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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	10333-41

CONFIRMATION NO. 6371

167137
SHERIDAN ROSS PC
1560 Broadway
Suite 1200
Denver, CO 80202

POWER OF ATTORNEY NOTICE

OC000000137565373

Date Mailed: 03/14/2023

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/08/2023.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71.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

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

/nrhayden/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	DALI0035US1

CONFIRMATION NO. 6371

107456
Artegis Law Group, LLP
John Carey
7710 Cherry Park Drive Suite T #104
Houston, TX 77095

POA ACCEPTANCE LETTER

OC000000137565391

Date Mailed: 03/14/2023

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/08/2023.

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**.

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

PTO/AIA/82A (07-13)
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NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	13/950,160
Filing Date	07/24/2013
First Named Inventor	Shawn Patrick STAPLETON
Title	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
Art Unit	2646
Examiner Name	Matthew C. Sams
Attorney Docket Number	DALI0035US1

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sarah Mirza/	Date (Optional)	
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.

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Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

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

Application Number	Filing Date

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

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

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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.

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

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.
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: DALI WIRELESS, INC.

Application No./Patent No.: 13/950,160 / 10,506,454 Filed/Issue Date: 07/24/2013 / 12/10/2019

Titled: OPTIMIZATION OF TRAFFIC LOAD IN A 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 and Seyed Amin Hejazi To: DALI SYSTEMS CO. LTD.

   The document was recorded in the United States Patent and Trademark Office at
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2. From: DALI SYSTEMS CO. LTD. To: DALI WIRELESS, INC.

   The document was recorded in the United States Patent and Trademark Office at
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STATEMENT UNDER 37 CFR 3.73(c)

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☐ 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.

/Sarah Mirza/	March 8, 2023
Signature	Date
Sarah Mirza	74866
Printed or Typed Name	Title or Registration Number

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
13/950,160	**03/08/2023 08:02:34 PM ET**	**10333-41**

Title of Invention

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	10506454
CONFIRMATION #	6371	FILED BY	Jennifer Ringer
PATENT CENTER #	61711903	FILING DATE	07/24/2013
CUSTOMER #	167137	FIRST NAMED INVENTOR	Shawn Patrick Stapleton
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Sarah Mirza

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
DALI0035US1 POA.PDF	3	Power of Attorney	295 KB
DALI0035US1 Statement Under 37 CFR373c.pdf	2	Assignee showing of ownership per 37 CFR 3.73	170 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
DALI0035US1 POA.PDF	ECC51796CB88E1E06FE5C431C14170F7E832B02A2EE25CB4C43521BC306B1A8147D35953A6F1BD9C38AD4816245A8BDC581E53DC3693D63042F85A2645217710

DALI0035US1 Statement Under 37 CFR373c.pdf	1A84A47035552D8D3E6D0B83CEB920BFD5E053C992335D329FE8ABA63C7677E25C5B6E962D614F767C205D44B09CD3D34860167DE10CBA31F5B0E7B2BBFABD51

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 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) **INTER PARTES REVIEW CERTIFICATE** (3009th)
United States Patent
Stapleton et al.

(10) **Number: US 10,506,454 K1**
(45) **Certificate Issued: Feb. 16, 2023**

(54) **OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM**

(71) Applicants: **Shawn Patrick Stapleton**; **Seyed Amin Hejazi**

(72) Inventors: **Shawn Patrick Stapleton**; **Seyed Amin Hejazi**

(73) Assignee: **DALI WIRELESS, INC.**

Trial Number:

IPR2021-00408 filed Jan. 8, 2021

Inter Partes Review Certificate for:

Patent No.: **10,506,454**
Issued: **Dec. 10, 2019**
Appl. No.: **13/950,160**
Filed: **Jul. 24, 2013**

The results of IPR2021-00408 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 **1-19** are found patentable.

* * * * *

Trials@uspto.gov
571-272-7822

Paper 30
Entered: July 19, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CORNING OPTICAL COMMUNICATIONS LLC,
Petitioner,

v.

DALI WIRELESS, INC.,
Patent Owner.

IPR2021-00408
Patent 10,506,454 B2

Before MELISSA A. HAAPALA, *Vice Chief Administrative Patent Judge*, and KARL D. EASTHOM and SHARON FENICK, *Administrative Patent Judges*.

Opinion for the Board filed by Administrative Patent Judge FENICK.

Opinion Dissenting filed by Administrative Patent Judge EASTHOM.

FENICK, *Administrative Patent Judge*.

DECISION
Final Written Decision
Determining No Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background and Summary

Corning Optical Communications LLC ("Petitioner") filed a Petition requesting *inter partes* review of claims 1–19 (the "challenged claims") of U.S. Patent No. 10,506,454 B2 (Ex. 1001, "the '454 patent"). Paper 2 ("Pet."), 1. Dali Wireless, Inc. ("Patent Owner"), filed a Preliminary Response. Paper 6. We determined that the information presented in the Petition established that there was a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims and we instituted this proceeding on December 3, 2020, as to all challenged claims and all grounds of unpatentability. Paper 7 ("Dec. on Inst.").

During the course of trial, Patent Owner filed a Patent Owner Response (Paper 11 "PO Resp."), Petitioner filed a Reply to the Patent Owner Response (Paper 15, "Pet. Reply"), and Patent Owner filed a Sur-reply (Paper 16, "PO Sur-reply"). An oral hearing was held on April 21, 2022, and a transcript was entered (Paper 29, "Tr.").

We have jurisdiction under 35 U.S.C. § 6(b)(4). This decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of claims 1–19 of the '454 patent. For the reasons discussed below, Petitioner has not demonstrated by a preponderance of the evidence that claims 1–19 of the '454 patent are unpatentable.

B. Real Parties in Interest

Petitioner identifies Corning, Inc. and Corning Research and Development Corp. as additional real parties in interest. Pet. 1; Paper 23 (Petitioner's Updated Mandatory Notices), 1. Patent Owner identifies no additional real parties in interest. Paper 4 (Patent Owner's Mandatory Notices), 1; Paper 13 (Patent Owner's Updated Mandatory Notices), 1.

C. Related Matters

Petitioner and Patent Owner each identify *Dali Wireless Inc. v. Corning Optical Communications LLC*, Case No. 3:20-cv-06469-EMC (N.D. Cal.) ("the related district court action") as a related action involving the '454 patent. Pet. 1; Paper 23, 1; Paper 4, 1; Paper 13, 1.

As discussed below, a claim construction order relating to terms of the '454 patent was issued in the related district court action. Ex. 1017.

D. The '454 Patent

The '454 patent, titled "Optimization of Traffic Load in a Distributed Antenna System," describes dynamically routing signals in a Distributed Antenna System (DAS) as part of a distributed wireless network. Ex. 1001, codes (54), (57), 1:15–17. The patent describes traffic monitoring and optimization to provide flexibility to manage, control, enhance, and facilitate radio resource efficiency and usage, and the overall performance of the distributed wireless network. *Id.* at 1:17–19, 4:13–17. One example of a DAS is provided in Figure 1, reproduced below.

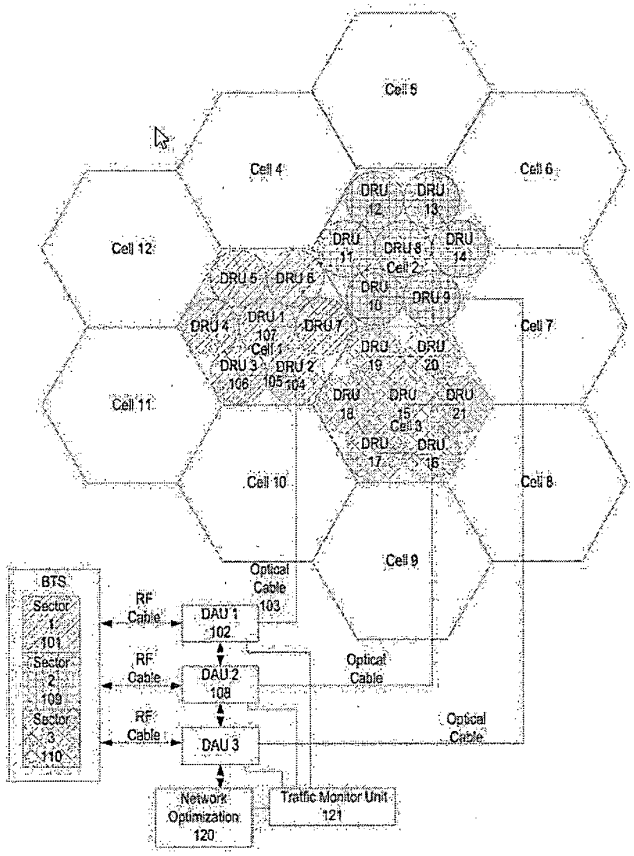

FIG. 1

Figure 1 is a block diagram showing a DAS system employing multiple Digital Access Units (DAUs) and Digital Remote Units (DRUs).

In the example according to one embodiment of the invention, as shown in Figure 1, a three-sector base station (BTS) includes sectors 101, 109, and 110, which provide downlink signals to DAU 1 102, DAU 2 108 and DAU 3, respectively. *Id.* at 2:20–24, 5:2–4 ("A typical base station comprises 3 independent radio resources, commonly known as sectors."), 5:60–65, 6:62–63, 7:2–4. The DAUs "function as the interface between the base stations and digital remote units (DRUs)." *Id.* at 4:60–63. DAU 1 102 is connected to and transports signals to DAU 2 108, and DAU 2 108 is connected to DAU 3. *Id.* at 6:23–24, 7:2–4. The inter-networking of the

DAUs facilitates the routing of DRU signals among the multiple DAUs and supports transport of radio frequency (RF) downlink and uplink signals between the base station (BTS) and the DRUs. *Id.* at 6:23–29, 7:4–7, 17:41.

Groups of DRUs, such as DRU 1 107, DRU 2 104, DRU 3 106, and DRU 4 through DRU 7 in Figure 1 are daisy chained together to achieve network coverage for a specific geographical area, which is identified as a cell (e.g. Cell 1). *Id.* at 5:65–6:1, 6:48–60. In this way each individual base station sector's radio resources are transported to a given geographical area through the daisy-chained DRUs in that area. *Id.* at 6:54–60. Thus, for example, downlink RF signals from BTS Sector 1 101 are received by DAU 1 102. *Id.* at 6:62–63. DAU 1 102 translates these signals to optical signals that are transported via optical cable 103 to DRU 2 104. *Id.* at 6:63–66. Optical cable 105 transports the optical signals to DRU 3 106, from where they are passed to each DRU in the daisy chain of Cell 1, ending at DRU 1 107. *Id.* at 6:66–7:4.

Additionally, traffic monitoring unit 121 tracks and collects traffic load at each DAU in the network, and stores this information in the network optimization unit 120. *Id.* at 7:8–12, 10:31–38, Fig. 9 (element 910). Network performance may be expressed by key performance indicators (KPIs) collected from different parts of the network. *Id.* at 5:52–54, 10:31–38, 11:48–50. Quality of service (QoS) metrics are determined by KPIs. *Id.* at 5:52–59, 11:25–31, 11:48–50, 11:54–55, 14:41–42, 14:50–51, Fig. 10.

Optimization of the network is performed in one embodiment as per a method illustrated in Figure 9, reproduced below.

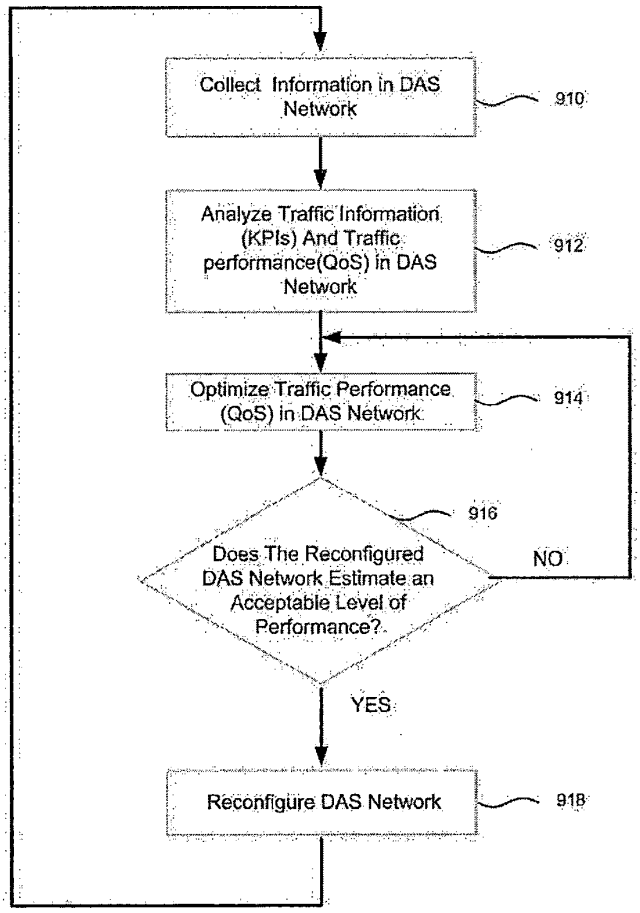

FIG. 9

Figure 9 is a flowchart illustrating a method of optimizing the DAS network. *Id.* at 2:63–64.

As shown in Figure 9, KPIs of the network traffic are collected in the DAS network. *Id.* at 10:30–38. Network optimization unit 120 "calculates the overall DAS network performance and determines the optimum reconfigured network to improve or maximize performance." *Id.* at 7:12–14, 10:39–47, Fig. 9 (elements 912, 914, 916). Network optimization unit 120 can "implement[] load rebalancing by communicating with the DAUs and

shifting traffic between sectors." *Id.* at 7:27–32, 10:47–54, Fig. 9 (element 918).

In other embodiments, multiple cells share the radio resources of one sector of the base station. *Id.* at 7:55–60, Fig. 2. Still other embodiments include a base station hotel with multiple BTSs or a base station hotel comprised of multiple Picocells. *Id.* at 8:23–47, 9:58–60, 10:5–6, 10:27–29, Fig. 3, Figs. 6–8.

E. Illustrative Claims

The Petition challenges independent claims 1 and 10 and dependent claims 2–9 and 11–19. Claim 1 illustrates the challenged claims at issue:

> 1. A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:
>
> one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;
>
> a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;
>
> a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and
>
> a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

> determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and
>
> reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

Ex. 1001, 17:50–18:11.

F. Asserted Grounds

Petitioner asserts that claims 1–19 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)/Basis
1–17, 19	102	Kummetz-464[2]
7, 15–18	103	Kummetz-464
7	103	Kummetz-464, Kummetz-579[3]
17	103	Kummetz-464, Kummetz-999[4]
15, 16, 18	103	Kummetz-464, Evans[5]

Petitioner additionally relies on the declaration of James A. Proctor, Jr. (Ex. 1003). Patent Owner filed a declaration of Shawn Stapleton Ph.D. (Ex. 2002) and a supplemental declaration from Dr. Stapleton (Ex. 2023).

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[1] 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 effective filing date for the claims of the '454 patent appears to be 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 (60) (provisional application filing date of July 31, 2012).

[2] Kummetz et al., US 9,398,464 B2, iss. July 19, 2016 (Ex. 1005).

[3] Kummetz et al., US 2011/0281579 A1, pub. Nov. 17, 2011 (Ex. 1006).

[4] Kummetz et al., US 9,735,999 B2, iss. Aug. 15, 2017 (Ex. 1007).

[5] Evans et al., US 2012/0057572 A1, pub. Mar. 8, 2012 (Ex. 1008).

II. ANALYSIS

A. Legal Standards

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring [*inter partes*] review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden never shifts to Patent Owner. *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)) (discussing the burden of proof in *inter partes* review). Furthermore, Petitioner must explain with particularity how the prior art would have rendered the challenged claims unpatentable. 35 U.S.C. § 312(a)(3); 37 C.F.R. § 42.104 ("The petition must specify where each element of the claim is found in the prior art patents or printed publications relied upon.").

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

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the 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. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations[6]. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

Relying on the testimony of Mr. Proctor, Petitioner contends that one of ordinary skill in the art at the time of the invention "would have had: (1) a bachelor's degree in electrical engineering; and (2) a minimum of 3-4 years of industry experience in wireless communications networks and engineering" but that "an individual with an advanced degree in electrical engineering would require less industry experience (e.g., 1-2 years)." Pet. 14 (citing Ex. 1003 ¶ 28).

In the Decision on Institution, we concluded that one of ordinary skill would have had (1) a bachelor's degree in electrical engineering; and (2) a minimum of 3-4 years of industry experience in wireless communications networks and engineering. Dec. on Inst. 9–10 (citing Ex. 1003 ¶ 28). We additionally concluded that "an individual with an advanced degree in electrical engineering would require less industry experience (e.g., 1-2 years)," and that "the person of ordinary skill at the time of the invention would additionally possess some experience with or knowledge of DAS."

[6] The record does not include any evidence of secondary considerations of nonobviousness.

Id. at 10 (citing Ex. 2019 (testimony of Mr. Proctor in the related district court action), 100:15–102:8). Patent Owner notes its agreement with this conclusion, and its expert adopted it. PO Resp. 22; Ex. 2023 ¶ 5. Petitioner provides no further comment in its post-institution briefing.

After considering the record, we conclude that the same level of skill we adopted in the Decision on Institution should apply. This level of skill comports with the disclosures of the '454 patent and the asserted prior art.

C. Claim Construction

"sector" terms – claims 1 and 10

Claim 1 and claim 10 each recite a system comprising, *inter alia*, "a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs" and a traffic monitoring unit "configured to . . . reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector." Ex. 1001 17:64–67, 18:9–11, 18:50–53, 18:62–64.

In the Petition, Petitioner argues that, "unless stated otherwise in the discussion of particular limitations [in the Petition]," we should give all terms their plain and ordinary meaning under the standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2015) (en banc). Pet. 15. In response to certain arguments by Patent Owner, Petitioner, consistent with its arguments in the related district court litigation, further argues that the plain and ordinary meaning of "sectors" is "independent radio resources." Pet. Reply 3–10; Ex. 2017, 9–10; Ex. 2021, 10–15. Petitioner generally presents an argument consistent with its proposed construction in the related district court action, noting that Kummetz-464 describes sectors as "represent[ing] an amount of telecommunication

capacity that can be allocated to wireless devices in one or more coverage zones," and that "a 'sector' refers to independent sets of radio resources." Pet. 26–27 (quoting Ex. 1005, 3:16–24, citing Ex. 1005, 5:19–23, 5:35–39), 42 n.5; Pet. Reply 3–10.

Patent Owner argues that we should construe "sector" as used in claims 1 and 10 to mean "a grouping of DRUs in a particular area or region." PO Resp. 22–34; PO Sur-reply 3–11. This position is consistent with Patent Owner's position in the related district court litigation. Ex. 2017, 9; Ex. 2018, 11–13; Ex. 2022, 4–7. Patent Owner presents an argument based on the language of claim 1, other intrinsic evidence from the specification and incorporated provisional application, certain prior art references cited during prosecution, and the prosecution history. PO Resp. 25–34 (citing Ex. 1001, 5:45–51, 5:65–6:1, 10:30–65, 11:37–39, 11:47–62, 12:8–10, 17:64–67, 18:10–12, Figs. 1, 9–11; Ex. 2004 ¶¶ 21, 22, Figs. 1–6; Ex. 2007 ¶¶ 2, 3; Ex. 2008, 9:36–37, Fig. 4; Ex. 2002 ¶¶ 8, 10–15, 28–29, 32–35; Ex. 2023 ¶¶ 9, 13–19, 41); PO Sur-reply 3–11.

In the Decision on Institution, we preliminarily adopted Patent Owner's proposed construction ("a grouping of DRUs in a particular area or region") for the term "sector," finding it to be consistent with the use of the term in the intrinsic and extrinsic evidence in the record. Dec. on Inst. 12–16. We also noted that the Petition included arguments that were consistent with Patent Owner's proposed construction. *Id.* at 15–16.

As noted in the Decision on Institution, a claim construction order issued in the related district court action in the final week of the period set forth for institution. *Id.* at 16 n.11. This claim construction order adopts Petitioner's proposed definition. Ex. 1017, 14–21.

As explained below, after consideration of the entire record, Petitioner has not established that Kummetz-464 teaches the determination of a QoS of network traffic. Thus, we need not resolve the parties' claim construction dispute. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (noting that "we 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)).

D. Anticipation of Claims 1–17 and 19 by Kummetz-464

Petitioner argues that claims 1–17 and 19 are anticipated by Kummetz-464. Pet. 20–60. Patent Owner contends that Petitioner has not shown how Kummetz-464 discloses certain features required in independent claims 1 and 10. PO Resp. 36–55; PO Sur-reply 11–17.

1. Kummetz-464

Kummetz-464 is titled "Base Station Router for Distributed Antenna Systems" and describes a DAS, through which cellular communication systems provide data services via remote antenna units. Ex. 1005, codes (54), (57), 1:14–27, 1:40–56. Figure 1 of Kummetz-464 is reproduced below:

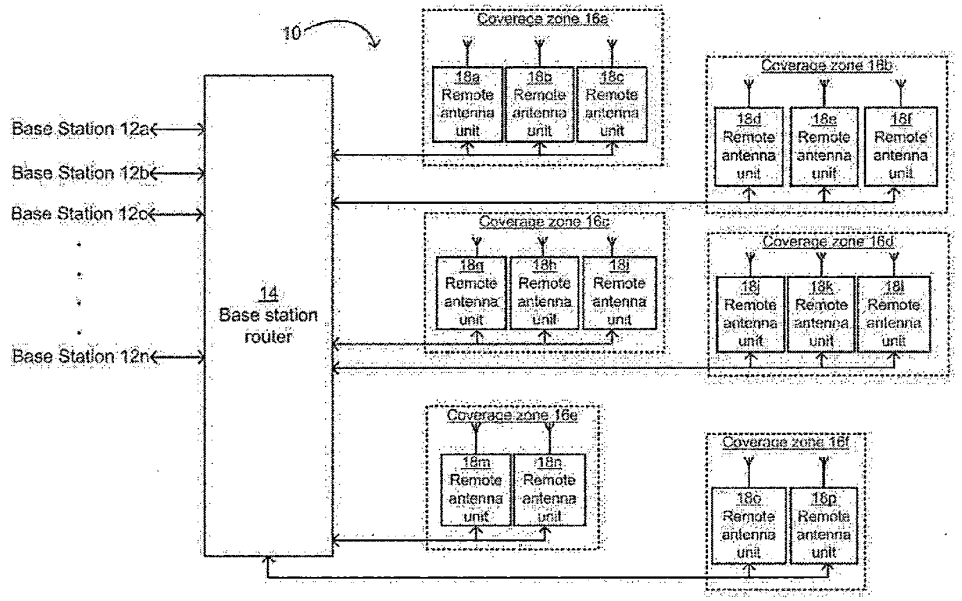

FIG. 1

Figure 1 illustrates a schematic view of a DAS. *Id.* at 2:14–15.

Kummetz-464 describes that, in the downlink direction, base stations 12a–12n send signals to base station router 14. *Id.* at 5:14–31. These signals are associated with one or more sectors, where each sector includes communication channels and represents an amount of telecommunication capacity. *Id.* at 1:43–46, 1:64–67, 3:20–24, 5:19–23, 5:28–31. Different sectors may also be associated with different telecommunications system operators. *Id.* at 4:5–7, 5:19–23. Base station router 14 can route signals between base stations 12a–12n and coverage zones 16a–16f. *Id.* at 5:32–33, 5:50–62.

Base station router 14 includes circuitry for routing signals from base stations 12a–12n to remote antenna units in coverage zones 16a–16f. *Id.* at 5:50–52. Each of coverage zones 16a–16f contains one or more remote antenna units (*e.g.* remote antenna units 18a–18c for coverage zone 16a) that

wirelessly communicate (radiate) the signals received from base station router 14 to wireless devices positioned in their physical area. *Id.* at 3:7–8, 3:12–14, 3:28–30, 3:51–53, 5:37–39, 7:4–8. All remote units in one coverage zone receive the same group of signals from base station router 14. *Id.* at 7:8–10. These coverages zones thus provide extended signal coverage for base stations 12a–12n. *Id.* at 1:21–25, 5:16–19, 6:63–7:3.

Base station router 14 includes an input interface that receives signals from and provides signals to the base stations 12a–12n, allowing uplink and downlink functionality. *Id.* at 7:45–48, 7:50–52, 7:66–8:1, 8:8–10, Fig. 2. Base station router 14 also includes an output section that receives signals from and provides signals to the remote antenna units, similarly allowing uplink and downlink functionality. *Id.* at 7:45–49, 8:23–24, 8:27–32, 8:41–42, Fig. 2.

Base station router 14 includes a controller that itself includes executable instructions for a configuration engine. *Id.* at 2:19–20, 8:54, 8:63–67, 9:22, Fig. 2, Fig. 3. Alternatively, the controller could be a separate device external to and in communication with base station router 14. *Id.* at 8:60–62. The controller 108 can re-configure the configurable digital signal processing circuitry of a backplane in the base station router to change the routing of signals from the base stations 12a–12n to coverage zones 16a–16f. *Id.* at 8:55–58.

The controller can receive data describing the routing of signals by the base station router 14, including data relating to the determined demand on each of coverage zones 16a–16f. *Id.* at 9:34–39. "The configuration engine . . . can include a configuration management function for determining how to redistribute signal capacity among coverage zones . . . in response to the detection of a traffic indicator." *Id.* at 9:40–44. This redistribution changes

which sectors are provided to which coverage zones. *Id.* at 3:15–16. For example, one sector may be distributed to a decreased number of coverage zones, which will increase the capacity density for those zones (how many mobile devices can use telecommunications services in the zones). *Id.* at 3:43–49, 3:54–68.

Figures 4 and 5 are reproduced below:

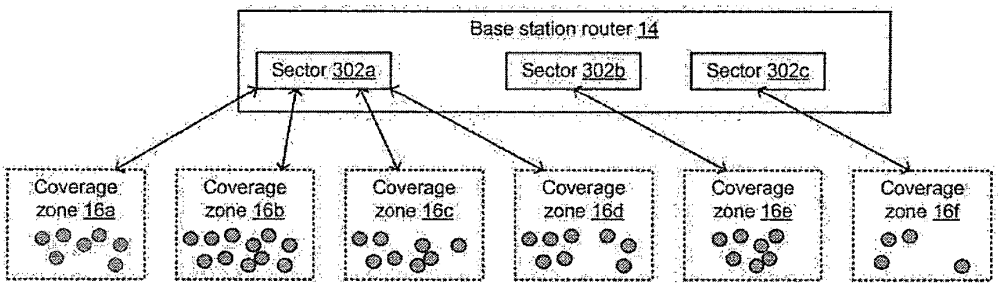

FIG. 4

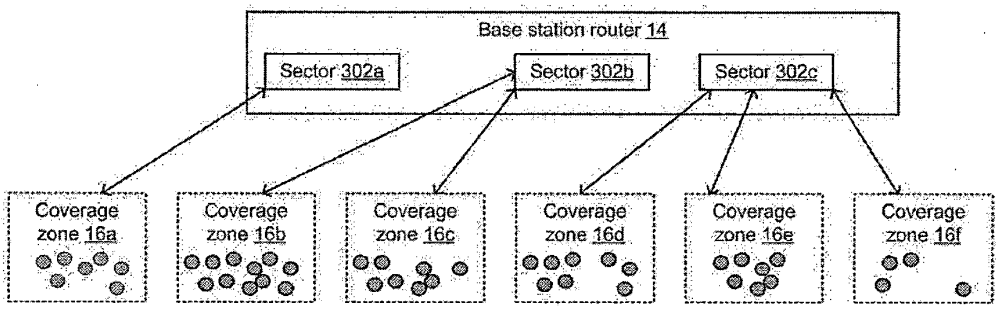

FIG. 5

Figures 4 and 5 provide an example of an initial configuration and a changed configuration of signal routing. *Id.* at 2:21–26, 10:30–32.

In these figures, coverage zones 16a–16f include remote antenna units, depicted as darkened circles. *Id.* at 10:35–38. As seen in Figure 4, base station router 14 distributes sectors 302a–302c among coverage zones 16a–16f, communicating the signals of sector 302a to coverage zones 16a–

16d, the signals of sector 302b to coverage zone 16e, and the signals of 302c to coverage zone 16f. *Id.* at 10:46–49. Thus the capacity of sector 302a is divided among coverage zones, while the capacity of sectors 302b and 302c are each devoted to one respective coverage zone. *Id.* at 10:49–53. Figure 5 depicts a change in this configuration, in which base station 14 communicates the signals of sector 302a to only one coverage zone (coverage zone 16a) and the signals of sectors 302b and 302c each are communicated to two coverage zones per sector. *Id.* at 11:21–25. This change in configuration may better serve users of wireless devices if, for example, fewer wireless devices are located in the area of coverage zones 16a–16d at a first time (thus requiring less capacity) and subsequently at a second time, more capacity is required in coverage zones 16a–16d because more wireless devices are in coverage zones 16a–16d relative to coverage zones 16e and 16f. *Id.* at 3:43–4:19, 10:64–11:28.

This redistribution may be in response to the detection of a traffic indicator. *Id.* at 1:46–1:48, 1:60–1:63, 9:42–44.

> A traffic indicator can include data describing or otherwise corresponding to a number of mobile devices in each coverage zone. Examples of a traffic indicator can include a scheduled event of a game, concert, or other type of event, a scheduled sequence of events with pre-game, game, and post-game configurations, traffic measurements passing low or high thresholds, base transceiver station failure events, and loss of capacity due to high inter-sector interference.

Id. at 9:44–52.

2. Analysis of Claim 1

Petitioner argues that claim 1 is anticipated by Kummetz-464. Pet. 20–40. Patent Owner presents several arguments asserting that Kummetz-464 does not anticipate claim 1. PO Resp. 36–55; PO Sur-reply 11–17. Our

analysis focuses primarily on arguments made with respect to the traffic monitoring unit. To place those arguments in the proper context, we review the Petitioner's assertions regarding the entirety of the claim and certain of Patent Owner's arguments.

a) Preamble

The preamble of claim 1 describes "[a] system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources." Ex. 1001, 17:50–52. Petitioner argues that even if the preamble is limiting, Kummetz-464 discloses it. Pet. 20–21.

Petitioner argues that Kummetz-464 discloses a system for dynamically routing signals in a DAS through its disclosure of a DAS "that can redistribute capacity among coverage zones services by the DAS" and that includes circuitry to route signals between a plurality of base stations (which are associated with different sectors of one telecommunications system operator or of a number of telecommunications system operators) and a plurality of remote antenna units. *Id.* (quoting Ex. 1005, 2:40–46; citing Ex. 1005, 5:19–23, 5:43–45, 8:54–58, 9:40–54, Figs. 1–5).

b) "one or more Digital Access Units . . ." and "a plurality of Digital Remote Units . . ." limitations

Claim 1 requires that the system comprise "one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port" ("the DAU limitation") and "a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to

transport signals between the plurality of DRUs and the one or more DAUs" ("the DRU limitation"). Ex. 1001, 17:53–63.

Petitioner argues that the DAU limitation of claim 1 is disclosed by Kummetz-464's base station router and that the DRUs of claim 1 are disclosed by Kummetz-464's remote antenna units. Pet. 22–25.

Petitioner argues that the base station routers of Kummetz-464 are operable to receive signals from different sectors of one telecommunications system operator or from different sectors of different telecommunications system operators. *Id.* at 22–23 (citing Ex. 1005, 4:20–24, 5:19–23; Ex. 1003 ¶ 81). Petitioner further argues that Kummetz-464's base station routers include bidirectional input and output ports that can carry uplink and downlink signals. *Id.* at 23–24 (citing Ex. 1005, 7:50–8:1, 8:23–54, Fig. 2; Ex. 1003 ¶ 82).

Petitioner argues that Kummetz-464's remote antenna units disclose the DRU limitation. *Id.* at 24–25. Petitioner asserts that these remote antenna units are described as sending and receiving signals to the base station router. *Id.* (citing Ex. 1005, 6:16–43, 8:23–54, 11:39–52, Fig. 1, Fig. 6; Ex. 1003 ¶ 85).

c) "a plurality of sectors formed from the plurality of DRUs . . ." limitation

Claim 1 further requires that the system comprises "a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs" ("plurality of sectors limitation"). Ex. 1001, 17:64–67.

Petitioner argues that Kummetz-464 discloses this limitation through its disclosure of "a plurality of 'remote antenna units' that may be divided

into a plurality of different sectors" in Kummetz-464's Figure 4 and Figure 5 and the associated disclosure. Pet. 26–27 (citing Ex. 1005, 3:16–24, 10:30–38, Figs. 4, 5; Ex. 1003 ¶¶ 87–88).

We note Patent Owner's contention that Petitioner's anticipation arguments with respect to this claim limitation are flawed because groupings of remote antenna units in coverage zones (e.g., coverage zones 16a – 16d) would not constitute a sector, under the preliminary construction of "sector" in our Institution Decision ("a grouping of DRUs in a particular area or region.") PO Resp. 37–41; Dec. on Inst. 30–31. Patent Owner argues that "*Kummetz*[-464]'s coverage zones are entirely static and the remote radios assigned to the various coverage zones keep those assignments indefinitely," and that a grouping based only on radio units being switched to certain sectors is inconsistent with providing a sector of radio units "in a particular area or region." PO Resp. at 39–41; PO Sur-reply 12–13. However, we do not address Patent Owner's arguments because we determine Kummetz-464 does not anticipate the claims based on issues with Petitioner's showing with respect to the "traffic monitoring unit" limitation of claim 1, as discussed below.

d) "a traffic monitoring unit" limitation

(1) the traffic monitoring unit

The system of claim 1 also comprises "a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port." Ex. 1001, 18:1–4. With respect to the traffic monitoring unit, Petitioner argues that the controller of the base station router in Kummetz-464 and its included configuration engine disclose a traffic monitoring unit. Pet. 27–29 (citing Ex. 1005, 8:54–58, 8:63–9:25, 9:34–565, Figs. 2, 3; Ex. 1003 ¶ 90).

(2) traffic monitoring unit configured to determine one or more KPIs and a QoS "of a network traffic"

The traffic monitoring unit is configured to "determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." Ex. 1001, 18:5–8. Petitioner argues that Kummetz-464 discloses KPIs in its traffic indicators, quoting the reference:

> A traffic indicator can include data describing or otherwise corresponding to a number of mobile devices in each coverage zone. Examples of a traffic indicator can include a scheduled event of a game, concert, or other type of event, a scheduled sequence of events with pre-game, game, and post-game configurations, traffic measurements passing low or high thresholds, base transceiver station failure events, and loss of capacity due to high inter-sector interference. In some aspects, the controller 108 can detect traffic and perform measurements independent of a wireless network standard and protocol.

Ex. 1005, 9:44–54 (quoted at Pet. 30).

Petitioner asserts that Kummetz-464 discloses that the controller can reconfigure signal capacity based on a traffic indicator. Pet. 31 (citing Ex. 1005, 9:40–47). Petitioner cites the example in Kummetz-464 of the configuration management function being executed "in response to the detection of a traffic indicator" "which can include data describing or otherwise corresponding to a number of devices in each coverage zone." *Id.* Thus, Petitioner argues that Kummetz-464 discloses an example in which reconfiguration occurs based on the number of wireless devices in the coverage zones, which Petitioner argues disclose KPIs, and that in this example "the relative concentration of those devices between respective coverage zones (a function of the KPIs) is the QoS." *Id.* (citing Ex. 1005, 10:30–43, 11:13–15, Figs. 4–5; Ex. 1003 ¶ 95). In its Reply, Petitioner

presents an additional example, based on the reconfiguration described in Kummetz-464, in which the number of user wireless devices in a stadium is a first KPI ("KPI 1") and the number of user wireless devices in a parking lot is a second KPI ("KPI 2"). Pet. Reply 20–21. Petitioner asserts that a QoS can be computed by determining the relative concentration of devices between the stadium and parking lot, which is a function of KPI 1 and KPI 2, and thus the description of this occurring in Kummetz-464 discloses the QoS of a network traffic. *Id.*

Patent Owner argues that Petitioner has failed to show a QoS being determined in Kummetz–464. PO Resp. 41–49. First, Patent Owner argues that one of ordinary skill would understand the plain meaning of QoS to be specifically related to network performance. *Id.* at 41 (citing Ex. 2023 ¶ 55). Patent Owner describes the computation of QoS in the specification of the '454 patent as consistent with this meaning, arguing that "cost factor KPIs" are described as being part of the calculation of a QoS, and that the system minimizes QoS values to improve network performance. *Id.* at 42–43 (citing Ex. 1001, 11:57–62, 12:10–14:55; Ex. 2002 ¶¶ 21, 45; Ex. 2023 ¶¶ 55–56).

Patent Owner contends Petitioner's argument that the relative concentration of devices in different areas in Kummetz-464 is a QoS "posits a contrived notion," arguing that the concentration of devices in coverage zones does not indicate network performance, but merely "can be an indication of traffic load – *if* [the wireless devices are] *in use*." *Id.* at 43 (citing Ex. 1005, 9:44–45, 11:13–28; Ex. 2002 ¶ 22; Ex. 2023 ¶ 58) (emphasis added). At the oral hearing, when asked to explain how the concentration of mobile devices would yield a quality of service metric, Petitioner's counsel described a situation in which devices might suddenly be used simultaneously and cause an increased need for transmission

capacity. Tr. 17:12–18:13. But Petitioner does not provide any further testimony or other evidence to support its proposition that relative concentration of devices in different areas, including devices that are not actively in use, discloses a measurement of QoS of network traffic. *Id.* at 18:14–19:6 (discussing Ex. 1003 ¶¶ 100–103; Ex. 1001, 11:27–31), 20:8–22:8; *see* Pet. Reply 20–21.

Claim 1 requires that the QoS be both "of a network traffic" and "a function of the one or more KPIs." Although Petitioner asserts Kummetz-464 discloses a number of KPIs through its description of traffic indicators (Pet. 30), Petitioner relies on a specific KPI—the number of users—in its assertion that Kummetz-464 discloses a QoS through its disclosure of a relative concentration of devices that is a function of the one or more KPIs. *See* Pet. 30–32. Petitioner further relies on this specific mapping of KPI to number of users and QoS to relative concentration of devices in its assertion that Kummetz-464 discloses "reconfiguring the plurality of sectors based on one or more KPIs and QoS" limitation. *See* Pet. 33–35. We, therefore, focus our analysis on whether Petitioner establishes Kummetz-464's description of a relative concentration of devices discloses the claimed QoS.

We agree with Petitioner that the relative concentration of devices is a function of the number of users, which is a KPI. *See* Pet. 31; Ex. 1003 ¶ 95. But we determine Petitioner fails to establish the relative concentration of devices is a quality of service of a network traffic. Petitioner's declarant describes QoS as a function of KPIs without more, and asserts that the relative concentration of devices between coverage zones would be a QoS. Ex. 1003 ¶¶ 93–103 (concluding that "Kummetz[-464] discloses that the controller 108 can determine one or more traffic indicators (i.e., KPIs) and a function of the traffic indicators (i.e., QoS = function of the one or more

KPIs)"); *see* Tr. 19:15–20:7 (arguing that "essentially anything can be a KPI" and "network performance is expressed by a number of KPIs which leads to the QoS"). While Petitioner's declarant describes this as consistent with the teachings of the '454 patent relating to adjusting traffic loads, no explanation is provided as to how capacity (as in Kummetz-464's example) would meet the requirement of a QoS of network traffic, and no further testimony or evidence was adduced regarding what one of ordinary skill in the art would have thought QoS to mean. *See id.*

We credit the testimony of Patent Owner's expert that the plain meaning of "QoS" requires that the QoS be a value that indicates network performance.[7] Ex. 2023 ¶ 55. We agree with Patent Owner that Petitioner does not establish Kummetz-464 discloses that a concentration of wireless devices is indicates network performance. *See* PO Resp. 43. As noted by Patent Owner during oral argument, "[y]ou can have perfect information of relative concentration of devices and still not know anything about network traffic." Tr. 36. Patent Owner provides an example of a church service in which there are a large number of users (large concentration of user devices), but no traffic. Tr. 38. Conversely, we observe that a small concentration of user devices may have a large impact on network performance if engaged in activities requiring heavy network traffic usage.

[7] We respectfully disagree with the dissent that the specification requires a different interpretation. The '454 patent describes a QoS as a weighted combination of three KPIs (cost factors) that indicates network performance. *See* Ex. 1001 11:48–50, 14:41–51. This supports Patent Owner's position that the plain and ordinary meaning of quality of service (QoS) indicates network performance. Although the KPIs discussed are exemplary, to fall within the bounds of claim 1, the plain meaning of quality of service of a network traffic requires the function to indicate network performance (i.e., the "quality" of the network).

The relative concentration of devices identified by Petitioner may therefore be a function of KPIs, but it is not a QoS according to the plain meaning of that term, and is not "of a network traffic" because it may be unrelated to network traffic. Thus, Petitioner fails to persuade us that Kummetz-464's description of a concentration of wireless devices discloses a quality of service of a network traffic.

We further determine that Petitioner fails to establish Kummetz-464's description of reconfiguring sectors based on relative concentration of user devices discloses reconfiguring "sectors based on the one or more KPIs and QoS," as required by claim 1. In the absence of a sufficient showing that Kummetz-464's reconfiguration is based on a QoS "of a network traffic," as required by the claim, we determine that Petitioner has not demonstrated by a preponderance of the evidence that Kummetz-464 discloses the determination of a QoS of a network traffic that is used as the basis to reconfigure sectors.

e) Conclusion – Claim 1

For the reasons discussed above, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claim 1 is anticipated by Kummetz-464.

E. Analysis of Claims 2–19

With respect to claims 2–19, Petitioner argues these claims with reference to arguments regarding similar or identical limitations of claim 1, and does not further address QoS with respect to Kummetz-464 or any other prior art. *See* Pet. 35–78. Thus, for the same reasons, we determine that Petitioner has not demonstrated by a preponderance of the evidence that claims 2–19 are unpatentable.

III. CONCLUSION

After considering all the evidence and arguments in the complete record, we conclude that Petitioner fails to demonstrate, by a preponderance of the evidence, that any of the challenged claims are unpatentable.

In summary:

Claims	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
1–17, 19	102	Kummetz-464		1–17, 19
7, 15–18	103	Kummetz-464		7, 15–18
7	103	Kummetz-464, Kummetz-579		7
17	103	Kummetz-464, Kummetz-999		17
15, 16, 18	103	Kummetz-464, Evans		15, 16, 18
Overall Outcome				1–19

IV. ORDER

Accordingly, it is

ORDERED that claims 1–19 are not unpatentable based on the instituted grounds of unpatentability;

FURTHER ORDERED that because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CORNING OPTICAL COMMUNICATIONS LLC,
Petitioner,

v.

DALI WIRELESS, INC.,
Patent Owner.

IPR2021-00408
Patent 10,506,454 B2

Before MELISSA A. HAAPALA, *Vice Chief Administrative Patent Judge*, and KARL D. EASTHOM and SHARON FENICK, *Administrative Patent Judges*.

EASTHOM, *Administrative Patent Judge,* dissenting.

I respectfully dissent from the majority's excellent opinion. I respectfully dissent because, in my view, Petitioner persuasively shows on this record that Kummetz-464 discloses the KPI/QoS limitation: "traffic monitoring unit . . . configured . . . to . . . determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." *See* Pet. 30–32.

This limitation requires that "QoS is a function of the one or more KPIs." There is no dispute that Petitioner shows that in Kummetz-464 and in the '454 patent, "QoS is a function of the one or more KPIs." *See* PO Resp. 40–41; Pet. 30–32. For example, Petitioner shows that Kummtez-464's "controller 108 [, the recited 'traffic monitor,'] can determine one or more traffic indicators (*i.e.*, KPIs) and a function of the traffic indicators (*i.e.*, QoS = function of the one or more KPIs)." Pet. 32.

The Petition explains that Kummetz-464 discloses that "the number of wireless devices in each respective coverage zone are the KPIs and the relative concentration of those devices between respective coverage zones (a function of the KPIs) is the QoS." Pet. 31 (citing Ex. 1005, 11:13–15, Figs. 4–5, 10:30–43; Ex. 1003 ¶ 95). To support this showing, the Petition explains that

> Kummetz[-464] provides an example in which "DAS 10 may service a stadium and a parking lot surrounding the stadium" having different coverage zones. [Ex. 1005], 10:64–65. In this example, "[t]he base station router 14 can be re-configured via the controller 108 *in response to changes in concentration of wireless devices in the respective coverage zones*."

Pet. 31 (emphasis added) (quoting Ex. 1005, 11:13–15; citing Ex. 1005, Figs. 4–5, 10:30–43; Ex. 1003 ¶ 95).

Patent Owner does not dispute, and the record shows, that Kummetz-454 determines "changes in concentration of wireless devices in the respective coverage zones." *See, e.g.*, Ex. 2002 ¶ 22 (Patent Owner's declarant testifying that "the concentration of wireless devices described in *Kummetz* is an indication of traffic load in a coverage zone"). Therefore, as Petitioner argues, Kummetz-464 discloses determining one or more KPIs (the number of wireless devices in different coverage zones) and a function of that number, the QoS (changes in concentration in each zone). None of this is in dispute.

Claim 1 requires a "traffic monitoring unit . . . configured . . . to . . . determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." Patent Owner notes that "the '454 Patent discloses a network monitoring unit that determines Quality of Service (QoS) values indicating *network performance as a function of key performance indicators (KPIs)* to solve a sectorization problem described in the '454 Patent." PO Resp. 42 (emphasis added). Patent Owner cites the following example described in the '454 patent:

> As described in the '454 Patent, *a network performance value (QoS) is calculated as a function of cost factor KPIs including KPI$_{BC}$, KPI$_{HO}$, and KPI$_{CI}$*:
>
> $$QoS = w_1KPI_{BC} + w_2KPI_{HO} + w_3KPI_{CI}$$
>
> Ex. 1001 at 14:50–55. Based on the calculated QoS and KPI values, at a time $t + 1$, *traffic performance* is optimized by determining a new sectorization of DRUs that minimizes QoS values to improve network performance since blocked calls, handovers, and compact indices should be minimized in the DAS.

PO Resp. 42 (emphasis added) (citing Ex. 1001, 11:60–62, 14:50–52; Ex. 2002 ¶ 45; Ex. 2023 ¶ 55).[8]

This argument by Patent Owner and the specification shows that the system calculates "network performance value QoS" in order to optimize "traffic performance." *See* PO Resp. 42; Ex. 1001. 11:37–39 (referring to "traffic performance (QoS)"). As Patent Owner notes, QoS, calculated as a simple weighted function of KPIs, indicates network performance. PO Resp. 42. Patent Owner also appears to equate "traffic performance" and "network performance" by referring to "acceptable performance," "improv[ed] network performance," and "optimized" "traffic performance." *See id.*

Moreover, in the example equation above referenced by Patent Owner ($QoS^{-1} = w_1 KPI^{-1}_{BC}$, when w_2 and $w_3 = 0$, *see supra* note 8), the '454 patent specification refers to determining, for example, a number of blocked calls (BCs) as indicating network performance and QoS of network traffic. *See* PO Resp. 42 (referring to "blocked calls" in calculating QoS). But a blocked call is not an indication of someone using the network, even though Patent Owner implies that this example somehow implies an "in use" requirement. *See id.* at 43 (arguing that in contrast to the claimed invention, Kummetz-464's calculation of "the concentration of wireless devices" "can be an indication of **traffic load**—if in use"). Rather, a blocked caller is not using the network, but attempting to use it. And a cell phone in Kummetz-464's system necessarily connects to the monitored network and system in order

[8] The equation reproduced by Patent Owner incorrectly omits the inverse relationship specified for QoS. *See* Ex. 1001, 14:50–55 ($QoS^{-1} = w_1 KPI^{-1}_{BC} + w_2 KPI^{-1}_{HO} + w_3 KPI^{-1}_{CI}$).

for the cell phone to be counted, even if no active call occurs at the time.[9] Tracking the '454 patent specification, Petitioner shows that determining a concentration of users QoS calculated as a function of a KPI also indicates network performance and QoS of network traffic. *See* Pet. 30–32.

As noted above, Patent Owner states that a function of KPIs ultimately defines "network performance value" QoS—"[a]s described in the '454 Patent, *a network performance value (QoS) is calculated as a function of cost factor KPIs.*" PO Resp. 42 (emphasis added). Moreover, the '454 patent specifically states that "[t]he *network's performance (expressed by the number of KPIs* from different parts of the network) determines the QoS values." Ex. 1001, 11:47–50 (emphasis added). And the '454 patent specification refers to using "the KPIs *of the network traffic.*" *Id.* at 10:55 (emphasis added). So the KPIs of network traffic determine the QoS of network traffic, and the weighed KPIs also "express" the network performance, which the system uses to alter network traffic and performance, according to the '454 patent specification and Patent Owner. *See* Ex. 1001, 11:47–50; PO Resp. 42.

As also indicated above, Patent Owner concedes that "[a] POSA understands that concentration of wireless devices in a coverage zone described in *Kummetz* can be an indication of **traffic load—**if in use." PO Resp. 43 (citing Ex. 1005, 9:44–45, 11:13–28; Ex. 1001, 14:40–51; Ex. 2002 ¶ 22; Ex. 2023 ¶ 58). But Dr. Stapleton, Patent Owner's expert, initially does not testify that traffic load "can be" an indication of load; rather, he

[9] Similarly, it is also not clear, and Patent Owner does not explain, how handoffs and compact indexes ($w_2KPI^{-1}_{HO}$, $w_3KPI^{-1}_{CI}$) require a measurement of users who are actively calling or their devices are "in use." *See* PO Resp. 42–43.

testifies that "the concentration of wireless devices described in Kummetz *is* an indication of traffic load in a coverage zone." Ex. 2002 ¶ 22 (emphasis added).[10] Patent Owner initially asserts that the plain meaning of QoS is a "value indicating network performance." PO Resp. 41. But as indicated, Patent Owner appears to read "configured to . . . determine (QoS) of network traffic" as requiring the capability of the traffic monitoring unit to measure network traffic by measuring network devices "in use." *See id.* at 43; Ex. 2002 ¶ 22; Ex. 2003 ¶ 58. Like the '454 patent specification, however, Patent Owner's untimely proffered evidence of plain and ordinary meaning of QoS shows "many alternative definitions" and does not support Patent Owner.[11]

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[10] Dr. Stapleton's supplemental declaration simply repeats the "in use" statement by Patent Owner without any meaningful explanation of what "in use" is or how the claims require it. Ex. 2023 ¶ 58.

[11] Patent Owner's Sur-reply provides two separate definitions of QoS from internet sources and argues that "a POSA would understand the plain and ordinary meaning of QoS to be a measure of network performance." Sur-reply 14–15. Even if these untimely evidentiary internet sources were proper in a Sur-reply, one definition that Patent Owner supplies does not support Patent Owner because it does not require that QoS involves a measurement "in use" or otherwise. *See id.* at 15. Rather, one internet source quoted by Patent Owner describes QoS as "the *description or measurement* of the overall performance of the service, particularly the performance seen by users of the network." *Id.* (emphasis added) (quoting Quality of Service, WIKIPEDIA, https://en.wikipedia.org/wiki/Quality_of_Service). The website also states that "quality of service refers to traffic prioritization and resource reservation control mechanisms rather than the achieved service quality." https://en.widipedia.org/wiki/Quality_of_Service. It also states that "QoS is *sometimes* used as a quality measure, *with many alternative definitions*, rather than referring to the ability to reserve resources." *Id.* (emphasis added).

The '454 patent specifically and broadly states that "traffic monitor unit 121 can be a server *determining the number of users on each DAU*." Ex. 1001, 7:22–23 (emphasis added). It also states that "KPI may comprise information such as: number of blocked calls, number of active calls, average power of uplink channels, average power of downlink channels, traffic on each sector, failed calls, number of satisfied users, *number of unsatisfied users*, *number of users operating through a given DRU, and the like*." Ex. 1001, 10:33–39 (emphasis added). Like a blocked caller, the specification does not state that an "unsatisfied user" is using the network while the system measures the level of satisfaction. It also does not state that "a number of users operating" necessarily represents a number of users actually on an active call while being measured by the system as an operating user. The '454 patent specification simply does not require a user to be on an active call for the system to measure a QoS of network traffic—it lists "number of active calls" as simply one option for a KPI. *See id.*

After stating that a "network's performance" is "expressed by the number of KPIs from different parts of the network," the next three sentences of the '454 patent state that "[d]ifferent operators may have different defined business goals and different services of interest," such that "efficient and cost effective network performance management *varies from operator to operator*," wherein "QoS metrics could be defined and mapped to a set of KPIs." Ex. 1001, 11:43–55 (emphasis added). Therefore, the '454 patent defines QoS based on a weighted set of KPIs of network traffic (including blocked calls, number of users, or other performance measures,

etc.), and different operators can define these KPIs and QoS of network traffic depending on service and business needs.[12]

As Petitioner also notes, the '454 patent specifically defines "KPIs of the network traffic" as indicating relative traffic loads:

> The '454 [p]atent explains that, "using the KPIs *of the network traffic*, the DAS network can be modified to improve system performance. As an example, if a particular DRU has *a higher load* than other adjacent DRUs, traffic can be routed to the adjacent DRUs in order *to reduce the load* on the particular DRU."

Pet. 32 (emphasis added) (quoting Ex. 1001, 10:55–59). The Petition also notes that Kummetz-464 discloses that "QoS metrics could be defined and mapped to a set of KPIs." *Id.* (quoting Ex. 11:54–55). In short, Petitioner shows that "Kummetz's disclosures are consistent with the disclosures in the '454 Patent with regard to KPIs and QoS." *Id.* (citing Ex. 1003 ¶¶ 97–98; Ex. 1001, 10:33–38).

Even if the challenged claims require a traffic monitor unit configured to measure cell phones or mobile devices "in use," Petitioner shows how Kummetz-464 monitors traffic/load of cell phones "in use," noting that Kummetz-464 discloses that a traffic monitor configured to determine "traffic measurements passing low or high thresholds," "loss of capacity due to high inter-sector interference," and "*detect[ing] traffic and perform[ing]*

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[12] Even if the specification indicates QoS (or QoS of network traffic) is *broader* than a plain and ordinary meaning of these terms as generally advanced by Patent Owner, Patent Owner unpersuasively cites cases that stand for the well-known legal principle that *narrowing* of the plain and ordinary meaning requires lexicography or disavowal. *See* Sur-reply 15 (citing *Hill-Rom Servs. v. Stryker Corp.*, 755 F.3d 1367, 1371 (Fed. Cir. 2014) ("we do not read limitations from the embodiments in the specification into the claims")).

measurements independent of a wireless network standard and protocol." *See* Pet. 30 (emphasis added) (quoting Ex. 1005, 9:44–54). Petitioner also shows that Kummetz-464 discloses "*implement[ing] any process for measuring uplink signals for traffic* and other types of information." *Id.* (emphasis added) (quoting Ex. 1005, 9:58–61). Therefore, Petitioner shows that Kummetz-464 discloses a traffic monitor configured to monitor, measure, and determine the number and relative concentration of mobile devices "in use" (e.g., on active calls or otherwise in "traffic"), thereby showing that Kummetz-464 discloses QoS of a network traffic even under Patent Owner's implied construction.

In summary, Petitioner shows that Kummetz-464's traffic monitor measures these KPIs and QoS while users are in traffic using the network after a game or event by detecting "traffic measurements passing low or high thresholds," "detect[ing] traffic and perform[ing] measurements," and/or "*implement[ing] any process for measuring uplink signals for traffic* and other types of information," as the monitor collects "data . . . corresponding to a number of mobile devices in each coverage zone." *See id.* at 30 (quoting Ex. 1005, 9:44–61). Patent Owner simply denies that Kummetz-464 shows measuring devices "in use" without addressing in a clear fashion Petitioner's showing that Kummetz-464's traffic monitoring unit measures devices in traffic as it determines the number of users in a coverage zone, and Patent Owner otherwise concedes Petitioner's showing related to KPIs/QoS. Petitioner persuasively shows that Kummetz-464 discloses the disputed QoS/KPI "of a network traffic" limitation.

Accordingly, I respectfully dissent.

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Paper 7
Date: July 21, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CORNING OPTICAL COMMUNICATIONS LLC,
Petitioner,

v.

DALI WIRELESS, INC.,
Patent Owner.

IPR2021-00408
Patent 10,506,454 B2

Before MELISSA A. HAAPALA, *Senior Lead Administrative Patent Judge*, and KARL D. EASTHOM and SHARON FENICK, *Administrative Patent Judges*.

FENICK, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background and Summary

Corning Optical Communications LLC ("Petitioner") filed a Petition requesting *inter partes* review of claims 1–19 (the "challenged claims") of U.S. Patent No. 10,506,454 B2 (Ex. 1001, "the '454 patent"). Paper 2

("Pet."), 1. Dali Wireless, Inc. ("Patent Owner"), filed a Preliminary Response. Paper 6 ("Prelim. Resp.").

The Board has authority to determine whether to institute an *inter partes* review. See 35 U.S.C. § 314(b); 37 C.F.R. § 42.4(a). Under 35 U.S.C. § 314(a), we may not authorize an *inter partes* review unless the information in the Petition and the Preliminary Response "shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." For the reasons that follow, we institute an *inter partes* review as to the challenged claims of the '454 patent on all grounds of unpatentability presented.

B. Real Parties in Interest

Petitioner identifies Corning, Inc., and Corning Research and Development Corp. as additional real parties in interest. Pet. 1. Patent Owner identifies no additional real parties in interest. Paper 4, 1.

C. Related Matters

Petitioner and Patent Owner each identify *Dali Wireless Inc. v. Corning Optical Communications LLC*, Case No. 3:20-cv-06469-EMC (N.D. Cal.) ("the related district court action") as a related action involving the '454 patent.[1] Pet. 1; Paper 4, 1.

D. The '454 Patent

The '454 patent, titled "Optimization of Traffic Load in a Distributed Antenna System," describes dynamically routing signals in a Distributed

[1] According to Petitioner, the case is in the early stages, a stay is likely, and no trial date has yet been set. *See* Pet. 81–83. 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). We do not consider this issue further.

Antenna System (DAS) as part of a distributed wireless network. Ex. 1001, codes (54), (57), 1:15–17. The patent describes traffic monitoring and optimization to provide flexibility to manage, control, enhance, and facilitate radio resource efficiency and usage, and the overall performance of the distributed wireless network. *Id.* at 1:17–19, 4:13–17. One example of a DAS is provided in Figure 1, reproduced below.

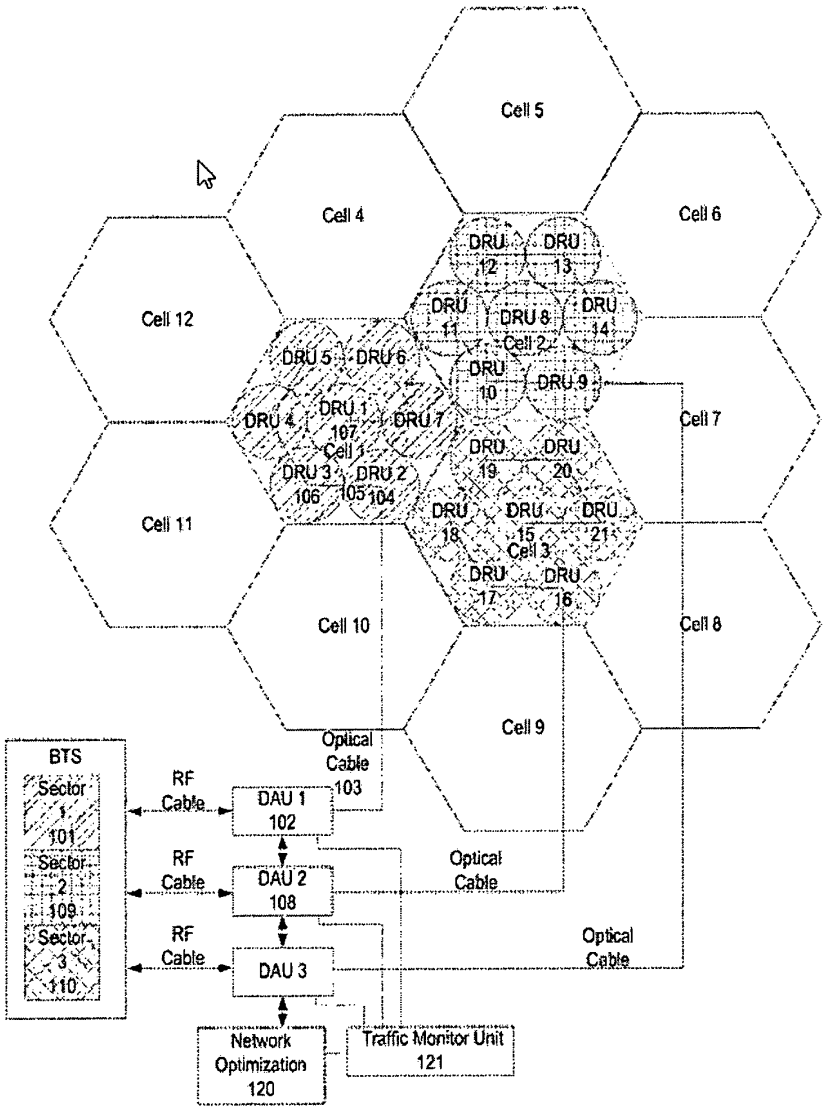

FIG. 1

Figure 1 is a block diagram showing a DAS system employing multiple Digital Access Units (DAUs) and Digital Remote Units (DRUs).

In the example according to one embodiment of the invention, as shown in Figure 1, a three-sector base station (BTS) includes sectors 101, 109, and 110, which provide downlink signals to DAU 1 102, DAU 2 108 and DAU 3, respectively. *Id.* at 2:20–24, 5:2–4 ("A typical base station comprises 3 independent radio resources, commonly known as sectors."), 5:60–65, 6:62–63, 7:2–4. The DAUs "function as the interface between the base stations and digital remote units (DRUs)." *Id.* at 4:60–63. DAU 1 102 is connected to and transports signals to DAU 2 108, and DAU 2 108 is connected to DAU 3. *Id.* at 6:23–24, 7:2–4. The inter-networking of the DAUs facilitates the routing of DRU signals among the multiple DAUs and supports transport of radio frequency (RF) downlink and uplink signals between the base station (BTS) and the DRUs. *Id.* at 6:23–29, 7:4–7, 17:41.

Groups of DRUs, such as DRU 1 107, DRU 2 104, DRU 3 106, and DRU 4 through DRU 7 in Figure 1 are daisy chained together to achieve network coverage for a specific geographical area, which is identified as a cell (e.g. Cell 1). *Id.* at 5:65–6:1, 6:48–60. In this way each individual base station sector's radio resources are transported to a given geographical area through the daisy-chained DRUs in that area. *Id.* at 6:54–60. Thus, for example, downlink RF signals from BTS Sector 1 101 are received by DAU 1 102. *Id.* at 6:62–63. DAU 1 102 translates these signals to optical signals that are transported via optical cable 103 to DRU 2 104. *Id.* at 6:63–66. Optical cable 105 transports the optical signals to DRU 3 106, from where they are passed to each DRU in the daisy chain of Cell 1, ending at DRU 1 107. *Id.* at 6:66–7:4.

Additionally, traffic monitoring unit 121 tracks and collects traffic load at each DAU in the network, and stores this information in the network optimization unit 120. *Id.* at 7:8–12, 10:31–38, Fig. 9 (element 910). Network performance may be expressed by key performance indicators (KPIs) collected from different parts of the network. *Id.* at 5:52–54, 10:31–38, 11:48–50. Quality of service (QoS) metrics are determined by KPIs. *Id.* at 5:52–59, 11:25–31, 11:48–50, 11:54–55, 14:41–42, 14:50–51, Fig. 10.

Optimization of the network is performed in one embodiment as per a method illustrated in Figure 9, reproduced below.

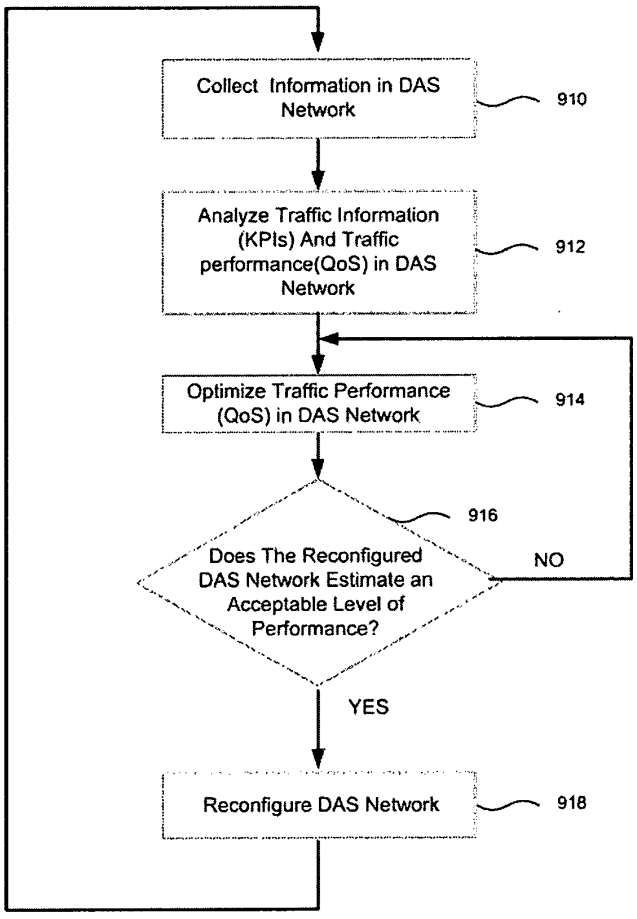

FIG. 9

Figure 9 is a flowchart illustrating a method of optimizing the DAS network. *Id.* at 2:63–64.

As shown in Figure 9, KPIs of the network traffic are collected in the DAS network. *Id.* at 10:30–38. Network optimization unit 120 "calculates the overall DAS network performance and determines the optimum reconfigured network to improve or maximize performance." *Id.* at 7:12–14, 10:39–47, Fig. 9 (elements 912, 914, 916). Network optimization unit 120 can "implement[] load rebalancing by communicating with the DAUs and shifting traffic between sectors." *Id.* at 7:27–32, 10:47–54, Fig. 9 (element 918).

In other embodiments, multiple cells share the radio resources of one sector of the base station. *Id.* at 7:55–60, Fig. 2. Still other embodiments include a base station hotel with multiple BTSs or a base station hotel comprised of multiple Picocells. *Id.* at 8:23–47, 9:58–60, 10:5–6, 10:27–29, Fig. 3, Figs. 6–8.

E. Illustrative Claims

The Petition challenges independent claims 1 and 10 and dependent claims 2–9 and 11–19. Claim 1 illustrates the challenged claims at issue:

> 1. A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:
>
> one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;
>
> a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals

between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

Ex. 1001, 17:50–18:11.

F. Asserted Grounds

Petitioner asserts that claims 1–19 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §[2]	Reference(s)/Basis
1–17, 19	102	Kummetz-464[3]
7	103	Kummetz-464

[2] 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 effective filing date for the claims of the '454 patent appears to be 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 (60) (provisional application filing date of July 31, 2012). Our institution determination would not change under the post-AIA version of these statutes.

[3] Kummetz et al., US 9,398,464 B2, iss. July 19, 2016 (Ex. 1005).

Claim(s) Challenged	35 U.S.C. §[2]	Reference(s)/Basis
7	103	Kummetz-464, Kummetz-579[4]
17	103	Kummetz-464
17	103	Kummetz-464, Kummetz-999[5]
15, 16, 18	103	Kummetz-464
15, 16, 18	103	Kummetz-464, Evans[6]

Petitioner additionally relies on the declaration of James A. Proctor, Jr. (Ex. 1003).

II. ANALYSIS

A. Legal Standards

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring [*inter partes*] review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). This burden never shifts to Patent Owner. *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)) (discussing the burden of proof in *inter partes* review). Furthermore, Petitioner must explain with particularity how the prior art would have rendered the challenged claims unpatentable. 35 U.S.C. § 312(a)(3); 37 C.F.R. § 42.104 ("The petition must specify where each element of the claim is found in the prior art patents or printed publications relied upon.").

[4] Kummetz et al., US 2011/0281579 A1, pub. Nov. 17, 2011 (Ex. 1006).
[5] Kummetz et al., US 9,735,999 B2, iss. Aug. 15, 2017 (Ex. 1007).
[6] Evans et al., US 2012/0057572 A1, pub. Mar. 8, 2012 (Ex. 1008).

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

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the 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. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations[7]. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

Relying on the testimony of Mr. Proctor, Petitioner contends that one of ordinary skill in the art at the time of the invention "would have had: (1) a bachelor's degree in electrical engineering; and (2) a minimum of 3-4 years of industry experience in wireless communications networks and

[7] The preliminary record does not include any evidence of secondary considerations of nonobviousness. *See* Pet. 83.

engineering" but that "an individual with an advanced degree in electrical engineering would require less industry experience (e.g., 1-2 years)." Pet. 14 (citing Ex. 1003 ¶ 28).

Patent Owner submits that prong (2) of Petitioner's definition should be modified to specify that one of ordinary skill in the art "should also have a minimum of 3-4 years of industry experience in wireless communications networks and engineering *including knowledge and experience with DAS*," citing testimony given by Mr. Proctor in the related district court action. Prelim. Resp. 23 (emphasis added) (citing Ex. 2019, 101:7–17). Reading the relevant portion of Mr. Proctor's testimony in its entirety, Mr. Proctor testifies that one of ordinary skill in the art would "understand the [DAS] art" and agrees that a person of ordinary skill "would have some experience or knowledge with DAS" at least to the extent that they would be aware of DAS art. Ex. 2019, 100:15–102:8 (emphasis added).

On the present record, requiring "knowledge and experience with DAS" as part of industry experience does not appear to be supported. Rather, for the purposes of institution and on the present record, we adopt Petitioner's definition for one of ordinary skill in the art, with the addition of the requirement that the person of ordinary skill at the time of the invention would additionally possess some experience with or knowledge of DAS. This level of skill comports with the disclosures of the '454 patent and the asserted prior art. We note that our current analysis and determinations with respect to unpatentability would be the same if we had adopted Petitioner's proposed definition or Patent Owner's proposed definition.

C. Claim Construction

Petitioner argues that, "unless stated otherwise in the discussion of particular limitations [in the Petition]," we should give all terms their plain

and ordinary meaning under the standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2015) (en banc). Pet. 15. Patent Owner argues that we should construe "sector[]" as used in claims 1 and 10 to mean "a grouping of DRUs in a particular area or region." Prelim. Resp. at 24–33.

1. Compliance with 37 C.F.R. § 42.104(b)(3)–(4)

Patent Owner argues that in the related district court action, "the term 'sectors' is hotly disputed and fully briefed by the parties," and that, in not providing a specific claim construction for "sectors," Petitioner has failed to comply with 37 C.F.R. § 42.104(b)(3)–(4). Prelim. Resp. 1–2, 19–23 (citing *Orthopediatrics Corp. v. K2M, Inc.*, IPR2018-01548, Paper 9, 9–11 (PTAB Mar. 1, 2019)). We note that the nonprecedential decision cited by Patent Owner was limited to the circumstances of that case, which included the petitioner advocating only for "how the claim limitations at issue *should not be construed*," "tak[ing] conflicting positions [in the IPR] and the related district court litigation," and not presenting any positive argument with respect to construction in a case where the interpretation of a claim limitation as a means-plus-function limitation was likely to be at issue. *Orthopediatrics Corp. v. K2M, Inc.*, IPR2018-01548, Paper 9, 9–10. Additionally in that proceeding "Petitioner advocated for a different claim construction in the related district court litigation." *Id.* at 10–11.

Thus, that decision is distinguishable for those reasons. Petitioner here, while initially asserting that all claim terms "unless stated otherwise in the discussion of particular limitations," should be interpreted according to their plain and ordinary meaning, does proceed to provide indications (though not clearly stated discussion) regarding its understanding of that plain and ordinary meaning. Pet. 15, 26–27, 42 n.5. Additionally, no

means-plus-function construction is implicated here. *See* 35 C.F.R. § 42.104(b)(3) (specifically discussing requirements for identification of how a challenged claim should be construed where the claim contains a means-plus-function limitation). Lastly, while consistency between proceedings is not necessarily required[8], Petitioner appears to be advocating for a construction (here as "plain and ordinary") consistent with what it proposed in the related district court action. *Compare* Pet. 26, 42 n.5 ("[A] 'sector' refers to independent sets of radio resources"), *with* Ex. 2017, 9–12 and Ex. 2021[9], 10–15 (Petitioner's position in the related district court action proposing, e.g., "a plurality of independent radio resources" as the proper construction for "a plurality of sectors"). While we agree that the rules place an affirmative burden on petitioners to show how the challenged claims should be construed and how the construed claims are unpatentable, in this case, we do not agree that the Petition has failed to meet its burden.

2. "sector" terms – claims 1 and 10

Claim 1 and claim 10 each recite a system comprising, *inter alia*, "a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs" and a traffic monitoring unit "configured to . . . reconfigure the plurality of sectors based on the one or

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[8] The Board does, however, "consider statements regarding claim construction made by patent owners and by a petitioner filed in other proceedings, if the statements are timely made of record." Patent Trial and Appeal Board Consolidated Trial Practice Guide ("Trial Practice Guide") (Nov. 2019) (available at https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf), 48–49.

[9] In citations to papers from the related district court action, consistent with Patent Owner's citations, we cite to the original page numbers of the document rather than the numbers added at bottom right.

more KPIs and QoS by allocating at least one DRU from the first sector to the second sector." Ex. 1001 17:64–67, 18:9–11, 18:50–53, 18:62–64.

As discussed *supra*, Petitioner requests only that we give terms their "plain and ordinary meaning" under *Phillips*. Pet. 15. Patent Owner directs us to Petitioner's arguments in the related district court action that the term "sectors" should be construed as "independent radio resources." Prelim. Resp. 19–20 (citing Ex. 2017; Ex. 2021, 10–15).

Patent Owner argues that the proper construction for "sector" in these claims is "a grouping of DRUs in a particular area or region." *Id.* at 24–33. Patent Owner argues that one of ordinary skill in the art "would understand that a sector is a subset or 'group' of DRUs" from the claim language itself, in which the sectors are "formed from the plurality of DRUs" and in which each of first and second sectors "compris[e] a subset of the plurality of DRUs." *Id.* at 25 (citing Ex. 1001, 17:66–67, 18:52–53). Patent Owner additionally cites the claim limitation describing "reconfiguring the plurality of sectors" as "simply allocat[ing]" a DRU "to another group of DRUs or subset of DRUs." *Id.* (citing Ex. 1001, 18:9–11, 18:62–64).

Patent Owner describes the specification of the '454 patent as supporting this definition, describing Figure 1 as illustrating "DRU sectorization" "with groupings of DRUs in 'sectors' ('DRU sectors') identified as cells 1–12 in contrast to BTS sectors 1–3. *Id.* at 27 (citing Ex. 1001 11:37–39, 11:57–62 ("Given the sectorization of DRUs at time period t, our problem is to obtain new sectorization at time period t+1 that adaptively balances the change in traffic demands."), 12:8–10, Figs. 9–11). Patent Owner annotates Figure 1, as reproduced below.

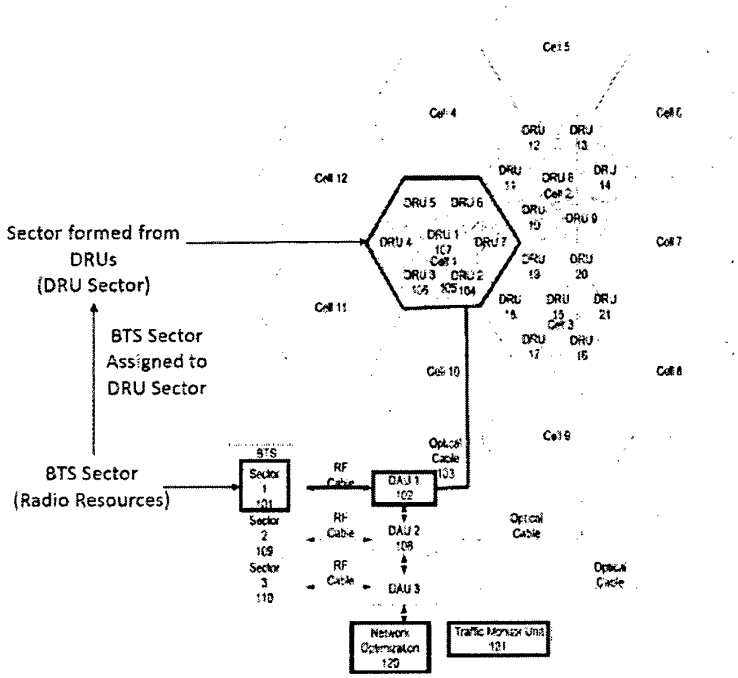

FIG. 1

Annotated Figure 1 illustrates Patent Owner's interpretation in which a "BTS sector" is assigned to a "Sector formed from DRUs (DRU Sector)." *Id.* at 26.

With reference to the embodiment of Figure 1, Patent Owner argues that, according to the '454 patent, "DRUs 1-7 in cell 1 are daisy-chained together to achieve coverage in a specific geographic area referred to as a 'sector' and each individual sector covers an independent geographical area which is identified as a 'Cell.'" *Id.* at 27 (citing Ex. 1001, 5:65–6:1, 17:64–65; Ex. 2002 ¶ 33). Patent Owner contends that, with reference to this embodiment, "the '454 Patent uses 'sector' synonymously with 'the DRUs' as in a group of DRUs covering a specific area or region." *Id.* Patent Owner also relies on portions of a provisional application incorporated by reference into the '454 patent (Provisional US 61/600,530 (Ex. 2004)), an argument

made during prosecution, and a declaration of an inventor of the '454 patent (Ex. 2002).[10] *Id.* at 25–29, 31–33 (citing Ex. 1002, 421; Ex. 2002 ¶¶ 8, 9, 16, 27–51; Ex. 2004 ¶¶ 18, 21, 22, Figs. 2–6); *see* Ex. 1001, 10:60–65. The provisional application discusses "a three sector" base station, and then describes how to "dynamically sectorize the DRUs" in order "to balance the traffic for each sector." Ex. 2004 ¶¶ 19, 20, 21, 23, 25.

Patent Owner additionally cites references applied by the Examiner describing "how the term 'sectors' has traditionally meant a particular 'coverage area.'" Prelim. Resp. 29–31 (citing Ex. 2002 ¶¶ 10–15; Ex. 2007 ¶¶ 2, 3, Fig. 1; Ex. 2008, 9:36–37, Fig. 4). This usage, argues Patent Owner, is consistent with its argued construction of "sector." *Id.*

As discussed above, Petitioner presents an argument consistent with its construction from the related district court action, noting that Kummetz-464 describes sectors as "represent[ing] an amount of telecommunication capacity that can be allocated to wireless devices in one or more coverage zones," and that "a 'sector' refers to independent sets of radio resources."

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[10] Patent Owner argues that its declaration of an inventor (Dr. Stapleton) "should be considered by the board to understand the invention." Prelim. Resp. 32 (citing *Solomon v. Kimberly-Clark Corp.*, 216 F.3d 1372, 1379–80 (Fed. Cir. 2000)). That case holds that an inventor's statements should be considered during prosecution of an application, but describes that such testimony, at a time when claims have been issued, is given "little or no probative weight" in a determination of claim construction. *Solomon*, 216 F.3d at 1377–1380. We consider Exhibit 2002, keeping in mind that inventor testimony "cannot be relied on to change the meaning of the patent claims" but also "may be pertinent as a form of expert testimony, for example, as to understanding the established meaning of particular terms in the relevant art." *Howmedica Osteonics Corp. v. Wright Medical Tech., Inc.*, 540 F.3d 1337, 1346–47 & n.5 (Fed. Cir. 2008) (citing *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 983 (Fed. Cir. 1995) (en banc) and *Phillips*, 415 F.3d at 1318).

Pet. 26–27 (quoting Ex. 1005, 3:16–24, citing Ex. 1005, 5:19–23, 5:35–39), 42 n.5. However, Petitioner argues that the sectors are disclosed by Kummetz-464's remote antenna units "divided into a plurality of different sectors," and by the disclosure that subsets of remote antenna units are "allocated to" or "associated with" sectors of one or more telecommunication systems operators. *Id.* at 26–27 (citing Ex. 1003 ¶¶ 87–88; Ex. 1005, 10:30–38), 33–35 (reconfiguration of sectors occurs "by allocating at least one DRU (remote antenna unit) from one sector to a different sector"). Thus, it appears that Petitioner's arguments with respect to Kummetz-464 are also consistent with Patent Owner's proposed construction of "sector."

We determine that Patent Owner's construction is consistent with the use of the term in the intrinsic and extrinsic evidence in the record, including the claim limitation relating to "allocating at least one DRU from the first sector to the second sector." Ex. 1001, 18:10–11, 18:63–64. We therefore preliminarily adopt that construction ("a grouping of DRUs in a particular area or region") for the term "sector" for the purposes of this Institution Decision. We reiterate the preliminary nature of this construction. As a trial is being instituted in this IPR, the parties may address this initial claim construction determination during the course of the proceeding.[11] Trial Practice Guide, 49.

[11] In particular, we note that, in the final week of the period set forth for institution, *see* 35 U.S.C. § 314(b)(1), a claim construction order has issued in the related district court action and Petitioner has requested permission to file that claim construction order in this proceeding. We invite the parties to address at trial, to the extent permissible under our rules, whether our preliminary construction is correct.

D. Anticipation of Claims 1–17 and 19 by Kummetz-464

Petitioner argues that claims 1–17 and 19 are anticipated by Kummetz-464. Pet. 20–60. Patent Owner contends that Petitioner has not shown how Kummetz-464 discloses certain features required in independent claims 1 and 10. Prelim. Resp. 36–50.

1. Kummetz-464

Kummetz-464 is titled "Base Station Router for Distributed Antenna Systems" and describes a DAS, through which cellular communication systems provide data services via remote antenna units. Ex. 1005 codes (54), (57), 1:14–27, 1:40–56. Figure 1 of Kummetz-464 is reproduced below:

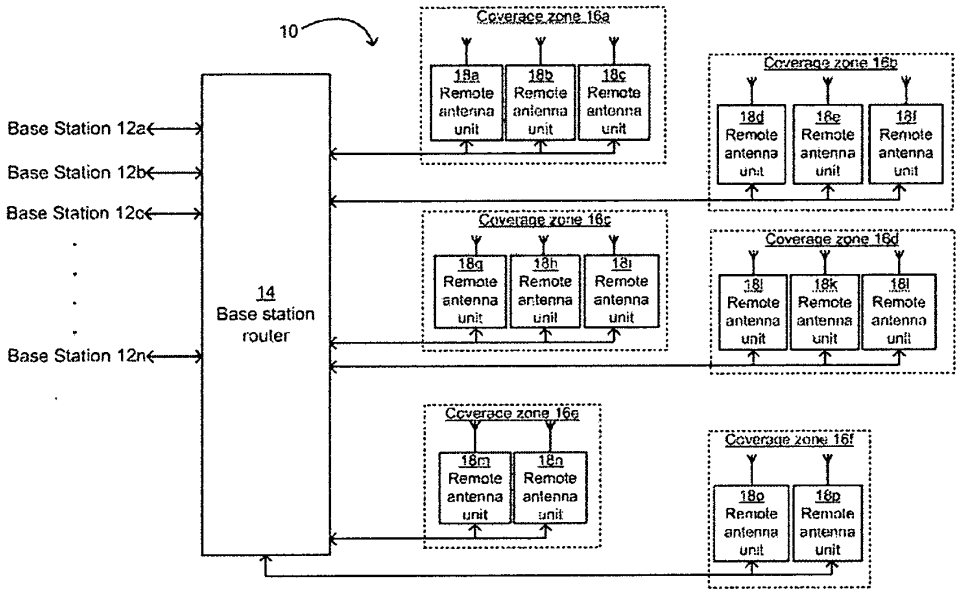

FIG. 1

Figure 1 illustrates a schematic view of a DAS. *Id.* at 2:14–15.

Kummetz-464 describes that, in the downlink direction, base stations 12a–12n send signals to base station router 14. *Id.* at 5:14–31. These

signals are associated with one or more sectors, where each sector includes communication channels and represents an amount of telecommunication capacity. *Id.* at 1:43–46, 1:64–67, 3:20–24, 5:19–23, 5:28–31. Different sectors may also be associated with different telecommunications system operators. *Id.* at 4:5–7, 5:19–23. Base station router 14 can route signals between base stations 12a–12n and coverage zones 16a–16f. *Id.* at 5:32–33, 5:50–62.

Base station router 14 includes circuitry for routing signals from base stations 12a–12n to remote antenna units in coverage zones 16a–16f. *Id.* at 5:50–52. Each of coverage zones 16a–16f contains one or more remote antenna units (*e.g.* remote antenna units 18a–18c for coverage zone 16a) that wirelessly communicate (radiate) the signals received from base station router 14 to wireless devices positioned in their physical area. *Id.* at 3:7–8, 3:12–14, 3:28–30, 3:51–53, 5:37–39, 7:4–8. All remote units in one coverage zone receive the same group of signals from base station router 14. *Id.* at 7:8–10. These coverages zones thus provide extended signal coverage for base stations 12a–12n. *Id.* at 1:21–25, 5:16–19, 6:63–7:3.

Base station router 14 includes an input interface that receives signals from and provides signals to the base stations 12a–12n, allowing uplink and downlink functionality. *Id.* at 7:45–48, 7:50–52, 7:66–8:1, 8:8–10, Fig. 2. Base station router 14 also includes an output section that receives signals from and provides signals to the remote antenna units, similarly allowing uplink and downlink functionality. *Id.* at 7:45–49, 8:23–24, 8:27–32, 8:41–42, Fig. 2.

Base station router 14 includes a controller that itself includes executable instructions for a configuration engine. *Id.* at 2:19–20, 8:54, 8:63–67, 9:22, Fig. 2, Fig. 3. Alternatively, the controller could be a

separate device external to and in communication with base station router 14. *Id.* at 8:60–62. The controller 108 can re-configure the configurable digital signal processing circuitry of a backplane in the base station router to change the routing of signals from the base stations 12a–12n to coverage zones 16a–16f. *Id.* at 8:55–58.

The controller can receive data describing the routing of signals by the base station router 14, including data relating to the determined demand on each of coverage zones 16a–16f. *Id.* at 9:34–39. "The configuration engine . . . can include a configuration management function for determining how to redistribute signal capacity among coverage zones . . . in response to the detection of a traffic indicator." *Id.* at 9:40–44. This redistribution changes which sectors are provided to which coverage zones. *Id.* at 3:15–16. For example, one sector may be distributed to a decreased number of coverage zones, which will increase the capacity density for those zones (how many mobile devices can use telecommunications services in the zones). *Id.* at 3:43–49, 3:54–68. Figures 4 and 5 are reproduced below:

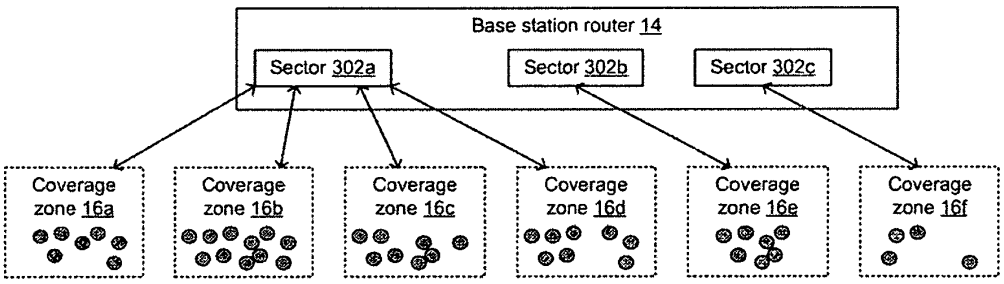

FIG. 4

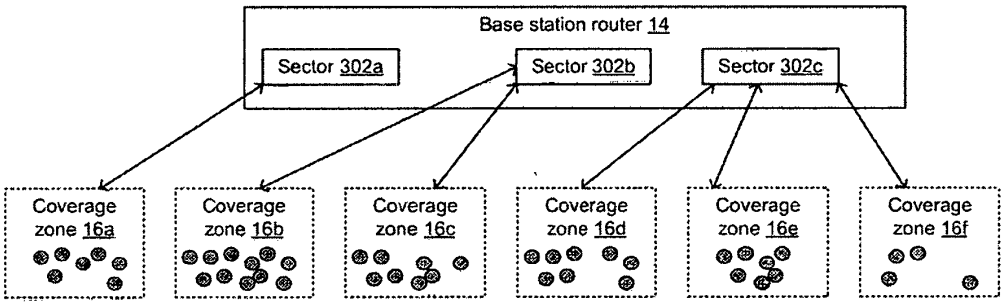

FIG. 5

Figures 4 and 5 provide an example of an initial configuration and a changed configuration of signal routing. *Id.* at 2:21–26, 10:30–32.

In these figures, coverage zones 16a–16f include remote antenna units, depicted as darkened circles. *Id.* at 10:35–38. As seen in Figure 4, base station router 14 distributes sectors 302a–302c among coverage zones 16a–16f communicating the signals of sector 302a to coverage zones 16a–16d, the signals of sector 302b to coverage zone 16e, and the signals of 302c to coverage zone 16f. *Id.* at 10:46–49. Thus the capacity of sector 302a is divided among coverage zones, while the capacity of sectors 302b and 302c are each devoted to one respective coverage zone. *Id.* at 10:49–53. Figure 5 depicts a change in this configuration, in which base station 14 communicates the signals of sector 302a to only one coverage zone

(coverage zone 16a) and the signals of sectors 302b and 302c each are communicated to two coverage zones per sector. *Id.* at 11:21–25. This change in configuration may better serve users of wireless devices if, for example, fewer wireless devices are located in the area of coverage zones 16a–16d at a first time (thus requiring less capacity) and subsequently at a second time, more capacity is required in coverage zones 16a–16d because more wireless devices are in coverage zones 16a–16d relative to coverage zones 16e and 16f. *Id.* at 3:43–4:19, 10:64–11:28.

This redistribution may be in response to the detection of a traffic indicator. *Id.* at 1:46–1:48, 1:60–1:63, 9:42–44. "A traffic indicator can include data describing or otherwise corresponding to a number of mobile devices in each coverage zone. Examples of a traffic indicator can include a scheduled event of a game, concert, or other type of event, a scheduled sequence of events with pre-game, game, and post-game configurations, traffic measurements passing low or high thresholds, base transceiver station failure events, and loss of capacity due to high inter-sector interference." *Id.* at 9:44–52.

2. Analysis of Claim 1

Petitioner argues that claim 1 is anticipated by Kummetz-464. Pet. 20–40. Patent Owner presents several arguments asserting that Kummetz-464 does not anticipate. Prelim. Resp. 35–50.

a) Preamble

The preamble of claim 1 describes "[a] system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources." Ex. 1001, 17:50–52. Petitioner argues that even if the preamble is limiting, Kummetz-464 discloses it. Pet. 20–21.

Petitioner argues that Kummetz-464 discloses a system for dynamically routing signals in a DAS through its disclosure of a DAS "that can redistribute capacity among coverage zones services by the DAS" and that includes circuitry to route signals between a plurality of base stations (which are associated with different sectors of one telecommunications system operator or of a number of telecommunications system operators) and a plurality of remote antenna units, and that can dynamically change the routing of signals. *Id.* (quoting Ex. 1005, 2:40–46; citing Ex. 1005, 5:19–23, 5:43–45, 8:54–58, 9:40–54, Figs. 1–5).

At this stage, Patent Owner does not dispute these contentions regarding the preamble of claim 1.

On the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the subject matter of the preamble of claim 1 in its disclosure of a DAS that dynamically routes signals and communicates with a plurality of sectors from telecommunications systems operators.

b) "one or more Digital Access Units . . ." and "one or more Digital Remote Units . . ."

Claim 1 requires that the system comprise "one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port" ("the DAU limitation") and "a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to

transport signals between the plurality of DRUs and the one or more DAUs" ("the DRU limitation"). Ex. 1001, 17:53–63.

Petitioner argues that the DAU limitation of claim 1 is disclosed by Kummetz-464's base station router and that the DRUs of claim 1 are disclosed by Kummetz-464's remote antenna units. Pet. 22–25.

Petitioner argues that the base station routers of Kummetz-464 are operable to receive signals from different sectors of one telecommunications system operator or from different sectors from more than one telecommunications system operator. *Id.* at 22–23 (citing Ex. 1005, 4:20–24, 5:19–23; Ex. 1003 ¶ 81). Petitioner further argues that Kummetz-464's base station routers include bidirectional input and output ports that can carry uplink and downlink signals. *Id.* at 23–24 (citing Ex. 1005, 7:50–8:1, 8:23–54, Fig. 2; Ex. 1003 ¶ 82).

Petitioner argues that Kummetz-464's remote antenna units disclose the DRU limitation. *Id.* at 24–25. Petitioner asserts that these remote antenna units are described as sending and receiving signals to the base station router. *Id.* (citing Ex. 1005, 6:16–43, 8:23–54, 11:39–52, Fig. 1, Fig. 6; Ex. 1003 ¶ 85).

At this stage, Patent Owner does not dispute Petitioner's contentions regarding the disclosures of Kummetz-464 and these two limitations of claim 1.

On the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the subject matter of the DAU limitation of claim 1 in its disclosure of base station routers that receive signals from different base stations and including input and output ports that provide uplink and downlink between remote antenna units and base

stations. Additionally, on the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the subject matter of the DRU limitation of claim 1 in its disclosure of remote antenna units that communicate with the base station router.

c) "a plurality of sectors formed from the plurality of DRUs" and

Claim 1 further requires that the system comprises "a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs" ("plurality of sectors limitation"). Ex. 1001, 17:64–67.

Petitioner argues that "Kummetz[-464] discloses a plurality of 'remote antenna units' that may be divided into a plurality of different sectors" and, in support of its argument, Petitioner reproduces and discusses Kummetz-464's Figure 4 and Figure 5 and the associated disclosure. Pet. 26–27 (citing Ex. 1005 10:30–38, Figs. 4, 5; Ex. 1003 ¶¶ 87–88). Petitioner also discusses the use of the term "sectors" in Kummetz-464 as representing "an amount of telecommunication capacity" and including "analog RF channels or digital signals," arguing that this use is consistent with the base station sectors described in the '454 patent. *Id.* (citing Ex. 1001, 5:2–6; Ex. 1005, 3:16–24, 5:19–23, 5:35–39).

Patent Owner argues that in Kummetz-464 does not show its remote antenna units being divided into sectors, but rather that the Kummetz-464 remote antenna units "formed coverage zones." Prelim. Resp. 36–38. Patent Owner argues that neither Kummetz-464's base station sectors 302a–302c nor Kummetz-464's coverage zones 16a–16f are groupings of DRUs that can be reconfigured, and thus that neither of these disclose "sectors" as

per this claim limitation. *Id.* (citing Ex. 1005, 1:43–46, 2:48–52, 3:16–24, 10:44–11:26, Figs. 4–5, Ex. 2002 ¶¶ 17–20, 23–26).

We have preliminarily determined that "sector" should be construed as "a grouping of DRUs in a particular area or region." *Supra* § II.C.2. With that in mind, we analyze whether Kummetz-464 discloses a plurality of groupings of remote antenna units in a particular area or region formed from the plurality of remote antenna units.

On the current record, we agree with Petitioner that it does. Kummetz-464 discloses coverage zones that include one or more remote antenna units in a physical area, providing communications coverage to mobile devices in the coverage zones. Ex. 1005, 1:43–45, 3:25–30, 3:51–53 (describing that coverage zones may be one remote antenna unit), 10:35–38. Kummetz-464 gives specific examples in which coverage zones may correspond to different sections of a stadium and the parking lot surrounding the stadium or different floors of an office building. *Id.* at 6:63–7:3. Kummetz-464 additionally describes that the coverage zones (and thus the antenna unit(s) in each coverage zone) may be grouped together. For example, where there are six coverage zones 16a–16f, coverage zones 16a–16d ("different sections of the stadium") may be grouped together and provided the same signals, as shown in Figure 4 and described in the accompanying written description. *Id.* at 10:30–38, 10:44–53. This describes a grouping of remote antenna units of these coverage zones, and discloses the grouping of DRUs in a particular area or region. Patent Owner's argument that remote antenna units are not divided into (base station) sectors 302a–302c does not address Petitioner's contentions regarding Kummetz-464's disclosure that remote antenna units in coverage

zones are grouped together by being "allocated to" or "associated with" the different base station sectors. Pet. 26–27, 33.

Thus, on the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the plurality of sectors limitation.

d) "a traffic monitoring unit" limitation

(1) the traffic monitoring unit

The system of claim 1 also comprises "a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port." Ex. 1001, 18:1–4. With respect to the traffic monitoring unit, Petitioner argues that the controller of the base station router in Kummetz-464 and its included configuration engine disclose a traffic monitoring unit. Pet. 27–29 (citing Ex. 1005, 8:54–58, 8:63–9:25, 9:34–565, Figs. 2, 3; Ex. 1003 ¶ 90).

At this stage of the proceeding, Patent Owner does not dispute Petitioner's contentions regarding the disclosures of Kummetz-464 and this portion of this limitation.

On the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses a traffic monitoring unit coupled to at least one DAU as claimed in claim 1.

(2) traffic monitoring unit configured to determine KPI(s) and a QoS

The traffic monitoring unit is configured to "determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." Ex. 1001, 18:5–8. Petitioner argues that Kummetz-464 discloses KPIs in its traffic indicators, which "include data describing or

otherwise corresponding to a number of mobile devices in each coverage zone" and that examples of such indicators include "traffic measurements passing low or high thresholds, base transceiver station failure events, and loss of capacity due to high inter-sector interference." Pet. 30–32 (quoting Ex. 1005, 9:44–54; citing Ex. 1005, 9:34–35, 9:40–47, 9:55–65, 10:30–43, 10:64–65, 11:13–15, Figs. 4–5; Ex. 1003 ¶¶ 93, 95, 97–98). Petitioner argues that the traffic indicators (number of wireless devices in a coverage zone) of Kummetz-464 disclose the KPIs and that the concentration of wireless devices in the respective coverage zones (a function of the number of wireless devices in a coverage zone) discloses the QoS. *Id.* at 31.

Patent Owner contends that Petitioner fails to show "a Quality of Service value '**QoS**' being determined that indicates network performance." Prelim. Resp. 38–41.

Patent Owner's argument first describes how QoS is calculated in an exemplary embodiment of the '454 patent. *Id.* at 39–40 (citing Ex. 1001, 11:57–62, 12:10–14:55; Ex. 2002 ¶¶ 21–22, 45). Patent Owner argues that "*Kummetz*[-464] fails to disclose such a determination of QoS values indicating network performance." *Id.* at 40 (emphasis omitted) (citing Ex. 2002 ¶¶ 21–22). Patent Owner argues that while the cited description of a concentration of wireless devices in a coverage zone in Kummetz-464 can be an indication of traffic load, one of ordinary skill in the art "would not equate traffic load with network performance indicated by a calculated QoS value that indicates network performance in the manner claimed **and described in the '454 Patent** to solve a sectorization problem." *Id.* (emphasis added). This argument however, at least in part, requests that we read an embodiment appearing in the written description into the claim. *See SuperGuide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 875 (Fed. Cir.

2004) ("Though understanding the claim language may be aided by the explanations contained in the written description, it is important not to import into a claim limitations that are not a part of the claim."). Kummetz-464 discloses that the relative concentration of wireless devices in coverage zones is evaluated and reconfiguration subsequently performed based on these calculations to provide sufficient resources for providing signal coverage. Ex. 1005, 9:34–35, 9:40–65, 10:64–11:28; Ex. 1003 ¶¶ 93, 95, 97–98; *see* Pet. 20, 30–32. This argument additionally assumes that the claim requires that the QoS be used "to solve a sectorization problem," which is not commensurate with the claim language.

Patent Owner also argues that Kummetz-464 is not enabled. Prelim. Resp. 55–57. Patent Owner argues that Kummetz-464 does not describe its invention in sufficient detail to enable a person of ordinary skill to carry out the reconfiguration of sectors as claimed in claim 1. *Id.* at 55. To some extent, it appears that Patent Owner's argument is that the relied upon subject matter of Kummetz-464 does not enable the optimization algorithm or QoS calculation described in the specification of the '454 patent. *Id.* at 55–56. But this does not convince us that Kummetz-464 does not enable the portions of its own disclosure alleged to anticipate the claimed invention. *See In re Antor Media Corp.*, 689 F.3d 1282, 1290 (Fed. Cir. 2012). On the present record we do not agree that Kummetz-464 is not enabling.

Patent Owner further argues that, "in Kummetz[-464], there is no reference or description of any kind to 'QoS' or 'QoS values' that are a function of KPIs to solve a sectorization problem in the manner disclosed in the '454 Patent." Prelim. Resp. 40 (emphasis omitted). However, anticipation "is not an 'ipsissimis verbis' test" in which the exact term used in the claim must be found in the anticipating reference. *In re Bond*, 910

F.2d 831, 832-33 (Fed. Cir. 1990) (citing *Akzo N.V. v. U.S. Int'l Trade Comm'n*, 808 F.2d 1471, 1479 n.11 (Fed. Cir. 1986)).

Patent Owner argues that the concentration of wireless devices would not indicate a QoS value indicating network performance, "because traffic load does not provide any indication how a network[] is performing." Prelim. Resp. 41–42 (citing Ex. 2002 ¶¶ 22–23). Patent Owner argues that "a POSA would not equate traffic load with network performance." *Id.* at 41. However, Patent Owner provides insufficient evidence supporting this contention or the implicit definition of "QoS," citing its declaration of an inventor including the inventor's evaluation of Kummetz-464 and conclusions regarding the reference, but not addressing the level of one of ordinary skill, whether the analysis is keyed to the relevant time, or whether the conclusions would have been reached by a person of ordinary skill at that time. The claim requires that QoS be "a function of the one or more KPIs" and Petitioner has identified a KPI and a QoS that would be a function of that KPI. The present record includes Exhibit 2008, prior art cited during the prosecution of the application that issued as the '454 patent, which describes "altering . . . the plurality of network parameters and evaluating of the cell congestion . . . continuously until a target quality of service is achieved." Ex. 2008, code (57). This indicates that congestion (traffic load) impacts the quality of service, even if they are not equivalent. We conclude that Petitioner has a reasonable likelihood of showing that Kummetz-464's relative concentration of wireless devices in coverage zones discloses a QoS value indicating network performance.

For these reasons, on the present record, and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the claimed

determination of one or more KPIs for the DAUs, and a QoS that is a function of the one or more KPIs in its traffic indicators, including data describing the number of devices in each coverage zone, and the relative concentration of devices between respective coverage zones discloses.

(3) traffic monitoring unit configured to reconfigure the plurality of sectors

The traffic monitoring unit is further configured to "reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector." Ex. 1001, 18:9–11.

Petitioner argues that Kummetz-464 discloses this reconfiguration in its disclosure that the controller and configuration engine can trigger a redistribution of signal capacity among coverage zones. Pet. 33–35. Petitioner cites Kummetz-464's description that "before an event begins the resources provided by a single sector 302a may sufficiently cover the entire stadium" (remote antennas in coverage zones 16a–16d). *Id.* at 34–35 (citing Ex. 1005, 10:64–11:28, Figs. 4, 5; Ex. 1003 ¶ 102). Petitioner explains that Kummetz-464 describes that, in response to changes in concentration of wireless devices in the coverage zones, reconfiguration occurs such that the signals of two base station sectors are used to provide coverage to those four coverage zones (16a—16d). *Id.*

Patent Owner argues that Kummetz-464 does not disclose that its sectors are reconfigured. Prelim. Resp. 42–44, 45–46. We note that this argument appears to conflate the claimed "sector" with Kummetz-464's "sector" language, describing signals as associated with one or more sectors, where each sector includes communication channels and represents an amount of telecommunication capacity and may be associated with different telecommunications systems operators. *Id.* at 1:43–46, 1:64–67, 3:20–24,

4:5–7, 5:19–23, 5:28–31. As Patent Owner argues, and we have herein preliminarily determined, "sector" should be construed as "a grouping of DRUs in a particular area or region." *Supra* §§ II.C.2, II.D.2.c. Thus this argument is inapposite, as it relates to a base station sector, and not a grouping of DRUs in a particular area or region.[12]

Patent Owner also reiterates, with respect to this claim limitation, the argument that the concentration of wireless devices in Kummetz-464 does not disclose the claimed QoS, and that therefore reconfiguring sectors formed from DRUs based on data regarding the concentration of wireless devices does not disclose reconfiguring the plurality of sectors based on a QoS. Prelim. Resp. 44–45; *see id.* at 38–41. As previously discussed, on the present record and preliminarily, we determine that Petitioner has a reasonable likelihood of succeeding in showing that the concentration of wireless devices in Kummetz-464 discloses the claimed QoS. *Supra* § II.D.2.d.(2).

Patent Owner further argues that no individual remote antenna units in Kummetz-464 are reallocated from one coverage zone to another coverage zone, as all of the remote antenna units in a coverage zone must be reallocated at once. Prelim. Resp. 46–48. Patent Owner contends that, therefore, Kummetz-464 "is not an efficient nor effective means of load balancing to address uneven traffic at a particular remote antenna or a specific hot spot within a coverage zone," and that the technique described

[12] Patent Owner's argument that Petitioner's expert declaration should be rejected as unreliable is based on a similar conflation of the claimed "sector" with Kummetz-464's sector language. *See* Prelim. Resp. 57–59. For the same reasons, for the purposes of institution, we do not agree that Mr. Proctor's expert declaration should be rejected as unreliable. Prelim. Resp. 57–59.

in the specification of the '454 patent adaptively balances the change in traffic demands and is more efficient than the technique of Kummetz-464. *Id.* at 48–50 (citing Ex. 2002 ¶¶ 36, 37, 49–53). However, this argument relies on distinctions between the technique disclosed in Kummetz-464 and the optimization algorithm disclosed in the specification of the '454 patent, but not claimed in claim 1. Additionally, to the extent this argument is based on the specific examples of Figures 4 and 5 of Kummetz-464 (in which each coverage zone contains more than one remote antenna unit), it disregards the disclosure in Kummetz-464 that a coverage zone may have only one remote antenna unit. Ex. 1005, 3:7–8, 3:51–53.

For these reasons, on the present record, and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 discloses the claimed reconfiguration of the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

e) Conclusion – Claim 1

For the reasons discussed above, we determine that, on the present record, and for the purposes of institution, Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 anticipates claim 1.

3. Analysis of Claim 10

With respect to most limitations, Petitioner argues the unpatentability of claim 10 as anticipated by Kummetz-464 with reference to arguments regarding similar or identical limitations of claim 1, or with arguments substantively similar to those claim 1 arguments. Pet. 35–40.

Unlike claim 1, claim 10 requires that the traffic monitoring unit be "external to" at least one of the DAUs. *Compare* Ex. 1001, 18:1–4 *with id.* at 18:54–57. Petitioner argues that Kummetz-464 discloses that "the controller 108 can be disclosed in a separate device external to and in communication with the base station router 14." Pet. 36 (quoting Ex. 1005, 8:58–62). At this stage of the proceeding, Patent Owner does not dispute Petitioner's contentions regarding the disclosures of Kummetz-464 and this portion of this limitation.

On the present record and for the purposes of institution, we determine that Petitioner has a reasonable likelihood of succeeding in showing that Kummetz-464 anticipates claim 10.

4. Claim 7

Claim 7, which depends from claim 1 and further requires that "the traffic monitoring unit is provided as a component of each of the plurality of DRUs." Ex. 1001, 18:26–28. Petitioner presents arguments that Kummetz-464 discloses the provision of the controller in each of the remote antenna units because it discloses the controller in a separate device from the base station router, and also discloses that the remote antenna units are separate from the base station router. Pet. 48 (citing Ex. 1005, 5:14–16, 8:54–62). Petitioner additionally argues that Kummetz-579 is incorporated by reference and discloses measurement receivers incorporated into remote antenna units. *Id.* (referencing Pet. 37–39, citing Ex. 1005, 9:61–65; Ex. 1006, code (57), ¶¶ 35, 36; Ex. 1003 ¶ 111).

Patent Owner argues as follows: "Kummetz[-464] describes that 'controller 108' can be disposed in a separate device, but does not teach or suggest that 'separate device' can be a remote antenna unit in one of the coverage zones 16a–f." Prelim. Resp. 51 (citing Ex. 1005, 8:59–62). At this

stage of the proceeding, we agree with Patent Owner. We also note that, while Petitioner addresses measurement receivers of Kummetz-579 as measuring network traffic (arguably disclosing the determination of KPI(s) and QoS), Petitioner does not address whether the measurement receivers of Kummetz-579 reconfigure a plurality of sectors by allocating at least one DRU from the first sector to the second sector. Claim 1, from which claim 7 depends, requires that the traffic monitoring unit be configured to perform both the determination of KPI(s) and QoS and the reconfiguration of the plurality of sectors.

For these reasons, on the present record and preliminarily, with respect to claim 7, Petitioner has not shown a reasonable likelihood of succeeding in showing that Kummetz-464 anticipates claim 7.

5. Claims 2–6, 8, 9, 11–17, and 19

At this stage of the proceeding, Patent Owner does not address separately Petitioner's explanations and supporting evidence regarding the anticipation contentions presented for balance of the dependent claims. *See generally* Prelim. Resp.

Petitioner provides detailed explanations as to how the prior art combinations teach or suggest these claims, citing Mr. Proctor's testimony for support. *See* Pet. 40–47, 49–60 (citing Ex. 1005, 1:43–46, 1:66–67, 2:54–59, 3:7–30, 3:32–34, 3:36–37, 3:43–61, 4:5–24, 4:61–5:4, 5:14–23, 5:50–58, 7:12–20, 7:45–8:33, 8:54–62, 8:64–9:5, 9:22–25, 9:34–35, 9:40–65, 10:30–43, 11:13–28, 11:39–52, Figs. 1–3, 6; Ex. 1003 ¶¶ 116, 117, 120–124, 134, 136, 144, 149–151, 153, 154, 156). Having reviewed Petitioner's arguments and supporting evidence in the present record, we determine Petitioner has demonstrated a reasonable likelihood that it will prevail on its

assertion that claims 2–6, 8, 9, 11–17, and 19 are anticipated by Kummetz-464.

E. Obviousness of Claim 7 over Kummetz-464 or Kummetz-464 and Kummetz-579

Petitioner argues that claim 7 is obvious over Kummetz-464 or over a combination of Kummetz-464 and Kummetz-579. Pet. 60–62. Petitioner relies generally on its arguments with respect to anticipation of claim 7 by Kummetz-464 for this obviousness ground. *Id.*

For the same reasons described *supra* Section II.D.4 with reference to those anticipation arguments, on the present record and preliminarily, with respect to claim 7, Petitioner has not shown a reasonable likelihood of succeeding in showing that claim 7 is obvious over Kummetz-464 or the combination of Kummetz-464 and Kummetz-579.

F. Additional Obvious Contentions – Claims 15–18

Petitioner argues that claim 17 is obvious over Kummetz-464 or over a combination of Kummetz-464 and Kummetz-999. Pet. 62–64. Petitioner additionally argues that claims 15, 16, and 18 are obvious over Kummetz-464 or over a combination of Kummetz-464 and Evans. Pet. 64–78 (citing Ex. 1005, 1:21–33, 3:7–8, 4:59–5:4, 5:14–19, 5:50–62, 6:5–15, 7:4–21, 7:45–65, 8:23–53, 11:39–62, Figs. 1, 2, 4–7; Ex. 1008 code (54), ¶¶ 1, 5, 9, 10, 21–24, 47–95; Ex. 1003 ¶¶ 164–169, 171, 173, 174, 176, 178).

At this stage in the proceeding, with respect to claim 17, Patent Owner reiterates its arguments with respect to claim 10 when addressing the obviousness of claim 17 over Kummetz-464 in combination with Kummetz-999. Prelim. Resp. 53.

Similarly, with respect to claims 15, 16, and 18, Patent Owner reiterates its arguments with respect to claim 10 when addressing the

obviousness of claim 15, 16, and 18 over Kummetz-464 in combination with Evans. Prelim. Resp. 54.

Having reviewed Petitioner's arguments and supporting evidence in the present record, we determine Petitioner has demonstrated a reasonable likelihood that it will prevail on its assertion that claim 17 is obvious over Kummetz-464 or over a combination of Kummetz-464 and Kummetz-999 and that claims 15, 16, and 18 are obvious over Kummetz-464 or over a combination of Kummetz-464 and Evans.

III. CONCLUSION

For the foregoing reasons, we determine that Petitioner has shown a reasonable likelihood that it would prevail in showing the unpatentability of at least one claim of the '454 patent, and accordingly, we institute an *inter partes* review of claim claims 1–19 of the '454 patent.

IV. ORDER

In consideration of the foregoing, it is hereby

ORDERED that, pursuant to 35 U.S.C. § 314(a), institution of an *inter partes* review of claims 1–19 of the '454 patent on the grounds presented in the Petition is granted; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(a) 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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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	P282739.US.02 (DW-1039)

CONFIRMATION NO. 6371

167137
SHERIDAN ROSS PC
1560 Broadway
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POA ACCEPTANCE LETTER

OC000000114564730

Date Mailed: 02/10/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/04/2020.

