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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 09/29/2022
North Weber & Baugh LLP - ASSIA
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EXAMINER
GRIJALVA LOBOS, BORIS D

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
09/29/2022	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):

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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 12/16/2021.

☐ 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 1/14/2022; 2/25/2022; 8/19/2022; 8/20/2022.

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

4) ☐ Other: _____.

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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.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 12/16/2021 has been entered.

Claims 1-23 are pending.

Information Disclosure Statement

The information disclosure statements (IDS) submitted on 1/14/2021, 2/25/2022, 8/19/2022, and 8/20/2022 are being considered by the examiner. The examiner notes that in the IDS submitted on 2/25/2022, citation No. 2 is title “Australian office action response filed 12/1/2021”. However, the non-patent literature (NPL) included with the IDS failed to include an Australian office action response. As such, the document has not been considered. The examiner further notes that NPL filed on 2/25/2022 contains a document dated 12/1/2021 but that appears to be internal communications between applicant representatives and not an Australian office action response. Additionally, the examiner notes that various NPL documents and a foreign reference document were submitted on 5/22/2022 but without a corresponding IDS.

Response to Arguments

Applicant's arguments filed 12/16/2021 have been fully considered but they are not persuasive.

Initially, the examiner notes that Applicant’s original argument is 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" (Applicant arguments, page 6). However, the 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" (Applicant arguments, page 8). This renders the remaining arguments moot since they are all based on Applicant's original argument. However, for clarity, the examiner has included a response to individual arguments.

In the response filed, applicant argues, in substance:

a) In pages 6-7 of the response filed, applicant argues that paragraph [0008] in the specification of the present application recites that the description and drawings of the invention "should not be taken to limit the invention to the specific embodiments" and therefore, a person of ordinary skill in the art "would not infer that applicant intended to limit its claimed interfaces to the single 'network interface' depicted in Fig. 6, or that 'network interface 602' is even a single interface.

In response to argument (a), the examiner notes that neither the Final Rejection dated 10/15/2021 nor the Advisory Action dated 11/29/2021 "limit" applicant's invention to a single interface.

Note, 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).

Under their plain meaning, the terms "first interface", "second interface", and "third interface" would be broad enough to encompass both a single interface and multiple interfaces. In fact, applicant, in page 8 of the response filed, admits as much: "claim 1 is 'broad enough' to include same interfaces or different 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".

Since applicant admits that claim 1 is broad enough to include same interfaces, then a rejection using prior art that encompasses a single interface is appropriate.

b) In pages 6-7 of the response filed, applicant argues that paragraph [0037] of the specification, as filed, recites that "[w]hile the embodiments 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", and from this, "a person of ordinary skill in the art would conclude that Applicant's depiction of individual items in the drawings are merely explanatory [...] rather than intended 'to limit the invention to the specific embodiments.

In response to argument (b), the examiner respectfully disagrees. The examiner notes that, as explained in argument (a), above, neither the Final rejection dated 10/15/2021 nor the Advisory Action dated 11/29/2021 "limit" applicant's invention to a single interface. Instead, the claims are examined using the Broadest Reasonable Interpretation standard, which, as applicant admitted in page 8 of the response filed, "claim 1 is 'broad enough' to include same interfaces".

c) In page 7 of the response filed, applicant argues that the examiner's assertion, in page 3 of the advisory action dated 11/29/2021, that "[r]eferring to each instance of a same device […] by different names is advantageous, and a common practice in the art" is wrong because "referring to different interfaces […] would lead to the same result […] and, thus, cannot support an interpretation against Applicant's express intent".

In response to argument (c), the examiner respectfully disagrees. It's unclear why applicant believes that using different interfaces leading to the same result as using a single interface would negate the fact that instances of a same devices are usually referred to by different names. In fact, in page 8 of the response filed, applicant notes that in an example which uses of the terms "first direction" and "second direction", the first direction and the second direction could be the "same direction" and that would be "nothing unusual".

d) In pages 7 (starting at line 23) and 8 of the response filed, applicant argues that the examiner "wrongly concludes that 'claim 18 would improperly'" broaden claim 1 because claim 1 "is 'broad enough' to include same or different interfaces".

In response to argument (d), the examiner is unclear on what applicant is arguing. The examiner notes that as stated by applicant in page 6 of the response filed, Applicant's argument was "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's hypothetical conclusion was based on 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", not on the broadest reasonable interpretation of the claims. Had the examiner found claim 18 to be broader than claim 1, claim 18 would have been rejected under 35 USC 112(d), but the claim was not rejected.

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

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

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

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
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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
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GOOGLE search performed (see attached)	09/24/2022	BGL
GOOGLE Patent search performed (see attached)	09/24/2022	BGL

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

Charter Communications, Inc.
Exhibit 1006
Page #486

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

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Charter Communications, Inc.
Exhibit 1006
Page #487

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						
	1	✓	✓	✓						
	2	✓	✓	✓						
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	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
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	12	✓	✓	✓						
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	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19	✓	=	=						
	20	✓	=	=						
	21	✓	=	=						
	22	✓	=	=						
	23	✓	=	=						

Charter Communications, Inc.
Exhibit 1006
Page #488

Google create policies for two managed networks

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https://resources.infosecinstitute.com › topic › vlan-net...

VLAN network segmentation and security- chapter five ...

Network segmentation with virtual local area networks (VLANs) creates a collection of isolated networks within the data center. Each network is a separate ...

https://csrc.nist.gov › Projects › 800-53-rev4-controls

ACCESS CONTROL POLICY AND PROCEDURES

SC-23 AC-2 (6) DYNAMIC PRIVILEGE MANAGEMENT The information system implements the ... key management, account management, network and system administration, ...

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Creating policies for external networks - Packt Subscription

When a network's external attribute is set to True , the network is shared among all projects. Access policies can be used to limit external networks to a ...

https://hbr.org › 2007/01 › how-leaders-create-and-use-...

