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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 09/26/2023
North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
09/26/2023	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):

docket1@northweber.com
mnorth@northweber.com

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APPLICATION NO.	ISSUE DATE	PATENT NO.
17/102,099	26-Sep-2023	11770313

North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants

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17/102,099	09/26/2023	11770313	20145-054USC	1038

146571 7590 09/06/2023

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ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

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 Center (https://patentcenter.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 Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Wonjong Rhee, San Francisco, CA;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

ASSIA SPE, LLC, Wilmington, DE;

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Document Code:WFEE

User :Sengpheth Sandara

Refund Accounting Date:08/30/2023

Effective Date	Sale Item Reference Number	Refund Total
08/13/2023	17102099	$2,000.00

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method	Account Number
I20238TD23436700	1820	RCE- 2ND AND SUBSEQUENT REQUEST	$2,000.00	Visa	**********3763

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Sale Adjustment Accounting Date:08/30/2023

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146571 7590 08/18/2023

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docket1@northweber.com
mnorth@northweber.com

Corrected ***Notice of Allowability***	**Application No.** 17/102,099	**Applicant(s)** Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	**Art Unit** 2446	**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 communications filed on 8/13/2023.
   ☐ 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 1-23 . 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 7/30/2023, 8/13/2023.
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 _____.

/BORIS D GRIJALVA LOBOS/
Primary Patent Examiner, Art Unit 2446

PTO/SB/08b (07-09)
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

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17/102,099
Filing Date	11-23-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	1	European office action filed 8/9/2023 in related European patent application no. 20762897.5, Attorney Docket No. [20145-117EP], (56 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	08/16/2023

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

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

This collection of information is required by 37 CFR 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 2 hours 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, 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.

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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.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17/102,099
Filing Date	11-23-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	1	Response to Chinese office action dated filed 7/26/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (3 pgs).	
	2	Canadian Notice of Allowance mailed 6/30/2023 in Canadian patent application No. 3,129,522, Attorney Docket No. [20145-117CA], (1 pg).	
	3	European summons to attend oral proceedings pursuant to Rule 115(1) EPC, mailed 6/29/2023 in EP patent application No. 18211162.5, Docket No. [20145-055EPD], (5 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	08/16/2023

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

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

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United States Patent and Trademark Office

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Document Code:WFEE

User :Charmise Carter

Sale Accounting Date:08/16/2023

Sale Item Reference Number	Effective Date
17102099	08/13/2023

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I20238F736485605	1806	SUBMISSION- INFORMATION DISCLOSURE STMT	$260.00	Deposit Account

PTO/SB/08b (07-09)
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Electronic Patent Application Fee Transmittal

Application Number:	17102099
Filing Date:	23-Nov-2020
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Filer:	Michael V. North/Domarina Alkhas
Attorney Docket Number:	20145-054USC

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
RCE- 2ND AND SUBSEQUENT REQUEST	1820	1	2000	2000
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2140**

UNITED STATES PATENT AND TRADEMARK OFFICE

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

Decision Date : August 13, 2023

In re Application of :

Wonjong Rhee

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 17102099

Filed : 23-Nov-2020

Attorney Docket No : 20145-054USC

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed August 13, 2023 , to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2446 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt	
EFS ID:	48433587
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	13-AUG-2023
Filing Date:	23-NOV-2020
Time Stamp:	17:44:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2140
RAM confirmation Number	E20238CH44297003
Deposit Account	502776
Authorized User	Domarina Alkhas
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	ePetition Request Form	petition-request.pdf	39869 9359e6b7d3662f9cca7445eda407913ab10a209b	no	2
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	054USC_SIDS_RCE_SB30.pdf	697671 afd6afb9a3ce54cf021143dffb8e9a89d500790f	no	3
Warnings:					
Information:					
3	Quick Path Information Disclosure Statement	054USC_SIDS_QPID_SB09.pdf	234918 edbc6a0610abb979e5bfbbb6b091d48fad0ba109	no	2
Warnings:					
Information:					
4	Transmittal Letter	054USC_SIDS_Trans.pdf	27886 2638c901b6d98d3eb2f9495c6c738b8f0c711150	no	3
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	323048 26ec34bf841f63e4711ae7b7db7762e58c7c2bc7	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
6	Non Patent Literature	054USC_SIDS_NPL1.pdf	2400534 f949d035c701565c14706906af83112ab2ef6cd7	no	56
Warnings:					

Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	40849 2e2496668318255 5a6b3eb5f8da76209c729a514	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	3764775	

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.

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	17102099
Filing Date	23-Nov-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	BORIS GRIJALVA LOBOS
Attorney Docket Number	20145-054USC
Title	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

- ○ Small Entity
- ○ Micro Entity
- ◉ Regular Undiscounted

Reason for withdrawal from issue

◯ One or more claims are unpatentable ◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees) ◯ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).
RCE request,submission, and fee. ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that : The RCE request ,submission, and fee have already been filed in the above-identified application on ☒ Are attached.
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application. ◯ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity. ◯ A sole inventor ◯ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ◯ A joint inventor; all of whom are signing this e-petition

Signature	/Michael North/
Name	Michael North
Registration Number	46963

Doc Code: QPIDS.REQ
Document Description: QuickPath Information Disclosure Statement

PTO/SB/09 (09-18)

CERTIFICATION AND REQUEST FOR CONSIDERATION OF AN INFORMATION DISCLOSURE STATEMENT FILED AFTER PAYMENT OF THE ISSUE FEE UNDER THE QPIDS PROGRAM

Non-Provisional Application Number: 17/102,099	Filing Date: 11-23-2020
First Named Inventor: Wonjong Rhee	Title of Invention: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATIC

THE UNDERSIGNED HEREBY CERTIFIES AND REQUESTS THE FOLLOWING FOR THE ABOVE-IDENTIFIED APPLICATION.

1. Consideration is requested of the information disclosure statement (IDS) submitted herewith, which is being filed after payment of the issue fee.
2. Check the box next to the appropriate selection:

   ☑ Each item of information contained in the IDS 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 IDS. See 37 CFR 1.97(e)(1).

   OR

   ☐ No item of information contained in the IDS 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 IDS was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(2).

   OR

   ☐ See attached certification statement in compliance with 37 CFR 1.97(e).
3. Please charge the IDS fee set forth in 37 CFR 1.17(p) to Deposit Account No. 50-2776.
4. A Petition to Withdraw from Issue After Payment of the Issue Fee (37 CFR 1.313(c)(2)), including the petition fee set forth in 37 CFR 1.17(h), is submitted herewith as a **Web-based ePetition**.
   WARNING: Do not submit the petition as a follow-on paper via EFS-Web. Submit the petition as a Web-based ePetition by signing on to EFS-Web as a registered user, selecting the radio button next to "Existing application/patent," and then selecting the radio button next to "ePetition (for automatic processing and immediate grant, if all petitions requirements are met)." Failure to use the Web-based ePetition interface will result in automatic entry of the RCE.
5. A request for continued examination (RCE) under 37 CFR 1.114 and the RCE fee under 37 CFR 1.17(e) are submitted herewith.
6. The RCE will be treated as a "conditional" RCE. In the event the examiner determines that any item of information contained in the IDS necessitates the reopening of prosecution in the application, the undersigned understands that (i) the RCE will be processed and treated as an RCE under 37 CFR 1.114 and therefore (ii) the IDS fee under 37 CFR 1.17(p) will be returned in accordance with 37 CFR 1.97(b)(4). In the event that no item of information in the IDS necessitates reopening prosecution, the undersigned understands that the RCE will not be processed and the RCE fee under 37 CFR 1.17(e) will be returned.
7. This certification and request is being filed as a **Web-based ePetition** and is not accompanied by an amendment to the application. Inclusion of an amendment will result in automatic entry of the RCE.

Signature /Michael V. North/	Date 2023-08-13
Name (Print/Typed) Michael V. North	Practitioner Registration Number (If applicable) 46,963

Note: *Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.**

☑ *Total of 1 forms are submitted.

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

Privacy Act Statement

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

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

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

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No. :	1038
Inventor	:	Wonjong Rhee		
Filing Date	:	11-23-2020		
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Art Unit	:	2446		
Examiner	:	GRIJALVA LOBOS, BORIS D		
Docket No.	:	20145-054USC		
Customer No.	:	146571		

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: August 13, 2023 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #26

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☐ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

This IDS is being filed after the payment of Issue Fee; with QPID attached.

AND

☒ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: August 13, 2023

By: /Michael V. North/
Michael V. North
Reg. No. 46,963

Charter Communications, Inc.
Exhibit 1006
Page #28

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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

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

146571 7590 05/02/2023
North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

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.

Domarina Alkhas	(Typed or printed name)
/Domarina Alkhas/	(Signature)
August 1, 2023	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

TITLE OF INVENTION: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/02/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
GRIJALVA LOBOS, BORIS D	2446	709-224000

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/AIA/122 or PTO/SB/122) attached.

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

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

1 North Weber & Baugh LLP
2 Michael North
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: ASSIA SPE, LLC
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Wilmington, DE

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)

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

☐ Electronic Payment via Patent Center or 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. 50-2776

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature /Michael North/ Date August 1, 2023

Typed or printed name Michael North Registration No. 46,963

Charter Communications, Inc.
Exhibit 1006
Page #29

Electronic Patent Application Fee Transmittal

Application Number:	17102099
Filing Date:	23-Nov-2020
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Filer:	Michael V. North/Domarina Alkhas
Attorney Docket Number:	20145-054USC

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt	
EFS ID:	48381549
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	01-AUG-2023
Filing Date:	23-NOV-2020
Time Stamp:	22:26:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E202381M27008900
Deposit Account	502776
Authorized User	Domarina Alkhas
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	Issue Fee Payment (PTO-85B)	054USC_PTOL085PartB_NOA.pdf	205485 c499ada46efb524a19a99b3fc9e71d01d820bd77	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38150 b50d4304f0058eebc7b11117b8c69f9462ff2dc8	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	243635		

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/08b (07-09)
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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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17/102,099
Filing Date	11-23-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	1	Response to Chinese office action dated filed 7/26/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (3 pgs).	
	2	Canadian Notice of Allowance mailed 6/30/2023 in Canadian patent application No. 3,129,522, Attorney Docket No. [20145-117CA], (1 pg).	
	3	European summons to attend oral proceedings pursuant to Rule 115(1) EPC, mailed 6/29/2023 in EP patent application No. 18211162.5, Docket No. [20145-055EPD], (5 pgs).	

Examiner Signature		Date Considered	

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

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

This collection of information is required by 37 CFR 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 2 hours 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, 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.

Privacy Act Statement

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

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

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

Electronic Patent Application Fee Transmittal

Application Number:	17102099
Filing Date:	23-Nov-2020
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Filer:	Michael V. North/Domarina Alkhas
Attorney Docket Number:	20145-054USC

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	260	260
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt	
EFS ID:	48368665
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	30-JUL-2023
Filing Date:	23-NOV-2020
Time Stamp:	15:21:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$260
RAM confirmation Number	E20237TF22237100
Deposit Account	502776
Authorized User	Domarina Alkhas
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	Transmittal Letter	054USC_SIDS_Trans.pdf	27561 e2bce2404599d559fa9676a8791e9e207db3368e	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	324142 a922f3c041ac2a772e7ce1b4096ef3552cdbcc42	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	179296 f7e9c7d58362bea94fcf3a985f452c69f53a90d7	no	3
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	164157 7c087480fc90d1f3b8f5097b46f2ea59a36ac7b9	no	1
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL3.pdf	388806 50524709ce21b9e5124c170565e95db9e4c21f95	no	5
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	38503 45490660e39b9f3e75cd1bc1a61af1338592ee02	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	1122465

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No.	:	1038
Inventor	:	Wonjong Rhee			
Filing Date	:	11-23-2020			
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER			
Art Unit	:	2446			
Examiner	:	GRIJALVA LOBOS, BORIS D			
Docket No.	:	20145-054USC			
Customer No.	:	146571			

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: July 30, 2023 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #41

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☐ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☒ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☒ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: July 30, 2023

By: /Michael V. North/
Michael V. North
Reg. No. 46,963

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.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 07/27/2023

North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER
GRIJALVA LOBOS, BORIS D

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
07/27/2023	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):

docket1@northweber.com
mnorth@northweber.com

Corrected ***Notice of Allowability***	**Application No.** 17/102,099	**Applicant(s)** Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	**Art Unit** 2446	**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 communications filed on 6/13/2023.
   ☐ 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 1-23 . 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 6/13/2023.
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 _____.

/BORIS D GRIJALVA LOBOS/
Primary Patent Examiner, Art Unit 2446

Charter Communications, Inc.
Exhibit 1006
Page #45

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

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	17102099
Filing Date	2020-11-23
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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

U.S.PATENT APPLICATION PUBLICATIONS Remove

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	20160323015	A1	2016-11-03	Henry et al.	
	2	20110013529	A1	2011-01-20	Bin et al.	
	3	20090287827	A1	2009-11-19	Horn et al.	
	4	20050025163	A1	2005-02-03	Christie, IV	

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

FOREIGN PATENT DOCUMENTS Remove

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

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	1							

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

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Response to Chinese office action dated 1/10/2023 filed 3/16/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (5 pgs).	
	2	Canadian Notice of Allowance mailed 5/10/2023 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (1 pg).	
	3	Notice of Allowance mailed 5/24/2023 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (23 pgs).	
	4	Chinese office action mailed 4/17/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (27 pgs).	X

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

EXAMINER SIGNATURE

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	07/24/2023

*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.

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2023-06-13
Name/Print	Michael North	Registration Number	46963

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.**

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	564700	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 01:26 AM
L2	18005156	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:06 PM
L4	131963	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:08 PM
L5	18193986	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT,	OR	ON	ON	2022/09/24 09:10 PM

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Exhibit 1006
Page #50

		(parameters value metrics performance)	JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L6	63720	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L7	3815	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L8	1131	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:13 PM
L9	4863868	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/09/24 09:15 PM

			CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L10	447	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:15 PM
L14	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 10:58 PM
L15	588308	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L16	18663680	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR,	OR	ON	ON	2023/01/09 11:01 PM

			TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L17	137696	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L18	18808165	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5 (parameters value metrics performance)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L19	66662	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L20	3955	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL,	OR	ON	ON	2023/01/09 11:01 PM

			NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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L22	5087541	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L23	453	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
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L25	1	"17102099"	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09

							11:56 PM
L26	1	"10848398".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:58 PM
L27	3	("20040143428" OR "20090245130" OR "20100316012").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/17 09:47 AM
L28	3289962	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 (perform$4 noise situation fail$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2023/04/26 01:18 AM
L29	598	7 AND @AD<="20111110"	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:20 AM
L30	384	7 AND @PD<="20111110"	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; IBM_TDB)	OR	ON	ON	2023/04/26 01:20 AM
L31	530	28 AND 29	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:21 AM
L32	314	28 AND 30	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; IBM_TDB)	OR	ON	ON	2023/04/26 01:26 AM
L33	4	("20050025163" OR "20090287827" OR "20110013529" OR "20160323015").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/24 11:43 AM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	94901	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM

		0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.					
N2	42717	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 noise).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N3	232800	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N4	133	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N5	73	1 AND 4	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N6	1	5 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N7	50	1 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:15 PM
N8	166	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N9	1	7 AND 8	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N10	3	(2 AND 3) AND (4 8)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:17 PM
N11	185	(adaptive near1 spectrum).as. (adaptive near1 spectrum).aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N12	4	(2 AND 3) AND (4 8 11)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N13	99160	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N14	138	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N15	176	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N17	185	(adaptive near1 spectrum).as. (adaptive	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:13 AM

		near1 spectrum).aanm.					
N18	68	13 AND 14 AND (15 17)	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:13 AM
N19	3299	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm) WITH performance).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:16 AM
N20	14	19 AND (14 15 17)	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:16 AM
N21	681155	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 (perform$4 noise situation fail$3)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:18 AM
N22	109	21 AND (14 15 17) NOT 20	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:18 AM
N23	69	13 AND 22	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:19 AM

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

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	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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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	20160323015	A1	2016-11-03	Henry et al.	
	2	20110013529	A1	2011-01-20	Bin et al.	
	3	20090287827	A1	2009-11-19	Horn et al.	
	4	20050025163	A1	2005-02-03	Christie, IV	

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FOREIGN PATENT DOCUMENTS Remove

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	1							

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Response to Chinese office action dated 1/10/2023 filed 3/16/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (5 pgs).	
	2	Canadian Notice of Allowance mailed 5/10/2023 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (1 pg).	
	3	Notice of Allowance mailed 5/24/2023 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (23 pgs).	
	4	Chinese office action mailed 4/17/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (27 pgs).	X

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2023-06-13
Name/Print	Michael North	Registration Number	46963

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.**

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

Electronic Patent Application Fee Transmittal

Application Number:	17102099
Filing Date:	23-Nov-2020
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Filer:	Michael V. North/Domarina Alkhas
Attorney Docket Number:	20145-054USC

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	260	260
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt	
EFS ID:	48144696
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	13-JUN-2023
Filing Date:	23-NOV-2020
Time Stamp:	14:39:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$260
RAM confirmation Number	E20236CE40057397
Deposit Account	502776
Authorized User	Domarina Alkhas
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	Transmittal Letter	054USC_SIDS_Trans.pdf	27527 0f606961a17e6dcc64439f71fdd6a93656af70f6	no	3
Warnings:					
Information:					
2	Non Patent Literature	054USC_SIDS_NPL1.pdf	91754 ac556064806bdf5b21250e64fd21833cfb216321	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL2.pdf	170178 8cebcc4d54525fd63ae7adbb02041b360e7da4b4	no	1
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL3.pdf	2909930 eabab2e32df88101e86e61a88fb64306b59663c3	no	23
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL4.pdf	724109 d9d10496ce3be88e66cd1cd3622ec19e31972fff	no	27
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08a.pdf	612491 3081d3a4675e277dff384d816dba194e510acf6d	no	4
Warnings:					
Information:					

7	Fee Worksheet (SB06)	fee-info.pdf	38503 bd5ffd028bf3dc3885351f86f01f8d1e8d4b2941	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	4574492	

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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No.	:	1038
Inventor	:	Wonjong Rhee			
Filing Date	:	11-23-2020			
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER			
Art Unit	:	2446			
Examiner	:	GRIJALVA LOBOS, BORIS D			
Docket No.	:	20145-054USC			
Customer No.	:	146571			

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: June 13, 2023 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #67

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☐ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☒ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☒ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: June 13, 2023

By: /Michael V. North/
Michael V. North
Reg. No. 46,963

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

146571 7590 05/02/2023
North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER
GRIJALVA LOBOS, BORIS D

ART UNIT	PAPER NUMBER
2446	

DATE MAILED: 05/02/2023

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

TITLE OF INVENTION: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/02/2023

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 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted 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. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

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

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

PTOL-85 (Rev. 02/11)

Charter Communications, Inc.
Exhibit 1006
Page #70

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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

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

146571 7590 05/02/2023
North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

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.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

TITLE OF INVENTION: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	08/02/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
GRIJALVA LOBOS, BORIS D	2446	709-224000

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/AIA/122 or PTO/SB/122) attached.

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

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

1 _____
2 _____
3 _____

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

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document 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)

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

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

❑ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Charter Communications, Inc.
Exhibit 1006
Page #71

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.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 05/02/2023

North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

DATE MAILED: 05/02/2023

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.

PTOL-85 (Rev. 02/11)

Charter Communications, Inc.
Exhibit 1006
Page #72

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. 17/102,099	Applicant(s) Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	Art Unit 2446	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 communications filed on 4/13/2023.
   ☐ 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 1-23 . 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 PTO-2323.

/BORIS D GRIJALVA LOBOS/
Primary Patent Examiner, Art Unit 2446

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Response to Amendment

This action is in response to communications filed on 4/13/2023.

Claims 1-18 have been amended. The amendments have been fully considered.

Claims 1-23 are pending.

Allowable Subject Matter

Claims 1-23 are allowed.

REASONS FOR ALLOWANCE

No reason for allowance is necessary as the record is clear. See MPEP 1302.14(I).

Conclusion

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."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BORIS D GRIJALVA LOBOS whose telephone number is (571)272-0767. The examiner can normally be reached M-F 10:30AM to 6:30PM 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, Brian Gillis can be reached on 571-272-7952. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BORIS D GRIJALVA LOBOS/
Primary Patent Examiner, Art Unit 2446

AFCP 2.0 Decision	Application No.	Applicant(s)	
	17/102,099	Rhee, Wonjong	
	Examiner	Art Unit	AIA (FITF) Status
	BORIS D GRIJALVA LOBOS	2446	No

This is in response to the After Final Consideration Pilot request filed 13 April 2023.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ The request is not the first proper AFCP 2.0 request submitted in response to the most recent final rejection.

   ☐ Other: _____

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☐ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☑ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action . See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other: _____

   Examiner Note: Please attach an interview summary when necessary as described above.

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	06/19/2021	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	10/09/2021	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	09/24/2022	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	01/09/2023	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	04/26/2023	BGL

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

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

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

Search Notes		
Search Notes	**Date**	**Examiner**
EAST Inventor Name Search Performed (see attached search notes)	06/19/2021	BGL

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

EAST Assignee Name Search Performed (see attached search notes)	06/19/2021	BGL
EAST Text Limited Classification Search Performed (see attached search notes)	06/19/2021	BGL
EAST Text Search Performed (see attached search notes)	06/19/2021	BGL
GOOGLE search performed (see attached)	06/19/2021	BGL
GOOGLE Patent search performed (see attached)	06/19/2021	BGL
Updated EAST Inventor and Assignee Name Search (see attached search history)	10/09/2021	BGL
Updated EAST Text Limited search of all CPC classes/subclasses indicated above (see attached search history)	10/09/2021	BGL
Updated EAST Text Search (see attached search history)	10/09/2021	BGL
GOOGLE and GOOGLE Patent search performed (see attached)	10/09/2021	BGL
PE2E Inventor Name Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Assignee Name Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Text Limited Classification Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Text Search Performed (see attached search notes)	09/24/2022	BGL
GOOGLE search performed (see attached)	09/24/2022	BGL
GOOGLE Patent search performed (see attached)	09/24/2022	BGL
Updated PE2E Inventor Name Search (see attached search notes)	01/09/2023	BGL
Updated PE2E Text Limited Classification Search (see attached search notes)	01/09/2023	BGL
Updated PE2E Text Search (see attached search notes)	01/09/2023	BGL
GOOGLE search performed (see attached)	01/09/2023	BGL
Updated PE2E Inventor and Assignee Search, PE2E Text Limited Classification Search, and PE2E Text Search (see attached search notes)	04/26/2023	BGL
GOOGLE search performed (see attached)	04/26/2023	BGL
GOOGLE Patent Search Performed (see attached)	04/26/2023	BGL
IP.COM Search Performed (see attached)	04/26/2023	BGL

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	06/18/2021	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	10/09/2021	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	09/24/2022	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	01/09/2023	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	04/26/2023	BGL

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	**Art Unit**
	BORIS D GRIJALVA LOBOS	2446

✓	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	06/19/2021	10/09/2021	09/23/2022	01/09/2023	04/26/2023				
	1	✓	✓	✓	✓	=				
	2	✓	✓	✓	✓	=				
	3	✓	✓	✓	✓	=				
	4	✓	✓	✓	✓	=				
	5	✓	✓	✓	✓	=				
	6	✓	✓	✓	✓	=				
	7	✓	✓	✓	✓	=				
	8	✓	✓	✓	✓	=				
	9	✓	✓	✓	✓	=				
	10	✓	✓	✓	✓	=				
	11	✓	✓	✓	✓	=				
	12	✓	✓	✓	✓	=				
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	16	✓	✓	✓	✓	=				
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	19	✓	=	=	=	=				
	20	✓	=	=	=	=				
	21	✓	=	=	=	=				
	22	✓	=	=	=	=				
	23	✓	=	=	=	=				

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/102,099	Rhee, Wonjong
	Examiner	**Art Unit**
	BORIS D GRIJALVA LOBOS	2446

CPC							
Symbol						**Type**	**Version**
H04L	/	43	/	04		F	2013-01-01
H04L	/	1	/	20		I	2013-01-01
H04L	/	1	/	0019		I	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	23	
/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	26 April 2023	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office — Part of Paper No.: 20230426

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	Examiner	**Art Unit**
	BORIS D GRIJALVA LOBOS	2446

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04L	/	12	/	26

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	26 April 2023	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office — Part of Paper No.: 20230426

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
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	Examiner	**Art Unit**
	BORIS D GRIJALVA LOBOS	2446

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

CLAIMS

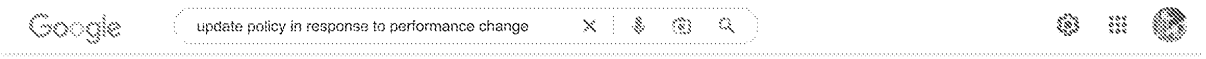
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19										
	2		11		20										
	3		12		21										
	4		13		22										
	5		14		23										
	6		15												
	7		16												
	8		17												
	9		18												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 23	
/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446 (Primary Examiner)	26 April 2023 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

U.S. Patent and Trademark Office

Part of Paper No.: 20230426

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It looks like there aren't many great matches for your search

Try using words that might appear on the page you're looking for. For example, "cake recipes" instead of "how to make a cake."

Need help? Check out **other tips** for searching on Google.

University of California, Berkeley
https://hr.berkeley.edu › managing-hr › planning › ex...

Performance Expectations = Results + Actions & Behaviors

Feb 14, 2006 — Build in flexibility. Regular status update and check-in meetings make it much easier to identify problems or shifts in unit priorities and change course.

WA.gov
https://ofm.wa.gov › best-practices-and-benchmarks

Improving Performance Evaluations

Feb 17, 2010 — Good performance evaluations require committed leaders, courageous supervisors, and open ... and update plans throughout the year as things change.

OPM (.gov)
https://www.opm.gov › ... › Performance Management

Performance Coaching and Feedback

Aug 22, 2008 — Effective application of performance coaching and feedback will result in better achievement of agency strategic goals, as well as professional growth for both ...

https://www.opm.gov › ... › Performance Management

Developing Performance Standards

May 26, 2006 — This article reviews the principles of writing good standards that can be used effectively to appraise employee performance of those elements. Definition. A ...

Equal Employment Opportunity Commission (.gov)
https://www.eeoc.gov › laws › guidance › applying-pe...

Applying Performance and Conduct Standards to ...

Sep 3, 2008 — This document provides information on the ADA and the responsibilities of both employers and employees when performance and conduct issues arise. Citation.

Acquisition.GOV (.gov)
https://www.acquisition.gov › far

52.243-7 Notification of Changes.

Feb 1, 2001 — (6) The Contractor's estimate of the time by which the Government must respond to the Contractor's notice to minimize cost, delay or disruption of performance.

University of Nebraska–Lincoln
https://hr.unl.edu › performance-management

Performance Management and Evaluation | Human Resources

Oct 7, 2011 — Performance Management · Challenges in Conducting Performance Evaluations. Changing nature of work, i.e., technological changes, job duties, or change in scope ...

Clarion University
https://www.clarion.edu › frequently-used-forms

EMPLOYEE PERFORMANCE REVIEW

Google

5 pages

SEC.gov
https://www.sec.gov › about › forms › formadv...

Appendix C Part 2 of Form ADV

Oct 1, 2011 — Do we need to include the summary of material changes that we prepare in response to Item 2 with our annual updating amendment filing on IARD? Yes, you need to ...
26 pages

U.S. Department of Education (.gov)
https://nces.ed.gov › pubs98 › safetech › chapter3

Chapter 3-Security Policy: Development and ... - NCES

Jan 31, 2001 — Update the employee handbook to reflect security procedures. Keep security reminders visible throughout the workplace (e.g., posters, FYI memos, and e-mail ...

Marines.mil
https://www.marines.mil › Portals › Publications

MCO P1610.7F W CH 1-2 PERFORMANCE EVALUATION ...

Jun 22, 2009 — Recent changes to the Marine Corps Physical Fitness Program and Marine ... (MMSB) promulgates policy, processes and maintains fitness report information,.
184 pages

National Science Foundation (.gov)
https://www.nsf.gov › bfa › dias › policy

Policy Office

May 27, 2011 — Head, Policy Office: Jean Feldman. The Policy Office in the Division of Institution and Award Support is responsible ... NSF Responses to Natural Disasters.

https://www.nsf.gov › manuals › gpm05_131 › gpm3

Chapter III - Grant Administration

Jul 15, 2005 — 300 MONITORING PROJECT PERFORMANCE 310 CHANGES IN PROJECT DIRECTION OR MANAGEMENT 320 CHANGES IN THE GRANT BUDGET 330 COST SHARING AN...

Google
https://developers.google.com › ... › Google Calendar

Performance tips | Google Calendar

Jul 19, 2011 — Partial response: A request where you specify which fields to include in the response (use the fields request parameter). · Patch: An update request where you ...

OECD
https://www.oecd.org › sti

Policy Responses to the Economic Crisis: Investing in ...

Jun 10, 2009 — respond to the changing nature of the innovation process and strengthen innovation performance to foster sustainable growth and address key global ...
37 pages

CA.gov
https://www.dir.ca.gov › dlse › dlse_enfomanual

The 2002 Update Of The DLSE Enforcement Policies and ...

Items 1 - 9 · Nov 15, 2005 — Manual summarizes the policies and interpretations which DLSE has ... performance or as an inducement to employees to remain in the employ of the ...
352 pages

Nevada Legislature
https://www.leg.state.nv.us › full › documents

Legislative Commission

Dec 20, 2010 — evaluate performance measures including the reliability of reported results, and (3) determine if policies, procedures, and computer access controls are ...
32 pages

Google

Support Policies

Oct 14, 2005 — Download our Technical Support Welcome Guide to help get you up and running with tour support product(s). CUSTOMER SUPPORT WELCOME CENTER TECHNICAL...

Washington Headquarters Services (.mil)
https://www.esd.whs.mil › Documents › Issuances

DoDI 1327.06, "Leave and Liberty Policy and Procedures," ...

Jun 16, 2009 — Change 4, 01/15/2021. 2. 3. DEFINITIONS. See Glossary. 4. POLICY. ... contributions to morale, level of performance, career motivation, and cost savings.

National Institutes of Health (.gov)
https://www.ncbi.nlm.nih.gov › books › NBK2682

Tools and Strategies for Quality Improvement and Patient ...

by RG Hughes · 2008 · Cited by 292 — Processes that are inefficient and variable, changing case mix of patients, ... involves assessing performance and using findings to inform change.

Azahcccs.gov
https://www.azahcccs.gov › Members › AlreadyCovered

Reporting Changes

Dec 1, 2009 — How do I report changes? If you need to report a change in your household including, but not limited to, a change of residential or mailing address, your income ...

Harvard Business Review
https://hbr.org › 1969/01 › how-to-deal-with-resistanc...

How to Deal With Resistance to Change

Dec 20, 2009 — Does it follow, therefore, that business management is forever saddled with the onerous job of "forcing" change down the throats of resistant people? My answer ...

Nintendo
https://www.nintendo.com › privacy-policy

Nintendo Privacy Policy - Official Site

Mar 15, 2006 — We may share your information to comply with legal process, respond to claims or ... Changes. Nintendo may update this privacy policy from time to time.

Group Policy Central
https://www.grouppolicy.biz › 2010/08 › how-to-use-...

How to use Group Policy to control Services

Aug 11, 2010 — Service Action will take place each time there is a group policy refresh so that you do not need to wait for the computer to reboot for the latest startup mode ...

IBM
https://www.ibm.com › docs › qsip

Creating a custom rule

Sep 28, 2005 — For example, event rules test incoming log source data and offense rules test the parameters of an offense to trigger more responses. In the Rule Wizard window, ...

GEICO
https://www.geico.com › contact-us

B2B Services Contact

Jan 24, 2008 — GEICO Homeowner Mortgagee Change Request Form · Vendor Online Services · Staff Counsel - SCIP Approved Vendors Only site. Contact. Emergency Response Service ...

The University of Kansas
https://cfh.ku.edu › maintain › overview

Section 1. Achieving and Maintaining Quality Performance

Jul 18, 2010 — How do you achieve quality performance, using TQM and other principles? ... but it keeps changing, responding both to student needs and feedback and to new ...

Google

Minimum, Prompted, and Slow/Fast Update Versions

May 13, 2011 — This change is in line with industry practices and designed to help ensure ... the AutoUpdate policy, not only remove the Check for Updates option in the ...

U.S. Department of Labor (.gov)
https://www.dol.gov › agencies › whd › fmla › faq

Questions and Answers About the Fair Labor Standards ...

Mar 23, 2010 -- The FLSA does not require performance evaluations. Performance evaluations are generally a matter of agreement between an employer and employee (or the ...

https://www.dol.gov › eta › foreign-labor › policy

Policies and Regulations

Mar 15, 2008 — The Office of Foreign Labor Certification also provides further guidance through various directives and advisories such as Training and Employment Guidance ...

Department of Justice (.gov)
https://www.justice.gov › oip › blog › foia-update-con...

FOIA Update: Congress Enacts FOIA Amendments | OIP

Jan 31, 2001 — A major change made by the FOIA amendments involves the maintenance of agency ... of any records processed and disclosed in response to a FOIA request that ...

HHS.gov
https://oig.hhs.gov › reports-and-publications › workp...

Work Plan | Office of Inspector General - HHS.gov

Feb 21, 2010 -- mandatory requirements for OIG reviews, as set forth in laws, regulations, ... OIG updates this dynamic, web-based Work Plan monthly to ensure that it more ...

National Institute of Standards and Technology (.gov)
https://nvlpubs.nist.gov › nistpubs › legacy

NIST SP 800-55 Revision 1, Performance Measurement ...

Jul 21, 2008 -- New measures will also be required and effectiveness if the organization's mission is redefined or if changes are made to information security policies and ...

Broadcom
https://techdocs.broadcom.com › eadocs › PDF › sit...

CA SiteMinder Policy Server Administration Guide

Oct 7, 2005 — Documentation Changes. The following documentation updates have been made since the last release of this documentation: o Configure the CA SiteMinder Event ...

MathWorks
https://www.mathworks.com › matlab › matlab_prog

Techniques to Improve Performance - MATLAB & Simulink

Mar 15, 2006 — To speed up the performance of your code, there are several techniques that you ... Create new variables if data type changes -- Create a new variable rather ...

Food and Drug Administration (.gov)
https://www.fda.gov › search-fda-guidance-documents

SUPAC-IR Questions and Answers about ...

Jan 31, 2001 -- Because such a change may have significant impact on formulation quality and performance, it is a level 3 composition change that needs a prior approval ...

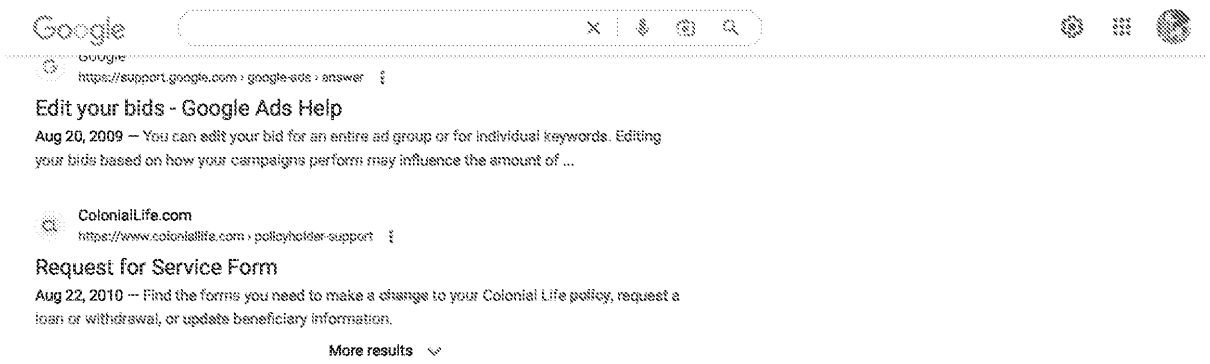
ManageEngine
https://www.manageengine.com › applications_manager

Application Monitor Software & Tools

Jan 5, 2010 -- Verify if frequent code changes have impacted the performance of your key business applications. Respond to incidents faster. Become aware of application ...

Rating: 4.6 · 320 reviews

https://www.manageengine.com › ... › On-premises


Google
https://support.google.com › google-ads › answer
Edit your bids - Google Ads Help
Aug 20, 2009 — You can edit your bid for an entire ad group or for individual keywords. Editing your bids based on how your campaigns perform may influence the amount of ...
ColonialLife.com
https://www.colonialife.com › policyholder-support
Request for Service Form
Aug 22, 2010 — Find the forms you need to make a change to your Colonial Life policy, request a loan or withdrawal, or update beneficiary information.
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Google update multiple network policies performance degradat

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It looks like there aren't many great matches for your search

Try using words that might appear on the page you're looking for. For example, "cake recipes" instead of "how to make a cake."

Need help? Check out other tips for searching on Google.

CISA (.gov)
https://www.cisa.gov › sites › default › files › re...

Recommended Practice for Patch Management of Control ...

Dec 17, 2008 — This document specifically identifies issues and recommends practices for ICS patch management in order to strengthen overall ICS security. 1.1 Background. ICSs ...

TechTarget
https://www.techtarget.com › searchnetworking › gracef...

What is graceful degradation? | Definition from TechTarget

Jan 17, 2007 — In graceful degradation, the operating efficiency or speed declines gradually as an increasing number of components fail.

GovInfo (.gov)
https://www.govinfo.gov › content › pkg › pdf

Guidelines on firewalls and firewall policy

Sep 23, 2009 — Policy rules may need to be updated as the organization's requirements change, such as when new applications or hosts are implemented within the network.
48 pages

SolarWinds
https://www.solarwinds.com › network-performance-...

Network Performance Monitor - Onsite & Remote Monitoring

Oct 7, 2007 — The network performance monitoring tool in NPM is built to automatically map between vPCs, port channels, and physical ports across your Nexus switches to help ...

VMware
https://www.vmware.com › pdf › techpaper › v...

Architecture, Performance and Best Practices - White Paper

Aug 6, 2010 — While NetIOC enables you to limit vMotion traffic initiated from a vSphere host, it fails to prevent performance loss when multiple vMotion traffic flows ...
28 pages

Palo Alto Networks
https://docs.paloaltonetworks.com › pan-os-release-notes

PAN-OS 10.2.3 Known Issues

Results 1 - 10 of 10 · Feb 3, 2010 — If you use multiple log forwarding cards (LFCs) on the PA-7000 series, all of the cards may not receive all of the updates and the mappings ...

Cisco
https://www.cisco.com › dam › datacenter › assets

Enhanced Business Continuity With Application Mobility ...

Jun 10, 2010 — paper is based on innovations in server, network, and storage virtualization driven by ... Performance degradation between data centers was less than 2%;.

Google

RFC 3449 - TCP Performance Implications of Network Path ...

Dec 15, 2002 — TCP Performance Implications of Network Path Asymmetry (RFC 3449, ... Such a change has many drawbacks in the general case and is currently not recommended ...

https://www.ietf.org › rfc › rfc2544

RFC 2544 Benchmarking Methodology for Network ...

Mar 15, 1999 — In addition, many of the same frame sizes are specified on each of the media types to allow for easy performance comparisons. Note: The inclusion of an ...

Northwestern University
https://www.it.northwestern.edu › policies › extensions

Policy and Enforcement Plan for Unapproved Campus ...

Aug 29, 2003 — Effects of Extending the Network on Performance and Reliability. Use of multi-port devices attached to the campus infrastructure blurs the deterministic nature ...

ManageEngine
https://www.manageengine.com › network-monitoring

Network Performance Monitoring (NPM) Software & Tools

Aug 6, 2010 — All network devices discard packets depending on their memory, which can effect performance. These problems are common with routers and switches. Since discards ...

Harmony Telephone Company
https://harmonytel.com › wp-content › uploads

Network-Management-Practices-and-Performance. ...

Nov 5, 2011 — Network Management Practices, Performance Characteristics, and ... They will be maintained and updated on this website. ... C. Device Attachment Rules.
5 pages

nixCraft
https://www.cyberciti.biz › faq › linux-tcp-tuning

Linux Tune Network Stack (Buffers Size) To Increase ...

Jul 8, 2009 — I've two servers located in two different data center. Both server deals with a lot of concurrent large file transfers. But network performance is very poor ...

Nmap
https://nmap.org › book › man-performance

Timing and Performance | Nmap Network Scanning

Jan 17, 2008 — Nmap has the ability to port scan or version scan multiple hosts in parallel. ... By default, the ideal parallelism can drop to one if the network proves ...

Red Hat
https://access.redhat.com › en-us › html › configuring...

Chapter 13. Configuring virtual machine network connections

Feb 11, 2010 — Based on the configuration of the virtual switch, a VM can use an existing virtual network managed by the hypervisor, or a different network connection method.
Missing: degradation | Must include: degradation

Yahoo
https://developer.yahoo.com › performance › rules

Best Practices for Speeding Up Your Web Site

Dec 12, 2006 — Keep in mind, if you use a far future Expires header you have to change ... Many of these performance rules deal with how external components are managed.

National Institute of Standards and Technology (.gov)
https://nvlpubs.nist.gov › nistpubs › legacy

NIST SP 800-41, Revision 1, Guidelines on Firewalls and ...

by K Scarfone · 2009 · Cited by 347 — and specific products, but many firewalls can have their performance ... Policy rules may need to be updated as the organization's requirements change,.

Google

by K Scarfone · 2011 · Cited by 145 — increased speed because the packets never hit physical networking devices. ... organization does not need to change its security policies to gain the ...

F5 Networks
https://techdocs.f5.com › tm-monitors-reference-12-0-0

Monitors Concepts - MyF5

Oct 10, 2010 — Performance monitors check the performance and load. If a monitored device, link, or service does not respond within a specified timeout period, or the status ...

Department of Defense (.gov)
https://dodcio.defense.gov › announcement

DoD IT Enterprise Strategy and Roadmap

Sep 6, 2011 — The number of networks the Department of Defense (DoD) uses to execute its ... associated policy, performance measures, architectures, and standards.
48 pages

Microsoft Press Store
https://www.microsoftpressstore.com › articles › article

Configuring Windows Firewall and Network Access ...

May 15, 2011 — Configure firewall rules to require IPsec connection security and, ... In networking, firewalls analyze communications and drop packets that haven't been ...

Valve
https://developer.valvesoftware.com › wiki › Source_...

Source Multiplayer Networking

May 30, 2005 — In addition, each client has a different network delay which varies over time due to other ... checks the game rules, and updates all object states.

National Institutes of Health (.gov)
https://www.ncbi.nlm.nih.gov › articles › PMC3150158

Social Relationships and Health: A Flashpoint for ...

by D Umberson · 2010 · Cited by 2784 — Social networks refer to the web of social relationships surrounding an individual ... can advance this policy agenda by addressing several specific...
Missing: performance | Must include: performance

U.S. Department of Education (.gov)
https://files.eric.ed.gov › fulltext

Implementing Proactive Network Management Solutions in ...

by P Bedi · 2005 — The network was constantly being overwhelmed with viruses which created performance issues for the students. All problems had to be fixed manually, which ...
4 pages

OECD
https://www.oecd.org › policyconference

Regulatory Policy and the Road to Sustainable Growth

Oct 28, 2010 — Chapter 2: Achievements of regulatory policy so far. ... performance and progress, and effective sequencing of further change. A renewal of the.

Server Fault
https://serverfault.com › questions › performance-per...

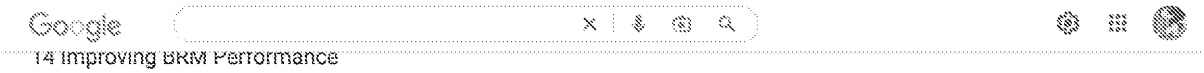
Performance penalty of multiple IP's per network interface

May 24, 2011 — But there would not be a performance penalty for additional IP addresses. ... running per development virtualization hosting server with no network issues.
3 answers · 2 votes: If you want to measure the performance penalty, you would need to create ...

Amazon.com
https://aws.amazon.com › faqs

Amazon S3 FAQs

Feb 5, 2010 — Q: Should I expect a change in Amazon S3 performance when using IPv6? ... between the source and destination, and packet loss rates on the network path.



14 Improving BRM Performance

Aug 6, 2001 — See "Policy-Driven Charging" in BRM Setting Up Pricing and Rating. ... Performance degrades when too many CMs are running on the same machine, depending on ...

Department of Energy (.gov)
https://www.energy.gov › sere › state-and-local-energ...

State and Local Energy Efficiency Action Network (SEE ...

Jun 3, 2010 — Learn more about SEE Action activities related to the following policies and programs below. Grid-Interactive Efficient Buildings.

Broadcom
https://ftpdocs.broadcom.com › cadocs › PDF › S...

CA Service Operations Insight Event and Alert ...

Dec 6, 2010 — example, performance degradation detected by CA APM takes the form of a quality ... The alert causes the associated Network service health to change to ...

More results

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	564700	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 01:26 AM
L2	18005156	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:06 PM
L4	131963	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:08 PM
L5	18193986	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT,	OR	ON	ON	2022/09/24 09:10 PM

Charter Communications, Inc.
Exhibit 1006
Page #94

		(parameters value metrics performance)	JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L6	63720	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L7	3815	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L8	1131	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:13 PM
L9	4863868	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/09/24 09:15 PM

			CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L10	447	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:15 PM
L14	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 10:58 PM
L15	588308	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L16	18663680	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR,	OR	ON	ON	2023/01/09 11:01 PM

			TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L17	137696	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L18	18808165	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5 (parameters value metrics performance)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L19	66662	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L20	3955	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL,	OR	ON	ON	2023/01/09 11:01 PM

			NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L21	1142	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L22	5087541	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L23	453	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L24	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:01 PM
L25	1	"17102099"	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09

							11:56 PM
L26	1	"10848398".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:58 PM
L27	3	("20040143428" OR "20090245130" OR "20100316012").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/17 09:47 AM
L28	3289962	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 (perform$4 noise situation fail$3))	(US-PGPUB; USPAT; EPO; JPO)	OR	ON	ON	2023/04/26 01:18 AM
L29	598	7 AND @AD<="20111110"	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:20 AM
L30	384	7 AND @PD<="20111110"	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; IBM_TDB)	OR	ON	ON	2023/04/26 01:20 AM
L31	530	28 AND 29	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:21 AM
L32	314	28 AND 30	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; IBM_TDB)	OR	ON	ON	2023/04/26 01:26 AM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	94901	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM

N2	42717	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 noise).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N3	232800	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N4	133	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N5	73	1 AND 4	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N6	1	5 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N7	50	1 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:15 PM
N8	166	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N9	1	7 AND 8	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N10	3	(2 AND 3) AND (4 8)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:17 PM
N11	185	(adaptive near1 spectrum).as. (adaptive near1 spectrum).aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N12	4	(2 AND 3) AND (4 8 11)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N13	99160	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N14	138	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N15	176	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:12 AM
N17	185	(adaptive near1 spectrum).as. (adaptive near1 spectrum).aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:13 AM
N18	68	13 AND 14 AND (15 17)	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:13 AM
N19	3299	((broadcast$3	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26

		disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm) WITH performance).clm.					01:16 AM
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N21	681155	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 (perform$4 noise situation fail$3)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:18 AM
N22	109	21 AND (14 15 17) NOT 20	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:18 AM
N23	69	13 AND 22	(US-PGPUB; USPAT)	OR	ON	ON	2023/04/26 01:19 AM

Google update policy in response to performance change

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www.google.com/patents/US7839780

Dynamic traffic rearrangement to enforce policy changes in ...

Grant · Filed Mar 30, 2006 · Issued Nov 23, 2010 · Narayanan Natarajan · Telcordia Technologies, Inc.

The system periodically monitors network performance, and rearranges LSPs ... If changes are performed by the PCE 54, then the latter performs the update, ...

Overview · Related · Discuss

www.google.com/patents/US9626640

Closed loop performance management for service delivery systems

Grant · Filed Aug 20, 2013 · Issued Apr 18, 2017 · Yixin Diao · International Business Machines Corporation

Due to this feedback mechanism and continual data updates, the controller quickly responds to changes in workload such as changes in volumes of customer service ...

Overview · Related · Discuss

www.google.com/patents/US7809906

Device for performance tuning in a system

Grant · Filed May 28, 2004 · Issued Oct 5, 2010 · Yoshiaki Eguchi · Hitachi, Ltd.

In the case where the load can be reduced by changing the configuration ... performance is judged based on the throughput or the response time, for example.

Overview · Related · Discuss

www.google.com/patents/US20080222642

Dynamic resource profiles for clusterware-managed resources

App. · Filed Mar 8, 2007 · Published Sep 11, 2008 · Sarat B. Kakarla · Oracle International Corporation

A clusterware policy manager may know ahead of time that a particular ... Hence, in response to a particular resource attribute being changed to a new value ...

Overview · Related · Discuss

www.google.com/patents/US20140122706

Method for determining system topology graph changes in a ...

App. · Filed Oct 15, 2013 · Published May 1, 2014 · Andreas Boemer · International Business Machines Corporation

The performance threshold values are determined based on a service level ... to update the topology graph to prevent occurrence of the event, in response to ...

Overview · Related · Discuss

www.google.com/patents/US8140589

Autonomic updating of templates in a content management system

Grant · Filed Mar 28, 2007 · Issued Mar 20, 2012 · John Edward Petri · International Business Machines Corporation

Autonomic template update mechanism 182 analyzes an existing template 156 and its corresponding policy 184, and determines from the autonomic template update ...

Overview · Related · Discuss

www.google.com/patents/US20120257499

Policy and charging rules function (pcrf) and performance ...

App. · Filed Dec 19, 2011 · Published Oct 11, 2012 · Amit H. Chatterjee · Chatterjee Amit H

% Bandwidth usage; Handset type; Application. Direction indicator: UP or DOWN to indicate if the new level was an upward or a downward change. The response ...
Overview · Related · Discuss

www.google.com/patents/US7277861

Insurance policy renewal method and system

Grant · Filed Aug 25, 2000 · Issued Oct 2, 2007 · Mark H. Benson · Westport Insurance Corporation
During this procedure, the agent answers any necessary update-questions associated with the class of work for which insurance coverage is to be provided, until ...
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Search History

Report Run Date: 2023-04-26 UTC
Searches: 3
Markers: 0

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Search #	Timestamp	Results	Page
1	2023-04-26 05:33 UTC	795,492	3
2	2023-04-26 05:34 UTC	25,678,923	3
3	2023-04-26 05:35 UTC	18,896,656	4

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Content: Patent Publications (169)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications

1 **2023-04-26 05:33 UTC | 795,492 results from**

De-Dup: None | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
update policy in response to performance change

Concept Modifiers: None

Filters: None

2 **2023-04-26 05:34 UTC | 25,678,923 results from**

De-Dup: None | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text

Charter Communications, Inc.
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Page #106

transmits, in response to the processor determining a change in performance in at least one of the first network or the second network, the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy

Concept Modifiers: None

Filters: None

3 **2023-04-26 05:35 UTC | 18,896,656 results from**

De-Dup: None | **Relevance Cut-off:** None | **Sort:** Relevance

Main Concept: Text
update multiple network policies performance degradation

Concept Modifiers: None

Filters: None

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Wonjong Rhee	Examiner: **Grijalva Lobos, Boris D.**
Application No.: 17/102,099	Art Group: 2446
Filed: November 23, 2020	Confirmation No.: 1038
For: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	Docket No.: 20145-054USC

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted to the United States Patent and Trademark Office via EFS-Web addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: April 13, 2023 By: /Domarina Alkhas/
Domarina Alkhas

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

REQUEST FOR CONSIDERATION UNDER AFCP 2.0 IN RESPONSE TO FINAL OFFICE ACTION

Examiner Grijalva Lobos:

Applicant hereby files this Response under the AFCP 2.0 program and respectfully requests further examination and reconsideration in view of the amendments and remarks set forth below.

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

Remarks/Arguments begin on page **7** of this paper.

OK TO ENTER: /B.D.G/

04/26/2023

Bibliographic Data

Application No: 17/102,099

Foreign Priority claimed: ○ Yes ◉ No

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

Verified and Acknowledged: /BORIS D GRIJALVA LOBOS/ (Examiner's Signature) | (Initials)

Title: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/23/2020	709	2446	
RULE			

APPLICANTS

ASSIA SPE, LLC, Wilmington, DE,

INVENTORS

Wonjong Rhee, San Francisco, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 14356581 05/06/2014 PAT 10848398

14356581 is a 371 of PCT/US2011/060265 11/10/2011

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Google update multiple network policies performance degradation

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www.google.com/patents/US6038596

Method and system in a network for decreasing performance ...

Grant · Filed May 23, 1997 · Issued Mar 14, 2000 · Wayne Ross Baldwin · International Business Machines Corporation

... performance degradation by preventing inadvertent launching of multiple ... Thereafter, the launching of the network application is terminated if the ...

Overview · Related · Discuss

www.google.com/patents/US20030126254

Network performance monitoring

App. · Filed Nov 26, 2001 · Published Jul 3, 2003 · Robert Cruickshank · Cruickshank Robert F.

... the first level of network performance, where the second level includes multiple issues that ... Examples of Status Rules for Calculating SDMH and DMH ...

Overview · Related · Discuss

www.google.com/patents/US8483093

Energy efficient network forwarding based on performance and ...

Grant · Filed Jun 30, 2009 · Issued Jul 9, 2013 · Ren Wang · Intel Corporation

As shown, higher utilization often results in performance degradation, ... 102 based on policies that can change the balancing of performance and energy ...

Overview · Related · Discuss

www.google.com/patents/US20130322265

System and method for monitoring and optimizing network ...

App. · Filed Aug 8, 2013 · Published Dec 5, 2013 · Steven E. Kozisek · Centurylink Intellectual Property Llc

it should be understood that different network types and different connection paths may have different indicia of network performance issues. For example, a T1 ...

Overview · Related · Discuss

www.google.com/patents/WO2016079721A1?cl=en

Passive performance measurement for inline service chaining

App. · Filed Nov 20, 2015 · Published May 26, 2016 · Ying Zhang · Telefonaktiebolaget L M Ericsson (Publ)

A method is implemented by a network device to monitor the performance of ... identifying packet loss where a matching hash value for a hash value from the ...

Overview · Related · Discuss

www.google.com/patents/US9667653

Context-aware network service policy management

Grant · Filed Dec 15, 2014 · Issued May 30, 2017 · Katherine Barabash · International Business Machines Corporation

handling packets by the data forwarding devices according to the conveyed updated set of network configuration forwarding rules. 2. The method according to ...

Overview · Related · Discuss

www.google.com/patents/US20020083169

Network monitoring system

App. · Filed May 23, 2001 · Published Jun 27, 2002 · Yuko Aki · Fujitsu Limited

The monitoring result is passed to a monitoring policy changing unit, which changes the current monitoring policy being set in the monitoring policy setting ...

Overview · Related · Discuss

www.google.com/patents/US20080049626

System and method for communicating network performance ...

App. · Filed May 31, 2007 · Published Feb 28, 2008 · Michael K. Bugenhagen · Bugenhagen Michael K

To attempt to locate a packet loss problem along a node segment (i.e., a path between two network communications devices) over a network a probe that may be ...

Overview · Related · Discuss

www.google.com/patents/US20090168726

Enhanced configuration and handoff scheme for femto systems

App. · Filed Dec 31, 2007 · Published Jul 2, 2009 · Sebastian Thalanany · United States Cellular Corporation

3. Change in the network policies that affect the currently active Femto system or Macro system, in terms of the QoS constraints that are required to be ...

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 04/14/2023
North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
04/14/2023	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):

docket1@northweber.com
mnorth@northweber.com

Applicant-Initiated Interview Summary	**Application No.** 17/102,099	**Applicant(s)** Rhee, Wonjong		
	Examiner BORIS D GRIJALVA LOBOS	**Art Unit** 2446	**AIA (First Inventor to File) Status** No	**Page** 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	**Title**	**Type**
BORIS D GRIJALVA LOBOS	Primary Examiner	Telephonic
ALI UYANIK (67,080)	Attorney	

Date of Interview: 10 April 2023

Issues Discussed:

Proposed Amendment(s)

Proposed amendments to claim 1 were discussed in light of the indicated allowable matter of claim 19.
An agreement was reached.

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

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.

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Exhibit 1006
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Grijalva Lobos, Boris

From: Grijalva Lobos, Boris
Sent: Monday, April 10, 2023 2:18 PM
To: Ali Uyanik
Subject: RE: Interview Request Application No. 17/102,099

Here is what I've gathered:

Claim 19 is allowable because of the phrase "in response to the server detecting a degradation".

The art covers "communicating the policy to at least one or more communication units that implement one or more algorithms that use the parameter and at least one rule or one condition for the one or more communication units to improve a performance of the one or more communication units". For example, NF rejection of application no. 14/356,581, dated 2/27/2020, maps those limitations to a combination of Clark et al. (US 5970064 A), Roy (US 2006/0187885 A1), and Stamoulis et al. (US 2009/0207730 A1).

The references, however, transmit the policy after receiving the previously claimed data from the monitoring devices, not after detecting a degradation of performance.

Going back to claim 1 of the present application, the amendments filed on 12/28/2022 did not have any 35 USC 112 or 101 issues, and the amendments filed on 3/13/2023 were not entered.

So for the next action I'd suggest amending claim 1, of the claims filed 12/28/2022, to recite "a third interface coupled to the processor, the third interface transmits, in response to the processor detecting a degradation of network performance in at least one of the first network or second network, the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy". This would make claim 1 allowable.

As far as changing memory to processor, I agree that could make a difference, but I also think we'd just chasing our tails with that. Even if I were to ultimately agree that the first, second and third interfaces are different, which is what the discussion has been revolving for some time now, I'd probably just combine the previously cited references with art that includes a device with multiple interfaces which would just prolong prosecution. I think the inventive concept here really revolves around generating the policy for different APs, so my suggestion would be amendments that closely modify that inventive concept.

Please let me know if the suggestion for claim 1 would be acceptable. Like we agreed, I'll call back at or after 3PM ET today to further discuss.

Very Respectfully,

Boris Daniel Grijalva Lobos
Patent Examiner
U.S. Patent & Trademark Office
Art Unit 2446
Tel. (571) 272-0767

From: Ali Uyanik <auyanik@northweber.com>
Sent: Monday, April 10, 2023 1:16 PM

Charter Communications, Inc.
Exhibit 1006
Page #114

To: Grijalva Lobos, Boris <Boris.GrijalvaLobos@USPTO.GOV>
Subject: Re: Interview Request Application No. 17/102,099

CAUTION: This email has originated from a source outside of USPTO. **PLEASE CONSIDER THE SOURCE** before responding, clicking on links, or opening attachments.

Btw: instead of arguing against the interpretation of "memory" in the AA, I could amend as follows:

a ~~memory~~ processor coupled to the first and second interfaces, the ~~memory~~ processor stores the first and second sets of collected data in memory and [[;]]

~~a processor coupled to the memory, the processor~~ generates at least one policy based at least in part on an analysis of the first and second sets of collected data; and [...]

with "coupled" including wireless coupling, of course.

Ali Uyanik | North Weber & Baugh, LLP | 2251 Grant Road, Suite H Los Altos, CA 94024 | Phone: (650) 353-3786 | Fax: (650) 856-0542

CONFIDENTIALITY NOTICE: This communication, and any files or previous e-mail messages attached to it, may contain confidential information that is legally privileged. If you have received this transmission in error, please immediately notify us by e-mail, or by telephone at (650) 353-3784, and destroy the original transmission and its attachments without reading or saving it.

From: Grijalva Lobos, Boris <Boris.GrijalvaLobos@USPTO.GOV>
Sent: Monday, April 10, 2023 8:48 AM
To: Ali Uyanik <auyanik@northweber.com>
Subject: Interview Request Application No. 17/102,099

Good morning Mr. Uyanik,

I've received your request for interview for application No. 17/102,099 (Att Docket No. 20145-054USC), but I tried calling back the number on the voice mail with no success. Was it 669-268-6134? I should be free any time this week, so we can set it up at your convenience. Morning would be preferred.

Looking forward to hear from you!

Very Respectfully,

Boris Daniel Grijalva Lobos
Patent Examiner
U.S. Patent & Trademark Office
Art Unit 2446
Tel. (571) 272-0767

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
20145-054USC	17/102,099	11-23-2020
First Named Inventor:	**Title:**	
Wonjong Rhee	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:

- Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
- The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
  - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
  - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
    - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
    - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
/Michael North/	April 13, 2023
Name (Print/Typed)	**Practitioner Registration No.**
Michael North	46,963

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

[✔] * Total of 1 forms are submitted.

Privacy Act Statement

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

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Wonjong Rhee	Examiner: **Grijalva Lobos, Boris D.**
Application No.: 17/102,099	Art Group: 2446
Filed: November 23, 2020	Confirmation No.: 1038
For: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	Docket No.: 20145-054USC

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted to the United States Patent and Trademark Office via EFS-Web addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: April 13, 2023 By: /Domarina Alkhas/
Domarina Alkhas

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

REQUEST FOR CONSIDERATION UNDER AFCP 2.0 IN RESPONSE TO FINAL OFFICE ACTION

Examiner Grijalva Lobos:

Applicant hereby files this Response under the AFCP 2.0 program and respectfully requests further examination and reconsideration in view of the amendments and remarks set forth below.

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

Remarks/Arguments begin on page **7** of this paper.

AMENDMENTS TO THE CLAIMS

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

Listing of the Claims:

1. (Currently amended) A ~~server~~ communication system comprising:

a first interface coupled to a first communication unit, the first interface receives a first set of collected data associated with a first network managed by the first communication unit;

a second interface coupled to a second communication unit, the second interface receives a second set of collected data associated with a second network managed by the second communication unit, the second network being a different network than the first network;

a memory coupled to the first and second interfaces, the memory stores the first and second sets of collected data;

a processor coupled to the memory, the processor generates at least one policy based at least in part on an analysis of the first and second sets of collected data; and

a third interface coupled to the processor, the third interface transmits, in response to the processor determining a change in performance in at least one of the first network or the second network, the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy.

2. (Currently amended) The ~~server~~ communication system of claim 1 wherein the adjustment within the first network is an implementation of an algorithm.

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Page #119

3. (Currently amended) The ~~server~~ communication system of claim 1 where in the adjustment within the first network is a change in a parameter value.

4. (Previously presented) The ~~server~~ communication system of claim 1 wherein the first communication unit reduces interference in the second network based on an implementation of the at least one policy within the first network.

5. (Currently amended) The ~~server~~ communication system of claim 4 wherein the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

6. (Currently amended) The ~~server~~ communication system of claim 5 wherein the channel transmission characteristics comprise a modification to a transmission band across the at least one wireless channel within the first network.

7. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise historical data.

8. (Currently amended) The ~~server~~ communication system of claim 1 wherein the processor:

generates a first control signal that is sent to the first communication unit at a first pre-defined time, the first control signal comprising a first policy adjustment to the first network; and

generates a second control signal that is sent to the second communication unit at a second pre-defined time, the second control signal comprising a second policy adjustment to the second network.

Charter Communications, Inc.
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Page #120

9. (Currently amended) The ~~server~~ communication system of claim 8 wherein the first pre-defined time and the second pre-defined time are different.

10. (Currently amended) The ~~server~~ communication system of claim 8 wherein the first policy adjustment and the second policy adjustment are different.

11. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second communication units are Wi-Fi access points.

12. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second communication units are cellular base stations.

13. (Currently amended) The ~~server~~ communication system of claim 12 wherein the first communication unit is a small cell base station.

14. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

15. (Currently amended) The ~~server~~ communication system of claim 14 wherein the at least one policy adjusts a transmission rate of at least one channel within the first network.

16. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks.

17. (Currently amended) The ~~server~~ communication system of claim 16 wherein the at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels.

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Exhibit 1006
Page #121

18. (Currently amended) The ~~server~~ communication system of claim 1 wherein ~~at least~~ two interfaces within the first, second and third interfaces are the same interface.

19. (Previously presented) A method for managing a plurality of networks, the method comprising:

receiving, by a server, from network monitoring devices that monitor data associated with an operation of two or more communication units located in at least two networks within the plurality of networks, the data comprising a parameter;

processing, by the server, the received data;

based on the processed data, determining a policy for at least one of the two or more communication units; and

in response to the server detecting a degradation of network performance in at least one network within the plurality of networks, communicating the policy to at least one or more communication units that implement one or more algorithms that use the parameter and at least one rule or one condition for the one or more communication units to improve a performance of the one or more communication units.

20. (Original) The method of claim 19 wherein determining the policy comprises selecting the policy from a set of policies that are stored on the one or more communication units and wherein the communicated policy updates the one or more algorithms implemented on the one or more communication units.

21. (Original) The method of claim 19 wherein the one or more communication units comprise a Wi-Fi access point.

Charter Communications, Inc.
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Page #122

22. (Original) The method of claim 19 wherein the one or more communication units comprise a cellular base station.

23. (Original) The method of claim 19 wherein the at least one rule or one condition comprises an adjustment to a wireless transmission band within the plurality of networks.

Charter Communications, Inc.
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REMARKS

Claims 1-23 were presented for examination and are pending in this patent application. In the Office Action, claims 1-18 were rejected and claims 19-23 were allowed. Claims 1-18 are amended herein. Claims 1-18 were amended to provide consistency with allowed claims 19-23. Applicant notes that these amendments were not made for reasons of patentability nor are they narrowing amendments. Accordingly, Applicant reserves all rights of Doctrine of Equivalents for all purposes. Applicant thanks the Examiner for noting that the IDS submissions have been received and were considered. On the basis of the following remarks, reconsideration and allowance of all pending claims is respectfully requested.

I. Claim Amendments

Applicant has amended the claims to provide consistency with allowed claims 19-23. In light of the present claim amendments, Applicant respectfully requests that all rejections of claims be withdrawn.

II. Conclusion

In view of the above arguments, Applicant believes that all pending claims, claims 1-23, are allowable and respectfully request that a Notice of Allowance be issued for this application in its current state. Applicant believes that more than a sufficient number of reasons have been stated to traverse all rejections.

Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the Examiner is invited to contact the undersigned at telephone number (650) 353-3786. If any fees are due in connection with the filing of this amendment, the Commissioner is authorized to charge such fees to Deposit Account 50-2776

Respectfully submitted,

Date: April 13, 2023

By:/ Ali Uyanik /
Ali Uyanik
Reg. No. 67,080

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Charter Communications, Inc.
Exhibit 1006
Page #124

Electronic Acknowledgement Receipt

EFS ID:	47836316
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	13-APR-2023
Filing Date:	23-NOV-2020
Time Stamp:	11:22:35
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	After Final Consideration Program Request	054USC_PilotAFCP.pdf	226539 937d708b3ad0d38598ea3e1fe161e1adf44025bd	no	2

Warnings:

Information:					
2		054USC_AFCP.pdf	40232 816493ffdb8961f37cbcf5d5525cf9d188cd7586	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	After Final Consideration Program Request	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	7

Warnings:	
Information:	
Total Files Size (in bytes):	266771

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)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/102,099	Filing Date 11/23/2020	☐ 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 $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/13/2023	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 23	Minus	** 23	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

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

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

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 03/22/2023

North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
03/22/2023	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):

docket1@northweber.com
mnorth@northweber.com

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 17/102,099	**Applicant(s)** Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	**Art Unit** 2446	**AIA (FITF) Status** No

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

THE REPLY FILED 13 March 2023 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☑ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☐ The period for reply expires ____ months from the mailing date of the final rejection.
   b) ☑ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection.The current period for reply expires ____ months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANTS FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37CFR 41.37(a).

AMENDMENTS

3. ☑ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☑ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☑ They raise the issue of new matter (see NOTE below);
   c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: See Continuation Sheet (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☑ For purposes of appeal, the proposed amendment(s):(a) ☑ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
13. ☑ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). 2/22/2023
14. ☑ Other: See Continuation Sheet.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
    Claim(s) allowed:19-23.
    Claim(s) objected to:_____.
    Claim(s) rejected:1-18.
    Claim(s) withdrawn from consideration:_____.

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

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Exhibit 1006
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Continuation of 3. NOTE: The amendments raise new issues that would require further search and consideration. New matter issues may also be raised (see below)

Continuation of REQUEST FOR RECONSIDERATION/OTHER 14. Other: In the response filed on 3/13/2023, applicant argues that support for the limitation "the first, second, and third interface being different from each other" is enabled by Fig. 2, and paragraphs [0037] because "multiple APs may be used in the WiFi communication system" and "each of any number of WiFi communication systems [...] may have their own communication interface". In response to the argument: Initially, the examiner notes that, as stated by applicant, each "communication unit" may have it's own interface, that is, each AP may have it's own interface. However, the examiner initially notes that the claimed "first" and "second" interfaces are not the interfaces on the APs, because, as recited by the claims, the first and second interfaces are coupled to the memory that stores the first and second set of collected data. This coupling implies that the first and second interfaces are interfaces of the Optimization Center of Fig. 2. Also, the fact that different APs have different interfaces does not necessarily imply that the "Optimization Center" of Fig. 2 has multiple interfaces to communicate with each and every AP nor that the communication channel of Fig. 2 is a plurality of interfaces. It's a known fact in the art that multiple devices, each with it's own interface, may be connected to a single device with a single interface, over a single communications channel. An example would be a home router with WiFi capabilities. The router would include a single interface to which a plurality of devices can be connected to using a single communications channel (i.e., WiFi). Further note that in the proposed amendments the "third interface" is also different than the first and second interfaces. Even if the first and second interfaces were different, it's unclear why the third interface is different than the first interface because both the first and third interfaces are used to communicate with the first communication unit and nothing in the specification appears to recites two different interfaces to communicate with a single communication unit, raising new matter issues. Furthermore, if the presence of multiple communication units implied multiple interfaces at the communication system simply because each communication unit has its own interface, then Clark et al. (US 5970064 A) would still anticipate the claimed limitations because in Clark the network controller receives information from a plurality of switches (i.e., each would have it's own interface). However, the examiner holds that the existence of multiple communication units does not imply the existence of multiple interfaces at the optimization center of Fig. 2 or even multiple interfaces as a medium of the communications channel.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Wonjong Rhee**	Examiner: **Grijalva Lobos, Boris D.**
Application No.: 17/102,099	Art Group: 2446
Filed: November 23, 2020	Confirmation No.: 1038
For: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	Docket No.: 20145-054USC

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted to the United States Patent and Trademark Office via EFS-Web addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: 3/13/2023 By: /Domarina Alkhas/
Domarina Alkhas

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

RESPONSE TO FINAL OFFICE ACTION

Examiner Grijalva Lobos:

This Amendment is in response to the Final Office Action dated January 13, 2023 and having a shortened statutory response period expiring April 13, 2023. Accordingly, this paper is timely filed. Applicant respectfully request further examination and reconsideration in view of the amendments and remarks set forth below.