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**.

/cnguyen/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	P282739.US.02 (DW-1039)

CONFIRMATION NO. 6371

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POWER OF ATTORNEY NOTICE

OC000000114564714

Date Mailed: 02/10/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 02/04/2020.

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

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

/cnguyen/

PTO/AIA/80 (07-17)
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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 Systems Co. Ltd.
No. 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/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.**

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EFS ID:	38490262
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A 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:	P282739.US.02 (DW-1039)
Receipt Date:	04-FEB-2020
Filing Date:	24-JUL-2013
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Application Type:	Utility under 35 USC 111(a)

Payment information:

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Statement_under_373c_w_POA_10333-41.pdf	235059 8a584bfed80fe730c9c400ee32adf1578735fd38	yes	3

	Multipart Description/PDF files in .zip description		
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National Stage of an International Application under 35 U.S.C. 371
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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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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: DALI SYSTEMS CO. LTD.

Application No./Patent No.: 13/950,160 Filed/Issue Date: July 24, 2013

Titled: OPTIMIZATION OF TRAFFIC LOAD IN A 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 031392, Frame 0084, 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:

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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.**

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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 4, 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
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	12/10/2019	10506454	P282739.US.02 (DW-1039)	6371

27076 7590 11/20/2019

DORSEY & WHITNEY LLP - SEATTLE
INTELLECTUAL PROPERTY DEPARTMENT
COLUMBIA CENTER
701 FIFTH AVENUE, SUITE 6100
SEATTLE, WA 98104-7043

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 SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS;
Shawn Patrick Stapleton, Burnaby, CANADA;
Seyed Amin Hejazi, Burnaby, CANADA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	P282739.US.02 (DW-1039)	6371

27076 7590 10/31/2019

DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
701 Fifth Avenue, Suite 6100
Seattle, WA 98104-7043

EXAMINER	
SAMS, MATTHEW C	

ART UNIT	PAPER NUMBER
2646	

NOTIFICATION DATE	DELIVERY MODE
10/31/2019	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):

ipdocket-se@dorsey.com
seattle.ip@dorsey.com

PTOL-90A (Rev. 04/07)

Corrected ***Notice of Allowability***	**Application No.** 13/950,160	**Applicant(s)** Stapleton et al.	
	Examiner MATTHEW C SAMS	**Art Unit** 2646	**AIA (FITF) Status** No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 10/23/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3. ☑ The allowed claim(s) is/are 1-2,4-11 and 13-21 . 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 _____.

/Matthew C Sams/
Primary Examiner, Art Unit 2646

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
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	13/950,160
	Filing Date	Jul 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2646
	Examiner Name	SAMS, MATTHEW C.
	Attorney Docket Number	P282739.US.02

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]
		Office Action for Indian Application No. 244/CHENP/2015 dispatched September 17, 2019, pp. all	

EXAMINER SIGNATURE			
Examiner Signature	/Matthew C Sams/ (10/25/2019)	Date Considered	10/25/2019

*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. /MS/

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
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	13/950,160
	Filing Date	Jul 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2646
	Examiner Name	SAMS, MATTHEW C.
	Attorney Docket Number	P282739.US.02

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	/Jennifer Spaith/	Date (YYYY-MM-DD)	2019-10-23
Name/Print	Jennifer Spaith	Registration Number	51,916

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. /MS/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	Jul 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2646
	Examiner Name	SAMS, MATTHEW C.
	Attorney Docket Number	P282739.US.02

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]
		Office Action for Indian Application No. 244/CHENP/2015 dispatched September 17, 2019, pp. all	

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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	Application Number	13/950,160
	Filing Date	Jul 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2646
	Examiner Name	SAMS, MATTHEW C.
	Attorney Docket Number	P282739.US.02

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	/Jennifer Spaith/	Date (YYYY-MM-DD)	2019-10-23
Name/Print	Jennifer Spaith	Registration Number	51,916

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:	13950160
Filing Date:	24-Jul-2013
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Jennifer Lane Spaith/Alexandra Yaeger
Attorney Docket Number:	P282739.US.02 (DW-1039)

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($)
Extension-of-Time:				
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	120	120
		Total in USD ($)		**620**

Electronic Acknowledgement Receipt	
EFS ID:	37542406
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	27076
Filer:	Jennifer Lane Spaith/Alexandra Yaeger
Filer Authorized By:	Jennifer Lane Spaith
Attorney Docket Number:	P282739.US.02 (DW-1039)
Receipt Date:	23-OCT-2019
Filing Date:	24-JUL-2013
Time Stamp:	16:51:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$620
RAM confirmation Number	E20190MG52223003
Deposit Account	501266
Authorized User	Alexandra Yaeger
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		20191023_IssueFee_P282739US02_DW-1039.pdf	543998 21c25011da18cc58dc69eb209704ba01d284dc14	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Maintenance Fee Address Change		2	2	
	Issue Fee Payment (PTO-85B)		1	1	
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	20191023_SIDS_P282739US02.pdf	511823 14ec9446072946bf7f6832e7c07a6d4b0bf892bb	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	P282739WO-IN_OA.pdf	228553 620b6b5f27c9eba303f359f9c9a3732b33070a5d	no	7
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32821 dfb7d8d09dcaab9df98a464fb684431aa00dd713	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1317195		

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/47 (09-06)
U.S. Patent and Trademark Office;
U.S. DEPARTMENT OF COMMERCE

"FEE ADDRESS" INDICATION FORM

Address to:

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

- OR -

Fax to:

(571) 273-6500

For the following listed application(s), please recognize as the "Fee Address" under the provisions of 37 CFR 1.363 the address associated with:

☒ Customer Number **000197**

OR

☐ The attached Request for Customer Number (PTO/SB/125) form.

Patent Number (if known)	Patent Date (if known)	Application Number	U.S. Filing Date	Attorney Docket No.
		13/950,160	07/24/2013	P282739.US.03 (DW-1039)

Signed /Jennifer Spaith/

Jennifer Spaith
Owner's Attorney of Record, Reg. No. 51,916
Customer No. 27,076
Dorsey & Whitney LLP
701 Fifth Avenue, Suite 6100
Seattle, WA 98101-7043
(206) 903-8800

JLS:aly

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

27076 7590 07/24/2019
DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
701 Fifth Avenue, Suite 6100
Seattle, WA 98104-7043

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

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

TITLE OF INVENTION: OPTIMIZATION OF TRAFFIC LOAD IN A 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	$0.00	$0.00	$500	10/24/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
SAMS, MATTHEW C	2646	455-445000

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

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

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

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

1 _____
2 _____
3 _____

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

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

(A) NAME OF ASSIGNEE: DALI SYSTEMS CO., LTD.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): GRAND CAYMAN, CAYMAN ISLANDS

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

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

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

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

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 50-1266

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature /Jennifer Spaith/ Date October 23, 2019

Typed or printed name Jennifer Spaith Registration No. 51,916

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
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Application Number:	13887133
Application Number:	13913207
Application Number:	14095891
Application Number:	14169719

Property Type	Number
Application Number:	14245190
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Application Number:	14480285
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Application Number:	14691152
Application Number:	14788567
Application Number:	14800515
Application Number:	14949405
Application Number:	14991264
Application Number:	15205820
Application Number:	15223819
Application Number:	14743789
Application Number:	14044668
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Application Number:	14574071
Application Number:	14837850
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Application Number:	16388680
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Application Number:	12108507
Application Number:	12330451
Application Number:	13481389
Application Number:	13776163
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Application Number:	12603419
Application Number:	13553967
Application Number:	14087682
Application Number:	14885890

Property Type	Number
Application Number:	12928934
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Application Number:	12928931
Application Number:	14337004
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Application Number:	14020425
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Application Number:	13211236
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Application Number:	14918371
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Application Number:	14225673
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Application Number:	13754702

Property Type	Number
Application Number:	14678779
Application Number:	15445467
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Application Number:	15917342
Application Number:	14257209
Application Number:	15819279

Property Type	Number
Application Number:	14590447
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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.

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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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NOTICE OF ALLOWANCE AND FEE(S) DUE

27076 7590 07/24/2019

DORSEY & WHITNEY LLP - Seattle
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EXAMINER
SAMS, MATTHEW C

ART UNIT	PAPER NUMBER
2646	

DATE MAILED: 07/24/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

TITLE OF INVENTION: OPTIMIZATION OF TRAFFIC LOAD IN A 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	$0.00	$0.00	$500	10/24/2019

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

27076 7590 07/24/2019
DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
701 Fifth Avenue, Suite 6100
Seattle, WA 98104-7043

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Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

TITLE OF INVENTION: OPTIMIZATION OF TRAFFIC LOAD IN A 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	$0.00	$0.00	$500	10/24/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
SAMS, MATTHEW C	2646	455-445000

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

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

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

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

1_____
2_____
3_____

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

27076 7590 07/24/2019

DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
701 Fifth Avenue, Suite 6100
Seattle, WA 98104-7043

EXAMINER	
SAMS, MATTHEW C	
ART UNIT	**PAPER NUMBER**
2646	

DATE MAILED: 07/24/2019

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

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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

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

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

Privacy Act Statement

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

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

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

Notice of Allowability	**Application No.** 13/950,160	**Applicant(s)** Stapleton et al.	
	Examiner MATTHEW C SAMS	**Art Unit** 2646	**AIA (FITF) Status** No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 5/28/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3. ☑ The allowed claim(s) is/are 1-2,4-11 and 13-21 . 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 areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

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

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

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

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
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 _____.

/Matthew C Sams/
Primary Examiner, Art Unit 2646

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Allowable Subject Matter

2. Claims 1, 2 4-11 and 13-21 are allowed.

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

Applicant's reply makes evident the reasons for allowance, satisfying the "record as a whole" provision of the rule 37 CFR 1.104(e). Specifically, the substance of the reply, dated 5/28/2019, are persuasive, as such the reasons for allowance are evident from the record and the stated differences of the prior art. Applicant's claims recite a particular combination that is neither taught nor suggested by the prior art and are allowed for these reasons and the reasons stated in the responses dated 5/26/2015, 10/30/2015, 7/5/2016, 1/4/2017, 8/29/2017, 2/26/2018 and 5/28/2019.

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."

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MATTHEW C SAMS whose telephone number is (571)272-8099. The examiner can normally be reached on M-F 8:30-5 EST.

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lester Kincaid can be reached on (571)272-7922. 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.

/Matthew C Sams/
Primary Examiner, Art Unit 2646

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination Stapleton et al.	
	Examiner MATTHEW C SAMS	Art Unit 2646	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-6785558-B1	08-2004	Stratford; Scott B.	H04W88/085	455/561
*	B	US-20080139205-A1	06-2008	Sayeedi; Shahab M.	H04W36/0038	455/436
*	C	US-20100278530-A1	11-2010	Kummetz; Thomas	H04W88/085	398/41
*	D	US-20130071112-A1	03-2013	Melester; Matthew Thomas	H04B17/0085	398/38
*	E	US-20130114963-A1	05-2013	Stapleton; Shawn Patrick	H04W24/02	398/115
*	F	US-8498207-B2	07-2013	Trigui; Hafedh	H04L41/5025	370/235
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	**Art Unit**
	MATTHEW C SAMS	2646

CPC							
Symbol						**Type**	**Version**
H04W	/	24	/	02		F	2013-01-01
H04W	/	16	/	04		I	2013-01-01
H04W	/	88	/	085		A	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	19	
/Matthew C Sams/ Primary Examiner, Art Unit 2646	16 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office — Part of Paper No.: 20190716

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	**Art Unit**
	MATTHEW C SAMS	2646

INTERNATIONAL CLASSIFICATION					
CLAIMED					
H04W24/02	/	24	/	02	
H04W16/04	/	16	/	04	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	19	
/Matthew C Sams/ Primary Examiner, Art Unit 2646	16 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office — Part of Paper No.: 20190716

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	**Art Unit**
	MATTHEW C SAMS	2646

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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	11	10	19	19										
2	2	12	11	8	20										
	3		12	9	21										
3	4	13	13												
10	5	14	14												
4	6	15	15												
5	7	16	16												
6	8	17	17												
7	9	18	18												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	19	
/Matthew C Sams/ Primary Examiner, Art Unit 2646	16 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office — Part of Paper No.: 20190716

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	Art Unit
	MATTHEW C SAMS	2646

CPC - Searched*		
Symbol	Date	Examiner
H04W88/085 OR H04B10/2575 OR H04B10/25753 OR H04L41/5025	07/16/2019	MCS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

* 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
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS
Google search for DAS with Daisy-Chain	7-29-2016	MS
Google search for DAUs, DRUs, Base Station in DAS topology	9-20-2017	MS
Google search for network monitoring in DAS topology	9-20-2017	MS
East Search	07/15/2019	MCS
East Search	07/16/2019	MCS

/Matthew C Sams/ Primary Examiner, Art Unit 2646	/MAJID SYED/ Examiner.Art Unit 2641

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	Art Unit
	MATTHEW C SAMS	2646

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	((370/328,334,329)|(375/267)| (455/13.3,63.3,562.1)). ccls.	01/28/2015	MS
Same as above		07/16/2019	MCS

/Matthew C Sams/ Primary Examiner, Art Unit 2646	/MAJID SYED/ Examiner.Art Unit 2641

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	**Art Unit**
	MATTHEW C SAMS	2646

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

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant					☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		**DATE**								
Final	Original	02/09/2015	06/01/2015	01/13/2016	07/29/2016	03/09/2017	09/21/2017	08/22/2018	07/16/2019	
1	1	✓	✓	✓	✓	✓	✓	✓	=	
2	2	✓	✓	✓	✓	✓	✓	✓	=	
	3	✓	-	-	-	-	-	-	-	
3	4	✓	✓	✓	✓	✓	✓	✓	=	
10	5	✓	✓	✓	✓	✓	✓	✓	=	
4	6	✓	✓	✓	✓	✓	✓	✓	=	
5	7	✓	✓	✓	✓	✓	✓	✓	=	
6	8	✓	✓	✓	✓	✓	✓	✓	=	
7	9	✓	✓	✓	✓	✓	✓	✓	=	
11	10	✓	✓	✓	✓	✓	✓	✓	=	
12	11	✓	✓	✓	✓	✓	✓	✓	=	
	12	✓	✓	-	-	-	-	-	-	
13	13	✓	✓	✓	✓	✓	✓	✓	=	
14	14	✓	✓	✓	✓	✓	✓	✓	=	
15	15	✓	✓	✓	✓	✓	✓	✓	=	
16	16	✓	✓	✓	✓	✓	✓	✓	=	
17	17	✓	✓	✓	✓	✓	✓	✓	=	
18	18	✓	✓	✓	✓	✓	✓	✓	=	
19	19	✓	✓	✓	✓	✓	✓	✓	=	
8	20		✓	✓	✓	✓	✓	✓	=	
9	21		✓	✓	✓	✓	✓	✓	=	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	28	(digital with remote with unit DRU) with (switch$3 chang$3 reconfigur$6) with sector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 10:53
L3	5	"20070077929"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 10:54
L4	127	(digital with remote with unit DRU) with (switch$3 chang$3 reconfigur$6) with (array sector)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:02
L5	384	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6) with (sector)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:24
L6	0	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6) with (sector) with feedback same (QOS qualit$3 with service kpi key with performance with indicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:25
L7	1	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6) with (sector) same feedback and (QOS qualit$3 with service kpi key with performance with indicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:49
L8	1	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6) with (array sector) same feedback and (QOS qualit$3 with service kpi key with performance with indicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:53
L9	134	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6) with (array sector) and feedback and (QOS qualit$3 with service kpi key with performance with indicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 11:53
L10	173	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3	US-PGPUB; USPAT;	OR	ON	2019/07/16 11:53

		reconfigur$6) with (beam array sector) and feedback and (QOS qualit$3 with service kpi key with performance with indicat$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L11	1	13/950160	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 13:02
L12	173	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6 remap$4) with (beam array sector) and feedback and (QOS qualit$3 with service kpi key with performance with indicat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 13:52
L14	67	traffic with monitor$3 with unit with feedback	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 14:49
L15	1044	(packet communicat$4 traffic) with monitor$3 with unit with feedback	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 14:54
L16	3763	(digital with remote with unit DRU transceiv$3) with (switch$3 chang$3 reconfigur$6 remap$4) with (beam array sector)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 14:55
L17	1	15 and 16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 14:56
L18	151	shift$3 with (dru beam antenna) with between with sectors	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 15:21
L19	22	shift$3 with (dru beam antenna) with between with sectors and "455".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/16 15:22
L22	3	(US-20100278530-$ or US-20130071112-$).did. or (US-8498207-$).did.	US-PGPUB; USPAT	OR	ON	2019/07/16 15:32
L23	25	5 AND ((H04W88/085 OR H04B10/2575 OR H04B10/25753 OR H04L41/5025).CPC.)	US-PGPUB; USPAT	OR	ON	2019/07/16 15:35
L24	2	"6785558".pn. "20080139205"	US-PGPUB; USPAT	OR	ON	2019/07/16 15:51

L25	29	("2014/0162664").URPN.	USPAT	OR	ON	2019/07/16 15:57
S1	4	digital with access with unit and sams-matthew$.xp.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 15:56
S2	0	dali and sams-matthew.xp.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 15:57
S3	0	dali and sams-matthew$.xp.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 15:57
S4	92	((("DALI") near3 ("SYSTEMS") near3 ("CO") near3 ("LTD"))).AS,AANM.	USPAT	OR	ON	2019/06/20 16:01
S5	221	((("STAPLETON") near3 ("Shawn")) OR (("HEJAZI") near3 ("Seyed"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/06/20 16:01
S6	2798	optimiz$6 with traffic with load	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 16:02
S7	55	(S4 or S5) and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 16:02
S8	1	15/819279	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/06/20 16:03
S9	10	"20100278530" "8498207".pn. "20130071112"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/15 10:41
S10	7	(digital with remote with unit DRU) with (chang$3 reconfigur$6) with sector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/07/15 16:43

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L20	66	shift$3 with (dru beam antenna) with between with sector	USPAT	OR	ON	2019/07/16 15:30
L21	15	shift$3 with (dru beam antenna) with between with sector and "455".clas.	USPAT	OR	ON	2019/07/16 15:30
L26	0	20 AND ((H04W88/085 OR H04B10/2575 OR H04B10/25753 OR H04L41/5025).CPC.)	USPAT	OR	ON	2019/07/16 16:35

7/ 16/ 2019 4:57:05 PM
C:\ Users\ msams\ Documents\ EAST\ Workspaces\ 13950160 vs2.wsp

Bibliographic Data

Application No: 13/950,160

Foreign Priority claimed: ○ Yes ◉ No

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

Verified and Acknowledged: Examiner's Signature | Initials

Title: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
07/24/2013	455	2646	091172-0882666-103900US
RULE			

APPLICANTS

DALI SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS

INVENTORS

Shawn Patrick Stapleton Burnaby, CANADA

Seyed Amin Hejazi Burnaby, CANADA

CONTINUING DATA

This application has PRO of 61678016 07/31/2012

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

08/07/2013

**** SMALL ENTITY ****

STATE OR COUNTRY

CANADA

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Seattle, WA 98104-7043
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US

CONFIRMATION NO. 6371

27076
DORSEY & WHITNEY LLP - Seattle
INTELLECTUAL PROPERTY DEPARTMENT
Columbia Center
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Seattle, WA 98104-7043

POA ACCEPTANCE LETTER

OC000000109423044

Date Mailed: 07/08/2019

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.

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/byemane/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US

CONFIRMATION NO. 6371

20350
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Suite 2800
Atlanta, GA 30309

POWER OF ATTORNEY NOTICE

OC000000109423027

Date Mailed: 07/08/2019

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**.

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

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Application Number	13/950,160
Filing Date	07-24-2013
First Named Inventor	Shawn Patrick Stapleton
Title	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
Art Unit	2646
Examiner Name	KINCAID, LESTER G
Attorney Docket Number	091172-0882666-103900US

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 SYSTEMS CO. LTD		

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.**

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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

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☑ 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

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

DALI SYSTEMS CO. LTD

☐ 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.

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Electronic Acknowledgement Receipt	
EFS ID:	36491487
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A 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:	091172-0882666-103900US
Receipt Date:	03-JUL-2019
Filing Date:	24-JUL-2013
Time Stamp:	12:33:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	POA_13950160_6371_P282739US02.pdf	642336 afc2a3ef8e6282827351ebae0d5898b779e82ad5	no	2

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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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I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 28, 2019.

KILPATRICK TOWNSEND & STOCKTON LLP

By: / Thuy Diep /

PATENT
Attorney Docket No.: 091172-0882666-103900US
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Shawn Patrick Stapleton

Application No.: 13/950,160

Filed: July 24, 2013

For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

Customer No.: 20350

Confirmation No.: 6371

Examiner: Lester G. Kincaid

Technology Center/Art Unit: 2646

APPEAL BRIEF

Mail Stop Appeal Brief-Patents
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Commissioner:

This is an Appeal Brief under 37 C.F.R. § 41.37 in connection with the final rejection of claims 1-2, 4-11 and 13-21 in the Final Office Action mailed August 27, 2018. Each of the topics required by 37 C.F.R. § 41.37 is presented herewith and is labeled appropriately.

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REAL PARTY IN INTEREST

The real party in interest in this patent application is Dali Systems Co. Ltd., (hereinafter "Appellant").

RELATED APPEALS AND INTERFERENCES

No appeals which may be related to, directly affect or be directly affected by, or have a bearing on the Board's decision in the pending appeal are known to Appellant or Appellant's representative.

STATUS OF CLAIMS

Claims 1-2, 4-11, and 13-21 stand rejected as of the Final Office Action mailed August 27, 2018. The rejections of claims 1-2, 4-11, and 13-21 are appealed.

STATUS OF AMENDMENTS

No proposed but unentered Amendments are known to Appellant. The February 26, 2018 Response to the Office Action dated September 28, 2017 was entered and is the last Amendment to the claims in the presently-appealed application.

DESCRIPTION OF THE FIELD OF THE INVENTION

Aspects of the invention relate to a system for managing resources use in a Distributed Antenna System to provide a highly efficient, easily deployed and dynamically reconfigurable wireless network that can provide a high degree of flexibility to manage, control, enhance and facilitate radio resource efficiency, usage and overall performance of the distributed wireless network.

SUMMARY OF CLAIMED SUBJECT MATTER

Aspects of the invention relate to a system for managing resources use in a Distributed Antenna System to provide a highly efficient, easily deployed and dynamically reconfigurable wireless network that can provide a high degree of flexibility to manage, control, enhance and facilitate radio resource efficiency, usage and overall performance of the distributed wireless network. The system can include a digital access unit (DAU) having an input port configured as a uplink/downlink port and an output port configured as an uplink/downlink port. The DAU is coupled to a plurality of digital remote units (DRUs), and a plurality of sectors can be formed from the plurality of DRUs, where each sector can include a subset of the plurality of DRUs. A traffic monitoring unit can be coupled to the DAU and configured to reconfigure the sectors by allocating a DRU from one sector to another based on one or more indicators of network traffic.

Independent Claim 1

Claim 1 is directed to a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources. The system includes one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, *each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port*;[1] a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs; a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; *and a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port*.[2] The traffic monitoring unit is configured to determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector. (*Emphasis added*).

---

[1] *See at least* FIG. 1 and Appellant's Specification at corresponding paragraphs [0038].
[2] *See at least* FIG. 1 and Appellant's Specification at corresponding paragraphs [0039] – [0040].

Independent Claim 5

Claim 5 is directed to a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more signal sources. The system can include one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, *each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port*;[3] a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs; a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; *and a traffic monitoring unit external to and coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port*.[4] The traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector. (*Emphasis added*).

[3] *See at least* FIG. 1 and Appellant's Specification at corresponding paragraphs [0038].
[4] *See at least* FIG. 1 and Appellant's Specification at corresponding paragraphs [0039] – [0040].

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In the Final Office Action of August 27, 2018 (herein "Office Action"), Claims 1-2, 4-11, and 13-21 are rejected under pre-AIA 35 USC 103(a) as allegedly unpatentable over Kummetz et al. (US 2010/0278530, hereinafter "Kummetz") in view of Trigui et al. (US 8,498,207, hereinafter "Trigui", and further in view of Melester et al. (US 2013/0071112 with 61/535060 as provisional, hereinafter "Melester".

ARGUMENT

35 U.S.C. § 103(a)

Claims 1-2, 4-11, and 13-21 are rejected under pre-AIA 35 USC 103(a) as allegedly unpatentable over Kummetz in view of Trigui, and further in view of Melester. (*See* Office Action, August 27, 2018, pg. 3).

To establish obviousness under 35 U.S.C. § 103, the Office must establish, either from the references themselves or in the knowledge generally available to one of ordinary skill in the art, that the cited references disclose or suggest each claimed element. *See* M.P.E.P. §§ 2141 and 2143; Graham v. John Deere Co., 383 U.S. 1 (1966); KSR Int'l Co. v. Teleflex, Inc., 550 U.S. 398 (2007).

Claim 1 recites a distributed antenna system (DAS) that includes "*a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port*." Appellant submits that the cited references, taken alone or in combination, fail to teach or suggest at least these elements in the manner claimed because (1) modifying the disclosure of Trigui with the disclosure of Melester would render Trigui unsatisfactory for its intended purpose and (2) the Office Action fails to set forth a *prima facie* case of obviousness.

Modifying Trigui with Melester would Render Trigui Unsatisfactory for its Intended Purpose

"If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." (*see In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984), and MPEP §2143.01).

Appellant notes the concession in the Office Action that "Kummetz does not explicitly teaches [sic], and a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." (*See* Office Action, August 27, 2018, pg. 4.).

Appellant further notes the concession in the Office Action that "the combination of Kummetz, Trigui do not explicitly teach, a traffic monitoring unit coupled to at least one of the DAUs (a) comprising the input port and output port each configured as an uplink/downlink port, each DAU of the one or more DAUs including an input port configured as an (b) uplink/downlink port and an output port configured as an uplink/downlink port;". (*See* Office Action, August 27, 2018, pg. 6.; emphasis copied from the Office Action). The Office Action then asserts that Melester discloses these limitations. *Id.*

Appellant submits that combining Melester with Trigui would render Trigui unsatisfactory for its intended purpose. Trigui discloses "a wireless communication network 100 illustrated in FIG. 1." (Trigui at column 3, lines 54-55). The wireless communication network 100 includes a plurality of base stations 103 operating on different frequency channels. (*Id.* at column 4, lines 40-43). Base stations 103 are coupled to antenna arrays 202, where "each antenna array 202 can be a multiple of active antennas coupled to a common source or load to produce a directive radiation pattern forming the coverage areas 105." (*Id.* at column 6, lines 29-33). "The dynamic load balancing apparatus 109 includes an algorithm that analyzes the data related to the wireless communication network 100 and sends control signals 115 for altering or shaping the coverage areas 105. (*Id.* at column 5, lines 26-29). "Apart from changing coverage areas in terms of pointing directions and azimuth width of some sub-sectors, the load balancing algorithm may alter other parameters such as antenna tilt angles; transmit power values and frequency plan." (*Id.* at column 5, lines 39-42).

The Office Action interprets antennas 202 in Trigui to read upon the DAUs of the present claims. (*see* Office Action, August 27, 2018, pg. 4). The Office Action however subsequently concedes that Trigui does not explicitly teach DAUs "comprising the input port and output port each configured as an uplink/downlink port", and then cites Melester as disclosing this limitation. (*see* Office Action, August 27, 2018, pg. 6). The Office Action specifically relies on the duplexing module 204 in Melester as teaching the DAU of the present claims. *Id.*

Appellant submits that the duplexing module 204 in Melester cannot replace the antenna array 202 in Trigui for at least the following reasons. Firstly, the Office Action has not demonstrated that duplexing module 204 in Melester produces "a directive radiation pattern" for a "coverage area" as disclosed in Trigui. The duplexing module 204 of Melester "can provide downlink signals to downlink path 14 and provide uplink signals to the base station." (Melester-provisional at [0032]). To radiate signals via downlink path 14, the downlink signals outputted by duplexing module 204 travel to sector matrix 114 first, then to zone combiner 116 and attenuator 324a in master unit 118, and then to amplifier 316, attenuator 324c, and isolation sub-system 318 in remote antenna unit 120, before reaching antenna 322, which transmits the signals. (Melester at FIGS. 2-4 and paragraphs [0032]-[0036]). The Office Action has not demonstrated that duplexing module 204 can radiate signals itself. Therefore, if antenna array 202 in Trigui were replaced by duplexing module 204 in Melester, Trigui would not function to produce a directive radiation pattern that forms coverage areas.

Secondly, Trigui uses a dynamic load balancing apparatus 109 coupled to the antenna 202 to analyze the data related to the wireless communication network 100 and send control signals 115 for altering or shaping the coverage areas 105 of the antenna 202. If dynamic load balancing apparatus 109, which is used by Trigui to alter or shape coverage areas, was coupled to duplexing module 204 of Melester (since the Office Action is proposing the replacement of antenna 202 with the duplexing module 204 in Melester), load balancing would not be achieved because the Office Action has not demonstrated how the duplexing module 204 in Melester produces a directive radiation pattern as discussed above. Thus, the Office Action has not demonstrated how dynamic load balancing apparatus 109 in Trigui would change the coverage areas of duplexing module 204 in Melester.

In fact, the dynamic load balancing apparatus 109 in Trigui adaptively shapes the coverage areas of antenna array 202 by modifying pointing directions, azimuth width, antenna tilt angles, transmit power values, and frequency of antenna array 202. The Office Action makes no mention of how applying the techniques of dynamic load balancing apparatus 109 to duplexing module 204 in Melester, which is located in i-POI system 112 and communicates with sector matrix 114, zone combiner 116, master unit 118, and remote antenna unit 120 prior communicating with antenna 322, will modify the operating parameters of duplexing module 204 in Melester.

Thus, Appellant submits that modifying the antennas 202 in Trigui with the duplexing module 204 in Melester as asserted by the Office Action would result in a wireless communication network 100 that does not produce directive radiation patterns, let alone directive radiation patterns that could be modified by the dynamic load balancing apparatus 109 as discussed by Trigui. Accordingly, combining Trigui with Melester would render Trigui unsatisfactory for its intended purpose.

Failing to Set Forth a Prima Facie Case of Obviousness - Obviousness is not Clearly Articulated

Appellant further submits that the Office Action fails to set forth articulated reasoning and rational underpinning in support of its obviousness rejection. "The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious." (*See* MPEP §2142). In an obviousness rejection, "there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." KSR Int'l v. Teleflex Inc., 127 S. Ct. 1727, 1741 (2007) (quoting In re Kahn, 441 F.3d 977, 988 (Fed. Cir. 2006). "When setting forth a rejection, Office personnel are to continue to make appropriate findings of fact as explained in MPEP § 2141 and § 2143, and must provide a reasoned explanation as to why the invention as claimed would have been obvious to a person of ordinary skill in the art at the time of the invention." (*See* MPEP §2143).

The Office Action submits that the reason for combining Melester with Kummetz and Trigui is because "Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units, Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved and Melester discusses, configuration Sub-System for Distributed Antenna Systems. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to configure subsystem equipment ports prior to [sic] commissioning." (*see* Office Action, August 27, 2018, pg. 6). Appellant respectfully submits that this assertion of obviousness is not clearly articulated, nor is it supported by any rational underpinning.

Firstly, Appellant submits that the Office Action fails to clearly articulate and support how a "configuration Sub-System" relates to the present claims, let alone how it relates to the disclosures of Kummetz and Trigui. As submitted by the Office Action, Kummetz discusses a

distributed antenna system and Trigui discusses network parameters and evaluating cell congestion, both of which appear to relate to the present claims; however, the Office Action does not explain how one skilled in the art would combine a "configuration Sub-System" with Kummetz and Trigui to disclose the elements recited in the present claims. The present claims make no mention of a "configuration Sub-System" or its equivalent, and the Office Action makes no effort to explain what the "configuration Sub-System" is and how it applies to the present claims.

Secondly, even if one skilled in the art could combine Melester with Kummetz and Trigui, although Appellant is not conceding that one could, the Office Action does not clearly articulate why it would be obvious to one skilled in the art to replace antenna array 202 in Trigui with duplexing module 204 in Melester. The Office Action simply asserts a conclusory statement and does not clearly explain the motivation for making such a replacement. Furthermore, the Office Action also does not explain how one skilled in the art would specifically modify Trigui to incorporate the disclosure of Melester. In particular, the Office Action provides no clearly articulated reasoning nor rational underpinning as to how the wireless communication network 100 in Trigui can be modified with elements from the DAS system in Melester to result in a combination that reads upon the present claims. On the contrary, the Office Action merely states the unsupported conclusion that one of skill in the art would "configure subsystem equipment ports prior [sic] commissioning."

Because the rationale for obviousness set forth in the Office Action is so unclear and not supported by any reasoned explanation, Appellant respectfully submits that the Office Action has failed to set forth a *prima facie* case of obviousness.

Independent claim 5 is also in condition for allowance for the reasons given above with respect to claim 1.

Dependent claims 2, 4, 6-11, and 13-21, which depend from independent claims 1 and 5, should be placed in condition for allowance for the reasons given above with respect to claim 1, as well as for the additional elements they recite.

CONCLUSION

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

Respectfully submitted,

/Stephen A. Mao/
Stephen A. Mao
Registration No. 73418

KILPATRICK TOWNSEND & STOCKTON, LLP

Attachments

DT

CLAIMS APPENDIX

1. A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;

a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

2. The system of claim 1 further comprising a plurality of BTSs coupled to the one or more DAUs, wherein each BTS comprises the plurality of sectors.

3. (Canceled).

4. The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors.

5. (Previously Presented) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit external to and coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

6. The system of claim 1 wherein the traffic monitoring unit is external to the one or more DAUs.

7. The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the one or more DAUs.

8. The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs .

9. The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. The system of claim 5 wherein the traffic monitoring unit is external to a plurality of BTSs and coupled to each of the plurality of BTSs.

11. The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. The system of claim 5 wherein the plurality of DAUs are connected to one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. The system of claim 5 wherein a single DAU port is connected to one or more BTSs.

20. The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS.

PTO/AIA/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 091172-0882666-103900US
Application Number 13/950,160	Filed July 24, 2013
For OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	
Art Unit 2646	Examiner Lester G. Kincaid

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.

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	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$____
☒ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$300
☐ 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 20-1430.

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I am the

☐ applicant.

☒ attorney or agent of record. Registration Number 73418

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

/Stephen A. Mao/	05-28-2019
Signature	Date
Stephen A. Mao	(650) 326 2400
Typed or printed name	Telephone Number

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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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Electronic Patent Application Fee Transmittal	
Application Number:	13950160
Filing Date:	24-Jul-2013
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Stephen A. Mao/Thuy Diep
Attorney Docket Number:	091172-0882666-103900US
Filed as Small Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
		Total in USD ($)		**300**

Electronic Acknowledgement Receipt	
EFS ID:	36135409
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Thuy Diep
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	28-MAY-2019
Filing Date:	24-JUL-2013
Time Stamp:	20:50:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$300
RAM confirmation Number	052919INTEFSW20513500
Deposit Account	201430
Authorized User	Thuy Diep
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	Appeal Brief Filed	2019-05-20_Appeal_Brief_DW1039.pdf	181731 8f7832cf8266e22497fc53a8180abcacc0606ebf	no	15
Warnings:					
Information:					
2	Extension of Time	2019-05-20_EOT_091172-0882666-103900US.pdf	139923 2b0081243461e9a53ff7c5fee825cd516c8cc08c	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30766 996a8f16fcee179f6c05480ba2fb2242aa3a9b2a	no	2
Warnings:					
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		Total Files Size (in bytes):	352420		

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New International Application Filed with the USPTO as a Receiving Office
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PTO/AIA/31 (03-14)
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NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

Docket Number (Optional): 091172-0882666-103900US

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Signature: /Vanessa M. Aguilar/

Typed or printed name: Vanessa M. Aguilar

In re Application of: Shawn Patrick Stapleton

Application Number	Filed
13/950,160	July 24, 2013

For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBU

Art Unit	Examiner
2646	Majid Syed

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

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

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

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Therefore, the fee shown above is reduced by 75%, and the resulting fee is: $ _____
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☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 201430.

☑ Payment made via EFS-Web.

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

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I am the

☐ applicant

☑ attorney or agent of record. Registration number 73,418

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

Signature: /Stephen A. Mao/

Typed or printed name: Stephen A. Mao

Telephone Number: (650) 326-2400

Date: January 25, 2019

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

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 41.20(b)(1) and 41.31. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal					
Application Number:	13950160				
Filing Date:	24-Jul-2013				
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Stephen A. Mao/Vanessa Aguilar				
Attorney Docket Number:	091172-0882666-103900US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
NOTICE OF APPEAL		2401	1	400	400
Post-Allowance-and-Post-Issuance:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
		Total in USD ($)		**700**

Electronic Acknowledgement Receipt	
EFS ID:	34968218
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Vanessa Aguilar
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	25-JAN-2019
Filing Date:	24-JUL-2013
Time Stamp:	17:55:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$700
RAM confirmation Number	012819INTEFSW17565700
Deposit Account	201430
Authorized User	Vanessa Aguilar
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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	Extension of Time	EOT_091172-0882666.pdf	135464 43958b28eb7e63ae724092269dab1bcc14f31bc5	no	1
Warnings:					
Information:					
2	Notice of Appeal Filed	Notice_Appeal_091172-0882666.pdf	329612 7320b4b39a754283742a657a66c25dc97fbc16a4	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32545 4630924bd82b11ecd1dfe12429b38f1dfdc24d62	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	497621		

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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 091172-0882666-103900US
Application Number 13/950,160	Filed July 24, 2013
For OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	
Art Unit 2646	Examiner Majid Syed

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

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

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$____
☒ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$300
☐ 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 20-1430.

☒ Payment made via EFS-Web.

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

I am the

☐ applicant.

☒ attorney or agent of record. Registration Number 73418

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

/Stephen A. Mao/	1-25-2019
Signature	Date
Stephen A. Mao	(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 _____ 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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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

20350 7590 08/27/2018

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Atlanta, GA 30309

EXAMINER	
SYED, MAJID	

ART UNIT	PAPER NUMBER
2646	

NOTIFICATION DATE	DELIVERY MODE
08/27/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

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

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

KTSDocketing2@kilpatrick.foundationip.com
ipefiling@kilpatricktownsend.com

PTOL-90A (Rev. 04/07)

Office Action Summary	**Application No.** 13/950,160	**Applicant(s)** Stapleton et al.	
	Examiner MAJID SYED	**Art Unit** 2646	**AIA Status** No

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

Period for Reply

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

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

Status

1)☑ Responsive to communication(s) filed on 2/26/2018.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-2,4-11 and 13-21 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) 1-2,4-11 and 13-21 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 See Continuation Sheet is/are: a)☑ accepted or b)☐ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

Continuation of Application Papers 11): 7/24/2013

DETAILED ACTION

This is in response to applicant's response filed on 2/26/2018, which has been entered and made of record.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 11/28/2017 was filed. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Response to Arguments

Applicant's arguments filed on 2/26/2018 have been fully considered. Applicant's arguments are directed towards newly amended claims, which are addressed by the added reference Melester et al., please see rejection below.

Claim Rejections - 35 USC § 103

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

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not i0dentically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-2, 4-11, 13-21 are rejected under 35 U.S.C. 103 as being unpatentable over Kummetz; Thomas et al. (US 20100278530 A1 hereinafter: "Kummetz") in view of Trigui; Hafedh et al. (US 8,498,207 B2 hereinafter: "Trigui"); further in view of Melester(P) et al. (US 2013/0071112 A1 with 61/535060 as provisional).

For claim 1 (Currently Amended), Kummetz teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources **([0031 The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs receiving first signal from 24 and second signal from 44)**;

a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs **([0031] The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs connected to 44 as DRUs)** and operable to transport signals between the plurality of DRUs **([0029], …A group of distributed antenna units 44 are interconnected via high speed digital transport links 46.)** and the one or more DAUs **([0057], … in FIG. 8, one of the optical links from the Master Unit 42 may be connected to an Extension Unit 192 … The Extension Unit 192 may communicate with Remote Units 44 using a two fiber 66 a, 66 b approach using the same**

wavelength in both directions, or Extension Unit 192 may communicate using a single fiber 67 using two wavelengths and a WDM (204 in FIG. 9), therefore 192 as DAU);

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs **([0003] … To improve the capacity of a base station 24 to handle more mobile users 30, cells 22 may be divided into sectors 38 or are further subdivided into smaller cells with the base station 24 being replaced with lower cost, reduced capability micro or pico cells 36.)**;

Kummetz does not explicitly teaches, and a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs, however, in the same field of endeavor Trigui teaches, and a traffic monitoring unit coupled to at least one of the DAUs **(Fig. 2 item 202 as DAU and 109 as Traffic Monitoring unit coupled via 115 as explained in [col 5 lines 29-35] … The dynamic load balancing apparatus 109 receives information (e.g., network statistics 110, network topology and parameters 111 and target criteria 112) regarding the wireless communication network 100; and provides control signals 115 for controlling coverage areas 105 to the antenna arrays 202.)** wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)** and a quality of service (QoS) of a network traffic for the one or more DAUs **([col 2 lines 33-35]**

and determining if there is an improvement in the cell congestion and quality of service based on altered network parameters.),

wherein the QoS is a function of the one or more KPIs **(Trigui [col 2 lines 57-60] The altering of the network parameters and evaluating of the cell congestion are performed continuously until a target quality of service in the wireless communication network is achieved.);**

and reconfigure the plurality of sectors based on the one or more KPIs and QoS **(Trigui [col 7 lines 23-45] then in step 305 one or more of network parameters are altered. The network parameters include, but are not limited to, the following: Exemplary Network Parameters)** by allocating at least one DRU from the first sector to the second sector **(Trigui [col 8 lines 23-26] … The alternative of adding antennas and cell sites is to consider sub-sectorization by means of antenna arrays … an active antenna array will be preferred to alter the boundaries of coverage areas whenever needed for matching the instantaneous traffic demand. In addition to splitting the azimuth in coverage areas, a two dimensional active antenna array can offer more flexibility in creating and tailoring coverage areas.).**

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

The combination of Kummetz, Trigui do not explicitly teach,

a traffic monitoring unit coupled to at least one of the DAUs) (a) comprising the input port and output port each configured as an uplink/downlink port,

each DAU of the one or more DAUs including an input port configured as an (b) uplink/downlink port and an output port configured as an uplink/downlink port;

Melester(P) 61/535060 as provisional teaches, (a traffic monitoring unit coupled to at least one of the DAUs) comprising the input port and output port each configured as an uplink/downlink port, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port (**Fig. 3 item 204 as explained in [0032], … [0032] The duplexing module 204 can provide a common port connecting the downlink path 14 and uplink path 16. …. The duplexing module 204 can provide downlink signals to downlink path 14. The duplexing module 204 can provide uplink signals to the base station via the conditioning module).**

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units, Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved and Melester discusses, configuration Sub-System for Distributed Antenna Systems. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to configure subsystem equipment ports prior commissioning.

For claim 2 (Previously Presented), Kummetz teaches, further comprising a plurality of BTSs coupled to the one or more DAUs, wherein each BTS comprises the plurality of sectors

([col 8 lines 35-39] … it is assumed that the required number of sectors to meet the peak traffic demand has been determined along with their locations and frequency plan. The present invention, for example, optimizes base station transmit power, antenna tilt, sub-sectors pointing direction and azimuth widths to balance the traffic between sub-sectors).

For claim 4 (Previously Presented), Kummetz teaches, further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors **([col 6 lines 57-58, Capacity For Each Sector/Carrier, …, Channel Elements (CE) Primary Use, % Primary Traffic CE Usage, % Secondary Traffic CE Usage, …, [col 4 lines 28-30] … Each coverage area 105 behaves as an independent sector serving its own set of subscribers 107.).**

For claim 5 (Currently Amended), Kummetz teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources **([0031 The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs receiving first signal from 24 and second signal from 44)**;;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs **([0031] The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44,**

hereinafter referred to as Remote Units, therefore master unit as DAUs connected to 44 as DRUs) and operable to transport signals between the plurality of DRUs **([0029], …A group of distributed antenna units 44 are interconnected via high speed digital transport links 46.)** and the one or more DAUs **([0057], … in FIG. 8, one of the optical links from the Master Unit 42 may be connected to an Extension Unit 192 … The Extension Unit 192 may communicate with Remote Units 44 using a two fiber 66 a, 66 b approach using the same wavelength in both directions, or Extension Unit 192 may communicate using a single fiber 67 using two wavelengths and a WDM (204 in FIG. 9), therefore 192 as DAU**;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs **([0003] … To improve the capacity of a base station 24 to handle more mobile users 30, cells 22 may be divided into sectors 38 or are further subdivided into smaller cells with the base station 24 being replaced with lower cost, reduced capability micro or pico cells 36.)**;

Kummetz does not explicitly teaches, and a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs, however, in the same field of endeavor Trigui teaches, and a traffic monitoring unit external to and coupled to-at least one of the DAUs **(Fig. 2 item 202 as DAU and 109 as Traffic Monitoring unit coupled via 115 as explained in [col 5 lines 29-35] … The dynamic load balancing apparatus 109 receives information (e.g., network statistics 110, network topology and parameters 111 and target**

criteria 112) regarding the wireless communication network 100; and provides control signals 115 for controlling coverage areas 105 to the antenna arrays 202, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)** and a quality of service (QoS) of a network traffic for the one or more DAUs **([col 2 lines 33-35] and determining if there is an improvement in the cell congestion and quality of service based on altered network parameters.)**, wherein the QoS is a function of the one or more KPIs **(Trigui [col 2 lines 57-60] The altering of the network parameters and evaluating of the cell congestion are performed continuously until a target quality of service in the wireless communication network is achieved.)**;

and reconfigure the plurality of sectors based on the one or more KPIs and QoS **(Trigui [col 7 lines 23-45] then in step 305 one or more of network parameters are altered. The network parameters include, but are not limited to, the following: Exemplary Network Parameters)** by allocating at least one DRU from the first sector to the second sector **(Trigui [col 8 lines 23-26] … The alternative of adding antennas and cell sites is to consider sub-sectorization by means of antenna arrays … an active antenna array will be preferred to alter the boundaries of coverage areas whenever needed for matching the instantaneous traffic demand. In addition to splitting the azimuth in coverage areas, a two dimensional active antenna array can offer more flexibility in creating and tailoring coverage areas.)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell

congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

The combination of Kummetz, Trigui do not explicitly teach,

a traffic monitoring unit coupled to at least one of the DAUs) (a) comprising the input port and output port each configured as an uplink/downlink port,

each DAU of the one or more DAUs including an input port configured as an (b) uplink/downlink port and an output port configured as an uplink/downlink port;

Melester[(P)] 61/535060 as provisional teaches, (a traffic monitoring unit coupled to at least one of the DAUs) comprising the input port and output port each configured as an uplink/downlink port, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port (**Fig. 3 item 204 as explained in [0032], … [0032] The duplexing module 204 can provide a common port connecting the downlink path 14 and uplink path 16. …. The duplexing module 204 can provide downlink signals to downlink path 14. The duplexing module 204 can provide uplink signals to the base station via the conditioning module).**

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units, Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved and Melester discusses, configuration Sub-System for Distributed Antenna Systems. It would have been

obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to configure subsystem equipment ports prior commissioning.

For 6 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is external to the plurality of DAUs, however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is external to the one or more of DAUs **(Fig. 1 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 103 Base Station as DAUs)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 7 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs, however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is provided as a component of each of the one or more DAUs **([col 7 lines 13-15] … the dynamic load balancing apparatus 109 continues to receive and monitor switch statistics related to the wireless communication network 100.)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring for each DAUs. It would have been obvious before the effective filing date of the claimed invention to a person

having ordinary skill in the art to provide monitoring of each DAUs for effective load balancing so as to achieve QoS and KPIs.

For claim 8 (Previously Presented), Kummetz does teach, wherein the traffic monitoring unit is external to the plurality of DRUs, however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is external to the plurality of DRUs **(Fig. 2 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 202 antennas as DRUs)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 9 (Previously Presented), Kummetz does teach, wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs., however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs **(Fig. 2 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 202 antennas as DRUs, therefore can be in integrated in DRU)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a

person having ordinary skill in the art to provide monitoring unit internal to DRU to provide one stop solution where end customer does not interoperate with other DRUs.

For claim 10 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs however, in the same filed of endeavor, Trigui teaches, wherein the traffic monitoring unit is external to a plurality of BTSs and coupled to each of the plurality of BTSs **(Fig. 1 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 103 Base Station as DAUs).**

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 11, Kummetz teaches, does not teach, a network optimization processor coupled to the traffic monitoring unit however, in the same field of endeavor, Trigui teaches, further comprising a network optimization processor coupled to the traffic monitoring unit **(Fig. 2 item 101 as Network Management Apparatus coupled with 109 as Dynamic Load Balancing Apparatus, therefore 109 as network optimization and 109 as traffic monitoring unit)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network optimization processor. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary

skill in the art to analyze the data related to the wireless communication network and sends control signals for altering or shaping the coverage areas so as to achieve QoS and KPIs.

For claim 13 (Previously Presented), Kummetz teaches, wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([0031], … The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54 … via one to four wideband digitally modulated optical interfaces 56, although one of ordinary skill in the art will appreciate that other Master Units may have more than four optical interfaces, therefore 42a, 42b as DAUs … [0035], … The DMOC 60 including the optical transceiver 108 may also be replaced by a different transceiver for high data rate media such as coax cable, twisted pair copper wires, free space RF or optics, or shared networks such as Ethernet 68, SONET, SDH, ATM, PDH, among others.**).

For claim 14. (Previously Presented) wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([00311] … Up to four Remote Units 44 may be daisy chained along each optical interface 56. The use of multiple optical interfaces 56 permits the Remote Units 44 a-d to be positioned in order to optimize coverage … [0035], … The DMOC 60 including the optical transceiver 108 may also be replaced by a different transceiver for high data rate media such as coax cable, twisted pair copper wires, free space RF or optics, or shared networks such as Ethernet 68, SONET, SDH, ATM, PDH, among others.**).

For claim 15 (Previously Presented), Kummetz teaches, wherein the plurality of DRUs are connected in a daisy chain configuration **([0031], … Up to four Remote Units 44 may be daisy chained along each optical interface 56.**).

For claim 16 (Previously Presented), Kummetz teaches, wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration **([0073], … The switch may be configured in a point-multipoint configuration where a single downlink signal may be repeated and transmitted over multiple outputs to other switches, remote units or mobile units 30, therefore multipoint as star configuration**).

For claim 17 (Previously Presented), Kummetz teaches, wherein the plurality of DAUs are connected to one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([0031], … . The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 4b as DAUs ad 56 as Optical fiber**).

For claim 18 (Previously Presented), Kummetz teaches, wherein the plurality of DRUs are connected in a loop to a plurality of DAUs **([0031], … The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 42 as DAUs and 44 as DRUs**).

For claim 19 (Previously Presented), Kummetz teaches, wherein a single DAU port is connected to one or more BTSs **([0031], … The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 42 as DAUs and 24 as BTSs)**.

For claim 20 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS, however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

For claim 21 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS however, in the same field of endeavor, Trigui teaches, wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS **([col 2 lines 33-35] and determining if**

there is an improvement in the cell congestion and quality of service based on altered network parameters.).

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas..

Conclusion

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

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)270-0524. The examiner can normally be reached on 7-4 EST.

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamran Afshar can be reached on 571.272.7796. 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.

/MAJID SYED/
Examiner, Art Unit 2646

/KAMRAN AFSHAR/
Supervisory Patent Examiner, Art Unit 2646

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination Stapleton et al.	
	Examiner MAJID SYED	Art Unit 2646	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-20130071112-A1	03-2013	Melester; Matthew Thomas	H04B17/0085	398/38
*	B	US-8498207-B2	07-2013	Trigui; Hafedh	H04L41/5025	370/235
*	C	US-20100278530-A1	11-2010	Kummetz; Thomas	H04W88/085	398/41
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	**Art Unit**
	MAJID SYED	2646

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

CLAIMS

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

CLAIM		DATE								
Final	Original	02/09/2015	06/01/2015	01/13/2016	07/29/2016	03/09/2017	09/21/2017	08/22/2018		
	1	✓	✓	✓	✓	✓	✓	✓		
	2	✓	✓	✓	✓	✓	✓	✓		
	3	✓	-	-	-	-	-	-		
	4	✓	✓	✓	✓	✓	✓	✓		
	5	✓	✓	✓	✓	✓	✓	✓		
	6	✓	✓	✓	✓	✓	✓	✓		
	7	✓	✓	✓	✓	✓	✓	✓		
	8	✓	✓	✓	✓	✓	✓	✓		
	9	✓	✓	✓	✓	✓	✓	✓		
	10	✓	✓	✓	✓	✓	✓	✓		
	11	✓	✓	✓	✓	✓	✓	✓		
	12	✓	✓	-	-	-	-	-		
	13	✓	✓	✓	✓	✓	✓	✓		
	14	✓	✓	✓	✓	✓	✓	✓		
	15	✓	✓	✓	✓	✓	✓	✓		
	16	✓	✓	✓	✓	✓	✓	✓		
	17	✓	✓	✓	✓	✓	✓	✓		
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	19	✓	✓	✓	✓	✓	✓	✓		
	20		✓	✓	✓	✓	✓	✓		
	21		✓	✓	✓	✓	✓	✓		

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13/950,160	Stapleton et al.
	Examiner	Art Unit
	MAJID SYED	2646

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

* 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
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS
Google search for DAS with Daisy-Chain	7-29-2016	MS
Google search for DAUs, DRUs, Base Station in DAS topology	9-20-2017	MS
Google search for network monitoring in DAS topology	9-20-2017	MS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	((370/328,334,329)|(375/267)| (455/13.3,63.3,562.1)). ccls.	01/28/2015	MS

	/MAJID SYED/ Examiner.Art Unit 2641

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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2001203691	JP		Jul 27, 2001	Nec Corp		
	2	2012124695	JP		Jun 28, 2012	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]
	3	Japanese Patent Application No. JP2015-525473 , "Office Action", August 28, 2017, 11 pages	

EXAMINER SIGNATURE

Examiner Signature	/MAJID SYED/	Date Considered	08/22/2018

*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.

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

PTO/SB/08a (01-10)
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	Application Number	13/950,160
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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

[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.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2017-11-28
Name/Print	Stephen A. Mao	Registration Number	73418

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.**

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	46571	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45
S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08

S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S25	1	"7098805".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:38
S26	1	"20140244149"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:52
S27	1	"8611260".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:07
S28	1	"20120270553"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:10
S29	1	"8467397".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:13
S30	1	"20130114963"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:37
S31	206375	DAS	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:43
S32	48659	S31 and dru$s	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S33	0	S32 and number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S34	238	DAS and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S35	0	S34 and number near5 user per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S36	0	S34 and number near5 per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S37	1	S34 and per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:47
S38	2	"20110122788"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 17:16
S39	2814	distance between base station	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S40	2	S39 and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S41	2	Distance between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:46
S42	1	Distance$s between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:48
S43	58	Distance$s between APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:49
S44	0	Access Aware APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:39
S45	0	(DAS | DRU) same number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:41
S46	0	(DAS | DRU) with number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S47	0	(DAS | DRU) with number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S48	0	(DAS | DRU) near5 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S49	0	(DAS | DRU) near15 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42

S50	11	"8958789"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S51	1	"8958789".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S52	0	"2003006900"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:27
S53	1	"20030069000"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:27
S54	2	"20120094657"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:28
S55	0	"2011085514"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:29
S56	7	("20030147353" | "20120119772" | "20010052011" | "20120039254" | "20020119772" | "20050153743" | "20120039320").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:36
S57	2	("20010052011" | "20120039254").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:39
S58	1	"8396368".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 15:38
S59	307548	((distributed antenna system)| DAS)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:53
S60	2970	(distributed antenna system)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S61	958	(Traffic Optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S62	9	S60 and (traffic optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:55
S63	84	S60 and drus	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:56
S64	1	"20120329523"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:00
S65	1969	S60 and das	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:07
S66	72	S60 and dau	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:07
S67	0	distributed antenna system with dru with dau with monitoring	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:16
S68	2642921	(distributed antenna system with dru with dau with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:16

S69	2642933	(distributed antenna system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S70	24	S60 and (system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S71	25	S60 and ((dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:19
S72	0	distributed anteena system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S73	2974	distributed antenna system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S74	2976	distributed antenna$1 system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S75	2976	distributed antenna$1 system$1	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S76	62	S75 and (dru$1 same dau$1)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S77	194	S75 and (daisy chain$4)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:26
S78	1	"8184050".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:10
S79	4	(20070117592| "20100278530")	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:49
S80	38	("8521172" "20120178483" "20170250765" "9363761" "9125047" "9026119" "20020077151" "20140031049" "9020555" "20150319711" "20140242999" "20110244914" "8831592" "8532580" "8254848" "20140011496" "20130150065" "9693321" "20170041936" "20120196611" "8346091" "7286507" "8867451" "8688131" "8676223" "20170026857" "20130308537" "9467876" "20130121703" "7230931" "20100278530" "20070280159" "7969910" "20140376499" "20130094454" "20080233967" "7620370" "7724803").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/20 09:58
S81	2	"20140226736"	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/20 15:41
S82	14	"8498207"	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/21 09:36
S83	1	"8498207".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/21 09:36
S84	1832775	(DRU$1 or DAUs)	US-PGPUB; USPAT; USOCR; EPO; DERWENT;	OR	ON	2018/08/22 06:21

			IBM_TDB			
S85	1809	Distributed near3 Remote near3 Unit$1	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:22
S86	492	Distributed near3 Access near3 Unit$1	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:22
S87	2282	S85 or S86	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:23
S88	179	S87 and (port near3 (configur$4 or provision$3))	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:27
S89	159	S88 And (input and output)	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:28
S90	30	S88 and input/output	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 06:28
S91	3	"20080147894"	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:02
S92	3	"20080147894"	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:02
S93	1809	Distributed near3 Remote near3 Unit$1	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:16
S94	492	Distributed near3 Access near3 Unit$1	US-PGPUB; USPAT; USOCR; EPO; DERWENT;	OR	ON	2018/08/22 10:16

			IBM_TDB			
S95	2282	S93 or S94	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:16
S96	423	S95 and (input/output)	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:16
S97	12	S96 and (configure same input/output)	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:17
S98	45	S96 and ((configure or provision or define) same input/output)	US-PGPUB; USPAT; USOCR; EPO; DERWENT; IBM_TDB	OR	ON	2018/08/22 10:18

EAST Search History (Interference)

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

20350 7590 03/01/2018

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

EXAMINER
SYED, MAJID

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
03/01/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

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

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ipefiling@kilpatricktownsend.com
KTSDocketing2@kilpatrick.foundationip.com

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	13/950,160	STAPLETON ET AL.	
	Examiner	Art Unit	
	MAJID SYED	2641	

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

(1) *MAJID SYED*.

(2) *Stephen Mao*.

(3) *Sahwan Stapleton*.

(4) _____.

Date of Interview: *20 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: *1*.

Identification of prior art discussed: *Trigui*.

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

Applicant presented DAS architecture flow, optimization control unit to DAS elements and amended claim-1. Examiner read out of amended claim-1 may over come art of record/Trigui or may require new art search.

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

/MAJID SYED/ Examiner, Art Unit 2641	/VLADIMIR MAGLOIRE/ Supervisory Patent Examiner, Art Unit 2641

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.

PTOL-413A (09-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Applicant Initiated Interview Request Form

Application No.: 13/950,160 First Named Applicant: Shawn Patrick Stapleton
Examiner Majid Syed Art Unit: 2641 Status of Application: Pending

Tentative Participants:
(1) Stephen Mao **(2) Craig Largent**
(3) Shawn Stapleton

Proposed Date of Interview: Tuesday, February 20, 2018 **Proposed Time: 2:00 PM (EST)**

Type of Interview Requested:
(1) [x] Telephonic (2) [ ] Personal (3) [ ] Video Conference

Exhibit To Be Shown or Demonstrated: [ ] YES [X] NO
If yes, provide brief description: _____

Issues To Be Discussed

Issues (Rej.,Obj.,etc.)	Claims Fig.#s	Prior Art	Discussed	Agreed	Not Agreed
§103 Rej.			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[x] Continuation Sheet Attached
Brief Description of Arguments to be Presented:
1. Discuss the invention.
2. Discuss §103 rejection.

An interview was conducted on the above-identified application on _____.
NOTE: This form should be completed by applicant and submitted to the examiner in advance of the interview (see MPEP § 713.01).
This application will not be delayed from issue because applicant's failure to submit a written record of this interview. Therefore, applicant is advised to file a statement of the substance of this interview (37 CFR 1.133(b)) as soon as possible.

/Stephen A. Mao/
Applicant/Applicant's Representative Signature

_____
Examiner/SPE Signature

Stephen A. Mao
Typed/Printed Name of Applicant or Representative

73,418
Registration Number, if applicable

This collection of information is required by 37 CFR 1.133. 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 21 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 (1-800-786-9199) and select option 2.

1. (Proposed Amendment) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources;

a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is positioned to transmit and receive signals downstream from one or more Base Transceiver Stations, and wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on February 26, 2018.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-0882666-103900US
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Shawn Patrick Stapleton et al.
Application No.: 13/950,160
Filed: July 24, 2013
For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
Customer No.: 20350

Confirmation No.: 6371
Examiner: Majid Syed
Technology Center/Art Unit: 2641

AMENDMENT / RESPONSE TO OFFICE ACTION

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

Commissioner:

In response to the Office Action mailed September 28, 2017, please enter the following amendments and remarks:

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

Applicant Summary of Interview with the Examiner begins on page 6 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. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;

a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

2. (Currently Amended) The system of claim 1 further comprising a plurality of BTSs coupled to the one or more DAUs, wherein each BTS comprises [[a]] the plurality of sectors.

3. (Canceled).

4. (Previously Presented) The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors.

5. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit external to and coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

6. (Currently Amended) The system of claim 1 wherein the traffic monitoring unit is external to the ~~plurality of~~ one or more DAUs.

7. (Currently Amended) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the ~~plurality of~~ one or more DAUs.

8. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs .

9. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. (Currently Amended) The system of claim 5 wherein the traffic monitoring unit is external to [[the]] a plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. (Currently Amended) The system of claim 5 wherein the plurality of DAUs are connected to [[the]] one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. (Currently Amended) The system of claim 5 wherein a single DAU port is connected to [[the]] one or more BTSs.

20. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS.

Applicant Summary of Interview with the Examiner

Applicant thanks Examiner Syed for the helpful telephonic interview held with the undersigned attorney as well as Craig Largent and Shawn Stapleton. During the interview, the present claims, cited prior art, and proposed amendments were discussed. It was agreed that the second variant of the proposed amendments discussed during the interview would appear to overcome the cited art, but that the Examiner would like to perform a new search and review the cited art again. The claims in this response are amended to be in-line with our discussions during the interview.

REMARKS/ARGUMENTS

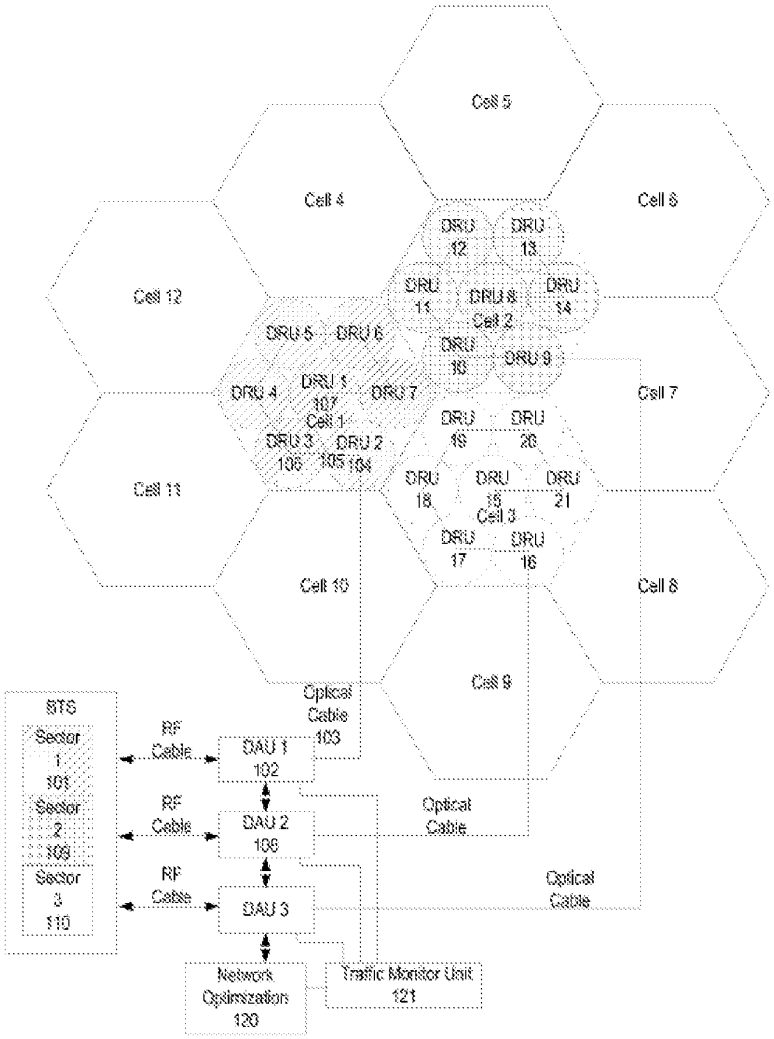
Upon entry of the present amendment, claims 1-2, 4-11, and 13-21 will be pending in this application. Claims 1-2, 5-7, 10, 17, and 19 have been amended, claims 3 and 12 remain canceled, and no claims have been added. No new matter is added. Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Claim Rejections – 35 USC §103

Claims 1-2, 4-11, 13-21 are rejected under 35 USC 103 as allegedly unpatentable over US 2010/0278530 in the name of Kummetz et al. (hereinafter "Kummetz") in view of US 8,498,207 in the name of Trigui et al. (hereinafter: "Trigui"). Office Action pages 3-16.

Claim 1 has been amended to recite, "one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources, each DAU of the one or more DAUs including an input port configured as an uplink/downlink port and an output port configured as an uplink/downlink port; a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port," among other claim elements.

As disclosed in the specification of the present invention, a DAS system, illustrated in FIG. 1, reproduced below for the Examiner's convenience, includes a plurality of DAUs (i.e., DAU 1, DAU 2, and DAU 3) and a plurality of DRUs (i.e., DRU 1 through DRU 21). A traffic monitoring unit 121 is coupled to each of the DAUs: DAU 1, DAU 2, and DAU 3. As discussed in at least paragraphs [0039] and [0040] of the present specification, the traffic monitoring unit 121 tracks the traffic load at each DAU in the network. Traffic monitoring unit 121 can monitor traffic in the DAS system to determine the number of users on each DAU. As illustrated in FIG. 4, also reproduced below for the Examiner's convenience, a DAS includes physical nodes 400 and a local router 401. (Specification at paragraph [0047]). The DAU includes uplink/downlink ports for coupling with BTSs as well as uplink/downlink ports for coupling with the plurality of DRUs. (Id.)


Cell 5
Cell 4
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Cell 12
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Cell 1
Cell 2
Cell 3
DRU 1 107
DRU 2 104
DRU 3 105
DRU 4 106
DRU 5
DRU 6
DRU 7
DRU 8
DRU 9
DRU 10
DRU 11
DRU 12
DRU 13
DRU 14
DRU 15
DRU 16
DRU 17
DRU 18
DRU 19
DRU 20
DRU 21
BTS
Sector 1 101
Sector 2 109
Sector 3 110
RF Cable
RF Cable
RF Cable
DAU 1 102
DAU 2 108
DAU 3
Optical Cable 103
Optical Cable
Optical Cable
Network Optimization 120
Traffic Monitor Unit 121

FIG. 1

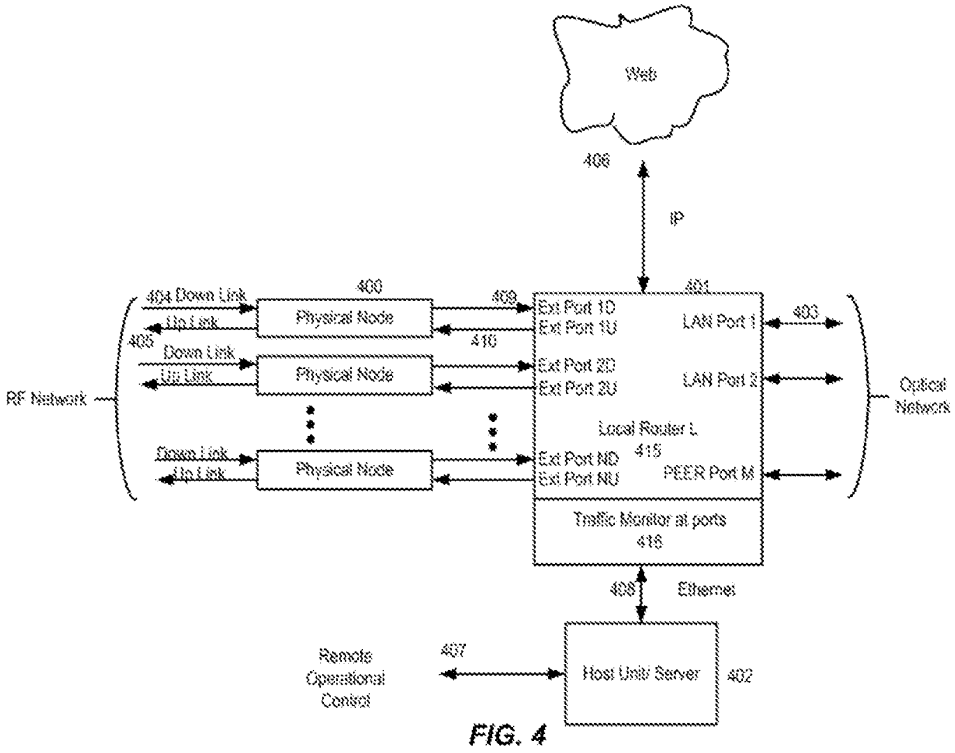

FIG. 4

Applicant respectfully submits that Kummetz and Trigui, alone or in combination, fail to teach and render obvious each and every element of claim 1. The Office Action concedes that "Kummetz does not explicitly teach...a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs." (Page 4 of the current Office Action). Thus, Applicant respectfully submits that Kummetz likewise fails to disclose "*a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs*," as recited in amended claim 1. The Office Action, however, cites Trigui as disclosing this limitation.

Applicant respectfully submits that Trigui fails to remedy the deficiencies of Kummetz. In the present rejection, the Examiner interprets antennas 202 to read upon the DAUs of the present claims. (Page 5 of the current Office Action). While the antennas in Trigui may have input ports from the BTSs, the antennas do not have an output port, let alone an output port that is an uplink/downlink port. Even if one were to interpret the input port to be the connection between the antenna 202 and dynamic load balancing apparatus 109 and the output port to be the connection between base station 103 and the antenna 202, the input port would not be an uplink/downlink port as information only flows one way (i.e., from the dynamic load balancing apparatus 109). Thus, Trigui does not disclose a dynamic load balancing apparatus coupled to a device that has input and output ports where both input and output ports are uplink/downlink ports. As such, Trigui fails to disclose "*a traffic monitoring unit coupled to at least one of the DAUs comprising the input port and output port each configured as an uplink/downlink port, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs*," as recited in amended claim 1.

Independent claim 5 recites elements similar to claim 1. Therefore, claim 5 is in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements it recites.

Claims 2 and 4-21, which depend from claims 1 and 5, respectively, are in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

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 SMao@kilpatricktownsend.com.

Respectfully submitted,

/Stephen A. Mao/
Stephen A. Mao
Registration No. 73418

KILPATRICK TOWNSEND & STOCKTON LLP

SAM:bsk

70241476V.1

Electronic Patent Application Fee Transmittal					
Application Number:	13950160				
Filing Date:	24-Jul-2013				
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Stephen A. Mao/Brian Kanter				
Attorney Docket Number:	091172-0882666-103900US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
		Total in USD ($)		**300**

Electronic Acknowledgement Receipt	
EFS ID:	31892254
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	26-FEB-2018
Filing Date:	24-JUL-2013
Time Stamp:	18:15:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$300
RAM confirmation Number	022718INTEFSW18183100
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMD_1039.pdf	290429 87748c261e3b3141af93b54b0f2d32900448447f	yes	11
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	5	
	Applicant summary of interview with examiner		6	6	
	Applicant Arguments/Remarks Made in an Amendment		7	11	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30810 84abd93abdde66f172e8795e9f8882df845c2630	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	321239		

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New Applications Under 35 U.S.C. 111

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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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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/950,160	Filing Date 07/24/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **02/26/2018**

	(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))	* 19	Minus	** 20	= 0	X $50 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $230 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

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
KIMBERLY PANNELL

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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2001203691	JP		Jul 27, 2001	Nec Corp		
	2	2012124695	JP		Jun 28, 2012	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]
	3	Japanese Patent Application No. JP2015-525473 , "Office Action", August 28, 2017, 11 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
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	Attorney Docket Number	091172-0882666-103900US

[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.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2017-11-28
Name/Print	Stephen A. Mao	Registration Number	73418

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Espacenet

Bibliographic data: JP2001203691 (A) — 2001-07-27

NETWORK TRAFFIC MONITOR SYSTEM AND MONITOR METHOD TO BE USED FOR IT

Inventor(s): NAGAO YASUTAKA ± (NAGAO YASUTAKA)

Applicant(s): NEC CORP ± (NEC CORP)

Classification: - international: ***G06F13/00; H04L12/24; H04L12/26; H04L12/28; H04L12/70;*** (IPC1-7): G06F13/00; H04L12/24; H04L12/26; H04L12/28; H04L12/56
- cooperative: **H04L41/024**; **H04L43/028**; **H04L43/18**; H04L43/062; H04L43/12

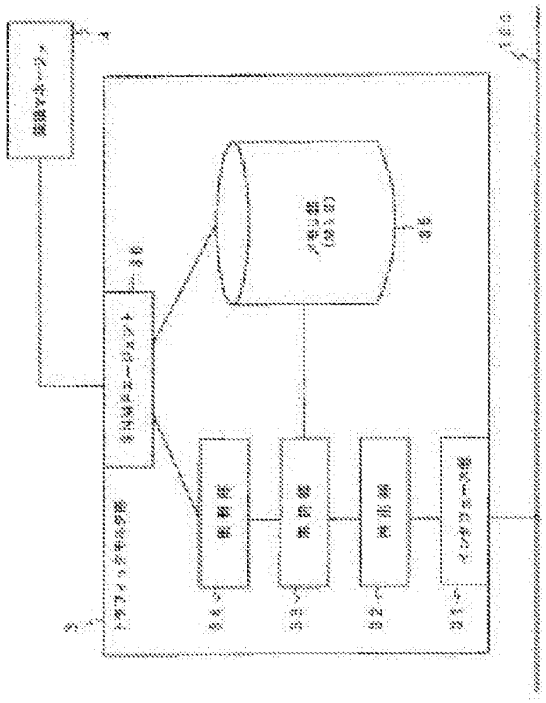
Application number: JP20000009605 20000119 Global Dossier

Priority number(s): JP20000009605 20000119

Also published as: US2001052011 (A1) US2004213267 (A1) US7440409 (B2)

Abstract of JP2001203691 (A)

PROBLEM TO BE SOLVED: To provide a network traffic monitor system that can cope with a large scale network by grasping a service distribution ruling the behavior of an IP network employing the Diffserv protocol. SOLUTION: An interface section 31 captures an IP packet and terminates the physical layer and the data link layer. An extract section 32 extracts a DSCP(Diffserv Code Point), a sender IP address and a destination IP address required for traffic tantalization from an IP header. An analysis section 33 totalizes traffic for each service class and each sub-network from the extracted information and a net mask and stores the result in a form of MIB(management information base) to a memory section 35. A control section 34 sets a net mask to calculate a sub network address from a monitor manager 4 via an SNMP agent 36 so as to control the entire operation of a traffic monitor section 3.



(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2001－203691
（Ｐ2001－203691Ａ）
(43)公開日　平成13年７月27日(2001.7.27)

(51)Int.Cl.[7]		識別記号	ＦＩ			ﾃｰﾏｺｰﾄﾞ(参考)
Ｈ０４Ｌ	12/24		Ｃ０６Ｆ	13/00	３５３Ｂ	５Ｂ０８９
	12/26		Ｈ０４Ｌ	11/08		５Ｋ０３０
Ｇ０６Ｆ	13/00	３５３		11/00	３１０Ｄ	５Ｋ０３３
Ｈ０４Ｌ	12/28			11/20	１０２Ａ	
	12/56					

審査請求　有　　請求項の数13　ＯＬ　（全 10 頁）

(21)出願番号　特願2000－9605(Ｐ2000－9605)

(22)出願日　平成12年１月19日(2000.1.19)

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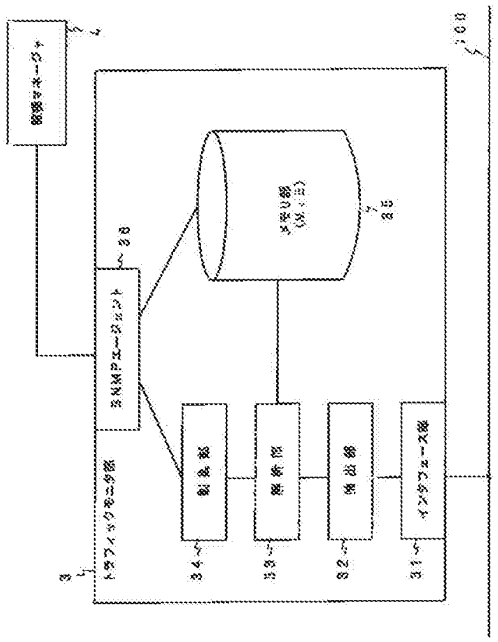
最終頁に続く

(54)【発明の名称】　ネットワークトラフィック監視システム及びそれに用いる監視方法

(57)【要約】
【課題】　Ｄｉｆｆｓｅｒｖプロトコルを用いたＩＰネットワークにおいてネットワークの挙動を左右するサービス分布を把握し、大規模ネットワークにも対応可能なネットワークトラフィック監視システムを提供する。
【解決手段】　インタフェース部３１はＩＰパケットのキャプチャを行い、物理層及びデータリンク層の終端を行う。抽出部３２はＩＰヘッダから集計に必要となるＤＳＣＰと送出元ＩＰアドレスと宛先ＩＰアドレスとを抽出する。解析部３３は抽出された情報とネットマスクとからサービスクラス毎及びサブネットワーク毎のトラフィックを集計し、ＭＩＢの形式でメモリ部３５に蓄積する。制御部３４はサブネットワークアドレス算出のためのネットマスクを監視マネージャ４からＳＮＭＰエージェント３６経由で設定し、トラフィックモニタ部３全体の動作制御を行う。



CommScope Exhibit 1024

【特許請求の範囲】

【請求項1】 IP(Internet Protocol)パケット毎にサービス単位に応じて優先度を変えて転送するIPネットワークにおいてトラフィック監視を行うネットワークトラフィック監視システムであって、前記トラフィック監視を前記サービス単位及び前記IPネットワークのサブネットワーク単位で行う手段を有することを特徴とするネットワークトラフィック監視システム。

【請求項2】 IP(Internet Protocol)ネットワークを構築するIPルータがリンクによって相互に接続され、IPパケット転送の品質をクラス分けするDiffserv(differentiated service)プロトコルに基づいてサービスクラス分けされたIPパケットの転送を行うネットワークにおいてトラフィック監視を行うネットワークトラフィック監視システムであって、前記リンク上を転送されるIPパケットを監視する手段と、その監視で検出されたIPパケットの前記サービスクラスを表す値と送出元IPアドレス及び宛先IPアドレスから割り出される送出元サブネットワークアドレスと宛先サブネットワークアドレスとに基づいてトラフィックを分類する手段と、その分類されたトラフィックを前記サービスクラス毎及び前記IPネットワークのサブネットワーク毎に蓄積する手段とからなるトラフィックモニタ部を有することを特徴とするネットワークトラフィック監視システム。

【請求項3】 前記サービスクラスを表す値は、前記IPパケットのヘッダ内フィールドの一部に前記サービスクラスを表す値を記録するためのフィールドとして割り当てられたDSCP(Diffserv Code Point)を用いるようにしたことを特徴とする請求項2記載のネットワークトラフィック監視システム。

【請求項4】 前記サービスクラス毎及び前記サブネットワーク毎に蓄積されたトラフィックデータに対して統計処理を施して前記トラフィックの表示と異常の監視とトレンドの把握とを行う監視マネージャを含むことを特徴とする請求項2または請求項3記載のネットワークトラフィック監視システム。

【請求項5】 前記監視マネージャは、前記サブネットワークのアドレス算出に必要なネットマスクを前記トラフィックモニタ部に供給するようにしたことを特徴とする請求項4記載のネットワークトラフィック監視システム。

【請求項6】 前記トラフィックモニタ部を前記IPルータ内に配置したことを特徴とする請求項2から請求項5のいずれか記載のネットワークトラフィック監視システム。

【請求項7】 前記トラフィックは、MIB(Management Information Base)の形式で蓄積するようにしたことを特徴とする請求項2から請求項6のいずれか記載のネットワークトラフィック監視システム。

【請求項8】 IP(Internet Protocol)パケット毎にサービス単位に応じて優先度を変えて転送するIPネットワークにおいてトラフィック監視を行うためのネットワークトラフィック監視方法であって、前記トラフィック監視を前記サービス単位及び前記IPネットワークのサブネットワーク単位で行うようにしたことを特徴とするネットワークトラフィック監視方法。

【請求項9】 IP(Internet Protocol)ネットワークを構築するIPルータがリンクによって相互に接続され、IPパケット転送の品質をクラス分けするDiffserv(differentiated service)プロトコルに基づいてサービスクラス分けされたIPパケットの転送を行うネットワークにおいてトラフィック監視を行うためのネットワークトラフィック監視方法であって、前記リンク上を転送されるIPパケットを監視し、その監視で検出されたIPパケットの前記サービスクラスを表す値と送出元IPアドレス及び宛先IPアドレスから割り出される送出元サブネットワークアドレスと宛先サブネットワークアドレスとに基づいてトラフィックを分類し、その分類されたトラフィックを前記サービスクラス毎及び前記IPネットワークのサブネットワーク毎に蓄積するようにしたことを特徴とするネットワークトラフィック監視方法。

【請求項10】 前記サービスクラスを表す値は、前記IPパケットのヘッダ内フィールドの一部に前記サービスクラスを表す値を記録するためのフィールドとして割り当てられたDSCP(Diffserv Code Point)を用いるようにしたことを特徴とする請求項9記載のネットワークトラフィック監視方法。

【請求項11】 前記サービスクラス毎及び前記サブネットワーク毎に蓄積されたトラフィックデータに対して統計処理を施して前記トラフィックの表示と異常の監視とトレンドの把握とを行うようにしたことを特徴とする請求項9または請求項10記載のネットワークトラフィック監視方法。

【請求項12】 前記IPルータ内において、前記分類されたトラフィックを前記サービスクラス毎及び前記IPネットワークのサブネットワーク毎に蓄積するようにしたことを特徴とする請求項9から請求項11のいずれか記載のネットワークトラフィック監視方法。

【請求項13】 前記トラフィックは、MIB(Management Information Base)の形式で蓄積するようにしたことを特徴とする請求項9から請求項12のいずれか記載のネットワークトラフィック監視方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はネットワークトラフィック監視システム及びそれに用いる監視方法に関し、特に大規模ＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）ネットワークにおけるトラフィック監視方法に関する。

【０００２】

【従来の技術】従来、トラフィック監視手法においては、一般に、ＩＰヘッダ内から送信元ＩＰアドレスと宛先ＩＰアドレスとを読出し、これらのＩＰアドレスペアと４層宛先ポート番号とから識別される上位アプリケーション種別によって集計を行っている。

【０００３】一方、ＩＥＴＦ（Ｉｎｔｅｒｎｅｔ　Ｅｎｇｉｎｅｅｒｉｎｇ　Ｔａｓｋ　Ｆｏｒｃｅ）によって新たなプロトコルとして、従来平等に転送されていたＩＰパケットに対して転送の優先度を設け、サービスに差別を設けるという技術が議論されるようになっている。これがＤｉｆｆｓｅｒｖ（ｄｉｆｆｅｒｅｎｔｉａｔｅｄ　ｓｅｒｖｉｃｅ）プロトコルである。

【０００４】Ｄｉｆｆｓｅｒｖプロトコルに対応した端末や、Ｄｉｆｆｓｅｒｖサービスの境界となるルータでは、転送するＩＰパケットの送信元ＩＰアドレスや宛先ＩＰアドレス、使用するポート番号等によってパケットを数種類（ＩＥＴＦのＲＦＣ２４７５では、１４種のクラス）のサービスクラスに分類し、ＤＳＣＰ（Ｄｉｆｆｓｅｒｖ　Ｃｏｄｅ　Ｐｏｉｎｔ）としてＩＰヘッダ内に情報を埋め込んでパケット転送を行う。

【０００５】Ｄｉｆｆｓｅｒｖプロトコルをサポートしたルータは、ＩＰヘッダ内に埋め込まれたＤＳＣＰの値を読込んで優先レベルを判断し、転送方法を決定するというアーキテクチャである。これによって、ＩＰパケットはクラス毎に分類された数種類のフローとして扱われ、特定のホストのＩＰパケットの廃棄率を低く設定したり、特定のアプリケーションパケットを低遅延で転送させたりすることが可能となる。

【０００６】

【発明が解決しようとする課題】以上のようなネットワークに対し、従来のトラフィック監視方式においては、４層プロトコルのポート番号によってアプリケーション毎に総トラフィック量を分類しているので、Ｄｉｆｆｓｅｒｖプロトコルによって生ずる転送優先度を把握することができず、ネットワークがどのようなサービスに割り当てられているかを監視することができない。

【０００７】また、Ｅｎｄ－ｔｏ－Ｅｎｄの端末同士でやりとりされるトラフィック量を分類しているので、ネットワークの規模が大きくなるにつれて扱うＩＰアドレス数が増加し、トラフィックモニタ部のメモリ容量圧迫や管理ネットワークへ負荷が増大するため、大規模ネットワークに対応しきれない。

【０００８】さらに、ＩＰｓｅｃ（ｓｅｃｕｒｉｔｙ ａｒｃｈｉｔｅｃｔｕｒｅ ｆｏｒｉｎｔｅｒｎｅｔ ｐｒｏｔｏｃｏｌ）やＩＰｏｖｅｒＩＰのようなプロトコルを用いたネットワークでは４層プロトコルのポート番号を監視することができなくなるため、トラフィックをアプリケーション毎に分類することができない。

【０００９】そこで、本発明の目的は上記の問題点を解消し、Ｄｉｆｆｓｅｒｖプロトコルを用いたＩＰネットワークにおいてネットワークの挙動を左右するサービス分布を把握することができ、大規模ネットワークにも対応することができるネットワークトラフィック監視システム及びそれに用いる監視方法を提供することにある。

【００１０】

【課題を解決するための手段】本発明によるネットワークトラフィック監視システムは、ＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）パケット毎にサービス単位に応じて優先度を変えて転送するＩＰネットワークにおいてトラフィック監視を行うネットワークトラフィック監視システムであって、前記トラフィック監視を前記サービス単位及び前記ＩＰネットワークのサブネットワーク単位で行う手段を備えている。

【００１１】本発明による他のネットワークトラフィック監視システムは、ＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）ネットワークを構築するＩＰルータがリンクによって相互に接続され、ＩＰパケット転送の品質をクラス分けするＤｉｆｆｓｅｒｖ（ｄｉｆｆｅｒｅｎｔｉａｔｅｄ　ｓｅｒｖｉｃｅ）プロトコルに基づいてサービスクラス分けされたＩＰパケットの転送を行うネットワークにおいてトラフィック監視を行うネットワークトラフィック監視システムであって、前記リンク上を転送されるＩＰパケットを監視する手段と、その監視で検出されたＩＰパケットの前記サービスクラスを表す値と送出元ＩＰアドレス及び宛先ＩＰアドレスから割り出される送出元サブネットワークアドレスと宛先サブネットワークアドレスとに基づいてトラフィックを分類する手段と、その分類されたトラフィックを前記サービスクラス毎及び前記ＩＰネットワークのサブネットワーク毎に蓄積する手段とからなるトラフィックモニタ部を備えている。

【００１２】本発明によるネットワークトラフィック監視方法は、ＩＰ（ＩｎｔｅｒｎｅｔＰｒｏｔｏｃｏｌ）パケット毎にサービス単位に応じて優先度を変えて転送するＩＰネットワークにおいてトラフィック監視を行うためのネットワークトラフィック監視方法であって、前記トラフィック監視を前記サービス単位及び前記ＩＰネットワークのサブネットワーク単位で行うようにしている。

【００１３】本発明による他のネットワークトラフィック監視方法は、ＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）ネットワークを構築するＩＰルータがリンクによって相互に接続され、ＩＰパケット転送の品質をクラス分けするＤｉｆｆｓｅｒｖ（ｄｉｆｆｅｒｅｎｔｉａｔ

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ｅｄ ｓｅｒｖｉｃｅ）プロトコルに基づいてサービスクラス分けされたＩＰパケットの転送を行うネットワークにおいてトラフィック監視を行うためのネットワークトラフィック監視方法であって、前記リンク上を転送されるＩＰパケットを監視し、その監視で検出されたＩＰパケットの前記サービスクラスを表す値と送出元ＩＰアドレス及び宛先ＩＰアドレスから割り出される送出元サブネットワークアドレスと宛先サブネットワークアドレスとに基づいてトラフィックを分類し、その分類されたトラフィックを前記サービスクラス毎及び前記ＩＰネットワークのサブネットワーク毎に蓄積するようにしている。

【００１４】すなわち、本発明のネットワークトラフィック監視システムは、インタネットやイントラネットに代表されるＩＰネットワークにおいて、トラフィック監視をサービス単位及びサブネットワーク単位で行うことによって収集するデータを集約させてデータ量を削減し、大規模ネットワーク監視に適した監視システムを提供することを特徴としている。

【００１５】より具体的に、本発明のネットワークトラフィック監視システムは、ＩＰネットワークを構築するＩＰルータであるＮＥ（ネットワークエレメント）がリンクによって相互に接続されており、Ｄｉｆｆｓｅｒｖ（ｄｉｆｆｅｒｅｎｔｉａｔｅｄ ｓｅｒｖｉｃｅ）プロトコルに基づいてクラス分けされたＩＰパケットの転送を行っている。

【００１６】ＤｉｆｆｓｅｒｖプロトコルはＩＥＴＦによって議論されているＩＰパケット転送の品質をクラス分けするプロトコルであり、ＩＰヘッダ内のフィールドの一部をサービスクラスを表すＤＳＣＰ（Ｄｉｆｆｓｅｒｖ Ｃｏｄｅ Ｐｏｉｎｔ）を記録するためのフィールドとして割り当て、このフィールドに設定される１４種のＤＳＣＰ値にしたがってパケット毎に優先度を変えて転送するという方式である。

【００１７】トラフィックモニタ部はリンク上を転送されるＩＰパケットを監視し、つまりパケットをキャプチャし、サービスクラスを表すＤＳＣＰの値と、送出元ＩＰアドレス及び宛先ＩＰアドレスから割り出される送出元サブネットワークアドレスと、宛先サブネットワークアドレスとに基づいてトラフィックを分類し、内部メモリに蓄積するための装置である。

【００１８】蓄積されたトラフィックデークはＳＮＭＰ（Ｓｉｍｐｌｅ ＮｅｔｗｏｒｋＭａｎａｇｅｍｅｎｔ Ｐｒｏｔｏｃｏｌ）等を用いて監視マネージャへ転送されて統計処理が施され、トラフィックの表示・異常の監視・トレンドの把握等に用いられる。監視マネージャではサブネットワークアドレス算出に必要なネットマスクを入力するためのユーザインタフェースも提供する。

【００１９】このようにして、本発明ではトラフィック監視の粒度としてサービスクラス毎及びサブネットワーク毎に集計を行っているので、ネットワーク上の全端末同士で交換されるトラフィック情報を全アプリケーション毎に把握する代わりに、サブネットワーク毎・サービスクラス毎のトラフィックとして集約させた形で捉えることが可能となり、トラフィックモニタ部に必要なメモリ量を節約したり、監視マネージャへの通信量を低くすることが可能となる。

【００２０】また、このようにして得られる集約されたトラフィックデークは、特に大規模ネットワークにおいてトラフィック管理をマクロ的に行う場合に有効な情報であることは言うまでもない。

【００２１】よって、Ｄｉｆｆｓｅｒｖプロトコルを用いたＩＰネットワークにおいて、トラフィック監視の集計をサービス単位及びサブネットワーク単位で収集することで情報を集約させて監視することによって、ネットワークの挙動を左右するサービス分布を把握し、かつ大規模ネットワークにも対応可能となる。

【００２２】

【発明の実施の形態】次に、本発明の実施例について図面を参照して説明する。図１は本発明の一実施例によるネットワークトラフィック監視システムの構成を示すブロック図である。図１において、ＮＥ（ネットワークエレメント）１，２はＩＰネットワークを構築するＩＰルータであり、リンク１００によって相互に接続されており、Ｄｉｆｆｓｅｒｖ（ｄｉｆｆｅｒｅｎｔｉａｔｅｄ ｓｅｒｖｉｃｅ）プロトコルに基づいてクラス分けされたＩＰパケットの転送を行っている。

【００２３】ＤｉｆｆｓｅｒｖプロトコルはＩＥＴＦによって議論されているＩＰパケット転送の品質をクラス分けするプロトコルであり、ＩＰヘッダ内のフィールドの一部をサービスクラスを表すＤＳＣＰ（Ｄｉｆｆｓｅｒｖ Ｃｏｄｅ Ｐｏｉｎｔ）を記録するためのフィールドとして割り当て、このフィールドに設定される１４種のＤＳＣＰ値にしたがって、パケット毎に優先度を変えて転送するという方式である。

【００２４】トラフィックモニク部（プローブ）３はリンク１００上を転送されるＩＰパケットを監視し、つまりパケットをキャプチャし、サービスクラスを表すＤＳＣＰの値と、送出元ＩＰアドレス及び宛先ＩＰアドレスから割り出される送出元サブネットワークアドレスと、宛先サブネットワークアドレスとに基づいてトラフィックを分類し、内部メモリ（図示せず）に蓄積するための装置である。

【００２５】蓄積されたトラフィックデークはＳＮＭＰ（Ｓｉｍｐｌｅ ＮｅｔｗｏｒｋＭａｎａｇｅｍｅｎｔ Ｐｒｏｔｏｃｏｌ）等を用いて監視マネージャ４へ転送されて統計処理が施され、トラフィックの表示・異常の監視・トレンドの把握等に用いられる。監視マネージャ４ではサブネットワークアドレス算出に必要なネットマスクを入力するためのユーザインタフェースも提供す

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る。

【0026】このようにして、本実施例ではトラフィック監視の粒度としてサービスクラス毎及びサブネットワーク毎に集計を行っているので、図示せぬネットワーク上の全端末同士で交換されるトラフィック情報を全アプリケーション毎に把握する代わりに、サブネットワーク毎・サービスクラス毎のトラフィックとして集約させた形で捉えることができ、トラフィックモニタ部3に必要なメモリ量を節約したり、監視マネージャ4への通信量を低くすることができる。

【0027】また、このようにして得られる集約されたトラフィックデータは、特に大規模ネットワークにおいてトラフィック管理をマクロ的に行う場合に有効な情報である。

【0028】図2は図1のトラフィックモニタ部3の構成を示すブロック図である。図2において、トラフィックモニタ部3はインタフェース部31と、抽出部32と、解析部33と、制御部34と、メモリ部（MIB：Management Information Base）35と、SNMPエージェント36とから構成されている。

【0029】インタフェース部31はネットワークリンク100と接続され、IPパケットのキャプチャを行い、物理層及びデータリンク層の終端を行う部分である。抽出部32は下位層の終端が行われたIPヘッダから、集計に必要となるDSCPと送出元IPアドレスと宛先IPアドレスとをそれぞれ抽出する。

【0030】解析部33は抽出された情報と制御部34から受け渡されるネットマスクとからサービスクラス毎及びサブネットワーク毎のトラフィックを集計し、MIBの形式でメモリ部35に蓄積を行う部分である。制御部34はサブネットワークアドレス算出のためのネットマスクを監視マネージャ4からSNMPエージェント36経由で設定したり、トラフィックモニタ部3全体の動作制御を行う部分である。SNMPエージェント36はトラフィックモニタ部3と監視マネージャ4との間のデータ交換に用いられる。

【0031】監視マネージャ4はSNMPプロトコルを用いてトラフィックモニタ部3にネットマスクを設定したり、定期的にトラフィックモニタ部3内のメモリ部35にMIBの形式で保存された収集データにアクセスを行って、このデータをさらに統計・加工処理してトラフィック状態を表示したり、データを蓄積して異常状態の監視やトレンドの把握を行う装置である。

【0032】以上、本実施例の構成について述べたが、監視マネージャ4は当業者にとってよく知られており、また本発明とは直接関係しないので、その詳細な構成及び動作についての説明は省略する。

【0033】図3は図2の抽出部32へ送られるヘッダ情報の詳細を示す図である。図3（a）はIPv4（Internet Protocol version 4）フォーマットのヘッダ情報を示し、図3（b）はIPv6（InternetProtocol version 6）フォーマットのヘッダ情報を示している。

【0034】図4は図2の解析部33にて行う集計動作を説明するための図である。これら図1～図4を参照して本発明の一実施例によるネットワークトラフィック監視システムの動作について説明する。

【0035】まず、トラフィック監視に先立ち、監視マネージャ4からトラフィックモニタ部3に対してサブネットワーク算出に用いるネットマスクが設定される。ネットマスクはIPアドレスのホストアドレスを隠蔽するためのビット列であり、設定はビットを指定しても良いし、例えば（255．255．255．0）や（255．255．0．0）、（255．0．0．0）といったアドレスの形式としても良い。トラフィックモニタ部3はこれを制御部34に記録しておく。

【0036】次に、トラフィックモニタ部3がリンク100上を流れるIPパケットを受信した場合、インタフェース部31では受信したIPパケットの物理層及びデータリンク層を終端し、ヘッダ情報を抽出部32へ送る。

【0037】ここで、抽出部32へ送られるヘッダ情報の詳細を図3に示す。図3（a）はIPv4フォーマットのヘッダ情報を示しており、IPヘッダの先頭から2バイト目にTOS（Type of Service）フィールド11が、3バイト目にLengthフィールド13が、13バイト目に宛先IPアドレスフィールド14が、17バイト目に送出元IPアドレスフィールド15がそれぞれ位置している。DSCPはTOSフィールド11にマッピングされている。

【0038】また、図3（b）はIPv6フォーマットのヘッダ情報を示しており、5ビット目にTraffic Classフィールド12が、5バイト目にLengthフィールド13が、9バイト目に宛先IPアドレスフィールド14が、25バイト目に送出元IPアドレスフィールド15がそれぞれ位置している。DSCPはTraffic Classフィールド12にマッピングされている。抽出部32はこれらの情報を読取って解析部33へと送る。

【0039】解析部33は制御部34から受け渡されたネットマスクと、IPヘッダから抽出された宛先IPアドレス及び送出元IPアドレスとの和をとることによって、宛先サブネットワークと送出元サブネットワークとを算出し、このサブネットワークのペアと、同様にIPヘッダから抽出されたDSCP値（すなわち、サービスクラス）毎にエントリを作成し、該当エントリについてLengthフィールド13で示されたIPパケット長、エントリを確認した回数（すなわち、該当IPパケットの受信回数）それぞれの累積を、メモリ部35にM

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ＩＢ情報として蓄積する。

【００４０】次に、解析部３３にて行う集計動作について例を挙げて説明する。現在、監視マネージャ４からトラフィックモニタ部３に、（２５５．２５５．０．０）というネットマスクが設定されているものとする。

【００４１】この状態において、トラフィックモニタ部３が送出元ＩＰアドレス（１０．２４．３２．１０１）から宛先アドレス（２０．３２．５２．２１１）に対して送られたＤＳＣＰ値（１０１１１０）のパケット長ＬのＩＰパケットを受信したとする。

【００４２】このとき、トラフィックモニタ部３の解析部３３では、図４に示すようなエントリ２１ａを作成する。作成されたエントリ２１ａはパケット長Ｌとともにメモリ部３５内にレングスカウンタ３５ｂ、エントリカウンタ３５ｃとともに１つのレコード３５ａとして格納される。

【００４３】エントリカウンタ３５ｃはレコード３５ａが生成された時に「１」であり、該当エントリが収集される毎に１ずつインクリメントされるカウンタで、すなわち該当ＩＰパケット通信個数を表す。レングスカウンタ３５ｂはキャプチャされる毎にパケットレングスが加算されるカウンタで、すなわち該当ＩＰパケットの通信オクテット数を表す。

【００４４】続いて、送出元ＩＰアドレス（１０．２４．３３．１０）から宛先アドレス（２０．３２．５２．２００）に対して送られたＤＳＣＰ値（１０１１１０）のパケット長ＭのＩＰパケットを受信したとする。このパケットのエントリは先に作られたエントリ２１ａのものと一致するので、エントリカウンタ３５ｃは「２」となり、レングスカウンタ３５ｂは「Ｌ＋Ｍ」となる。

【００４５】また、送出元ＩＰアドレス（１０．２４．３３．１０）から宛先アドレス（２０．３２．５２．．２１１）に対して送られたＤＳＣＰ値（００１０１０）のパケット長ＭのＩＰパケットを受信したとする。この場合、サブネットアドレスは先に送られているＩＰパケットと一致するが，ＤＳＣＰが異なるため、新たなエントリ２１ｂとしてメモリ部３５に格納される。

【００４６】このように、従来方式のように個々のＩＰアドレスでエントリを作成した場合，ｎ台のホストがある状況では最大でｎ×（ｎ－１）個のエントリを作成しなければならず、また４層ポート番号によってプロトコルの識別を行っているため、使用されるポート番号の個数に比例したエントリがさらに必要となる。

【００４７】一方、本実施例のようにサービス毎・サブネットワーク毎に集計を行えば、プロトコルは１４種のサービスのいずれかに分類されるため、サブネットワークがｍ個（ｍ＜ｎ）である場合，エントリは最大でもｍ×（ｍ－１）×１４個だけ作成されることになる。

【００４８】よって、本実施例ではサービス毎・サブネットワーク毎に集計を取っているので、プロトコル毎・Ｅｎｄ－ｔｏ－Ｅｎｄの端末毎に情報を蓄積する場合に比べて情報量が少なくなり、トラフィックモニタ部３のメモリを節約することができる。

【００４９】また、本実施例ではサービス毎・サブネットワーク毎に集計を取っているので、大規模ネットワークに対しても監視の適用が可能となる。エントリ数はｎやｍの２乗に比例するので、ｎとｍとの差が大きければ大きいほど、つまり大規模ネットワークほど効果が大きく表れる。

【００５０】さらに、本実施例ではサービス毎・サブネットワーク毎に集計を取っているので、監視マネージャ４へ転送する情報も少なくなるため、管理ネットワーク上の通信負荷を削減することができる。

【００５１】さらにまた、抽出する情報が全てＩＰヘッダ上にあるため、ＩＰｓｅｃ（ｓｅｃｕｒｉｔｙ ａｒｃｈｉｔｅｃｔｕｒｅ ｆｏｒｉｎｔｅｒｎｅｔ ｐｒｏｔｏｃｏｌ）のＥＳＰ（Ｅｎｃａｐｓｕｌａｔｉｏｎ Ｓｅｃｕｒｉｔｙ Ｐａｙｌｏａｄ）やＩＰｏｖｅｒＩＰのようなカプセル化プロトコルを用いたネットワークに対しても、サービスレベルでのトラフィック監視が可能となる。

【００５２】従来方式では上記のＩＰｓｅｃやＩＰｏｖｅｒＩＰプロトコルが用いられたネットワークにおいて，４層ポート番号が暗号化されたり、ヘッダ先頭からの位置が変化してしまうので，情報を抽出することができず、トラフィックをプロトコル毎に分類することができない。

【００５３】一方，本実施例のようにＤＳＣＰに基づいたサービス毎のトラフィック集計はカプセル化外部のＩＰヘッダ内にその情報が含まれるため、その監視を行うことができる。また，Ｄｉｆｆｓｅｒｖプロトコルを用いたネットワークにおいては、各種アプリケーションによって分類されたトラフィック情報よりも、転送優先度に基づいて分類されたトラフィック情報の方が、ネットワークのＱｏＳ（Ｑｕａｌｉｔｙ ｏｆ Ｓｅｒｖｉｃｅ）を端的に表現することができるため、付加価値の高い情報として扱うことができる。本実施例では以上の効果から、監視システム全体としての監視性能向上が見込まれる。

【００５４】上記の監視マネージャ４からトラフィックモニタ部３に設定するネットマスクは自由に設定可能であるため、（２５５．２５５．２５５．２５５）のようなマスクを設定した場合、サブネットワークアドレスがホストＩＰアドレスと等しくなり、従来のようなＥｎｄ－ｔｏ－Ｅｎｄ毎のトラフィック監視も可能となる。

【００５５】図５は本発明の他の実施例によるルータの構成を示すブロック図である。図５においては本発明の他の実施例によるルータ５内部にトラフィックモニタ部５１を組込んだ例を示している。

【００５６】ルータ５のインタフェース＃１～＃ｎからなるインタフェース部３１に到着したパケットのヘッダ情報はフォワーディングエンジン部５２へ転送され、宛先ＩＰアドレスからハードウェア的に送出先が検索される。このヘッダ情報を抽出部３２にもフォワーディングエンジン部５２と同様に受け渡すことによって、ルータ５のインタフェース部３１に関わらずトラフィックを収集することができるようになる。よって、ノードにおけるトラフィック監視が可能となる。

【００５７】この形態において、（０，０，０，０）のようなマスクを設定した場合には、図示せぬネットワーク内のサービス分布（どのノードにどのサービスが集中しているか等）を把握することも可能となる。

【００５８】また、上記の形態において、トラフィックモニタ部５１と監視マネージャ（図示せず）との間の通信にＣＯＰＳ（Ｃｏｍｍｏｎ　Ｏｐｅｎ　Ｐｏｌｉｃｙ　Ｓｙｓｔｅｍ）プロトコルを用いた場合には、トラフィックモニタ５１部と監視マネージャ部との信頼性の高い通信や、監視ポリシーの設定を実現することができる。ＣＯＰＳプロトコルを利用する場合にはポリシー受け渡しのためのクライアントタイプを予め設定しなければならないが、トラフィックモニタのためのクライアントタイプはＩＥＴＦでも決定はされていないため、新たなクライアントタイプとして登録を行う。

【００５９】

【発明の効果】以上説明したように本発明によれば、ＩＰ（Ｉｎｔｅｒｎｅｔ　Ｐｒｏｔｏｃｏｌ）パケット毎にサービス単位に応じて優先度を変えて転送するＩＰネットワークにおいてトラフィック監視を行うネットワークトラフィック監視システムにおいて、トラフィック監視をサービス単位及びＩＰネットワークのサブネットワーク単位で行うことによって、Ｄｉｆｆｓｅｒｖプロトコルを用いたＩＰネットワークにおいてネットワークの挙動を左右するサービス分布を把握することができ、大規模ネットワークにも対応することができるという効果がある。

【図面の簡単な説明】

【図１】本発明の一実施例によるネットワークトラフィック監視システムの構成を示すブロック図である。

【図２】図１のトラフィックモニタ部の構成を示すブロック図である。

【図３】（ａ）はＩＰｖ４フォーマットのヘッダ情報を示す図、（ｂ）はＩＰｖ６フォーマットのヘッダ情報を示す図である。

【図４】図２の解析部にて行う集計動作を説明するための図である。

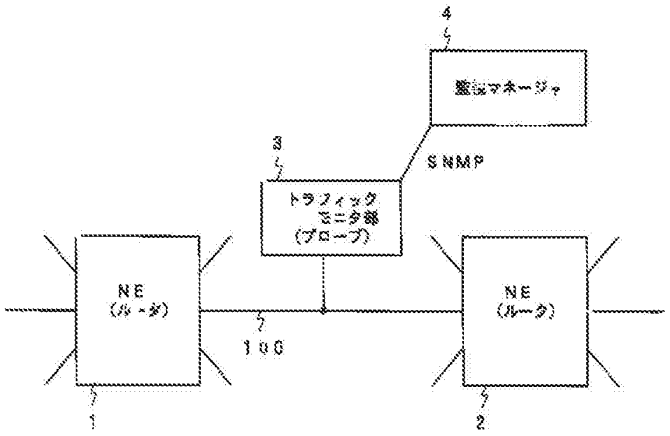
【図５】本発明の他の実施例によるルータの構成を示すブロック図である。

【符号の説明】

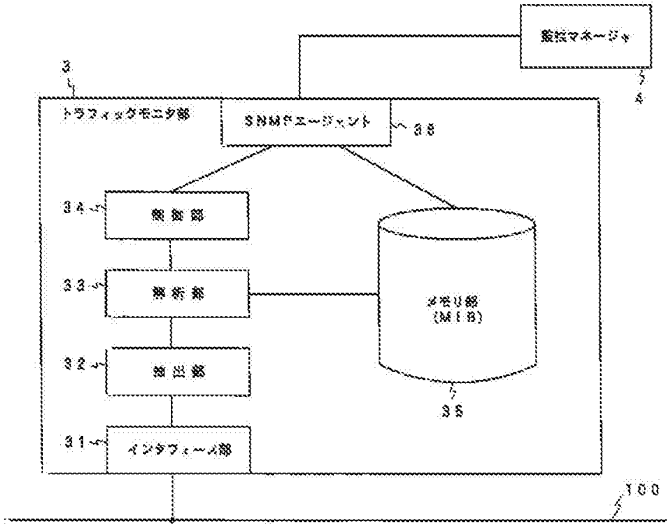
１，２　ＮＥ
３，５１　トラフィックモニタ部
４　監視マネージャ
５　ルータ
１１　ＴＯＳフィールド
１２　Ｔｒａｆｆｉｃ　Ｃｌａｓｓフィールド
１３　Ｌｅｎｇｔｈフィールド
１４　宛先ＩＰアドレスフィールド
１５　送出元ＩＰアドレスフィールド
２１ａ，２１ｂ　エントリ
３１　インタフェース部
３２　抽出部
３３　回析部
３４　制御部
３５　メモリ部
３５ａ　レコード
３５ｂ　レングスカウンタ
３５ｃ　エントリカウンタ
３６　ＳＮＭＰエージェント
５２　フォワーディングエンジン部
１００　リンク

CommScope Exhibit 1024

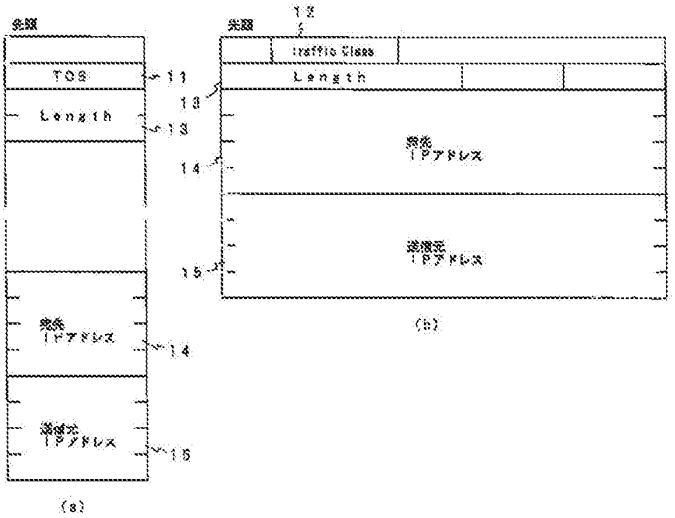
【図1】


4
監視マネージャ
3
SNMP
トラフィック
モニタ部
(プローブ)
NE
(ルータ)
NE
(ルータ)
100
1
2

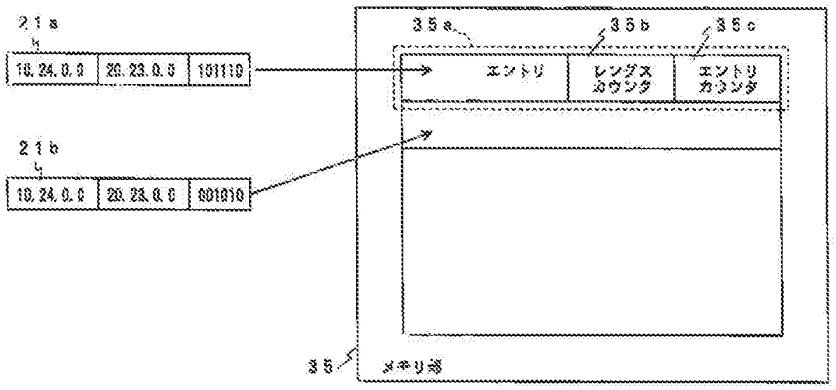
【図2】


監視マネージャ
4
3
トラフィックモニタ部
SNMPエージェント
36
34
33
32
31
インタフェース部
メモリ部
(MIB)
35
100

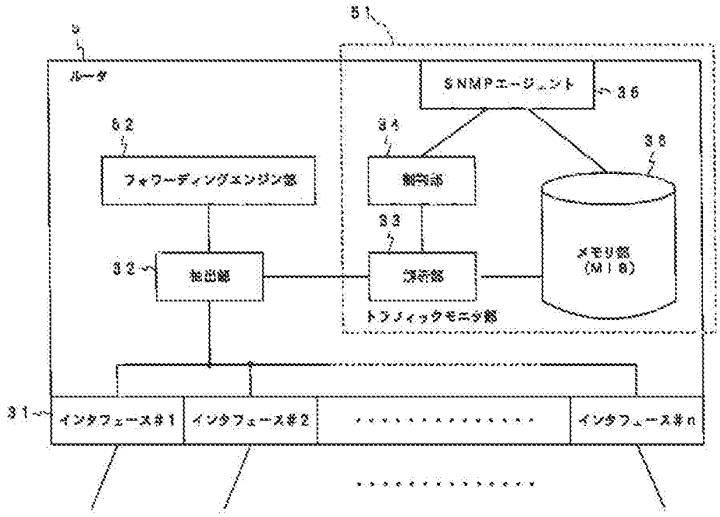
【図3】


TOS
Length
Traffic Class
Length
(a)
(b)

【図4】


21a
10.24.0.0
20.23.0.0
101110
21b
10.24.0.0
20.23.0.0
001010
35a
35b
35c
エントリ
レングス
エントリ
35
メモリ部

【図5】



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DISTRIBUTION ANTENNA SYSTEM, BASE STATION DEVICE, AND ANTENNA SELECTION CONTROL METHOD

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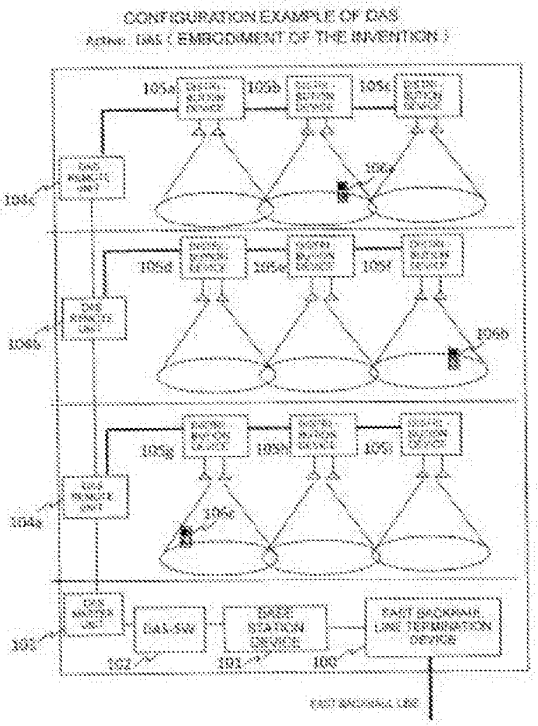
Abstract of JP2012124695 (A)

PROBLEM TO BE SOLVED: To select an optimum communication mode and an optimum antenna depending on a terminal traffic and a radio propagation status. ;SOLUTION: Traffic information between a base station and a terminal is used (812). When the traffic is small, SISO communication or SIMO communication is performed, and on the other hand, when the traffic is large, whether or not MIMO communication should be performed is determined (813). Information on a radio propagation channel between a distribution antenna of the base station and an antenna of the terminal is used for selecting an antenna which can exercise an effect in the MIMO communication. In addition, since antenna selection is changed by performing the MIMO communication, an antenna optimum for the terminal which is performing the SISO communication or the SIMO communication is re-selected in



consideration of interference influence to the terminal which is performing the SISO communication or the SIMO communication. ;COPYRIGHT: (C)2012,JPO&INPIT;PROBLEM TO BE SOLVED: To select an optimum communication mode and an optimum antenna depending on a terminal traffic and a radio propagation status.SOLUTION: Traffic information between a base station and a terminal is used (812). When the traffic is small, SISO communication or SIMO communication is performed, and on the other hand, when the traffic is large, whether or not MIMO communication should be performed is determined (813). Information on a radio propagation channel between a distribution antenna of the base station and an antenna of the terminal is used for selecting an antenna which can exercise an effect in the MIMO communication. In addition, since antenna selection is changed by performing the MIMO communication, an antenna optimum for the terminal which is performing the SISO communication or the SIMO communication is re-selected in consideration of interference influence to the terminal which is performing the SISO communication or the SIMO communication.