How Leaders Create and Use Networks

The first helped them manage current internal responsibilities, the second boosted their personal development, and the third opened their eyes to new business ...

https://www.dnsstuff.com › network-management

Network Management Guide: How To, Best Practices, & Tools

Sep 12, 2019 — Decentralized Network Management. Centralized and decentralized networks refer to two differing philosophies for how to best create manageable, ...

http://ijs.academicdirect.org › ...

Policies and Guidelines for Effective Network Management from

by K Jonathan Gana — Network security and management in Information and Communication Technology ... develop issue-specific policies using the components defined in table 3.

https://www.ncbi.nlm.nih.gov › articles › PMC4232916

DETERMINANTS OF NETWORK OUTCOMES: THE IMPACT ...

by T YSA · 2014 · Cited by 85 — (3) Does active network management improve the level of trust in networks? ... on those networks that develop policies and convert them into action.

https://www.ancopcnair.com › intune

Managing Network Drive Mappings With Intune HTMD Blog

Aug 10, 2022 — ADMX-Backed Policy. However, there is also a way of creating the required registry keys and values via MDM policy thanks to ADMX-backed policy ...

https://blog.gigamon.com › Networking

What Is Network Management? - Gigamon Blog

Mar 21, 2019 — We deliver visibility and analytics on all data-in-motion across the hybrid cloud network to solve for critical security, performance and ...

https://loft.sh › blog › kubernetes-network-policies-a-pr...

Kubernetes Network Policies: A Practitioner's Guide - Loft Labs

Sep 8, 2021 — The functionality of controlling traffic is typically achieved in networks by using firewalls (software or hardware). Here in Kubernetes that ...

Related searches

network policy and services	**how to establish network access** policies
network policy template	**network access policy examples**
example of network policy	**how does network** policies **work**
what is a network policy	**meraki group policy firewall rules**

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Doc description: Information Disclosure Statement (IDS) Filed

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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	20140269269	A1	2014-09-18	Kovvali et al.	
	3	20180242191	A1	2018-08-23	Lundqvist et al.	
	4	20140280679	A1	2014-09-18	Dey et al.	
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	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

	6	20190364457	A1	2019-11-28	Szilagyi et al.	

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	2	European office action mailed 10/26/2021 in related European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD], (4 pgs).	
	3	Response to Canadian office action filed 9/23/2021 in related Canadian patent application No. 2855461, Attorney Docket No. [20145-054CA], (5 pgs).	
	4	European exam report mailed 9/10/2021 in related European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (7 pgs).	
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	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
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CERTIFICATION STATEMENT

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

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See attached certification statement.

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Signature	/Michael North/	Date (YYYY-MM-DD)	2021-11-09
Name/Print	Michael North	Registration Number	46963

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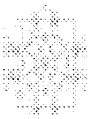
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Patents

obtain data from two networks and transmit policy

Blockchain network interaction controller



WO EP US CN • US20210243033A1 • Quan Wang • Visa International Service Association

Priority 2017-06-16 • Filed 2021-04-22 • Published 2021-08-05

Described herein are systems and methods for virtualizing policy enforcement amongst participants of an overlay network. In some embodiments, each of the participants may maintain a separate blockchain network. The overlay network may receive smart contracts or other policy documents that include ...

System and method for secure relayed communications from an implantable medical ...

US • US10841104B2 • Alexander I Poltorak • Poltorak Technologies Llc

Priority 2013-03-15 • Filed 2019-05-24 • Granted 2020-11-17 • Published 2020-11-17

The present invention provides systems and methods for supporting encrypted communications with a medical device, such as an implantable device, through a relay device to a remote server, and may employ cloud computing technologies. An implantable medical device is generally constrained to employ ...

Systems and methods for using an HTTP-aware client agent



US • US9948680B2 • Junxiao He • Citrix Systems, Inc.

Priority 2006-08-03 • Filed 2015-01-12 • Granted 2018-04-17 • Published 2018-04-17

Systems and methods are described for using a client agent operating in a virtual private network environment to intercept HyperText Transfer Protocol (HTTP) communications. Methods include: intercepting at the network layer, by a client agent executing on a client, an HTTP request from an ...

Identity-based internet protocol networking



WO US • US10630725B2 • Shu NAKAMOTO • The Mitre Corporation

Priority 2013-04-04 • Filed 2018-03-06 • Granted 2020-04-21 • Published 2020-04-21

Disclosed herein are system, method, and computer program product embodiments for identity-based internet protocol networking. An embodiment operates by receiving a packet from a device of a secured network. A strength of authentication of the device is determined based on how a user account ...

Detecting and reacting to malicious activity in decrypted application data



US • US10057284B2 • Maran Hart • Cybersark Software Ltd.

Priority 2015-05-07 • Filed 2017-07-24 • Granted 2018-08-21 • Published 2018-08-21

Described herein are systems and methods for detecting potentially malicious activity in a network session. Embodiments may involve identifying a requested network session between a first computer device and a second computer device, wherein the requested network session includes at least one ...

Systems and methods for split proxying of SSL via WAN appliances



WO EP US CN • US8949591B2 • Michael Ovsiannikov • Citrix Systems, Inc.

Priority 2010-04-21 • Filed 2013-09-16 • Granted 2015-02-03 • Published 2015-02-03

The present invention is directed towards systems and methods for split proxying Secure Socket Layer (SSL) communications via intermediaries deployed between a client and a server. The method includes establishing, by a server-side intermediary, a SSL session with a server. A client-side ...

Latency increase estimated rate limiter adjustment



WO EP US • EP3714580B1 • Douglas Dillon • Hughes Network Systems, LLC

Priority 2017-11-22 • Filed 2018-11-20 • Granted 2022-07-20 • Published 2022-07-20

A method, comprising: periodically measuring (1710) outbound latency of communications over a network from a first networked device to a second networked device, wherein one or more outbound latency measurements are made; storing (1720) the one or more outbound latency measurements and a time ...

System, apparatus and method for providing a unified firewall manager



US CA • US10785190B2 • Patricio Humberto Saavedra • Adaptiv Networks Inc.