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

Remarks/Arguments begin on page **7** of this paper.

DO NOT ENTER: /B.D.G/

03/17/2023

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	564700	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 01:26 AM
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L4	131963	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:08 PM
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Charter Communications, Inc.
Exhibit 1006
Page #132

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L8	1131	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:13 PM
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Exhibit 1006
Page #133

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L16	18663680	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR,	OR	ON	ON	2023/01/09 11:01 PM

			TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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			NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
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L23	453	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L24	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:01 PM
L25	1	"17102099"	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09

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Exhibit 1006
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							11:56 PM
L26	1	"10848398".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:58 PM
L27	3	("20040143428" OR "20090245130" OR "20100316012").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/17 09:47 AM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	94901	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N2	42717	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 noise).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N3	232800	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N4	133	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N5	73	1 AND 4	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N6	1	5 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N7	50	1 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:15 PM
N8	166	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N9	1	7 AND 8	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N10	3	(2 AND 3) AND (4 8)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:17 PM
N11	185	(adaptive near1 spectrum).as. (adaptive near1 spectrum).aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N12	4	(2 AND 3) AND (4 8 11)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24

							10:18 PM

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

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	17102099
Filing Date	2020-11-23
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS Remove

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	20040143428	A1	2004-07-22	Rappaport et al.	
	2	20090245130	A1	2009-10-01	Bing	
	3	20100316012	A1	2010-12-16	Stanwood et al.	

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

FOREIGN PATENT DOCUMENTS Remove

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

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

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

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Non-final office action mailed 11/22/2022 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (43 pgs).	
	2	European office action mailed 11/22/2022 in the European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD], (27 pgs).	
	3	Chinese response to office action filed 11/29/2022, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (10 pgs).	☒
	4	Canadian response to office action filed 1/27/2023 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (2 pgs).	☐
	5	Chinese office action mailed 1/10/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (26 pgs).	☒
	6	Response to Canadian examination report filed 2/3/2023 in Canadian patent application No. 3,129,522, Attorney Docket No. [20145-117CA], (15 pgs).	☐
	7	Notice of Allowance mailed 1/4/2023 in US patent application No. 16/804,000, Attorney Docket No. [20145-117US], (19 pgs).	☐
	8	Response to non-final office action filed 2/22/2023 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (13 pgs).	☐

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

EXAMINER SIGNATURE			
Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	03/17/2023

*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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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.D.G/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

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

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See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2023-02-22
Name/Print	Michael North	Registration Number	46963

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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.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Wonjong Rhee**	Examiner: **Grijalva Lobos, Boris D.**
Application No.: 17/102,099	Art Group: 2446
Filed: November 23, 2020	Confirmation No.: 1038
For: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	Docket No.: 20145-054USC

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted to the United States Patent and Trademark Office via EFS-Web addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: 3/13/2023 By: /Domarina Alkhas/
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RESPONSE TO FINAL OFFICE ACTION

Examiner Grijalva Lobos:

This Amendment is in response to the Final Office Action dated January 13, 2023 and having a shortened statutory response period expiring April 13, 2023. Accordingly, this paper is timely filed. Applicant respectfully request further examination and reconsideration in view of the amendments and remarks set forth below.

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

Remarks/Arguments begin on page **7** of this paper.

AMENDMENTS TO THE CLAIMS

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

Listing of the Claims:

1. (Currently amended) A ~~server~~ communication system comprising:

a first interface coupled to a first communication unit, the first interface receives a first set of collected data associated with a first network managed by the first communication unit;

a second interface coupled to a second communication unit, the second interface receives a second set of collected data associated with a second network managed by the second communication unit, the second network being a different network than the first network;

a memory coupled to the first and second interfaces, the memory stores the first and second sets of collected data;

a processor coupled to the memory, the processor generates at least one policy based at least in part on an analysis of the first and second sets of collected data; and

a third interface coupled to the processor, the third interface transmits the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy, the first, second, and third interfaces being different from each other.

2. (Currently amended) The ~~server~~ communication system of claim 1 wherein the adjustment within the first network is an implementation of an algorithm.

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3. (Currently amended) The ~~server~~ communication system of claim 1 where in the adjustment within the first network is a change in a parameter value.

4. (Previously presented) The ~~server~~ communication system of claim 1 wherein the first communication unit reduces interference in the second network based on an implementation of the at least one policy within the first network.

5. (Currently amended) The ~~server~~ communication system of claim 4 wherein the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

6. (Currently amended) The ~~server~~ communication system of claim 5 wherein the channel transmission characteristics comprise a modification to a transmission band across the at least one wireless channel within the first network.

7. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise historical data.

8. (Currently amended) The ~~server~~ communication system of claim 1 wherein the processor:

generates a first control signal that is sent to the first communication unit at a first pre-defined time, the first control signal comprising a first policy adjustment to the first network; and

generates a second control signal that is sent to the second communication unit at a second pre-defined time, the second control signal comprising a second policy adjustment to the second network.

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Page #146

9. (Currently amended) The ~~server~~ communication system of claim 8 wherein the first pre-defined time and the second pre-defined time are different.

10. (Currently amended) The ~~server~~ communication system of claim 8 wherein the first policy adjustment and the second policy adjustment are different.

11. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second communication units are Wi-Fi access points.

12. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second communication units are cellular base stations.

13. (Currently amended) The ~~server~~ communication system of claim 12 wherein the first communication unit is a small cell base station.

14. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

15. (Currently amended) The ~~server~~ communication system of claim 14 wherein the at least one policy adjusts a transmission rate of at least one channel within the first network.

16. (Currently amended) The ~~server~~ communication system of claim 1 wherein the first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks.

17. (Currently amended) The ~~server~~ communication system of claim 16 wherein the at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels.

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18. (Currently amended) The ~~server~~ communication system of claim 1 wherein ~~at least~~ two interfaces within the first, second and third interfaces are the same interface.

19. (Previously presented) A method for managing a plurality of networks, the method comprising:

receiving, by a server, from network monitoring devices that monitor data associated with an operation of two or more communication units located in at least two networks within the plurality of networks, the data comprising a parameter;

processing, by the server, the received data;

based on the processed data, determining a policy for at least one of the two or more communication units; and

in response to the server detecting a degradation of network performance in at least one network within the plurality of networks, communicating the policy to at least one or more communication units that implement one or more algorithms that use the parameter and at least one rule or one condition for the one or more communication units to improve a performance of the one or more communication units.

20. (Original) The method of claim 19 wherein determining the policy comprises selecting the policy from a set of policies that are stored on the one or more communication units and wherein the communicated policy updates the one or more algorithms implemented on the one or more communication units.

21. (Original) The method of claim 19 wherein the one or more communication units comprise a Wi-Fi access point.

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22. (Original) The method of claim 19 wherein the one or more communication units comprise a cellular base station.

23. (Original) The method of claim 19 wherein the at least one rule or one condition comprises an adjustment to a wireless transmission band within the plurality of networks.

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REMARKS

Claims 1-23 were presented for examination and are pending in this patent application. In the Office Action, claims 1-18 were rejected and claims 19-23 were allowed. Claims 1-18 are amended herein. Claims 1-18 were amended to clarify the claim language. Applicant notes that these amendments were not made for reasons of patentability nor are they narrowing amendments. Accordingly, Applicant reserves all rights of Doctrine of Equivalents for all purposes. Applicant thanks the Examiner for noting that the IDS submissions have been received and were considered. On the basis of the following remarks, reconsideration and allowance of all pending claims is respectfully requested.

I. Re: Response to Arguments

In the Office Action, the Examiner responds to Applicant's argument that an interpretation of claim 1 as reciting the same interface three times is unreasonable because the fact that dependent claim 18 requires "at least two interfaces within the first, second and third interfaces are the same interface" precludes such interpretation because claim 1 has to be broader than claim 18 to avoid having identical claim scopes, which would trigger a rejection under 35 U.S.C. § 112(d), first, by correctly reiterating that "the specification does contain embodiments that reasonably enable the first interface and second interface to be the same interface (in view of Fig. 2 and ¶[0037])." Office Action, p. 3 (emphasis added).

However, the Examiner incorrectly asserts that "the specification of the present application fails "to describe a single embodiment in which the first interface is a different device or object than the second interface." *id*; *see also id.* at 3-4 ("[the application] fails to recite anywhere in its specification, including the claims and drawings, anything regarding a 'first interface' and 'second interface', much less these 'first interface' and 'second interface' being different entities"). Further, the Examiner views Applicant's interpretation as "new matter" *Id.* Applicant respectfully disagrees.

First, Applicant's specification states that "[w]hile the embodiment of FIG. 2 illustrates a WiFi communication system 200 with a single AP 201, multiple APs may be used in the WiFi communication system 200 which are operable to communicate with the remote server 204 via the Communication Channel 208." Spec. ¶ 37; *see also id.* ("the remote server 204 is operable to communicate with the AP 201 and/or with any or all of the stations 202.sub.1-N via the communication Channel 208").

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Based on this disclosure alone, it is apparent that each of any number of WiFi communication systems (denoted as numeral 200 in FIG. 2) may have their own communication interface, i.e., each claimed *communication unit* may have its own claimed *interface*, such that the claimed *first interface coupled to a first communication unit* may be different and distinct from different the claimed *second interface coupled to a second communication unit*. Applicant notes that, according to the Examiner's own interpretation, claim 18 cannot be interpreted as failing to properly narrow amended claim 1 since there remains a "possibility" to combine two of the interfaced into one such as to have only two interfaces being different from each other. Further, In the interest of advancing prosecution, Applicant has amended claims 1-18 to clarify that, in claim 1, the first, second, and third interfaces are indeed different from each other.

Accordingly, Applicant respectfully requests that all rejections be withdrawn and that claims 1-23 be allowed as currently amended.

II. Conclusion

In view of the above arguments, Applicant believes that all pending claims, claims 1-23, are allowable and respectfully request that a Notice of Allowance be issued for this application in its current state. Applicant believes that more than a sufficient number of reasons have been stated to traverse all rejections.

Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the Examiner is invited to contact the undersigned at telephone number (650) 353-3786. If any fees are due in connection with the filing of this amendment, the Commissioner is authorized to charge such fees to Deposit Account 50-2776

Respectfully submitted,

Date: March 13, 2023

By: / Ali Uyanik /

Ali Uyanik
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Electronic Acknowledgement Receipt

EFS ID:	47676334
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	13-MAR-2023
Filing Date:	23-NOV-2020
Time Stamp:	22:42:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		054USC_FOAResp.pdf	49682 3c199e1d75c92dc54ddff63fd4808ef4a8b37163	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	8
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FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
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☐ 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 $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ 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))					
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	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	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 $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
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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	
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☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	03/13/2023	(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))	* 23	Minus	** 23	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	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 $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/DORIS M KING/
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

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	2	20090245130	A1	2009-10-01	Bing	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Non-final office action mailed 11/22/2022 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (43 pgs).	
	2	European office action mailed 11/22/2022 in the European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD], (27 pgs).	
	3	Chinese response to office action filed 11/29/2022, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (10 pgs).	☒
	4	Canadian response to office action filed 1/27/2023 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (2 pgs).	☐
	5	Chinese office action mailed 1/10/2023, in the Chinese patent application No. 202010074633.2, Attorney Docket No. [20145-054CND], (26 pgs).	☒
	6	Response to Canadian examination report filed 2/3/2023 in Canadian patent application No. 3,129,522, Attorney Docket No. [20145-117CA], (15 pgs).	☐
	7	Notice of Allowance mailed 1/4/2023 in US patent application No. 16/804,000, Attorney Docket No. [20145-117US], (19 pgs).	☐
	8	Response to non-final office action filed 2/22/2023 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (13 pgs).	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2023-02-22
Name/Print	Michael North	Registration Number	46963

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.**

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

Electronic Patent Application Fee Transmittal

Application Number:	17102099
Filing Date:	23-Nov-2020
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Filer:	Michael V. North/Domarina Alkhas
Attorney Docket Number:	20145-054USC

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

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

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	260	260
		Total in USD ($)		**260**

Electronic Acknowledgement Receipt	
EFS ID:	47575786
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	22-FEB-2023
Filing Date:	23-NOV-2020
Time Stamp:	18:54:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$260
RAM confirmation Number	E20232LI55307801
Deposit Account	502776
Authorized User	Domarina Alkhas
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	Transmittal Letter	054USC_SIDS_Trans.pdf	26445 ecc5f36144eb0647d6143bfe5bdf722ef5167caf	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08a.pdf	612777 d17da94a3c787fd77e76c67f5209f6d348bf1c0b	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	4050890 bebc1d2ef9d5c8991cbcade0a7ccdbbf00079f8e	no	43
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	641604 0c4dd2ea85b50ef86f9fee646306df1d760d83e6	no	27
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL3.pdf	451414 000f21d2a651e40be44434b2274e3c06256 5a612	no	10
Warnings:					
Information:					
6	Non Patent Literature	054USC_SIDS_NPL4.pdf	101827 559302103af404e209330122053be652ef4 0153e	no	2
Warnings:					
Information:					

7	Non Patent Literature	054USC_SIDS_NPL5.pdf	2089076 5b353814a4c5193f844339509f8c5d7404b85568	no	26
Warnings:					
Information:					
8	Non Patent Literature	054USC_SIDS_NPL6.pdf	279841 ae9ba288f63f933e27ec4d3fc0cd751e6babeaa8	no	15
Warnings:					
Information:					
9	Non Patent Literature	054USC_SIDS_NPL7.pdf	2308615 b12537cccdcf727e5d636ad21a2ee204806092a5	no	19
Warnings:					
Information:					
10	Non Patent Literature	054USC_SIDS_NPL8.pdf	95877 263b753473e9f3ad3f61102f0dcc8924a6da041a	no	13
Warnings:					
Information:					
11	Fee Worksheet (SB06)	fee-info.pdf	38502 325c0d34e01df45e4289aa3cdf8c7566dd09f706	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	10696868	

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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No. :	1038
Inventor	:	Wonjong Rhee		
Filing Date	:	11-23-2020		
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Art Unit	:	2446		
Examiner	:	GRIJALVA LOBOS, BORIS D		
Docket No.	:	20145-054USC		
Customer No.	:	146571		

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: February 22, 2023 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #167

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☐ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☒ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☒ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: February 22, 2023

By: /Michael V. North/
Michael V. North
Reg. No. 46,963

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC	1038

146571 7590 01/13/2023

North Weber & Baugh LLP - ASSIA
2251 Grant Road, Suite H
Los Altos, CA 94024

EXAMINER
GRIJALVA LOBOS, BORIS D

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
01/13/2023	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):

docket1@northweber.com
mnorth@northweber.com

Office Action Summary	**Application No.** 17/102,099	**Applicant(s)** Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	**Art Unit** 2446	**AIA (FITF) 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 12/28/2022.

☐ 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) 1-23 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☑ Claim(s) 19-23 is/are allowed.

7) ☑ Claim(s) 1-18 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: _____.

Charter Communications, Inc.
Exhibit 1006
Page #171

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

This Office action is in response to communications filed on 12/28/2022.

Claims 1-23 are pending.

DETAILED ACTION

Response to Arguments

Applicant's arguments filed 12/28/2022 have been fully considered but they are not persuasive. In the response filed, applicant argues, in substance:

a) In page 6, of the response filed, applicant argues that the examiner incorrectly interpreted applicant's argument that "claim 1 is broad enough to encompass the possibility of the first, second, and third (that is, all three) interfaces to be the same" as an admission from applicant that claim 1 is broad enough that all three of the recited interfaces can be considered a single interface because applicant's quote includes the qualifier "possibility".

In response to argument (a), the examiner respectfully disagrees. Note that what is being quoted by applicant (i.e., that "claim 1 is broad enough to encompass the possibility of the first, second, and third (that is, all three) interfaces to be the same") is not applicant's own wording, rather, the examiner's (see Applicant Arguments filed 12/16/2021, page 7, lines 26-27), in supporting a rejection where the first, second, and third interfaces are interpreted as encompassing a single interface. Applicant's admission is that the statement made by the examiner is correct (i.e., "the Examiner, first, correctly states that "claim 1 is broad enough to encompass the possibility of the first, second, and third (that is, all three) interfaces to be the same"" (see Applicant Arguments filed 12/16/2021, page 7, lines 26-27)).

In the quoted text, the examiner used the word "possibility" because during patent examination, the pending claims must be "given their broadest reasonable interpretation consistent with the specification." The Federal Circuit's en banc decision in Phillips v. AWH Corp., 415 F.3d 1303, 75

USPQ2d 1321 (Fed. Cir. 2005) expressly recognized that the USPTO employs the "broadest reasonable interpretation" standard.

Although claims of issued patents are interpreted in light of the specification, prosecution history, prior art and other claims, this is not the mode of claim interpretation to be applied during examination. During examination, the claims must be interpreted as broadly as their terms reasonably allow. In re American Academy of Science Tech Center, 367 F.3d 1359, 1369, 70 USPQ2d 1827, 1834 (Fed. Cir. 2004) (The USPTO uses a different standard for construing claims than that used by district courts; during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification). This means that the words of the claim must be given their plain meaning unless the plain meaning is inconsistent with the specification. In re Zletz, 893 F.2d 319, 321, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989) (discussed below); Chef America, Inc. v. Lamb-Weston, Inc., 358 F.3d 1371, 1372, 69 USPQ2d 1857 (Fed. Cir. 2004).

The broadest reasonable interpretation of the claims enables the first interface, second interface, and third interface in the claims to be interpreted as either different interfaces or as the same interface, as long as the specification supports either interpretation (and hence why the word “possibility” is used by the examiner).

As stated in the Final Rejection dated 10/15/2021, page 3, line 20, to page 4, line 9, the specification of the present application fails “to describe a single embodiment in which the first interface is a different device or object than the second interface”.

As also stated in the Final Rejection dated 10/15/2021, page 3, line 21 to page 4, line 9, the specification does contain embodiments that reasonably enable the first interface and second interface to be the same interface (in view of Fig. 2 and ¶[0037]).

The examiner further notes that the present application is a Continuation (and not a Continuation in Part) of US Patent Application No. 14/356,581 (now Patent No. 10,848,398) which fails

to recite anywhere in its specification, including the claims and drawings, anything regarding a "first interface" and "second interface", much less these "first interface" and "second interface" being different entities. Since the inclusion of new matter is improper in a Continuation, the evidence suggests that the "first interface" and "second interface" are simply the same interface having different nomenclature in the claims.

b) In page 6 of the response filed, applicant argues that because Claim 18 recites "at least two interfaces within the first, second and third interfaces are the same interface", it is improper to interpret claim 1 as "reciting the same interface three times" (presumably supporting applicant's argument that the first interface, second interface, and third interface of claim 1 are different interfaces).

In response to argument (b), the examiner respectfully disagrees. 37 CFR 1.71 (c) recites that "Claims in dependent form shall be construed to include all the limitations of the claim incorporated by reference into the dependent claim".

Assuming arguendo that in claim 1 all three interfaces were the same, that property would be inherited by claim 18 because all the limitations of claim 1 must be included in claim 18. This would create a bizarre scenario where claim 18 interprets both the first and second interfaces as being both different and the same, at the same time.

In order for claim 18 to properly incorporate the limitations of claim 1, without triggering a 35 USC 112(d) rejection, the limitations of claim 1 must enable the possibility of the interfaces being interpreted as the same interface. This enablement is what enables the present prior art rejection.

The fact that claim 1 also enables the possibility that the interfaces could be different does not preclude a rejection where the interfaces have been interpreted as being the same and, as detailed in the response to argument (a), above, evidence in the application suggests giving that interpretation to claim 1.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim(s) 1-4, 7-10, and 18 is/are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Clark et al. (US 5970064 A, hereinafter Clark).

Regarding claim 1, Clark discloses a server (Fig. 2, a network controller 200) comprising:

a first interface coupled to a first communication unit (col. 12, lines 21-23, collecting information from switches (the communication units); col. 10, lines 52-55, the information transmitted to the network controller is from each switch (see also Fig. 7, each switch, including S2, transmits the information, interface to receive the information inherent)),

the first interface receives a first set of collected data associated with a first network managed by the first communication unit (col. 12, lines 21-23, collecting information from switches (the communication units); col. 10, lines 52-55, the information transmitted to the network controller is from each switch (see also Fig. 7, each switch, including S2, transmits the information); col. 1, line 67, to col. 2, line 3, each switch manages devices attached to the switch (i.e. a network local to the switch), therefore, the collected information is associated to the network managed by each respective switch);

a second interface coupled to a second communication unit (col. 12, lines 21-23, collecting information from switches (the communication units); col. 10, lines 52-55, the information transmitted to the network controller is from each switch (see also Fig. 7, each switch, including S5, transmits the information, interface to receive the information inherent)),

the second interface receives a second set of collected data associated with a second network managed by the second communication unit (col. 12, lines 21-23, collecting information from switches; col. 10, lines 52-55, the information transmitted to the network controller is from each switch (see also Fig. 7, each switch, including S5, transmits the information); col. 1, line 67, to col. 2, line 3, each switch manages devices attached to the switch (i.e. a network local to the switch), therefore, the collected information is associated to the network managed by each respective switch),

the second network being a different network than the first network (Fig. 2, switches S2 and S5 are different as they include different customer equipment devices (CEQs) attached to them);

a memory coupled to the first and second interfaces, the memory stores the first and second sets of collected data (col. 12, lines 64-67, the information is "collected" by the network controller (collection implies storage));

a processor coupled to the memory, the processor generates at least one policy based at least in part on an analysis of the first and second sets of collected data (col. 12, lines 64-67, a policy is generated from the collected information from each switch); and

a third interface coupled to the processor, the third interface transmits the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy (col. 12, lines 24-31, producing, as a result of the processing, at least one policy to be implemented by the switches; col. 13, lines 6-10, the policies are distributed from the network controller to the switches - interface to communicate the policy implied).

Regarding claim 2, Clark discloses the server of claim 1 wherein the adjustment within the first network is an implementation of an algorithm (col. 17, line 54-65, in response to receiving policy data, selecting a decision table, based on a condition and quality of service information).

Regarding claim 3, Clark discloses the server of claim 1 where in the adjustment within the first network is a change in a parameter value (col. 13, lines 33-50, and col. 14, lines 44-61, parameters used by the switches to operate is evolved into new parameters).

Regarding claim 4, Clark discloses the server of claim 1 wherein the first communication unit reduces interference in the second network based on an implementation of the at least one policy within the first network (col. 12, lines 21-31, the new policies, when implemented by individual switches, will result in "optimized traffic control operation of the network as a whole" (i.e. the network of Fig. 2, which includes switches S1-S1 and thus the corresponding local networks, see col. 10, lines 8-12); col. 6, line 42, to col. 7, line 11, admission control is used to prevent a new connection from interfering with existing connections across the network).

Regarding claim 7, Clark discloses the server of claim 1 wherein the first and second sets of collected data comprise historical data (col. 13, lines 35-60, " Each switch transmits across the network, its current active policy data, optionally along with the corresponding current status data for each node device, to the network controller [...] The status data may include service request parameters such as the input call demand, i.e. the rate at which calls are arriving at each switch, both currently and historically").

Regarding claim 8, Clark discloses the server of claim 1 wherein the processor: generates a first control signal that is sent to the first communication unit at a first pre-defined time, the first control signal comprising a first policy adjustment to the first network (col. 14, lines 56-61 "After a predetermined optimization period, comprising a large number of passages through steps 1502-1506, or when no further significant improvement in the population occurs from generation to generation, in

step 1507 the selected strings form the basis of the new policy data transmitted to the switches"; col. 16, lines 42-43, "Periodically, the population of strings, representing new policy data is transmitted to the switches in step 1507"); and

generates a second control signal that is sent to the second communication unit at a second pre-defined time, the second control signal comprising a second policy adjustment to the second network (col. 14, lines 56-61 "After a predetermined optimization period, comprising a large number of passages through steps 1502-1506, or when no further significant improvement in the population occurs from generation to generation, in step 1507 the selected strings form the basis of the new policy data transmitted to the switches"; col. 16, lines 42-43, "Periodically, the population of strings, representing new policy data is transmitted to the switches in step 1507").

Regarding claim 9, Clark discloses the server of claim 8 wherein the first pre-defined time and the second pre-defined time are different (col. 16, lines 42-43, "Periodically, the population of strings, representing new policy data is transmitted to the switches in step 1507").

Regarding claim 10, Clark discloses the server of claim 8 wherein the first policy adjustment and the second policy adjustment are different (col. 16, lines 42-43, "Periodically, the population of strings, representing new policy data is transmitted to the switches in step 1507").

Regarding claim 18, Clark discloses the server of claim 1 wherein at least two interfaces within the first, second and third interfaces are the same interface (Fig. 2, a single interface (e.g. link from controller to S1) is used).

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 5-6 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Clark (US 5970064 A) in view of Jaszewski et al. (US 5933420 A, hereinafter Jaszewski).

Regarding claim 5, Clark discloses the server of claim 4.

Clark does not disclose that the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

Jaszewski discloses at least one policy that adjusts channel transmission characteristics of at least one wireless channel within the first network (col. 3, lines 33-35, nodes on a network may be wireless access points; col. 5, lines 12-25, a network manager collects data pertaining to the wireless access points and generates a policy (new set of channel assignments) for the access points that, when implemented by the access points, results in the access points communicating with other devices without interference).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Clark in view of Jaszewski so that the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

One of ordinary skill in the art would have been motivated because it would improve network communications in wireless environments.

Regarding claim 6, the combined system of Clark and Jaszewski discloses the invention substantially as applied to claim 5, above, wherein the channel transmission characteristics comprise a modification to a transmission band across the at least one wireless channel within the first network (Jaszewski, col. 5, lines 12-25, a network manager collects data pertaining to the wireless access points and generates a policy (new set of channel assignments) for the access points; col. 1, lines 46-48, channels encompass bands).

Claims 11-14 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Clark (US 5970064 A) in view of Malik et al. (US 20090059872 A1, hereinafter Malik).

Regarding claim 11, Clark discloses the server of claim 1 wherein the first and second communication units are access points (Fig. 2, the communication units are access points because they connect customer equipment devices (and may be wireless, see col. 1, lines 16-18)).

Clark does not disclose that the access points are WI-FI access points.

Malik discloses that access points may be WI-FI access points (¶[0017], access points may be WI-FI access points).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Clark in view of Malik for the access points to be WI-FI access points.

One of ordinary skill in the art would have been motivated because well-known standards would facilitate implementation of wireless networks.

Regarding claim 12, Clark discloses the server of claim 1.

Clark does not disclose that the first and second communication units are cellular base stations.

Malik discloses that first and second communication units may be cellular base stations (Fig. 1, the access points provide connection to mobile user devices 160; ¶[0018], user devices include mobile telephones).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Clark in view of Malik so that the first and second communication units are cellular base stations.

One of ordinary skill in the art would have been motivated because it would enable users with commonly used devices to make use of the network.

Regarding claim 13, the combined system of Clark and Malik discloses the invention substantially as applied to claim 12, above, wherein the first communication unit is a small cell base

station (Malik, ¶[0018], the mobile devices may be mobile telephones; ¶[0019], the access points are for local area networks (small networks)).

Regarding claim 14, Clark discloses the server of claim 1.

Clark does not disclose that the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

Malik discloses that first and second sets of collected data comprise RSSI measurements collected within the first and second networks (¶[0028], collecting "signal strength indicators (RSSIs) from different access points" to transmit a policy to the access points (see ¶[0029]-[0030] and ¶[0047])).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Clark in view of Malik so that the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

One of ordinary skill in the art would have been motivated because it would improve the connectivity of user devices when multiple access points are present.

Claim 15 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Clark (US 5970064 A) in view of Malik (US 20090059872 A1), as applied to claim 14, above, and further in view of Roy et al. (US 2006/0187885 A1, hereinafter Roy).

Regarding claim 15, the combined system of Clark and Malik discloses the invention substantially as applied to claim 14.

The combined system of Clark and Malik does not disclose that the at least one policy adjusts a transmission rate of at least one channel within the first network.

Roy discloses that the at least one policy adjusts a transmission rate of at least one channel within the first network (¶[0061], a first station transmitting information to a second station, including a parameter (RSSI or SNR) and receiving, from the second station, a rate command (policy) indicating a

preferred rate; ¶[0031], using an algorithm using the parameter (RSSI) and the preferred transmission rate (received from the second station)).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combined system of Clark and Malik in view of Roy so that the one or more algorithms use the parameter.

One of ordinary skill in the art would have been motivated because it would allow adaptation on networks with fading conditions (Roy, paragraph [0002])

Claim 16 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Clark (US 5970064 A) in view of Roy (US 2006/0187885 A1).

Regarding claim 16, Clark discloses the server of claim 1.

Clark does not disclose that the first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks.

discloses that first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks (¶[0061], a first station transmitting information to a second station, including a parameter (RSSI or SNR) and receiving, from the second station, a rate command (policy) indicating a preferred rate; ¶[0031], using an algorithm using the parameter (RSSI) and the preferred transmission rate (received from the second station); ¶[0023], adaptation is performed for each wireless channel).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Clark in view of Roy so that the first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks.

One of ordinary skill in the art would have been motivated because it would allow adaptation on networks with fading conditions (Roy, paragraph [0002]).

Claim 17 is/are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Clark (US 5970064 A) in view of Roy (US 2006/0187885 A1), as applied to claim 16, above, and further in view of Raghothaman et al. (US 20100167771 A1, hereinafter Raghothaman).

Regarding claim 17, Clark discloses the server of claim 16.

The combined system of Clark and Roy does not disclose that the at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels.

Raghothaman discloses at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels (paragraph [0081], a first device determines a transmission power to be used by an access point; ¶[0076], providing power parameters to the access point).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the combined system of Clark and Roy in view of Raghothaman so that the at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels.

One of ordinary skill in the art would have been motivated because it would prevent interference between competing access points (Raghothaman, implied, see paragraph [0072]).

Allowable Subject Matter

Claims 19-23 are allowed.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BORIS D GRIJALVA LOBOS whose telephone number is (571)272-0767. The examiner can normally be reached M-F 10:30AM to 6:30PM 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, Brian Gillis can be reached on 571-272-7952. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional

questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BORIS D GRIJALVA LOBOS/
Primary Patent Examiner, Art Unit 2446

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

✓	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	06/19/2021	10/09/2021	09/23/2022	01/09/2023					
	1	✓	✓	✓	✓					
	2	✓	✓	✓	✓					
	3	✓	✓	✓	✓					
	4	✓	✓	✓	✓					
	5	✓	✓	✓	✓					
	6	✓	✓	✓	✓					
	7	✓	✓	✓	✓					
	8	✓	✓	✓	✓					
	9	✓	✓	✓	✓					
	10	✓	✓	✓	✓					
	11	✓	✓	✓	✓					
	12	✓	✓	✓	✓					
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	14	✓	✓	✓	✓					
	15	✓	✓	✓	✓					
	16	✓	✓	✓	✓					
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	18	✓	✓	✓	✓					
	19	✓	=	=	=					
	20	✓	=	=	=					
	21	✓	=	=	=					
	22	✓	=	=	=					
	23	✓	=	=	=					

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	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
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CPC - Searched*		
Symbol	**Date**	**Examiner**
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	06/19/2021	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	10/09/2021	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	09/24/2022	BGL
H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32	01/09/2023	BGL

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

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

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

/BORIS D GRIJALVA LOBOS/ Primary Patent Examiner, Art Unit 2446	

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	17/102,099	Rhee, Wonjong
	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

Search Notes		
Search Notes	**Date**	**Examiner**
EAST Inventor Name Search Performed (see attached search notes)	06/19/2021	BGL
EAST Assignee Name Search Performed (see attached search notes)	06/19/2021	BGL
EAST Text Limited Classification Search Performed (see attached search notes)	06/19/2021	BGL
EAST Text Search Performed (see attached search notes)	06/19/2021	BGL
GOOGLE search performed (see attached)	06/19/2021	BGL
GOOGLE Patent search performed (see attached)	06/19/2021	BGL
Updated EAST Inventor and Assignee Name Search (see attached search history)	10/09/2021	BGL
Updated EAST Text Limited search of all CPC classes/subclasses indicated above (see attached search history)	10/09/2021	BGL
Updated EAST Text Search (see attached search history)	10/09/2021	BGL
GOOGLE and GOOGLE Patent search performed (see attached)	10/09/2021	BGL
PE2E Inventor Name Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Assignee Name Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Text Limited Classification Search Performed (see attached search notes)	09/24/2022	BGL
PE2E Text Search Performed (see attached search notes)	09/24/2022	BGL
GOOGLE search performed (see attached)	09/24/2022	BGL
GOOGLE Patent search performed (see attached)	09/24/2022	BGL
Updated PE2E Inventor Name Search (see attached search notes)	01/09/2023	BGL
Updated PE2E Text Limited Classification Search (see attached search notes)	01/09/2023	BGL
Updated PE2E Text Search (see attached search notes)	01/09/2023	BGL
GOOGLE search performed (see attached)	01/09/2023	BGL

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	Examiner	Art Unit
	BORIS D GRIJALVA LOBOS	2446

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	06/18/2021	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	10/09/2021	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	09/24/2022	BGL
H04L	1/0019,20; 41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038; 43/04,08-0817,0876-10,16	01/09/2023	BGL

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	564700	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 01:26 AM
L2	18005156	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:06 PM
L4	131963	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:08 PM
L5	18193986	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT,	OR	ON	ON	2022/09/24 09:10 PM

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		(parameters value metrics performance)	JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L6	63720	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L7	3815	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:11 PM
L8	1131	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:13 PM
L9	4863868	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/09/24 09:15 PM

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Page #191

			CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L10	447	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/09/24 09:15 PM
L14	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 10:58 PM
L15	588308	(H04L1/00,0019,20 H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L16	18663680	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (parameters values adjustment))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR,	OR	ON	ON	2023/01/09 11:01 PM

			TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L17	137696	(parameters values metrics) near10 (performance near5 (threshold degrad$3 decreas$3 drop$4 maximum minimum))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L18	18808165	(adjust$3 modif$7 chang$3 edit$4 control$4 adapt$3 regulat$3 fine-tun$3 (fine near1 tun$3) finetun$3 alter$3 rectif$4) near5 (parameters value metrics performance)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L19	66662	2 AND 4 AND 5	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L20	3955	6 AND 1	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL,	OR	ON	ON	2023/01/09 11:01 PM

			NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L21	1142	7 AND @AD<="20111110"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L22	5087541	(first AND (third second additional)) near6 (parameters values metrics)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L23	453	8 AND 9	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DK, EA, EE, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/01/09 11:01 PM
L24	4	("20050190868" OR "20140269269" OR "20150172216" OR "20150326455").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09 11:01 PM
L25	1	"17102099"	(US-PGPUB; USPAT)	OR	ON	ON	2023/01/09

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L26	1	"10848398".pn.	(US-PGPUB; USPAT)	OR	ON	ON	11:56 PM 2023/01/09 11:58 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	94901	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N2	42717	((detect$3 determin$3 identif$7 observ$3 encounter$3 recogniz$3 diagnos$3 diagnostic$6) near5 noise).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N3	232800	((broadcast$3 disseminat$3 publish$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3 convey$3 communicat$3 receiv$3 obtain$3) near5 (policy configuration algorithm)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:13 PM
N4	133	(rhee near1 wonjong).in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N5	73	1 AND 4	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N6	1	5 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:14 PM
N7	50	1 AND 2 AND 3	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:15 PM
N8	166	assia.as. assia.aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N9	1	7 AND 8	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:16 PM
N10	3	(2 AND 3) AND (4 8)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:17 PM
N11	185	(adaptive near1 spectrum).as. (adaptive near1 spectrum).aanm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM
N12	4	(2 AND 3) AND (4 8 11)	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24 10:18 PM

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Exhibit 1006
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PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17/102,099
Filing Date	11-23-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	1	Canadian office action mailed 10/3/2022 in related Canadian application No. 3,129,522, Attorney Docket No. [20145-117CA], (4 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	01/09/2023

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

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

This collection of information is required by 37 CFR 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 2 hours 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, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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.

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

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	17102099
Filing Date	2020-11-23
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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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	20050190868	A1	2005-09-01	Khandekar et al.	
	2	20140269269	A1	2014-09-18	Kovvali et al.	
	3	20150172216	A1	2015-06-18	Bellizia et al.	
	4	20150326455	A1	2015-11-12	Hui et al.	

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
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	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	1	2013085485	WO	A1	2013-06-13	Cioffi et al.		
	2	2016123497	WO	A1	2016-08-04	VID Scale, Inc.		
	3	2018068857	WO	A1	2018-04-19	Huawei Technologies Co., Ltd.		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Response to Non-Final office action filed 7/28/2022 in US patent application No. 16/804,000, Attorney Docket No. [20145-117US], (11 pgs).	
	2	Indian hearing notice mailed 8/17/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (2 pgs).	×
	3	Indian hearing response filed 9/16/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (633 pgs).	☒
	4	Indian certificate granted, with allowed claims mailed 9/30/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (8 pgs).	☒
	5	Response to final office action & RCE filed 9/9/2022 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (11 pgs).	☐
	6	Canadian office action mailed 9/29/2022 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (5 pgs).	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	7	Indian office action mailed 9/16/2022 in related Indian patent application No. 202117038738, Attorney Docket No. [20145-117IN], (6 pgs).	☒
	8	Response to European office action filed 10/7/2022 in European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (9 pgs).	☐
	9	European search report mailed 10/7/2022 in related European patent application No. 20762897.5, Attorney Docket No. [20145-117EP], (11 pgs).	☐
	10	YAOHUA SUN ET AL: "Application of Machine Learning in Wireless Networks: Key Techniques and Open Issues", ARXIV.ORG, CORNELL UNIVERSITY LIBRARY, 201 OLIN LIBRARY CORNELL UNIVERSITY ITHACA, NY 14853, 24 September 2018, XP081194458, available from the Internet, <URL:https://arxiv.org/pdf/1809.08707.pdf>, (34 pgs).	☐

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

EXAMINER SIGNATURE

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	01/09/2023

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

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2022-10-27
Name/Print	Michael North	Registration Number	46963

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

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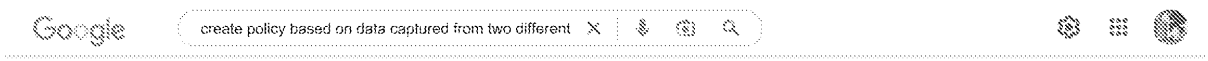
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Guidelines on firewalls and firewall policy - GovInfo

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48 pages

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Wonjong Rhee	Examiner: **Grijalva Lobos, Boris D.**
Application No.: 17/102,099	Art Group: 2446
Filed: November 23, 2020	Confirmation No.: 1038
For: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	Docket No.: 20145-054USC

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RESPONSE TO NON-FINAL OFFICE ACTION

Examiner Grijalva Lobos:

This Amendment is in response to the Non-Final Office Action dated September 29, 2022 and having a shortened statutory response period expiring December 29, 2022. Accordingly, this paper is timely filed. Applicant respectfully request further examination and reconsideration in view of the amendments and remarks set forth below.

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 the Claims:

1. (Previously presented) A server comprising:

a first interface coupled to a first communication unit, the first interface receives a first set of collected data associated with a first network managed by the first communication unit;

a second interface coupled to a second communication unit, the second interface receives a second set of collected data associated with a second network managed by the second communication unit, the second network being a different network than the first network;

a memory coupled to the first and second interfaces, the memory stores the first and second sets of collected data;

a processor coupled to the memory, the processor generates at least one policy based at least in part on an analysis of the first and second sets of collected data; and

a third interface coupled to the processor, the third interface transmits the at least one policy to the first communication unit that makes a performance-related adjustment within the first network based on the at least one policy.

2. (Previously presented) The server of claim 1 wherein the adjustment within the first network is an implementation of an algorithm.

3. (Previously presented) The server of claim 1 where in the adjustment within the first network is a change in a parameter value.

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4. (Previously presented) The server of claim 1 wherein the first communication unit reduces interference in the second network based on an implementation of the at least one policy within the first network.

5. (Previously presented) The server of claim 4 wherein the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

6. (Previously presented) The server of claim 5 wherein the channel transmission characteristics comprise a modification to a transmission band across the at least one wireless channel within the first network.

7. (Previously presented) The server of claim 1 wherein the first and second sets of collected data comprise historical data.

8. (Previously presented) The server of claim 1 wherein the processor:

generates a first control signal that is sent to the first communication unit at a first pre-defined time, the first control signal comprising a first policy adjustment to the first network; and

generates a second control signal that is sent to the second communication unit at a second pre-defined time, the second control signal comprising a second policy adjustment to the second network.

9. (Previously presented) The server of claim 8 wherein the first pre-defined time and the second pre-defined time are different.

10. (Previously presented) The server of claim 8 wherein the first policy adjustment and the second policy adjustment are different.

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11. (Previously presented) The server of claim 1 wherein the first and second communication units are Wi-Fi access points.

12. (Previously presented) The server of claim 1 wherein the first and second communication units are cellular base stations.

13. (Previously presented) The server of claim 12 wherein the first communication unit is a small cell base station.

14. (Previously presented) The server of claim 1 wherein the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

15. (Previously presented) The server of claim 14 wherein the at least one policy adjusts a transmission rate of at least one channel within the first network.

16. (Previously presented) The server of claim 1 wherein the first and second sets of collected data comprise collected measurements related to SNR across a plurality of wireless channels within the first and second networks.

17. (Previously presented) The server of claim 16 wherein the at least one policy adjusts a transmission power level across a first wireless channel within the plurality of wireless channels.

18. (Previously presented) The server of claim 1 wherein at least two interfaces within the first, second and third interfaces are the same interface.

19. (Previously presented) A method for managing a plurality of networks, the method comprising:

receiving, by a server, from network monitoring devices that monitor data associated

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with an operation of two or more communication units located in at least two networks within the plurality of networks, the data comprising a parameter;

processing, by the server, the received data;

based on the processed data, determining a policy for at least one of the two or more communication units; and

in response to the server detecting a degradation of network performance in at least one network within the plurality of networks, communicating the policy to at least one or more communication units that implement one or more algorithms that use the parameter and at least one rule or one condition for the one or more communication units to improve a performance of the one or more communication units.

20. (Original) The method of claim 19 wherein determining the policy comprises selecting the policy from a set of policies that are stored on the one or more communication units and wherein the communicated policy updates the one or more algorithms implemented on the one or more communication units.

21. (Original) The method of claim 19 wherein the one or more communication units comprise a Wi-Fi access point.

22. (Original) The method of claim 19 wherein the one or more communication units comprise a cellular base station.

23. (Original) The method of claim 19 wherein the at least one rule or one condition comprises an adjustment to a wireless transmission band within the plurality of networks.

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REMARKS

Claims 1-23 were presented for examination and are pending in this patent application. In the Office Action, claims 1-18 were rejected, and claims 19-23 were allowed. No claims are amended herein. On the basis of the following remarks, reconsideration and allowance of all pending claims is respectfully requested. For purposes of brevity, Applicant does not repeat herein arguments made in prior responses, which arguments are hereby incorporated by reference in their entirety and preserved for use on appeal.

I. Re: Response to Arguments

In the Office Action, the Examiner makes another attempt to rebut Applicant's argument that there is no logical reason why a person of ordinary skill in the art would believe that applicant has enumerated three separate interfaces in the same claim just to claim the same interface three times. The Examiner now alleges that Appellant's argument is "moot in light of applicant's own admission: 'claim 1 is 'broad enough' to include same interfaces [...] this is exactly how the person of skill in the art familiar with the cannons of claim interpretation would interpret claims 1 and 18.'" Office Action, p. 2-3 (citing to Applicant arguments, p. 8).

However, the interpretation is fatally flawed as it misquotes Applicant's argument and then misconstrues it as an admission of something that does not exist. First, the recited quotation leaves out the important qualifier that "claim 1 is broad enough to encompass the possibility of the first, second, and third (that is, all three) interfaces to be the same." Second, the interpretation completely ignores Applicant's actual argument, i.e., that an improper broadening of claim 1 "would ignore the fact that in claim 1 the interfaces are different.'" *Id.* (emphasis added).

In the Office Action, the Examiner emphasizes that claim 18 was not rejected as being "broader than claim 1." Office Action, p. 5. In other words, the Examiner admits that claim 1 is broader than claim 18. Claim 18 requires "at least two interfaces within the first, second and third interfaces are the same interface." Applicant respectfully notes, because claim 1, which has to be broader than claim 18, thus, cannot have two interfaces that are the same interface. This implies that claim 1 cannot have any interfaces that are the same. In other words, if any two same interfaces in claim 1 could be interpreted as the same, this would be equal what claim 18 requires, thus, making the claim scopes of claim 1 and 18 identical, thus, triggering a rejection under 35 U.S.C. § 112(d). Stated differently, the mere fact that claim 18 requires "at least two

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interfaces within the first, second and third interfaces are the same interface" precludes an interpretation of claim 1, from which claim 18 depends, as requiring two (or, as the Examiner implies, three) same interfaces. Therefore, an interpretation of claim 1 as reciting the same interface three times is unreasonable and, thus, improper.

Further, Applicant notes that a person of ordinary skill in the art would have no reason to believe that the plain meaning of claim 1 requiring first, second and third interfaces is "inconsistent with the specification," especially since claim 18 is part of "the specification."

Overall, because the entire rejection of the claims 1-4, 7-10, and 18 under 35 U.S.C. § 102 is based on a flawed claim interpretation, the rejection should be withdrawn. For reasons previously stated, Applicant respectfully requests that the rejections under 35 U.S.C. § 103 also be withdrawn and that all pending claims 1-23 be allowed.

II. Conclusion

Applicant notes that at least some of the claims include additional claim elements that are missing from the cited documents; however, additional reasons and responses to additional rejections for the independent and dependent claims are not presented in order to avoid unnecessary and/or cumulative arguments. Applicant reserves the right to challenge any assertions made by the Examiner in the Office Action that are not herein addressed, including but not limited to, the right to challenge that one or more of the cited documents were valid references. It is noted that the absence of any discussion about one or more of the rejections is in no way an acceptance by acquiescence by the Applicant.

The Commissioner is hereby authorized to charge any fees which may be due, and to credit any overpayment of fees, to Deposit Account No. 50-2776.

Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at 650-353-3786.

Respectfully submitted,

Date: December 28, 2022

By: / Ali Uyanik /

Ali Uyanik
Reg. No. 67,080

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International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	28-DEC-2022
Filing Date:	23-NOV-2020
Time Stamp:	12:57:18
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		054USC_NFOAResp.pdf	45558 a4e10d79e33e97df9b3ad80f488117412e103fcb	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Request for Reconsideration-After Non-Final Rejection	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	7
Warnings:			
Information:			
	Total Files Size (in bytes):	45558	

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 17/102,099	Filing Date 11/23/2020	☐ 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 $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	12/28/2022	(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))	* 23	Minus	** 23	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	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 $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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

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

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

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17/102,099
Filing Date	11-23-2020
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	1	Canadian office action mailed 10/3/2022 in related Canadian application No. 3,129,522, Attorney Docket No. [20145-117CA], (4 pgs).	

Examiner Signature		Date Considered	

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

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

This collection of information is required by 37 CFR 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 2 hours 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, 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.

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt	
EFS ID:	46911687
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	28-OCT-2022
Filing Date:	23-NOV-2020
Time Stamp:	00:41:03
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	Transmittal Letter	054USC_SIDS_Trans.pdf	26408 5d79160125 4fcad8cf988b3493ca8602aa63b144	no	3
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	322873 1bebb7b2a079e066352109d73bf25847529cb8b3	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	1302351 c06a9fb27383e76d431d501cb0e574a8d3fe262c	no	4
Warnings:					
Information:					
		Total Files Size (in bytes):	1651632		

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<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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No. :	1038
Inventor	:	Wonjong Rhee		
Filing Date	:	11-23-2020		
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Art Unit	:	2446		
Examiner	:	GRIJALVA LOBOS, BORIS D		
Docket No.	:	20145-054USC		
Customer No.	:	146571		

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: October 27, 2022 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #223

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☐ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

Charter Communications, Inc.
Exhibit 1006
Page #224

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☒ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: October 27, 2022

By: /Michael V. North/
Michael V. North
Reg. No. 46,963

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	17102099
Filing Date	2020-11-23
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	GRIJALVA LOBOS, BORIS D
Attorney Docket Number	20145-054USC

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS Remove

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	20050190868	A1	2005-09-01	Khandekar et al.	
	2	20140269269	A1	2014-09-18	Kovvali et al.	
	3	20150172216	A1	2015-06-18	Bellizia et al.	
	4	20150326455	A1	2015-11-12	Hui et al.	

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

FOREIGN PATENT DOCUMENTS Remove

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	1	2013085485	WO	A1	2013-06-13	Cioffi et al.		
	2	2016123497	WO	A1	2016-08-04	VID Scale, Inc.		
	3	2018068857	WO	A1	2018-04-19	Huawei Technologies Co., Ltd.		

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

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Response to Non-Final office action filed 7/28/2022 in US patent application No. 16/804,000, Attorney Docket No. [20145-117US], (11 pgs).	
	2	Indian hearing notice mailed 8/17/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (2 pgs).	☒
	3	Indian hearing response filed 9/16/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (633 pgs).	☒
	4	Indian certificate granted, with allowed claims mailed 9/30/2022 in Indian patent application No. 1113/MUMNP/2014, Attorney Docket No. [20145-056IN], (8 pgs).	☒
	5	Response to final office action & RCE filed 9/9/2022 in US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (11 pgs).	☐
	6	Canadian office action mailed 9/29/2022 in Canadian patent application No. 3,124,797, Attorney Docket No. [20145-055CAD2], (5 pgs).	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	7	Indian office action mailed 9/16/2022 in related Indian patent application No. 202117038738, Attorney Docket No. [20145-117IN], (6 pgs).	☒
	8	Response to European office action filed 10/7/2022 in European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (9 pgs).	☐
	9	European search report mailed 10/7/2022 in related European patent application No. 20762897.5, Attorney Docket No. [20145-117EP], (11 pgs).	☐
	10	YAOHUA SUN ET AL: "Application of Machine Learning in Wireless Networks: Key Techniques and Open Issues", ARXIV.ORG, CORNELL UNIVERSITY LIBRARY, 201 OLIN LIBRARY CORNELL UNIVERSITY ITHACA, NY 14853, 24 September 2018, XP081194458, available from the Internet, <URL:https://arxiv.org/pdf/1809.08707.pdf>, (34 pgs).	☐

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2022-10-27
Name/Print	Michael North	Registration Number	46963

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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
13 June 2013 (13.06.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/085485 A1

(51) International Patent Classification:
H04L 12/56 (2006.01) *H04L 12/28* (2006.01)

(21) International Application Number:
PCT/US2011/063326

(22) International Filing Date:
5 December 2011 (05.12.2011)

(25) Filing Language: English

(26) Publication Language: English

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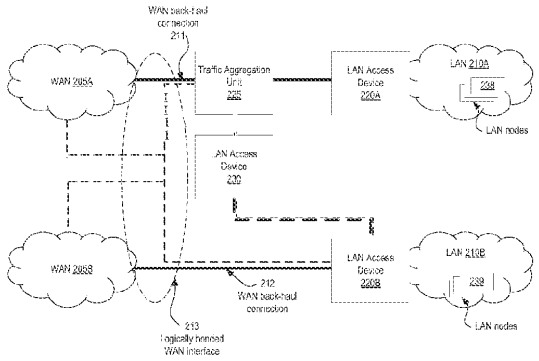
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, 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, 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).

[Continued on next page]

(54) Title: SYSTEMS AND METHODS FOR TRAFFIC AGGREGATION ON MULTIPLE WAN BACKHAULS AND MULTIPLE DISTINCT LAN NETWORKS

FIG. 2A



(57) Abstract: In accordance with embodiments disclosed herein, there are provided methods, systems, mechanisms, techniques, and apparatuses for traffic aggregation on multiple WAN backhauls and multiple distinct LAN networks; for traffic load balancing on multiple WAN backhauls and multiple distinct LAN networks; and for performing self-healing operations utilizing multiple WAN backhauls serving multiple distinct LAN networks. For example, in one embodiment, a first Local Area Network (LAN) access device is to establish a first LAN; a second LAN access device is to establish a second LAN; a first Wide Area Network (WAN) backhaul connection is to provide the first LAN access device with WAN connectivity; a second WAN backhaul connection is to provide the second LAN access device with WAN connectivity; and a traffic aggregation unit is to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul. In some embodiments an optional traffic de-aggregation unit may be used.

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Declarations under Rule 4.17:

---- *of inventorship (Rule 4.17(iv))*

Published:

---- *with international search report (Art. 21(3))*

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SYSTEMS AND METHODS FOR TRAFFIC AGGREGATION ON MULTIPLE WAN BACKHAULS AND MULTIPLE DISTINCT LAN NETWORKS

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TECHNICAL FIELD

[0002] The subject matter described herein relates generally to the field of computing, and more particularly, to systems and methods for traffic aggregation on multiple WAN backhauls and multiple distinct LAN networks; to systems and methods for traffic load balancing on multiple WAN backhauls and multiple distinct LAN networks; and to systems and methods for performing self-healing operations utilizing multiple WAN backhauls serving multiple distinct LAN networks.

BACKGROUND

[0003] The subject matter discussed in the background section should not be assumed to be prior art merely as a result of its mention in the background section. Similarly, a problem mentioned in the background section or associated with the subject matter of the background section should not be assumed to have been previously recognized in the prior art. The subject matter in the background section merely represents different approaches, which in and of themselves may also correspond to embodiments of the claimed subject matter.

[0004] The "Internet" is a Wide Area Network that joins together many other networks, providing a communications path between devices operating within distinct and often geographically dispersed networks. A Local Area Network (LAN)

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enables multiple distinct devices within an end-user's premises to communicate amongst themselves locally. Home LAN technologies include wired Ethernet, WiFi, power line, coax, phoneline and other transmission systems. An end-user's LAN is often connected to the Internet via a WAN backhaul connection to an Internet Service Provider (ISP) that provides the end-user consumer with Internet connectivity and Internet Bandwidth. WAN backhaul technologies include DSL, cable modems, fiber, and wireless. Devices within the end-user's LAN may communicate with devices external to the LAN over the WAN backhaul connection provided by the end-user's ISP.

[0005] Traditionally, the WAN is controlled, managed and maintained by service providers, such as Internet Service Providers, Telecommunications Operators, etc. Conversely, a LAN is typically managed and maintained at a customer's premises by end users/customers, which may be residential users or commercial/business customers. Moreover, operators and service providers typically refrain from addressing any LAN related problems, notwithstanding the fact that, at times, some problems and issues exhibited via the LAN may be related to WAN configurations and settings. Opportunities for enhanced management of the LAN to WAN interfaces may benefit LANs, LAN devices, and end-to-end service delivery. However, such enhanced management opportunities have not yet been made available to the relevant consuming public and have not yet been explored in earnest by relevant Service Providers.

[0006] The present state of the art may therefore benefit from systems and methods for traffic aggregation on multiple WAN backhauls and multiple distinct LAN networks; systems and methods for traffic load balancing on multiple WAN backhauls and multiple distinct LAN networks; and systems and methods for performing self-healing operations utilizing multiple WAN backhauls serving multiple distinct LAN networks, each of which are described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments are illustrated by way of example, and not by way of limitation, and will be more fully understood with reference to the following detailed description when considered in connection with the figures in which:

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[0008] **Figure 1** illustrates an exemplary architecture in which embodiments may operate;

[0009] **Figures 2A, 2B, 2C, 2D, 2E, 2F, 2G, and 2H** illustrate alternative exemplary architectures in which embodiments may operate;

[0010] **Figures 3A, 3B, 3C, 3D, and 3E** illustrate alternative exemplary architectures in which embodiments may operate;

[0011] **Figures 4A, 4B, 4C, 4D, 4E, 4F, and 4G** illustrate alternative exemplary architectures in which embodiments may operate;

[0012] **Figures 5A and 5B** show diagrammatic representations of systems in accordance with which embodiments may operate, be installed, integrated, or configured;

[0013] **Figures 6A, 6B, and 6C** are flow diagrams illustrating methods for traffic aggregation; methods for traffic load balancing; and methods for performing self-healing in accordance with described embodiments; and

[0014] **Figure 7** illustrates a diagrammatic representation of a machine in the exemplary form of a computer system, in accordance with one embodiment.

DETAILED DESCRIPTION

[0015] Described herein are systems and methods for traffic aggregation on multiple WAN backhauls and multiple distinct LAN networks; systems and methods for traffic load balancing on multiple WAN backhauls and multiple distinct LAN networks; and systems and methods for performing self-healing operations utilizing multiple WAN backhauls serving multiple distinct LAN networks.

[0016] Demand for data traffic is bursty, with frequent large changes in traffic. Demand for streaming services such as video can also vary substantially as sessions come and go, such as when turning a TV on and off. Moreover, the supply of bandwidth can vary considerably, with different LAN connections such as wireless proving different bit rates, and different WAN connections such as broadband access backhaul also providing different bit rates. It is often the case that when one line is heavily loaded, an adjacent line is lightly loaded. Traffic aggregation takes advantage of this, statistically smoothing demand and supply by pooling multiple users together into a single logically created connection.

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[0017] LAN/WAN bonding solutions heretofore have been limited to specific pre-determined implementations. The traffic aggregation mechanisms disclosed herein are more dynamic in nature and allow for combining traffic across different WAN backhauls and LAN networks in an adaptive fashion. Traffic aggregation might include, among other things, techniques such as packet reordering, classification by packet type (control or data), etc. Traffic can also be aggregated across devices in different subnets, networks being serviced by different service providers, etc. Certain traffic aggregation mechanisms do not differentiate incoming traffic on the basis of traffic flows, so that resources are allocated to the whole set of flows. There are also traffic aggregation mechanisms that do not treat all incoming traffic as the same and each flow can be allocated its own dedicated resources. Any traffic handling scheme presents different requirements in terms of link capacity and also has its own sensitivity to changes in the traffic load offered to the network. This interdependency between the performance of traffic aggregation schemes and link status (capacity, offered load, flow characteristics, etc.) is present regardless of whether aggregation is performed by aggregating traffic over a single connection or by switching or routing physically or logically distinct traffic sources and sinks over different connections, and in both cases requires to adapt configuration to the specific scenario at hand. Traffic aggregation is thus more adaptive and may be adapted to suit the situation at hand where as bonding tends to be more static.

[0018] For example, in one embodiment, a first Local Area Network (LAN) access device is to establish a first LAN; a second LAN access device is to establish a second LAN; a first Wide Area Network (WAN) backhaul connection is to provide the first LAN access device with WAN connectivity; a second WAN backhaul connection is to provide the second LAN access device with WAN connectivity; and a traffic aggregation unit is to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul. In some embodiments an optional traffic de-aggregation unit may be used.

[0019] In another embodiment, a first Local Area Network (LAN) access device is to establish a first LAN; a second LAN access device is to establish a second LAN; a first Wide Area Network (WAN) backhaul connection is to provide

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the first LAN access device with WAN connectivity; a second WAN backhaul connection to provide the second LAN access device with WAN connectivity; a management device is communicatively interfaced with each of the first LAN access device, the second LAN access device, the first WAN backhaul connection, and the second WAN backhaul connection; and the management device routes a first portion of traffic originating from the first LAN over the first WAN backhaul connection and routes a second portion of the traffic originating from the first LAN over the second WAN backhaul connection.

[0020] In another embodiment, a first Local Area Network (LAN) access device is to establish a first LAN; a second LAN access device is to establish a second LAN; a first Wide Area Network (WAN) backhaul connection is to provide the first LAN access device with WAN connectivity; a second WAN backhaul connection is to provide the second LAN access device with WAN connectivity; a management device is communicatively interfaced with each of the first LAN access device, the second LAN access device, the first WAN backhaul connection, and the second WAN backhaul connection; and the management device, responsive to a failure event, re-routes traffic associated with the first LAN onto the second WAN backhaul connection or re-routes traffic associated with the second LAN onto the first WAN backhaul connection.

[0021] In accordance with embodiments described herein, end-user consumers, including residential consumers and business consumers, may connect to the Internet by way of a Wide Area Network (WAN) backhaul connection to a Service Provider (SP), such as an Internet Service Provider (ISP), or to a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers. Such Service Providers may include a Digital Subscriber Line (DSL) internet service provider which provides its subscribing end-users with Internet bandwidth at least partially over copper twisted pair telephone lines, such as that conventionally utilized to carry analog telephone service (e.g., Plain Old Telephone Service (POTS); a coaxial cable internet service provider which provides end-users with Internet bandwidth at least partially over coaxial cable, such as that conventionally utilized to carry "cable" television signals; or a fiber optics internet service provider

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which provides end-users with Internet bandwidth at over fiber optic cable that terminates at a customer's premises. Other variants exist as well, such as ISPs which provide Internet bandwidth as an analog signal over an analog telephone based connection, ISPs that provide Internet bandwidth over a one-way or two-way satellite connection, and ISPs that provide Internet bandwidth at least partially over power lines, such as power lines conventionally utilized to transmit utility power (e.g., electricity) to an end-user's premises, or ISPs that provide Internet bandwidth at least partially over wireless channels, such as wireless (e.g., WiFi) connectivity at hotspots, or mobile data connectivity via technologies and standards such as WiMax, 3G/4G, LTE, etc.

[0022] At an end-user's premises, Internet bandwidth and other compatible services provided via a WAN backhaul connection to an ISP is commonly distributed amongst multiple devices within the end-user's premises via a Local Area Network (LAN), which may be established via a LAN device. Distribution of the Internet Bandwidth and other services provided via the WAN backhaul may further extend to an area around an end-user's premises, such as to an area outside a home, to a space or area outside of or around a business in which the Internet Bandwidth is accessible via the end-user's LAN wirelessly. At the end-user's premises, network traffic may be distributed within the LAN via wired connections or wireless connections, for example, over coaxial wiring, electrical power wiring, twisted-pair telephone wiring, variants of Ethernet/Category-5 type wiring, and various types of wireless radio signals using licensed and unlicensed spectrum and various protocols. In accordance with one embodiment, access to Internet bandwidth and other services provided by the WAN backhaul may be secured.

[0023] Some network traffic associated with the end-user's premises remains local to the LAN, while other traffic destined for locations external to the LAN traverse the LAN onto the WAN interface and onto the Internet via the WAN backhaul.

[0024] Besides network traffic traversing the WAN and LAN networks and interfaces, various types of information is available, retrievable, or observable from each of the distinct WAN and LAN networks. The management device described herein may collect information collected from the WAN and LAN networks via

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respective WAN and LAN interfaces to such networks, and perform or enable various enhancements, such as performing self-healing operations utilizing multiple WAN backhauls serving multiple distinct LAN networks; and load balancing traffic utilizing multiple WAN backhauls serving multiple distinct LAN networks. The management device may further coordinate or instruct the formation of a logical WAN backhaul connection over multiple underlying physical or wireless WAN backhauls. Some embodiments make use of a traffic aggregation unit which may form a logically bonded WAN interface from two or more underlying WAN interfaces. In some embodiments, a traffic de-aggregation unit may optionally be employed. Traffic aggregation may use inverse multiplexing, Ethernet switching, IP routing, Asynchronous Transfer Mode (ATM), Time-Division Multiplexing (TDM), Point-to-Point Protocol (PPP), PPP Multi-Link Protocol (MLPPP), or other technologies.

[0025] An alternative to classic traffic aggregation is to selectively aggregate traffic by switching or routing physically or logically distinct traffic sources and sinks over different connections. For example, traffic from a first subnet on a LAN can travel over a first WAN connection, while traffic from a second subnet on a LAN can travel over a second WAN connection. This selective aggregation mechanism can switch or route traffic according to physical port, priority level, Ethernet VLAN or MAC identities, IP number, subnet, TCP/UDP port number, protocol, type of service (TOS), DiffServ Code Point (DSCP), IP precedence, MPLS tag, application layer, etc.

[0026] Aggregation via selectively switching or routing traffic may be performed with no physical aggregation element, for example, an aggregation element may be either physical entity or a logically defined entity in accordance with the various described embodiments.

[0027] Aggregation and selection of connections may be varied adaptively, as traffic demands and connection bandwidths change over time. For example, a high traffic demand from a first LAN may be routed over both a first and a second WAN, but when the traffic demand from the first LAN decreases the traffic ceases to be routed over the second WAN. If traffic demand increases on the second LAN such traffic may then be routed over the first WAN. More involved real-time load

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balancing may be incorporated to match overall traffic demands with bandwidth supply in an adaptive fashion.

[0028] Disclosed embodiments may also be extended to cases with more than two LANs or more than two WAN connections. In such cases, traffic aggregation schemes have multiple traffic inputs and multiple choices on how to aggregate traffic, for example, over a single connection or multiple connections each with its own link quality, capacity. Since there is interdependency between the performances of traffic aggregation schemes and input flow characteristics and link quality, traffic can be aggregated taking a weighted approach to better serve the scenario at hand. Traffic can be weighted to account for the fact that not all access point conditions are equal, therefore when connections are made to more than two access points, the connections to different access points may be weighted accordingly, for example, to compensate for the different speeds, throughput, latency, or other characteristics associated with the distinct access points. In one embodiment, weighting is dependent upon the supply of bandwidth on the different WAN connections, and further dependent upon the traffic demand from the different LANs. The weighting may further vary with the type or priority of traffic, different service levels, different services, etc. The weighting may also be time varying as a consequence of the fact that channel quality also changes over time. This applies also the LAN case where it is well known that in-home power line communications (PLC) faces time varying impairments.

[0029] Disclosed embodiments may also be extended to cases where the same LAN extends over multiple physically separated channels. For example, such as the case of having a LAN where G.hn (ITU-T standardized unified high-speed wire-line based home networking) nodes operate over phoneline, power lines, and coax; or in the case of a hybrid wireline/wireless LAN. In cases, traffic aggregation over the WAN may apply different weights on input flows originating on coax or phoneline or power line or wireless. Similarly, when one source requires so many channel resources that no single physical channel is able to satisfy them, then traffic handling schemes may split the input traffic and simultaneously transmit the input traffic over multiple channels. This can be accomplished using possibly unequal weights depending on link conditions and then re-aggregate the input traffic over the

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WAN or eventually at the sink within the LAN. The way in which incoming traffic is simultaneously transmitted over multiple channels can change over time with link condition and traffic requirements.

[0030] In the following description, numerous specific details are set forth such as examples of specific systems, languages, components, etc., in order to provide a thorough understanding of the various embodiments. It will be apparent, however, to one skilled in the art that these specific details need not be employed to practice the disclosed embodiments. In other instances, well known materials or methods have not been described in detail in order to avoid unnecessarily obscuring the disclosed embodiments.

[0031] In addition to various hardware components depicted in the figures and described herein, embodiments further include various operations which are described below. The operations described in accordance with such embodiments may be performed by hardware components or may be embodied in machine-executable instructions, which may be used to cause a general-purpose or special-purpose processor programmed with the instructions to perform the operations. Alternatively, the operations may be performed by a combination of hardware and software, including software instructions that perform the operations described herein via memory and one or more processors of a computing platform.

[0032] Embodiments also relate to a system or apparatus for performing the operations herein. The disclosed system or apparatus may be specially constructed for the required purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a non-transitory computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, flash, NAND, solid state drives (SSDs), CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing non-transitory electronic instructions, each coupled to a computer system bus. In one embodiment, a non-transitory computer readable storage medium having instructions stored thereon, causes one or more processors within a Management Device, a traffic aggregation unit, and/or a traffic de-aggregator to perform the

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methods and operations which are described herein. In another embodiment, the instructions to perform such methods and operations are stored upon a non-transitory computer readable medium for later execution.

[0033] The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus nor are embodiments described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the embodiments as described herein.

[0034] **Figure 1** illustrates an exemplary architecture 100 in which embodiments may operate. Asymmetric Digital Subscriber Line (ADSL) systems (one form of Digital Subscriber Line (DSL) systems), which may or may not include splitters, operate in compliance with the various applicable standards such as ADSL1 (G.992.1), ADSL-Lite (G.992.2), ADSL2 (G.992.3), ADSL2-Lite G.992.4, ADSL2+ (G.992.5) and the G.993.x emerging Very-high-speed Digital Subscriber Line or Very-high-bitrate Digital Subscriber Line (VDSL) standards, as well as the G.991.1 and G.991.2 Single-Pair High-speed Digital Subscriber Line (SHDSL) standards, all with and without bonding, and/or the G.997.1 standard (also known as G.ploam).

[0035] In performing the disclosed functions, systems may utilize a variety of operational data (which includes performance data) that is available at an Access Node (AN).

[0036] In Figure 1, users terminal equipment 102 (e.g., a Customer Premises Equipment (CPE) device or a remote terminal device, network node, LAN device, etc.) is coupled to a home network 104, which in turn is coupled to a Network Termination (NT) Unit 108. DSL Transceiver Units (TU) are further depicted (e.g., a device that provides modulation on a DSL loop or line). In one embodiment, NT unit 108 includes a TU-R (TU Remote), 122 (for example, a transceiver defined by one of the ADSL or VDSL standards) or any other suitable network termination modem, transceiver or other communication unit. NT unit 108 also includes a Management Entity (ME) 124. Management Entity 124 can be any suitable hardware device, such as a microprocessor, microcontroller, or circuit state machine in firmware or hardware, capable of performing as required by any

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applicable standards and/or other criteria. Management Entity 124 collects and stores, among other things, operational data in its Management Information Base (MIB), which is a database of information maintained by each ME capable of being accessed via network management protocols such as Simple Network Management Protocol (SNMP), an administration protocol used to gather information from a network device to provide to an administrator console/program or via Transaction Language 1 (TL1) commands, TL1 being a long-established command language used to program responses and commands between telecommunication network elements. In one embodiment, Network Termination Unit 108 is communicably interfaced with a management device 170 as described herein. In another embodiment, TU-R 122 is communicably interfaced with management device 170.