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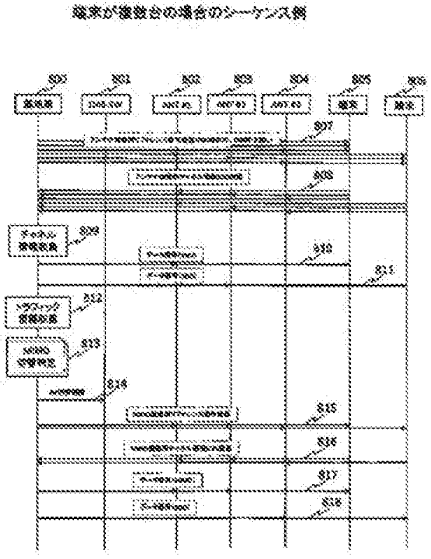
最終頁に続く

(54)【発明の名称】分散アンテナシステム、基地局装置、アンテナ選択制御方法

(57)【要約】
【課題】　端末のトラフィックと無線伝搬状況に応じて、最適な通信モードと最適なアンテナを選択する。
【課題を解決するための手段】　基地局と端末の間のトラフィック情報を用いて８１２、トラフィックが小さい場合はＳＩＳＯ通信もしくはＳＩＭＯ通信を行い、トラフィックが大きい場合はＭＩＭＯ通信をすべきかどうか判定を行い８１３、基地局の分散アンテナと端末のアンテナ間の無線伝搬チャネル情報を用いてＭＩＭＯ通信として効果が発揮できるアンテナを選択する。また、ＭＩＭＯ通信を行うことによって、アンテナの選択が変わるため、ＳＩＳＯ通信やＳＩＭＯ通信を行っている端末への干渉影響を考慮して、ＳＩＳＯ通信やＳＩＭＯ通信を行っている端末にとって最適なアンテナを再選択する。
【選択図】　図１６



【特許請求の範囲】
【請求項１】
複数のアンテナポートを持つ基地局装置と、複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチを備えた分散アンテナシステムにおいて、
前記基地局装置は、
上り下り通信のトラフィック情報を収集するトラフィック情報収集部と、
分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集するチャネル情報収集部と、
前記トラフィック情報収集部及び前記チャネル情報収集部からの情報に基づき、ひとつの端末との通信に複数のアンテナを用いる第１通信と、ひとつの端末との送信又は受信にひとつのアンテナを用いる第２通信との切り替え判定を行う切替判定部と
を備え、
前記切替判定部は、
端末のトラフィック量が予め定められた第１閾値以上でない場合には、第２通信を行うこととし、
端末のトラフィック量が第１閾値以上の場合には、
端末が第１の通信の適用中であり、且つ、現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上である場合、第１の通信を適用するという第１判定を行い、
端末が第１の通信の適用中であり且つ現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上でない場合、又は、端末が第１の通信の適用中でない場合、
（ｉ）複数のアンテナを組み合わせた場合に通信速度又はスループットが、予め定められた第３閾値以上であれば第１通信を適用し、第３閾値以上でなければ第２通信を適用するという第２判定を行う、又は、
（ｉｉ）該端末が利用しているアンテナを利用している他の端末の端末数が、第４閾値以上であれば第１通信を適用し、第４閾値以上でなければ第２通信を適用するという第３判定を行う
ことを特徴とする分散アンテナシステム。

【請求項２】
請求項１に記載の分散アンテナシステムにおいて、
前記第２判定において、
分散アンテナシステムの各アンテナと端末の間のチャネル情報（ＣＳＩ）から、各アンテナのチャネル容量を算出し、
算出したチャネル容量に基づいて、各アンテナの見込み通信速度又はスループットを推定し、
全アンテナを対象として、見込み通信速度又はスループットの速いアンテナ順にリストアップし、
そのリスト上位Ｎ組（Ｎは、１以上の整数）のアンテナを組み合わせた場合、見込み通信速度又はスループットが、前記第３閾値以上である場合は第１通信を適用し、前記第３閾値以上でないである場合は第２通信を適用する
ことを特徴とする分散アンテナシステム。

【請求項３】
請求項２に記載の分散アンテナシステムにおいて、
Ｎは、予め定められた固定値、又は、通信速度又はスループットが所定閾値以上のアンテナ数であることを特徴とする分散アンテナシステム。

【請求項４】
請求項１乃至３のいずれかに記載の分散アンテナシステムにおいて、
前記第２判定により前記端末が第１通信を適用するとした場合に、第２通信を適用している他の端末が別のアンテナを選択するかどうかをさらに判断して最適なアンテナを選び直すことを特徴とする分散アンテナシステム。

【請求項５】
請求項１乃至４のいずれかに記載の分散アンテナシステムにおいて、
前記第２判定により前記端末が第１通信を適用するとした場合に、
第１通信をする端末が利用するアンテナに繋がっている第２通信を行っている他の端末を選択し、
前記他の端末と各アンテナ間のＣＩＮＲ（Ｃａｒｒｉｅｒ Ｉｎｔｅｒｆｅｒｅｎｃｅ Ｎｏｉｓｅ Ｒａｔｉｏ）又はＳＮＲ（Ｓｉｇｎａｌ Ｎｏｉｓｅ Ｒａｔｉｏ）を測定し、
該ＣＩＮＲ又はＳＮＲが閾値以上かを判別し、
該ＣＩＮＲ又はＳＮＲが閾値以上であれば、現在のアンテナを継続使用し、一方、
該ＣＩＮＲ又はＳＮＲが閾値以上でなければ、第２通信をしている他の端末にとってＣＩＮＲ又はＳＮＲが最も良い又は所定値より良いアンテナを再選択する
ことを特徴とする分散アンテナシステム。

【請求項６】
請求項１乃至５のいずれかに記載の分散アンテナシステムにおいて、
前記基地局装置は、
アンテナ切替用リファレンス信号を各アンテナから送信し、
各アンテナが端末から受信したＣＳＩ又はＳＮＲに基づいて、各アンテナの通信速度又はスループットを計算する
ことを特徴とする分散アンテナシステム。

【請求項７】
請求項１乃至５のいずれかに記載の分散アンテナシステムにおいて、
前記基地局装置は、
各アンテナが端末から受信したサウンディング信号又は他の参照信号からチャネル推定処理を行うことでチャネル情報（ＣＳＩ）又はＳＮＲを求め、
求めたＣＳＩ又はＳＮＲに基づいて、各アンテナの通信速度又はスループットを計算する
ことを特徴とする分散アンテナシステム。

【請求項８】
請求項１乃至７のいずれかに記載の分散アンテナシステムにおいて、
前記第１通信は、ＭＩＭＯ（Ｍｕｌｔｉｐｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）であり、
前記第２通信は、ＳＩＳＯ（Ｓｉｇｌｅ Ｉｎｐｕｔ Ｓｉｎｇｌｅ Ｏｕｔｐｕｔ）通信もしくはＳＩＭＯ（Ｓｉｎｇｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）である
ことを特徴とする分散アンテナシステム。

【請求項９】
複数のアンテナポートを持つ基地局装置と、複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチを備えた分散アンテナシステムにおける前記

基地局装置であって、
上り下り通信のトラフィック情報を収集するトラフィック情報収集部と、
分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集するチャネル情報収集部と、
前記トラフィック情報収集部及び前記チャネル情報収集部からの情報に基づき、ひとつの端末との通信に複数のアンテナを用いる第１通信と、ひとつの端末との送信又は受信にひとつのアンテナを用いる第２通信との切り替え判定を行う切替判定部と
を備え、
前記切替判定部は、
端末のトラフィック量が予め定められた第１閾値以上でない場合には、第２通信を行うこととし、
端末のトラフィック量が第１閾値以上の場合には、
端末が第１の通信の適用中であり、且つ、現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上である場合、第１の通信を適用するという第１判定を行い、
端末が第１の通信の適用中であり且つ現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上でない場合、又は、端末が第１の通信の適用中でない場合、
（ｉ）複数のアンテナを組み合わせた場合に通信速度又はスループットが、予め定められた第３閾値以上であれば第１通信を適用し、第３閾値以上でなければ第２通信を適用するという第２判定を行う、又は、
（ｉｉ）該端末が利用しているアンテナを利用している他の端末の端末数が、第４閾値以上であれば第１通信を適用し、第４閾値以上でなければ第２通信を適用するという第３判定を行う
ことを特徴とする基地局装置。

【請求項１０】
複数のアンテナポートを持つ基地局装置と、複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチを備えた分散アンテナシステムにおけるアンテナ選択制御方法であって、
前記基地局装置は、
上り下り通信のトラフィック情報を収集するトラフィック情報収集部と、
分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集するチャネル情報収集部と、
前記トラフィック情報収集部及び前記チャネル情報収集部からの情報に基づき、ひとつの端末との通信に複数のアンテナを用いる第１通信と、ひとつの端末との送信又は受信にひとつのアンテナを用いる第２通信との切り替え判定を行う切替判定部と
を備え、
前記切替判定部は、
端末のトラフィック量が予め定められた第１閾値以上でない場合には、第２通信を行うこととし、
端末のトラフィック量が第１閾値以上の場合には、
端末が第１の通信の適用中であり、且つ、現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上である場合、第１の通信を適用するという第１判定を行い、
端末が第１の通信の適用中であり且つ現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上でない場合、又は、端末が第１の通信の適用中でない場合、
（ｉ）複数のアンテナを組み合わせた場合に通信速度又はスループットが、予め定められ

た第３閾値以上であれば第１通信を適用し、第３閾値以上でなければ第２通信を適用するという第２判定を行う、又は、
（ｉｉ）該端末が利用しているアンテナを利用している他の端末の端末数が、第４閾値以上であれば第１通信を適用し、第４閾値以上でなければ第２通信を適用するという第３判定を行う
ことを特徴とするアンテナ選択制御方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、分散アンテナシステム、基地局装置、アンテナ選択制御方法に係り、特に、ＤＡＳ（分散アンテナシステム）スイッチを用いたＭＩＭＯ向けの分散アンテナシステム、基地局装置、アンテナ選択制御方法に関する。
【背景技術】
【０００２】
電波が届きにくい建物内部の無線環境をよくするために、アンテナを建物内部に分散配置する分散アンテナシステム（ＤＡＳ：Ｄｉｓｔｒｉｂｕｔｅｄ Ａｎｔｅｎｎａ Ｓｙｓｔｅｍ）が知られている。従来の分散アンテナシステムでは，基地局装置から漏洩同軸ケーブルを引きまわして、敷設したケーブルの周囲に電波を輻射する方法が知られている。また、基地局装置が入出力するアナログ伝送信号を分岐結合する装置を介して複数のアンテナに同軸ケーブルで分配する方法が知られている。従来の分散アンテナシステムにおいては、基地局装置の入出力信号を複数のアンテナに分配しているため、すべてのアンテナから同じ信号が入出力されている。近年、ＬＴＥ（Ｌｏｎｇ Ｔｅｒｍ Ｅｖｏｌｕｔｉｏｎ）やＷｉＭＡＸ（Ｗｏｒｌｄｗｉｄｅ Ｉｎｔｅｒｏｐｅｒａｂｉｌｉｔｙ ｆｏｒ Ｍｉｃｒｏｗａｖｅ Ａｃｃｅｓｓ）といった高速無線通信インフラが整備されようとしている。これらの通信方式では、周波数利用効率向上の観点から、複数アンテナからデータを送信して複数アンテナで受信するＭＩＭＯ（Ｍｕｌｔｉｐｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）技術が採用されている。このＭＩＭＯ技術では、複数のアンテナから異なる信号を送受信することが必要となるため、分散アンテナシステムにおいても複数のアンテナから異なる信号を送受信することが求められている。
【０００３】
ＭＩＭＯ技術を分散アンテナシステムに適用する場合の背景技術として、特開２０１０－０６８４９６（特許文献１）がある。この文献には、「端末の電力測定部が、分散アンテナシステムの各アンテナから送信されているパイロット信号の受信電力を長期間測定する。端末は、受信電力が強い所定数個のアンテナを通信アンテナ候補として選択し通信アンテナ候補及びそれに対応する受信電力を無線基地局装置に通知する。端末のチャネル推定部は、無線基地局装置から，通信可能アンテナとそれに付与されるアンテナインデックス情報とを受信して、通信可能なアンテナに関してチャネル推定を行う。ＭＩＭＯ通信を行うためには基地局装置の送信信号に対して演算を行うプリコーディングマトリクスを決定する必要があるが、端末のチャネル推定に基づいて通信可能なアンテナに関するプリコーディングマトリックスインデックス（ＰＭＩ）を求め、アンテナインデックス情報を使って無線基地局装置に通信して通知することによって、データ通信を実行するアンテナ毎の位相回転量、電力比率等を制御する。」　ことが開示されている。
【０００４】
また、特開２００７－５３７６８号公報（特許文献２）がある。この文献には、「無線アクセスユニットからの上り情報を推定することにより，各無線アクセスユニットと該ユーザ間の距離減衰を取得し、距離減衰を取得する。距離減衰推定器は，各距離減衰及び無線アクセスユニットの番号を対応付けて記憶する。リソース割当器は、前記記憶された距離減衰及び無線アクセスユニットの番号に基づいて、該ユーザが採用する無線アクセスユニットを含むリソース割当情報を取得する。送信処理器は、前記リソース割当情報に基づいて、該ユーザデータに対して、対応する送信信号処理を行い、該ユーザが採用する無線

アクセスユニットの各無線アクセスユニットに対するベースバンド信号ストリームを生成する。無線アクセスユニット選択器は、前記リソース割当情報に基づいて、中央処理ユニットに接続されたすべての無線アクセスユニットから、対応する無線アクセスユニットを選択して、前記送信処理器により処理された各ベースバンド信号ストリームを送信する。そして、無線アクセスユニット選択器から出力したベースバンド信号ストリームに対してそれぞれアップコンバート処理を行い、アップコンバート処理後のベースバンド信号ストリームを、下り情報として、伝送リンクを介して、それぞれ対応する無線アクセスユニットへ送信する」ことが開示されている。

【先行技術文献】

【特許文献】

【０００５】

【特許文献１】特開２０１０－０６８４９６号公報

【特許文献２】特開２００７－０５３７６８号公報

【非特許文献】

【０００６】

【非特許文献１】ｈｔｔｐ：／／ｗｗｗ．ｊｐｏ．ｇｏ．ｊｐ／ｓｈｉｒｙｏｕ／ｓ＿ｓｏｎｏｔａ／ｈｙｏｕｊｏｎ＿ｇｉｊｕｔｓｕ／ｍｉｍｏ／１－２－２．ｐｄｆ＃ｐａｇｅ＝１

【非特許文献２】ｈｔｔｐ：／／ｗｗｗ．ｊｐｏ．ｇｏ．ｊｐ／ｓｈｉｒｙｏｕ／ｓ＿ｓｏｎｏｔａ／ｈｙｏｕｊｏｎ＿ｇｉｊｕｔｓｕ／ｍｉｍｏ／１－２－２．ｐｄｆ＃ｐａｇｅ＝３

【発明の概要】

【発明が解決しようとする課題】

【０００７】

上述の分散アンテナシステム（以下、ＤＡＳ）において、すべてのアンテナから同一の無線信号が送信されるように運用すると、エリアを広くカバーするメリットがある一方で、ある特定の端末にのみ送信すればよい信号を不要なアンテナから送信することになる。また、ある特定の端末がＭＩＭＯ通信を行う場合において、上述の特開２０１０－０６８４９６（特許文献１）を適用した場合、ＭＩＭＯ通信用のアンテナが選択されても，それ以外のアンテナを通信に用いるかどうかについての開示がなされていない。ＭＩＭＯ通信以外のアンテナは干渉となるため、用いないことが考えられるが、ある程度，離れたアンテナであれば他のユーザに向けての通信が可能な場合もある。また、特許文献１では、ＭＩＭＯ通信を常にすることを前提としており、ＰＭＩの情報を端末から基地局に常にフィードバックする必要がある。もし、端末と基地局間の通信トラフィック量が少ないときは、ＭＩＭＯ通信を行わずに１本の送受信アンテナでＳＩＳＯ（Ｓｉｎｇｌｅ Ｉｎｐｕｔ Ｓｉｎｇｌｅ Ｏｕｔｐｕｔ）通信もしくはＳＩＭＯ（Ｓｉｎｇｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）通信をしていれば十分であり，ＭＩＭＯ通信を続けるとＰＭＩフィードバックのために無線リソースを消費したり、複数アンテナに対するチャネル推定処理など不必要な信号処理を行うことになる。

【０００８】

また、前記の特許文献２では、端末と基地局の間の距離減衰を基準としてアンテナ等の物理リソースを選択することが開示されている。これによれば、端末に近いアンテナが選ばれることになるが、ＭＩＭＯ通信で例えば２本のアンテナを選択した場合，端末と選ばれた２本のアンテナの距離減衰が小さくても、相関の高い無線伝搬路であればＭＩＭＯ通信として効果を発揮できない場合がある。

【０００９】

本発明は、以上の点に鑑み、端末のトラフィックの大きさに応じてＭＩＭＯ通信、ＳＩＳＯ通信、ＳＩＭＯ通信等の通信方式を最適に選択することを可能とし、常にＭＩＭＯ通信等の複数アンテナを用いる通信を行う場合に比べてＰＭＩ情報などのフィードバックによる無線リソースの消費を節約することを可能とし、及び／又は、効率的な無線通信を実

現することを目的とする。また、本発明は、ＳＩＳＯ通信やＳＩＭＯ通信等のひとつのアンテナを送信又は受信に用いる通信を行う端末を選ぶことによって、トラフィックに応じて必要な信号処理量とし、常にＭＩＭＯ通信等の複数アンテナを用いる通信を行う場合に比べて端末の消費電力を低減することを目的とする。

【００１０】

また、本発明は、ＭＩＭＯ通信等の複数アンテナを用いる通信を行うために、無線伝搬チャネル情報に基づいてアンテナを再選択するため、ＭＩＭＯ通信等の複数アンテナを用いる通信で効果を発揮することのできるアンテナを選択することを目的とする。

また、本発明によれば、ある特定の端末がＭＩＭＯ通信等の複数アンテナを用いる通信を行うことになった場合には、ＭＩＭＯ通信の複数アンテナを用いる通信で用いるアンテナを共用する端末でＳＩＳＯ通信やＳＩＭＯ通信等のひとつのアンテナを送信又は受信に用いる通信を行っている端末への干渉の影響を考慮し、信号対干渉雑音電力比が大きな品質のよいアンテナを再選択することによって、システム全体のスループットを向上することを目的とする

【課題を解決するための手段】

【００１１】

本発明では、上記課題を解決するために、例えば、基地局と端末の間のトラフィック情報を用いて、トラフィックが小さい場合はＳＩＳＯ通信、もしくはＳＩＭＯ通信を行い、トラフィックが大きい場合はＭＩＭＯ通信をすべきかどうか判定を行い、基地局の分散アンテナと端末のアンテナ間の無線伝搬チャネル情報を用いてＭＩＭＯ通信として効果が発揮できるアンテナを選択する分散アンテナシステムを提供する。また、ＭＩＭＯ通信を行うことによって，アンテナの選択が変わるため、ＳＩＳＯ通信やＳＩＭＯ通信を行っている端末への干渉影響を考慮して、ＳＩＳＯ通信やＳＩＭＯ通信を行っている端末にとって最適なアンテナを再選択することを特徴とすることができる。

【００１２】

本発明における分散アンテナシステムでは、例えば、複数のアンテナポートを持つ基地局装置と，複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチとを備えており、基地局装置では，上り下り通信のトラフィック情報を収集する手段と、分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集する手段と，ＭＩＭＯ（Ｍｕｌｔｉｐｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）通信を行うか否かを判定する手段と、ある端末がＭＩＭＯ通信を行うとした場合に、ＳＩＳＯ（Ｓｉｇｌｅ Ｉｎｐｕｔ Ｓｉｎｇｌｅ Ｏｕｔｐｕｔ）通信もしくはＳＩＭＯ（Ｓｉｎｇｌｅ Ｉｎｐｕｔ Ｍｕｌｔｉｐｌｅ Ｏｕｔｐｕｔ）通信をしている端末のアンテナを選択する手段を有し、端末のトラフィック量がある閾値以上でない場合には、トラフィック量の大きさによってＳＩＳＯ通信、もしくはＳＩＭＯ通信を行うこととし、端末のトラフィック量が閾値以上の場合には、ＭＩＭＯ通信を行うかどうかを判定して、もし、前記端末がＭＩＭＯ通信を行うとした場合に、他のＳＩＳＯ通信もしくはＳＩＭＯ通信を行っている端末が別のアンテナを選択するかどうかを判断して最適なアンテナを選び直すことを特徴とすることができる。

【００１３】

上記のＭＩＭＯ通信を行うか否かを判定する手段においては、端末のトラフィックがある閾値を超えた場合、分散アンテナシステムの各アンテナと端末の間のチャネル情報（ＣＳＩ）から、各アンテナのチャネル容量を算出して、各アンテナの見込み通信速度を推定し、全アンテナを対象として、見込み通信速度の速いアンテナ順にリストアップし、そのリスト上位Ｎ組のアンテナを組み合わせた場合に、見込み通信速度が閾値以上となる場合にＭＩＭＯを適用し、当該リスト上位Ｎ組のアンテナを組み合わせた場合、見込み推定速度が閾値未満である場合はＭＩＭＯを適用しない。これによって、チャネル情報に基づいてＭＩＭＯ通信の効果が発揮できる場合にのみＭＩＭＯ通信を行うことになる。

【００１４】

なお、チャネル容量の計算は、例えば、非特許文献１及び２に記載の計算式を参照するものとする。

もしくは、上記のＭＩＭＯ通信を行うか否かを判定する手段において、端末のトラフィックがある閾値を超えた場合に、その端末が利用しているアンテナを利用している他の端末数が閾値以上の場合に、ＭＩＭＯ通信を行うものとし、他の端末数が閾値以上でない場合にはＭＩＭＯ通信を行わなくてもよい。

【００１５】

また、上記で、ある特定の端末がＭＩＭＯ通信を行うと決定した場合に、ＳＩＳＯ通信もしくはＳＩＭＯ通信をしている端末のアンテナを選択する手段において、ＭＩＭＯ通信をする端末が利用するアンテナに繋がっているその他のＳＩＳＯもしくはＳＩＭＯ通信を行っている端末を選択し、前記端末と各アンテナ間のＣＩＮＲ（Ｃａｒｒｉｅｒ Ｉｎｔｅｒｆｅｒｅｎｃｅ Ｎｏｉｓｅ Ｒａｔｉｏ）を測定し、当該ＣＩＮＲが閾値以上のアンテナに対して、ＳＩＳＯもしくはＳＩＭＯ通信をしている端末にとってＣＩＮＲが最も良いアンテナを再選択することができる。

ＣＩＮＲは、例えば、ＣＳＩを取得後、そのタイミングでその都度ＣＩＮＲを計算するものとする。なお、ＣＩＮＲ以外のパラメータとして、ＳＮＲ（Ｓｉｇｎａｌ Ｎｏｉｓｅ Ｒａｔｉｏ）がアンテナ再選択に使用される場合もある。

【００１６】

本発明の第１の解決手段によると、

複数のアンテナポートを持つ基地局装置と、複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチを備えた分散アンテナシステム、及び、アンテナ選択制御方法であって、

前記基地局装置は、

上り下り通信のトラフィック情報を収集するトラフィック情報収集部と、

分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集するチャネル情報収集部と、

前記トラフィック情報収集部及び前記チャネル情報収集部からの情報に基づき、ひとつの端末との通信に複数のアンテナを用いる第１通信と、ひとつの端末との送信又は受信にひとつのアンテナを用いる第２通信との切り替え判定を行う切替判定部と

を備え、

前記切替判定部は、

端末のトラフィック量が予め定められた第１閾値以上でない場合には、第２通信を行うこととし、

端末のトラフィック量が第１閾値以上の場合には、

端末が第１の通信の適用中であり、且つ、現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上である場合、第１の通信を適用するという第１判定を行い、

端末が第１の通信の適用中であり且つ現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上でない場合、又は、端末が第１の通信の適用中でない場合、

（ｉ）複数のアンテナを組み合わせた場合に通信速度又はスループットが、予め定められた第３閾値以上であれば第１通信を適用し、第３閾値以上でなければ第２通信を適用するという第２判定を行う、又は、

（ｉｉ）該端末が利用しているアンテナを利用している他の端末の端末数が、第４閾値以上であれば第１通信を適用し、第４閾値以上でなければ第２通信を適用するという第３判定を行う

ことを特徴とする分散アンテナシステム、及び、アンテナ選択制御方法が提供される。

【００１７】

本発明の第２の解決手段によると、

複数のアンテナポートを持つ基地局装置と、複数のアンテナを持つ端末と、複数の分配装置を空間的に分散配置して分配装置のアンテナと基地局装置のアンテナポートの接続を上り下り通信で切り替えるアンテナスイッチを備えた分散アンテナシステムにおける前記基地局装置であって、

上り下り通信のトラフィック情報を収集するトラフィック情報収集部と、

分散アンテナから端末のアンテナまでの無線伝搬チャネルの情報を収集するチャネル情報収集部と、

前記トラフィック情報収集部及び前記チャネル情報収集部からの情報に基づき、ひとつの端末との通信に複数のアンテナを用いる第１通信と、ひとつの端末との送信又は受信にひとつのアンテナを用いる第２通信との切り替え判定を行う切替判定部と

を備え、

前記切替判定部は、

端末のトラフィック量が予め定められた第１閾値以上でない場合には、第２通信を行うこととし、

端末のトラフィック量が第１閾値以上の場合には、

端末が第１の通信の適用中であり、且つ、現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上である場合、第１の通信を適用するという第１判定を行い、

端末が第１の通信の適用中であり且つ現在のアンテナの組み合わせによる通信速度又はスループットが予め定められた第２閾値以上でない場合、又は、端末が第１の通信の適用中でない場合、

（ｉ）複数のアンテナを組み合わせた場合に通信速度又はスループットが、予め定められた第３閾値以上であれば第１通信を適用し、第３閾値以上でなければ第２通信を適用するという第２判定を行う，又は，

（ｉｉ）該端末が利用しているアンテナを利用している他の端末の端末数が、第４閾値以上であれば第１通信を適用し，第４閾値以上でなければ第２通信を適用するという第３判定を行う

ことを特徴とする基地局装置が提供される。

【発明の効果】

【００１８】

本発明によれば、端末のトラフィックの大きさに応じてＭＩＭＯ通信、ＳＩＳＯ通信、ＳＩＭＯ通信等の通信方式を最適に選択することが可能となり、常にＭＩＭＯ通信等の複数アンテナを用いる通信を行う場合に比べてＰＭＩ情報などのフィードバックによる無線リソースの消費を節約することが可能であり、及び／又は、効率的な無線通信を実現することができる。また、本発明によれば、ＳＩＳＯ通信やＳＩＭＯ通信等のひとつのアンテナを送信又は受信に用いる通信を行う端末を選ぶことによって、トラフィックに応じて必要な信号処理量となり、常にＭＩＭＯ通信等の複数アンテナを用いる通信を行う場合に比べて端末の消費電力を低減することができる。

【００１９】

また、本発明によれば、ＭＩＭＯ通信等の複数アンテナを用いる通信を行うために、無線伝搬チャネル情報に基づいてアンテナを再選択するため、ＭＩＭＯ通信等の複数アンテナを用いる通信で効果を発揮することのできるアンテナを選択することができる。

また、本発明によれば、ある特定の端末がＭＩＭＯ通信等の複数アンテナを用いる通信を行うことになった場合には、ＭＩＭＯ通信の複数アンテナを用いる通信で用いるアンテナを共用する端末でＳＩＳＯ通信やＳＩＭＯ通信等のひとつのアンテナを送信又は受信に用いる通信を行っている端末への干渉の影響を考慮し、信号対干渉雑音電力比が大きな品質のよいアンテナを再選択することによって、システム全体のスループットを向上することができる。

【図面の簡単な説明】

【００２０】

【図１】ＤＡＳの構成例である。
【図２】ＤＡＳの他の構成例（ＤＡＳ－ＳＷから直接アンテナを分配）である。
【図３】基地局の構成ブロック図の例である。
【図４】ＤＡＳスイッチ構成ブロックの例である。
【図５】基地局内ＭＩＭＯ切替判定部のフローチャート例（その１）である。
【図６】基地局内トラフィック情報収集部におけるトラフィック量判定図の例である。
【図７】基地局内ＭＩＭＯ切替判定部のフローチャート例（その２）である。
【図８】ＤＡＳスイッチの例である。
【図９】ＤＡＳスイッチ例（ＳＩＳＯ時）である。
【図１０】ＤＡＳスイッチ例（ＭＩＭＯ時）である。
【図１１】端末が１台の場合のシーケンスの例である。
【図１２】ＤＡＳスイッチ実施の形態（ＳＩＭＯ時）である。
【図１３】ＤＡＳスイッチ実施の形態（ＭＩＭＯ時）である。
【図１４】ＤＡＳスイッチ実施の形態（複数台ＳＩＭＯ時）である。
【図１５】ＤＡＳスイッチ実施の形態（ＭＩＭＯ、ＳＩＳＯ共存時）である。
【図１６】端末が複数台の場合のシーケンスの例である。
【図１７】ＤＡＳスイッチ実施の形態（その３）である。
【図１８】基地局内ＭＩＭＯ切替判定部のフローチャートの例（その３）である。
【図１９】基地局内ＭＩＭＯ切替判定部のフローチャートの例（その６）である。
【図２０】チャネル情報（ＣＳＩ）のデータベース配列である。
【図２１】基地局内ＭＩＭＯ切替判定部のフローチャートの例（その４）である。
【図２２】基地局内ＭＩＭＯ切替判定部のフローチャートの例（その５）である。
【発明を実施するための形態】
【００２１】
以下に，本発明における実施の形態について説明する。

Ａ．実施の形態１

１．システム構成

図１に，本実施の形態におけるＤＡＳの構成例を示す。ダウンリンクについて、高速バックホールからのデータ信号は、高速バックホール回線終端装置１００を経由し、基地局装置１０１で無線通信方式に従った符号化・変調・増幅等の処理が行われる。ＤＡＳスイッチ１０２は、入力端は基地局装置１０１のアンテナポートと接続され、出力端はＤＡＳ親機１０３に接続されており，基地局装置１０１のアンテナポートと分散アンテナシステムのアンテナ間をスイッチによって切替制御が行われる。ＤＡＳ親機１０３で終端・中継された信号は、建物の各階に設置されたＤＡＳ子機１０４ａ～１０４ｃへ中継され，ＤＡＳスイッチ１０２の切替制御に従って、分配装置１０５ａ～１０５ｉへ信号が送信される。その後，分配装置１０５ａ～１０５ｉ内の各アンテナから適宜、データ信号が送信される。アップリンクについては、上記と逆の過程となる。図１のＤＡＳスイッチは、基地局装置とＤＡＳ親機の間に設置する形態であるか、ＤＡＳスイッチのその他の形態としては、基地局装置内に組み込むものや、ＤＡＳ親機内に組み込まれている場合がある。
【００２２】
図２に，ＤＡＳの他の構成例を示す。図２は、図１の構成例で想定した建物よりも小規模な場合におけるＤＡＳの構成例である。ダウンリンクについて、高速バックホール回線からのデータ信号が、高速バックホール回線終端装置２００、基地局装置２０１を経由する部分は図１と同様であるが、図１と異なる部分は、ＤＡＳスイッチ２０２が直接アンテナ２０３ａ～２０３ｈへ直接接続されていることである。この場合，ＤＡＳスイッチ２０２は切替制御のみならず、図１のＤＡＳ親機１０３の機能である信号終端・中継等の機能を有する場合もある。アップリンクについては、上記と逆の過程となる。

【００２３】
図３に、基地局構成ブロック図の例を示す。基地局３００は、大きく、基地局と高速バックバックホール間のデータの送受信経路となる高速バックホール回線３０１と、バックホール回線を終端するバックホール回線インタフェース３０２と、制御部３０７と、信号の生成、変調、増幅およびその他信号処理を行うベースバンド／ＲＦ（Ｒａｄｉｏ Ｆｒｅｑｕｅｎｃｙ）部３０９と、ＲＦ外部インタフェース３１３と、アンテナポート３１４を備える。制御部３０７では、データのトラフィック情報を収集するトラフィック情報収集部３０３と、トラフィック情報のデータベースであるトラフィック情報３０４と、スイッチの切替制御やＭＩＭＯ等の通信に必要なチャネル情報（ＣＳＩ：Ｃｈａｎｎｅｌ Ｓｔａｔｅ Ｉｎｆｏｒｍａｔｉｏｎ）を収集するチャネル情報収集部３０５と、チャネル情報のデータベースであるチャネル情報３０６と、トラフィック情報３０４及びチャネル情報３０６を利用してＭＩＭＯを実施するか否かを判定するＭＩＭＯ切替判定部３０７と、ＭＩＭＯ切替判定部３０７で決定されたフローに従って、スイッチ切替を制御するための信号処理を行う制御信号処理部３０８を備える。ベースバンド／ＲＦ部３０９は、ベースバンド信号処理及びＲＦ信号処理以外に、アンテナ切替用やＭＩＭＯ通信用のリファレンス信号生成３１０と、ＳＩＳＯ信号処理３１１と、ＭＩＭＯ信号処理３１２の機能が含まれる。ベースバンド／ＲＦ部３０９で処理された信号はＲＦ信号へ変調・増幅された後、ＲＦ外部インタフェース３１３を経由し，アンテナポート３１４から送信される。ここで、本発明に係る全ての実施の形態において、トラフィックとはダウンリンクにおけるトラフィック量を指すが，別の形態として、アップリンクのトラフィック量の場合もある。また、ＳＩＳＯ信号処理３１１では，受信にダイバーシティ受信を考慮して複数のアンテナで受信するＳＩＭＯ信号処理３１１であってもよい。
【００２４】
図４に，ＤＡＳスイッチ構成ブロック図の例を示す。ＤＡＳスイッチ３１５は、基地局アンテナポートと接続される入力ポート３１６と、基地局からのスイッチ切替制御信号を処理する制御部３１７と、制御部３１７の制御に従って切替を行うスイッチ３１８と、ＤＡＳ親機もしくはＤＡＳアンテナと接続される出力ポート３１９を備える。
【００２５】
２．ＭＩＭＯ切替判定フロー

図５に，基地局内ＭＩＭＯ切替判定部のフローチャート例（その１）を示す。このフローチャートは、図３の基地局３００内のＭＩＭＯ切替判定部３０７の内部処理を説明するものであり、ある特定の端末１台にフォーカスしたものである。端末へのトラフィックがある閾値を超えた場合（Ｓｔｅｐ１）、各チャネル情報（ＣＳＩ）から、各ＤＡＳアンテナのチャネル容量を計算する（Ｓｔｅｐ２）。このＣＳＩは、アンテナ切替用として用いられる。次に、計算されたチャネル容量に基づき、各アンテナの見込み通信速度を推定する。見込み通信速度は、例えば、チャネル容量からそのアンテナにつながっている端末数で除したもの等から算定される。その後、全アンテナを対象として、見込み通信速度の速いアンテナ順にリストアップを実施する（Ｓｔｅｐ４）。さらに、そのリスト上位Ｎ組のアンテナを組合せた場合、見込み通信速度が閾値以上である場合（Ｓｔｅｐ５）、ＭＩＭＯ適用（Ｓｔｅｐ６）となる。Ｓｔｅｐ１でトラフィック量が閾値以上でない、あるいは、Ｓｔｅｐ５で見込み通信速度が閾値以上でない場合は、ＭＩＭＯ適用しない（Ｓｔｅｐ７）。Ｓｔｅｐ６またはＳｔｅｐ７の後は，Ｓｔｅｐ１へ戻る。このＭＩＭＯ切替判定は定期的あるいは周期的に実施されるものとし、その都度，データ（ＣＳＩ情報等）が更新される為、見込み通信速度リストの上位のアンテナがＭＩＭＯ通信に採用される。なお、Ｓｔｅｐ１における閾値は、ＳＩＳＯ通信もしくはＳＩＭＯ通信からＭＩＭＯ通信に切り替わる際に用いる閾値とは別に、ＭＩＭＯ通信からＳＩＳＯ通信もしくはＳＩＭＯ通信に切り替わる閾値を設定してもよい。
【００２６】
図６に、トラフィック量判定図の例を示す。縦軸はトラフィック量であり，横軸は時間

である。トラフィック量判定には図３の基地局３００内のトラフィック情報３０４のデータが使用される。このトラフィック量が閾値１以上でない場合は、ＭＩＭＯ通信が実施されることはなく、ＳＩＳＯまたはＳＩＭＯのみ実施される。ある時間ｔ１において、閾値１以上となった場合、ＭＩＭＯ切替判定の次のステップへ進む。後述の図５または図７または図２２のフローチャートであれば、ＳｔｅｐｌからＳｔｅｐ２のフローに該当し、後述の図１８または図１９または図２１のフローチャートであれば、Ｓｔｅｐ２からＳｔｅｐ３のフローに該当する。

【００２７】

３．ＤＡＳスイッチ

図８に、ＤＡＳスイッチの動作例を示す。ＤＡＳスイッチ４００は、一例として入力端に４ポート、出力端に８ポートを有しており、入力端は、図１の基地局装置１０１または図２の基地局装置２０１のアンテナポートと接続され、出力端は、図１のＤＡＳ親機１０３または図２のアンテナ２０３ａ～２０３ｈと接続される。図８では、入力端（つまり、基地局装置のアンテナポート）＜１＞～＜４＞が出力端の各アンテナ番号＃３～６と各々接続されている様子を示している。この場合は、アンテナ番号＃３～＃６の４本のアンテナが基地局装置１０１にとって４本の独立したアンテナとして動作することになる。

【００２８】

図９に、ＳＩＳＯ適用時におけるＤＡＳスイッチの動作例を示す。この図では、ＤＡＳスイッチ５０１において、基地局装置のアンテナポート＜１＞とアンテナ＃１が接続されている。基地局装置の他のアンテナポートはＤＡＳスイッチ５０１内において接続されていない。従って、端末５００とアンテナ＃１の間でＳＩＳＯ通信が行われる。

【００２９】

図１０に、ＭＩＭＯ適用時におけるＤＡＳスイッチの動作例を示す。この図では、ＤＡＳスイッチ５０３において、基地局装置のアンテナポート＜１＞とアンテナ＃１、基地局装置のアンテナポート＜２＞とアンテナ＃２が各々接続されている。基地局装置の他のアンテナ番号はＤＡＳスイッチ５０１内において接続されていない。従って、端末５００とアンテナ＃１及び＃２の間で送受信アンテナ２本でのＭＩＭＯ通信が行われる。

上記の例では、ＳＩＳＯ通信やＭＩＭＯ通信の接続の例を示したが、使用していない基地局のアンテナポートを他のアンテナに接続して、他のユーザ端末と通信を行ってもよい。

【００３０】

４．シーケンス１（端末が１台の場合）

図１１に、端末が１台の場合における基地局装置と端末間のシーケンスを示す。

基地局６００から送信されたアンテナ切替用リファレンス信号６０６はＤＡＳスイッチ６０１を経て、アンテナ６０２～６０４から各々送信され、端末６０５で受信される。その後、端末６０５は、リファレンス信号からチャネル推定処理によってチャネル情報（ＣＳＩ）を求め、アンテナ切替用チャネル情報（ＣＳＩ）６０７をフィードバック信号として送信し、各アンテナ６０２～６０４で受信され、ＤＡＳスイッチ６０１を経て、基地局６００で受信される。但し、ＴＤＤ（Ｔｉｍｅ　Ｄｉｖｉｓｉｏｎ　Ｄｕｐｌｅｘ）システムにおいては、アンテナ切替用リファレンス信号の送信は行わなくてもよく、アップリンクに既知のサウンディング信号を送信することによって、基地局側で受信したサウンディング信号からチャネル推定処理を行うことでチャネル情報（ＣＳＩ）を求め、求めたチャネル情報をダウンリンクのチャネル情報として活用してもよい。

【００３１】

その後、チャネル情報収集６０８において、チャネル情報収集部３０５は、取得したチャネル情報をデータベース化する。例えば、データベースとしては、使用するアンテナ本数に対応したアンテナ番号と対象となる端末のチャネル情報（ＣＳＩ）が対応づけで記憶される。この時、基地局６００から端末６０５へはデータ信号（ＳＩＳＯ）６０９が送信

されているが、その際にトラフィック情報収集６１０にて、トラフィック情報収集部３０３により、データトラフィック量が集計される。なお、この例では、ＳＩＳＯを前提としたが、これ以外にもＳＩＭＯ、ＭＩＭＯ等の適宜の通信方式によりデータ信号を送信する場合を前提とすることができる。

【００３２】

以上のトラフィック情報とチャネル情報により、ＭＩＭＯ切替判定６１１にて、ＭＩＭＯ切替判定部３０７により、ＭＩＭＯを実施するか否かが判定され、ＭＩＭＯが実施される場合には，チャネル情報によって最適なアンテナが選択され、選択されたアンテナを基地局６００からＤＡＳスイッチ６０１に対して、スイッチ切替制御６１２が制御信号処理部３０８により行われる。スイッチ切替制御が完了すると、基地局６００からＭＩＭＯ通信用リファレンス信号６１３がＤＡＳスイッチ６０１を経て、アンテナ６０２及びアンテナ６０３から送信され，端末６０５で受信される。その後，端末６０５からＭＩＭＯ通信用チャネル情報（ＣＳＩ）６１４を送信し、アンテナ６０２及び６０３、ＤＡＳスイッチ６０１を経て、基地局６００で受信される。その後，基地局６００から送信されたデータ信号（ＭＩＭＯ）６１５が、ＤＡＳスイッチ６０１を経て，アンテナ６０２及びアンテナ６０３を使用して、端末６０５で受信される。このようにして、ＭＩＭＯ通信に最適なアンテナが選択され、選択されたアンテナを用いてＭＩＭＯ通信が行われる。

【００３３】

図１２に、ＳＩＭＯ適用時におけるＤＡＳスイッチの動作例を示す。横軸を時間として、各アンテナ＃１～８のダウンリンク（ＤＬ）及びアップリンク（ＵＬ）での基地局装置のアンテナポート＜１＞～＜４＞との対応を表している。図の左側から説明すると，最初のＤＬでは、アンテナ＃１、＃２、＃３、＃４には基地局装置のアンテナポート＜１＞、＜２＞、＜３＞，＜４＞が繋がっており、各々アンテナ切替用リファレンス信号送信のために使用されている。図中のＳｌｏｔ１は，スイッチング時間及び基地局装置がアンテナ切替用リファレンス信号を送信する期間である。アンテナ＃５～８とは基地局装置のいずれのアンテナとも接続されていない。最初のＵＬではＤＬと同じスイッチング状態を保持しているが、端末のアンテナ切替用チャネル情報（ＣＳＩ）送信に使用されている。図中のＳｌｏｔ２は，スイッチング時間及び端末がアンテナ切替用チャネル情報（ＣＳＩ）を送信する期間である。２番目のＤＬでは、アンテナ＃５，＃６，＃７，＃８には基地局装置のアンテナポート＜１＞、＜２＞，＜３＞、＜４＞が繋がっており，各々アンテナ切替用リファレンス信号送信のために使用されている。図中のＳｌｏｔ３は、スイッチング時間及び基地局装置がアンテナ切替用リファレンス信号を送信する期間である。アンテナ＃１～４とは基地局装置のいずれのアンテナとも接続されていない。２番目のＵＬでは２番目ＤＬと同じスイッチング状態を保持しているが，端末のアンテナ切替用チャネル情報（ＣＳＩ）送信時間として使用されている。図中のＳｌｏｔ４は，スイッチング時間及び端末がチャネル情報（ＣＳＩ）を送信する期間である。以上の＃１～８の全アンテナについてのアンテナ切替用チャネル情報の収集プロセスは、例えば、周期的または定期的に実施されるものとする。

【００３４】

Ｓｌｏｔ１からＳｌｏｔ４にて、基地局装置からリファレンス信号を送信して、端末からチャネル情報をフィードバックして得る例を示したが，上記のように端末からサウンディング信号を送信して，サウンディング信号からチャネル情報を基地局で求め、このチャネル情報を下りのチャネル情報として活用するＴＤＤシステムでは、アップリンクでの受信のみ切り替えればよい。

Ｓｌｏｔ４以降では、アンテナ＃１にはＤＬ／ＵＬいずれも基地局装置のアンテナポート＜１＞が、アンテナ＃２にはＵＬのみ基地局装置のアンテナポート＜２＞が割り当てられており、ある期間，ＳＩＭＯ通信を実施している例を示している。

【００３５】

図１３に、ＭＩＭＯ適用時におけるＤＡＳスイッチの動作例を示す。この図では、図１２と異なり、Ｓｌｏｔ１～Ｓｌｏｔ４の期間を終えると、アンテナ＃１及び＃２には、基

地局装置のアンテナポート＜１＞、＜２＞が常に割り当てられ、ＭＩＭＯ通信が実施される。

【００３６】

５．アンテナの移動動作

図１４に、複数端末が繋がっており、いずれもＳＩＳＯ通信中のＤＡＳスイッチの実施の形態を示す。この図では、ＤＡＳスイッチ７０２において、基地局装置のアンテナポート＜１＞、＜２＞が各々アンテナ＃１、＃４と接続されている。またアンテナ＃１、＃４と端末７００、７０１間で各々ＳＩＳＯ通信が行われている例を示している。

【００３７】

図１５は、図１４の状態から、端末７００の１台がＭＩＭＯを適用した時のアンテナ再割当の様子を示している。この図では、ＤＡＳスイッチ７０５において、基地局装置のアンテナポート＜１＞、＜２＞とアンテナ＃１、＃２が各々接続されており、アンテナ＃１、＃２と端末７００でＭＩＭＯが開始されると、ＳＩＳＯ通信を行っている端末７０１はＭＩＭＯ通信への干渉が少ないアンテナ、即ち、この例ではアンテナ＃６へ移動する。具体的には、ＣＩＮＲを判定パラメータとし、アンテナ＃４からアンテナ＃６へ再割当が実施される。ここで、アンテナ＃６は、基地局装置のアンテナポート＜３＞と接続されている。

【００３８】

このように、ある端末がＭＩＭＯ開始した際、例えばＳＩＳＯやＳＩＭＯを行っている端末はＣＩＮＲ値をパラメータとして、ＭＩＭＯ通信への干渉が少ないアンテナへ移動することができる。

【００３９】

ここで、既知のパイロット信号を基地局装置側のアンテナ＃ｉから送信し、端末側のアンテナ＃ｊで受信した信号に対してチャネル推定した結果のチャネル情報を$h_{j,i}$とすると、基地局装置のアンテナ＃４と端末７０１間のＳＩＳＯ通信において、各所望波、各干渉波、ノイズはそれぞれ以下となる。但し、基地局装置の全送信電力をＰとすると、アンテナ＃１および＃２の送信電力は各Ｐ／４、アンテナ＃４の送信電力は、Ｐ／２に配分されたケースであり、その他の電力配分も同様の手法で算出できる。

【数１】

所望波（＃ｃ）：$\frac{P}{2}|h_{4c}|^2$ （数式１）

所望波（＃ｄ）：$\frac{P}{2}|h_{4d}|^2$ （数式２）

干渉波（アンテナ＃ｃ）：$\frac{P}{4}|h_{1c}|^2+\frac{P}{4}|h_{2c}|^2$ （数式３）

干渉波（アンテナ＃ｄ）：$\frac{P}{4}|h_{1d}|^2+\frac{P}{4}|h_{2d}|^2$ （数式４）

したがって、

【数２】

$$\mathrm{CINR}(\text{アンテナ}\#c):\frac{\frac{P}{2}|h_{1c}|^2}{\sigma^2+\frac{P}{4}|h_{1c}|^2+\frac{P}{4}|h_{2c}|^2} \qquad (\text{数式}5)$$

$$\mathrm{CINR}(\text{アンテナ}\#d):\frac{\frac{P}{2}|h_{1d}|^2}{\sigma^2+\frac{P}{4}|h_{1d}|^2+\frac{P}{4}|h_{2d}|^2} \qquad (\text{数式}6)$$

$$\mathrm{CINR}(\text{端末}701):\frac{\frac{P}{2}|h_{1c}|^2+\frac{P}{2}|h_{1d}|^2}{2\sigma^2+\frac{P}{4}|h_{1c}|^2+\frac{P}{4}|h_{2c}|^2+\frac{P}{4}|h_{1d}|^2+\frac{P}{4}|h_{2d}|^2} \qquad (\text{数式}7)$$

ここで、σ^2は、熱雑音電力である。端末７０１のＣＩＮＲを表すものには、アンテナ＃ｃと＃ｄ間での合成ダイバーシティを示す数式７のほかに、数式５と数式６の平均をとったもの、もしくは数式５と数式６のどちらか値の大きな方を選ぶ方法（選択ダイバーシティ）が挙げられる。

【００４０】

６．シーケンス２（端末が複数台の場合）

図１６に、端末が複数台の場合における基地局装置と端末間のシーケンスを示す。基地局８００から送信されたアンテナ切替用リファレンス信号８０７はＤＡＳスイッチ８０１を経て、アンテナ８０２～８０４から各々送信され、端末８０５及び８０６で受信される。その後、端末８０５及び８０６では、リファレンス信号からチャネル推定処理によってチャネル情報（ＣＳＩ）を求め、アンテナ切替用チャネル情報（ＣＳＩ）８０８を送信する。このアンテナ切替用チャネル情報（ＣＳＩ）８０８は、各アンテナ８０２～８０４で受信され、ＤＡＳスイッチ８０１を経て、基地局８００で受信される。その後、チャネル情報収集８０９において、チャネル情報収集部３０５は、取得したチャネル情報をデータベース化する。なお、データベースの詳細については、図２０で後述する。但し、ＴＤＤシステムにおいては、上述のように端末が送信するサウンディング信号を基地局装置で受信してチャネル推定処理を行うことでチャネル情報を収集し、このチャネル情報を下りのチャネル情報として活用する。この時、基地局８００から端末８０５及び８０６へはデータ信号（ＳＩＳＯ）８１０及び８１１が送信されているが、その際にトラフィック情報収集８１２にて、トラフィック情報収集部３０３により、データトラフィック量が集計される。なお、この例では、ＳＩＳＯを前提としたが、これ以外にもＳＩＭＯ、ＭＩＭＯ等の適宜の通信方式によりデータ信号を送信する場合を前提とすることができる。

【００４１】

以上のトラフィック情報とチャネル情報より、ＭＩＭＯ切替判定８１３にて、ＭＩＭＯ切替判定部３０７が、ＭＩＭＯを実施するか否かの判定後、基地局８００からＤＡＳスイッチ８０１に対して、スイッチ切替制御８１４が制御信号処理部３０８により行われる。

スイッチ切替制御が完了すると、基地局８００からＭＩＭＯ通信用リファレンス信号８１５がＤＡＳスイッチ８０１を経て、アンテナ８０２～８０４から送信され、端末８０５及び８０６で受信される。その後、端末８０５及び８０６では、リファレンス信号からチャネル情報を求め、ＭＩＭＯ通信用チャネル情報（ＣＳＩ）８１６を送信する。ＭＩＭＯ通信用チャネル情報（ＣＳＩ）８１６は、アンテナ８０２～８０４、ＤＡＳスイッチ８０１を経て、基地局８００で受信される。基地局８００から送信されたデータ信号（ＭＩＭＯ）８１７は、ＤＡＳスイッチ８０１を経て、アンテナ８０２及び８０３から端末８０５

へ送信される。また基地局８００から送信されたデータ信号（ＳＩＳＯ）は、ＤＡＳスイッチ８０１を経て、アンテナ８０４から端末８０６へ送信される。なお、この例では、端末８０５がＭＩＭＯ通信を行い、端末８０６がＳＩＭＯ通信を行うようにした場合を示すが、これに限らず、ＭＩＭＯ切替判定により設定された適宜の通信方式により各端末が通信することができる。

【００４２】

図１７に、ＭＩＭＯ通信が開始された場合に、ＳＩＳＯを行っている他の端末と繋がっているアンテナが、ＭＩＭＯ通信への干渉が少ないアンテナへと再割当が実施される際のＤＡＳスイッチの動作例を示す。Ｓｌｏｔ１～Ｓｌｏｔ４の期間までは、図１２と同様である。Ｓｌｏｔ４の後、アンテナ＃１にはＤｌ／Ｕｌいずれも基地局装置のアンテナポート＜１＞が、アンテナ＃４にはＤｌ／Ｕｌいずれも基地局装置のアンテナポート＜２＞が割り当てられており、２台の端末がＳＩＳＯ通信を行っている。ある時点でトラフィックが増大したため、端末の１台（ユーザ１）がアンテナ＃１、＃２を使用してＭＩＭＯ通信を開始したとする。この時、アンテナ＃１、＃２には、各々、基地局装置のアンテナポート＜１＞、＜２＞が割り当てられたとする。ＭＩＭＯ開始前は、残りの１台（ユーザ２）は、アンテナ＃４に基地局装置のアンテナポート＜２＞を使用して通信をしていたが、基地局装置のアンテナポート＜２＞がＭＩＭＯ通信を開始した端末（ユーザ１）に使用されるため、干渉が少ないアンテナ＃６が再割当されている様子を示している。この図では、ユーザ２に対しては、基地局装置のアンテナポート＜３＞と接続されたアンテナ＃６が再割当されている。図１２と同様、＃１～８の全アンテナについてのアンテナ切替用チャネル情報の収集プロセスは、周期的または定期的に実施されるものとする。

【００４３】

このように、ある端末がＭＩＭＯ開始した際、ＳＩＳＯやＳＩＭＯを行っている端末はＣＩＮＲ値をパラメータとして、ＭＩＭＯ通信への干渉が少ないアンテナへ移動することができる（なお、具体的なＭＩＭＯ切替判定フローは、「Ｃ．実施の形態３」図１８及びその説明箇所等参照。）。

【００４４】

図２０に、チャネル情報（ＣＳＩ）のデータベース配列を示す。

本データベースは、チャネル情報３０６に有するものであって、使用するアンテナ本数に対応したアンテナ番号とエリア内の端末のチャネル情報（ＣＳＩ）が対応づけて記憶される。図２０では一例としてアンテナ数８本の例を示している。

【００４５】

Ｂ．実施の形態２

図７は、基地局内ＭＩＭＯ切替判定部のフローチャート例（その２）である。この図は、実施の形態１における図５のフローチャートの別の実施の形態を示す。ＭＩＭＯ適用後のアンテナの取り扱いが図５と一部異なっている。

端末へのトラフィックがある閾値を超えた場合（Ｓｔｅｐ１）、現在ＭＩＭＯを適用中かの判別を行う（Ｓｔｅｐ２）。ＭＩＭＯ適用中であって、現在のアンテナの組合せで、見込み通信速度が閾値以上の場合（Ｓｔｅｐ３）、現状のアンテナを継続使用し、ＭＩＭＯ通信を実施する（Ｓｔｅｐ８）。Ｓｔｅｐ２において、ＭＩＭＯ適用中でない場合、もしくはＳｔｅｐ３において、見込み通信速度が閾値以上でない場合は、Ｓｔｅｐ４に進む。

【００４６】

Ｓｔｅｐ４以降では、図５と同様に、アンテナ切替用チャネル情報（ＣＳＩ）から、各アンテナのチャネル容量が算出され、その値をもとに、Ｓｔｅｐ５において、見込み通信速度を推定する。見込み通信速度は、例えば、チャネル容量からそのアンテナにつながっている端末数で除したもの等から算定される。その後、全アンテナを対象として、見込み通信速度の速いアンテナ順にリストアップを実施する（Ｓｔｅｐ６）。さらに、そのリスト上位Ｎ組のアンテナを組合せた場合、見込み通信速度が閾値以上である場合（Ｓｔｅｐ

７），ＭＩＭＯ適用（Ｓｔｅｐ８）となる。Ｓｔｅｐ１でトラフィック量が閾値以上でない、あるいは、Ｓｔｅｐ７で見込み通信速度が閾値以上でない場合は、ＭＩＭＯ適用しない（Ｓｔｅｐ９）。Ｓｔｅｐ８またはＳｔｅｐ９の後は、Ｓｔｅｐ１へ戻る。このＭＩＭＯ切替判定は定期的あるいは周期的に実施されるものとし、その都度、データ（ＣＳＩ情報等）が更新される為、見込み通信速度リストの上位のアンテナがＭＩＭＯ通信に採用される。

【００４７】

Ｃ．実施の形態３

図１８は、基地局内ＭＩＭＯ切替判定部のフローチャートの例（その３）である。この図は、実施の形態１における図５のフローチャートの別の実施の形態を示す。図１８では、ある特定の端末に対してＭＩＭＯ通信が開始された場合に、ＳＩＳＯ通信又はＳＩＭＯ通信を行っている他の端末に対して、ＭＩＭＯ通信に対する干渉が少ないアンテナへと再割当が実施される際のＭＩＭＯ切替判定部のフローチャートを示している。

【００４８】

まず、図５と同様に、対象となる端末を選択後（Ｓｔｅｐ１），端末のトラフィック量が閾値以上か否かを判定する（Ｓｔｅｐ２）。Ｓｔｅｐ２で閾値以上であれば、チャネル情報（ＣＳＩ）から、各アンテナのチャネル容量を算出する（Ｓｔｅｐ３）。その後、各アンテナの見込み通信速度を推定する（Ｓｔｅｐ４）。見込み通信速度の推定方法の一つとして、チャネル容量をアンテナに繋がっているユーザ数で除したものなどがある。その後，全アンテナについて見込み通信速度順にリストアップされると（Ｓｔｅｐ５），リスト上位Ｎ組のアンテナを組み合わせた場合，見込み通信速度が閾値以上かの判別を行う（Ｓｔｅｐ６）。Ｓｔｅｐ６で，閾値以上であれば、ＭＩＭＯ適用となる（Ｓｔｅｐ７）。

【００４９】

ＭＩＭＯ適用後、周囲でＳＩＳＯもしくはＳＩＭＯ通信を行っている端末をサーチ・選択する（Ｓｔｅｐ８）。当該端末に対して，ＭＩＭＯ通信を開始した端末との干渉度合いを調べるため、ＣＩＮＲを測定し（Ｓｔｅｐ９），ＣＩＮＲが閾値以上かを判別する（Ｓｔｅｐ１０）。もし、現在通信しているアンテナに対するＣＩＮＲが閾値以上でない場合には、他のアンテナの中でＣＩＮＲが最も高い他のアンテナを選択する（Ｓｔｅｐ１１）。もし、現在通信しているアンテナに対するＣＩＮＲが閾値以上であれば、ＭＩＭＯ通信を行っている端末との干渉の影響が少ないと判断し、当該端末は現在繋がっているアンテナを継続使用して、ＳＩＳＯ通信もしくはＳＩＭＯ通信を行う（Ｓｔｅｐ１３）。ここで、Ｓｔｅｐ２もしくはＳｔｅｐ６で各々閾値以上でないである場合、ＭＩＭＯ適用しない（Ｓｔｅｐ１２）。なお、Ｓｔｅｐ１１、Ｓｔｅｐ１２，Ｓｔｅｐ１３の処理が完了すると，Ｓｔｅｐ１へ戻る。

【００５０】

なお、ＣＩＮＲの代わりにＳＮＲを用いてもよい。

このように、ある端末がＭＩＭＯ開始した際、ＳＩＳＯやＳＩＭＯを行っている端末はＣＩＮＲ値又はＳＮＲ値をパラメータとして、ＭＩＭＯ通信への干渉が少ないアンテナへ移動することができる。

【００５１】

Ｄ．実施の形態４

図２１は、基地局内ＭＩＭＯ切替判定部のフローチャートの例（その４）である。この図は、実施の形態１における図５のフローチャートの別の実施の形態を示す。図２１では、ある特定の端末のトラフィック量が増えた場合に、その端末と同じアンテナにつながっている端末数が上限を超えた場合、ＭＩＭＯが適用されるというＭＩＭＯ切替判定部のフローチャートの例を示している。

【００５２】

まず対象となる端末を選択後（Ｓｔｅｐ１），端末のトラフィック量が閾値以上かを判

測する（Ｓｔｅｐ２）。Ｓｔｅｐ２において、トラフィック量が閾値以上だった場合、対象となる端末が利用しているアンテナと同じアンテナに繋がっている他の端末数を計測する（Ｓｔｅｐ３）。その後、計測した端末数が閾値以上かを判別し（Ｓｔｅｐ４）、端末数が閾値以上であれば、ＭＩＭＯ適用となる（Ｓｔｅｐ５）。一方、Ｓｔｅｐ２でトラフィック量が閾値より小さい場合、又は、Ｓｔｅｐ４で端末数が閾値より小さい場合、ＭＩＭＯ適用しない（Ｓｔｅｐ１０）。

【００５３】

Ｅ．実施の形態５

図２２は、基地局内ＭＩＭＯ切替判定部のフローチャート例（その５）である。この図は、実施の形態１における図５のフローチャート又は実施の形態４における図２１のフローチャートの別の実施の形態を示す。ＭＩＭＯ適用後のアンテナの取り扱いが図２１と一部異なっている。

【００５４】

端末へのトラフィックがある閾値を超えた場合（Ｓｔｅｐ１），現在ＭＩＭＯを適用中かの判別を行う（Ｓｔｅｐ２）。ＭＩＭＯ適用中であって，現在のアンテナの組合せで、見込み通信速度が閾値以上の場合（Ｓｔｅｐ３）、現状のアンテナを継続使用し、ＭＩＭＯ通信を実施する（Ｓｔｅｐ８）。Ｓｔｅｐ２において、ＭＩＭＯ適用中でない場合、もしくはＳｔｅｐ３において、見込み通信速度が閾値以上でない場合は、Ｓｔｅｐ４に進む。

【００５５】

Ｓｔｅｐ４以降では，図２１と同様に、対象となる端末が利用しているアンテナと同じアンテナに繋がっている他の端末数を計測する（Ｓｔｅｐ４）。その後、計測した端末数が閾値以上かを判別し（Ｓｔｅｐ７）、端末数が閾値以上であれば、ＭＩＭＯ適用となる（Ｓｔｅｐ８）。Ｓｔｅｐ１でトラフィック量が閾値以上でない、あるいは、Ｓｔｅｐ７で端末数が閾値以上でない場合は、ＭＩＭＯ適用しない（Ｓｔｅｐ９）。Ｓｔｅｐ８またはＳｔｅｐ９の後は、Ｓｔｅｐ１へ戻る

【００５６】

Ｆ．実施の形態６

図１９は、基地局内ＭＩＭＯ切替判定部のフローチャートの例（その６）である。この図は、実施の形態１における図５のフローチャート又は実施の形態４における図２１のフローチャートの別の実施の形態を示す。図１９では、ある特定の端末に対してＭＩＭＯ通信が開始された場合に、ＳＩＳＯ通信又はＳＩＭＯ通信を行っている他の端末に対して、ＭＩＭＯ通信に対する干渉が少ないアンテナへと再割当が実施される際のＭＩＭＯ切替判定部のフローチャートを示している。

【００５７】

まず対象となる端末を選択後（Ｓｔｅｐ１）、端末のトラフィック量が閾値以上かを判別する（Ｓｔｅｐ２）。Ｓｔｅｐ２において、トラフィック量が閾値以上だった場合、対象となる端末が利用しているアンテナと同じアンテナに繋がっている他の端末数を計測する（Ｓｔｅｐ３）。その後、計測した端末数が閾値以上かを判別し（Ｓｔｅｐ４），端末数が閾値以上であれば、ＭＩＭＯ適用となる（Ｓｔｅｐ５）。一方、Ｓｔｅｐ２でトラフィック量が閾値より小さい場合、又は、Ｓｔｅｐ４で端末数が閾値より小さい場合、ＭＩＭＯ適用しない（Ｓｔｅｐ１０）。

【００５８】

ＭＩＭＯ適用後、図１８と同様に、周囲でＳＩＳＯ通信もしくはＳＩＭＯ通信を行っている端末をサーチ・選択する（Ｓｔｅｐ６）。当該端末に対して、ＭＩＭＯ通信を開始した端末との干渉度合いを調べるため、ＣＩＮＲを測定し（Ｓｔｅｐ７）、ＣＩＮＲが閾値以上かを判別する（Ｓｔｅｐ８）。もし、現在通信しているアンテナに対するＣＩＮＲが閾値以上でない場合には、ＣＩＮＲが最も高い他のアンテナを選択する（Ｓｔｅｐ９）。

もし、現在通信しているアンテナに対するＣＩＮＲが閾値以上であれば、ＭＩＭＯ通信を行っている端末との干渉の影響が少ないと判断し、当該端末は現在繋がっているアンテナを継続使用して、ＳＩＳＯもしくはＳＩＭＯを行う（Ｓｔｅｐ１１）。ここで、Ｓｔｅｐ２もしくはＳｔｅｐ４で各々閾値以上でないである場合、ＭＩＭＯ適用しない（Ｓｔｅｐ１０）。なお、Ｓｔｅｐ９、Ｓｔｅｐ１０、Ｓｔｅｐ１１の処理が完了すると、Ｓｔｅｐ１へ戻る。

【００５９】

なお、ＣＩＮＲの代わりにＳＮＲを用いてもよい。

このように、ある端末がＭＩＭＯ開始した際、ＳＩＳＯやＳＩＭＯを行っている端末はＣＩＮＲ値又はＳＮＲ値をパラメータとして、ＭＩＭＯ通信への干渉が少ないアンテナへ移動することができる。

【産業上の利用可能性】

【００６０】

本発明は、いわゆるＤＡＳ以外にも、複数のアンテナを分散配置した様々な分散アンテナシステムに適用することができる。また、通信速度を例に処理を説明したが、これに限らず、スループット又はこれらに類似のデータ等の適宜のデータを用いて処理を行うことができる。

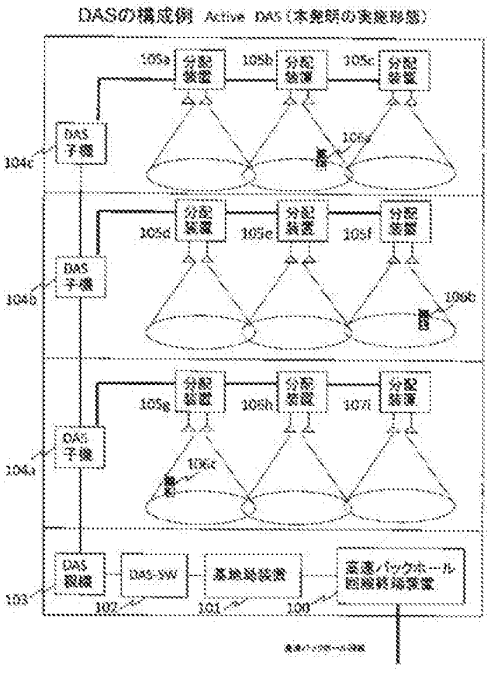
【符号の説明】

【００６１】

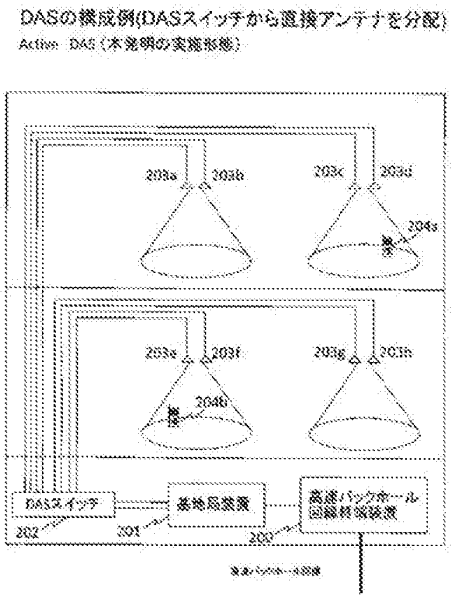
１００　高速バックホール回線終端装置
１０１　基地局装置
１０２　分散アンテナシステム（以下、ＤＡＳ）切替スイッチ
１０３　ＤＡＳ親機
１０４ａ～１０４ｃ　ＤＡＳ子機
１０５ａ～１０５ｉ　分配装置
１０６ａ～１０６ｃ　端末
２００　高速バックホール回線終端装置
２０１　基地局装置
２０２　ＤＡＳスイッチ
２０３ａ～２０３ｂ　ＤＡＳアンテナ
２０４ａ～２０４ｂ　端末
３００　基地局装置
３０１　バックホール回線
３０２　バックホール回線インタフェース
３０３　トラフィック情報収集部
３０４　トラフィック情報
３０５　チャネル情報収集部
３０６　チャネル情報
３０７　ＭＩＭＯ切替判定部
３０８　制御信号処理部
３０９　ベースバンド／ＲＦ部
３１０　リファレンス信号生成部
３１１　ＳＩＳＯ信号処理部
３１２　ＭＩＭＯ信号処理部
３１３　ＲＦ外部インタフェース
３１４　アンテナポート
３１５　ＤＡＳスイッチ
３１６　ＤＡＳスイッチ入力ポート
３１７　ＤＡＳスイッチ制御部
３１８　ＤＡＳスイッチング部

３１９　ＤＡＳスイッチ出力ポート
４００　ＤＡＳスイッチ
５００　端末
５０１　ＤＡＳスイッチ
５０２　端末
５０３　ＤＡＳスイッチ
６００　基地局装置
６０１　ＤＡＳスイッチ
６０２　アンテナ＃１
６０３　アンテナ＃２
６０４　アンテナ＃３
６０５　端末
６０６　アンテナ切替用リファレンス信号送信
６０７　アンテナ切替用チャネル情報（ＣＳＩ）送信
６０８　チャネル情報収集
６０９　データ信号（ＳＩＳＯ）
６１０　トラフィック情報収集
６１１　ＭＩＭＯ切替判定
６１２　スイッチ切替制御
６１３　ＭＩＭＯ通信用リファレンス信号送信
６１４　ＭＩＭＯ通信用チャネル情報（ＣＳＩ）送信
６１５　データ信号（ＭＩＭＯ）
７００　端末１
７０１　端末２
７０２　ＤＡＳスイッチ
７０３　端末１
７０４　端末２
７０５　ＤＡＳスイッチ
８００　基地局装置
８０１　ＤＡＳスイッチ
８０２　アンテナ＃１
８０３　アンテナ＃２
８０４　アンテナ＃３
８０５　端末
８０６　端末
８０７　アンテナ切替用リファレンス信号送信
８０８　アンテナ切替用チャネル情報（ＣＳＩ）送信
８０９　チャネル情報収集
８１０　データ信号（ＳＩＳＯ）
８１１　データ信号（ＳＩＳＯ）
８１２　トラフィック情報収集
８１３　ＭＩＭＯ切替判定
８１４　スイッチ切替制御
８１５　ＭＩＭＯ通信用リファレンス信号送信
８１６　ＭＩＭＯ通信用チャネル情報（ＣＳＩ）送信
８１７　データ信号（ＭＩＭＯ）
８１８　データ信号（ＳＩＳＯ）

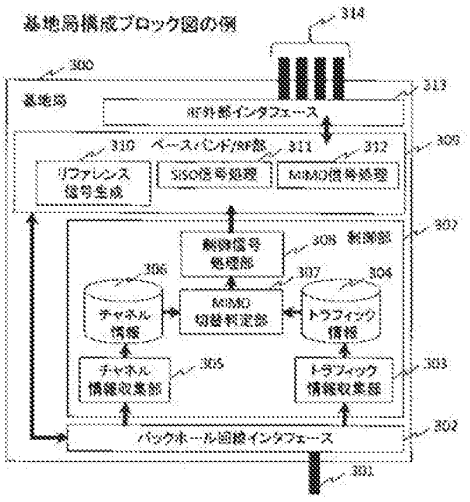
【図１】


DASの構成例 Active DAS（本発明の実施形態）
105a
105b
105c
105d
105e
105f
105g
105h
107i
106a
106b
106c
104c
104b
104a
103
102
101
100
DAS-SW
基地局装置
高速バックホール回線終端装置

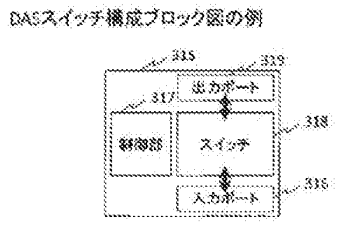
【図２】


DASの構成例(DASスイッチから直接アンテナを分配)
Active DAS（本発明の実施形態）
203a
203b
203c
203d
203e
203f
203g
203h
204a
204b
DASスイッチ
基地局装置
高速バックホール回線終端装置
202
201
200

【図３】

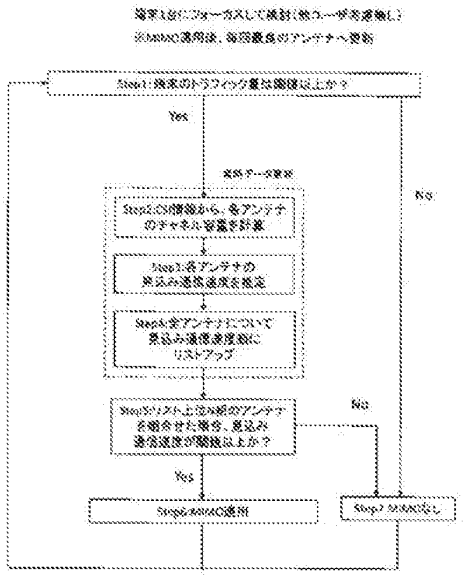

基地局構成ブロック図の例
314
300
基地局
313
RF外部インタフェース
310
ベースバンド/RF部
311
312
309
リファレンス信号生成
SISO信号処理
MIMO信号処理
302
制御信号処理部
308
制御部
306
307
304
チャネル情報
MIMO切替判定部
トラフィック情報
305
チャネル情報収集部
トラフィック情報収集部
303
バックホール回線インタフェース
302
301

【図４】


DASスイッチ構成ブロック図の例
315
319
出力ポート
317
318
制御部
スイッチ
316
入力ポート

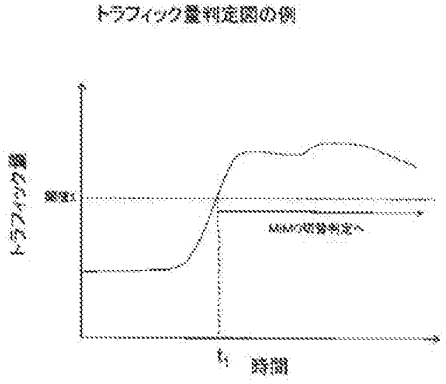
【図５】

基地局内MIMO切替判定部のフローチャート例(その1)



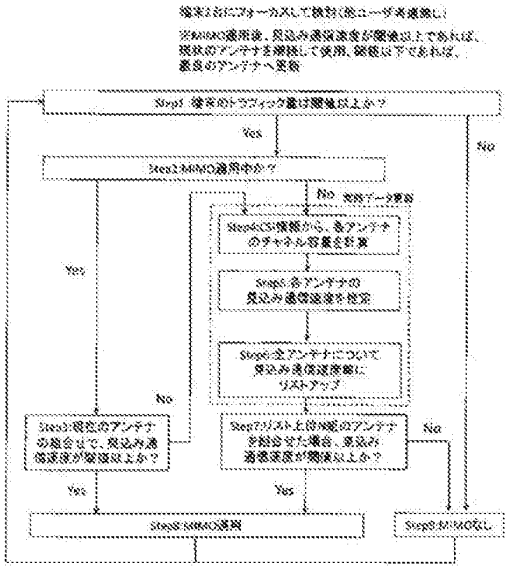
【図６】

トラフィック量判定図の例



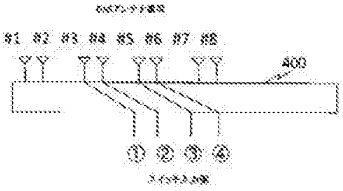
【図７】

基地局内MIMO切替判定部のフローチャート例(その2)

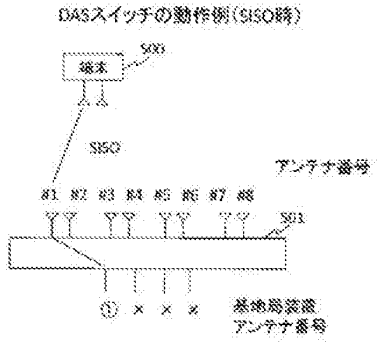


【図８】

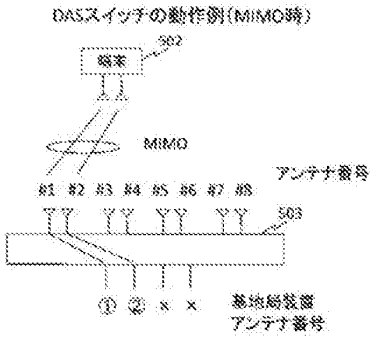
DASスイッチの動作例



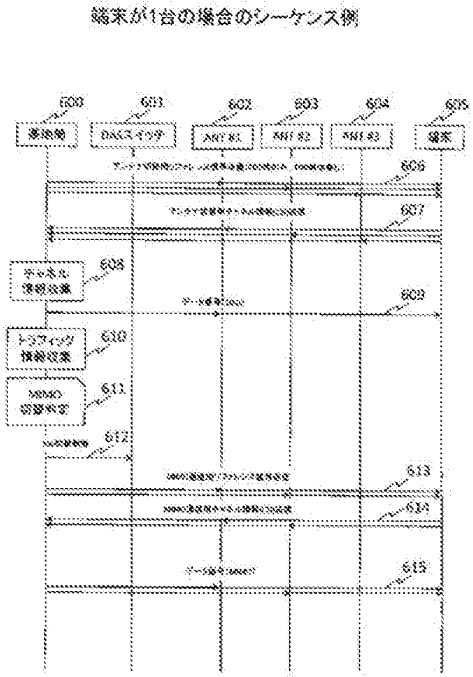
【図９】



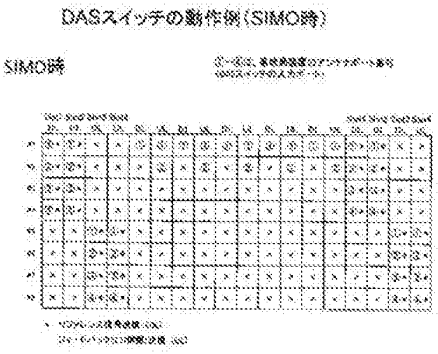
【図１０】



【図１１】

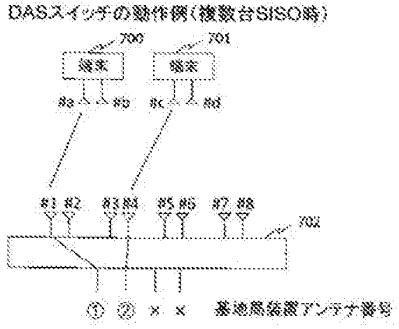


【図１２】

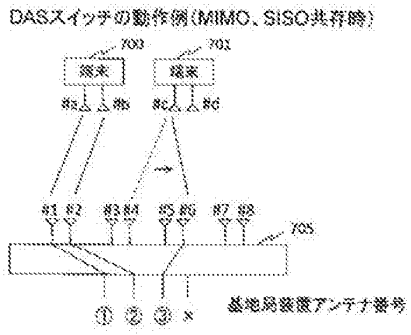


【図１３】

【図１４】

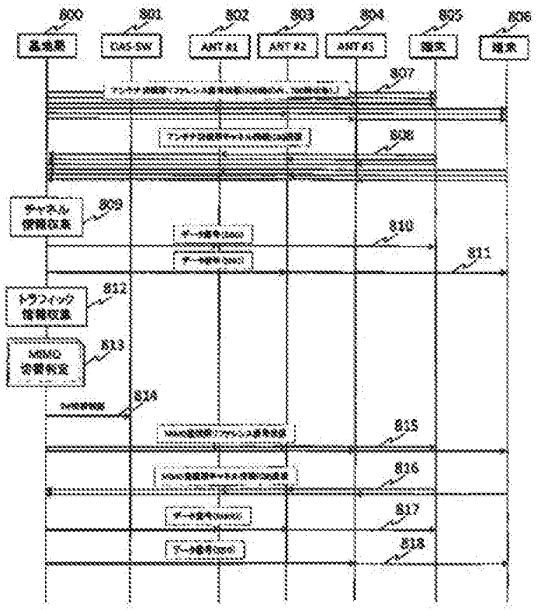


【図１５】



【図１６】

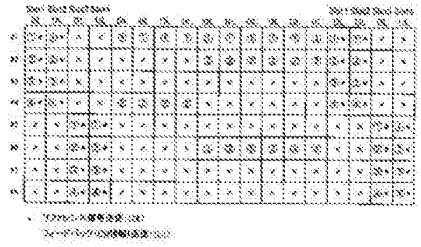
端末が複数台の場合のシーケンス例



【図１７】

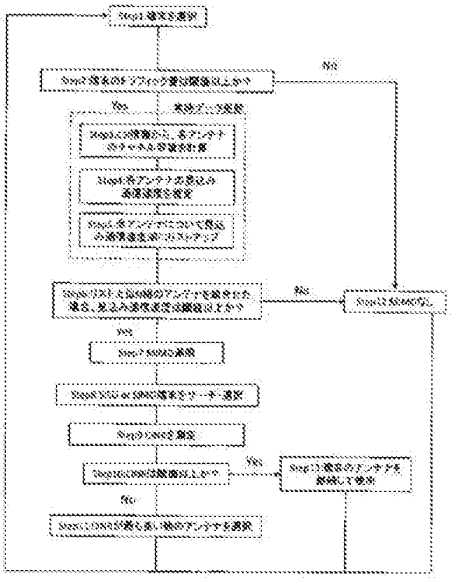
DASスイッチの動作例(その3)

SIMO時



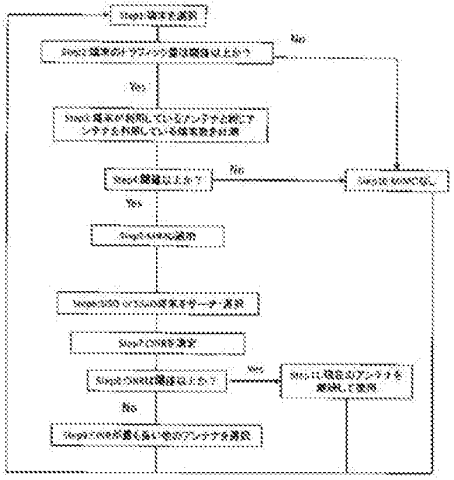
【図１８】

基地局内MIMO切替判定部の
フローチャートの例(その3)



【図１９】

基地局内MIMO切替判定部の
フローチャートの例(その6)



【図２０】

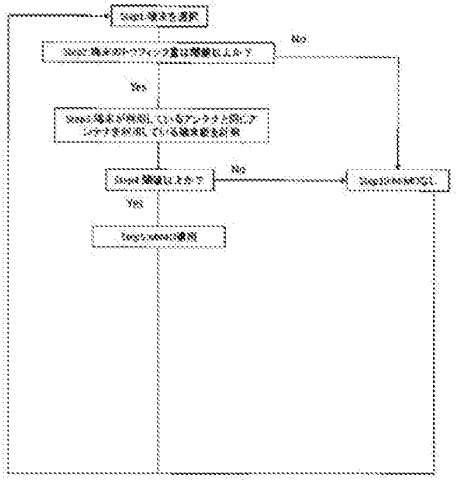
チャネル情報(CSI)のデータベース配列

注:一例として、図15を基に作成

アンテナ番号	端末700	端末701
#1	h1a,h1b	h1c,h1d
#2	h2a,h2b	h2c,h2d
#3	h3a,h3b	H3c,h3d
#4	h4a,h4b	h4c,h4d
#5	h5a,h5b	h5c,h5d
#6	h6a,h6b	h6c,h6d
#7	h7a,h7b	h7z,h7d
#8	h8a,h8b	h8c,h8d
・・・	・・・	・・・
#n	h1na,h12b	h12z,h12d

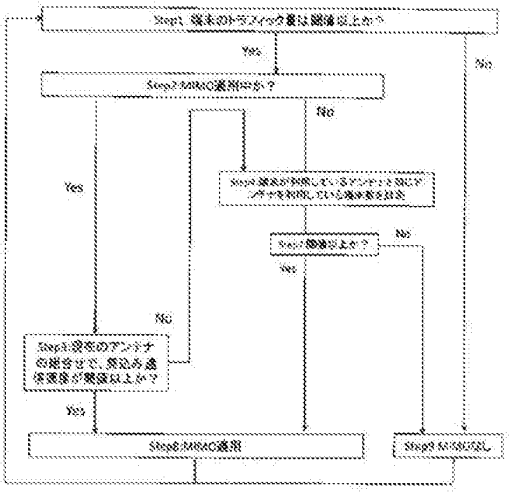
【図２１】

基地局内MIMO切替判定部の
フローチャートの例(その4)



【図２２】

基地局内MIMO切替判定部の
フローチャート例(その5)



フロントページの続き

Fターム(参考) 5K022 FF00
5K067 AA21 BB21 EE02 EE10 EE03
5K159 DD01 EE02 GG18

Electronic Acknowledgement Receipt	
EFS ID:	31068591
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	28-NOV-2017
Filing Date:	24-JUL-2013
Time Stamp:	20:28:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_1039.pdf	122014 6225a13525b5259e2eac95448d4f91a8d7c6b86f	no	2

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	JP_2001203691_A__.pdf	12272386 452e2ea366b17417ec9f55ed585116163fb555a1	no	12
Warnings:					
Information:					
3	Non Patent Literature	NPL_JP_2015525473_OA_08282017__.pdf	3069973 45821092e1ccd0379a929b63d3ebbfe3356c29ba	no	11
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Information:					
4	Foreign Reference	JP_2012124695_A__a.pdf	6544074 bdc8f1d529280ddc07d501f92355bc4cf7dc6acb	no	29
Warnings:					
Information:					
			Total Files Size (in bytes):	22008447	

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

20350 7590 09/28/2017

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

EXAMINER
SYED, MAJID

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
09/28/2017	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

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *8/29/2017*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-2, 4-11, 13-21* 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) *1,2,4-11 and 13-21* 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 *7/24/2013* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

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

This is in response to applicant's response filed on 8/29/2017, which has been entered and made of record.

Continued Examination under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8/29/2017 has been entered.

Claims 1 and 5 are amended. Claims 3 and 12 are previously cancelled.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 8/29/2017 was filed. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 103

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

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not i0dentically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-2, 4-11, 13-21 are rejected under 35 U.S.C. 103 as being unpatentable over Kummetz; Thomas et al. (US 20100278530 A1 hereinafter: "Kummetz") in view of Trigui; Hafedh et al. (US 8,498,207 B2 hereinafter: "Trigui").

For claim 1 (Currently Amended), Kummetz teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources **([0031 The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs receiving first signal from 24 and second signal from 44)**;

a plurality of Digital Remote Units (DRUs) coupled to the one or more DAUs **([0031] The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs connected to 44 as DRUs)** and operable to transport signals between the plurality of DRUs **([0029], …A group of distributed antenna units 44 are interconnected via high speed digital transport links 46.)** and the one or more DAUs **([0057], … in FIG. 8, one of the optical links from the Master Unit 42 may be connected to an Extension Unit 192 … The Extension Unit 192 may communicate with Remote Units 44 using a two fiber 66 a, 66 b approach using the same wavelength in both directions, or Extension Unit 192 may communicate using a single fiber 67 using two wavelengths and a WDM (204 in FIG. 9), therefore 192 as DAU)**;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs **([0003] … To improve the capacity of a base station 24 to handle more mobile users 30, cells 22 may be divided into sectors 38 or are further subdivided into smaller cells with the base station 24 being replaced with lower cost, reduced capability micro or pico cells 36.)**;

Kummetz does not explicitly teaches, and a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs, however, in the same field of endeavor Trigui teaches, and a traffic monitoring unit coupled to at least one of the DAUs

(Fig. 2 item 202 as DAU and 109 as Traffic Monitoring unit coupled via 115 as explained in [col 5 lines 29-35] … The dynamic load balancing apparatus 109 receives information (e.g., network statistics 110, network topology and parameters 111 and target criteria 112) regarding the wireless communication network 100; and provides control signals 115 for controlling coverage areas 105 to the antenna arrays 202.) wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)** and a quality of service (QoS) of a network traffic for the one or more DAUs **([col 2 lines 33-35] and determining if there is an improvement in the cell congestion and quality of service based on altered network parameters.),**

wherein the QoS is a function of the one or more KPIs **(Trigui [col 2 lines 57-60] The altering of the network parameters and evaluating of the cell congestion are performed continuously until a target quality of service in the wireless communication network is achieved.);**

and reconfigure the plurality of sectors based on the one or more KPIs and QoS **(Trigui [col 7 lines 23-45] then in step 305 one or more of network parameters are altered. The network parameters include, but are not limited to, the following: Exemplary Network Parameters)** by allocating at least one DRU from the first sector to the second sector **(Trigui [col 8 lines 23-26] … The alternative of adding antennas and cell sites is to consider sub-sectorization by means of antenna arrays … an active antenna array will be preferred to**

alter the boundaries of coverage areas whenever needed for matching the instantaneous traffic demand. In addition to splitting the azimuth in coverage areas, a two dimensional active antenna array can offer more flexibility in creating and tailoring coverage areas.).

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

For claim 2 (Previously Presented), Kummetz teaches, The system of claim 1 wherein each BTS comprises a plurality of sectors (**[col 8 lines 35-39] … it is assumed that the required number of sectors to meet the peak traffic demand has been determined along with their locations and frequency plan. The present invention, for example, optimizes base station transmit power, antenna tilt, sub-sectors pointing direction and azimuth widths to balance the traffic between sub-sectors**).

For claim 4 (Previously Presented), Kummetz teaches, The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors (**[col 6 lines 57-58, Capacity For Each Sector/Carrier, …, Channel Elements (CE) Primary Use, % Primary Traffic CE Usage, % Secondary Traffic CE Usage, …, [col 4 lines 28-30] … Each coverage area 105 behaves as an independent sector serving its own set of subscribers 107.).**

For claim 5 (Currently Amended), Kummetz teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more signal sources, the system comprising:

one or more Digital Access Units (DAUs) operable to receive at least one signal from at least one of a first signal source and a second signal source from the plurality of signal sources **([0031 The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs receiving first signal from 24 and second signal from 44)**;;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs **([0031] The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, therefore master unit as DAUs connected to 44 as DRUs)** and operable to transport signals between the plurality of DRUs **([0029], …A group of distributed antenna units 44 are interconnected via high speed digital transport links 46.)** and the one or more DAUs **([0057], … in FIG. 8, one of the optical links from the Master Unit 42 may be connected to an Extension Unit 192 … The Extension Unit 192 may communicate with Remote Units 44 using a two fiber 66 a, 66 b approach using the same wavelength in both directions, or Extension Unit 192 may communicate using a single fiber 67 using two wavelengths and a WDM (204 in FIG. 9), therefore 192 as DAU**;

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of

DRUs **([0003] … To improve the capacity of a base station 24 to handle more mobile users 30, cells 22 may be divided into sectors 38 or are further subdivided into smaller cells with the base station 24 being replaced with lower cost, reduced capability micro or pico cells 36.)**;

Kummetz does not explicitly teaches, and a traffic monitoring unit coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs, however, in the same field of endeavor Trigui teaches, and a traffic monitoring unit external to and coupled to at least one of the DAUs **(Fig. 2 item 202 as DAU and 109 as Traffic Monitoring unit coupled via 115 as explained in [col 5 lines 29-35] … The dynamic load balancing apparatus 109 receives information (e.g., network statistics 110, network topology and parameters 111 and target criteria 112) regarding the wireless communication network 100; and provides control signals 115 for controlling coverage areas 105 to the antenna arrays 202.)** wherein the traffic monitoring unit is configured to:

determine one or more key performance indicators (KPIs) **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)** and a quality of service (QoS) of a network traffic for the one or more DAUs **([col 2 lines 33-35] and determining if there is an improvement in the cell congestion and quality of service based on altered network parameters.)**, wherein the QoS is a function of the one or more KPIs **(Trigui [col 2 lines 57-60] The altering of the network parameters and evaluating of the cell**

congestion are performed continuously until a target quality of service in the wireless communication network is achieved.);

and reconfigure the plurality of sectors based on the one or more KPIs and QoS **(Trigui [col 7 lines 23-45] then in step 305 one or more of network parameters are altered. The network parameters include, but are not limited to, the following: Exemplary Network Parameters)** by allocating at least one DRU from the first sector to the second sector **(Trigui [col 8 lines 23-26] … The alternative of adding antennas and cell sites is to consider sub-sectorization by means of antenna arrays … an active antenna array will be preferred to alter the boundaries of coverage areas whenever needed for matching the instantaneous traffic demand. In addition to splitting the azimuth in coverage areas, a two dimensional active antenna array can offer more flexibility in creating and tailoring coverage areas.)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

For 6 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is external to the plurality of DAUs, however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs

(Fig. 1 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 103 Base Station as DAUs).

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 7 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs, however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs **([col 7 lines 13-15] … the dynamic load balancing apparatus 109 continues to receive and monitor switch statistics related to the wireless communication network 100.)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring for each DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring of each DAUs for effective load balancing so as to achieve QoS and KPIs.

For claim 8 and 9 (Previously Presented), Kummetz does teach, wherein the traffic monitoring unit is external to the plurality of DRUs, however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is external to the

plurality of DRUs **(Fig. 2 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 202 antennas as DRUs)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 9 (Previously Presented), Kummetz does teach, wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs., however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs **(Fig. 2 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 202 antennas as DRUs, therefore can be in integrated in DRU)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit internal to DRU to provide one stop solution where end customer does not interoperate with other DRUs.

For claim 10 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs however, in the same filed of endeavor, Trigui teaches, The system of claim 5 wherein the traffic

monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs **(Fig. 1 item 109 as Dynamic Load Balancing Apparatus as Traffic Monitoring Unit external to item 103 Base Station as DAUs).**

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network traffic monitoring unit as external to DAUs. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to provide monitoring unit separate because of limited space in install of DAUs.

For claim 11, Kummetz teaches, does not teach, a network optimization processor coupled to the traffic monitoring unit however, in the same field of endeavor, Trigui teaches, (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit **(Fig. 2 item 101 as Network Management Apparatus coupled with 109 as Dynamic Load Balancing Apparatus, therefore 109 as network optimization and 109 as traffic monitoring unit)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network optimization processor. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to analyze the data related to the wireless communication network and sends control signals for altering or shaping the coverage areas so as to achieve QoS and KPIs.

For claim 13 (Previously Presented), Kummetz teaches, The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave

Line of Sight Link, Wireless Link, or Satellite Link (**[0031], … The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54 … via one to four wideband digitally modulated optical interfaces 56, although one of ordinary skill in the art will appreciate that other Master Units may have more than four optical interfaces, therefore 42a, 42b as DAUs … [0035], … The DMOC 60 including the optical transceiver 108 may also be replaced by a different transceiver for high data rate media such as coax cable, twisted pair copper wires, free space RF or optics, or shared networks such as Ethernet 68, SONET, SDH, ATM, PDH, among others.**).

For claim 14. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link (**[00311] … Up to four Remote Units 44 may be daisy chained along each optical interface 56. The use of multiple optical interfaces 56 permits the Remote Units 44 a-d to be positioned in order to optimize coverage … [0035], … The DMOC 60 including the optical transceiver 108 may also be replaced by a different transceiver for high data rate media such as coax cable, twisted pair copper wires, free space RF or optics, or shared networks such as Ethernet 68, SONET, SDH, ATM, PDH, among others.**).

For claim 15 (Previously Presented), Kummetz teaches, The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration (**[0031], … Up to four Remote Units 44 may be daisy chained along each optical interface 56.**).

For claim 16 (Previously Presented), Kummetz teaches, The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration **([0073], … The switch may be configured in a point-multipoint configuration where a single downlink signal may be repeated and transmitted over multiple outputs to other switches, remote units or mobile units 30, therefore multipoint as star configuration)**.

For claim 17 (Previously Presented), Kummetz teaches, The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([0031], … . The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 4b as DAUs ad 56 as Optical fiber)**.

For claim 18 (Previously Presented), Kummetz teaches, The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs **([0031], … The Master Units 42 a, 42 b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 42 as DAUs and 44 as DRUs)**.

For claim 19 (Previously Presented), Kummetz teaches, The system of claim 5 wherein a single DAU port is connected to the one or more BTSs **([0031], … The Master Units 42 a, 42**

b are connected to the base stations 24 a-d via conducted coupling interfaces 54. The Master Units 42 a, 42 b are also connected to a series of distributed antenna units 44, hereinafter referred to as Remote Units, via one to four wideband digitally modulated optical interfaces 56, therefore 42a, 42 as DAUs and 24 as BTSs).

For claim 20 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS, however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS **(Trigui [col 6 line 48] Sensitive KPIs To Operators Per Sector/Carrier Such as Dropped Calls and Blocked Calls)**.

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas.

For claim 21 (Previously Presented), Kummetz does not teach, wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS **([col 2 lines 33-35]**

and determining if there is an improvement in the cell congestion and quality of service based on altered network parameters.).

Kummetz discusses, distributed antenna system communicating with a plurality of base stations and remote units and Trigui discusses network parameters and evaluating of the cell congestion is performed continuously until a target quality of service is achieved. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to dynamically adjust radio resources and network parameters to match a time varying traffic demand such as splitting the azimuth in coverage areas..

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)270-0524. The examiner can normally be reached on Mon-Fri 7 am to 4 pm.

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on 571-272-4186. 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.

/MAJID SYED/
Examiner, Art Unit 2641

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 2641

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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-2010/0278530 A1	11-2010	Kummetz; Thomas	H04W88/085	398/41
*	B	US-8,498,207 B2	07-2013	Trigui; Hafedh	H04L41/5025	370/235
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	Art Unit
	MAJID SYED	2641

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

* 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
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS
Google search for DAS with Daisy-Chain	7-29-2016	MS
Google search for DAUs, DRUs, Base Station in DAS topology	9-20-2017	MS
Google search for network monitoring in DAS topology	9-20-2017	MS

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

/MAJID SYED/ Examiner.Art Unit 2641	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	46571	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45
S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB;	ADJ	ON	2015/01/29 11:47

			USPAT			
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S25	1	"7098805".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:38
S26	1	"20140244149"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:52
S27	1	"8611260".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:07
S28	1	"20120270553"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:10
S29	1	"8467397".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:13
S30	1	"20130114963"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:37
S31	206375	DAS	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:43
S32	48659	S31 and dru$s	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S33	0	S32 and number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S34	238	DAS and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S35	0	S34 and number near5 user per DRU	US-PGPUB;	ADJ	ON	2016/01/12 14:46

			USPAT			
S36	0	S34 and number near5 per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S37	1	S34 and per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:47
S38	2	"20110122788"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 17:16
S39	2814	distance between base station	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S40	2	S39 and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S41	2	Distance between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:46
S42	1	Distance$s between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:48
S43	58	Distance$s between APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:49
S44	0	Access Aware APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:39
S45	0	(DAS | DRU) same number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:41
S46	0	(DAS | DRU) with number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S47	0	(DAS | DRU) with number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S48	0	(DAS | DRU) near5 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S49	0	(DAS | DRU) near15 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S50	11	"8958789"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S51	1	"8958789".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S52	0	"2003006900"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:27
S53	1	"20030069000"	US-PGPUB;	OR	ON	2016/07/29 07:27

			USPAT; USOCR			
S54	2	"20120094657"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:28
S55	0	"2011085514"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:29
S56	7	("20030147353" | "20120119772" | "20010052011" | "20120039254" | "20020119772" | "20050153743" | "20120039320").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:36
S57	2	("20010052011" | "20120039254").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:39
S58	1	"8396368".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 15:38
S59	307548	((distributed antenna system)| DAS)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:53
S60	2970	(distributed antenna system)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S61	958	(Traffic Optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S62	9	S60 and (traffic optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:55
S63	84	S60 and drus	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:56
S64	1	"20120329523"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:00
S65	1969	S60 and das	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:07
S66	72	S60 and dau	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:07
S67	0	distributed antenna system with dru with dau with monitoring	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:16
S68	2642921	(distributed antenna system with dru with	US-	OR	ON	2017/03/13

		dau with monitoring)	PGPUB; USPAT; USOCR			16:16
S69	2642933	(distributed antenna system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S70	24	S60 and (system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S71	25	S60 and ((dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:19
S72	0	distributed anteena system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S73	2974	distributed antenna system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S74	2976	distributed antenna$1 system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S75	2976	distributed antenna$1 system$1	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S76	62	S75 and (dru$1 same dau$1)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S77	194	S75 and (daisy chain$4)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:26
S78	1	"8184050".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:10
S79	4	(20070117592| "20100278530")	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:49
S80	38	("8521172" "20120178483" "20170250765" "9363761" "9125047" "9026119" "20020077151" "20140031049" "9020555" "20150319711" "20140242999" "20110244914" "8831592" "8532580" "8254848" "20140011496" "20130150065" "9693321" "20170041936" "20120196611" "8346091" "7286507" "8867451" "8688131" "8676223" "20170026857" "20130308537" "9467876" "20130121703" "7230931" "20100278530" "20070280159" "7969910" "20140376499" "20130094454" "20080233967" "7620370" "7724803").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/20 09:58
S81	2	"20140226736"	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/20 15:41
S82	14	"8498207"	US-	OR	ON	2017/09/21

			PGPUB; USPAT; USOCR			09:36
S83	1	"8498207".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/09/21 09:36

EAST Search History (Interference)

<This search history is empty>

9/21/2017 3:27:26 PM
C:\Users\msyed\Documents\EAST\Workspaces\13950160-DAS-Traffic-Optimize.wsp

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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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

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	20120149411	A1	Jun 14, 2012	MIYOSHI, KINGO 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[5]
	2	EP13825612.8 , "Office Action", March 8, 2017, 5 pages	

EXAMINER SIGNATURE

Examiner Signature	/MAJID SYED/	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.

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

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	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

[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.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2017-08-29
Name/Print	Stephen A. Mao	Registration Number	73418

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.**

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015	06/01/2015	01/13/2016	07/29/2016	03/09/2017	09/21/2017			
	1	✓	✓	✓	✓	✓	✓			
	2	✓	✓	✓	✓	✓	✓			
	3	✓	-	-	-	-	-			
	4	✓	✓	✓	✓	✓	✓			
	5	✓	✓	✓	✓	✓	✓			
	6	✓	✓	✓	✓	✓	✓			
	7	✓	✓	✓	✓	✓	✓			
	8	✓	✓	✓	✓	✓	✓			
	9	✓	✓	✓	✓	✓	✓			
	10	✓	✓	✓	✓	✓	✓			
	11	✓	✓	✓	✓	✓	✓			
	12	✓	✓	-	-	-	-			
	13	✓	✓	✓	✓	✓	✓			
	14	✓	✓	✓	✓	✓	✓			
	15	✓	✓	✓	✓	✓	✓			
	16	✓	✓	✓	✓	✓	✓			
	17	✓	✓	✓	✓	✓	✓			
	18	✓	✓	✓	✓	✓	✓			
	19	✓	✓	✓	✓	✓	✓			
	20		✓	✓	✓	✓	✓			
	21		✓	✓	✓	✓	✓			

PTO/SB/30EFS (07-14)
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	13950160	Filing Date	2013-07-24	Docket Number (if applicable)	091172-0882666-103900US	Art Unit	2641
First Named Inventor	Shawn Patrick Stapleton			Examiner Name	Majid Syed		

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 _____

☒ 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 201430

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (07-14)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Signature of Registered U.S. Patent Practitioner			
Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2017-08-29
Name	Stephen A. Mao	Registration Number	73418

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 August 29, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-103900US-0882666
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	AMENDMENT UNDER 37 CFR § 1.116 EXPEDITED PROCEDURE
Customer No.: 20350	

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

Commissioner:

In response to the Final Office Action mailed March 30, 2017 on the above-referenced application, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 6 of this paper.

Amendments to the Claims:

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

Listing of Claims:

1. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of ~~Base Transceiver Stations (BTSs)~~ signal sources, the system comprising:

~~a plurality of~~ one or more Digital Access Units (DAUs) operable to receive at least one signal ~~of radio frequency (RF) or digital signals~~ from at least one of a first signal source and a second signal source from the plurality of signal sources ~~one or more of the plurality of BTSs, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs~~;

a plurality of Digital Remote Units (DRUs) coupled to the ~~plurality of~~ one or more DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs; [[and]]

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit coupled to ~~each of the plurality of~~ at least one of the DAUs, wherein the traffic monitoring unit is configured to: ~~determine at least one of a number of users per DRU or a distance between DRUs~~

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

2. (Previously Presented) The system of claim 1 wherein each BTS comprises a plurality of sectors.

3. (Canceled).

4. (Previously Presented) The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors.

5. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more ~~Base Transceiver Stations (BTSs)~~ signal sources, the system comprising:

~~a plurality of~~ one or more Digital Access Units (DAUs) operable to receive at least one signal ~~of radio frequency (RF) or digital signals~~ from at least one of a first signal source and a second signal source from the plurality of signal sources ~~one or more of the plurality of BTSs, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs~~;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the one or more DAUs; [[and]]

a plurality of sectors formed from the plurality of DRUs comprising a first sector and a second sector different from the first sector, each sector comprising a subset of the plurality of DRUs; and

a traffic monitoring unit external to and coupled to ~~each of the plurality of~~ at least one of the DAUs, wherein the traffic monitoring unit is configured to: ~~determine at least one of a number of users per DRU or a distance between DRUs~~

determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and

reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector.

6. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs.

7. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs.

8. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs .

9. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. (Previously Presented) The system of claim 5 wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. (Previously Presented) The system of claim 5 wherein a single DAU port is connected to the one or more BTSs.

20. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 1-2, 4-11, and 13-21 will be pending in this application. Claims 1 and 5 have been amended, claims 3 and 12 remain canceled, and no claims have been added. No new matter is added. Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Office Action Summary

Claims 1, 4-11, 13-19 are rejected under 35 USC 103 as allegedly unpatentable over US 2012/0327789 in the name of Grenier et al. (hereinafter "Grenier") in view of US 2011/0122788 in the name of Sombrutzki et al. (hereinafter "Sombrutzki"). Office Action pages 2-11.

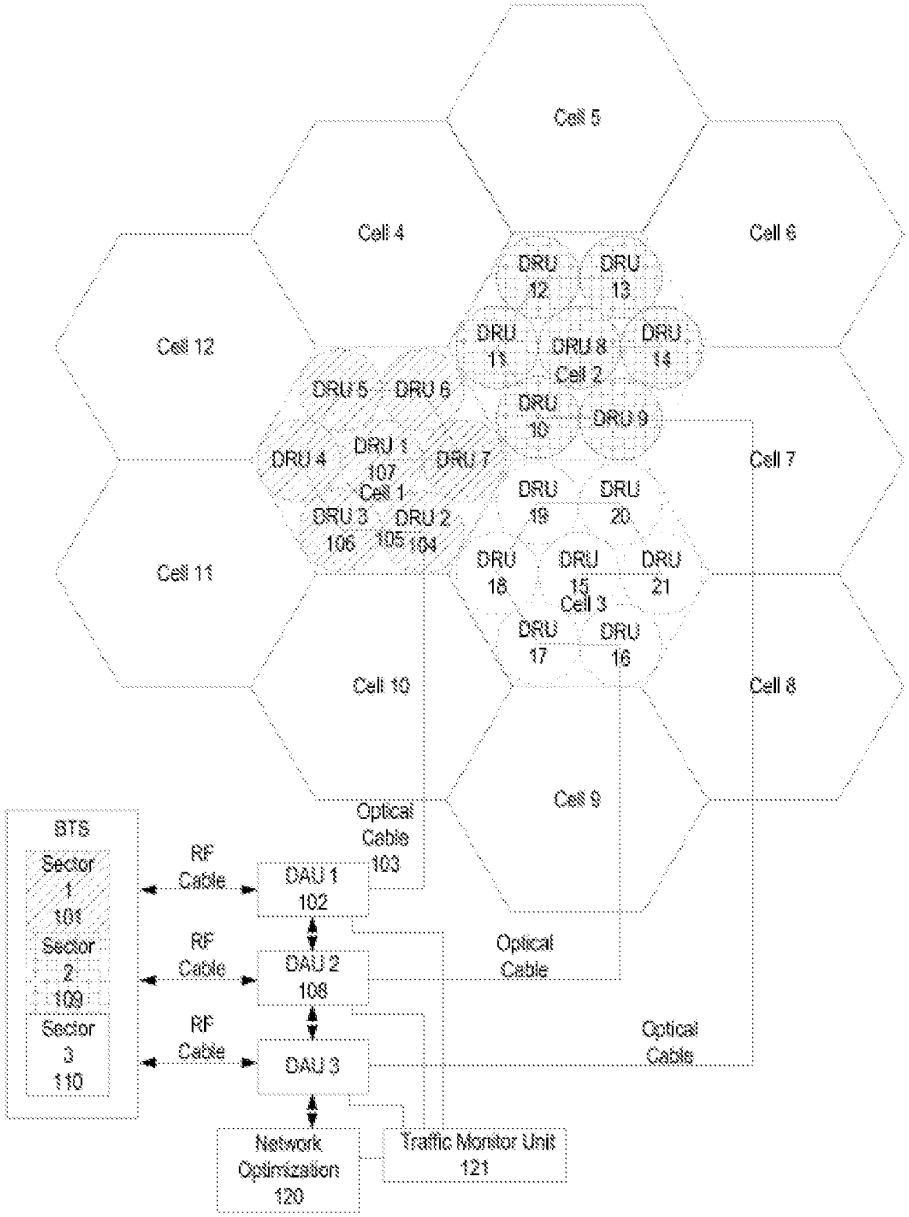
Claims 2, 4, 20 and 21 are rejected under 35 USC 103 as allegedly unpatentable over Grenier, in view of Sombrutzki, further in view of US 8,498,207 in the name of Trigui et al. (hereinafter "Trigui"). Office Action page 11-15.