Priority 2017-12-13 • Filed 2017-12-13 • Granted 2020-09-22 • Published 2020-09-22

A network system is provided between at least a first client site and a second client site, the first and the second client site are at a distance from one another. A client site network component is implemented at least at the first client site, the client site network component bonding or ...

Cloud over IP session layer network



US • US10986133B1 • Jaushin Lee • Zentera Systems, Inc.
Priority 2013-02-26 • Filed 2019-05-28 • Granted 2021-04-20 • Published 2021-04-20
A controller connects to endpoints. Profiles specify valid flows between groups of endpoints. Endpoints are provisioned according to the profiles. Provisioning includes the controller generating static routing tables. A static routing table includes an IP subnet that an endpoint will be allowed to ...

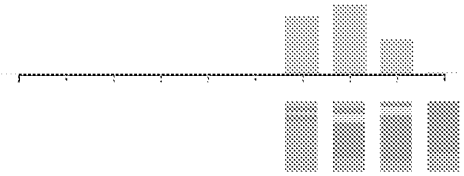
Highly scalable architecture for application network appliances



WO EP US • US9106027B2 • Nagaraj Bagepalli • Cisco Technology, Inc.
Priority 2007-08-28 • Filed 2013-04-10 • Granted 2015-08-04 • Published 2015-08-04
A highly scalable application network appliance is described herein. According to one embodiment, a network element includes a switch fabric, a first service module coupled to the switch fabric, and a second service module coupled to the first service module over the switch fabric. In response to ...

 About 135,665 results

Top 1000 results by filing date



Relative count of top 5 values

Assignees	Inventors	CPCs
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Commvault Systems, Inc.		12.4%
Huawei Technologies Co., Ltd.		2.7%
Seven Networks, Llc		2.2%
Amazon Technologies, Inc.		2.2%

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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	Notice of allowance mailed 7/8/2022 in related Australian patent application No. 2020202897, Attorney Docket No. [20145-055AUD3], (3 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	09/24/2022

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PTO/SB/08b (07-09)
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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 response filed 2/25/2022 in related European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD2], (3 pgs).	
	2	Australian office action response filed 12/1/2021 in related Australian patent application No. 2018200888, Attorney Docket No. [20145-055AUD3], (5 pgs).	
	3	European office action response filed 1/7/2022 in related European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (4 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	09/24/2022

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Chapter 8

Two computers using TCP/IP can communicate even if they are based on different hardware and software platforms. Data sent from one computer to the other passes ...

https://eyenetworks.no › Hjem › mesh

Five Reasons Not to Get a Wi-Fi Repeater - Eye Networks

This is a small device that can send Wi-Fi signals on to parts of the home where ... everyone using the network must relate to multiple network names and ...

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Bandwidth Definition - Investopedia

Bandwidth is the data transfer capacity of a computer network in bits per ... Bandwidth is a measure of how much information a network, a group of two or ...

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ResNet - Texas A&M Division of IT

Acceptable Use Policy. The Texas A&M University Network is governed by rules covering responsibilities when connecting to the network. These rules are not ...

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Dec 10, 2018 – When two devices attempt to share a single IP, you see the dreaded "Address Already in Use" Kill – with no ability to access the network.

https://apple.stackexchange.com › questions › how-doe...

How does the Mac choose which connection to use when both ...

6 answers

From the Apple Support database article regarding network connection priority: If you connect to the Internet or a network in several different ways (using ...

https://www.mightynetworks.com › privacy-policy

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Jan 14, 2022 – To offer the personalized experience of a Mighty Network, we collect personal information about you ("Personal Data"). This policy describes ...

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Protecting Federal Tax Information (FTI) In a Wireless Network

Mar 24, 2022 – All connections to WLANs that receive, store, process or transmit FTI must use

the IEEE 802.11i Robust Security Network (RSN) framework with

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	3	Response to final office action filed 6/19/2022 in related U.S. patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (12 pgs).	
	4	Advisory action mailed 8/5/2022 in related U.S. patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (3 pgs).	
	5	Notice of allowance mailed 7/8/2022 in related European patent application No. 11787994.0 Attorney Docket No. [20145-054EP], (7 pgs).	
	6	Australian office action mailed 6/9/2022 in related Australian patent application No. 2020229857, Attorney Docket No. [20145-117AU], (3 pgs).	

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High performance software-defined core network

GB · US20200296026A1 · Nitin Michael · The Mode Group

Priority 2017-01-31 • Filed 2018-12-02 • Published 2020-09-17

A system comprising nodes configured to form a network comprising virtual links in an overlay network provisioned over an underlay network. The system includes at least one virtual machine (VM) at each node. The VM is coupled to the network and to a tenant of the node. The VM includes routing ...

Intelligent wide area network (iwan)

EP US CN · US20200412647A1 · Dana L. Blair · Cisco Technology, Inc.

Priority 2015-07-07 • Filed 2020-09-11 • Published 2020-12-31

In one embodiment, an electronic device maintains one or more tunnel-based overlays for a communication network. The communication network includes two or more physical provider networks. The device maintains a mapping between a particular application and the one or more overlays for the ...

Rendering network policy and monitoring compliance

US · US9806991B2 · Solomon T. Lucas · Cisco Technology, Inc.

Priority 2015-01-21 • Filed 2015-05-29 • Granted 2017-10-31 • Published 2017-10-31

In one embodiment, a network controller receives data indicative of one or more traffic requirements for network traffic. The network controller maps the data indicative of the one or more traffic requirements into a network policy. The network controller causes installation of the network policy ...

Methods and apparatus for pre-programming layer-0 service turn up speeds for ...



US · US10069737B1 · Choudhury A. Al SAYEED · Ciena Corporation

Priority 2017-05-04 • Filed 2017-05-04 • Granted 2018-08-14 • Published 2018-08-14

Similar Pre-programming Layer-0 optical protection path restoration speeds is provided based on available path margin. Higher layer routers and switches can be made aware of the expected Layer-0 restoration time, and their switch time can be programmed accordingly. The proposed method can provide users an ...

System, apparatus, procedure, and computer program product for planning and ...



US · US10616074B2 · David W. Jenkins · Coriant Operations, Inc.