[0037] Each TU-R 122 in a system may be coupled with an TU-C (TU Central) in a Central Office (CO) or other central location. TU-C 142 is located at an Access Node (AN) 114 in Central Office 146. A Management Entity 144 likewise maintains an MIB of operational data pertaining to TU-C 142. The Access Node 114 may be coupled to a broadband network 106 or other network, as will be appreciated by those skilled in the art. TU-R 122 and TU-C 142 are coupled together by a loop 112, which in the case of ADSL may be a twisted pair line, such as a telephone line, which may carry other communication services besides DSL based communications. Either management entity 124 or management entity 144 may implement and incorporate a management device 170 as described herein. Management entity 124 or management entity 144 may further store collected WAN information and collected LAN information within an associated MIB.

[0038] Several of the interfaces shown in Figure 1 are used for determining and collecting operational data. The Q interface 126 provides the interface between the Network Management System (NMS) 116 of the operator and ME 144 in Access Node 114. Parameters specified in the G.997.1 standard apply at the Q interface 126. The near-end parameters supported in Management Entity 144 may be derived from TU-C 142, while far-end parameters from TU-R 122 may be derived by either of two interfaces over the UA interface. Indicator bits and EOC messages may be sent using embedded channel 132 and provided at the Physical Medium Dependent (PMD) layer, and may be used to generate the required TU-R

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122 parameters in ME 144. Alternately, the operations, Administration and Maintenance (OAM) channel and a suitable protocol may be used to retrieve the parameters from TU-R 122 when requested by Management Entity 144. Similarly, the far-end parameters from TU-C 142 may be derived by either of two interfaces over the U-interface. Indicator bits and EOC message provided at the PMD layer may be used to generate the required TU-C 142 parameters in Management Entity 124 of NT unit 108. Alternately, the OAM channel and a suitable protocol may be used to retrieve the parameters from TU-C 142 when requested by Management Entity 124.

[0039] At the U interface (also referred to as loop 112), there are two management interfaces, one at TU-C 142 (the U-C interface 157) and one at TU-R 122 (the U-R interface 158). Interface 157 provides TU-C near-end parameters for TU-R 122 to retrieve over the U interface/loop 112. Similarly, U-R interface 158 provides TU-R near-end parameters for TU-C 142 to retrieve over the U interface/loop 112. The parameters that apply may be dependent upon the transceiver standard being used (for example, G.992.1 or G.992.2). The G.997.1 standard specifies an optional Operation, Administration, and Maintenance (OAM) communication channel across the U interface. If this channel is implemented, TU-C and TU-R pairs may use it for transporting physical layer OAM messages. Thus, the TU transceivers 122 and 142 of such a system share various operational data maintained in their respective MIBs.

[0040] Depicted within Figure 1 is management device 170 operating at various optional locations in accordance with several alternative embodiments. For example, management device 170 is located within home network 104, such as within a LAN. In an alternative embodiment, management device 170 is located at central office 146 and interfaced to home network 104 (e.g., a LAN) and broadband network 106 (e.g., a WAN) via NMS 116. In yet another embodiment, management device 170 operates on the broadband network 106 (e.g., on the WAN or Internet).

[0041] Also depicted within Figure 1 is a traffic aggregation unit 180 operating at various optional locations in accordance with several embodiments. For example, traffic aggregation unit 180 may reside within TE 102, may reside within a LAN device 103 which is connected with TE 102, traffic aggregation unit 180 may

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recite on the loop 112 at the CPE or CO side. As depicted here, traffic aggregation unit 180 is placed on the loop 112 at NT 108. These and other examples and their benefits and function will be described in further detail below.

[0042] As used herein, the terms "user," "subscriber," and/or "customer" refer to a person, business and/or organization to which communication services and/or equipment are and/or may potentially be provided by any of a variety of service provider(s). Further, the term "customer premises" refers to the location to which communication services are being provided by a service provider. For an example Public Switched Telephone Network (PSTN) used to provide DSL services, customer premises are located at, near and/or are associated with the network termination (NT) side of the telephone lines. Example customer premises include a residence or an office building.

[0043] As used herein, the term "service provider" refers to any of a variety of entities that provide, sell, provision, troubleshoot and/or maintain communication services and/or communication equipment. Example service providers include a telephone operating company, a cable operating company, a wireless operating company, an internet service provider, or any service that may independently or in conjunction with a broadband communications service provider offer services that diagnose or improve broadband communications services (DSL, DSL services, cable, etc.).

[0044] Additionally, as used herein, the term "DSL" refers to any of a variety and/or variant of DSL technology such as, for example, Asymmetric DSL (ADSL), High-speed DSL (HDSL), Symmetric DSL (SDSL), and/or Very high-speed/Very high-bit-rate DSL (VDSL). Such DSL technologies are commonly implemented in accordance with an applicable standard such as, for example, the International Telecommunications Union (I.T.U.) standard G.992.1 (a.k.a. G.dmt) for ADSL modems, the I.T.U. standard G.992.3 (a.k.a. G.dmt.bis, or G.adsl2) for ADSL2 modems, I.T.U. standard G.992.5 (a.k.a. G.adsl2plus) for ADSL2+ modems, I.T.U. standard G.993.1 (a.k.a. G.vdsl) for VDSL modems, I.T.U. standard G.993.2 for VDSL2 modems, I.T.U. standard G.994.1 (G.hs) for modems implementing handshake, and/or the I.T.U. G.997.1 (a.k.a. G.ploam) standard for management of DSL modems.

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[0045] References to connecting a DSL modem and/or a DSL communication service to a customer are made with respect to exemplary Digital Subscriber Line (DSL) equipment, DSL services, DSL systems and/or the use of ordinary twisted-pair copper telephone lines for distribution of DSL services, it should be understood that the disclosed methods and apparatus to characterize and/or test a transmission medium for communication systems disclosed herein may be applied to many other types and/or variety of communication equipment, services, technologies and/or systems. For example, other types of systems include wireless distribution systems, wired or cable distribution systems, coaxial cable distribution systems, Ultra High Frequency (UHF) / Very High Frequency (VHF) radio frequency systems, satellite or other extra-terrestrial systems, cellular distribution systems, broadband power-line systems and/or fiber optic networks. Additionally, combinations of these devices, systems and/or networks may also be used. For example, a combination of twisted-pair and coaxial cable interfaced via a balun connector, or any other physical-channel-continuing combination such as an analog fiber to copper connection with linear optical-to-electrical connection at an Optical Network Unit (ONU) may be used.

[0046] The phrases "coupled to," "coupled with," connected to," "connected with" and the like are used herein to describe a connection between two elements and/or components and are intended to mean coupled/connected either directly together, or indirectly, for example via one or more intervening elements or via a wired/wireless connection. References to a "communication system" are intended, where applicable, to include reference to any other type of data transmission system.

[0047] **Figure 2A** illustrates an alternative exemplary architecture 200 in which embodiments may operate. Figure 2A depicts a first Wide Area Network (WAN) at element 205A, a second WAN 205B, a first Local Area Network (LAN) at element 210A, and a second LAN 210B. LAN access device 220A connects LAN 210A with WAN 205A through traffic aggregation unit 225. LAN 210B is connected with WAN 205B through LAN access device 220B. LAN access device 230 provides a communications interface between traffic aggregation unit 225 and LAN access device 220B.

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[0048] In the series of exemplary embodiments set forth at Figures 2A through 2H there are two LAN access devices shown (e.g., 220A and 220B of Figure 2A). However, more than two LAN access devices may permissible operate in accordance with the described embodiments and the depiction of two such LAN access devices in the exemplary figures is not to be construed as being limited to only two.

[0049] In accordance with one embodiment, such an architecture 200 or system includes a first Local Area Network (LAN) access device 220A to establish a first LAN 210A and a second LAN access device 220B to establish a second LAN 210B which is operationally distinct from the first LAN 210A. In such an embodiment, the architecture 200 or system further includes a first Wide Area Network (WAN) backhaul connection 211 to provide the first LAN access device 220A with WAN connectivity. In this embodiment, the architecture 200 or system further includes a second WAN backhaul connection 212 to provide the second LAN access device 210A with WAN connectivity. In this embodiment, each of the first WAN backhaul connection 211 and the second WAN backhaul connection 212 are physically distinct. The architecture 200 or system of this embodiment further includes traffic aggregation unit 225 to form a logically bonded WAN interface 213 over the first WAN backhaul connection 211 and the second WAN backhaul connection 212.

[0050] In one embodiment, the logically bonded WAN interface 213 provides the first LAN access device 220A and the second LAN access device 220B with WAN connectivity via a combination of first bandwidth accessible via the first WAN backhaul connection 211 and second bandwidth accessible via the second WAN backhaul connection 212.

[0051] In one embodiment, the logically bonded WAN interface 213 provides the first LAN access device 220A with WAN connectivity and further provides the second LAN access device 220B with WAN connectivity. In such an embodiment, the logically bonded WAN interface 213 supplants (e.g., is used in place of, replaces, supersedes, etc.) the first WAN backhaul connection 211 for providing the first LAN access device 220A with its respective WAN connectivity and further supplants the second WAN backhaul connection 212 for providing the

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second LAN access device 220B with its respective WAN connectivity. For example, in such an embodiment, both LAN access devices 220A-B communicate via logically bonded WAN interface 213 once established, rather than their respective WAN interfaces 211 and 212 respectively.

[0052] In one embodiment, the first WAN backhaul connection 211 provides the first LAN access device 220A with WAN connectivity via the first WAN backhaul connection 211 to a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers. In one embodiment, the second WAN backhaul connection 212 provides the second LAN access device 220B with WAN connectivity via the second WAN backhaul connection 212 to the same Service Provider via a physically distinct communications link to the same Service Provider. For example, WAN backhaul connections 211 and 212 may represent physically distinct communications links, yet both communicably link to the same service provider. Such a service provider may implement or establish the Wide Area Networks 205A-B.

[0053] In one embodiment, the physically distinct communications link to the same Service Provider associated with the second WAN backhaul connection is identified by an Internet Protocol (IP) address distinct from an IP address for the first WAN backhaul connection. In such an embodiment, the physically distinct communications link to the same Service Provider associated with the second WAN backhaul connection 212 is associated with a subscriber's account distinct from a subscriber's account associated with the first WAN backhaul connection 211. For example, the first WAN backhaul connection 211 may lead to one house or office, and the second WAN backhaul connection 212 may lead to a separate and distinct house or office. Nevertheless, both may trace back to the same service provider.

[0054] In one embodiment, the first WAN backhaul connection 211 provides the first LAN access device 220A with WAN connectivity via the first WAN backhaul connection 211 to a first Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers and the second WAN backhaul connection 212 provides the second LAN access device 220B with WAN connectivity via the

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second WAN backhaul connection 212 to a second Service Provider separate and distinct from the first Service Provider. For example, different from the preceding example, each of the first and second WAN backhaul connections 211 and 212 may lead to completely different service providers.

[0055] In one embodiment, at least a portion of traffic originating from the first LAN 210A and at least a portion of traffic originating from the second LAN 210B traverses the logically bonded WAN interface 213.

[0056] In one embodiment: (a) a first plurality of traffic packets originating from the first LAN 210A traverses the logically bonded WAN interface 213 via the first WAN backhaul 211 through the traffic aggregation unit 225; (b) a second plurality of traffic packets originating from the first LAN 210A traverses the logically bonded WAN interface 213 via the second WAN backhaul 212 through the traffic aggregation unit 225; (c) a third plurality of traffic packets originating from the second LAN 210B traverses the logically bonded WAN interface 213 via the first WAN backhaul 211 through the traffic aggregation unit 225; and (d) a fourth plurality of traffic packets originating from the second LAN 210B traverses the logically bonded WAN interface 213 via the second WAN backhaul 212 through the traffic aggregation unit 225. Thus, packets originating from either LAN 210A-B may traverse the logically bonded WAN interface 213 via either or both underlying WAN backhaul connection 211 and/or 212. In such an embodiment, LAN devices within either LAN 210A-B may operate wholly agnostic or ignorant of which underlying backhaul connection is being utilized for any given packet, as the traffic aggregation unit 225 provides the necessary coordination for the plurality of packets sent to, or designated for, various locations accessible within the WANs 205A-B (e.g., such as packets which must be routed to a location over the Internet, etc.).

[0057] In one embodiment, the first LAN 210A includes a first plurality of interconnected LAN nodes 238. In such an embodiment, each of the first plurality of interconnected LAN nodes 238 are identifiable within the first LAN 210A by a private Internet Protocol (IP) address managed by the first LAN access device 220A. In such an embodiment, the second LAN 210B includes a second plurality of interconnected LAN nodes 239, in which each of the second plurality of interconnected LAN nodes 239 are identifiable within the second LAN 210B by a

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private IP address managed by the second LAN access device 220B. In such an embodiment, the first LAN access device 220A is identifiable via a first unique Public IP address assigned to the first LAN access device 220A and the second LAN access device 220B is identifiable via a second unique Public IP address assigned to the second LAN access device 220B.

[0058] The LAN nodes 238 and 239 may associate with the LAN access devices 220A and 220B, respectively according to their respective selection criteria. For example, LAN nodes 238 and 239 might associate with the LAN access device with the highest received power as indicated for example by RSSI (Received Signal Strength Indication). Alternatively, nodes might associate with LAN access devices based on the bandwidth that the LAN access devices can service the respective LAN node with, after servicing existing nodes. The WAN backhaul capacity of a LAN access device might also be taken into account to make this choice or selection. Another selection criterion might be that a LAN node associates with the LAN access device servicing fewer existing nodes. In other cases, the security requirements to associate with a LAN access device might leave the node with only one LAN access device to associate with.

[0059] For example, each of the unique Public IP addresses may be assigned by an ISP or service provider which provides internet connectivity to the respective LAN access devices 220A-B. Thus, in accordance with one embodiment, each of the first and second unique Public IP address are directly addressable via a public Internet. In one embodiment, the private Internet Protocol (IP) addresses managed by the LAN access device 220A-B are not directly addressable via the Internet, but instead, must rely upon Network Address Translation (NAT) or some forwarding mechanism, for example, a forwarding mechanism provided by a modem, a router, etc. Thus, in accordance with one embodiment, none of the first or second plurality of interconnected LAN nodes 238 and 239 are directly addressable via the public Internet as each of the first or second plurality of interconnected LAN nodes 238 and 239 require address translation to a corresponding private IP address associated with the respective one of the first or second plurality of interconnected LAN nodes 238 and 239 to receive traffic from the public Internet. For example, the LAN access devices may be Internet facing, whereas the interconnected LAN nodes

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238 and 239 are not, and are thus protected to some extent as traffic must first traverse at least the LAN access device before any of the plurality of interconnected LAN nodes 238 and 239 can be accessed.

[0060] In an alternative embodiment, the first LAN 210A includes a first plurality of interconnected LAN nodes 238, each of which are identifiable within the first LAN 210A by one or more Virtual Local Area Network (VLAN) tags managed by the first LAN access device 220A and the second LAN 210B includes a second plurality of interconnected LAN nodes 239, each of which are identifiable within the second LAN 210B by a second one or more VLAN tags which are managed by the second LAN access device 220B. In such an alternative embodiment, the first LAN access device 220A provides Voice over Internet Protocol (VoIP) services and/or Internet Protocol Television (IPTV) services to one or more of the interconnected LAN nodes 238 within the first LAN 220A based on Ethernet level addressing using the one or more VLAN tags and the second LAN access device 220B provides VoIP services and/or IPTV services to one or more of the interconnected LAN nodes 239 within the second LAN 210B based on Ethernet level addressing using the second one or more VLAN tags. In this embodiment, any of the first and second plurality of interconnected LAN nodes 238 and 239 may be uniquely identifiable based at least on the one or more VLAN tags respectively managed by the first or second LAN access device 220A-B. For example, the units may be addressable over the Internet via remote devices using the one or more VLAN tags.

[0061] In accordance with one embodiment, the traffic aggregation unit 225 includes or is allocated or assigned a Public Internet Protocol (IP) address distinct from a public IP address associated with the first LAN access device 220A and distinct from a public IP address associated with the second LAN access device 220B. Thus, it is distinctly, uniquely, and separately identifiable and addressable, separately from either of the LAN access devices 220A-B.

[0062] In one embodiment, the first WAN backhaul connection 211 includes or corresponds to a first transfer rate with the first LAN 210A and the second WAN backhaul connection 212 includes or corresponds to a second average transfer rate with the second LAN 210B. In such embodiments, the bonded WAN

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interface 213 includes or corresponds to an aggregate transfer rate with the first LAN 210A and with the second LAN 210B which is greater than the first transfer rate and is greater than the second transfer rate of the first and second WAN backhaul connections 211 and 212 respectively. Thus, a client device within one of the LANs 210A-B, such as one of the LAN nodes 238, may attain greater transfer rates using the logically bonded WAN interface 213 than would be possible using only one of the underlying first or second WAN backhaul connections 211 and 212. For example, the first and second transfer rates may constitute one of an instantaneous data rate, an average peak data rate, or a peak transfer rate, and further in which the aggregate transfer rate results in data throughput capability which is greater than either of the first or the second respective transfer rates individually.

[0063] In accordance with one embodiment, the traffic aggregation unit 225 operates physically separate and distinct from each of the first LAN access device 220A and the second LAN access device 220B. In such an embodiment, the traffic aggregation unit 225 is communicatively interfaced between the first LAN access device 220A and the first WAN backhaul connection 211, in which the traffic aggregation unit has a direct communications link to each of the first LAN access device 220A and the first WAN backhaul connection 211. In such an embodiment, the traffic aggregation unit 225 is further communicatively interfaced with the second LAN access device 220B, in which the traffic aggregation unit 225 has an indirect communications link to the second WAN backhaul connection 212 through the second LAN access device 220B which operates in direct communication with the second WAN backhaul connection 212. For example, the direct communications link communicably interfacing the traffic aggregation unit 225 between the first LAN access device 220A and the first WAN backhaul connection 211 may constitute a communications link with no other intermediate nodes, whereas the indirect communication link to the second WAN backhaul connection 212 includes at least one intermediate node before the indirect connection reaches the second WAN backhaul connection 212.

[0064] As depicted, LAN access device 230 is an intermediate node. LAN access device 220B may also serve as an intermediate node as the depicted route traverses the second LAN access device 220B to reach the second WAN backhaul

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connection 212. Thus, in accordance with an alternative embodiment, the system or architecture 200 further includes a third LAN access device 230 which is communicatively interfaced between the traffic aggregation unit 225 and the second LAN access device 220B. In such an embodiment, the third LAN access device 230 has a direct communications link to each of the traffic aggregation unit 225 and the second LAN access device 220B. In this alternative embodiment, the traffic aggregation unit 225 has an indirect communications link to the second LAN access device 220B through the third LAN access device 230, in which the third LAN access device 230 provides an alternate backup communications path to the logically bonded WAN interface 213 over the first WAN backhaul connection 211 and the second WAN backhaul connection 212 responsive to a failure event at one of the first LAN access device 220A or the second LAN access device 220B.

[0065] **Figure 2B** illustrates an alternative exemplary architecture 201 in which embodiments may operate. Figure 2B additionally introduces traffic de-aggregator unit 235.

[0066] In accordance with one embodiment, such an architecture 201 or system further includes a traffic de-aggregator unit 235 communicatively interfaced between the first WAN backhaul connection 211 and the second WAN backhaul connection 212. In such an embodiment, the traffic aggregation unit 225 (forming the logically bonded WAN interface 213) bonds Internet Protocol (IP) addresses associated with traffic originating from both the first LAN 210A and the second LAN 210B. In such an embodiment, the traffic aggregation unit 225 further routes the traffic having the bonded IP addresses through the traffic de-aggregator unit 235.

[0067] In accordance with one embodiment, the traffic de-aggregator unit 235 is managed by a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers via the first and second WAN backhaul connections 211 and 212. In such an embodiment, the traffic de-aggregator unit 235 operates physically separate and distinct from each of the first LAN access device 220A, the second LAN access device 220B, the third LAN access device 230, and the traffic aggregation unit 225.

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[0068] **Figure 2C** illustrates an alternative exemplary architecture 202 in which embodiments may operate. Figure 2C introduces the traffic aggregation unit 225 as an integrated sub-component of a LAN access device 220A.

[0069] In accordance with one embodiment, the traffic aggregation unit 225 operates as an integrated sub-component of the first LAN access device 220A, in which the first LAN access device 220A operates physically separate and distinct from the second LAN access device 220B. In such an embodiment, the traffic aggregation unit 225 is communicatively interfaced with the first WAN backhaul connection 211 via a communications interface of the first LAN access device 220A (e.g., internal circuitry of 220A, etc.). In such an embodiment, the traffic aggregation unit 225 is communicatively interfaced with the second LAN access device 220B, in which the traffic aggregation unit 225 uses an indirect communications link to the second WAN backhaul connection 212 through the second LAN access device 220B which operates in direct communication with the second WAN backhaul connection 212.

[0070] **Figure 2D** illustrates an alternative exemplary architecture 203 in which embodiments may operate. Figure 2D introduces the traffic aggregation unit 225 as an integrated sub-component of a LAN access device 220A in communication with a traffic de-aggregator unit 235.

[0071] In one embodiment, the described architecture 203 or system includes a traffic de-aggregator unit 235 which is communicatively interfaced between the first WAN backhaul connection 211 and the second WAN backhaul connection 212, in which the traffic aggregation unit 225 forms a logically bonded WAN interface 213 over the first WAN backhaul 211 and the second WAN backhaul 212 by bonding Internet Protocol (IP) addresses associated with traffic originating from the first LAN 210A and the second LAN 210B and by further routing the traffic having the bonded IP addresses through the traffic de-aggregator unit 235. In accordance with one embodiment, the first WAN 205A and the second WAN 205B and the corresponding first WAN backhaul connection 211 and second WAN backhaul connection 212 form an aggregation network via the traffic de-aggregator 235, the traffic de-aggregator 235 being connected with Internet WAN 299 as shown.

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[0072] **Figure 2E** illustrates an alternative exemplary architecture 204 in which embodiments may operate. Figure 2E introduces LAN devices 240 having one or more wireless transceiver 241 (e.g., each with one or more antennas) to establish one or more wireless communication paths 242A and 242B. Wireless coverage areas 243 are further depicted as are wireless transceivers 244A and 244B at the LAN access devices 220A-B.

[0073] In one embodiment, at least one of a plurality of LAN devices 240 operating within the first LAN 210A use a first communication path to the first WAN backhaul connection 211 through the first LAN access device 220A and in such an embodiment, at least one of a plurality of LAN devices 240 operating within the first LAN 210A also use a second communication path to the second WAN backhaul connection 212 through the second LAN access device 220B. In such an embodiment, at least one LAN device 240 includes at least one of: a multiplexing wireless transceiver 241 capable to simultaneously maintain a first wireless communication path 242A to the first LAN access device 220A and a second wireless communication path 242B to the second LAN access device 220B by multiplexing between the first and second wireless communication paths 242A-B respectively; a wireless transceiver 241 capable to establish the first wireless communication path 242A to the first LAN access device 220A and capable to establish the wireless second communication path 242B to the second LAN access device 220B by terminating the first wireless communication path 242A and switching to the second wireless communication path 242B; and a first wireless transceiver 241 and a second wireless transceiver 241, the first and second wireless transceivers 241 capable to establish the first wireless communication path 242A to the first LAN access device 220A and capable to establish the wireless second communication path 242B to the second LAN access device 220B either concurrently or not concurrently with the first wireless communication path 242A to the first LAN access device 220A.

[0074] In one embodiment, the first LAN access 220A device is within a residential premises common to the at least one of a plurality of LAN devices 240 operating within the first LAN 210A and the second LAN access device 220B is within a second residential premises in a neighboring vicinity to the first residential

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premises. In such an embodiment, a wireless coverage area 243 associated with the second LAN access device 220B overlaps with the first residential premises and the at least one of a plurality of LAN devices 240 operating within the first LAN 210A. In such an embodiment, the at least one of a plurality of LAN devices 240 operating within the first LAN 210A establishes connectivity with the second WAN backhaul connection 212 through the second LAN access device 220B responsive to a failure event associated with the first LAN access device 220A.

[0075] In one embodiment, at least one of a plurality of LAN devices 240 operating within the first LAN 210A, responsive to a failure event associated with the first LAN access device 220A, establishes connectivity to the second WAN backhaul connection 212 via a wireless connection path 242B between an transceiver 241 of the at least one of the plurality of LAN devices 240 within the first plurality of LAN devices 240 and an transceiver 244B of the second LAN access device 220B which is external to, and operationally distinct from, the first LAN access device 220A. In such an embodiment, the failure event corresponds to a hard failure event characterized by a total loss of connectivity between the first LAN access device 220A and the corresponding first WAN backhaul connection 211 or a soft failure event characterized by degraded connectivity, based on a threshold, between the first LAN access device 220A and the corresponding first WAN backhaul connection 211.

[0076] In one embodiment, the wireless connection between the transceiver 241 of at least one of the plurality of LAN devices 240 within the first LAN 210A and the transceiver 244B of the second LAN access device 220B constitutes at least one of the plurality of LAN devices 240 connecting with the second LAN access device 220B using a guest SSID (Service Set Identification) on the second LAN access device 220B. In a particular embodiment, the guest SSID on the second LAN access device 220B enables guest devices (e.g., such as one of LAN devices 240 from the distinct LAN 210A) to communicate with the second WAN backhaul connection 212 through the second LAN access device 220B. In such an embodiment, the guest SSID on the second LAN access device 220B further restricts the guest devices from communicating with any devices operating within the second LAN 210B without first traversing the second WAN backhaul

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connection 212. For example, despite such devices within the second LAN 210B being immediately networked to the same LAN access device 220B, the guest devices must nevertheless communicate through the WAN 205A-B, for example, by establishing communication via the Internet, as if the guest devices were still connected to their originating LAN access device 220A. In so doing, security can be maintained for the secondary network infrastructure while allowing the guest devices to utilize the second WAN backhaul 212 resource.

[0077] **Figure 2F** illustrates an alternative exemplary architecture 206 in which embodiments may operate. Figure 2F introduces a traffic aggregation unit 225 as an integrated sub-component within one of a plurality of LAN devices 240A.

[0078] In accordance with one embodiment, the traffic aggregation unit 225 operates as an integrated sub-component within one of a plurality of LAN devices 240A operating within the first LAN 210A. In such an embodiment, the traffic aggregation unit 225 is communicatively interfaced with the first WAN backhaul connection 211 via a communications path to the first LAN access device 220A which in turn is interfaced via a communications path to the first WAN backhaul connection 211. In this embodiment, the traffic aggregation unit 225, integrated as a sub-component within the one of the plurality of LAN devices 240A operating within the first LAN 210A, further is communicatively interfaced with the second LAN access device 220B, in which the traffic aggregation unit 225 uses an indirect communications link to the second WAN backhaul connection 212 through the second LAN access device 220B which operates in direct communication with the second WAN backhaul connection 212.

[0079] In one embodiment, the traffic aggregation unit 225 communicates with the first LAN access device 220A through a wireless communication path 242A from the one of the plurality of LAN devices 240A to the first LAN access device 220A and further wherein the traffic aggregation unit 225 communicates with the second LAN access device 220B through a second wireless communication path 242B from the one of the plurality of LAN devices 240A to the second LAN access device 220B.

[0080] In one embodiment, the first and second wireless communication paths 242A-B from the one of the plurality of LAN devices 240A to the first and

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second LAN access devices 220A-B respectively, include at least one of: wireless connectivity via a multiplexing wireless transceiver 241 that simultaneously maintains the first wireless communication path 242A to the first LAN access device 220A and the second wireless communication path 242B to the second LAN access device 220B by multiplexing between the first and second wireless communication paths 242A-B respectively; wireless connectivity via a wireless transceiver 241 capable to establish the first wireless communication path 242A to the first LAN access device 220A and capable to establish the wireless second communication path 242B to the second LAN access device 220B by terminating the first wireless communication path 242A and switching to the second wireless communication path 242A; and wireless connectivity via a first wireless transceiver 241 and a second wireless transceiver 241, the first and second wireless transceivers 241 capable to establish the first wireless communication path 242A to the first LAN access device 220A and capable to establish the wireless second communication path 242B to the second LAN access device 220B, either concurrently or not concurrently, with the first wireless communication path 242A to the first LAN access device 220A.

[0081] **Figure 2G** illustrates an alternative exemplary architecture 207 in which embodiments may operate. Figure 2G re-introduces the traffic de-aggregator unit 235.

[0082] In one embodiment, the architecture 207 or system further includes a traffic de-aggregator unit 235 communicatively interfaced between the first WAN backhaul connection 211 and the second WAN backhaul connection 212, in which the traffic aggregation unit 225 (which is integrated as a sub-component of one of the LAN devices 240A) forms a logically bonded WAN interface 213 over the first WAN backhaul connection 211 and the second WAN backhaul connection 212 by bonding Internet Protocol (IP) addresses associated with traffic originating from both the first LAN 210A and the second LAN 210B and further by routing the traffic having the bonded IP addresses through the traffic de-aggregator unit 235. The traffic de-aggregator may be managed by a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers via the first and second WAN

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backhaul connections. The traffic de-aggregator unit 235 may be physically separate and distinct from each of the first LAN access device 220A, the second LAN access device 220B, a third LAN access device 230 (if one is present), and the traffic aggregation unit 225.

[0083] In accordance with the various embodiments described herein, each of the first WAN backhaul connection 211 and the second WAN backhaul connection 212 are selected from the group of WAN backhaul connections which includes: a broadband connection; a Digital Subscriber Line (DSL) connection; a cable connection; a femtocell connection; a mobile connection; a fiber connection; a wireless connection; and an access Broadband over Power Line (BPL) connection.

[0084] In accordance with the various embodiments described herein, each of the first and second LANs 210A and 210B include at least a user device. In accordance with the disclosed embodiments, each of the first and second LAN access devices 220A-B communicably link each of the respective user devices with one of the first WAN backhaul connection 211 or the second WAN backhaul connection 212. For example, any one of the interconnected LAN nodes 238 and 239 or the LAN devices 240 from Figure 2E, 240A and 240B may be a user device.

[0085] In accordance with the various embodiments described herein, each of the first LAN 210A and the second LAN 210B include a plurality of interconnected LAN nodes 238 and 239. In such an embodiment, each of the plurality of interconnected LAN nodes 238 and 239 communicate via at least one of: an Ethernet based network connection; a wireless based network connection; an Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards based network connection; an 802.11a, 802.11b, 802.11g, and/or 802.11η wireless compatible network connection; a femto network connection transmitting via a mobile cellular compatible protocol including at least one of a third generation (3G) compatible protocol, a fourth generation (4G) compatible protocol, and a Long Term Evolution (LTE) compatible protocol; a power line connection; a telephone system connection; a Plain Old Telephone Service (POTS) connection; a G.hn (ITU-T standardized unified high-speed wire-line based home networking) connection; and a Coax cable connection.

[0086] In accordance with the various embodiments described herein, each

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of the first LAN access device 220A and the second LAN access device 220B are selected from the group of access devices which includes: a base station; an access point; a modem; a router; a gateway; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home power line device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a set-top box (STB)/set-top unit (STU) customer electronics device; an Internet Protocol (IP) enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; a HomePlug device; an IEEE P1901 standards compatible access Broadband over Power Line (BPL) device; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0087] **Figure 2H** illustrates an alternative exemplary architecture 208 in which embodiments may operate. Figure 2H introduces a traffic aggregation unit 225 as an integrated sub-component within one a third LAN access device 230.

[0088] In one embodiment, the architecture 208 or system further includes a third LAN access device 230 which is communicably interfaced between the first LAN access device 220A and the second LAN access device 220B. In such an embodiment the traffic aggregation unit 225 operates as an integrated sub-component of the third LAN access device 230, in which the third LAN access device 230 operates physically separate and distinct from each of the first LAN access device 220A and the second LAN access device 220B.

[0089] In one embodiment, the traffic aggregation unit uses a first connection, via a device communicably interfaced with the second LAN access device 220B and uses a second connection to communicably interface the traffic aggregation unit 225 with the first WAN backhaul connection 211. In such an embodiment, a data aggregation unit 231 combines traffic from the first connection and traffic from the second connection into aggregated traffic.

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[0090] In one embodiment, a data de-aggregation unit 236 is communicably interfaced with the first WAN backhaul connection 211 and communicably interfaced with the second WAN backhaul connection 212. In such an embodiment, the data de-aggregation unit 236 de-aggregates traffic onto the first connection and onto the second connection as de-aggregated traffic.

[0091] **Figure 3A** illustrates an alternative exemplary architecture 300 in which embodiments may operate. Depicted are a first Wide Area Network (WAN) at element 305A and a second WAN at 305B. WAN 305A being connected with Local Area Network (LAN) 310A via WAN backhaul connection 311 and WAN 305B being connected with LAN 310B via WAN backhaul connection 312.

[0092] In accordance with one embodiment, such an architecture 300 or system includes a first Local Area Network (LAN) access device 320A to establish a first LAN 310A and a second LAN access device 320B to establish a second LAN 310B which is operationally distinct from the first LAN 310A. In this embodiment, a first Wide Area Network (WAN) backhaul connection 311 provides the first LAN access device 320A with WAN connectivity and a second WAN backhaul connection 312 provides the second LAN access device 320B with WAN connectivity, in which each of the first WAN backhaul connection 311 and the second WAN backhaul connection 312 are physically distinct. This embodiment further includes a management device 325 communicatively interfaced with each of the first LAN access device 310A, the second LAN access device 310B, the first WAN backhaul connection 311, and the second WAN backhaul connection 312. In such an embodiment, the management device 325, responsive to a failure event, re-routes traffic associated with the first LAN 310A onto the second WAN backhaul connection 312 or re-routes traffic associated with the second LAN 310B onto the first WAN backhaul connection 311.

[0093] **Figure 3B** illustrates an alternative exemplary architecture 301 in which embodiments may operate. In accordance with one embodiment, the management device 325 is implemented within the first LAN access device 320A and communicatively interfaced with the LAN access device 320A via an internal communications bus of the first LAN access device (e.g., via internal circuitry). In such an embodiment, the management device 325 is communicatively interfaced

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with each of the second LAN access device 320B, the first WAN backhaul connection 311, and the second WAN backhaul connection 312 via one or more communication paths 350 external to the first LAN access device 320A.

[0094] **Figure 3C** illustrates an alternative exemplary architecture 302 in which embodiments may operate. In accordance with one embodiment, the management device 325 is implemented within a WAN access device 335A communicatively coupled with the first WAN backhaul connection 311 via an internal communications bus of the first WAN access device (e.g., via internal circuitry). In such an embodiment, the management device 325 is communicatively interfaced with each of the first LAN access device 320A, the second LAN access device 320B, and the second WAN backhaul connection 312 via one or more communication paths 350 external to the first WAN access device 335A.

[0095] **Figure 3D** illustrates an alternative exemplary architecture 303 in which embodiments may operate. In accordance with one embodiment, the management device 325 is implemented as an externally separate and physically distinct device from a first WAN access device 335A communicatively coupled with the first WAN backhaul connection 311, as an externally separate and physically distinct device from a second WAN access device 335B communicatively coupled with the second WAN backhaul connection 312, as an externally separate and physically distinct device from the first LAN access device 320A, and as an externally separate and physically distinct device from the second LAN access device 320B. In such an embodiment, the management device 325 is communicatively interfaced with each of the first WAN access device 335A, the second WAN access device 335B, the first LAN access device 320A, and the second LAN access device 320B, via one or more communication paths 350 external to the externally separate and physically distinct implementation of the management device 325.

[0096] **Figure 3E** illustrates an alternative exemplary architecture 304 in which embodiments may operate. In accordance with one embodiment, such an architecture 304 or system further includes a traffic aggregation unit 345 which operates externally separate and physically distinct from each of the first LAN access device 320A and the second LAN access device 320B. In such an

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embodiment, the traffic aggregation unit 345 forms a logically bonded WAN interface 313 over the first WAN backhaul 311 and the second WAN backhaul 312. In accordance with this embodiment, the management device 325 is implemented within the traffic aggregation unit 345 and is communicatively interfaced with each of the first LAN access device 320A, the second LAN access device 320B, the first WAN backhaul connection 311, and the second WAN backhaul connection 312 via one or more communication paths 350 external to the traffic aggregation unit 345.

[0097] In accordance with several of the various embodiments, the traffic aggregation unit 345 or the management device 325 operates in accordance with Synchronous optical networking (SONET) or synchronous digital hierarchy (SDH) multiplexing protocols. In one embodiment, the traffic aggregation unit 345 or the management device 325, responsive to a failure event, re-routes the traffic by performing a SONET or SDH compatible rapid re-route function. In one the traffic aggregation unit 345 or the management device 325, responsive to a failure event, re-routes the traffic via an Ethernet Resilient Packet Ring (RPR) implementation.

[0098] In accordance with one embodiment, the management device 345, responsive to a failure event, re-routes the traffic by instituting one or more of the following events: (a) performing a first traffic re-route operation responsive to a hard failure event characterized by a total loss of connectivity for one of the first LAN access device 320A and the second LAN access device 320B with the corresponding first or second WAN backhaul connection 311 or 312; or (b) performing a second traffic re-route operation responsive to a soft failure event characterized by degraded connectivity as determined by a threshold for one of the first LAN access device 320A and the second LAN access device 320B with the corresponding first or second WAN backhaul connection 311 or 312. In such an embodiment, the first traffic re-route operation may be different than the second traffic re-route operation.

[0099] **Figure 4A** illustrates an alternative exemplary architecture 400 in which embodiments may operate. Depicted are a first Wide Area Network (WAN) at element 405A and a second WAN at 405B. WAN 405A being connected with Local Area Network (LAN) 410A via WAN backhaul connection 411 and WAN 405B being connected with LAN 410B via WAN backhaul connection 412.

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[00100] In accordance with one embodiment, such an architecture 400 or system includes a first Local Area Network (LAN) access device 420A to establish a first LAN 410A and a second LAN access device 420B to establish a second LAN 410B operationally distinct from the first LAN 410A. In such an embodiment, a first Wide Area Network (WAN) backhaul connection 411 provides the first LAN access device 420A with WAN connectivity and a second WAN backhaul connection 412 provides the second LAN access device 420B with WAN connectivity, in which each of the first WAN backhaul connection 411 and the second WAN backhaul connection 412 are physically distinct. In this embodiment, a management device 425 is communicatively interfaced with each of the first LAN access device 420A, the second LAN access device 420B, the first WAN backhaul connection 411, and the second WAN backhaul connection 412. In this embodiment, the management device 425 routes a first portion 498 of traffic originating from the first LAN 410A over the first WAN backhaul connection 411 and the management device 425 further routes a second portion 499 of the traffic originating from the first LAN 410A over the second WAN backhaul connection 412.

[00101] In one embodiment, the management device 425 routes the first portion 498 of traffic over the first WAN backhaul connection 411 and further routes the second portion 499 of the traffic over the second WAN backhaul connection 412 to implement load-balancing for the first LAN 410A.

[00102] In one embodiment, the management device 425 implements load balancing for the second LAN 410B by routing a first portion 444 of traffic originating from the second LAN 410B over the second WAN backhaul connection 412 and by further routing a second portion 445 of the traffic originating from the second LAN 410B over the first WAN backhaul connection 411. Management device 425 may implement load balancing for the respective first and/or second LANs regardless of whether the management device is internal to LAN access device 420A or 420B.

[00103] In one embodiment, the management device 425 implementing load balancing includes determining what portions of traffic 498 and 499 to route over the first and second WAN backhauls, respectively, based on factors such as bandwidth capacity of the first and second WAN backhauls, or based on other

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factors such as payment options chosen by the first and second subscribers, or conditions imposed by their internet service providers, based on a number of nodes associated with each of the LAN access devices, based on traffic patterns of each of the nodes, the security options, or the capacity and capabilities of the LAN access devices etc. These factors, among others, will cause the management device 425 to vary the portion of traffic to route across the first and second WAN backhauls.

[00104] In one embodiment, traffic portion 498 includes control and management traffic and traffic portion 499 includes the payload portion of traffic corresponding to traffic portion 498. In such an embodiment, the management device 425 implements load balancing for the first LAN 410A by routing the first portion 498 of traffic over the first WAN backhaul connection 411 and further routes the second portion 499 of the traffic over the second WAN backhaul connection 412. Separating or splitting the payload and control traffic portions in such a way reduces the overhead caused due to the control and management traffic. For example, when an IEEE 802.11n LAN access device is operating in the presence of a legacy station operating on IEEE 802.11b, there will be substantial overhead due to control frames such as RTS/CTS and ACK. In such an event, routing all the control traffic over the second WAN backhaul can help reduce overhead and improve throughput.

[00105] **Figure 4B** illustrates an alternative exemplary architecture 401 in which embodiments may operate. In accordance with one embodiment, first LAN access device is a wireless LAN access device 421 having a first transfer rate for the first LAN 410A which is greater than a second transfer rate for the first WAN backhaul connection 411, in which the second transfer rate for the first WAN backhaul connection 411 results (e.g., causes) a bottleneck to the traffic (e.g., the first and second portions 498 and 499) originating from the wireless LAN access device 421 directed to the first WAN backhaul connection 411. In one embodiment, the management device 425 implements load-balancing for the first LAN 410A by routing the first portion 498 of traffic over the first WAN backhaul connection 411 at a rate which is less than the second transfer rate for the first WAN backhaul connection 411 and further by routing the second portion of the traffic 499 over the second WAN backhaul connection 412, in which the second portion 499 of the

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traffic is a remaining portion of the traffic originating from the first LAN 410A.

[00106] In one embodiment, the management device 425 implements load-balancing for the first LAN 410A by implementing an aggregate transfer rate for WAN connectivity provided to the first LAN 410A by the wireless LAN access device 421 and by implementing an aggregate transfer rate for WAN connectivity provided to the second LAN 410B, in which the aggregate transfer rate for WAN connectivity is greater than the second transfer rate for the first WAN backhaul connection 411. For example, by utilizing both the first and second WAN backhaul connections 411 and 412, an aggregate transfer rate for WAN connectivity can be realized for the LANs 410A-B which is greater than they would otherwise attain from using only their respective single WAN backhaul connections (e.g., either 411 or 412, but not both). In an alternative embodiment, the management device 425 implements load-balancing for the first LAN 410A by assigning incoming flows to the most lightly-loaded WAN connection. For example, the management device 425 may assign, route, or otherwise place a new incoming flow, such as a new VoIP connection or Internet TV stream, onto the most lightly-loaded WAN connection.

[00107] In one embodiment, the management device 425 routes the first portion 498 of traffic over the first WAN backhaul connection 411 and further routes the second portion 499 of the traffic over the second WAN backhaul connection 412 by allocating a portion of bandwidth associated with the second WAN backhaul connection 412 to the first LAN access device (e.g., 420A from Figure 4A or the wireless LAN access device 421 of Figure 4B), in which the allocation is based on a paid subscription tier or a service level tier associated with the first LAN access device (420A or 421). For example, the paid subscription tier or a service level tier may be chosen by a user when signing up for service from a service provider. A user may elect to pay an increased subscription fee to enable a higher aggregate transfer rate than is otherwise attainable from using only a single WAN backhaul connection 411 or 412. Alternatively, a user might obtain a subsidized subscription fee to allow other users access to his unused WAN bandwidth.

[00108] **Figure 4C** illustrates an alternative exemplary architecture 402 in which embodiments may operate. In accordance with one embodiment, the

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architecture 402 or system further includes a wireless communications link 422 between the first LAN access device operating as a wireless LAN access device 421 and the second LAN access device operating as a second wireless LAN access device 423. In such an embodiment, the management device 425 instructs the wireless LAN access device 421 to route or switch the second portion of traffic 499 over the wireless communications link 422 from the first wireless LAN access device 421 to the second wireless LAN access device 423 and onto the second WAN backhaul connection 412.

[00109] In one embodiment, the second LAN access device 423 can operate as a wireless LAN access device, distinct from the first wireless LAN access device 421. The communication link 422 may be a wireless communication link between the first LAN access device operating as a wireless LAN access device 421 and the second LAN access device operating as a second wireless LAN access device 423.

[00110] In accordance with one embodiment, the first WAN backhaul connection 411 provides the first LAN access device (e.g., 420A at Figure 4A or 421 at Figure 4C) with WAN connectivity via the first WAN backhaul connection 411 to a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers. In this embodiment, the second WAN backhaul connection 412 provides the second LAN access device (e.g., 420B at Figure 4A or 423 at Figure 4C) with WAN connectivity via the second WAN backhaul connection 412 to the same Service Provider via a physically distinct communications link to the same Service Provider.

[00111] In one embodiment, the first WAN backhaul connection 411 provides the first LAN access device (420A or 421) with WAN connectivity via the first WAN backhaul connection 411 to a first Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers and in this embodiment, the second WAN backhaul connection 412 provides the second LAN access device (420B or 423) with WAN connectivity via the second WAN backhaul connection 412 to a second Service Provider which is separate and distinct from the first Service Provider.

[00112] **Figure 4D** illustrates an alternative exemplary architecture 403 in

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which embodiments may operate. In accordance with one embodiment, the architecture 403 or system further includes the management device 425 collecting a first information set 470A about the first WAN backhaul connection 411; further includes the management device 425 collecting a second information set 470B about the first LAN 410A; further includes the management device 425 collecting a third information 470C set about the second WAN backhaul connection 412; and further includes the management device 425 collecting a fourth information set 470D about the second LAN 410B. In such an embodiment, the management device 425 jointly analyzes at least a portion from each of the first, second, third, and fourth information sets 470A-D collected and identifies an operational condition 471 affecting the first and second WAN backhaul connections 411-412 and further affecting the first and second LANs 410A-B based on the jointly analyzed collected information sets 470A-D. In accordance with such an embodiment, the management device 425 initiates a management event 472 responsive to the operational condition 471 being identified.

[00113] In one embodiment, responsive to the operational condition 471 being identified, the management device 425 initiating the management event 472 constitutes generating instructions specifying a configuration change to one or more of: a configuration change for a channel allocation associated with a wireless based first LAN access device 420A or a wireless based second LAN access device 420B, or both; a configuration change to a power allocation scheme for signals associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to STA (Station) to AP (Access Point) associations associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to beacon power characteristics associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to beacon intervals associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to transmission rates associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to beamforming

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characteristics of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to a Request to Send / Clear to Send (RTS/CTS) configuration associated with the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to fragmentation configuration of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to the wireless mode (e.g. IEEE 802.11a/b/g/n) configuration of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to the bandwidth utilized by the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both (example, channel bonding in IEEE 802. 11n); a configuration change to frame aggregation of traffic from the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to guard interval of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to an antenna array configuration of the wireless based first LAN access device 420A or to the wireless based second LAN access device 420B, or both; a configuration change to preamble length used by the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to handoff techniques of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; a configuration change to power saving modes of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both; and a configuration change to maximum number of retransmission attempts of the wireless based first LAN access device 420A or the wireless based second LAN access device 420B, or both.

[00114] The wireless based LAN access devices involved in this configuration may be chosen from a wider set of wireless based LAN access devices already available. Such LAN access devices may support high throughput. In one embodiment, selection of these LAN access devices is based on one or more of a Received Signal Strength Indicator (RSSI), a wireless bit rate, channel usage, pre-

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existing traffic loads, overall achievable throughput, other similar performance indicators, or by using a combination of such indicators to estimate available throughput.

[00115] In one embodiment, the management event 472 is selected from the group of management events 472 which includes sending instructions 478 to establish a direct communications link 476 between the first LAN access device 420A and the second LAN access device 420B responsive to the joint analysis indicating an operational problem (e.g., such as the identified operational condition 471) with the first WAN backhaul connection 411. For example, the operational problem may be derived from or correspond to the identified operational condition 471.

[00116] **Figure 4E** illustrates an alternative exemplary architecture 404 in which embodiments may operate. In accordance with one embodiment, the management event 472 is selected from the group of management events 472 which includes sending instructions 478 to establish a direct communications link 476 between a node 477 operating within the first LAN 410A, and the second LAN access device 420B, responsive to the joint analysis indicating an operational problem with the first LAN access device 410A. For example, responsive to the operational condition 471 being identified. The instructions 478 may correspond to or be derived from the management event 472. In accordance with the disclosed embodiments, node 477 may be implemented as one of a wireless node, a mobile node, or as a LAN device node.

[00117] In accordance with several of the various embodiments, the management device 425 jointly analyzes the collected information sets 470A-D by analyzing bandwidth usage over time of the first LAN 410A and bandwidth usage over time of the second LAN 410B and detects, as the operational condition 471, a traffic imbalance between the first LAN 410A and the second LAN 410B. In such an embodiment, initiating the management event 472 constitutes the management device 425 allocating unused bandwidth associated with the first WAN backhaul connection 411 to the second LAN access device 420A or constitutes allocating unused bandwidth associated with the second WAN backhaul connection 412 to the first LAN access device 420A based on the identified traffic imbalance between the

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first LAN 410A and the second LAN 410B.

[00118] In one embodiment, initiating the management event 472 constitutes the management device 425 determining whether a LAN access device has unused bandwidth at a given time of the day or week. In such an embodiment, in addition to or as an alternative to utilizing the bandwidth for a second LAN device, multiple SSIDs may be used to open the unused bandwidth for public or private usage during the given time of the day or week or during some other specified time.

[00119] In accordance with several of the various embodiments, the second information set 470B about the first LAN 410A and the fourth information set 470D about the second LAN 410B each include information specific to a first communication layer of the first and second LANs 410A-B and the first information set 470A about the first WAN backhaul connection 411 and the third information set 470C about the second WAN backhaul connection 412 includes information specific to a second communication layer of the first and second WAN backhaul connections 411-412 which is different than the first communication layer of the first and second LANs 410A-B.

[00120] **Figure 4F** illustrates an alternative exemplary architecture 406 in which embodiments may operate. In accordance with one embodiment, the second information set 470B about the first LAN 410A and the fourth information set 470D about the second LAN 410B each include neighborhood analysis relating to Internet connectivity provided to a plurality of other locations in a shared geographical area 469 with the management device 425. In such an embodiment, the management device 425 initiating the management event 472 responsive to the operational condition 471 being identified constitutes generating instructions 479 to change a configuration of the first WAN backhaul connection 411 or constitutes generating instructions 479 to change a configuration of the second WAN backhaul connection 412, or both, based on the neighborhood analysis.

[00121] In accordance with one embodiment, the first information set 470A about the first WAN 410A and the third information set 470C about the second WAN 410B each include neighborhood analysis relating to Internet connectivity provided to a plurality of other locations in a shared geographical area 469 with the management device and the management device 425 initiating the management

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event 472 responsive to the operational condition being identified 471 constitutes the management device 425 generating instructions 479 to change a configuration of the first LAN access device 420A or the second LAN access device 420B, or both, based on the neighborhood analysis. The neighborhood analysis and the various information sets 470A-D depicted at Figures 4D through 4F may be utilized in association with the other disclosed embodiments described herein, including all of the exemplary embodiments depicted and described with regard to Figures 4A through 4E.

[00122] In one embodiment, the management device 425 initiating the management event 472 responsive to the operational condition being identified 471 constitutes the management device 425 generating instructions 479 to modify the identified operational condition 471 in which the management device 425 communicates the generated instructions 479 to one or more of: a network element 466, a WAN device 468, and/or a LAN device 467 communicatively interfaced with the management device and further in which the generated instructions 479 are communicated via a protocol selected from the group of protocols which includes: a TR-069 (Technical Report 069) compatible communications protocol; a Transmission Control Protocol/Internet Protocol (TCP/IP) communications protocol; a Simple Network Management Protocol (SNMP) communications protocol; an out-of-band telephone line protocol; a Digital Subscriber Line Embedded Operations Channel (DSL EOC) communications protocol; a cable control channel communications protocol; a power line control channel communications protocol; a Command Line Interface (CLI) protocol; and a Transaction Language 1 (TL1) communications protocol.

[00123] In accordance with one embodiment, the first WAN backhaul connection 411 and the second WAN backhaul connection 412 are each communicably interfaced with the management device 425 via one of: a wireless network connection; a wired network connection; a Digital Subscriber Line (DSL) network connection; a power line network connection; a Passive Optical Network (PON) based network connection; a fiber optic based network connection; and a cable based network connection.

[00124] In one embodiment, the management device 425 is one of: a Digital

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Subscriber Line (DSL) modem operating as a Customer Premises Equipment (CPE) device to communicatively interface a DSL based backhaul provided via the first WAN backhaul connection 411 to the first LAN 410A; a cable modem operating to communicatively interface a cable network based backhaul provided via the first WAN backhaul connection 411 to the first LAN 410A; a wireless modem operating to communicatively interface a wireless based backhaul provided via the first WAN backhaul connection 411 to the first LAN 410A; a power line modem operating to communicatively interface a power line based backhaul provided via the first WAN backhaul connection 411 to the first LAN 410A; an Optical Network Terminal (ONT) operating to communicatively interface a fiber optic based backhaul provided via the first WAN backhaul connection 411 to the first LAN 410A; a router operating to communicatively interface the first WAN backhaul connection 411 to the first LAN 410A; a gateway operating to communicatively interface the first WAN backhaul connection 411 to the first LAN 410A; and a computing device remotely located from a WAN/LAN interface through which a communication channel related to the first WAN backhaul connection 411 and the first LAN 410A is connected, in which the computing device provides remote monitoring and management functionality for the WAN/LAN interface.

[00125] In accordance with the various embodiments, the management device 425 collecting the first, second, third, and fourth information sets 470A-D constitutes the management device 425 collecting each of the information sets 470A-D from an information source selected from the group of information sources which includes: a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home power line device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a set-top box (STB)/set-top unit (STU) customer electronics device; an Internet Protocol (IP) enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an

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Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[00126] In accordance with the various embodiments, the first WAN backhaul connection 411 and the second WAN backhaul connection 412 are selected from the group of WAN backhaul connections 411 and 412 which include: a broadband connection; a DSL connection; a cable connection; a femtocell connection; a mobile connection; a fiber connection; a wireless connection; and an access Broadband over Power Line (BPL) connection.

[00127] In one embodiment, each of the first LAN 410A and the second LAN 410B include a plurality of interconnected LAN nodes 238. In such an embodiment, each of the plurality of interconnected LAN nodes 238 communicate via at least one of: an Ethernet based network connection; a wireless based network connection; an Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards based network connection; an 802.11a, 802.11b, 802.11g, 802.11ad at 60 GHz, and/or 802.11n wireless compatible network connection; a femto network connection transmitting via a mobile cellular compatible protocol including at least one of a third generation (3G) compatible protocol, a fourth generation (4G) compatible protocol, and a Long Term Evolution (LTE) compatible protocol; a power line connection; a telephone system connection; a Plain Old Telephone Service (POTS) connection; a G.hn (ITU-T standardized unified high-speed wire-line based home networking) connection; and a Coax cable connection.

[00128] In one embodiment, each of the first LAN access device 420A and the second LAN access device 420B are selected from the group of devices which includes: a base station; an access point; a modem; a router; a gateway; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home power line device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a set-top box (STB)/set-top unit (STU) customer electronics device; an Internet Protocol (IP) enabled television; an IP enabled media player; an IP enabled gaming console; ; a

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60 GHz capable station; PAN (Personal Area Networks) capable device; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[00129] In one embodiment, each of the first LAN 410A and the second LAN 410B include a plurality of interconnected LAN nodes 238 and each of the plurality of interconnected LAN nodes 238 are selected from the group of nodes which includes: a computer with LAN connectivity; a notebook with LAN connectivity; a mobile phone with LAN connectivity; a game console with LAN connectivity; an electronic computing machine with LAN connectivity; an IPTV with LAN connectivity; storage devices with LAN connectivity; devices that are primarily purposed for other applications and can have LAN connectivity, for example, household lighting, alarm systems, heating/cooling and other household appliances, etc.

[00130] **Figure 4G** illustrates an alternative exemplary architecture 407 in which embodiments may operate. In accordance with certain embodiments, the management device 425 collects, for joint analysis, information from the LANs 410A, 410B, 410C, 410D, 410E, and 410F, including neighborhood analysis 440 relating to Internet connectivity provided to a plurality of locations in a neighborhood or a shared geographical area 469 with the management device 425. In such an embodiment, initiating a management event 472 includes a management device 425 generating instructions or commands to change a configuration of a WAN device based on the neighborhood analysis 440 collected. In an alternative embodiment, initiating a management event 472 includes a management device 425 generating instructions to change a configuration of a LAN device (e.g., one of nodes 477A-C) based on the neighborhood analysis 440.

[00131] Joint analysis by the management device 425 may include conducting neighborhood analysis including aggregating information multiple sources to provide a broader analytical context. For example, nodes 477A, 477B, and 477C are depicted as traversing a shared back-haul 414 to a WAN 405A. WAN 405A includes a management device 425 implemented as described herein. Because

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nodes 477A-C all traverse a common or shared back-haul 414, information may be retrievable from each of the nodes *All* A-*C* and correspondingly from Local Area Networks 410A, 41OB, and 41OC respectively. The information may be collected by management device 425 within WAN 405A and utilized to optimize the WAN and LAN networks and the communication paths between the respective WAN and LAN networks.

[00132] For example, a shared back-haul 414 may exist with DSL networks in which multiple twisted pair lines traverse a common DSL binder; a shared back-haul 414 may be present with multiple coaxial cable internet customers each contending for WAN based resources over a single coaxial cable over which at least a portion of WAN back-haul is implemented; a shared back-haul 414 may be present with a power line based Internet service provider in which multiple LANs (e.g., 410A-C) associated with distinct end-users contend for WAN based resources over the same physical transmission lines; a shared back-haul 414 may similarly be present where multiple LANs (e.g., 410A-C) associated with distinct end-users contend for WAN based resources over the same wireless transmission spectrum; a shared back-haul 414 may be present with fiber optic based connections each contending for WAN based resources; or a shared back-haul 414 may comprise of a combination of the above communication means, such as a combination of coaxial cable, fiber and twisted pairs.

[00133] In such embodiments, a management device 425 may collect information from multiple distinct LANs and analyze the collected information from the multiple LANs to identify an operational condition 471. Such analysis may be referred to as neighborhood analysis. The management device 425 may then report, diagnose, monitor, or generate instructions to implement an operational change via a management event 472 based on the neighborhood analysis. For example, the management device 425 may implement WAN/LAN network optimizations which include increasing transmit power and data rates to one LAN (e.g., 410A) based on determination that another LAN represented within the neighborhood analysis is inactive or has a low activity rate (e.g., LAN 410C may be determined to be underutilized). In such an embodiment, a corresponding decrease of transmit power and data rate may be implemented for the underutilized LAN (e.g., 410C in such an

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example).

[00134] In another embodiment, neighborhood analysis may indicate that the shared back-haul 414 is saturated due to a demand load in excess of capacity based on analysis of LAN information retrieved from the multiple distinct LANs 410A-C in which case the management device 425 may responsively implement a load-balancing algorithm on a WAN/LAN interface (e.g., a DSL modem, cable modem, ONT unit, etc.) interfacing each of the respective LANs 410A-C to the single shared back-haul 414. In such a way, overall network efficiency may be improved by reducing collisions, buffering queues, data re-transmits, and other excessive overhead waste that may occur due to an overwhelmed network communication path, such as a shared WAN back-haul 414.

[00135] In accordance with an alternative embodiment, a collection module of a management device 425 collects the neighborhood analysis from a WAN operator (e.g., WAN 405B), where the neighborhood analysis describes LAN wireless transmission channels for a plurality of locations in a shared geographical area 469 with the management device. For example, within the neighborhood or shared geographical area 469 are multiple distinct LANs 410D, 410E, and 410F. Each of the distinct LANs 410D-F are transmitting information 440 to WAN 405B, such as an ISP or Wide Area Network Operator. The information 440 sent via each of the LANs may describe various characteristics about the LAN from which the information originated. In one embodiment, the WAN 405B aggregates the information 440 and makes the aggregate information available as neighborhood analysis. Each management device 425 within each of the respective LANs 410D-F may then collect and analyze the neighborhood analysis, and may additionally implement operational changes within a corresponding LAN 410D-F based on the information collected from the WAN 405B.

[00136] Thus, in accordance with one embodiment, instructions are generated by a management device 425 to change the configuration of a LAN device based on the neighborhood analysis. In one embodiment, the generated instructions select a LAN wireless transmission channel for a LAN device communicatively interfaced with the management device 425 that minimizes wireless interference between the LAN device and a plurality of other locations in

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the neighborhood or shared geographical area 469 with the management device 425. In some embodiments, each of the management devices within the various LANs 410D-F implement similar instructions, although, the management devices 425 within the respective LANs 410D-F need not have operational awareness of any other management device 425 as the neighborhood analysis is collected from WAN 405B. In alternative embodiments, a management device within the WAN 405B or located elsewhere may initiate instructions to implement an operational change via a management event 472 within the WAN 405B or within multiple distinct LANs 410D-F.

[00137] In the above embodiment, operational efficiency of the individual LANs 410A-F may be improved by reducing interference between closely located LANs, based on the neighborhood analysis. Such information may be correlated by a WAN operator based on, for example, mapping overlapping identifiers to a virtually rendered neighborhood or shared geographic area 469 or alternatively, based on actual knowledge of geographic locations for multiple LANs 410, for example, by cross referencing subscribers' service address information to physical locations.

[00138] Diagnostics may similarly rely upon neighborhood analysis yielded from multiple distinct LANs 410. For example, multiple LAN devices 410A-F exhibiting high error counts, or abnormal retrains/modem resets, may be indicative of a fault within the WAN 405A-B infrastructure rather than a statistically less likely coincidence that multiple LAN side devices are each simultaneously exercising a similar fault. In a complementary way, neighborhood analysis from multiple LANs 410A-F within a common geographical area or multiple LANs associated with a single shared back-haul 414 may aid in systematically diagnosing a LAN side fault within a particular end-user consumer's local area network where similar devices operating in neighboring LANs 410A-F do not present corresponding errors or faults within the neighborhood analysis.

[00139] **Figure 5A** shows a diagrammatic representation of a system 500 in accordance with which embodiments may operate, be installed, integrated, or configured.

[00140] In one embodiment, system 500 includes a memory 595 and a

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processor or processors 596. For example, memory 595 may store instructions to be executed and processor(s) 596 may execute such instructions. Processor(s) 596 may also implement or execute implementing logic 560 having logic to implement the methodologies discussed herein. System 500 includes communication bus(es) 515 to transfer transactions, instructions, requests, and data within system 500 among a plurality of peripheral devices communicably interfaced with one or more communication buses 515. In one embodiment, system 500 includes a communication bus 515 to interface, transfer, transact, relay, and and/or communicate information, transactions, instructions, requests, and data within system 500, and among plurality of peripheral devices. System 500 further includes management interface 525, for example, to receive requests, return responses, and otherwise interface with network elements located separately from system 500.

[00141] In some embodiments, management interface 525 communicates information via an out-of-band connection separate from LAN and/or WAN based communications, where "in-band" communications are communications that traverse the same communication means as payload data (e.g., content) being exchanged between networked devices and where "out-of-band" communications are communications that traverse an isolated communication means, separate from the mechanism for communicating the payload data. An out-of-band connection may serve as a redundant or backup interface over which to communicate control data between the management device 501 (or one of 170, 325, or 425) and other networked devices or between the management device 501 and a third party service provider.

[00142] System 500 further includes LAN interface 530 to communicate information via a LAN based connection, including collecting LAN information from within a LAN, reporting information and diagnostics to other entities within the LAN, and for initiating instructions and commands over the LAN. Information communicated via a LAN interface 530 may, in some embodiments, traverse the LAN to a LAN to WAN interface and continue to a destination within a connected WAN. System 500 further includes WAN interface 535 to communicate information via a WAN based connection, including collecting WAN information from within a WAN, reporting information and diagnostics to other entities within

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the WAN, and for initiating instructions and commands over the WAN. Information communicated via WAN interface 535 may, in some embodiments, traverse the WAN to a WAN to LAN interface and continue to a LAN based destination.

[00143] System 500 further includes stored historical information 550 that may be analyzed or referenced when conducting long term trending analysis and reporting. System 500 may further include multiple management events 555, any of which may be initiated responsive to the identification of an operational condition. For example, corrective actions, additional diagnostics, information probes, configuration change requests, local commands, remote execution commands, and the like may be specified by and triggered as a management event 555. Similarly, operational reports, configuration reports, network activity reports and diagnostic reports may be generated and sent in accordance with stored management events 555. The stored historical information 550 and the management events 555 may be stored upon a hard drive, persistent data store, a database, or other storage location within system 500.

[00144] Distinct within system 500 is Management Device 501 which includes collection module 570, analysis module 575, diagnostics module 580, and implementation module 585. Management Device 501 may be installed and configured in a compatible system 500 as is depicted by Figure 5A, or provided separately so as to operate in conjunction with appropriate implementing logic 560 or other software.

[00145] In accordance with one embodiment, collection module 570 collects information from available sources, such as LAN information and WAN information via interfaces of system 500, including one or more of management interface 525, LAN interface 530, and/or WAN interface 535. Analysis module 575 analyzes the information retrieved via collection module 570. In some embodiments, LAN information and WAN information isjointly analyzed to identify an operational condition within the LAN based on collected WAN information or identify an operational condition within the WAN based on collected LAN information. Analysis module 575 may further perform long term trending analysis based on stored historical information 550 or conduct neighborhood analysis based on aggregation data yielded from multiple separate and distinct

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LANs, or conduct other joint analysis based on LAN information sets received and/or based on WAN backhaul connection information sets received. Diagnostics module 580 may conduct specialized diagnostic routines and algorithms in conjunction with or separately from analysis module 575. Diagnostics module 580 may conduct additional probing diagnostics to retrieve or trigger the output of additional diagnostics information for further analysis. Implementation module 585 implements and initiates various management events 555 including generating and instantiating instructions for local or remote execution, generating and transmitting configuration change requests, generating and sending operational reports, diagnostic reports, and configuration reports.

[00146] **Figure 5B** shows a diagrammatic representation of a system 502 in accordance with which embodiments may operate, be installed, integrated, or configured. Depicted as before are a memory 595, processor(s), bus 515, a management interface 525 to communicate with system 502 including to communicate with sub-components 591 and 590 of system 502, LAN interface 530 capable to communicate with LANs and LAN devices, WAN interface 535 capable to communicate with WANs, WAN backhaul connections and WAN devices, and implementing logic 560.

[00147] Traffic aggregation unit 591 and traffic de-aggregator 590 are separately depicted within system 502. Traffic aggregation unit 591 includes receiving unit 581 to receive data, packets, traffic, control signals and messages, and so forth. Traffic aggregation unit 591 includes backhaul bonding unit 582 to bond multiple distinct WAN backhaul connections into a single logical backhaul connection. Traffic aggregation unit 591 includes data aggregation unit 583 to collect and aggregate data, packets, traffic, and so forth associated with multiple distinct connections, such as distinct LAN connections, and place the incoming data, packets, traffic, etc., onto a logical bonded backhaul connection formed by the traffic aggregation unit 591. The data, packets, traffic, etc., once aggregated by data aggregation unit 583 are transmitted, forwarded, or routed forward via the transmitting unit 584.

[00148] Traffic de-aggregator 590 includes receiving unit 591 to receive incoming data, packets, traffic, etc. For example, such incoming data, packets,

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control packets, traffic may originate from various sources within a WAN, such as from sources accessible via the Internet, and be destined for one of the LANs communicably interfaced with the traffic de-aggregator 590. Traffic de-aggregator 590 further includes data de-aggregation unit 593 to split, separate, divide up, de-aggregate incoming data, packets, traffic etc. which is received by receiving unit 591. For example, data coming into the traffic de-aggregator 590 needs to be split up and placed onto different WAN backhaul connections for transmission back to an originating source or to a target source in accordance with the described embodiments. Traffic de-aggregator 590 further includes transmitting unit 594 to place de-aggregated data, packets, frames, etc., onto multiple WAN backhaul connections for transmission to a specified target as described above.

[00149] Figures 6A, 6B, and 6C are flow diagrams 600A, 600B, and 600C respectively, illustrating methods for traffic aggregation; methods for traffic load balancing; and methods for self-healing in accordance with described embodiments. Methods 600A, 600B, and/or 600C may be performed by processing logic that may include hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (e.g., instructions run on a processing device to perform various operations such as interfacing functions, collecting, monitoring, diagnosing and reporting information, and executing/initiating management events, commands and instructions responsive to analysis and diagnosis, or some combination thereof). In one embodiment, methods 600A, 600B, and 600C are performed or coordinated via a Management device such as that depicted at element 170 of Figure 1 or via a Management Device such as that depicted at element 501 of Figure 5A. Other embodiments utilize a traffic aggregation unit such as that set forth at element 225 beginning at Figure 2A and element 591 of Figure 5B. Still other embodiments utilize a traffic de-aggregator such as that set forth at element 235 beginning at Figure 2B and element 590 of Figure 5B. Some of the blocks and/or operations listed below are optional in accordance with certain embodiments. The numbering of the blocks presented is for the sake of clarity and is not intended to prescribe an order of operations in which the various blocks must occur. Additionally, operations from the various flows 600A, 600B, and 600C may be utilized in a variety of combinations.

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[00150] Method 600A begins with processing logic for establishing a first Local Area Network (LAN) via a first access device as set forth at block 602. At block 604, processing logic establishes a second LAN via a second access device.

[00151] At block 606, processing logic provides the first LAN access device with WAN connectivity via a first Wide Area Network (WAN) backhaul connection and at block 608, processing logic provides the second LAN access device with WAN connectivity via a second WAN backhaul connection.

[00152] At block 610, processing logic communicatively interfaces a traffic aggregation unit.

[00153] At block 612, processing logic forms a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul.

[00154] At block 614, processing logic combines traffic from different connections into aggregated traffic.

[00155] At block 616, processing logic communicatively interfaces a traffic de-aggregator.

[00156] At block 618, processing logic bonds Internet Protocol (IP) addresses associated with traffic originating from both the first LAN and the second LAN.

[00157] At block 620, processing logic routes the traffic having the bonded IP addresses through the traffic de-aggregator.

[00158] At block 622, processing logic provides an alternate backup communications path to the logically bonded WAN interface responsive to a failure event.

[00159] Method 600B begins with processing logic for establishing a first Local Area Network (LAN) via a first access device as set forth at block 640. At block 642, processing logic establishes a second LAN via a second access device.