Claim Rejections – 35 USC §103

Claim 1 has been amended to recite a system that includes "a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the plurality of DAUs, wherein the QoS is a function of the one or more KPIs; and reconfigure the DAU network based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector," among other claim elements.

As disclosed in the specification of the present invention, a DAS system, illustrated in FIG. 1 reproduced below for the Examiner's convenience, includes a plurality of DAUs (i.e., DAU 1, DAU 2, and DAU 3) and a plurality of DRUs (i.e., DRU 1 through DRU 21). A traffic monitoring unit 121 is coupled to each of the DAUs: DAU 1, DAU 2, and DAU 3. As discussed in at least paragraphs [0039] and [0040] of the present specification, the traffic monitoring unit 121 tracks the traffic load at each DAU in the network. Traffic monitoring unit 121 can monitor traffic in the DAS system to determine the number of users on each DAU. Additionally, traffic monitoring unit 121 can analyze traffic information and traffic performance

of the DAS. For instance, the traffic monitoring unit can analyze Key Performance Indicators (KPIs) as well as Quality of Service (QoS) values. (Specification at paragraph [0060]). The traffic monitoring unit can then optimize the DAU system based on the KPI and QoS by allocating DRUs to different sectors. (Specification at paragraph [0057]).



Applicants respectfully submit that the cited references do not teach or suggest each and every claim element of amended claim 1. On page 4 of the current Office Action, the

Examiner concedes that Grenier does not teach "a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs." Applicants respectfully submit that because Grenier does not disclose a traffic monitoring unit, Grenier likewise does not disclose "*a traffic monitoring unit external to and coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector*," among other claim elements. The Examiner, however, cites Sombrutzki as disclosing this limitation.

Applicant respectfully submits that Sombrutzki fails to remedy the deficiencies of Grenier. Sombrutzki discusses "a method for organizing an architecture of access points in a distributed wireless network," such as "a GPRS network, a WiMax type network or an IEEE 802.11 type or Wi-Fi network." (Sombrutzki at paragraph [0019]). "The efficiency of an IEEE 802.11 infrastructure network is determined by the achieved level of Quality of Service (QOs). With the proposed method QoS can be improved in terms of an increased data throughput and a decreased latency and jitter." (Id. at paragraph [0026]). Thus, Sombrutzki relates to Wi-Fi networks and access points, which is not analogous to a DAU network. Furthermore, Sombrutzki does not disclose reconfiguring a DAU network based on KPI and QoS. Nor does Sombrutzki disclose splitting access points into first and second sectors and reconfiguring the wireless network by allocating at least one access point from the first sector to the second sector. As such, Sombrutzki fails to disclose "*a traffic monitoring unit external to and coupled to at least one of the DAUs, wherein the traffic monitoring unit is configured to: determine one or more key performance indicators (KPIs) and a quality of service (QoS) of a network traffic for the one or more DAUs, wherein the QoS is a function of the one or more KPIs; and reconfigure the plurality of sectors based on the one or more KPIs and QoS by allocating at least one DRU from the first sector to the second sector*," as recited in claim 1.

Independent claim 5 recites elements similar to claim 1. Therefore, claim 5 is in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements it recites.

Claims 2 and 4-21, which depend from claims 1 and 5, respectively, are in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

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 SMao@kilpatricktownsend.com.

Respectfully submitted,

/Stephen A. Mao/
Stephen A. Mao
Registration No. 73418

KILPATRICK TOWNSEND & STOCKTON LLP
SAM:bsk

69267787V.1

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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	20120149411	A1	Jun 14, 2012	MIYOSHI, KINGO 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[5]
	2	EP13825612.8 , "Office Action", March 8, 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

[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.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2017-08-29
Name/Print	Stephen A. Mao	Registration Number	73418

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:	13950160				
Filing Date:	24-Jul-2013				
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Stephen A. Mao/Brian Kanter				
Attorney Docket Number:	091172-0882666-103900US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
RCE- 2ND AND SUBSEQUENT REQUEST	2820	1	850	850
		Total in USD ($)		**1150**

Electronic Acknowledgement Receipt	
EFS ID:	30211373
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	29-AUG-2017
Filing Date:	24-JUL-2013
Time Stamp:	13:27:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1150
RAM confirmation Number	082917INTEFSW13290100
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	Request for Continued Examination (RCE)	RCE_DW-1039.pdf	1350069 12ab3add3db7de6ded01680ff677641716ff0d98	no	3
Warnings:					
Information:					
2		AMD_DW-1039.pdf	142305 d0ae21bd3e069c4d0c636b182596ebde717dea07	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	5
	Applicant Arguments/Remarks Made in an Amendment	6	9

Warnings:					
Information:					
3	Non Patent Literature	NPL_EP_138256128_OA_03082017.pdf	162690 36edc325f8d49aa6426a42ca2d3fbaf768d588da	no	5
Warnings:					
Information:					
4	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	105164 cd2b0fa775ffef166c4a52ac392a51f7a417efed	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					

5	Fee Worksheet (SB06)	fee-info.pdf	32463 c2e8c566c8ba7806068f3d8b90909019b475af88	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	1792691	

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 13/950,160	Filing Date 07/24/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT		(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	

AMENDMENT	08/29/2017	(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))	* 19	Minus	** 20	= 0	X $40 =	0
	Independent (37 CFR 1.16(h))	* 2	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**

* 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
THERESA LINDSAY

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

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

20350 7590 03/30/2017

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

EXAMINER	
SYED, MAJID	

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
03/30/2017	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
jlhice@kilpatrick.foundationip.com

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *1/4/2017*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-2, 4-11, 13-21* 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) *1,2,4-11 and 13-21* 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 *7/24/2013* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

This is in response to applicant's amendment/response filed on 1/4/2017, which has been entered and made of record. Claims 1 and 5 have been amended. All dependent claims are therefore amended by virtue.

Response to Arguments

Applicant's arguments with respect to claim 1 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Claim Rejections - 35 USC § 103

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

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not i0dentically disclosed as set forth in section 102 of this title, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 4-11, 13-19 are rejected under 35 U.S.C. 103 as being unpatentable Grenier; James Robert et al. (US 2012/0327789 A1 hereinafter: "Grenier") in view of Sombrutzki; Robert et al. (US 2011/0122788 A1 hereinafter: "Sombrutzki").

For Claim 1 (Currently Amended), Grenier teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs **([0026] ... the host base station** (*as DAUs*) **interface 103 communicated digitized spectrum or signals with the base station 101** *(as BTs)*), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 1B as explained in [0041], … The communications network 100B represents a multipoint-to-multipoint communications network …. communication network 100B includes two or more host nodes 102 (such as host node 102-1 and host node 102-2,** *host nodes as DAUs*) **coupled with two or more base stations 101 (such as base station 101-1 and base station 101-2));**

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **([0041], … In communications network 100B, a single remote node 104** (*as DRUs*) **can be coupled to a plurality of host nodes 102 (such as remote node 104-2 which is connected to both host node 102-1 and host node 102-2), …, further in [0042], …, two host nodes, a single remote unit may have two RF to digital interfaces 109, where one is associated with a host base station interface 103 in one host node 102 (such as host base station interface 103-1 of host node 102-1) and the other is associated with a different host base station interface 103 in another host node 102 (such as host base station interface 103-2 in host node 102-2)**;

Grenier does not teach, a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs, in the same field of endeavor, Sombrutzki teaches, a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs **(Fig. 5 with Traffic Aware APS, …, as explained in [0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …, traffic changes can be represented by the number of users connected to the access points that comprise the system and for the number and types (unicast/multicast or constant/variable data rate) of applications that are running in the computing devices of the users connected to the access points, …, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs)**.

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree and Sombrutzki system for organizing an architecture of access points in a distributed wireless network that is capable of adapting to current traffic conditions. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved.

For claim 5 (Currently Amended), Grenier teaches, A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs **([0026] ... the host base station** (*as DAUs*) **interface 103 communicated digitized spectrum or signals with the base station 101** *(as BTs)*), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 1B as explained in [0041], … The communications network 100B represents a multipoint-to-multipoint communications network …. communication network 100B includes two or more host nodes 102 (such as host node 102-1 and host node 102-2,** *host nodes as DAUs*) **coupled with two or more base stations 101 (such as base station 101-1 and base station 101-2)**);

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **([0041], … In communications network 100B, a single remote node 104** (*as DRUs*) **can be coupled to a plurality of host nodes 102 (such as remote node 104-2 which is connected to both host node 102-1 and host node 102-2), …, further in [0042], …, two host nodes, a single remote unit may have two RF to digital interfaces 109, where one is associated with a host base station interface 103 in one host node 102 (such as host base station interface 103-1 of host node 102-1) and the other is associated with a different host base station interface 103 in another host node 102 (such as host base station interface 103-2 in host node 102-2)**; and

Grenier does not teach, a traffic monitoring unit external to and coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs, however, in the same field of endeavor, Sombrutzki teaches, a traffic monitoring unit external to and coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs (**Fig. 5 with Traffic Aware APS, …, as explained in [0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …, traffic changes can be represented by the number of users connected to the access points that comprise the system and for the number and types (unicast/multicast or constant/variable data rate) of applications that are running in the computing devices of the users connected to the access points, …, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs**).

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree and Sombrutzki system for organizing an architecture of access points in a distributed wireless network that is capable of adapting to current traffic conditions. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved.

For claim 6 (Previously Presented), the combination of Grenier and Sombrutzki do not teach, wherein the traffic monitoring unit is external to the plurality of DAUs, however, in the same field of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs **(Fig. 1B as explained in [0041], … communication network 100B includes two or more host nodes 102 (such as host node 102-1 and host node 102-2,** *host nodes as DAUs*) **coupled with two or more base stations 101 (such as base station 101-1 and base station 101-2)), further in [0049], …. The application layer 202 is responsive to at least one of a simple network management protocol (SNMP), a common management information protocol (CMIP), a remote monitoring (RM) protocol, and any network communications protocol standard suitable for remote monitoring and network management**).

For claim 7 (Previously Presented), Grenier teaches, The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs **((Fig. 1B as explained in [0041], … communication network 100B includes two or more host nodes 102 (such as host node 102-1 and host node 102-2,** *host nodes as DAUs*) **coupled with two or more base stations 101 (such as base station 101-1 and base station 101-2)), further in [0049], …. The application layer 202 is responsive to at least one of a simple network management protocol (SNMP), a common management information protocol (CMIP), a remote monitoring (RM) protocol, and any network communications protocol standard suitable for remote monitoring and network management).**

For claim 8 (Previously Presented), Grenier teaches, The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs **([0041], … In communications**

network 100B, a single remote node 104 (*as DRUs*) can be coupled to a plurality of host nodes 102 (such as remote node 104-2 which is connected to both host node 102-1 and host node 102-2), …, further in [0049], …. The application layer 202 is responsive to at least one of a simple network management protocol (SNMP), a common management information protocol (CMIP), a remote monitoring (RM) protocol, and any network communications protocol standard suitable for remote monitoring and network management).

For claim 9 (Previously Presented), Grenier teaches, The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs **([0041], … In communications network 100B, a single remote node 104 (*as DRUs*) can be coupled to a plurality of host nodes 102 (such as remote node 104-2 which is connected to both host node 102-1 and host node 102-2), …, further in [0049], …. The application layer 202 is responsive to at least one of a simple network management protocol (SNMP), a common management information protocol (CMIP), a remote monitoring (RM) protocol, and any network communications protocol standard suitable for remote monitoring and network management**).

For claim 10 (Previously Presented), Grenier teaches, The system of claim 5 wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs (**Fig. 1B as explained in [0041], … The communications network 100B represents a multipoint-to-multipoint communications network …. communication network 100B includes two or more host nodes 102 (such as host node 102-1 and host node 102-2, *host nodes as DAUs*) coupled with two or more base stations 101 (such as base station 101-1 and base station 101-2), …., further in [0049], …. The application layer 202 is responsive to at**

least one of a simple network management protocol (SNMP), a common management information protocol (CMIP), a remote monitoring (RM) protocol, and any network communications protocol standard suitable for remote monitoring and network management).

For claim 11 (Original), Grenier teaches, The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit **([0021], … each host node processor 106 and remote node processor 108 is configured to execute software or firmware (not shown) that causes the host node processor 106 and/or the remote node processor 108 to carry out various functions described herein).**

For claim 13 (Previously Presented), Greneir teaches, The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([0049], … as explained in … The physical layer 208 is communicatively coupled to, and provides low level support for the data link layer 206, the network layer 204, and the application layer 202. In some embodiments, the physical layer 208 resides on at least one of an optical fiber network, a coaxial cable network, and a wireless network**).

For claim 14 (Previously Presented), Grenier teaches, The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **([0049], … as explained in … The physical layer 208 is communicatively coupled to, and provides low level support for the data link layer 206, the network layer 204, and the application layer**

202. In some embodiments, the physical layer 208 resides on at least one of an optical fiber network, a coaxial cable network, and a wireless network).

For claim 15 (Previously Presented), Grenier teaches, The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration **([0045], …, as explained in … As is shown in the example embodiment shown in FIG. 1B, a plurality of analog remote nodes can be daisy chained off from a remote node in the communications network 100B**).

For claim 16 (Previously Presented), Grenier teaches, The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration **([0020], The communications network 100A represents a point-to-multipoint communications network that comprises a base station 101, a host node 102 responsive to the base station 101, and remote nodes 104-1 to 104-M in communication with the host node 102).**

For claim 17 (Previously Presented), Grenier teaches, The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link (**[0049], … as explained in … The physical layer 208 is communicatively coupled to, and provides low level support for the data link layer 206, the network layer 204, and the application layer 202. In some embodiments, the physical layer 208 resides on at least one of an optical fiber network, a coaxial cable network, and a wireless network**).

For claim 18 (Previously Presented), Grenier teaches, The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs (**[0041], …. the communications network 100B represents a multipoint-to-multipoint communications**

network that shares many components with communications network 100A shown in FIG. 1A and described above).

For claim 19 (Previously Presented), Grenier teaches, The system of claim 5 wherein a single DAU port is connected to the one or more BTSs **([0026], … The host base station interface 103 and each of the RF to digital interfaces 109 include ports D1, D2, and D3)**.

Claims 2, 4, 20 and 21 are rejected under 35 U.S.C. 103 as being unpatentable Grenier; in view of Sombrutzki; further in view of Trigui; Hafedh et al. (US 8,498,207 hereinafter: "Trigui").

For claim 2, the combination of Grenier and Sombrutzki do not teach, the system of claim 1 wherein each BTS comprises a plurality of sectors, however, in the same field of endeavor, Trigui teaches, the system of claim 1 wherein each BTS comprises a plurality of sectors **(Fig. 4 and 5 showing plurality of sectors, further explained in [col 9 lines 35-36] … Each coverage area 401 behaves as an independent sector serving its own set of subscribers 402 ..., therefore, each BTS comprises a plurality of sectors).**

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree, Sombrutzki system organizing an architecture of access points in a distributed wireless network interference between the access points, assigning sectors channels to the access points based on the measured interference and Trigui discusses, dynamic load balancing of coverage areas in a wireless communication network. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill

in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved as taught by Trigui.

For claim 4, the combination of Grenier and Sombrutzki do not teach, the network optimization goal comprising a percentage of users associated with each of the plurality of sectors, however, in the same field of endeavor Trigui teaches, the system of claim 2 further comprising the network optimization goal comprising a percentage of users associated with each of the plurality of sectors **(Fig. 3 item 303 and 309 as explained in [col 7 lines 16-20], … the congestion in the coverage areas is evaluated, which is also referred to as cell congestion. Congestion refers to the number of subscribers within the coverage areas, further in [col 7 lines 58-62], …in step 309, it is determined again if there is improvement in the operating conditions in the wireless communication network 100 based on the change in optimization direction and changes in parameters, …, therefore congestion evaluation as the network optimization goal comprising a percentage of users associated with each of the plurality of sectors)**.

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree, Sombrutzki system organizing an architecture of access points in a distributed wireless network interference between the access points, assigning sectors channels to the access points based on the measured interference and Trigui discusses, dynamic load balancing of coverage areas in a wireless communication network. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill

in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved as taught by Trigui.

For claim 20 (New), the combination of Grenier and Sombrutzki do not teach, wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS, however, in the same field of endeavor, Trigui teaches, the system of claim 1 wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS **(Fig. 3 item 306, as explained in [col 6 lines 45-55], …. In step 306, the dynamic load balancing apparatus 109 determines if there is any improvement in the operating conditions of the wireless communication network 100 based on the changes made to one or more of the network parameters. If there is improvement, then the one or more of network parameters continued to be changed (as in step 305) until it is determined if there is no improvements in the operating conditions of the wireless communication network 100. In step 307, the optimization direction of the antenna 202 is modified and in step 308 one or more network parameters are changed, if it is determined that there is no improvement in operating conditions of the wireless communication network 100 in step 306, …, therefore, the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS).**

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree, Sombrutzki system organizing an architecture of access points in a distributed wireless network interference between the access points, assigning sectors

channels to the access points based on the measured interference and Trigui discusses, dynamic load balancing of coverage areas in a wireless communication network. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved as taught by Trigui.

For claim 21 (New), the combination of Grenier and Sombrutzki do not teach, wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS , however, in the same filed of endeavor, Trigui teaches, The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS **(as explained in [col 2 lines 57-60], … The altering of the network parameters and evaluating of the cell congestion are performed continuously until a target quality of service in the wireless communication network is achieved, …, therefore, the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS).**

Grenier discusses, host unit (as DAU) is coupled between a base station and the plurality of remote units (as DRU) in one of many possible network configurations, such as hub and spoke, daisy-chain, or branch-and-tree, Sombrutzki system organizing an architecture of access points in a distributed wireless network interference between the access points, assigning sectors channels to the access points based on the measured interference and Trigui discusses, dynamic load balancing of coverage areas in a wireless communication network. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Grenier with Sombrutzki to continuously alter the plurality

of network parameters and evaluate cell congestion until a target quality of service is achieved as taught by Trigui.

Conclusion

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

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)270-0524. The examiner can normally be reached on Mon-Fri 7 am to 4 pm.

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on 571-272-4186. 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.

/MAJID SYED/

Examiner, Art Unit 2641

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 2641

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2011/0122788 A1	05-2011	Sombrutzki; Robert	H04W16/10	370/252
*	B	US-2012/0327789 A1	12-2012	Grenier; James Robert	H04L43/10	370/252
*	C	US-8,498,207 B2	07-2013	Trigui; Hafedh	H04L41/5025	370/235
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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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

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	2003/0147353	A1	Aug 7, 2003	CLARKSON, KENNETH L., et al.	
	2	2012/0119772	A1	May 17, 2012	HIRAKO et al.	

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

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]
	3	AU2013296819 , "First Examiner Report", August 31, 2016, 2 pages	
	4	EA201500184 , "Office Action", November 7, 2016, 2 pages	

EXAMINER SIGNATURE

Examiner Signature	/MAJID SYED/	Date Considered	03/09/2017

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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.

CERTIFICATION STATEMENT

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

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OR

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

☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-11-30
Name/Print	Stephen A. Mao	Registration Number	73418

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-**

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	2	2012/0039254	A1	Feb 16, 2012	Stapleton, Shawn P., et al.	

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Examiner Initial*	Cite No	Foreign Document Number [3]	Country Code [2]	Kind Code [4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T [5]
	3	2011085514	WO		Jul 21, 2011	ALCATEL-LUCENT SHANGHAI BELL CO., LTD	English Abstract Attached	

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]
	4	EP13825612.8 , "Extended European Search Report", June 24, 2016, 8 pages	

EXAMINER SIGNATURE

Examiner Signature	/MAJID SYED/	Date Considered	03/09/2017

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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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☐ See attached certification statement.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-07-28
Name/Print	Stephen A. Mao	Registration Number	73418

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.**

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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

68620439V.1

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

PTO/SB/08a (01-10)
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	Examiner Name	Majid Syed
	Attorney Docket Number	091172-103900US-0882666

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

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

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[5]
	1.	Written Opinion for Singapore application no. 11201500770U issued January 13, 2016, 6 pages.	

EXAMINER SIGNATURE			
Examiner Signature /MAJID SYED/		Date Considered 03/09/2017	

*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.

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	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-103900US-0882666

[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	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-02-10
Name/Print	Stephen A. Mao	Registration Number	73418

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.**

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015	06/01/2015	01/13/2016	07/29/2016	03/09/2017				
	1	✓	✓	✓	✓	✓				
	2	✓	✓	✓	✓	✓				
	3	✓	-	-	-	-				
	4	✓	✓	✓	✓	✓				
	5	✓	✓	✓	✓	✓				
	6	✓	✓	✓	✓	✓				
	7	✓	✓	✓	✓	✓				
	8	✓	✓	✓	✓	✓				
	9	✓	✓	✓	✓	✓				
	10	✓	✓	✓	✓	✓				
	11	✓	✓	✓	✓	✓				
	12	✓	✓	-	-	-				
	13	✓	✓	✓	✓	✓				
	14	✓	✓	✓	✓	✓				
	15	✓	✓	✓	✓	✓				
	16	✓	✓	✓	✓	✓				
	17	✓	✓	✓	✓	✓				
	18	✓	✓	✓	✓	✓				
	19	✓	✓	✓	✓	✓				
	20		✓	✓	✓	✓				
	21		✓	✓	✓	✓				

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	1	"8184050".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:10
L5	4	(20070117592| "20100278530")	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/15 09:49
S1	46571	((370/328,334,329)|(375/267)| (455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)| (455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45

S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S25	1	"7098805".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:38
S26	1	"20140244149"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:52
S27	1	"8611260".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:07
S28	1	"20120270553"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:10
S29	1	"8467397".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:13
S30	1	"20130114963"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:37
S31	206375	DAS	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:43
S32	48659	S31 and dru$s	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44

S33	0	S32 and number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S34	238	DAS and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S35	0	S34 and number near5 user per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S36	0	S34 and number near5 per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S37	1	S34 and per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:47
S38	2	"20110122788"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 17:16
S39	2814	distance between base station	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S40	2	S39 and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S41	2	Distance between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:46
S42	1	Distance$s between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:48
S43	58	Distance$s between APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:49
S44	0	Access Aware APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:39
S45	0	(DAS | DRU) same number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:41
S46	0	(DAS | DRU) with number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S47	0	(DAS | DRU) with number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S48	0	(DAS | DRU) near5 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S49	0	(DAS | DRU) near15 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S50	11	"8958789"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S51	1	"8958789".pn.	US-PGPUB;	OR	ON	2016/07/28 17:59

			USPAT; USOCR			
S52	0	"2003006900"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:27
S53	1	"20030069000"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:27
S54	2	"20120094657"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:28
S55	0	"2011085514"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/29 07:29
S56	7	("20030147353" | "20120119772" | "20010052011" | "20120039254" | "20020119772" | "20050153743" | "20120039320").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:36
S57	2	("20010052011" | "20120039254").PN.	US-PGPUB; USPAT	OR	ON	2017/03/09 13:39
S58	1	"8396368".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 15:38
S59	307548	((distributed antenna system)| DAS)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:53
S60	2970	(distributed antenna system)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S61	958	(Traffic Optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:54
S62	9	S60 and (traffic optimization)	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:55
S63	84	S60 and drus	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 15:56
S64	1	"20120329523"	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:00
S65	1969	S60 and das	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:07
S66	72	S60 and dau	US-	ADJ	ON	2017/03/13

			PGPUB; USPAT; USOCR			16:07
S67	0	distributed antenna system with dru with dau with monitoring	US-PGPUB; USPAT; USOCR	ADJ	ON	2017/03/13 16:16
S68	2642921	(distributed antenna system with dru with dau with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:16
S69	2642933	(distributed antenna system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S70	24	S60 and (system same (dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:17
S71	25	S60 and ((dru | dau) with monitoring)	US-PGPUB; USPAT; USOCR	OR	ON	2017/03/13 16:19
S72	0	distributed anteena system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S73	2974	distributed antenna system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S74	2976	distributed antenna$1 system	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:22
S75	2976	distributed antenna$1 system$1	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S76	62	S75 and (dru$1 same dau$1)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:23
S77	194	S75 and (daisy chain$4)	US-PGPUB; USPAT	ADJ	ON	2017/03/14 19:26

EAST Search History (Interference)

<This search history is empty>

3/15/2017 2:42:46 PM
C:\Users\msyed\Documents\EAST\Workspaces\13950160-DAS-Traffic-Optimize.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	Art Unit
	MAJID SYED	2641

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

SEARCH NOTES		
Search Notes	Date	Examiner
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS
Google search for DAS with Daisy-Chain	7-29-2016	MS

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

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on January 4, 2017.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-0882666-103900US
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A 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 August 8, 2016, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 5 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. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs.

2. (Previously Presented) The system of claim 1 wherein each BTS comprises a plurality of sectors.

3. (Canceled).

4. (Previously Presented) The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors.

5. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring unit external to and coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs.

6. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs.

7. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs.

8. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs .

9. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. (Previously Presented) The system of claim 5 wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. (Previously Presented) The system of claim 5 wherein a single DAU port is connected to the one or more BTSs.

20. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 1-2 and 4-11 and 13-21 will be pending in this application. Claims 1 and 5 have been amended, claims 3 and 12 remain canceled, and no claims have been added. No new matter is added. Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Claim Rejections – 35 USC §103

Claims 1-2, 4-11, 13-14, 16-17, 19-21 are rejected under 35 US. 103 as allegedly unpatentable over US 8,498,207 in the name of Trigui et al. (hereinafter: "Trigui") in view of US 2011/0122788 in the name of Sombrutzki et al. (hereinafter: "Sombrutzki"). Office Action pages 2-10.

Claims 15 and 18 are rejected over Trigui in view of Sombrutzki, further in view of US 8,958,789 in the name of Bauman et al. (hereinafter: "Bauman"). Office Action pages 10-12.

Claim 1 has been amended to recite, "*a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs*," among other claim elements. Applicants respectfully submit that the cited reference does not teach or suggest each and every claim element of amended claim 1.

As disclosed in the specification of the present invention, a DAS system, illustrated in FIG. 1 and reproduced below for the Examiner's convenience, includes a plurality of DAUs (i.e., DAU 1, DAU 2, and DAU 3) and a plurality of DRUs (i.e., DRU 1 through DRU 21). In the embodiment illustrated in FIG. 1, the plurality of DAUs are coupled to base transceiver station (BTS) hotel containing sectors 101, 109, and 110 via RF cables. In such embodiments, the plurality of DAUs can receive RF signals from the BTS as discussed in at least paragraph [0038]. Furthermore, in the embodiment illustrated in FIG. 8, the plurality of DAUs (e.g., DAU 1, DAU 2, and DAU 3) can be coupled to BTS hotel 810 via digital interfaces 830 to receive digital signals from the BTS hotel 810.

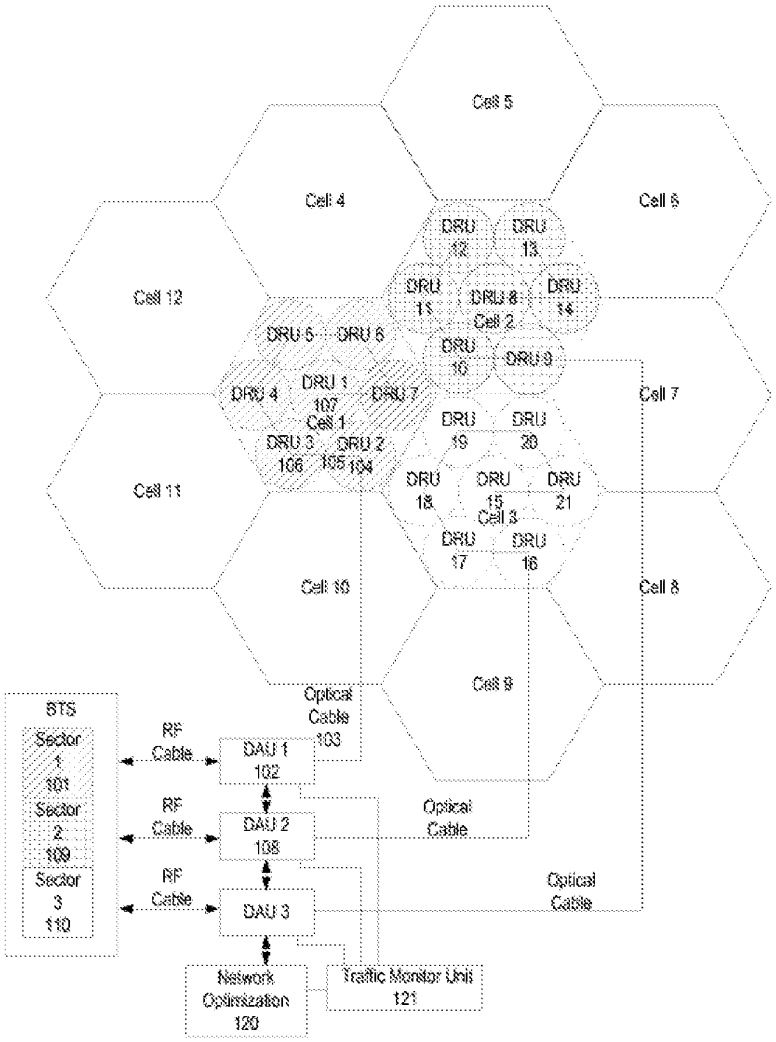

FIG. 1

In contrast, Trigui discusses "a wireless communication network 100 illustrated in FIG. 1." (Trigui at column 3, lines 54-55). The wireless communication network 100 includes a plurality of base stations 103 operating on different frequency channels. (Id. at column 4, lines 40-43). Base stations 103 are coupled to antenna arrays 202, "each antenna array 202 can be a multiple of active antennas coupled to a common source or load to produce a directive radiation pattern forming the coverage areas 105." (Id. at column 6, lines 29-33). Thus, Trigui discusses base stations 103 coupled directly to antennas 202, which produce directive radiation patterns.

Trigui does not discuss receiving radio frequency (RF) or digital signals at the antennas 202 from the base stations 103. In fact, Trigui is silent with respect to what type of signals are being sent between the base stations 103 and the antenna arrays 202. Furthermore, Applicant respectfully submits that the base stations 103 in Trigui cannot be used to read on the DAUs in claim 1 because the base stations 103 are base stations in and of themselves, and cannot be operable to receive signals from themselves. As such, Trigui fails to disclose "*a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs*," as recited in claim 1.

Sombrutzki fails to remedy the deficiencies of Trigui. Sombrutzki discusses "a method for organizing an architecture of access points in a distributed wireless network," such as "a GPRS network, a WiMax type network or an IEEE 802.11 type or Wi-Fi network." (Sombrutzki at paragraph [0019]). As shown in FIGS. 2 and 3, a distributed wireless network can include a plurality of access points coupled to a management server. Thus, Sombrutzki relates to Wi-Fi networks and access points, which is not analogous to a DAU network. Additionally, a management server is not analogous to a base transceiver station for a DAU network. Moreover, Sombrutzki does not disclose receiving radio frequency (RF) or digital signals at the access points from the management server. As such, Sombrutzki fails to disclose "*a plurality of Digital Access Units (DAUs) operable to receive at least one of radio frequency (RF) or digital signals from one or more of the plurality of BTSs*," as recited in claim 1.

Independent claim 5 recites elements similar to claim 1. Therefore, claim 5 is in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

Claims 2, 4, 6-11, and 13-21, which depend from claims 1 and 5, are in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

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.

Respectfully submitted,

/Craig C. Largent/
Craig C. Largent
Registration No. 56400

KILPATRICK TOWNSEND & STOCKTON LLP
SAM:CCL:bsk

68669103V.1

Electronic Patent Application Fee Transmittal					
Application Number:	13950160				
Filing Date:	24-Jul-2013				
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM				
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton				
Filer:	Craig Cody Largent/Brian Kanter				
Attorney Docket Number:	091172-0882666-103900US				
Filed as Small Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
		Total in USD ($)		**300**

Electronic Acknowledgement Receipt	
EFS ID:	27971452
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A 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:	091172-0882666-103900US
Receipt Date:	04-JAN-2017
Filing Date:	24-JUL-2013
Time Stamp:	19:53:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$300
RAM confirmation Number	010517INTEFSW19550800
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		AMD_103900US_68669103_1.pdf	151825 0447fd2a2ff0e3c6a3f19759c913809f82433b56	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	4
	Applicant Arguments/Remarks Made in an Amendment	5	8

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30904 91de91e378c7a8a27aea2a47a614da3f76614201	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	182729		

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
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/950,160	Filing Date 07/24/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT 01/04/2017

	(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))	* 19	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 2	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.

SLIE
ANISSA D. DEVLIN

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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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	2003/0147353	A1	Aug 7, 2003	CLARKSON, KENNETH L., et al.	
	2	2012/0119772	A1	May 17, 2012	HIRAKO 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[5]
	3	AU2013296819 , "First Examiner Report", August 31, 2016, 2 pages	
	4	EA201500184 , "Office Action", November 7, 2016, 2 pages	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

*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.

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

☐ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-11-30
Name/Print	Stephen A. Mao	Registration Number	73418

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-**

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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

1450.

Electronic Acknowledgement Receipt	
EFS ID:	27657555
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	30-NOV-2016
Filing Date:	24-JUL-2013
Time Stamp:	18:08:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_103900US_68943275_1.pdf	110491 5766b71f5e1d1baaa320fd1617215b136e643373	no	3

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	NPL_AU_2013296819_1ExRep_08312016.pdf	887887 0e200439a764a63bd08e1f3cd82754c648653654	no	2
Warnings:					
Information:					
3	Non Patent Literature	NPL_EA_201500184_OA_11072016.pdf	1159440 25a2fba96a2cc2b306a9bf01c97410b3d92e54ea	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	2157818	

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	091172-0882666-103900US	6371

20350 7590 08/08/2016

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

EXAMINER
SYED, MAJID

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
08/08/2016	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
jlhice@kilpatrick.foundationip.com

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *7/5/2016*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1,2,4-11 and 13-21* 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) *1,2,4-11 and 13-21* 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 *7/24/2103* 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

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

Response to Arguments

Applicant's arguments, see page 5 of 7, filed 7/5/2016, with respect to the rejection(s) of claim(s) 1-2, 4-11, 13-21 under 35 U.S.C. 103 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Trigui et al..

Claim Rejections - 35 USC § 103

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

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

Claims 1-2, 4-11, 13-14, 16-17, 19-21 are rejected under 35 U.S.C. 103 as being unpatentable Trigui; Hafedh et al. (US 8,498,207 hereinafter: "Trigui") in view of Sombrutzki; Robert et al. (US 2011/0122788 A1 hereinafter: "Sombrutzki").

For claim 1, Trigui discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 2 item 103 as DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 2 item 102 as Star Connectivity)**;

a plurality of Digital Remote Units (DRUs) **(Fig. 2 item 202 Antenna as DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs **(Fig. 2 item 202 as DAU star connected with 109 as Dynamic Load Balancing Apparatus)** and DAUs **(Fig. 2 item 202 as DRUs connected to item 203 as DAUs)**;

and a traffic monitoring unit coupled to each of the plurality of DAUs **(Fig. 2 item 102 as Controller connected to each DAUs)**;

Trigui does not teach traffic monitoring unit configured to determine number of users per DRU, in the same field of endeavor, Sombrutzki teaches, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs **(Fig. 5 with Traffic Aware APS, …, as explained in [0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …, traffic changes can be represented by the number of users connected to the access points that comprise the system and for the number and types (unicast/multicast or constant/variable data rate) of applications that are running in the computing devices of the users connected**

to the access points, …, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs).

Trigui discusses dynamic load balancing by evaluating cell congestion based on location information of subscribers in the wireless communication network, collecting network parameters related to the wireless communication network and altering network parameters based on the evaluated cell congestion and Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs). It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Trigui with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved.

For claim 2, Trigui discloses, the system of claim 1 wherein each BTS comprises a plurality of sectors **(as explained in [col 6 lines 29-34] each antenna array 202 can be a multiple of active antennas coupled to a common source or load to produce a directive radiation pattern forming the coverage areas 105. For example, the antenna array can be an integrated digital antenna array. ... further in [col 7 lines 53-57 In step 307, the optimization direction of the antenna 202 is modified and in step 308 one or more network parameters are changed, if it is determined that there is no improvement in operating conditions of the wireless communication network 100 in step 306, ..., therefore, each BTS comprises a plurality of sectors)**

For claim 4, Trigui discloses, the system of claim 2 further comprising the network optimization goal comprising a percentage of users associated with each of the plurality of

sectors **(Fig. 3 item 303 and 309 as explained in [col 7 lines 16-20], … the congestion in the coverage areas is evaluated, which is also referred to as cell congestion. Congestion refers to the number of subscribers within the coverage areas, further in [col 7 lines 58-62], …in step 309, it is determined again if there is improvement in the operating conditions in the wireless communication network 100 based on the change in optimization direction and changes in parameters, …, therefore congestion evaluation as the network optimization goal comprising a percentage of users associated with each of the plurality of sectors)**.

For claim 5 (currently amended), Trigui discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 2 item 103 as DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 2 item 102 as Star Connectivity)** ;

a plurality of Digital Remote Units (DRUs) **(Fig. 2 item 202 Antenna as DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs **(Fig. 2 item 202 as DAU star connected with 109 as Dynamic Load Balancing Apparatus)** and DAUs **(Fig. 2 item 202 as DRUs connected to item 203 as DAUs)**;

Trigui does not teach traffic monitoring unit configured to determine number of users per DRU, in the same field of endeavor, Sombrutzki teaches, and a traffic monitoring unit external to and wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between **(Fig. 5 with Traffic Aware APS, …, as explained in**

[0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …, traffic changes can be represented by the number of users connected to the access points that comprise the system and for the number and types (unicast/multicast or constant/variable data rate) of applications that are running in the computing devices of the users connected to the access points, …, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs).

Trigui discusses dynamic load balancing by evaluating cell congestion based on location information of subscribers in the wireless communication network, collecting network parameters related to the wireless communication network and altering network parameters based on the evaluated cell congestion and Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs). It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Trigui with Sombrutzki to continuously alter the plurality of network parameters and evaluate cell congestion until a target quality of service is achieved.

Consider claim 6 (currently amended), Trigui discloses, the system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs **(Fig. 2 item 102 as DAUs star connected externally to item 102 as Controller, …, therefore, the traffic monitoring unit is external to the plurality of DAUs) .**

For claim 7 (currently amended) , Trigui discloses, the system of claim 1 wherein the one or more traffic monitoring unit is provided as a component of each of the plurality of DAUs **(Fig. 1 item 103 as DAUs connected to Controller 102 further connected to item 101 as Network Management apparatus, ..., therefore, one or more traffic monitoring unit is provided as a component of each of the plurality of DAUs)**.

For claim 8 (currently amended), Trigui discloses, the system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs **(Fig. 2 item 202 as DRUs connected externally to item 109 as Dynamic Load Balancing Apparatus, …, therefore, item 109 as the traffic monitoring unit is external to the plurality of DRUs).**

For claim 9 (currently amended), Trigui discloses, the system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs **(Fig. 2 item 202 as DRUs star connected externally to item 109 as Dynamic Load Balancing Apparatus, …, therefore, traffic monitoring unit is provided as a component of each of the plurality of DRUs)**

For claim 10 (currently amended), Trigui discloses, the system of claim 5 wherein the monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs **(Fig. 1 item 101/Network Management Apparatus, 102/Controller and 109/Dynamic Load Balancing, all or individual or combination as monitoring units, …, therefore, monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs)**.

For claim 11, Trigui discloses, the system of claim 5 further comprising a network optimization processor **(Fig. 6 item 602 as processor)** coupled to the traffic monitoring unit

(Fig. 6 item 109 and 606 as Dynamic Load Balancing Apparatus, …., therefore, optimization processor coupled to the traffic monitoring unit via Bus 606).

For claim 13, Trigui discloses, the system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(as explained in [col 10 lines 33-37], ... As another example, communication interface 605 may be a local area network (LAN) card (e.g., for ethernet.TM. or an Asynchronous Transfer Mode (ATM) network) to provide a data communication connection to a compatible LAN, …, therefore, the plurality of DAUs are coupled via at least one of Ethernet cable**).

For claim 14, Trigui discloses, the system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight 3 Link, Wireless Link, or Satellite Link **(as explained in [col 10 lines 33-37], ... As another example, communication interface 605 may be a local area network (LAN) card (e.g., for ethernet.TM. or an Asynchronous Transfer Mode (ATM) network) to provide a data communication connection to a compatible LAN, …, therefore, the plurality of DAUs are coupled via at least one of Ethernet cable)** .

For claim 16, Trigui discloses, the system of claim 5 wherein the plurality of DRUs are connected to the DAUs in a star configuration **(Fig. 2 item 202 as DRUs connected to item 203 as DAUs in star configuration**).

For claim 17, Trigui discloses, the system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber,

Microwave Line of Sight Link, Wireless Link, or Satellite Link **(as explained in [col 10 lines 33-37], ... As another example, communication interface 605 may be a local area network (LAN) card (e.g., for ethernet.TM. or an Asynchronous Transfer Mode (ATM) network) to provide a data communication connection to a compatible LAN, …, therefore, the plurality of DAUs are coupled via at least one of Ethernet cable)**.

For claim 19 (currently amended), Trigui discloses, the system of claim 5 wherein a single DAU port is connected to the one or more BTSs **(Fig. 2 item 102 connected to 3 DAUs, …, therefore, single DAU port is connected to the one or more BTSs).**

For claim 20 (New), Trigui discloses, the system of claim 1 wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS **(Fig. 3 item 306, as explained in [col 6 lines 45-55], …. In step 306, the dynamic load balancing apparatus 109 determines if there is any improvement in the operating conditions of the wireless communication network 100 based on the changes made to one or more of the network parameters. If there is improvement, then the one or more of network parameters continued to be changed (as in step 305) until it is determined if there is no improvements in the operating conditions of the wireless communication network 100. In step 307, the optimization direction of the antenna 202 is modified and in step 308 one or more network parameters are changed, if it is determined that there is no improvement in operating conditions of the wireless communication network 100 in step 306, …, therefore, the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS).**

For claim 21 (New), Trigui discloses, The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS **(as explained in [col 2 lines 57-60], … The altering of the network parameters and evaluating of the cell congestion are performed continuously until a target quality of service in the wireless communication network is achieved, …, therefore, the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS).**

Claims 15 and 18 are rejected over Trigui in view of Sombrutzki, further in view of Bauman; Philip M. et al. (US 8,958,789 B2 hereinafter: "Bauman").

For claim 15, the combination of Trigui and Sombrutzki do not teach the plurality of DRUs are connected in a daisy chain configuration, however, in the same field of endeavor, Bauman teaches, the system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration **(Fig. 1 item 105-108 as DRUs in daisy chain connected, …, as explained in [col 3 lines 55-60], … One or more remote units (105-108) are connected to the host unit (101) through an optical medium, such as fiber optic lines (120 and 125), in a daisy-chain arrangement, …, therefore, the plurality of DRUs are connected in a daisy chain configuration)**.

Trigui discusses dynamic load balancing by evaluating cell congestion based on location information of subscribers in the wireless communication network, collecting network parameters related to the wireless communication network and altering network parameters based on the evaluated cell congestion, Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs) and Bauman discusses DAS connection in Daisy Chain over

fiber optic. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Trigui and Sombrutzki with Bauman to connect DRUs in Daisy Topology because of signal repeat and/or ease in expansion in coverage when in dark spots such as tunnels, elevators, etc.

For claim 18, the combination of Trigui and Sombrutzki do not teach, the system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs, however, in the same field of endeavor, Bauman teaches, the system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs **(Fig. 1 item 120 and 125, as explained in [col 3 lines 4-10] The embodiment of FIG. 1 uses a separate fiber optic line for each direction of communication. Each fiber carries a different wavelength. For example, the fiber optic line (120) from the host unit (101) to the remote units (105-108) carries a wavelength of .lamda..sub.1. The fiber optic line (125) from the remote units (105-108) to the host unit (101) carries a wavelength of .lamda..sub.2. In alternate embodiments, each fiber carries the same wavelength, …, therefore, 120 and 125 as loop, therefore, the plurality of DRUs are connected in a loop to a plurality of DAUs).**

Trigui discusses dynamic load balancing by evaluating cell congestion based on location information of subscribers in the wireless communication network, collecting network parameters related to the wireless communication network and altering network parameters based on the evaluated cell congestion, Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs) and Bauman discusses DAS connection in Daisy Chain over fiber optic. It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the teachings of Trigui and Sombrutzki with

Bauman to connect DRUs in Daisy Topology looped because of topology reliability enhancement as well as signal reliability comparison at start with last hop.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)270-0524. The examiner can normally be reached on Mon-Fri 7 am to 4 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on 571-272-4186. 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.

/MAJID SYED/
Examiner, Art Unit 2641

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 2641

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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-2011/0122788 A1	05-2011	Sombrutzki; Robert	H04W16/10	370/252
*	B	US-8,958,789 B2	02-2015	Bauman; Donald R.	H04B10/25755	342/58
	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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015	06/01/2015	01/13/2016	07/29/2016					
	1	✓	✓	✓	✓					
	2	✓	✓	✓	✓					
	3	✓	-	-	-					
	4	✓	✓	✓	✓					
	5	✓	✓	✓	✓					
	6	✓	✓	✓	✓					
	7	✓	✓	✓	✓					
	8	✓	✓	✓	✓					
	9	✓	✓	✓	✓					
	10	✓	✓	✓	✓					
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	15	✓	✓	✓	✓					
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	17	✓	✓	✓	✓					
	18	✓	✓	✓	✓					
	19	✓	✓	✓	✓					
	20		✓	✓	✓					
	21		✓	✓	✓					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	46571	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45
S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08

S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S25	1	"7098805".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:38
S26	1	"20140244149"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:52
S27	1	"8611260".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:07
S28	1	"20120270553"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:10
S29	1	"8467397".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:13
S30	1	"20130114963"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:37
S31	206375	DAS	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:43
S32	48659	S31 and dru$s	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S33	0	S32 and number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S34	238	DAS and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S35	0	S34 and number near5 user per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S36	0	S34 and number near5 per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S37	1	S34 and per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:47
S38	2	"20110122788"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 17:16
S39	2814	distance between base station	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S40	2	S39 and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
S41	2	Distance between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:46
S42	1	Distance$s between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:48
S43	58	Distance$s between APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:49
S44	0	Access Aware APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:39
S45	0	(DAS | DRU) same number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:41
S46	0	(DAS | DRU) with number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S47	0	(DAS | DRU) with number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S48	0	(DAS | DRU) near5 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42
S49	0	(DAS | DRU) near15 number of user$s	US-PGPUB; USPAT	ADJ	ON	2016/01/13 07:42

S50	11	"8958789"	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59
S51	1	"8958789".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/07/28 17:59

EAST Search History (Interference)

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7/29/2016 7:25:10 AM
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	Art Unit
	MAJID SYED	2641

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

SEARCH NOTES		
Search Notes	Date	Examiner
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS
Google search for DAS with Daisy-Chain	7-29-2016	MS

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

/MAJID SYED/ Examiner.Art Unit 2641	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

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	2001/0052011	A1	Dec 13, 2001	Nagao	
	2	2012/0039254	A1	Feb 16, 2012	Stapleton, Shawn P., 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	2011085514	WO		Jul 21, 2011	ALCATEL-LUCENT SHANGHAI BELL CO., LTD	English Abstract Attached	

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]
	4	EP13825612.8 , "Extended European Search Report", June 24, 2016, 8 pages	

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-0882666-103900US

*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).

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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	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-07-28
Name/Print	Stephen A. Mao	Registration Number	73418

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METHOD AND EQUIPMENT FOR INTER-CELL INTERFERENCE COORDINATION IN RELAY-ASSISTED CELLULAR SYSTEM

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Abstract of WO2011085514 (A1)

A method for inter-cell interference coordination (ICIC) in a relay-assisted network is provided in the present invention, and in the relay-assisted network, user equipments (UE) are divided into macro UEs which are directly serviced by base stations, and relay UEs which are indirectly serviced by the base stations through relay nodes. The method includes the following steps: calculating the mean percentage of relay UEs, wherein the mean percentage of relay UEs is the mean percentage of the number of relay UEs serviced by a single relay node in the cell to the total number of UEs; according to the calculated mean percentage of relay UEs, determining the system bandwidth to be distributed to the relay nodes, and distributing the rest system bandwidth to the base station; and determining the further scheduling of the relay nodes and base station to the distributed system bandwidth based on the scheduling algorithm. An equipment for inter-cell interference coordination ICIC in the relay-assisted network is also provided in the present invention.

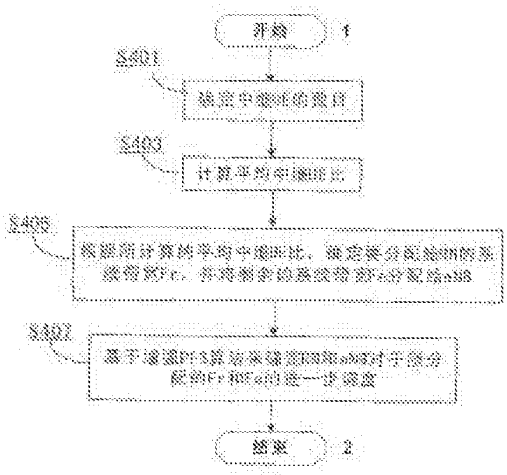

图 4 /Fig.4

1 START
S401 DETERMINING THE NUMBER OF RELAY UES
S403 CALCULATING THE MEAN PERCENTAGE OF RELAY UES
S405 ACCORDING TO THE CALCULATED MEAN PERCENTAGE OF RELAY UES, DETERMINING THE SYSTEM BANDWIDTH FR WHICH WILL BE DISTRIBUTED TO RNS, AND DISTRIBUTING THE REST SYSTEM BANDWIDTH FE TO ENB;
S407 DETERMINING THE FURTHER SCHEDULING OF RNS AND ENB TO THE DISTRIBUTED FR AND FE BASED ON THE REINFORCED PFS ALGORITHM
2 END

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(54) Title: METHOD AND EQUIPMENT FOR INTER-CELL INTERFERENCE COORDINATION IN RELAY-ASSISTED CELLULAR SYSTEM

(54) 发明名称 : 中继辅助蜂窝系统中用于小区间干扰协调的方法和设备

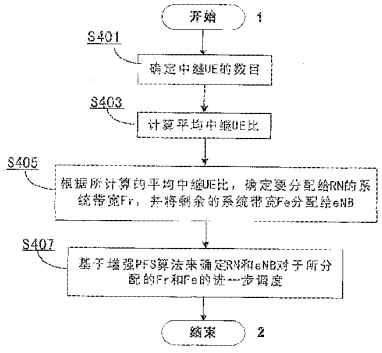

图 4 /Fig.4

1 START
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S407 DETERMINING THE FURTHER SCHEDULING OF RNS AND ENB TO THE DISTRIBUTED FR AND FE BASED ON THE REINFORCED PFS ALGORITHM
2 END

(57) **Abstract**: A method for inter-cell interference coordination (ICIC) in a relay-assisted network is provided in the present invention, and in the relay-assisted network, user equipments (UE) are divided into macro UEs which are directly serviced by base stations, and relay UEs which are indirectly serviced by the base stations through relay nodes. The method includes the following steps: calculating the mean percentage of relay UEs, wherein the mean percentage of relay UEs is the mean percentage of the number of relay UEs serviced by a single relay node in the cell to the total number of UEs; according to the calculated mean percentage of relay UEs, determining the system bandwidth to be distributed to the relay nodes, and distributing the rest system bandwidth to the base station; and determining the further scheduling of the relay nodes and base station to the distributed system bandwidth based on the scheduling algorithm. An equipment for inter-cell interference coordination ICIC in the relay-assisted network is also provided in the present invention.

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(57) **摘要**:

本发明提供了一种中继辅助网络中进行小区间干扰协调 ICIC 的方法，在所述中继辅助网络中，用户设备 UE 被划分为由基站直接服务的宏 UE 和经由中继节点间接由基站服务的中继 UE，所述方法包括以下步骤：计算平均中继 UE 比，其中所述平均中继 UE 比是小区中的单个中继节点所服务的中继 UE 数目占所有 UE 数目的平均百分比；根据所计算的平均中继 UE 比，确定要分配给中继节点的系统带宽，并将剩余的系统带宽分配给基站；以及基于调度算法来确定中继节点和基站对于所分配的系统带宽的进一步调度。本发明还提供了一种中继辅助网络中的小区间干扰协调 ICIC 设备。

中继辅助蜂窝系统中用于小区间干扰协调的方法和设备

技术领域

本发明涉及蜂窝系统中的干扰协调方法和设备，更具体地讲，涉及在中继辅助蜂窝网络中进行小区间干扰协调的方法和设备。

背景技术

正交频分多址接入（OFDMA）已被第三代伙伴计划长期演进（3GPP LTE）接受为用于下一代系统的有前景的下行链路空中接口技术（参见 S. Sesia, I. Toufik, and M. Baker, "LTE – the UMTS long term evolution: from theory to practice," Wiley Press, 2009，在此一并引入作为参考）。OFDMA 为无线电资源分配和避免小区内干扰提供了固有的灵活性。然而，由密集资源复用导致的强小区间干扰限制了充分利用 OFDMA 方案的可能。因而，为减小小区间干扰，提供适合的无线电资源管理（RRM）是十分必要的。

目前，主要考虑以下三种降低小区间干扰（ICIM）的技术：1）干扰随机化，2）干扰消除，3）干扰协调（参见 M. Rahman, H. Yanikomeroglu, and W. Wong, "Interference avoidance with dynamic inter-cell coordination for downlink LTE system," Proc. IEEE WCNC' 09, April 2009，在此一并引入作为参考）。，然而，干扰随机化并没有从本质上降低干扰，而干扰消除仅能够消除主要干扰，因此以协调的方式对下行链路资源管理进行限制以实现最佳网络性能的干扰协调被视为 3GPP LTE 中最有前景的 ICIM 方式。

大量的可用小区间干扰协调（ICIC）技术基于如图 1 所示的分数频率复用（FFR）原理。FFR 考虑复用分割，其中向小区边缘用户设备（UE）分配具有比小区中心 UE 高的复用因子的资源（一部分频谱），分配给小区中心 UE 的资源（整个频带或一部分频谱）仅以比至小区边缘 UE 的增强型节点 B（eNB）传输的功率低的受限功率进行复用。然而，基于各种考虑（尤其是下行链路功率控制可能使下行链路信道质量指示符（CQI）测量混乱，因而影响下行链路自适应和调度的有效性），最终在 LTE 中的数据信道上并不支持下行链路功率控制，这使得 FFR 对于 ICIC 是无效或无意义的。

近来，在 LTE 和 LTE-A 中广泛地对多跳中继技术进行了讨论，并将其引入了 3GPP

版本 9 及更高版本(参见 3GPP TR 36.814, "Further Advancements for E-UTRA Physical Layer Aspects," v1.2.1, June 2009, 在此一并引入作为参考)。在中继辅助系统中，每个 UE 可以主动或被动地访问 eNB 或中继节点（RN)。通过在小区边缘部署 RN，小区边缘 UE 可以体验来自服务 RN 的提高的接收信号功率。这样，使得在不降低小区中心频率资源处的 eNB 传输功率的情况下，FFR 在 LTE 中可用。基于上述考虑完成了本发明。

发明内容

为了解决现有技术中存在的问题，本发明提出了在中继辅助网络中进行小区间干扰协调 ICIC 的方法和设备。

根据本发明的一方面，提供了一种在中继辅助网络中进行小区间干扰协调 ICIC 的方法，在所述中继辅助网络中，用户设备 UE 被划分为由基站直接服务的宏 UE 和经由中继节点间接由基站服务的中继 UE，所述方法包括以下步骤：计算平均中继 UE 比，其中所述平均中继 UE 比是小区中的单个中继节点所服务的中继 UE 数目占所有 UE 数目的平均百分比；根据所计算的平均中继 UE 比，确定要分配给中继节点的系统带宽，并将剩余的系统带宽分配给基站；以及基于调度算法来确定中继节点和基站对于所分配的系统带宽的进一步调度。

优选地，所述调度算法是依赖于缓冲器队列状态因素的增强比例公平调度算法。

其中，分配给中继节点的系统带宽和分配给基站的系统带宽是相互正交的。

其中确定进一步调度的步骤包括：基于第一增强比例公平调度算法来计算针对中继节点的第一调度准则，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级。通过下式实现第一增强比例公平调度算法，

$$M_r(t) = \arg\max_m \frac{\min\{R^m_{inst}(t), R^m_{buffer}(t)\}}{R^m_{aver}(t)},$$

其中，t 表示时间索引，$R^m_{inst}(t)$ 表示中继 UE m 的瞬时可支持数据速率，$R^m_{aver}(t)$ 表示针对某一时间常量 τ 的中继 UE m 的指数滤波平均服务速率，以及 $R^m_{buffer}(t)$ 表示中继 UE m 的期望缓冲速率。

其中确定进一步调度的步骤还包括：基于第二增强比例公平调度算法来计算针对基站的第二调度准则，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级。通过下式实现第二增强比例公平调度算法，

$$M_e(t) = \arg\max_{n,l_m}\left\{\frac{R^n_{inst}(t)}{R^n_{aver}(t)}, \frac{R^{l_m}_{imp}(t)}{R^{l_m}_{aver}(t)}\right\},$$

其中，t 表示时间索引，$R^n_{inst}(t)$ 表示宏 UE n 的瞬时可支持数据速率，$R^n_{aver}(t)$ 表示针对某一时间常量 τ 的宏 UE n 的指数滤波平均服务速率，$R^{l_m}_{aver}(t)$ 表示中继 UE m 所对应的回程链路的平均速率，以及 $R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率。

该方法还包括，根据当前的 UE 关联方案和业务量负载信息，确定 UE 是中继 UE 还是宏 UE。

根据本发明的另一方面，提供了一种中继辅助网络中进行小区间干扰协调 ICIC 的设备，在所述中继辅助网络中，用户设备 UE 被划分为由基站直接服务的宏 UE 和经由中继节点间接由基站服务的中继 UE，所述设备包括：计算装置，用于计算平均中继 UE 比，其中所述平均中继 UE 比是小区中的单个中继节点所服务的中继 UE 数目占所有 UE 数目的平均百分比；分配装置，用于根据所计算的平均中继 UE 比，确定要分配给中继节点的系统带宽，并将剩余的系统带宽分配给基站；以及调度装置，用于基于调度算法来确定中继节点和基站对于所分配的系统带宽的进一步调度。

优选地，所述调度算法是依赖于缓冲器队列状态因素的增强比例公平调度算法。其中，分配给中继节点的系统带宽和分配给基站的系统带宽是相互正交的。

所述调度装置包括：第一调度装置，用于基于第一增强比例公平调度算法来计算针对中继节点的第一调度准则，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级。通过下式实现第一增强比例公平调度算法，

$$M_r(t) = \arg\max_m \frac{\min\{R^m_{inst}(t), R^m_{buffer}(t)\}}{R^m_{aver}(t)},$$

其中，t 表示时间索引，$R^m_{inst}(t)$ 表示中继 UE m 的瞬时可支持数据速率，$R^m_{aver}(t)$ 表示针对某一时间常量 τ 的中继 UE m 的指数滤波平均服务速率，以及 $R^m_{buffer}(t)$ 表示中继 UE m 的期望缓冲速率。

所述调度装置还包括：第二调度装置，用于基于第二增强比例公平调度算法来计算针对基站的第二调度准则，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级。通过下式实现第二增强比例公平调度算法，

$$M_e(t) = \arg\max_{n,l_m}\left\{\frac{R^n_{inst}(t)}{R^n_{aver}(t)}, \frac{R^{l_m}_{imp}(t)}{R^{l_m}_{aver}(t)}\right\},$$

其中，t 表示时间索引，$R^n_{inst}(t)$ 表示宏 UE n 的瞬时可支持数据速率，$R^n_{aver}(t)$ 表示针对某一时间常量 τ 的宏 UE n 的指数滤波平均服务速率，$R^{l_m}_{aver}(t)$ 表示中继 UE m 所对应的回程链路的平均速率，以及 $R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率。

该设备还包括，确定装置，用于根据当前的 UE 关联方案和业务量负载信息，确

定 UE 是中继 UE 还是宏 UE。

本发明针对中继辅助蜂窝网络中的 LTE 下行链路传输，提出了一种利用相应的增强型 PFS 算法的新的基于 FFR 的 ICIC 方案。在该 FFR 模型中，将整个系统带宽分为两个正交部分，一个用于由 eNB 直接服务的宏 UE，另一个用于由小区边缘 RN 服务的中继 UE。用于中继 UE 的资源可以由所有 RN 复用，因为 RN 具有有限的传输功率；类似地，用于宏 UE 的资源也可以由所有 eNB 复用，因为这些资源是用于小区中心 UE 的。该频谱划分并不需要在 eNB 处的功率控制功能，而是非常容易实现的。通过根据当前的 UE 关联和业务量负载确定中继 UE 的数目，继而根据所计算的平均中继 UE 比确定中继 UE 资源的量，以进行半静态调整。同时，为了完全利用该 FFR 模型，提出了在调度优先级准则中考虑中继缓冲器状态的增强型 PFS，以提供一种资源使用的均衡方式。本发明可以显著地提高部署了中继节点的蜂窝系统的系统性能。

附图说明

结合附图，本发明的上述和其它方面、特征和优点将从以下对于本发明的非限制性实施例的详细描述中变得更加清楚，其中：

图 1 示出了根据本发明示意性实施例的典型的 FFR 配置；

图 2 示出了根据本发明示意性实施例的中继辅助传输示意图；

图 3 示出了根据本发明示意性实施例的小区间干扰协调设备的结构框图；

图 4 示出了根据本发明示意性实施例的小区间干扰协调方法的流程图；

图 5 示出了根据本发明示意性实施例的多小区六边形的布局以及相应的频谱划分；

图 6 示出了根据本发明示意性实施例的 LTE FDD 下行链路帧结构；

图 7 示出了根据本发明示意性实施例的半静态资源分配；以及

图 8 示出了根据本发明示意性实施例的基于 FRR 的 ICIC 方案的吞吐量增益。

具体实施方式

以下将结合附图，对本发明的示意性实施例进行描述。在该示意性实施例中，以 LTE 系统为例。但是本领域技术人员应当理解，本发明的范围并不限于此，该示意性实施例仅用于描述目的，应将其看作本发明的示例而非对本发明的任何限制，任何利用了本发明实施例的方案均落入本发明的保护范围内。

本发明提出了一种新的针对中继辅助蜂窝网络中的小区间干扰协调 ICIC 的分数频率复用 FFR 方案。本发明的基本思想是，通过基于中继 UE 关联比的半静态正交资源分配、和经由增强比例公平调度（PFS）算法的动态资源调度，来避免从 eNB 至 RN 的小区内和小区间干扰，其包括以下主要的几点：

（1）在小区边缘部署中继节点；

（2）将每个小区中的所有 UE 分为两类：直接由 eNB 访问和服务的 UE 被称为宏 UE；以及经由 RN 间接由 eNB 服务的 UE 被称为中继 UE；

（3）将整个系统频谱分为两个正交子频带，例如 Fe 和 Fr，其中 Fe 被分配给 eNB，并由 eNB 最终利用 PFS 分配给宏 UE 和中继回程（backhaul）链路；以及 Fr 被相应地分配给 RN，并由 RN 最终利用 PFS 分配给中继 UE。这样的划分保证了在 eNB 与 RN 之间没有干扰；

（4）网络中的所有小区遵循相同的频谱划分，即，Fe 可以由所有施主 eNB 复用，以及 Fr 可以由所有 RN 复用。由于 Fe 用于小区中心 UE，因而期望来自相邻 eNB 的干扰功率远小于来自施主 eNB 的信号功率。同时，也可以假设小区间 RN 干扰处于可以接受的范围内，因为 RN 具有非常有限的覆盖范围（RN 的传输功率比 eNB 的传输功率低得多）；

（5）Fr 的宽度与平均中继 UE 比成正比，并且以半静态方式进行调整以与当前的网络状态相匹配；

（6）平均中继 UE 比是单个 RN 所服务的中继 UE 数目占单个小区平均 UE 总数目的平均百分比，具体地，是全网总的中继 UE 数目除以全网总 UE 数目后再除以全网总的 RN 数目。因为每个小区可能分布不同的 UE 总数，也可能包含不同数量的 RN 数目，而每个 RN 也可能服务不同数目的中继 UE。为了计算该平均中继 UE 比，一方面，将中继 UE 数目经由 Un 接口从每个下级 RN 报告给施主 eNB；另一方面，通过 X2 接口，在不同的 eNB 中互相交换中继 UE 数目。本领域技术人员应当理解，Un 接口是 Rn 与 eNB 之间的接口；以及 X2 接口是 eNB 与 eNB 之间的接口；

（7）为了充分利用该 FFR 方案，资源分配是基于增强 PF 调度（PFS）算法的。通过将缓冲器队列状态的因素引入调度准则来获得该增强，从而实现更加适合的资源分配。

参见图 3，图 3 示出了根据本发明示意性实施例的小区间干扰协调设备 300 的结构框图。如图 3 所示，小区间干扰协调设备 300 包括：计算装置 301、用于计算平均

中继 UE 比，其中所述平均中继 UE 比是小区中的单个 RN 所服务的中继 UE 数目占所有 UE 数目的平均百分比；分配装置 303，用于根据所计算的平均中继 UE 比，确定要分配给 RN 的系统带宽，并将剩余的系统带宽分配给 eNB；调度装置 305，用于基于增强比例公平调度算法来确定 RN 和 eNB 对于所分配的系统带宽的进一步调度。

该调度装置 305 包括：第一调度装置（未示出），用于基于第一增强 PFS 算法来计算 RN 处的第一调度结果，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级；以及第二调度装置（未示出），用于基于第二增强 PFS 算法来计算 eNB 处的第二调度结果，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级，其中，所述第一和第二增强 PFS 算法依赖于缓冲器队列状态因素。

此外，小区间干扰协调设备 300 还可以包括设置在计算装置 301 之前的确定装置（未示出），用于根据当前的 UE 关联方案和业务量负载信息，确定 UE 是中继 UE 还是宏 UE，以便确定中继 UE 的数目。

以下参照图 4-7，对根据本发明示意性实施例的小区间干扰协调方法进行描述，在该示意性实施例中，以 LTE FDD 下行链路传输为例。可以理解，本发明不限于此，而是可以应用于其它无线领域。

图 5 示意性地示出了多小区六边形的布局以及相应的频谱划分。如图 5 所示，在每个小区边缘可以部署，例如，两个 RN。以 LTE FDD 系统为例，典型地，LTE FDD 系统中的每个下行链路帧长 10ms，包括 20 个长度为 0.5ms 的时隙，标记为 0-19，如图 6 所示。将子帧定义为两个连续的时隙，其中子帧 i 包括时隙 2i 和 2i+1。

在 10MHz 系统带宽的情况下，在每个子帧中存在总数为 50 的物理资源块(PRB)。假设平均 25 个 UE 均匀地分布在每个小区中，并根据当前适合的 UE 关联方案（例如，考虑最大接收信号功率、或最短距离等）以及实际的业务量负载，由 eNB 或 RN 之一服务。如前所述，直接由 eNB 服务的 UE 称为宏 UE，通过 RN 间接由 eNB 服务的 UE 称为中继 UE。

在步骤 401 中，确定装置根据当前的 UE 关联方案和业务量负载信息，确定 UE 是中继 UE 还是宏 UE，以便确定中继 UE 的数目。

然后，每个 RN 通过 Un 接口向 eNB 报告中继 UE 数目，并通过 X2 接口在不同的 eNB 中互相交换该 UE 关联信息（即中继 UE 数目）。

在步骤 S403 中，通过计算装置 301 计算平均中继 UE 比。

在步骤 S405 中，分配装置 303 根据所计算的平均中继 UE 比，确定要分配给 RN

的系统带宽，并将剩余的系统带宽分配给 eNB。

例如，假设在特定持续时间内，平均地，每个 RN 间接地服务 3 个 UE，即，中继 UE，（由此可知平均中继 UE 比为 3/25=12%），以及施主 eNB 直接服务 19 个 UE。因此，可以根据平均中继 UE 比 12%，将整个系统带宽划分为以下两个部分：Fr，1-6 个 PRB；以及 Fe，7-50 个 PRB，即，将前 12%的资源分配给 RN 以便服务于中继 UE，以及将剩余资源分配给 eNB 以便服务于宏 UE 和中继回程链路，如图 7 所示。

由于资源调度算法极大地影响着 FFR 的性能，为此，本发明提出了增强 PFS，通过在调度准则中引入涉及缓冲器队列状态的因素来获得该增强，从而实现更加适合的资源分配。

在步骤 S407 中，调度装置 305 基于增强 PFS 算法来确定 RN 和 eNB 对于分配装置 303 所分配的 Fr 和 Fe 的进一步调度。

具体地讲，在步骤 S407 中，由第一调度装置基于第一增强 PFS 算法来计算 RN 处的第一调度结果，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级。第二调度装置基于第二增强 PFS 算法来计算 eNB 处的第二调度结果，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级。其中，

1）实现第一增强 PFS 算法如下面的表达式（1）—（3）给出：

针对 Fr 频带的每个 PRB 的 RN PFS，调度优先级准则为

$$M_r(t) = \arg\max_m \frac{\min\{R^m_{inst}(t), R^m_{buffer}(t)\}}{R^m_{aver}(t)} \qquad (1)$$

其中，t是时间索引，$R^m_{inst}(t)$是中继UE m的瞬时可支持数据速率，以及$R^m_{aver}(t)$是根据下式进行更新的针对某一时间常量τ的中继UE m的指数滤波平均服务速率

$$R^m_{aver}(t+1) = \begin{cases} (1-\tau)R^m_{aver}(t) + \tau \cdot \min\{R^m_{inst}(t), R^m_{buffer}(t)\}, & 若 M_r(t) = m \\ (1-\tau)R^m_{aver}(t), & 若\ M_r(t) \neq m \end{cases} \qquad (2)$$

。以及$R^m_{buffer}(t)$是中继UE m的期望缓冲速率，被定义为：

$$R^m_{buffer}(t) = \frac{\text{UE } m\text{的缓冲器队列总长度(以比特为单位)}}{\text{TTI}} \qquad (3)$$

其中，TTI 等于 1ms，即，一个子帧的传输时间间隔。通过新到达的数据队列长度和服务 RN 处的重传数据队列长度二者来确定缓冲器队列的总长度。

与现有技术中的 PFS 算法$M(t) = \arg\max_m \frac{R^m_{inst}(t)}{R^m_{aver}(t)}$相比，本发明所提出的调度优先级准则考虑了 UE 的缓冲器状态，从而避免了以空的缓冲器来调度 UE。

2）实现第二增强 PFS 算法如下面的表达式（4）和（5）给出：

假设 eNB 处的业务量加载模型是无限负载模型（infinitely-backlogged model），也称为满负荷模型，针对 Fe 频带的每个 RPB 处的 eNB PFS，在每个时间步骤中，调度优先级准则为

$$M_e(t) = \arg\max_{n,l_m}\left\{\frac{R^n_{inst}(t)}{R^n_{aver}(t)}, \frac{R^{l_m}_{imp}(t)}{R^{l_m}_{aver}(t)}\right\} \quad (4)$$

其中，t 表示时间索引，$R^n_{inst}(t)$ 表示宏 UE n 的瞬时可支持数据速率，$R^n_{aver}(t)$ 表示针对某一时间常量 τ 的宏 UE n 的指数滤波平均服务速率，$R^{l_m}_{aver}(t)$ 表示中继 UE m 所对应的回程链路的平均速率，以及 $R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率。其中宏 UE n 的 PF 优先级的计算（$R^n_{inst}(t)/R^n_{aver}(t)$）、以及中继 UE m 所对应的回程链路的平均速率（$R^{l_m}_{aver}(t)$）的计算与现有技术中相同。然而，对于与中继 UE m 对应的中继回程链路 l_m，$R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率：

$$R^{l_m}_{imp}(t) = \begin{cases} 0, & \text{如果链路 } l_m \text{ 的缓冲器队列长度大于特定阈值S1} \\ +\infty, & \text{如果链路 } l_m \text{ 的缓冲器为空,且总的RN缓冲器队列长度小于特定阈值S2} \\ R^{l_m}_{inst}(t), & \text{其它情况} \end{cases} \quad (5)$$

其中，$R^{l_m}_{inst}(t)$ 是回程链路 l_m 的瞬时可支持信道速率。

通过采用 $R^{l_m}_{imp}(t)$ 而非 $R^{l_m}_{inst}(t)$，中继回程链路不会耗费过多的 Fe 频带资源，同时可以向中继 UE 提供均衡的数据流。于是，可以在宏 UE 和中继回程链路中更恰当地使用 Fe 频带。

因而，将半静态资源分配和增强 PFS 相结合，可以在中继辅助蜂窝网络中有效地实现基于 FFR 的 ICIC，而不用限制 eNB 处的功率控制。

本发明针对中继辅助蜂窝网络中的 LTE 下行链路传输，提出了一种利用相应的增强 PFS 算法的新的基于 FFR 的 ICIC 方案。在该 FFR 模型中，将整个系统带宽分为两个正交部分，一个用于由 eNB 直接服务的宏 UE，另一个用于由小区边缘 RN 服务的中继 UE。用于中继 UE 的资源可以由所有 RN 复用，因为 RN 具有有限的传输功率。类似地，用于宏 UE 的资源也可以由所有 eNB 复用，因为这些资源是用于小区中心 UE 的。该频谱划分并不需要在 eNB 处的功率控制功能，而是非常容易实现的。通过根据当前的 UE 关联和业务量负载确定中继 UE 的数目，继而根据所计算的平均中继 UE 比确定中继 UE 资源的量，以进行半静态调整。同时，为了完全利用该 FFR 模型，提出了在调度优先级准则中考虑中继缓冲器状态的增强型 PFS，以提供一种资源使用的均衡方式。

此外，所提出的方法可以用于类型 I 和类型 II 中继节点，非常有利于在 3GPP LTE-A 标准中的应用。

根据本发明的基于 FFR 的 ICIC 方案可以在小区平均和小区边缘频谱效率方面提

供更好的系统性能。

图 8 示出了所提出的方法的显著性能增益（归一化用户吞吐量）示意图。下面的表 1 记录了针对图 8 中每种情况的相应小区平均和小区边缘(5%)用户吞吐量增益(表 1 中已对吞吐量进行了归一化)。经过计算可以得知，通过采用 RN 复用，在小区平均和小区边缘吞吐量上分别有 9.4%和 4.0%的增加；通过在每个小区内采用正交 RN 传输，在小区平均和小区边缘吞吐量上分别有 3.0%和 16.0%的增加。

表 1

	在没有 RN 的情况下的基线	*RN 正交*	*RN 复用*
小区平均(bps/Hz/小区)	1.741	1.794 (+3.0%)	1.905 (+9.4%)
小区边缘(bps/Hz)	0.025	0.029(+16.0%)	0.026 (+4.0%)

下面的表 2 给出了在无线蜂窝系统中利用本发明的方法和设备进行仿真时所采用的参数。

表 2

参数	值
蜂窝布局	单层 7 eNB 站点的环绕（wrap-round）布局，每个 eNB 站点包含 3 个小区，小区成六边形结构
系统带宽	10MHz, 下行链路
ISD（基站间距）	500 m (3GPP 场景 1)
最大 eNodeB 功率	46 dBm
RN 传输功率	30 dBm
每个小区的 RN 数目	2
每个小区的 UE 数目	25
调度方案	增强比例公平
调度中继	6ms
调度粒度	5PRB
下行链路 HARQ	具有 CC 的异步 HARQ, 最大三次重传，以及中继网络中的逐跳 HARQ
信道	针对 3GPP 场景 1 的 SCM 室内宏蜂窝高扩展模型
eNodeB 天线配置	具有在 3GPP TS 36.814 V1.2.1 中定义的天线模式的 1 个传输天线
RN 天线配置	具有在 3GPP TS 36.814 V1.2.1 中定义的天线模式的 1 个传输天线和 2 个接收天线
UE 天线配置	2 个传输天线(0 dBi 天线增益, 全向的)
下行链路接收类型	MRC
路径损失模型	参见 3GPP TS 36.814 V1.2.1
业务量模型	满负荷模型
控制信道开销, ACK 等	LTE：用于 DL CCH 的 L=3 个符号，用于解调参考信号的开销

表 2. 系统级仿真参数

通过上面给出的数据可知，本发明可以显著地改进部署了中继节点的蜂窝系统的系统性能。根据本发明的方案具有以下特性：

- eNB 和它的下级 RN 使用正交频率资源；
- 以半静态方式执行小区内的资源分配；
- 通过 Un 接口，将 UE 关联信息从 RN 报告给施主 eNB；
- 不同的 eNB 彼此交互，以通过 X2 接口交换它们相应的 UE 关联结果等。

本发明主要涉及基于 FFR 的 ICIC 解决方案，满足 3GPP LTE 中继定义，因而可以直接基于现有的技术来实现。

本领域技术人员应该很容易认识到，可以通过编程，利用计算机来实现上述方法的不同步骤。在此，一些实施方式同样包括机器可读或计算机可读的程序存储设备（如，数字数据存储介质）以及编码机器可执行或计算机可执行的程序指令，其中，该指令执行上述方法的一些或全部步骤。例如，程序存储设备可以是数字存储器、磁存储介质（如磁盘和磁带）、硬件或光可读数字数据存储介质。实施方式同样包括执行存储介质上记录的程序以执行上述方法的所述步骤的计算机。

上面结和附图所做的描述只是为了说明本发明而示例性给出的。本领域技术人员可以理解，能够基于上面所描述的本发明的原理提出不同的结构，虽然这些不同的结构未在此处明确描述或示出，但体现了本发明的原理并包括在其精神和范围之内。此外，所有此处提到的示例明确地主要只用于教学目的以帮助读者理解本发明的原理以及发明人所贡献的促进本领域的构思，并应被解释为不是对这些特定提到的示例和条件的限制。此外，此处所有提到本发明的原则、方面和实施方式的陈述及其特定的示例包含其等同物在内。

权 利 要 求

1. 一种在中继辅助网络中进行小区间干扰协调 ICIC 的方法，在所述中继辅助网络中，用户设备 UE 被划分为由基站直接服务的宏 UE 和经由中继节点间接由基站服务的中继 UE，所述方法包括以下步骤：

计算平均中继 UE 比，其中所述平均中继 UE 比是小区中的单个中继节点所服务的中继 UE 数目占所有 UE 数目的平均百分比；

根据所计算的平均中继 UE 比，确定要分配给中继节点的系统带宽，并将剩余的系统带宽分配给基站；以及

基于调度算法来确定中继节点和基站对于所分配的系统带宽的进一步调度。

2. 根据权利要求 1 所述的方法，其中，所述调度算法是依赖于缓冲器队列状态因素的增强比例公平调度算法。

3. 根据权利要求 1 所述的方法，其中，分配给中继节点的系统带宽和分配给基站的系统带宽是相互正交的。

4. 根据权利要求 2 所述的方法，其中确定进一步调度的步骤包括：

基于第一增强比例公平调度算法来计算针对中继节点的第一调度准则，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级。

5. 根据权利要求 4 所述的方法，其中通过下式实现第一增强比例公平调度算法，

$$M_r(t) = \arg\max_m \frac{\min\{R^m_{inst}(t), R^m_{buffer}(t)\}}{R^m_{aver}(t)},$$

其中，t 表示时间索引，$R^m_{inst}(t)$ 表示中继 UE m 的瞬时可支持数据速率，$R^m_{aver}(t)$ 表示针对某一时间常量 τ 的中继 UE m 的指数滤波平均服务速率，以及 $R^m_{buffer}(t)$ 表示中继 UE m 的期望缓冲速率。

6. 根据权利要求 2 所述的方法，其中确定进一步调度的步骤还包括： 基于第二增强比例公平调度算法来计算针对基站的第二调度准则，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级。

7. 根据权利要求 6 所述的方法，其中通过下式实现第二增强比例公平调度算法，

$$M_e(t) = \arg\max_{n,l_m}\left\{\frac{R^n_{inst}(t)}{R^n_{aver}(t)}, \frac{R^{l_m}_{imp}(t)}{R^{l_m}_{aver}(t)}\right\},$$

其中，t 表示时间索引，$R^n_{inst}(t)$ 表示宏 UE n 的瞬时可支持数据速率，$R^n_{aver}(t)$ 表示针对某一时间常量 τ 的宏 UE n 的指数滤波平均服务速率，$R^{l_m}_{aver}(t)$ 表示中继 UE m 所对应的回程链路的平均速率，以及 $R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率。

8. 根据权利要求 1 所述的方法，还包括，根据当前的 UE 关联方案和业务量负载信息，确定 UE 是中继 UE 还是宏 UE。

9. 一种中继辅助网络中进行小区间干扰协调 ICIC 的设备，在所述中继辅助网络中，用户设备 UE 被划分为由基站直接服务的宏 UE 和经由中继节点间接由基站服务的中继 UE，所述设备包括：

计算装置，用于计算平均中继 UE 比，其中所述平均中继 UE 比是小区中的单个中继节点所服务的中继 UE 数目占所有 UE 数目的平均百分比；

分配装置，用于根据所计算的平均中继 UE 比，确定要分配给中继节点的系统带宽，并将剩余的系统带宽分配给基站；以及

调度装置，用于基于调度算法来确定中继节点和基站对于所分配的系统带宽的进一步调度。

10. 根据权利要求 9 所述的设备，其中，所述调度算法是依赖于缓冲器队列状态因素的增强比例公平调度算法。

11. 根据权利要求 9 所述的设备，其中，分配给中继节点的系统带宽和分配给基站的系统带宽是相互正交的。

12. 根据权利要求 10 所述的设备，其中所述调度装置包括：

第一调度装置，用于基于第一增强比例公平调度算法来计算针对中继节点的第一调度准则，以确定将所分配的系统带宽进一步分配给中继 UE 的调度优先级。

13. 根据权利要求 12 所述的设备，其中通过下式实现第一增强比例公平调度算法，

$$M_r(t) = \arg\max_m \frac{\min\{R^m_{inst}(t), R^m_{buffer}(t)\}}{R^m_{aver}(t)},$$

其中，t 表示时间索引，$R^m_{inst}(t)$ 表示中继 UE m 的瞬时可支持数据速率，$R^m_{aver}(t)$ 表示针对某一时间常量 τ 的中继 UE m 的指数滤波平均服务速率，以及 $R^m_{buffer}(t)$ 表示中继 UE m 的期望缓冲速率。

14. 根据权利要求 10 所述的设备，其中所述调度装置还包括：第二调度装置，用于基于第二增强比例公平调度算法来计算针对基站的第二调度准则，以确定将所分配的系统带宽进一步分配给宏 UE 和中继回程链路的调度优先级。

15. 根据权利要求 14 所述的设备，其中通过下式实现第二增强比例公平调度算法，

$$M_e(t) = \arg\max_{n,l_m}\left\{\frac{R^n_{inst}(t)}{R^n_{aver}(t)}, \frac{R^{l_m}_{imp}(t)}{R^{l_m}_{aver}(t)}\right\},$$

其中，t 表示时间索引，$R^{n}_{inst}(t)$ 表示宏 UE n 的瞬时可支持数据速率，$R^{n}_{aver}(t)$ 表示针对某一时间常量 τ 的宏 UE n 的指数滤波平均服务速率，$R^{l_m}_{aver}(t)$ 表示中继 UE m 所对应的回程链路的平均速率，以及 $R^{l_m}_{imp}(t)$ 表示考虑了中继缓冲器队列状态的改进型回程链路速率。

16. 根据权利要求 9 所述的设备，还包括，确定装置，用于根据当前的 UE 关联方案和业务量负载信息，确定 UE 是中继 UE 还是宏 UE。

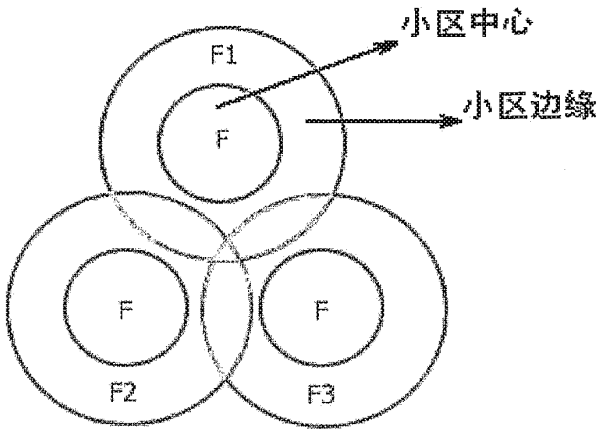

图 1

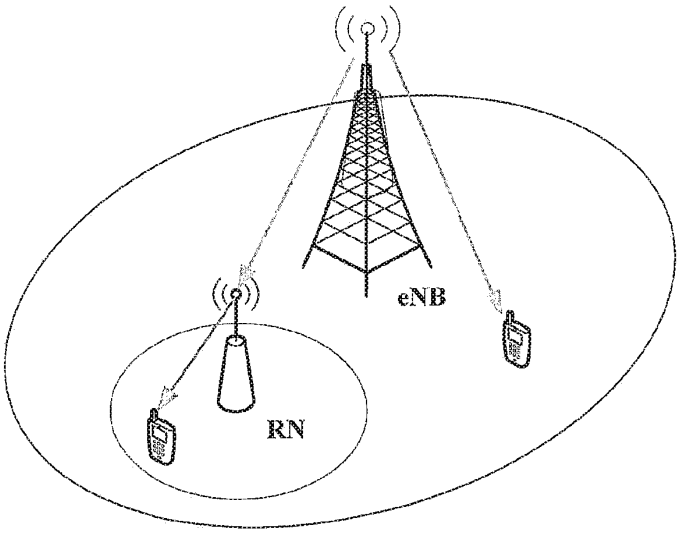

图 2

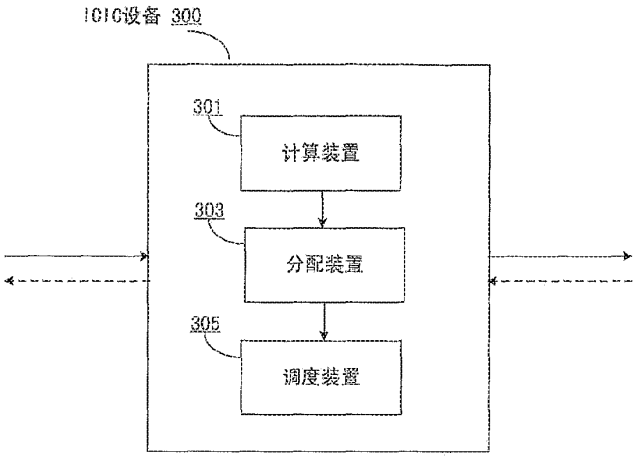
ICIC设备 300
301
计算装置
303
分配装置
305
调度装置

图 3

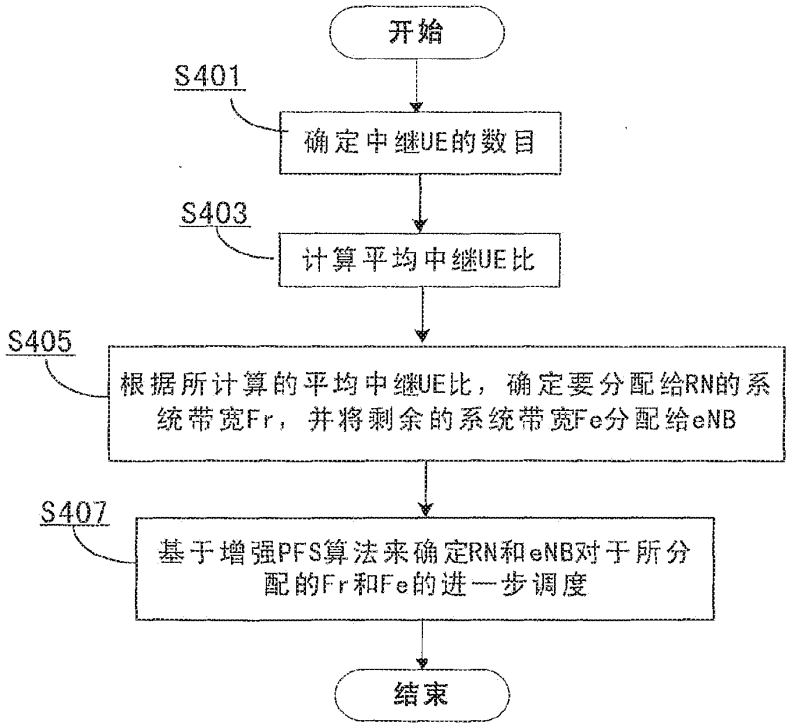
开始
S401
确定中继UE的数目
S403
计算平均中继UE比
S405
根据所计算的平均中继UE比，确定要分配给RN的系统带宽Fr，并将剩余的系统带宽Fe分配给eNB
S407
基于增强PFS算法来确定RN和eNB对于所分配的Fr和Fe的进一步调度
结束

图 4

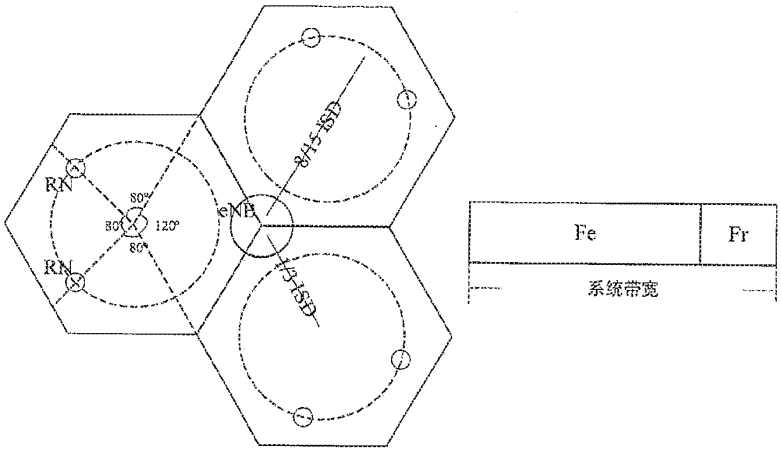
RN
RN
80°
80°
120°
80°
eNB
ISD
ISD
Fe
Fr
系统带宽

图 5

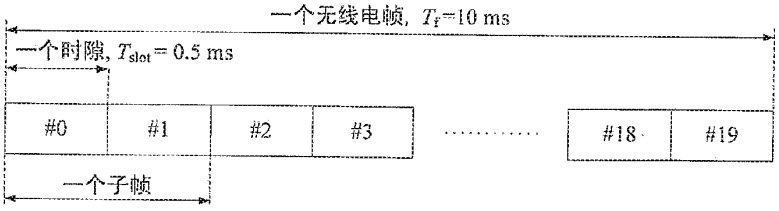
一个无线电帧, T_f=10 ms
一个时隙, T_{slot} = 0.5 ms
#0
#1
#2
#3
#18
#19
一个子帧

图 6

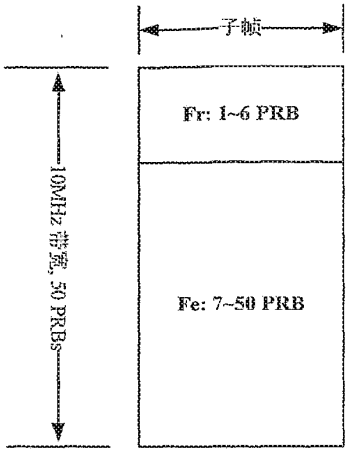
子帧
Fr: 1~6 PRB
Fe: 7~50 PRB
10MHz 带宽, 50 PRBs

图 7

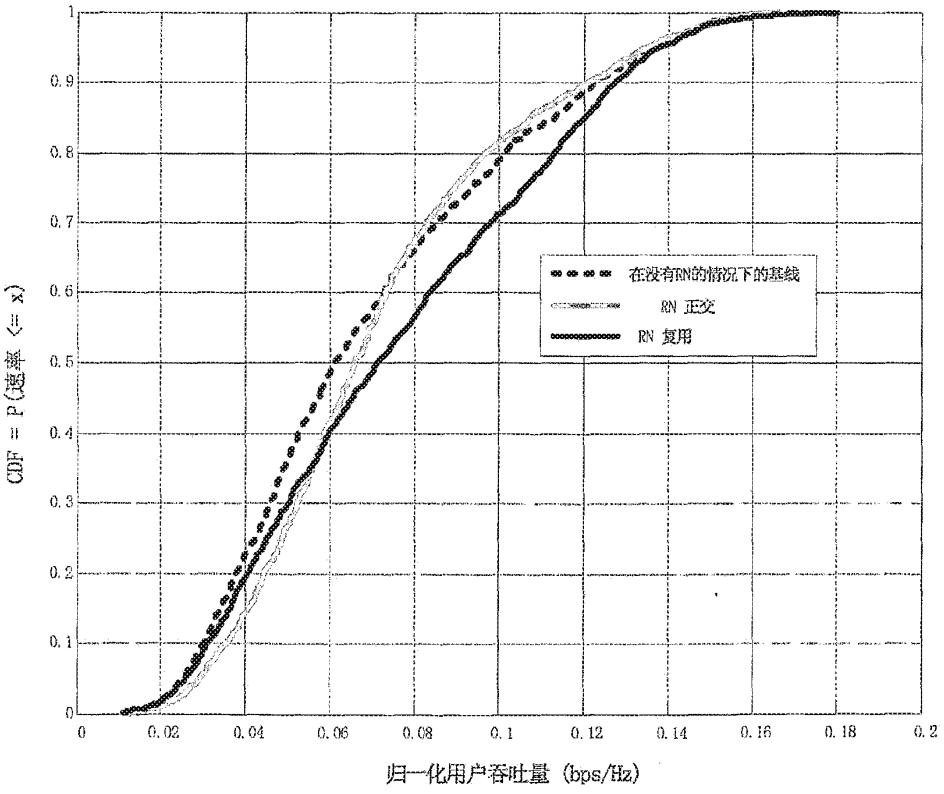
CDF = P(速率 <= x)
归一化用户吞吐量 (bps/Hz)
在没有RN的情况下的基线
RN 正交
RN 复用
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.02
0.04
0.06
0.08
0.12
0.14
0.16
0.18
0.2

图 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/000055

A. CLASSIFICATION OF SUBJECT MATTER

H04W72/00 (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)

IPC: H04W72/-

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)

CPRSABS,CNKI,WPI,EPODOC: INTERFERENCE W COORDINATION, RELAY, BANDWIDTH, RESOURCE, SCHEDULE, DISTRIBUTE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN101610518A (INTEL CORP)23 Dec.2009 (23.12.2009) See the whole document	1-16
A	CN101009622A (ALCATEL LUCENT)01 Aug.2007 (01.08.2007) See the whole document	1-16
A	CN101335971A(LENOVO BEIJING LTD)31Dec.2008 (31.12.2008) See the whole document	1-16
A	WO2009129413A2 (QUALCOMM INC) 22 Oct.2009 (22.10.2009) See the whole document	1-16

☐ 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
12 Oct.2010(12.10.2010)	**21 Oct. 2010 (21.10.2010)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer JIANG, Jingjing Telephone No. (86-10)62411430

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/000055

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN101610518A	23.12.2009	EP2101528A1	16.09.2009
		US2009233544A1	17.09.2009
CN101009622A	01.08.2007	CN100534057C	26.08.2009
		EP1806942A1	11.07.2007
		US2007155431A1	05.07.2007
CN101335971A	31.12.2008	US2009003260A1	01.01.2009
WO2009129413A2	22.10.2009	WO2009129413A3	25.03.2010
		US2009264077A1	22.10.2009

Form PCT/ISA /210 (patent family annex) (July 2009)

国际检索报告

国际申请号
PCT/CN2010/000055

A. 主题的分类

H04W72/00 (2009.01)i

按照国际专利分类(IPC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC：H04W72/-

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）)

CPRSABS,CNKI:干扰协调,中继,带宽,资源,调度,分配,

WPI,EPODOC: INTERFERENCE W COORDINATION, RELAY, BANDWIDTH, RESOURCE, SCHEDULE, DISTRIBUTE

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	CN101610518A (英特尔公司)23.12 月 2009 (23.12.2009) 全文	1-16
A	CN101009622A (阿尔卡特朗讯公司)01.8 月 2007 (01.08.2007) 全文	1-16
A	CN101335971A(联想有限公司)31.12 月 2008 (31.12.2008) 全文	1-16
A	WO2009129413A2 (QUALCOMM INC) 22.10 月 2009 (22.10.2009) 全文	1-16

☐ 其余文件在 C 栏的续页中列出。　　☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件（如具体说明的）

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
12.10 月 2010 (12.10.2010)	**21.10 月 2010 (21.10.2010)**

ISA/CN 的名称和邮寄地址：	受权官员
中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号：　(86-10)62019451	江婧敬 电话号码：(86-10) **62411430**

PCT/ISA/210 表(第 2 页) (2009 年 7 月)

国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2010/000055

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN101610518A	23.12.2009	EP2101528A1	16.09.2009
		US2009233544A1	17.09.2009
CN101009622A	01.08.2007	CN100534057C	26.08.2009
		EP1806942A1	11.07.2007
		US2007155431A1	05.07.2007
CN101335971A	31.12.2008	US2009003260A1	01.01.2009
WO2009129413A2	22.10.2009	WO2009129413A3	25.03.2010
		US2009264077A1	22.10.2009

Electronic Acknowledgement Receipt	
EFS ID:	26486882
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-0882666-103900US
Receipt Date:	28-JUL-2016
Filing Date:	24-JUL-2013
Time Stamp:	17:01:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS_68620439_1.pdf	111306 8ca083a80344452392a42e05c697334441b a2f00	no	3

Warnings:

Information:					
This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	WO_2011085514_A1.pdf	23492091 0684a20e5c54ddc3deb77117589507be3cc17539	no	25
Warnings:					
Information:					
3	Non Patent Literature	NPL_EP_13825612_OA_062420 16.pdf	281727 244bd58919aa4c8e8d16d0864033094f22c30132	no	8
Warnings:					
Information:					
			Total Files Size (in bytes):	23885124	

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 July 5, 2016.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-0882666-103900US
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A 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 February 2, 2016, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 5 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. (Previously Presented) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs.

2. (Previously Presented) The system of claim 1 wherein each BTS comprises a plurality of sectors.

3. (Canceled)

4. (Previously Presented) The system of claim 2 further comprising a network optimization goal comprising a percentage of users associated with each of the plurality of sectors.

5. (Previously Presented) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring unit external to and coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs.

6. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs.

7. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs.

8. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs .

9. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. (Previously Presented) The system of claim 5 wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. (Previously Presented) The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Previously Presented) The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. (Previously Presented) The system of claim 5 wherein a single DAU port is connected to the one or more BTSs.

20. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (Previously Presented) The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 1-2, 4-11, and 13-21 will be pending in this application. No claims have been amended, claims 3 and 12 remain canceled, and no new claims have been added. No new matter is added. Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Claim Rejections – 35 USC §103

Claims 1-2,4-11, 13-21 are rejected under 35 U.S.C. 103 as being allegedly unpatentable over US 2013/0128810 in the name of Albert S. Lee et al. ("Lee") in view of US 2011/0122788 in the name of Robert Sombrutzki et al. ("Sombrutzki"). Office Action pages 3-12.

Pursuant to 35 U.S.C. § 103(c), Lee cannot be used to render any of the pending claims obvious, since Lee is prior art under pre-AIA 35 U.S.C. § 102(e) and was owned by the assignee of the present application at the time of filing of the present application. The American Inventors Protection Act of 1999 ("AIPA") amended pre-AIA 35 U.S.C. § 103(c) to add that subject matter that only qualifies as prior art under pre-AIA 35 U.S.C. § 102(e) and that was commonly owned, or subject to an obligation of assignment to the same person, at the time the invention was made cannot be applied in a rejection under pre-AIA 35 U.S.C. § 103(a). Specifically, pre-AIA 35. U.S.C. § 103(c) states:

> Subject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f), and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

According to AIPA § 4807(b), pre-AIA 35 U.S.C. § 103(c) applies to any patent application filed on or after the date of enactment, November 29, 1999. Here, the present application was filed on July 24, 2013 (i.e., after November 29, 1999) so that the changes to pre-AIA 35 U.S.C. § 103(c) made by the AIPA apply to this application. Lee was filed on November 6, 2012 and published as U.S. Patent Application Pub. No. 2013/0128810 A1 on May 23, 2013, making Lee prior art under pre-AIA 35 U.S.C. § 102(e). Lee and the present application were

also commonly owned or subject to assignment to the same person at the time that the invention of the present application was made. In this regard, the undersigned, an attorney of record states:

U.S. Patent Application Nos. 13/950,160 and 13/670,290 were, at the time the invention of U.S. Patent Application No. 13/950,160 was made, owned by Dali Systems Co. Ltd. or subject to an obligation of assignment to Dali Systems Co. Ltd.

In support of this statement, copies of the Patent Assignment Abstract of Title associated with U.S. Patent Application No. 13/950,160 is attached as Exhibit A and a copy of the Patent Assignment Abstract of Title associated with U.S. Patent Application No. 13/670,290 is attached as Exhibit B.

In sum, because Lee is prior art under pre-AIA 35 U.S.C. § 102(e) and because Lee and the present application were commonly assigned or subject to assignment to the same person at the time of the invention, Lee cannot be used to render the claims obvious pursuant to pre-AIA 35 U.S.C. § 103(a). Accordingly, Applicants respectfully request that the pending obviousness rejections of claims 1-3 and 6-19 under 35 U.S.C. § 103(a) as being unpatentable over Lee be withdrawn.

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 SMao@kilpatricktownsend.com.

Respectfully submitted,

/Stephen A. Mao/
Stephen A. Mao
Registration No. 73418

KILPATRICK TOWNSEND & STOCKTON LLP
SMAO:bsk

68178465V.1

PTO/AIA/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 091172-0882666-103900US
Application Number 13/950,160	Filed July 24, 2013
For OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	
Art Unit 2641	Examiner SYED, Majid

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

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

		Fee	Small Entity Fee	Micro Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 300.00
☐	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 20-1430.

☑ Payment made via EFS-Web.

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

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 73418.

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

/Stephen A. Mao/	2016-07-05
Signature	Date
Stephen A. Mao	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: Mail Stop PCT, 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 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.

US 20140162664A1

(19) **United States**

(12) **Patent Application Publication**

Stapleton et al.

(10) **Pub. No.: US 2014/0162664 A1**

(43) **Pub. Date: Jun. 12, 2014**

(54) **OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM**

(71) Applicant: **DALI SYSTEMS CO. LTD.**, George Town (KY)

(72) Inventors: **Shawn Patrick Stapleton**, Burnaby (CA); **Seyed Amin Hejazi**, Burnaby (CA)

(73) Assignee: **DALI SYSTEMS CO. LTD.**, George Town (KY)

(21) Appl. No.: **13/958,160**

(22) Filed: **Jul. 24, 2013**

Related U.S. Application Data

(60) Provisional application No. 61/678,016, filed on Jul. 31, 2012.

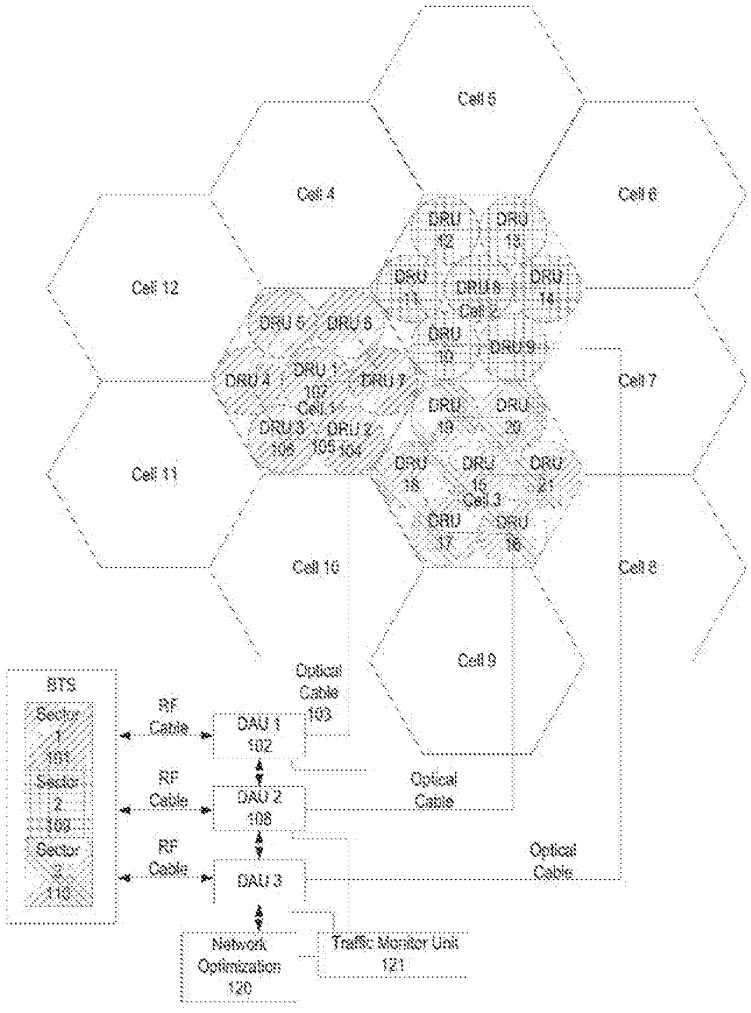
Publication Classification

(51) **Int. Cl.**
H04W 24/02 (2006.01)

(52) **U.S. Cl.**
CPC *H04W 24/02* (2013.01)
USPC **455/445**

(57) **ABSTRACT**

A system for dynamically routing signals in a Distributed Antenna System includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system further includes a plurality of traffic monitoring modules and a network optimization goal and optimization algorithm.