Priority 2012-12-13 • Filed 2017-10-06 • Granted 2020-04-07 • Published 2020-04-07

Similar A procedure for evaluating a network, and a system, apparatus, and computer program that operate in accordance with the procedure. The procedure includes aggregating packet information from one or more sources in a network, and executing a correlation algorithm to determine traffic flow ...

Route signaling driven service management



US · US10771434B1 · Harsha Srinath · Juniper Networks, Inc.

Priority 2015-03-31 • Filed 2019-03-29 • Granted 2020-09-08 • Published 2020-09-08

Similar A system and method for modifying services provided by one or more network devices. A processor of a first network device identifies defined events in each of a plurality of applications, including a first defined event associated with a first application. The processor assigns a signal-route to ...

System and method for automatically regulating messages between networks



US · US9521160B2 · Michael K. Bugenhagen · Centurylink Intellectual Property Llc

Priority 2006-10-25 • Filed 2012-04-27 • Granted 2016-12-13 • Published 2016-12-13

Similar A system, method, and profiler for regulating access between a remote network and a host network. The profiler includes a processor for executing a set of instructions and a memory for storing the set of instructions. The set of instructions are executed to determine one or more target devices for ...

Pre-computing effects of modifying components in a data center switch



GB · US9391843B1 · Amit Kumar Saha · Juniper Networks, Inc.

Priority 2012-12-31 • Filed 2012-12-31 • Granted 2016-07-12 • Published 2016-07-12

Similar The disclosure describes techniques to pre-compute the effect of modifying components in a data center switch prior to actually modifying the components. A data center analyzer is configured to discover the topology of the switch and present an editable version of the topology to a data center ...

Route signalling based resilient application overlay network



US • US9986577B1 • Harsha Srinath • Juniper Networks, Inc.
Priority 2015-03-31 • Filed 2015-09-30 • Granted 2018-05-29 • Published 2018-05-29
Similar A system and method for handling critical events in service delivery gateways. Events are defined that cause a transition from a master redundancy state to a standby redundancy state in service delivery gateways and a plurality of signal-routes are stored. Each signal-route is associated with one ...

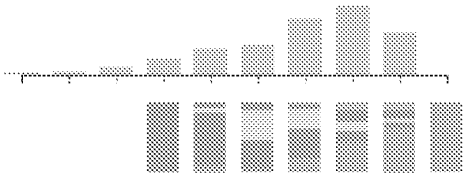
Traffic steering in fastpath



US • US11201817B2 • Linus ARANHA • Cisco Technology, Inc.
Priority 2017-04-17 • Filed 2017-04-17 • Granted 2021-12-14 • Published 2021-12-14
A method may include an instruction to route the data to a destination. The method may additionally include inspecting the data to identify metadata associated with the data. The method may further include identifying, based on the metadata, a first routing path and a second routing path that both ...

 About 133,559 results

Top 1000 results by filing date



Relative count of top 5 values

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Citrix Systems, Inc.		8.6%
Amazon Technologies, Inc.		6.3%
Cisco Technology, Inc.		4.3%
Splunk Inc.		2.3%

Expand

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	1	Notice of Allowance mailed 12/1/2021 in related US application No. 16/705,180, Attorney Docket No. [20145-055USC2], (15 pgs).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	09/24/2022

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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

Charter Communications, Inc.
Exhibit 1006
Page #510

		(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

Charter Communications, Inc.
Exhibit 1006
Page #511

			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

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	(US-PGPUB; USPAT)	OR	ON	ON	2022/09/24

Charter Communications, Inc.
Exhibit 1006
Page #512

		wonjong).in.					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

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	Notice of allowance mailed 7/8/2022 in related Australian patent application No. 2020202897, Attorney Docket No. [20145-055AUD3], (3 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:	46452129
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:	20-AUG-2022
Filing Date:	23-NOV-2020
Time Stamp:	00:20:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b1.pdf	326654 5b7cfb6dc36d4b54f6a9731ed1674740f1faf36b	no	2
Warnings:					

Information:					
This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	054USC_SIDS_NPL1-1.pdf	126307 024d76961375b8b54cf985665ccd72bcbe9c98f5	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	452961	

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
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	European office action mailed 5/20/2022 in related European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD], (5 pgs).	
	2	Australian office action response filed 5/25/2022 in related Australian patent application No. 2020202897, Attorney Docket No. [20145-055AUD3], (6 pgs).	
	3	Response to final office action filed 6/19/2022 in related U.S. patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (12 pgs).	
	4	Advisory action mailed 8/5/2022 in related U.S. patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (3 pgs).	
	5	Notice of allowance mailed 7/8/2022 in related European patent application No. 11787994.0 Attorney Docket No. [20145-054EP], (7 pgs).	
	6	Australian office action mailed 6/9/2022 in related Australian patent application No. 2020229857, Attorney Docket No. [20145-117AU], (3 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.

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

Electronic Acknowledgement Receipt

EFS ID:	46452069
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:	19-AUG-2022
Filing Date:	23-NOV-2020
Time Stamp:	22:56:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	054USC_SIDS_Trans.pdf	26399 85d39ff38361af5f32af94df898e237fd003809a	no	3

Warnings:

Information:					
2	Non Patent Literature	054USC_SIDS_NPL1.pdf	465356 5bff1c803e18c640352af103668a4ecc2fed9508	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL2.pdf	387282 386c3dabf3de4cfebf0266eea60f8793a096d891	no	6
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL3.pdf	83669 4973e04469884b5f10ccfbbd0b3555aa3cd9b4bf	no	12
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL4.pdf	394672 17813d17765c6567339ad0b94d9aaa7cc2a77b6b	no	3
Warnings:					
Information:					
6	Non Patent Literature	054USC_SIDS_NPL5.pdf	670319 8548f80e7e24b1d5d304bec57404e98471c2ebca	no	7
Warnings:					
Information:					
7	Non Patent Literature	054USC_SIDS_NPL6.pdf	143143 cf1e5fcd208180f422655aa32e334b07aeb5fb0c	no	3
Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	328830 3ec481b59d7e4d645886ba2db11a40a689616569	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					

Total Files Size (in bytes):	2499670

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New Applications Under 35 U.S.C. 111

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New International Application Filed with the USPTO as a Receiving Office

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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 19, 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.