[00160] At block 644, processing logic provides the first LAN access device with WAN connectivity via a first Wide Area Network (WAN) backhaul connection and at block 646, processing logic provides the second LAN access device with WAN connectivity via a second WAN backhaul connection.

[00161] At block 648, processing logic communicatively interfaces a management device.

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[00162] At block 650, processing logic routes a first portion of traffic originating from the first LAN over the first WAN backhaul connection.

[00163] At block 652, processing logic routes a second portion of the traffic originating from the first LAN over the second WAN backhaul connection.

[00164] At block 654, processing logic implements load-balancing for the first LAN or the second LAN or both.

[00165] At block 656, processing logic implements an aggregate transfer rate for WAN connectivity which is greater than a transfer rate for the first or second WAN backhaul connections individually.

[00166] At block 658, processing logic allocates a portion of bandwidth associated with the second WAN backhaul connection to the first LAN access device.

[00167] At block 660, processing logic instructs a first LAN device to route or switch the second portion of traffic over a wireless communications link from the first LAN access device to the second LAN access device and onto the second WAN backhaul connection.

[00168] At block 662, processing logic collects information about the first and second WAN backhaul connections and the first and second LANs.

[00169] At block 664, processing logic jointly analyzes the collected information to identify an operational condition.

[00170] At block 666, processing logic initiates a management event responsive to the operational condition being identified.

[00171] At block 668, processing logic generates instructions specifying a configuration change to a network element responsive to the operational condition.

[00172] Method 600C begins with processing logic for establishing a first Local Area Network (LAN) via a first access device as set forth at block 680. At block 682, processing logic establishes a second LAN via a second access device.

[00173] At block 684, processing logic provides the first LAN access device with WAN connectivity via a first Wide Area Network (WAN) backhaul connection and at block 686, processing logic provides the second LAN access device with WAN connectivity via a second WAN backhaul connection.

[00174] At block 688, processing logic communicatively interfaces a

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management device.

[00175] At block 690, processing logic implements the management device from within the first LAN access device, from within a WAN access device, from within an externally separate and physically distinct device separate from the LAN access device and the WAN access device, or from within a service provider, and operates the management device therefrom.

[00176] At block 692, processing logic re-routes traffic responsive to a failure event.

[00177] At block 694, processing logic performs a SONET or SDH compatible rapid re-route function.

[00178] At block 696, processing logic performs a first traffic re-route operation responsive to a hard failure event characterized by a total loss of connectivity.

[00179] At block 698, processing logic performs a second traffic re-route operation responsive to a soft failure event characterized by degraded connectivity.

[00180] **Figure 7** illustrates a diagrammatic representation of a machine 700 in the exemplary form of a computer system, in accordance with one embodiment, within which a set of instructions, for causing the machine 700 to perform any one or more of the methodologies discussed herein, may be executed. In alternative embodiments, the machine may be connected (e.g., networked) to other machines in a Local Area Network (LAN), a Wide Area Network, an intranet, an extranet, or the Internet. The machine may operate in the capacity of a server or a client machine in a client-server network environment, or as a peer machine in a peer-to-peer (or distributed) network environment. Certain embodiments of the machine may be in the form of a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a server, a network router, switch or bridge, computing system, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines (e.g., computers) that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed

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herein.

[00181] The exemplary computer system 700 includes a processor 702, a main memory 704 (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) such as synchronous DRAM (SDRAM) or Rambus DRAM (RDRAM), etc., static memory such as flash memory, static random access memory (SRAM), volatile but high-data rate RAM, etc.), and a secondary memory 718 (e.g., a persistent storage device including hard disk drives and persistent data base implementations), which communicate with each other via a bus 730. Main memory 704 includes information and instructions and software program components necessary for performing and executing the functions with respect to the various embodiments of the Management Device, the traffic aggregation unit, and/or the traffic de-aggregator as described herein. For example, historical WAN/LAN information 724 may be collected LAN information from a LAN and WAN information from a LAN which may be collected over a period of time and referenced later for performing trending analysis. Management events may be initiated based on historical WAN/LAN information 724. Operational conditions may be derived from historical WAN/LAN information 724. Such historical WAN/LAN information 724 may include various information sets, such as those collected from LANs, WANs, or WAN backhaul connections, historical WAN/LAN information 724 may include neighborhood analysis, and so forth. Management events 723 may be stored within main memory 704 and as collected and determined by management device 734. Main memory 704 and its sub-elements (e.g. 723 and 724) are operable in conjunction with processing logic 726 and/or software 722 and processor 702 to perform the methodologies discussed herein.

[00182] Processor 702 represents one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. More particularly, the processor 702 may be a complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, processor implementing other instruction sets, or processors implementing a combination of instruction sets. Processor 702 may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array

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(FPGA), a digital signal processor (DSP), network processor, or the like. Processor 702 is configured to execute the processing logic 726 for performing the operations and functionality which is discussed herein.

[00183] The computer system 700 may further include one or more network interface cards 708 to communicatively interface the computer system 700 with one or more networks 720 from which information may be collected for analysis. The computer system 700 also may include a user interface 710 (such as a video display unit, a liquid crystal display (LCD), or a cathode ray tube (CRT)), an alphanumeric input device 712 (e.g., a keyboard), a cursor control device 714 (e.g., a mouse), and a signal generation device 716 (e.g., an integrated speaker). The computer system 700 may further include peripheral device 736 (e.g., wireless or wired communication devices, memory devices, storage devices, audio processing devices, video processing devices, etc.). The computer system 700 may perform the functions of a Management Device 734 capable interfacing networks, monitoring, collecting, analyzing, and reporting information, and initiating, triggering, and executing various management events including the execution of commands and instructions to alter an identified operational condition or perform corrective measures on a diagnosed fault, as well as the various other functions and operations described herein. Data aggregation unit 735 implements data aggregation operations, such as collecting and combining data, traffic, frames, packets, etc., which are associated with a source, such as a LAN device or a LAN node. Data de-aggregator 733 implements data de-aggregation operations, such as collecting and splitting, dividing, separating, etc., data, traffic, frames, packets, and so forth from a source which is destined for a target, such as a node or device within a connected LAN.

[00184] The secondary memory 718 may include a non-transitory machine-readable storage medium (or more specifically a non-transitory machine-accessible storage medium) 731 on which is stored one or more sets of instructions (e.g., software 722) embodying any one or more of the methodologies or functions described herein. Software 722 may also reside, or alternatively reside within main memory 704, and may further reside completely or at least partially within the processor 702 during execution thereof by the computer system 700, the main

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memory 704 and the processor 702 also constituting machine-readable storage media. The software 722 may further be transmitted or received over a network 720 via the network interface card 708.

[00185] While the subject matter disclosed herein has been described by way of example and in terms of the specific embodiments, it is to be understood that the claimed embodiments are not limited to the explicitly enumerated embodiments disclosed. To the contrary, the disclosure is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements. It is to be understood that the above description is intended to be illustrative, and not restrictive. Many other embodiments will be apparent to those of skill in the art upon reading and understanding the above description. The scope of the disclosed subject matter is therefore to be determined in reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

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CLAIMS

What is claimed is:

1. A system comprising:

a first Local Area Network (LAN) access device to establish a first LAN;

a second LAN access device to establish a second LAN operationally distinct from the first LAN;

a first Wide Area Network (WAN) backhaul connection to provide the first LAN access device with WAN connectivity;

a second WAN backhaul connection to provide the second LAN access device with WAN connectivity, wherein each of the first WAN backhaul and the second WAN backhaul are physically distinct; and

a traffic aggregation unit to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul.

2. The system of claim 1, wherein the logically bonded WAN interface to provide the first LAN access device and the second LAN access device with WAN connectivity via a combination of first bandwidth accessible via the first WAN backhaul connection and second bandwidth accessible via the second WAN backhaul connection.

3. The system of claim 2, wherein the logically bonded WAN interface to provide the first LAN access device with WAN connectivity and further provide the second LAN access device with WAN connectivity, and wherein the logically bonded WAN interface to supplant the first WAN backhaul connection for providing the first LAN access device with its respective WAN connectivity and to further supplant the second WAN backhaul connection for providing the second LAN access device with its respective WAN connectivity.

4. The system of claim 1:

wherein the first WAN backhaul connection to provide the first LAN access device with WAN connectivity comprises the first WAN backhaul connection to provide the first LAN access device with WAN connectivity via the first WAN backhaul connection to a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile

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device connectivity to a plurality of subscribers; and

wherein the second WAN backhaul connection to provide the second LAN access device with WAN connectivity comprises the second WAN backhaul connection to provide the second LAN access device with WAN connectivity via the second WAN backhaul connection to the same Service Provider via a physically distinct communications link to the same Service Provider.

5. The system of claim 4:

wherein the physically distinct communications link to the same Service Provider associated with the second WAN backhaul connection is identified by an Internet Protocol (IP) address distinct from an IP address for the first WAN backhaul connection; and

wherein the physically distinct communications link to the same Service Provider associated with the second WAN backhaul connection is associated with a subscriber's account distinct from a subscriber's account associated with the first WAN backhaul connection.

6. The system of claim 1:

wherein the first WAN backhaul connection to provide the first LAN access device with WAN connectivity comprises the first WAN backhaul connection to provide the first LAN access device with WAN connectivity via the first WAN backhaul connection to a first Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers; and

wherein the second WAN backhaul connection to provide the second LAN access device with WAN connectivity comprises the second WAN backhaul connection to provide the second LAN access device with WAN connectivity via the second WAN backhaul connection to a second Service Provider separate and distinct from the first Service Provider.

7. The system of claim 1, wherein at least a portion of traffic originating from the first LAN and at least a portion of traffic originating from the second LAN traverses the logically bonded WAN interface.

8. The system of claim 1:

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a) wherein a first plurality of traffic packets originating from the first LAN traverses the logically bonded WAN interface via the first WAN backhaul through the traffic aggregation unit;

b) wherein a second plurality of traffic packets originating from the first LAN traverses the logically bonded WAN interface via the second WAN backhaul through the traffic aggregation unit;

c) wherein a third plurality of traffic packets originating from the second LAN traverses the logically bonded WAN interface via the first WAN backhaul through the traffic aggregation unit; and

d) wherein a fourth plurality of traffic packets originating from the second LAN traverses the logically bonded WAN interface via the second WAN backhaul through the traffic aggregation unit.

9. The system of claim 1:

wherein the first LAN comprises a first plurality of interconnected LAN nodes, each of the first plurality of interconnected LAN nodes identifiable within the first LAN by a private Internet Protocol (IP) address managed by the first LAN access device;

wherein the second LAN comprises a second plurality of interconnected LAN nodes, each of the second plurality of interconnected LAN nodes identifiable within the second LAN by a private IP address managed by the second LAN access device;

wherein the first LAN access device is identifiable via a first unique Public IP address assigned to the first LAN access device; and

wherein the second LAN access device is identifiable via a second unique Public IP address assigned to the second LAN access device.

10. The system of claim 9:

wherein each of the first and second unique Public IP address are directly addressable via a public Internet; and

wherein none of the first or second plurality of interconnected LAN nodes are directly addressable via the public Internet and wherein each of the first or second plurality of interconnected LAN nodes require address translation to a corresponding private IP address associated with the respective one of the

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first or second plurality of interconnected LAN nodes to receive traffic from the public Internet.

11. The system of claim 1:

wherein the first LAN comprises a first plurality of interconnected LAN nodes, each of the first plurality of interconnected LAN nodes identifiable within the first LAN by one or more Virtual Local Area Network (VLAN) tags managed by the first LAN access device;

wherein the second LAN comprises a second plurality of interconnected LAN nodes, each of the second plurality of interconnected LAN nodes identifiable within the second LAN by a second one or more VLAN tags which are managed by the second LAN access device;

wherein the first LAN access device provides Voice over Internet Protocol (VoIP) services and/or Internet Protocol Television (IPTV) services to one or more of the interconnected LAN nodes within the first LAN based on Ethernet level addressing using the one or more VLAN tags;

wherein the second LAN access device provides VoIP services and/or IPTV services to one or more of the interconnected LAN nodes within the second LAN based on Ethernet level addressing using the second one or more VLAN tags; and

wherein any of the first and second plurality of interconnected LAN nodes are uniquely identifiable based at least on the one or more VLAN tags respectively managed by the first or second LAN access device.

12. The system of claim 1, wherein the traffic aggregation unit comprises a Public Internet Protocol (IP) address distinct from a public IP address associated with the first LAN access device and distinct from a public IP address associated with the second LAN access device.

13. The system of claim 1:

wherein the first WAN backhaul connection comprises a first transfer rate with the first LAN;

wherein the second WAN backhaul connection comprises a second transfer rate with the second LAN; and

wherein the logically bonded WAN interface comprises an aggregate transfer rate

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with the first LAN and with the second LAN which is greater than the first transfer rate and is greater than the second transfer rate.

14. The system of claim 1:

wherein the traffic aggregation unit operates physically separate and distinct from each of the first LAN access device and the second LAN access device;

wherein the traffic aggregation unit is communicatively interfaced between the first LAN access device and the first WAN backhaul connection, the traffic aggregation unit having a direct communications link to each of the first LAN access device and the first WAN backhaul connection; and

wherein the traffic aggregation unit is communicatively interfaced with the second LAN access device, the traffic aggregation unit comprising an indirect communications link to the second WAN backhaul connection through the second LAN access device which operates in direct communication with the second WAN backhaul connection.

15. The system of claim 14:

further comprising a third LAN access device, the third LAN access device communicatively interfaced between the traffic aggregation unit and the second LAN access device and having a direct communications link to each of the traffic aggregation unit and the second LAN access device; and

wherein the traffic aggregation unit communicatively interfaced with the second LAN access device comprises the traffic aggregation unit having an indirect communications link to the second LAN access device through the third LAN access device, wherein the third LAN access device provides an alternate backup communications path to the logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul responsive to a failure event at one of the first LAN access device or the second LAN access device.

16. The system of claim 15, further comprising a traffic de-aggregator communicatively interfaced between the first WAN backhaul connection and the second WAN backhaul connection; and

wherein the traffic aggregation unit to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul comprises the traffic

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aggregation unit to bond Internet Protocol (IP) addresses associated with traffic originating from both the first LAN and the second LAN, and further to route the traffic having the bonded IP addresses through the traffic de-aggregator.

17. The system of claim 16:

wherein the traffic de-aggregator is managed by a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers via the first and second WAN backhaul connections; and

wherein the traffic de-aggregator operates physically separate and distinct from each of the first LAN access device, the second LAN access device, the third LAN access device, and the traffic aggregation unit.

18. The system of claim 1:

wherein the traffic aggregation unit operates as an integrated sub-component of the first LAN access device, the first LAN access device operating physically separate and distinct from the second LAN access device;

wherein the traffic aggregation unit is communicatively interfaced with the first WAN backhaul connection via a communications interface of the first LAN access device; and

wherein the traffic aggregation unit is communicatively interfaced with the second LAN access device, the traffic aggregation unit comprising an indirect communications link to the second WAN backhaul connection through the second LAN access device which operates in direct communication with the second WAN backhaul connection.

19. The system of claim 18, further comprising a traffic de-aggregator communicatively interfaced between the first WAN backhaul connection and the second WAN backhaul connection; and

wherein the traffic aggregation unit to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul comprises the traffic aggregation unit to bond Internet Protocol (IP) addresses associated with traffic originating from the first LAN and the second LAN and route the traffic having the bonded IP addresses through the traffic de-aggregator.

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20. The system of claim 1:

wherein at least one of a plurality of LAN devices operating within the first LAN comprises a first communication path to the first WAN backhaul connection through the first LAN access device and further comprises a second communication path to the second WAN backhaul connection through the second LAN access device.

21. The system of claim 20, wherein the at least one LAN device comprises at least one of:

a multiplexing wireless transceiver capable to simultaneously maintain a first wireless communication path to the first LAN access device and a second wireless communication path to the second LAN access device by multiplexing between the first and second wireless communication paths respectively;

a wireless transceiver capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device by terminating the first wireless communication path and switching to the second wireless communication path; and

a first wireless transceiver and a second wireless transceiver, the first and second wireless transceivers capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device either concurrently or not concurrently with the first wireless communication path to the first LAN access device.

22. The system of claim 20:

wherein the first LAN access device is within a residential premises common to the at least one of a plurality of LAN devices operating within the first LAN;

wherein the second LAN access device is within a second residential premises in a neighboring vicinity to the first residential premises, wherein a wireless coverage area associated with the second LAN access device overlaps with the first residential premises and the at least one of a plurality of LAN devices operating within the first LAN; and

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wherein the at least one of a plurality of LAN devices operating within the first LAN establishes connectivity with the second WAN backhaul connection through the second LAN access device responsive to a failure event associated with the first LAN access device.

23. The system of claim 20:

wherein at least one of a plurality of LAN devices operating within the first LAN, responsive to a failure event associated with the first LAN access device, establishes connectivity to the second WAN backhaul connection via a wireless connection between an transceiver of the at least one of the plurality of LAN devices within the first plurality of LAN devices and an transceiver of the second LAN access device which is external to, and operationally distinct from, the first LAN access device; and

wherein the failure event corresponds to a hard failure event characterized by a total loss of connectivity between the first LAN access device and the corresponding first WAN backhaul connection or a soft failure event characterized by degraded connectivity, based on a threshold, between the first LAN access device and the corresponding first WAN backhaul connection.

24. The system of claim 23, wherein the wireless connection between the transceiver of the at least one of the plurality of LAN devices within the first LAN and the transceiver of the second LAN access device comprises the at least one of the plurality of LAN devices connecting with the second LAN access device using a guest SSID (Service Set Identification) on the second LAN access device.

25. The system of claim 24, wherein the guest SSID on the second LAN access device enables guest devices to communicate with the second WAN backhaul connection through the second LAN access device and further wherein the guest SSID on the second LAN access device restricts the guest devices from communicating with any devices operating within the second LAN without first traversing the second WAN backhaul connection.

26. The system of claim 1:

wherein the traffic aggregation unit operates as an integrated sub-component within

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one of a plurality of LAN devices operating within the first LAN;

wherein the traffic aggregation unit is communicatively interfaced with the first WAN backhaul connection via a communications path to the first LAN access device which in turn is interfaced via a communications path to the first WAN backhaul connection; and

wherein the traffic aggregation unit, integrated as the sub-component within the one of the plurality of LAN devices operating within the first LAN, is communicatively interfaced with the second LAN access device, wherein the traffic aggregation unit comprises an indirect communications link to the second WAN backhaul connection through the second LAN access device which operates in direct communication with the second WAN backhaul connection.

27. The system of claim 26, wherein the traffic aggregation unit communicates with the first LAN access device through a wireless communication path from the one of the plurality of LAN devices to the first LAN access device and further wherein the traffic aggregation unit communicates with the second LAN access device through a second wireless communication path from the one of the plurality of LAN devices to the second LAN access device.

28. The system of claim 27, wherein the first and second wireless communication paths from the one of the plurality of LAN devices to the first and second LAN access devices respectively comprises at least one of:

wireless connectivity via a multiplexing wireless transceiver that simultaneously maintains the first wireless communication path to the first LAN access device and the second wireless communication path to the second LAN access device by multiplexing between the first and second wireless communication paths respectively;

wireless connectivity via a wireless transceiver capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device by terminating the first wireless communication path and switching to the second wireless communication path; and

wireless connectivity via a first wireless transceiver and a second wireless

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transceiver, the first and second wireless transceivers capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device either concurrently or not concurrently with the first wireless communication path to the first LAN access device.

29. The system of claim 26, further comprising a traffic de-aggregator communicatively interfaced between the first WAN backhaul connection and the second WAN backhaul connection; and

wherein the traffic aggregation unit to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul comprises the traffic aggregation unit to bond Internet Protocol (IP) addresses associated with traffic originating from both the first LAN and the second LAN, and further to route the traffic having the bonded IP addresses through the traffic de-aggregator.

30. The system of claim 29:

wherein the traffic de-aggregator is managed by a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers via the first and second WAN backhaul connections; and

wherein the traffic de-aggregator operates physically separate and distinct from each of the first LAN access device, the second LAN access device, the third LAN access device, and the traffic aggregation unit.

31. The system of claim 1, wherein each of the first WAN backhaul connection and the second WAN backhaul connection are selected from the group of WAN backhaul connections comprising:

a broadband connection;

a Digital Subscriber Line (DSL) connection;

a cable connection;

a femtocell connection;

a mobile connection;

a fiber connection;

a wireless connection; and

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an access Broadband Over Power Line (BPL) connection.

32. The system of claim 1:

wherein each of the first and second LANs comprise at least a user device; and

wherein each of the first and second LAN access devices communicably link each of the respective user devices with one of the first WAN backhaul connection or the second WAN backhaul connection.

33. The system of claim 1 wherein each of the first LAN and the second LAN comprise a plurality of interconnected nodes; and

wherein each of the plurality of interconnected nodes communicate via at least one of:

an Ethernet based network connection;

a wireless based network connection;

an Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards based network connection;

an 802.11a, 802.11b, 802.11g, and/or 802.11η wireless compatible network connection;

a femto network connection transmitting via a mobile cellular compatible protocol including at least one of a third generation (3G) compatible protocol, a fourth generation (4G) compatible protocol, and a Long Term Evolution (LTE) compatible protocol;

a power line connection;

a telephone system connection;

a Plain Old Telephone Service (POTS) connection;

a G.hn (ITU-T standardized unified high-speed wire-line based home networking) connection; and

a Coax cable connection.

34. The system of claim 1, wherein each of the first LAN access device and the second LAN access device are selected from the group of access devices comprising:

a base station;

an access point;

a modem;

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a router;

a gateway;

a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;

an in-home power line device;

a Home Phoneline Network Alliance (HPNA) based device;

an in-home coax distribution device;

a G.hn compatible device;

an in-home metering communication device;

an in-home appliance communicatively interfaced with the LAN;

a wireless femtocell base station;

a wireless compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

a HomePlug device;

an IEEE P1901 standards compatible access Broadband over Power Line (BPL) device;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

35. The system of claim 1, further comprising

a third LAN access device, communicably interfaced between the first LAN access device and the second LAN access device; and

wherein the traffic aggregation unit operates as an integrated sub-component of the third LAN access device, the third LAN access device operating physically

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separate and distinct from each of the first LAN access device and the second LAN access device.

36. The system of claim 1, wherein the traffic aggregation unit comprises:

a first connection, via a device communicably interfaced with the second LAN access device;

a second connection, to communicably interface the traffic aggregation unit with the first WAN backhaul connection; and

a data aggregation unit to combine traffic from the first connection and traffic from the second connection into aggregated traffic.

37. The system of claim 36, further comprising:

a data de-aggregation unit communicably interfaced with the first WAN backhaul connection and communicably interfaced with the second WAN backhaul connection, the data de-aggregation unit to de-aggregate traffic onto the first connection and onto the second connection as de-aggregated traffic.

38. A method comprising:

establishing a first Local Area Network (LAN) via a first access device;

establishing a second LAN via a second access device, wherein the second LAN is operationally distinct from the first LAN;

providing the first LAN access device with WAN connectivity via a first Wide Area Network (WAN) backhaul connection;

providing the second LAN access device with WAN connectivity via a second WAN backhaul connection, wherein each of the first WAN backhaul and the second WAN backhaul are physically distinct; and

forming a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul.

39. The method of claim 38:

wherein the logically bonded WAN interface provides the first LAN access device and the second LAN access device with WAN connectivity via a combination of first bandwidth accessible via the first WAN backhaul connection and second bandwidth accessible via the second WAN backhaul connection; and

wherein the logically bonded WAN interface to supplants the first WAN backhaul

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connection for providing the first LAN access device with its respective WAN connectivity and supplants the second WAN backhaul connection for providing the second LAN access device with its respective WAN connectivity.

40. The method of claim 38:

a) wherein a first plurality of traffic packets originating from the first LAN traverses the logically bonded WAN interface via the first WAN backhaul through the traffic aggregation unit;

b) wherein a second plurality of traffic packets originating from the first LAN traverses the logically bonded WAN interface via the second WAN backhaul through the traffic aggregation unit;

c) wherein a third plurality of traffic packets originating from the second LAN traverses the logically bonded WAN interface via the first WAN backhaul through the traffic aggregation unit; and

d) wherein a fourth plurality of traffic packets originating from the second LAN traverses the logically bonded WAN interface via the second WAN backhaul through the traffic aggregation unit.

41. The method of claim 38:

wherein the first WAN backhaul connection comprises a first transfer rate with the first LAN;

wherein the second WAN backhaul connection comprises a second transfer rate with the second LAN; and

wherein the logically bonded WAN interface comprises an aggregate transfer rate with the first LAN and with the second LAN which is greater than the first transfer rate and is greater than the second transfer rate.

42. The method of claim 38:

wherein the traffic aggregation unit operates physically separate and distinct from each of the first LAN access device and the second LAN access device;

wherein the traffic aggregation unit is communicatively interfaced between the first LAN access device and the first WAN backhaul connection, the traffic aggregation unit having a direct communications link to each of the first LAN access device and the first WAN backhaul connection; and

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wherein the traffic aggregation unit is communicatively interfaced with the second LAN access device, the traffic aggregation unit comprising an indirect communications link to the second WAN backhaul connection through the second LAN access device which operates in direct communication with the second WAN backhaul connection.

43. The method of claim 38:

communicatively interfacing a third LAN access device between the traffic aggregation unit and the second LAN access device;

establishing a direct communications link from the third LAN access device to each of the traffic aggregation unit and the second LAN access device; and

wherein the traffic aggregation unit communicatively interfaces with the second LAN access device by establishing an indirect communications link to the second LAN access device through the third LAN access device, wherein the third LAN access device provides an alternate backup communications path to the logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul responsive to a failure event at one of the first LAN access device or the second LAN access device.

44. The method of claim 38, further comprising:

communicatively interfacing a traffic de-aggregator between the first WAN backhaul connection and the second WAN backhaul connection; and

wherein forming the logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul comprises a traffic aggregation unit:

(a) bonding Internet Protocol (IP) addresses associated with traffic originating from both the first LAN and the second LAN, and

(b) routing the traffic having the bonded IP addresses through the traffic de-aggregator.

45. The method of claim 44:

wherein the traffic de-aggregator is managed by a Service Provider that provides one or more of data connectivity, voice connectivity, video connectivity, and mobile device connectivity to a plurality of subscribers via the first and second WAN backhaul connections; and

wherein the traffic de-aggregator operates physically separate and distinct from each

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of the first LAN access device, the second LAN access device, the third LAN access device, and the traffic aggregation unit.

46. The method of claim 38:

wherein at least one of a plurality of LAN devices operating within the first LAN comprises a first communication path to the first WAN backhaul connection through the first LAN access device and further comprises a second communication path to the second WAN backhaul connection through the second LAN access device.

47. The method of claim 46, wherein the at least one LAN device comprises at least one of:

a multiplexing wireless transceiver capable to simultaneously maintain a first wireless communication path to the first LAN access device and a second wireless communication path to the second LAN access device by multiplexing between the first and second wireless communication paths respectively;

a wireless transceiver capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device by terminating the first wireless communication path and switching to the second wireless communication path; and

a first wireless transceiver and a second wireless transceiver, the first and second wireless transceivers capable to establish the first wireless communication path to the first LAN access device and capable to establish the wireless second communication path to the second LAN access device either concurrently or not concurrently with the first wireless communication path to the first LAN access device.

48. The method of claim 38, further comprising:

establishes connectivity from at least one of a plurality of LAN devices operating within the first LAN to the second WAN backhaul connection via a wireless connection between an transceiver of the at least one of the plurality of LAN devices within the first plurality of LAN devices and an transceiver of the second LAN access device which is external to, and operationally distinct

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from, the first LAN access device, responsive to a failure event associated with the first LAN access device; and

wherein the failure event corresponds to a hard failure event characterized by a total loss of connectivity between the first LAN access device and the corresponding first WAN backhaul connection or a soft failure event characterized by degraded connectivity, based on a threshold, between the first LAN access device and the corresponding first WAN backhaul connection.

49. The method of claim 38, wherein a guest SSID on the second LAN access device enables the at least one of a plurality of LAN devices operating within the first LAN to communicate with the second WAN backhaul as a guest device connection through the second LAN access device and further wherein the guest SSID on the second LAN access device restricts the guest device from communicating with any devices operating within the second LAN without first traversing the second WAN backhaul connection.

50. The method of claim 38:

wherein the traffic aggregation unit operates as an integrated sub-component within one of a plurality of LAN devices operating within the first LAN;

wherein the traffic aggregation unit is communicatively interfaced with the first WAN backhaul connection via a communications path to the first LAN access device which in turn is interfaced via a communications path to the first WAN backhaul connection; and

wherein the traffic aggregation unit, integrated as the sub-component within the one of the plurality of LAN devices operating within the first LAN, is communicatively interfaced with the second LAN access device, wherein the traffic aggregation unit comprises an indirect communications link to the second WAN backhaul connection through the second LAN access device which operates in direct communication with the second WAN backhaul connection.

51. The method of claim 38, wherein the traffic aggregation unit comprises:

a first connection, via a device communicably interfaced with the second LAN access device;

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a second connection, to communicably interface the traffic aggregation unit with the first WAN backhaul connection; and

wherein the method further comprises combining traffic into aggregated traffic, via a data aggregator, from the first connection and traffic from the second connection.

52. The method of claim 51, further comprising:

communicably interfacing a data de-aggregator with the first WAN backhaul connection;

communicably interfacing the data de-aggregator with the second WAN backhaul connection; and

de-aggregating traffic onto the first connection and onto the second connection as de-aggregated traffic.

53. The method of claim 38, further comprising

communicably interfacing a third LAN access device between the first LAN access device and the second LAN access device; and

wherein the traffic aggregation unit operates as an integrated sub-component of the third LAN access device, the third LAN access device operating physically separate and distinct from each of the first LAN access device and the second LAN access device.

54. A traffic aggregation unit comprising:

a first interface to a first Local Area Network (LAN) access device that establishes a first LAN;

a second interface to a second LAN access device that establishes a second LAN which is operationally distinct from the first LAN;

a third interface to a first Wide Area Network (WAN) backhaul connection that provides the first LAN access device with WAN connectivity;

a fourth interface to a second WAN backhaul connection that provides the second LAN access device with WAN connectivity, wherein each of the first WAN backhaul and the second WAN backhaul are physically distinct; and

a backhaul bonding unit to form a logically bonded WAN interface over the first WAN backhaul and the second WAN backhaul.

55. A traffic de-aggregator comprising:

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a first interface to a first Local Area Network (LAN) access device that establishes a first LAN;

a second interface to a second LAN access device that establishes a second LAN which is operationally distinct from the first LAN;

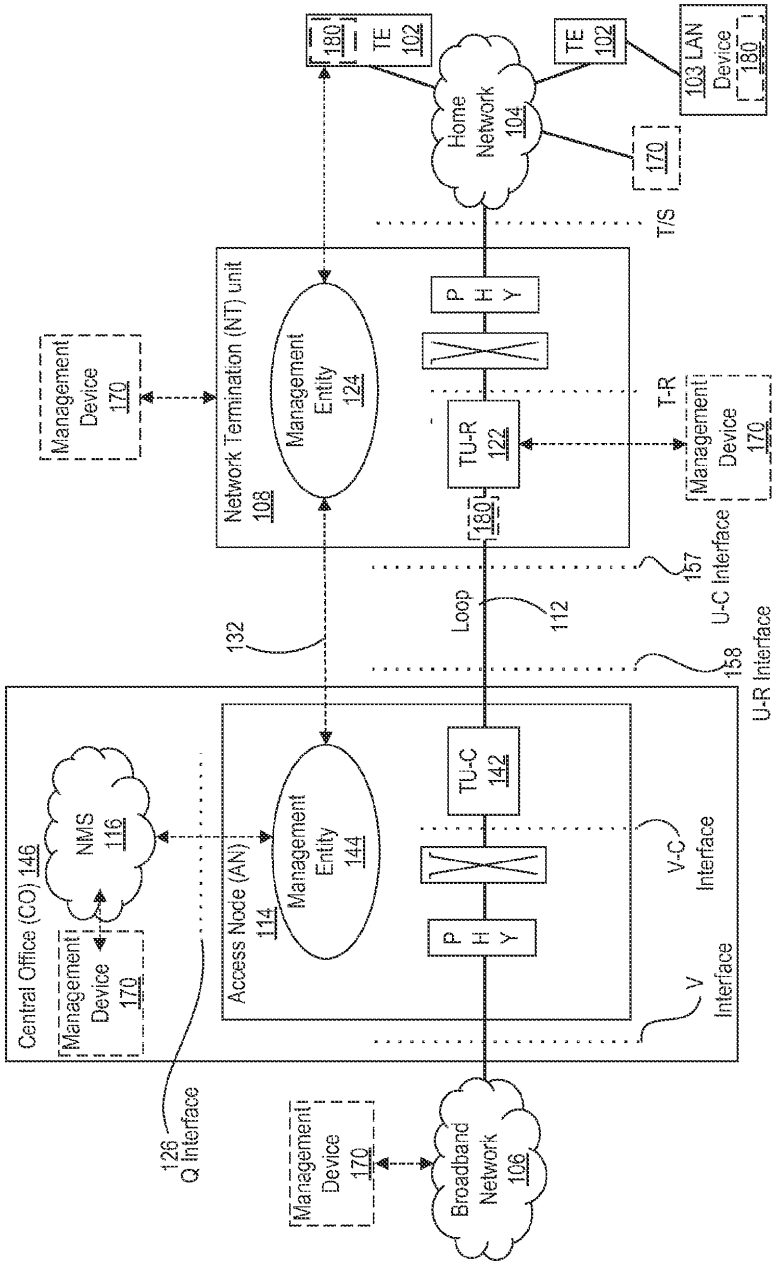
a third interface to a first Wide Area Network (WAN) backhaul connection that provides the first LAN access device with WAN connectivity;

a fourth interface to a second WAN backhaul connection that provides the second LAN access device with WAN connectivity, wherein each of the first WAN backhaul and the second WAN backhaul are physically distinct; and

a Data de-aggregation Unit to receive packets and to forward the packets to a traffic aggregation unit over a logically bonded WAN interface formed over the first WAN backhaul and the second WAN backhaul.

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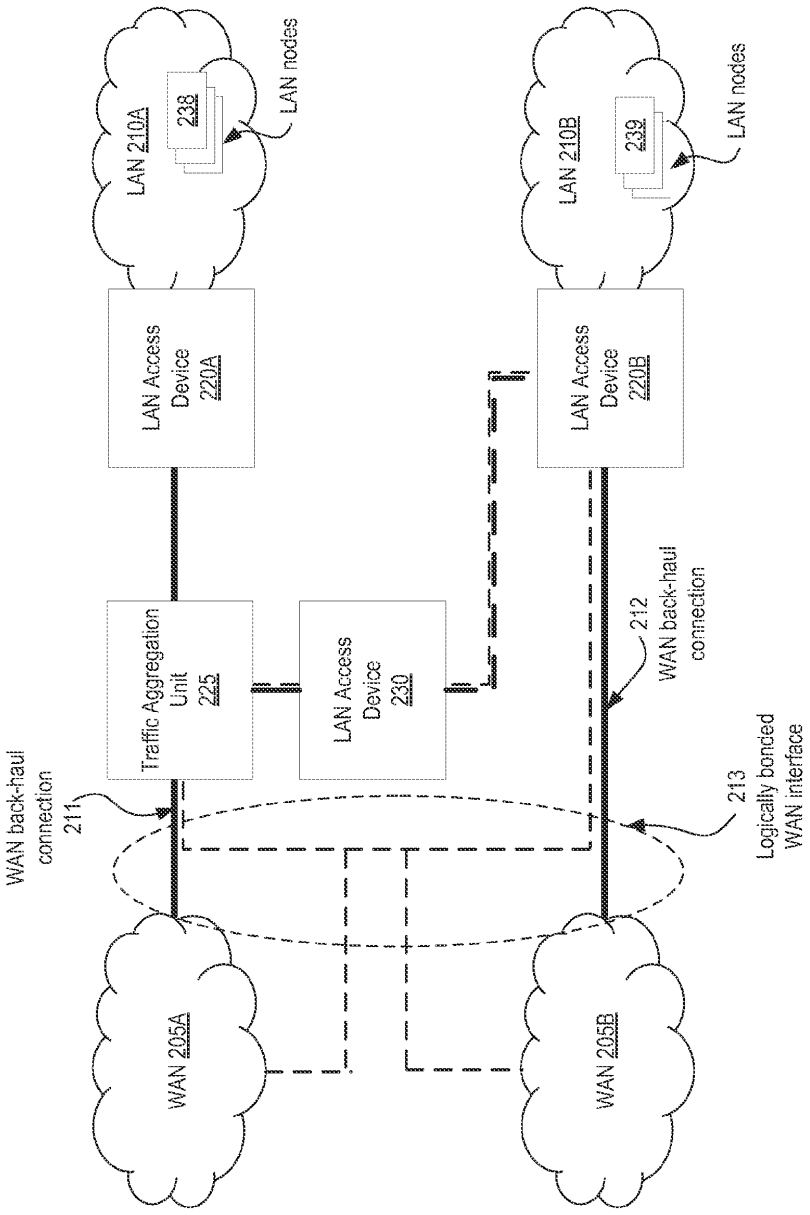
FIG. 1



SUBSTITUTE SHEET (RULE 26)

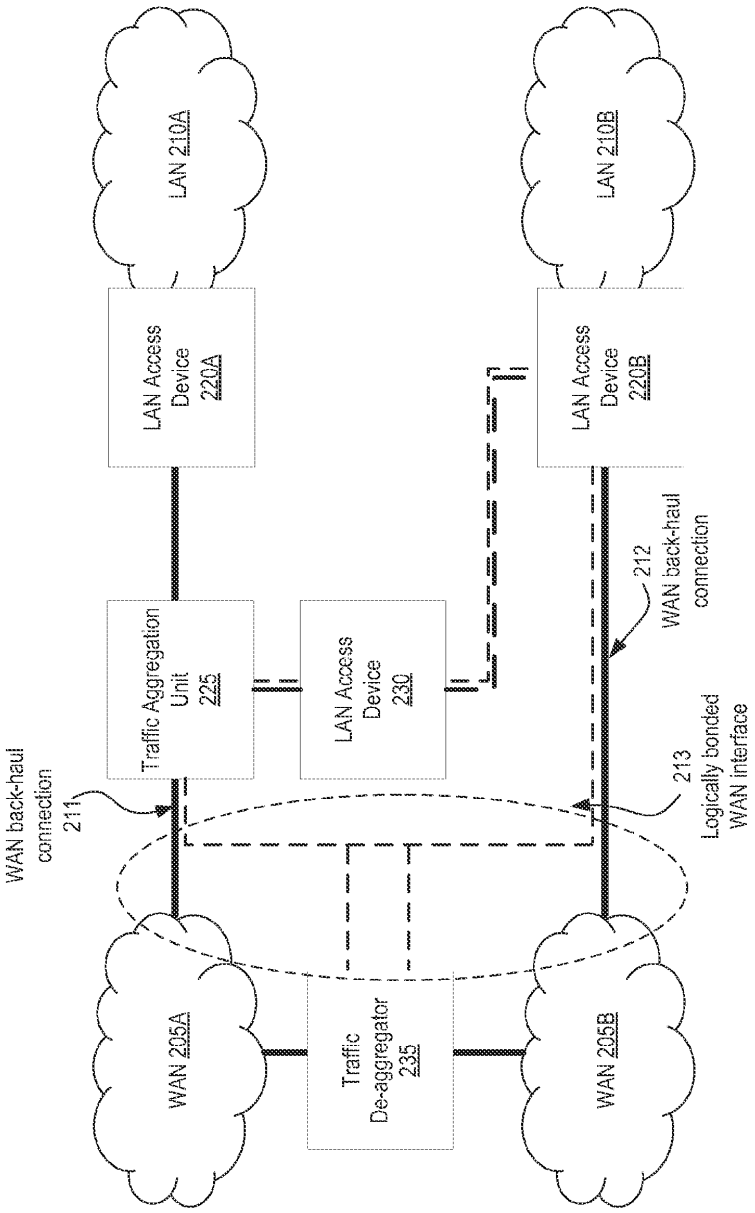
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FIG. 2A



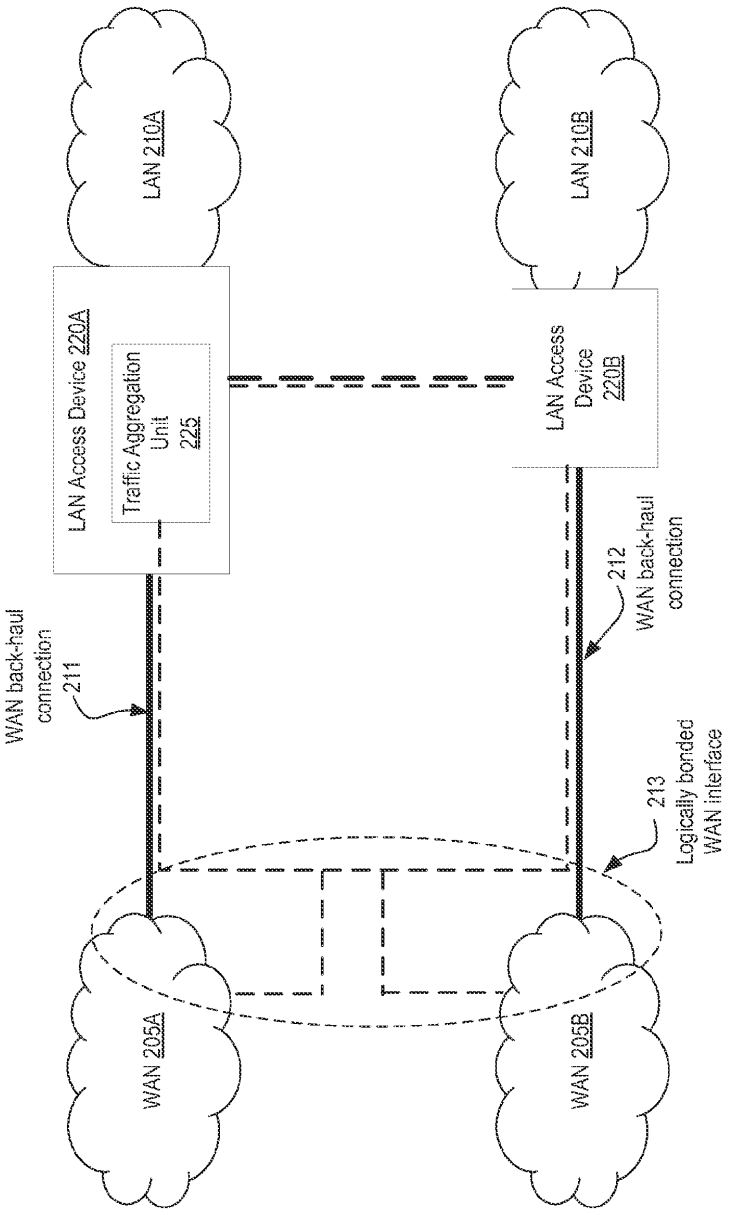
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FIG. 2B



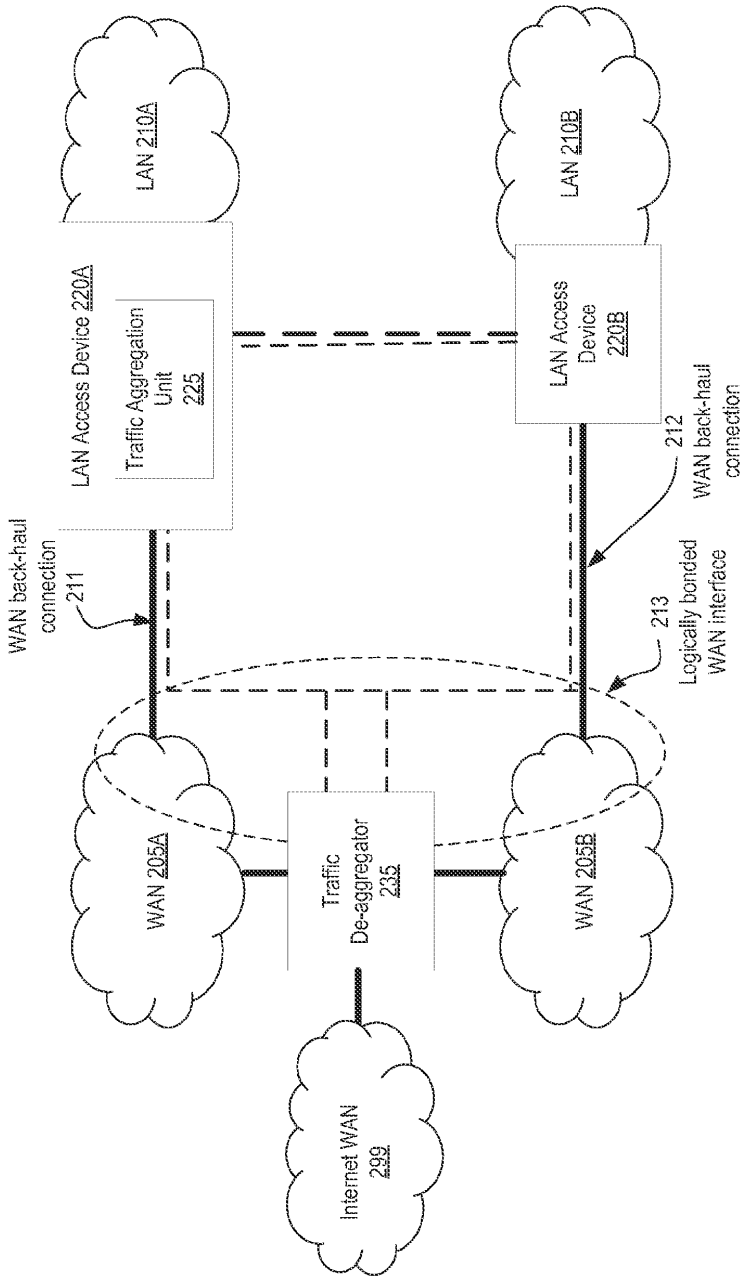
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FIG. 2C



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FIG. 2D



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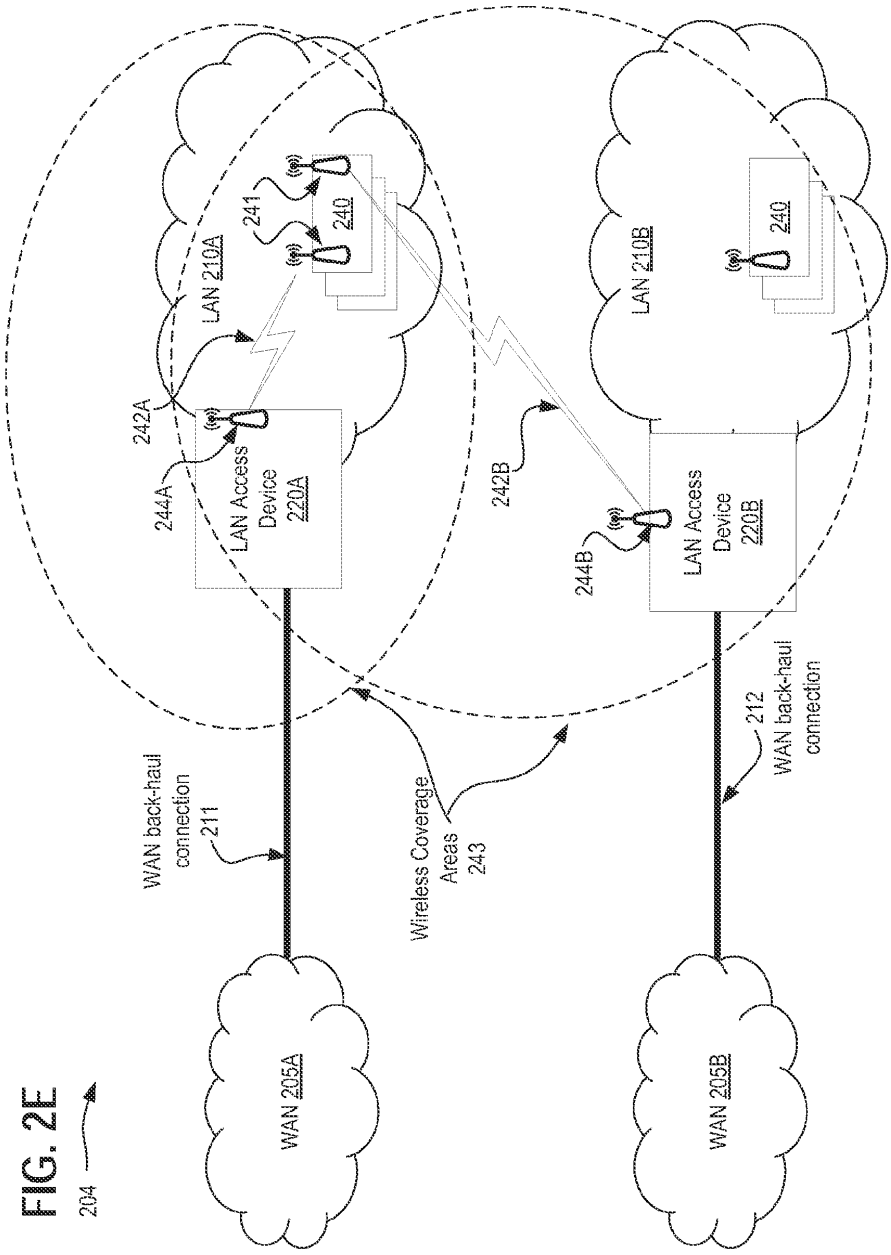


FIG. 2E
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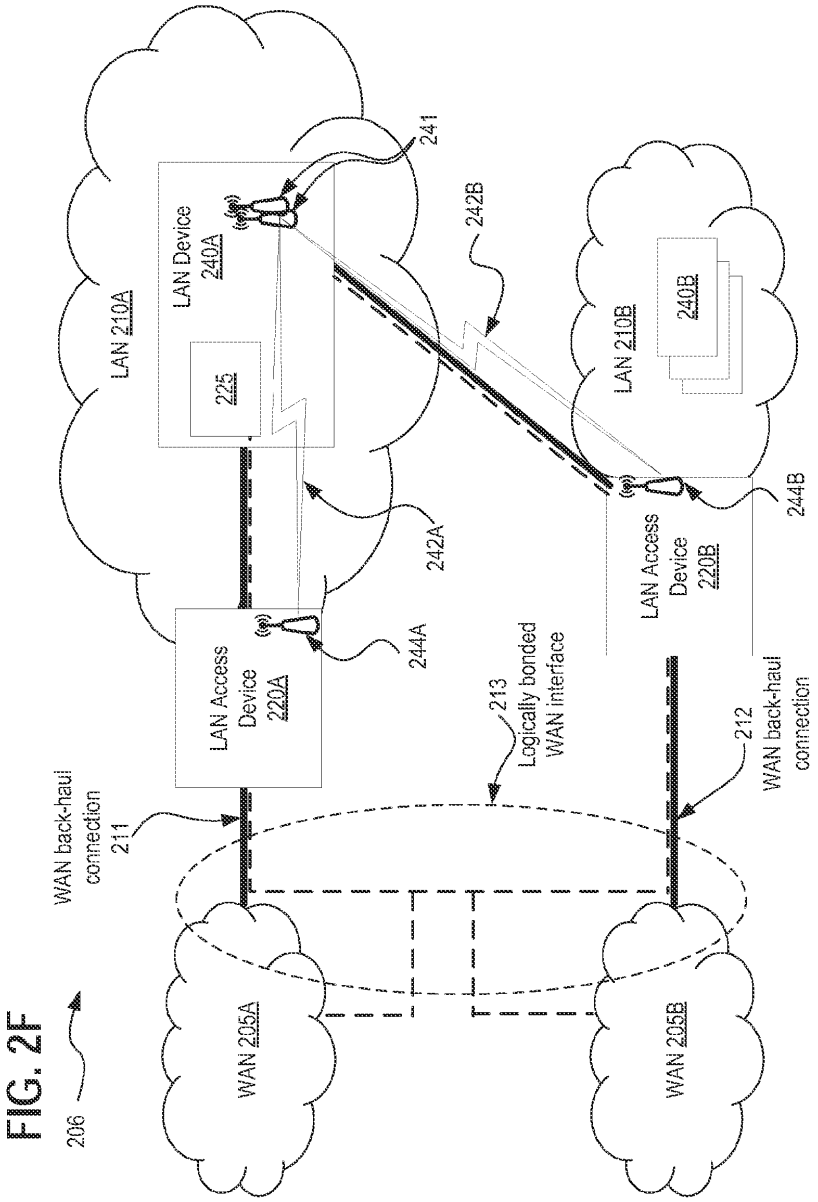


FIG. 2F

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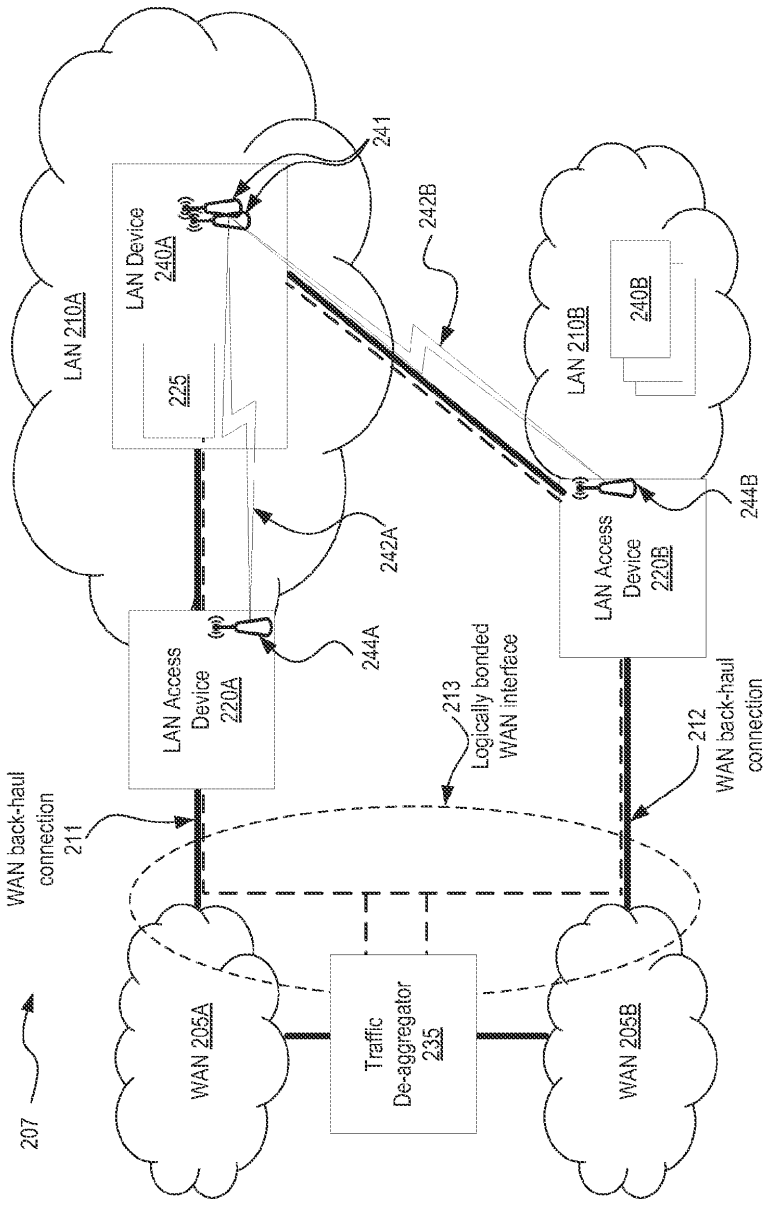
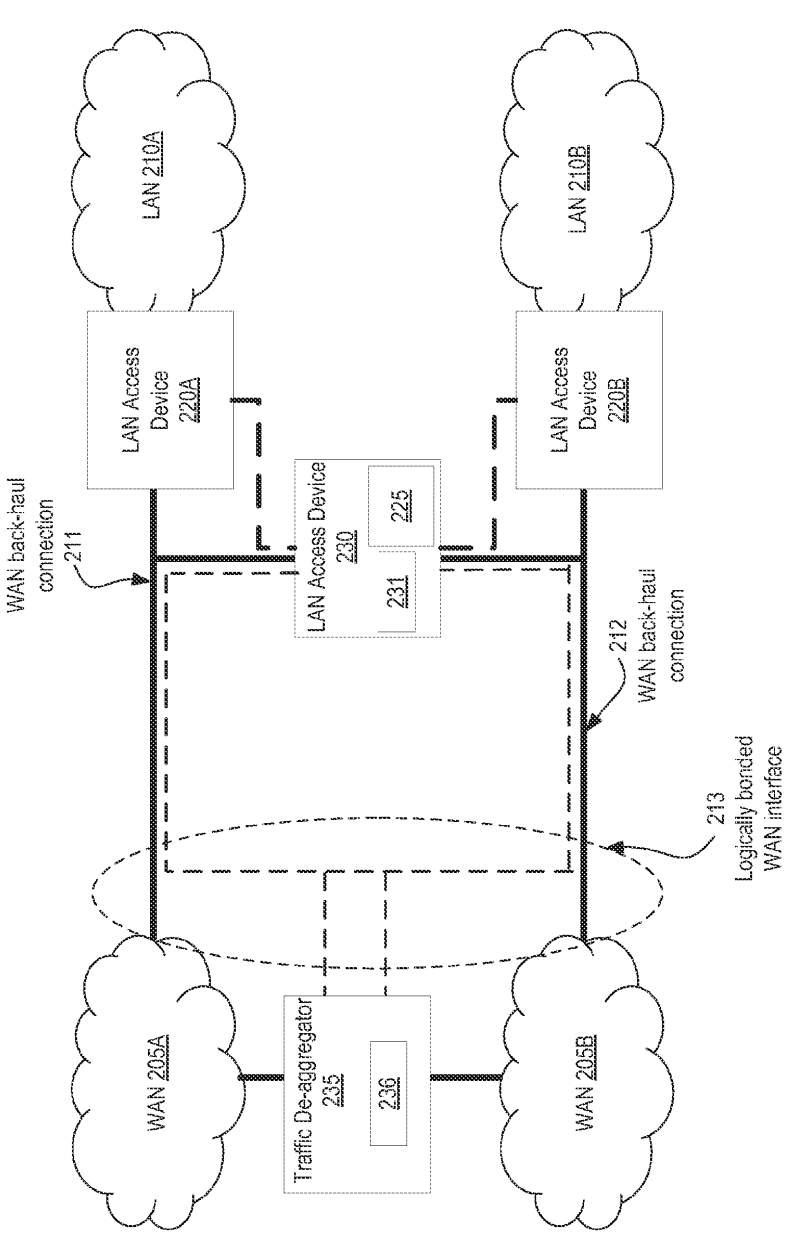


FIG. 2G

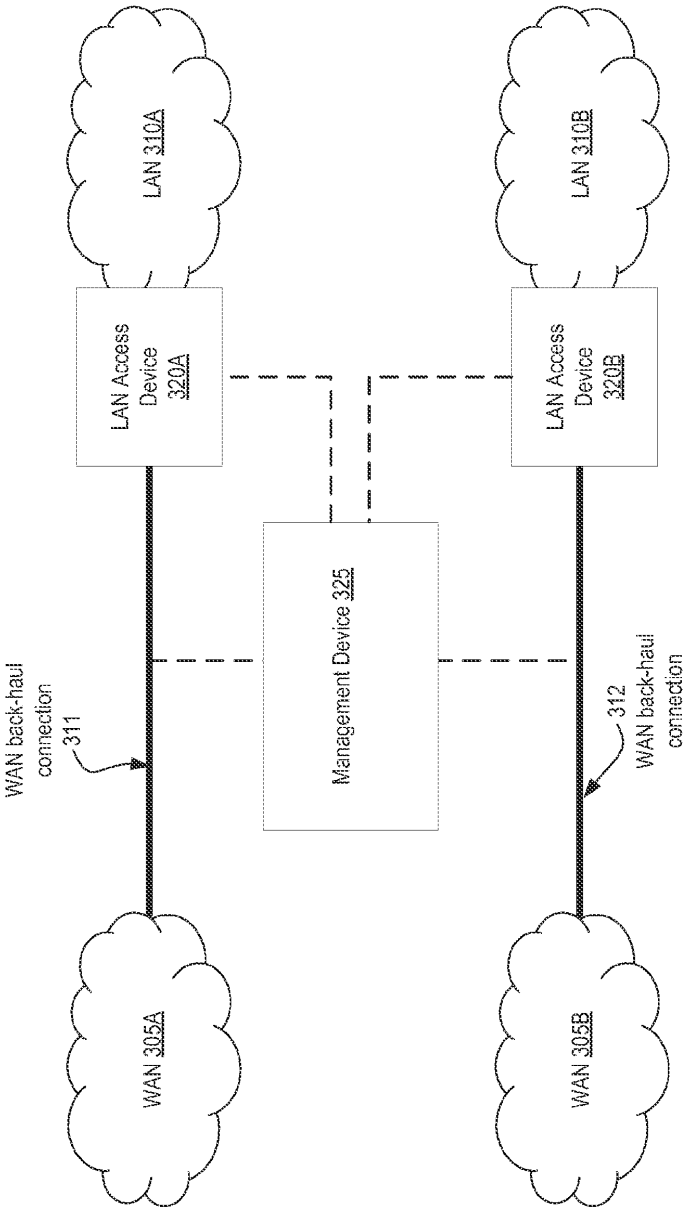
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FIG. 2H



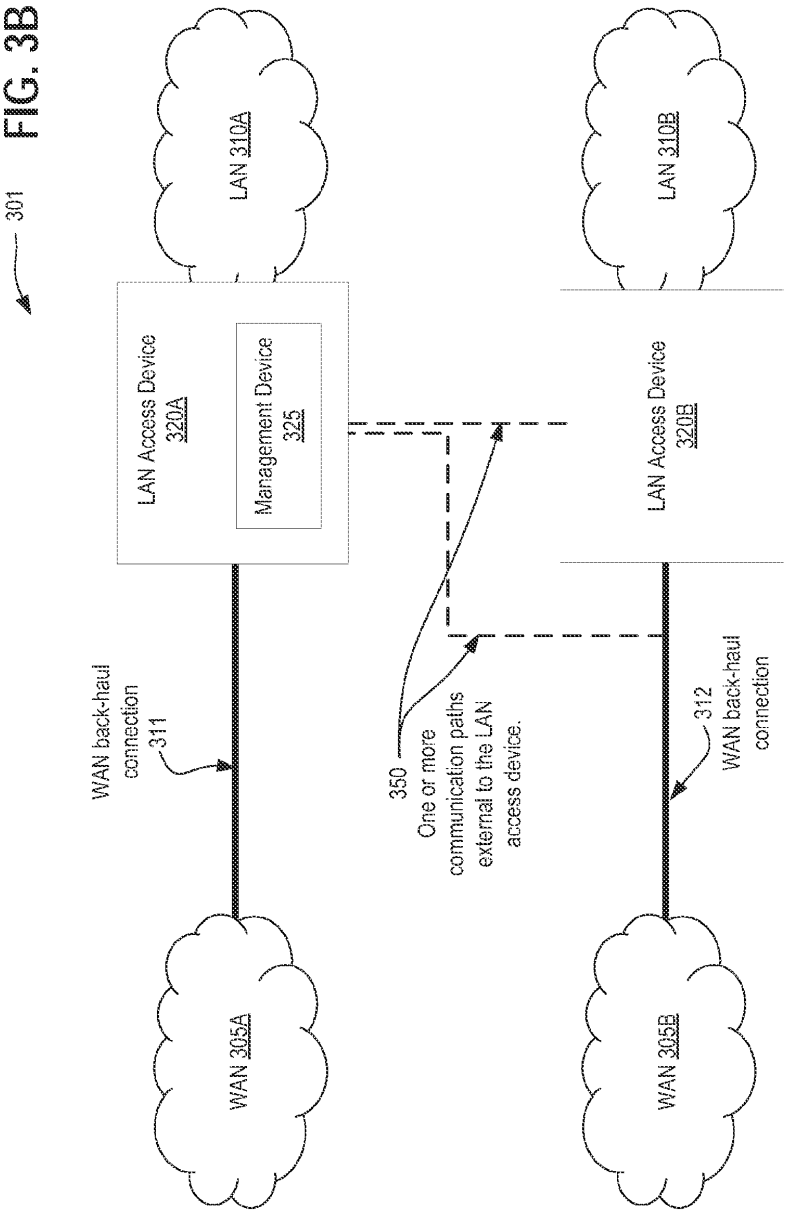
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FIG. 3A



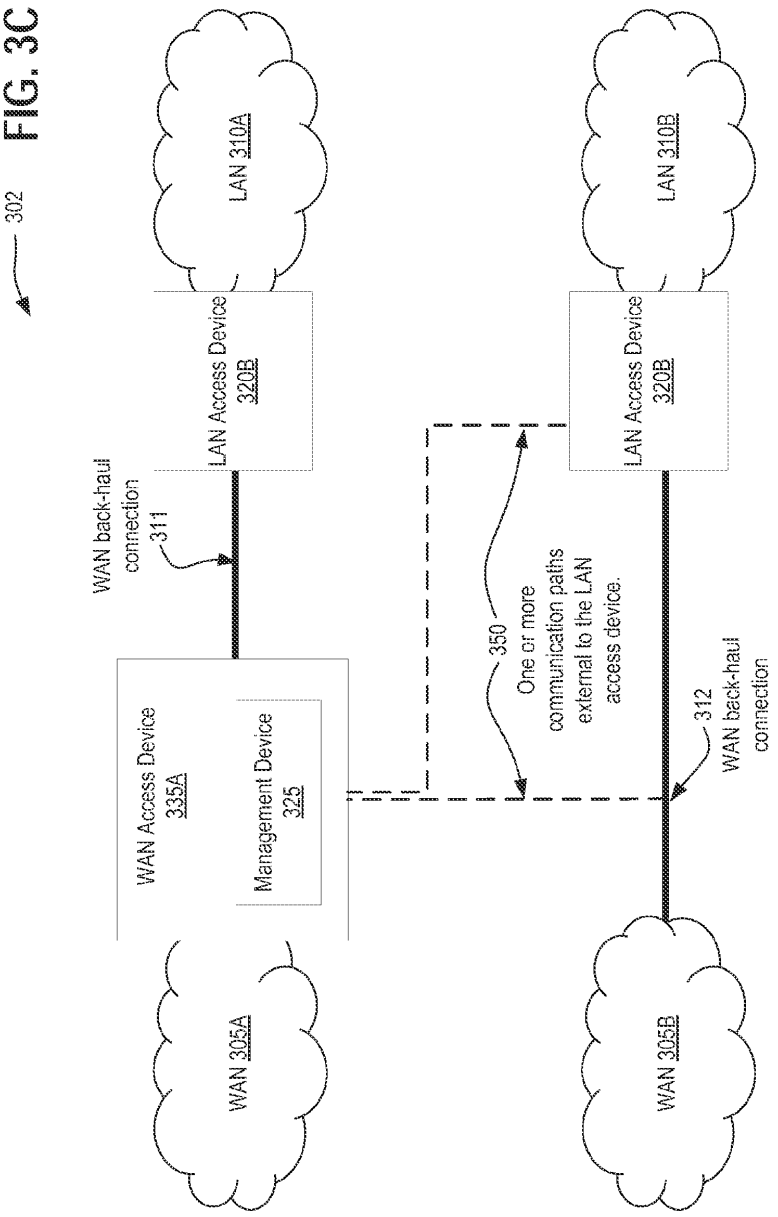
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FIG. 3B



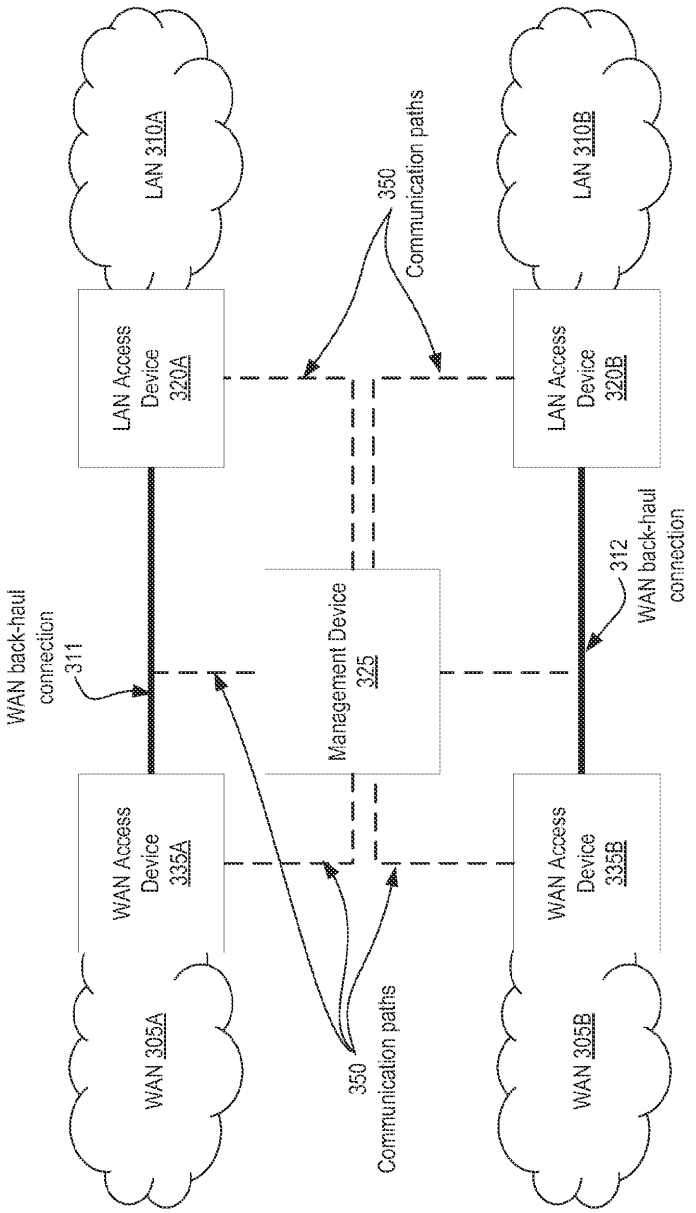
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FIG. 3C