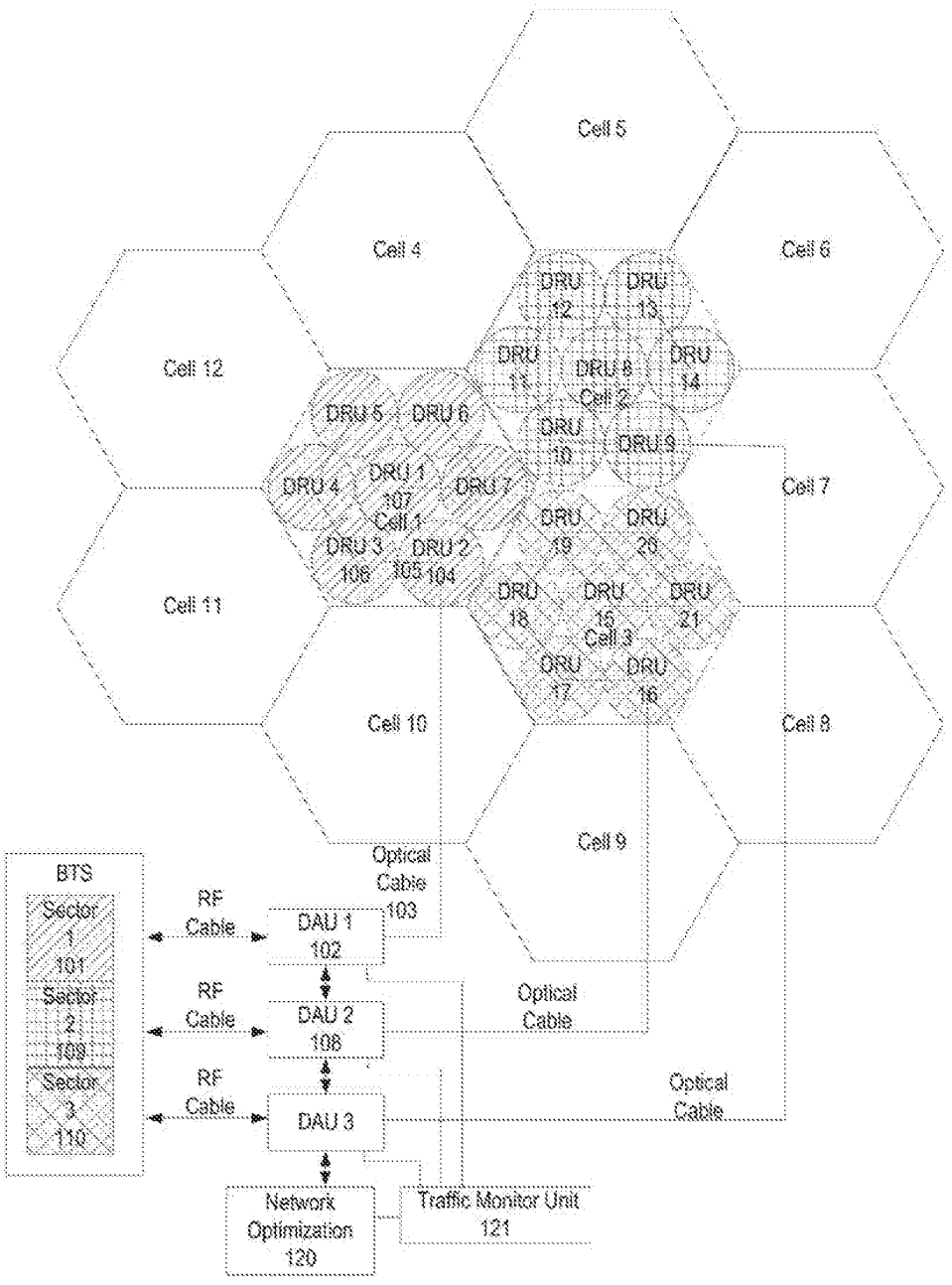

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
Cell 1
Cell 2
Cell 3
DRU 1 107
DRU 2 105
DRU 3 106
DRU 4
DRU 5
DRU 6
DRU 7
DRU 8
DRU 9
DRU 10
DRU 11
DRU 12
DRU 13
DRU 14
DRU 15
DRU 16
DRU 17
DRU 18
DRU 19
DRU 20
DRU 21
104
BTS
Sector 1 101
Sector 2 109
Sector 3 110
RF Cable
RF Cable
RF Cable
DAU 1 102
DAU 2 108
DAU 3
Optical Cable 103
Optical Cable
Optical Cable
Network Optimization 120
Traffic Monitor Unit 121

FIG. 1

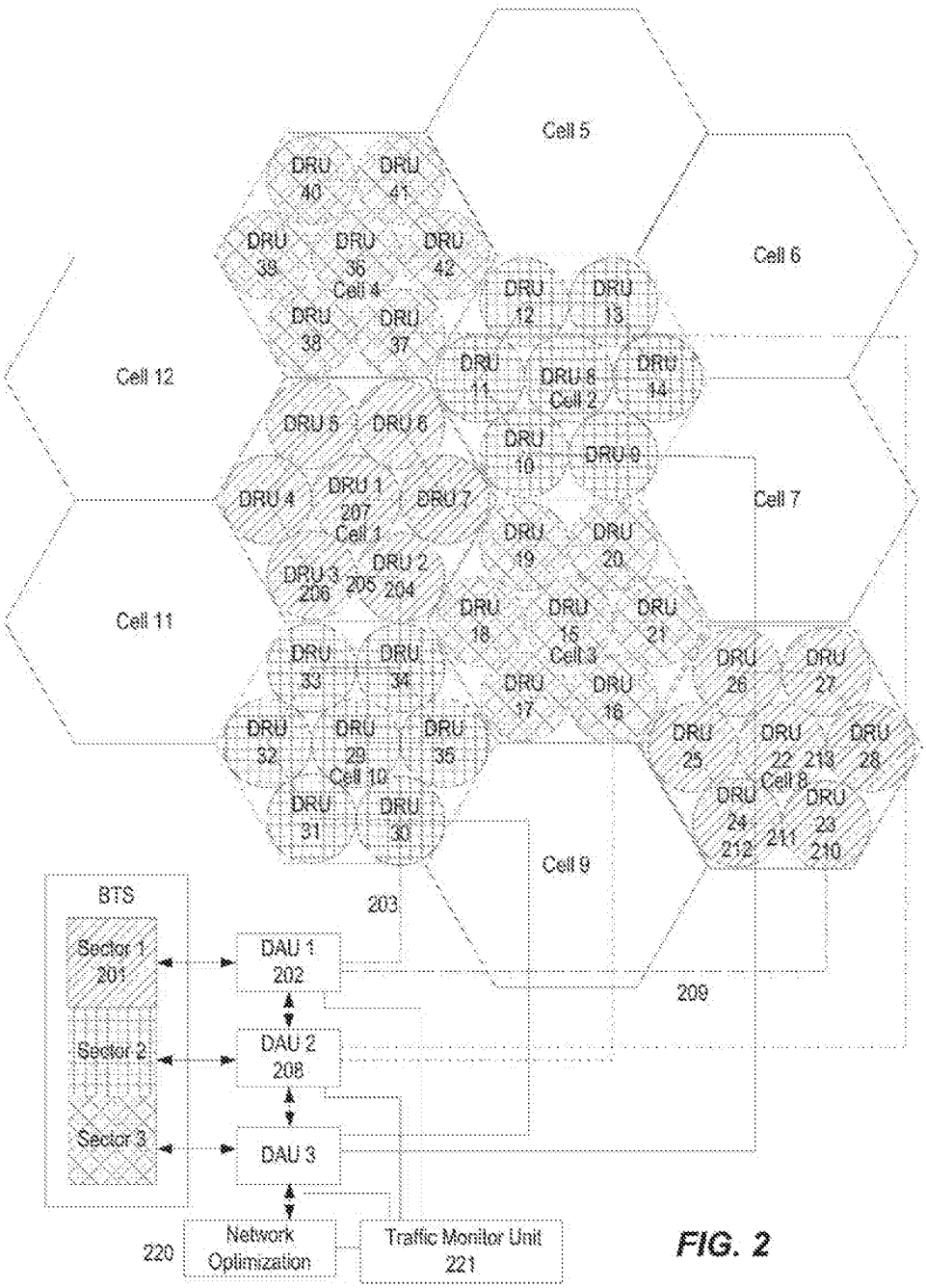

Cell 5
Cell 6
Cell 7
Cell 8
Cell 9
Cell 10
Cell 11
Cell 12
Cell 1
Cell 2
Cell 3
Cell 4
DRU 1
DRU 2
DRU 3
DRU 4
DRU 5
DRU 6
DRU 7
DRU 8
DRU 9
DRU 10
DRU 11
DRU 12
DRU 13
DRU 14
DRU 15
DRU 16
DRU 17
DRU 18
DRU 19
DRU 20
DRU 21
DRU 22
DRU 23
DRU 24
DRU 25
DRU 26
DRU 27
DRU 28
DRU 29
DRU 30
DRU 31
DRU 32
DRU 33
DRU 34
DRU 35
DRU 36
DRU 37
DRU 38
DRU 39
DRU 40
DRU 41
DRU 42
207
205
204
206
210
211
212
213
203
209
BTS
Sector 1
201
Sector 2
Sector 3
DAU 1
202
DAU 2
208
DAU 3
220
Network
Optimization
Traffic Monitor Unit
221

FIG. 2

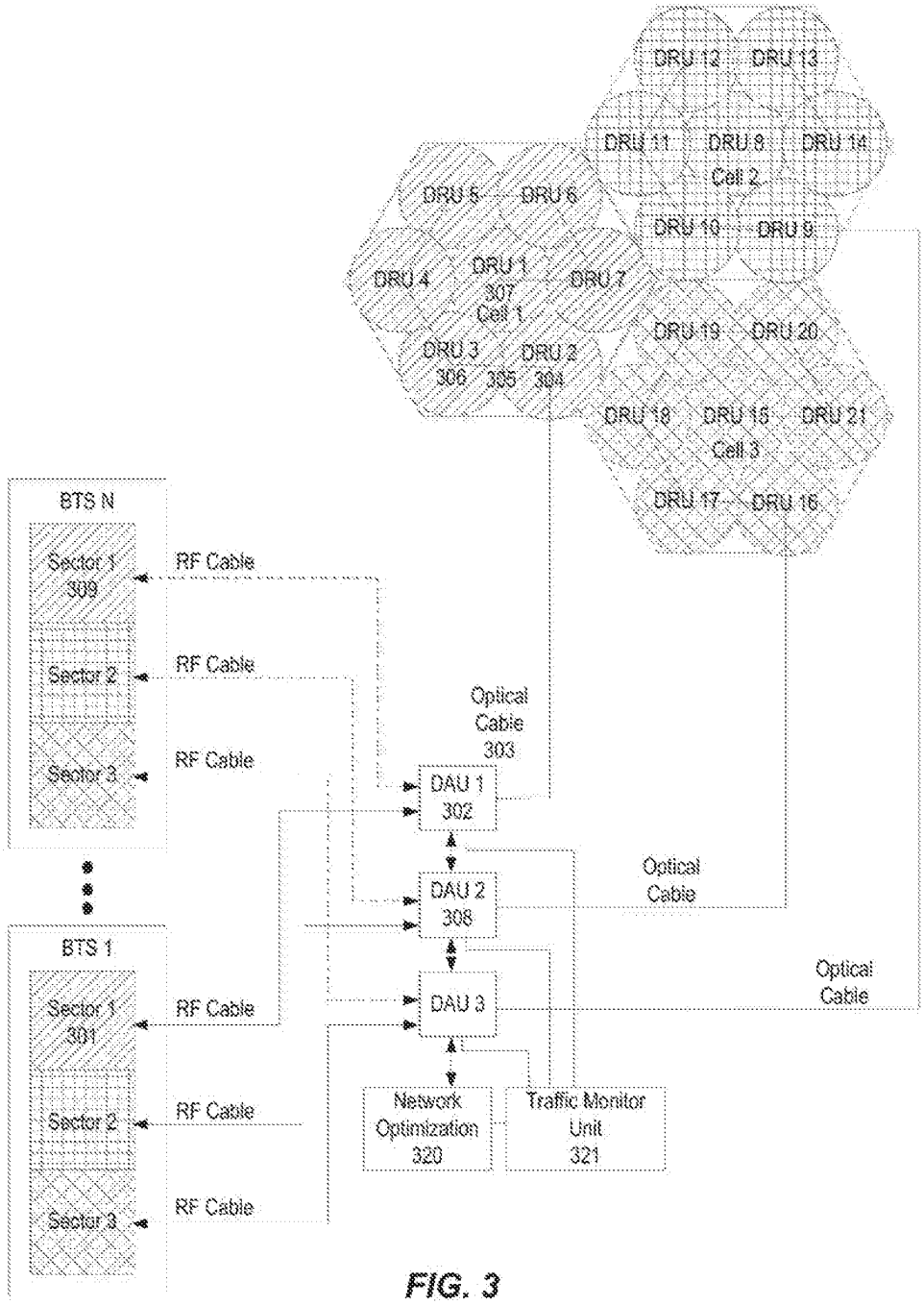

DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
307
Cell 1
DRU 7
DRU 19
DRU 20
DRU 3
306
DRU 2
305
304
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS N
Sector 1
309
RF Cable
Sector 2
RF Cable
Sector 3
RF Cable
Optical
Cable
303
DAU 1
302
Optical
Cable
DAU 2
308
BTS 1
Optical
Cable
Sector 1
301
RF Cable
DAU 3
Sector 2
RF Cable
Network
Optimization
320
Traffic Monitor
Unit
321
Sector 3
RF Cable

FIG. 3

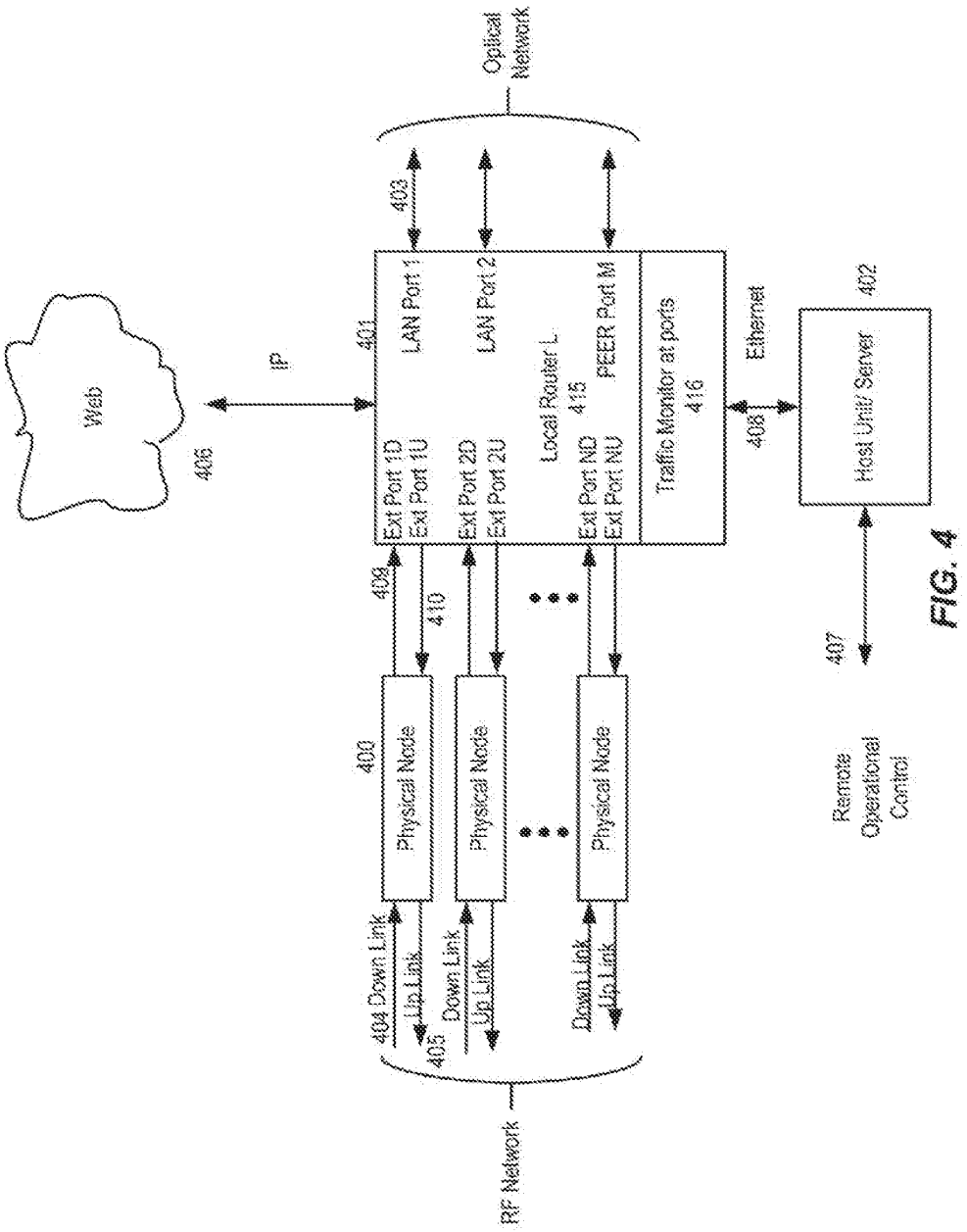

Optical Network
403
Web
406
IP
401
LAN Port 1
LAN Port 2
PEER Port M
Local Router L
415
Traffic Monitor at ports
416
Ethernet
408
Host Util/ Server
402
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
409
410
400
Physical Node
Physical Node
Physical Node
404 Down Link
Up Link
405
Down Link
Up Link
Down Link
Up Link
RF Network
407
Remote Operational Control

FIG. 4

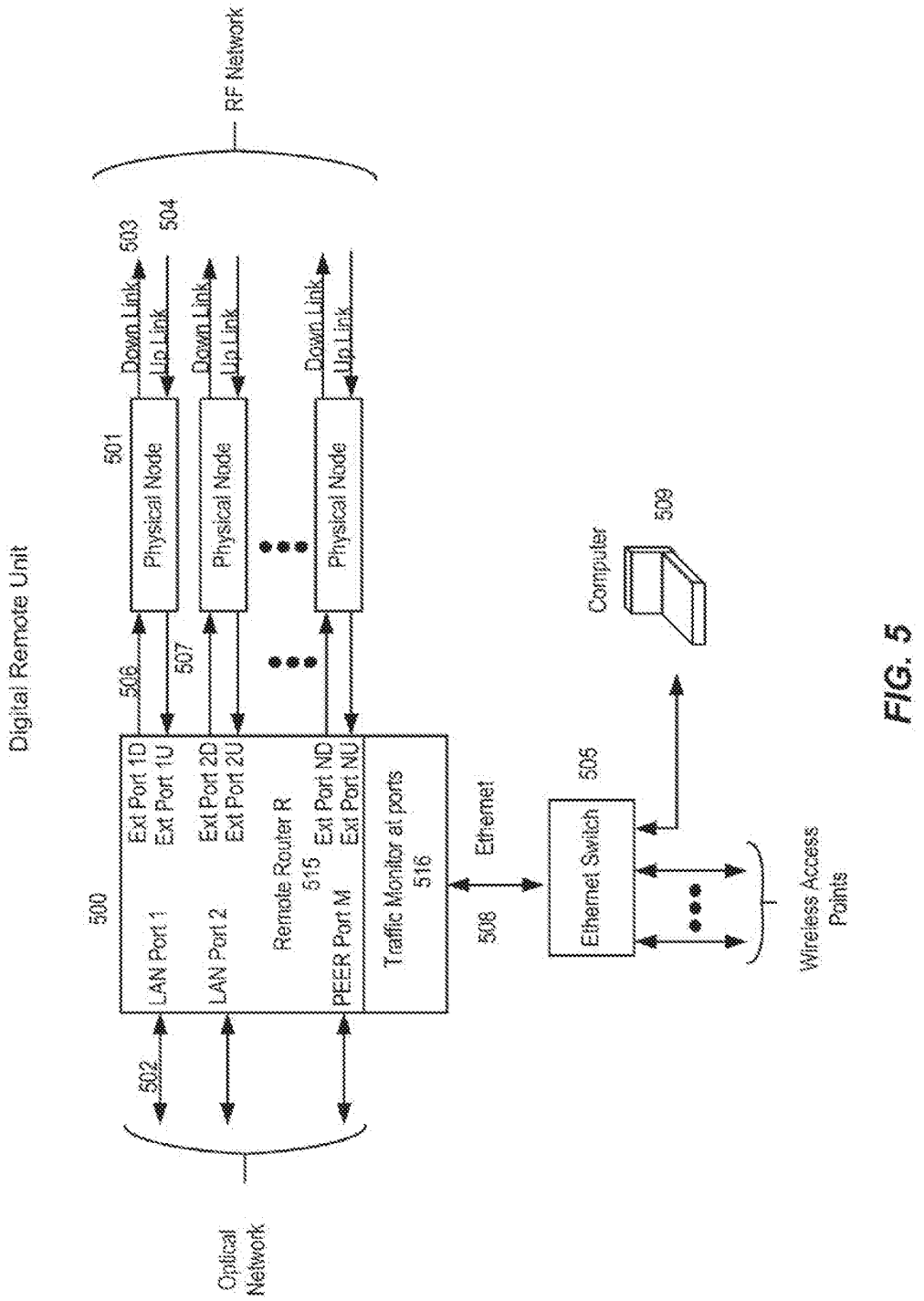

Digital Remote Unit
RF Network
Optical Network
500
501
502
503
504
505
506
507
508
509
LAN Port 1
LAN Port 2
PEER Port M
Remote Router R
515
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
Traffic Monitor at ports
516
Physical Node
Down Link
Up Link
Ethernet
Ethernet Switch
Computer
Wireless Access Points

FIG. 5

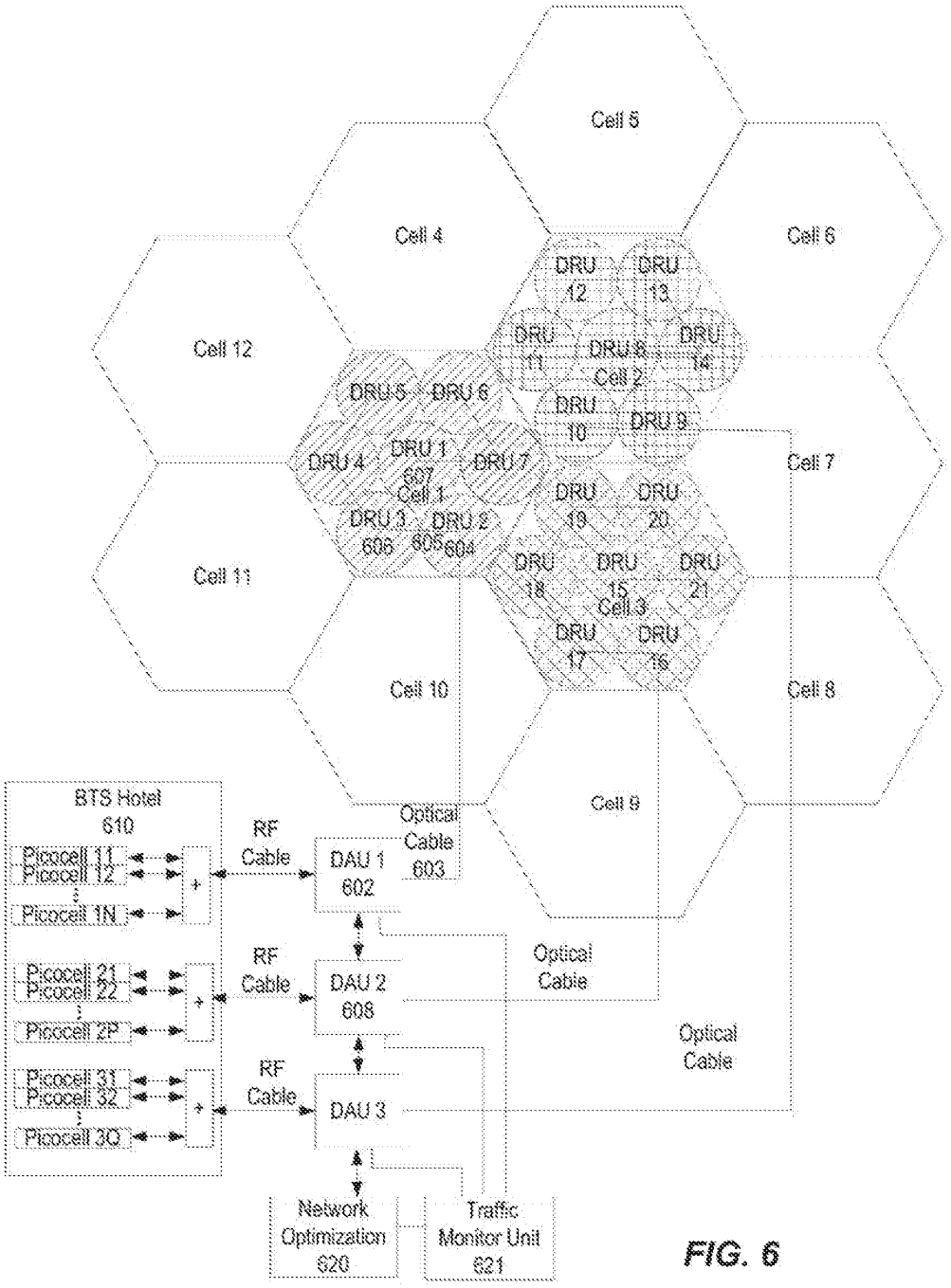

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
607
DRU 7
Cell 1
DRU 3
606
DRU 2
605
604
DRU 19
DRU 20
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS Hotel
610
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3O
RF Cable
RF Cable
RF Cable
DAU 1
602
DAU 2
608
DAU 3
Optical Cable
603
Optical Cable
Optical Cable
Network Optimization
620
Traffic Monitor Unit
621

FIG. 6

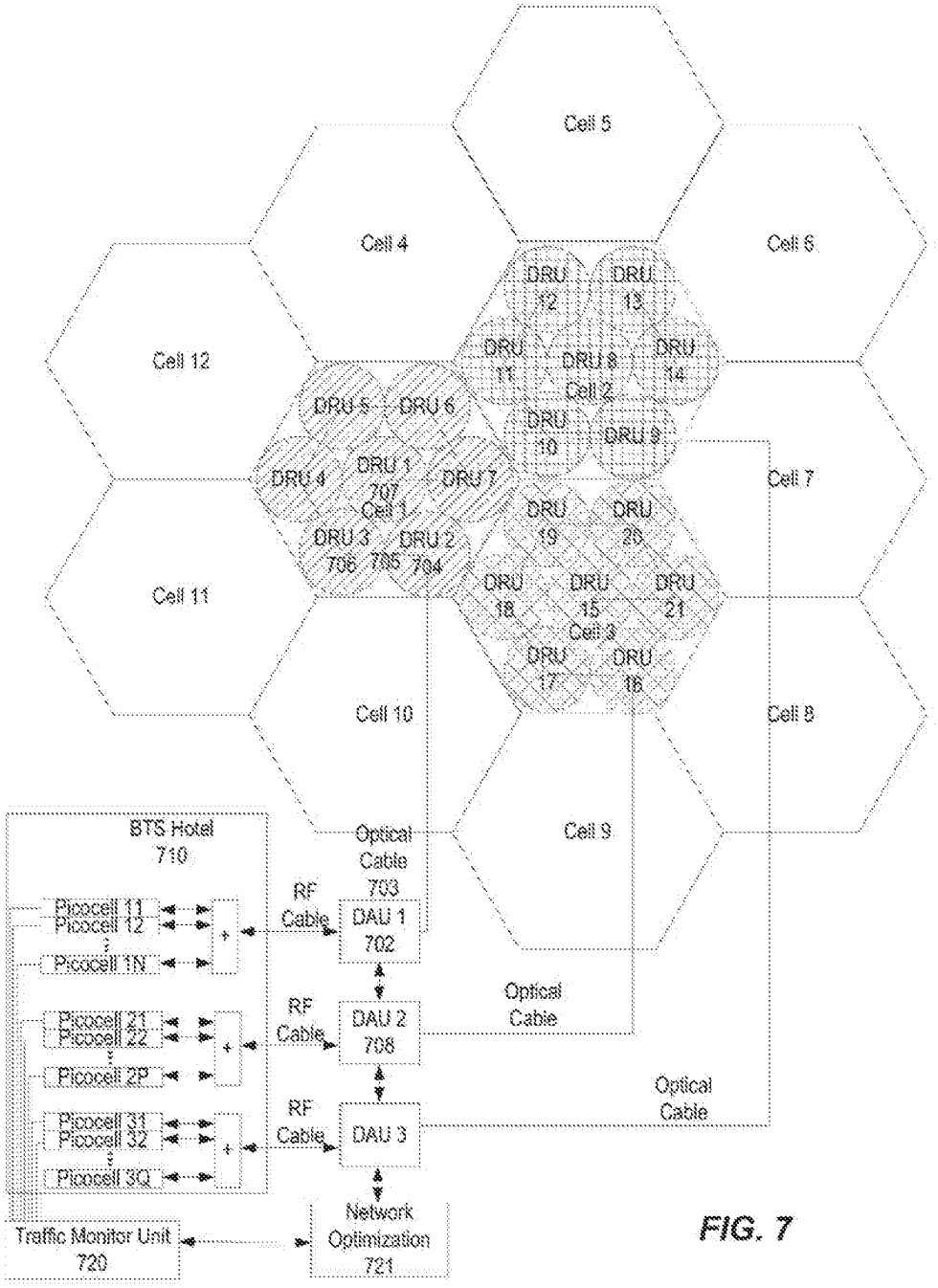

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
Cell 2
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
707
DRU 7
Cell 1
DRU 19
DRU 20
DRU 3
706
DRU 2
705
704
DRU 18
DRU 15
Cell 3
DRU 21
DRU 17
DRU 16
BTS Hotel
710
Optical
Cable
703
RF
Cable
DAU 1
702
Picocell 11
Picocell 12
Picocell 1N
Optical
Cable
RF
Cable
DAU 2
708
Picocell 21
Picocell 22
Picocell 2P
Optical
Cable
RF
Cable
DAU 3
Picocell 31
Picocell 32
Picocell 3Q
Network
Optimization
721
Traffic Monitor Unit
720

FIG. 7

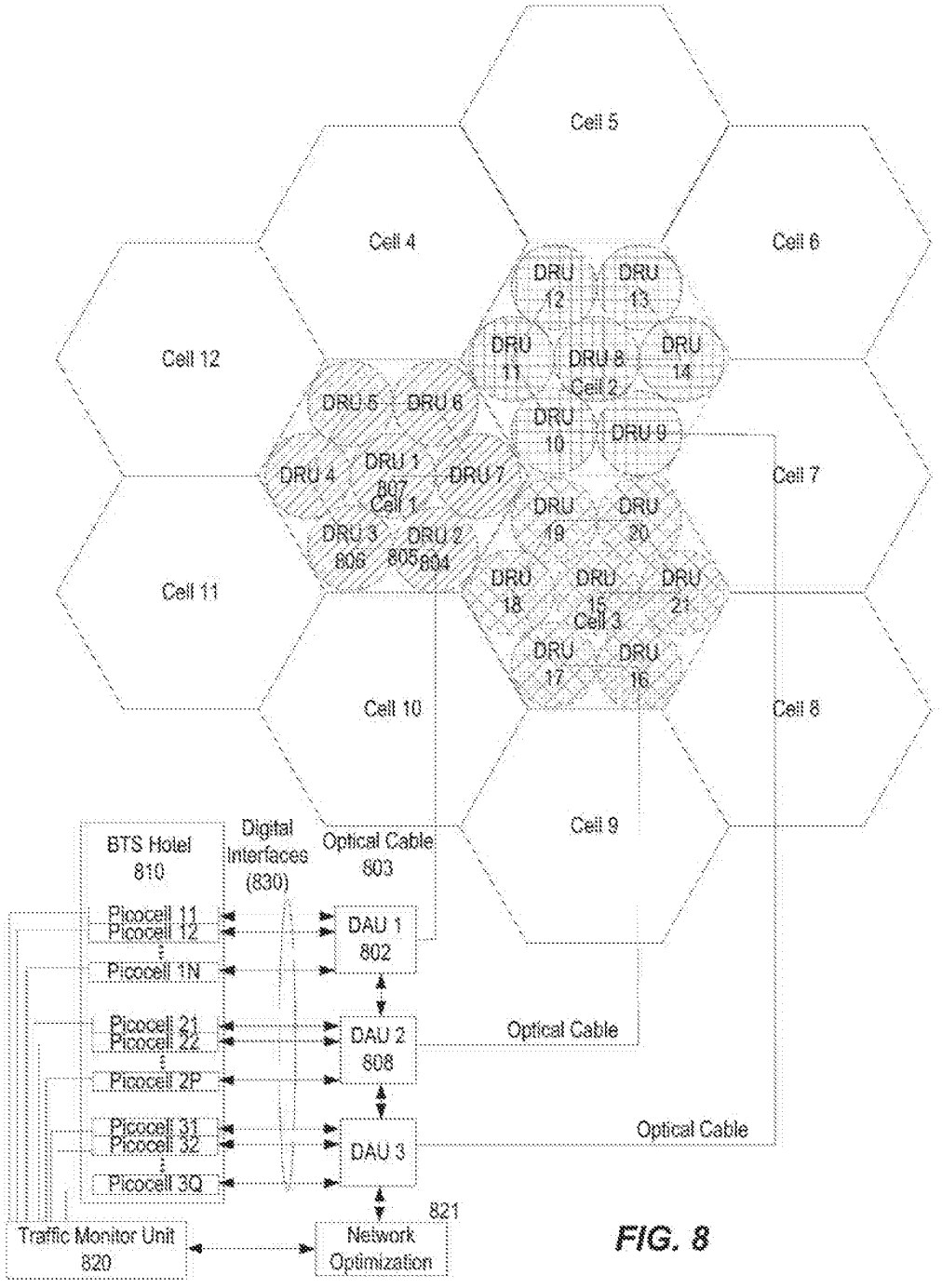

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
Cell 2
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
807
DRU 7
Cell 1
DRU 19
DRU 20
DRU 3
806
DRU 2
805
804
DRU 18
DRU 15
Cell 3
DRU 21
DRU 17
DRU 16
BTS Hotel
810
Digital
Interfaces
(830)
Optical Cable
803
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3Q
DAU 1
802
DAU 2
808
DAU 3
Optical Cable
Optical Cable
821
Traffic Monitor Unit
820
Network
Optimization

FIG. 8

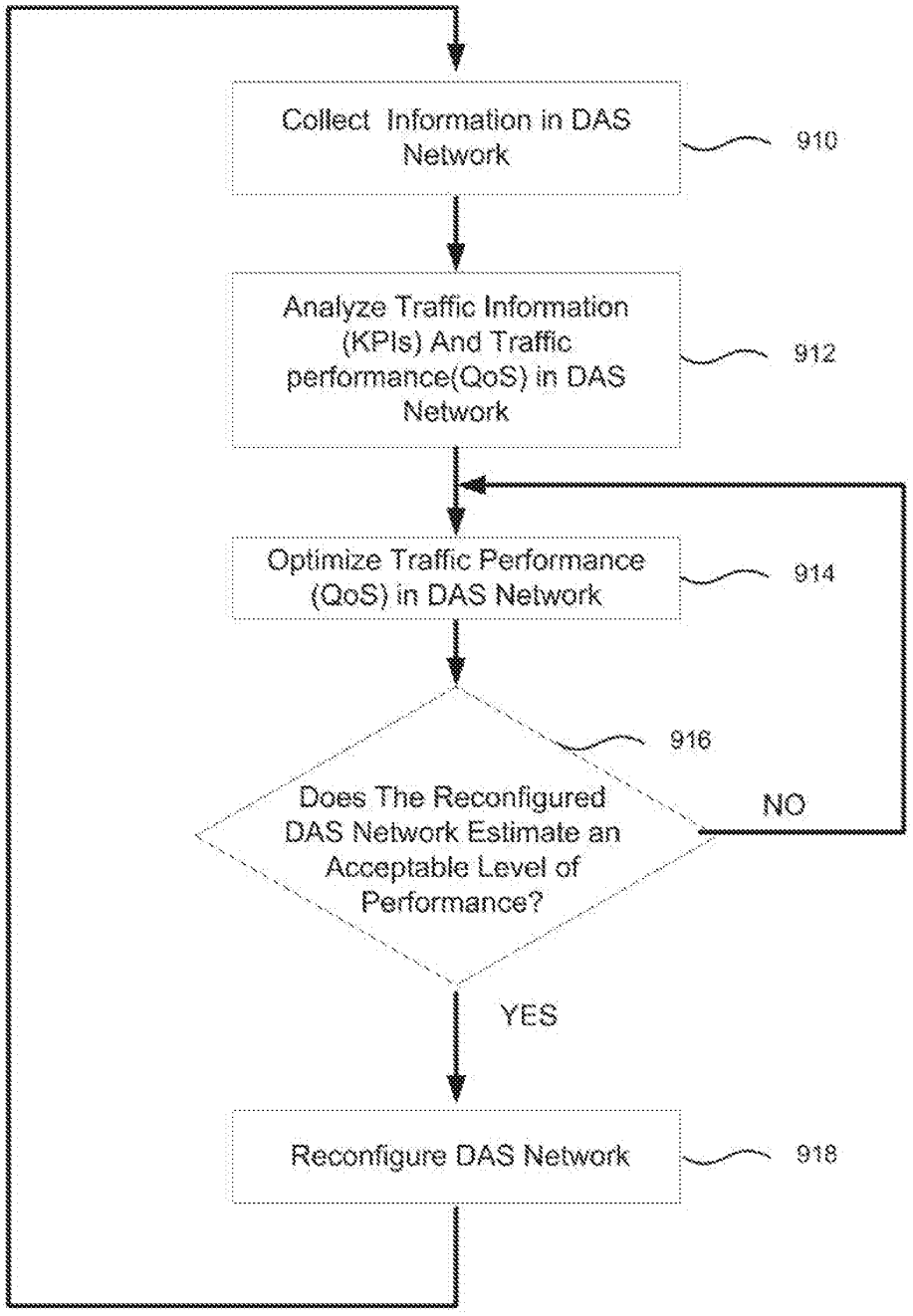

Collect Information in DAS Network
910
Analyze Traffic Information (KPIs) And Traffic performance(QoS) in DAS Network
912
Optimize Traffic Performance (QoS) in DAS Network
914
916
Does The Reconfigured DAS Network Estimate an Acceptable Level of Performance?
NO
YES
Reconfigure DAS Network
918

FIG. 9

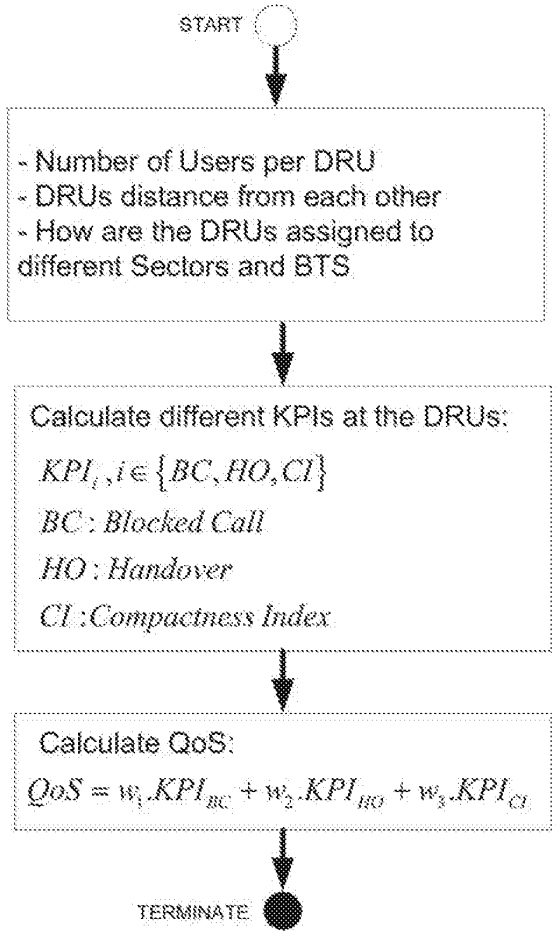
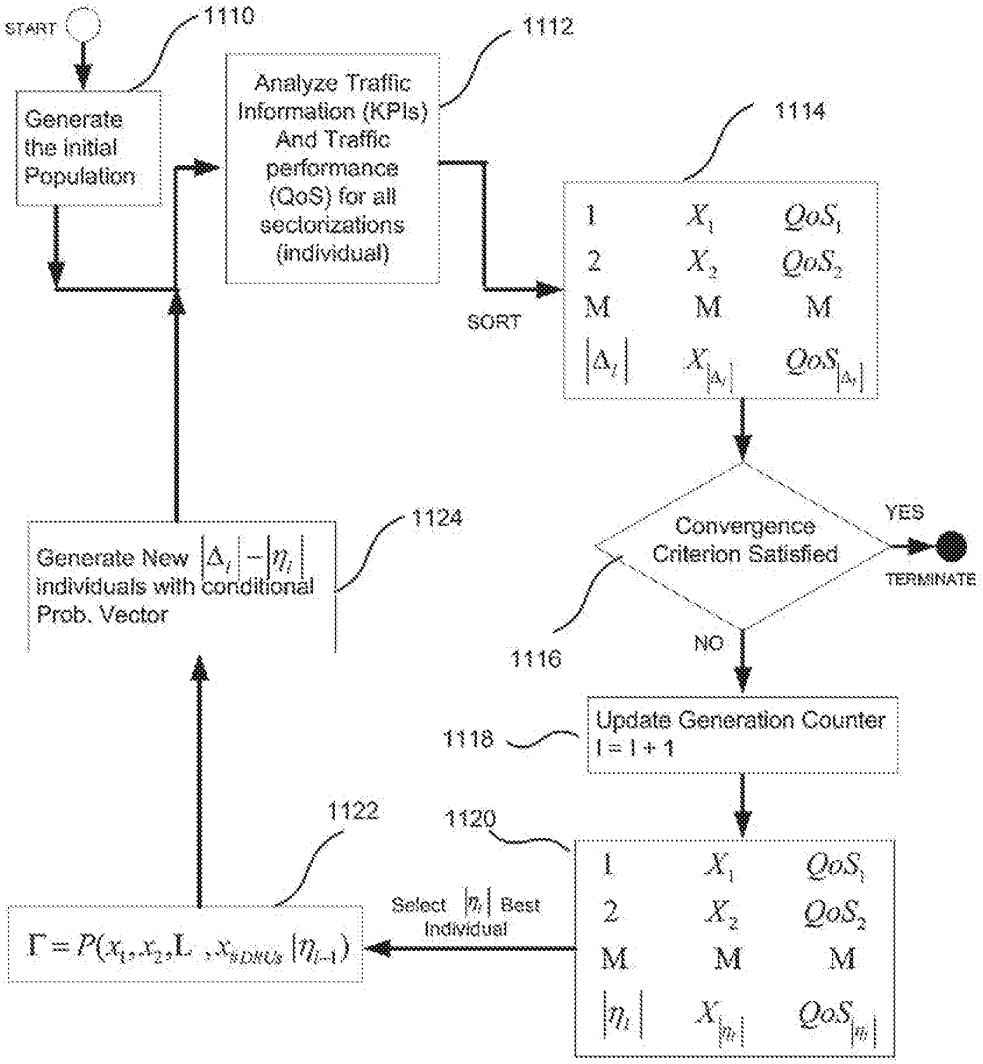

START
- Number of Users per DRU
- DRUs distance from each other
- How are the DRUs assigned to different Sectors and BTS
Calculate different KPIs at the DRUs:
$KPI_i, i \in \{BC, HO, CI\}$
BC : Blocked Call
HO : Handover
CI : Compactness Index
Calculate QoS:
$QoS = w_1.KPI_{BC} + w_2.KPI_{HO} + w_3.KPI_{CI}$
TERMINATE

FIG. 10



- Δ_l is Set of Individuals(population)
- Individual $X_j = (x_1, x_2, \ldots, x_{NORUS}), x_i \in \{S_{nm} | \text{sector "n" from BTS "m"}\}$

FIG. 11

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/678,016, filed on Jul. 31, 2012, entitled "Optimization of Traffic Load in a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

SUMMARY 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 traffic monitoring and optimization. Wireless network operators faces the continuing challenge of building networks that effectively manage high data-traffic growth rates. Mobility and an increased level of multimedia content for end users typically employs end-to-end network adaptations that support new services and the increased demand for broadband and flat-rate Internet access. One of the most difficult challenges faced by network operators is caused by the physical movement of subscribers from one location to another, and particularly when wireless subscribers congregate in large numbers at one location. A notable example is a business enterprise facility during lunchtime, when a large number of wireless subscribers visit a lunch room or cafeteria location in the building. At that time, a large number of subscribers have moved away from their offices and usual work areas. It's likely that during lunchtime, there are many locations throughout the facility where there are very few subscribers. If the indoor wireless network resources were properly sized during the design process for subscriber loading as it is during normal working hours when subscribers are in their normal work areas, it is very likely that the lunchtime scenario will present some unexpected challenges with regard to available wireless capacity and data throughput.

[0003] According to an embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs. The system further includes one or more Base Transceiver Stations (BTSs) and one or more traffic monitoring units.

[0004] According to another embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system further includes a plurality of traffic monitoring modules and a network optimization goal and optimization algorithm.

[0005] In an embodiment, a system for dynamically routing signals in a Distributed Antenna System is provided and includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and one or more Base Transceiver Stations (BTSs). The system further includes a traffic monitoring unit.

[0006] Numerous benefits are achieved by way of the present invention over conventional techniques. For example, embodiments of the present invention provide for traffic monitoring in a DAS network, improving network performance and user experience. These and other embodiments of the invention along with many of its advantages and features are described in more detail in conjunction with the text below and attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0008] FIG. **2** is a block diagram according to one embodiment of the invention showing the basic structure for a frequency reuse pattern of N=1 and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0009] FIG. **3** is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having multiple 3 sector BTSs with 3 DAUs and 7 DRUs daisy chained together for each cell. In this embodiment, multiple three sector base stations are connected to a daisy chained DAS network.

[0010] FIG. **4** is a block diagram of a Digital Access Unit (DAU), which contains Physical Nodes, a Local Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0011] FIG. **5** is a block diagram of a Digital Remote Unit (DRU), which contains Physical Nodes, a Remote Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0012] FIG. **6** depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring and Network Optimization functionality according to an embodiment of the present invention.

[0013] FIG. **7** depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0014] FIG. **8** depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0015] FIG. **9** is a simplified flowchart illustrating a method of optimizing the DAS network according to an embodiment of the present invention.

[0016] FIG. **10** is a simplified flowchart illustrating a method of calculating KPIs and QoS for a DAS network according to an embodiment of the present invention.

[0017] FIG. **11** is a simplified flowchart illustrating an optimization algorithm according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] To accommodate variations in wireless subscriber loading at wireless network antenna locations at various times of day and for different days of the week, there are several candidate conventional approaches.

[0019] One approach is to deploy many low-power high-capacity base stations throughout the facility. The quantity of base stations is determined based on the coverage of each base station and the total space to be covered. Each of these base stations is provisioned with enough radio resources, i.e., capacity and broadband data throughput to accommodate the maximum subscriber loading which occurs during the course of the workday and work week. Although this approach typically yields a high quality of service for wireless subscribers, the notable disadvantage of this approach is that many of the base stations' capacity is being wasted for a large part of the time. Since a typical indoor wireless network deployment involves capital and operational costs which are assessed on a per-subscriber basis for each base station, the typically high total life cycle cost for a given enterprise facility is far from optimal.

[0020] A second candidate approach involves deployment of a DAS along with a centralized group of base stations dedicated to the DAS. A conventional DAS deployment falls into one of two categories. The first type of DAS is "fixed", where the system configuration doesn't change based on time of day or other information about usage. The remote units associated with the DAS are set up during the design process so that a particular block of base station radio resources is thought to be enough to serve each small group of DAS remote units. A notable disadvantage of this approach is that most enterprises seem to undergo frequent re-arrangements and re-organizations of various staff groups within the enterprise. Therefore, it's highly likely that the initial DAS setup will need to be changed from time to time, requiring deployment of additional direct staff and contract resources with appropriate levels of expertise regarding wireless networks.

[0021] The second type of DAS is equipped with a type of network switch which allows the location and quantity of DAS remote units associated with any particular centralized base station to be changed manually. Although this approach would appear to support dynamic DAS reconfiguration based on the needs of the enterprise or based on time of day, it frequently implies that additional staff resources would need to be assigned to provide real-time management of the network. Another issue is that it's not always correct or best to make the same DAS remote unit configuration changes back and forth on each day of the week at the same times of day. Frequently it is difficult or impractical for an enterprise IT manager to monitor the subscriber loading on each base station. And it is almost certain that the enterprise IT manager has no practical way to determine the loading at a given time of day for each DAS remote unit; they can only guess the percentage loading.

[0022] Another major limitation of conventional DAS deployments is related to their installation, commissioning and optimization process. Some challenging issues which must be overcome include selecting remote unit antenna locations to ensure proper coverage while minimizing downlink interference from outdoor macro cell sites, minimizing uplink interference to outdoor macro cell sites, and ensuring proper intra-system handovers while indoors and while moving from outdoors to indoors (and vice-versa). The process of performing such deployment optimization is frequently characterized as trial-and-error. Therefore, the results may not be consistent with a high quality of service.

[0023] Based on the conventional approaches described herein, it is apparent that a highly efficient, easily deployed and dynamically reconfigurable wireless network is not achievable with conventional systems and capabilities. Embodiments of the present invention substantially overcome the limitations of the conventional approach discussed above. The advanced system architecture provided by embodiments of the present invention provides a high degree of flexibility to manage, control, enhance and facilitate radio resource efficiency, usage and overall performance of the distributed wireless network. This advanced system architecture enables specialized applications and enhancements including, but not limited to, 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, and/or traffic tagging. Embodiments of the present invention can also serve multiple operators, multi-mode radios (modulation-independent) and multiple frequency bands per operator to increase the efficiency and traffic capacity of the operators' wireless networks.

[0024] Accordingly, embodiments of this architecture provide a capability for Flexible Simulcast. With Flexible Simulcast, the amount of radio resources (such as RF carriers, LTE Resource Blocks, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs can be set via software control to meet desired capacity and throughput objectives or wireless subscriber needs. 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.

[0025] According to an embodiment of the present invention, a traffic monitoring unit is provided as a component of one or more elements of the system, enabling measurement of the network traffic in the network. A network optimization goal and optimization algorithm is also provided so that based on traffic measurements, which is typically a function of the number of users on the system, performance of the network is optimized using the goal and associated algorithm.

[0026] As an example of traffic monitoring, the system could track the power of the down link or the power of the uplink. Another example, would include some signal processing, including examining certain control signals, for example, pilot signals sent by mobile devices. By locking onto these control signals, the traffic monitor can obtain information on the number of users using various components of the system.

[0027] A distributed antenna system (DAS) provides an efficient means of utilization of base station resources. The base station or base stations associated with a DAS can be located in a central location and/or facility commonly known as a base station hotel. The DAS network comprises one or more digital access units (DAUs) that function as the interface between the base stations and the digital remote units (DRUs). The DAUs can be collocated with the base stations. The DRUs can be daisy chained together and/or placed in a

star configuration and provide coverage for a given geographical area. The DRUs are typically connected with the DAUs by employing a high-speed optical fiber link. This approach facilitates transport of the RF signals from the base stations to a remote location or area served by the DRUs. A typical base station comprises 3 independent radio resources, commonly known as sectors. These 3 sectors are typically used to cover 3 separate geographical areas without creating co-channel interference between users in the 3 distinct sectors.

[0028] Traffic monitoring in a DAS network is provided by embodiments of the present invention, which has not been performed in conventional systems. As described herein, the traffic monitoring unit can be implemented as a stand-alone unit in conjunction with one or more system components, including DAUs, DRUs, a BTS, a BTS hotel, or the like.

[0029] Once traffic resources are aggregated into eNodeB hotels, the discrete resources of a single eNodeB are still allocated to a specific set of antennas associated with that eNodeB and providing coverage to a specific geographic area. The traffic resources are fixed, i.e., only the resources associated with a specific eNodeB can be allocated to the antennas associated with that eNodeB. However, because the eNodeBs are collocated in an eNodeB hotel, the system can use the aggregated traffic resources of the discrete eNodeBs as a single, pooled traffic resource that can be allocated according to various algorithms. Assumptions are typically predicated on worst-case traffic assets in all areas, network design is wasteful 99 percent of the time, inevitably resulting in over- or under-provisioning of fixed resources. Traffic resources either go unused (idle channels), or are under-provisioned and are insufficient to handle the offered traffic. Both circumstances give rise to the same outcome: lost revenue and lost opportunity. When a site's traffic resources are idle and unused, the traffic asset fails to provide an optimal return on investment. But a site that lacks sufficient capacity to support the offered traffic at any point during the day garners dropped calls, lost revenue opportunity, and dissatisfied customers. The traffic information derived from an extensive sensor network will be used to dynamically allocate the traffic resources to the required geographical areas only for the time period the service is needed. Once the service is supplied and the traffic sensor network determines that the traffic resources are no longer required, they are returned to the resource pool for reallocation. The entire network automatically reconfigures itself based on the perceived (sensed) need or in the event of disruption due to natural or manmade events. Geographic load balancing using DAS is recognized as a new approach for traffic load balancing which provides dynamic load redistribution in real time according to the current geographic traffic conditions. It can be used to improve the performance for any distributed systems containing non-uniformly distributed traffic, especially for resolving traffic hot spots.

[0030] The network's performance (expressed by the number of KPIs (Key Performance Indicators) from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs.

[0031] An embodiment shown in FIG. 1 illustrates a basic DAS network architecture according to an embodiment of the present invention and provides an example of a data transport network, traffic monitoring and network optimization scenario between a 3 sector Base Station and multiple DRUs. In this embodiment, the DRUs are daisy chained together to achieve coverage in a specific geographical area. Each individual sector covers an independent geographical area, which is identified as a Cell. Although embodiments are discussed in terms of optimization of DAS networks, the term optimization is properly understood to include performance improvements in comparison to conventional systems, even if complete optimization is not achieved. Thus, optimization does not require the maximum values for traffic management metrics, but also includes distribution of traffic that improves system performance while remaining short of maximum performance.

[0032] FIG. 1 depicts a DAS system employing multiple Digital Remote Units (DRUs) and multiple Digital Access Units (DAUs). In accordance with the present invention, each DRU provides unique information associated with each DRU which uniquely identifies uplink data received by that particular Digital Remote Unit.

[0033] One feature of embodiments of the present invention is the ability to route Base Station radio resources among the DRUs or group(s) of DRUs. In order to route radio resources available from one or more Base Stations, it is desirable to configure the individual router tables of the DAUs and DRUs in the DAS network. This functionality is provided by embodiments of the present invention.

[0034] The DAUs are networked together to facilitate the routing of DRU signals among multiple DAUs. The DAUs support the transport of the RF downlink and RF uplink signals between the Base Station and the DRUs. This architecture enables the various Base Station signals to be transported to and from multiple DRUs. PEER ports are used for interconnecting DAUs and interconnecting DRUs.

[0035] The DAUs have the capability to control the gain (in small increments over a wide range) of the downlink and uplink signals that are transported between the DAU and the base station (or base stations) connected to that DAU. This capability provides flexibility to simultaneously control the uplink and downlink connectivity of the path between a particular DRU (or a group of DRUs via the associated DAU or DAUs) and a particular base station sector.

[0036] Embodiments of the present invention use router tables to configure the networked DAUs. The local router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from an External Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the LAN Ports and PEER Ports need to merge into the same data stream.

[0037] The remote router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from a LAN Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the External Ports and PEER Ports need to merge into the same data stream.

[0038] As shown in FIG. 1, the individual base station sector's radio resources are transported to a daisy-chained network of DRUs. Each individual sector's radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 1 demonstrates how three cells, each

cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. **1** and by way of example, DAU 1 (**102**) receives downlink signals from BTS Sector 1 (**101**). DAU 1 translates the RF signals to optical signals and the optical fiber cable **103** transports the desired signals to DRU 2 (**104**). Optical cable **105** transports all the optical signals to DRU 3 (**106**). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (**107**). DAU 1 (**102**) is networked with DAU 2 (**108**) to allow the downlink signals from Sector 2 (**109**) and Sector 3 (**110**) to be transported to all the DRUs in Cell 1. The system's switching and routing functions enable the selection of which sectors' signals are transmitted and received by each DRU.

[0039] An embodiment illustrating a Traffic monitoring unit (**121**) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (**120**). The optimization unit (**120**) calculates the overall DAS network performance and determines the optimum reconfigured network to improve or maximize performance. Utilizing the traffic monitoring unit **121** in conjunction with the DAUs provides for optimization of the DAS network through a traffic monitoring unit external to the DAUs. Thus, embodiments of the present invention provide for traffic monitoring in a DAS network. Optimization of the DAS network can then be performed using information related to the traffic monitoring.

[0040] Referring to FIG. **1**, the traffic monitor unit **121** can be a server determining the number of users on each DAU, with each DAU having multiple ports in some embodiments. Data from the traffic monitor unit **121** is then provided to the network optimization unit **120**, which can be the same server including the traffic monitor unit or a different server. The network optimization unit **120** (which can be software running on a server) can model the rebalancing of the traffic load and, after determining that the performance will be acceptable, implements the load rebalancing by communicating with the DAUs and shifting traffic between sectors. Although the network optimization unit **120** is illustrated as coupled to the DAUs in FIG. **1**, this is not required by embodiments of the present invention and the network optimization could be performed at one of the DRUs, with data regarding network optimization being transmitted back to the DAUs using, for example, using an Ethernet backhaul connecting the DRUs to the DAUs. Thus, the network optimization server could be located at one of the DRUs, controlling the entire network from that location. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0041] The network optimization unit can implement a network optimization goal, which may relate to the number of users per sector, for example, that each sector carry a percentage of traffic less than 50% of the total traffic, less than 40% of the total traffic, or less than 35% of the total traffic, that each sector have less than 50% of the users, less than 40% of the users, less than 35% of the users, or that each sector have 33% of the users, or the like. Thus, the optimization goals can include metrics of the system performance. Although the system may not reach the goals, progress toward the goals can be provided, improving the user experience.

[0042] FIG. **2** shows an embodiment illustrating how a single base station can be used to provide coverage for a larger geographical area when a frequency reuse pattern of N=1 is used. Referring to FIG. **2**, cell 1 and cell 8 would share the radio resources of sector 1 of the base station. Similarly, cell 2 and cell 10 would share the radio resources of sector 2.

[0043] The DAUs control the routing of data between the base station and the DRUs. Each individual data packet is provided with a header that uniquely identifies which DRU it is associated with. The DAUs are interconnected to allow transport of data among multiple DAUs. This feature provides the unique flexibility in the DAS network to route signals between the sectors and the individual DRUs. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. **2**, and by way of example, DAU 1 (**202**) receives downlink signals from BTS 1 Sector 1 (**201**). DAU 1 translates the RF signals to optical signals and the optical fiber cable **203** transports the desired signals to DRU 2 (**204**). Optical cable **205** transports all the optical signals to DRU 3 (**206**). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (**207**). DAU 1 (**202**) is networked with DAU 2 (**208**) to allow the downlink signals from Sector 2 and Sector 3 to be transported to all the DRUs in Cell 1. Optical fiber cable **209** transports the desired signals to DRU 23 (**210**). Optical cable **211** transports all the optical signals to DRU 24 (**212**). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 22 (**213**). An embodiment illustrating a Traffic monitoring unit (**221**) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (**220**). The optimization unit (**220**) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0044] FIG. **3** shows an embodiment illustrating an application employing a base station hotel where N BTSs are interconnected to serve a given geographical area. The base stations may represent independent wireless network operators and/or multiple standards (WCDMA, LTE, etc.) or they may represent provision of additional RF carriers. The base station signals may be combined before they are connected to a DAU, as may be the case for a Neutral Host application. Referring to FIG. **3** and by way of example, DAU 1 (**302**) receives downlink signals from BTS Sector 1 (**301**). DAU 1 translates the RF signals to optical signals and the optical fiber cable **303** transports the desired signals to DRU 2 (**304**). Optical cable **305** transports all the optical signals to DRU 3 (**306**). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (**307**). DAU 1 (**302**) is networked with DAU 2 (**308**) to allow the downlink signals from BTS 1 Sector 2 to be transported to all the DRUs in Cell 1. DAU 1 (**302**) receives downlink signals from BTS Sector N (**309**). DAU 1 translates the RF signals to optical signals and the optical fiber cable **303** transports the desired signals to DRU 2 (**304**). Optical cable **305** transports all the optical signals to DRU 3 (**306**). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (**307**). The additional base stations provide the capability to add capacity for Cell 1.

[0045] In order to efficiently utilize the limited base station resources, the network of DRUs should have the capability of re-directing their individual uplink and downlink signals to and from any of the BTS sectors. Because the DRUs data traffic has unique streams, the DAU Router has the mechanism to route the signal to different sectors. An embodiment illustrating a Traffic monitoring unit (**321**) at the DAUs is included to track the traffic load at each DAU in the network.

The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (**320**). The optimization unit (**320**) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0046] FIG. **4** shows the two primary elements in a DAU, the Physical Nodes (**400**) and the Local Router (**401**). The Physical Nodes translate the RF signals to baseband for the Downlink and from baseband to RF for the Uplink. The Local Router directs the traffic between the various LAN Ports, PEER Ports and the External Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, or the like. The physical nodes can combine the downlink and uplink signals via a duplexer or they can keep them separate, as would be the case for a simplex configuration. In one embodiment, Traffic monitoring (**416**) capability is provided in each DAU for determining the traffic load at each of the DAU ports. In this embodiment, the traffic monitoring function is performed in each DAU in comparison with other implementations in which the traffic monitoring is performed externally.

[0047] FIG. **4** shows an embodiment whereby the physical nodes have separate outputs for the uplinks (**405**) and separate inputs for the downlink paths (**404**). The physical node translates the signals from RF to baseband for the downlink path and from baseband to RF for the uplink path. The physical nodes are connected to a Local Router via external ports (**409**,**410**)). The router directs the uplink data stream from the LAN and PEER ports to the selected External U ports. Similarly, the router directs the downlink data stream from the External D ports to the selectal LAN and PEER ports.

[0048] In one embodiment, the LAN and PEER ports are connected via an optical fiber to a network of DAUs and DRUs. The network connection can also use copper interconnections such as CAT 5 or 6 cabling, or other suitable interconnection equipment. The DAU is also connected to the internet network using IP (**406**). An Ethernet connection (**408**) is also used to communicate between the Host Unit and the DAU. The DRU can also connect directly to the Remote Operational Control center (**407**) via the Ethernet port.

[0049] FIG. **5** shows the two primary elements in a DRU, the Physical Nodes (**501**) and the Remote Router (**500**). The DRU includes both a Remote Router and Physical Nodes. The Remote Router directs the traffic between the LAN ports, External Ports and PEER Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, etc. FIG. **5** shows an embodiment whereby the physical nodes have separate inputs for the uplinks (**504**) and separate outputs for the downlink paths (**503**). The physical node translates the signals from RF to baseband for the uplink path and from baseband to RF for the downlink path. The physical nodes are connected to a Remote Router via external ports (**506**,**507**). The router directs the downlink data stream from the LAN and PEER ports to the selected External D ports. Similarly, the router directs the uplink data stream from the External U ports to the selected LAN and PEER ports. The DRU also contains a Ethernet Switch (**505**) so that a remote computer or wireless access points can connect to the internet.

[0050] In one embodiment, the traffic monitoring (**516**) capability is provided in each DRU for determining the traffic load at each of the DRU ports. In this embodiment, the traffic monitoring function is performed in each DRU in comparison with other implementations in which the traffic monitoring is performed externally.

[0051] As shown in FIG. **6**, the base station hotel (**610**) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. **6** demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (**621**), which is connected to the network of DAUs.

[0052] As shown in FIG. **7**, the base station hotel (**710**) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. **7** demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (**721**), which is connected to the Picocells. The BTS Hotel **710** includes a plurality of Picocells that are coupled to traffic monitoring unit **720**. The traffic information flows from the Picocells to the traffic monitoring unit, which uses this traffic information to optimize the DAS network. The traffic monitoring unit **820** works in conjunction with network optimization unit **721**, which can include traffic management algorithms used to distribute traffic efficiently throughout the DAS network.

[0053] FIG. **8** shows an embodiment of a base station hotel (**810**), which is comprised of multiple picocells that are interconnected to a network of DAUs via a digital interface (**830**).

[0054] FIG. **9** illustrates one embodiment of the DAS network optimization flow diagram. The Key Performance Indicators (KPIs) of the network traffic are collected at the various network nodes (**910**). KPI may comprise information such as: number of blocked calls, number of active calls, average power of uplink channels, average power of downlink channels, traffic on each sector, failed calls, number of satisfied users, number of unsatisfied users, number of users operating through a given DRU, and the like.

[0055] The DAS network performance is then analyzed in the context of the available DAS network radio resources (**912**). An optimization algorithm is applied to the existing DAS network with the objective to determine the optimum routing of network traffic (**914**). Once an optimum DAS network has been determined then an estimate of the reconfigured DAS network performance is determined (**916**). The reconfigured DAS network is evaluated prior to an implementation to insure that the performance will be acceptable. If the reconfigured DAS network has been determined to be acceptable then the reconfigured DAS network is implemented (**918**) and the entire process is repeated. In an embodiment, the load on the sectors prior to reconfiguration and after the

proposed reconfiguration can be compared to determine if the shifting of the DRUs to the other sectors improves the system performance.

[0056] Thus, using the KPIs of the network traffic, the DAS network can be modified to improve system performance. As an example, if a particular DRU has a higher load than other adjacent DRUs, traffic can be routed to the adjacent DRUs in order to reduce the load on the particular DRU. Additional description related to load balancing is provided in U.S. Patent Application No. 61/600,530, filed on Feb. 17, 2012, entitled "Evolutionary Algorithms for Geographic Load Balancing Using a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0057] As an example of optimizing network performance, a base station typically has three sectors. The DRU can be allocated to different sectors in order to improve performance by shifting traffic from a first sector (e.g., a high traffic sector) to a second sector (e.g., a low traffic sector) by shifting a DRU allocated to the first sector to the second sector. Although some embodiments of the present invention will not optimize performance of the system, the system performance can be improved using the techniques described herein, for example, by measuring the traffic load on the DRUs, performing load balancing of the traffic on the DRUs, to reduce the load on a first DRU characterized by a first traffic load by shifting the load to a second DRU characterized by a second traffic load less than the first traffic load. In the optimization process, system performance can be measured against a predetermined threshold, with the optimization process terminating once the predetermined threshold has been reached. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0058] As another example, power settings for the DRUs can be modified to improve system performance as discussed in additional detail in U.S. Patent Application No. 61/669,572, filed on Jul. 9, 2012 and entitled, "A Self-Optimizing Distributed Antenna System Using Soft Frequency Reuse," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0059] FIG. **10** illustrates one embodiment of the DAS network calculation of the KPIs and QoS. The important parameters for determining the DAS network QoS include the number of users allocated to a given DRU, the spatial distance between the various DRUs, as well as identifying which DRUs are assigned to which BTS sector.

[0060] FIG. **11** illustrates one embodiment of the flow chart for the optimization algorithm. In this embodiment an Estimation Distribution Algorithm (EDA) is used. Various DRU allocation scenarios are investigated to determine the optimum DRU scenario that achieves the highest QoS. In an embodiment, the initial population is generated (**1110**). The traffic information (KPIs) is analyzed and traffic performance (QoS) for all sectorization is analyzed (**1112**). A sort procedure is performed (**1114**) and a determination is made if the convergence criterion are satisfied (**1116**). If so, the process is terminated. If not, then the generation counter is updated (**1118**), a sort operation is performed (**1120**), the parameter Γ is computed (**1122**) and a new population is generated (**1124**). Then the method proceeds to the traffic information and performance analysis (**1112**).

[0061] Network Optimization

[0062] The network's performance (expressed by the number of KPIs from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs. When a set of KPIs is used, then the mapping needs to be represented by a weighted normalized function.

[0063] In this section we formulate the sectorization problem with mixed integer programming to balance traffic among sectors and to minimize handoffs with connected and compact sectors. Given the sectorization of DRUs at time period t, our problem is to obtain new sectorization at time period t+1 that adaptively balances the change in traffic demands.

[0064] In order to formulate the problem, we consider a service coverage area with N DRUs. Each DRU is assumed to have traffic demand T_i i=1, . . . , N. Note that, UE_A belongs to DRU_B if the received uplink power from UE_A at DRU_B is greater than the other DRUs. Let p_{ij} be the transition probability of mobiles from DRU_i to DRU_j. Then, the handoff calls from DRU_i to DRU_j become $h_{ij}=p_{ij}T_i$. The distance between DRU_i and DRU_j is inversely proportional to p_{ij}. Assume that an eNodeB hotel has M VBSs. Let SOS_m and SOD_k be the set of sectors in VBS_m and the set of DRUs allocated to $Sector_k$, respectively, such that $|SOS_m|=3$ (if each eNodeB/VBS has three sectors), m=1, . . . , M and k=1, . . . , K. We consider the following three cost factors (KPIs) in the sectorization problem:

[0065] KPI_{BC}, (Inverse of the number of Blocked Calls): The penalty of the blocked calls caused by hard capacity and soft capacity. Let HC_m and SC_k be the hard capacity of VBS_m and soft capacity of $Sector_k$ respectively such that

$$HC_m = \sum_{s_k \in SOS_m} SC_k,$$

The binary variable $x_{ik}=1$, when DRU_i belongs to $Sector_k$.

$$N_{sk} = \sum_{i \in SOD_k} x_{ik},$$

then $y_{km}=1$ when DRU_i belongs to VBS_m.

$$N_m = \sum_{k \in SOS_m} x_{ik},$$

Since a penalty occurs only when the calls are blocked, we apply just sc_k to the objective function, because the hc_m is a function of sc_k and there is no need to add it as another term to the objective function. sc_k is a nonnegative real variable. So,

$$KPI_{BC} = \left| \sum_{k \in SOD_m} sc_k \right|^{-1} \quad (2)$$

[0066] KPI_{HO} (Inverse of the number of Handoffs): we consider three different types of Handoffs:

[0067] A. Inter-eNodeB Handoff: When user equipment (UE) with an ongoing call moves from one VBS to another VBS, then the UE needs an inter-eNodeB handoff. Inter-eNodeB handoff is executed using the X2 interface (as long as the UE does not leave the LTE coverage area) or S1 interface (when the UE leaves the serving cell). The X2 handoff includes establishing a signaling connection using the X2 Application Part (X2AP) from the source to the target eNodeB. The target eNodeB updates the MME (Mobility Management Entity) with the new geographic position of the UE. To enable this procedure, the MME needs to communicate with S-GW (Serving Gateway) to negotiate the new endpoint. During the S1 handoff, the MME receives the relocation preparation request of the source eNodeB, it starts the handoff resource allocation procedure to request the necessary radio resource from the target eNodeB. After the target eNodeB sends the required radio interface parameters embedded in a handoff command message, the MME forwards this handoff command message transparently to the UE, which executes the handoff. The main procedure is triggered by the MME and executed by S-GW.

[0068] Let the binary variable $z_{ijm}=1$, when DRU_i and DRU_j belong to VBS_m. Then the inter-eNodeB handoff cost is computed by using the variable

$$c_{ij} = 1 - \sum_m z_{ijm},$$

the cost becomes

$$\sum_i \sum_j b_{ij} c_{ij}.$$

[0069] Note that inter-eNodeB handoff occurs when DRU_i and DRU_j belong to different VBS, i.e., $z_{ijm}=0$.

[0070] B. Intra-eNodeB Handoff. When a UE with an ongoing call moves from one sector to another in a VBS, then the mobile needs an intra-eNodeB handoff. This procedure doesn't need to involve MME or S-GW because it can be handled entirely within that VBS. Now by letting the binary variable $w_{ijk}=1$ when DRU_i and DRU_j belong to sector k, the intra-eNodeB handoff Cost is computed by using two variables $w_{ij}=z_{ij}$ where

$$w_{ij} = 1 - \sum_k w_{ijk},$$

the cost becomes

$$\sum_i \sum_j b_{ij} (w_{ij} - z_{ij}).$$

[0071] An intra-eNodeB handoff occurs when DRU_i and DRU_j belong to different sectors of the same VBS.

[0072] C. Forced Handoff. When a DRU changes its sector, all ongoing calls in the cell have to change their pilot PN offsets for WCDMA. The cost of forced handoff is computed by employing the current sectorization a_{ik}, which is equal to zero when DRU_i is in $Sector_k$. Since the cost occurs when DRU_i currently in another sector moves into $Sector_k$, the cost becomes

$$\sum_i \sum_k a_{ik} r_{ik}.$$

[0073] The weighted combination of these three handoff cost would be:

$$KPI_{HO} = \left[\omega_1 \sum_i \sum_j b_{ij} c_{ij} + \omega_2 \sum_i \sum_j b_{ij} (w_{ij} - z_{ij}) + \omega_3 \sum_i \sum_k a_{ik} r_{ik} \right]^{-1} \quad (3)$$

[0074] KPI_{CI} (Inverse of the Compactness Index): we will try to minimize the length of handoff border with the compactness index CI which is introduced in Section II.B. In Equation (4) the numerator term represents the number of handoff DRU sides between two different sectors.

$$KPI_{CI} = [CI]^{-1} = \left[\frac{\sum_i \sum_{j \in i} w_{ij} B_{ij}}{\sum_i \sum_{j \in i} B_{ij}} \right]^{-1} \quad (4)$$

Where $B_{ij}=1$, if DRU_i and DRU_j are adjacent.

Now we consider the following constraints required in the formulation:

1. each DRU has to belong to a sector, that is,

$$\sum_k x_{ik} = 1 \text{ for all } i \quad (5)$$

2. The relationship between any two DRUs in a $Sector_k$ has to satisfy $w_{ijk}=1$ if and only if $x_{ik}=x_{jk}=1$. Thus we have:

$$w_{ijk} \le x_{ik}, w_{ijk} \le x_{jk} \text{ and } w_{ijk} \ge x_{ik} + x_{jk} - 1 \text{ for all } i, j \text{ and } k \quad (6)$$

[0075] The relationship between two DRUs in a VBS_m, $z_{ijm}=1$ if and only if $y_{im}=y_{jm}=1$ which leads to:

$$z_{ijm} \le y_{im}, z_{ijm} \le y_{jm} \text{ and } z_{ijm} \ge y_{im} + y_{jm} - 1 \text{ for all } i, j \text{ and } k \quad (7)$$

3. Connected sectorization. if a sector has more than one DRU, then the DRUs of the sector have to be connected. For the formulation of connected sectors we employ the cut theorem [26] on SOD_k. If $Sector_k$ is connected, then any cut that separates cells in SOD_k has at least one common side of the hexagonal cells. Let $S1_k$ be a proper subset of SOD_k, that is, $S1_k \subset SOD_k$, $S1_k \neq \phi$, and $S1_k \neq SOD_k$. Also let $S2_k$ be the opposite set of $S1_k$, that is, $S2_k = SOD_k - S1_k$. Because two subsets are connected, there exists at least one common side of the DRUs separated by the subsets. Thus we have

$$\sum_{cell_i} \sum_{j \in SO_i} B_{ij} \geq 1 \quad (8)$$

[0076] Now, our QoS function is the weighted combination of three KPIs (cost factors) which we have already introduced. Obviously our objective function is to maximize the QoS function. They are penalties of blocked calls by hard and soft capacities and handoff calls. The DRU sectorization can be formulated as the following mixed integer linear programming.

$$\text{Minimize} \quad (9)$$

$$QoS^{-1} = w_1 \cdot KPI_{HC}^1 + w_2 \cdot KPI_{HO}^1 + w_3 \cdot KPI_C^1$$

Subject to:

$$\sum_i x_{ik} = 1 \text{ for all } i$$

$$w_{ijk} \leq x_{ik},$$

$$w_{ijk} \leq x_{jk} \text{ and } w_{ijk} \geq x_{ik} + x_{jk} - 1 \text{ for all } i, j \text{ and } k$$

$$w_{ij} = 1 - \sum_k w_{ijk} \text{ for all } i, j$$

$$y_{im} = \sum_{i \in SO_{im}} x_{ik} \text{ for all } m$$

$$z_{ijm} \leq y_{im},$$

$$z_{ijm} \leq y_{jm} \text{ and } z_{ijm} \geq y_{im} + y_{jm} - 1 \text{ for all } i, j \text{ and } m$$

$$z_{ij} = 1 - \sum_m z_{ijm} \text{ for all } i, j$$

$$\sum_{cell_i} \sum_{j \in SO_i} B_{ij} \geq 1$$

for all $SI_k \subset SOD_k$ where $SI_k \neq \phi$ and

$SI_k \neq SOD_k$ and $S2_k = SOD_k - SI_k$

$b_{ij} p_{ij} F_i$ for all i and j

$hc_m = \sum_i T_{i,2,m} - HC_m$ for all m

$$sc_k = \begin{cases} 0 & \text{if } \sum_i T_{i,2,k} < SC_k \\ \sum_i T_{i,2,k} - SC_k & \text{otherwise} \end{cases}$$

for all k

$x_{ik}, w_{ijk}, z_{ijm}, F_i \in \{0, 1\}$ for all i, j, k and m

[0077] Note that many grouping problems which are special cases of the sectorization problem are well-known NP-hard problems. Since our problem is NP hard, the time it takes to execute the algorithm is exponentially increasing with the size of the problem. Such an algorithm is thus in most cases unusable for real-world size problem. As an encouraging result on NP-hard problems, we investigate evolutionary algorithms to solve the sectorization problem and compare the performance with the solutions obtained by the mixed integer programming.

[0078] Estimation distribution algorithm (EDA)

[0079] Unlike other evolutionary algorithms, in EDA a new population of individuals in each generation is generated without crossover and mutation operators. Instead, in EDA a new population is generated based on a probability distribution, which is estimated from the best selected individuals of previous generation. We introduce each main-vector as an individual for our EDA approach, and also our fitness function is objective function that we mentioned it in section III. In general, conventional EDAs can be characterized by parameters and notations:

$$(I_v, F, \Delta_0, \eta_0, \beta_0, p_0, \Gamma, l_{max}) \quad (11)$$

where

1) I_v is the space of all potential solutions (entire search space of individuals).

2) F denotes a fitness function.

3) Δ_l is the set of individuals (population) at the l_{th} generation.

4) η_l is the set of best candidate solutions selected from set Δ_l at the l_{th} generation.

5) We denote $\beta_l = \Delta_l - \eta_l = \Delta_l \cap \eta_l^C$, where η_l^C is the complement of η_l.

6) p_0 is the selection probability. The EDA algorithm selects $p_0|\Delta_l|$ individuals from set Δ_l to make up set η_l.

7) We denote by Γ the distribution estimated from η_l (the set of selected candidate solutions) at each generation.

8) l_{max} are the maximum number of generation.

In conventional EDAs, each individual is designated by a string. A typical EDA is described in the following steps:

Step 0: Generate initial population Δ_0. The initial population ($|\Delta_0|$ individuals) is typically obtained by sampling according the uniform (equally likely) distribution:

$$(\theta_1, \theta_2, L, \theta_n) = \prod_{i=1}^{n} p_i(\theta_i), \quad (12)$$

$$i = 1, 2, \ldots, n, \text{ and}$$

$$p_i(\theta_i = S_{i1}) = p_i(\theta_i = S_{i2}) = \ldots = p_i(\theta_i = S_{i|SOS_i|}) = \frac{1}{\sum_{i=1}^{M} |SOS_i|}$$

For generation $l = 1, 2, \ldots,$ follow steps 1 through 6

Step 1: Evaluate the individuals in the current population Δ_{l-1} according to the fitness function F. Sort the candidate solutions (individuals in the current population) according to their fitness orders.

Step 2: If the best candidate solution satisfies the convergence criterion or the number of generation exceeds its limit l_{max}, then terminate; else go to step 3.

Step 3: Select the best $p_0|\Delta_{l-1}|$ candidate solutions (individuals) from current population Δ_{l-1}. This selection is accomplished according to the sorted candidate solutions.

Step 4: Estimate the probability distribution $p(\theta_1, \theta_2, L, \theta_n)$ on the basis of $|\eta_{l-1}|$ best candidate solutions. We denote this estimation by

$$\Gamma = P(\theta_1, \theta_2, L, \theta_n | \eta_{l-1}) \quad (13)$$

Step 5: Generate new $|\Delta_{l-1}| - |\eta_{l-1}|$ individuals on the basis of this new estimated probability distribution Γ. Replace the bad $|\beta_{l-1}|$ individuals with newly $|\Delta_{l-1}| - |\eta_{l-1}|$ individuals.

Step 6: Go to step 1 and repeat the steps

[0080] We followed the steps of the above pseudo code for our EDA implementation. In our experimentation, for estimation (13), we used a simple scheme of estimating the marginal distributions separately and using product form

$$= p(\theta_1, \theta_2, \ldots, \theta_n \mid \eta_{n-1}) \quad (14)$$

$$= \prod_{i=1}^{n} p(\theta_i \mid \eta_{n-1})$$

$$= \prod_{i=1}^{n} \left(\frac{\sum_{j=1}^{N_{n-1}} \delta(x_j^i = \theta_i \mid \eta_{n-1})}{N_{n-1}} \right)$$

Where δ is an indicator function and it can be expressed as

$$\delta(x_j^i = \theta \mid \eta_{n-1}) = \begin{cases} 1 & \text{if } x_j^i = \theta \\ 0 & \text{otherwise} \end{cases} \quad (15)$$

[0081] It is also understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

[0082] Appendix I is a glossary of terms used herein, including acronyms.

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

CDMA Code Division Multiple Access

CFR Crest Factor Reduction

DAC Digital to Analog Converter

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

[0083] GSM Global System for Mobile communications

I-Q In-phase/Quadrature

IF Intermediate Frequency

[0084] LINC Linear Amplification using Nonlinear Components

LO Local Oscillator

LPF Low Pass Filter

MCPA Multi-Carrier Power Amplifier

MDS Multi-Directional Search

OFDM Orthogonal Frequency Division Multiplexing

PA Power Amplifier

PAPR Peak-to-Average Power Ratio

PD Digital Baseband Predistortion

PLL Phase Locked Loop

QAM Quadrature Amplitude Modulation

QPSK Quadrature Phase Shift Keying

RF Radio Frequency

RRH Remote Radio Head

RRU Remote Radio Head Unit

SAW Surface Acoustic Wave Filter

UMTS Universal Mobile Telecommunications System

UPC Up Converter

WCDMA Wideband Code Division Multiple Access

[0085] WLAN Wireless Local Area Network

What is claimed is:

1. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

a plurality of Base Transceiver Stations (BTS);

a plurality of traffic monitoring modules; and

a network optimization goal and optimization algorithm.

2. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

3. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

4. The system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors.

5. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

one or more Base Transceiver Stations (BTSs); and

one or more traffic monitoring units.

6. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DAUs and coupled to each of the plurality of DAUs.

7. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DAUs.

8. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DRUs and coupled to each of the plurality of DRUs.

9. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DRUs.

10. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. The system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal.

13. The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. The system of claim 5 wherein the DRUs are connected in a daisy chain configuration.

16. The system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration.

17. The system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. The system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs.

19. The system of claim 5 wherein a single DAU port is connected to a plurality of Base Transceiver Stations.

* * * * *

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(54) **VIRTUALIZED WIRELESS NETWORK**

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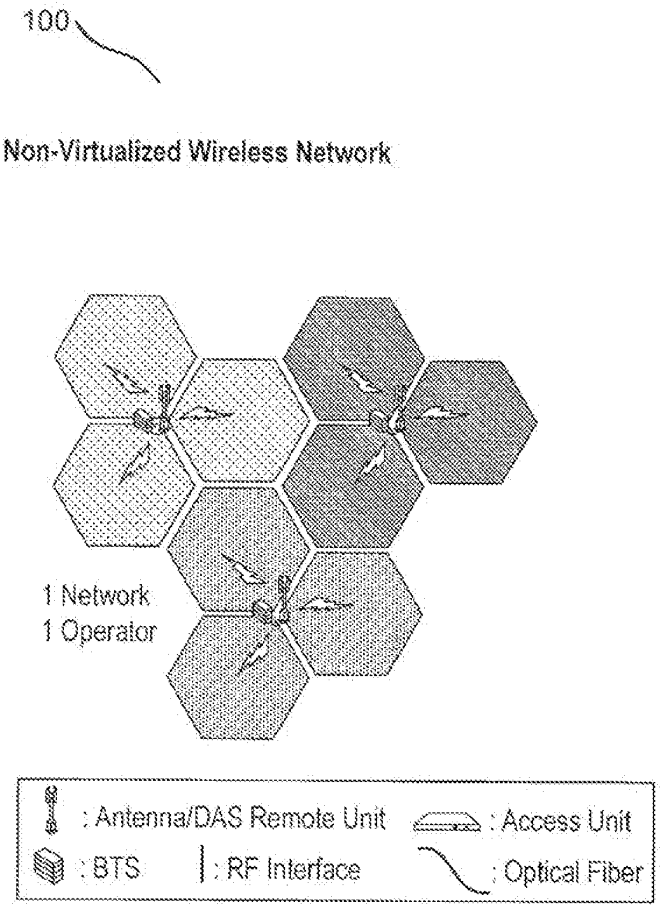
CPC *H04W 84/042* (2013.01)
USPC **370/328**

(57) **ABSTRACT**

According to an embodiment of the present invention, a network is provided. The network may include a first base transceiver station (BTS). The first BTS may be operable to provide a first signal including a plurality of first carriers. The network may also include a second BTS operable to provide a second signal including a plurality of second carriers. The network may also include a set of one or more digital access units (DAUs), each of the one or more DAUs being coupled to at least one of the first BTS or the second BTS. A set of one or more digital remote units (DRUs) may be included in the network, each of the DRUs being coupled to one of the one or more DAUs and operable to broadcast the first signal or the second signal.



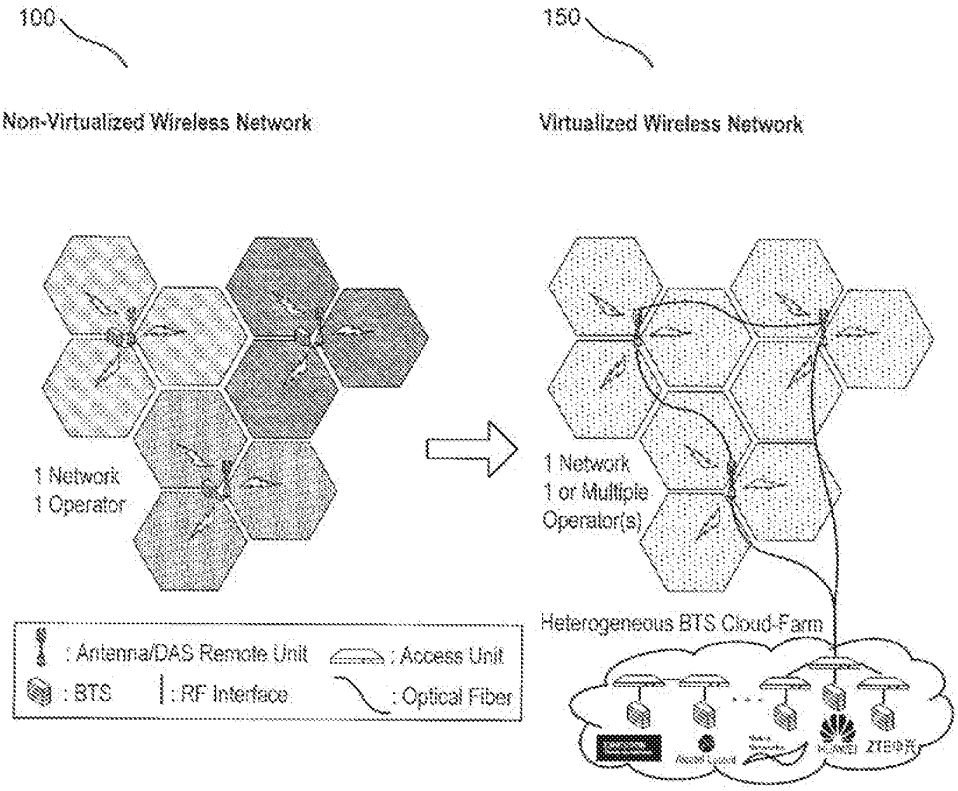

100
Non-Virtualized Wireless Network
1 Network
1 Operator
: Antenna/DAS Remote Unit
: Access Unit
: BTS
: RF Interface
: Optical Fiber
150
Virtualized Wireless Network
1 Network
1 or Multiple
Operator(s)
Heterogeneous BTS Cloud-Farm

FIG. 1A

FIG. 1B

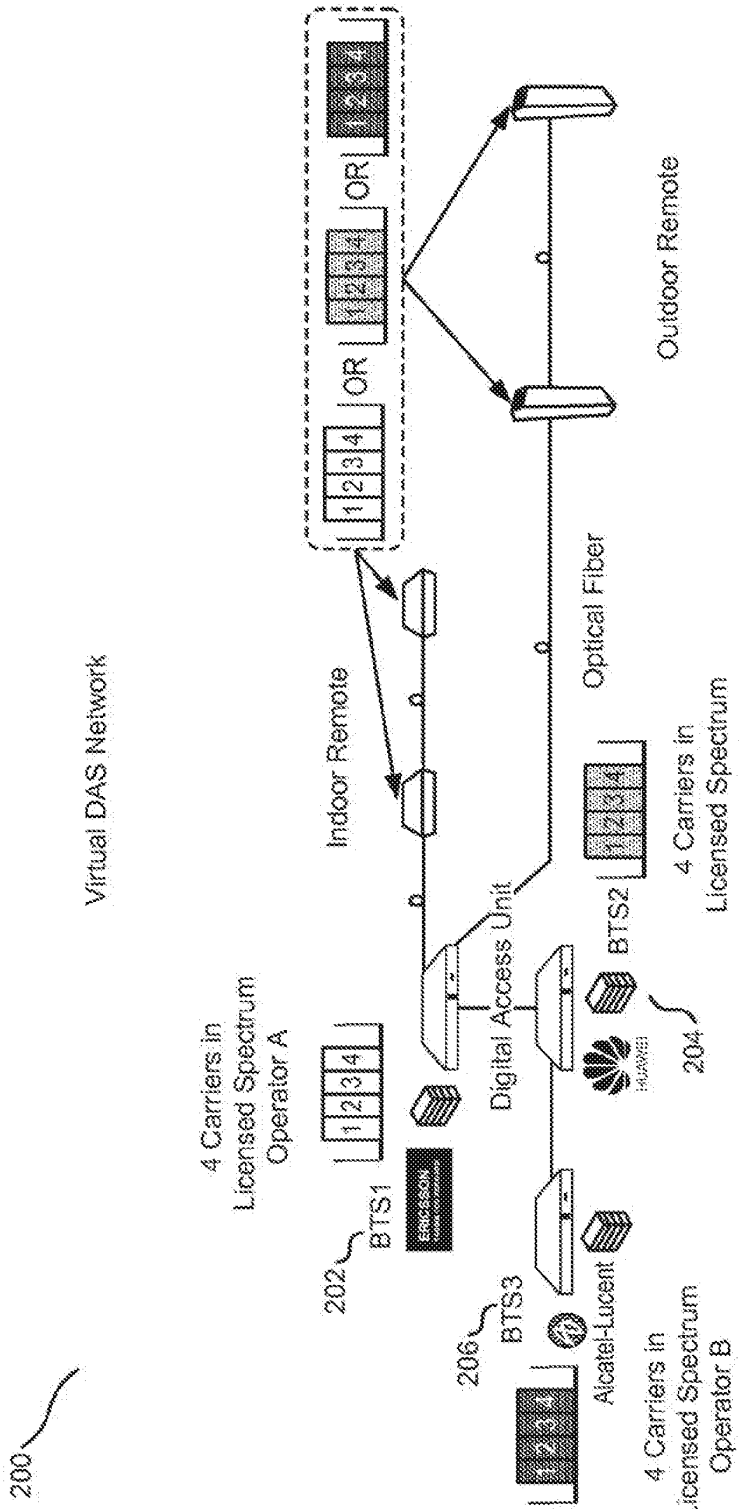

200
Virtual DAS Network
4 Carriers in Licensed Spectrum Operator A
1 2 3 4
202
BTS1
4 Carriers in Licensed Spectrum Operator B
1 2 3 1
206
BTS3
Alcatel-Lucent
Indoor Remote
1 2 3 4
OR
1 2 3 4
OR
1 2 3 4
Digital Access Unit
Optical Fiber
Outdoor Remote
BTS2
1 2 3 4
204
4 Carriers in Licensed Spectrum Operator C

FIG. 2

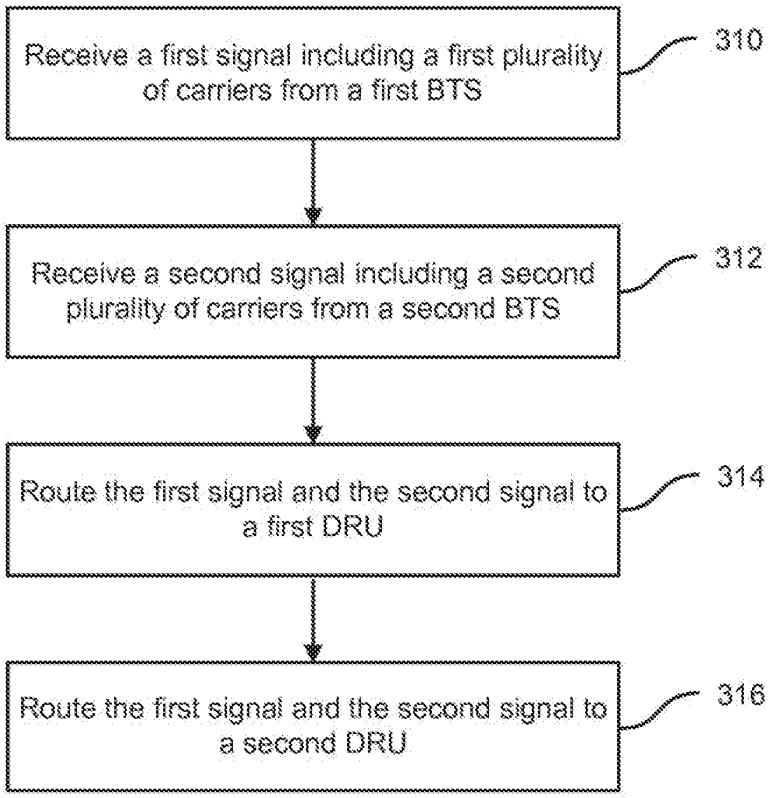

Receive a first signal including a first plurality of carriers from a first BTS
310
Receive a second signal including a second plurality of carriers from a second BTS
312
Route the first signal and the second signal to a first DRU
314
Route the first signal and the second signal to a second DRU
316

FIG. 3

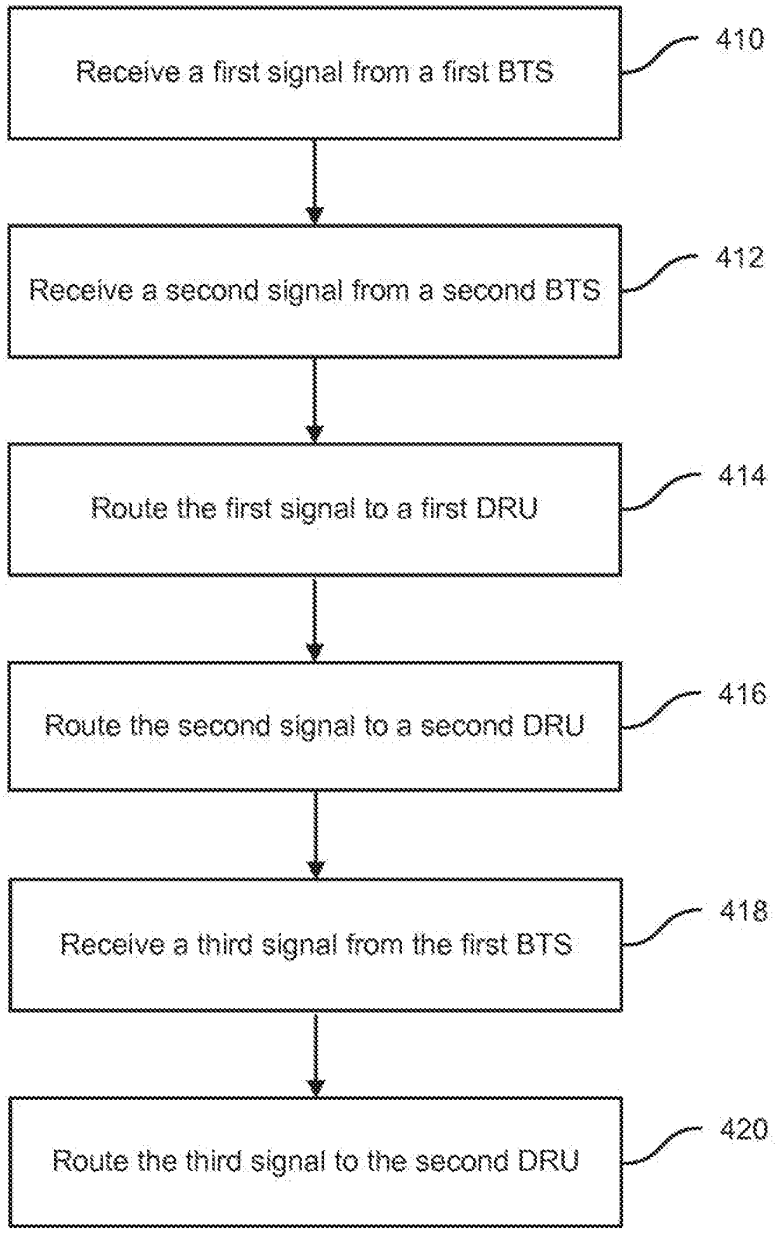

Receive a first signal from a first BTS
410
Receive a second signal from a second BTS
412
Route the first signal to a first DRU
414
Route the second signal to a second DRU
416
Receive a third signal from the first BTS
418
Route the third signal to the second DRU
420

FIG. 4

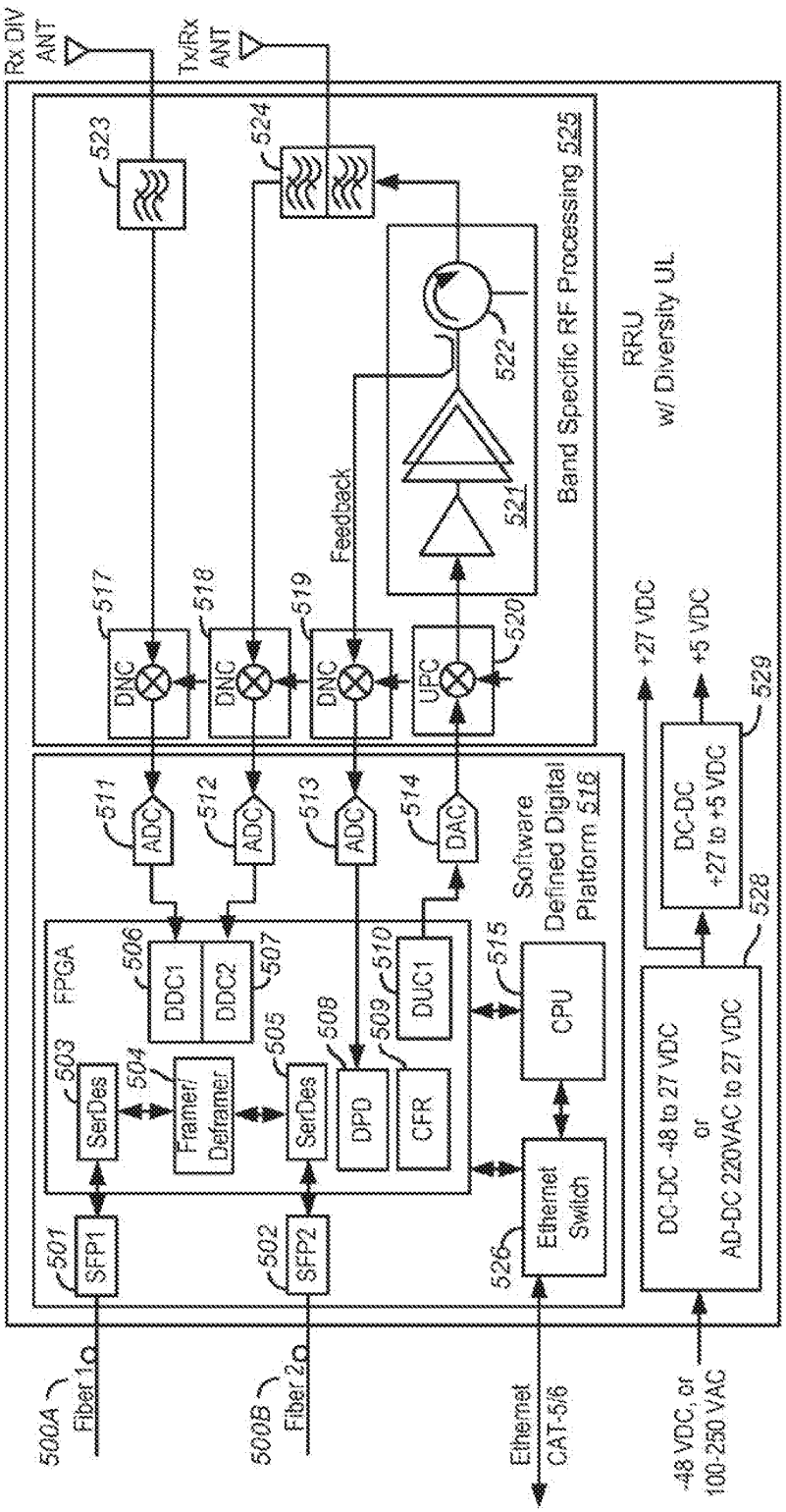
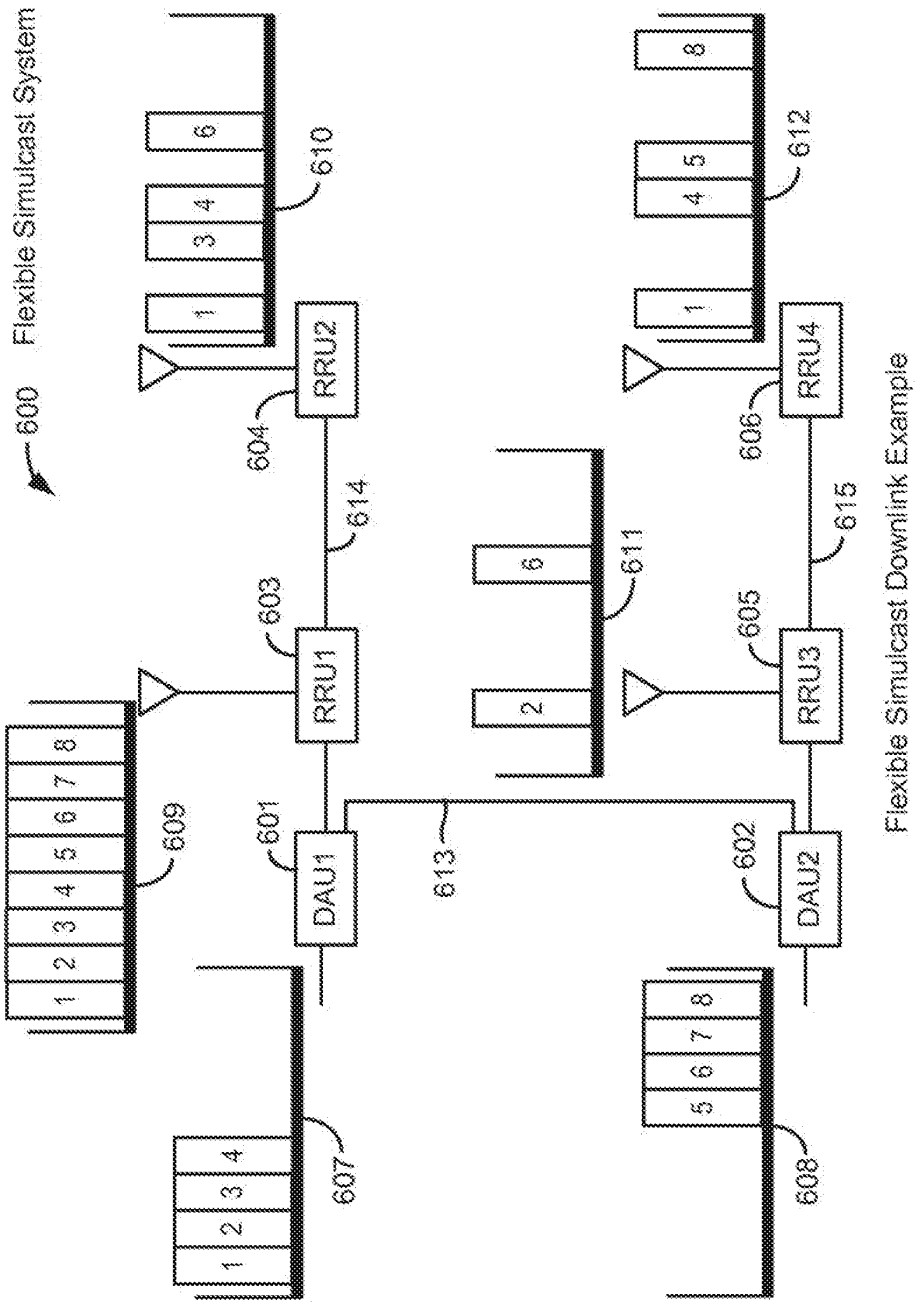


FIG. 5
Remote Radio Head Unit



Flexible Simulcast Downlink Example

FIG. 6

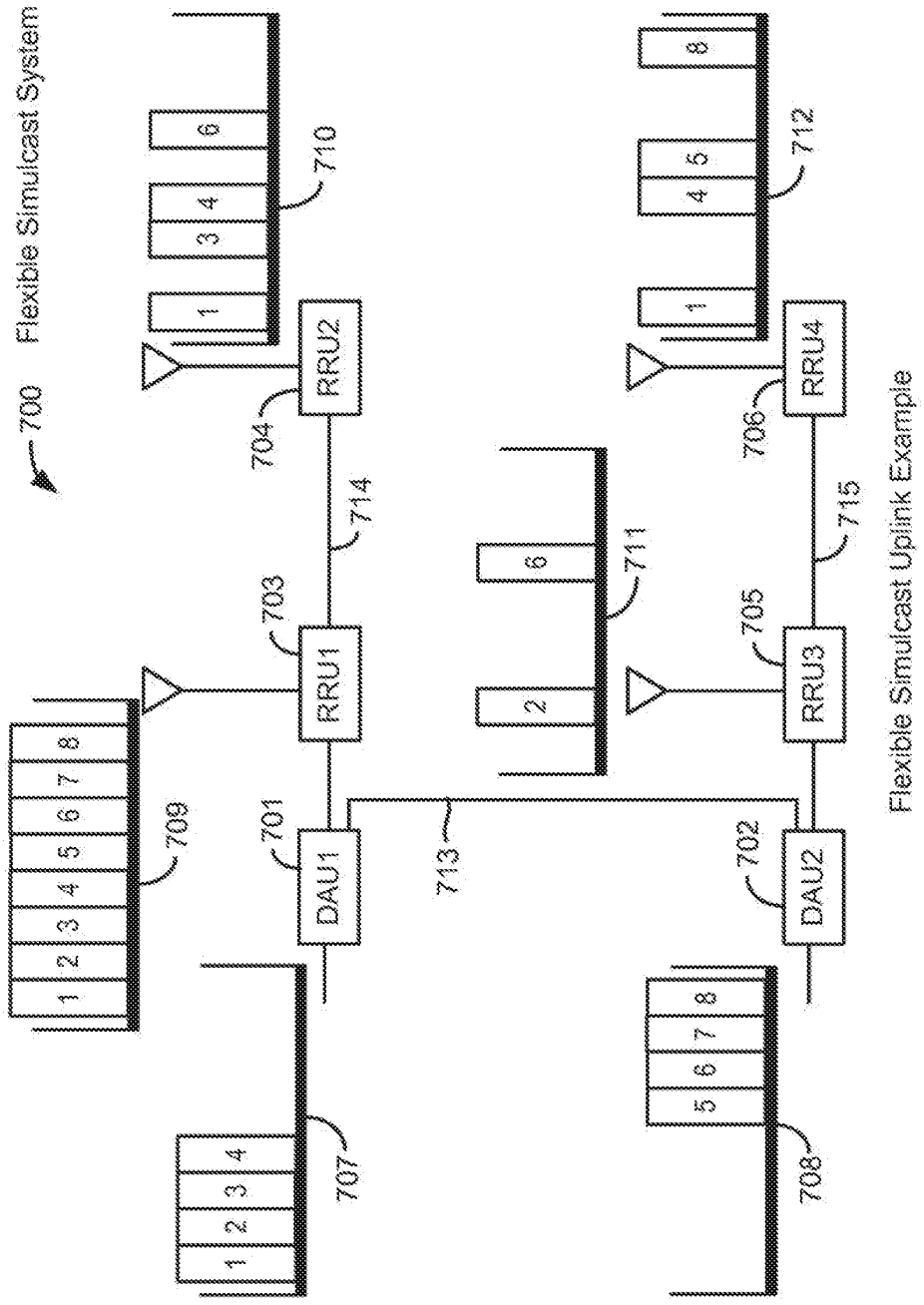

Flexible Simulcast System
700
RRU1
RRU2
RRU3
RRU4
DAU1
DAU2
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
Flexible Simulcast Uplink Example

FIG. 7

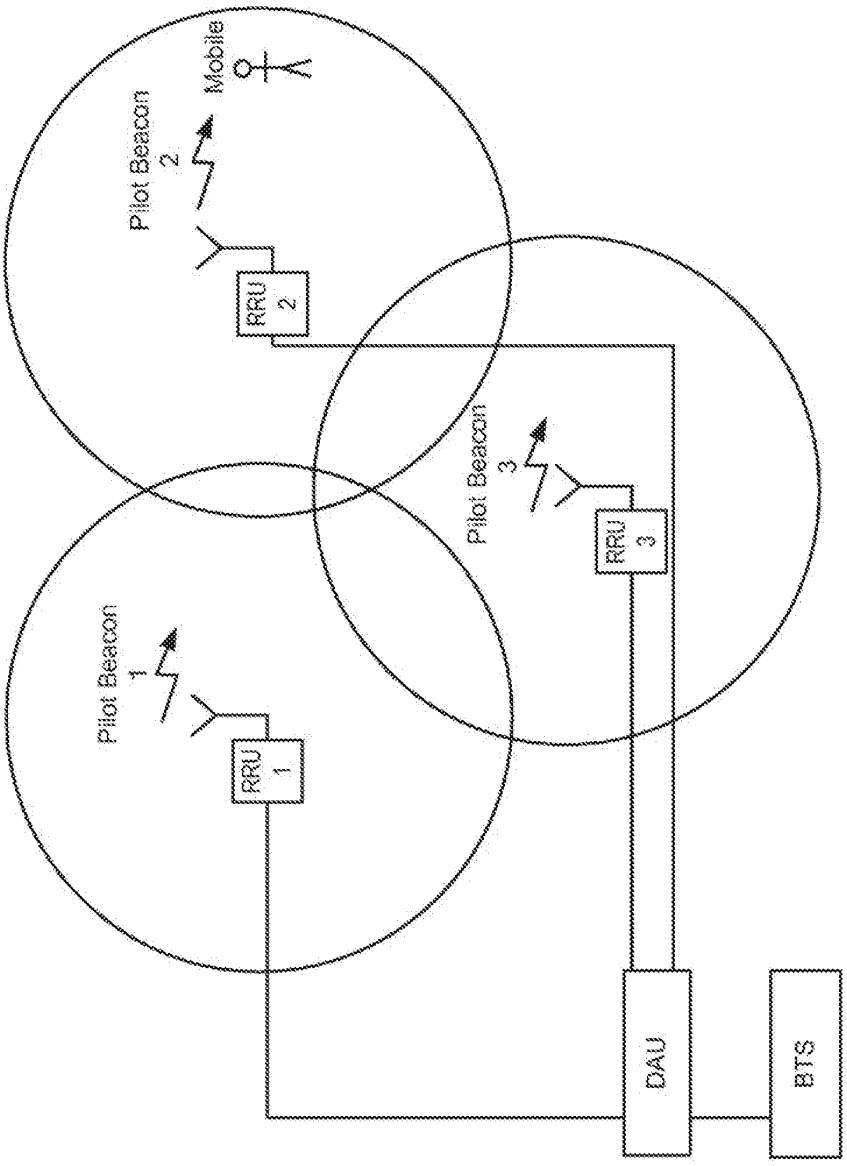
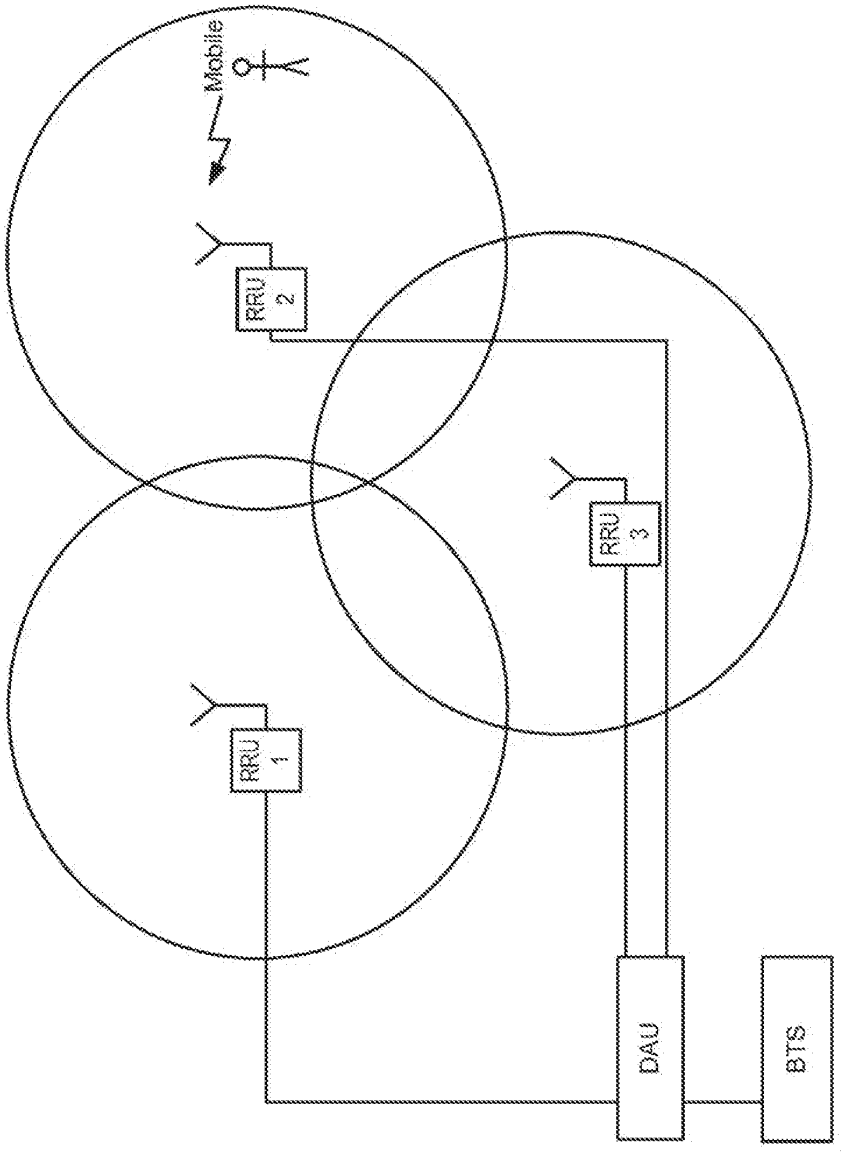


FIG. 8

Pilot Beacon Indoor Localization System for CDMA and WCDMA



Indoor Localization System of GSM and LTE

FIG. 9

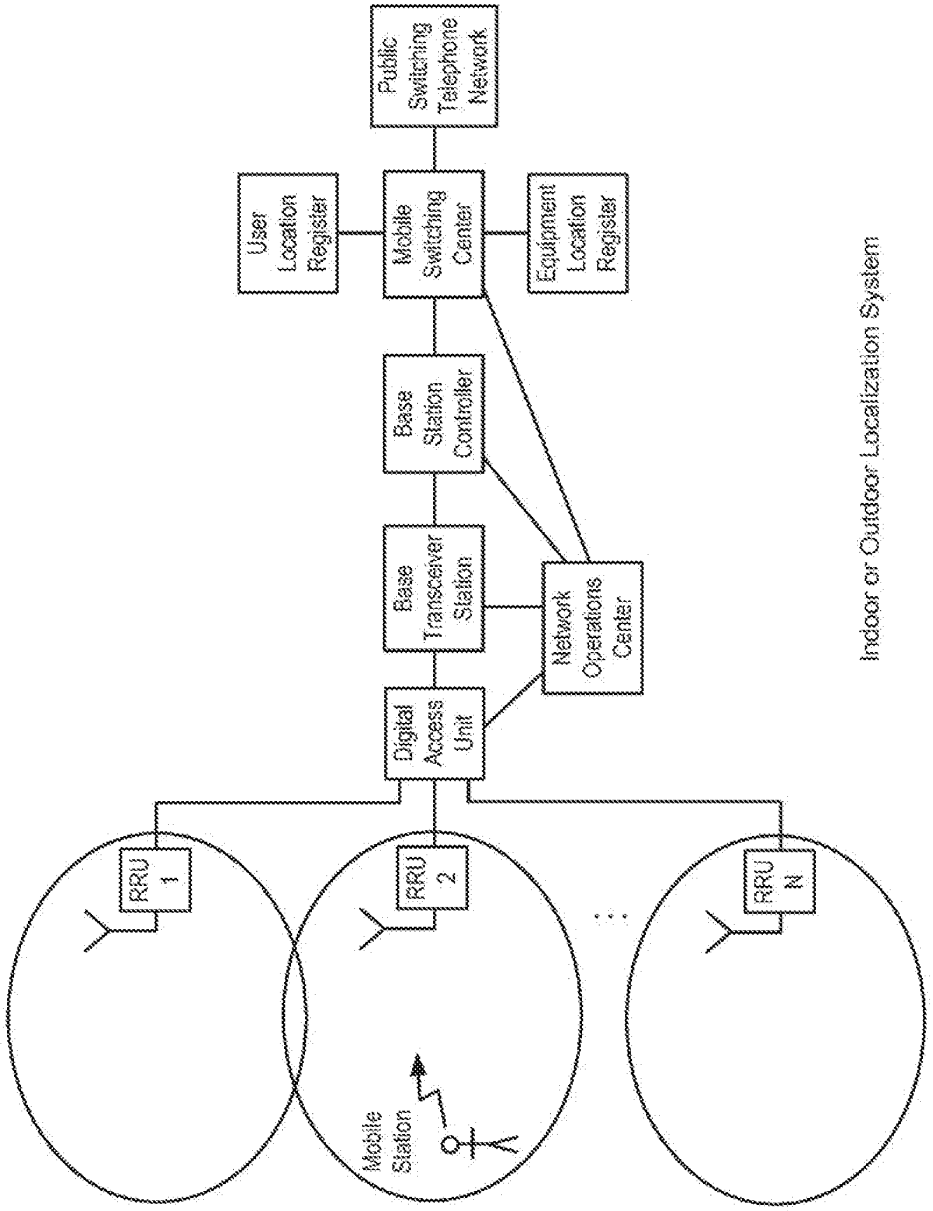

Public Switching Telephone Network
User Location Register
Mobile Switching Center
Equipment Location Register
Base Station Controller
Base Transceiver Station
Network Operations Center
Digital Access Unit
RRU 1
RRU 2
RRU N
Mobile Station
Indoor or Outdoor Localization System