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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):

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☐ 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 19, 2022

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

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[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04L 1/00 (2006.01)
H04L 1/20 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200780018637.1

[43] 公开日 2009 年 6 月 3 日

[11] 公开号 CN 101449503A

[22] 申请日 2007.4.4
[21] 申请号 200780018637.1
[30] 优先权
[32] 2006.5.23 [33] US [31] 11/438,921
[86] 国际申请 PCT/SE2007/050216 2007.4.4
[87] 国际公布 WO2007/136337 英 2007.11.29
[85] 进入国家阶段日期 2008.11.21
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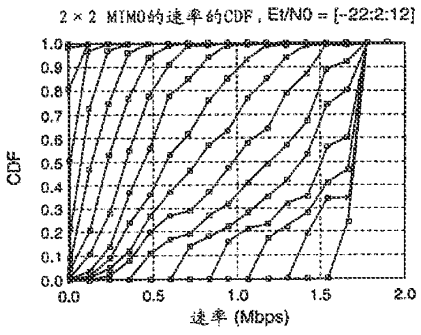
权利要求书 8 页 说明书 16 页 附图 6 页

[54] 发明名称

用于产生无线通信的信道质量信息的方法和设备

[57] 摘要

用于产生信道质量信息的方法和设备，例如可以被用于传送链路适配，提供不同的操作模式，例如可以在传播信道估计不可靠时使用的第一模式，以及可以在传播信道估计可靠时使用的第二模式。在一个或多个实施例中，针对在传播信道实现的范围内接收器输入信号质量的不同值、使用以限定的信道质量度量－例如所支持的数据速率－表征接收器性能的接收器性能信息来产生信道质量信息。信道质量信息能够通过根据接收器输入信号质量和在传播信道实现的范围内满足所限定的性能要求的期望概率来选择信道质量度量，或者通过根据接收器输入信号质量和特定的传播信道实现来选择信道质量度量而产生。



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1. 一种用于确定与无线通信设备(12)相关联的传送传播信道的信道质量信息的方法，所述方法的特征在于:

在第一模式下，根据不依赖于当前传播信道估计的第一算法来产生信道质量信息；以及

在第二模式下，根据依赖于当前传播信道估计的第二算法来产生信道质量信息。

2. 根据权利要求1所述的方法，其进一步特征在于根据传播信道衰落条件来确定是在第一模式下还是第二模式下操作。

3. 根据权利要求1所述的方法，其进一步特征在于响应于无线通信设备（12）所进行的对传播信道估计的可靠性的评估而确定是在第一模式下还是第二模式下操作。

4. 根据权利要求1所述的方法，其中根据不依赖于当前传播信道估计的第一算法来产生信道质量信息包括：将无线通信设备（12）的接收器输入信号质量映射到在传播信道条件的范围内能够以期望概率达到的数据速率选择。

5. 根据权利要求4所述的方法，其中将无线通信设备（12）的接收器输入信号质量映射到在传播信道条件的范围内能够以期望概率达到的数据速率选择包括：使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言能够达到的数据速率。

6. 根据权利要求5所述的方法，其中使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言能够达到的数据速率包括：选择用于将接收信号质量与在假设的传播信道实现的集合范围内能够达到的数据速率相联系的CDF曲线。

7. 根据权利要求6所述的方法，其进一步特征在于根据估计与无线通信设备(12)相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射。

8. 根据权利要求7所述的方法，其中根据估计与无线通信设备（12）相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射包括：根据长期传播信道估计、无线通信设备(12)的移动速率、无线通信设备（12）所要求的数据服务类型或者就无线通信

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设备（12）而言有效的数据服务类型、分配给无线通信设备（12）的下行链路带宽或者就无线通信设备（12）而言可用的下行链路带宽以及被用于或期望用于无线通信设备（12）的调制和编码方案中的一个或多个来产生一个或多个CDF曲线。

9. 根据权利要求1所述的方法，其中根据第二算法产生信道质量信息包括：将无线通信设备（12）的接收器输入信号质量映射到就与当前传播信道估计相对应的传播信道条件而言能够达到的数据速率选择。

10. 根据权利要求1所述的方法，其中无线通信设备（12）产生信道质量信息作为用于传送链路适配的反馈。

11. 根据权利要求1所述的方法，其中无线通信设备（12）产生信道质量测量，并且支持无线通信网络中的基站（10）根据对信道质量测量的接收来产生信道质量信息。

12. 根据权利要求11所述的方法，其中用于第一模式的信道质量测量至少包括接收器输入信号质量测量，并且其中用于第二模式的信道质量测量包括接收器输入信号质量测量和相应的传播信道估计。

13. 根据权利要求1所述的方法，其进一步特征在于存储接收器性能数据以供在至少第一模式下在产生信道质量信息的过程中使用，所述接收器性能数据表征与无线通信设备（12）相对应的接收器类型并且针对多个接收器输入信号质量中的每一个标识就多个传播信道实现而言所支持的数据速率。

14. 根据权利要求13所述的方法，其中根据第一算法产生信道质量信息包括：选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，以及识别在传播信道实现的范围内就接收器输入信号质量而言能够支持的数据速率。

15. 根据权利要求13所述的方法，其中根据第二算法产生信道质量信息包括：选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，选择与无线通信设备（12）所进行的传播信道估计相对应的传播信道实现或约束范围的传播信道实现，以及识别就接收器输入信号质量以及选定传播信道实现或约束范围的传播信道实现而言能够支持的数据速率。

16. 根据权利要求1所述的方法，其进一步特征在于根据以下中的至少一个而有选择地在第一和第二模式下操作：（a）要由无线通信设备（12）

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传送的数据的分组长度，（b）与要由无线通信设备（12）传送的分组数据相关联的延迟要求，（c）与无线通信设备（12）处有效的通信服务相关联的延迟要求，（d）无线通信设备（12）的标识，以及（e）网络使用或拥塞级别。