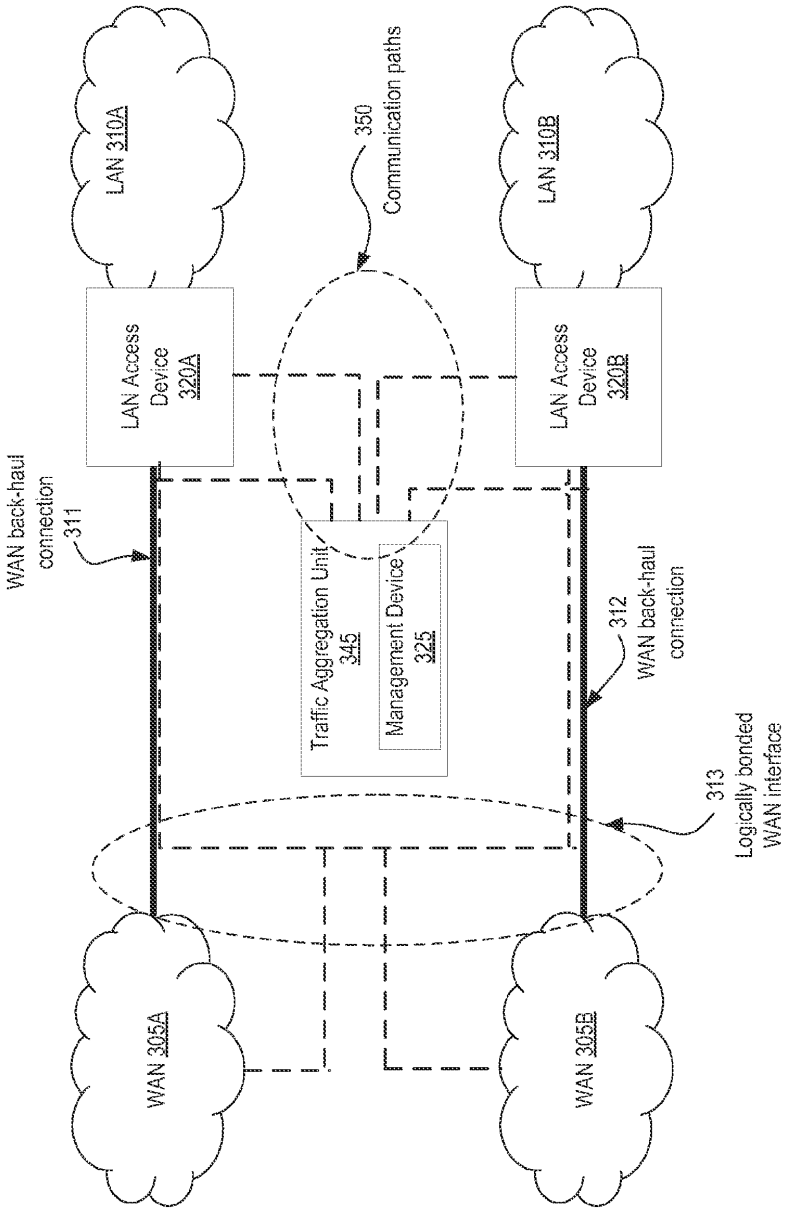
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FIG. 3D



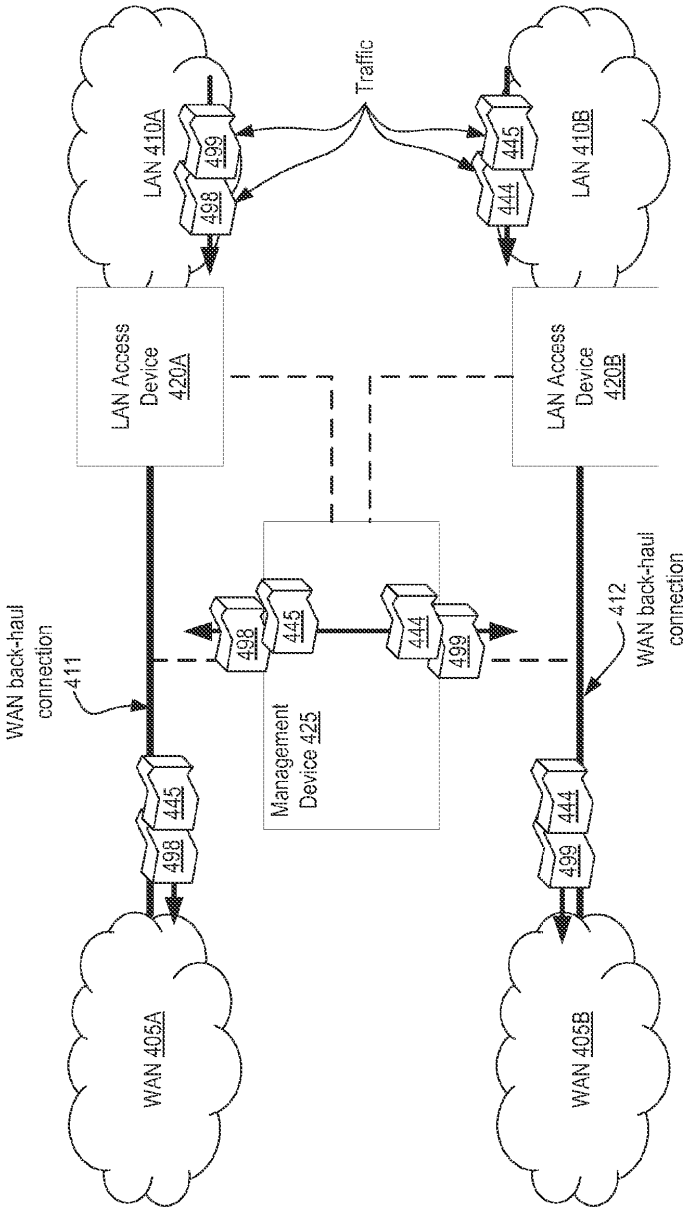
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FIG. 3E



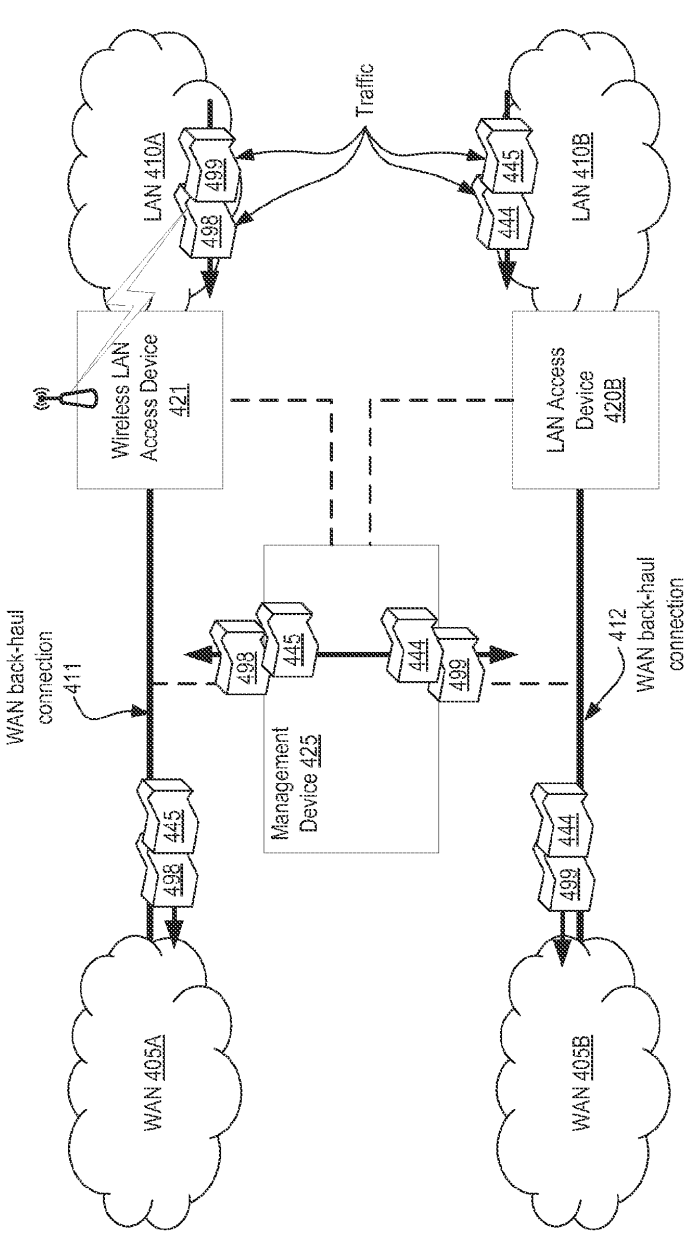
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FIG. 4A



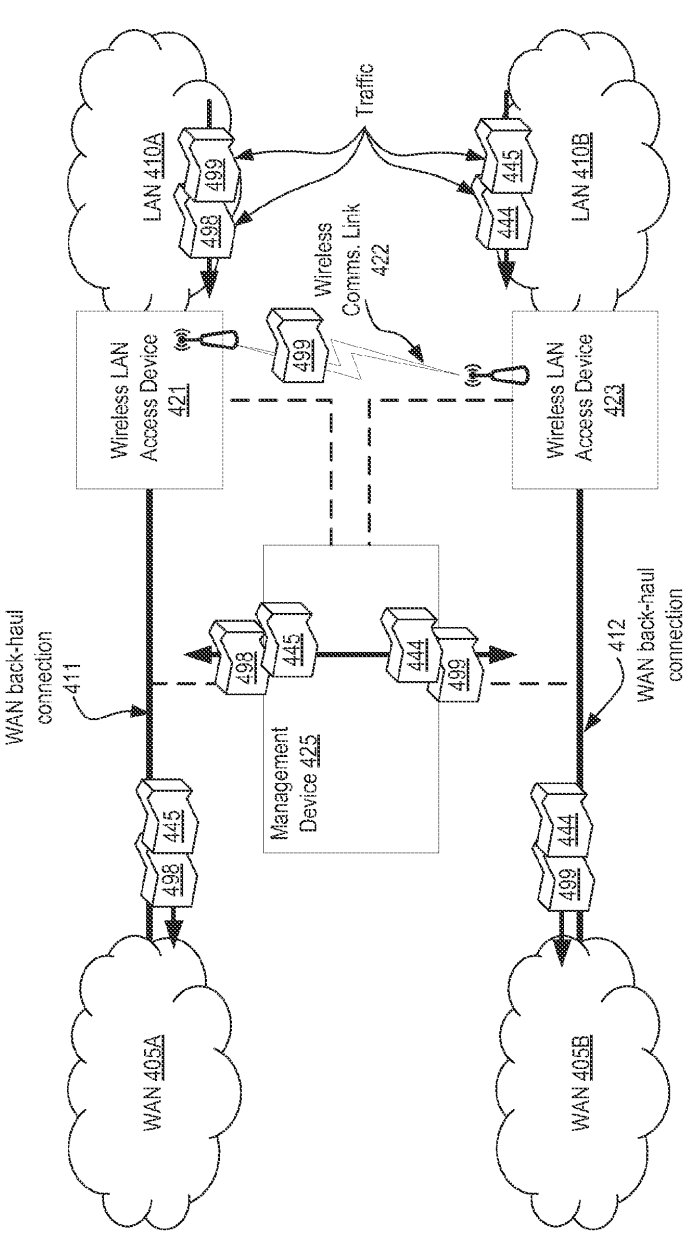
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FIG. 4B



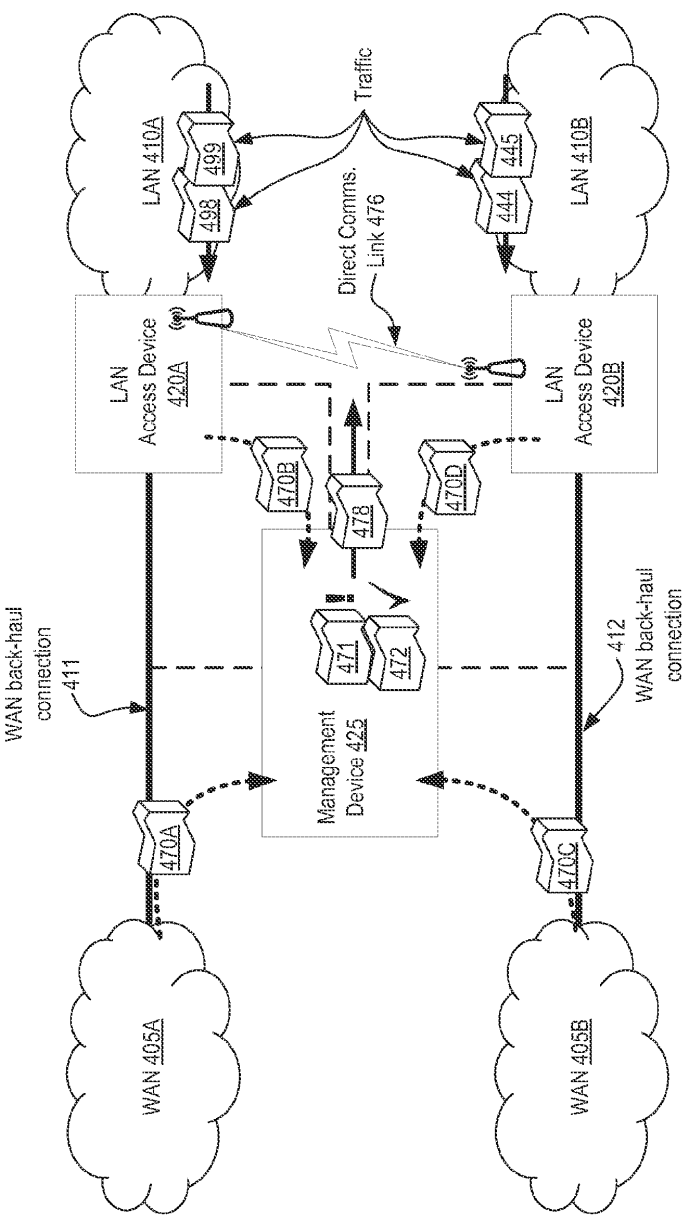
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FIG. 4C



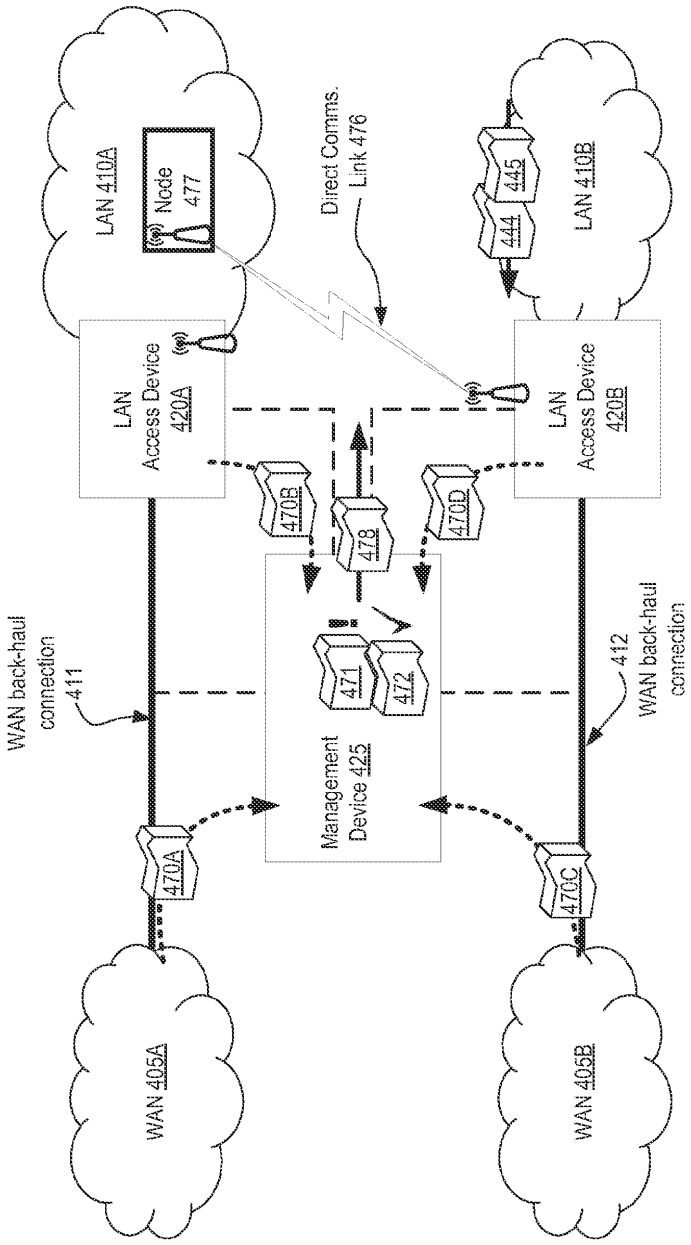
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FIG. 4D



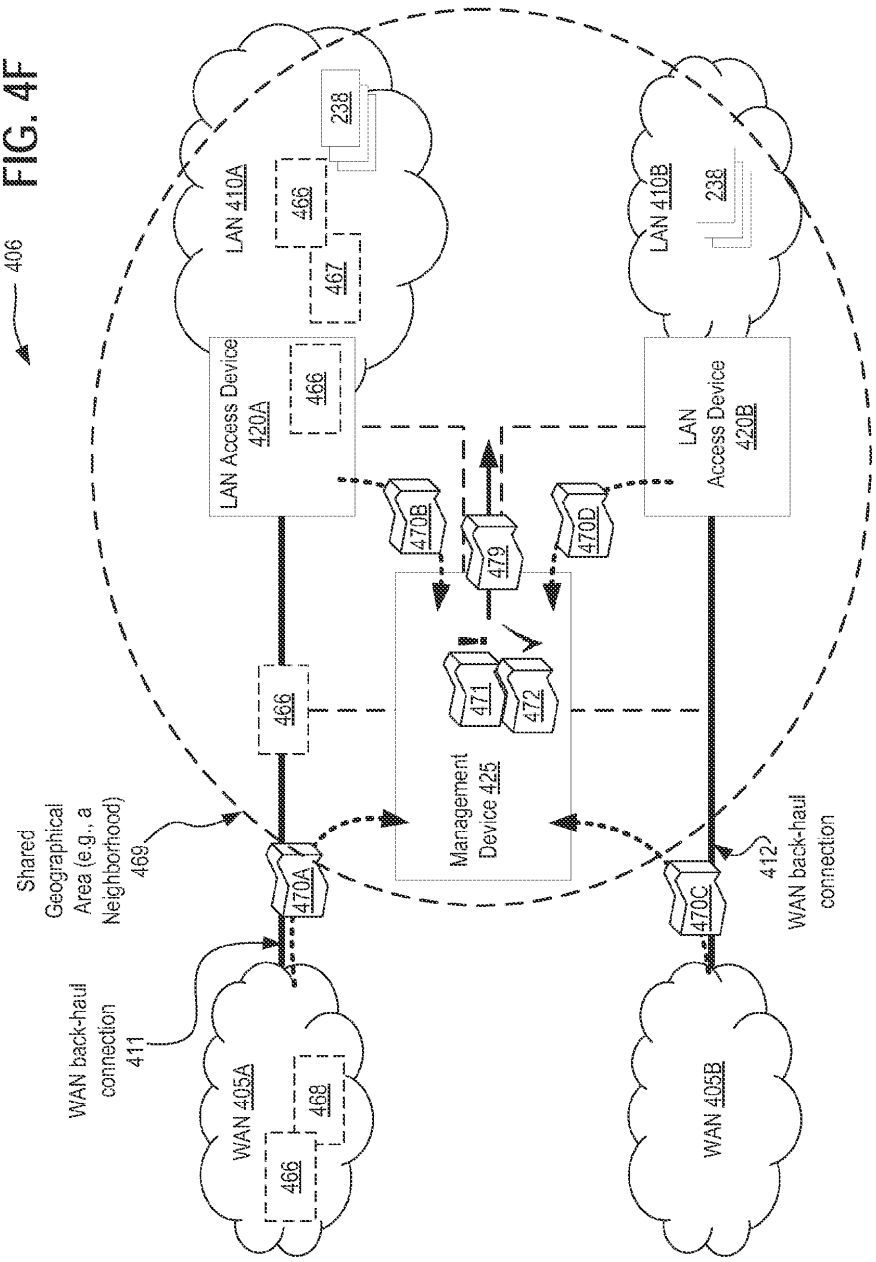
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FIG. 4E



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FIG. 4F



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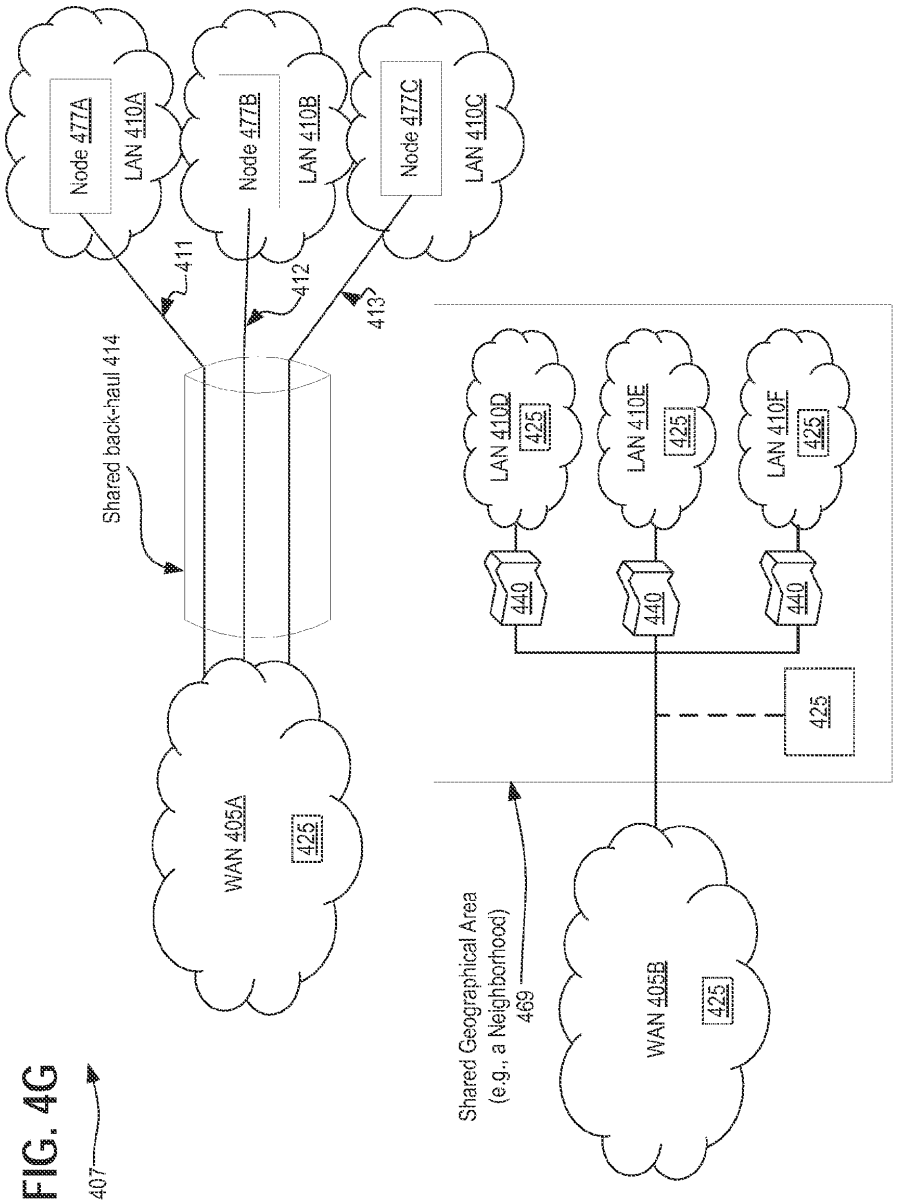


FIG. 4G

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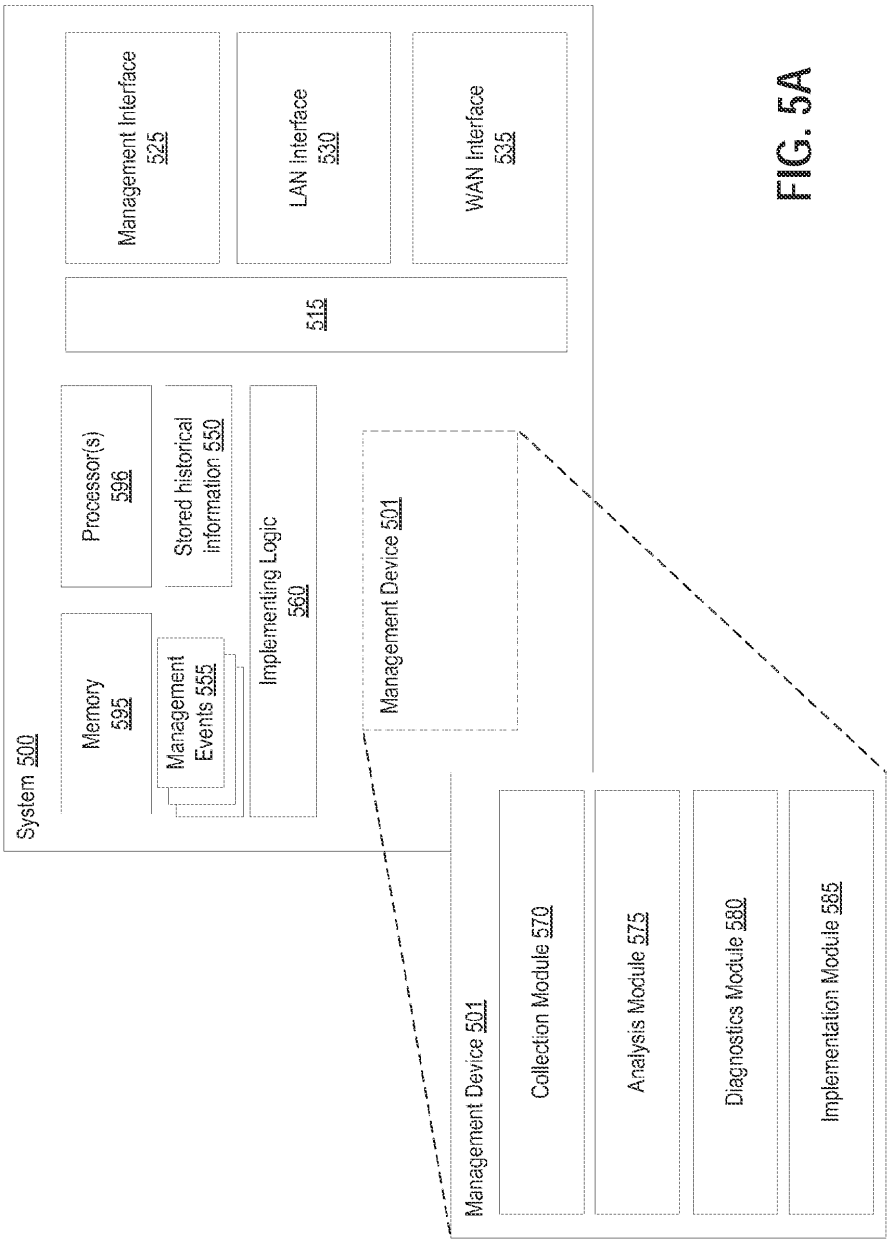


FIG. 5A

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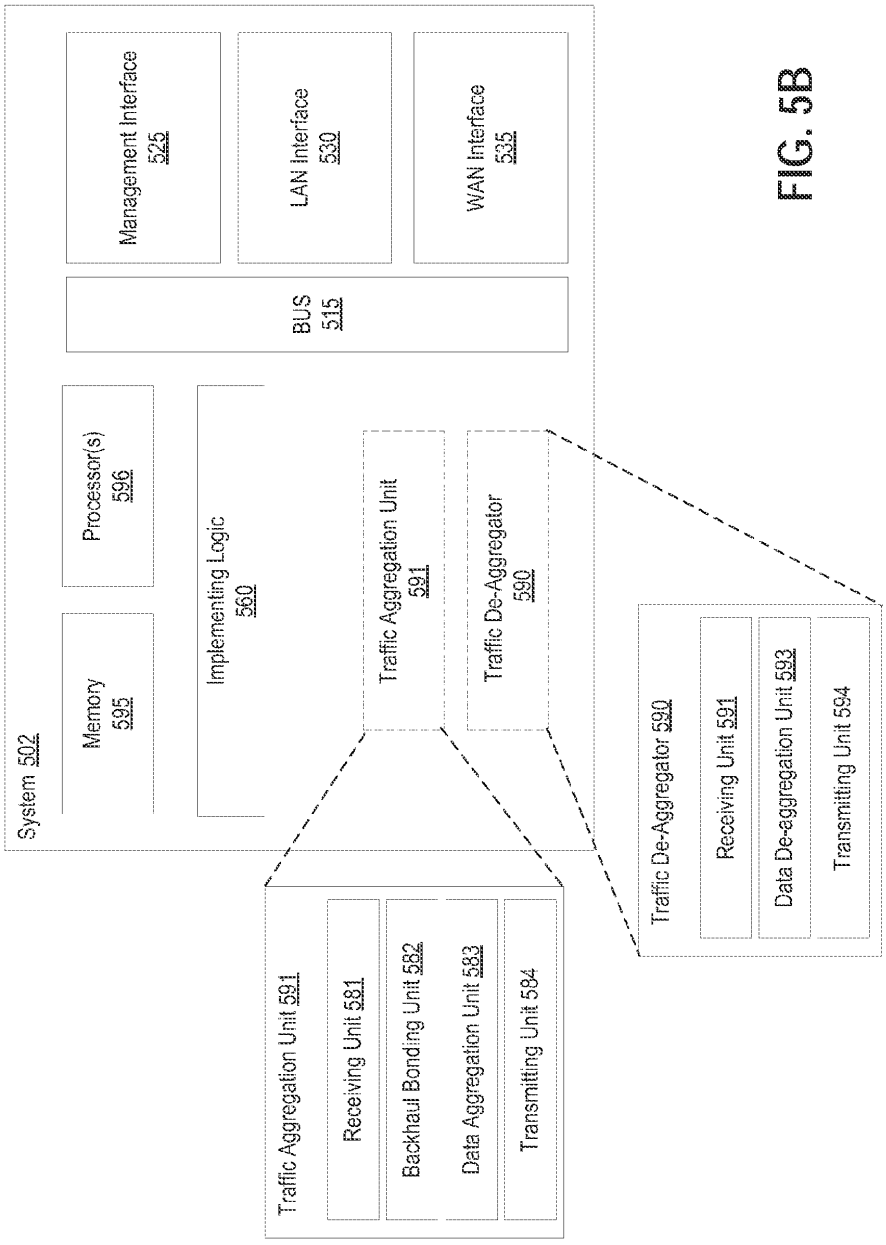
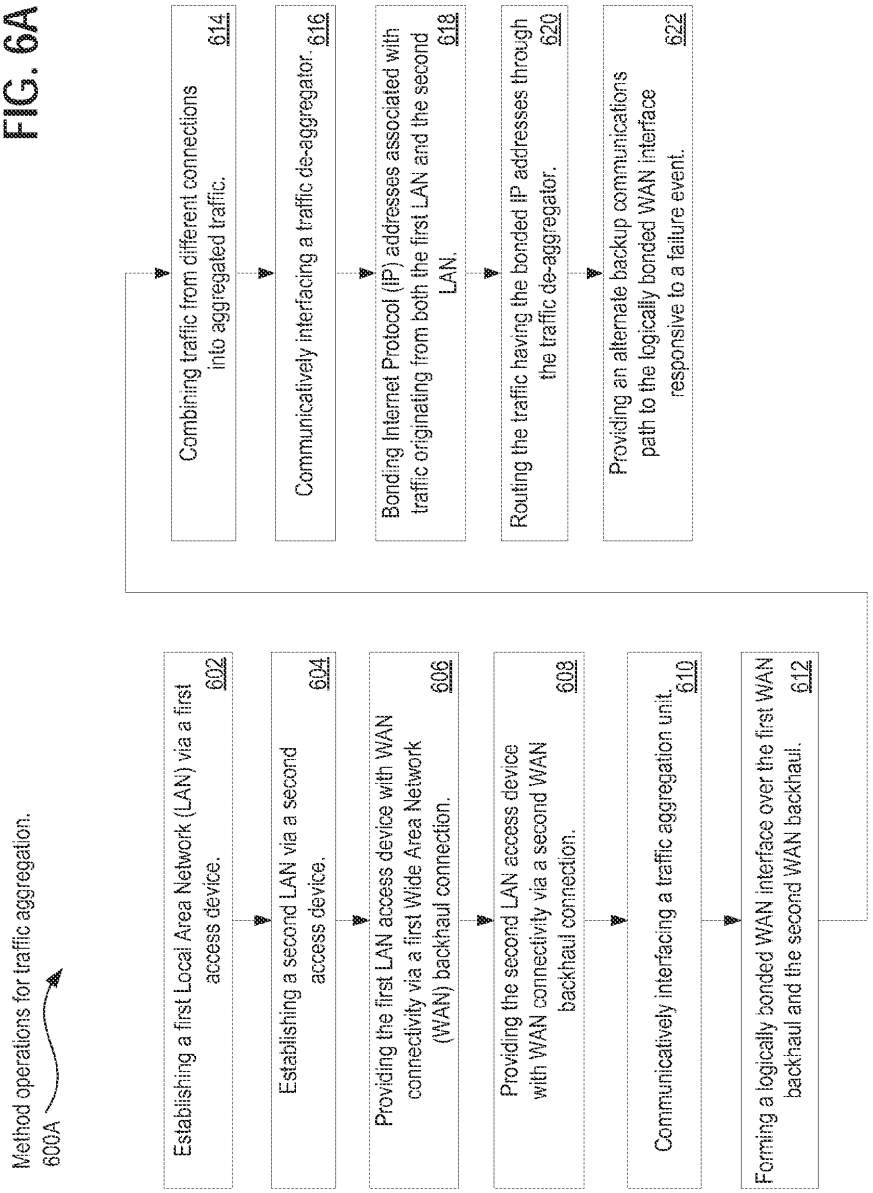


FIG. 5B

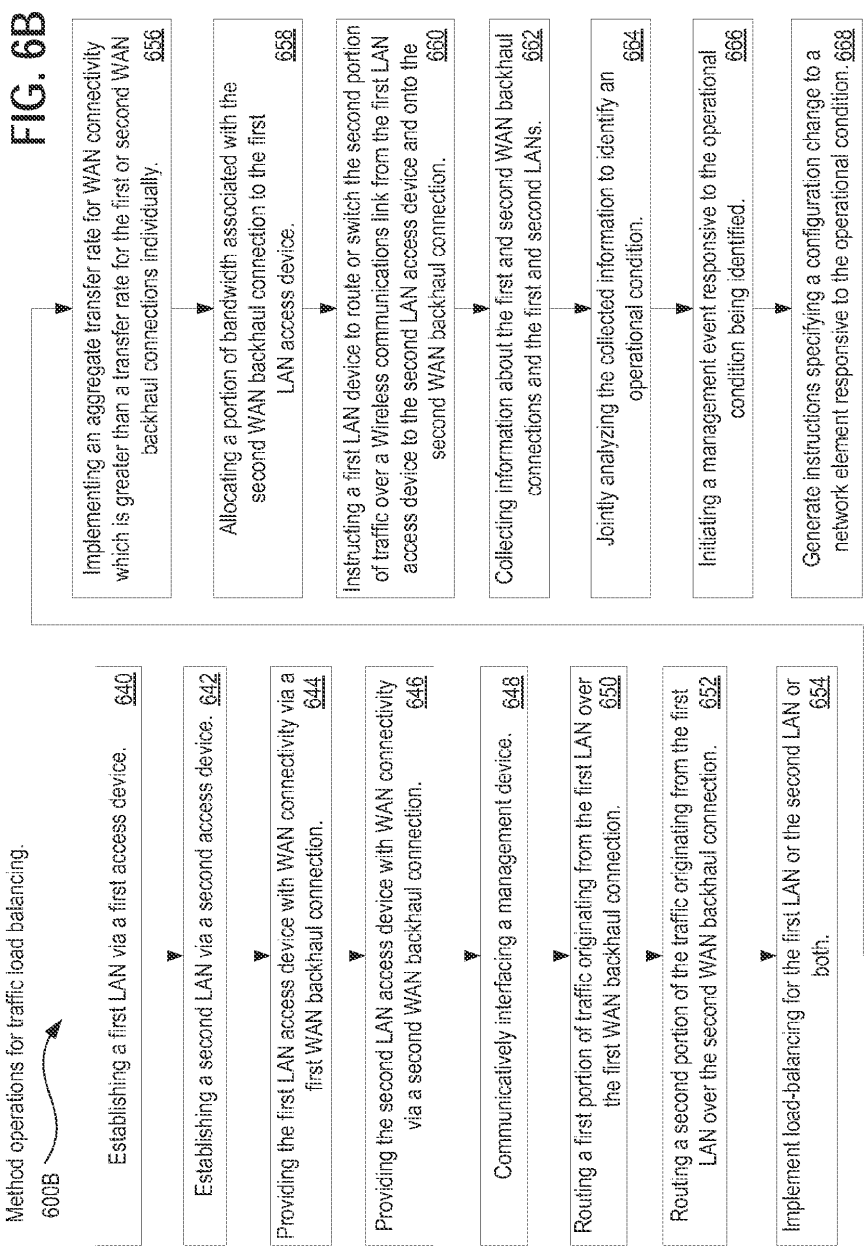
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FIG. 6A



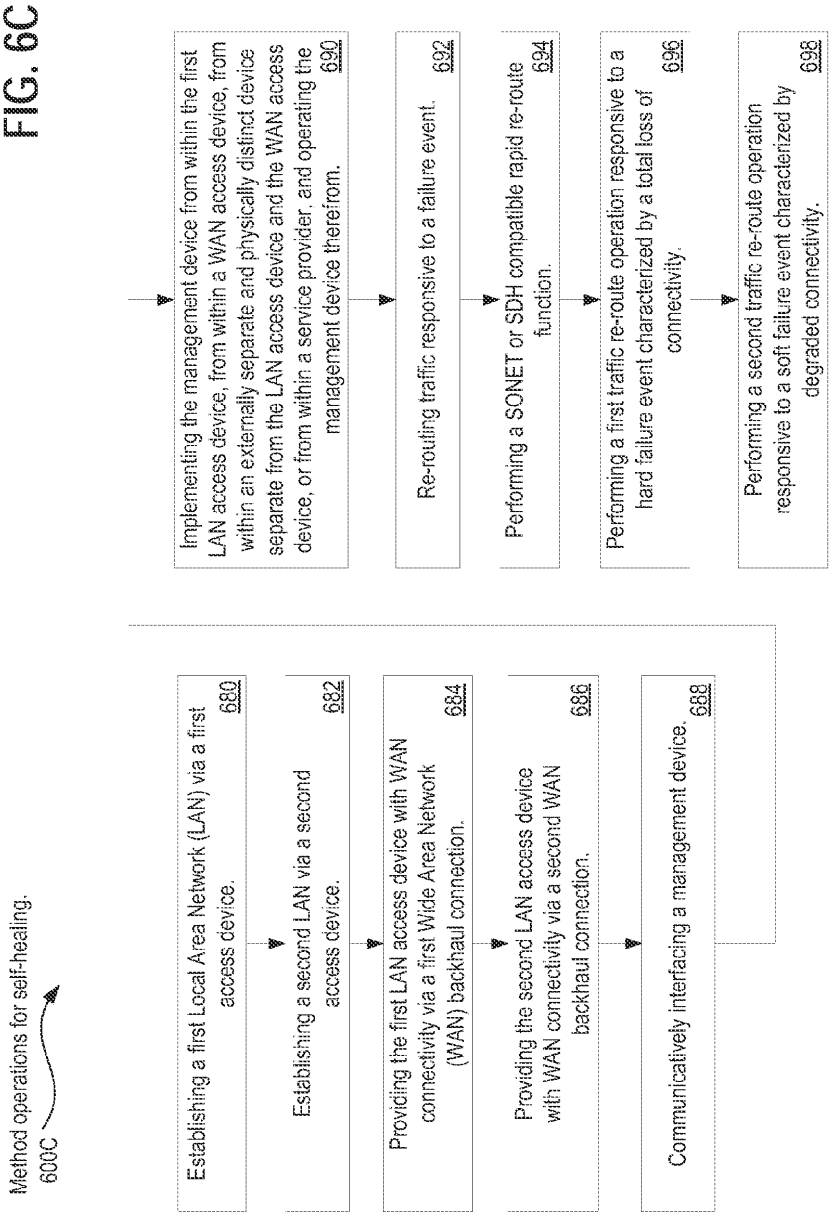
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FIG. 6B



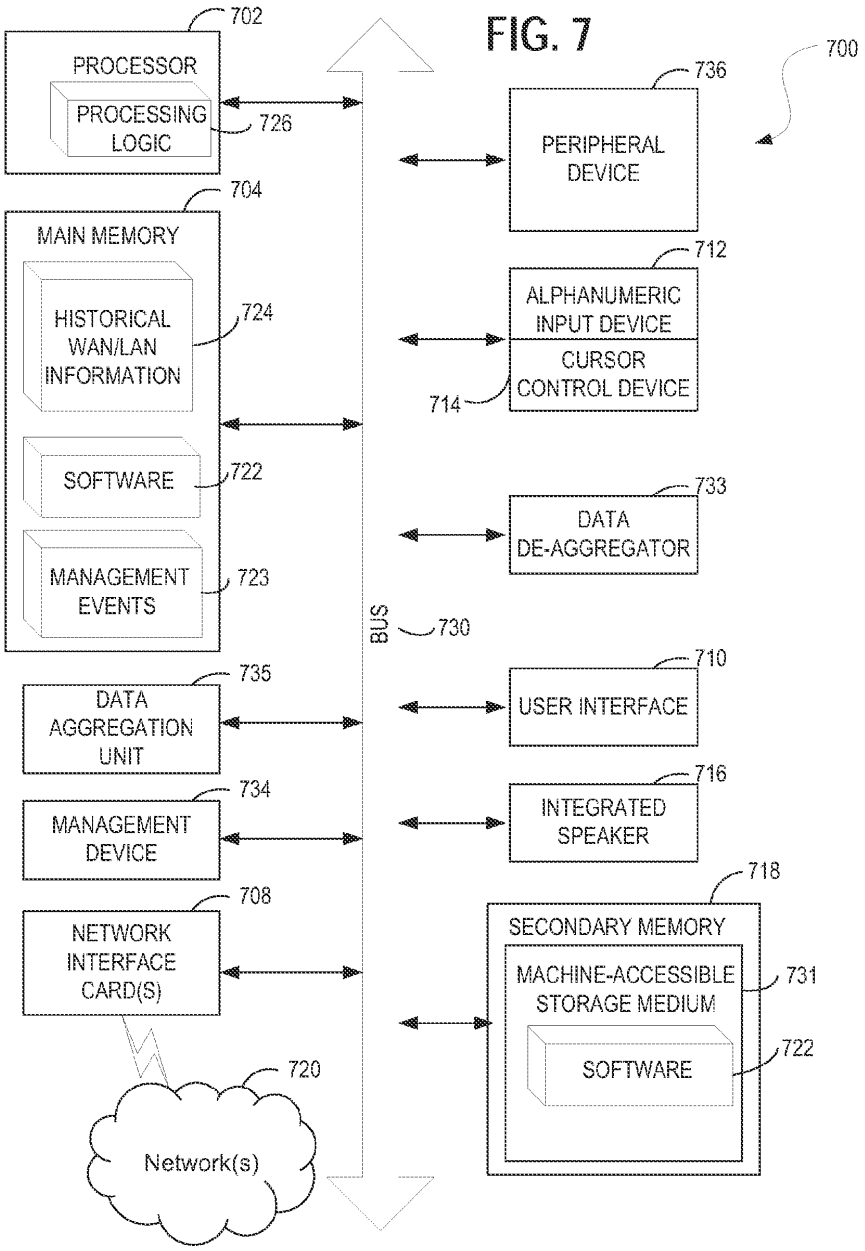
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FIG. 6C



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FIG. 7



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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/063326

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/56 H04L12/28
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/116411 A1 (LINK FUSION LTD [IL]; FERMON ISRAEL [IL]) 18 October 2007 (2007-10-18) the whole document	1-55
X	US 2011/110359 A1 (COOKE STEPHEN P [CA] ET AL) 12 May 2011 (2011-05-12) the whole document	1-55
X	EP 2 112 781 A1 (KONINKL KPN NV [NL]) 28 October 2009 (2009-10-28) the whole document	1,38,54, 55

-/-

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 February 2012	15/02/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schneider, Gernot

1

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	BEES DUNCAN: "Flexible Bandwidth Services with DSL Bonding", INTERNET CITATION, 1 August 2002 (2002-08-01), pages 1-23, XP002495657, Retrieved from the Internet: URL: http://www.pmc-sierra.com/cgi-bin/document.pl?docnum=2021395 [retrieved on 2002-08-01] the whole document ------	1-55

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/063326

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007116411 A1	18-10-2007	NONE	
US 2011110359 A1	12-05-2011	CA 2730020 A1	14-01-2010
		EP 2304893 A1	06-04-2011
		US 2011110359 A1	12-05-2011
		WO 2010003251 A1	14-01-2010
EP 2112781 A1	28-10-2009	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 August 2016 (04.08.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/123497 A1

(51) International Patent Classification:
H04L 29/06 (2006.01) *H04W 4/02* (2009.01)

(21) International Application Number:
PCT/US2016/015683

(22) International Filing Date:
29 January 2016 (29.01.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/109,590 29 January 2015 (29.01.2015) US

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(74) Agents: **ROCCIA, Vincent, J.** et al.; 1800 JFK Blvd., Suite 1700, Philadelphia, PA 19103 (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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

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

(54) Title: BANDWIDTH PREDICTION AND PREFETCHING FOR ENHANCING THE QOE OF APPLICATIONS OVER WIRELESS NETWORKS

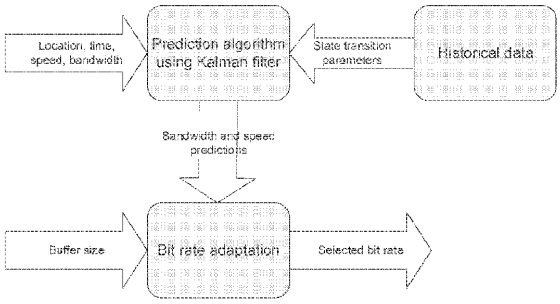


FIG. 3

(57) Abstract: Systems and methods for adaptively streaming video content to a wireless transmit/receive unit (WTRU) may comprise determining current information associated with the WTRU, the current information including at least one of a location, a speed, a time, a data throughput, and a day; comparing the current information with previously determined information for the WTRU; predicting a future location for the WTRU; predicting an available network bandwidth at the future location; and determining a bit rate for the WTRU to request for a content segment, based on the predicted available network bandwidth for the predicted future location.

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BANDWIDTH PREDICTION AND PREFETCHING FOR ENHANCING THE QOE OF APPLICATIONS OVER WIRELESS NETWORKS

CROSSREFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. provisional patent application no. 62/109,590, filed January 29, 2015, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Video streaming clients, network access points (*e.g.*, Access Points in a Wi-Fi network, eNB in an LTE network), and/or content delivery network (CDN) edge servers may use Dynamic Adaptive Streaming over HTTP (DASH), where a video file is stored on an HTTP server, as a series of small video segments. Each video segment may contain several seconds of video content and may be encoded at different bit rates, *e.g.*, video qualities. The video client may determine which bit rate of the subsequent video segment should be requested.

SUMMARY

[0003] Systems and methods for adaptively streaming video content to a wireless transmit/receive unit (WTRU) may comprise determining current information associated with the WTRU, the current information including at least one of a location, a speed, a time, a data throughput, and a day; comparing the current information with previously determined information for the WTRU; predicting a future location for the WTRU; predicting an available network bandwidth at the future location; and determining a bit rate for the WTRU to request for a content segment, based on the predicted available network bandwidth for the predicted future location.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 is an example diagram of collaborative bandwidth prediction.

[0005] FIG. 2 is an example diagram of standalone bandwidth prediction.

[0006] FIG. 3 is an example diagram of prediction and rate adaptation.

[0007] FIG. 4 is an example diagram of pre-fetching data.

[0008] FIG. 5 is an example diagram of pre-fetched data.

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[0009] FIG. 6 is an example diagram of the effect of pre-fetching on bit rate.

[0010] FIG. 7 is an example diagram of signaling between an edge server, client, and a DASH media content provider.

[0011] FIG. 8 is an example graph showing the cumulative distribution function (CDF) of the error of bandwidth prediction.

[0012] FIG. 9 is an example graph showing video bit rates for a WTRU.

[0013] FIG. 10 is an example graph showing video bit rates for a WTRU.

[0014] FIG. 11 is an example graph showing the CDF of the video bit rates.

[0015] FIG. 12A is a system diagram of an example communications system in which one or more disclosed embodiments may be implemented.

[0016] FIG. 12B is a system diagram of an example wireless transmit/receive unit (WTRU) that may be used within the communications system illustrated in FIG. 12A.

[0017] FIG. 12C is a system diagram of an example radio access network and an example core network that may be used within the communications system illustrated in FIG. 12A.

[0018] FIG 12D is a system diagram of another example radio access network and an example core network that may be used within the communications system illustrated in FIG. 12A.

[0019] FIG. 12E is a system diagram of another example radio access network and an example core network that may be used within the communications system illustrated in FIG. 12A.

DETAILED DESCRIPTION

[0020] A detailed description of illustrative embodiments will now be described with reference to the various Figures. Although this description provides a detailed example of possible implementations, it should be noted that the details are intended to be examples and in no way limit the scope of the application.

[0021] Systems and methods for adaptively streaming video content to a wireless transmit/receive unit may improve QoE ("quality of experience") of applications by predicting the available bandwidth. This prediction may be based on the previous measurements of the past and/or current trips, and/or pre-fetching data. Although the available bandwidth may change and may change quickly in wireless networks, the bandwidths of the same location measured at the same time of a day and the same day of a week (*e.g.*, or a weekday or opposed to a weekend) may exhibit significant similarity. This observation may provide an opportunity to predict the available bandwidth at the same locations in the future. With the prediction, systems may

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improve and/or optimize the bit rate selection algorithm of DASH to improve the video quality in terms of video bit rate. This improvement and/or optimization may avoid rebuffering and/or may reduce the frequency of video bit rate switching. The prediction may be used for other applications and/or may be used to provide a user feedback for route selection. A current serving radio access point may inform the next radio access point which may then pre-fetch data for a wireless transmit/receive unit (WTRU).

[0022] A standalone bandwidth prediction system that allows the video client (*e.g.*, a WTRU) to predict the bandwidth and/or the vehicle speed based on its own measurements made in the past and current trips may be provided.

[0023] An available bandwidth algorithm and/or a Kalman filter may be used. An offline algorithm may be used to determine the parameters in the Kalman filter's state transition models, and/or a prediction algorithm based on the Kalman filter. A vehicle speed prediction algorithm may be included which may be similar to that used to determine the parameters in the Kalman filter's state transition.

[0024] A video bit rate adaptation algorithm for DASH that may improve and/or maximize the video quality, and/or avoid buffer underflows.

[0025] Route selection based on the available bandwidth of the WTRU route may be utilized.

[0026] A current serving radio access point may be used to inform the next radio access point which may then pre-fetch data for the WTRU.

[0027] Multiple system architectures of bandwidth prediction for DASH are described. However, the applications are not limited to DASH, and may include video telephony, web browsing, cloud gaming, cloud computing, augmented reality, and/or the like. One or more examples disclosed herein may relate to predicting the available bandwidth at a future location, improving a bit rate selection algorithm for DASH, and/or data pre-fetching mechanisms for improving the "quality of experience" (QoE) of applications, such as DASH-based video streaming, for example. One or more systems and methods may include a collaborative bandwidth prediction, where one or more users may share bandwidth measurements with a server, and the server may make the prediction for a user. One or more systems and methods may include a standalone bandwidth prediction, where a user (*e.g.*, the mobile device of a user or WTRU) may make a prediction based on its own previous measurements.

[0028] One or more of the systems and methods disclosed may be applied to many wireless networks (for example, Hotspot 2.0). The systems and methods may use a wireless transmit/receive unit (WTRU) in a vehicle. The systems and methods may use a WTRU that is not in a vehicle. The systems and methods may be used with a WTRU carried by a pedestriain.

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For example, the systems and methods may be used with a WTRU carried by a pedestriain walking in a shopping mall. The systems and methods may be used in a DASH enviornemnt, and are applicable to other environments.

[0029] FIG. 1 is a diagram of an example of a collaborative bandwidth prediction (CBP) system and method. In FIG. 1, the DASH media server may store video segments generated from different encoding versions of a video content. A DASH media presentation description (MPD) server may comprise MPD files describing basic segment information, including any of URL, video resolution, bit rate, codec, time and/or duration. The CBP server may collect the users' bandwidth measurements, including any of time, device type information (*e.g.*, Long Term Evolution (LTE), Evolved High-Speed Packet Access (HSPA+), antenna configuration, *etc.*), and wireless carrier information (*e.g.*, AT&T, Verizon, *etc.*). The CBP server may select a subset of users that used or are using the same wireless network at a location for which the prediction is to be made. The CBP server may make the prediction for users. Users in the network may report their own bandwidth to the CBP server periodically, and, for example, may do so even when they are not in a video streaming session. With this bandwidth information, the CBP server may maintain a bandwidth map containing the real-time bandwidths at different locations. The DASH client may predict its own movement. The DASH client may request the available bandwidths of the locations where it may probably arrive in subsequent time durations from the CBP server. With the predicted bandwidth, movement, and/or MPD, the WTRU may determine the appropriate video segment and/or may request the media data from the DASH media server.

[0030] An advantage of the CBP approach is that it may provide accurate and/or real-time prediction to the video client, including at locations the video client has never been before. The CBP server may maintain a bandwidth map for multiple kinds of client models because different client models may use different wireless networks or may have different technical specifications (*e.g.*, different numbers of antennas), which may result in different bandwidths at the same time at the same location.

[0031] The measurements taken at a WTRU may not have to be in the original form, for example, to save communication bandwidth. The measurements may include summary statistics. For example, if the original distance interval for the measurement is d meters, the summary statistics may be in kd meters, where k is an interger greater than 1.

[0032] An application may be downloaded to a WTRU. The application may carry out the messaging between the WTRU and the CBP. The application may provide the client the option to share its measurements or not, and different pricing schemes may be associated with the

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choice. For example, if the user shares, the cost of using this service may be lower or free. Otherwise, the cost may be higher.

[0033] The application may check the available bandwidth of the route the WTRU is taking, and if the available bandwidth is not sufficient to maintain the quality of the application, it may suggest that the user take a different route, for example, by prompting a suggestion on a GUI.

[0034] FIG. 2 is an example of a diagram of a standalone bandwidth prediction (SBP) system and method. In systems and methods using a standalone bandwidth prediction (SBP) a user (*e.g.*, the mobile device of a user or WTRU) makes a prediction based on its own previous measurements. A difference between SBP and CBP is that there may be no CBP server in the SBP network. With a SBP system, a DASH client (*e.g.*, WTRU) may measure its own bandwidth and may save the bandwidth measurement and the corresponding location at its local storage. For example, a DASH client (*e.g.*, WTRU) may measure its own bandwidth each time it visits a location and may save the bandwidth measurement and the corresponding location at its local storage. The DASH client (*e.g.*, WTRU) may predict the bandwidth of the location before it takes the next visit to that location, for example, after several visits to a location. A DASH client (*e.g.*, WTRU) may request the appropriate video segments from a DASH media presentation server, for example, similar to the CBP architecture, with the predicted bandwidth and/or movement.

[0035] An advantage of the SBP approach may be easy implementation that a new node may not be required at the network to access the bandwidth information of the LTE network. In the SBP approach, a DASH client (*e.g.*, WTRU) may need to learn its bandwidth map, and during the learning phase, the bandwidth prediction and/or the DASH bit rate selection may not be accurate.

[0036] FIG. 3 illustrates an architecture of a local prediction and rate adaptation to improve and/or optimize the video quality. Current location, time, speed and/or bandwidth are used to predict the speed and/or bandwidth of upcoming locations. A Kalman filter may be used to predict the speed and/or bandwidth. State transition parameters may be determined by historical data. The bandwidth, speed predictions, and/or the current buffer size may be fed to the bit rate adaptation algorithm to choose an appropriate bit rate.

[0037] The historical data may contain the following information: the network operator; the available bandwidth and/or the speed as a function of location and/or time.

[0038] The local predictor may check the available bandwidth of the route of the WTRU. If the available bandwidth is not sufficient to maintain the quality of the call, the local predictor

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may suggest that the user take a different route, for example, by prompting a suggestion on a GUI.

[0039] Given the available bandwidth prediction, the WTRU may use the available bandwidth prediction in different ways. If there is excess available bandwidth in some sections of the predicted path and the prediction indicates later sections of the path having insufficient bandwidth ahead, the WTRU may use or may plan to use the excess available bandwidth in some sections to pre-fetch content to be used in the later sections of the path, assuming that the WTRU has suffcient buffer space. This may improve the content quality for future sections.

[0040] If there is no excess available bandwidth in some sections of the predicted path, for example, the availabe bandwidth is already fully utilized for the content to be played in the sections, the WTRU may request lower bitrate content for the sections and that may leave some available bandwidth unused, which may be used to pre-fetch the content to be played for future sections. This may avoid rebuffering.

[0041] The standalone bandwidth prediction approach may incur zero communication overhead, which may be an advantage over the collaborative bandwidth prediction approach.

[0042] FIG. 4 is an example of a diagram of a system and method for pre-fetching data. The current radio access point may predict the route that a WTRU may take and may notify the subsequent radio access points on the route. The notification may include one or more of the following: the predicted time when the WTRU may enter the service area of the subsequent radio access points, the source of the data the WTRU is consuming, what data objects the WTRU is consuming, and/or what data objects the WTRU is expected to consume in the future. These subsequent radio access points may pre-fetch data in anticipation that the WTRU may visit their respective service area in the future. The pre-fetched data may be cached and may be sent when the WTRU gets into the service area of the radio access point that caches the data.

[0043] As an example, Fig. 4 shows an architecture for an LTE network. eNB 1 may notify eNB 2 of the time T when the WTRU may probably enter the service area of eNB 2. eNB1 may notice eNB2 of the source of data that the WTRU may require, and eNB 2 may pre-fetch the required data. To assist the transition from eNB 1 to eNB 2, the data pre-fetched at eNB 2 may overlap with that at eNB 1. When the WTRU enters the service area of eNB 2, the WTRU may download the data directly from eNB 2, which may reduce the RTT, and may increase the throughput. The WTRU may download the data directly from eNB 2 instead of downloading data from the Internet. This method may be applied to, but is not limited to, DASH.

[0044] The content cached by one access point may overlap with the content cached by the next access point, which may assist in maintaining the continuity of the content. This may be

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beneficial if there is prediction inaccuracy. The amount of overlapping may be a function of prediction inaccuracy. As an example, for the network shown in FIG. 4, the content may be portioned in playback time (*e.g.*, in seconds) as shown in FIG. 5. The first access point, eNB1, may pre-fetch the content from the first second to the fifth second, and the second access point, eNB2, may pre-fetch the content from the fifth second to the ninth second. The two pre-fetched contents may overlap in the 5th second, as shown in FIG. 5.

[0045] FIG. 6 is an example of a diagram showing the bit rate over time for a WTRU transitioning between eNB 1 and e NB 2. As illustrated in FIG. 6, assume that the WTRU, which may be a DASH video player, enters the service area of eNB 2 at time T, and its buffered data plays until time T'. Without pre-fetching, the WTRU continues to play low quality video after T'. If the pre-fetching at eNB 2 is enabled, high bit rate video may be pre-fetched at eNB 2. Because high bit rate video has been pre-fetched and is available at the access point, the throughput to the WTRU may be increased. Thus, the video bit rate after T' may be improved.

[0046] The throughput may increase because of the following: the throughput of a TCP connection is upper bounded by:

$$Throughput \leq \frac{M \cdot C}{RTT\sqrt{p}} \quad (1)$$

M is the maximum segment size, RTT is the round trip time, P is the probability of packet loss, and C is a constant determined by the TCP implementation. RTT is the sum of RTT_1 and RTT_2, which are the round trip times between the UE and the eNB, and between the eNB and the Internet server, respectively. For LTE network, RTT_1 is usually between 30 to 60 msec, and is proposed to be less than 1 msec for 5G networks. RTT is usually dominated by RTT_2, which may be hundreds of milliseconds when the connection goes through intercontinental routes. When the pre-fetching is enabled, RTT reduces to RTT_1, which increases the throughput.

[0047] FIG. 7 is an example of a diagram of the signaling between the client (*e.g.*, WTRU), a DASH media content provider, and a content distribution network (CDN) edge server. An edge server may be collocated at a wireless access point such as an eNB. The content provider may predict the route based on information provided by the WTRU. The client may send the coverage update, which may include by way of example, one or more of the following: address of video content (*e.g.*, which part of the video content under request), bit rate, bandwidth, location and speed, and/or phone number or other identifier. The client may provide the coverage update to the media server periodically. The content provider may predict the client's (*e.g.*, WTRU's) route, decide edge servers to be pre-cached, and/or may send the client (*e.g.*,

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WTRU) the address of such edge servers. The content provider may suggest the bit rate for the client.

[0048] The content provider may obtain the predicted route from a third party including a location service, such as Google, *etc*. The location may be obtained in various ways. For example, the phone number associated with the client may be passed to the third-party location service to query about the location of the client.

[0049] For a standalone approach, the client may predict its own movement, and may send the content provider its future locations. The media server may pre-cache the media data to the corresponding edge servers (*e.g.*, based on the predicted route information provided by the client). The network-only approach may involve multiple content providers along the route. Cloud computing may be applied to reduce the delay including RTT, computing time of the algorithm, *etc*. The WTRU may use the same prediction algorithms and the bit rate selection algorithm that are described with respect to the SBP approach.

[0050] The historical data on the available bandwidth and speed for one or more WTRUs are stored in the network. The network may predict the future locations of a WTRU and/or the times associated with the locations. The network may decide which wireless access point (or access points) may pre-fetch the content that the WTRU is likely to use in the future. The network may provide to the client information about the quality and/or the bit rate of the content to be requested.

[0051] A client (*e.g.*, WTRU) may observe its current location, speed, and available bandwidth, device type, and/or the associated network operator (*e.g.*, AT&T or Verizon) and provide the information to an entity (network service enhancing node or NSEN) in the network. The NSEN may aggregate such information from one or multiple clients.

[0052] The NSEN may predict which access point a WTRU may visit in the future. The NSEN may instruct the access point to pre-fetch content that is likely to be used by the WTRU in the future.

[0053] The NSEN may provide the WTRU information about which quality level (*e.g.*, bit rate of the video) the WTRU needs to request in the future. This information may be used together with the available bandwidth observed locally by the WTRU to decide which quality level to be requested.

[0054] The NSEN may build a map of expected available bandwidth, *e.g.*, as a function of one or more of location, time, day of week, network operator, device type. For a particular WTRU, the NSEN may refine the prediction of the available bandwidth using for example one or

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more of that WTRU's current location, speed, available bandwidth, the number of other devices and the traffic demand of other devices that use the same network.

[0055] The available bandwidth and/or vehicle speed at the future locations may be predicted based on the measurement of the current and/or previous trips. The prediction methods and systems may work cooperatively with both CBP and SBP architectures. The predictive methods and systems may contain movement prediction and/or bandwidth prediction, which predict the vehicle speed and the available bandwidth at future locations, respectively. The algorithms for the movement and bandwidth prediction may be similar.

[0056] An example of the bandwidth prediction algorithm is described below. Assume that the travel route is given and is partitioned into segments of equal length L, for example, L=300 meters. Denote by V_i and B_i the random variables of the vehicle speed and the bandwidth at the i-th segment, respectively. Let the random variable b_i be the measured bandwidth at i-th segment. Generally, the measurement is not accurate and contains random variations. If repeated trips are conducted to collect the historical data, let $\tilde{b}_{i,t}$ be the measured bandwidth at the i-th segment during the t-th trip. Based on the current measured bandwidth, with the help of the historical measurements, the bandwidth prediction may generate a more precise estimate of the bandwidth and may also predict the available bandwidths in the subsequent segments. The prediction method is based on a Kalman filter, which is widely applied in vehicle navigation. The bandwidth may be modeled in the following form:

$$B_{i+1} = \phi_i B_i + N_i \tag{2}$$

for all i, where ϕ_i is the state transition parameter from B_i to B_{i+1}, and N_i is the process noise which is assumed to be drawn from a zero mean Gaussian distribution with variance Q_i. Assume that N_i is independent of B_j and b_j for all j. At the i-th segment, the measurement of the bandwidth is obtained from the following model:

$$b_i = B_i + n_i \tag{3}$$

where n_i is the measurement error which is assumed to be drawn from a zero mean Gaussian distribution with variance q_i. Assume that n_i is independent of B_j, b_j and N_j for all j.

[0057] Before performing the Kalman filter, the parameters ϕ_i, Q_i and q_i in (1) and (2) may be determined from historical data. From (1) and (2), the measured bandwidth b_{i+1}, b_i and b_{i-1} may be expressed as:

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$$b_{i+1} = B_{i+1} + n_{i+1}$$
$$= \phi_i B_i + N_i + n_{i+1}$$
$$= \phi_i \phi_{i-1} B_{i-1} + \phi_i N_{i-1} + N_i + n_{i+1} \quad (4)$$
$$b_i = B_i + n_i$$
$$= \phi_{i-1} B_{i-1} + N_{i-1} + n_i \quad (5)$$
$$v_{i-1} = V_{i-1} + n_{i-1} \quad (6)$$

[0058] The mean of the measured bandwidth b_{i+1} may be written as

$$\mathrm{E}[b_{i+1}] = \mathrm{E}[B_{i+1}] = \phi_i \mathrm{E}[B_i] = \phi_i \mathrm{E}[b_i] \quad (7)$$

[0059] Because of the independence of the random variables B_{i-1}, N_{i-1} and n_i, the variance of the measured bandwidth b_i is obtained from (4),

$$\mathrm{Var}[b_i] = \phi_{i-1}^2 \mathrm{Var}[B_{i-1}] + Q_{i-1} + q_i \quad (8)$$
$$\mathrm{Var}[b_{i-1}] = \mathrm{Var}[B_{i-1}] + q_{i-1} \quad (9)$$

[0060] Because of the independence of B_i, N_i and n_i for all i, the following covariances from are obtained,

$$\mathrm{Cov}[b_{i+1}, b_i] = \phi_i \phi_{i-1}^2 \mathrm{Var}[B_{i-1}] + \phi_i Q_{i-1} \quad (10)$$
$$\mathrm{Cov}[b_{i+1}, b_{i-1}] = \phi_i \phi_{i-1} \mathrm{Var}[B_{i-1}] \quad (11)$$
$$\mathrm{Cov}[b_i, b_{i-1}] = \phi_{i-1} \mathrm{Var}[B_{i-1}] \quad (12)$$

[0061] Referring to the above equations, the mean $\mathrm{E}[b_i]$, variance $\mathrm{Var}[b_i]$, and covariance $\mathrm{Cov}[b_i, b_j]$ of the measured bandwidths may be estimated by the sample mean m_i, sample variance σ_i^2 and sample covariance $\sigma_{i,j}$ of the historical data, where

$$m_i = \frac{1}{N} \sum_{t=1}^{N} \tilde{b}_{i,t} \quad (13)$$
$$\sigma_i^2 = \frac{1}{N-1} \sum_{t=1}^{N} (\tilde{b}_{i,t} - m_i)^2 \quad (14)$$
$$\sigma_{i,j} = \frac{1}{N-1} \sum_{t=1}^{N} (\tilde{b}_{i,t} - m_i)(\tilde{b}_{j,t} - m_j). \quad (15)$$

[0062] Let $\beta_{i-1} = \mathrm{Var}[B_{i-1}]$. Then the equations become:

$$m_{i+1} - \phi_i m_i = 0 \quad (16)$$

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$$\sigma_i^2 - \phi_{i-1}^2 \beta_{i-1} - Q_{i-1} - q_i = 0 \tag{17}$$

$$\sigma_{i-1}^2 - \beta_{i-1} - q_{i-1} = 0 \tag{18}$$

$$\sigma_{i+1,i} - \phi_i \phi_{i-1}^2 \beta_{i-1} - \phi_i Q_{i-1} = 0 \tag{19}$$

$$\sigma_{i+1,i-1} - \phi_i \phi_{i-1} \beta_{i-1} = 0 \tag{20}$$

$$\sigma_{i,i-1} - \phi_{i-1} \beta_{i-1} = 0 \tag{21}$$

[0063] Assume that q_{i-1} and ϕ_{i-1} are known, which may actually be obtained in the previous steps of the algorithm as shown below. The left hand side of the above equations (13)-(21) may be denoted by functions $f_1(\phi)$, $f_2(Q_{i-1}, q_i, \beta_{i-1})$, $f_3(\beta_{i-1})$, $f_4(\phi_i, Q_{i-1}, \beta_{i-1})$, $f_5(\phi_i, \beta_{i-1})$ and $f_6(\beta_{i-1})$. Determining ϕ_i, Q_{i-1} and q_i reduces to solving the following optimization problem,

$$\begin{aligned} &\underset{q_i, Q_{i-1}, \phi_i, \beta_{i-1}}{\text{minimize}} && f(\phi_i, Q_{i-1}, q_i, \beta_{i-1}) = \sum_{m=1}^{6} f_m^2 \\ &\text{subject to} && \phi_i, Q_{i-1}, q_i, \beta_{i-1} > 0. \end{aligned} \tag{22}$$

[0064] The algorithm may be written as described below. This algorithm may be performed offline and may not increase the complexity or latency of the DASH player. The parameters ϕ_i, Q_i and q may be provided to the DASH player. In an example, the algorithm includes the following:

Example Algorithm 1: Determine the state transition paremeter ϕ_i and/or the variances Q_i and q_i of the noises N_i and n_i, respectively.