FIG. 10

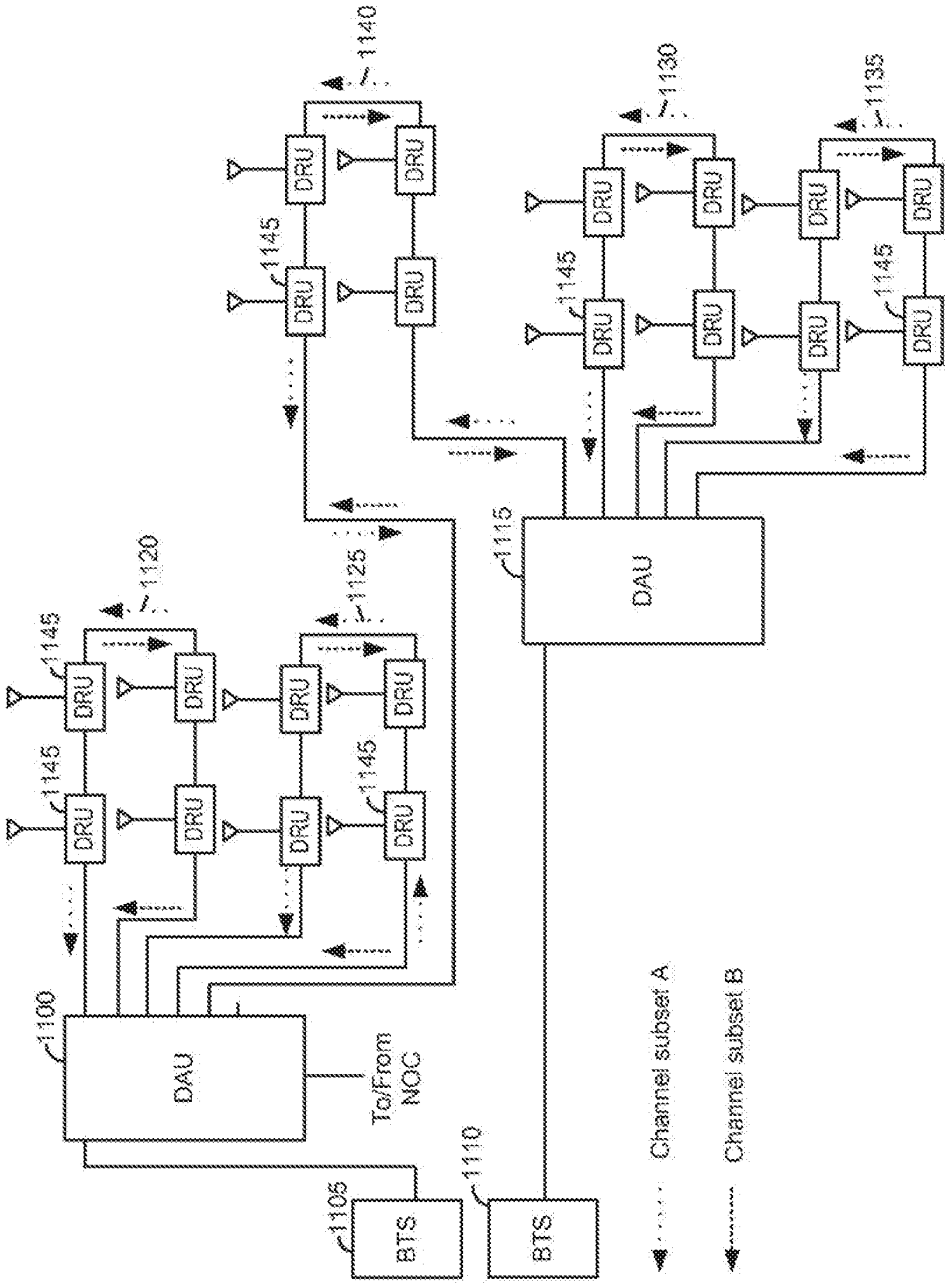

1100
DAU
To/From NOC
1105
BTS
1110
BTS
1115
DAU
1120
1125
1130
1135
1140
1145
DRU
Channel subset A
Channel subset B

FIG. 11

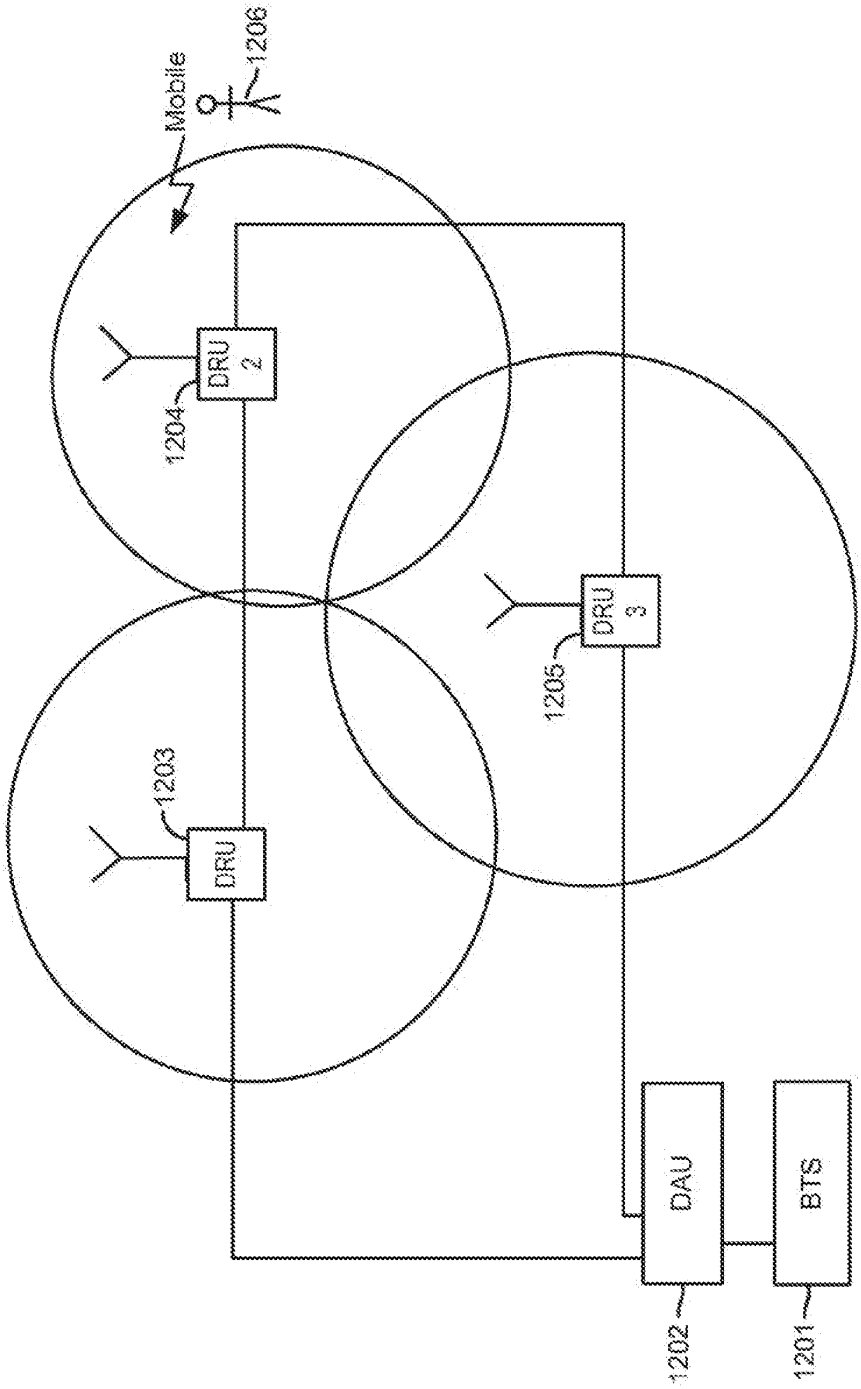


FIG. 12

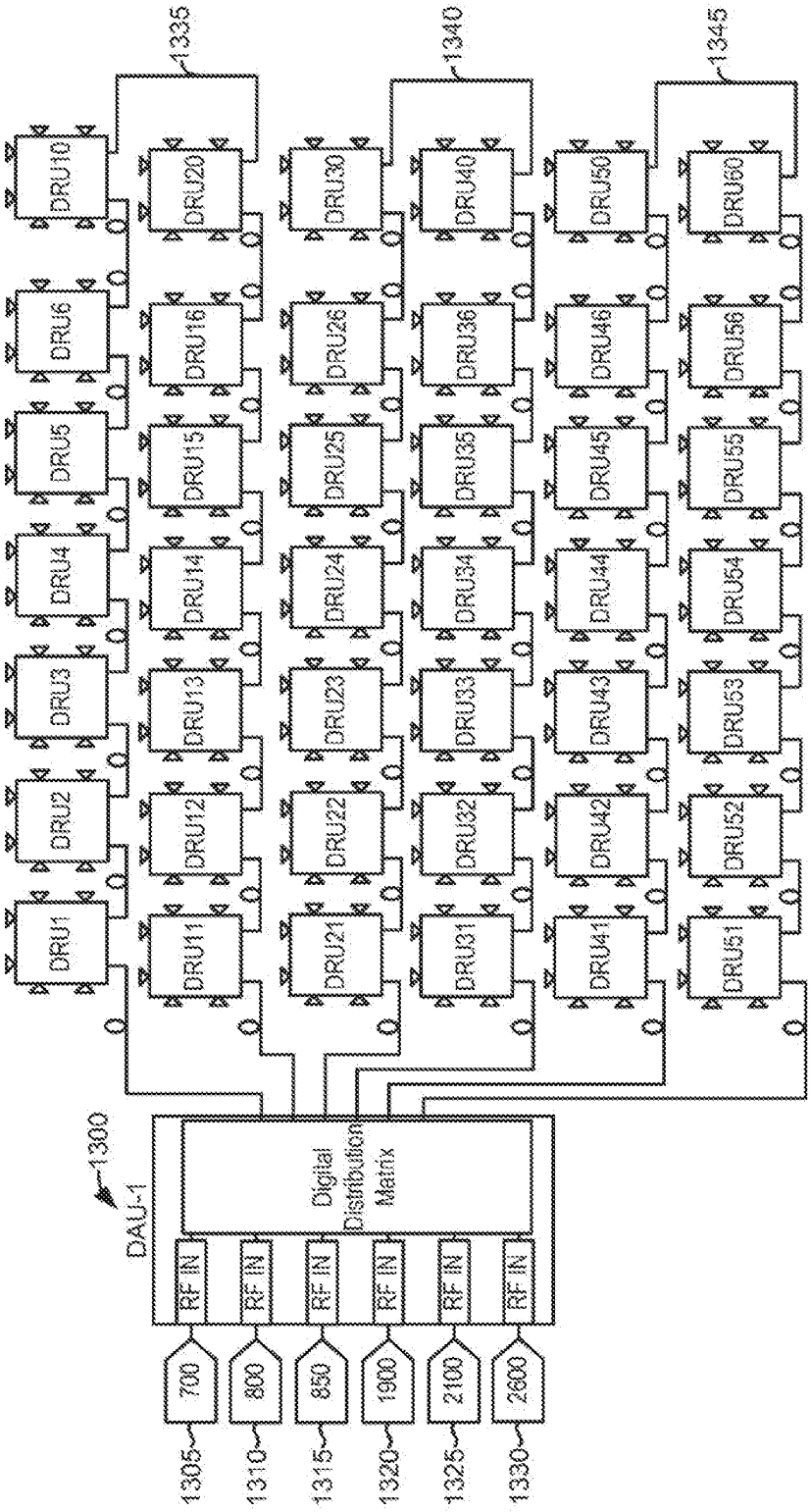

1335
1340
1345
DRU1
DRU2
DRU3
DRU4
DRU5
DRU6
DRU10
DRU11
DRU12
DRU13
DRU14
DRU15
DRU16
DRU20
DRU21
DRU22
DRU23
DRU24
DRU25
DRU26
DRU30
DRU31
DRU32
DRU33
DRU34
DRU35
DRU36
DRU40
DRU41
DRU42
DRU43
DRU44
DRU45
DRU46
DRU50
DRU51
DRU52
DRU53
DRU54
DRU55
DRU56
DRU60
1300
DAU-1
Digital Distribution Matrix
RF IN
RF IN
RF IN
RF IN
RF IN
RF IN
700
800
850
1900
2100
2600
1305
1310
1315
1320
1325
1330

FIG. 13

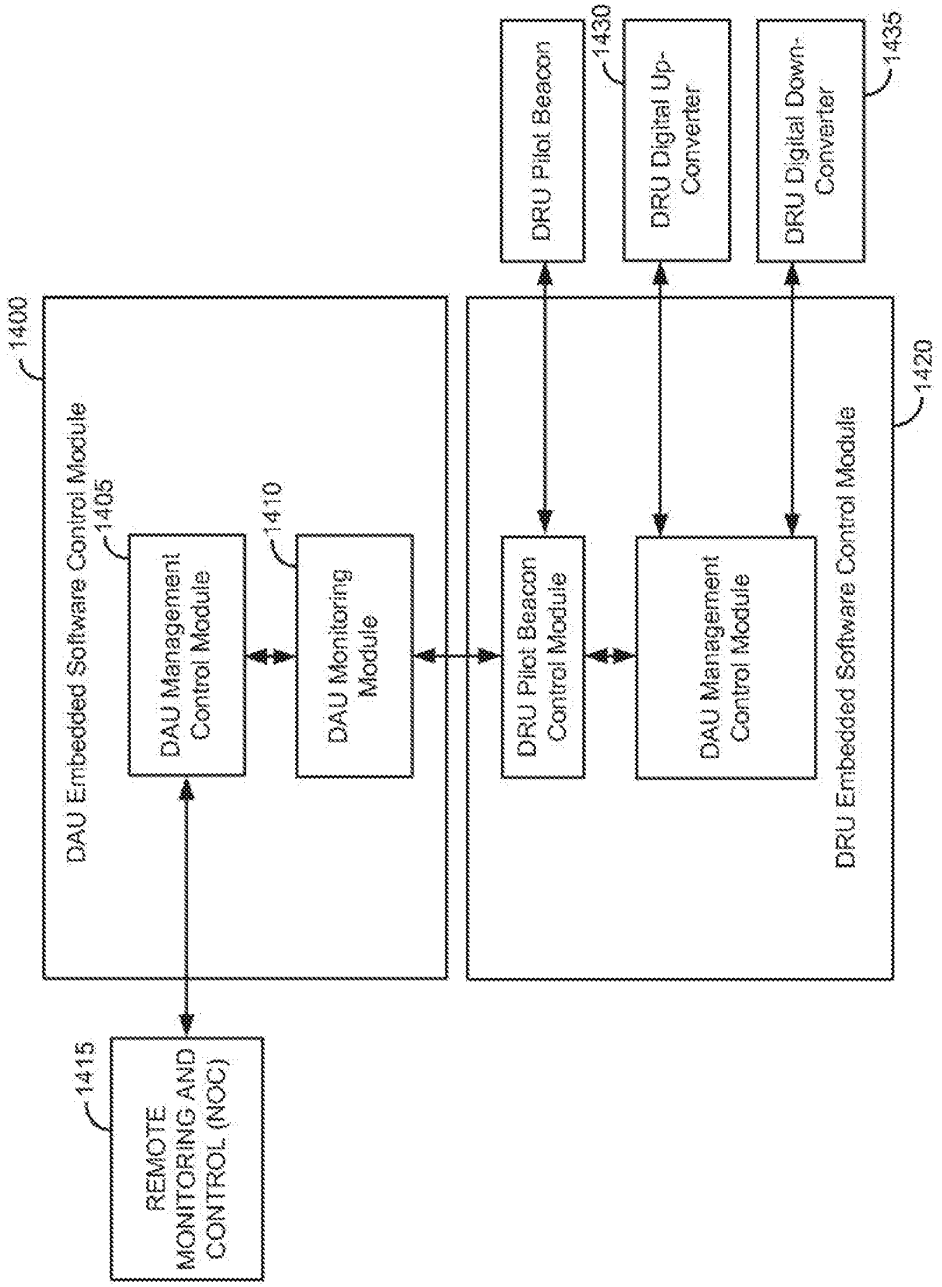

1400
DAU Embedded Software Control Module
1405
DAU Management Control Module
1410
DAU Monitoring Module
1415
REMOTE MONITORING AND CONTROL (NOC)
1420
DRU Embedded Software Control Module
DRU Pilot Beacon Control Module
DAU Management Control Module
1430
DRU Pilot Beacon
DRU Digital Up-Converter
1435
DRU Digital Down-Converter

FIG. 14

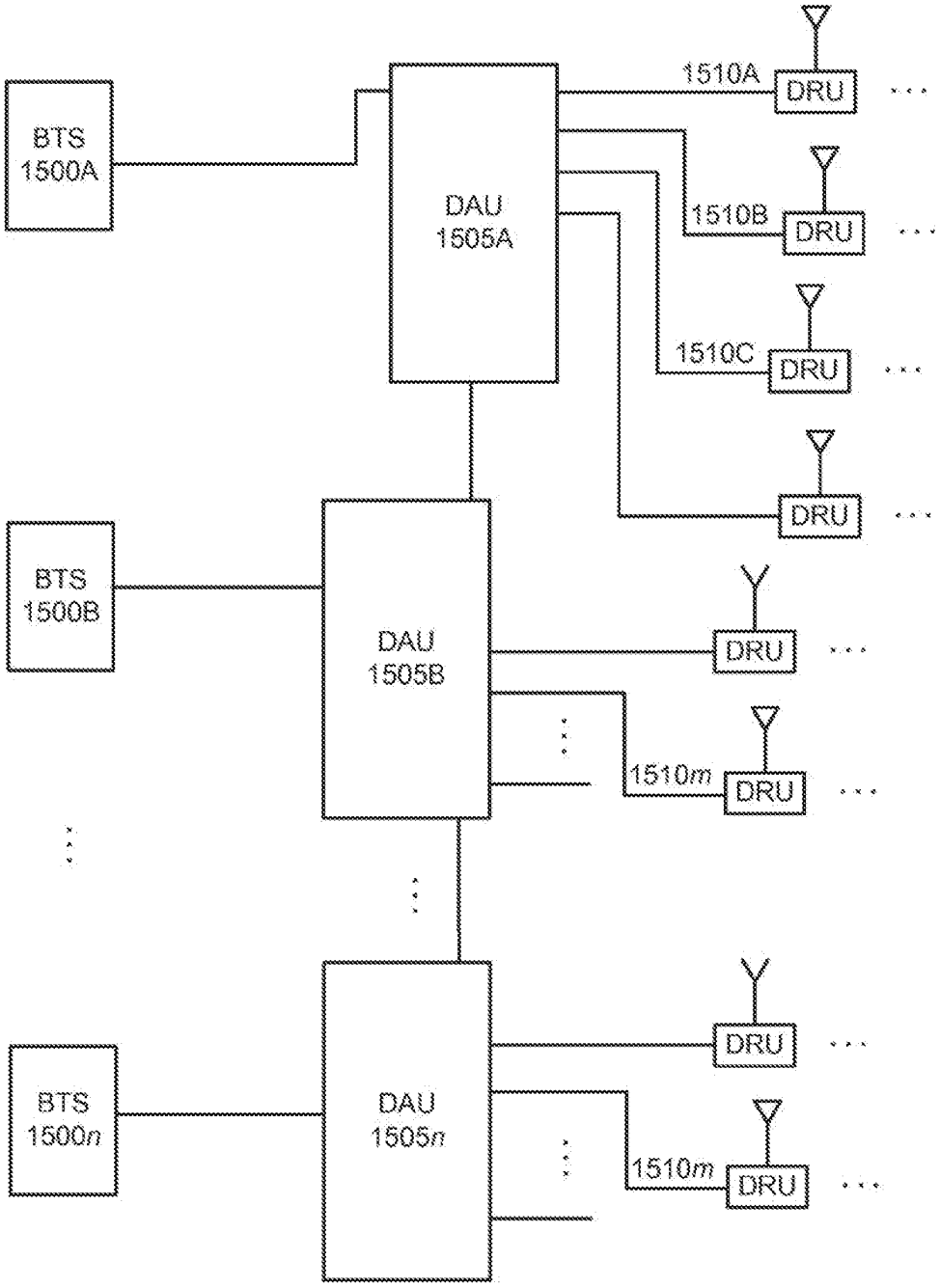

BTS
1500A
DAU
1505A
1510A
DRU
1510B
DRU
1510C
DRU
DRU
BTS
1500B
DAU
1505B
DRU
1510m
DRU
BTS
1500n
DAU
1505n
DRU
1510m
DRU

FIG. 15

VIRTUALIZED WIRELESS NETWORK

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/556,715, filed on Nov. 7, 2011, titled "Virtualized Wireless Network," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

BACKGROUND OF THE INVENTION

[0002] The proliferation of Internet-enabled smart phones and mobile devices have driven wireless subscribers to consume an unprecedented amount of multimedia and multimodal mobile data traffic, such as real-time video streaming, high definition movies downloading, and the like. This explosion has been augmented by machine-to-machine (M2M) type real-time applications, such as utility-meter monitoring, that operate autonomously and independently from user transactions. Such advances have resulted in exponential growth of the demand for mobile data capacity on a global scale, challenging traditional cellular networks. Yet, the supply of mobile data capacity provided by existing radio network solutions may only be growing linearly. Therefore, there may be a need to address the gap between supply and demand for mobile data capacity as the gap is rapidly widening.

SUMMARY OF THE INVENTION

[0003] These and other problems may be addressed by embodiments of the present invention. The present invention relates to wireless communication systems. More particularly, the present invention provides methods and systems related to a virtualized wireless network.

[0004] According to embodiments of the present invention, the virtualization of a wireless network is provided utilizing software configurable radio-based distributed antenna system (DAS). As described herein, embodiments of the present invention enable wireless network operators to virtualize their base station farms or hotels (allowing the operators to mix-and-match base stations from different OEM vendors) and to provide on demand wireless capacity and coverage in an anywhere/anytime format. As a result, embodiments of the present invention enable increased efficiency and utilization of new and existing assets that fundamentally change the manner in which operators are able to plan and deploy their wireless networks.

[0005] According to an embodiment of the present invention, a network is provided. The network may include a first base transceiver station (BTS). The first BTS may be operable to provide a first signal including a plurality of first carriers. The network may also include a second BTS operable to provide a second signal including a plurality of second carriers. The network may also include a set of one or more digital access units (DAUs), each of the one or more DAUs being coupled to at least one of the first BTS or the second BTS. A set of one or more digital remote units (DRUs) may be included in the network, each of the DRUs being coupled to one of the one or more DAUs and operable to broadcast the first signal or the second signal.

[0006] In some embodiments, the first BTS may be associated with a first infrastructure supplier and the second BTS may be associated with a second infrastructure supplier. In some embodiments, the first infrastructure supplier and the second infrastructure supplier are a same infrastructure supplier.

[0007] The one or more BTSs may provide the signal including the plurality of carriers using differing broadcast protocols. The different broadcast protocols may include at least one of CDMA, WCDMA, or LTE. The one or more DAUs may include a plurality of DAUs coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link. The one or more DAUs may include a plurality of DAUs coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link. The one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration and/or a star configuration. Each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, e.g., via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

[0008] In some embodiments of the invention, a method of operating a virtual DAS network is provided. The method may include: receiving a first signal including a first plurality of carriers from a first BTS; receiving a second signal including a second plurality of carriers from a second BTS; routing the first and second signals to a first DRU; and routing the first and second signals to a second DRU. The method may further include: associating the first and second signals with one of a plurality of DRUs based on a geographic usage pattern, the plurality of DRUs comprising the first DRU and the second DRU. Routing the first and second signals to the second DRU may include routing the first a second signals through a plurality of DAUs.

[0009] In some embodiments of the invention, a method of operating a virtual DAS network is provided. The method may include: receiving a first signal from a first BTS; receiving a second signal from a second BTS; routing the first signal to a first DRU; routing the second signal to a second DRU; receiving a third signal from the first BTS; and routing the third signal to the second DRU. The method may further include: repeatedly assigning the first DRU to one of a plurality of BTSs, the plurality of BTSs including the first BTS and the second BTS. The first DRU may be assigned at least partly in an attempt to evenly distribute combined BTS resources across DRUs in the network. Routing the third signal to the second DRU may include: routing the third signal through a plurality of DAUs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIGS. **1**A and **1**B illustrate two types of wireless networks: a non-virtualized wireless network and a virtualized wireless network according to an embodiment of the present invention;

[0011] FIG. **2** is a simplified schematic diagram of a virtual DAS network according to an embodiment of the present invention;

[0012] FIG. **3** is a simplified flowchart illustrating a method of operating a virtual DAS network according to an embodiment of the present invention;

[0013] FIG. **4** is a simplified flowchart illustrating a method of operating a virtual DAS network according to an embodiment of the present invention;

[0014] FIG. **5** is a block diagram showing a multi-channel High Power Remote Radio Head Unit according to one embodiment of the present invention;

[0015] FIG. **6** is a block diagram according to one embodiment of the invention showing the basic structure and an example of a Flexible Simulcast downlink transport scenario based on having 2 DAU and 4 DRU;

[0016] FIG. **7** is a block diagram in accordance with an embodiment of the invention showing the basic structure and an example of a Flexible Simulcast uplink transport scenario based on having 2 DAU and 4 DRU;

[0017] FIG. **8** shows an embodiment of an indoor system employing multiple Remote Radio Head Units (RRUs) and a central Digital Access Unit (DAU);

[0018] FIG. **9** shows an embodiment of an indoor system in accordance with the invention which employs multiple Remote Radio Head Units (RRUs) and a central Digital Access Unit (DAU);

[0019] FIG. **10** illustrates an embodiment of a cellular network system employing multiple Remote Radio Heads according to the present invention;

[0020] FIG. **11** 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;

[0021] FIG. **12** illustrates an embodiment of a cellular network system employing multiple DRUs according to the present invention;

[0022] FIG. **13** 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;

[0023] FIG. **14** illustrates in block diagram form the interaction between the DAU embedded software control module and the DRU embedded software control module; and

[0024] FIG. **15** 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

[0025] Embodiments of the present invention generally relate to wireless communication systems employing Distributed Antenna System (DAS) as part of a virtualized wireless network. More specifically, embodiments of the present invention relate to a wireless network that utilizes virtualization technology provided by software configurable radio (SCR) (which may also be referred to as a software defined radio (SDR)) DAS, as presented in U.S. patent application Ser. No. 13/211,236 (DW-1022U), filed Aug. 16, 2011, entitled Neutral Host Architecture for a Distributed Antenna System, and U.S. patent application Ser. No. 13/211,243 (DW-1023U), filed Aug. 16, 2011, entitled Remotely Reconfigurable Distributed Antenna System and Methods, the disclosures of which are hereby incorporated by reference in their entireties.

[0026] The proliferation of Internet-enabled smart phones and mobile devices have driven wireless subscribers to consume an unprecedented amount of multimedia and multimodal mobile data traffic, such as real-time video streaming, high definition movies downloading, and the like. This explosion is augmented by machine-to-machine (M2M) type real-time applications, such as utility-meter monitoring, that operate autonomously and independently from user transactions. This exponential growth of the demand for mobile data capacity on a global scale is challenging traditional cellular networks. The supply of mobile data capacity provided by existing radio network solutions is only growing linearly. Therefore, the gap between supply and demand for mobile data capacity is rapidly widening.

[0027] Wireless network operators currently over-provision wireless capacity in order to accommodate peak-time period usage. For example, a football stadium is normally empty most of the time. When a game or match is on, the same football stadium may have tens of thousands of attendees, and those attendees are likely to have smart phones with which they communicate with friends and family throughout the match, and in other cases, watch online instant replays on their mobile devices. Another example of variable bandwidth demand is rush hour traffic. A popular highway or freeway is usually deserted during non-peak hours (e.g., during the early morning hours). When peak traffic hours arrive (e.g., 8 a.m. or 5 p.m. for most U.S. cities), many vehicles are traveling on the busy highway or freeway. In situations where a significant number of drivers and/or passengers of the vehicles engaged in the rush hour use their cell phones for communications, bandwidth demand increases. Yet another example of variable bandwidth demand is bandwidth use within an office building or shopping mall. During regular office hours, an office-building cafeteria and/or mall food court may have little foot traffic (e.g., and relatively small bandwidth demand). However, during lunch hours, many customers may congregate in the cafeteria and/or food court and there will likely be a parallel surge of mobile data traffic. In all the above examples, wireless network operators may attempt to ensure that cell sites covering the stadiums, highways or freeways, and/or cafeterias or food courts have sufficient wireless capacities to handle the peak usage time period. With conventional wireless or radio frequency (RF) equipment, in which a base station is tied to a fixed or limited amount of capacity and a specific coverage area of a cell site, wireless network operators typically over-provision their cell sites to handle peak demand.

[0028] Over-provisioning results in wasted excess capacity during low usage time periods. In addition, the amount of over-provisioning needed at any particular cell site is difficult to gauge, and is in constant flux. If demand for mobile capacity outweighs supply at a particular cell site, then under-provisioning occurs. Under-provisioning may lead to degradation of service, large latency, service interruptions or dropped calls.

[0029] The current exponential growth of demand for mobile data capacity results in a need for exponential over-provisioning for many wireless network operators. Even if an operator had an exponential growth in capital to build capacity supply, there are physical limitations that may prevent exponential growth in installations of conventional wireless equipment such as physical space, municipality zoning requirements, power availability, and the like.

[0030] Embodiments of the present invention provide solutions to the widening gap discussed above with game-changing SCR technologies for broadband mobile networks. SCR may comprise a complex interplay of digital signal processing (DSP) algorithms, RF technologies, intelligent network protocols, and system architectures. SCR-based distributed antenna systems (DAS) and small cell solutions may impact the user experience for wireless operators, enterprises and end users. In particular, the virtualization technology described herein may enable massive, scalable broadband data throughput while providing efficiency, flexibility, and control that is unparalleled in the wireless infrastructure

industry. The increased efficiency and utilization of new and existing assets may fundamentally change the way operators plan and deploy their wireless networks.

[0031] Embodiments of the present invention provide a flexible, cloud-like architecture not available using conventional systems. FIGS. **1**A and **1**B illustrate two types of wireless networks: a non-virtualized wireless network **100** and a virtualized wireless network **150**. Referring to FIG. **1**A, in the non-virtualized wireless network **100**, base station hotels merely co-locate conventional systems together in the same locations. BTS equipment inside base station hotels may have limited, if any, interoperability among different BTS OEM vendors. For example, BTS OEM vendors may have architected their BTS equipment to work mostly with their own kind because of technical issues and/or economic motivations. From a technical viewpoint, BTS have sophisticated management and control signals that are proprietary to a particular OEM, and so BTS interoperability among different BTS OEM vendors may be difficult to achieve. Some BTS OEM vendors would claim that their BTS equipment had virtualization features, but a closer look may reveal that such claimed virtualization only occur within similar systems of the same vendor. From the economic side, BTS OEM may be incentivized to monopolize or "lock-up" as many operator customers as possible and therefore BTS OEM vendors have historically demonstrated strong resistance and reluctance to make their BTS architecture a true open standard. For example, vendors may sell BTS equipment initial at substantial discounts to wireless operators, though they may then later make substantial economic benefits against their operator customers by charging a premium on service agreements or upgrades. BTS equipment used in conjunction with conventional DAS system in a base station hotel may provide some form of joint-operation on the conventional DAS network, but again the BTS's of different OEM vendors are not interoperable with respect to each other.

[0032] Referring to FIG. **1**B, a virtualized wireless network **150** may include a base station "farm" in which base stations are provisioned in a novel way, enabling underlying BTS hardware to be commoditized and used in a freely interoperable and scalable configurations. As described herein, embodiments of the present invention may enable the mix-and-match usage of base station from different OEM vendors. RF outputs of each BTS may be subject to rigorous industry standard. However, virtualized wireless networks may include one or more DAUs connected to one or more BTSs, such that the DAUs receive standard RF output of the BTSs. Thus, the DAUs may connect to BTSs from any OEM vendor, and BTSs from any OEM vendor can thus be added heterogeneously to the network, forming a basis of a base station farm. Similarly, DAUs may connect to one or more BTSs which provide a signal including a plurality of carriers using different broadcast protocols (e.g., CDMA, WCDMA or LTE). Also, due to the novel SCR-based architecture of the DAS network, all BTS from any BTS OEM vendors can supply capacity resources interoperable to the same network. Thus, embodiments of the present invention may provide a form of true virtualization not available using conventional systems. Embodiments of the present invention may provide for virtualization of base station farms to harness massive, scalable capacity resources. Some embodiments of the present invention are applicable in relation to mixed-mode air-interfaces in which LTE is included as one of the carriers (along with a mix of other signals such as WCDMA).

[0033] As described herein, virtualization of wireless network may provide significant benefits to wireless operators. For example, multiple BTSs can be pooled into one or more BTS farms. This may vastly simplify network management and maintenance. Since each BTS in a conventional wireless network may be provisioned inflexibly to a particular coverage area, virtualization as disclosed herein may eliminate one-to-one dependency between a BTS and an associated fixed coverage area. Instead, each BTS can be flexibility provisioned for a large number of DRUs on a virtual DAS network at any time. If coverage is needed for a new area, additional DRUs can easily be added and configured to the existing virtual DAS network at the new area for the new coverage. This virtualization scheme may ensure provisioning of highest capacity availability and performance, while at the same time increasing efficiency, utilization, and flexibility of existing assets since BTS equipment can be recycled anytime, anywhere on the virtual DAS network. All these benefits could result in a substantial reduction in wireless operators' capital expenditures and operating expenses.

[0034] FIG. **2** is a simplified schematic diagram **200** of a virtual DAS network according to some embodiments. As illustrated in FIG. **2**, a plurality of BTSs (BTS1 **202**, BTS2 **204**, and BTS3 **206**) are provided in a BTS farm. In the illustrated embodiment, each BTS is coupled to a DAU, although in some embodiments, multiple BTSs can be coupled to each DAU. The plurality of BTSs can be associated with different operators and utilize different carriers in different spectral bands. In the illustrated embodiment, the present disclosure enables the virtualization of wireless network for the broadcast type air interface technologies, such as CDMA, WCDMA, LTE, or other suitable standards (the "Broadcast Case"). The DAUs are networked together, as presented in U.S. patent application Ser. No. 13/211,247 (DW-1024U), filed Aug. 16, 2011, titled "Daisy Chained Ring of Remote Units for a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety, using suitable connection technologies including Ethernet, optical fiber, microwave links, or the like. In the Broadcast Case, all carriers of a specific BTS may be or must be present or "powered-on" simultaneously at any particular DRU. Capacity may then be controlled by adjusting the number of DRUs any of the BTS in the BTS farm is corresponded. For example, referring to FIG. **2**, the capacity resources of BTS **1 202**, BTS **2 204**, or BTS **3 206** can be shared across all four DRUs in the virtual DAS network. The capacity resources of the three BTSs **202**, **204**, and **206** can be mixed and matched among the four DRUs, but each of the DRUs in the illustrated embodiment must be exclusively powered by one of the **3** BTSs. If more capacity is demanded at any of the four DRUs, one of the BTSs can concentrate some or all of its capacity resources to that particular DRU by either, e.g.,: (i) becoming inactive on one, two, or three of the other DRUs, and thereby focusing the BTS's capacity resources onto that particular DRU, or (ii) adding a new BTS **4** (not shown) onto the BTS farm, and have that BTS **4** focus on powering the particular DRU. This example is illustrative and is evident that one skill in the art can vary the capacity resources configuration to achieve desirable results.

[0035] In one embodiment, the present disclosure enables the virtualization of wireless network for a channelized case, such as GSM (the "Channelized Case"), through control of individual channels, or Flexible Simulcast, as presented in U.S. patent application Ser. No. 13/211,243 (DW-1023U),

filed Aug. 16, 2011, titled "Remotely Reconfigurable Distributed Antenna System and Methods," the disclosure of which is hereby incorporated by reference in its entirety.

[0036] Referring to FIG. **2**, non-virtualized wireless networks may be characterized by a number of criteria and limitations. In a typical non-virtualized wireless network, one wireless operator builds a wireless network for its own exclusive use. Each BTS on the wireless network covers a fixed cell area, and over-provisioning is needed to accommodate peak time traffic. Wireless operators would need to add BTS more capacity. This is a non-scalable approach.

[0037] Embodiments of the present invention provide a virtualized wireless network that is characterized by a number of benefits and improvements over conventional systems. For example, a virtualized wireless network such as one disclosed herein may allow one wireless network to serve one wireless operator exclusively or the same wireless network to serve multiple wireless operators, as in a "neutral host" environment. Further, since all heterogeneous BTSs in the BTS farm or cloud-farm need not be fixed to any particular cell site (as in the case of conventional wireless network), each of the BTS in the farm or cloud-farm can provide capacity and coverage to one of the multiple configurable areas where a suitable DRU is located. As a result, unlimited capacity can, in theory, be harnessed from the BTS farm or cloud-farm to the virtualized wireless network. This is a novel and highly scalable approach.

[0038] FIG. **3** is a simplified flowchart illustrating a method of operating a virtual DAS network according to an embodiment of the present invention. At **310**, a first signal including a first plurality of carriers from a first BTS may be received. At **312**, a second signal including a second plurality of carriers from a second BTS may be received. At **314**, the first and second signal may be routed to a first DRU. At **316**, the first and second signal may be routed to a second DRU.

[0039] FIG. **4** is a simplified flowchart illustrating a method of operating a virtual DAS network according to an embodiment of the present invention. At **410**, a first signal from a first BTS may be received. At **412**, a second signal from a second BTS may be received. At **414**, the first signal may be routed to a first DRU. At **416**, the second signal may be routed to a second DRU. Signals subsequently received from the BTSs may be routed differently (e.g., based on network demands). For example, at **418**, a third signal may be received from the first BTS. At **420**, the third signal may be routed to the second DRU, rather than the first DRU. It may be apparent that the descriptions of FIGS. **3** and **4** may correspond to any of the descriptions provided in FIGS. **1** and **2**.

[0040] It should be appreciated that the specific steps illustrated in FIG. **3** or FIG. **4** provide a particular method of operating a virtual DAS network according to some embodiments of the present invention. Other sequences of steps may also be performed according to alternative embodiments. For example, alternative embodiments of the present invention may perform the steps outlined above in a different order. Moreover, the individual steps illustrated in FIG. **3** or FIG. **4** may include multiple sub-steps that may be performed in various sequences as appropriate to the individual step. Furthermore, additional steps may be added or removed depending on the particular applications. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0041] An embodiment of a Remote Radio Head Unit in accordance with the invention is shown in FIG. **5**. Additional description related to remote radio head units is provided in U.S. patent application Ser. No. 13/211,236, filed on Aug. 16, 2011, the disclosure of which is hereby incorporated by reference in its entirety for all purposes. Fiber **1**, indicated at **500**A, may be a high speed fiber cable that transports data between the BTS and the Remote Radio Head Unit. Fiber **2**, indicated at **500**B, may be used to daisy chain other remote radio head units which are thereby interconnected to the BTS or DAU. The software-defined digital platform **516** may perform baseband signal processing, typically in an FPGA or equivalent. Building block **503** is a Serializer/Deserializer. The deserializer portion may extract the serial input bit stream from the optical fiber **501** and converts it into a parallel bit stream. The serializer portion performs the inverse operation for sending data from the Remote Radio Head Unit to the BTS. In an embodiment, the two distinct bit streams communicate with the BTS using different optical wavelengths over one fiber, although multiple fibers can be used in alternative arrangements. The deframer **504** deciphers the structure of the incoming bit stream and sends the deframed data to the Crest Factor Reduction Algorithm **509**. The Crest Factor Reduction block **509** may reduce the Peak-to-Average Ratio of the incoming signal so as to improve the Power amplifier DC-to-RF conversion efficiency. The waveform may then be presented to the Digital Predistorter block **508**. The digital predistorter may compensate for the nonlinearities of the Power Amplifier **521** in an adaptive feedback loop. Digital Upconverter **510** may filter and digitally translate the deframed signal to an IF frequency. The Framer **504** may take the data from the two digital downconverters **506**, **507** and may pack it into a Frame for transmission to the BTS over the optical fiber **501**. Elements **511** and **512** are Analog to Digital converters that may be used to translate the two analog receive signals into digital signals. The receiver comprises a diversity branch which contains a downconverter **517** and a Band Pass Filter **523**. The main branch has a receiver path comprised of a duplexer **524** and a downconverter **518**. In some embodiments, one or both downconverters **517** and **518** can have an integral uplink low-noise amplifier.

[0042] The power amplifier has an output coupler for extracting a replica of the output signal in the feedback path. The feedback signal is frequency-translated by downconverter **519** to either an IF frequency or baseband and presented to an Analog to Digital converter **513**. This feedback signal is used in an adaptive loop for performing Digital Predistortion to compensate for any nonlinearities created by the power amplifier.

[0043] The Ethernet cable is used to locally communicate with the Remote Radio Head Unit. Switch **526** is used to allow easy access to either the FPGA or the CPU. DC power converters **528** and **529** are used to obtain the desired DC voltages for the Remote Radio Head Unit. Either an external voltage can be connected directly into the RRU or the DC power may be supplied through the Ethernet cable.

[0044] Although the description of the instant embodiment is directed to an application where a second optical fiber connection provides a capability for daisy chaining to other Remote Radio Head Units, an alternative embodiment provides multiple optical fiber connections to support a modified "hybrid star" configuration for appropriate applications which dictate this particular optical transport network configuration.

[0045] Referring to FIG. **6** of the instant patent application, an alternative embodiment of the present invention may be

described as follows. In a previous arrangements, an embodiment involved having downlink signals from two separate base stations belonging to the same wireless operator enter DAU1 and DAU2 input ports respectively. In an alternative embodiment, a second composite downlink input signal from e.g., a second base station belonging to a different wireless operator enters DAU2 at the DAU2 RF input port. In this embodiment, signals belonging to both the first operator and the second operator are converted and transported to RRU1 **603**, RRU2 **604**, RRU3 **605** and RRU4 **606**, respectively. This embodiment provides an example of a neutral host wireless system, where multiple wireless operators share a common infrastructure comprised of DAU1 **601**, DAU2 **602**, RRU1 **603**, RRU2 **604**, RRU3 **605** and RRU4 **606**. Signals belonging to both the first operator and the second may reach all RRUs described herein because DAU1 **601** and DAU2 **602** may be connected via cable **613**. Thus, bandwidths **607** provided to DAU1 **601** and bandwidths **608** provided to DAU2 **602** may reach any and all of the RRUs described herein. For example, all carrier bandwidths **607** and **608** may be provided to RRU1 **603**, as shown in bandwidth output **609**. In contrast, only bandwidth inputs **1**, **3**, **4**, **6** may need to be provided to RRU2 **604**, as shown in bandwidth output **610**. Additionally, only bandwidth inputs **2**,**6** may need to be provided to RRU3 **605**, as shown in bandwidth output **611**. Last, RRU4 **606** may only need to provide bandwidth inputs **1**, **4**, **5**, and **8** as shown in bandwidth output **612**. Thus, for example, two different carriers, one each controlling DAU1 and DAU2, respectively, may be able to provide coverage to all of the RRUs according to embodiments presented herein. All the previously mentioned features and advantages accrue to each of the two wireless operators. Additional description related to this embodiment is provided in U.S. patent application Ser. No. 13/211,243, filed on Aug. 16, 2011, the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0046] As disclosed in U.S. Provisional Application Ser. No. 61/374,593, titled "Neutral Host Architecture for a Distributed Antenna System," filed Aug. 17, 2010 and also referring to FIG. **6** of the instant patent application, the Digital Up Converters present in the RRU 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 RRUs 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 Ser. No. 61/374,593, titled "Neutral Host Architecture for a Distributed Antenna System," filed Aug. 17, 2010. In one embodiment of the present invention where a wideband CDMA signal is present within e.g., the bandwidth corresponding to carrier **1** at the input port to DAU1, the transmitted signal at the antenna ports of RRU1, RRU2 and RRU4 will be a wideband CDMA signal which is virtually identical to the signal present within the bandwidth corresponding to carrier **1** at the input port to DAU1.

[0047] As disclosed in U.S. Provisional Application Ser. No. 61/374,593, titled "Neutral Host Architecture for a Distributed Antenna System," filed Aug. 17, 2010 and also referring to FIG. **6** of the instant patent application, it is understood that the Digital Up Converters present in the respective RRUs can be programmed to transmit any desired composite signal format to each of the respective RRU antenna ports. As an example, the Digital Up Converters present in RRU1 and RRU2 can be dynamically software-reconfigured as described previously so that the signal present at the antenna port of RRU1 would correspond to the spectral profile shown in FIG. **6** as **610**, and also that the signal present at the antenna port of RRU2 would correspond to the spectral profile shown in FIG. **6** as **609**. One application for such a dynamic rearrangement of RRU capacity would be e.g., if a company meeting were suddenly convened in the area of the enterprise corresponding to the coverage area of RRU2. Although the description of some embodiments in the instant application refers to base station signals **607** and **608** as being on different frequencies, the system and method of the present invention readily supports configurations where one or more of the carriers which are part of base station signals **607** and **608** and are identical frequencies, since the base station signals are digitized, packetized, routed and switched to the desired RRU.

[0048] Another embodiment of the Distributed Antenna System in accordance with the present invention is shown in FIG. **7**. As disclosed in U.S. Provisional Application Ser. No. 61/374,593, titled "Neutral Host Architecture for a Distributed Antenna System," filed Aug. 17, 2010 and also as shown in FIG. **7** the Flexible Simulcast System **700** can be used to explain the operation of Flexible Simulcast with regard to uplink signals. As discussed previously with regard to downlink signals and by referring to FIG. **6**, the uplink system shown in FIG. **7** is mainly comprised of DAU1 indicated at **701**, RRU1 indicated at **703**, RRU2 indicated at **704**, DAU2 indicated at **702**, RRU3 indicated at **705**, and RRU4 indicated at **706**. In a manner similar to the downlink operation explained by referring to FIG. **6**, the operation of the uplink system shown in FIG. **7** can be understood as follows.

[0049] The Digital Down Converters present in each of RRU1 **703**, RRU2 **704**, RRU3 **705** and RRU4 **706** 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 RRU1 **703**, RRU2 **704**, RRU3 **705** and RRU4 **706** are selected based on the desired uplink band(s) to be processed and filtered, converted and transported to the appropriate uplink output port of either DAU1 **701** or DAU2 **702**. The DAUs and RRUs 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 RRUs. Header information is transmitted along with the data packet which identifies the RRU and DAU that corresponds to the individual data packet.

[0050] In one example for the embodiment shown in FIG. **7**, RRU1 **703** and RRU3 **705** are configured to receive uplink signals within the Carrier **2** bandwidth, whereas RRU2 **704** and RRU4 **706** are both configured to reject uplink signals within the Carrier **2** bandwidth. When RRU3 **705** receives a strong enough signal at its receive antenna port within the Carrier **2** bandwidth to be properly filtered and processed, the Digital Down Converters within RRU3 facilitate processing and conversion. Similarly, when RRU1 receives a strong enough signal at its receive antenna port within the Carrier **2** bandwidth to be properly filtered and processed, the Digital Down Converters within RRU1 **703** facilitate processing and conversion. The signals from RRU1 **703** and RRU3 **705** are combined based on the active signal combining algorithm, and are fed to the base station connected to the uplink output port of DAU1 **701**. The term simulcast is frequently used to

describe the operation of RRU1 **703** and RRU3 **705** with regard to uplink and downlink signals within Carrier **2** bandwidth. The term Flexible Simulcast refers to the fact that the present invention supports dynamic and/or manual rearrangement of which specific RRU are involved in the signal combining process for each Carrier bandwidth.

[0051] Referring to FIG. **7**, the Digital Down Converters present in RRU1 are configured to receive and process signals within Carrier **1**-**8** bandwidths. The Digital Down Converters present in RRU2 are configured to receive and process signals within Carrier **1**, **3**, **4** and **6** bandwidths. The Digital Down Converters present in RRU3 are configured to receive and process signals within Carrier **2** and **6** bandwidths. The Digital Down Converters present in RRU4 are configured to receive and process signals within Carrier **1**, **4**, **5** and **8** bandwidths. The respective high-speed digital signals resulting from processing performed within each of the four RRU are routed to the two DAUs. As described previously, the uplink signals from the four RRUs are combined within the respective DAU corresponding to each base station.

[0052] An aspect of the present invention includes an integrated Pilot Beacon function within the each RRU. In an embodiment, each RRU comprises a unique software programmable Pilot Beacon as discussed hereinafter This approach is intended for use in CDMA and/or WCDMA indoor DAS networks. A very similar approach can be effective for indoor location accuracy enhancement for other types of networks such as LTE and WiMAX. Because each RRU is already controlled and monitored via the DAUs which comprise the network, there is no need for costly deployment of additional dedicated wireless modems for remote monitoring and control of pilot beacons.

[0053] An RRU-integrated Pilot Beacon approach is employed for both CDMA and WCDMA networks. Each operational pilot beacon function within an RRU employs a unique PN code (in that area) which effectively divides the WCDMA or CDMA indoor network coverage area into multiple small "zones" (which each correspond to the coverage area of a low-power Pilot Beacon). Each Pilot Beacon's location, PN code and RF Power level are known by the network. Each Pilot Beacon is synchronized to the WCDMA or CDMA network, via its connection to the DAU.

[0054] Unlike the transmit signal from a base station which is "dynamic," the Pilot Beacon transmit signal will be effectively "static" and its downlink messages will not change over time based on network conditions.

[0055] For a WCDMA network, in Idle mode each mobile subscriber terminal is able to perform Pilot Signal measurements of downlink signals transmitted by base stations and Pilot Beacons. When the WCDMA mobile subscriber terminal transitions to Active mode, it reports to the serving cell all its Pilot Signal measurements for base stations and for Pilot Beacons. For CDMA networks, the operation is very similar. For some RRU deployed in an indoor network, the RRU can be provisioned as either a Pilot Beacon or to serve mobile subscribers in a particular operator bandwidth, but not both.

[0056] For a WCDMA network, existing inherent capabilities of the globally-standardized networks are employed. The WCDMA mobile subscriber terminal is able to measure the strongest CPICH RSCP (Pilot Signal Code Power) in either Idle mode or any of several active modes. Also, measurements of CPICH Ec/No by the mobile subscriber terminal in either Idle mode or any of several active modes are possible. As a result, the mobile subscriber terminal reports all available RSCP and Ec/No measurements via the serving base station (whether indoor or outdoor) to the network. Based on that information, the most likely mobile subscriber terminal location is calculated and/or determined. For CDMA networks, the operation is very similar to the process described herein.

[0057] A previously described embodiment of the present invention referring to FIG. **6** involved having a wideband CDMA signal present within e.g., the bandwidth corresponding to carrier **1** at the input port to DAU1. In the previously described embodiment, the transmitted signal at the antenna ports of RRU1, RRU2 and RRU4 is a wideband CDMA signal which is virtually identical to the signal present within the bandwidth corresponding to carrier **1** at the input port to DAU1. An alternative embodiment of the present invention is one where a wideband CDMA signal is present within e.g., the bandwidth corresponding to carrier **1** at the input port to DAU1. However, in the alternative embodiment the transmitted signal at the antenna port of RRU1 differs slightly from the previous embodiment. In the alternative embodiment, a wideband CDMA signal is present within e.g., the bandwidth corresponding to carrier **1** at the input port to DAU1. The transmitted signal from RRU1 is a combination of the wideband CDMA signal which was present at the input port to DAU1, along with a specialized WCDMA pilot beacon signal. The WCDMA pilot beacon signal is intentionally set well below the level of the base station pilot signal.

[0058] A further alternative embodiment can be explained referring to FIG. **8** which applies in the case where CDMA signals are generated by the base station connected to the input port of DAU1. In this further alternative embodiment of the present invention, the transmitted signal at the antenna port of RRU1 is a combination of the CDMA signal which was present at the input port to DAU1, along with a specialized CDMA pilot beacon signal. The CDMA pilot beacon signal is intentionally set well below the level of the base station pilot signal.

[0059] An embodiment of the present invention provides enhanced accuracy for determining location of indoor wireless subscribers. FIG. **9** depicts a typical indoor system employing multiple Remote Radio Head Units (RRUs) and a central Digital Access Unit (DAU). Each Remote Radio Head provides a unique header information on data received by that Remote Radio Head. This header information in conjunction with the mobile user's radio signature are used to localize the user to a particular cell. The DAU signal processing can identify the individual carriers and their corresponding time slots. A header is included with each data packet that uniquely identifies the corresponding RRU. The DAU can detect the carrier frequency and the corresponding time slot associated with the individual RRUs. The DAU has a running data base that identifies each carrier frequency and time slot with a respective RRU. The carrier frequency and time slot is the radio signature that uniquely identifies the GSM user.

[0060] The DAU communicates with a Network Operation Center (NOC) via a Ethernet connection or an external modem, as depicted in FIG. **10**. Once a E911 call is initiated the Mobile Switching Center (MSC) in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call. The user can be localized within a BTS cell. The NOC then makes a request to the individual DAUs to determine if the E911 radio signature is active in their indoor cell. The DAU checks its data base for the active carrier frequency and time slot. If that radio signa-

ture is active in the DAU, then that DAU will provide the NOC with the location information of the corresponding RRU.

[0061] A further embodiment of the present invention includes LTE to provide enhanced accuracy for determining the location of indoor wireless subscribers. GSM uses individual carriers and time slots to distinguish users whereas LTE uses multiple carriers and time slot information to distinguish users. The DAU can simultaneously detect multiple carriers and their corresponding time slots to uniquely identify the LTE user. The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU.

[0062] Referring next to FIG. **11**, a still further an alternative embodiment of the present invention may be understood. Additional description related to this alternative embodiment is provided in U.S. patent application Ser. No. 13/211,247, filed on Aug. 16, 2011, the disclosure of which is hereby incorporated by reference in its entirety for all purposes. In the embodiment of FIG. **11**, a first composite signal enters a first DAU **1100** at that DAU's RF input port from a base station **1105**, and a second composite downlink input signal from, e.g., a second base station **1110** belonging to a different wireless operator enters DAU **1115** at that second DAU's RF input port. DAU **1100** directly supports two rings **1120** and **1125**. DAU **1115** directly supports two rings **1130** and **1135**, and a ring **1140** is shared between DAU **1100** and DAU **1105**. Each of the rings comprises daisy-chained DRU's generally indicated at **1145** and connected via, for example, fiber optic links. 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 **1145** on ring **1140** because DAU **1100** and DAU **1105** are daisy-chained through the fiber optic cable **1140**. This embodiment provides an example of a neutral host wireless system, where multiple wireless operators share a common infrastructure comprised of DAU **1100**, DAU **1115**, and DRU's **1145**. All the previously mentioned features and advantages accrue to each of the two wireless operators. It will further be appreciated that, while FIG. **11** 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 FIG. **15**, below.

[0063] Referring next to FIG. **12**, an alternative embodiment of the present invention may be better understood. 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 **1202**, again under the control of a NOC (not shown), is associated with a base station **1201** and in turn interfaces with three DRU's **1203**, **1204** and **1205**. A user **1206** with a mobile device is provided relatively uniform coverage throughout the area covered by the three DRU's.

[0064] Referring next to FIG. **13**, a still further alternative embodiment may be better appreciated. The input frequency bands **1305-1330** (here denoted as six frequency bands at 700, 800, 850, 1900, 2100 and 2600 MHz) are input into the DAU **1300** 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 DRU**1**-DRU**60**, daisy-chained along three separate rings **1335**, **1340** and **1345** 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.

[0065] Referring next to FIG. **14**, the software embedded in the DAU and DRU, which controls the operation of keys functions of these devices, can be better understood. In particular, the DAU embedded software control module **1400** comprises a DAU Management Control Module **1405** and a DAU monitoring module **1410**. The DAU Management Control Module **1405** communicates with the NOC **1415**, and also the DAU monitoring module **1410**. 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 **1415** 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.

[0066] 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 **1420** 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.

[0067] In turn, the DRU Management Control module **1425** within the DRU Embedded Software Control Module sets the individual parameters of all the DRU Digital Up-Converters **1430** 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 **1435** 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 **1440**, which communicates with a DRU Pilot Beacon **1445**.

[0068] Referring next to FIG. **15**, 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 **1500**A-**1500***n* are each associated with one of DAU's **1505**A-n. The DAU's are daisy-chained, and each DAU communicates with one or more daisy-chains **1510**A-**1510***m* 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.

[0069] 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 infor-

mation 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 **1415**. 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.

[0070] It is also understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

What is claimed is:

1. A network comprising:

a first base transceiver station (BTS) operable to provide a first signal including a plurality of first carriers;

a second BTS operable to provide a second signal including a plurality of second carriers;

a set of one or more digital access units (DAUs), each of the one or more DAUs being coupled to at least one of the first BTS or the second BTS; and

a set of one or more digital remote units (DRUs), each of the DRUs being coupled to one of the one or more DAUs and operable to broadcast the first signal or the second signal.

2. The network of claim **1** wherein the first BTS is associated with a first infrastructure supplier and the second BTS is associated with a second infrastructure supplier.

3. The network of claim **2** wherein the first infrastructure supplier and the second infrastructure supplier are a same infrastructure supplier.

4. The network of claim **1** wherein the one or more BTSs provide the signal including the plurality of carriers using differing broadcast protocols.

5. The network of claim **4** wherein the different broadcast protocols comprise at least one of CDMA or WCDMA.

6. The network of claim **4** wherein the different broadcast protocols comprise LTE.

7. The network of claim **1** wherein the one or more DAUs comprise a plurality of DAUs coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

8. The network of claim **7** wherein the one or more DAUs comprise a plurality of DAUs coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

9. The network of claim **1** wherein the one or more DRUs comprise a plurality of DRUs connected in a daisy chain configuration.

10. The network of claim **1** wherein the one or more DRUs comprise a plurality of DRUs connected to the one or more DAUs in a star configuration.

11. The network of claim **1** wherein each of the one or more DAUs are coupled to at least one of the first BTS or the second BTS via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

12. A method of operating a virtual DAS network, the method comprising:

receiving a first signal including a first plurality of carriers from a first BTS;

receiving a second signal including a second plurality of carriers from a second BTS;

routing the first and second signals to a first DRU; and

routing the first and second signals to a second DRU.

13. The method of claim **12** further comprising:

associating the first and second signals with one of a plurality of DRUs based on a geographic usage pattern, the plurality of DRUs comprising the first DRU and the second DRU.

14. The method of claim **12** wherein routing the first and second signals to the second DRU comprises routing the first a second signals through a plurality of DAUs.

15. The method of claim **12** wherein the first BTS is associated with a first infrastructure supplier and the second BTS is associated with a second infrastructure supplier.

16. The method of claim **15** wherein the first infrastructure supplier and the second infrastructure supplier are a same infrastructure supplier.

17. A method of operating a virtual DAS network, the method comprising:

receiving a first signal from a first BTS;

receiving a second signal from a second BTS;

routing the first signal to a first DRU;

routing the second signal to a second DRU;

receiving a third signal from the first BTS; and

routing the third signal to the second DRU.

18. The method of claim **17** further comprising:

repeatedly assigning the first DRU to one of a plurality of BTSs, the plurality of BTSs including the first BTS and the second BTS.

19. The method of claim **18** wherein the first DRU is assigned at least partly in an attempt to evenly distribute combined BTS resources across DRUs in the network.

20. The method of claim **17** wherein routing the third signal to the second DRU comprises routing the third signal through a plurality of DAUs.

21. The method of claim **17** wherein the first BTS is associated with a first infrastructure supplier and the second BTS is associated with a second infrastructure supplier.

22. The method of claim **21** wherein the first infrastructure supplier and the second infrastructure supplier are a same infrastructure supplier.

* * * * *

Electronic Patent Application Fee Transmittal

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Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Stephen A. Mao/Brian Kanter
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Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
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Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
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First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		AMD_0882666.pdf	89671 c5c772aa9379d0a2921ae03c845d46c4000614db	yes	7
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment/Req. Reconsideration-After Non-Final Reject		1	1	
	Claims		2	4	
	Applicant Arguments/Remarks Made in an Amendment		5	7	
Warnings:					
Information:					
2	Extension of Time	EOT_0882666_68575940_1.pdf	164395 bb8287c94c815eae5c1c2d5c19ecb91272ee3a52	no	2
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	ExhibitA.pdf	7529960 b0d2e6133e1447692f7d477f9b4b9b5f40f9f9cb	no	22
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	ExhibitB.pdf	7679118 0c2a700947504b13a4061fcc58c14359669d784b	no	24
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	30810 1acdd2cf3ec5cfeb6f45f24f4f8e2475e7a6819b	no	2

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

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

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

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/950,160	Filing Date 07/24/2013	☐ To be Mailed

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APPLICATION AS FILED – PART I

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☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
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☐ 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 07/05/2016

	(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))	* 19	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 2	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
/JERMAINE MINOR/

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.

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	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-103900US-0882666

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

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[5]
	1.	Written Opinion for Singapore application no. 11201500770U issued January 13, 2016, 6 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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	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2641
	Examiner Name	Majid Syed
	Attorney Docket Number	091172-103900US-0882666

[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	/Stephen A. Mao/	Date (YYYY-MM-DD)	2016-02-10
Name/Print	Stephen A. Mao	Registration Number	73418

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:	24882864
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	091172-103900US-0882666
Receipt Date:	10-FEB-2016
Filing Date:	24-JUL-2013
Time Stamp:	17:52:26
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_103900US_68189271_1.pdf	145335 0e0d40d4dc19031a46b65b416feb91f6a18232d9	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	103900SG_WO_01132016_6pp.pdf	230548 d5eb9d8545cbed3ea9b84f2330c46a4462ea2a42	no	6
Warnings:					
Information:					
		Total Files Size (in bytes):	375883		

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 February 10, 2016.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 091172-103900US-0882666
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	INFORMATION DISCLOSURE STATEMENT
Customer No.: 20350	

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. Copies of the references in compliance with the requirements of 37 CFR § 1.98(a)(2) are enclosed.

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.

I hereby certify 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.

Specifically, we certify that the references were cited in a Written Opinion dated January 13, 2015, in Singapore Application No. 11201500770U, which is not more than thirty (30) days 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,

/Stephen A. Mao/

Stephen A. Mao
Registration No. 73418

KILPATRICK TOWNSEND & STOCKTON LLP
Two Embarcadero Center, Eighth Floor
San Francisco, California 94111-3834
Tel: 650-326-2400
Attachments

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	91172-882666(103900US)	6371

20350 7590 02/02/2016

KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

EXAMINER	
SYED, MAJID	

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
02/02/2016	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
jlhice@kilpatrick.foundationip.com

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *10/30/2015*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1,2,4-11 and 13-21* 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) *1,2,4-11 and 13-21* 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 *7/24/2103* 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: _____.

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

DETAILED ACTION

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 10/30/2015 has been entered. Claims 3 and 12 are cancelled.

Response to Arguments

Applicant's arguments, see "…the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs …", filed 10/30/2015, with respect to the rejection(s) of claim(s) 1, 5 and claims 2, 4, 6-11, and 13-21, which depend from claims 1 and 5, under 102(e) , have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Lee and Sombrutzki.

Claim Rejections - 35 USC § 103

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

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

Claims 1-2, 4-11, 13-21 are rejected under 35 U.S.C. 103 as being unpatentable over Lee; Albert S. et al. (US 2013/0128810 A1: hereinafter "Lee") in view of Sombrutzki; Robert et al. (US 2011/0122788 A1 hereinafter: "Sombrutzki").

Consider claim 1, Lee discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals)**; and a traffic monitoring unit coupled to each of the

plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …, further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ..., therefore a traffic monitoring module coupled to each of the plurality of DAUs)**;

Lee does not teach traffic monitoring unit configured to determine number of users per DRU, in the same field of endeavor, Sombrutzki teaches, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs **(Fig. 5 with Traffic Aware APS, …, as explained in [0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …traffic changes can be represented by the number of users connected to the access points that comprise the system …, therefore, traffic aware as with traffic monitoring unit, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU).**

Lee discusses one or more digital access units (DAUs), each of the one or more DAUs being coupled to at least one of the first BTS or the second BTS and Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs). It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the concept of distributed antennas with channel assignment, so that the system can

react to changes in the traffic conditions because dynamic change in number of users, applications in use by users, and interference levels.

Consider claim 2, Lee discloses, the system of claim 1 wherein each BTS comprises a plurality of sectors (**Fig. 9. Items 1, 2, 3, therefore BTS comprises a plurality of sectors).**

Consider claim 4, Lee discloses, the system of claim 2 further comprising the network optimization goal comprising a percentage of users associated with each of the plurality of sectors **(in [0069] discloses, 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,…, therefore users percentage assignment in sectors for the purpose of performance optimization)**.

Consider claim 5 (currently amended), Lee discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, , therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, , therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to

transport signals between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals**);

coupled to each of the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ..., therefore a traffic monitoring module coupled to each of the plurality of DAUs).**

Lee does not teach traffic monitoring unit configured to determine number of users per DRU, in the same field of endeavor, Sombrutzki teaches, and a traffic monitoring unit external to and wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs **(Fig. 5 with Traffic Aware APS, …, as explained [0028], … One part is responsible for the traffic aware RF channel assignment that is to associate to each access point a RF channel depending on the network traffic situation, …, further in [0032], …traffic changes can be represented by the number of users connected to the access points that comprise the system …, therefore, traffic aware DAU as with external traffic monitoring unit, therefore, the traffic monitoring unit is configured to determine at least one of a number of users per DRU).**

Lee discusses one or more digital access units (DAUs), each of the one or more DAUs being coupled to at least one of the first BTS or the second BTS and Sombrutzki discusses clients (UE) assignments to the best channels (antennas/DAUs). It would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to combine the concept of distributed antennas with channel assignment, so that the system can react to changes in the traffic conditions because dynamic change in number of users, applications in use by users, and interference levels.

Consider claim 6 (currently amended), Lee discloses, the system of claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., therefore a traffic monitoring unit is external to the plurality of DAUs).**

Consider claim 7 (currently amended) , Lee discloses, the system of claim 1 wherein the one or more traffic monitoring unit is provided as a component of each of the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ...,therefore one or more traffic monitoring module coupled to each of the plurality of DAUs).**

Consider claim 8 (currently amended), Lee discloses, the system of claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs **(in Fig. 15, plurality DRUs externally coupled to DAU and in Fig. 14, item 1410 traffic monitoring component external to plurality of DRUs, further explained in [0067] In turn, the DRU Management Control module 1425 within the DRU Embedded Software Control Module sets the individual parameters of all the DRU Digital Up-Converters 1430 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 1435 to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs, …., therefore resource configuration for the purpose of traffic monitoring in each DRU).**

Consider claim 9 (currently amended), Lee discloses, the system of claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of **DRUs (Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ..., therefore a traffic monitoring module coupled to each of the plurality of DAUs).**

Consider claim 10 (currently amended), Lee discloses, the system of claim 5 wherein the monitoring unit is external to the plurality of BTSs **(Fig. 14, item 1410 further explained in**

[0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ..., therefore monitoring unit is external to the plurality of BTSs) and coupled to each of the plurality of BTSs **(Fig. 15 item 1505A as DAU is coupled to item 1500A as BTS, therefore plurality of BTSs)**.

Consider claim 11, Lee discloses, the system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit **(in [0069] discloses, 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 1415…, therefore network optimization processor coupled to traffic monitoring unit)**.

Consider claim 13, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(Fig. 10 further explained, in [0060] discloses, the DAU**

communicates with a Network Operation Center (NOC) via a Ethernet connection, …, therefore DAUs coupled via Ethernet cable).

Consider claim 14, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight 3 Link, Wireless Link, or Satellite Link **(Fig. 5 item Ethernet CAT-5/6, 500A as Fiber, therefore, DRUs coupled with DAUs via fiber or ethernet cable at least)**.

Consider claim 15, Lee discloses, the system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration …., therefore DRUs are daisy chained)**.

Consider claim 16, Lee discloses, the system of claim 5 wherein the plurality of DRUs are connected to the DAUs in a star configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration and/or a star configuration, therefore, DRUs in star topology)**.

Consider claim 17, Lee discloses, the system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(in [0007] discloses, .., Each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, e.g., via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link, therefore all physical medium, therefore DAUs communicating with variety of access links)**.

Consider claim 18, Lee discloses, the system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs **(Fig. 11, DRUs 1145 connected to DAUs 1100 & 1115, therefore DRUs connected to DAUs in loop)**.

Consider claim 19 (currently amended), Lee discloses, the system of claim 5 wherein a single DAU port is connected to the one or more BTSs **(in [0007] discloses, …, each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, …, therefor DAU is connected to plurality of BTSs)**.

Consider claim 20 (New), Lee discloses, the system of claim 1 wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS **(in [0069] discloses, 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 1415, …., therefore Fig. 14, items 1405 & 1410 configured to analyze Key Performance Indicators (KPIs) of the DAS).**

Consider claim 21 (New), Lee discloses, The system of claim 1 wherein the traffic monitoring unit is configured to analyze Quality of Service (QoS) values of the DAS **([0065], …, 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, ..., therefore**

throughput monitoring module configured to analyze Quality of Service (QoS) values of the DAS for the purpose of capacity allocation for improved throughput as a QoS attribute).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)270-0524. The examiner can normally be reached on Mon-Fri 7 am to 4 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire can be reached on 571-272-4186. 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.

/MAJID SYED/
Examiner, Art Unit 2641

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 2641

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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-2011/0122788 A1	05-2011	Sombrutzki; Robert	H04W16/10	370/252
*	B	US-2013/0128810 A1	05-2013	Lee; Albert S.	H04W84/042	370/328
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	Art Unit
	MAJID SYED	2641

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

SEARCH NOTES		
Search Notes	Date	Examiner
See EAST search history.	01-29-2015	MS
Distances between APs	01-12-2016	MS

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

/MAJID SYED/ Examiner.Art Unit 2641	

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BIB DATA SHEET

CONFIRMATION NO. 6371

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/950,160	07/24/2013 RULE	455	2641	91172-882666(103900US)

APPLICANTS
DALI SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS;

INVENTORS
Shawn Patrick Stapleton, Burnaby, CANADA;
Seyed Amin Hejazi, Burnaby, CANADA;

**** CONTINUING DATA ***************************
This appln claims benefit of 61/678,016 07/31/2012

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
08/07/2013

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and Acknowledged /MAJID SYED/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CANADA	11	19	2

ADDRESS

KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834
UNITED STATES

TITLE

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

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

BIB (Rev. 05/07).

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L21	2814	distance between base station	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
L22	2	l21 and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:45
L23	2	Distance between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:46
L24	1	Distance$s between DRUs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:48
L25	58	Distance$s between APs	US-PGPUB; USPAT	ADJ	ON	2016/01/13 06:49
S1	46571	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45
S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49

S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S25	1	"7098805".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:38
S26	1	"20140244149"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 10:52
S27	1	"8611260".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:07
S28	1	"20120270553"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:10
S29	1	"8467397".pn.	US-PGPUB; USPAT	ADJ	ON	2016/01/12 11:13
S30	1	"20130114963"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:37
S31	206375	DAS	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:43
S32	48659	S31 and dru$s	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S33	0	S32 and number of users	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S34	238	DAS and DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:44
S35	0	S34 and number near5 user per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S36	0	S34 and number near5 per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:46
S37	1	S34 and per DRU	US-PGPUB; USPAT	ADJ	ON	2016/01/12 14:47
S38	2	"20110122788"	US-PGPUB; USPAT	ADJ	ON	2016/01/12 17:16

EAST Search History (Interference)

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1/ 13/ 2016 7:26:38 AM
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015	06/01/2015	01/13/2016						
	1	✓	✓	✓						
	2	✓	✓	✓						
	3	✓	-	-						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	✓	✓	✓						
	12	✓	✓	✓						
	13	✓	✓	-						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	✓	✓	✓						
	20		✓	✓						
	21		✓	✓						

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Request For Continued Examination (RCE) Transmittal

Address to:
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P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/950,160
Filing Date	July 24, 2013
First Named Inventor	Shawn Patrick Stapleton
Art Unit	2641
Examiner Name	Majid Syed
Attorney Docket Number	91172-882666(103900US)

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. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 C.F.R. 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
ii. ☐ Other _____

b. . ☒ Enclosed

i. ☒ Amendment/Reply
ii ☐ Affidavit(s)/Declaration(s)
iii. ☐ Information Disclosure Statement (IDS)
iv. ☐ Other _____

2. Miscellaneous

a. ☐ Suspension of action on the above-identified application is requested under 37 C.F.R. 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 C.F.R. 1.17(i) required)

b. ☐ Other _____

3. **Fees** The RCE fee under 37 C.F.R. 1.17(e) is required by 37 C.F.R. 1.114 when the RCE is filed.

a. ☒ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 20-1430.

i. ☒ RCE fee required under 37 C.F.R. 1.17(e)
ii. ☒ Extension of time fee (37 C.F.R. 1.136 and 1.17)
iii. ☐ Other _____

b. ☐ Check in the amount of $ _____ enclosed

c. ☒ Payment by credit card (Form PTO-2038 enclosed)

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

SIGNATURE OF APPLICANT, ATTORNEY OR AGENT REQUIRED			
Signature	/Stephen A. Mao/	Date	10-30-2015
Name (Print /Type)	Stephen A. Mao	Registration No.	73418

CERTIFICATE OF MAILING OR TRANSMISSION			
I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.			
Signature			
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This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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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 October 30, 2015.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Brian Kanter/

PATENT
Attorney Docket No.: 91172-882666(103900US)
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	AMENDMENT UNDER 37 CFR § 1.116 EXPEDITED PROCEDURE
Customer No.: 20350	

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

Commissioner:

In response to the Final Office Action mailed July 1, 2015 on the above-referenced application, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 5 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. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring ~~module~~ unit coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs~~; and~~

~~a network optimization goal and optimization algorithm~~.

2. (Currently Amended) The system of claim 1 wherein ~~the Base Transceiver Station~~ each BTS comprises a plurality of sectors ~~small cells~~.

3. (Canceled)

4. (Currently Amended) The system of claim 2 ~~1 wherein the wherein the~~ further comprising a network optimization goal ~~comprises~~ comprising a percentage of users associated with each of [[a]] the plurality of sectors.

5. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

a traffic monitoring unit external to and coupled to each of the plurality of DAUs, wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs.

6. (Currently Amended) The system of ~~claim 5~~ claim 1 wherein the traffic monitoring unit is external to the plurality of DAUs.

7. (Currently Amended) The system of ~~claim 5~~ claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DAUs.

8. (Currently Amended) The system of ~~claim 5~~ claim 1 wherein the traffic monitoring unit is external to the plurality of DRUs ~~and coupled to each of the plurality of DRUs~~.

9. (Currently Amended) The system of ~~claim 5~~ claim 1 wherein the traffic monitoring unit is provided as a component of each of the plurality of DRUs.

10. (Previously Presented) The system of claim 5 wherein the traffic monitoring unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Canceled).

13. (Currently Amended) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

14. (Currently Amended) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Currently Amended) The system of claim 5 wherein the plurality of DRUs are connected in a daisy chain configuration.

16. (Currently Amended) The system of claim 5 wherein the plurality of DRUs are connected to the plurality of DAUs in a star configuration.

17. (Currently Amended) The system of claim 5 wherein the plurality of DAUs are connected to the one or more BTSs via at least one of [[a]] an Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Currently Amended) The system of claim 5 wherein the plurality of DRUs are connected in a loop to a plurality of DAUs.

19. (Currently Amended) The system of claim 5 wherein a single DAU port is connected to the one or more BTSs ~~Base Transceiver Stations~~.

20. (Currently Amended) The system of claim 1 wherein the traffic monitoring ~~module~~ unit is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (Currently Amended) The system of claim 1 wherein the traffic monitoring ~~module~~ unit is configured to analyze Quality of Service (QoS) values of the DAS.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 1-2 and 4-11 and 13-21 will be pending in this application. Claims 1-2, 4-9, and 13-21 have been amended, claim 12 has been canceled, and no claims have been added. No new matter is added. Based on the following remarks, Applicant respectfully requests reconsideration and allowance of the pending claims.

Claim Rejections - 35 USC § 102(e)

Claims 1-2, 4-19, are rejected under 35 U.S .C. 102(e) as allegedly being anticipated by US 2013/0128810 A1 in the name of Lee; Albert S. et al. (hereinafter "Lee").

Claim 1 has been amended to recite a system that includes a traffic monitoring unit, "wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs," among other claim elements. Applicants respectfully submit that the cited reference does not teach or suggest each and every claim element of amended claim 1.

As disclosed in the specification of the present invention, a DAS system, illustrated in FIG. 1 and reproduced below for the Examiner's convenience, includes a plurality of DAUs (i.e., DAU 1, DAU 2, and DAU 3) and a plurality of DRUs (i.e., DRU 1 through DRU 21). In the embodiment illustrated in FIG. 1, a traffic monitoring unit 121 is coupled to each of the DAUs: DAU 1, DAU 2, and DAU 3. As discussed in at least paragraphs [0039] and [0040] of the present specification, the traffic monitoring unit 121 tracks the traffic load at each DAU in the network. Traffic monitoring unit 121 can monitor traffic in the DAS system to determine the number of users on each DAU. (Specification at paragraph [0040]). Additionally, traffic monitoring unit 121 can determine the spatial distance between the various DRUs. (Specification at paragraph [0059] and FIG. 10).

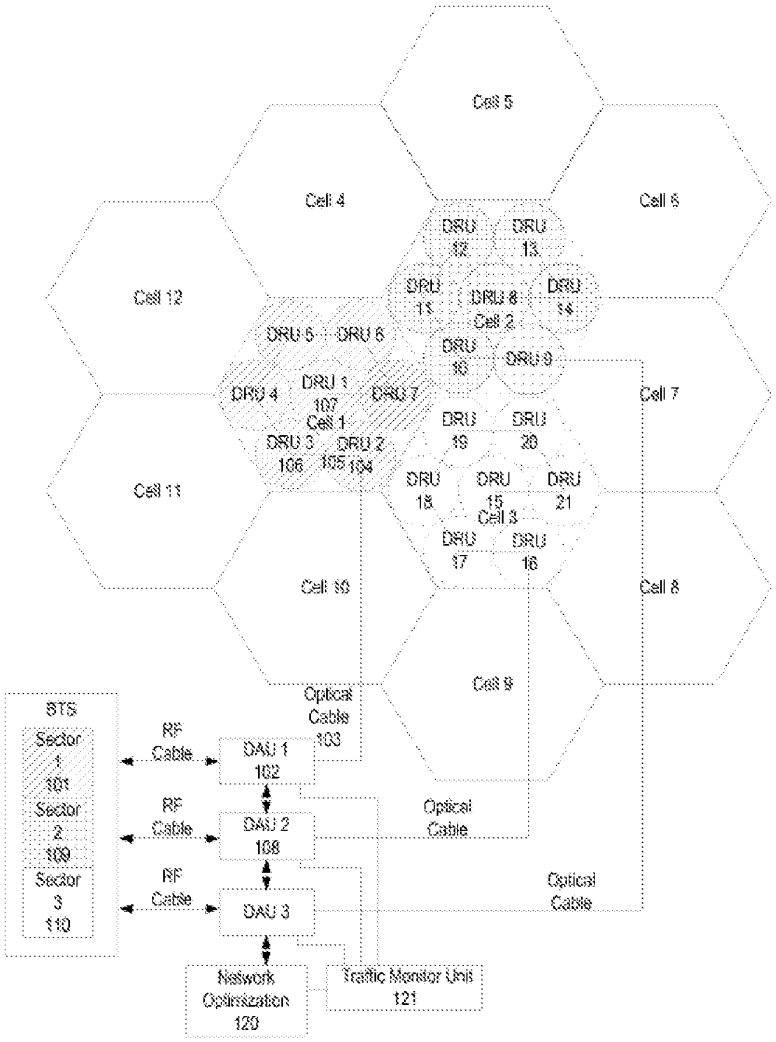

FIG. 1

In contrast, Lee, which is commonly assigned, discusses a network containing a base transceiver station (BTS) and a set of one or more digital access units (DAUs). (Lee at paragraph [0005]). A set of digital remote units (DRUs) may be included in the network, each of the DRUs being coupled to one of the one or more DAUs. *Id*. A DAU embedded software module 1400 may be embedded within a DAU. (Paragraph [0065]). The DAU embedded software module 1400 may include a DAU management control module 1405 that communicates

with a Network Operation Center (NOC). The NOC monitors DAUs in the DAS operation. (Lee at paragraph [0065]).

Lee does not teach or suggest a traffic monitoring unit, "wherein the traffic monitoring unit is configured to determine at least one of a number of users per DRU or a distance between DRUs," among other claim elements, as recited in amended claim 1. Therefore, for at least these reasons, claim 1 is in condition for allowance.

Independent claim 5 recites elements similar to claim 1. Therefore, claim 5 is in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

Claims 2, 4, 6-11, and 13-21, which depend from claims 1 and 5, are in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

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.

Respectfully submitted,

/Stephen A. Mao/
Stephen A. Mao
Registration No. 73,418

KILPATRICK TOWNSEND & STOCKTON LLP
SMAO/kep
67502077v.4

Electronic Patent Application Fee Transmittal	
Application Number:	13950160
Filing Date:	24-Jul-2013
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Stephen A. Mao/Brian Kanter
Attorney Docket Number:	91172-882666(103900US)
Filed as Small Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	2251	1	100	100
Miscellaneous:				
Request for Continued Examination	2801	1	600	600
		Total in USD ($)		**700**

Electronic Acknowledgement Receipt	
EFS ID:	23952027
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Stephen A. Mao/Brian Kanter
Filer Authorized By:	Stephen A. Mao
Attorney Docket Number:	91172-882666(103900US)
Receipt Date:	30-OCT-2015
Filing Date:	24-JUL-2013
Time Stamp:	20:41:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$700
RAM confirmation Number	6844
Deposit Account	201430
Authorized User	MAO, STEPHEN
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)	
Charge any Additional Fees required under 37 C.F.R. Section 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	Request for Continued Examination (RCE)	Transmittal67873733_1.pdf	127442 aed88471c475a5bba9aeafe779ae6ce33899839a	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2		FINAL67502077_4.pdf	156781 2e87880f0249affe495e4654ca3dced1e969764b	yes	7

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment Submitted/Entered with Filing of CPA/RCE	1	1
Claims	2	4
Applicant Arguments/Remarks Made in an Amendment	5	7

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32681 ec9787c67c6e4cb55cd7d2d85572fc56a2eb0ac4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	316904		

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 13/950,160	Filing Date 07/24/2013	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT **10/30/2015**

	(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))	* 19	Minus	** 20	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 2	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
/TARA WITCHER/

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
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	91172-882666(103900US)	6371

20350 7590 07/01/2015

KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

EXAMINER	
SYED, MAJID	

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
07/01/2015	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
jlhice@kilpatrick.foundationip.com

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	13/950,160	STAPLETON ET AL.	
	Examiner	Art Unit	
	MAJID SYED	2641	

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

(1) *MAJID SYED*.

(2) *NATHAN MITCHELL*.

(3) *CRAIG LARGENT, Ph.D*.

(4) _____.

Date of Interview: *13 May 2015*.

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

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

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

Claim(s) discussed: *1*.

Identification of prior art discussed: *Lee*.

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

Applicant's represenative addressed perceived differences between the application and the prior art. Examiner further explained his view of the prior art. Applicant's representative discussed possibly amending the claims to emphasize traffic monitoring. No specific amendment was discussed. No agreement was reached. Examiner indicated further search and/or consideration would occur after the response is 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

/MAJID SYED/ Examiner, Art Unit 2641	

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.

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *03* 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 *05/26/2015*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-21* is/are pending in the application.

5a) Of the above claim(s) *3* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-21* 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

This is in response to applicant's amendment/response filed on May 26th, 2015, which has been entered and made of record. Claims 1, 5-10, and 19 have been amended, all dependent claims are therefore amended, and claim 3 has been canceled, and claims 20 and 21 have been added.

Response to Arguments

Applicant's arguments filed on May 26th, 2015 have been fully considered but they are not persuasive.

Applicant states, Lee does not teach or suggest "a traffic monitoring module coupled to each of the plurality of DAUs,…" . Refer to Fig. 14, monitoring module 1410, Lee discloses in [0066], The DAU Monitoring module, in addition to other functions, detects which carriers and corresponding time slots are active for each DRU,…, therefore, a data traffic monitoring component in the DAU for the purpose of monitoring traffic in addition to OAM (operation administration and management) signaling alarms monitoring. Lee further in [0027] discloses, …, wireless network operators may attempt to ensure that cell sites covering the stadiums, highways or freeways, and/or cafeterias or food courts have sufficient wireless capacities to handle the peak usage time period. Therefore data traffic monitoring functionality in each DAU for the purpose of KPI and QoS determination and actions upon trigger of defined thresholds.

To meet the newly amended claim limitations, a new rejection is made. See below.

Claim Rejections - 35 USC § 102

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 –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-2, 4-19, are rejected under 35 U.S.C. 102(e) as being anticipated by Lee; Albert S. et al. (US 2013/0128810 A1: hereinafter "Lee").

Consider claim 1, Lee discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs),the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to transport signals

between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals)**; a traffic monitoring module coupled to each of the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …, further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ..., therefore a traffic monitoring module coupled to each of the plurality of DAUs)**; and a network optimization goal and optimization algorithm **(in [0069] discloses, …, [0069] an algorithm operating within the DAU Monitoring module, …, therefore algorithm for the purpose of optimization)**.

Consider claim 2, Lee discloses, the system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells **(Fig. 9. Items 1, 2, 3, therefore BTS comprises a plurality of small cells).**

Claim 3. Canceled.

Consider claim 4, Lee discloses, the system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors **(in [0069] discloses, 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,…, therefore users percentage assignment in sectors for the purpose of performance optimization).

Consider claim 5 (currently amended), Lee discloses, a system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, , therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, , therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals)**; and a traffic monitoring unit coupled to each of the plurality of DAUs

(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ...,therefore a traffic monitoring module coupled to each of the plurality of DAUs).

Consider claim 6 (currently amended), Lee discloses, the system of claim 5 wherein the traffic monitoring unit is external to the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., therefore a traffic monitoring unit is external to the plurality of DAUs).**

Consider claim 7 (currently amended) , Lee discloses, the system of claim 5 wherein the one or more traffic monitoring unit is provided as a component of each of the plurality of DAUs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ...,therefore one or more traffic monitoring module coupled to each of the plurality of DAUs).**

Consider claim 8 (currently amended), Lee discloses, the system of claim 5 wherein the traffic monitoring unit is external to the plurality of DRUs and coupled to each of the plurality of DRUs **(in Fig. 15, plurality DRUs externally coupled to DAU and in Fig. 14, item 1410 traffic monitoring component external to plurality of DRUs, further explained in [0067] In turn, the DRU Management Control module 1425 within the DRU Embedded Software Control Module sets the individual parameters of all the DRU Digital Up-Converters 1430 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 1435 to enable or disable specific radio resources from being transmitted by a particular DRU or group of DRUs, …., therefore resource configuration for the purpose of traffic monitoring in each DRU).

Consider claim 9 (currently amended), Lee discloses, the system of claim 5 wherein the traffic monitoring unit is provided as a component of each of the plurality of **DRUs (Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is made to the DAU, ...,therefore a traffic monitoring module coupled to each of the plurality of DAUs).**

Consider claim 10 (currently amended), Lee discloses, the system of claim 5 wherein the monitoring unit is external to the plurality of BTSs **(Fig. 14, item 1410 further explained in [0065], …, In particular, the DAU embedded software control module 1400 comprises a DAU Management Control Module 1405 and a DAU monitoring module 1410, …., further in [0060] ... in conjunction with the NOC can identify the corresponding Base Transceiver Station (BTS) where the user has placed the call, ...further in [0061], ..., The DAU has a running data base that identifies the carrier frequencies and time slot radio signature for the respective RRU. This information can be retrieved from the NOC once a request is**

made to the DAU, ..., therefore monitoring unit is external to the plurality of BTSs) and coupled to each of the plurality of BTSs **(Fig. 15 item 1505A as DAU is coupled to item 1500A as BTS, therefore plurality of BTSs)**.

Consider claim 11, Lee discloses, the system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit **(in [0069] discloses, 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 1415…, therefore network optimization processor coupled to traffic monitoring unit)**.

Consider claim 12, Lee discloses, the system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal (in [0069] discloses, …,. **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 1415…, therefore threshold as optimization goal).**

Consider claim 13, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(Fig. 10 further explained, in [0060] discloses, the DAU**

communicates with a Network Operation Center (NOC) via a Ethernet connection, …, therefore DAUs coupled via Ethernet cable).

Consider claim 14, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight 3 Link, Wireless Link, or Satellite Link **(Fig. 5 item Ethernet CAT-5/6, 500A as Fiber, therefore, DRUs coupled with DAUs via fiber or ethernet cable at least)**.

Consider claim 15, Lee discloses, the system of claim 5 wherein the DRUs are connected in a daisy chain configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration …., therefore DRUs are daisy chained)**.

Consider claim 16, Lee discloses, the system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration and/or a star configuration, therefore, DRUs in star topology)**.

Consider claim 17, Lee discloses, the system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(in [0007] discloses, .., Each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, e.g., via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link, therefore all physical medium, therefore DAUs communicating with variety of access links)**.

Consider claim 18, Lee discloses, the system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs **(Fig. 11, DRUs 1145 connected to DAUs 1100 & 1115, therefore DRUs connected to DAUs in loop)**.

Consider claim 19 (currently amended), Lee discloses, the system of claim 5 wherein a single DAU port is connected to the one or more Base Transceiver Stations **(in [0007] discloses, …., each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, …, therefor DAU is connected to plurality of BTSs)**.

Consider claim 20 (New), Lee discloses, the system of claim 1 wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS **(in [0069] discloses, 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 1415, …., therefore Fig. 14, items 1405 & 1410 configured to analyze Key Performance Indicators (KPIs) of the DAS).**

Consider claim 21 (New), Lee discloses, The system of claim 1 wherein the traffic monitoring module is configured to analyze Quality of Service (QoS) values of the DAS **([0065], …, 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, ..., therefore**

throughput monitoring module configured to analyze Quality of Service (QoS) values of the DAS for the purpose of capacity allocation for improved throughput as a QoS attribute).

Conclusion

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

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)-270-0524. The examiner can normally be reached on Monday-Thursday 8:00 - 4:00 EST. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire be reached on (571)-270-5144. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/MAJID SYED/
Examiner, Art Unit 2641

/NATHAN MITCHELL/
Primary Examiner, Art Unit 2641

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	13/950,160	STAPLETON ET AL.	
	Examiner	Art Unit	
	MAJID SYED	2641	

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

(1) *MAJID SYED*.

(2) *NATHAN MITCHELL*.

(3) *CRAIG LARGENT, Ph.D*.

(4) _____.

Date of Interview: *13 May 2015*.

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

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

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

Claim(s) discussed: *1*.

Identification of prior art discussed: *Lee*.

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

Applicant's represenative addressed perceived differences between the application and the prior art. Examiner further explained his view of the prior art. Applicant's representative discussed possibly amending the claims to emphasize traffic monitoring. No specific amendment was discussed. No agreement was reached. Examiner indicated further search and/or consideration would occur after the response is 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

/MAJID SYED/ Examiner, Art Unit 2641	

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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015	06/01/2015							
	1	✓	✓							
	2	✓	✓							
	3	✓	-							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20		✓							
	21		✓							

I hereby certify that this correspondence is being filed via EFS-Web with the United States Patent and Trademark Office on May 26, 2015.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Kristina Alvarez/
Kristina Alvarez

PATENT
Attorney Docket No.: 91172-882666-103900US
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: 6371
Shawn Patrick Stapleton et al.	Examiner: Majid Syed
Application No.: 13/950,160	Technology Center/Art Unit: 2641
Filed: July 24, 2013	
For: OPTIMIZATION OF TRAFFIC LOAD IN A 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 February 24, 2015, please enter the following amendments and remarks:

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

Remarks/Arguments begin on page 5 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. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with a plurality of Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

~~a plurality of Base Transceiver Stations (BTS);~~

a ~~plurality of~~ traffic monitoring ~~modules~~ module coupled to each of the plurality of DAUs; and

a network optimization goal and optimization algorithm.

2. (Original) The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

3. (Canceled)

4. (Original) The system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors.

5. (Currently Amended) A system for dynamically routing signals in a Distributed Antenna System (DAS) operable to communicate with one or more Base Transceiver Stations (BTSs), the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs; and

~~one or more Base Transceiver Stations (BTSs); and~~

~~one or more~~ a traffic monitoring ~~units~~ unit coupled to each of the plurality of DAUs.

6. (Currently Amended) The system of claim 5 wherein the ~~one or more~~ traffic monitoring ~~units~~ unit is external to the plurality of DAUs ~~and coupled to each of the plurality of DAUs~~.

7. (Currently Amended) The system of claim 5 wherein the ~~one or more~~ traffic monitoring ~~units~~ unit is ~~comprise a plurality of traffic monitoring units each~~ provided as a component of each of the plurality of DAUs.

8. (Currently Amended) The system of claim 5 wherein the ~~one or more~~ traffic monitoring ~~units~~ unit is external to the plurality of DRUs and coupled to each of the plurality of DRUs.

9. (Currently Amended) The system of claim 5 wherein the ~~one or more~~ traffic monitoring ~~units~~ unit is ~~comprise a plurality of traffic monitoring units each~~ provided as a component of each of the plurality of DRUs.

10. (Currently Amended) The system of claim 5 wherein the ~~one or more~~ traffic monitoring ~~units~~ unit is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. (Original) The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. (Original) The system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal.

13. (Original) The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link

14. (Original) The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. (Original) The system of claim 5 wherein the DRUs are connected in a daisy chain configuration.

16. (Original) The system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration.

17. (Original) The system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. (Original) The system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs.

19. (Currently Amended) The system of claim 5 wherein a single DAU port is connected to [[a]] the one or more ~~plurality of~~ Base Transceiver Stations.

20. (New) The system of claim 1 wherein the traffic monitoring module is configured to analyze Key Performance Indicators (KPIs) of the DAS.

21. (New) The system of claim 1 wherein the traffic monitoring module is configured to analyze Quality of Service (QoS) values of the DAS.

REMARKS/ARGUMENTS

Upon entry of the present amendment, claims 1-2 and 4-21 will be pending in this application. Claims 1, 5-10, and 19 have been amended, claim 3 has been canceled, and claims 20 and 21 have been added. No new matter is added by the claim amendments or new claims. Based on the following remarks, Applicants respectfully request reconsideration and allowance of the pending claims.

Claims 1-2 and 4-19 are rejected under 35 U.S.C. § 102(e) as being anticipated by Lee et al. (2013/0128810).

Examiner Interview

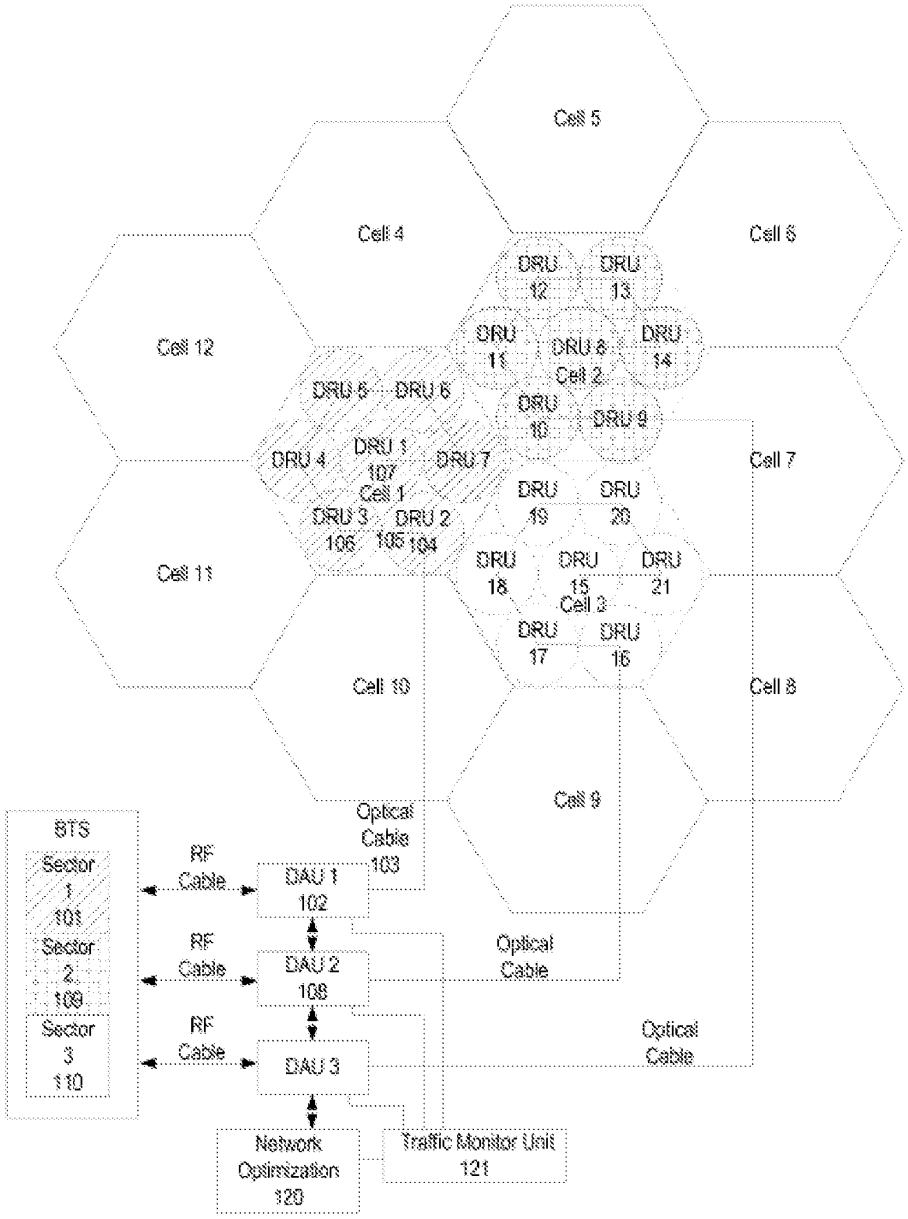
The undersigned thank Examiner Majid Syed for the helpful in-person interview conducted on May 13, 2015. During the interview, proposed amendments to the claims were discussed. It was agreed that the proposed amendments overcome the pending rejections, although further search and examiner is required. The claims in this response have been amended consistent with the proposed amendments discussed during the interview.

Claim Rejection Under 35 U.S.C. 102(e)

Claim 1 has been amended to recite a system that includes "a traffic monitoring module coupled to each of the plurality of DAUs," among other claim elements. Applicants respectfully submit that the cited reference does not teach or suggest each and every claim element of amended claim 1.

As disclosed in the specification of the present invention, a DAS system, illustrated in FIG. 1 reproduced below for the Examiner's convenience, includes a plurality of DAUs (i.e., DAU 1, DAU 2, and DAU 3) and a plurality of DRUs (i.e., DRU 1 through DRU 21). A traffic monitoring unit 121 is coupled to each of the DAUs: DAU 1, DAU 2, and DAU 3. As discussed in at least paragraphs [0039] and [0040] of the present specification, the traffic monitoring unit 121 tracks the traffic load at each DAU in the network. Traffic monitoring unit 121 can monitor traffic in the DAS system to determine the number of users on each DAU. Additionally, traffic monitoring unit 121 can analyze traffic information and traffic performance of the DAS. For instance, the traffic monitoring unit can analyze Key Performance Indicators (KPIs) as well as Quality of Service (QoS) values. (Specification at paragraph [0060]). KPI may

include information such as a number of active cells and number of users in a given DRU in a DAS system. (Specification at paragraph [0054]).



In contrast, Lee, which is commonly assigned, discusses a network containing a base transceiver station (BTS) and a set of one or more digital access units (DAUs). (Lee at paragraph [0005]). A set of digital remote units (DRUs) may be included in the network, each of the DRUs being coupled to one of the one or more DAUs. *Id*. A DAU embedded software module 1400 may be embedded within a DAU. (Paragraph [0065]). The DAU embedded

software module 1400 may include a DAU management control module 1405 that communicates with a Network Operation Center (NOC). The NOC monitors DAUs in the DAS operation. (Lee at paragraph [0065]).

Lee does not teach or suggest "a traffic monitoring module coupled to each of the plurality of DAUs," among other claim elements, as recited in amended claim 1. Therefore, for at least these reasons, claim 1 is in condition for allowance.

Independent claim 5 recites elements similar to claim 1. Therefore, claim 5 is in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

Claims 2 and 4-21, which depend from claims 1 and 5, respectively, are in condition for allowance, for at least the reasons discussed in relation to claim 1, as well as for the additional elements they recite.

CONCLUSION

In view of the foregoing, Applicants believe 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.

Respectfully submitted,

/Craig C. Largent/
Craig C. Largent
Registration No. 56,400

KILPATRICK TOWNSEND & STOCKTON LLP
CCL/SAM/ka
67047716V.1

Electronic Patent Application Fee Transmittal

Application Number:	13950160
Filing Date:	24-Jul-2013
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Craig Cody Largent/Kristina Alvarez
Attorney Docket Number:	91172-882666(103900US)

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	1	40	40
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**40**

Electronic Acknowledgement Receipt	
EFS ID:	22444675
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Kristina Alvarez
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	91172-882666(103900US)
Receipt Date:	26-MAY-2015
Filing Date:	24-JUL-2013
Time Stamp:	15:45:01
Application Type:	Utility under 35 USC 111(a)

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Payment was successfully received in RAM	$40
RAM confirmation Number	2681
Deposit Account	201430
Authorized User	LARGENT, CRAIG C.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 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		Amendment_103900US.pdf	143444 9d87965150d4d667c3978e59078535231cc c3495	yes	7

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	4
Applicant Arguments/Remarks Made in an Amendment	5	7

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	31081 27a8fc269e889f506d3f9909fdbb348a38b8 db1e	no	2

Warnings:

Information:

Total Files Size (in bytes):	174525

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

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

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

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/950,160	07/24/2013	Shawn Patrick Stapleton	91172-882666(103900US)	6371

20350 7590 02/24/2015

KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

EXAMINER	
SYED, MAJID	

ART UNIT	PAPER NUMBER
2641	

NOTIFICATION DATE	DELIVERY MODE
02/24/2015	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
jlhice@kilpatrick.foundationip.com

Office Action Summary	Application No. 13/950,160	Applicant(s) STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	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 *03* 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 *07/24/2013*.

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

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

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

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-19* 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

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

Claim Objections – 37 CFR 1.75

Claim 3 is objected under 37 CFR 1.75 as being a substantial duplicate of claim 2. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claim Rejections - 35 USC § 102

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 –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-2, 4-19, are rejected under 35 U.S.C. 102(e) as being anticipated by Lee; Albert S. et al. (US 2013/0128810 A1: hereinafter "Lee").

Consider claim 1, Lee discloses, a system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals)**; a plurality of Base Transceiver Stations (BTS) **(Fig. 15 items 1500A – 1500n, therefore plurality of BTS)**; a plurality of traffic monitoring modules **(Fig. 14, item 1415 further explained in [0065], …, the NOC 1415 monitors, therefore traffic monitor attached to DAUs, therefore plurality of traffic monitors)**; and a network optimization goal and optimization algorithm **(in [0069] discloses, …, [0069] an algorithm operating within the DAU Monitoring module, …, therefore algorithm for the purpose of optimization)**.

Consider claim 2, Lee discloses, the system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells **(Fig. 9. Items 1, 2, 3, therefore BTS comprises a plurality of small cells).**

Consider claim 4, Lee discloses, the system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors **(in [0069] discloses, 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,…, therefore users percentage assignment in sectors for the purpose of performance optimization).

Consider claim 5, Lee discloses, a system for dynamically routing signals in a Distributed Antenna System, the system comprising:
a plurality of Digital Access Units (DAUs) **(Fig. 15 items 1505A-1505n, , therefore plurality of DAUs)**, wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs **(Fig. 15, 1505A-1505B, are connected, therefore coupled and operable to route signals)**; a plurality of Digital Remote Units (DRUs) **(Fig. 15 items 1510A-1510m, , therefore plurality of DRUs)** coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs **(Fig. 15, items 1510A-1510C) are connected, therefore operable to transport signals)**; one or more Base Transceiver Stations (BTSs) **(Fig. 15 items 1500A – 1500n)**; and one or more traffic monitoring units **(Fig. 14, item 1415 further explained in [0065], …,the NOC 1415 monitors,…, therefore traffic monitor attached to DAUs, therefore plurality of traffic monitors)**.

Consider claim 6, Lee discloses, the system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DAUs and coupled to each of the plurality of DAUs **(Fig. 14, item 1415 further explained in [0065], …, the NOC 1415 monitors, therefore plurality of traffic monitor modules external to DAU and coupled with DAU)**.

Consider claim 7, Lee discloses, the system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DAUs **(Fig. 14, item 1415 further explained in [0065], …, the NOC**

1415 monitors, therefore plurality of traffic monitor modules external to DAU, further explained in Fig. 14, item 1410 DAU monitoring module, therefore traffic monitoring provided as a component).

Consider claim 8, Lee discloses, the system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DRUs and coupled to each of the plurality of DRUs **(in Fig. 15, plurality DRUs externally coupled to DAU and in Fig. 14, item 1410 traffic monitoring component external to plurality of DRUs).**

Consider claim 9, Lee discloses, the system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units **(Fig. 14 item 1415 is coupled with DAU and in Fig. 15 items 1505A-1505n plurality of DAUS, therefore plurality of traffic monitoring units)** each provided as a component of each of the plurality of DRUs **(Fig. 15 items 1510A-1510m, therefore plurality of DRUs).**

Consider claim 10, Lee discloses, the system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of BTSs **(Fig. 14 item 1415, therefore traffic monitoring coupled with DAU and in Fig. 15 items 1500A-1500n, DAU is connected to BTS, therefore traffic monitoring unit external to plurality BTS)** and coupled to each of the plurality of BTSs **(Fig. 15 item 1505A as DAU is coupled to item 1500A as BTS, therefore plurality of BTSs)**.

Consider claim 11, Lee discloses, the system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit **(in [0069] discloses, 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 1415…, therefore network optimization processor coupled to traffic monitoring unit).

Consider claim 12, Lee discloses, the system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal (in [0069] discloses, …,. **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 1415…, therefore threshold as optimization goal).**

Consider claim 13, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(Fig. 10 further explained, in [0060] discloses, the DAU communicates with a Network Operation Center (NOC) via a Ethernet connection, …, therefore DAUs coupled via Ethernet cable**).

Consider claim 14, Lee discloses, the system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight 3 Link, Wireless Link, or Satellite Link **(Fig. 5 item Ethernet CAT-5/6, 500A as Fiber, therefore, DRUs coupled with DAUs via fiber or ethernet cable at least**).

Consider claim 15, Lee discloses, the system of claim 5 wherein the DRUs are connected in a daisy chain configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration …., therefore DRUs are daisy chained)**.

Consider claim 16, Lee discloses, the system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration **(in [007] discloses, the one or more DRUs may include a plurality of DRUs connected in a daisy chain configuration and/or a star configuration, therefore, DRUs in star topology)**.

Consider claim 17, Lee discloses, the system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link **(in [0007] discloses, .., Each of the one or more DAUs may be coupled to at least one of the first BTS or the second BTS, e.g., via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link, therefore all physical medium, therefore DAUs communicating with variety of access links)**.

Consider claim 18, Lee discloses, the system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs **(Fig. 11, DRUs 1145 connected to DAUs 1100 & 1115, therefore DRUs connected to DAUs in loop)**.

Consider claim 19, Lee discloses, the system of claim 5 wherein a single DAU port is connected to a plurality of Base Transceiver Stations **(in [0007] discloses, …., each of the one**

or more DAUs may be coupled to at least one of the first BTS or the second BTS, …,

therefor DAU is connected to plurality of BTSs).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAJID SYED whose telephone number is (571)-270-0524. The examiner can normally be reached on Monday-Thursday 7:00 - 4:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vladimir Magloire be reached on (571)-270-5144. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/MAJID SYED/
Examiner, Art Unit 2641

/VLADIMIR MAGLOIRE/
Supervisory Patent Examiner, Art Unit 2641

Notice of References Cited	Application/Control No. 13/950,160	Applicant(s)/Patent Under Reexamination STAPLETON ET AL.	
	Examiner MAJID SYED	Art Unit 2641	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2013/0128810 A1	05-2013	Lee et al.	370/328
	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	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	46571	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:11
S2	157	S1 And (DAUs|DRUs)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:13
S3	33	S1 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 16:33
S4	3060	S1 and (congestion)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:01
S5	1	S1 and (congestion optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S6	239	S1 and (traffic distribution)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:02
S7	435	S1 and (Distributed Antenna System)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:46
S8	0	S7 and (traffic management)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S9	3	S7 and (traffic optimization)	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:47
S10	153	S7 and centralized	US-PGPUB; USPAT	ADJ	ON	2015/01/28 17:48
S11	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S12	64	S11 and kpi	US-PGPUB; USPAT	ADJ	ON	2015/01/29 08:55
S13	18951	S11 and (coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:45
S14	326	S11 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:46
S15	0	S14 and (traffic balance)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:47
S16	3	S14 and (load balance)	US-PGPUB;	ADJ	ON	2015/01/29 11:47

			USPAT			
S17	8874	S11 and (KPI|Qos)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S18	68	S17 and (base stations coupled)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 11:49
S19	46646	((370/328,334,329)|(375/267)|(455/13.3,63.3,562.1)).ccls.	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S20	46646	S19	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:07
S21	0	S19 and (interconnnected remote antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S22	0	S19 and (interconnnected antennas)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:08
S23	0	S19 and (interconnnected antenna)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10
S24	5	S19 and (interconnected BTS)	US-PGPUB; USPAT	ADJ	ON	2015/01/29 14:10

2/9/2015 12:02:51 PM
C:\Users\msyed\Documents\EAST\Workspaces\13950160-DAS-Traffic-Optimize.wsp

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2642
	Examiner Name	Unassigned
	Attorney Docket Number	91172-882666 (103900US)

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	Patent Number	Kind Code [1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/M.S./	1.	US-2002/0119772	A1	08-29-2002	Yoshida	
/M.S./	2.	US-2005/0153743	A1	07-14-2005	Berra et al.	
/M.S./	3.	US-2012/0039320	A1	02-16-2012	Lemson et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Country Code [2]	Foreign Document Number [3]	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]
/M.S./	4.	WO	2012/024349	A1	02-23-2012	Dali Systems Co. Ltd.		
/M.S./	5.	WO	2014/022211	A2	02-06-2014	Dali Systems Co. 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]
/M.S./	6.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration; International Search Report and Written Opinion Of The International Searching Authority for corresponding International application No. PCT/US2013/052206 mailed on October 31, 2013, 8 pages.	

EXAMINER SIGNATURE

Examiner Signature	/Majid Syed/	Date Considered	02/09/2015	

*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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2642
	Examiner Name	Unassigned
	Attorney Docket Number	91172-882666 (103900US)

[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.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	Art Unit
	MAJID SYED	2641

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	67.11, 562.1, 524,	01-28-2015	MS
370	328, 311, 329,	01-29-2015	MS

SEARCH NOTES		
Search Notes	Date	Examiner
See EAST search history.	01-29-2015	MS

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

/MAJID SYED/ Examiner.Art Unit 2641	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13950160	STAPLETON ET AL.
	Examiner	**Art Unit**
	MAJID SYED	2641

✓	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	02/09/2015								
	1	✓								
	2	✓								
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	18	✓								
	19	✓								

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/950,160	07/24/2013	Shawn Patrick Stapleton	91172-882666(103900US)

CONFIRMATION NO. 6371

20350
KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

PUBLICATION NOTICE

Title:OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

Publication No.US-2014-0162664-A1
Publication Date:06/12/2014

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.

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

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/950,160

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))	19 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 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($)	ADDITIONAL FEE($)	OR	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.

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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/950,160	07/24/2013	2642	800	91172-882666(103900US)	19	2

CONFIRMATION NO. 6371

UPDATED FILING RECEIPT

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EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

OC00000006689O159

Date Mailed: 03/05/2014

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;
Seyed Amin Hejazi, Burnaby, CANADA;

Applicant(s)

DALI SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS

Assignment For Published Patent Application

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 appln claims benefit of 61/678,016 07/31/2012

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.