17. 一种包括一个或多个处理电路（40）的无线通信设备（12），所述一个或多个处理电路（40）被配置成针对无线通信设备（12）所接收的一个或多个信号来确定信道质量信息，用于确定信道质量信息的所述一个或多个处理电路的操作的特征在于：

在第一模式下，根据不依赖于当前传播信道估计的第一算法来产生信道质量信息；以及

在第二模式下，根据依赖于当前传播信道估计的第二算法来产生信道质量信息。

18. 根据权利要求17所述的无线通信设备（12），其中所述一个或多个处理电路（40）包括信道质量信息产生电路（44），所述信道质量信息产生电路（44）被配置成通过有选择地在第一和第二模式下操作而产生信道质量信息。

19. 根据权利要求18所述的无线通信设备（12），其中所述一个或多个处理电路（40）包括用于产生可靠性指示器的可靠性评估电路（46），所述可靠性指示器指示在无线通信设备（12）处产生的传播信道估计是否可靠，并且其中信道质量信息产生电路（44）被配置成在可靠性指示器指示传播信道估计不可靠的情况下选择第一操作模式，并且在可靠性指示器指示信道估计可靠的情况下选择第二操作模式。

20. 根据权利要求17所述的无线通信设备（12），其中所述一个或多个处理电路（40）被配置成根据无线通信设备（12）所进行的传播信道估计的可靠性来确定是在第一模式下还是第二模式下操作。

21. 根据权利要求17所述的无线通信设备（12），其中第一算法包括：将无线通信设备（12）的接收器输入信号质量映射到在传播信道条件的范围内能够以期望概率达到的数据速率选择。

22. 根据权利要求21所述的无线通信设备（12），其中将无线通信设备（12）的接收器输入信号质量映射到在传播信道条件的范围内能够以期望概率达到的数据速率选择包括：使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言

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能够达到的数据速率。

23. 根据权利要求22所述的无线通信设备（12），其中使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言能够达到的数据速率包括：选择用于将接收信号质量与在假设的传播信道实现的集合范围内能够达到的数据速率相联系的CDF曲线。

24. 根据权利要求23所述的无线通信设备（12），其中所述一个或多个处理电路（40）被配置成根据估计与无线通信设备（12）相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射。

25. 根据权利要求24所述的无线通信设备（12），其中所述一个或多个处理电路（4）被配置成通过以下操作根据估计与无线通信设备（12）相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射：根据长期传播信道估计、无线通信设备（12）的移动速率、无线通信设备（12）所要求的数据服务类型或者就无线通信设备（12）而言有效的数据服务类型、分配给无线通信设备（12）的下行链路带宽或者就无线通信设备（12）而言可用的下行链路带宽以及被用于或期望用于无线通信设备（12）的调制和编码方案中的一个或多个来产生一个或多个CDF曲线。

26. 根据权利要求17所述的无线通信设备（12），其中第二算法包括：将无线通信设备（12）的接收器输入信号质量映射到就与当前传播信道估计相对应的传播信道条件而言能够达到的数据速率选择。

27. 根据权利要求17所述的无线通信设备（12），其中无线通信设备（12）包括存储器（42），所述存储器（42）存储接收器性能数据以供所述一个或多个处理电路（40）在至少第一模式下在产生信道质量信息的过程中使用，所述接收器性能数据表征与无线通信设备（12）相对应的接收器类型并且针对多个接收器输入信号质量中的每一个来标识就多个传播信道实现而言所支持的数据速率。

28. 根据权利要求27所述的无线通信设备（12），其中第一算法包括：选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，以及识别在传播信道实现的范围内就接收器输入信号质量而言能够支持的数据速率。

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29. 根据权利要求27所述的无线通信设备（12），其中第二算法包括：选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，选择与无线通信设备（12）所进行的传播信道估计相对应的传播信道实现或约束范围的传播信道实现，以及识别就接收器输入信号质量以及选定传播信道实现或约束范围的传播信道实现而言能够支持的数据速率。

30. 一种包括一个或多个处理电路（60）的基站（10），所述一个或多个处理电路（60）被配置成确定与关联于基站（10）的无线通信设备（12）相对应的传送传播信道的信道质量信息，基于：

在第一模式下，根据不依赖于无线通信设备（12）的当前传播信道估计的第一算法来产生信道质量信息；以及

在第二模式下，根据依赖于无线通信设备（12）的当前传播信道估计的第二算法来产生信道质量信息。

31. 根据权利要求30所述的基站（10），其中，在第一模式下，基站（10）至少接收无线通信设备（12）的接收器输入信号质量信息，并且其中第一算法包括将接收器输入信号质量映射到在传播信道实现的范围内能够以期望概率达到的数据速率。

32. 根据权利要求31所述的基站（10），其中基站（10）被配置成将无线通信设备（12）的接收器输入信号质量映射到在传播信道条件的范围内能够以期望概率达到的数据速率选择包括：使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言能够达到的数据速率。

33. 根据权利要求32所述的基站（10），其中使用累积分布函数（CDF）和接收器输入信号质量来识别在假设的传播信道实现的范围内就期望的误差限度而言能够达到的数据速率包括：选择用于将接收信号质量与在假设的传播信道实现的集合范围内能够达到的数据速率相联系的CDF曲线。

34. 根据权利要求33所述的基站（10），其中基站（10）被配置成根据估计与无线通信设备（12）相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射。

35. 根据权利要求34所述的基站（10），其中基站（10）被配置成通过以下操作根据估计与无线通信设备（12）相关联的传播信道的长期传播信道条件来产生一个或多个CDF曲线以支持对接收信号质量的映射：根据长

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期传播信道估计、无线通信设备（12）的移动速率、无线通信设备（12）所要求的数据服务类型或者就无线通信设备（12）而言有效的数据服务类型、分配给无线通信设备（12）的下行链路带宽或者就无线通信设备（12）而言可用的下行链路带宽以及被用于或期望用于无线通信设备（12）的调制和编码方案中的一个或多个来产生一个或多个CDF曲线。