1. Initialize ϕ_1 and q_1;
2. **FOR** $i = 2$ to N
3. Solve the optimization problem A_i to obtain ϕ_i, Q_{i-1} and q_i;
4. **END FOR**

[0065] With the parameters, the systems and methods may predict the bandwidth at the following segments using the Kalman filter. Let K_i be the Kalman gain at the i-th segment, and P_i^- be the predicted estimate error variance. When a measurement b_i is available, the estimate may be updated by:

$$\hat{B}_i = \hat{B}_i^- + K_i(b_i - \hat{B}_i^-) \tag{23}$$

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where $\hat{B}_i^-$ is a prior estimate without b_i, and $\hat{B}_i$ is the updated estimate. The error variance for the updated estimate may be computed:

$$P_i = (1 - K_i)P_i^- \tag{24}$$

The prior estimate for the next segment may be computed, and the predicted estimate error variance and the Kalman gain for the next segment may be computed:

$$\hat{B}_{i+1}^- = \phi_i \hat{B}_i \tag{25}$$

$$P_{i+1}^- = \phi_i^2 P_i + Q_i \tag{26}$$

$$K_{i+1} = \frac{P_{i+1}^-}{P_{i+1}^- + q_{i+1}} \tag{27}$$

[0066] A Kalman filter may be used. With the measuremetn of b_i of the i -th segment, the speed of the next segment $\hat{B}_{i+1}^-$ may be predicted.

[0067] Similar to the above bandwidth prediction, the vehicle speed may be modeled by the following equations:

$$v_i = V_i + w_i \tag{28}$$

$$V_{i+1} = \psi_i V_i + W_i \tag{29}$$

where v_i is the measured speed at the i-th segment; ψ_i is the state transition parameter from V_i to V_{i+1}, and W_i and w_i are the process noise and the measurement noise, which are independent and are assumed to be drawn from zero mean Gaussian distribution with variance R_i and r_i, respectively. In the systems and methods, the speed $\hat{V}_{i+1}^-$ of the next segment from the measurement v_i of the current segment may be predicted. Following Example Algorithm 1 above and the Kalman filter, the predicted bandwidth $\hat{V}_{i+1}^-$ for the next segment may be obtained.

[0068] Although the available bandwidth may change and in some instances may change relatively quickly in wireless networks, the bandwidths of the same location measured at the same time of a day and the same day of a week (e.g., or weekday as opposed to weekend) show some similarity. Based on this observation, the systems and methods may select measurements at the same time of a day and the same day of a week as historical data to calculate m_i, σ_i and $\sigma_{i,j}$, and optimize ϕ_i, Q_{i+1} and q_i in Problem (A_1) referenced above.

[0069] A video bit rate adaption algorithm may apply in various applications (for example, DASH or another application). The video bit rate adapation may use the predictions of available bandwidth and/or vehicle speed at the future locations based on the measurement of the current

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and/or previous trips. For an example, of the video bit rate adapation, assume that the measurements of the current segment, v_i and b_i, are available and the predictions of the next segment, $\hat{V}_{i+1}$ and $\hat{B}_{i+1}$, are available. An aim of the bit rate adaption algorithm is to choose the bit rate to improve and/or maximize the video quality, and this may be done so while avoiding buffer underflow. Assume that the length of a segment (*e.g.*, every segment) is L meters. In one example, the algorithm optimizes the video quality for the subsequent M segments. Denote by BS the current buffer size measured in real time, which is the video playback time of the buffered data. Let $\hat{V}_{i,j}$ and $\hat{B}_{i,j}$ be the predicted speed and the predicted bandwidth at the $(i+j)$ -th segment, when the measurements (*e.g.* only the measurements) before the i-th segment are available, respectively, where

$$\hat{V}_{i,1} = \hat{V}_{i+1} \tag{30}$$

$$\hat{B}_{i,1} = \hat{B}_{i+1} \tag{31}$$

$$\hat{V}_{i,k} = \phi_{i+k}\phi_{i+k-1}\cdots\phi_{i+1}\hat{V}_{i+1} \tag{32}$$

$$\hat{B}_{i,k} = \psi_{i+k}\psi_{i+k-1}\cdots\psi_{i+1}\hat{B}_{i+1} \tag{33}$$

for $2 \le k \le M$. The time duration traveling through the $(i+m)$ -th segment, $1 \le m \le M$, is

$$T_{i,m} = \frac{L}{\hat{V}_{i,m}} \tag{34}$$

The total data downloaded during the $(i+m)$ -th segment is

$$D_{i,m} = \hat{B}_{i,m}T_{i,m} = \frac{\hat{B}_{i,m}L}{\hat{V}_{i,m}} \tag{35}$$

[0070] If the buffer size BS is no more than a lower bound BS_low, then rebuffering may occur with a significant probability, and the client may be forced to switch to the lowest bit rate. Otherwise, to avoid rebuffering, the following may be used:

$$\Sigma_{k=1}^{m}T_{i,k} \le BS + \frac{\Sigma_{k=1}^{m}D_{i,k}}{BR}, \tag{36}$$

for $1 \le m \le M$, where BR is the chosen bit rate. From the above inequality:

$$\frac{\Sigma_{k=1}^{m}D_{i,k}}{BR} \ge \Sigma_{k=1}^{m}T_{i,k} - BS \tag{37}$$

When $\Sigma_{k=1}^{m}T_{i,k} > BS$, the selected bit rate has an upper bound,

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$$BR \le \frac{\Sigma_{k=1}^{m} D_{i,k}}{\Sigma_{k=1}^{m} T_{i,k} - BS} \tag{38}$$

When $\Sigma_{k=1}^{m} T_{i,k} \le BS$, no upper bound may be imposed on BR.

[0071] The bit rate adaptation algorithm may be written as described below. In an example, the algorithm includes the following:

Example Algorithm 2: Given the predicted speed $\hat{V}_{i,m}$ and the predicted available bandwidth $\hat{B}_{i,m}$ for $1 \le m \le M$ and the current buffer size BS, determine the upper bound for the video bit rate to avoid the rebuffering, and/or choose the bit rate to maximize the video quality.

1. **IF** $BS > BS_{low}$
2. Initialize $T_{sum} = 0$, $D_{sum} = 0$, $BR_{max} = \infty$;
3. **FOR** $m = 1$ to M $T_{sum} = T_{sum} + \frac{L}{\hat{V}_{i,m}}$
4. $T_{sum} = T_{sum} + \frac{L}{\hat{V}_{i,m}}$;
5. $D_{sum} = D_{sum} + \frac{\hat{B}_{i,m} L}{\hat{V}_{i,m}}$;
6. **IF** $\Sigma_{k=1}^{m} T_{i,k} > BS$
7. $temp = \frac{\Sigma_{k=1}^{m} D_{i,k}}{\Sigma_{k=1}^{m} T_{i,k} - BS}$;
8. **IF** $temp < BR_{max}$
9. $BR_{max} = temp$;
10. **END IF**
11. **END IF**
12. **END FOR**
13. Choose the maximum bit rate, which is no more than BR_{max}.
14. **ELSE** Choose the minimum bit rate.
15. **END IF**

[0072] The media presentation description (MPD) may contain information of media streams, *e.g.*, codec, duration of a media segment, and/or resolution and bandwidth of each

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representation. The maximum bit rate BR_max from above Algorithm 2 may obtained. The next video representation with the highest bit rate no greater than BR_max may be selected.

[0073] In line 13 of Example Algorithm 2, the maximum may take over the available bit rates specified in the MPD file. As an example, an MPD file may contain 10 bit rates as follows:

```
<?xml version="1.0" encoding="utf-8"?>
<MPD xmlns="urn:mpeg:dash:schema:mpd:2011"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
profiles="urn:mpeg:dash:profile:isoff-live:2011" type="static"
mediaPresentationDuration="PT9M56.458S"
minBufferTime="PT4S"><Period><AdaptationSet id="1" group="1"
profiles="ccff" bitstreamSwitching="true" segmentAlignment="true"
contentType="video" mimeType="video/mp4" codecs="avc1.640028"
maxWidth="1920" maxHeight="1080"
startWithSAP="1"><SegmentTemplate timescale="10000000"
media="QualityLevels($Bandwidth$)/Fragments(video=$Time$,format=m
pd-time-csf)"
initialization="QualityLevels($Bandwidth$)/Fragments(video=i,form
at=mpd-time-csf)"><SegmentTimeline><S d="30000000" r="197"/><S
d="24166667"/></SegmentTimeline></SegmentTemplate>
<Representation id="1_V_video_1" bandwidth="6000000"
width="1920"height="1080"/>
<Representation id="1_V_video_2" bandwidth="5027000"
width="1600"height="900"/>
<Representation id="1_V_video_3" bandwidth="2962000" width="1280"
height="720"/>
<Representation id="1_V_video_4" bandwidth="2056000" width="992"
height="560"/>
<Representation id="1_V_video_5" bandwidth="1427000" width="768"
height="432"/>
<Representation id="1_V_video_6" bandwidth="991000" width="592"
height="332"/>
<Representation id="1_V_video_7" bandwidth="688000" width="448"
height="252"/>
<Representation id="1_V_video_8" bandwidth="477000" width="368"
height="208"/>
<Representation id="1_V_video_9" bandwidth="331000" width="284"
height="160"/>
<Representation id="1_V_video_10" bandwidth="230000" width="224"
height="128"/>
...
```


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[0074] Another application is video telephony. With video telephony, a WTRU may maintain measurements of available bandwidth and may share the measurements with other users *via* the CBP. When a user is making a video call, the application may check the available bandwidth of the route the WTRU is moving along. If the available bandwidth is not sufficient to maintain the quality of the call, the application may suggest that the user take a different route, for example, by prompting a suggestion on a GUI.

[0075] The systems and methods described herein may predict the available bandwidth based on the measurements of the current and previous trips. In addition, the systems and methods may include a video bit rate adaptation algorithm for applications, including DASH, that involve determining the predicted bandwidth and/or considering the current buffer size. The systems and mthods may be implemented in an LTE network or other wireless networks. In one example, a WTRU has a self-contained client. The WTRU for example may have an enhanced DASH client and/or may be programmed with algorithms to build a historical database of location & throughput. The historical database may include any or all off the following: recording location history vs. time, and recognizing patterns; recording travel speed history and/or changes of speed/location, *etc.*, and recording bandwidth/throughput history vs. time and location. A WTRU user may select video content to stream (*e.g.*, via web site or DASH client or other streaming client) by using any or all of the following: the client obtains content info (*e.g.*, DASH MPD) and begins streaming content; the client observes location state as the route is traversed (*e.g.*, location, speed, progress…); the client uses history (*e.g.*, location/throughput patterns), content info, and/or location state to predict (*e.g.*, and periodically update prediction of) path vs. time and/or BW/throughput vs. time. Using any or all of the foregoing, the client may plan in advance and may perform predictive local caching (*e.g.*, pre-fetching) in order to improve playback quality and prevent rebuffering. For example, if a section along a WTRU path is predicted to not have sufficient bandwidth for high quality streaming, the client may pre-fetch the high quality version of the required content segments in advance. For example, the WTRU may use excess available bandwidth in previous sections of the path. This assumes that the WTRU has sufficient buffer to do pre-fetching. Local cache management is considered in implementing the algorithm. If a section along the WTRU path is predicted to not have sufficient bandwidth for high quality streaming, the WTRU might pre-fetch the low quality version of the required content segments in advance, if there is no excess available bandwidth in previous sections of the path. There may be no change needed on the network side, and no special/added communication between the WTRU and the network. Implementation may be

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done entirely within the WTRU for example *via* a downloadable app or an enhanced DASH client.

[0076] The systems and methods include client path prediction with predictive caching in a network. A WTRU may have an enhanced DASH client which communicates with a network in order to implement predictive pre-fetching to cache elements associated with, for example co-located with, network access points. The client may be equipped to do any or all of the following: recording location history vs. time, and recognizing patterns; recording travel speed history, changes of speed/location, *etc.*; and recording bandwidth/throughput history vs. time and location. A user may select video content to stream (*e.g.*, via web site or DASH client or other streaming client) by using any or all of the following: client obtains content info (*e.g.*, dash mpd) and begins streaming content; client observes location state as the route is traversed (*e.g.*, location, speed, progress…); client uses history (*e.g.*, location/throughput patterns), content info, and/or location state to predict (*e.g.*, and periodically update prediction of) path vs. time; and client sends updates of path vs. time to network.

[0077] The network may determine improved and/or optimal pre-fetching positions (*e.g.*, specific caches collocated with network access points) and times for content segments. For contents which (based on the predicted path vs. time) are expected to be needed by the client when the client is passing within communication range of the network access points, content can be pre-fetched. The network may pre-fetch content at a certain bit rate to the cache of a certain network access point based on the expected available bandwidth for that WTRU at the time the WTRU may pass within communication range of a network access point. The network may (*e.g.*, optionally) provide a message to the WTRU which indicates a preferred bit rate(s) to request, which may be based on the network's knowledge of available bandwidth at the access point and/or the knowledge of which bit rates have been predictively cached at the access point. As the WTRU travels the path, the WTRU may send updates of the predicted path vs. time to the network. The WTRU may request content segments in order to obtain, decode, and play back the content. The WTRU may receive messages from the network which indicate the preferred bit rate(s) to request. The WTRU or the network may determine the bit rate to request based on any or all of: information about the content (*e.g.*, DASH MPD), the WTRU's recorded history of location & bandwidth/throughput vs. time, and/or based on the preferred bit rate(s) signaled by the network.

[0078] A WTRU may have a standard DASH client which may not be aware of nor have any special signaling related to the location based prediction functions of the network. The WTRU may report observations of location and/or available network bandwidth to an entity in the

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network. This may be part of existing location services and network feedback; as opposed to being functionality of an enhanced DASH client. For example, many phones have location services and associated reporting turned on by default, or to support other applications. The network may record the observations of location and available network bandwidth (along with associated observation times) for the client. The network may aggregate the available network bandwidth data from multiple clients in order to build a map of expected available network bandwidth. This map may be a function of location, time, and/or day of week. The WTRU may request streaming content (*e.g.*, request an MPD; start a DASH session). The network may predict a path for the WTRU based on the recorded observations of the past locations & times of the WTRU, and/or based on the current location, direction, and/or speed of the WTRU. The network may predict (*e.g.*, based on current location/speed of WTRU, and current content segments the WTRU is requesting) how to pre-fetch future content to the caches associated with network access points along the predicted path of the WTRU. The content segment to pre-fetch may be based on the predicted segment to be needed at the predicted time that the user may be in range of a particular network access point. The bit rate of the content segment to pre-fetch may be based on the expected available network bandwidth at the predicted time and location. The network may (*e.g.*, optionally) provide messages to the WTRU which indicate content segments and/or bit rates that the WTRU should request (*e.g.*, which recommend that the WTRU to request the proper bit rate of a content segment). These content segments and/or bit rates may be based on the bit rate the network has chosen to pre-fetch to the cache at a given network access point. The message may be explicit signaling that recommends a bit rate. The message may take the form of an updated MPD. For example, the updated MPD may limit the available bit rates listed for the given content segment. The limited available bit rates in the updated MPD may reflect one or more bit rates of content segments pre-fetched and available in a cache. There may be no modification of the DASH client on the WTRU. The WTRU may continue traveling along the path and may request and receive the needed video segments as it travels. The WTRU may receive, decode, and play back the video segments.

[0079] Tests were conducted using an example of an SBP approach (*e.g.*, described above with reference to FIG. 2). In the tests, the DASH MPD server was an Apache web server running on Ubuntu 14.04, which also hosts the Javascript program DASH.sj. In the tests, the WTRU was a Samsung Galaxy Tab 4 accessing a Verizon LTE network. The video sequence "Big Buck Bunny" was used in the tests and was provided by the DASH.sj program. The video sequence used was approximately 600 seconds in duration and a video segment (*e.g.*, every

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video segment) contained about three seconds of video content. There were ten video bit rates: 0.23, 0.33, 0.45, 0.67, 0.99, 1.43, 2.06, 2.96, 5.03, and 6 Mbps.

[0080] In the experiment, two routes were selected in the San Diego area. The routes had the same starting and ending points. The first route traveled mostly on highways, while the other route was mainly on local streets. More than thirty-five repeated experiments were conducted along these two routes in both directions from September, 2014 to January, 2015. The experiments were performed during both peak and off-peak hours, and as a result, each lasted for about 20 to about 50 minutes. Each route was partitioned into segments of approximate 300 meters.

[0081] Historical data was collected, which imitated the accumulation of measurements, for example, a per commutes regularly to work. For each route, there was a corresponding set of historical data. This data contained the location and speed, which are provided by the GPS device on the client with an accuracy of 4 meters, as well as the bandwidth obtained by dividing the size of the download data by the duration between the request and the reception. In a segment, more than one measurement may be obtained and if so the average of all measurements in the segment was used as the measurement for that segment. With the historical data, Algorithm 1 described above was run offline to determine the parameters in the state transition models, and they were fed to the DASH player. Predictions were implemented using the Kalman filter and the bit rate adaptation algorithm to the DASH.js.

[0082] Performance was evaluated. The accuracy of the bandwidth prediction algorithm was considerd. In FIG. 8, the cumulative distribution function (CDF) of the percentage of the difference between the predicted and the measured bandwidth. Almost 60% of the predictions have errors less than 20%. Since the video bit rates are quantized into 10 levels from 0.23 Mbps to 6 Mbps, the bit rate selection algorithm may still make the right decision with with errors being less than 20%.

[0083] In FIGS. 9 and 10, the video bit rates selected by the algorithm and Thang's algorithm under the same chanel realization are shown. Thang's algorithm calculates a moving average of the measured bandwidth as the prediction, and then selects the maximum available bit rate which is not greater than the prediction. The performance of Thang's algorithm was obtained by simulations using the historical data (available bandwidth as a function of time/segment) obtained from the experiment run with the highway data described above. FIG. 10 is an example that shows that the bit rates selected by an example of the algorithm has a greater average than those selected by Thang's algorithm, which is confirmed by the CDFs of the video bit rates for these two algorithms in FIG. 11. The disclosed algorithm provides a smoother bit rate selection

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than Thang's algorithm, where the switching probability for the disclosed algorithm is 6.1% compared to 27.8% for Thang's algorithm.

[0084] The systems and methods predict the available bandwidth and may do so based on the measurements of current and/or previous trips. The systems and methods may provide a video bit rate adaptation algorithm for DASH. The systems and methods may consider the predicted bandwidth and/or the current buffer size. The tests conducted in an LTE network how that the disclosed systems and methods may be effective in improving the QoE to the video client.

[0085] FIG. 12A is a diagram of an example communications system 100 in which one or more disclosed embodiments may be implemented. The communications system 100 may be a multiple access system that provides content, such as voice, data, video, messaging, broadcast, *etc.*, to multiple wireless users. The communications system 100 may enable multiple wireless users to access such content through the sharing of system resources, including wireless bandwidth. For example, the communications systems 100 may employ one or more channel access methods, such as code division multiple access (CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), orthogonal FDMA (OFDMA), single-carrier FDMA (SC-FDMA), and the like.

[0086] As shown in FIG. 12A, the communications system 100 may include wireless transmit/receive units (WTRUs) 102a, 102b, 102c, and/or 102d (which generally or collectively may be referred to as WTRU 102), a radio access network (RAN) 103/104/105, a core network 106/107/109, a public switched telephone network (PSTN) 108, the Internet 110, and other networks 112, though it will be appreciated that the disclosed embodiments contemplate any number of WTRUs, base stations, networks, and/or network elements. Each of the WTRUs 102a, 102b, 102c, 102d may be any type of device configured to operate and/or communicate in a wireless environment. By way of example, the WTRUs 102a, 102b, 102c, 102d may be configured to transmit and/or receive wireless signals and may include user equipment (UE), a WTRU, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, consumer electronics, and the like.

[0087] The communications systems 100 may also include a base station 114a and a base station 114b. Each of the base stations 114a, 114b may be any type of device configured to wirelessly interface with at least one of the WTRUs 102a, 102b, 102c, 102d to facilitate access to one or more communication networks, such as the core network 106/107/109, the Internet 110, and/or the networks 112. By way of example, the base stations 114a, 114b may be a base transceiver station (BTS), a Node-B, an eNode B, a Home Node B, a Home eNode B, a site

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controller, an access point (AP), a wireless router, and the like. While the base stations 114a, 114b are each depicted as a single element, it will be appreciated that the base stations 114a, 114b may include any number of interconnected base stations and/or network elements.

[0088] The base station 114a may be part of the RAN 103/104/105, which may also include other base stations and/or network elements (not shown), such as a base station controller (BSC), a radio network controller (RNC), relay nodes, *etc.* The base station 114a and/or the base station 114b may be configured to transmit and/or receive wireless signals within a particular geographic region, which may be referred to as a cell (not shown). The cell may further be divided into cell sectors. For example, the cell associated with the base station 114a may be divided into three sectors. Thus, in one embodiment, the base station 114a may include three transceivers, *e.g.*,one for each sector of the cell. The base station 114a may employ multiple-input multiple output (MIMO) technology and, therefore, may utilize multiple transceivers for each sector of the cell.

[0089] The base stations 114a, 114b may communicate with one or more of the WTRUs 102a, 102b, 102c, 102d over an air interface 115/116/117, which may be any suitable wireless communication link (*e.g.*, radio frequency (RF), microwave, infrared (IR), ultraviolet (UV), visible light, *etc.*). The air interface 115/116/117 may be established using any suitable radio access technology (RAT).

[0090] More specifically, as noted above, the communications system 100 may be a multiple access system and may employ one or more channel access schemes, such as CDMA, TDMA, FDMA, OFDMA, SC-FDMA, and the like. For example, the base station 114a in the RAN 103/104/105 and the WTRUs 102a, 102b, 102c may implement a radio technology such as Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA), which may establish the air interface 115/116/117 using wideband CDMA (WCDMA). WCDMA may include communication protocols such as High-Speed Packet Access (HSPA) and/or Evolved HSPA (HSPA+). HSPA may include High-Speed Downlink Packet Access (HSDPA) and/or High-Speed Uplink Packet Access (HSUPA).

[0091] The base station 114a and the WTRUs 102a, 102b, 102c may implement a radio technology such as Evolved UMTS Terrestrial Radio Access (E-UTRA), which may establish the air interface 115/116/117 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A).

[0092] The base station 114a and the WTRUs 102a, 102b, 102c may implement radio technologies such as IEEE 802.16 (*e.g.*, Worldwide Interoperability for Microwave Access (WiMAX)), CDMA2000, CDMA2000 1X, CDMA2000 EV-DO, Interim Standard 2000 (IS-

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2000), Interim Standard 95 (IS-95), Interim Standard 856 (IS-856), Global System for Mobile communications (GSM), Enhanced Data rates for GSM Evolution (EDGE), GSM EDGE (GERAN), and the like.

[0093] The base station 114b in FIG. 12A may be a wireless router, Home Node B, Home eNode B, or access point, for example, and may utilize any suitable RAT for facilitating wireless connectivity in a localized area, such as a place of business, a home, a vehicle, a campus, and the like. In one embodiment, the base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.11 to establish a wireless local area network (WLAN). The base station 114b and the WTRUs 102c, 102d may implement a radio technology such as IEEE 802.15 to establish a wireless personal area network (WPAN). The base station 114b and the WTRUs 102c, 102d may utilize a cellular-based RAT (*e.g.*, WCDMA, CDMA2000, GSM, LTE, LTE-A, *etc.*) to establish a picocell or femtocell. As shown in FIG. 12A, the base station 114b may have a direct connection to the Internet 110. Thus, the base station 114b may not be required to access the Internet 110 via the core network 106/107/109.

[0094] The RAN 103/104/105 may be in communication with the core network 106/107/109, which may be any type of network configured to provide voice, data, applications, and/or voice over internet protocol (VoIP) services to one or more of the WTRUs 102a, 102b, 102c, 102d. For example, the core network 106/107/109 may provide call control, billing services, mobile location-based services, pre-paid calling, Internet connectivity, video distribution, *etc.*, and/or perform high-level security functions, such as user authentication. Although not shown in FIG. 12A, it will be appreciated that the RAN 103/104/105 and/or the core network 106/107/109 may be in direct or indirect communication with other RANs that employ the same RAT as the RAN 103/104/105 or a different RAT. For example, in addition to being connected to the RAN 103/104/105, which may be utilizing an E-UTRA radio technology, the core network 106/107/109 may also be in communication with another RAN (not shown) employing a GSM radio technology.

[0095] The core network 106/107/109 may also serve as a gateway for the WTRUs 102a, 102b, 102c, 102d to access the PSTN 108, the Internet 110, and/or other networks 112. The PSTN 108 may include circuit-switched telephone networks that provide plain old telephone service (POTS). The Internet 110 may include a global system of interconnected computer networks and devices that use common communication protocols, such as the transmission control protocol (TCP), user datagram protocol (UDP) and the internet protocol (IP) in the TCP/IP internet protocol suite. The networks 112 may include wired or wireless communications networks owned and/or operated by other service providers. For example, the

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networks 112 may include another core network connected to one or more RANs, which may employ the same RAT as the RAN 103/104/105 or a different RAT.

[0096] Some or all of the WTRUs 102a, 102b, 102c, 102d in the communications system 100 may include multi-mode capabilities, *e.g.* the WTRUs 102a, 102b, 102c, 102d may include multiple transceivers for communicating with different wireless networks over different wireless links. For example, the WTRU 102c shown in FIG. 12A may be configured to communicate with the base station 114a, which may employ a cellular-based radio technology, and with the base station 114b, which may employ an IEEE 802 radio technology.

[0097] FIG. 12B is a system diagram of an example WTRU 102. As shown in FIG. 12B, the WTRU 102 may include a processor 118, a transceiver 120, a transmit/receive element 122, a speaker/microphone 124, a keypad 126, a display/touchpad 128, non-removable memory 130, removable memory 132, a power source 134, a global positioning system (GPS) chipset 136, and other peripherals 138. It will be appreciated that the WTRU 102 may include any sub-combination of the foregoing elements while remaining consistent with an embodiment. Also, embodiments contemplate that the base stations 114a and 114b, and/or the nodes that base stations 114a and 114b may represent, for example, a transceiver station (BTS), a Node-B, a site controller, an access point (AP), a home node-B, an evolved home node-B (eNodeB), a home evolved node-B (HeNB), a home evolved node-B gateway, and proxy nodes, among others, may include some or all of the elements depicted in FIG. 12B and described herein.

[0098] The processor 118 may be a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Array (FPGAs) circuits, any other type of integrated circuit (IC), a state machine, and the like. The processor 118 may perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment. The processor 118 may be coupled to the transceiver 120, which may be coupled to the transmit/receive element 122. While FIG. 12B depicts the processor 118 and the transceiver 120 as separate components, it will be appreciated that the processor 118 and the transceiver 120 may be integrated together in an electronic package or chip.

[0099] The transmit/receive element 122 may be configured to transmit signals to, or receive signals from, a base station (*e.g.*, the base station 114a) over the air interface 115/116/117. For example, in one embodiment, the transmit/receive element 122 may be an antenna configured to transmit and/or receive RF signals. The transmit/receive element 122 may be an emitter/detector

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configured to transmit and/or receive IR, UV, or visible light signals, for example. The transmit/receive element 122 may be configured to transmit and receive both RF and light signals. It will be appreciated that the transmit/receive element 122 may be configured to transmit and/or receive any combination of wireless signals.

[0100] In addition, although the transmit/receive element 122 is depicted in FIG. 12B as a single element, the WTRU 102 may include any number of transmit/receive elements 122. More specifically, the WTRU 102 may employ MIMO technology. Thus, in one embodiment, the WTRU 102 may include two or more transmit/receive elements 122 (*e.g.*, multiple antennas) for transmitting and receiving wireless signals over the air interface 115/116/117.

[0101] The transceiver 120 may be configured to modulate the signals that are to be transmitted by the transmit/receive element 122 and to demodulate the signals that are received by the transmit/receive element 122. As noted above, the WTRU 102 may have multi-mode capabilities. Thus, the transceiver 120 may include multiple transceivers for enabling the WTRU 102 to communicate via multiple RATs, such as UTRA and IEEE 802.11, for example.

[0102] The processor 118 of the WTRU 102 may be coupled to, and may receive user input data from, the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128 (*e.g.*, a liquid crystal display (LCD) display unit or organic light-emitting diode (OLED) display unit). The processor 118 may also output user data to the speaker/microphone 124, the keypad 126, and/or the display/touchpad 128. In addition, the processor 118 may access information from, and store data in, any type of suitable memory, such as the non-removable memory 130 and/or the removable memory 132. The non-removable memory 130 may include random-access memory (RAM), read-only memory (ROM), a hard disk, or any other type of memory storage device. The removable memory 132 may include a subscriber identity module (SIM) card, a memory stick, a secure digital (SD) memory card, and the like. In other embodiments, the processor 118 may access information from, and store data in, memory that is not physically located on the WTRU 102, such as on a server or a home computer (not shown).

[0103] The processor 118 may receive power from the power source 134, and may be configured to distribute and/or control the power to the other components in the WTRU 102. The power source 134 may be any suitable device for powering the WTRU 102. For example, the power source 134 may include one or more dry cell batteries (*e.g.*, nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion), *etc.*), solar cells, fuel cells, and the like.

[0104] The processor 118 may also be coupled to the GPS chipset 136, which may be configured to provide location information (*e.g.*, longitude and latitude) regarding the current

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location of the WTRU 102. In addition to, or in lieu of, the information from the GPS chipset 136, the WTRU 102 may receive location information over the air interface 115/116/117 from a base station (*e.g.*, base stations 114a, 114b) and/or determine its location based on the timing of the signals being received from two or more nearby base stations. It will be appreciated that the WTRU 102 may acquire location information by way of any suitable location-determination method while remaining consistent with an embodiment.

[0105] The processor 118 may further be coupled to other peripherals 138, which may include one or more software and/or hardware modules that provide additional features, functionality and/or wired or wireless connectivity. For example, the peripherals 138 may include an accelerometer, an e-compass, a satellite transceiver, a digital camera (for photographs or video), a universal serial bus (USB) port, a vibration device, a television transceiver, a hands free headset, a Bluetooth® module, a frequency modulated (FM) radio unit, a digital music player, a media player, a video game player module, an Internet browser, and the like.

[0106] FIG. 12C is a system diagram of the RAN 103 and the core network 106 according to an embodiment. As noted above, the RAN 103 may employ a UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 115. The RAN 103 may also be in communication with the core network 106. As shown in FIG. 12C, the RAN 103 may include Node-Bs 140a, 140b, 140c, which may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 115. The Node-Bs 140a, 140b, 140c may each be associated with a particular cell (not shown) within the RAN 103. The RAN 103 may also include RNCs 142a, 142b. It will be appreciated that the RAN 103 may include any number of Node-Bs and RNCs while remaining consistent with an embodiment.

[0107] As shown in FIG. 12C, the Node-Bs 140a, 140b may be in communication with the RNC 142a. Additionally, the Node-B 140c may be in communication with the RNC142b. The Node-Bs 140a, 140b, 140c may communicate with the respective RNCs 142a, 142b via an Iub interface. The RNCs 142a, 142b may be in communication with one another via an Iur interface. Each of the RNCs 142a, 142b may be configured to control the respective Node-Bs 140a, 140b, 140c to which it is connected. In addition, each of the RNCs 142a, 142b may be configured to carry out or support other functionality, such as outer loop power control, load control, admission control, packet scheduling, handover control, macrodiversity, security functions, data encryption, and the like.

[0108] The core network 106 shown in FIG. 12C may include a media gateway (MGW) 144, a mobile switching center (MSC) 146, a serving GPRS support node (SGSN) 148, and/or a gateway GPRS support node (GGSN) 150. While each of the foregoing elements are depicted as

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part of the core network 106, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0109] The RNC 142a in the RAN 103 may be connected to the MSC 146 in the core network 106 via an IuCS interface. The MSC 146 may be connected to the MGW 144. The MSC 146 and the MGW 144 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices.

[0110] The RNC 142a in the RAN 103 may also be connected to the SGSN 148 in the core network 106 via an IuPS interface. The SGSN 148 may be connected to the GGSN 150. The SGSN 148 and the GGSN 150 may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between and the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0111] As noted above, the core network 106 may also be connected to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0112] FIG. 12D is a system diagram of the RAN 104 and the core network 107 according to an embodiment. As noted above, the RAN 104 may employ an E-UTRA radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 116. The RAN 104 may also be in communication with the core network 107.

[0113] The RAN 104 may include eNode-Bs 160a, 160b, 160c, though it will be appreciated that the RAN 104 may include any number of eNode-Bs while remaining consistent with an embodiment. The eNode-Bs 160a, 160b, 160c may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 116. In one embodiment, the eNode-Bs 160a, 160b, 160c may implement MIMO technology. Thus, the eNode-B 160a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a.

[0114] Each of the eNode-Bs 160a, 160b, 160c may be associated with a particular cell (not shown) and may be configured to handle radio resource management decisions, handover decisions, scheduling of users in the uplink and/or downlink, and the like. As shown in FIG. 12D, the eNode-Bs 160a, 160b, 160c may communicate with one another over an X2 interface.

[0115] The core network 107 shown in FIG. 12D may include a mobility management gateway (MME) 162, a serving gateway 164, and a packet data network (PDN) gateway 166. While each of the foregoing elements are depicted as part of the core network 107, it will be

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appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

[0116] The MME 162 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via an S1 interface and may serve as a control node. For example, the MME 162 may be responsible for authenticating users of the WTRUs 102a, 102b, 102c, bearer activation/deactivation, selecting a particular serving gateway during an initial attach of the WTRUs 102a, 102b, 102c, and the like. The MME 162 may also provide a control plane function for switching between the RAN 104 and other RANs (not shown) that employ other radio technologies, such as GSM or WCDMA.

[0117] The serving gateway 164 may be connected to each of the eNode-Bs 160a, 160b, 160c in the RAN 104 via the S1 interface. The serving gateway 164 may generally route and forward user data packets to/from the WTRUs 102a, 102b, 102c. The serving gateway 164 may also perform other functions, such as anchoring user planes during inter-eNode B handovers, triggering paging when downlink data is available for the WTRUs 102a, 102b, 102c, managing and storing contexts of the WTRUs 102a, 102b, 102c, and the like.

[0118] The serving gateway 164 may also be connected to the PDN gateway 166, which may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices.

[0119] The core network 107 may facilitate communications with other networks. For example, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices. For example, the core network 107 may include, or may communicate with, an IP gateway (*e.g.*, an IP multimedia subsystem (IMS) server) that serves as an interface between the core network 107 and the PSTN 108. In addition, the core network 107 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0120] FIG. 12E is a system diagram of the RAN 105 and the core network 109 according to an embodiment. The RAN 105 may be an access service network (ASN) that employs IEEE 802.16 radio technology to communicate with the WTRUs 102a, 102b, 102c over the air interface 117. As will be further discussed below, the communication links between the different functional entities of the WTRUs 102a, 102b, 102c, the RAN 105, and the core network 109 may be defined as reference points.

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[0121] As shown in FIG. 12E, the RAN 105 may include base stations 180a, 180b, 180c, and an ASN gateway 182, though it will be appreciated that the RAN 105 may include any number of base stations and ASN gateways while remaining consistent with an embodiment. The base stations 180a, 180b, 180c may each be associated with a particular cell (not shown) in the RAN 105 and may each include one or more transceivers for communicating with the WTRUs 102a, 102b, 102c over the air interface 117. In one embodiment, the base stations 180a, 180b, 180c may implement MIMO technology. Thus, the base station 180a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102a. The base stations 180a, 180b, 180c may also provide mobility management functions, such as handoff triggering, tunnel establishment, radio resource management, traffic classification, quality of service (QoS) policy enforcement, and the like. The ASN gateway 182 may serve as a traffic aggregation point and may be responsible for paging, caching of subscriber profiles, routing to the core network 109, and the like.

[0122] The air interface 117 between the WTRUs 102a, 102b, 102c and the RAN 105 may be defined as an R1 reference point that implements the IEEE 802.16 specification. In addition, each of the WTRUs 102a, 102b, 102c may establish a logical interface (not shown) with the core network 109. The logical interface between the WTRUs 102a, 102b, 102c and the core network 109 may be defined as an R2 reference point, which may be used for authentication, authorization, IP host configuration management, and/or mobility management.

[0123] The communication link between each of the base stations 180a, 180b, 180c may be defined as an R8 reference point that includes protocols for facilitating WTRU handovers and the transfer of data between base stations. The communication link between the base stations 180a, 180b, 180c and the ASN gateway 182 may be defined as an R6 reference point. The R6 reference point may include protocols for facilitating mobility management based on mobility events associated with each of the WTRUs 102a, 102b, 102c.

[0124] As shown in FIG. 12E, the RAN 105 may be connected to the core network 109. The communication link between the RAN 105 and the core network 109 may defined as an R3 reference point that includes protocols for facilitating data transfer and mobility management capabilities, for example. The core network 109 may include a mobile IP home agent (MIP-HA) 184, an authentication, authorization, accounting (AAA) server 186, and a gateway 188. While each of the foregoing elements are depicted as part of the core network 109, it will be appreciated that any one of these elements may be owned and/or operated by an entity other than the core network operator.

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[0125] The MIP-HA may be responsible for IP address management, and may enable the WTRUs 102a, 102b, 102c to roam between different ASNs and/or different core networks. The MIP-HA 184 may provide the WTRUs 102a, 102b, 102c with access to packet-switched networks, such as the Internet 110, to facilitate communications between the WTRUs 102a, 102b, 102c and IP-enabled devices. The AAA server 186 may be responsible for user authentication and for supporting user services. The gateway 188 may facilitate interworking with other networks. For example, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to circuit-switched networks, such as the PSTN 108, to facilitate communications between the WTRUs 102a, 102b, 102c and traditional land-line communications devices. In addition, the gateway 188 may provide the WTRUs 102a, 102b, 102c with access to the networks 112, which may include other wired or wireless networks that are owned and/or operated by other service providers.

[0126] Although not shown in FIG. 12E, it will be appreciated that the RAN 105 may be connected to other ASNs and the core network 109 may be connected to other core networks. The communication link between the RAN 105 the other ASNs may be defined as an R4 reference point, which may include protocols for coordinating the mobility of the WTRUs 102a, 102b, 102c between the RAN 105 and the other ASNs. The communication link between the core network 109 and the other core networks may be defined as an R5 reference, which may include protocols for facilitating interworking between home core networks and visited core networks.

[0127] Although features and elements are described above in particular combinations, one of ordinary skill in the art will appreciate that each feature or element may be used alone or in any combination with the other features and elements. In addition, the methods described herein may be implemented in a computer program, software, or firmware incorporated in a computer-readable medium for execution by a computer or processor. Examples of computer-readable media include electronic signals (transmitted over wired or wireless connections) and computer-readable storage media. Examples of computer-readable storage media include, but are not limited to, a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs). A processor in association with software may be used to implement a radio frequency transceiver for use in a WTRU, UE, terminal, base station, RNC, or any host computer.

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CLAIMS

What is Claimed:

1. A method for adaptively streaming video content using a wireless transmit/receive unit (WTRU), comprising:

determining current information associated with the WTRU, the current information including at least one of a location, a speed, a time, a data throughput, and a day;

comparing the current information with previously determined information for the WTRU;

predicting a future location for the WTRU;

predicting an available network bandwidth at the future location; and

determining a bit rate for the WTRU to request for a content segment, based on the predicted available network bandwidth for the predicted future location.

2. The method of claim 1, further comprising requesting the content segment at the determined bit rate.

3. The method of claim 1, further comprising determining the current buffer size.

4. The method of claim 1, further comprising requesting additional content segments and caching the additional content segments for subsequent playback if the future location is predicted to have relatively less available network bandwidth.

5. The method of claim 1, further comprising applying a Kalman filter to predict the WTRU's future location.

6. The method of claim 5, wherein the future location for the WTRU is predicted by predicting the speed.

7. The method of claim 1, wherein the future location for the WTRU is predicted based on previously determined locations and at least one of a speed, a time, and a day associated with the previously determined locations.

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8. The method of claim 7, wherein the future location, previously determined locations, at least one of a speed, a time, and a day associated with the previously determined locations are determined solely by the WTRU.

9. The method of claim 1, wherein the future location for the WTRU is adjusted based on subsequent determinations of location and at least one of a speed, a time, and a day associated with the location.

10. The method of claim 1, wherein multiple future locations for the WTRU are predicted.

11. The method of claim 1, further comprising applying a Kalman filter to predict the available network bandwidth at the future location for the WTRU.

12. The method of claim 1, further comprising mapping reoccurring patterns of location and available network bandwidth.

13. The method of claim 1, further comprising sending an alert when the future location is predicted to have relatively less available network bandwidth.

14. A wireless transmit receive unit (WTRU), comprising:

a processor with executable instructions for:

determining current information associated with the WTRU, the current information including at least one of a location, a speed, a time, a data throughput, and a day;

comparing the current information with previously determined information for the WTRU;

predicting a future location for the WTRU;

predicting an available network bandwidth at the future location; and

determining a bit rate for the WTRU to request for a content segment, based on the predicted available network bandwidth for the predicted future location.

15. The WTRU of claim 14, wherein the processor has executable instructions for requesting the content segment at the determined bit rate.

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16. The WTRU of claim 14, wherein the processor has executable instructions for determining the current buffer size.

17. The WTRU of claim 14, wherein the processor has executable instructions for requesting additional content segments and caching the additional content segments for subsequent playback if the future location is predicted to have relatively less available network bandwidth.

18. The WTRU of claim 14, wherein the processor has executable instructions for applying a Kalman filter to predict the WTRU's future location.

19. The WTRU of claim 18, wherein the future location for the WTRU is predicted by predicting the speed.

20. The WTRU of claim 14, wherein the future location for the WTRU is predicted based on previously determined locations and at least one of a speed, a time, and a day associated with the previously determined locations.

21. The WTRU of claim 20, wherein the future location, previously determined locations, at least one of a speed, a time, and a day associated with the previously determined locations are determined solely by the WTRU.

22. The WTRU of claim 14, wherein the future location for the WTRU is adjusted based on subsequent determinations of location and at least one of a speed, a time, and a day associated with the location.

23. The WTRU of claim 14, wherein multiple future locations for the WTRU are predicted.

24. The WTRU of claim 14, wherein the processor has executable instructions for applying a Kalman filter to predict the available network bandwidth at the future location for the WTRU.

25. The WTRU of claim 14, wherein the processor has executable instructions for mapping reoccurring patterns of location and available network bandwidth.

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26. The WTRU of claim 14, wherein the processor has executable instructions for sending an alert when the future location is predicted to have relatively less available network bandwidth.

27. A method for adaptively streaming video content using a wireless transmit/receive unit (WTRU), comprising:

predicting a future location for the WTRU;

predicting an available network bandwidth at the future location, based upon information previously measured at the future location by the WTRU; and

determining a bit rate for the WTRU to request for a content segment, based on the predicted available network bandwidth for the future location.

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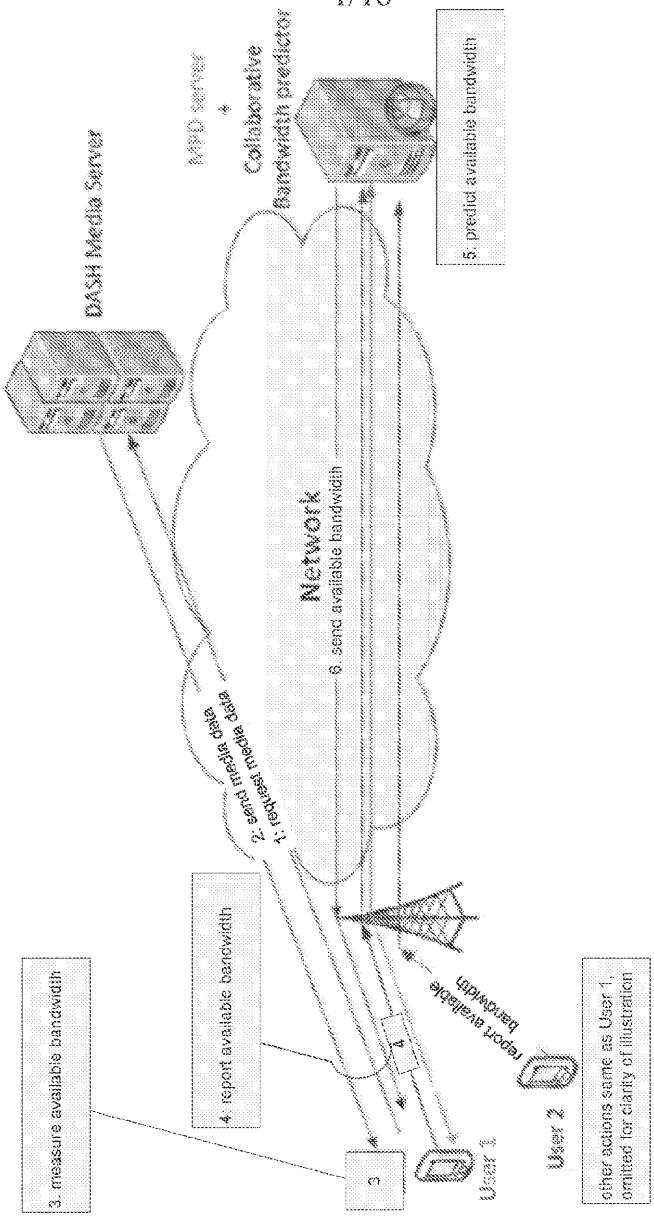


FIG. 1

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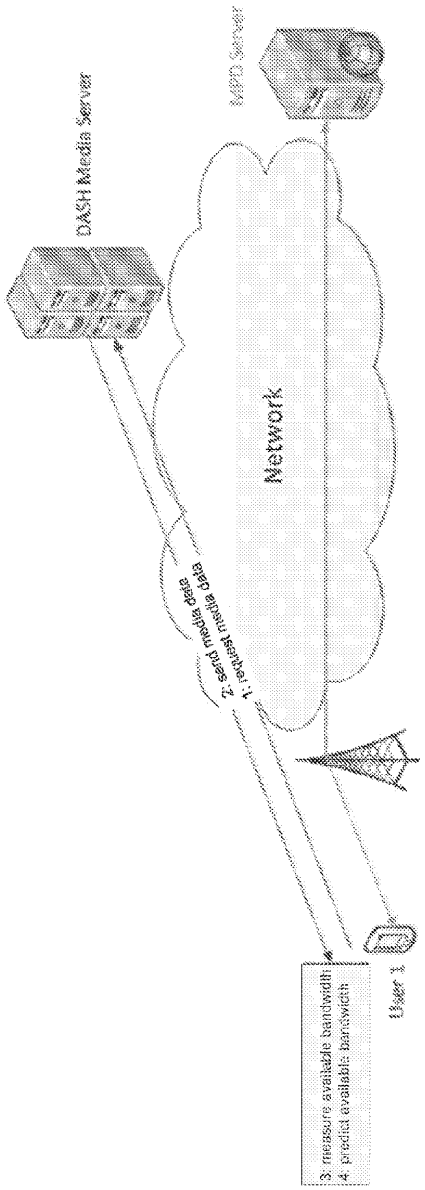


FIG. 2

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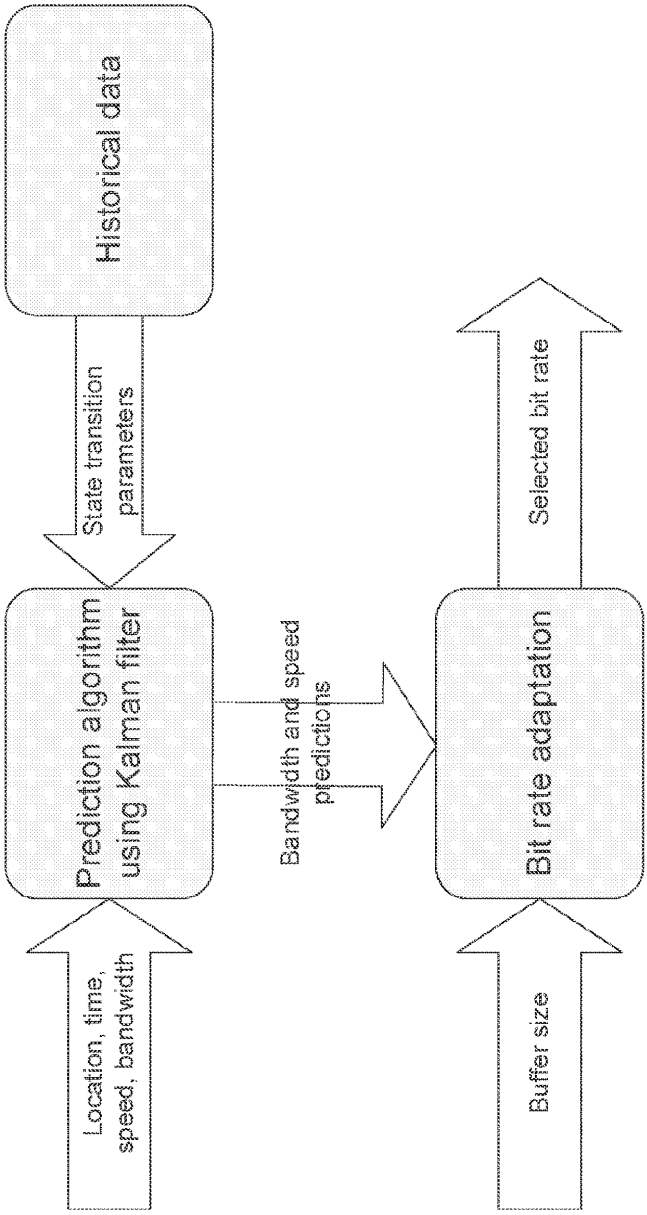


FIG. 3

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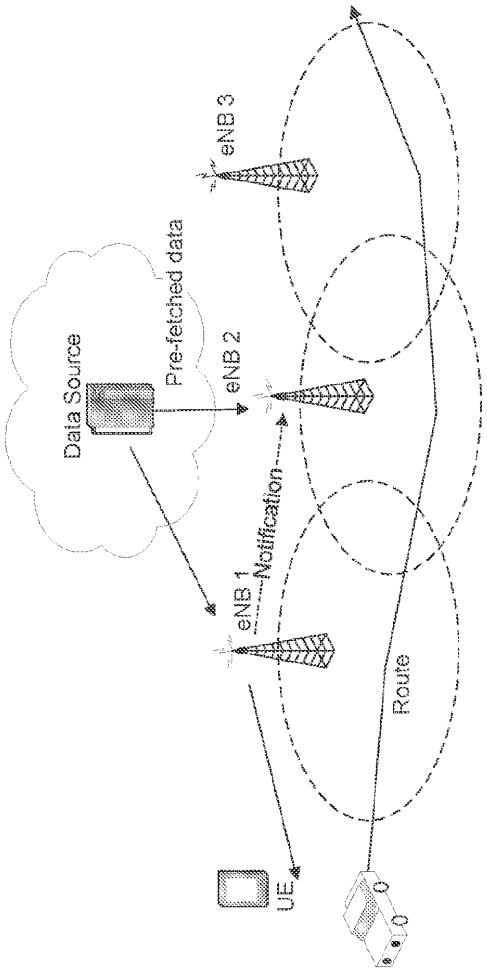


FIG. 4

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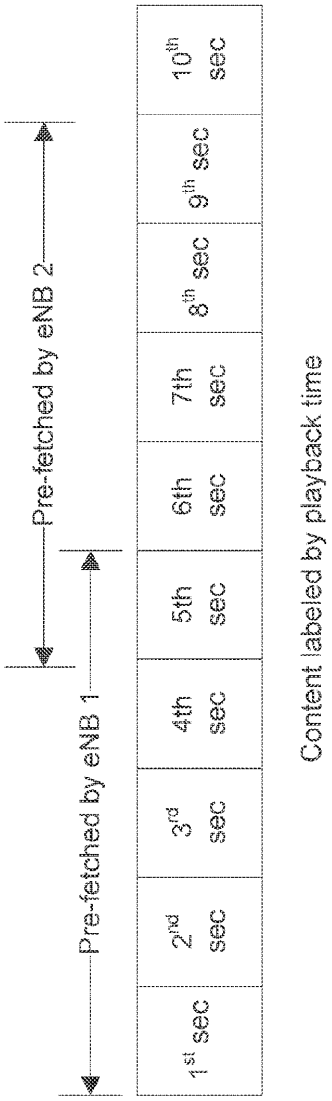


FIG. 5

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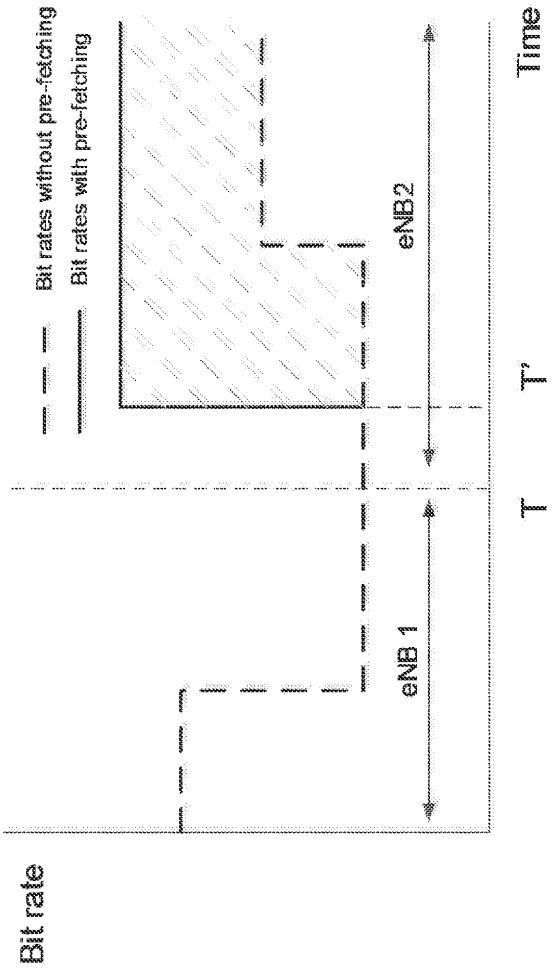


FIG. 6

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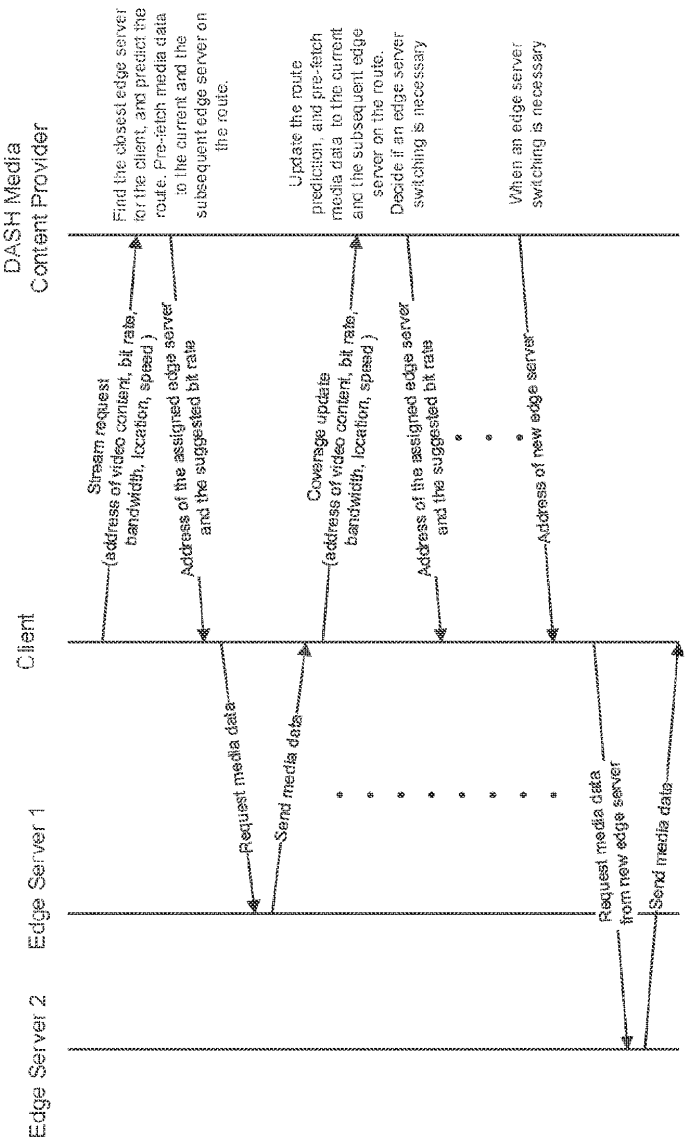


FIG. 7

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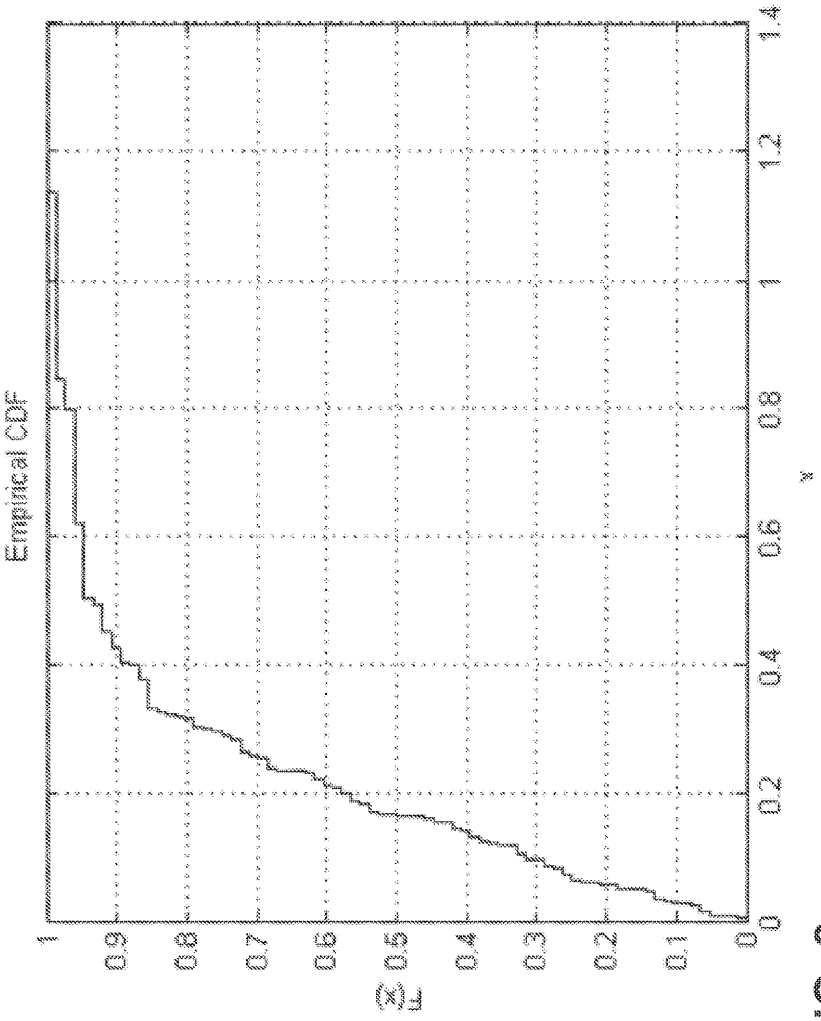


FIG. 8

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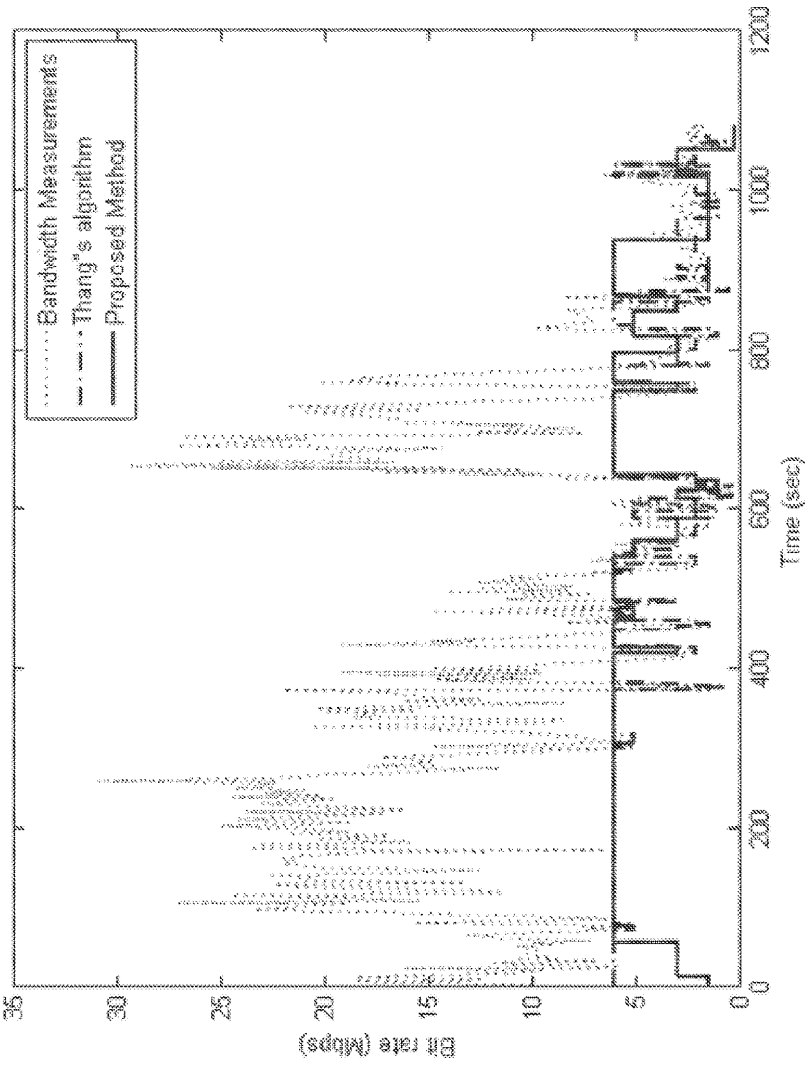


FIG. 9

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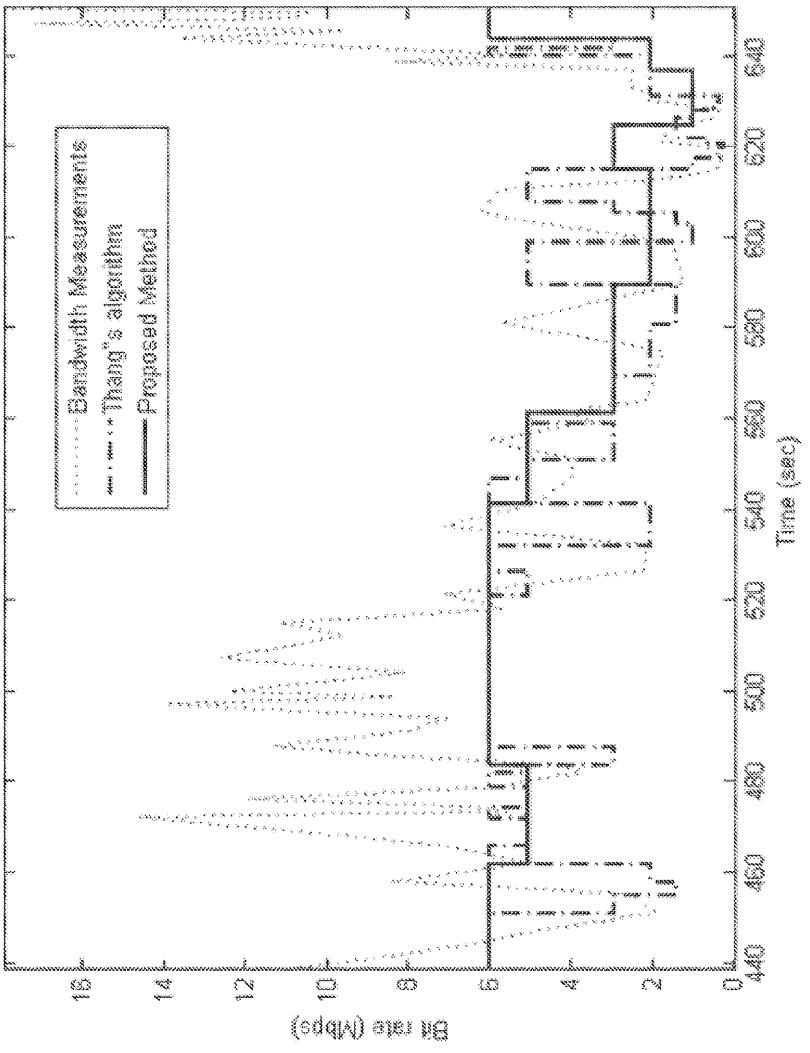


FIG. 10

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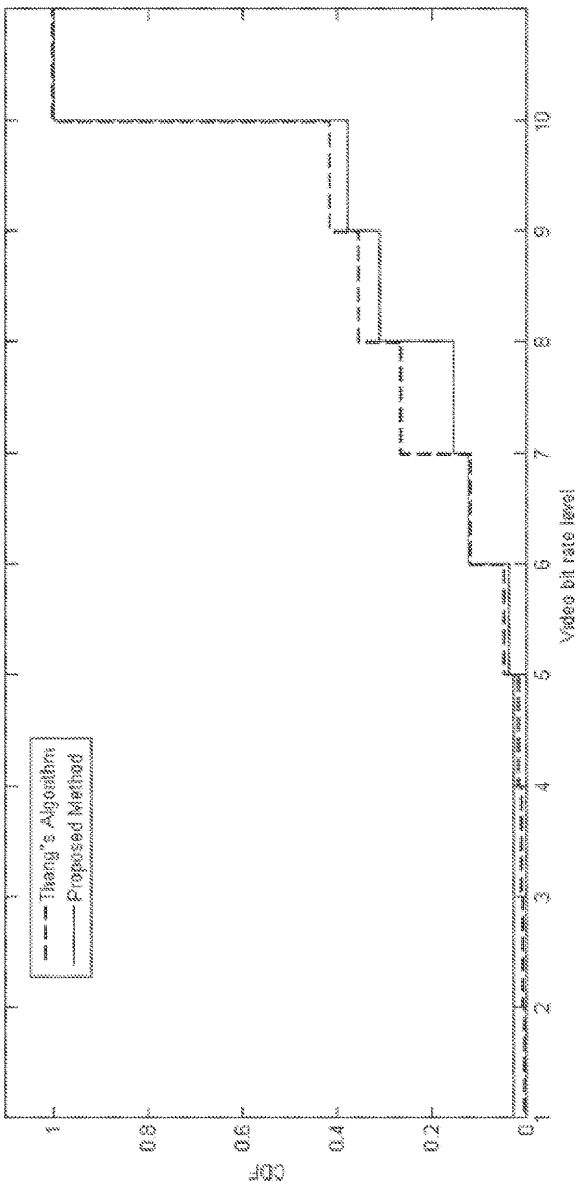


FIG. 11

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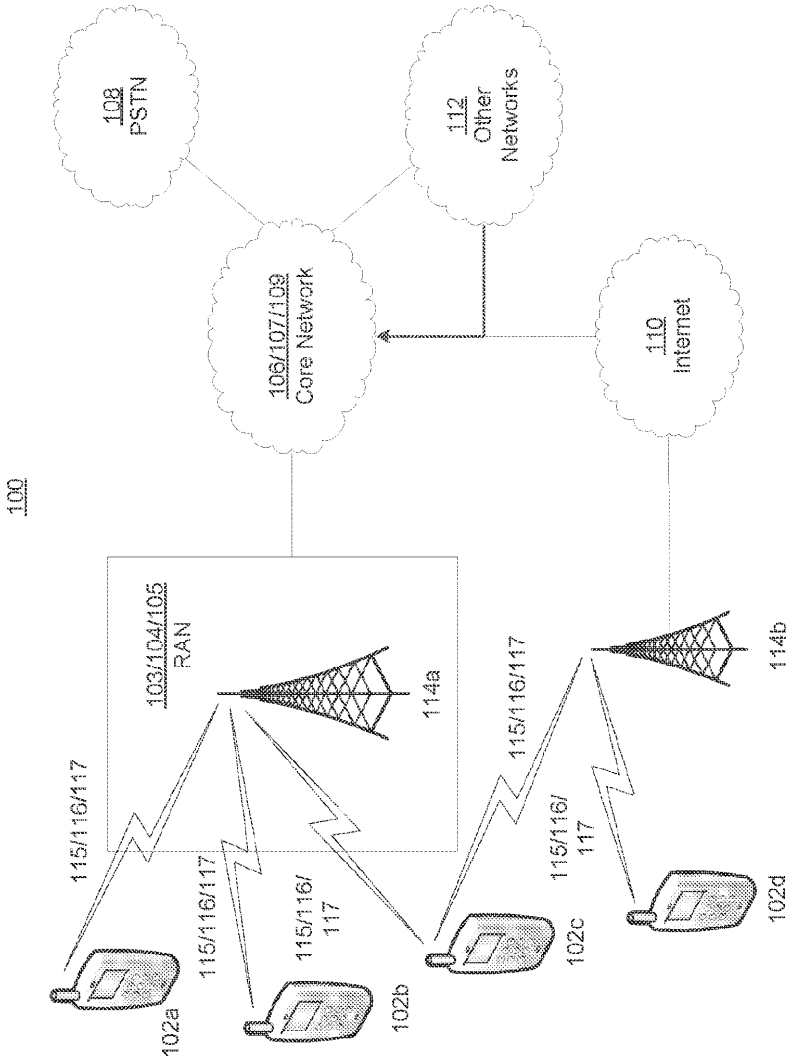


FIG. 12A

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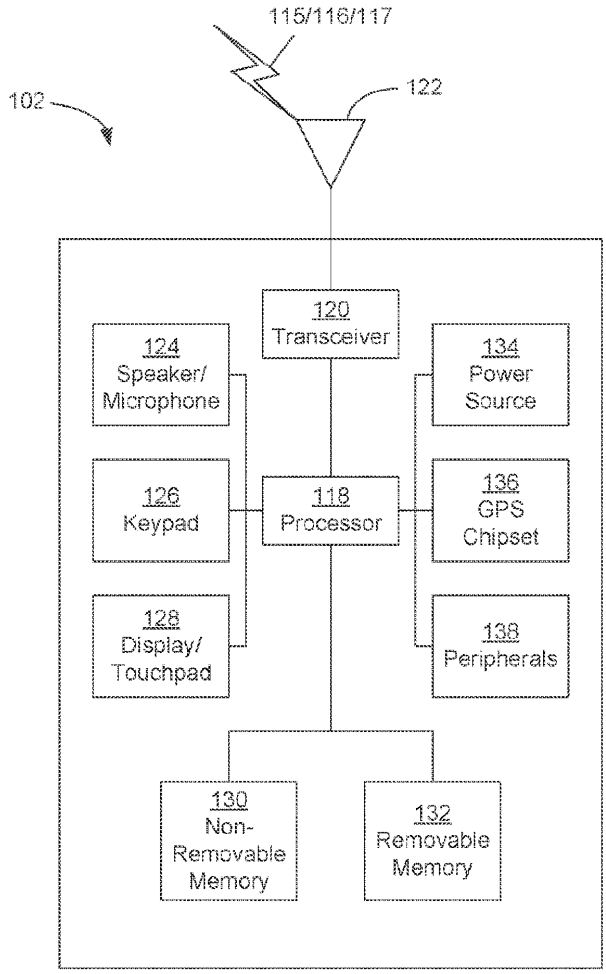


FIG. 12B

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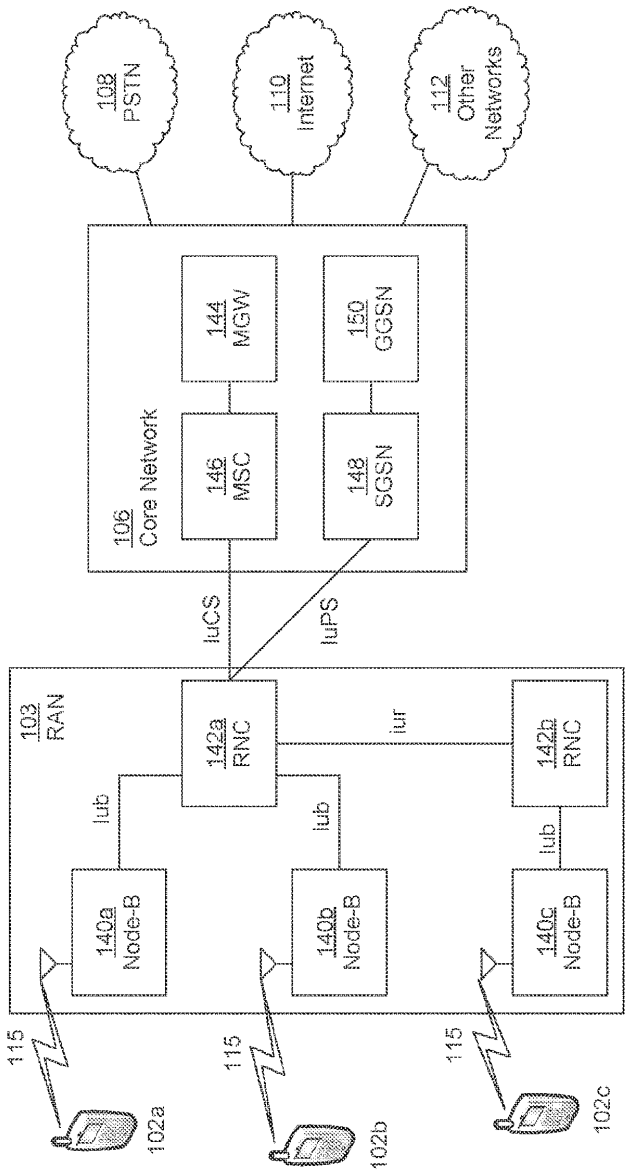


FIG. 12C

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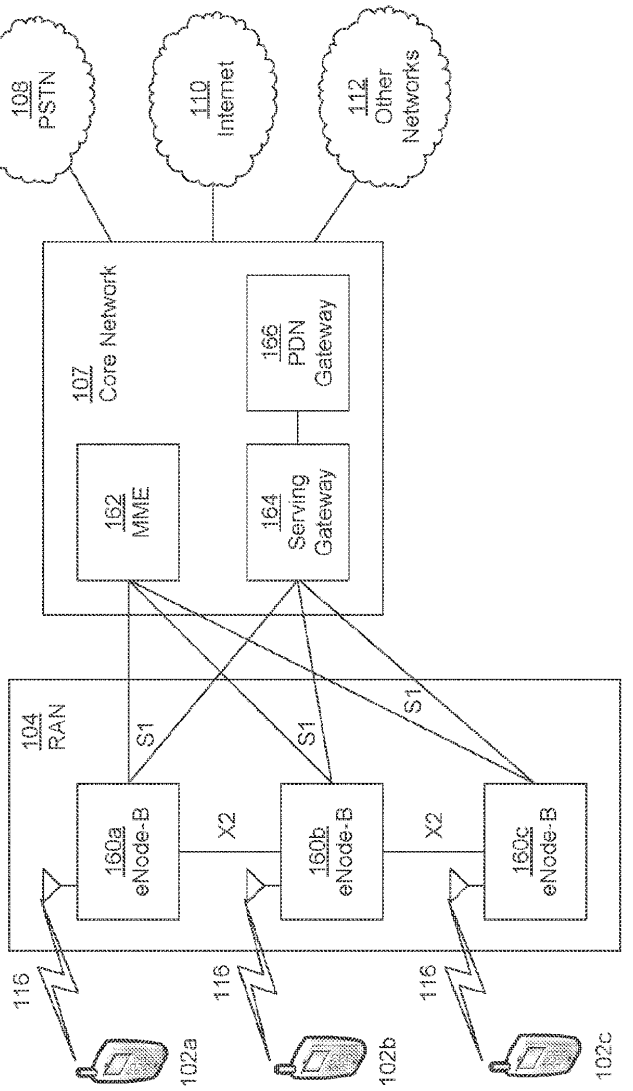


FIG. 12D

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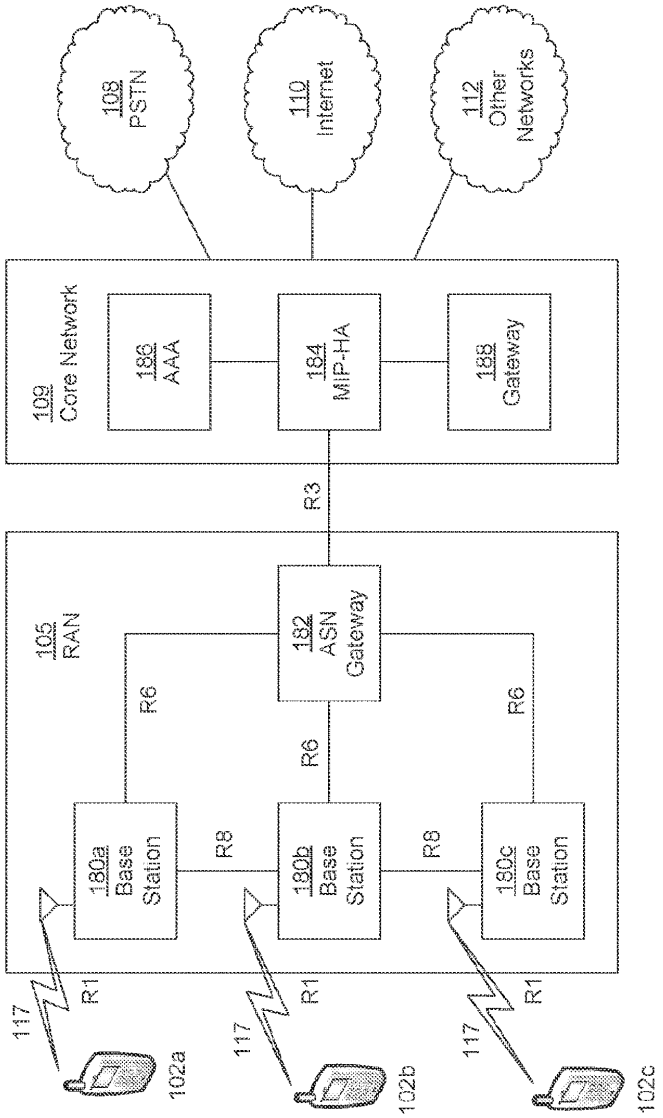


FIG. 12E

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/015683

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/06 H04W4/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W H04L

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/052271 A1 (GOOGLE INC [US]) 3 April 2014 (2014-04-03)	1-4, 6-10, 12-17, 19-23, 25-27
Y	page 1, paragraph 5 - page 6, paragraph 15 page 8, paragraph 26 - page 14, paragraph 45 page 16, paragraph 51 - page 21, paragraph 71	5,11,18, 24
Y	US 2014/099967 A1 (EGNER WILL A [US] ET AL) 10 April 2014 (2014-04-10) page 13, paragraph 111 - paragraph 112	5,18

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2016	13/04/2016

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/015683

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/175191 A1 (LIN CHUNG-WEI [TW] ET AL) 9 July 2009 (2009-07-09) page 1, paragraph 7 - paragraph 8 page 3, paragraph 29 - paragraph 31	11,24
X	EP 2 073 486 A1 (ALCATEL LUCENT [FR]) 24 June 2009 (2009-06-24)	1-4, 6-10, 12-17, 19-23, 25-27
Y	page 2, paragraph 8 - page 4, paragraph 41	5,11,18, 24
X	US 2012/009890 A1 (CURCIO IGOR DANILO DIEGO [FI] ET AL) 12 January 2012 (2012-01-12) page 5, paragraph 42 - page 7, paragraph 50 page 8, paragraph 55 - page 10, paragraph 68 page 10, paragraph 71 - page 12, paragraph 76	1-4, 6-10, 12-17, 19-23, 25-27
X	US 2014/258505 A1 (LIAO KEVIN [US] ET AL) 11 September 2014 (2014-09-11) page 1, paragraph 3 - paragraph 5 page 1, paragraph 18 - page 5, paragraph 42	1-4, 6-10, 12-17, 19-23, 25-27
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/015683

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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
19 April 2018 (19.04.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/068857 A1

(51) International Patent Classification:
H04W 24/08 (2009.01) *H04W 72/04* (2009.01)
H04W 28/16 (2009.01)

(21) International Application Number:
PCT/EP2016/074617

(22) International Filing Date:
13 October 2016 (13.10.2016)

(25) Filing Language: English

(26) Publication Language: English

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(74) Agent: **KREUZ, Georg** et al.; Huawei Technologies Duesseldorf GmbH, Riesstr. 8, 80992 Munich (DE).