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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 13/950,160**
Projected Publication Date: 06/12/2014
Non-Publication Request: No

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

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

455

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

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
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POA ACCEPTANCE LETTER

OC000000066890228

Date Mailed: 03/05/2014

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/11/2013.

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

/ddinh/

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2642
	Examiner Name	Unassigned
	Attorney Docket Number	91172-882666 (103900US)

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	Patent 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-2002/0119772	A1	08-29-2002	Yoshida	
	2.	US-2005/0153743	A1	07-14-2005	Berra et al.	
	3.	US-2012/0039320	A1	02-16-2012	Lemson et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Country Code [2]	Foreign Document Number [3]	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.	WO	2012/024349	A1	02-23-2012	Dali Systems Co. Ltd.		
	5.	WO	2014/022211	A2	02-06-2014	Dali Systems Co. 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]
	6.	Notification Of Transmittal Of The International Search Report And The Written Opinion Of The International Searching Authority, Or The Declaration; International Search Report and Written Opinion Of The International Searching Authority for corresponding International application No. PCT/US2013/052206 mailed on October 31, 2013, 8 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13/950,160
	Filing Date	July 24, 2013
	First Named Inventor	Shawn Patrick Stapleton
	Art Unit	2642
	Examiner Name	Unassigned
	Attorney Docket Number	91172-882666 (103900US)

[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.
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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 February 2012 (23.02.2012)

PCT

(10) International Publication Number
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(51) International Patent Classification:
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(25) Filing Language: English

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(30) Priority Data:

61/374,593	17 August 2010 (17.08.2010)	US
61/382,836	14 September 2010 (14.09.2010)	US
12/928,943	21 December 2010 (21.12.2010)	US
12/928,934	21 December 2010 (21.12.2010)	US
12/928,933	21 December 2010 (21.12.2010)	US
12/928,931	21 December 2010 (21.12.2010)	US
61/439,940	7 February 2011 (07.02.2011)	US
13/211,247	16 August 2011 (16.08.2011)	US
13/211,236	16 August 2011 (16.08.2011)	US
13/211,243	16 August 2011 (16.08.2011)	US

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(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **STAPLETON, Shawn, Patrick** [CA/CA]; 7991 Woodhurst Drive, Burnaby, BC V5A 4C6 (CA). **LEMSON, Paul** [US/US]; 20208 NE 160th Street, Woodinville, WA 98077 (US). **LIN, Bin** [CN/CA]; 158-2979 Panorama Drive, Coquitlam, BC V3E 2W8 (CA).

(74) Agent: **LARGENT, Craig C.**; Kilpatrick Townsend & Stockton LLP, 1080 Marsh Road, Menlo Park, CA 94025 (US).

(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, QA, 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,

[Continued on next page]

(54) Title: DAISY-CHAINED RING OF REMOTE UNITS FOR A DISTRIBUTED ANTENNA SYSTEM

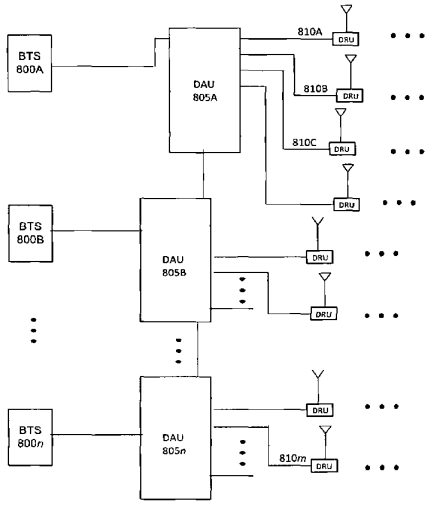

Figure 8

(57) Abstract: 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. More specifically, the present invention relates to a DAS utilizing one or more Daisy-Chained Rings of Remote Units. 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.

WO 2012/024349 A1

CommScope Exhibit 1024

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, RS, 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))*

Daisy-Chained Ring of Remote Units for a Distributed Antenna System

SPECIFICATION

Related Applications

[001] This application claims the benefit of the following U.S. Patent applications, all of which are incorporated herein by reference:

Serial Number	Filing Date	Title
61/374,593	8/17/2010	Neutral Host Architecture for a Distributed Antenna System
61/382,836	9/14/2010	Remotely Reconfigurable Distributed Antenna System and Methods
12/928,931	12/21/2010	Modulation Agnostic Digital Hybrid Mode Power Amplifier System and Method
12/928,933	12/21/2010	Remote Radio Head Unit System with Wideband Power Amplifier and Method
12/928,934	12/21/2010	Multi-Band Wideband Power Amplifier Digital Predistortion System and Method

12/928,943	12/21/2010	High Efficiency, Remotely Reconfigurable Remote Radio Head Unit System and Method for Wireless Communications
61/439,940	2/7/2011	Daisy Chained Ring of Remote Units for a Distributed Antenna System
[not assigned yet]	8/16/2011	Neutral Host Architecture for a Distributed Antenna System
[not assigned yet]	8/16/2011	Remotely Reconfigurable Distributed Antenna System and Methods
[not assigned yet]	8/16/2011	Daisy Chained Ring of Remote Units for a Distributed Antenna System

FIELD OF THE INVENTION

[002] 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

[003] Wireless and mobile network operators face the continuing challenge of 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.

[004] 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.

[005] 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.

[006] 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

[007] 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.

[008] 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.

[009] 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 and attached as Appendix A, 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.

THE FIGURES

[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.

[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 in accordance with the present invention. 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 120*n* are received at the DAU 105 from one or more base station units (BTS) indicated at 110A through 110p. 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 110*p* belonging to the same wireless operator enters DAU1 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, incorporated herein by reference and attached hereto as Appendix B.

[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 150B, and DRU 125*k* connects to DRU 125C, or the *k*th-1 DRU, via cable 150*m*. 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 DRU125B. 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 155B at the antenna port of DRU 125B. 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 125B, 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-150*m*.

[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 DRU's. 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 K*i*, $1 \leq i \leq n$ (including uplink and downlink). A channel K*i* requires a bandwidth of b(K*i*) 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 K*i* decreasingly by bandwidth b(K*i*). 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 K*i* with required bandwidth b(K*i*), $1 \le i \le n$.

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

[0046] ALGORITHM (T, L, D)

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

[0048] Step 2 (Schedule a channel)

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

[0050] If $D_1 \le D_2$, 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 125B and DRU*k* 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 125B 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 125B 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, a alternative embodiment of the present invention may be better understood. 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. 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, the software embedded in the DAU and DRU, which controls the operation of keys 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-800*n* 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-810*m* 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.

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.

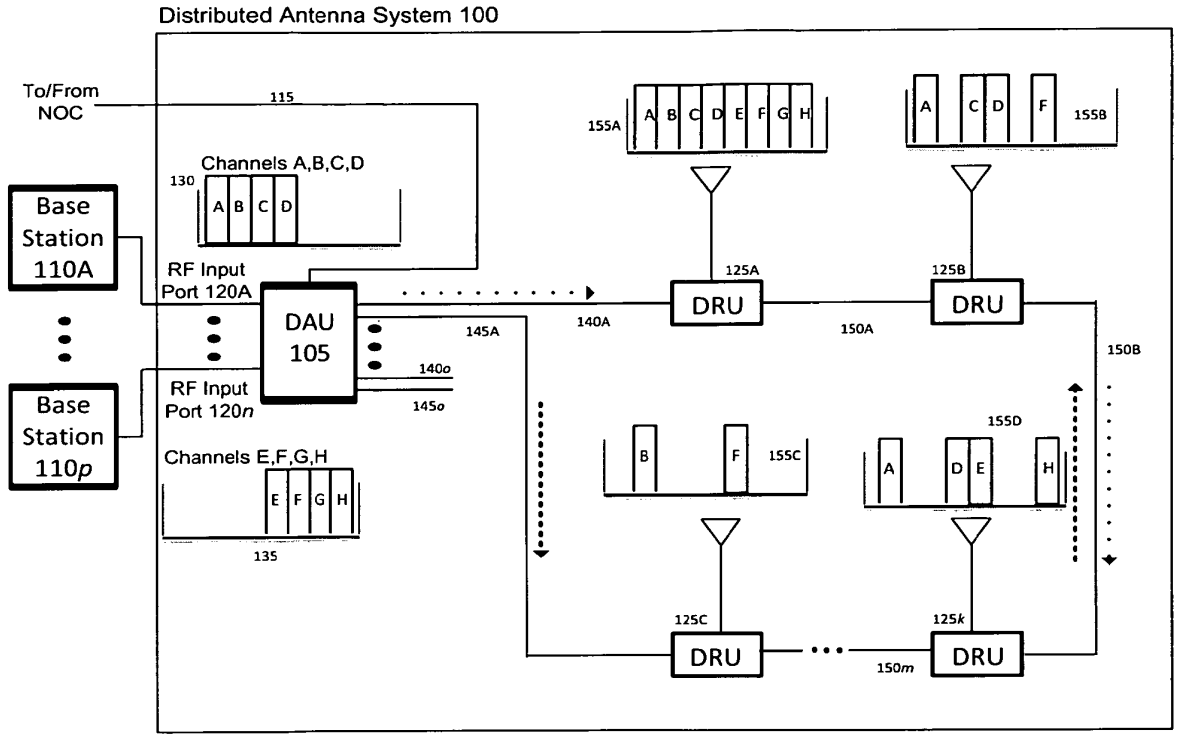
Distributed Antenna System 100
To/From NOC
115
Channels A,B,C,D
130
A B C D
Base Station 110A
Base Station 110p
RF Input Port 120A
RF Input Port 120n
DAU 105
145A
140o
145o
Channels E,F,G,H
E F G H
135
140A
155A
A B C D E F G H
125A
DRU
150A
A C D F
155B
125B
DRU
150B
155D
A D E H
B F
155C
125C
DRU
125k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

Figure 1

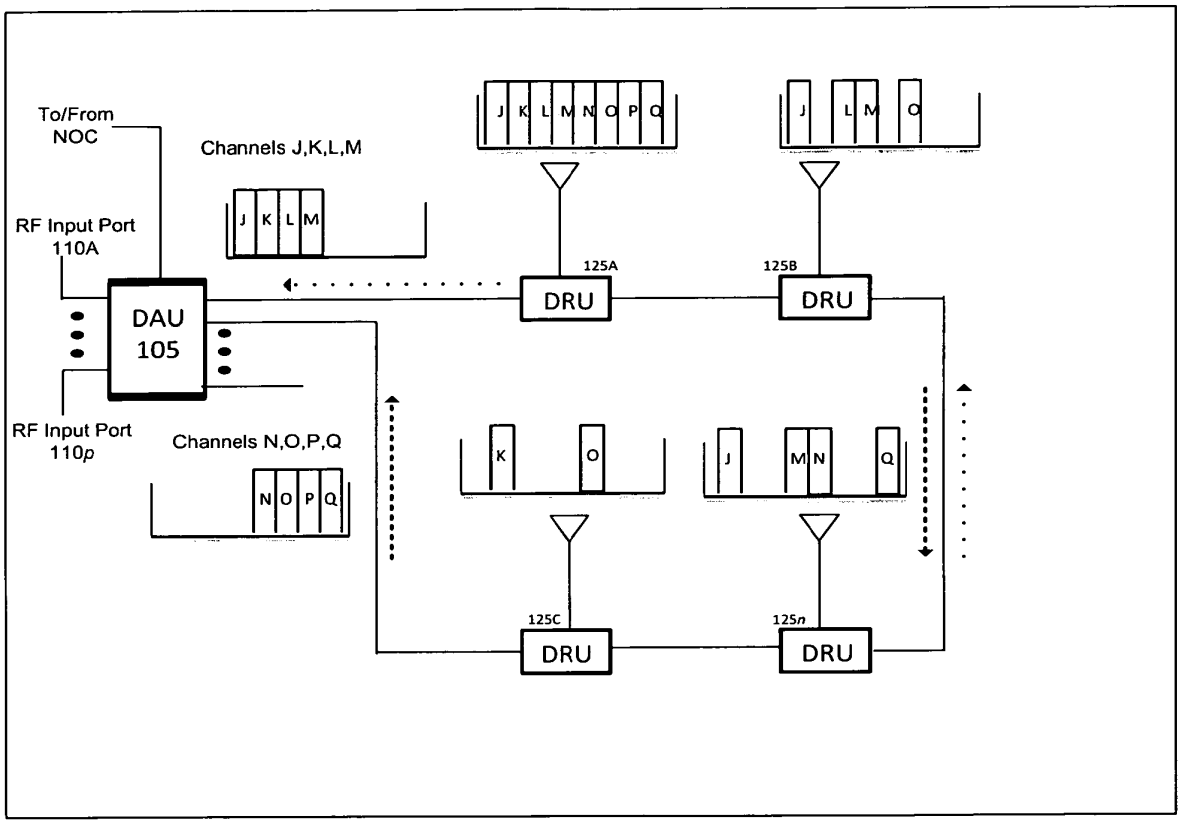
To/From NOC
Channels J,K,L,M
J K L M N O P Q
J L M Q
RF Input Port 110A
J K L M
125A
125B
DRU
DRU
DAU 105
RF Input Port 110p
Channels N,O,P,Q
N O P Q
K O
J M N Q
125C
125n
DRU
DRU

Figure 2

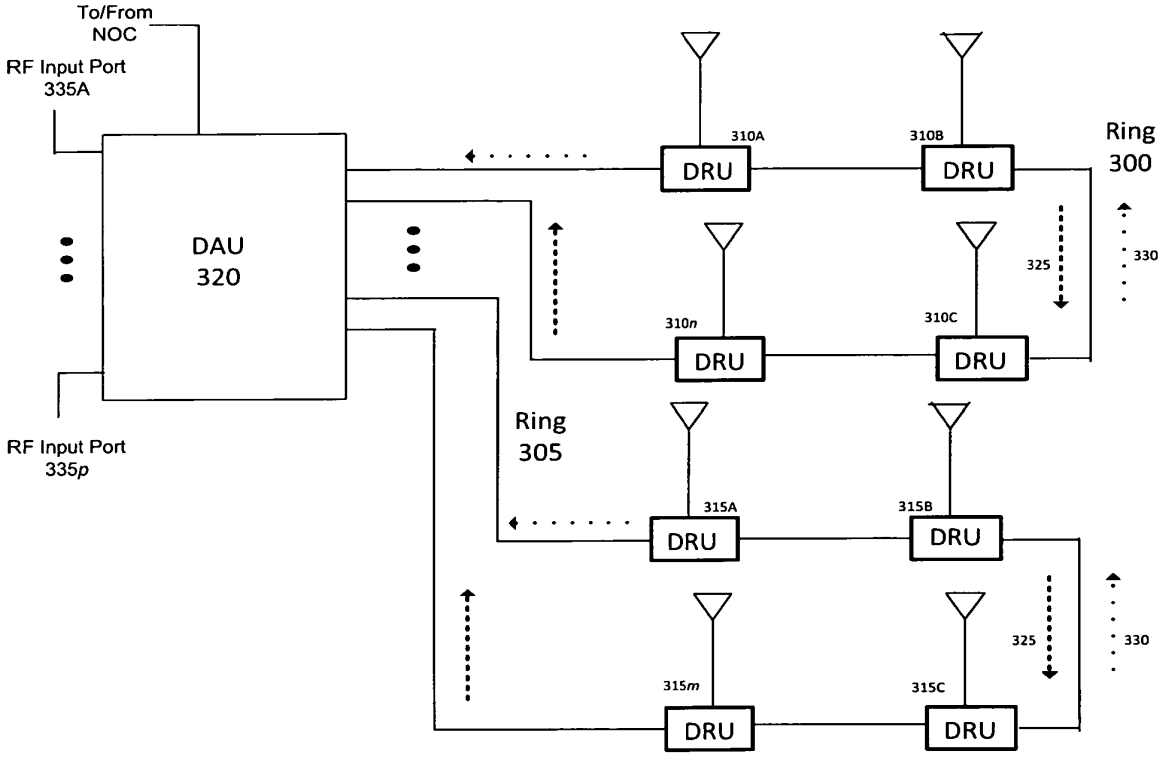
To/From
NOC
RF Input Port
335A
DAU
320
RF Input Port
335p
310A
310B
DRU
DRU
Ring
300
325
330
310n
310C
DRU
DRU
Ring
305
315A
315B
DRU
DRU
325
330
315m
315C
DRU
DRU

Figure 3

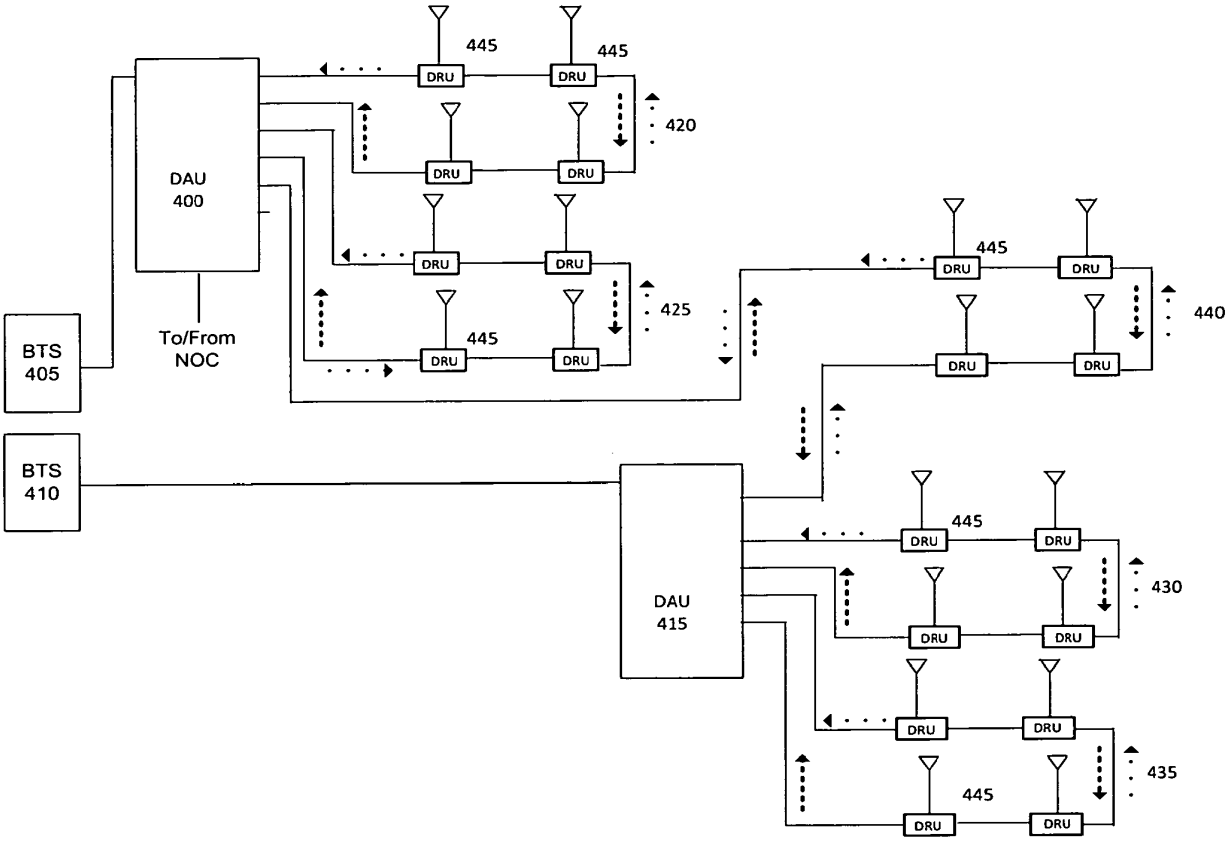
445
445
DRU
DRU
420
DAU
400
DRU
DRU
DRU
DRU
425
445
DRU
DRU
To/From
NOC
BTS
405
BTS
410
445
DRU
DRU
440
DRU
DRU
DAU
415
445
DRU
DRU
430
DRU
DRU
DRU
DRU
435
445
DRU
DRU

Figure 4

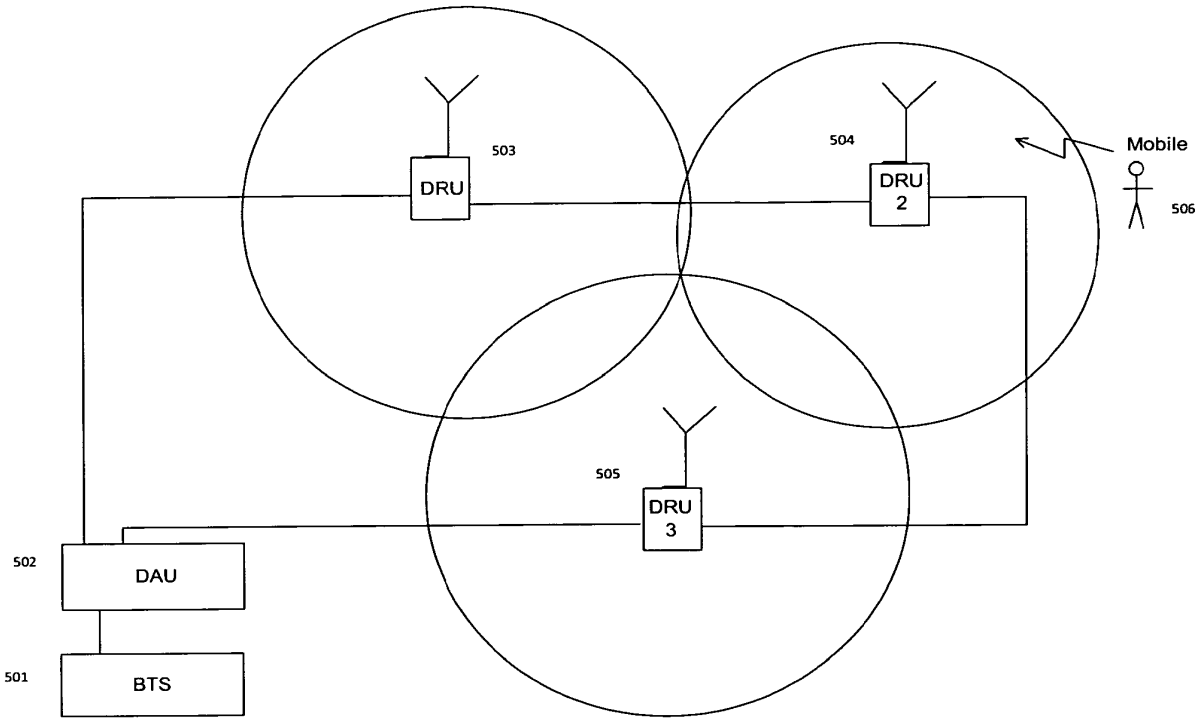

Figure 5

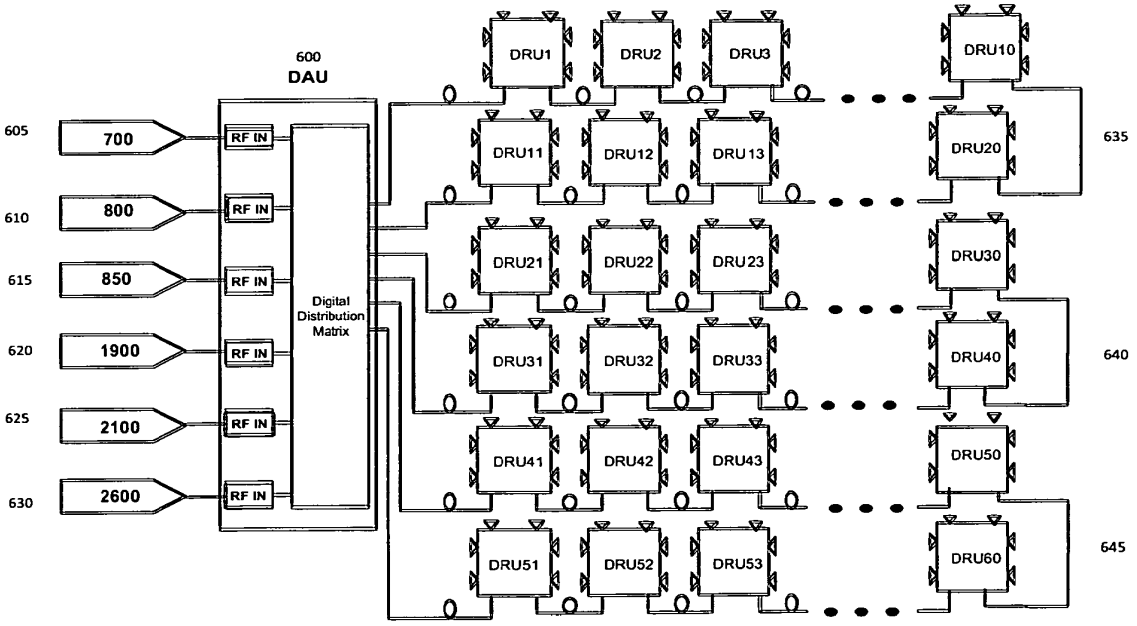
600
DAU
605
700
610
800
615
850
620
1900
625
2100
630
2600
RF IN
RF IN
RF IN
RF IN
RF IN
RF IN
Digital Distribution Matrix
DRU1
DRU2
DRU3
DRU10
DRU11
DRU12
DRU13
DRU20
635
DRU21
DRU22
DRU23
DRU30
DRU31
DRU32
DRU33
DRU40
640
DRU41
DRU42
DRU43
DRU50
DRU51
DRU52
DRU53
DRU60
645

Figure 6

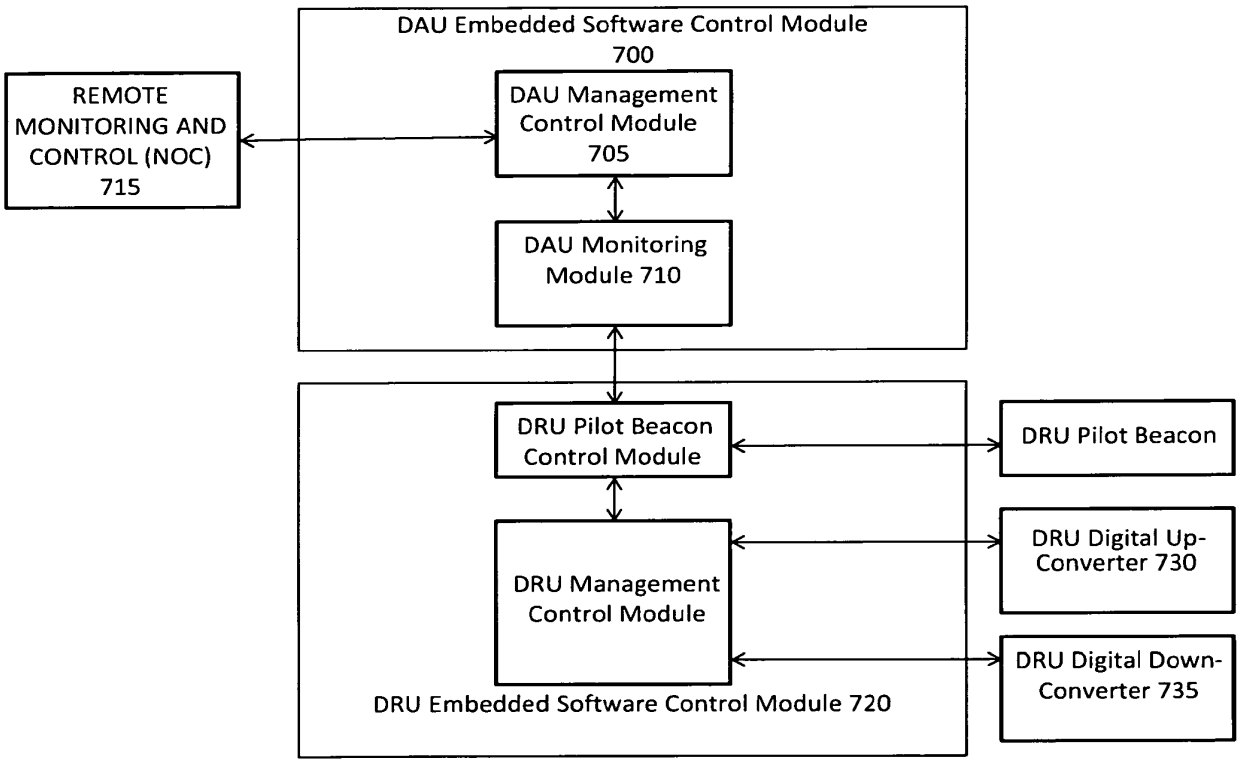
DAU Embedded Software Control Module
700
REMOTE MONITORING AND CONTROL (NOC) 715
DAU Management Control Module 705
DAU Monitoring Module 710
DRU Pilot Beacon Control Module
DRU Pilot Beacon
DRU Management Control Module
DRU Digital Up-Converter 730
DRU Digital Down-Converter 735
DRU Embedded Software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

Figure 7

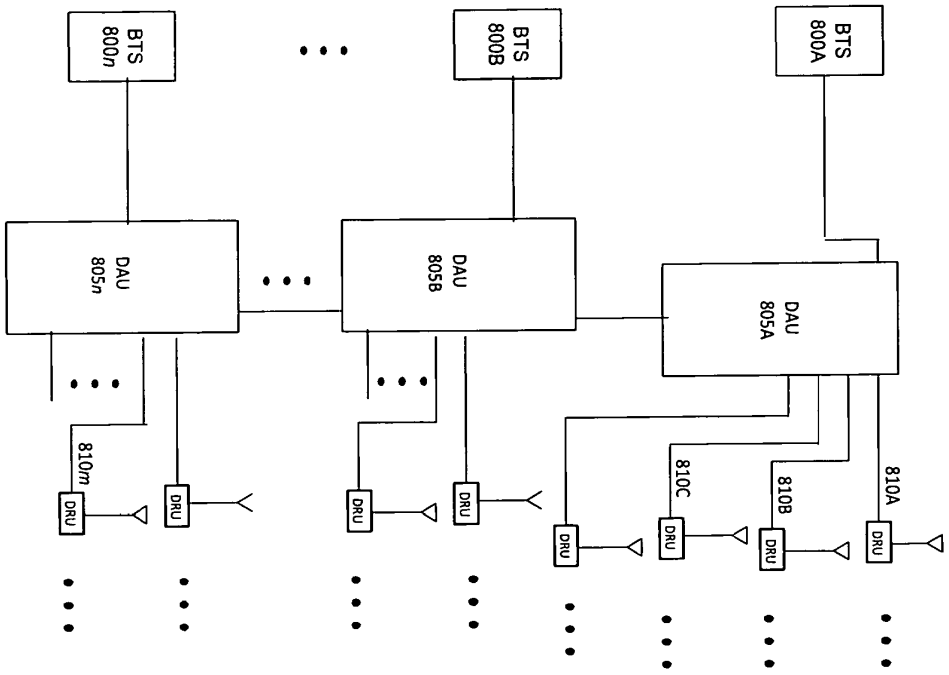
BTS
800n
BTS
800B
BTS
800A
DAU
805n
DAU
805B
DAU
805A
810m
810C
810B
810A
DRU

Figure 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/48004

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04B 1/38 (2011.01)
USPC - 375/219
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)
USPC: 375/219

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 375/219, 221; 370/277 (keyword limited - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; Google Scholar
Search Terms: antenna, packet, uplink, downlink, remote, radio, digital, frequency, configure, switching, route, loop, daisy-chained

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002/0093926 A1 (Kilfoyle) 18 July 2002 (18.07.2002), entire document, especially; abstract, para. [0015], [0065]-[0067]	1
Y	US 2003/0181221 A1 (Nguyen) 25 September 2003 (25.09.2003), entire document, especially; abstract, para. [0003]-[0005], [0027], [0028]	1
A	US 2008/0146146 A1 (Binder et al.) 19 June 2008 (19.06.2008), entire document	1

☐ Further documents are listed in the continuation of Box C. ☐

* 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
11 December 2011 (11.12.2011)	05 JAN 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

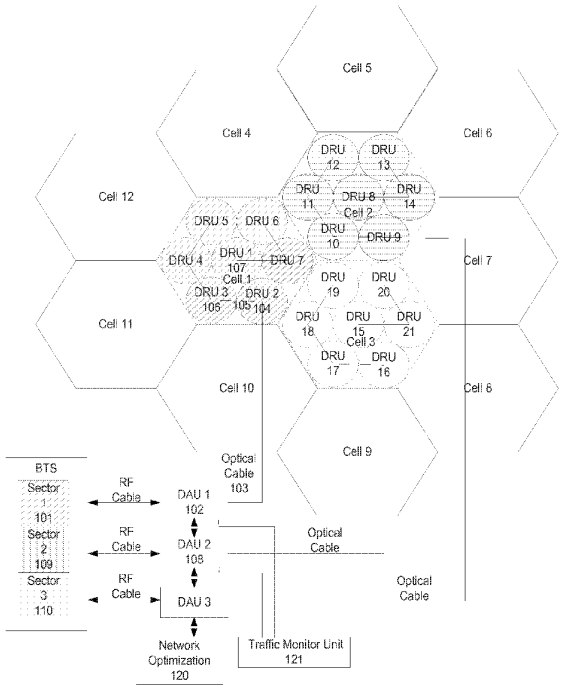


FIG. 1

(57) Abstract: A system for dynamically routing signals in a Distributed Antenna. System includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a. plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transcei ver Stations (BTS). The system further includes a pluraiity of traffic monitoring modules and a network optimization goaf and optimization algorithm.

WO 2014/022211 A2

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/678,016, filed on July 31, 2012, entitled "Optimization of Traffic Load in a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

SUMMARY 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 traffic monitoring and optimization. Wireless network operators faces the continuing challenge of building networks that effectively manage high data-traffic growth rates. Mobility and an increased level of multimedia content for end users typically employs end-to-end network adaptations that support new services and the increased demand for broadband and flat-rate Internet access. One of the most difficult challenges faced by network operators is caused by the physical movement of subscribers from one location to another, and particularly when wireless subscribers congregate in large numbers at one location. A notable example is a business enterprise facility during lunchtime, when a large number of wireless subscribers visit a lunch room or cafeteria location in the building. At that time, a large number of subscribers have moved away from their offices and usual work areas. It's likely that during lunchtime, there are many locations throughout the facility where there are very few subscribers. If the indoor wireless network resources were properly sized during the design process for subscriber loading as it is during normal working hours when subscribers are in their normal work areas, it is very likely that the lunchtime scenario will present some unexpected challenges with regard to available wireless capacity and data throughput.

[0003] According to an embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital

Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs. The system further includes one or more Base Transceiver Stations (BTSs) and one or more traffic monitoring units.

[0004] According to another embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system further includes a plurality of traffic monitoring modules and a network optimization goal and optimization algorithm.

[0005] In an embodiment, a system for dynamically routing signals in a Distributed Antenna System is provided and includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and one or more Base Transceiver Stations (BTSs). The system further includes a traffic monitoring unit.

[0006] Numerous benefits are achieved by way of the present invention over conventional techniques. For example, embodiments of the present invention provide for traffic monitoring in a DAS network, improving network performance and user experience. These and other embodiments of the invention along with many of its advantages and features are described in more detail in conjunction with the text below and attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0008] FIG. 2 is a block diagram according to one embodiment of the invention showing the basic structure for a frequency reuse pattern of N=1 and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0009] FIG. 3 is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having multiple 3 sector BTSs with 3 DAUs and 7 DRUs daisy chained together for each cell. In this embodiment, multiple three sector base stations are connected to a daisy chained DAS network.

[0010] FIG. 4 is a block diagram of a Digital Access Unit (DAU), which contains Physical Nodes, a Local Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0011] FIG. 5 is a block diagram of a Digital Remote Unit (DRU), which contains Physical Nodes, a Remote Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0012] FIG. 6 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring and Network Optimization functionality according to an embodiment of the present invention.

[0013] FIG. 7 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0014] FIG. 8 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0015] FIG. 9 is a simplified flowchart illustrating a method of optimizing the DAS network according to an embodiment of the present invention.

[0016] FIG. 10 is a simplified flowchart illustrating a method of calculating KPIs and QoS for a DAS network according to an embodiment of the present invention.

[0017] FIG. 11 is a simplified flowchart illustrating an optimization algorithm according to an embodiment of the present invention .

DETAILED DESCRIPTION OF THE INVENTION

[0018] To accommodate variations in wireless subscriber loading at wireless network antenna locations at various times of day and for different days of the week, there are several candidate conventional approaches.

[0019] One approach is to deploy many low-power high-capacity base stations throughout the facility. The quantity of base stations is determined based on the coverage of each base station and the total space to be covered. Each of these base stations is provisioned with enough radio resources, i.e., capacity and broadband data throughput to accommodate the maximum subscriber loading which occurs during the course of the workday and work week. Although this approach typically yields a high quality of service for wireless subscribers, the notable disadvantage of this approach is that many of the base stations' capacity is being wasted for a large part of the time. Since a typical indoor wireless network deployment involves capital and operational costs which are assessed on a per-subscriber basis for each base station, the typically high total life cycle cost for a given enterprise facility is far from optimal.

[0020] A second candidate approach involves deployment of a DAS along with a centralized group of base stations dedicated to the DAS. A conventional DAS deployment falls into one of two categories. The first type of DAS is "fixed", where the system configuration doesn't change based on time of day or other information about usage. The remote units associated with the DAS are set up during the design process so that a particular block of base station radio resources is thought to be enough to serve each small group of DAS remote units. A notable disadvantage of this approach is that most enterprises seem to undergo frequent re-arrangements and re-organizations of various staff groups within the enterprise. Therefore, it's highly likely that the initial DAS setup will need to be changed from time to time, requiring deployment of additional direct staff and contract resources with appropriate levels of expertise regarding wireless networks.

[0021] The second type of DAS is equipped with a type of network switch which allows the location and quantity of DAS remote units associated with any particular centralized base station to be changed manually. Although this approach would appear to support dynamic DAS reconfiguration based on the needs of the enterprise or based on time of day, it frequently implies that additional staff resources would need to be assigned to provide real-time management of the network. Another issue is that it's not always correct or best to make the same DAS remote unit configuration changes back and forth on each day of the week at the same times of day. Frequently it is difficult or impractical for an enterprise IT manager to monitor the subscriber loading on each base station. And it is almost certain that the enterprise IT manager has no practical way to determine the loading at a given time of day for each DAS remote unit; they can only guess the percentage loading.

[0022] Another major limitation of conventional DAS deployments is related to their installation, commissioning and optimization process. Some challenging issues which must be overcome include selecting remote unit antenna locations to ensure proper coverage while minimizing downlink interference from outdoor macro cell sites, minimizing uplink interference to outdoor macro cell sites, and ensuring proper intra-system handovers while indoors and while moving from outdoors to indoors (and vice-versa). The process of performing such deployment optimization is frequently characterized as trial-and-error. Therefore, the results may not be consistent with a high quality of service.

[0023] Based on the conventional approaches described herein, it is apparent that a highly efficient, easily deployed and dynamically reconfigurable wireless network is not achievable with conventional systems and capabilities. Embodiments of the present invention substantially overcome the limitations of the conventional approach discussed above. The advanced system architecture provided by embodiments of the present invention provides a high degree of flexibility to manage, control, enhance and facilitate radio resource efficiency, usage and overall performance of the distributed wireless network. This advanced system architecture enables specialized applications and enhancements including, but not limited to, 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, and/or traffic tagging. Embodiments of the present invention can also serve multiple operators, multi-mode radios (modulation-independent) and multiple frequency bands per operator to increase the efficiency and traffic capacity of the operators' wireless networks.

[0024] Accordingly, embodiments of this architecture provide a capability for Flexible Simulcast. With Flexible Simulcast, the amount of radio resources (such as RF carriers, LTE Resource Blocks, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs can be set via software control to meet desired capacity and throughput objectives or wireless subscriber needs. 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.

[0025] According to an embodiment of the present invention, a traffic monitoring unit is provided as a component of one or more elements of the system, enabling measurement of the network traffic in the network. A network optimization goal and optimization algorithm is also provided so that based on traffic measurements, which is typically a function of the

number of users on the system, performance of the network is optimized using the goal and associated algorithm.

[0026] As an example of traffic monitoring, the system could track the power of the down link or the power of the uplink. Another example, would include some signal processing, including examining certain control signals, for example, pilot signals sent by mobile devices. By locking onto these control signals, the traffic monitor can obtain information on the number of users using various components of the system.

[0027] A distributed antenna system (DAS) provides an efficient means of utilization of base station resources. The base station or base stations associated with a DAS can be located in a central location and/or facility commonly known as a base station hotel. The DAS network comprises one or more digital access units (DAUs) that function as the interface between the base stations and the digital remote units (DRUs). The DAUs can be collocated with the base stations. The DRUs can be daisy chained together and/or placed in a star configuration and provide coverage for a given geographical area. The DRUs are typically connected with the DAUs by employing a high-speed optical fiber link. This approach facilitates transport of the RF signals from the base stations to a remote location or area served by the DRUs. A typical base station comprises 3 independent radio resources, commonly known as sectors. These 3 sectors are typically used to cover 3 separate geographical areas without creating co-channel interference between users in the 3 distinct sectors.

[0028] Traffic monitoring in a DAS network is provided by embodiments of the present invention, which has not been performed in conventional systems. As described herein, the traffic monitoring unit can be implemented as a stand-alone unit in conjunction with one or more system components, including DAUs, DRUs, a BTS, a BTS hotel, or the like.

[0029] Once traffic resources are aggregated into eNodeB hotels, the discrete resources of a single eNodeB are still allocated to a specific set of antennas associated with that eNodeB and providing coverage to a specific geographic area. The traffic resources are fixed, i.e., only the resources associated with a specific eNodeB can be allocated to the antennas associated with that eNodeB. However, because the eNodeBs are collocated in an eNodeB hotel, the system can use the aggregated traffic resources of the discrete eNodeBs as a single, pooled traffic resource that can be allocated according to various algorithms. Assumptions are typically predicated on worst-case traffic assets in all areas, network design is wasteful 99 percent of the time, inevitably resulting in over- or under-provisioning of fixed resources.

Traffic resources either go unused (idle channels), or are under-provisioned and are insufficient to handle the offered traffic. Both circumstances give rise to the same outcome: lost revenue and lost opportunity. When a site's traffic resources are idle and unused, the traffic asset fails to provide an optimal return on investment. But a site that lacks sufficient capacity to support the offered traffic at any point during the day garners dropped calls, lost revenue opportunity, and dissatisfied customers. The traffic information derived from an extensive sensor network will be used to dynamically allocate the traffic resources to the required geographical areas only for the time period the service is needed. Once the service is supplied and the traffic sensor network determines that the traffic resources are no longer required, they are returned to the resource pool for reallocation. The entire network automatically reconfigures itself based on the perceived (sensed) need or in the event of disruption due to natural or manmade events. Geographic load balancing using DAS is recognized as a new approach for traffic load balancing which provides dynamic load redistribution in real time according to the current geographic traffic conditions. It can be used to improve the performance for any distributed systems containing non-uniformly distributed traffic, especially for resolving traffic hot spots.

[0030] The network's performance (expressed by the number of KPIs (Key Performance Indicators) from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs.

[0031] An embodiment shown in FIG. 1 illustrates a basic DAS network architecture according to an embodiment of the present invention and provides an example of a data transport network, traffic monitoring and network optimization scenario between a 3 sector Base Station and multiple DRUs. In this embodiment, the DRUs are daisy chained together to achieve coverage in a specific geographical area. Each individual sector covers an independent geographical area, which is identified as a Cell. Although embodiments are discussed in terms of optimization of DAS networks, the term optimization is properly understood to include performance improvements in comparison to conventional systems, even if complete optimization is not achieved. Thus, optimization does not require the maximum values for traffic management metrics, but also includes distribution of traffic that improves system performance while remaining short of maximum performance.

[0032] FIG. 1 depicts a DAS system employing multiple Digital Remote Units (DRUs) and multiple Digital Access Units (DAUs). In accordance with the present invention, each DRU provides unique information associated with each DRU which uniquely identifies uplink data received by that particular Digital Remote Unit.

[0033] One feature of embodiments of the present invention is the ability to route Base Station radio resources among the DRUs or group(s) of DRUs. In order to route radio resources available from one or more Base Stations, it is desirable to configure the individual router tables of the DAUs and DRUs in the DAS network. This functionality is provided by embodiments of the present invention.

[0034] The DAUs are networked together to facilitate the routing of DRU signals among multiple DAUs. The DAUs support the transport of the RF downlink and RF uplink signals between the Base Station and the DRUs. This architecture enables the various Base Station signals to be transported to and from multiple DRUs. PEER ports are used for interconnecting DAUs and interconnecting DRUs.

[0035] The DAUs have the capability to control the gain (in small increments over a wide range) of the downlink and uplink signals that are transported between the DAU and the base station (or base stations) connected to that DAU. This capability provides flexibility to simultaneously control the uplink and downlink connectivity of the path between a particular DRU (or a group of DRUs via the associated DAU or DAUs) and a particular base station sector.

[0036] Embodiments of the present invention use router tables to configure the networked DAUs. The local router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from an External Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the LAN Ports and PEER Ports need to merge into the same data stream.

[0037] The remote router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from a LAN Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the External Ports and PEER Ports need to merge into the same data stream.

[0038] As shown in FIG. 1, the individual base station sector's radio resources are transported to a daisy-chained network of DRUs. Each individual sector's radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 1 demonstrates how three cells, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. 1 and by way of example, DAU 1 (102) receives downlink signals from BTS Sector 1 (101). DAU 1 translates the RF signals to optical signals and the optical fiber cable 103 transports the desired signals to DRU 2 (104). Optical cable 105 transports all the optical signals to DRU 3 (106). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (107). DAU 1 (102) is networked with DAU 2 (108) to allow the downlink signals from Sector 2 (109) and Sector 3 (110) to be transported to all the DRUs in Cell 1. The system's switching and routing functions enable the selection of which sectors' signals are transmitted and received by each DRU.

[0039] An embodiment illustrating a Traffic monitoring unit (121) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (120). The optimization unit (120) calculates the overall DAS network performance and determines the optimum reconfigured network to improve or maximize performance. Utilizing the traffic monitoring unit 121 in conjunction with the DAUs provides for optimization of the DAS network through a traffic monitoring unit external to the DAUs. Thus, embodiments of the present invention provide for traffic monitoring in a DAS network. Optimization of the DAS network can then be performed using information related to the traffic monitoring.

[0040] Referring to FIG. 1, the traffic monitor unit 121 can be a server determining the number of users on each DAU, with each DAU having multiple ports in some embodiments. Data from the traffic monitor unit 121 is then provided to the network optimization unit 120, which can be the same server including the traffic monitor unit or a different server. The network optimization unit 120 (which can be software running on a server) can model the rebalancing of the traffic load and, after determining that the performance will be acceptable, implements the load rebalancing by communicating with the DAUs and shifting traffic between sectors. Although the network optimization unit 120 is illustrated as coupled to the DAUs in FIG. 1, this is not required by embodiments of the present invention and the network optimization could be performed at one of the DRUs, with data regarding network optimization being transmitted back to the DAUs using, for example, using an Ethernet

backhaul connecting the DRUs to the DAUs. Thus, the network optimization server could be located at one of the DRUs, controlling the entire network from that location. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0041] The network optimization unit can implement a network optimization goal, which may relate to the number of users per sector, for example, that each sector carry a percentage of traffic less than 50% of the total traffic, less than 40% of the total traffic, or less than 35% of the total traffic, that each sector have less than 50% of the users, less than 40% of the users, less than 35% of the users, or that each sector have 33% of the users, or the like. Thus, the optimization goals can include metrics of the system performance. Although the system may not reach the goals, progress toward the goals can be provided, improving the user experience.

[0042] FIG. 2 shows an embodiment illustrating how a single base station can be used to provide coverage for a larger geographical area when a frequency reuse pattern of N=1 is used. Referring to FIG. 2, cell 1 and cell 8 would share the radio resources of sector 1 of the base station. Similarly, cell 2 and cell 10 would share the radio resources of sector 2.

[0043] The DAUs control the routing of data between the base station and the DRUs. Each individual data packet is provided with a header that uniquely identifies which DRU it is associated with. The DAUs are interconnected to allow transport of data among multiple DAUs. This feature provides the unique flexibility in the DAS network to route signals between the sectors and the individual DRUs. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. 2, and by way of example, DAU 1 (202) receives downlink signals from BTS 1 Sector 1 (201). DAU 1 translates the RF signals to optical signals and the optical fiber cable 203 transports the desired signals to DRU 2 (204). Optical cable 205 transports all the optical signals to DRU 3 (206). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (207). DAU 1 (202) is networked with DAU 2 (208) to allow the downlink signals from Sector 2 and Sector 3 to be transported to all the DRUs in Cell 1. Optical fiber cable 209 transports the desired signals to DRU 23 (210). Optical cable 211 transports all the optical signals to DRU 24 (212). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 22 (213). An embodiment illustrating a Traffic monitoring unit (221) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (220). The optimization unit (220) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0044] FIG. 3 shows an embodiment illustrating an application employing a base station hotel where N BTSs are interconnected to serve a given geographical area. The base stations may represent independent wireless network operators and/or multiple standards (WCDMA, LTE, etc.) or they may represent provision of additional RF carriers. The base station signals may be combined before they are connected to a DAU, as may be the case for a Neutral Host application. Referring to FIG. 3 and by way of example, DAU 1 (302) receives downlink signals from BTS Sector 1 (301). DAU 1 translates the RF signals to optical signals and the optical fiber cable 303 transports the desired signals to DRU 2 (304). Optical cable 305 transports all the optical signals to DRU 3 (306). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (307). DAU 1 (302) is networked with DAU 2 (308) to allow the downlink signals from BTS 1 Sector 2 to be transported to all the DRUs in Cell 1. DAU 1 (302) receives downlink signals from BTS Sector N (309). DAU 1 translates the RF signals to optical signals and the optical fiber cable 303 transports the desired signals to DRU 2 (304). Optical cable 305 transports all the optical signals to DRU 3 (306). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (307). The additional base stations provide the capability to add capacity for Cell 1.

[0045] In order to efficiently utilize the limited base station resources, the network of DRUs should have the capability of re-directing their individual uplink and downlink signals to and from any of the BTS sectors. Because the DRUs data traffic has unique streams, the DAU Router has the mechanism to route the signal to different sectors. An embodiment illustrating a Traffic monitoring unit (321) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (320). The optimization unit (320) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0046] FIG. 4 shows the two primary elements in a DAU, the Physical Nodes (400) and the Local Router (401). The Physical Nodes translate the RF signals to baseband for the Downlink and from baseband to RF for the Uplink. The Local Router directs the traffic between the various LAN Ports, PEER Ports and the External Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, or the like. The physical nodes can combine the downlink and uplink signals via a duplexer or they can keep them separate, as would be the case for a simplex configuration. In one embodiment, Traffic monitoring (416)

capability is provided in each DAU for determining the traffic load at each of the DAU ports. In this embodiment, the traffic monitoring function is performed in each DAU in comparison with other implementations in which the traffic monitoring is performed externally.

[0047] FIG. 4 shows an embodiment whereby the physical nodes have separate outputs for the uplinks (405) and separate inputs for the downlink paths (404). The physical node translates the signals from RF to baseband for the downlink path and from baseband to RF for the uplink path. The physical nodes are connected to a Local Router via external ports (409,410)). The router directs the uplink data stream from the LAN and PEER ports to the selected External U ports. Similarly, the router directs the downlink data stream from the External D ports to the selected LAN and PEER ports.

[0048] In one embodiment, the LAN and PEER ports are connected via an optical fiber to a network of DAUs and DRUs. The network connection can also use copper interconnections such as CAT 5 or 6 cabling, or other suitable interconnection equipment. The DAU is also connected to the internet network using IP (406). An Ethernet connection (408) is also used to communicate between the Host Unit and the DAU. The DRU can also connect directly to the Remote Operational Control center (407) via the Ethernet port.

[0049] FIG. 5 shows the two primary elements in a DRU, the Physical Nodes (501) and the Remote Router (500). The DRU includes both a Remote Router and Physical Nodes. The Remote Router directs the traffic between the LAN ports, External Ports and PEER Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, etc. FIG. 5 shows an embodiment whereby the physical nodes have separate inputs for the uplinks (504) and separate outputs for the downlink paths (503). The physical node translates the signals from RF to baseband for the uplink path and from baseband to RF for the downlink path. The physical nodes are connected to a Remote Router via external ports (506,507). The router directs the downlink data stream from the LAN and PEER ports to the selected External D ports. Similarly, the router directs the uplink data stream from the External U ports to the selected LAN and PEER ports. The DRU also contains a Ethernet Switch (505) so that a remote computer or wireless access points can connect to the internet.

[0050] In one embodiment, the traffic monitoring (516) capability is provided in each DRU for determining the traffic load at each of the DRU ports. In this embodiment, the traffic monitoring function is performed in each DRU in comparison with other implementations in which the traffic monitoring is performed externally.

[0051] As shown in FIG. 6, the base station hotel (610) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 6 demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (621), which is connected to the network of DAUs.

[0052] As shown in FIG. 7, the base station hotel (710) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 7 demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (721), which is connected to the Picocells. The BTS Hotel 710 includes a plurality of Picocells that are coupled to traffic monitoring unit 720. The traffic information flows from the Picocells to the traffic monitoring unit, which uses this traffic information to optimize the DAS network. The traffic monitoring unit 820 works in conjunction with network optimization unit 721, which can include traffic management algorithms used to distribute traffic efficiently throughout the DAS network.

[0053] FIG. 8 shows an embodiment of a base station hotel (810), which is comprised of multiple picocells that are interconnected to a network of DAUs via a digital interface (830).

[0054] FIG. 9 illustrates one embodiment of the DAS network optimization flow diagram. The Key Performance Indicators (KPIs) of the network traffic are collected at the various network nodes (910). KPI may comprise information such as: number of blocked calls, number of active calls, average power of uplink channels, average power of downlink channels, traffic on each sector, failed calls, number of satisfied users, number of unsatisfied users, number of users operating through a given DRU, and the like.

[0055] The DAS network performance is then analyzed in the context of the available DAS network radio resources (912). An optimization algorithm is applied to the existing DAS network with the objective to determine the optimum routing of network traffic (914). Once an optimum DAS network has been determined then an estimate of the reconfigured DAS network performance is determined (916). The reconfigured DAS network is evaluated prior to an implementation to insure that the performance will be acceptable. If the reconfigured DAS network has been determined to be acceptable then the reconfigured DAS network is implemented (918) and the entire process is repeated. In an embodiment, the load on the sectors prior to reconfiguration and after the proposed reconfiguration can be compared to determine if the shifting of the DRUs to the other sectors improves the system performance.

[0056] Thus, using the KPIs of the network traffic, the DAS network can be modified to improve system performance. As an example, if a particular DRU has a higher load than other adjacent DRUs, traffic can be routed to the adjacent DRUs in order to reduce the load on the particular DRU. Additional description related to load balancing is provided in U.S. Patent Application No. 61/600,530, filed on February 17, 2012, entitled "Evolutionary Algorithms for Geographic Load Balancing Using a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0057] As an example of optimizing network performance, a base station typically has three sectors. The DRU can be allocated to different sectors in order to improve performance by shifting traffic from a first sector (e.g., a high traffic sector) to a second sector (e.g., a low traffic sector) by shifting a DRU allocated to the first sector to the second sector. Although some embodiments of the present invention will not optimize performance of the system, the system performance can be improved using the techniques described herein, for example, by measuring the traffic load on the DRUs, performing load balancing of the traffic on the DRUs, to reduce the load on a first DRU characterized by a first traffic load by shifting the load to a second DRU characterized by a second traffic load less than the first traffic load. In the optimization process, system performance can be measured against a predetermined threshold, with the optimization process terminating once the predetermined threshold has been reached. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0058] As another example, power settings for the DRUs can be modified to improve system performance as discussed in additional detail in U.S. Patent Application No. 61/669,572, filed on July 9, 2012 and entitled, "A Self-Optimizing Distributed Antenna

System Using Soft Frequency Reuse," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0059] FIG. 10 illustrates one embodiment of the DAS network calculation of the KPIs and QoS. The important parameters for determining the DAS network QoS include the number of users allocated to a given DRU, the spatial distance between the various DRUs, as well as identifying which DRUs are assigned to which BTS sector.

[0060] FIG. 11 illustrates one embodiment of the flow chart for the optimization algorithm. In this embodiment an Estimation Distribution Algorithm (EDA) is used. Various DRU allocation scenarios are investigated to determine the optimum DRU scenario that achieves the highest QoS. In an embodiment, the initial population is generated (1110). The traffic information (KPIs) is analyzed and traffic performance (QoS) for all sectorization is analyzed (1112). A sort procedure is performed (1114) and a determination is made if the convergence criterion are satisfied (1116). If so, the process is terminated. If not, then the generation counter is updated (1118), a sort operation is performed (1120), the parameter Γ is computed (1122) and a new population is generated (1124). Then the method proceeds to the traffic information and performance analysis (1112).

[0061] Network Optimization

[0062] The network's performance (expressed by the number of KPIs from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs. When a set of KPIs is used, then the mapping needs to be represented by a weighted normalized function.

[0063] In this section we formulate the sectorization problem with mixed integer programming to balance traffic among sectors and to minimize handoffs with connected and compact sectors. Given the sectorization of DRUs at time period *t*, our problem is to obtain new sectorization at time period *t+1* that adaptively balances the change in traffic demands.

[0064] In order to formulate the problem, we consider a service coverage area with N DRUs. Each DRU is assumed to have traffic demand T_i $i = 1,...,N$. Note that, UE_A belongs to DRU_B if the received uplink power from UE_A at DRU_B is greater than the other $DRUs$. Let p_{ij} be the transition probability of mobiles from DRU_i to DRU_j. Then, the handoff calls from DRU_i to DRU_j become $h_{ij} = p_{ij}T_i$. The distance between DRU_i and DRU_j is inversely

proportional to p_{ij} . Assume that an eNodeB hotel has M VBSs. Let SOS_m and SOD_k be the set of sectors in VBS_m and the set of DRUs allocated to $Sector_k$, respectively, such that $|SOS_m| = 3$ (if each eNodeB/VBS has three sectors), $m=1,\ldots, M$ and $k=1,\ldots, K$. We consider the following three cost factors (KPIs) in the sectorization problem:

[0065] *KPI_{BC} (Inverse of the number of Blocked Calls) :* The penalty of the blocked calls caused by hard capacity and soft capacity. Let HC_m and SC_k be the hard capacity of VBS_m and soft capacity of $Sector_k$ respectively such that $HC_m = \sum_{k \in SOS_m} SC_k$. The binary variable $x_{ik} = 1$, when DRU_i belongs to $Sector_k$. $y_{im} = \sum_{k \in SOS_m} x_{ik}$, then $y_{im} = 1$ when DRU_i belongs to VBS_m .

$$sc_k = \begin{cases} 0 & if \quad \sum_i T_i x_{ik} < SC_k \\ \sum_i T_i x_{ik} - SC_k & otherwise \end{cases}$$

$$\begin{aligned} hc_m &= \sum_i T_i y_{im} - HC_m = \sum_i T_i \sum_{k \in SOS_m} x_{ik} - \sum_{k \in SOS_m} SC_k \\ &= \sum_{k \in SOS_m} \sum_i T_i x_{ik} - SC_k \\ &= \sum_{k \in SOS_m} sc_k \end{aligned}$$

(1)

Since a penalty occurs only when the calls are blocked, we apply just sc_k to the objective function, because the hc_m is a function of sc_k and there is no need to add it as another term to the objective function. sc_k is a nonnegative real variable. So,

$$KPI_{BC} = \left[\sum_{k \in SOS_m} sc_k \right]^{-1}$$

(2)

[0066] KPI_{HO} (Inverse of the number of Handoffs): we consider three different types of Handoffs :

[0067] **A. *Inter-eNodeB Handoff:*** When user equipment (UE) with an ongoing call moves from one VBS to another VBS, then the UE needs an inter-eNodeB handoff. Inter-eNodeB handoff is executed using the X2 interface (as long as the UE does not leave the LTE

coverage area) or S1 interface (when the UE leaves the serving cell). The X2 handoff includes establishing a signaling connection using the X2 Application Part (X2AP) from the source to the target eNodeB. The target eNodeB updates the MME (Mobility Management Entity) with the new geographic position of the UE. To enable this procedure, the MME needs to communicate with S-GW (Serving Gateway) to negotiate the new endpoint. During the S1 handoff, the MME receives the relocation preparation request of the source eNodeB, it starts the handoff resource allocation procedure to request the necessary radio resource from the target eNodeB. After the target eNodeB sends the required radio interface parameters embedded in a handoff command message; the MME forwards this handoff command message transparently to the UE, which executes the handoff. The main procedure is triggered by the MME and executed by S-GW.

[0068] Let the binary variable $z_{ijm} = 1$, when DRU_i and DRU_j belong to VBS_m. Then the inter-eNodeB handoff cost is computed by using the variable $z_{ij} = 1 - \sum_m z_{ijm}$, the cost becomes $\sum_i \sum_j h_{ij} z_{ij}$.

[0069] Note that inter-eNodeB handoff occurs when DRU_i and DRU_j belong to different VBS, i.e., $z_{ijm} = 0$.

[0070] *B. **Intra-eNodeB Handoff:*** When a UE with an ongoing call moves from one sector to another in a VBS, then the mobile needs an intra-eNodeB handoff. This procedure doesn't need to involve MME or S-GW because it can be handled entirely within that VBS. Now by letting the binary variable $w_{ijk} = 1$ when DRU_i and DRU_j belong to sector k, the intra-eNodeB handoff cost is computed by using two variables $w_{ij} - z_{ij}$ where $w_{ij} = 1 - \sum_k w_{ijk}$, the cost becomes $\sum_i \sum_j h_{ij}(w_{ij} - z_{ij})$.

[0071] An intra-eNodeB handoff occurs when DRU_i and DRU_j belong to different sectors of the same VBS.

[0072] *C. **Forced Handoff:*** When a DRU changes its sector, all ongoing calls in the cell have to change their pilot PN offsets for WCDMA. The cost of forced handoff is computed by employing the current sectorization a_{ik}, which is equal to zero when DRU_i is in $Sector_k$.

Since the cost occurs when DRU_i currently in another sector moves into $Sector_k$, the cost becomes $\sum_i \sum_k a_{ik} T_i x_{ik}$.

[0073] The weighted combination of these three handoff cost would be:

$$KPI_{HO} = \left[c_1 \sum_i \sum_j h_{ij} z_{ij} + c_2 \sum_i \sum_j h_{ij} (w_{ij} - z_{ij}) + c_3 \sum_i \sum_k a_{ik} T_i x_{ik} \right]^{-1}$$

(3)

[0074] ***KPI_{CI} (Inverse of the Compactness Index):*** we will try to minimize the length of handoff border with the compactness index CI which is introduced in Section II.B. In Equation (4) the numerator term represents the number of handoff DRU sides between two different sectors.

$$KPI_{CI} = [CI]^{-1} = \left[\frac{\sum_i \sum_{i<j} w_{ij} B_{ij}}{\sum_i \sum_{i<j} B_{ij}} \right]^{-1}$$

(4)

Where $B_{ij} = 1$, if DRU_i and DRU_j are adjacent.

Now we consider the following constraints required in the formulation:

1. each DRU has to belong to a sector, that is,

$$\sum_k x_{ik} = 1 \qquad \text{for all } i$$

(5)

2. The relationship between any two DRUs in a $Sector_k$ has to satisfy $w_{ijk} = 1$ if and only if $x_{ik} = x_{jk} = 1$. Thus we have:

$$w_{ijk} \le x_{ik}, w_{ijk} \le x_{jk} \; and \; w_{ijk} \ge x_{ik} + x_{jk} - 1 \qquad \text{for all } i,j \text{ and } k$$

(6)

[0075] The relationship between two DRUs in a VBS_m. $z_{ijm} = 1$ if and only if $y_{im} = y_{jm} = 1$ which leads to:

$$z_{ijm} \le y_{im}, z_{ijm} \le y_{jm} \; and \; z_{ijm} \ge y_{im} + y_{jm} - 1 \qquad \text{for all } i,j \text{ and } k$$

(7)

3. Connected sectorization, if a sector has more than one DRU, then the DRUs of the sector have to be connected. For the formulation of connected sectors we employ the cut theorem [26] on SOD_k. If $Sector_k$ is connected, then any cut that separates cells in SOD_k has at least one common side of the hexagonal cells. Let $S1_k$ be a proper subset of SOD_k, that is, $S1_k \subset SOD_k$, $S1_k \neq \phi$, and $S1_k \neq SOD_k$. Also let $S2_k$ be the opposite set of $S1_k$, that is, $S2_k = SOD_k - S1_k$. Because two subsets are connected, there exists at least one common side of the DRUs separated by the subsets. Thus we have

$$\sum_{i \in S1_k} \sum_{j \in S2_k} B_{ij} \geq 1 \quad (8)$$

[0076] Now, our QoS function is the weighted combination of three KPIs (cost factors) which we have already introduced. Obviously our objective function is to maximize the QoS function. They are penalties of blocked calls by hard and soft capacities and handoff calls. The DRU sectorization can be formulated as the following mixed integer linear programming.

Minimize

$$QoS^{-1} = w_1.KPI_{BC}^{-1} + w_2.KPI_{HO}^{-1} + w_3.KPI_{CI}^{-1} \quad (9)$$

Subject to:

$$\sum_k x_{ik} = 1 \qquad for\ all\ \ i$$

$$w_{ijk} \leq x_{ik}, w_{ijk} \leq x_{jk}\ and\ w_{ijk} \geq x_{ik} + x_{jk} - 1 \qquad for\ all\ i, j\ and\ k$$

$$w_{ij} = 1 - \sum_k w_{ijk} \qquad for\ all\ i, j$$

$$y_{im} = \sum_{k \in SOS_m} x_{ik} \qquad for\ all\ \ m$$

$$z_{ijm} \leq y_{im}, z_{ijm} \leq y_{jm}\ and\ z_{ijm} \geq y_{im} + y_{jm} - 1 \qquad for\ all\ i, j\ and\ m$$

$$z_{ij} = 1 - \sum_k z_{ijk} \qquad for\ all\ i, j$$

$$\sum_{i \in S1_k} \sum_{j \in S2_k} B_{ij} \geq 1$$

$$for\ all\ S1_k \subset SOD_k\ \ where\ \ S1_k \neq \phi\ \ \ and\ \ \ S1_k \neq SOD_k\ \ \ and\ \ \ S2_k = SOD_k - S1_k$$

$$h_{ij} = p_{ij} T_i \qquad for\ all\ \ i\ and\ \ j$$

$$hc_m = \sum_i T_i y_{im} - HC_m \qquad for\ all\ \ m$$

$$sc_k = \begin{cases} 0 & if \quad \sum_i T_i x_{ik} < SC_k \\ \sum_i T_i x_{ik} - SC_k & otherwise \end{cases} \qquad for\ all\ \ k$$

$$x_{ik}, w_{ijk}, z_{ijm}, P_k \in \{0,1\} \qquad for\ all\ i, j, k\ and\ \ m$$

[0077] Note that many grouping problems which are special cases of the sectorization problem are well-known NP-hard problems. Since our problem is NP hard, the time it takes to execute the algorithm is exponentially increasing with the size of the problem. Such an algorithm is thus in most cases unusable for real-world size problem. As an encouraging result on NP-hard problems, we investigate evolutionary algorithms to solve the sectorization problem and compare the performance with the solutions obtained by the mixed integer programming.

[0078] Estimation distribution algorithm (EDA)

[0079] Unlike other evolutionary algorithms, in EDA a new population of individuals in each generation is generated without crossover and mutation operators. Instead, in EDA a new population is generated based on a probability distribution, which is estimated from the best selected individuals of previous generation. We introduce each main-vector as an individual for our EDA approach, and also our fitness function is objective function that we mentioned it in section III. In general, conventional EDAs can be characterized by parameters and notations:

$$(I_s, F, \Delta_l, \eta_l, \beta_l, p_s, \Gamma, I_{Ter}) \quad (11)$$

where

1) I_s is the space of all potential solutions (entire search space of individuals).

2) F denotes a fitness function.

3) Δ_l is the set of individuals (population) at the l_{th} generation.

4) η_l is the set of best candidate solutions selected from set Δ_l at the l_{th} generation.

5) We denote $\beta_l \equiv \Delta_l - \eta_l \equiv \Delta_l \cap \eta_l^C$ .where η_l^C is the complement of η_l.

6) p_s is the selection probability. The EDA algorithm selects $p_s|\Delta_l|$ individuals from set Δ_l to make up set η_l.

7) We denote by Γ the distribution estimated from η_l (the set of selected candidate solutions) at each generation.

8) I_{Ter} are the maximum number of generation

In conventional EDAs, each individual is designated by a string. A typical EDA is described in the following steps:

Step 0: Generate initial population Δ_0. The initial population ($|\Delta_0|$ individuals) is typically obtained by sampling according the uniform (equally likely) distribution:

$$(\theta_1,\theta_2,\cdots,\theta_n)=\prod_{i=1}^{n}p_i(\theta_i),$$

$$i=1,2,...,n,\ \text{and}\ p_i(\theta_i=S_{i1})=p_i(\theta_i=S_{21})=...=p_i(\theta_i=S_{|SOS_M|M})=\frac{1}{\sum_{n=1}^{M}|SOS_n|} \quad (12)$$

For generation l = 1,2, ..., follow steps 1 through 6

***Step 1*:** Evaluate the individuals in the current population Δ_{l-1} according to the fitness function *F*. Sort the candidate solutions (individuals in the current population) according to their fitness orders.

***Step 2*:** If the best candidate solution satisfies the convergence criterion or the number of generation exceeds its limit I_{Ter} , then terminate; else go to step 3.

Step 3: Select the best $p_s\Delta_{l-1}$ candidate solutions (individuals) from current population Δ_{l-1}. This selection is accomplished according to the sorted candidate solutions.

Step 4: Estimate the probability distribution $p(\theta_1,\theta_2,\cdots,\theta_n)$ on the basis of $|\eta_{l-1}|$ best candidate solutions. We denote this estimation by

$$=P(\theta_1,\theta_2,\cdots,\theta_n|\eta_{l-1}) \quad (13)$$

Step 5: Generate new $|\Delta_{l-1}|-|\eta_{l-1}|$ individuals on the basis of this new estimated probability distribution Γ . Replace the bad $|\beta_{l-1}|$ individuals with newly generated $|\Delta_{l-1}|-|\eta_{l-1}|$ individuals.

Step 6: Go to step 1 and repeat the steps

We followed the steps of the above pseudo code for our EDA implementation. In our experimentation, for estimation (13), we used a simple scheme of estimating the marginal distributions separately and using product form

$$=p(\theta_1,\theta_2,\cdots,\theta_n|\eta_{l-1})=\prod_{i=1}^{n}p_i(\theta_i|\eta_{l-1})$$
$$=\prod_{i=1}^{n}\left(\frac{\sum_{j=1}^{|\eta_{l-1}|}\delta(x_i^j=\theta_i|\eta_{l-1})}{|\eta_{l-1}|}\right) \quad (14)$$

Where δ is an indicator function and it can be expressed as

$$\delta(x_i^j=\theta|\eta_{l-1})=\begin{cases}1 & \text{if } x_i^j=\theta\\ 0 & \text{otherwise}\end{cases} \quad (15)$$

[0080] It is also understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

[0081] Appendix I is a glossary of terms used herein, including acronyms.

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
CDMA	Code Division Multiple Access
CFR	Crest Factor Reduction
DAC	Digital to Analog Converter
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
LINC	Linear Amplification using Nonlinear Components
LO	Local Oscillator
LPF	Low Pass Filter
MCPA	Multi-Carrier Power Amplifier
MDS	Multi-Directional Search
OFDM	Orthogonal Frequency Division Multiplexing
PA	Power Amplifier
PAPR	Peak-to-Average Power Ratio
PD	Digital Baseband Predistortion
PLL	Phase Locked Loop
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RRH	Remote Radio Head
RRU	Remote Radio Head Unit
SAW	Surface Acoustic Wave Filter
UMTS	Universal Mobile Telecommunications System
UPC	Up Converter

WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

WHAT IS CLAIMED IS:

1. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

a plurality of Base Transceiver Stations (BTS);

a plurality of traffic monitoring modules; and

a network optimization goal and optimization algorithm.

2. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

3. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

4. The system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors.

5. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

one or more Base Transceiver Stations (BTSs); and

one or more traffic monitoring units.

6. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DAUs and coupled to each of the plurality of DAUs.

7. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DAUs.

8. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DRUs and coupled to each of the plurality of DRUs.

9. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DRUs.

10. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. The system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal.

13. The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link

14. The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. The system of claim 5 wherein the DRUs are connected in a daisy chain configuration.

16. The system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration.

17. The system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. The system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs.

19. The system of claim 5 wherein a single DAU port is connected to a plurality of Base Transceiver Stations.

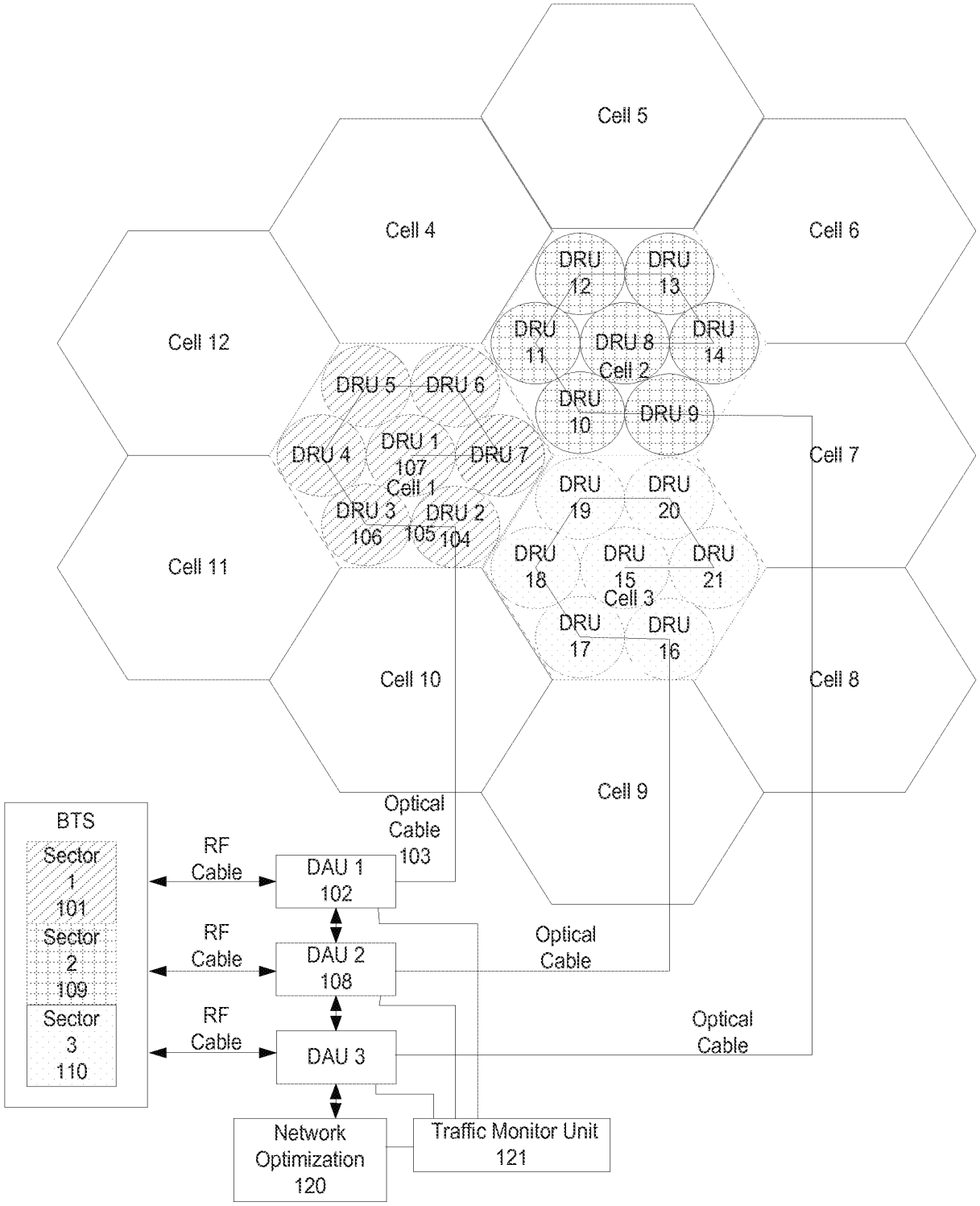

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
Cell 2
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
107
Cell 1
DRU 7
DRU 3
106
DRU 2
105
104
DRU 19
DRU 20
DRU 18
DRU 15
Cell 3
DRU 21
DRU 17
DRU 16
BTS
Sector 1 101
Sector 2 109
Sector 3 110
RF Cable
RF Cable
RF Cable
DAU 1 102
DAU 2 108
DAU 3
Optical Cable 103
Optical Cable
Optical Cable
Network Optimization 120
Traffic Monitor Unit 121

FIG. 1

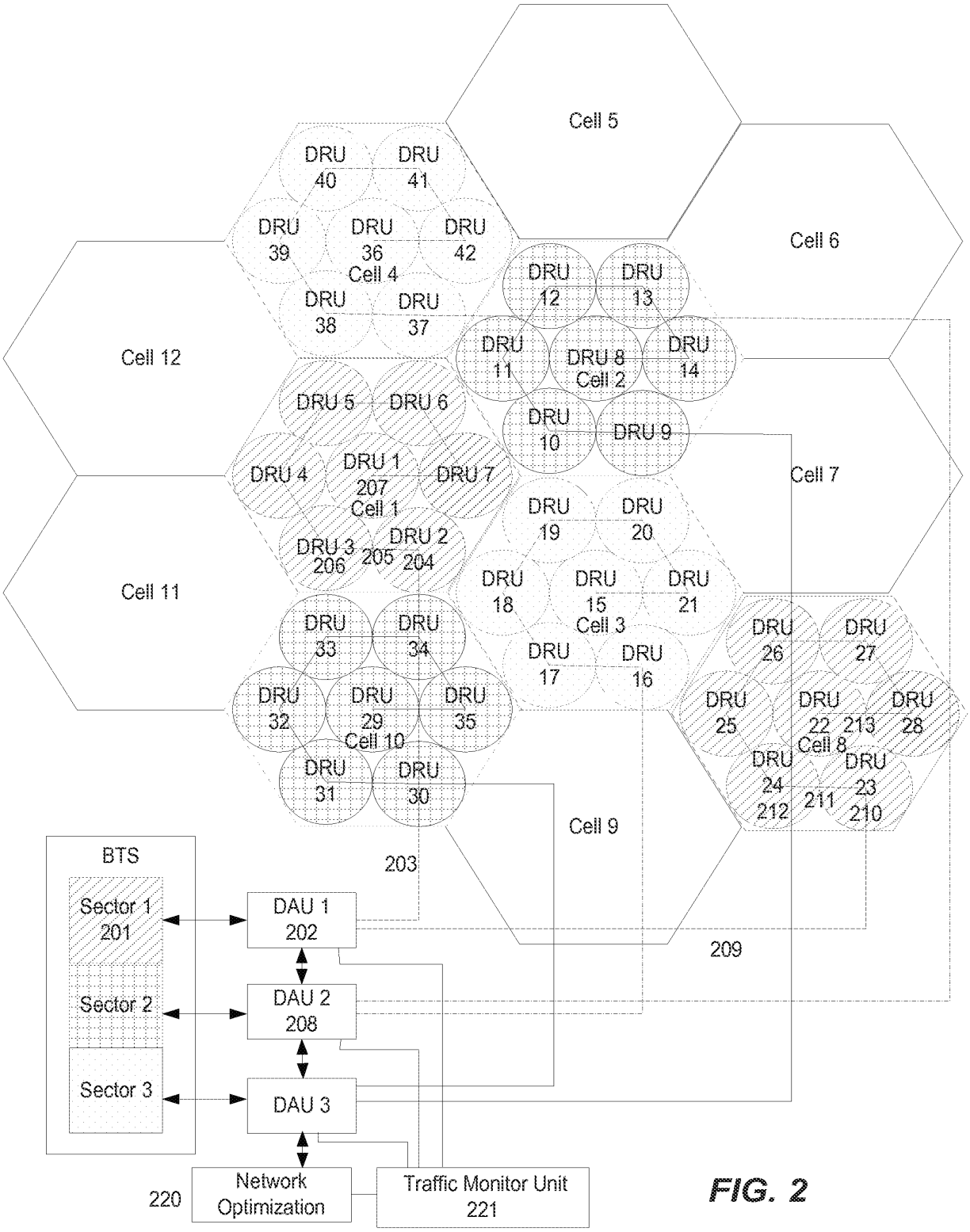

Cell 5
Cell 6
Cell 12
Cell 7
Cell 11
Cell 9
Cell 4
Cell 2
Cell 1
Cell 3
Cell 10
Cell 8
DRU 40
DRU 41
DRU 39
DRU 36
DRU 42
DRU 38
DRU 37
DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
207
DRU 7
DRU 19
DRU 20
DRU 3
206
DRU 2
205
204
DRU 18
DRU 15
DRU 21
DRU 33
DRU 34
DRU 17
DRU 16
DRU 26
DRU 27
DRU 32
DRU 29
DRU 35
DRU 25
DRU 22
213
DRU 28
DRU 31
DRU 30
DRU 24
212
211
DRU 23
210
203
209
BTS
Sector 1
201
Sector 2
Sector 3
DAU 1
202
DAU 2
208
DAU 3
220
Network
Optimization
Traffic Monitor Unit
221

FIG. 2

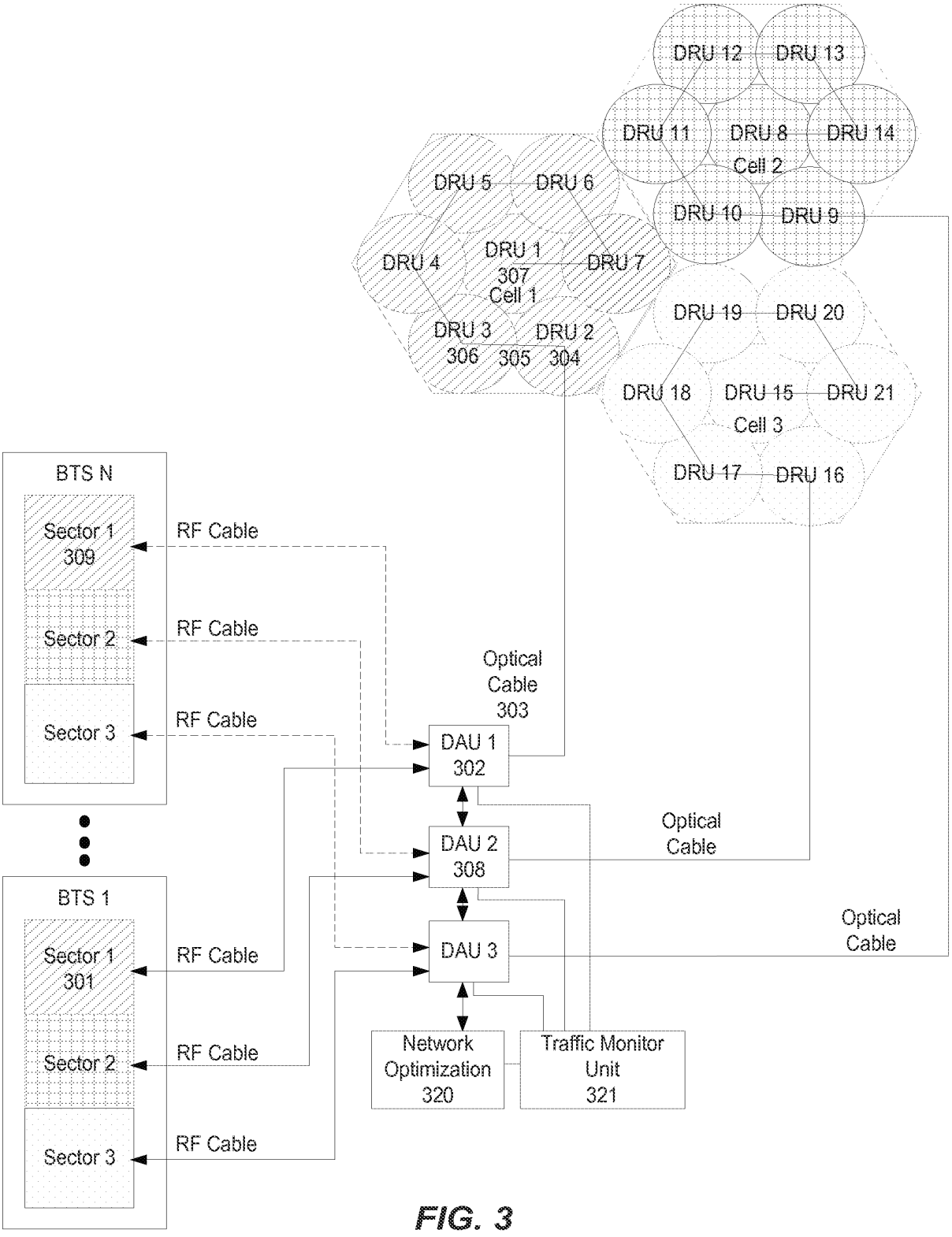

DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
307
DRU 7
Cell 1
DRU 19
DRU 20
DRU 3
306
DRU 2
305
304
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS N
Sector 1
309
RF Cable
Sector 2
RF Cable
Sector 3
RF Cable
Optical
Cable
303
DAU 1
302
Optical
Cable
DAU 2
308
Optical
Cable
BTS 1
Sector 1
301
RF Cable
DAU 3
Sector 2
RF Cable
Network
Optimization
320
Traffic Monitor
Unit
321
Sector 3
RF Cable

FIG. 3

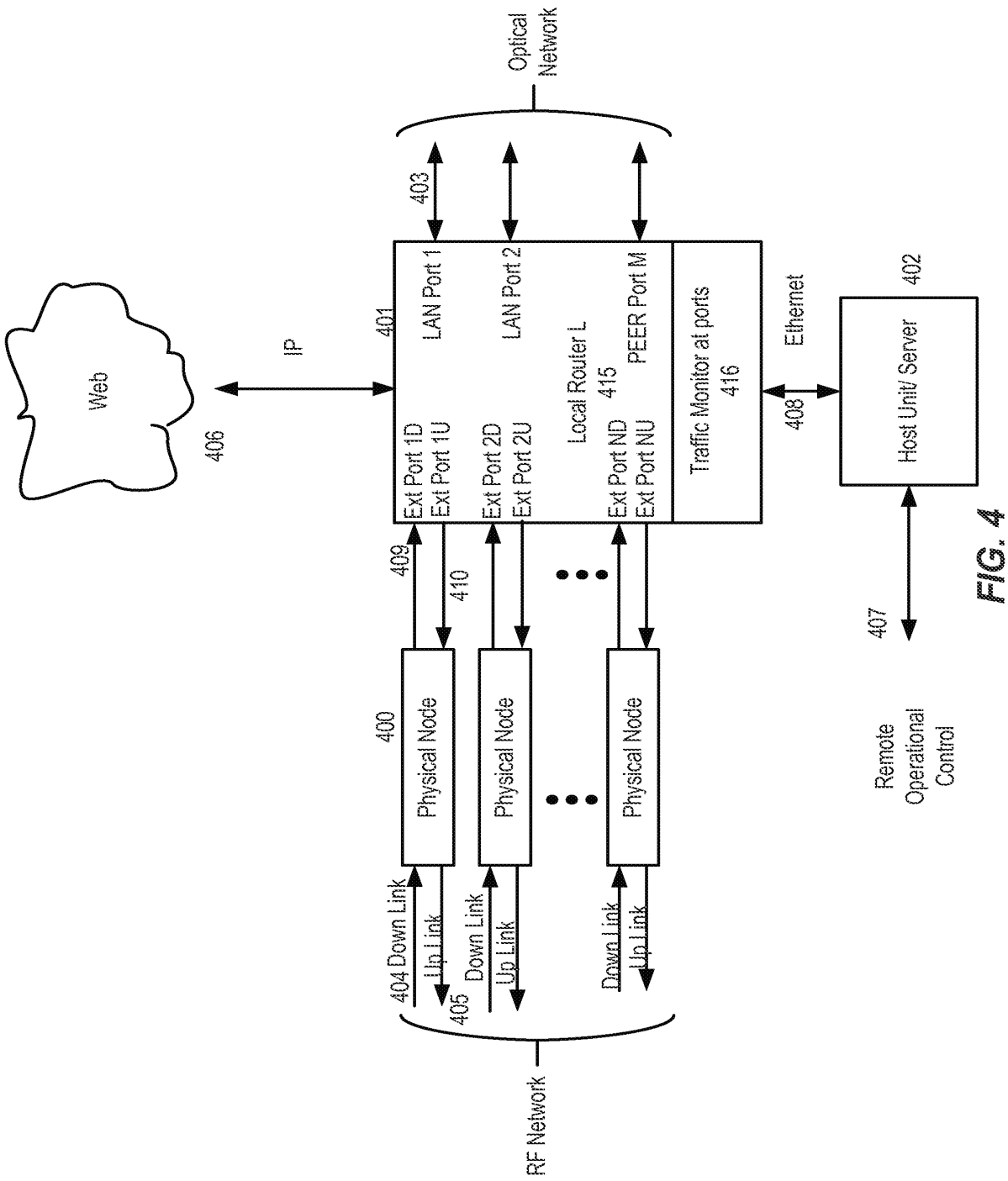

Optical Network
403
Web
406
IP
401
LAN Port 1
LAN Port 2
PEER Port M
Local Router L
415
Traffic Monitor at ports
416
Ethernet
408
Host Unit/ Server
402
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
409
410
400
Physical Node
Physical Node
Physical Node
404 Down Link
Up Link
405
Down Link
Up Link
Down Link
Up Link
RF Network
407
Remote Operational Control

FIG. 4

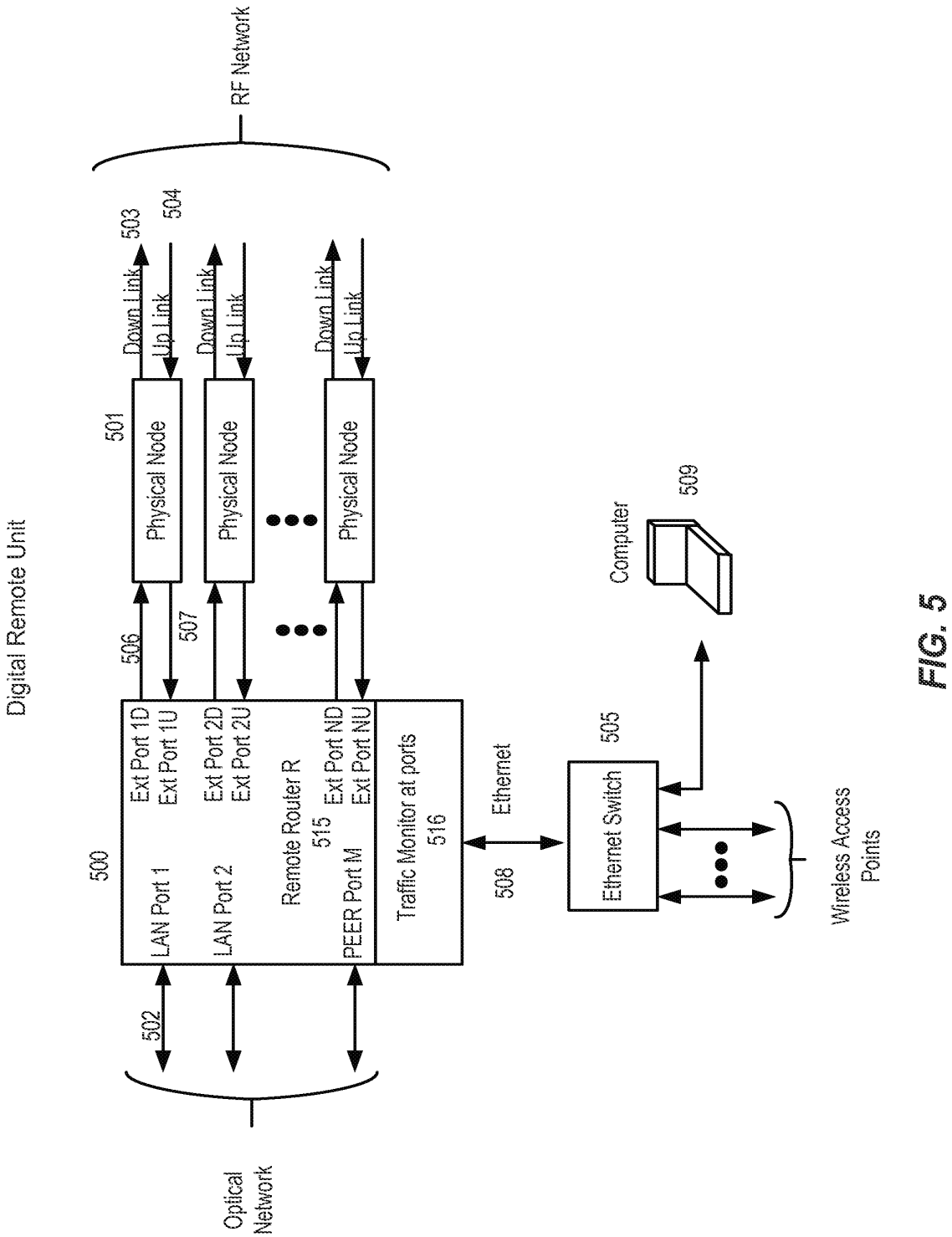

Digital Remote Unit
RF Network
Down Link
Up Link
503
504
501
Physical Node
506
507
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
LAN Port 1
LAN Port 2
Remote Router R
515
PEER Port M
Traffic Monitor at ports
516
500
502
Optical Network
Ethernet
508
Ethernet Switch
505
Computer
509
Wireless Access Points

FIG. 5

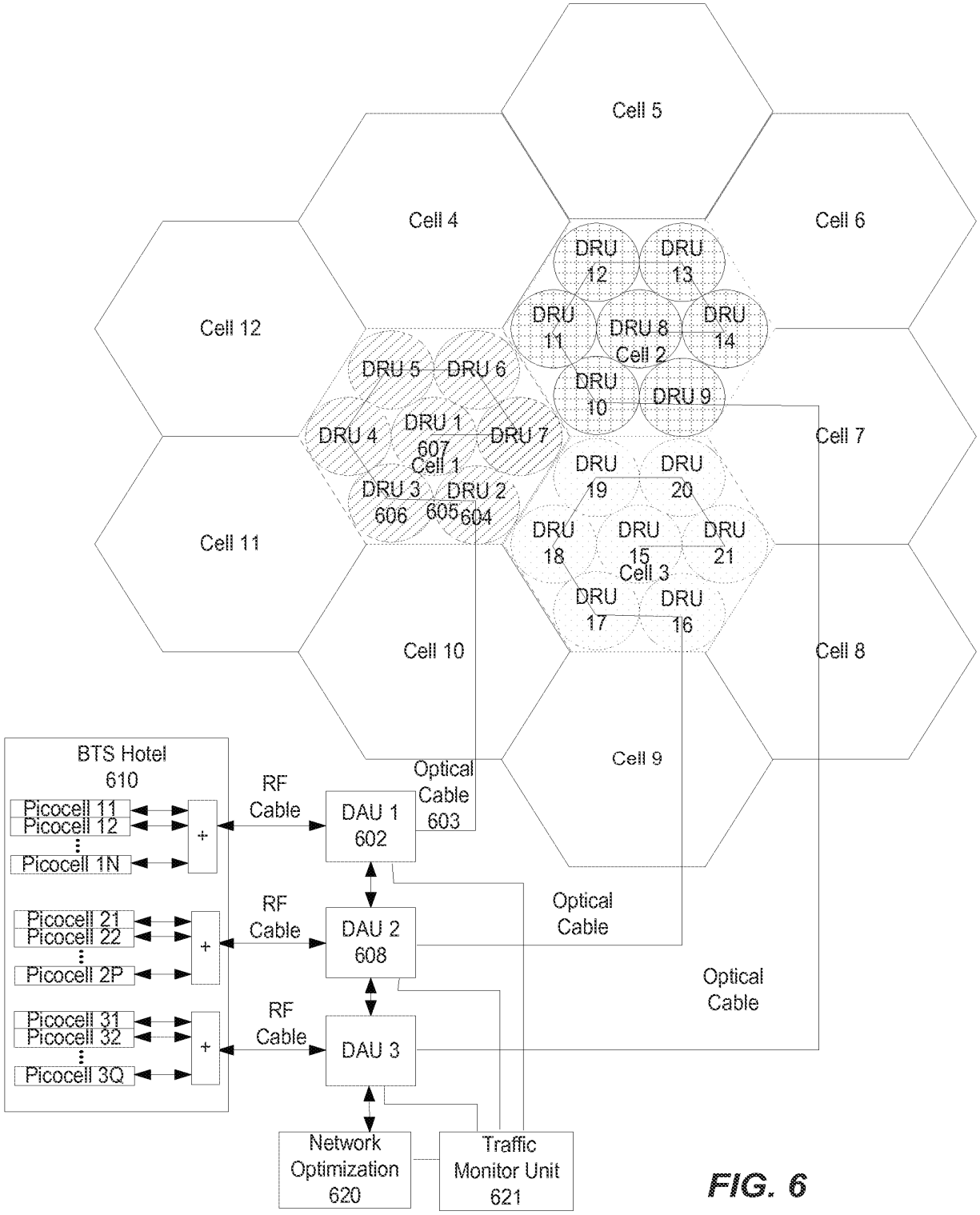

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
Cell 2
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
607
DRU 7
Cell 1
DRU 3
606
DRU 2
605
604
DRU 19
DRU 20
DRU 18
DRU 15
Cell 3
DRU 21
DRU 17
DRU 16
BTS Hotel
610
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3Q
RF
Cable
RF
Cable
RF
Cable
DAU 1
602
DAU 2
608
DAU 3
Optical
Cable
603
Optical
Cable
Optical
Cable
Network
Optimization
620
Traffic
Monitor Unit
621

FIG. 6

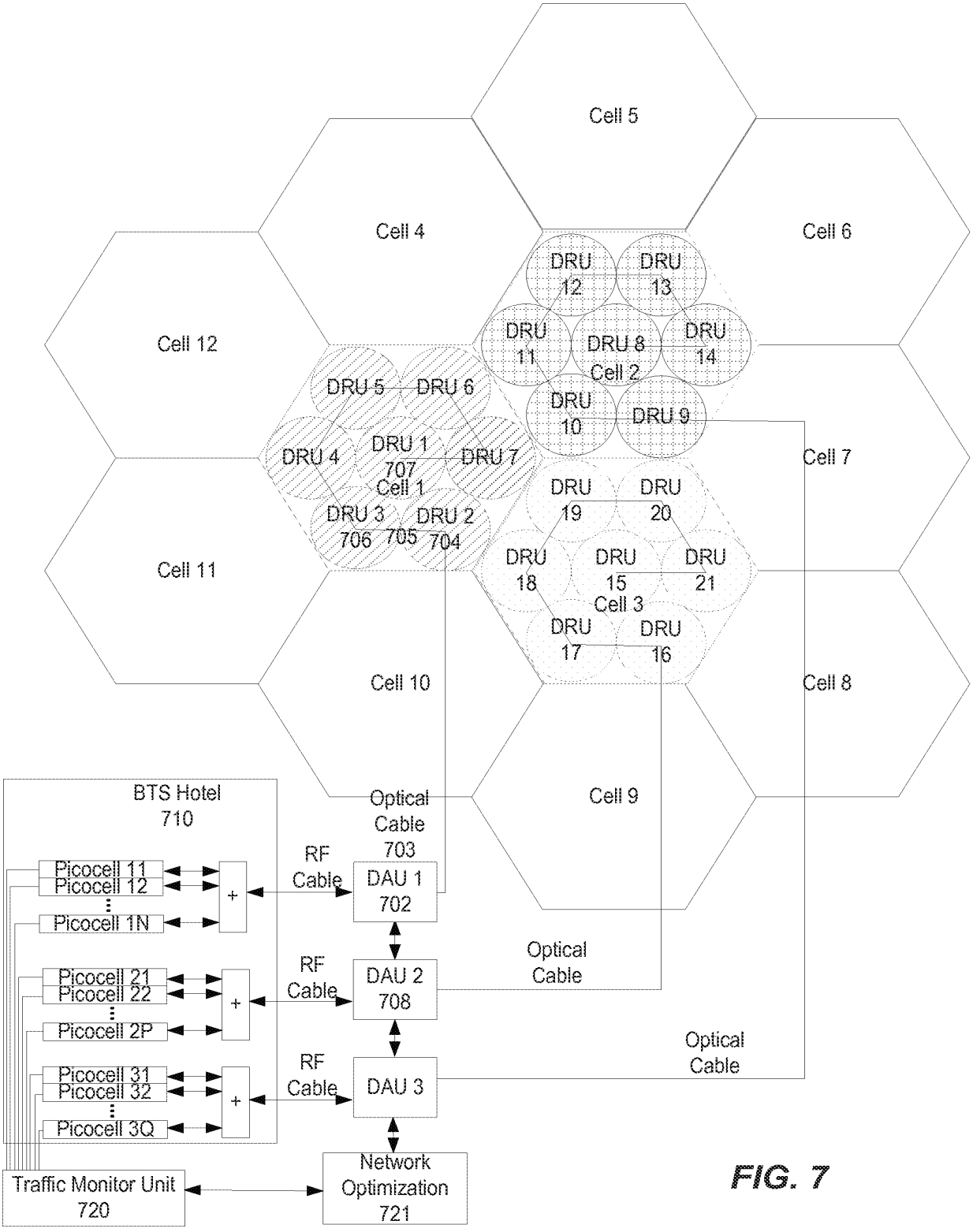

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
Cell 1
Cell 2
Cell 3
DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
707
DRU 7
DRU 19
DRU 20
DRU 3
706
DRU 2
705
704
DRU 18
DRU 15
DRU 21
DRU 17
DRU 16
BTS Hotel
710
Optical
Cable
703
RF
Cable
DAU 1
702
Picocell 11
Picocell 12
Picocell 1N
+
Optical
Cable
RF
Cable
DAU 2
708
Picocell 21
Picocell 22
Picocell 2P
+
Optical
Cable
RF
Cable
DAU 3
Picocell 31
Picocell 32
Picocell 3Q
+
Network
Optimization
721
Traffic Monitor Unit
720

FIG. 7

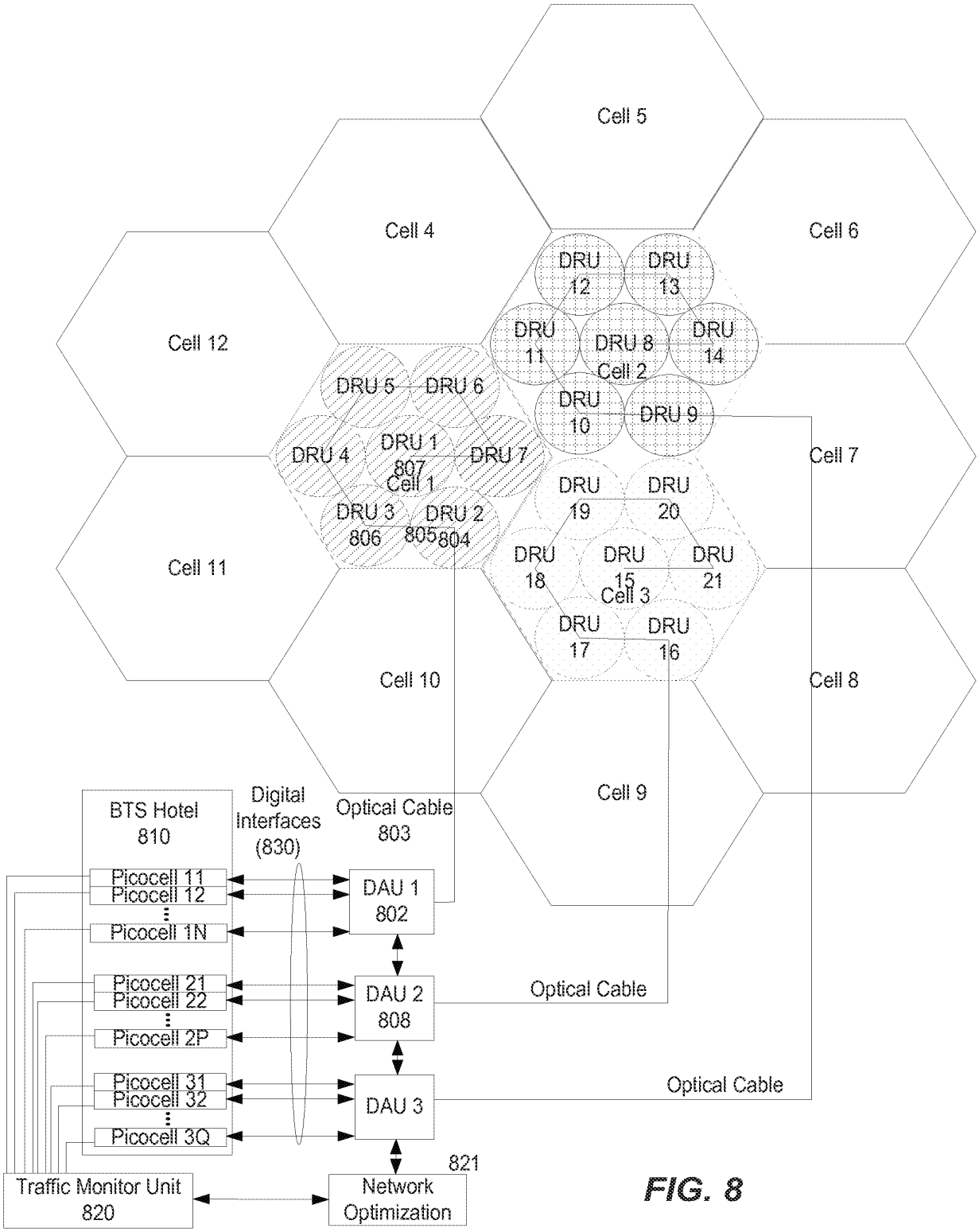

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
Cell 2
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
807
DRU 7
Cell 1
DRU 3
806
DRU 2
805
804
DRU 19
DRU 20
DRU 18
DRU 15
Cell 3
DRU 21
DRU 17
DRU 16
BTS Hotel
810
Digital
Interfaces
(830)
Optical Cable
803
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3Q
DAU 1
802
DAU 2
808
DAU 3
Optical Cable
Optical Cable
821
Traffic Monitor Unit
820
Network
Optimization

FIG. 8

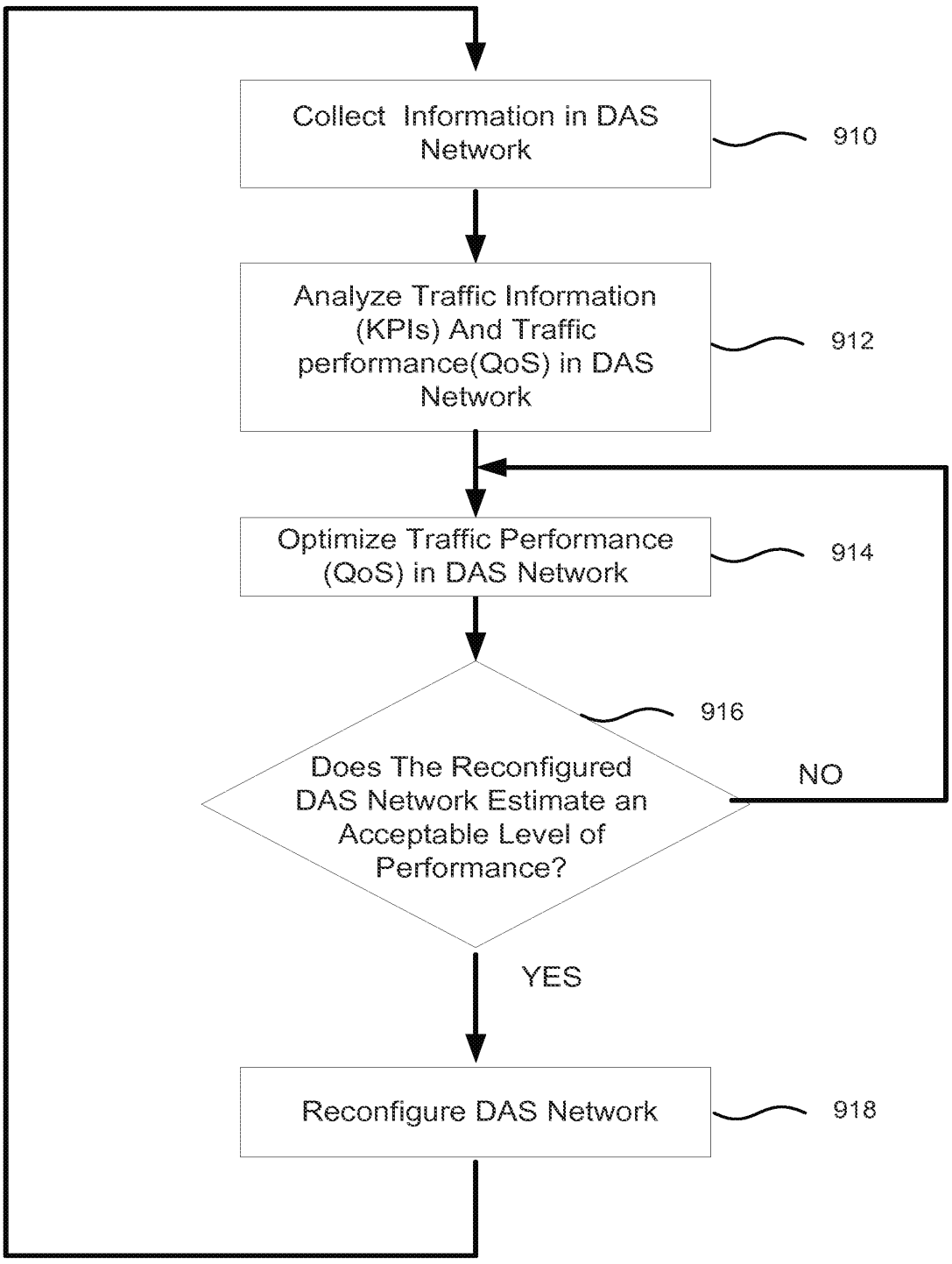

Collect Information in DAS Network
910
Analyze Traffic Information (KPIs) And Traffic performance(QoS) in DAS Network
912
Optimize Traffic Performance (QoS) in DAS Network
914
916
Does The Reconfigured DAS Network Estimate an Acceptable Level of Performance?
NO
YES
Reconfigure DAS Network
918

FIG. 9

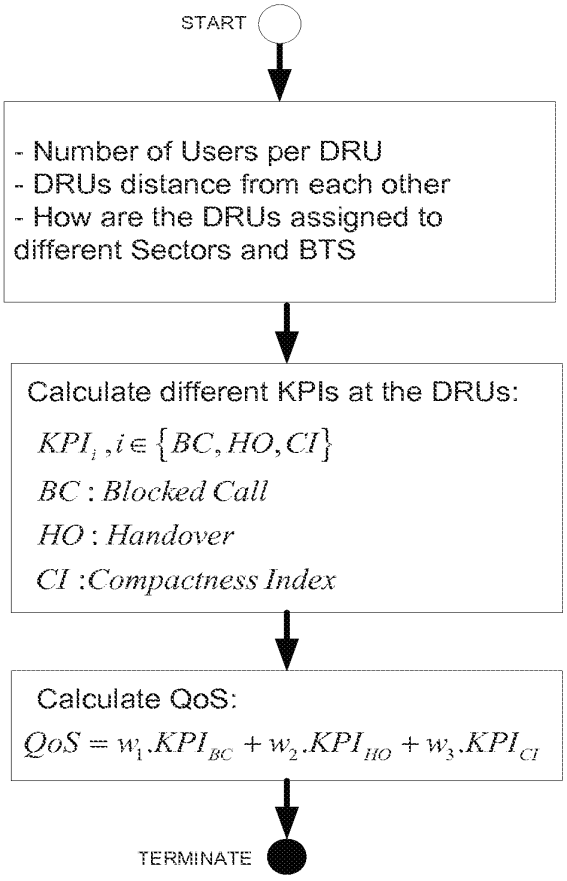
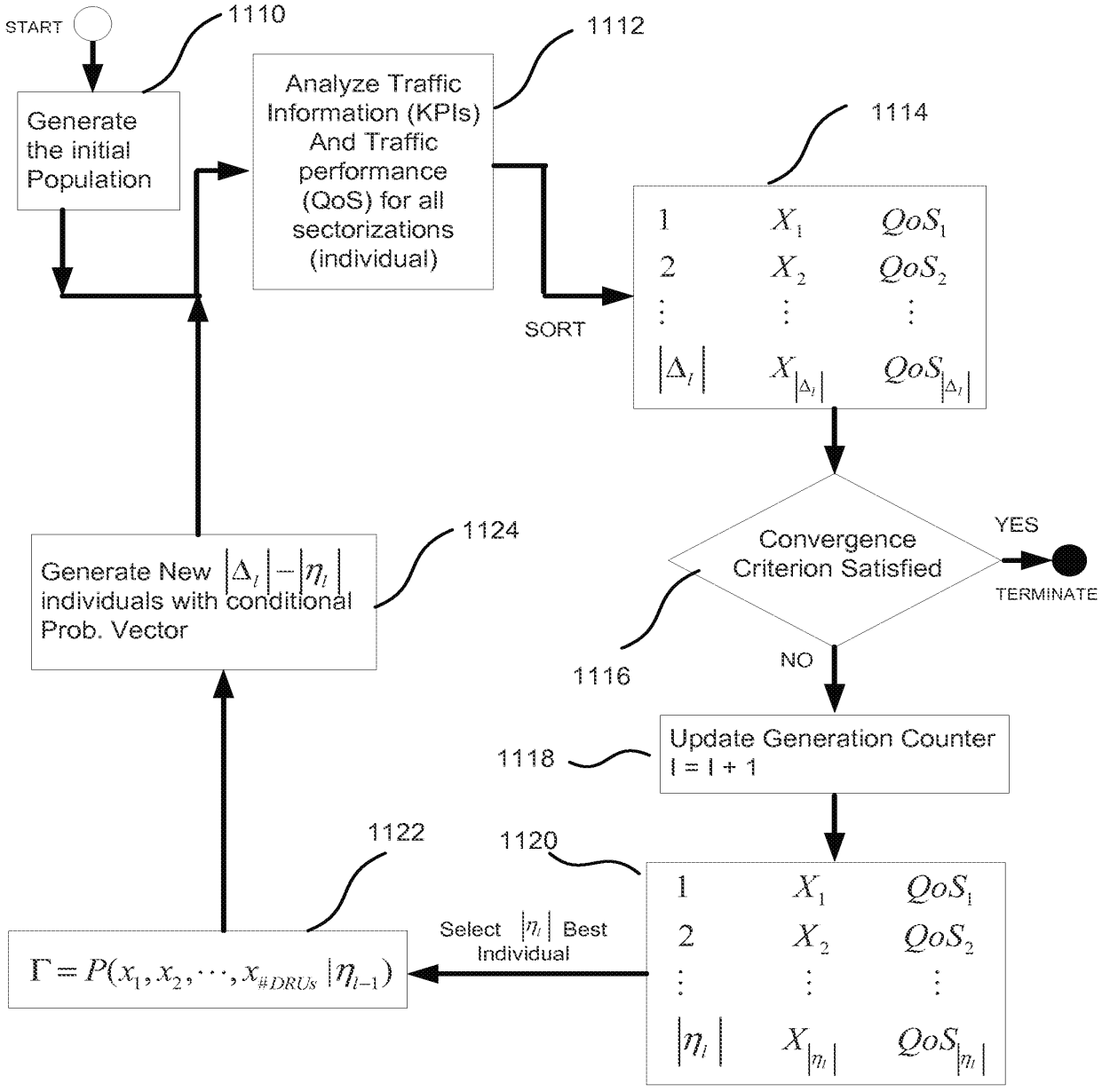

START
- Number of Users per DRU
- DRUs distance from each other
- How are the DRUs assigned to different Sectors and BTS
Calculate different KPIs at the DRUs:
$KPI_i, i \in \{BC, HO, CI\}$
BC : $Blocked\ Call$
HO : $Handover$
CI :$Compactness\ Index$
Calculate QoS:
$QoS = w_1.KPI_{BC} + w_2.KPI_{HO} + w_3.KPI_{CI}$
TERMINATE

FIG. 10



- Δ_l is Set of Individuals(population)
- Individual $X_j = (x_1, x_2, ..., x_{\#DRUs}), x_i \in \{S_{nm} | \text{sector "n" from BTS "m"}\}$

FIG. 11

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: CRAIG C. LARGENT
KILPATRICK TOWNSEND & STOCKTON LLP
1080 MARSH ROAD
MENLO PARK, CA 94025

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 31 OCT 2013
Applicant's or agent's file reference 91172-881579	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2013/052206	International filing date *(day/month/year)* 26 July 2013
Applicant DALI SYSTEMS CO. LTD.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 91172-881579	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2013/052206	International filing date *(day/month/year)* 26 July 2013	(Earliest) Priority Date *(day/month/year)* 31 July 2012
Applicant DALI SYSTEMS CO. LTD.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/052206

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04W 40/00 (2013.01)
USPC - 370/338
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - H04W 40/00, 64/00 (2013.01)
USPC - 370/338, 396

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - H04W 40/00, 64/00 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2012/0039320 A1 (LEMSON et al) 16 February 2012 (16.02.2012) entire document	1,5-15,17,18 ---- 2-4,16,19
Y	US 2002/0119772 A1 (YOSHIDA) 29 August 2002 (29.08.2002) entire document	2-4
Y	WO 2012/024349 A1 (STAPLETON et al) 23 February 2012 (23.02.2012) entire document	16,19
A	US 2005/0153743 A1 (BERRA et al) 14 July 2005 (14.07.2005) entire document	1-19

☐ Further documents are listed in the continuation of Box C. ☐

* 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
24 October 2013	31 OCT 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: CRAIG C. LARGENT
KILPATRICK TOWNSEND & STOCKTON LLP
1080 MARSH ROAD
MENLO PARK, CA 94025

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	31 OCT 2013
Applicant's or agent's file reference 91172-881579	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/052206	26 July 2013	31 July 2012

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H04W 40/00 (2013.01)
USPC - 370/338

Applicant DALI SYSTEMS CO. LTD.