36. 根据权利要求30所述的基站(10)，其中，在第二模式下，基站(10)接收无线通信设备（12）的传播信道估计和接收器输入信号质量信息，并且其中第二算法包括将接收器输入信号质量映射到就与传播信道估计相对应的特定传播信道实现或约束范围的传播信道实现而言能够达到的数据速率。

37. 根据权利要求30所述的基站（10），其中基站（10）被配置成在其接收到无线通信设备（12）的接收器输入信号质量信息而没有接收到无线通信设备（12）的相应传播信道估计的情况下选择在第一模式下操作。

38. 根据权利要求30所述的基站（10），其中基站（10）被配置成在其确定无线通信设备（12）的传播信道估计不可靠的情况下选择在第一模式下操作。

39. 根据权利要求30所述的基站（10），其中基站（10）被配置成在无线通信设备（12）在快衰落条件下操作的情况下选择在第一模式下操作，并且被配置成在无线通信设备（12）不在快衰落条件下操作的情况下选择在第二模式下操作。

40. 根据权利要求30所述的基站(10)，其中基站(10)包括存储器(62)，所述存储器（62）存储接收器性能数据以供所述一个或多个处理电路（60）在至少第一模式下在产生信道质量信息的过程中使用，所述接收器性能数据表征与无线通信设备（12）相对应的接收器类型并且针对多个接收器输入信号质量中的每一个标识就多个传播信道实现而言所支持的数据速率。

41. 根据权利要求40所述的基站（10），其中第一算法包括：使用接收器性能数据来选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，以及识别在传播信道实现的范围内就接收器输入信号质量而言能够支持的数据速率。

42. 根据权利要求40所述的基站（10），其中第二算法包括：使用接收器性能数据来选择与无线通信设备（12）所进行的接收器输入信号质量测量相对应的接收器输入信号质量，选择与无线通信设备（12）所进行的传

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播信道估计相对应的传播信道实现或约束范围的传播信道实现，以及识别就接收器输入信号质量以及选定传播信道实现或约束范围的传播信道实现而言能够支持的数据速率。

43. 一种表征接收器性能的方法，所述方法的特征在于：

针对多个接收器输入信号质量中的每一个以及多个调制和编码方案中的每一个，计算多个传播信道实现中的每一个的预期误差率；

针对所述接收器输入信号质量中的每一个以及所述调制和编码方案中的每一个，计算就每个传播信道实现而言能够支持的数据速率；以及

针对每个接收器输入信号质量，计算与传播信道实现相对应的所支持数据速率的累积分布函数。

44. 根据权利要求43所述的方法，其中计算就每个传播信道实现而言能够支持的数据速率包括：根据与调制和编码方案相对应的数据速率（R_{mcs}）以及传播信道实现的预期误块率（BLER）来确定能够支持的数据速率（R）。

45. 根据权利要求44所述的方法，其中根据与调制和编码方案相对应的数据速率（R_{mcs}）以及传播信道实现的预期误块率（BLER）来确定能够支持的数据速率（R）包括将R计算为：$R = R_{mcs}(1 - BLER)$。

46. 根据权利要求44所述的方法，其中根据与调制和编码方案相对应的数据速率（R_{mcs}）以及传播信道实现的预期误块率（BLER）来确定能够支持的数据速率（R）包括将R计算为：$R = R_{mcs}/(1 - BLER)$。

47. 根据权利要求43所述的方法，其中计算就每个传播信道实现而言能够支持的数据速率包括：根据与调制和编码方案相对应的数据速率（R_{mcs}）、传播信道实现的预期误块率（BLER）以及目标误块率（BLER（目标））来确定能够支持的数据速率（R）。

48. 根据权利要求47所述的方法，其中根据与调制和编码方案相对应的数据速率（R_{mcs}）、传播信道实现的预期误块率（BLER）以及目标误块率（BLER（目标））来确定能够支持的数据速率（R）包括：在BLER＜BLER（目标）的情况下将R确定为$R = R_{mcs}$，否则将R确定为$R = 0$。

49. 一种用于把来自无线通信设备（12）的速率适配反馈提供给支持无线通信网络的方法，其特征在于存储根据权利要求43的表征接收器性能的方法而确定的接收器性能数据，以及在第一操作模式下，根据与无线通信设备所进行的测量相对应的接收器输入信号质量以及就传播信道实现

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的范围而言达到选定数据速率的期望概率、使用接收器性能数据来选择所支持的数据速率，以及在第二操作模式下，根据与无线通信设备所进行的测量相对应的接收器输入信号质量以及与无线通信设备（12）的传播信道估计相对应的特定传播信道实现或约束范围的传播信道实现、使用接收器性能数据来选择所支持的数据速率。

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用于产生无线通信的信道质量信息的方法和设备

背景

本发明大体上涉及产生无线通信，尤其涉及产生信道质量信息。

信道质量信息能够以多种方式来表示，例如用于标识无线通信接收器的有效信号质量的信道质量指示器。有效信号质量表示接收器可以提供的任何干扰消除增益、分集合并增益、编码增益等的好处。换言之，给定接收器的输出信号质量可能明显优于接收器的输入信号质量，所述输入信号质量通常被表示为接收信号能量与背景噪声和干扰的“原始（raw）”未补偿的比率。

无线通信领域的技术人员将会理解到根据输出信号质量而不是输入信号质量来产生信道质量信息的价值，这是因为输出信号质量更好地表示与解调质量和解码性能有关的实际信号质量。也就是说，假定信道质量信息被用于链路适配（link adaptation），例如选择适合于向接收器传送的调制和编码方案（MCS），使用输入信号质量而不是输出信号质量将会引起长期对传输链路利用不足。

然而，对于某些类型的接收器而言，作为进行中的接收器操作的一部分来准确地确定输出信号质量不是直接的建议。特别地，非线性接收器在输入信号质量和输出信号质量之间通常具有复杂的关系。非线性接收器的例子包括采用连续干扰消除的多级接收器以及联合检测接收器。