(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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:
— *with international search report (Art. 21(3))*

(54) **Title:** METHOD AND UNIT FOR RADIO RESOURCE MANAGEMENT USING REINFORCEMENT LEARNING

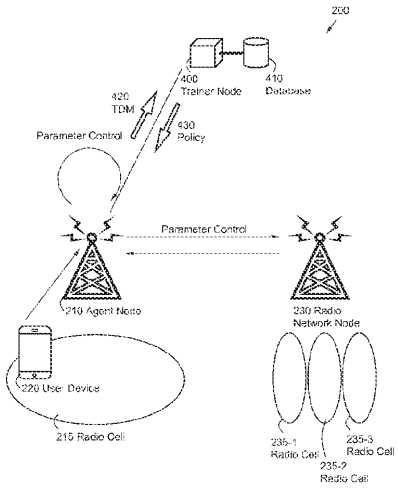


Fig. 3

(57) **Abstract:** Agent node (210, 500) and method (600) therein, for configuring a radio resource parameter of a radio cell (215) of a communication system (200). The agent node (210, 500) is configured to obtain a control policy (430); determine a feature representing a state of at least a part of the communication system (200), at a first time period; determine a control action to be performed for control in the radio cell (215) at the first time period, out of a set of available control actions associated with the radio cell (215), based on the obtained control policy (430) and the determined at least one feature; and configure an instruction of the radio cell (215) based on the determined control action. Also, a corresponding trainer node (400) and method (800) for providing the agent node (210, 500) with the control policy (430), based on received parameters is disclosed.

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METHOD AND UNIT FOR RADIO RESOURCE MANAGEMENT USING REINFORCEMENT LEARNING

TECHNICAL FIELD

Implementations described herein generally relate to a network access unit and a method in a network access unit. In particular is herein described a mechanism for configuring a radio resource parameter of a radio cell of a communication system.

BACKGROUND

Radio Resource Management (RRM) in state of the art radio access networks, such as the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) system, comprises several problems that include power control, radio resource scheduling, link adaptation, load balancing, radio antenna tilting, cell range expansion, user association to radio cells, etc. Each RRM problem may require of either controlling a certain radio resource parameter (e.g., downlink transmission power of one or more eNodeBs, uplink transmit power of one or more user devices, electrical tilt of one or more eNodeBs, etc.), or controlling the parameter of a given control algorithms (e.g., a threshold value for performing cell handover, for selecting one or more radio frequency carriers to be assigned to a user device, etc.) or allocating a part of the shared radio resources (e.g. a time-frequency resource block) to user devices. Radio environmental measurements reported by the user devices as well as radio measurements performed by the radio access network nodes provide the basic information required by RRM algorithm to control one or more network operations. Radio environmental measurements include, for instance, Reference Signal Received Power (RSRP), Signal to Noise Ratio (SNR), interference, Channel Quality Indicator (CQI), Channel State Information (CSI), etc.

Different RRM problems are traditionally tackled with a dedicated algorithm that optimises the network operation for one specific RRM task, but the same algorithm cannot typically be reused for other RRM tasks. Additionally, within the RRM architecture different RRM tasks affect one another or require interacting with each other. This introduces large signalling overhead, additional complexity, and possibly performance degradation when the RRM task cannot be fully completed within the associated critical time limit or when only partial information from other RRM tasks is made available.

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There is room for improvement for a method of accessing a UE to a heterogeneous network.

SUMMARY

It is therefore an objective to obviate at least some of the above mentioned disadvantages and to improve the radio resource management of a communication system.

This and other objectives are achieved by the features of the appended independent claims. Further implementation forms are apparent from the dependent claims, the description and the figures.

According to a first aspect, an agent node for configuring a radio resource parameter of a radio cell of a communication system is provided. The agent node is configured to obtain a control policy. Further the agent node is configured to determine at least one feature representing a state of at least a part of the communication system, at a first time period. The agent node is also configured to determine a control action to be performed for configuring the radio resource parameter in the radio cell at the first time period, out of a set of available control actions associated with the radio cell, based on the obtained control policy and the determined at least one feature. Also the agent node is configured to configure the radio resource parameter of the radio cell based on the determined control action.

By autonomously learning different radio resource management strategies using measurements collected from an algorithmic interaction with the radio environment, an appropriate adjustment of any radio resource parameter may be made. Thus, radio resource management based on learning the network environmental performance is provided, which may adapt to changes in radio environment conditions without manual adjustment. Thereby radio resources may be better managed, leading to increased network performance.

According to a first possible implementation of the first aspect, the agent node may be further configured to determine a feature representing the state of the part of the communication system, at a second time period. Also, the agent node may be configured to determine a performance measurement, associated with the performance within the radio cell. Furthermore, the agent node may be configured to transmit a training data message to a trainer node, comprising one or more in the group of: the determined feature representing

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the state at the first time period, the determined control action performed at the first time period, the determined feature representing the state at the second time period, and the determined performance measurement. Further the obtained control policy is received from the trainer node.

According to a second possible implementation of the first aspect, or the first possible implementation thereof, the agent node may be further configured to select which at least one feature to utilise for representing the state of at least a part of the communication system. Also the agent node may be configured to select which performance measurement associated with the radio cell to utilise for representing the performance of the radio cell.

According to a third possible implementation of the first aspect, or any previously described implementation thereof, wherein a radio network node controlling the radio cell is not co-located with the agent node, the agent node may be further configured to transmit an instruction to the radio network node for configuring the radio resource parameter of the radio cell.

According to a fourth possible implementation of the first aspect, or any previously described implementation thereof, wherein the feature representing the state of at least a part of the communication system, is determined based on any of: a measurement related to received signal quality made by and received from a user device in the radio cell; a measurement related to received signal quality made by and received from a user device in another radio cell; a measurement related to received signal quality made by and received from a user device in another radio cell; a measurement related to downlink transmission power of the radio cell made by and obtained from the radio network node controlling the radio cell; a measurement related to a number of active user devices in the radio cell; a measurement related to types, or distribution, of traffic within the radio cell; a measurement related to location, or distribution, of user devices in the radio cell; a performance measurement, associated with the performance within the radio cell; a measurement related to resource utilisation in the radio cell; and/ or a measurement related to electrical tilt associated with the radio cell.

According to a fifth possible implementation of the first aspect, or any previously described implementation thereof, the agent node may be further configured to compute a

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performance measurement associated with at least a part of the communication system, based on the determined performance measurement and at least one other network performance measurement received from another radio network node in the communication system. Also, the agent node may be configured to transmit the training data message to the trainer node comprising the computed performance measurement.

According to a sixth possible implementation of the first aspect, or any previously described implementation thereof, wherein the obtained control policy further comprises an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy, the agent node may be further configured to determine application of the obtained control policy, based on the obtained exploration-to-exploitation control parameter.

According to a seventh possible implementation of the first aspect, or any previously described implementation thereof, wherein a radio network node controlling the radio cell is another agent node, the training data message transmitted to the trainer node comprises a training data message received from the other agent node; the agent node may be further configured to forward the control policy to be utilised for configuring the radio resource parameter in the radio cell of the other agent node in the communication system, received from the trainer node, to the other agent node.

According to an eighth possible implementation of the first aspect, or any previously described implementation thereof, the agent node may be further configured to iterate the determination of the feature representing the state of at least a part of the communication system; the determination of the control action; the configuration of the radio resource parameter instruction; the determination of the performance measurement; the transmission of the training data message, or a plurality of training data messages, to the trainer node and the obtaining of the control policy.

According to a ninth possible implementation of the first aspect, or any previously described implementation thereof, the agent node may be further configured to adjust the set of available control actions associated with the radio cell, based on the determined at least one feature representing the state of the part of the communication system, or based on the obtained control policy.

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According to a tenth possible implementation of the first aspect, or any previously described implementation thereof, wherein the obtained control policy may be represented by one or more of: an indication of a neural network architecture, a parameter describing the number of inputs to the first layer of the neural network, a set of parameters describing the number of layers of the neural network, a set of parameters describing the number of neurons in different layers of the neural network, a parameter indicating the type of non-linear activation function used at each layer (which may comprise an s-shaped function like the sigmoid or the hyperbolic tangent, or a rectified linear unit, or an exponential linear unit, etc.), a set of parameters describing the connections between units of consecutive or non consecutive layers in the neural network, a set of indicators to at least one neural network index, a set of neural network weights, a number of neural networks to be configured for radio resource parameter control, a voting policy to be configured for determining the control action when the control policy comprises multiple neural networks.

According to an eleventh possible implementation of the first aspect, or any previously described implementation thereof, wherein the obtained control policy further may comprise: an indicator configuring a combining method for the agent node to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to a twelfth possible implementation of the first aspect, or any previously described implementation thereof, the agent node may be further configured to determine the performance measurement associated with the radio cell, given the feature representing

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the state at the first time period t and the power control action a_t taken at the first time period t.

According to a thirteenth possible implementation of the first aspect, or any previously described implementation thereof, the agent node may be further configured to determine the performance measurement, associated with the performance within the radio cell by computing a weighted sum of scalars $x_i \in \mathcal{X}$, parameterised by a scalar coefficient $\alpha \in [0, \infty)$ and transformed by a function $h_i: \mathcal{X} \rightarrow \mathrm{R}$ (with domain $\mathcal{X}$ and range of real scalars),

$$r_t(\boldsymbol{x}) = \frac{1}{1-\alpha} \sum_{x_i \in \mathcal{X}} w_i (h_i(x_i)^{1-\alpha} - 1) \quad \alpha \in [0, \infty),$$

where x_i represents a radio measurement or a performance indicator associated with the radio cell, $\mathcal{X}$ is the set of all radio measurements or performance indicators associated with the radio cell and used for the definition of the performance measurement, w_i is a weight associated with x_i, and $\boldsymbol{x} = [x_1, \ldots x_{|\mathcal{X}|}]$ is a vector comprising all $x_i \in \mathcal{X}$.

According to a fourteenth possible implementation of the first aspect, or any previously described implementation thereof, the radio resource parameter to be configured is one or more in the group of: a control parameter associated with downlink power control in one or more radio cells, such as downlink power control adjustment value for a downlink power budget, a downlink power control adjustment value associated with at least one portion of a radio frequency spectrum utilised by one or more radio cells; a control parameter associated with uplink power control in one or more user devices, such as an uplink power control adjustment value, a fractional pathloss adjustment value, an open-loop power control configuration value; a control parameter associated with allocation of shared radio resources of one or more radio cells to one or more user devices, such as time-frequency resource blocks; a control parameter associated to an electronic tilt of one or more antennae; a control parameter for performing hand over or cell (re-)selection for the user device, such a threshold value of a signal strength indicator, an offset value of the signal strength indicator, a threshold value associated with resource availability in the cell, a threshold value associated with an expected data rate from the radio cell, a threshold value associated with experienced data rate from the radio cell; a control parameter associated with allocation of radio resources for control channel signalling, such as the number of Orthogonal Frequency-Division Multiplexing symbols allocated to a Physical Downlink Control Channel, number or allocation of time-frequency resource groups for Physical Downlink Control Channel; a

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control parameter associated with allocation of resources for sounding reference signals associated to one or more user devices in one or more radio cells, such as periodicity and distribution of sounding signals over time and frequency; a control parameter associated with numerology or type of waveform utilised in at least one portion of frequency spectrum of one radio cell, such as the duration of a transmission time interval, number of Orthogonal Polarisation and Frequency Division Multiplexing symbols, length of cyclic prefix, and indication to enable/ disable cyclic prefix, duration of a symbol in time and frequency domain; a control parameter algorithm related to a threshold value for performing hand over or selecting one or more radio frequency carrier to be assigned to the user device.

According to a second aspect, a method in an agent node according to the first aspect, or any possible implementations thereof, for configuring a radio resource parameter of a radio cell of a communication system, is provided. The method comprises obtaining a control policy. Further the method may comprise determining at least one feature representing a state of at least a part of the communication system, at a first time period. In addition, the method also may comprise determining a control action to be performed for configuring the radio resource parameter in the radio cell at a first time period, out of a set of available control actions associated with the radio cell, based on the obtained control policy. Also the method in addition comprises configuring the radio resource parameter of the radio cell based on the determined control action.

According to a first possible implementation of the second aspect, the method may further comprise determining a feature representing the state of the part of the communication system at a second time period. Also, the method may further comprise determining a performance measurement, associated with the performance within the radio cell. In addition, the method may also comprise transmitting a training data message to the trainer node, comprising one or more in the group of: the determined feature representing the state at the first time period, the determined control action performed at the first time period, the determined feature representing the state at the second time period, and the determined performance measurement. The method may also comprise receiving the obtained control policy from the trainer node.

According to a second possible implementation of the second aspect, or the first possible implementation thereof, the method further may comprise selecting which at least one

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feature to utilise for representing the state of at least a part of the communication system. Also, the method comprises selecting which performance measurement associated with the radio cell to utilise for representing the performance of the radio cell.

According to a third possible implementation of the second aspect, or the first possible implementation thereof, wherein the radio network node controlling the radio cell is not co-located with the agent node, the method further may comprise transmitting an instruction to the radio network node for configuring the radio resource parameter of the radio cell of the radio network node.

According to a fourth possible implementation of the second aspect, or any previously described implementation thereof, wherein the feature representing the state of at least a part of the communication system, is determined based on any of: a measurement related to received signal quality made by and received from a user device in the radio cell; a measurement related to received signal quality made by and received from a user device in another radio cell; a measurement related to downlink transmission power of the radio cell made by and obtained from the radio network node controlling the radio cell; a measurement related to a number of active user devices in the radio cell; a measurement related to types or distribution of traffic within the radio cell; a measurement related to location or distribution of user devices in the radio cell; a performance measurement, associated with the performance within the radio cell a measurement related to resource utilisation in the radio cell; or a measurement related to electrical tilt associated with the radio cell.

According to a fifth possible implementation of the second aspect, or any previously described implementation thereof, the method further may comprise computing a performance measurement associated with at least a part of the communication system, based on the determined performance measurement and a network performance measurement received from another radio network node in the communication system; and wherein the training data message transmitted to the trainer node comprises the computed performance measurement.

According to a sixth possible implementation of the second aspect, or any previously described implementation thereof, the method further may comprise obtaining an

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exploration-to-exploitation control parameter, associated with a probability of applying the control policy. The method further comprises determining application of the obtained control policy, based on the obtained exploration-to-exploitation control parameter.

According to a seventh possible implementation of the second aspect, or any previously described implementation thereof, wherein the radio network node controlling the radio cell of the configured radio resource parameter is another agent node, the training data message transmitted to the trainer node comprises a training data message received from the other agent node; and wherein the control policy to be utilised for radio resource parameter control in the radio cell of the other agent node in the communication system, obtained from the trainer node, is forwarded to the other agent node.

According to an eighth possible implementation of the second aspect, or any previously described implementation thereof, the method comprises iterating the determination of the feature representing the state of at least a part of the communication system; the determination of the control action; the configuration of the radio resource parameter; the determination of the performance measurement; the transmission of the training data message, or a plurality of training data messages, to the trainer node and the obtaining of the control policy.

According to a ninth possible implementation of the second aspect, or any previously described implementation thereof, the method may comprise adjusting the set of available control actions associated with the radio cell, based on the determined at least one feature representing the state of the part of the communication system, or based on the control policy received by the trainer node.

According to a tenth possible implementation of the second aspect, or any previously described implementation thereof, the method may comprise iterating the method according to the second aspect, or any previously described implementation thereof.

According to an eleventh possible implementation of the second aspect, or any previously described implementation thereof, the method may comprise adjusting the set of available control actions associated with the radio cell, based on the determined feature representing the state of the part of the communication system.

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According to a twelfth possible implementation of the second aspect, or any previously described implementation thereof, the method may comprise representing the obtained control policy by one or more of: an indicator configuring a combining method for the agent node to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to a thirteenth possible implementation of the second aspect, or any previously described implementation thereof, wherein the obtained control policy further comprises: an indicator configuring a combining method for the agent node to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to a fourteenth possible implementation of the second aspect, or any previously described implementation thereof, further comprising determining the performance measurement associated with the radio cell, given the feature representing the state at the

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first time period t and the power control action a_t taken at the first time period t.

According to a fifteenth possible implementation of the second aspect, or any previously described implementation thereof, further comprising determining the performance measurement, associated with the performance within the radio cell by computing a weighted sum of scalars $x_i \in \mathcal{X}$, parameterised by a scalar coefficient $\alpha \in [0, \infty)$ and transformed by a function $h_i: \mathcal{X} \rightarrow \mathrm{R}$ (with domain $\mathcal{X}$ and range of real scalars),

$$r_t(\boldsymbol{x}) = \frac{1}{1-\alpha} \sum_{x_i \in \mathcal{X}} w_i (h_i(x_i)^{1-\alpha} - 1) \quad \alpha \in [0, \infty),$$

where x_i represents a radio measurement or a performance indicator associated with the radio cell, $\mathcal{X}$ is the set of all radio measurements or performance indicators associated with the radio cell and used for the definition of the performance measurement, w_i is a weight associated with x_i, and $\boldsymbol{x} = [x_1, \ldots x_{|\mathcal{X}|}]$ is a vector comprising all $x_i \in \mathcal{X}$.

According to a sixteenth possible implementation of the second aspect, or any previously described implementation thereof, wherein the radio resource parameter to be configured is one or more in the group of: a control parameter associated with downlink power control in one or more radio cells, such a downlink power control adjustment value for a downlink power budget, a downlink power control adjustment value associated with at least one portion of a radio frequency spectrum utilised by one or more radio cells; a control parameter associated to uplink power control in one or more user devices, such an uplink power control adjustment value, a fractional pathloss adjustment value, an open-loop power control configuration value; a control parameter associated with allocation of shared radio resources of one or more radio cells to one or more user devices, such as time-frequency resource blocks; a control parameter associated to an electronic tilt of one or more antennae; a control parameter for performing hand over or cell (re-)selection for the user device, such a threshold value of a signal strength indicator, an offset value of the signal strength indicator, a threshold value associated with resource availability in the cell, a threshold value associated with an expected data rate from the cell, a threshold value associated with experienced data rate from the cell; a control parameter associated with allocation of radio resources for control channel signalling, such as the number of Orthogonal Frequency-Division Multiplexing symbols allocated to a Physical Downlink Control Channel, number or allocation of time-frequency resource groups for Physical Downlink Control Channel; a control parameter associated with allocation of resources for sounding reference signals

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associated to one or more user devices in one or more radio cells, such as periodicity and distribution of sounding signals over time and frequency; a control parameter associated with numerology or type of waveform utilised in at least one portion of frequency spectrum of one radio cell, such as the duration of a transmission time interval, number of Orthogonal Polarisation and Frequency Division Multiplexing symbols, length of cyclic prefix, and indication to enable/ disable cyclic prefix, duration of a symbol in time and frequency domain; a control parameter algorithm related to a threshold value for performing hand over or selecting one or more radio frequency carrier to be assigned to the user device.

According to a third aspect, a computer program is provided, with a program code for performing a method according to the second aspect, or any possible implementation thereof, when the computer program runs on a computer.

According to a fourth aspect, a trainer node is provided for determining a control policy to be utilised by an agent node for configuring a radio resource parameter of a radio cell of a communication system. The trainer node is configured to: receive a training data message, associated with the radio cell, from the agent node, wherein the training data message comprises one or more in the group of: a feature representing a state of at least a part of the communication system at a first time period, a power control action performed by the agent node in the radio cell at the first time period, a feature representing the state at the second time period, and a performance measurement. Furthermore, the trainer node is configured to store the received training data message in a database associated with the radio cell. Also, the trainer node is configured to determine a control policy for the radio cell, based on at least one training data message, stored in the database. Furthermore, the trainer node is configured to transmit the determined control policy to the agent node.

According to a first possible implementation of the fourth aspect, the determined control policy may be determined by one or more of: an indicator configuring a combining method for the agent node to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy based on the decision forest; an indicator of a parameter representing a quadratic data split function for

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the control policy based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to a second possible implementation of the fourth aspect, or any previously described implementation thereof, the determined control policy further comprises: an indicator configuring a combining method for the agent node to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to a third possible implementation of the fourth aspect, or any previously described implementation thereof, the trainer node may be further configured to determine an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy; and wherein the determined exploration-to-exploitation control parameter is transmitted to the agent node together with the determined control policy.

According to a fourth possible implementation of the fourth aspect, or the first possible implementation thereof, the trainer node may be configured to determine the exploration-to-exploitation control parameter so that the probability of applying the determined control policy is increased over time.

According to a fifth possible implementation of the fourth aspect, or any previously

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described implementation thereof, the trainer node may be configured to compute a performance measurement associated with at least a part of the communication system, based on the performance measurement received in the training data message received from the agent node and another performance measurement received from another radio network node in the communication system.

According to a sixth possible implementation of the fourth aspect, or any previously described implementation thereof, the trainer node may be configured to select which at least one feature the agent node is to utilise for representing the state of at least a part of the communication system and provide the made selection to the agent node.

According to a seventh possible implementation of the fourth aspect, or any previously described implementation thereof, the trainer node may be configured to select which performance measurement associated with the radio cell, the agent node is to utilise for representing the performance of the radio cell and provide the made selection to the agent node.

According to a fifth aspect, a method in a trainer node is provided for determining a control policy to be utilised by an agent node for configuring a radio resource parameter of a radio cell of a communication system. The method comprises receiving a training data message, associated with the radio cell, from the agent node, wherein the training data message comprises one or more in the group of: a feature representing a state of at least a part of the communication system at a first time period, a control action performed by the agent node in the radio cell at the first time period, a feature representing the state at the second time period, and a performance measurement. The method also comprises storing the received training data message in a database, associated with the radio cell. In addition, the method comprises determining a control policy for the radio cell, based on at least one training data message, stored in the database. The method also comprises transmitting the determined control policy to the agent node.

According to a first possible implementation of the fifth aspect, the method may comprise determining an exploration-to-exploitation control parameter, associated with the control policy; and wherein the determined exploration-to-exploitation control parameter is transmitted to the agent node together with the determined control policy.

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According to a second possible implementation of the fifth aspect, or the first possible implementation thereof, wherein the exploration-to-exploitation control parameter is determined to be reduced over time.

According to a third possible implementation of the fifth aspect, or any of the previously described implementation thereof, the method may also comprise computing a performance measurement associated with at least a part of the communication system, based on the performance measurement received in the training data message received from the agent node and another performance measurement received from another radio network node in the communication system.

According to a fourth possible implementation of the fifth aspect, or any of the previously described implementation thereof, the method may also comprise selecting which at least one feature the agent node is to utilise for representing the state of at least a part of the communication system wherein the radio cell is comprised and sending the made selection to the agent node.

According to a fifth possible implementation of the fifth aspect, or any of the previously described implementation thereof, the method may also comprise selecting which performance measurement associated with the radio cell the agent node is to utilise for representing the performance of the radio cell and sending the made selection to the agent node.

According to a sixth aspect, a computer program is provided, with a program code for performing a method according to the fifth aspect, or any possible implementation thereof, when the computer program runs on a computer.

Thanks to the provided agent node, trainer node and methods therein, radio resource management is simplified and to some extent automated. By applying machine learning such as e.g. Reinforcement Learning, adaptation of radio resource parameters may be made without involving manual adjustments, also when e.g. traffic patterns, radio traffic intensity, communication content, etc., are changing over time. Thereby spectral efficiency of the system is enhanced.

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Other objects, advantages and novel features of the aspects of the invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are described in more detail with reference to attached drawings, illustrating examples of embodiments of the invention in which:

Figure 1 is a block diagram illustrating a wireless communication network with an agent node controlling the downlink transmission power budget for a co-located radio cell.

Figure 2 is a block diagram illustrating a wireless communication network with an agent node controlling the downlink transmission power budget of a non co-located radio cell.

Figure 3 is a block diagram illustrating a wireless communication network illustrating interaction between agent node and trainer node.

Figure 4 is a block diagram illustrating a wireless communication network with multiple agent nodes.

Figure 5 is a flow chart illustrating a method in an agent node according to an embodiment of the invention.

Figure 6 is a block diagram illustrating an agent node architecture according to an embodiment of the invention.

Figure 7 is a flow chart illustrating a method in a trainer node according to an embodiment of the invention.

Figure 8 is a block diagram illustrating a trainer node architecture according to an embodiment of the invention.

DETAILED DESCRIPTION

Embodiments of the invention described herein are defined as a network access unit and a method in a network access unit, which may be put into practice in the embodiments described below. These embodiments may, however, be exemplified and realised in many different forms and are not to be limited to the examples set forth herein; rather, these illustrative examples of embodiments are provided so that this disclosure will be thorough and complete.

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Still other objects and features may become apparent from the following detailed description, considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the herein disclosed embodiments, for which reference is to be made to the appended claims. Further, the drawings are not necessarily drawn to scale and, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

Figure 1 is a schematic illustration over a radio communication system **200** wherein the agent node **210** resides in a radio network node, such as an eNodeB of an LTE system, and controls radio resources of at least one radio cell **215** co-located with the radio access node. The radio resource of the cell 215 may be determined based on radio environmental measurements received from a user device **220** camping within the controlled radio cells 215, as well as based on information received by other radio network nodes **230** representing a performance measure associated to the communication system. The neighbour radio network node 230 in the illustrated example may control three radio cells **235-1, 235-2, 235-3**.

A massive densification of radio access nodes in future radio communication systems 200 makes inter-cell interference management particularly difficult due to the potentially large number of interferers affecting the transmission to/ from a user device 220, and therefore comes with a number of new challenges related to spectral efficiency and energy savings.

Solving this problem to optimality requires extensive channel state measurements correlating the channel quality experienced by each user device from multiple radio network nodes 230 (i.e., radio cells) to fully characterise the state of the system. Such measurements should be collected by a central node so as to jointly optimise the downlink power budget used by multiple radio network nodes 230. The signalling overhead to implement such solution makes it prohibitive already with slow varying radio channel.

The object of the herein disclosed embodiments is to provide a method which mitigates and/ or solves the disadvantages of the prior art solutions. More specifically, it is herein disclosed a method for performing RRM based on learning a network environmental

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performance.

More specifically, it discloses a method for autonomously learning different radio resource management strategies using measurements and Key Performance Indicators (KPIs) collected from an algorithmic interaction with the radio environment. Such algorithmic interaction with the radio environment is based on ideas from machine learning and, more specifically, reinforcement learning and tailors them to the specifics of the radio communication system 200. Using the methodology proposed in this solution it is possible to design better solutions for the management of radio resources which are more performing and adaptive to the changing radio environment conditions.

Thereby autonomous learning is provided, leading to better performance and improved adaptability.

The disclosed embodiments comprise a general framework for resource management in a radio communication system 200 based on machine learning. The method may require two logical entities: the agent node 210 (e.g., an eNodeB), configured to interact with the radio environment and determine an action based on an associated control policy; and a trainer node (e.g., an eNodeB or a remote server) configured to learn initially only part and eventually all of such associated control policy based on observation of the state of the communication system 200 received from one or more agent nodes and the actions performed in the communication system 200.

The action taken by the agent node 210 according to the learned control policy may comprise either the change of a radio resource parameter (e.g., downlink transmission power of one or more eNodeBs, uplink transmit power of one or more user device 220, electrical tilt of one or more eNodeBs, etc.), the change of the parameter of a given control algorithms (e.g., one threshold value for performing hand over or selecting one or more radio frequency carrier to be assigned to the user device 220, typically threshold values related to Signal to Interference plus Noise Ratio (SINR), Signal to Noise Ratio (SNR or S/N), Reference Signal Received Power (RSRP), or any similar measurement or ratio related to a comparison of the power level of a desired signal with the level of undesired background noise, measured by the user device 220; or the allocation of a part of the shared radio resources (e.g. a time-frequency resource block) to a given user device 220.

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Instead of RSRP, other similar measurements related to signal strength/ quality may be used such as e.g. Received Signal Strength Indication (RSSI) and/ or Received Channel Power Indicator (RCPI).

Further, instead of SNR or SINR, other similar signal to interference ratios may be utilised such as e.g. signal-to-interference ratio (SIR), Peak signal-to-noise ratio (PSNR), Signal-to-noise and distortion ratio (SINAD), or similar.

In the following, these types of actions for simplicity are referred to as adjustments of radio resource parameters.

In addition, embodiments herein further disclose an efficient method to exchange information related to the state of the communication system 200 either across agent nodes 210 or between the agent node 210 and the trainer node.

Additionally, the invention discloses a method for the trainer node to efficiently reconstruct a complete or partial state of the communication system 200 and store a sequence of such states and actions in order to learn a new control policy to be assigned to the agent node 210.

A method is therefore provided for control in the radio communication system 200 based on learning features characterising the state of the radio environment with limited signalling overhead and exploiting features to learn an optimal, or at least improved, control policy for radio cells 215, 235-1, 235-2, 235-3 in the radio communication system 200. In some embodiments, two logical entities may be involved: the agent node 210 (e.g., an eNodeB), configured to interact with the radio environment and determine an action for optimising/ improving the assignment of radio resource parameter of one or more radio network nodes 230, based on a control policy.

The agent node 210 may be co-located with the radio network node 230 in some embodiments. However, in other embodiments, the agent node 210 may be a separate entity versus the radio network node 230. One agent node 210 may further control a plurality of radio cells either co-located 215 or not co-located 235-1, 235-2, 235-3. Thus the expression

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"radio network node" as utilised in this disclosure, may indicate both an agent node 210 co-located with a radio network node 230, or a separate radio network node 230.

The other logical entity is the trainer node (e.g., an eNodeB or a remote server in different embodiments), configured to learn a control policy based on e.g. observation/s of the state, performed actions and/ or rewards received from the environment. In some embodiments, the trainer node may be co-located with the agent node 210. In other embodiments however, the agent node 210 and the trainer node may be separate entities.

In some embodiments, the trainer node may be kept in a centralised server room or similar, where it may withstand wind and weather while being appropriately protected from theft and damage. Further, appropriate maintenance and software updates may conveniently be performed by skilled personnel.

Further, in some embodiments, information associated with the state of the radio communication system 200, or a subset thereof, may be communicated or exchanged either among agent nodes 210 or between the agent node 210 and the trainer node.

Additionally, a method in the trainer node is disclosed, to efficiently reconstruct, store, and exploit knowledge of at least one part of the state of the communication system 200 to create a new control policy for RRM control of the radio cells 215, 235-1, 235-2, 235-3.

In some embodiments, the agent node 210 is configured to control a radio resource parameter of the agent node 210 or at least another radio network node. The agent node 210 is configured to receive a message from the user device 220 in radio cell 215 controlled by the agent node 210 comprising at least one radio environment measurement.

Further, the agent node 210 may be configured to receive, from at least one radio network node 230, a message comprising at least one network performance measurement, or local reward as it also may be referred to as, associated with the communication system 200, or a subset thereof, such as e.g. a subset of the communication system 200 wherein the cell 215, 235-1, 235-2, 235-3 is situated.

The agent node 210 may additionally be configured to determine at least one feature

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representing, partly or entirely, the state of the communication system 200 based on the received radio environmental measurement/-s and/ or the at least one network performance measurement. Further, in some embodiments, the agent node 210 may also be configured to determine a control action associated with the radio cell 215, 235-1, 235-2, 235-3 in the communication system 200 based on the control policy, a set of available control actions, and at least one feature representing the state of the communication system 200, or a subset thereof. The agent node 210 may further be configured to configure the radio resource parameter associated to the radio cell 215, 235-1, 235-2, 235-3 based on the determined control action.

The radio resource parameter can be one or more of the subsequently enumerated examples. In some embodiments, the radio resource parameter may be a control parameter associated with downlink power control in one or more radio cells 215, 235-1, 235-2, 235-3, such a power control adjustment value for the downlink power budget, a power control adjustment value associated to at least one portion of the radio frequency spectrum utilised by one or more radio cells 215, 235-1, 235-2, 235-3.

Further, the radio resource parameter may be a control parameter associated with uplink power control in one or more use devices 210, such a power control adjustment value, a fractional pathloss adjustment value, an open-loop power control configuration value.

In some embodiments, the radio resource parameter may be a control parameter associated with allocation of shared radio resources of one or more radio cells 215, 235-1, 235-2, 235-3 to one or more user devices 220, such as time-frequency resource blocks.

In some alternative embodiments, the radio resource parameter may be a control parameter associated with electronic tilt of one or more antennae.

The radio resource parameter may, according to some embodiments comprise a control parameter for performing hand over or cell (re-)selection for the user device 220, such a threshold value of a signal strength indicator (e.g., RSRP, SINR, SNR, etc.), an offset value of a signal strength indicator (e.g., RSRP, SINR, SNR, etc.), a threshold value associated to the resource availability in the radio cells 215, 235-1, 235-2, 235-3, a threshold value associated with the expected data rate from the radio cell 215, 235-1, 235-2, 235-3, a

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threshold value associated with the experienced data rate from the radio cell 215, 235-1, 235-2, 235-3.

The radio resource parameter may optionally further comprise a control parameter associated with the allocation of radio resources for control channel signalling, such as the number of Orthogonal Frequency-Division Multiplexing (OFDM) symbols allocated to a physical downlink control channel, the number or the allocation of time-frequency resource groups for physical downlink control channel.

Furthermore, the radio resource parameter may comprise a control parameter associated with the allocation of resources for sounding reference signals associated to one or more user devices 220 in one or more radio cells 215, 235-1, 235-2, 235-3, such as the periodicity and distribution of the sounding signals over time and frequency.

The radio resource parameter may also in some embodiments comprise a control parameter associated to the numerology or type of waveform utilised in at least one portion of the frequency spectrum of one radio cell, such as the duration of a transmission time interval, the number of OPFDM symbols, the length of the cyclic prefix, and indication to enable/ disable cyclic prefix, the duration of a symbol in time and frequency domain.

The radio network node 230 can be designated as a base station, e.g. a Radio Base Station (RBS), which in some networks may be referred to as transmitter, "eNB", "eNodeB", "NodeB" or "B node", depending on the technology and terminology used. The radio network nodes 230 may be of different classes such as e.g. macro eNodeB, home eNodeB or pico base station, based on transmission power and thereby also cell size. One or more radio cells 235-1, 235-2, 235-3 can be controlled by one radio network node 230, or possibly agent node 210, such as e.g. a tri-sectorial radio site.

The communication system 200 may at least partly be based on radio access technologies such as, e.g., 3GPP LTE, LTE-Advanced, Evolved Universal Terrestrial Radio Access Network (E-UTRAN), Universal Mobile Telecommunications System (UMTS), Global System for Mobile Communications (originally: Groupe Spécial Mobile) (GSM)/ Enhanced Data rate for GSM Evolution (GSM/EDGE), Wideband Code Division Multiple Access (WCDMA), Time Division Multiple Access (TDMA) networks, Frequency Division

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Multiple Access (FDMA) networks, Orthogonal FDMA (OFDMA) networks, Single-Carrier FDMA (SC-FDMA) networks, Worldwide Interoperability for Microwave Access (WiMax), or Ultra Mobile Broadband (UMB), High Speed Packet Access (HSPA) Evolved Universal Terrestrial Radio Access (E-UTRA), Universal Terrestrial Radio Access (UTRA), GSM EDGE Radio Access Network (GERAN), 3GPP2 CDMA technologies, e.g., CDMA2000 1x RTT and High Rate Packet Data (HRPD), just to mention some few options. The expressions "wireless communication network", "wireless communication system" and/ or "cellular telecommunication system" may within the technological context of this disclosure sometimes be utilised interchangeably.

It is to be noted that the illustrated network setting of one agent node 210, one radio network node 230 and one user device 220 in Figure 1 is to be regarded as a non-limiting example of an embodiment only. The radio communication system 200 may comprise any other number and/ or combination of agent nodes 210, radio network nodes 230 and/ or user devices 220. A plurality of user devices 220 and another configuration of radio network nodes 230 and/ or agent node 210 may thus be involved in some embodiments of the disclosed invention.

Thus whenever "one" or "a/ an" user device 220, radio network node 230 and/ or agent node 210 is referred to in the present context, a plurality of user devices 220, radio network nodes 230 and/ or agent nodes 210 may be involved, according to some embodiments.

The set of available discrete control actions $\mathcal{A} = \{a_i\}_{i=1}^{A}$ may comprise positive or negative offset values to be applied to the current radio resource parameter value. Each value may therefore correspond to increase (positive offset), decrease (negative offset) or hold (zero offset) the current parameter value. The parameter values can equivalently be expressed in binary, linear, logarithmic (decibel), or other suitable scales. Moreover, typically a radio environmental parameter may have a feasible range of variable which defines the domain of the parameter. In one example, the radio cells 235-1, 235-2, 235-3 may transmit power budget as the control parameter takes minimum and maximum feasible values in the range [10dB, 46dB] and the set of available power control actions may comprise the values $\mathcal{A} = \{0, \pm 1, \pm 3\}$ dB.

Furthermore, the feasible range of the radio resource parameter may further depend on the

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current state of the communication system 200. In one example, the transmit power budget of radio cells 235-1, 235-2, 235-3 may be as the control parameter and the current value of the transmit power is a part of the state at a time t. Then the set of available power control actions to be taken at time t, further may depend on the current value of the power budget. For instance, if the current value of the power budget is 46dB then the set of available power control actions (according to the previous example) may be limited to $\mathcal{A} = \{0, -1, -3\}$ dB.

In another example the control variable might be the threshold parameter for triggering a HandOver and have a similar set of available control actions comprising the offsets $\mathcal{A} = \{0, \pm 1, \pm 3\}$ dB. In another example the actions might consist in the downlink or uplink allocation of time-frequency resource blocks to the user devices 220. In such case the set of actions would consist of the Cartesian product of the available resource blocks (RBs) and user devices 220: $\mathcal{A} = \{RBs\}_{k=1}^{K} \times \{UEs\}_{n=1}^{N}$.

In some embodiments of the invention, the agent node 210 may be configured to determine a control action for controlling a radio resource parameter for at least one radio cells 235-1, 235-2, 235-3 controlled by the radio network node 230, not co-located with the agent node 210.

Further according to some embodiments, the agent node 210 may be configured to transmit a control message to the radio network node 230 comprising at least said radio resource parameter adjustments.

Figure 2 illustrates an embodiment wherein the agent node 210 is not co-located with the radio network node 230. In this case the agent node 210 controls the radio resource parameter associated with at least one radio cell 235-1, 235-2, 235-3 not co-located with the agent node 210. The advantage of this embodiment is to enable centralised control of a plurality of radio network nodes 230, with the aim of improving KPIs like the spectral efficiency of the system 200, the satisfaction of Quality and Service (QoS) requirements and the fairness of the distribution of resources across user devices 220.

Additionally, the control message of the agent node 210 may further comprise an indication of time associated with the control action, such as a starting time indicating when to apply

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the control action and a window indicating the validity of the control action. Furthermore, the control message may comprise additionally comprise a list of control actions and an associated indication of time. The control actions may further be associated with one or more radio cells 235-1, 235-2, 235-3 controlled by the radio network node 230, or a plurality of radio network nodes 230.

The agent node 210 may determine a set of features $\mathcal{F} = \{f_j\}_{j=1}^{F}$ wherein each feature f_j is used to represent part of the state s_t of the communication system 200 at a given time t. Each feature $f_j \in \mathcal{F}$ can be determined based on radio measurements received from user devices 220 within one or more radio cells 215, 235-1, 235-2, 235-3 controlled by the agent node 210 or based on measurements associated with the communication system 200 received from the at least one radio network node 230. For instance, the set of features $\mathcal{F} = \{f_j\}_{j=1}^{F}$ may comprise one or more of the following features, depending on the radio resource parameter being controlled.

Thus the set of features may comprise an indicator of the downlink transmission power associated with the at least one radio cell 215 controlled by the agent node 210. Further, the set of features may comprise an indicator of the downlink transmission power associated with at least one radio cell 235-1, 235-2, 235-3 controlled by the radio network node 230 non co-located with the agent node 210. Also, the set of features may comprise an indicator of the average, minimum, or maximum Reference Signal Received Power (RSRP) associated with the user devices 220 within at least one radio cell 215, 235-1, 235-2, 235-3 controlled by the agent node 210. The set of features may optionally comprise an indicator of the measured interference associated to the radio cell 215 controlled by the agent node 210 and at least one neighbouring cell, such as the average, minimum or maximum interference. The interference may thereby be measured by the user devices 220 within the at least one radio cell 215, 235-1, 235-2, 235-3 controlled by the agent node 210 and reported to the agent node 210. Furthermore, the set of features may also comprise an indicator of the average, minimum or maximum Signal to Noise Ratio (SNR) associated with the user devices 220 within at least one radio cell 215 controlled by the agent node 210. Additionally, the set of features may comprise an indicator of the average, minimum or maximum Signal to Interference plus Noise Ratio (SINR) associated with the user devices 220 within at least one radio cell 215 controlled by the agent node 210. The set of features

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may further comprise an indicator of the reward function associated with the radio cell 235-1, 235-2, 235-3 controlled by the radio network node 230. Also, the set of features may further comprise the number of active user devices 220 in the radio cell 215, 235-1, 235-2, 235-3. In further addition, the set of features may optionally comprise the type of traffic of the active user devices 220 in the radio cell 215, 235-1, 235-2, 235-3. The set of features may also comprise the traffic load of the radio cell 215, 235-1, 235-2, 235-3 associated with one or more frequency carrier. In addition, the set of features may further comprise resource utilisation within the radio cell 215, 235-1, 235-2, 235-3, such as an indication of the average, maximum, or minimum resource utilisation. The set of features may comprise an indication of the electrical tilt associated with one or more radio cells 215, 235-1, 235-2, 235-3.

More generally, the set of features may comprise a list of radio control parameters associated with one or more radio resource management algorithms to be controlled by the agent node 210. In one example, for HandOver or cell reselection algorithms, the set of features may comprise threshold values or measurement gaps related to SINR, SNR, RSRP, or other measurements of signal strength from the user device 220 to one or more radio network nodes 230.

Thereby, the radio environmental measurement received from user devices 220 with the radio cell 215, 235-1, 235-2, 235-3 controlled by the agent node 210 may comprise at least one or more in the group of: a measurement of the RSRP associated to at least one radio cell 215 controlled by the agent node 210 (specifically, useful signal); a measurement of RSRP associated to at least one neighbouring cell (i.e., interference); a measurement of the SNR associated to at least one radio cell 215 controlled by the agent node 210; and/ or a measurement of the SINR associated to at least one neighbouring cell controlled by the agent node 210.

The agent node 210 can further determine/ characterise the state s_t associated with part or the entire communication system 200 at a given time t by selecting a subset of features $f_j \in \mathcal{F}$, i.e. $s_t = \{f_{k,t}\}_{k\in\mathcal{S}}$ with $\mathcal{S} \subseteq \mathcal{F}$ and $f_{k,t}$ indicating the value of feature $f_k \in \mathcal{S}$ at time t. Thereby, the state of the communication system 200 can be represented by different combinations of features and different number of features. Each feature may comprise a measurement or a function of some radio measurements.

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The agent node 210 is further configured to determine a performance measurement r_t, which may be referred to as a reward associated with one or more radio cells 215, 235-1, 235-2, 235-3 in the communication system 200 at a given time t given the power control action $a_t \in \mathcal{A}$ taken at time t and the state s_t of the communication system 200 at time t, i.e., $r_t = g(a_t, s_t)$. Rather than explicitly modelling the dependency of r_t on the state and power control action, the agent node 210 can estimate the cell performance measurement r_t based on the radio environmental measurements $x_i \in \mathcal{X}$ received by the user devices 220 served by the radio cell 215, 235-1, 235-2, 235-3. In other words, the user measurements may provide observations of the cell state and reward at time $t+1$ resulting from the application of the control action a_t in state s_t at time t, in some embodiments.

In one embodiment, the agent node 210 determines the performance measurement r_t associated with the controlled radio cell 215, 235-1, 235-2, 235-3 as weighted sum of the state observations $x_i \in \mathcal{X}$ parametrised by a scalar coefficient $\alpha \in [0, \infty)$ and transformed by a concave increasing function h_i,

$$r_t(\boldsymbol{x}) = \frac{1}{1-\alpha} \sum_{x_i \in \mathcal{X}} w_i (h_i(x_i)^{1-\alpha} - 1) \quad \alpha \in [0, \infty) \qquad [1]$$

where w_i is a weight associated to the radio environmental measurement of user i, and $\boldsymbol{x} = [x_1, \ldots x_{|\mathcal{X}|}]$ is a vector comprising the radio environmental measurements of all user devices 220, used for the definition of the reward function $r_t(\boldsymbol{x})$.

In one non-limiting exemplifying case, the function and $h_i(x_i)$ represents the average data throughput of user i in the radio cell 215, 235-1, 235-2, 235-3 and the reward $r_t(\boldsymbol{x})$ in equation [1] can be approximated for different values of α and weights w_i with e.g. any, some or all of the following expressions: The average data throughput associated with the user devices 220 in the radio cell 215, 235-1, 235-2, 235-3, i.e., $r_t(\boldsymbol{x}) = \frac{1}{|\mathcal{X}|} \sum_{x_i \in \mathcal{X}} h_i(x_i)$, if $\alpha = 0$, $w_i = \frac{1}{|\mathcal{X}|}$ for all i; The average data throughput associated to the radio cell 215, 235-1, 235-2, 235-3, i.e., $r_t(\boldsymbol{x}) = \sum_{x_i \in \mathcal{X}} h_i(x_i)$, if $\alpha = 0$, $w_i = 1$ for all i; The average log-transformed data throughput associated to the user devices 220 in the radio cell 215, 235-1, 235-2, 235-3, i.e., $r_t(\boldsymbol{x}) = \frac{1}{|\mathcal{X}|} \sum_{x_i \in \mathcal{X}} \log(h_i(x_i))$, if $\alpha = 1$, $w_i = 1/|\mathcal{X}|$ for all i; The average sum of log-transformed data throughput associated with the radio cell 215, 235-1, 235-2, 235-3, i.e., $r_t(\boldsymbol{x}) = \sum_{x_i \in \mathcal{X}} \log(h_i(x_i))$, if $\alpha = 1$, $w_i = 1$ for all i; The average harmonic data throughput associated with the user devices 220 in the radio cell 215, 235-1, 235-2, 235-3,

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i.e., $r_t(\boldsymbol{x}) = \frac{|\mathcal{X}|}{\sum_{x_i \in \mathcal{X}} h_t(x_i)^{-1}}$, if $\alpha = 2$, $w_i = 1/|\mathcal{X}|$ for all i; The average harmonic data throughput associated with the radio cell 215, 235-1, 235-2, 235-3, i.e., $r_t(\boldsymbol{x}) = \frac{1}{\sum_{x_i \in \mathcal{X}} h_t(x_i)^{-1}}$, if $\alpha = 2$, $w_i = 1$ for all i.

Each reward expression enables the agent node 210 to optimise a different performance metric that can either be associated with individual user devices 220, to radio cells 215, 235-1, 235-2, 235-3, or the communication system 200 as a whole.

The power control policy is a function, mapping the state of the communication system 200 to the set of the available actions. The power control policy may be e.g. deterministic, stochastic, probabilistic or a combination thereof.

In one embodiment of the invention, the power control policy may be represented by one or more neural network, wherein each neural network comprises an input layer comprising a set of input units, a set of hidden layers each consisting a set of hidden units, and one output layer consisting of one or more output units. Each neural network may be represented by a set of weights $W = \{\boldsymbol{w}^{(1)}, \ldots, \boldsymbol{w}^{L-1}\}$, with $\boldsymbol{w}^{(l)} = \left[w_1^{(l)}, \ldots, w_{N_l}^{(l)}\right]^T$ denoting a $N_l \times 1$ real-valued vector whose components represent the weights between units of layer l and units of layer $l+1$. Furthermore, the neural network may be represented by an activation function, possibly S-shaped, which introduces a non-linearity in transforming the input received by the unit into its output.

The agent node 210 can be configured with a codebook of neural networks $\mathcal{N}$ indexed by $n = 1, \ldots, N$, eventually of different size (i.e. with different number of hidden layer, and with different number of units in the input, output and hidden layers).

In one embodiment, the agent node 210 determines a control action by inputting at least one neural network associated with a Q-value function, with at least one action $a_i \in \mathcal{A}$ and with at least a feature $f_j \in \mathcal{X}$. The output layer of each neural network n determines a real-value $q_{a_i}^{(n)} \in [0, 1]$ associated with the corresponding control action a_i inputted at the input layer. The value $q_{a_i}^{(n)}$ represents the cumulative discounted reward that the agent node 210 is expected to achieve by choosing the control action a_i and following the policy implemented

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by the neural network n afterwards.

Therefore, in one embodiment, the agent node 210 may be configured with a control policy represented by a single neural network and determine the control action a_{i^*} with the maximum likelihood coefficient as:

$$a_{i^*} = \arg\max_{a_i} q_{a_i} \quad [2]$$

In one alternative embodiment, the agent node 210 may be configured with a control policy represented by a neural network and determine a power control action a_{i^*} based on the following steps of determine, for each neural network n representing the control policy, the control action $a_{i^*}^{(n)}$ with the maximum q-value based on equation [2]. A next step may be to choose the control action a_{i^*} as the one that has been selected by largest number of neural networks (e.g., majority vote). If two or more actions have been selected by an equal number of neural networks with majority vote, one of said actions may be chosen at random with equal probability, in some embodiments.

An advantage of this described alternative embodiment may be a possibility of correcting errors of some neural networks which might have learned an incorrect policy in some parts of the state space.

In one alternative embodiment, the control policy may be represented by one or more decision forests, with each decision forest comprising a set of decision trees, wherein each decision tree is characterised by a number of nodes each of which splits the incoming data into two subsets based on a threshold value. The data samples provided to each node of a decision three comprises a set of features $f_j \in \mathcal{F}$. The data may be split based on a split function defined on a subspace of the feature space. Such subspace may be created by selecting at random one or more features of the full feature space $\mathcal{F}$ and at random one or more parameters of the split function characterising (but not limited to) one of the following split criterion: axis aligned split (i.e., either vertical or horizontal alignment), one parameter indicates a feature value $f_j \in \mathcal{F}$; linear split, wherein at least two parameters define the slope and the intercept value of a linear function of the features; and/ or quadratic split, wherein at least three parameters define a quadratic function of the features.

An information gain criterion may determine which features or the parameters

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characterising of the split function, to be chosen at random. Additionally, a stopping criterion may be used to determine the depth of the decision forest, such as maximum depth, minimum information gain or minimum number of data samples to be split.

The control policy can be learned by the agent node 210 based on the available radio measurements received from user devices 220 in the radio cells 215, 235-1, 235-2, 235-3 controlled by the agent node 210. In an alternative embodiment, the agent node 210 may receive a message comprising the control policy.

Therefore, in one embodiment of the invention, the agent node 210 may be further configured to: receive, from a trainer node, a control message comprising a control policy for adjusting a radio resource parameter regulating the radio resources parameter (like downlink power) or the threshold of an algorithm managing some radio resources or the allocation of a time-frequency resource block to a given user device 220.

The received control action can be associated with one or more radio cells 215 controlled by the agent node 210, or with one or more radio network nodes 230 controlled by the agent node 210. The embodiment is illustrated in **Figure 3** wherein the control message comprising a control policy **430** is transmitted by the trainer node **400** to the agent node 210.

Figure 3 illustrates an example of interaction between the agent node 210 and the trainer node 400 in the communication system 200.

Furthermore, the control policy 430 may be represented by one or more of: a message indicating a neural network architecture (specifying input, hidden layers, output and number of neurons or units per layer, and activation function). The control policy 430 may further be represented by at least one neural network indicator indicating one neural network in the codebook of neural networks N already available for the agent node 210. In some embodiments, the control policy 430 may be represented by at least one set of neural network weights W to be configured for at least one neural network associated with the control policy (the neural network may further be addressed by the neural network indicator in some embodiments). The control policy 430 may alternatively be represented by a number of neural networks to be configured for controlling the action; an indicator

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configuring a combining method for the agent node 210 to aggregate the results produced by individual neural networks for determining the control action. For example, the agent node 210 may be configured with a set of combining methods, such as majority voting, weighted majority voting and/ or borda counting. The control policy 430 may be represented by an indicator of the activation function for neurons in at least one neural network. Also, the control policy 430 may be represented by an indicator of a parameter representing/ associated with an axis aligned data split function for a control policy based on a decision forest. The control policy 430 may furthermore be represented by an indicator of at least two parameters representing/ associated with a linear data split function for the control policy 430 based on a decision forest. Also, the control policy 430 may furthermore be represented by an indicator of a parameter representing/ associated with a quadratic data split function for the control policy 430 based on a decision forest. The control policy 430 may in addition be represented by an indication one or more hyper-parameters characterising a decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

In some embodiments of the invention, the agent node 210 may be further configured to receive, from the trainer node 400, a control message 430 further comprising an exploration-to-exploitation control parameter ϵ associated with the control policy. Also, the agent node 210 may be configured to determine whether to apply the control policy 430 based on the exploration-to-exploitation control parameter ϵ.

The exploration-to-exploitation control parameter ϵ may indicate how often in average the control policy 430 should be used compared to an alternative control policy 430, such as, for instance, selecting a random action in the set $\mathcal{A}$. The advantage of this method is to allow the exploration of new states of the communication system 200 that would otherwise not be observed by the agent node 210 by using always the received control policy 430.

In some embodiments, the agent node 210 is further configured to determine a Training Data Message (TDM) **420** comprising at least an indication of: The state s_t of the communication system 200 measured at a certain time t; The control action a_t taken by the agent node 210 at time t; The state of the communication system 200 s_{t+1} measured after

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the control action; A measurement of the system performance r_{t+1} i.e. the reward associated with the new state of the communication system 200 and the control action. The determined training data message 420 is then transmitted to the trainer node 400.

The training data message 420 may furthermore be associated with one or more radio cells 215, 235-1, 235-2, 235-3 or with one or more radio network nodes 210, 230, in the communication system 200. Thereby, the training data message 420 may provide observations of the state of the communication system 200 associated with the control action taken by one or more radio cells 215, 235-1, 235-2, 235-3 or radio network nodes 210, 230. This embodiment, enables the trainer node 400 to efficiently adapt the control policy to changes in the communication system 200 so as to optimise the system performance.

The trainer node 400 may further be configured to: receive, from at least one agent node 210, at least one training data message 420; determine a control policy 430 associated with at least one radio cell 215, 235-1, 235-2, 235-3 in the communication system 200 based at least on the received training data message 420; transmit, to the agent node 210, a control message comprising the control policy 430 for optimising the radio resource parameter.

The training data message may further carry a batch of training data, i.e. a set of quadruplets $\{(s_t, a_t, s_{t+1}, r_{t+1})\}_{t=1}^{T}$ associated with $T \geq 1$ observations of the state transition due to the control action.

The radio cell 215, 235-1, 235-2, 235-3 associated with the control policy 430 can either be controlled by the agent node 210 or by another radio network node 230 controlled by the agent node 210. In the latter case, the agent node 210 may transmit to the radio network node 230 control commands associated with the radio cell 235-1, 235-2, 235-3 computed based on the control policy 230 according to former embodiments of the invention.

Figure 4 illustrates interaction between the first agent node and a second agent node **500** in the communication system 200, e.g., via the X2 interface of an LTE system, or the S1 interface.

In one embodiment of the invention, the agent node 210 may be further configured to

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determine at least one inter-agent message comprising of at least one of the following items: a network performance measurement (local reward) associated with the radio cell/-s 215 controlled by the agent node 210; a control message comprising the current control policy 430; and/ or a Training Data Message (TDM).

The agent node 210 may furthermore be configured to transmit the message/s to at least another agent node 500 which can be represented by the radio network node 230 previously mentioned, or being co-located with the trainer node 400. Upon receiving this information, the second agent node 500 may further determine a performance measurement r_s associated with at least one part or the whole communication system 200 (e.g., a group of more than one radio cell 215, 235-1, 235-2, 235-3) based on the at least one (local) reward received by the first agent node 210 and the performance measurement r_t associated to at least one radio cell 235-1, 235-2, 235-3 controlled by the second agent node 500.

In some embodiments, the control policy for the agent node 210 may be determined by the trainer node 400 upon receiving at least one data training message 420.

The control policy 430 could additionally be associated to a group of more than one radio cell 215, 235-1, 235-2, 235-3. In one example, the control policy 430 may be associated with a group of three radio cells 235-1, 235-2, 235-3 co-located in a tri-sectorial radio network node 235. The agent node 210, 500 can either reside in said radio network node 230 or control said radio network node 230 in different embodiments.

In one implementation of the embodiment, the trainer node 400 may determine a new control policy 430 based on the new training data comprised on the received training data message 420 and based on formerly received training data. The received training data 420 is thereafter stored by the trainer node 400, for instance in a database **410**, to be available for future derivations of the control policy 430. The training data stored by the trainer node 400 may be received from one or more agent nodes 210, 500 and thereby be associated with different radio cells 215, 235-1, 235-2, 235-3 or different radio network nodes 210, 230, 500 in the communication system 200.

In one embodiment of the invention, the training node 400 may be further configured to determine an exploration-to-exploitation control parameter ϵ associated with the control

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policy 430; and transmit, to the agent node 210, a control message further comprising the exploration-to-exploitation control parameter ϵ.

The exploration-to-exploitation control parameter ϵ regulates the utilisation of the control policy 430 at the agent node 210. In one exemplifying case, exploration-to-exploitation control parameter ϵ may take values in the interval $\epsilon \in [0, 1]$ (with zero and one included in the interval). Thereby, a given value of the exploration-to-exploitation control parameter ϵ indicates how often in average the control policy 430 should be used compared to an alternative control policy, such as, for instance, selecting a random action in the set $\mathcal{A}$. Thereby, a value $\epsilon = 0.2$ may indicate to the agent node 210 to select a control action $a_t \in \mathcal{A}$ based on the received control policy 430 in 80% of the times, whilst selecting a control action $a_t \in \mathcal{A}$ at random in 20% of times (or vice versa).

The advantage of this embodiment is to allow the exploration of states of the communication system 200 that would otherwise not be observed by the agent node 210 and the trainer node 400. The explored states of the communication system 200 may be reported by the agent node 210 to the trainer node 400 via the training data message 420 according to previously described embodiments.

An efficient control of the exploration versus exploitation trade-off may be an advantage as exploring at random the states of the communication system 200 may lead to degradation of the system spectral efficiency. Thereby, in one embodiment of the invention, the exploration-to-exploitation control parameter ϵ is gradually reduced over time according to a predefined method so as to gradually reduce exploration of the unknown state space and gradually increase exploitation of the control policy 430. In one example, the exploration-to-exploitation control parameter ϵ_k updated every time an action is selected may be computed as:

$$\epsilon_k = \lambda\epsilon_{min} + (1 - \lambda)\epsilon_{max},\ \lambda = \min\left(1, \frac{k}{N}\right),$$

wherein ϵ_{min} represents a minimum value of the exploration-to-exploitation control parameter that the agent node 210 will preserve once the main exploration phase is completed, ϵ_{max} is the largest epsilon value with which the agent node 210 will start. Here $k \geq 0$ is a discrete counter representing the number of actions executed up until the current time, and N is the total number of actions during which the annealing from ϵ_{max} to ϵ_{min} should take place.

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The trainer node 400 can determine the optimal control policy 430 based on a Reinforcement Learning (RL) algorithm. The reinforcement learning algorithm solves the problem of associating the experienced reward to the control actions that, taken in a given state of the system 200, lead to that reward. The control policy 430, resulting from a reinforcement learning algorithm, maps a given system state to the action to be taken (among the available set of actions) in order to maximise the cumulative reward.

Some of the most popular methods in RL are critic-only methods. They are based on the idea of finding an optimal value function and then deriving a policy from it.

Possibly the most well-known of the critic-only algorithms is that of Q-learning. A Q-value function is a prediction of future reward, more precisely the Q-value function tries to learn "how much total reward can I expect from taking action a in state s and following the policy π".

By extracting a Q-function, rather than learning directly what action to take in a given state, it may be learned how valuable it is to take an action in a given state and then derive a policy from it.