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	24 October 2013	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/052206

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/052206

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2-4, 6, 8, 12, 14, 19	YES
	Claims	1, 5, 7, 9-11,13-15,17,18	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-19	NO
Industrial applicability (IA)	Claims	1-19	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 5, 7, 9-11, 13-15, 17, 18 lack novelty under PCT Article 33(2) as being anticipated by Lemson et al., hereinafter referred to as Lemson.

Regarding claim 1, Lemson discloses a system for dynamically routing signals in a Distributed Antenna System (Distributed Antenna system, abstract; Flexible Simulcast supports dynamic and/or manual rearrangement [rerouting signals] of which specific RRU are involved in signal combining process, para 0039), the system comprising: a plurality of Digital Access units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs (DAU1 [101] and DAU2 [102] [plurality of DAUs] are coupled and operable to route signals between them using bidirectional optical cable 113, para 0030, see fig. 1); a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs (RRU1 [here RRU is the DRU of the inventor specification] and RRU2 are coupled to DAU1, RRU3, RRU4 are coupled to DAU2, see fig. 1, para 0030) and operable to transport signals between DRUs and DAUs (one signal from DAU1 is fed to RRU1, RRU2 is fed by second optical port via bidirectional optical cable 114 to RRU2, para 0030, see fig. 1; RRU3 is coupled to RRU4 via optical cable 115, para 0031, see fig. 1 [where RRU3 is fed by DAU2]); a plurality of Base Transceiver Stations (BTS) (Composite downlink input signal 107 from a base station enters DAU1 at the DAU1 RF input port, a second composite downlink input signal from a second base station [multiple BTSs] enters DAU2 at the DAU2 RF input port, para 0030, see fig. 1; base transceiver station, para 0049); a plurality of traffic monitoring modules (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7); and a network optimization goal and optimization algorithm (an algorithm operating within the DAU monitoring module detects which carriers and corresponding time slots for each carrier are active for each RRU and control modification of system based on usage [network optimization algorithm with a goal of modification based on the load], para 0052, para 0016 [optimization]).

Regarding claim 5, Lemson discloses a system for dynamically routing signals in a Distributed Antenna System (Distributed Antenna system, abstract; Flexible Simulcast supports dynamic and/or manual rearrangement [rerouting signals] of which specific RRU are involved in signal combining process, para 0039), the system comprising: a plurality of Digital Access units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs (DAU1 [101] and DAU2 [102] [plurality of DAUs] are coupled and operable to route signals between them using bidirectional optical cable 113, para 0030, see fig. 1); a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs (RRU1 [here RRU is the DRU of the inventor specification] and RRU2 are coupled to DAU1, RRU3, RRU4 are coupled to DAU2, see fig. 1, para 0030) and operable to transport signals between DRUs and DAUs (one signal from DAU1 is fed to RRU1, RRU2 is fed by second optical port via bidirectional optical cable 114 to RRU2, para 0030, see fig. 1; RRU3 is coupled to RRU4 via optical cable 115, para 0031, see fig. 1 [where RRU3 is fed by DAU2]); one or more Base Transceiver Stations (BTSs) (Composite downlink input signal 107 from a base station enters DAU1 at the DAU1 RF input port, a second composite downlink input signal from a second base station [multiple BTSs] enters DAU2 at the DAU2 RF input port, para 0030, see fig. 1; base transceiver station, para 0049); and one or more traffic monitoring units (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7).

Regarding claim 7, Lemson teaches wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DAUs (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7 [the module is internal to the DAU so component of the DAU]).

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding claim 9, Lemson teaches wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DRUs (RRU management control module [internal or component of the DRU] sets the individual parameters of the RRU digital up converters to enable or disable specific radio resources [traffic control], para 0051, 0052).

Regarding claim 10, Lemson teaches wherein the one or more traffic monitoring units is external to the plurality of BTSs and coupled to each of the plurality of BTSs (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7; wherein the DAU are connected to the BTS, see fig. 1 [external to the BTSs]).

Regarding claim 11, Lemson teaches a network optimization processor coupled to the traffic monitoring unit (a network operations center (NOC) coupled to the DAU [which has the internal monitoring unit] which requests and identifies the BTS where the user has placed the call and asks DAU to determine the radio signature, para 0049).

Regarding claim 13, Lemson teaches wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber (DAU1 and DAU2 are coupled using a bidirectional optical cable 113, para 0030, see fig. 1), Microwave Line of Sight Link, Wireless Link, or Satellite Link.

Regarding claim 14, Lemson teaches wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber (DAU1 uses an optical port [optical fiber] to feed RRU1 and RRU1 is connected to RRU2 by bidirectional optical cable, para 0030, see fig. 1), Microwave Line of Sight Link, Wireless Link, or Satellite Link.

Regarding claim 15, Lemson teaches wherein the DRUs are connected in a daisy chain configuration (Optical cable 114 performs the function of daisy chaining RRU2 with RRU1, para 0030, see fig. 1).

Regarding claim 17, Lemson teaches wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link (BTS signal is fed to the DAU via a RF input port where the RF signals are received from BTS, para 0030), Wireless Link, or Satellite Link.

Regarding claim 18, Lemson teaches wherein the DRUs are connected in a loop to a plurality of DAUs (DAU is coupled to a daisy chain of RRUs and in a loop, para 0030, see fig. 1).

Claims 6, 8, 12 lack an inventive step under PCT Article 33(3) as being obvious over Lemson.

Regarding claims 6 and 8, Lemson lacks the teaching wherein the one or more traffic monitoring units is external to the plurality of DAUs and coupled to each of the plurality of DAUs. However, Lemson teaches wherein the one or more traffic monitoring units is internal to the plurality of DAUs and coupled to each of the plurality of DAUs (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7). Further, Lemson teaches a network Operation center which controls operation and assignment of users to the corresponding BTS external to the DAU and coupled to the DAU (Network Operation Center (NOC) via external modem to DAU, para 0049, see fig. 5). Furthermore, defining a structural component with same functions to be internal or external would have been a matter of design choice. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the traffic monitoring unit in the invention of Lemson for the purpose of dynamically reconfiguring the system (modification) to balance the load (Lemson, para 0051, abstract).

Regarding claim 12, Lemson lacks the teaching wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal. However, Lemson teaches a network optimization goal and optimization algorithm (an algorithm operating within the DAU monitoring module detects which carriers and corresponding time slots for each carrier are active for each RRU and control modification of system based on usage [network optimization algorithm with a goal of modification based on the load], para 0052, para 0016 [optimization]). Furthermore, defining a specific position or component for the algorithm would have been a matter of design choice. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the network optimization algorithm in the invention of Lemson for the purpose of dynamically reconfiguring the system (modification) to balance the load (Lemson, para 0051, abstract).

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 2-4 lack an inventive step under PCT Article 33(3) as being obvious over Lemson and in view of Yoshida.

Regarding claims 2 and 3, Lemson lacks the teaching wherein the Base Transceiver Station comprises a plurality of small cells. However, Lemson teaches a base transceiver station comprising a cell (a user can be located in a BTS cell, para 0049). Yoshida is in the field of base testing for use in testing an active base transceiver station (abstract) and teaches wherein the Base Transceiver station comprises a plurality of small cells (BTS has a cell divided into three or six sectors [cover different areas], para 0003, BTS2 is divided into six sectors, para 0039, see fig. 1 [each base station has 3 independent radio resources known as sectors, para 0027]). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Yoshida to incorporate the sectors in the invention of Lemson for the purpose of repeatedly utilizing the same radio wave resources in a plurality of the BTS and accommodate a great number of subscribers in each BTS (Yoshida, para 0003).

Regarding claim 4, Lemson teaches wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of DRUs (DAU Monitoring module [each DAU has one module so DAU1 and DAU2 have the modules so plurality of monitoring modules] determining and setting the appropriate amount of radio resources, para 0051, see fig. 7; wherein the module controls the downlink load of carrier based on percentage [of users as the usage of the RRUs] of carrier and in the RRU's corresponding coverage area, para 0052). Lemson lacks the teaching of plurality of sectors. Yoshida teaches wherein the Base Transceiver station comprises a plurality of small cells (BTS has a cell divided into three or six sectors [cover different areas], para 0003, BTS2 is divided into six sectors, para 0039, see fig. 1 [each base station has 3 independent radio resources known as sectors, para 0027]). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Yoshida to incorporate the sectors in the invention of Lemson for the purpose of repeatedly utilizing the same radio wave resources in a plurality of the BTS and accommodate a great number of subscribers in each BTS (Yoshida, para 0003).

Claims 16, 19 lack an inventive step under PCT Article 33(3) as being obvious over Lemson and in view of Stapleton et al., hereinafter referred to as Stapleton.

Regarding claim 16, Lemson lacks the teaching wherein the DRUs are connected to the DAUs in a star configuration. Stapleton is in the field of daisy-chained ring of remote units for a distributed antenna system (title, abstract) and teaches wherein the DRUs are connected to the DAUs in a star configuration (DAU coupled to DRUs 125A-125C arranged in a ring configuration, para 0029, see fig. 1). Furthermore, defining a specific configuration for communication was well known in the art and the specifics would have been a matter of design choice. Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Stapleton to incorporate the configuration of the DRUs in the invention of Lemson for the purpose of connecting in a ring configuration fault tolerance is built into the system resulting in high availability (Stapleton, para 0009).

Regarding claim 19, Lemson lacks the teaching wherein a single DAU port is connected to a plurality of Base Transceiver Stations. Stapleton teaches wherein a single DAU port is connected to a plurality of Base Transceiver Stations (RF input signals 120A through 120N are received at the DAU 105 from one or more Base Station units (BTS) at 110A through 110p, para 00029, see fig. 1). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Stapleton to incorporate the single DAU to multiple BTSs in the invention of Lemson for the purpose of delivering parallel data streams to different DRUs (Stapleton, para 0029).

Claims 1-19 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Electronic Acknowledgement Receipt	
EFS ID:	18286943
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Julia Panibratyuk
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	91172-882666(103900US)
Receipt Date:	24-FEB-2014
Filing Date:	24-JUL-2013
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		IDS.pdf	143028 c6b16df21b0c844750654320a923de84bbb55e53	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	WO12024349.pdf	1248372 a99a91412b384207101d5a9fb18d2a2193ed954f	no	38
Warnings:					
Information:					
3	Foreign Reference	WO2014022211.pdf	2397785 ce7be1bd7a1030711237ad4d7cc30e2c4baef81c	no	38
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	2013_10_31_ISR_WO_PCTUS2013052206.pdf	514065 1ad57ebb0af1d4fbbf7b0b56d884dfae153c2be8	no	8
Warnings:					
Information:					
		Total Files Size (in bytes):	4303250		

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 February 24, 2014.

KILPATRICK TOWNSEND & STOCKTON LLP

By: /Julia Panibratyuk/
Julia Panibratyuk

PATENT
Attorney Docket No.: 91172-882666 (103900US)
Client Ref. No.: DW-1039

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Shawn Patrick Stapleton et al. Application No.: 13/950,160 Filed: July 24, 2013 For: OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM Customer No.: 20350	Confirmation No.: 6371 Examiner: Unassigned Technology Center/Art Unit: 2642 INFORMATION DISCLOSURE STATEMENT

Mail Stop IDS
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. Copies of the references in compliance with the requirements of 37 CFR § 1.98(a)(2) are enclosed.

Also enclosed is a copy of the Search/Examination report corresponding to the PCT application.

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 a fee is required, the Commissioner is authorized to deduct such fee from the undersigned's Deposit Account No. 20-1430. Please deduct any additional fees from, or credit any overpayment to, the above-noted Deposit Account.

Respectfully submitted,

/Craig C. Largent/

Craig C. Largent
Registration No. 56,400

KILPATRICK TOWNSEND & STOCKTON LLP
Two Embarcadero Center, Eighth Floor
San Francisco, California 94111-3834
Tel: 650-326-2400
Fax: 415-576-0300
CCL/jp

KILPATRICK TOWNSEND 66096533 1

81172-725400

PTO/AIA/82 (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 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.

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 Systems Co., Ltd.

Application No./Patent No.: 13/950,160 Filed/Issue Date: July 24, 2013

Titled: OPTIMIZATION OF TRAFFIC LOAD IN A 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: _____ To: _____

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

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

2. 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.

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.

/Craig C. Largent/	October 11, 2013
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.

Attorney Docket No.: 91172-882666(103900US)

ASSIGNMENT OF PATENT APPLICATION

JOINT

WHEREAS, Shawn Patrick Stapleton of Burnaby, BC, Canada; and Seyed Amin Hejazi of Burnaby, BC, Canada, hereinafter referred to as "Assignors," is the inventor of the invention described and set forth in the below-identified application for United States Letters Patent:

Title of Invention: **OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM**

Date(s) of execution of Declaration: 26 July 2013

Filing Date: July 24, 2013

Application No.: 13/950,160; and

WHEREAS, DALI SYSTEMS CO. LTD., located at Maples Corporate Services Limited, P.O. Box 309, Ugland House, South Church Street, George Town, Grand Cayman KY1-1104, Cayman Islands, hereinafter referred to as "ASSIGNEE," is desirous of acquiring an interest in the invention and application and in any U.S. Letters Patent and Registrations which may be granted on the same;

For good and valuable consideration, receipt of which is hereby acknowledged by Assignor, Assignor has assigned, and by these presents does assign to Assignee all right, title and interest in and to the invention and application and to all foreign counterparts (including patent, utility model and industrial designs), and in and to any Letters Patent and Registrations which may hereafter be granted on any patent application claiming priority from the same in the United States and all countries throughout the world, and to claim the priority from the application as provided by the Paris Convention. The right, title and interest is to be held and enjoyed by Assignee and Assignee's successors and assigns as fully and exclusively as it would have been held and enjoyed by Assignor had this Assignment not been made, for the full term of any Letters Patent and Registrations which may be granted thereon, or of any division, renewal, continuation in whole or in part, substitution, conversion, reissue, prolongation or extension thereof.

Assignors further agree that Assignors will, without charge to Assignors, but at Assignee's expense, (a) cooperate with Assignee in the prosecution of U.S. Patent applications and foreign counterparts on the invention and any improvements, (b) execute, verify, acknowledge and deliver all such further papers, including applications and instruments of transfer, and (c) perform such other acts as Assignee lawfully may request to obtain or maintain Letters Patent and Registrations for the invention and improvements in any and all countries, and to vest title thereto in Assignee, or Assignee's successors and assigns.

IN TESTIMONY WHEREOF, Assignor has signed his/her name on the date indicated.

Dated: 7/25/2013

Shawn Patrick Stapleton

Dated: 26 July 2013

Seyed Amin Hejazi

Electronic Patent Application Fee Transmittal

Application Number:	13950160
Filing Date:	24-Jul-2013
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Filer:	Craig Cody Largent/Kristina Alvarez
Attorney Docket Number:	91172-882666(103900US)

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

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($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		800

Electronic Acknowledgement Receipt	
EFS ID:	17111201
Application Number:	13950160
International Application Number:	
Confirmation Number:	6371
Title of Invention:	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM
First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
Customer Number:	20350
Filer:	Craig Cody Largent/Kristina Alvarez
Filer Authorized By:	Craig Cody Largent
Attorney Docket Number:	91172-882666(103900US)
Receipt Date:	11-OCT-2013
Filing Date:	24-JUL-2013
Time Stamp:	17:50:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$800
RAM confirmation Number	5355
Deposit Account	201430
Authorized User	LARGENT, CRAIG C.
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)	
Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)	
Charge any Additional Fees required under 37 C.F.R. Section 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	Oath or Declaration filed	Declaration.pdf	562399 1c010b2c8c1d2bc91ed95fc9e29b4badf4b6bd58	no	2
Warnings:					
Information:					
2	Power of Attorney	PwrAtty.pdf	276353 a1866bef9d42c9cc5a228b4f720f8461b214eee5	no	1
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73.	373c3.pdf	571905 86f79e208020ea9e08a0cb08a4d75c27232e2284	no	4
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	37334 bae4f415dfeb43bd600cd923acdeb66024452168	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1447991		

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/01 (05-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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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	OPTIMIZATION OF TRAFFIC LOAD IN A 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 13/950,160 filed on July 24, 2013

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

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

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Shawn Patrick Stapleton Date (Optional): 7/25/2013

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.

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

PTO/AIA/01 (06-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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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	OPTIMIZATION OF TRAFFIC LOAD IN A 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 13/950,160 filed on July 24, 2013

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

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

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Seyed Amin Hejazi Date (Optional): 26 July 2013

Signature: A.H

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.

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

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/950,160

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))	19 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 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($)	ADDITIONAL FEE($)	OR	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
13/950,160	07/24/2013	Shawn Patrick Stapleton	91172-882666(103900US)

CONFIRMATION NO. 6371

20350
KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

FORMALITIES LETTER

OC000000063112098

Date Mailed: 08/13/2013

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.
  *Applicant must submit $**70** to complete the basic filing fee for a small entity.*

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A surcharge (for late submission of the basic filing fee, search fee, examination fee or inventor's oath or declaration) as set forth in 37 CFR 1.16(f) of $ **70** for a small entity in compliance with 37 CFR 1.27, must be submitted.

SUMMARY OF FEES DUE:

Total fee(s) required within **TWO MONTHS** from the date of this Notice is $ **800** for a small entity
- $ **70** Statutory basic filing fee.
- $ **70** Surcharge.
- The application search fee has not been paid. Applicant must submit $ **300** to complete the search fee.
- The application examination fee has not been paid. Applicant must submit $ **360** to complete the examination fee for a small entity in compliance with 37 CFR 1.27.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):

Shawn Patrick Stapleton
Seyed Amin Hejazi

Applicant may submit the inventor's oath or declaration at any time before the Notice of Allowance and Fee(s) Due, PTOL-85, is mailed.

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.
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.

/rerry/

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

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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
13/950,160	07/24/2013	2642	0.00	91172-882666(103900US)	19	2

CONFIRMATION NO. 6371

20350
KILPATRICK TOWNSEND & STOCKTON LLP
TWO EMBARCADERO CENTER
EIGHTH FLOOR
SAN FRANCISCO, CA 94111-3834

FILING RECEIPT

OC000000063112097

Date Mailed: 08/13/2013

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

Inventor(s)
Shawn Patrick Stapleton, Burnaby, CANADA;
Seyed Amin Hejazi, Burnaby, CANADA;

Applicant(s)
DALI SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS

Assignment For Published Patent Application
DALI SYSTEMS CO. LTD., George Town, CAYMAN ISLANDS

Power of Attorney: None

Domestic Priority data as claimed by applicant
This appln claims benefit of 61/678,016 07/31/2012

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

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 08/07/2013
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/950,160**
Projected Publication Date: To Be Determined - pending completion of Missing Parts
Non-Publication Request: No

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

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

Preliminary Class

455

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

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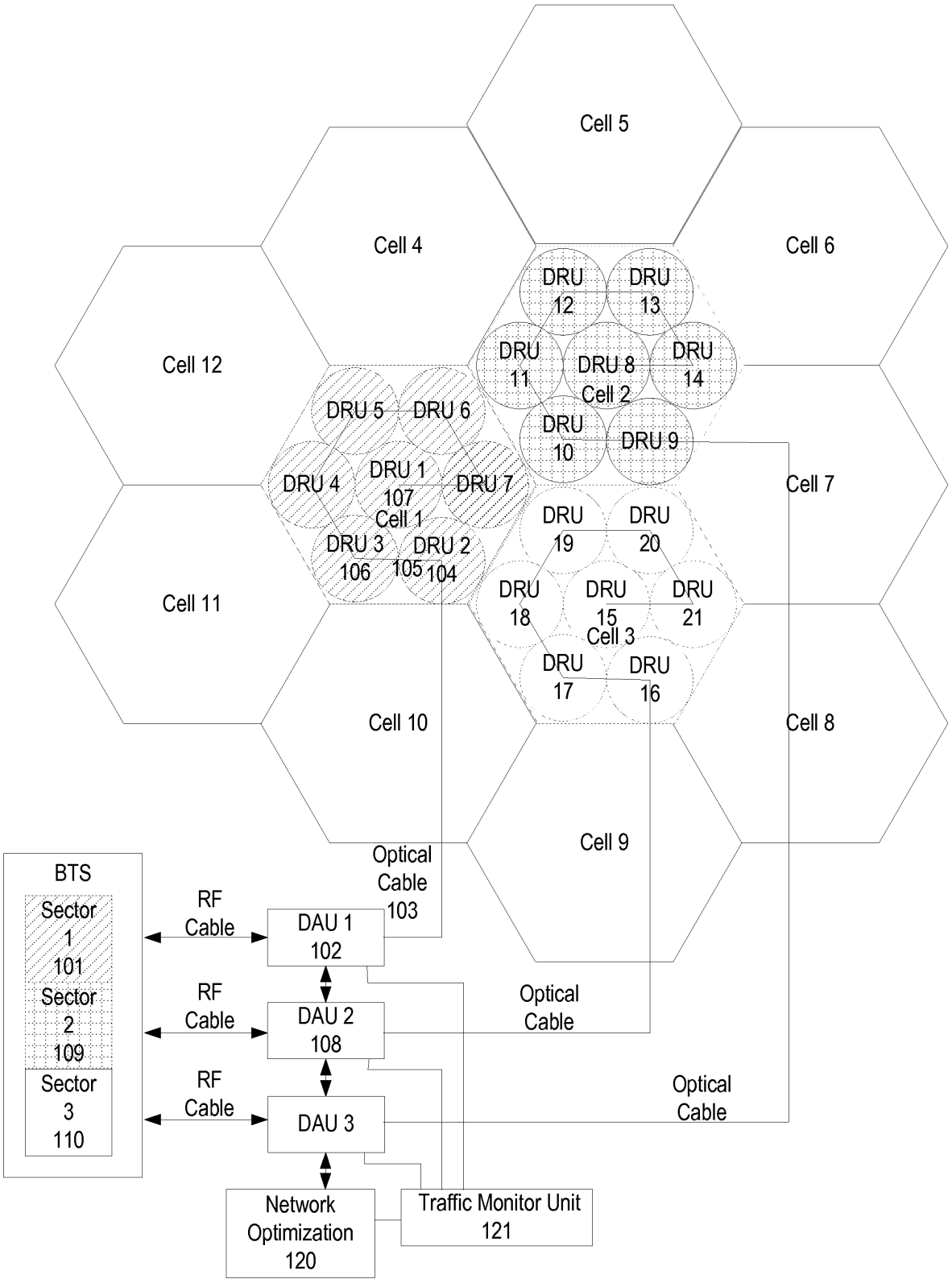
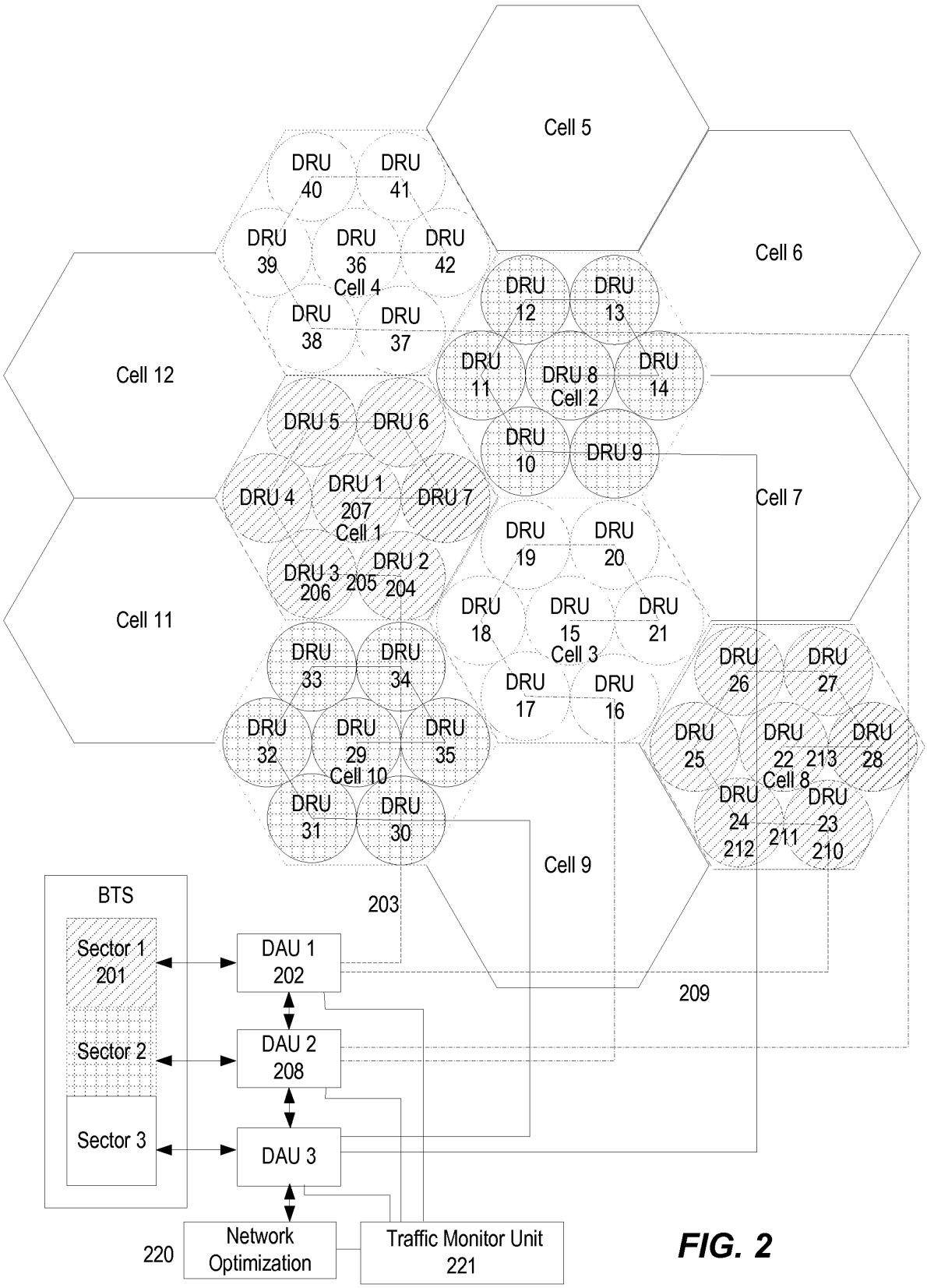

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
107
DRU 7
Cell 1
DRU 19
DRU 20
DRU 3
106
DRU 2
105
104
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS
Sector 1 101
Sector 2 109
Sector 3 110
RF Cable
RF Cable
RF Cable
DAU 1 102
DAU 2 108
DAU 3
Optical Cable 103
Optical Cable
Optical Cable
Network Optimization 120
Traffic Monitor Unit 121

FIG. 1


Cell 5
Cell 6
Cell 7
Cell 8
Cell 9
Cell 10
Cell 11
Cell 12
Cell 1
Cell 2
Cell 3
Cell 4
DRU 1
DRU 2
DRU 3
DRU 4
DRU 5
DRU 6
DRU 7
DRU 8
DRU 9
DRU 10
DRU 11
DRU 12
DRU 13
DRU 14
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DRU 37
DRU 38
DRU 39
DRU 40
DRU 41
DRU 42
207
205
204
206
213
211
212
210
203
209
BTS
Sector 1
201
Sector 2
Sector 3
DAU 1
202
DAU 2
208
DAU 3
220
Network
Optimization
Traffic Monitor Unit
221

FIG. 2

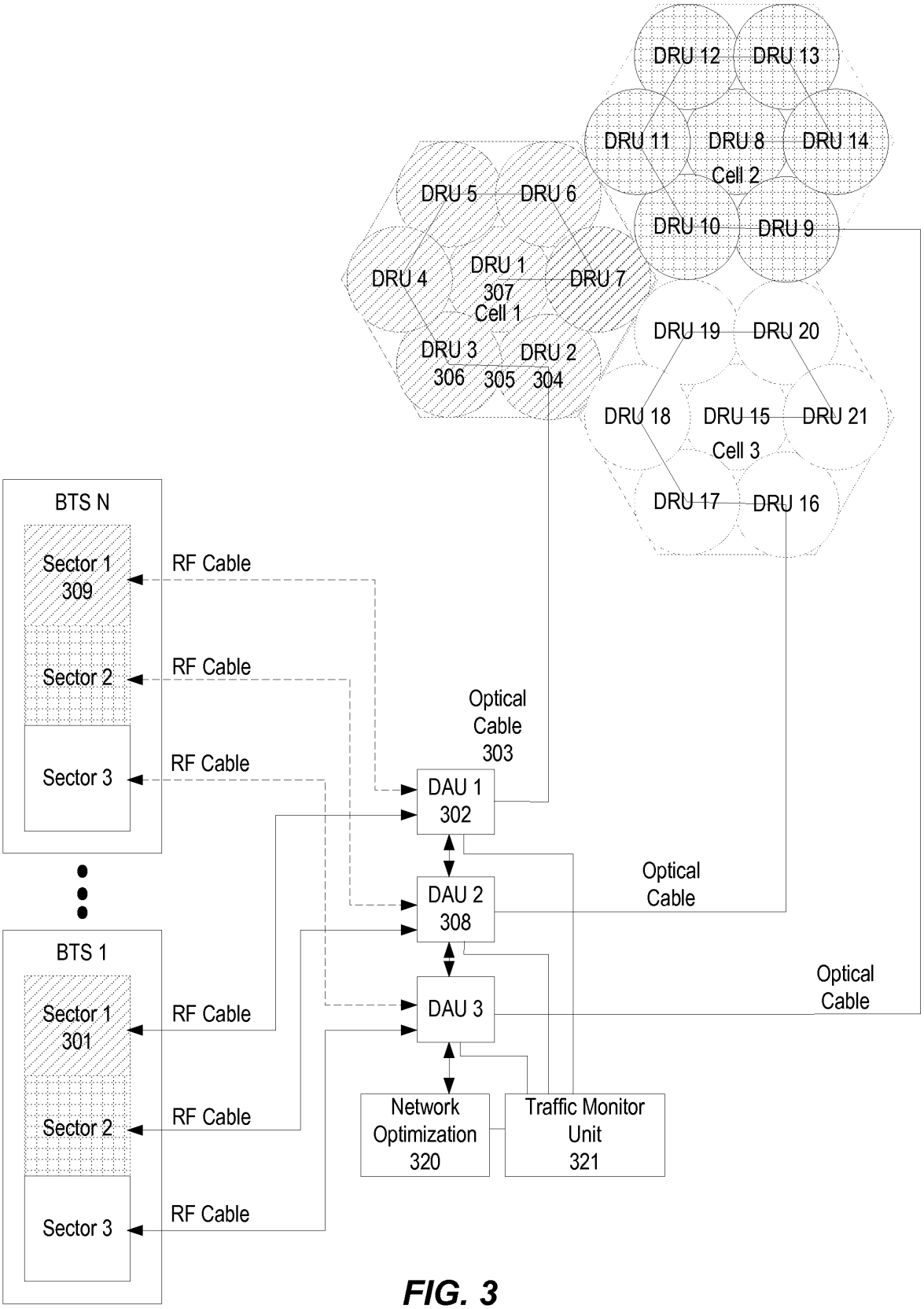

DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
307
Cell 1
DRU 7
DRU 19
DRU 20
DRU 3
306
305
DRU 2
304
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS N
Sector 1
309
RF Cable
Sector 2
RF Cable
Optical
Cable
303
Sector 3
RF Cable
DAU 1
302
Optical
Cable
DAU 2
308
BTS 1
Optical
Cable
Sector 1
301
RF Cable
DAU 3
Sector 2
RF Cable
Network
Optimization
320
Traffic Monitor
Unit
321
Sector 3
RF Cable

FIG. 3

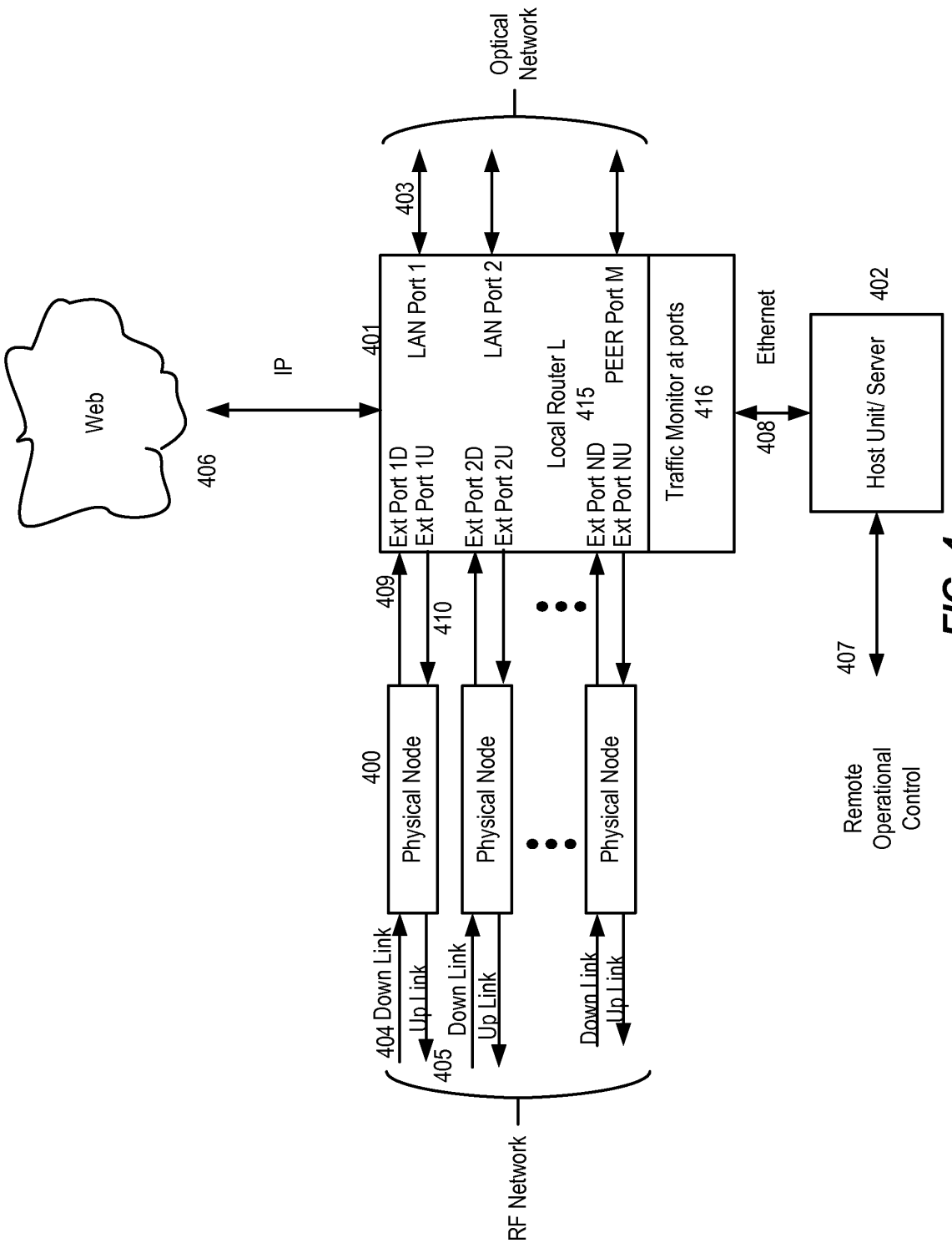

Optical Network
403
Web
406
IP
401
LAN Port 1
LAN Port 2
PEER Port M
Local Router L
415
Traffic Monitor at ports
416
Ethernet
408
Host Unit/ Server
402
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
409
410
400
Physical Node
Physical Node
Physical Node
404 Down Link
Up Link
405
Down Link
Up Link
Down Link
Up Link
RF Network
407
Remote Operational Control

FIG. 4

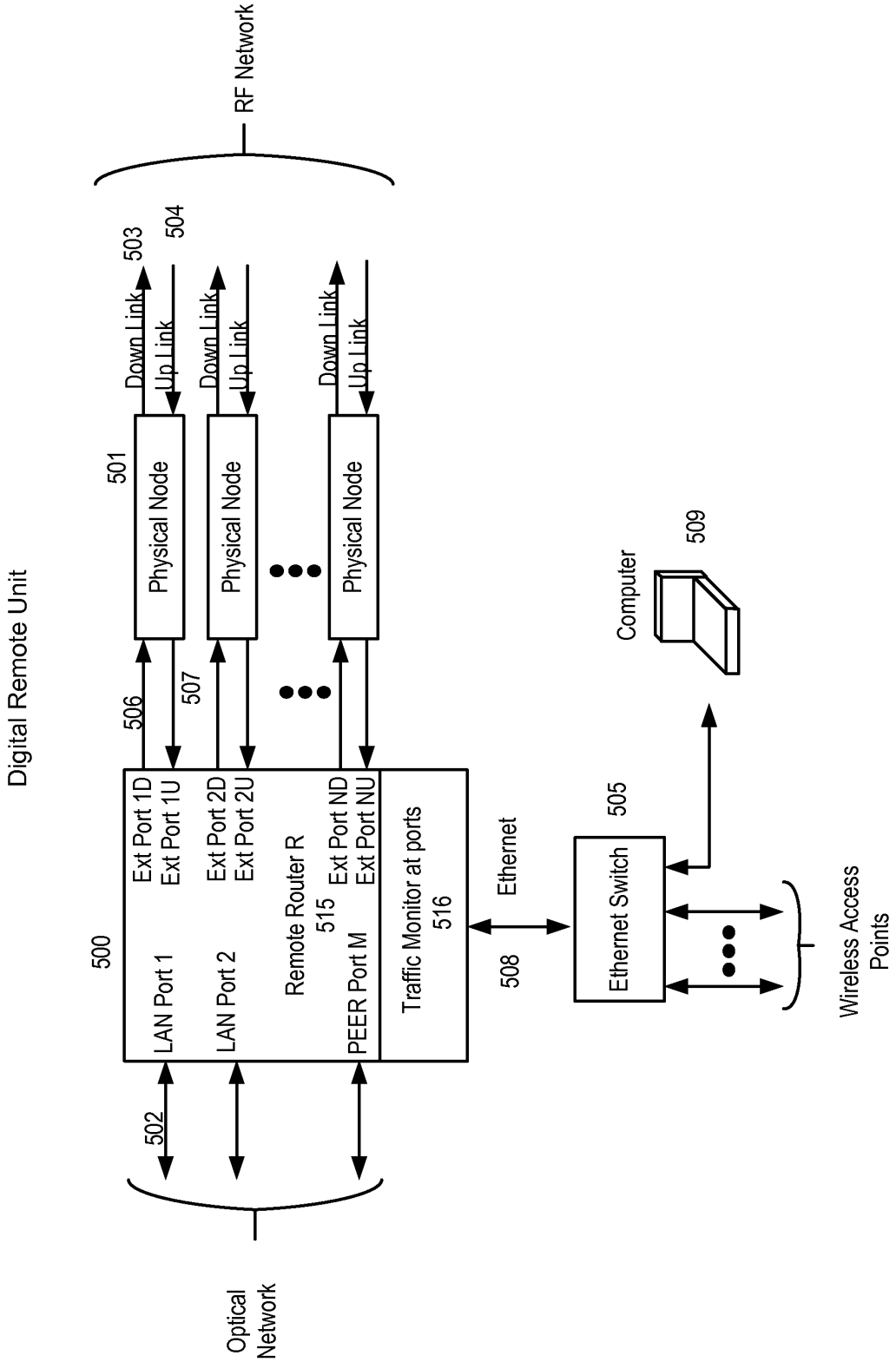
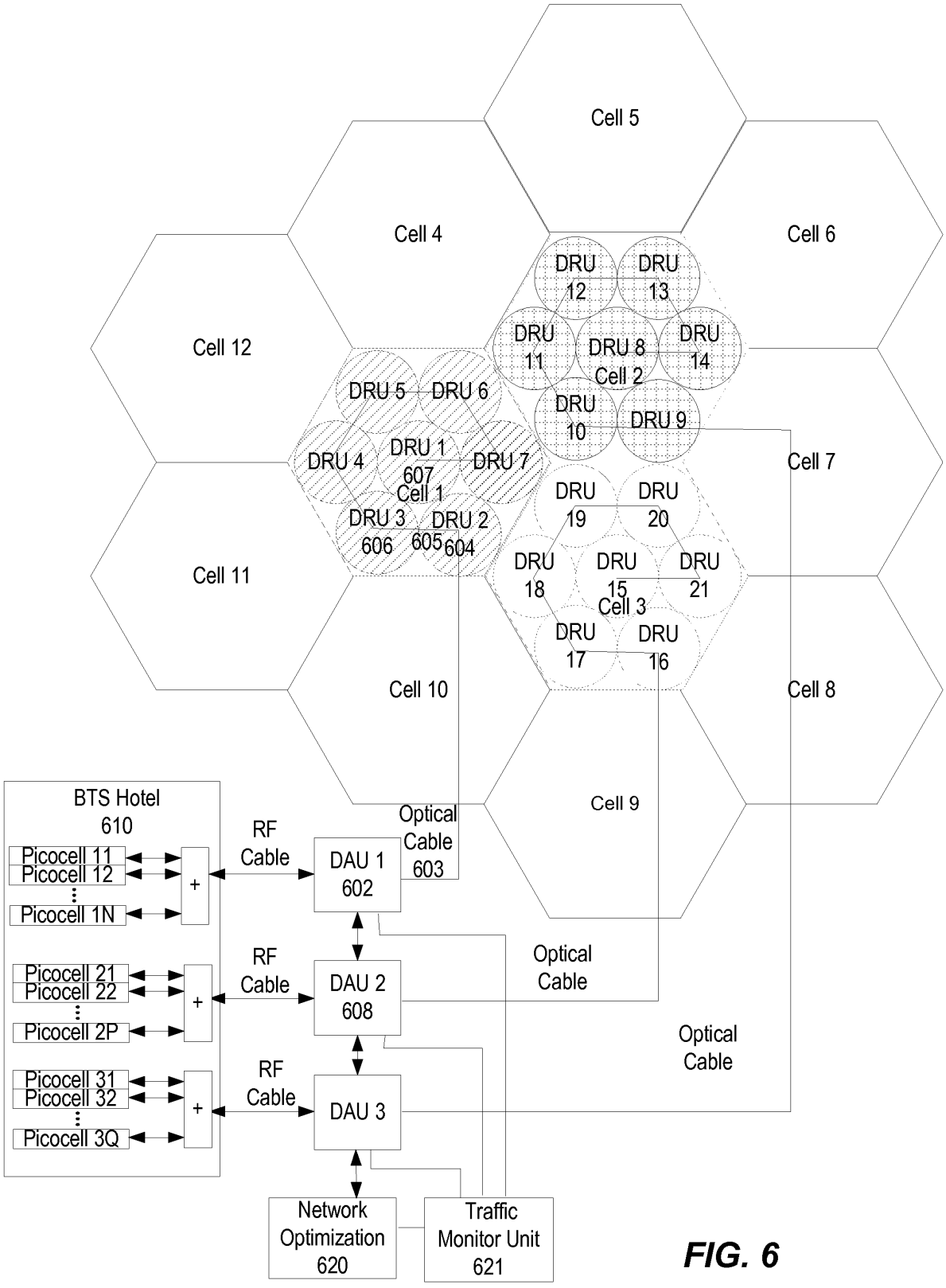

RF Network
Down Link
Up Link
503
504
Physical Node
501
506
507
Digital Remote Unit
500
Ext Port 1D
Ext Port 1U
Ext Port 2D
Ext Port 2U
Ext Port ND
Ext Port NU
LAN Port 1
LAN Port 2
Remote Router R
515
PEER Port M
Traffic Monitor at ports
516
Ethernet
508
Ethernet Switch
505
Computer
509
Wireless Access
Points
502
Optical
Network

FIG. 5


Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
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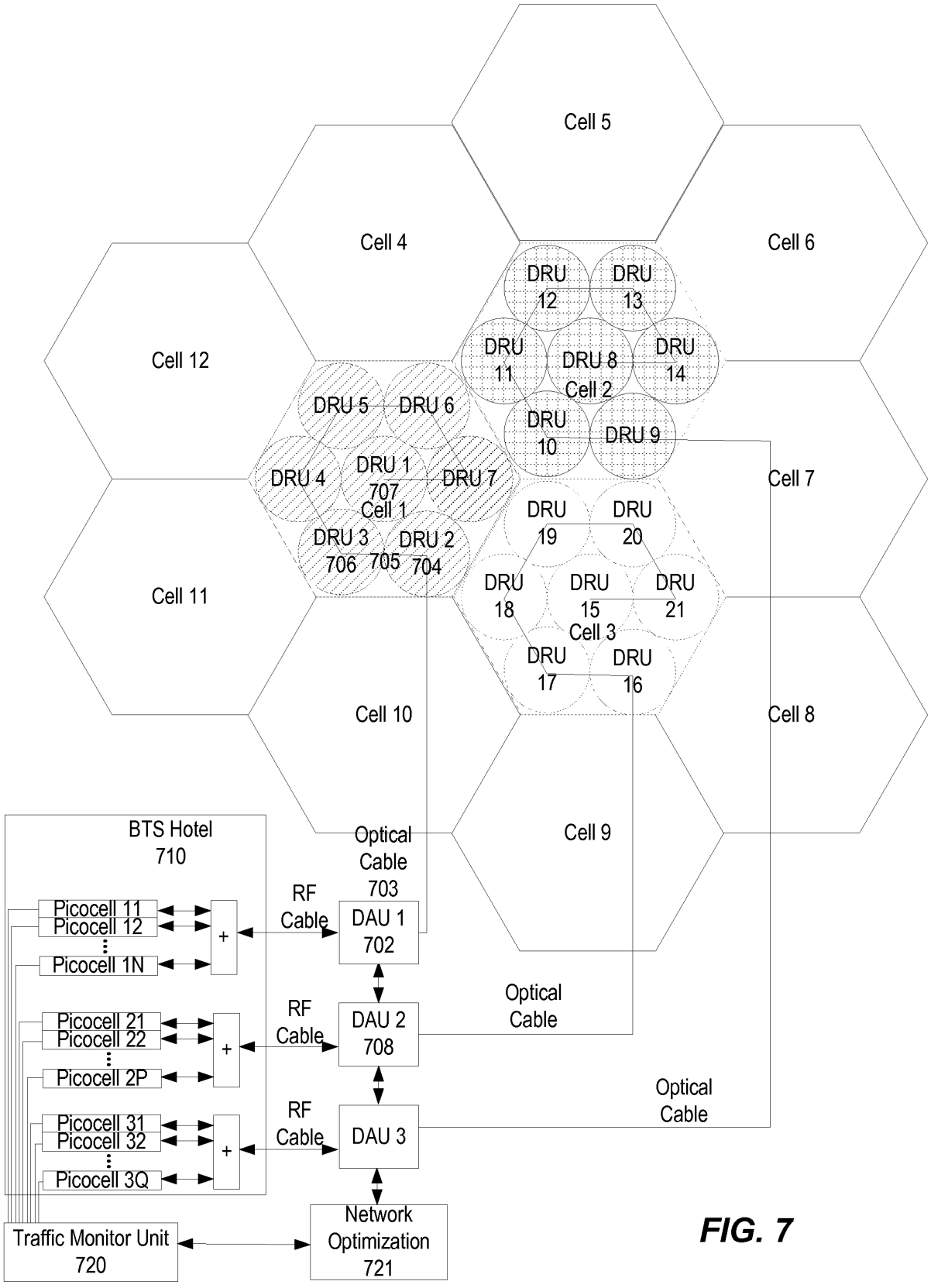
Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
607
DRU 7
Cell 1
DRU 3
606
DRU 2
605
604
DRU 19
DRU 20
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS Hotel
610
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3Q
+
RF Cable
DAU 1
602
Optical Cable
603
DAU 2
608
DAU 3
Network Optimization
620
Traffic Monitor Unit
621

FIG. 6


Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
DRU 12
DRU 13
DRU 11
DRU 8
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Cell 2
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
707
DRU 7
Cell 1
DRU 3
706
DRU 2
705
704
DRU 19
DRU 20
DRU 18
DRU 15
DRU 21
Cell 3
DRU 17
DRU 16
BTS Hotel
710
Optical
Cable
703
RF
Cable
DAU 1
702
Picocell 11
Picocell 12
Picocell 1N
+
Optical
Cable
RF
Cable
DAU 2
708
Picocell 21
Picocell 22
Picocell 2P
+
Optical
Cable
RF
Cable
DAU 3
Picocell 31
Picocell 32
Picocell 3Q
+
Network
Optimization
721
Traffic Monitor Unit
720

FIG. 7

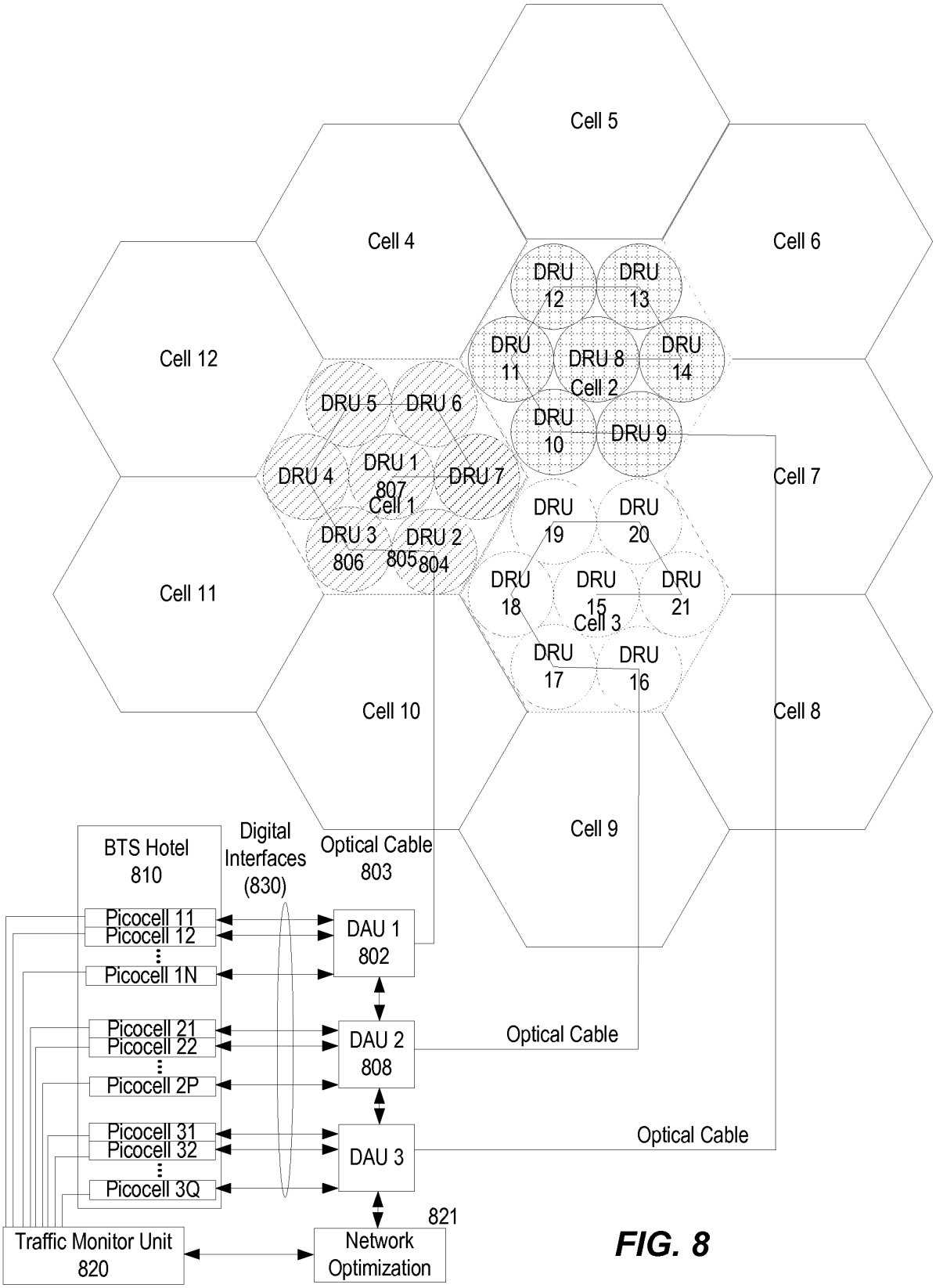

Cell 5
Cell 4
Cell 6
Cell 12
Cell 7
Cell 11
Cell 10
Cell 8
Cell 9
Cell 1
Cell 2
Cell 3
DRU 12
DRU 13
DRU 11
DRU 8
DRU 14
DRU 5
DRU 6
DRU 10
DRU 9
DRU 4
DRU 1
807
DRU 7
DRU 19
DRU 20
DRU 3
806
DRU 2
805
804
DRU 18
DRU 15
DRU 21
DRU 17
DRU 16
BTS Hotel
810
Digital
Interfaces
(830)
Optical Cable
803
Picocell 11
Picocell 12
Picocell 1N
Picocell 21
Picocell 22
Picocell 2P
Picocell 31
Picocell 32
Picocell 3Q
DAU 1
802
DAU 2
808
DAU 3
Optical Cable
Optical Cable
821
Traffic Monitor Unit
820
Network
Optimization

FIG. 8

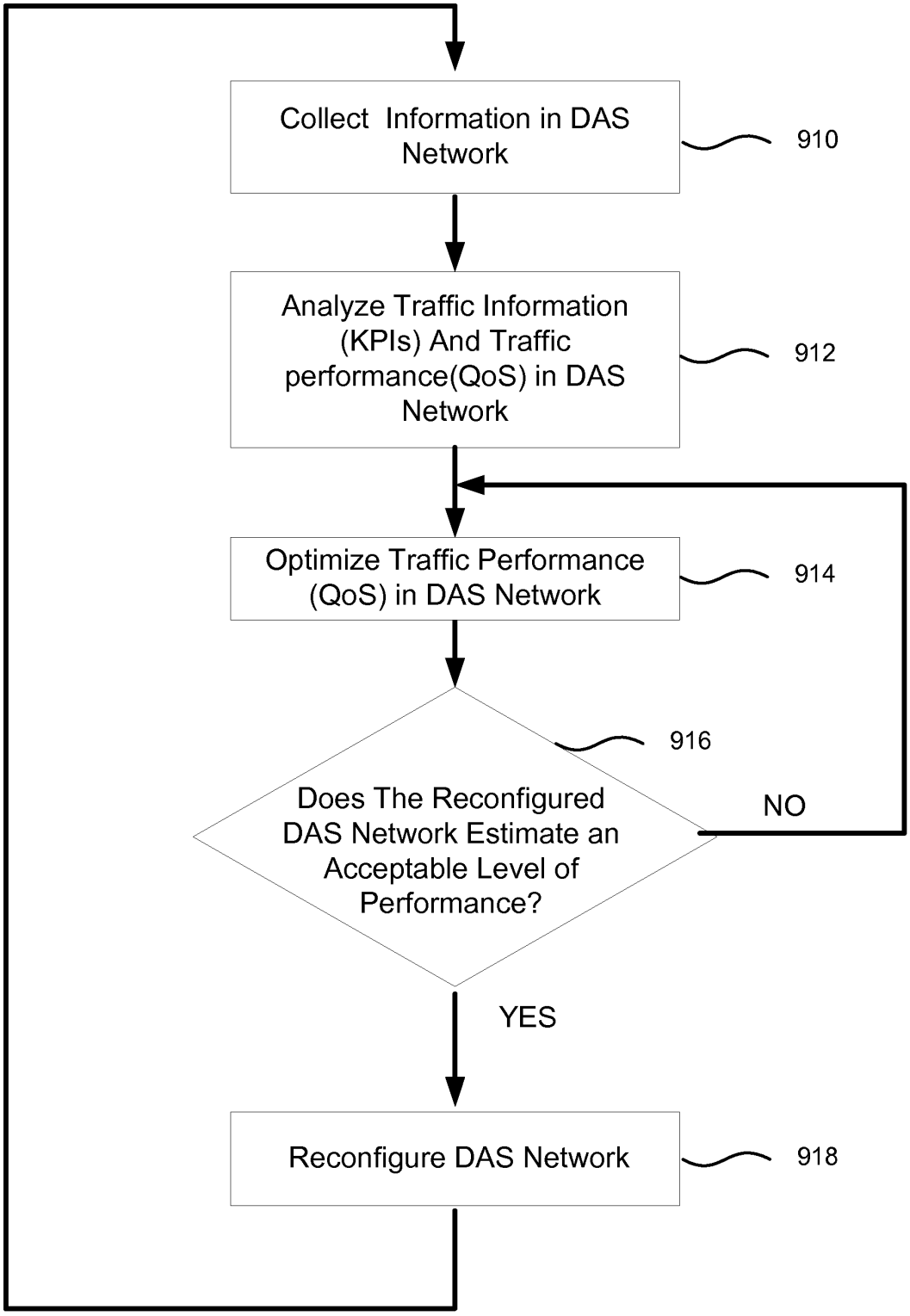

Collect Information in DAS Network
910
Analyze Traffic Information (KPIs) And Traffic performance(QoS) in DAS Network
912
Optimize Traffic Performance (QoS) in DAS Network
914
916
Does The Reconfigured DAS Network Estimate an Acceptable Level of Performance?
NO
YES
Reconfigure DAS Network
918

FIG. 9

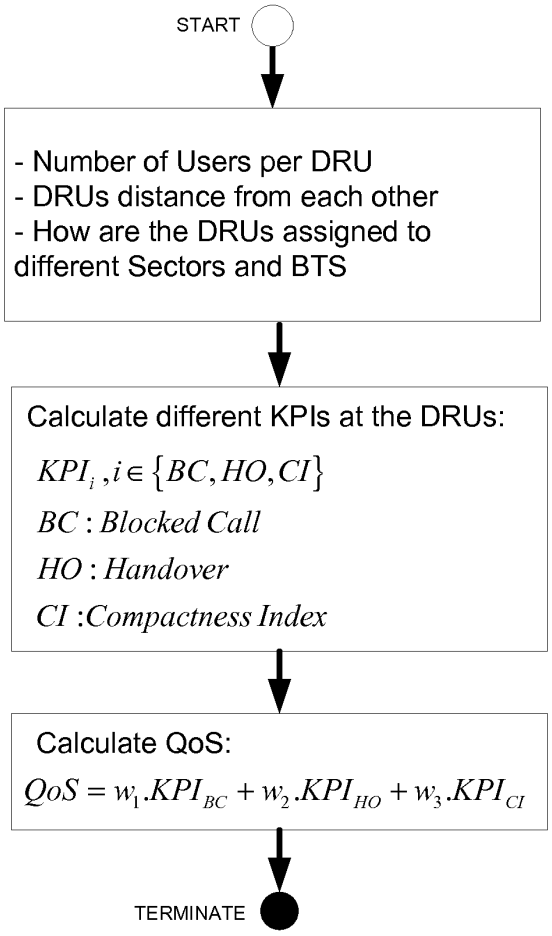
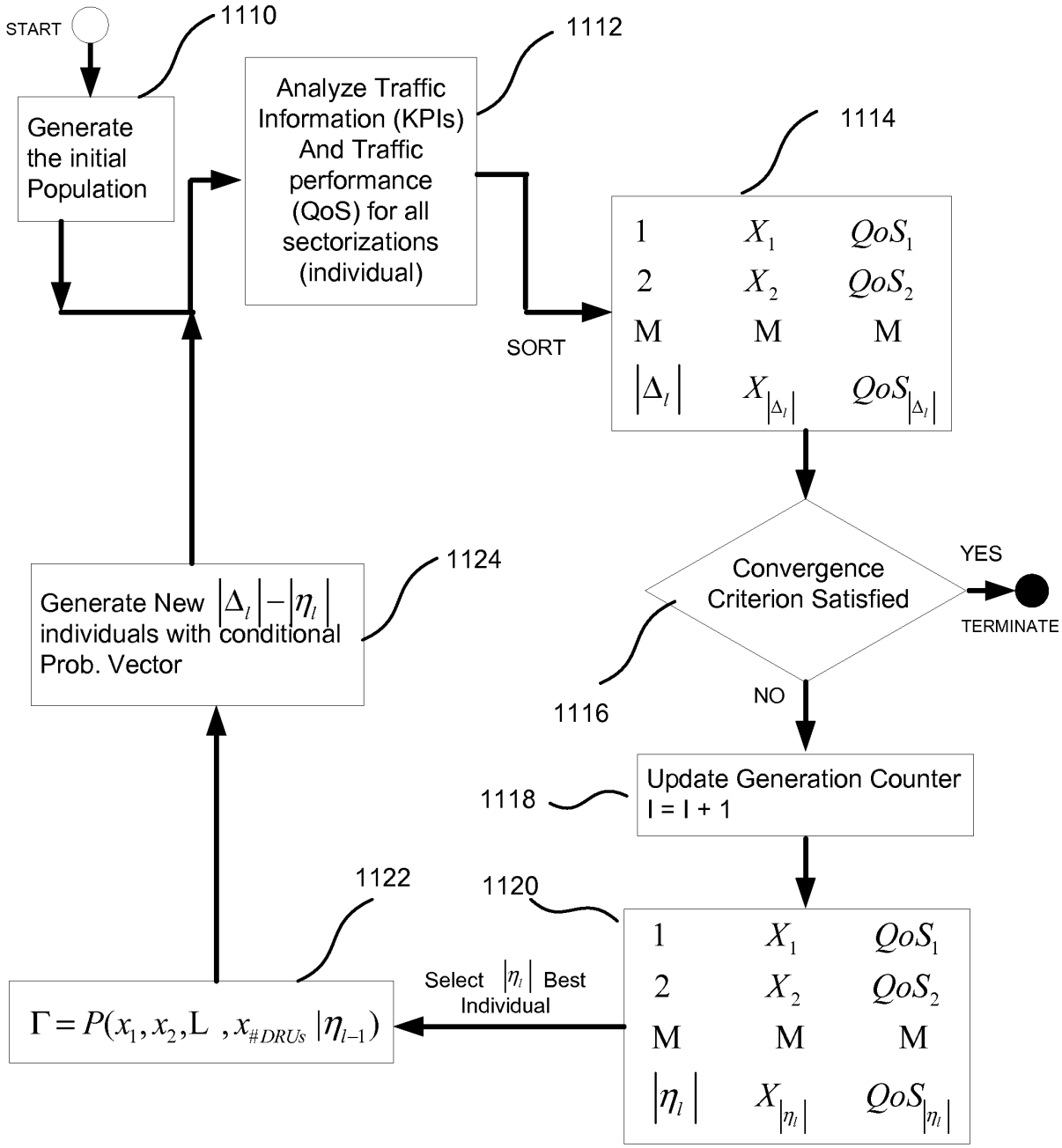

START
- Number of Users per DRU
- DRUs distance from each other
- How are the DRUs assigned to different Sectors and BTS
Calculate different KPIs at the DRUs:
$KPI_i, i \in \{BC, HO, CI\}$
BC : $Blocked\ Call$
HO : $Handover$
CI :$Compactness\ Index$
Calculate QoS:
$QoS = w_1.KPI_{BC} + w_2.KPI_{HO} + w_3.KPI_{CI}$
TERMINATE

FIG. 10



- Δ_l is Set of Individuals(population)
- Individual $X_j = (x_1, x_2, ..., x_{\#DRUs}), x_i \in \{S_{nm} | \text{sector "n" from BTS "m"}\}$

FIG. 11

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	91172-882666(103900US)
	Application Number	
Title of Invention	OPTIMIZATION OF TRAFFIC LOAD IN A 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

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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 i	CA

Mailing Address of Inventor:

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

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Seyed	Amin	Hejazi	

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	P.O. Box 309, Ugland House, South Church Street		
Address 2			
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:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	91172-882666(103900US)
	Application Number	
Title of Invention	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	

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Customer Number	20350		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM		
Attorney Docket Number	91172-882666(103900US)	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	11	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
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Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	20350		

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Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61678016	2012-07-31

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	91172-882666(103900US)
	Application Number	
Title of Invention	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	

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

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

Remove

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

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

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

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

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	91172-882666(103900US)
	Application Number	
Title of Invention	OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM	

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Attorney Docket No.: 91172-882666(103900US)
Client Reference No.: DW-1039

PATENT APPLICATION

OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

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OPTIMIZATION OF TRAFFIC LOAD IN A DISTRIBUTED ANTENNA SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/678,016, filed on July 31, 2012, entitled "Optimization of Traffic Load in a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

SUMMARY 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 traffic monitoring and optimization. Wireless network operators faces the continuing challenge of building networks that effectively manage high data-traffic growth rates. Mobility and an increased level of multimedia content for end users typically employs end-to-end network adaptations that support new services and the increased demand for broadband and flat-rate Internet access. One of the most difficult challenges faced by network operators is caused by the physical movement of subscribers from one location to another, and particularly when wireless subscribers congregate in large numbers at one location. A notable example is a business enterprise facility during lunchtime, when a large number of wireless subscribers visit a lunch room or cafeteria location in the building. At that time, a large number of subscribers have moved away from their offices and usual work areas. It's likely that during lunchtime, there are many locations throughout the facility where there are very few subscribers. If the indoor wireless network resources were properly sized during the design process for subscriber loading as it is during normal working hours when subscribers are in their normal work areas, it is very likely that the lunchtime scenario will present some unexpected challenges with regard to available wireless capacity and data throughput.

[0003] According to an embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital

Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs. The system further includes one or more Base Transceiver Stations (BTSs) and one or more traffic monitoring units.

[0004] According to another embodiment of the present invention, a system for dynamically routing signals in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system further includes a plurality of traffic monitoring modules and a network optimization goal and optimization algorithm.

[0005] In an embodiment, a system for dynamically routing signals in a Distributed Antenna System is provided and includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and one or more Base Transceiver Stations (BTSs). The system further includes a traffic monitoring unit.

[0006] Numerous benefits are achieved by way of the present invention over conventional techniques. For example, embodiments of the present invention provide for traffic monitoring in a DAS network, improving network performance and user experience. These and other embodiments of the invention along with many of its advantages and features are described in more detail in conjunction with the text below and attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0008] FIG. 2 is a block diagram according to one embodiment of the invention showing the basic structure for a frequency reuse pattern of N=1 and an example of the transport routing, traffic monitoring and network optimization based on having a single 3 sector BTS with 3 DAUs and 7 DRUs daisy chained together for each cell.

[0009] FIG. 3 is a block diagram according to one embodiment of the invention showing the basic structure and an example of the transport routing, traffic monitoring and network optimization based on having multiple 3 sector BTSs with 3 DAUs and 7 DRUs daisy chained together for each cell. In this embodiment, multiple three sector base stations are connected to a daisy chained DAS network.

[0010] FIG. 4 is a block diagram of a Digital Access Unit (DAU), which contains Physical Nodes, a Local Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0011] FIG. 5 is a block diagram of a Digital Remote Unit (DRU), which contains Physical Nodes, a Remote Router, and Port Traffic Monitoring capability according to an embodiment of the present invention.

[0012] FIG. 6 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring and Network Optimization functionality according to an embodiment of the present invention.

[0013] FIG. 7 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0014] FIG. 8 depicts a typical topology where multiple Local Routers are interconnected with multiple Remote Routers along with Traffic monitoring at each Picocell and Network Optimization functionality according to an embodiment of the present invention.

[0015] FIG. 9 is a simplified flowchart illustrating a method of optimizing the DAS network according to an embodiment of the present invention.

[0016] FIG. 10 is a simplified flowchart illustrating a method of calculating KPIs and QoS for a DAS network according to an embodiment of the present invention.

[0017] FIG. 11 is a simplified flowchart illustrating an optimization algorithm according to an embodiment of the present invention .

DETAILED DESCRIPTION OF THE INVENTION

[0018] To accommodate variations in wireless subscriber loading at wireless network antenna locations at various times of day and for different days of the week, there are several candidate conventional approaches.

[0019] One approach is to deploy many low-power high-capacity base stations throughout the facility. The quantity of base stations is determined based on the coverage of each base station and the total space to be covered. Each of these base stations is provisioned with enough radio resources, i.e., capacity and broadband data throughput to accommodate the maximum subscriber loading which occurs during the course of the workday and work week. Although this approach typically yields a high quality of service for wireless subscribers, the notable disadvantage of this approach is that many of the base stations' capacity is being wasted for a large part of the time. Since a typical indoor wireless network deployment involves capital and operational costs which are assessed on a per-subscriber basis for each base station, the typically high total life cycle cost for a given enterprise facility is far from optimal.

[0020] A second candidate approach involves deployment of a DAS along with a centralized group of base stations dedicated to the DAS. A conventional DAS deployment falls into one of two categories. The first type of DAS is "fixed", where the system configuration doesn't change based on time of day or other information about usage. The remote units associated with the DAS are set up during the design process so that a particular block of base station radio resources is thought to be enough to serve each small group of DAS remote units. A notable disadvantage of this approach is that most enterprises seem to undergo frequent re-arrangements and re-organizations of various staff groups within the enterprise. Therefore, it's highly likely that the initial DAS setup will need to be changed from time to time, requiring deployment of additional direct staff and contract resources with appropriate levels of expertise regarding wireless networks.

[0021] The second type of DAS is equipped with a type of network switch which allows the location and quantity of DAS remote units associated with any particular centralized base station to be changed manually. Although this approach would appear to support dynamic DAS

reconfiguration based on the needs of the enterprise or based on time of day, it frequently implies that additional staff resources would need to be assigned to provide real-time management of the network. Another issue is that it's not always correct or best to make the same DAS remote unit configuration changes back and forth on each day of the week at the same times of day. Frequently it is difficult or impractical for an enterprise IT manager to monitor the subscriber loading on each base station. And it is almost certain that the enterprise IT manager has no practical way to determine the loading at a given time of day for each DAS remote unit; they can only guess the percentage loading.

[0022] Another major limitation of conventional DAS deployments is related to their installation, commissioning and optimization process. Some challenging issues which must be overcome include selecting remote unit antenna locations to ensure proper coverage while minimizing downlink interference from outdoor macro cell sites, minimizing uplink interference to outdoor macro cell sites, and ensuring proper intra-system handovers while indoors and while moving from outdoors to indoors (and vice-versa). The process of performing such deployment optimization is frequently characterized as trial-and-error. Therefore, the results may not be consistent with a high quality of service.

[0023] Based on the conventional approaches described herein, it is apparent that a highly efficient, easily deployed and dynamically reconfigurable wireless network is not achievable with conventional systems and capabilities. Embodiments of the present invention substantially overcome the limitations of the conventional approach discussed above. The advanced system architecture provided by embodiments of the present invention provides a high degree of flexibility to manage, control, enhance and facilitate radio resource efficiency, usage and overall performance of the distributed wireless network. This advanced system architecture enables specialized applications and enhancements including, but not limited to, 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, and/or traffic tagging. Embodiments of the present invention can also serve multiple operators, multi-mode radios (modulation-independent) and multiple frequency bands per operator to increase the efficiency and traffic capacity of the operators' wireless networks.

[0024] Accordingly, embodiments of this architecture provide a capability for Flexible Simulcast. With Flexible Simulcast, the amount of radio resources (such as RF carriers, LTE Resource Blocks, CDMA codes or TDMA time slots) assigned to a particular DRU or group of DRUs can be set via software control to meet desired capacity and throughput objectives or wireless subscriber needs. 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.

[0025] According to an embodiment of the present invention, a traffic monitoring unit is provided as a component of one or more elements of the system, enabling measurement of the network traffic in the network. A network optimization goal and optimization algorithm is also provided so that based on traffic measurements, which is typically a function of the number of users on the system, performance of the network is optimized using the goal and associated algorithm.

[0026] As an example of traffic monitoring, the system could track the power of the down link or the power of the uplink. Another example, would include some signal processing, including examining certain control signals, for example, pilot signals sent by mobile devices. By locking onto these control signals, the traffic monitor can obtain information on the number of users using various components of the system.

[0027] A distributed antenna system (DAS) provides an efficient means of utilization of base station resources. The base station or base stations associated with a DAS can be located in a central location and/or facility commonly known as a base station hotel. The DAS network comprises one or more digital access units (DAUs) that function as the interface between the base stations and the digital remote units (DRUs). The DAUs can be collocated with the base stations. The DRUs can be daisy chained together and/or placed in a star configuration and provide coverage for a given geographical area. The DRUs are typically connected with the DAUs by employing a high-speed optical fiber link. This approach facilitates transport of the RF signals from the base stations to a remote location or area served by the DRUs. A typical base station comprises 3 independent radio resources, commonly known as sectors. These 3 sectors are typically used to cover 3 separate geographical areas without creating co-channel interference between users in the 3 distinct sectors.

[0028] Traffic monitoring in a DAS network is provided by embodiments of the present invention, which has not been performed in conventional systems. As described herein, the traffic monitoring unit can be implemented as a stand-alone unit in conjunction with one or more system components, including DAUs, DRUs, a BTS, a BTS hotel, or the like.

[0029] Once traffic resources are aggregated into eNodeB hotels, the discrete resources of a single eNodeB are still allocated to a specific set of antennas associated with that eNodeB and providing coverage to a specific geographic area. The traffic resources are fixed, i.e., only the resources associated with a specific eNodeB can be allocated to the antennas associated with that eNodeB. However, because the eNodeBs are collocated in an eNodeB hotel, the system can use the aggregated traffic resources of the discrete eNodeBs as a single, pooled traffic resource that can be allocated according to various algorithms. Assumptions are typically predicated on worst-case traffic assets in all areas, network design is wasteful 99 percent of the time, inevitably resulting in over- or under-provisioning of fixed resources. Traffic resources either go unused (idle channels), or are under-provisioned and are insufficient to handle the offered traffic. Both circumstances give rise to the same outcome: lost revenue and lost opportunity. When a site's traffic resources are idle and unused, the traffic asset fails to provide an optimal return on investment. But a site that lacks sufficient capacity to support the offered traffic at any point during the day garners dropped calls, lost revenue opportunity, and dissatisfied customers. The traffic information derived from an extensive sensor network will be used to dynamically allocate the traffic resources to the required geographical areas only for the time period the service is needed. Once the service is supplied and the traffic sensor network determines that the traffic resources are no longer required, they are returned to the resource pool for reallocation. The entire network automatically reconfigures itself based on the perceived (sensed) need or in the event of disruption due to natural or manmade events. Geographic load balancing using DAS is recognized as a new approach for traffic load balancing which provides dynamic load redistribution in real time according to the current geographic traffic conditions. It can be used to improve the performance for any distributed systems containing non-uniformly distributed traffic, especially for resolving traffic hot spots.

[0030] The network's performance (expressed by the number of KPIs (Key Performance Indicators) from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these

considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs.

[0031] An embodiment shown in FIG. 1 illustrates a basic DAS network architecture according to an embodiment of the present invention and provides an example of a data transport network, traffic monitoring and network optimization scenario between a 3 sector Base Station and multiple DRUs. In this embodiment, the DRUs are daisy chained together to achieve coverage in a specific geographical area. Each individual sector covers an independent geographical area, which is identified as a Cell. Although embodiments are discussed in terms of optimization of DAS networks, the term optimization is properly understood to include performance improvements in comparison to conventional systems, even if complete optimization is not achieved. Thus, optimization does not require the maximum values for traffic management metrics, but also includes distribution of traffic that improves system performance while remaining short of maximum performance.

[0032] FIG. 1 depicts a DAS system employing multiple Digital Remote Units (DRUs) and multiple Digital Access Units (DAUs). In accordance with the present invention, each DRU provides unique information associated with each DRU which uniquely identifies uplink data received by that particular Digital Remote Unit.

[0033] One feature of embodiments of the present invention is the ability to route Base Station radio resources among the DRUs or group(s) of DRUs. In order to route radio resources available from one or more Base Stations, it is desirable to configure the individual router tables of the DAUs and DRUs in the DAS network. This functionality is provided by embodiments of the present invention.

[0034] The DAUs are networked together to facilitate the routing of DRU signals among multiple DAUs. The DAUs support the transport of the RF downlink and RF uplink signals between the Base Station and the DRUs. This architecture enables the various Base Station signals to be transported to and from multiple DRUs. PEER ports are used for interconnecting DAUs and interconnecting DRUs.

[0035] The DAUs have the capability to control the gain (in small increments over a wide range) of the downlink and uplink signals that are transported between the DAU and the base station (or base stations) connected to that DAU. This capability provides flexibility to

simultaneously control the uplink and downlink connectivity of the path between a particular DRU (or a group of DRUs via the associated DAU or DAUs) and a particular base station sector.

[0036] Embodiments of the present invention use router tables to configure the networked DAUs. The local router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from an External Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the LAN Ports and PEER Ports need to merge into the same data stream.

[0037] The remote router tables establish the mapping of the inputs to the various outputs. Internal Merge blocks are utilized for the Downlink Tables when the inputs from a LAN Port and a PEER Port need to merge into the same data stream. Similarly, Merge blocks are used in the Uplink Tables when the inputs from the External Ports and PEER Ports need to merge into the same data stream.

[0038] As shown in FIG. 1, the individual base station sector's radio resources are transported to a daisy-chained network of DRUs. Each individual sector's radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 1 demonstrates how three cells, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. 1 and by way of example, DAU 1 (102) receives downlink signals from BTS Sector 1 (101). DAU 1 translates the RF signals to optical signals and the optical fiber cable 103 transports the desired signals to DRU 2 (104). Optical cable 105 transports all the optical signals to DRU 3 (106). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (107). DAU 1 (102) is networked with DAU 2 (108) to allow the downlink signals from Sector 2 (109) and Sector 3 (110) to be transported to all the DRUs in Cell 1. The system's switching and routing functions enable the selection of which sectors' signals are transmitted and received by each DRU.

[0039] An embodiment illustrating a Traffic monitoring unit (121) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (120). The optimization unit (120) calculates the overall DAS network performance and determines the optimum reconfigured network to improve or maximize performance. Utilizing the traffic monitoring unit 121 in

conjunction with the DAUs provides for optimization of the DAS network through a traffic monitoring unit external to the DAUs. Thus, embodiments of the present invention provide for traffic monitoring in a DAS network. Optimization of the DAS network can then be performed using information related to the traffic monitoring.

[0040] Referring to FIG. 1, the traffic monitor unit 121 can be a server determining the number of users on each DAU, with each DAU having multiple ports in some embodiments. Data from the traffic monitor unit 121 is then provided to the network optimization unit 120, which can be the same server including the traffic monitor unit or a different server. The network optimization unit 120 (which can be software running on a server) can model the rebalancing of the traffic load and, after determining that the performance will be acceptable, implements the load rebalancing by communicating with the DAUs and shifting traffic between sectors. Although the network optimization unit 120 is illustrated as coupled to the DAUs in FIG. 1, this is not required by embodiments of the present invention and the network optimization could be performed at one of the DRUs, with data regarding network optimization being transmitted back to the DAUs using, for example, using an Ethernet backhaul connecting the DRUs to the DAUs. Thus, the network optimization server could be located at one of the DRUs, controlling the entire network from that location. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0041] The network optimization unit can implement a network optimization goal, which may relate to the number of users per sector, for example, that each sector carry a percentage of traffic less than 50% of the total traffic, less than 40% of the total traffic, or less than 35% of the total traffic, that each sector have less than 50% of the users, less than 40% of the users, less than 35% of the users, or that each sector have 33% of the users, or the like. Thus, the optimization goals can include metrics of the system performance. Although the system may not reach the goals, progress toward the goals can be provided, improving the user experience.

[0042] FIG. 2 shows an embodiment illustrating how a single base station can be used to provide coverage for a larger geographical area when a frequency reuse pattern of N=1 is used. Referring to FIG. 2, cell 1 and cell 8 would share the radio resources of sector 1 of the base station. Similarly, cell 2 and cell 10 would share the radio resources of sector 2.

[0043] The DAUs control the routing of data between the base station and the DRUs. Each individual data packet is provided with a header that uniquely identifies which DRU it is

associated with. The DAUs are interconnected to allow transport of data among multiple DAUs. This feature provides the unique flexibility in the DAS network to route signals between the sectors and the individual DRUs. A server is utilized to control the switching function provided in the DAS network. Referring to FIG. 2, and by way of example, DAU 1 (202) receives downlink signals from BTS 1 Sector 1 (201). DAU 1 translates the RF signals to optical signals and the optical fiber cable 203 transports the desired signals to DRU 2 (204). Optical cable 205 transports all the optical signals to DRU 3 (206). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (207). DAU 1 (202) is networked with DAU 2 (208) to allow the downlink signals from Sector 2 and Sector 3 to be transported to all the DRUs in Cell 1. Optical fiber cable 209 transports the desired signals to DRU 23 (210). Optical cable 211 transports all the optical signals to DRU 24 (212). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 22 (213). An embodiment illustrating a Traffic monitoring unit (221) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (220). The optimization unit (220) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0044] FIG. 3 shows an embodiment illustrating an application employing a base station hotel where N BTSs are interconnected to serve a given geographical area. The base stations may represent independent wireless network operators and/or multiple standards (WCDMA, LTE, etc.) or they may represent provision of additional RF carriers. The base station signals may be combined before they are connected to a DAU, as may be the case for a Neutral Host application. Referring to FIG. 3 and by way of example, DAU 1 (302) receives downlink signals from BTS Sector 1 (301). DAU 1 translates the RF signals to optical signals and the optical fiber cable 303 transports the desired signals to DRU 2 (304). Optical cable 305 transports all the optical signals to DRU 3 (306). The other DRUs in the daisy chain are involved in passing the optical signals onward to DRU 1 (307). DAU 1 (302) is networked with DAU 2 (308) to allow the downlink signals from BTS 1 Sector 2 to be transported to all the DRUs in Cell 1. DAU 1 (302) receives downlink signals from BTS Sector N (309). DAU 1 translates the RF signals to optical signals and the optical fiber cable 303 transports the desired signals to DRU 2 (304). Optical cable 305 transports all the optical signals to DRU 3 (306). The other DRUs in the daisy

chain are involved in passing the optical signals onward to DRU 1 (307). The additional base stations provide the capability to add capacity for Cell 1.

[0045] In order to efficiently utilize the limited base station resources, the network of DRUs should have the capability of re-directing their individual uplink and downlink signals to and from any of the BTS sectors. Because the DRUs data traffic has unique streams, the DAU Router has the mechanism to route the signal to different sectors. An embodiment illustrating a Traffic monitoring unit (321) at the DAUs is included to track the traffic load at each DAU in the network. The traffic load associated with each DAU is collected and stored in the Network Optimization Unit (320). The optimization unit (320) calculates the overall DAS network performance and determines the optimum reconfigured network to maximize performance.

[0046] FIG. 4 shows the two primary elements in a DAU, the Physical Nodes (400) and the Local Router (401). The Physical Nodes translate the RF signals to baseband for the Downlink and from baseband to RF for the Uplink. The Local Router directs the traffic between the various LAN Ports, PEER Ports and the External Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, or the like. The physical nodes can combine the downlink and uplink signals via a duplexer or they can keep them separate, as would be the case for a simplex configuration. In one embodiment, Traffic monitoring (416) capability is provided in each DAU for determining the traffic load at each of the DAU ports. In this embodiment, the traffic monitoring function is performed in each DAU in comparison with other implementations in which the traffic monitoring is performed externally.

[0047] FIG. 4 shows an embodiment whereby the physical nodes have separate outputs for the uplinks (405) and separate inputs for the downlink paths (404). The physical node translates the signals from RF to baseband for the downlink path and from baseband to RF for the uplink path. The physical nodes are connected to a Local Router via external ports (409,410)). The router directs the uplink data stream from the LAN and PEER ports to the selected External U ports. Similarly, the router directs the downlink data stream from the External D ports to the selected LAN and PEER ports.

[0048] In one embodiment, the LAN and PEER ports are connected via an optical fiber to a network of DAUs and DRUs. The network connection can also use copper interconnections such as CAT 5 or 6 cabling, or other suitable interconnection equipment. The DAU is also

connected to the internet network using IP (406). An Ethernet connection (408) is also used to communicate between the Host Unit and the DAU. The DRU can also connect directly to the Remote Operational Control center (407) via the Ethernet port.

[0049] FIG. 5 shows the two primary elements in a DRU, the Physical Nodes (501) and the Remote Router (500). The DRU includes both a Remote Router and Physical Nodes. The Remote Router directs the traffic between the LAN ports, External Ports and PEER Ports. The physical nodes connect to the BTS at radio frequencies (RF). The physical nodes can be used for different operators, different frequency bands, different channels, etc. FIG. 5 shows an embodiment whereby the physical nodes have separate inputs for the uplinks (504) and separate outputs for the downlink paths (503). The physical node translates the signals from RF to baseband for the uplink path and from baseband to RF for the downlink path. The physical nodes are connected to a Remote Router via external ports (506,507). The router directs the downlink data stream from the LAN and PEER ports to the selected External D ports. Similarly, the router directs the uplink data stream from the External U ports to the selected LAN and PEER ports. The DRU also contains a Ethernet Switch (505) so that a remote computer or wireless access points can connect to the internet.

[0050] In one embodiment, the traffic monitoring (516) capability is provided in each DRU for determining the traffic load at each of the DRU ports. In this embodiment, the traffic monitoring function is performed in each DRU in comparison with other implementations in which the traffic monitoring is performed externally.

[0051] As shown in FIG. 6, the base station hotel (610) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 6 demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (621), which is connected to the network of DAUs.

[0052] As shown in FIG. 7, the base station hotel (710) is comprised of multiple Picocells. The Picocells are typically wireless operator dependent and frequency band dependent. Picocells that

operate in the same frequency band are combined at RF and input to the respective DAUs. The DAU radio resources from the combined Picocells are transported to a daisy-chained network of DRUs. Each individual DAUs radio resources provide coverage to an independent geographical area via the networked DRUs. FIG. 7 demonstrates how multiple DAUs, each cell comprising an independent network of 7 DRUs, provide coverage to a given geographical area. In one embodiment, the traffic monitoring functionality is located in an external Traffic Monitoring Unit (721), which is connected to the Picocells. The BTS Hotel 710 includes a plurality of Picocells that are coupled to traffic monitoring unit 720. The traffic information flows from the Picocells to the traffic monitoring unit, which uses this traffic information to optimize the DAS network. The traffic monitoring unit 820 works in conjunction with network optimization unit 721, which can include traffic management algorithms used to distribute traffic efficiently throughout the DAS network.

[0053] FIG. 8 shows an embodiment of a base station hotel (810), which is comprised of multiple picocells that are interconnected to a network of DAUs via a digital interface (830).

[0054] FIG. 9 illustrates one embodiment of the DAS network optimization flow diagram. The Key Performance Indicators (KPIs) of the network traffic are collected at the various network nodes (910). KPI may comprise information such as: number of blocked calls, number of active calls, average power of uplink channels, average power of downlink channels, traffic on each sector, failed calls, number of satisfied users, number of unsatisfied users, number of users operating through a given DRU, and the like.

[0055] The DAS network performance is then analyzed in the context of the available DAS network radio resources (912). An optimization algorithm is applied to the existing DAS network with the objective to determine the optimum routing of network traffic (914). Once an optimum DAS network has been determined then an estimate of the reconfigured DAS network performance is determined (916). The reconfigured DAS network is evaluated prior to an implementation to insure that the performance will be acceptable. If the reconfigured DAS network has been determined to be acceptable then the reconfigured DAS network is implemented (918) and the entire process is repeated. In an embodiment, the load on the sectors prior to reconfiguration and after the proposed reconfiguration can be compared to determine if the shifting of the DRUs to the other sectors improves the system performance.

[0056] Thus, using the KPIs of the network traffic, the DAS network can be modified to improve system performance. As an example, if a particular DRU has a higher load than other adjacent DRUs, traffic can be routed to the adjacent DRUs in order to reduce the load on the particular DRU. Additional description related to load balancing is provided in U.S. Patent Application No. 61/600,530, filed on February 17, 2012, entitled "Evolutionary Algorithms for Geographic Load Balancing Using a Distributed Antenna System," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0057] As an example of optimizing network performance, a base station typically has three sectors. The DRU can be allocated to different sectors in order to improve performance by shifting traffic from a first sector (e.g., a high traffic sector) to a second sector (e.g., a low traffic sector) by shifting a DRU allocated to the first sector to the second sector. Although some embodiments of the present invention will not optimize performance of the system, the system performance can be improved using the techniques described herein, for example, by measuring the traffic load on the DRUs, performing load balancing of the traffic on the DRUs, to reduce the load on a first DRU characterized by a first traffic load by shifting the load to a second DRU characterized by a second traffic load less than the first traffic load. In the optimization process, system performance can be measured against a predetermined threshold, with the optimization process terminating once the predetermined threshold has been reached. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[0058] As another example, power settings for the DRUs can be modified to improve system performance as discussed in additional detail in U.S. Patent Application No. 61/669,572, filed on July 9, 2012 and entitled, "A Self-Optimizing Distributed Antenna System Using Soft Frequency Reuse," the disclosure of which is hereby incorporated by reference in its entirety for all purposes.

[0059] FIG. 10 illustrates one embodiment of the DAS network calculation of the KPIs and QoS. The important parameters for determining the DAS network QoS include the number of users allocated to a given DRU, the spatial distance between the various DRUs, as well as identifying which DRUs are assigned to which BTS sector.

[0060] FIG. 11 illustrates one embodiment of the flow chart for the optimization algorithm. In this embodiment an Estimation Distribution Algorithm (EDA) is used. Various DRU allocation scenarios are investigated to determine the optimum DRU scenario that achieves the highest

QoS. In an embodiment, the initial population is generated (1110). The traffic information (KPIs) is analyzed and traffic performance (QoS) for all sectorization is analyzed (1112). A sort procedure is performed (1114) and a determination is made if the convergence criterion are satisfied (1116). If so, the process is terminated. If not, then the generation counter is updated (1118), a sort operation is performed (1120), the parameter Γ is computed (1122) and a new population is generated (1124). Then the method proceeds to the traffic information and performance analysis (1112).

[0061] Network Optimization

[0062] The network's performance (expressed by the number of KPIs from different parts of the network) determines the QoS values. Different operators may have different defined business goals and different services of interest. Based on these considerations, efficient and cost effective network performance management varies from operator to operator. Therefore, QoS metrics could be defined and mapped to a set of KPIs. When a set of KPIs is used, then the mapping needs to be represented by a weighted normalized function.

[0063] In this section we formulate the sectorization problem with mixed integer programming to balance traffic among sectors and to minimize handoffs with connected and compact sectors. Given the sectorization of DRUs at time period *t*, our problem is to obtain new sectorization at time period *t+1* that adaptively balances the change in traffic demands.

[0064] In order to formulate the problem, we consider a service coverage area with N DRUs. Each DRU is assumed to have traffic demand $T_i \; i = 1,...,N$. Note that, UE_A belongs to DRU_B if the received uplink power from UE_A at DRU_B is greater than the other $DRUs$. Let p_{ij} be the transition probability of mobiles from DRU_i to DRU_j. Then, the handoff calls from DRU_i to DRU_j become $h_{ij} = p_{ij}T_i$. The distance between DRU_i and DRU_j is inversely proportional to p_{ij} . Assume that an eNodeB hotel has M VBSs. Let SOS_m and SOD_k be the set of sectors in VBS_m and the set of DRUs allocated to $Sector_k$, respectively, such that $|SOS_m| = 3$ (if each eNodeB/VBS has three sectors), $m=1,..., M$ and $k=1,..., K$. We consider the following three cost factors (KPIs) in the sectorization problem:

[0065] KPI_{BC} *(Inverse of the number of Blocked Calls) :* The penalty of the blocked calls caused by hard capacity and soft capacity. Let HC_m and SC_k be the hard capacity of VBS_m and

soft capacity of $Sector_k$ respectively such that $HC_m = \sum_{k \in SOS_m} SC_k$. The binary variable $x_{ik} = 1$, when DRU_i belongs to $Sector_k$. $y_{im} = \sum_{k \in SOS_m} x_{ik}$, then $y_{im} = 1$ when DRU_i belongs to VBS_m.

$$
\begin{aligned}
sc_k &= \begin{cases} 0 & if \quad \sum_i T_i x_{ik} < SC_k \\ \sum_i T_i x_{ik} - SC_k & otherwise \end{cases} \\
hc_m &= \sum_i T_i y_{im} - HC_m = \sum_i T_i \sum_{k \in SOS_m} x_{ik} - \sum_{k \in SOS_m} SC_k \\
&= \sum_{k \in SOS_m} \sum_i T_i x_{ik} - SC_k \\
&= \sum_{k \in SOS_m} sc_k
\end{aligned}
\tag{1}
$$

Since a penalty occurs only when the calls are blocked, we apply just sc_k to the objective function, because the hc_m is a function of sc_k and there is no need to add it as another term to the objective function. sc_k is a nonnegative real variable. So,

$$
KPI_{BC} = \left[\sum_{k \in SOS_m} sc_k \right]^{-1} \tag{2}
$$

[0066] KPI_{HO} (Inverse of the number of Handoffs): we consider three different types of Handoffs :

[0067] **A. *Inter-eNodeB Handoff:*** When user equipment (UE) with an ongoing call moves from one VBS to another VBS, then the UE needs an inter-eNodeB handoff. Inter-eNodeB handoff is executed using the X2 interface (as long as the UE does not leave the LTE coverage area) or S1 interface (when the UE leaves the serving cell). The X2 handoff includes establishing a signaling connection using the X2 Application Part (X2AP) from the source to the target eNodeB. The target eNodeB updates the MME (Mobility Management Entity) with the new geographic position of the UE. To enable this procedure, the MME needs to communicate with S-GW (Serving Gateway) to negotiate the new endpoint. During the S1 handoff, the MME receives the relocation preparation request of the source eNodeB, it starts the handoff resource allocation procedure to request the necessary radio resource from the target eNodeB. After the target eNodeB sends the required radio interface parameters embedded in a handoff command

message; the MME forwards this handoff command message transparently to the UE, which executes the handoff. The main procedure is triggered by the MME and executed by S-GW.

[0068] Let the binary variable $z_{ijm} = 1$, when DRU_i and DRU_j belong to VBS_m. Then the inter-eNodeB handoff cost is computed by using the variable $z_{ij} = 1 - \sum_m z_{ijm}$, the cost becomes $\sum_i \sum_j h_{ij} z_{ij}$.

[0069] Note that inter-eNodeB handoff occurs when DRU_i and DRU_j belong to different VBS, i.e., $z_{ijm} = 0$.

[0070] *B.* ***Intra-eNodeB Handoff:*** When a UE with an ongoing call moves from one sector to another in a VBS, then the mobile needs an intra-eNodeB handoff. This procedure doesn't need to involve MME or S-GW because it can be handled entirely within that VBS. Now by letting the binary variable $w_{ijk} = 1$ when DRU_i and DRU_j belong to sector k, the intra-eNodeB handoff cost is computed by using two variables $w_{ij} - z_{ij}$ where $w_{ij} = 1 - \sum_k w_{ijk}$, the cost becomes $\sum_i \sum_j h_{ij}(w_{ij} - z_{ij})$.

[0071] An intra-eNodeB handoff occurs when DRU_i and DRU_j belong to different sectors of the same VBS.

[0072] *C.* ***Forced Handoff:*** When a DRU changes its sector, all ongoing calls in the cell have to change their pilot PN offsets for WCDMA. The cost of forced handoff is computed by employing the current sectorization a_{ik}, which is equal to zero when DRU_i is in $Sector_k$. Since the cost occurs when DRU_i currently in another sector moves into $Sector_k$, the cost becomes $\sum_i \sum_k a_{ik} T_i x_{ik}$.

[0073] The weighted combination of these three handoff cost would be:

$$KPI_{HO} = \left[c_1 \sum_i \sum_j h_{ij} z_{ij} + c_2 \sum_i \sum_j h_{ij}(w_{ij} - z_{ij}) + c_3 \sum_i \sum_k a_{ik} T_i x_{ik} \right]^{-1} \quad (3)$$

[0074] ***KPI_{CI} (Inverse of the Compactness Index):*** we will try to minimize the length of handoff border with the compactness index *CI* which is introduced in Section II.*B* . In Equation (4) the numerator term represents the number of handoff DRU sides between two different sectors.

$$KPI_{CI} = \left[CI\right]^{-1} = \left[\frac{\sum_{i}\sum_{i<j} w_{ij}B_{ij}}{\sum_{i}\sum_{i<j} B_{ij}}\right]^{-1} \tag{4}$$

Where $B_{ij} = 1$, if DRU_i and DRU_j are adjacent.

Now we consider the following constraints required in the formulation:

1. each DRU has to belong to a sector, that is,

$$\sum_{k} x_{ik} = 1 \qquad \text{for all } i \tag{5}$$

2. The relationship between any two DRUs in a $Sector_k$ has to satisfy $w_{ijk} = 1$ if and only if $x_{ik} = x_{jk} = 1$. Thus we have:

$$w_{ijk} \le x_{ik}, w_{ijk} \le x_{jk} \; and \; w_{ijk} \ge x_{ik} + x_{jk} - 1 \qquad \text{for all } i,j \text{ and } k \tag{6}$$

[0075] The relationship between two DRUs in a VBS_m. $z_{ijm} = 1$ if and only if $y_{im} = y_{jm} = 1$ which leads to:

$$z_{ijm} \le y_{im}, z_{ijm} \le y_{jm} \; and \; z_{ijm} \ge y_{im} + y_{jm} - 1 \qquad \text{for all } i,j \text{ and } k \tag{7}$$

3. Connected sectorization, if a sector has more than one DRU, then the DRUs of the sector have to be connected. For the formulation of connected sectors we employ the cut theorem [26] on SOD_k. If $Sector_k$ is connected, then any cut that separates cells in SOD_k has at least one common side of the hexagonal cells. Let $S1_k$ be a proper subset of SOD_k, that is, $S1_k \subset SOD_k, S1_k \neq \phi$, and $S1_k \neq SOD_k$. Also let $S2_k$ be the opposite set of $S1_k$, that is, $S2_k = SOD_k - S1_k$. Because two subsets are connected, there exists at least one common side of the DRUs separated by the subsets. Thus we have

$$\sum_{i \in S1_k}\sum_{j \in S2_k} B_{ij} \ge 1 \tag{8}$$

[0076] Now, our QoS function is the weighted combination of three KPIs (cost factors) which we have already introduced. Obviously our objective function is to maximize the QoS function.

They are penalties of blocked calls by hard and soft capacities and handoff calls. The DRU sectorization can be formulated as the following mixed integer linear programming.

Minimize

$$QoS^{-1} = w_1.KPI_{BC}{}^{-1} + w_2.KPI_{HO}{}^{-1} + w_3.KPI_{CI}{}^{-1} \quad (9)$$

Subject to:

$$\sum_k x_{ik} = 1 \qquad for\ all\ \ i$$

$$w_{ijk} \le x_{ik}, w_{ijk} \le x_{jk}\ and\ w_{ijk} \ge x_{ik} + x_{jk} - 1 \qquad for\ all\ i, j\ and\ k$$

$$w_{ij} = 1 - \sum_k w_{ijk} \qquad for\ all\ i, j$$

$$y_{im} = \sum_{k \in SOS_m} x_{ik} \qquad for\ all\ \ m$$

$$z_{ijm} \le y_{im}, z_{ijm} \le y_{jm}\ and\ z_{ijm} \ge y_{im} + y_{jm} - 1 \qquad for\ all\ i, j\ and\ m$$

$$z_{ij} = 1 - \sum_k z_{ijk} \qquad for\ all\ i, j$$

$$\sum_{i \in S1_k} \sum_{j \in S2_k} B_{ij} \ge 1$$

$$for\ all\ S1_k \subset SOD_k\ \ where\ \ S1_k \ne \phi\ \ \ and\ \ \ S1_k \ne SOD_k\ \ \ and\ \ \ S2_k = SOD_k - S1_k$$

$$h_{ij} = p_{ij} T_i \qquad for\ all\ \ i\ and\ \ j$$

$$hc_m = \sum_i T_i y_{im} - HC_m \qquad for\ all\ \ m$$

$$sc_k = \begin{cases} 0 & if \quad \sum_i T_i x_{ik} < SC_k \\ \sum_i T_i x_{ik} - SC_k & otherwise \end{cases} \qquad for\ all\ \ k$$

$$x_{ik}, w_{ijk}, z_{ijm}, P_k \in \{0,1\} \qquad for\ all\ i, j, k\ and\ \ m$$

[0077] Note that many grouping problems which are special cases of the sectorization problem are well-known NP-hard problems. Since our problem is NP hard, the time it takes to execute the algorithm is exponentially increasing with the size of the problem. Such an algorithm is thus in most cases unusable for real-world size problem. As an encouraging result on NP-hard problems, we investigate evolutionary algorithms to solve the sectorization problem and compare the performance with the solutions obtained by the mixed integer programming.

[0078] Estimation distribution algorithm (EDA)

[0079] Unlike other evolutionary algorithms, in EDA a new population of individuals in each generation is generated without crossover and mutation operators. Instead, in EDA a new population is generated based on a probability distribution, which is estimated from the best

selected individuals of previous generation. We introduce each main-vector as an individual for our EDA approach, and also our fitness function is objective function that we mentioned it in section III. In general, conventional EDAs can be characterized by parameters and notations:

$$(I_s,F,\Delta_l,\eta_l,\beta_l,p_s,\Gamma, I_{Ter}) \tag{11}$$

where

1) I_s is the space of all potential solutions (entire search space of individuals).

2) F denotes a fitness function.

3) Δ_l is the set of individuals (population) at the l_{th} generation.

4) η_l is the set of best candidate solutions selected from set Δ_l at the l_{th} generation.

5) We denote $\beta_l \equiv \Delta_l - \eta_l \equiv \Delta_l \cap \eta_l^C$ .where η_l^C is the complement of η_l.

6) p_s is the selection probability. The EDA algorithm selects $p_s|\Delta_l|$ individuals from set Δ_l to make up set η_l.

7) We denote by Γ the distribution estimated from η_l (the set of selected candidate solutions) at each generation.

8) I_{Ter} are the maximum number of generation

In conventional EDAs, each individual is designated by a string. A typical EDA is described in the following steps:

Step 0: Generate initial population Δ_0. The initial population ($|\Delta_0|$ individuals) is typically obtained by sampling according the uniform (equally likely) distribution:

$$(\theta_1,\theta_2,\mathrm{L}\ ,\theta_n)=\prod_{i=1}^{n} p_i\,(\theta_i),$$

$$i=1,2,...,n,\ \text{ and }\ p_i\,(\theta_i=S_{11})=p_i\,(\theta_i=S_{21})=...=p_i\,(\theta_i=S_{|SOS_M|M})=\frac{1}{\sum_{n=1}^{M}|SOS_n|} \tag{12}$$

For generation l = 1,2, ..., follow steps 1 through 6

***Step 1*:** Evaluate the individuals in the current population Δ_{l-1} according to the fitness function F. Sort the candidate solutions (individuals in the current population) according to their fitness orders.

***Step 2*:** If the best candidate solution satisfies the convergence criterion or the number of generation exceeds its limit I_{Ter} , then terminate; else go to step 3.

Step 3: Select the best $p_s\Delta_{l-1}$ candidate solutions (individuals) from current population Δ_{l-1}. This selection is accomplished according to the sorted candidate solutions.

Step 4: Estimate the probability distribution $p(\theta_1,\theta_2,\mathrm{L}\ ,\theta_n)$ on the basis of $|\eta_{l-1}|$ best candidate

solutions. We denote this estimation by

$$= P(\theta_1, \theta_2, \mathrm{L}\ , \theta_n \mid \eta_{l-1}) \tag{13}$$

Step 5: Generate new $|\Delta_{l-1}| - |\eta_{l-1}|$ individuals on the basis of this new estimated probability distribution Γ. Replace the bad $|\beta_{l-1}|$ individuals with newly generated $|\Delta_{l-1}| - |\eta_{l-1}|$ individuals.

Step 6: Go to step 1 and repeat the steps

We followed the steps of the above pseudo code for our EDA implementation. In our experimentation, for estimation (13), we used a simple scheme of estimating the marginal distributions separately and using product form

$$\begin{aligned} &= p(\theta_1, \theta_2, \mathrm{L}\ , \theta_n \mid \eta_{l-1}) = \prod_{i=1}^{n} p_i(\theta_i \mid \eta_{l-1}) \\ &= \prod_{i=1}^{n} \left(\frac{\sum_{j=1}^{|\eta_{l-1}|} \delta\left(x_i^j = \theta_i \mid \eta_{l-1}\right)}{|\eta_{l-1}|} \right) \end{aligned} \tag{14}$$

Where δ is an indicator function and it can be expressed as

$$\delta\left(x_i^j = \theta \mid \eta_{l-1}\right) = \begin{cases} 1 & \text{if } x_i^j = \theta \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

[0080] It is also understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

[0081] Appendix I is a glossary of terms used herein, including acronyms.

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
CDMA	Code Division Multiple Access
CFR	Crest Factor Reduction
DAC	Digital to Analog Converter
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
LINC	Linear Amplification using Nonlinear Components
LO	Local Oscillator
LPF	Low Pass Filter
MCPA	Multi-Carrier Power Amplifier
MDS	Multi-Directional Search
OFDM	Orthogonal Frequency Division Multiplexing
PA	Power Amplifier
PAPR	Peak-to-Average Power Ratio
PD	Digital Baseband Predistortion
PLL	Phase Locked Loop
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RRH	Remote Radio Head

	RRU	Remote Radio Head Unit
	SAW	Surface Acoustic Wave Filter
	UMTS	Universal Mobile Telecommunications System
	UPC	Up Converter
5	WCDMA	Wideband Code Division Multiple Access
	WLAN	Wireless Local Area Network

WHAT IS CLAIMED IS:

1. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

a plurality of Base Transceiver Stations (BTS);

a plurality of traffic monitoring modules; and

a network optimization goal and optimization algorithm.

2. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

3. The system of claim 1 wherein the Base Transceiver Station comprises a plurality of small cells.

4. The system of claim 1 wherein the wherein the network optimization goal comprises a percentage of users associated with each of a plurality of sectors.

5. A system for dynamically routing signals in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs;

one or more Base Transceiver Stations (BTSs); and

one or more traffic monitoring units.

6. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DAUs and coupled to each of the plurality of DAUs.

7. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DAUs.

8. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of DRUs and coupled to each of the plurality of DRUs.

9. The system of claim 5 wherein the one or more traffic monitoring units comprise a plurality of traffic monitoring units each provided as a component of each of the plurality of DRUs.

10. The system of claim 5 wherein the one or more traffic monitoring units is external to the plurality of BTSs and coupled to each of the plurality of BTSs.

11. The system of claim 5 further comprising a network optimization processor coupled to the traffic monitoring unit.

12. The system of claim 11 wherein the network optimization processor comprises an optimization algorithm, which optionally includes an optimization goal.

13. The system of claim 5 wherein the plurality of DAUs are coupled via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link

14. The system of claim 5 wherein the plurality of DAUs are coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

15. The system of claim 5 wherein the DRUs are connected in a daisy chain configuration.

16. The system of claim 5 wherein the DRUs are connected to the DAUs in a star configuration.

17. The system of claim 5 wherein the DAUs are connected to the BTSs via at least one of a Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

18. The system of claim 5 wherein the DRUs are connected in a loop to a plurality of DAUs.

19. The system of claim 5 wherein a single DAU port is connected to a plurality of Base Transceiver Stations.

ABSTRACT OF THE DISCLOSURE

A system for dynamically routing signals in a Distributed Antenna System includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system further includes a plurality of traffic monitoring modules and a network optimization goal and optimization algorithm.

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First Named Inventor/Applicant Name:	Shawn Patrick Stapleton
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1	Drawings-only black and white line drawings	Drawings_103900US.pdf	148117 0eb1084d3eb28ae00ccc8d511cba3768ea397225	no	11
Warnings:					
Information:					

2	Application Data Sheet	ADS.pdf	1509956 d8db161adaa4f779a79852a425f5b3a3904f29f9	no	7
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3		PatentApp_103900US.pdf	249156 ce1fa5f9ad3907c7afdda0e5180f2597f753d9da	yes	29

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	Document Description	**Start**	**End**
	Specification	1	25
	Claims	26	28
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