The Q-value function associated with taking action a in state s, following the policy π and with discount factor γ is written as:

$$Q^{\pi}(s,a) = E[r_{t+1} + \gamma r_{t+2} + \gamma^2 r_{t+3} + \cdots | s,a]$$

Such Q-value function can be learned by the method of the temporal differences:

$$Q(s_t,a_t) \leftarrow Q(s_t,a_t) + \alpha(r_{t+1} + \gamma max_{a' \in A} Q(s_{t+1},a') - Q(s_t,a_t))$$

The difference may be calculated as the discrepancy between the Q-value predicted by the Q-value function at time step t, that is $Q(s_t,a_t)$ and the actual reward plus discounted Q-value at time step $t+1$, that is $r_{t+1} + \gamma max_{a' \in A} Q(s_{t+1},a')$.

Such discrepancy between what is predicted and what is actually experienced is used to correct (after multiplication with a certain learning rate α) the estimated Q-function and bring it closer to the true Q-function which is to be learned. The algorithms described above

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assumed that the value function may somehow be represented in an appropriate way, e.g., by storing it in a table. However, in practice state spaces might become very large or even infinite so that a table based representation is not possible. Moreover, filling these large tables would require a huge amount of observed transitions. To overcome this problem, value functions are typically represented in terms of parameterised function approximators, e.g., linear functions or, as mentioned in this description, neural networks. Instead of updating individual entries of the value functions, the parameters of the function approximator are changed using gradient descent to minimise the error:

$$L = \frac{1}{2}\left[r + max_{a'}Q(s', a') - Q(s, a)\right]^2,$$

where $r + \max_{a'} Q(s', a')$ is the target and $Q(s, a)$ is the prediction.

Figure 5 is a flow chart illustrating embodiments of a method **600** in an agent node 210 for configuring a radio resource parameter of a radio cell 215, 235-1, 235-2, 235-3 of a communication system 200. The radio cell 215, 235-1, 235-2, 235-3 is controlled by the agent node 210 or in some embodiments by another agent node 500, or alternatively by a network node 230. The agent node 210 may be co-located with a trainer node 400 and/ or the network node 230 controlling the radio cell 215, 235-1, 235-2, 235-3 in some embodiments. Alternatively, the agent node 210 may be situated at a distance from the trainer node 400 and/ or the network node 230.

The communication system 200 may be based on 3GPP LTE. Further, the wireless communication system 200 may be based on Frequency-Division Duplex (FDD) or Time Division Duplex (TDD) in different embodiments.

To appropriately configure the radio resource parameter instruction of the radio cell 215, 235-1, 235-2, 235-3, the method 600 may comprise a number of steps **601-612**.

It is however to be noted that any, some or all of the described steps 601-612, may be performed in a somewhat different chronological order than the enumeration indicates, be performed simultaneously or even be performed in a completely reversed order according to different embodiments. Some actions such as e.g. step 602-603, 607-612 may be performed within some, but not necessarily all embodiments. Further, it is to be noted that some actions may be performed in a plurality of alternative manners according to different embodiments, and that some such alternative manners may be performed only within some, but

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not necessarily all embodiments.

The agent node 210 may in some embodiments periodically re-perform any, some or all of step 601-612, thereby enabling application of a new control policy 430 according to some embodiments. The method 600 may comprise the following steps:

Step 601 comprises obtaining the control policy 430. The control policy 430 may be received from the trainer node 400.

In some embodiments wherein the radio network node 500 controlling the radio cell 235-1, 235-2, 235-3 to be controlled is another agent node 500, the control policy 430 to be utilised for configuring the radio resource parameter in the radio cell 235-1, 235-2, 235-3 of the other agent node 500 in the communication system 200, obtained from the trainer node 400, may be forwarded to the other agent node 500.

The control policy 430 may be obtained iteratively in some embodiments.

The obtained control policy 430 may be represented by one or more of: an indicator configuring a combining method for the agent node 210, 500 to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to various embodiments, the obtained control policy 430 may further comprise: an adjustment of the set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3; an indicator configuring a combining method for the agent node 210, 500

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to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

Step 602, which only may be comprised in some embodiments, may comprise selecting which at least one feature to utilise for representing the state of at least a part of the communication system 200.

The feature representing the state of at least a part of the communication system 200, may be selected based on any, some or a combination of: a measurement related to received signal quality made by and received from a user device 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to received signal quality made by and received from a user device 220 in another radio cell 215, 235-1, 235-2, 235-3; a measurement related to downlink transmission power of the radio cell 215, 235-1, 235-2, 235-3 made by and obtained from the radio network node 210, 230, 500 controlling the radio cell 215, 235-1, 235-2, 235-3; a measurement related to a number of active user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to types or distribution of traffic within the radio cell 215, 235-1, 235-2, 235-3; a measurement related to location or distribution of user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; or a performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3.

Step 603, which only may be comprised in some embodiments, may comprise selecting which performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3 to utilise for representing the performance of the radio cell 215, 235-1, 235-2, 235-3.

Step 604 comprises determining at least one feature representing a state of at least a part of

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the communication system 200, at a first time period. The part of the communication system 200 may be the part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 for which control of the radio resource parameter is to be performed, is situated.

The determination of said feature may in some embodiments comprise iterating the determination of the feature representing the state of at least the part of the communication system 200.

The feature representing the state of at least a part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 may be situated, may be determined based on any, some or a combination of: a measurement related to received signal quality made by and received from a user device 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to received signal quality made by and received from a user device 220 in another radio cell 215, 235-1, 235-2, 235-3; a measurement related to downlink transmission power of the radio cell 215, 235-1, 235-2, 235-3 made by and obtained from the radio network node 210, 230, 500 controlling the radio cell 215, 235-1, 235-2, 235-3; a measurement related to a number of active user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to types or distribution of traffic within the radio cell 215, 235-1, 235-2, 235-3; a measurement related to location or distribution of user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; or a performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3.

Step 605 comprises determining a control action to be performed for configuring the radio resource parameter in the radio cell 215, 235-1, 235-2, 235-3 at the first time period, out of a set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3, based on the obtained 601 control policy 430.

The determination of the control action may be iterated according to some embodiments.

Further, the set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3 may be adjusted according to some embodiments, based on the determined 604 at least one feature representing the state of the part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 may be comprised, or based on the control policy

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430 received by the trainer node 400.

Step 606 comprises configuring the radio resource parameter of the radio cell 215, 235-1, 235-2, 235-3 based on the determined 605 control action.

The configuration of the radio resource parameter may be iterated according to some embodiments.

Step 607, which only may be comprised in some embodiments wherein the radio network node 230 controlling the radio cell 235-1, 235-2, 235-3 is not co-located with the agent node 210, may comprise transmitting the configured 606 radio resource parameter of the radio cell 235-1, 235-2, 235-3 to the radio network node 230 for control of the radio resource parameter in the radio cell 235-1, 235-2, 235-3 of the radio network node 230.

Step 608, which only may be comprised in some embodiments, may comprise determining the feature representing the state of the part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 may be situated, at a second time period.

The feature representing the state of the part of the communication system 200 may typically be the same as previously determined 604 at the first time period, enumerated in step 604.

Step 609, which only may be comprised in some embodiments, may comprise determining a performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3, or within the communication system 200 or a subset thereof.

The performance measurement may be made at the first time period in some embodiments and at the second time period in some embodiments.

The determined performance measurement may be iterated in some embodiments.

The performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3 may in some embodiments be determined, given the feature representing the state at the first time period t and the control action a_t taken at the first time period t.

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The performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3 may in some embodiments be determined by computing a weighted sum of scalars $x_i \in \mathcal{X}$, parameterised by a scalar coefficient $\alpha \in [0, \infty)$ and transformed by a function h_i: $\mathcal{X} \rightarrow$R (with domain $\mathcal{X}$ and range of real scalars),

$$r_t(\boldsymbol{x}) = \frac{1}{1-\alpha} \sum_{x_i \in \mathcal{X}} w_i (h_i(x_i)^{1-\alpha} - 1) \quad \alpha \in [0, \infty),$$

where x_i represents a radio measurement or a performance indicator associated with the radio cell 215, 235-1, 235-2, 235-3, $\mathcal{X}$ is the set of all radio measurements or performance indicators associated with the radio cell 215, 235-1, 235-2, 235-3 and used for the definition of the performance measurement, w_i is a weight associated with x_i, and $\boldsymbol{x} = [x_1, \ldots x_{|\mathcal{X}|}]$ is a vector comprising all $x_i \in \mathcal{X}$.

Step 610, which only may be comprised in some embodiments wherein step 609 has been performed, may comprise computing a performance measurement associated with at least a part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 may be situated, based on the determined 609 performance measurement and a network performance measurement received from another radio network node 230, 500 in the communication system 200.

Step 611, which only may be comprised in some embodiments, may comprise transmitting a training data message 420 to the trainer node 400, comprising one or more in the group of: the determined 604 feature representing the state at the first time period, the determined 605 control action performed at the first time period, the determined 608 feature representing the state at the second time period, and the determined 609 performance measurement.

In some embodiments wherein step 610 has been performed, the training data message 420 transmitted to the trainer node 400 comprises the computed 610 performance measurement.

In some embodiments wherein the radio network node 500 controlling the radio cell 235-1, 235-2, 235-3 of the control is another agent node 500, the training data message 420 transmitted to the trainer node 400 may comprise a training data message 420 which has previously been received from the other agent node 500.

The transmission of the training data message 420, or of a plurality of training data

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messages 420 in a collected batch of training data messages 420 to the trainer node 400, may be iterated in some embodiments.

Step 612, which only may be comprised in some embodiments wherein the obtained 601 control policy 430 further may comprise an exploration-to-exploitation control parameter, associated with a probability of applying the control policy 430, may comprise determining application of the obtained 601 control policy 430, based on the obtained 601 exploration-to-exploitation control parameter.

In some embodiments, any, some or all method steps 601-612 may be iterated infinitely, for a limited period of time, or until a threshold limit is achieved.

Figure 6 illustrates an embodiment of an agent node 210, 500 for configuring a radio resource parameter of a radio cell 215, 235-1, 235-2, 235-3 of a communication system 200. The agent node 210, 500 is configured to perform the method 600 according to any, some, all, or at least one of the enumerated method steps 601-612, according to some embodiments.

The agent node 210 is thus configured to obtain a control policy 430. Further, the agent node 210 is configured to determine at least one feature representing a state of at least a part of the communication system 200, e.g. wherein the radio cell 215, 235-1, 235-2, 235-3 is situated, at a first time period. In addition, the agent node 210 is configured to determine a control action to be performed for configuring a radio resource parameter in the radio cell 215, 235-1, 235-2, 235-3 at the first time period, out of a set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3, based on the obtained control policy 430 and the determined at least one feature. Furthermore, the agent node 210 is also configured to configure the radio resource parameter of the radio cell 215, 235-1, 235-2, 235-3 based on the determined control action.

Furthermore, in some embodiments, the agent node 210, 500 may be further configured to determine a feature representing the state of the part of the communication system 200, at a second time period. The part of the communication system 200 may be the part wherein the radio cell 215, 235-1, 235-2, 235-3 is situated. The agent node 210, 500 may also be configured to determine a performance measurement, associated with the performance

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within the radio cell 215, 235-1, 235-2, 235-3. Also, the agent node 210, 500 may be additionally configured to transmit a training data message 420 to a trainer node 400, comprising one or more in the group of: the determined feature representing the state at the first time period, the determined control action performed at the first time period, the determined feature representing the state at the second time period, and/ or the determined performance measurement. The agent node 210, 500 may also be configured to obtain the control policy 430 by receiving the control policy 430 from the trainer node 400.

In some optional embodiments, the agent node 210, 500 may be configured to select which at least one feature to utilise for representing the state of at least a part of the communication system 200. Further, the agent node 210, 500 may also be configured to select which performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3 to utilise for representing the performance of the radio cell 215, 235-1, 235-2, 235-3.

According to some embodiments, the agent node 210, 500 may be configured to transmit the configured radio resource parameter instruction of the radio cell 235-1, 235-2, 235-3 to the radio network node 230 for adjusting the radio resource parameter of the radio cell 235-1, 235-2, 235-3 of the radio network node 230, when the radio network node 230 controlling the radio cell 235-1, 235-2, 235-3 is not co-located with the agent node 210.

Furthermore, the agent node 210, 500 may also be configured to determine the feature representing the state of at least a part of the communication system 200, e.g. where the radio cell 215, 235-1, 235-2, 235-3 is situated, based on any of: a measurement related to received signal quality made by and received from a user device 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to received signal quality made by and received from a user device 220 in another radio cell 215, 235-1, 235-2, 235-3; a measurement related to downlink transmission power of the radio cell 215, 235-1, 235-2, 235-3 made by and obtained from the radio network node 210, 230, 500 controlling the radio cell 215, 235-1, 235-2, 235-3; a measurement related to a number of active user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; a measurement related to types, or distribution, of traffic within the radio cell 215, 235-1, 235-2, 235-3; a measurement related to location, or distribution, of user devices 220 in the radio cell 215, 235-1, 235-2, 235-3; or a performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3.

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The agent node 210, 500 may be configured to compute a performance measurement associated with at least a part of the communication system 200, e.g. wherein the radio cell 215, 235-1, 235-2, 235-3 is comprised, based on the determined performance measurement and at least one other network performance measurement received from another radio network node 230, 500 in the communication system 200. Further, the agent node 210, 500 may also be configured to transmit the training data message 420 to the trainer node 400 comprising the computed performance measurement, in some embodiments.

In addition, the agent node 210, 500 may be configured to obtain an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy 430. The agent node 210, 500 may further be configured to determine application of the obtained control policy 430, based on the obtained exploration-to-exploitation control parameter. The exploration-to-exploitation control parameter may e.g. be received from the trainer node 400 together with the control policy 430 in some embodiments.

In some embodiments, wherein a radio network node 500 controlling the radio cell 235-1, 235-2, 235-3 is another agent node 500, the agent node 210 may be configured to transmit the training data message 420 to the trainer node 400 comprising a training data message 420 received from the other agent node 500. The agent node 210, 500 may also be further configured to forward the control policy 430 to be utilised for radio resource parameter adjustment in the radio cell 235-1, 235-2, 235-3 of the other agent node 500 in the communication system 200, received from the trainer node 400, to the other agent node 500.

According to some optional embodiments, the agent node 210, 500 may be configured to iterate the determination of the feature representing the state of at least a part of the communication system 200; the determination of the control action; the configuration of the radio resource parameter instruction; the determination of the performance measurement; the transmission of the training data message 420, or a plurality of training data messages 420, to the trainer node 400 and/ or the obtaining of the control policy 430.

The agent node 210, 500 may in addition be configured to adjust the set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3, based on the determined at

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least one feature representing the state of the part of the communication system 200, or based on the obtained control policy 430.

Also, in some embodiments, the agent node 210, 500 may be configured to obtain the control policy 430, represented by one or more of: an indicator configuring a combining method for the agent node 210, 500 to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

Additionally, the agent node 210, 500 may be configured, in some embodiments, to obtain the control policy 430, comprising an adjustment of the set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3; an indicator configuring a combining method for the agent node 210, 500 to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; and/ or at least one indication of the stopping criteria to determine the depth of the decision forest.

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The agent node 210, 500 may in some embodiments be configured to determine the performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3, given the feature representing the state of the communication system 200, or a subset thereof, at the first time period t and the control action a_t taken at first time period t.

In some embodiments, the agent node 210, 500 may be additionally configured to determine the performance measurement, associated with the performance within the radio cell 215, 235-1, 235-2, 235-3 by computing a weighted sum of scalars $x_i \in \mathcal{X}$, parameterised by a scalar coefficient $\alpha \in [0, \infty)$ and transformed by a function $h_i: \mathcal{X} \rightarrow \mathrm{R}$ (with domain $\mathcal{X}$ and range of real scalars),

$$r_t(\boldsymbol{x}) = \frac{1}{1-\alpha} \sum_{x_i \in \mathcal{X}} w_i (h_i(x_i)^{1-\alpha} - 1) \quad \alpha \in [0, \infty),$$

where x_i represents a radio measurement or a performance indicator associated with the radio cell 215, 235-1, 235-2, 235-3, $\mathcal{X}$ is the set of all radio measurements or performance indicators associated with the radio cell 215, 235-1, 235-2, 235-3 and used for the definition of the performance measurement, w_i is a weight associated with x_i, and $\boldsymbol{x} = [x_1, \ldots x_{|\mathcal{X}|}]$ is a vector comprising all $x_i \in \mathcal{X}$.

For enhanced clarity, any internal electronics or other components of the agent node 210, not completely indispensable for understanding the herein described embodiments has been omitted from Figure 6.

The agent node 210 comprises a receiver **710**, configured for receiving e.g. signal strength/ quality measurements from one or more user devices 220, for receiving e.g. signal strength/ quality measurements or other information from one or more radio network nodes 230; or for receiving e.g. the control policy 430 from the trainer node 400.

Further, the agent node 210 comprises a processor **720**, configured for configuring a radio resource parameter of the radio cell 215, 235-1, 235-2, 235-3 in the communication system 200, by performing at least some steps 601-612 of the described method 600.

Such processor 720 may comprise one or more instances of a processing circuit, i.e. a Central Processing Unit (CPU), a processing unit, a processing circuit, a processor, an Application Specific Integrated Circuit (ASIC), a microprocessor, or other processing logic

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that may interpret and execute instructions. The herein utilised expression "processor" may thus represent a processing circuitry comprising a plurality of processing circuits, such as, e.g., any, some or all of the ones enumerated above.

Further, the agent node 210 may in some embodiments comprise a transmitter **730**, configured for transmitting various signals, to be received by the user device 220, radio network node 230, other agent node 500 and/ or trainer node 400.

In further addition, the agent node 210 may comprise at least one memory **725**, according to some embodiments. The optional memory 725 may comprise a physical device utilised to store data or programs, i.e., sequences of instructions, on a temporary or permanent basis. According to some embodiments, the memory 725 may comprise integrated circuits comprising silicon-based transistors. Further, the memory 725 may be volatile or non-volatile.

At least a sub-set of the previously described method steps 601-612 to be performed in the agent node 210 may be implemented through the one or more processing circuits 720 in the agent node 210, together with a computer program product for performing the functions of at least some of the method steps 601-612. Thus a computer program product, comprising instructions for performing the method steps 601-612 may perform radio resource parameter adjustment of the radio cell 215, 235-1, 235-2, 235-3 in the communication system 200, when the computer program is loaded into the processor 720 of the agent node 210.

The computer program mentioned above may be provided for instance in the form of a data carrier carrying computer program code for performing at least some of the method steps 601-612 according to some embodiments when being loaded into the processor 720. The data carrier may be, e.g., a hard disk, a CD ROM disc, a memory stick, an optical storage device, a magnetic storage device or any other appropriate medium such as a disk or tape that may hold machine readable data in a non-transitory manner. The computer program product may furthermore be provided as computer program code on a server and downloaded to the agent node 210 remotely, e.g., over an Internet or an intranet connection.

Figure 7 is a flow chart illustrating embodiments of a method **800** in a trainer node 400 for determining a control policy 430 to be utilised by an agent node 210, 500 for configuring a

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radio resource parameter of a radio cell 215, 235-1, 235-2, 235-3 of a communication system 200.

The radio cell 215, 235-1, 235-2, 235-3 is controlled by the agent node 210 or in some embodiments by another agent node 500, or alternatively by a network node 230, which in turn is controlled by the agent node 210, 500. The agent node 210 may be co-located with a trainer node 400 and/ or the network node 230 controlling the radio cell 215, 235-1, 235-2, 235-3 in some embodiments. Alternatively, the agent node 210 may be situated at a distance from the trainer node 400 and/ or the network node 230.

The control policy 430 may be represented by one or more of: an indicator configuring a combining method for the agent node 210, 500 to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

According to various embodiments, the obtained control policy 430 may further comprise: an adjustment of the set of available control actions associated with the radio cell 215, 235-1, 235-2, 235-3; an indicator configuring a combining method for the agent node 210, 500 to aggregate results produced by individual neural networks for determining the control action; an indicator of the activation function for neurons in at least one neural network; an indicator of a parameter representing an axis aligned data split function for the control policy 430 when based on a decision forest; an indicator of at least two parameters representing a linear data split function for the control policy 430 based on the decision forest; an indicator of a parameter representing a quadratic data split function for the control policy 430 based on the decision forest; an indication one or more hyper-parameters

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characterising the decision forest in the group of: maximum or minimum depth of the decision forest; depth of the decision forest; maximum or minimum number of decision trees; number of decision trees in the decision forest; information gain criterion; at least one indication of the stopping criteria to determine the depth of the decision forest.

To appropriately determine the control policy 430 to be utilised by the agent node 210, 500 for configuring the radio resource parameter of the radio cell 215, 235-1, 235-2, 235-3 the method 800 may comprise a number of steps **801-805**.

It is however to be noted that any, some or all of the described steps 801-805, may be performed in a somewhat different chronological order than the enumeration indicates, be performed simultaneously or even be performed in a completely reversed order according to different embodiments. Some actions such as e.g. step 804 may be performed within some, but not necessarily all embodiments. Further, it is to be noted that some actions may be performed in a plurality of alternative manners according to different embodiments, and that some such alternative manners may be performed only within some, but not necessarily all embodiments.

The trainer node 400 may in some embodiments periodically re-perform any, some or all of step 801-805, thereby providing a continuously updated control policy 430 according to some embodiments. The method 800 may comprise the following steps:

Step 801 comprises receiving a training data message 420, associated with the radio cell 215, 235-1, 235-2, 235-3, from the agent node 210, 500, wherein the training data message 420 comprises one or more in the group of: a feature representing a state of at least a part of the communication system 200 at a first time period, a control action performed by the agent node 210, 500 in the radio cell 215, 235-1, 235-2, 235-3 at the first time period, a feature representing the state at the second time period, and a performance measurement.

The performance measurement may have been made at the first time period in some embodiments and at the second time period in some embodiments.

In some embodiments, a conjunct performance measurement may be computed, associated with at least a part of the communication system 200, based on the performance

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measurement received in the training data message 420 received from the agent node 210, 500 and another performance measurement received from another radio network node 230, 500 in the communication system 200.

Step 802 comprises storing the received 801 training data message 420 in a database 410, associated with the radio cell 215, 235-1, 235-2, 235-3.

Step 803 comprises determining the control policy 430 for the radio cell 215, 235-1, 235-2, 235-3, based on at least one training data message 420, stored 802 in the database 410.

Step 804, which only may be comprised in some embodiments, may comprise determining an exploration-to-exploitation control parameter, associated with the determined 803 control policy 430.

The exploration-to-exploitation control parameter may be determined to be reduced over time, in some embodiments.

Step 805 comprises transmitting the determined 803 control policy 430 to the agent node 210, 500.

In some embodiments, wherein step 804 has been performed may comprise transmitting the determined 804 exploration-to-exploitation control parameter to the agent node 210, 500 together with the determined 803 control policy 430.

In some alternative embodiments, the method 800 further may comprise selecting which at least one feature the agent node 210, 500 is to utilise for representing the state of at least a part of the communication system 200 wherein the radio cell 215, 235-1, 235-2, 235-3 is comprised and sending the made selection to the agent node 210, 500.

The method 800 may further comprise selecting which performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3 the agent node 210, 500 is to utilise for representing the performance of the radio cell 215, 235-1, 235-2, 235-3 and sending the made selection to the agent node 210, 500, in some embodiments.

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In some embodiments, any, some or all method steps 801-805 may be iterated infinitely, for a limited period of time, or until a threshold limit is achieved.

Figure 8 illustrates an embodiment of a trainer node 400 for determining a control policy 430 to be utilised by an agent node 210, 500 for configuring a radio resource parameter of a radio cell 215, 235-1, 235-2, 235-3 of a communication system 200. The trainer node 400 is configured to perform the method 800 according to any, some, all, or at least one of the enumerated method steps 801-805, according to some embodiments.

The trainer node 400 is thus configured to receive a training data message 420, associated with the radio cell 215, 235-1, 235-2, 235-3, from the agent node 210, 500, wherein the training data message 420 comprises one or more in the group of: a feature representing a state of at least a part of the communication system 200 at a first time period, a control action performed by the agent node 210, 500 in the radio cell 215, 235-1, 235-2, 235-3 at the first time period, a feature representing the state at the second time period, and a performance measurement. The trainer node 400 is also configured to store the received training data message 420 in a database 410 associated with the radio cell 215, 235-1, 235-2, 235-3. Further, the trainer node 400 is configured to determine the control policy 430 for the radio cell 215, 235-1, 235-2, 235-3, based on at least one training data message 420, stored in the database 410. In addition, the trainer node 400 is further configured to transmit the determined control policy 430 to the agent node 210, 500.

In some embodiments, the trainer node 400 may be configured to determine an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy 430, e.g. based on a time period parameter in some alternative embodiments; and wherein the determined exploration-to-exploitation control parameter is transmitted to the agent node 210, 500 together with the determined control policy 430.

In addition, the trainer node 400 may be configured to determine the exploration-to-exploitation control parameter so that the probability of applying the determined control policy 430 is increased over time.

Also, the trainer node 400 may be further configured to compute a performance measurement associated with at least a part of the communication system 200, based on the

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performance measurement received in the training data message 420 received from the agent node 210, 500 and at least one other performance measurement received from another radio network node 230, 500 in the communication system 200.

Furthermore, the trainer node 400 may be configured to select which at least one feature the agent node 210, 500 is to utilise for representing the state of at least a part of the communication system 200 and provide the made selection to the agent node 210, 500.

The trainer node 400 may in addition be configured to select which performance measurement associated with the radio cell 215, 235-1, 235-2, 235-3, the agent node 210, 500 is to utilise for representing the performance of the radio cell 215, 235-1, 235-2, 235-3 and provide the made selection to the agent node 210, 500.

For enhanced clarity, any internal electronics or other components of the trainer node 400, not completely indispensable for understanding the herein described embodiments has been omitted from Figure 8.

The trainer node 400 comprises a receiver **910**, configured for receiving e.g. signal strength/ quality measurements in a Training Data Message 420 from one or more agent nodes 210, 500.

Further, the trainer node 400 comprises a processor **920**, configured for determining the control policy 430 to be utilised by the agent node 210, 500 for downlink power control of the radio cell 215, 235-1, 235-2, 235-3 of a communication system 200, by performing at least some steps 801-805 of the described method 800.

Such processor 920 may comprise one or more instances of a processing circuit, i.e. a Central Processing Unit (CPU), a processing unit, a processing circuit, a processor, an Application Specific Integrated Circuit (ASIC), a microprocessor, or other processing logic that may interpret and execute instructions. The herein utilised expression "processor" may thus represent a processing circuitry comprising a plurality of processing circuits, such as, e.g., any, some or all of the ones enumerated above.

Further, the trainer node 400 may in some embodiments comprise a transmitter **930**,

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configured for transmitting various signals and instructions, e.g. comprising the determined control policy 430, to be received by the agent node 210, 500; or possibly another training node.

In further addition, the trainer node 400 may comprise at least one memory **925**, according to some embodiments. The optional memory 925 may comprise a physical device utilised to store data or programs, i.e., sequences of instructions, on a temporary or permanent basis. According to some embodiments, the memory 925 may comprise integrated circuits comprising silicon-based transistors. Further, the memory 925 may be volatile or non-volatile.

At least a sub-set of the previously described method steps 801-805 to be performed in the trainer node 400 may be implemented through the one or more processing circuits 920 in the trainer node 400, together with a computer program product for performing the functions of at least some of the method steps 801-805. Thus a computer program product, comprising instructions for performing the method steps 801-805 may determine the control policy 430 to be utilised by the agent node 210, 500 for configuring a radio resource parameter of the radio cell 215, 235-1, 235-2, 235-3 in the communication system 200.

The computer program mentioned above may be provided for instance in the form of a data carrier carrying computer program code for performing at least some of the method steps 801-805 according to some embodiments when being loaded into the processor 920. The data carrier may be, e.g., a hard disk, a CD ROM disc, a memory stick, an optical storage device, a magnetic storage device or any other appropriate medium such as a disk or tape that may hold machine readable data in a non-transitory manner. The computer program product may furthermore be provided as computer program code on a server and downloaded to the trainer node 400 remotely, e.g., over an Internet or an intranet connection.

The terminology used in the description of the embodiments as illustrated in the accompanying drawings is not intended to be limiting of the described agent node 210, method 600 therein, trainer node 400, or method 800 therein. Various changes, substitutions and/ or alterations may be made, without departing from the invention as defined by the appended claims.

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As used herein, the term "and/ or" comprises any and all combinations of one or more of the associated listed items. The term “or” as used herein, is to be interpreted as a mathematical OR, i.e., as an inclusive disjunction; not as a mathematical exclusive OR (XOR), unless expressly stated otherwise. In addition, the singular forms "a", "an" and "the" are to be interpreted as “at least one”, thus also possibly comprising a plurality of entities of the same kind, unless expressly stated otherwise. It will be further understood that the terms "includes", "comprises", "including" and/ or "comprising", specifies the presence of stated features, actions, integers, steps, operations, elements, and/ or components, but do not preclude the presence or addition of one or more other features, actions, integers, steps, operations, elements, components, and/ or groups thereof. A single unit such as e.g. a processor may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A computer program may be stored/ distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms such as via Internet or other wired or wireless communication system.

Finally, it should be understood that the present invention is not limited to the embodiments described above, but also relates to and incorporates all embodiments within the scope of the appended independent claims.

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CLAIMS

1. An agent node (210, 500) for configuring a radio resource parameter of a radio cell (215, 235-1, 235-2, 235-3) of a communication system (200); wherein the agent node (210, 500) is configured to:

obtain the control policy (430);

determine at least one feature representing a state of at least a part of the communication system (200), at a first time period;

determine a control action to be performed for configuring the radio resource parameter in the radio cell (215, 235-1, 235-2, 235-3) at the first time period, out of a set of available control actions associated with the radio cell (215, 235-1, 235-2, 235-3), based on the obtained control policy (430) and at least one feature representing the state of the part of the communication system (200), at the first time period; and

configure the radio resource parameter of the radio cell (215, 235-1, 235-2, 235-3) based on the determined control action.

2. The agent node (210, 500) according to claim 1, further configured to:

determine the feature representing the state of the part of the communication system (200), at a second time period;

determine a performance measurement, associated with the performance within the radio cell (215, 235-1, 235-2, 235-3); and

transmit a training data message (420) to a trainer node (400), comprising one or more in the group of:

the determined feature representing the state at the first time period,

the determined control action performed at the first time period,

the determined feature representing the state at the second time period, and

the determined performance measurement;

and wherein the obtained control policy (430) is received from the trainer node (400).

3. The agent node (210, 500) according to any of claim 1 or claim 2, wherein a radio network node (230) controlling the radio cell (235-1, 235-2, 235-3) is not co-located with the agent node (210); and wherein the agent node (210, 500) is further configured to:

transmit an instruction to the radio network node (230) for configuring the radio resource parameter of the radio cell (235-1, 235-2, 235-3).

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4. The agent node (210, 500) according to any of claims 1-3, wherein the feature representing the state of at least a part of the communication system (200), is determined based on any of:

a measurement related to received signal quality made by and received from a user device (220) in the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to received signal quality made by and received from a user device (220) in another radio cell (215, 235-1, 235-2, 235-3);

a measurement related to downlink transmission power of the radio cell (215, 235-1, 235-2, 235-3) made by and obtained from the radio network node (210, 230, 500) controlling the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to a number of active user devices (220) in the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to types or distribution of traffic within the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to location or distribution of user devices (220) in the radio cell (215, 235-1, 235-2, 235-3); or

a performance measurement, associated with the performance within the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to resource utilisation in the radio cell (215, 235-1, 235-2, 235-3);

a measurement related to electrical tilt associated with the radio cell (215, 235-1, 235-2, 235-3).

5. The agent node (210, 500) according to any of claims 2-4, further configured to:

compute a performance measurement associated with at least a part of the communication system (200), based on the determined performance measurement and at least one other network performance measurement received from another radio network node (230, 500) in the communication system (200);

and wherein the training data message (420) transmitted to the trainer node (400) comprises the computed performance measurement.

6. The agent node (210, 500) according to any of claims 1-5, wherein the obtained control policy (430) further comprises an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy (430); and wherein

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the agent node (210, 500) is further configured to:

determine application of the obtained control policy (430), based on the obtained exploration-to-exploitation control parameter.

7. The agent node (210, 500) according to any of claims 2-6, wherein the radio network node (500) controlling the radio cell (235-1, 235-2, 235-3) for which the radio resource parameter is configured is another agent node (500) and the training data message (420) transmitted to the trainer node (400) comprises a training data message (420) received from the another agent node (500); and wherein the agent node (210, 500) is further configured to forward the control policy (430) to be utilised for configuring the radio resource parameter in the radio cell (235-1, 235-2, 235-3) of the other agent node (500) in the communication system (200), received from the trainer node (400), to the other agent node (500).

8. The agent node (210, 500) according to any of claims 2-7, further configured to iterate the determination of the feature representing the state of at least a part of the communication system (200); the determination of the control action; the configuration of the radio resource parameter instruction; the determination of the performance measurement; the transmission of the training data message (420), or a plurality of training data messages (420), to the trainer node (400) and the obtaining of the control policy (430).

9. A method (600) in an agent node (210, 500) for configuring a radio resource parameter of a radio cell (215, 235-1, 235-2, 235-3) of a communication system (200); which method (600) comprises:

obtaining (601) the control policy (430);

determining (604) at least one feature representing a state of at least a part of the communication system (200), at a first time period;

determining (605) a control action to be performed for configuring the radio resource parameter in the radio cell (215, 235-1, 235-2, 235-3) at a first time period, out of a set of available control actions associated with the radio cell (215, 235-1, 235-2, 235-3), based on the obtained (601) control policy (430); and

configuring (606) the radio resource parameter of the radio cell (215, 235-1, 235-2, 235-3) based on the determined (605) control action.

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10. A computer program with a program code for performing a method (600) according to claim 9, when the computer program runs on a computer.

11. A trainer node (400), for determining a control policy (430) to be utilised by an agent node (210, 500) for configuring a radio resource parameter of a radio cell (215, 235-1, 235-2, 235-3) of a communication system (200); which trainer node (400) is configured to:

receive a training data message (420), associated with the radio cell (215, 235-1, 235-2, 235-3), from the agent node (210, 500), wherein the training data message (420) comprises one or more in the group of:

a feature representing a state of at least a part of the communication system (200) at a first time period,

a control action performed by the agent node (210, 500) in the radio cell (215, 235-1, 235-2, 235-3) at the first time period,

a feature representing the state at the second time period, and

a performance measurement;

store the received training data message (420) in a database (410) associated with the radio cell (215, 235-1, 235-2, 235-3);

determine a control policy (430) for the radio cell (215, 235-1, 235-2, 235-3), based on at least one training data message (420), stored in the database (410); and

transmit the determined control policy (430) to the agent node (210, 500).

12. The trainer node (400) according to claim 11, further configured to:

determine an exploration-to-exploitation control parameter, associated with a probability of applying the determined control policy (430); and wherein the determined exploration-to-exploitation control parameter is transmitted to the agent node (210, 500) together with the determined control policy (430).

13. The trainer node (400) according to any of claim 11 or claim 12, further configured to determine the control policy (430) for the radio cell (215, 235-1, 235-2, 235-3), represented by one or more of:

an indication of a neural network architecture,

a parameter describing the number of inputs to the first layer of the neural network,

a set of parameters describing the number of layers of the neural network,

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a set of parameters describing the number of neurons in different layers of the neural network,

a parameter indicating the type of non-linear activation function used at each layer such as an s-shaped function like the sigmoid or the hyperbolic tangent, or a rectified linear unit, or an exponential linear unit,

a set of parameters describing the connections between units of consecutive or non-consecutive layers in the neural network,

a set of indicators to at least one neural network index,

a set of neural network weights, a number of neural networks to be configured for power control,

a voting policy to be configured for determining the power control action when the control policy (430) comprises multiple neural networks.

14. A method (800) in a trainer node (400), for determining a control policy (430) to be utilised by an agent node (210, 500) for configuring a radio resource parameter of a radio cell (215, 235-1, 235-2, 235-3) of a communication system (200); which method (800) comprises:

receiving (801) a training data message (420), associated with the radio cell (215, 235-1, 235-2, 235-3), from the agent node (210, 500), wherein the training data message (420) comprises one or more in the group of:

a feature representing a state of at least a part of the communication system (200) at a first time period,

a control action performed by the agent node (210, 500) in the radio cell (215, 235-1, 235-2, 235-3) at the first time period,

a feature representing the state at the second time period, and

a performance measurement;

storing (802) the received (801) training data message (420) in a database (410), associated with the radio cell (215, 235-1, 235-2, 235-3);

determining (803) the control policy (430) for the radio cell (215, 235-1, 235-2, 235-3), based on at least one training data message (420), stored (802) in the database (410); and

transmitting (805) the determined (803) control policy (430) to the agent node (210, 500).

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15. A computer program with a program code for performing a method (800) according to claim 14, when the computer program runs on a computer.

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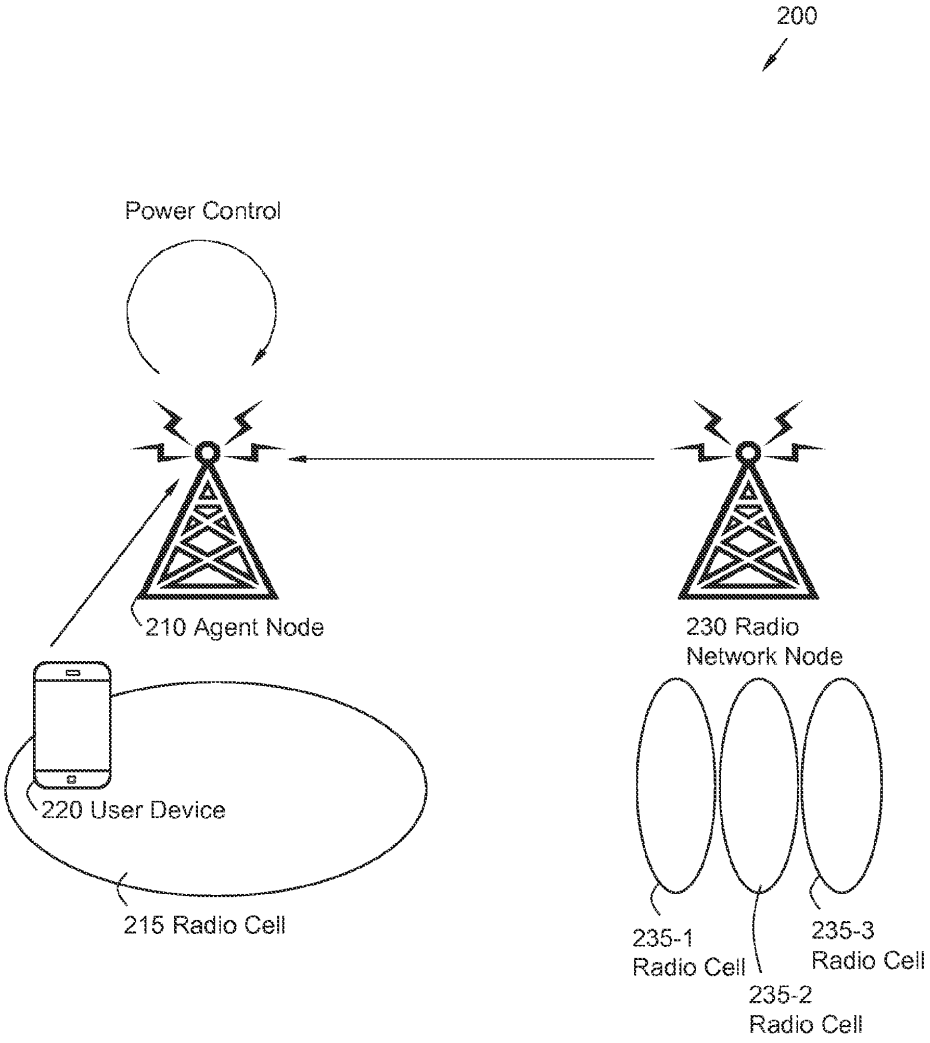

200
Power Control
210 Agent Node
230 Radio
Network Node
220 User Device
215 Radio Cell
235-1
Radio Cell
235-2
Radio Cell
235-3
Radio Cell

Fig. 1

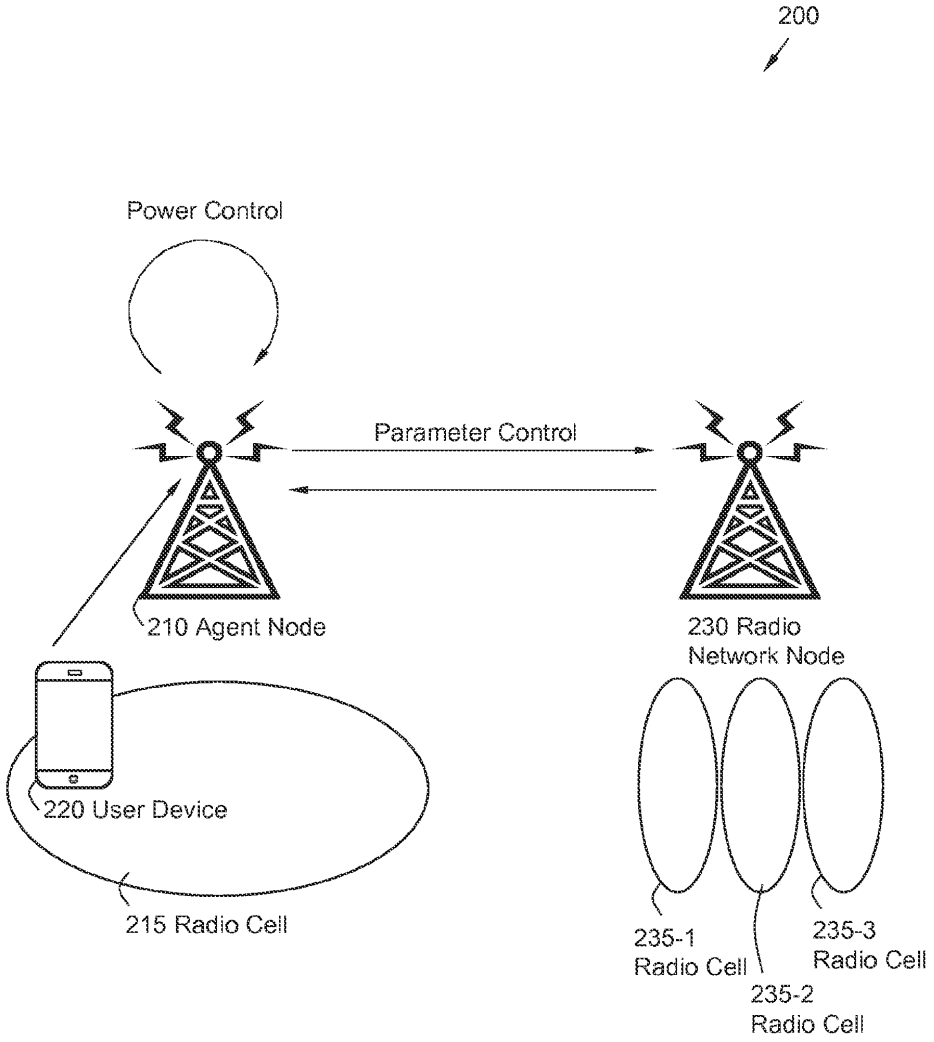

200
Power Control
Parameter Control
210 Agent Node
230 Radio
Network Node
220 User Device
215 Radio Cell
235-1
Radio Cell
235-2
Radio Cell
235-3
Radio Cell

Fig. 2

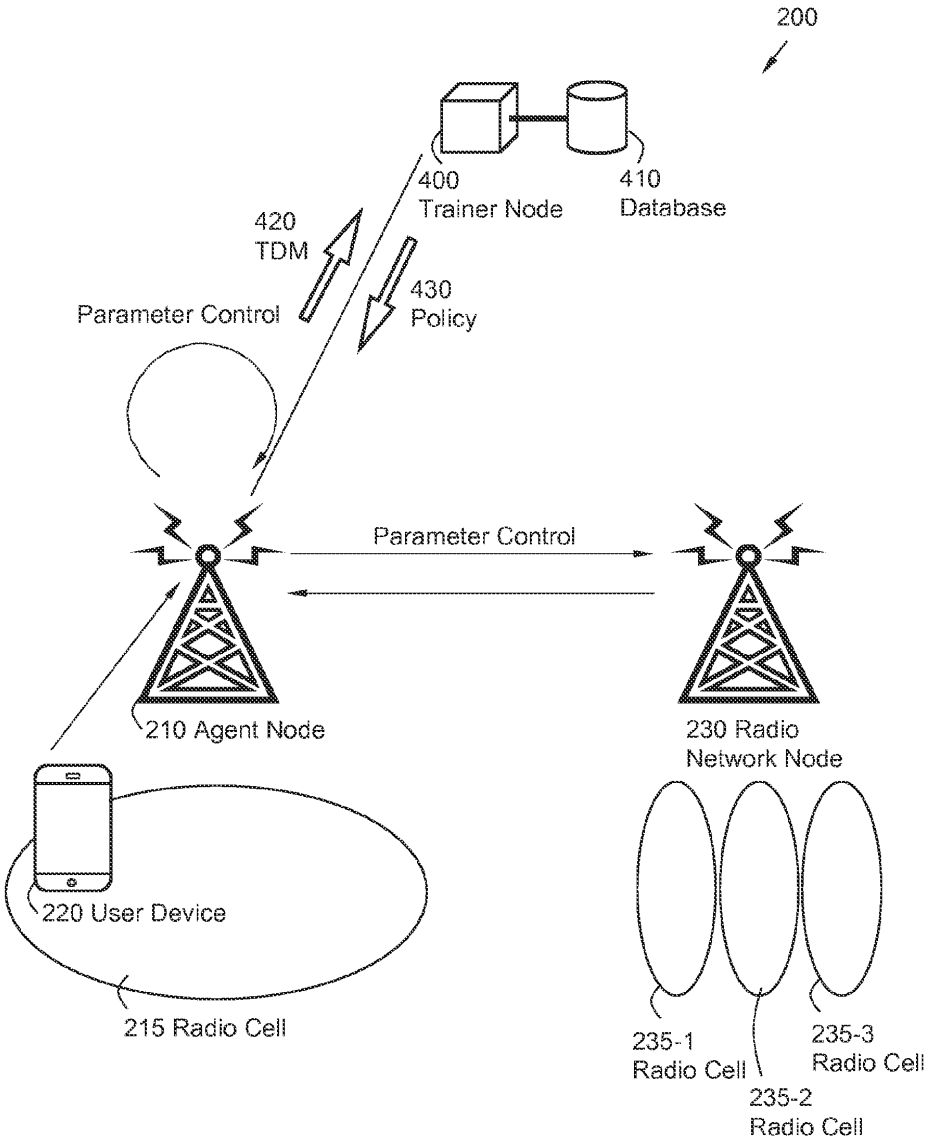

200
400
Trainer Node
410
Database
420
TDM
430
Policy
Parameter Control
Parameter Control
210 Agent Node
230 Radio
Network Node
220 User Device
215 Radio Cell
235-1
Radio Cell
235-2
Radio Cell
235-3
Radio Cell

Fig. 3

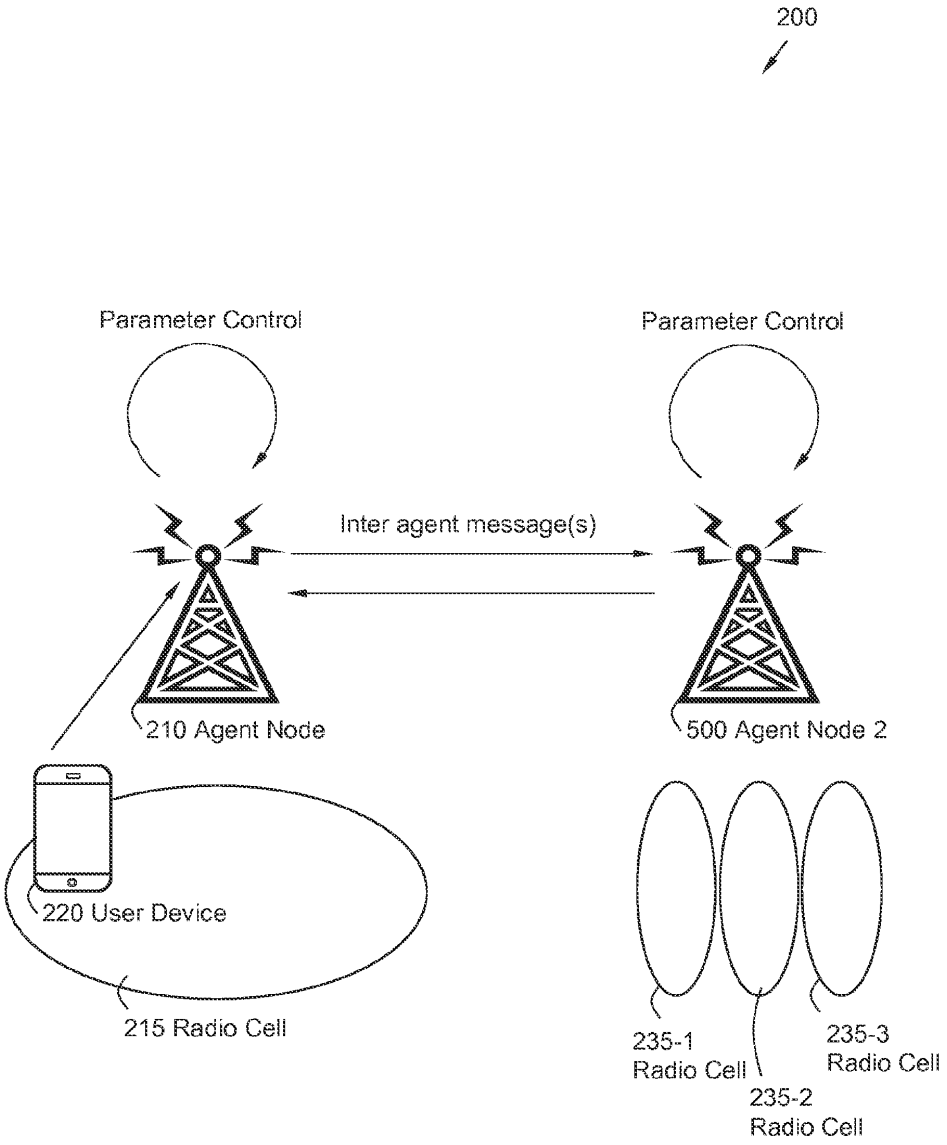

200
Parameter Control
Parameter Control
Inter agent message(s)
210 Agent Node
500 Agent Node 2
220 User Device
215 Radio Cell
235-1
Radio Cell
235-2
Radio Cell
235-3
Radio Cell

Fig. 4

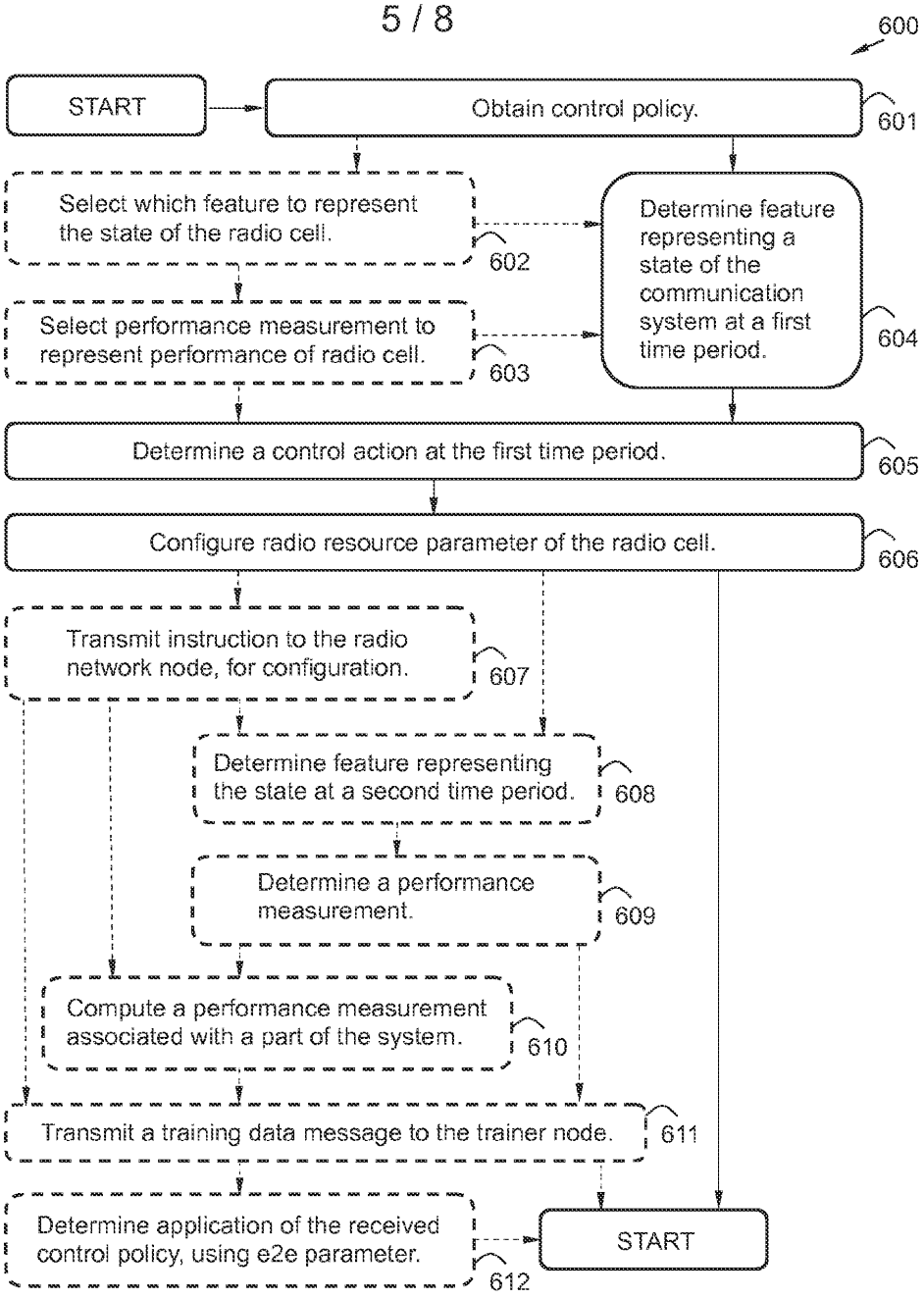


Fig. 5

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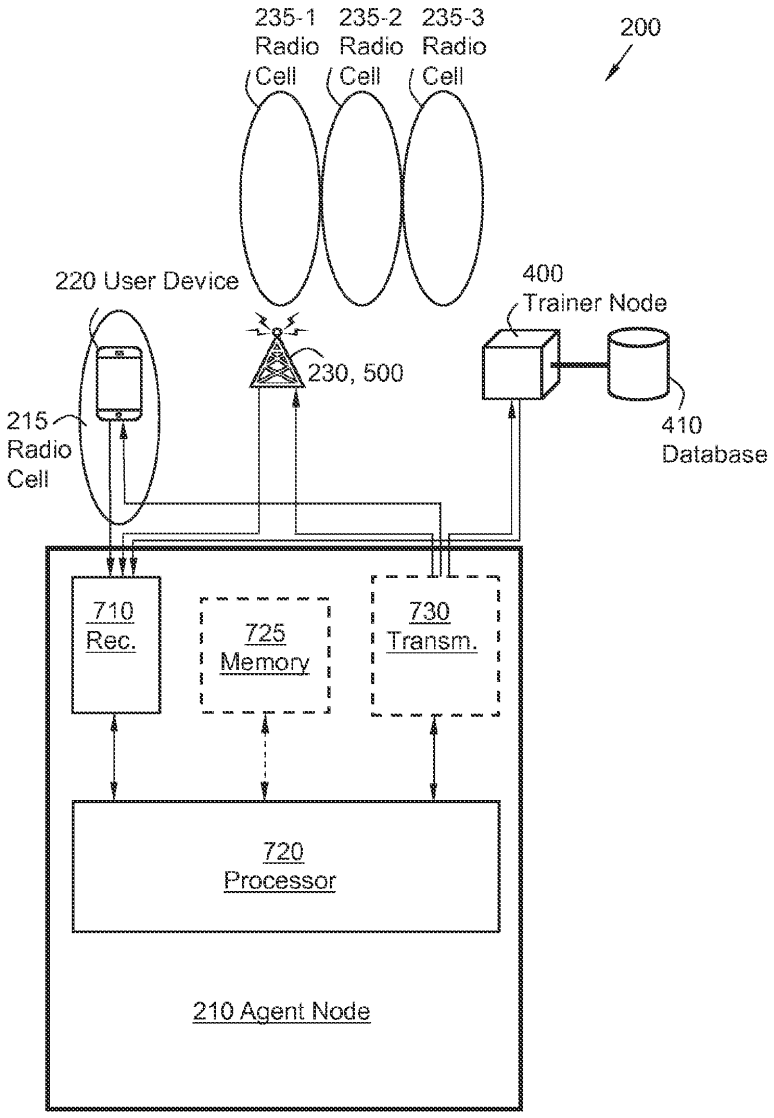

235-1 Radio Cell
235-2 Radio Cell
235-3 Radio Cell
200
220 User Device
400 Trainer Node
230, 500
215 Radio Cell
410 Database
710 Rec.
725 Memory
730 Transm.
720 Processor
210 Agent Node

Fig. 6

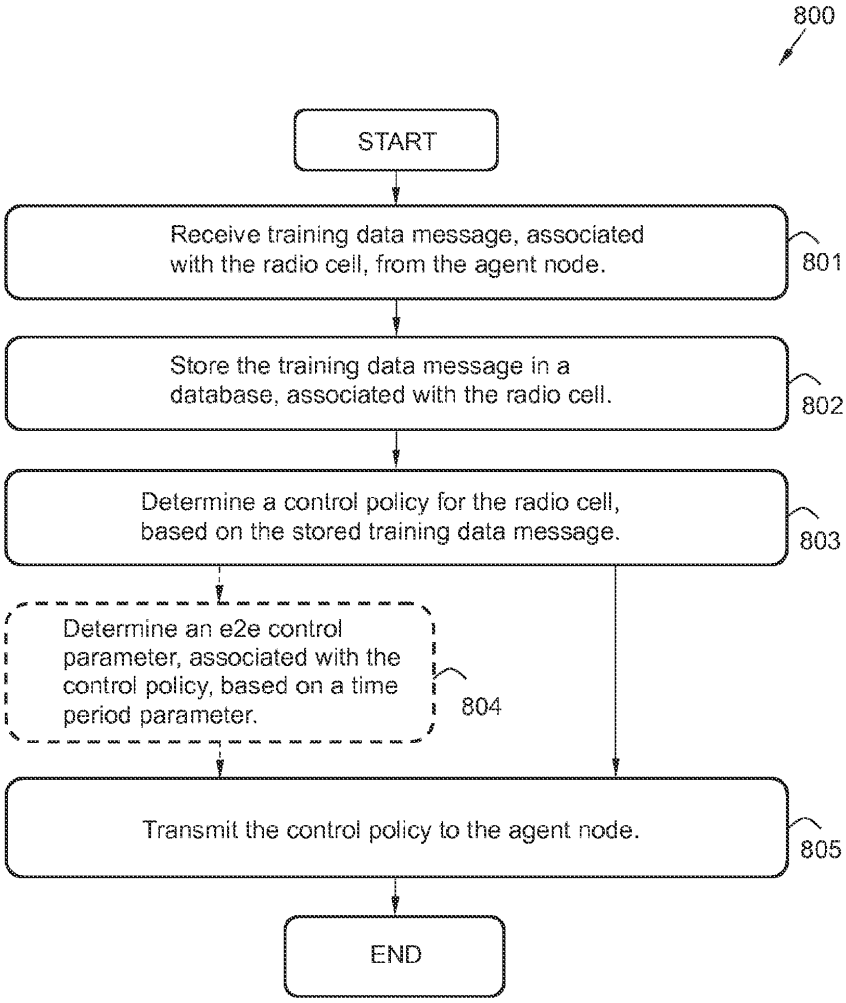


Fig. 7

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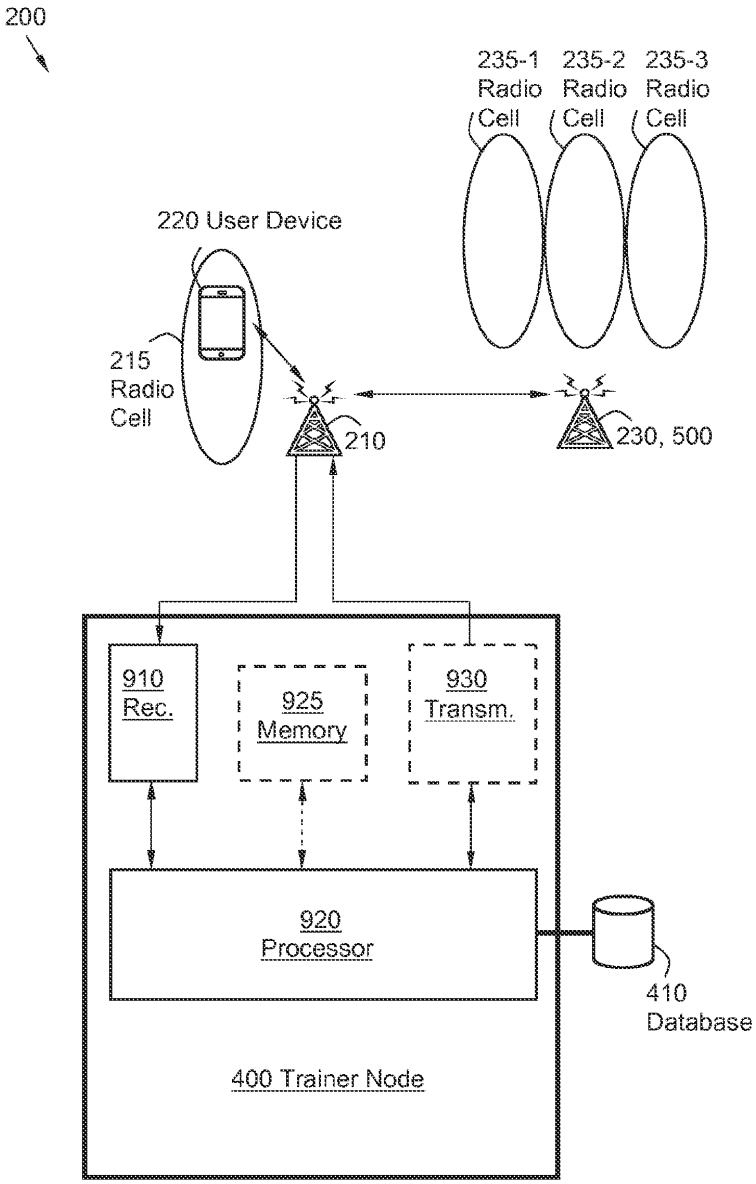

200
235-1 Radio Cell
235-2 Radio Cell
235-3 Radio Cell
220 User Device
215 Radio Cell
210
230, 500
910 Rec.
925 Memory
930 Transm.
920 Processor
410 Database
400 Trainer Node

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/074617

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W24/08 H04W28/16 H04W72/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/154366 A1 (ZTE CORP [CN]) 15 October 2015 (2015-10-15) abstract & EP 3 154 238 A1 (ZTE CORP [CN]) 12 April 2017 (2017-04-12) abstract paragraphs [0030] - [0041] paragraphs [0054], [0058] -----	1-15
X	US 2008/032677 A1 (CATOVIC AMER [US] ET AL) 7 February 2008 (2008-02-07) abstract paragraphs [0036] - [0039], [0046] paragraphs [0049] - [0053] -----	1-15
A	US 2013/198755 A1 (KIM YOUNG-HO [KR] ET AL) 1 August 2013 (2013-08-01) the whole document -----	1-15

☐ 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
5 July 2017	13/07/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Jurca, Dan

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/074617

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015154366 A1	15-10-2015	CN 105245395 A	13-01-2016
		EP 3154238 A1	12-04-2017
		WO 2015154366 A1	15-10-2015
US 2008032677 A1	07-02-2008	TW 200816744 A	01-04-2008
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US 2013198755 A1	01-08-2013	KR 20130088512 A	08-08-2013
		US 2013198755 A1	01-08-2013

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Electronic Acknowledgement Receipt

EFS ID:	46911672
Application Number:	17102099
International Application Number:	
Confirmation Number:	1038
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	28-OCT-2022
Filing Date:	23-NOV-2020
Time Stamp:	00:24:16
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	Transmittal Letter	054USC_SIDS_Trans.pdf	26441 6e1c2ac9413650c95fbe2b13a263485f4aaeb25d	no	3

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08a.pdf	613272 c7d95f8e1319591af8d45841a9b67ed813e76766	no	5
Warnings:					
Information:					
3	Foreign Reference	054USC_SIDS_FR1.pdf	4441740 1977581cd871c4a00e5698b88b4489d22b38b5e2	no	107
Warnings:					
Information:					
4	Foreign Reference	054USC_SIDS_FR2.pdf	6774685 84672ecd5d74ec79b52221d53f58540f6144ff49	no	53
Warnings:					
Information:					
5	Foreign Reference	054USC_SIDS_FR3.pdf	7990498 247d6cc7249d2dac0df78554dbd5bb82c68fe220	no	71
Warnings:					
Information:					
6	Non Patent Literature	054USC_SIDS_NPL1.pdf	89153 6edab3c906b29bf4e1fb30757a1cc2519ea5b71d	no	11
Warnings:					
Information:					
7	Non Patent Literature	054USC_SIDS_NPL2.pdf	113968 32050e322891b5c91f955f3c217442ad6c3b7669	no	2
Warnings:					
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8	Non Patent Literature	054USC_SIDS_NPL3.pdf	24903946 e3c6564a3cf4985b9fbd87bad10a1156bbf6fdfb	no	633
Warnings:					
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9	Non Patent Literature	054USC_SIDS_NPL4.pdf	1089835 baf20017eb9d2b1a81faa8069dbcd869abcf8240	no	8
Warnings:					
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10	Non Patent Literature	054USC_SIDS_NPL5.pdf	79842 85f76ca109d3e34ade804e81c0013a30a1d1709c	no	11
Warnings:					
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11	Non Patent Literature	054USC_SIDS_NPL6.pdf	1266889 bf38bf6ec6ccd5437adca400d0de14d5639c49de	no	5
Warnings:					
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12	Non Patent Literature	054USC_SIDS_NPL7.pdf	215581 fadae3bd02e25fd337e7db29c92ae3bd401fae4a	no	6
Warnings:					
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13	Non Patent Literature	054USC_SIDS_NPL8.pdf	427939 59939ab624e0cbb9ff5f2691da3077fd5f7b243b	no	9
Warnings:					
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14	Non Patent Literature	054USC_SIDS_NPL9.pdf	1163889 69826e42ca690f055bd65ef282cbd3fac9baa9d0	no	11
Warnings:					
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15	Non Patent Literature	054USC_SIDS_NPL10.pdf	1004837 fd3de7b370065ae4ebf155587526563ccb26a0e9	no	34
Warnings:					
Information:					
		Total Files Size (in bytes):	50202515		

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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	17/102,099	Confirmation No. :	1038
Inventor	:	Wonjong Rhee		
Filing Date	:	11-23-2020		
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Art Unit	:	2446		
Examiner	:	GRIJALVA LOBOS, BORIS D		
Docket No.	:	20145-054USC		
Customer No.	:	146571		

CERTIFICATE OF MAILING (37 CFR §1.8)

I hereby certify, pursuant to 37 CFR §1.8, that this correspondence is being electronically transmitted via EFS-Web addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Date: October 27, 2022 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner Grijalva Lobos:

Filed herewith, in accordance with the provisions of 37 CFR §§ 1.56 and 1.97–1.98, listing various references for consideration by the Examiner, is an Information Disclosure Statement ("IDS").

The filing of this IDS shall not be construed as a representation that a search has been made, or regarding the completeness of the list of references, or that no other material information exists. Furthermore, the filing of this IDS shall not be construed as a representation that inclusion of a reference in this list is an admission that it is prior art or is pertinent to this application, or as an admission that the information listed is, or may be considered to be, material to the patentability of the above referenced application. The filing of this IDS shall not be construed in any manner as an admission against interest.

Charter Communications, Inc.
Exhibit 1006
Page #466

This IDS is being filed:

☐ within three months of the filing date of a national application, other than a continued prosecution application under § 1.53(d);

☐ within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

☐ before the mailing of a first Office Action on the merits;

☒ before the mailing of a first Office Action after the filing of a request for continued examination under § 1.114;

☐ after three months of the filing date or entry into the national stage or after the mailing of a first Office action on the merits, but before the mailing date of any final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

OR

☒ Applicant certifies pursuant to 37 CFR § 1.97(e):

☒ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☐ on or before the payment of the issue fee but after the mailing of a final action under § 1.113, a notice of allowance under §1.311, or an action that otherwise closes prosecution in the application;

AND

☐ enclosed herein is the fee set forth in 37 CFR § 1.17(p);

AND

☐ Applicant certifies pursuant to 37 CFR § 1.97(e):

Charter Communications, Inc.
Exhibit 1006
Page #467

☐ That each item of information contained in the information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this information disclosure statement;

OR

☐ That no item of information contained in this 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 this certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in § 1.56(c) more than three months prior to the filing of this information disclosure statement.

☒ Applicant submits that the enclosed Information Disclosure Statement is timely; therefore, no fee is required.

☒ Except as provided for under 37 CFR § 1.98(a)(2), Applicant has enclosed a copy of each listed reference.

☐ Pursuant to 37 CFR § 1.704(d), Applicant certifies that each of the references cited herein were first cited in a communication from a foreign patent office in a counterpart application and that this communication was not received by any individual designated in 37 CFR § 1.56(c) more than thirty days prior to the filing of this Information Disclosure Statement.

Consideration of the listed references and favorable action are requested. If any additional fees are due in connection with the filing of this Information Disclosure Statement, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-2776.

Respectfully submitted,

Date: October 27, 2022

By: /Michael V. North/
Michael V. North
Reg. No. 46,963