此外，即使假定输出信号质量的可计算性，这样的计算在一些情况下也可能是不准确的。例如，给定接收器可达到的性能取决于多个变量，包括传播信道条件。一些信道条件与其他相比转化为更好的接收器性能。因此，即使对于相同的接收器输入信号，接收器输出信号质量将会根据变化的信道条件而改变。如果信道条件快速改变，或者输入信号太弱以至于无法进行可靠的信道估计，则报告输出信号质量，或与输出信号质量有关的某一度量（metric）可能会引起控制误差。

例如，支持基站可以响应于接收到来自无线通信设备的信道质量信息而执行传送链路适配，所述信道质量信息用某一度量（例如信道质量指示器、速率选择指示器等）来标识信道质量。因此，基站能够调整传送数据速率，例如根据由设备所报告的信道质量指示器来调整。该控制机制在实

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际信道条件与链路适配控制滞后相比缓慢变化的情况下工作得很好。然而，如果实际传播信道条件与链路适配控制定时相比快速变化，则在考虑到那些条件的情况下执行链路适配变得不可靠。

概要

根据在此讲授的一个或多个方法和设备实施例，不同的操作模式被用于根据例如无线通信设备的传播信道估计的可靠性来确定无线通信设备的信道质量信息。例如，在一个实施例中，在第一模式下，通过将接收器输入信号质量映射到在传播信道实现的范围内能够以期望概率支持的数据速率来确定信道质量信息。所支持的数据速率可以被定义为能够在期望的性能要求（例如误块率（BLER））的情况下达到的容许数据速率。此外，在第二模式下，通过将接收器输入信号质量映射到就与无线通信设备所获得的当前信道估计相对应的约束范围的传播信道条件而言能够支持的数据速率或者就特定传播信道实现而言能够支持的数据速率来确定信道质量信息。

因此，第一模式考虑到在短期传播信道估计不可靠时（例如在与传送链路适配相关联的时滞与传播信道衰落的相干时间相比很大的情况下）根据长期传播信道条件产生信道质量信息。相反地，第二模式考虑到在短期传播信道估计可靠时根据短期传播信道条件产生信道质量信息。模态（Modal）操作能够通过确定无线通信设备所产生的信道估计可靠与否来驱动。可靠性可以通过评估（evaluate）无线通信设备的移动性（例如移动速度、多普勒频率等）或通过评估信道估计来确定。

考虑到以上论述，在一个实施例中，确定与无线通信设备相关联的传送传播信道的信道质量信息的方法包括：在第一模式下根据不依赖于信道估计的第一算法来产生信道质量信息，以及在第二模式下，根据依赖于信道估计的第二算法来产生信道质量信息。表征与无线通信设备相关联的接收器类型的接收器性能的接收器性能数据可以被用于在第一和第二模式下产生信道质量反馈，并且这种产生可以由无线通信设备自身或者由支持无线通信网络中的基站来执行。

例如，无线通信设备或基站可以包括一个或多个处理电路，所述一个或多个处理电路被配置成基于在第一模式下根据不依赖信道估计的第一算法产生信道质量信息以及在第二模式下根据依赖于信道估计的第二算

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法产生信道质量信息来针对无线通信设备所接收的一个或多个信号确定信道质量信息。在一个或多个实施例中，处理电路（一个或多个）被配置成根据信道估计是否可靠而有选择地在第一或第二模式下操作。

补充上述信道质量信息产生的方法，接收器性能表征方法的一个实施例包括：针对多个接收器输入信号质量中的每一个，计算多个传播信道实现中每一个的预期误差率，以及针对所计算的每个误差率，针对每个接收器输入信号质量计算就每个传播信道实现而言能够支持的数据速率，并且针对每个接收器输入信号质量，计算与传播信道实现相对应的所支持数据速率的累积分布函数（CDF）。这样的性能表征数据可以由无线通信设备来存储或者由支持无线通信网络来存储。通常，性能表征数据对于接收器类型是特定的，并且能够为不同的接收器类型存储不同的数据。例如，特定类型的广义RAKE（耙式）（G-RAKE）或者其他最小均方误差（MMSE）接收器将具有与特定类型的联合检测（JD）接收器不同的表征数据。类似地，能够为不同的传送/接收方式（MISO、MIMO等），甚至为相同的接收器类型存储不同的性能表征数据。

用于把来自无线通信设备的速率适配反馈提供给支持无线通信网络的相应方法通过根据与无线通信设备所获得的测量相对应的接收器输入信号质量以及就传播信道实现的范围而言达到选定数据速率的期望概率、使用接收器性能数据来选择所支持的数据速率而在第一模式下操作。在第二模式下，通过根据与无线通信设备所获得的信道估计相对应的约束范围的传播信道实现或特定传播信道实现以及接收器输入信号质量来选择所支持的数据速率，从而使用接收器性能数据来产生信道质量信息。

当然，本发明不局限于上述特征和优势。实际上，本领域技术人员在阅读以下详细描述时以及在观察附图时将会意识到另外的特征和优势。

附图简述

图1是基站和无线通信设备（例如移动站）的框图，其中根据在此所讲授的一个或多个方法实施例来产生信道质量信息。

图2是用于信道质量信息的模态产生的处理逻辑的一个实施例的逻辑流程图。

图3是用于在图2的环境（context）中选择操作模式的一个实施例的逻辑流程图。

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图4是在图2的环境中选择操作模式的另一个实施例的逻辑流程图。

图5是接收器性能表征方法的一个实施例的逻辑流程图。

图6和7是描绘针对不同类型的无线通信设备接收器通过图5的接收器性能表征方法所获得的接收器性能表征的曲线。

图8是通过使用接收器性能数据而模态地（Modally）产生信道质量信息的一个实施例的逻辑流程图。

图9是被配置成产生信道质量信息的无线通信设备的一个实施例的框图。

图10和图11是在产生信道质量信息的过程中使用的处理电路的实施例的框图。

图12是被配置成根据无线通信设备的接收信道质量测量来产生信道质量信息的基站的一个实施例的框图。

详细描述

图1图示了基站10和无线通信设备12，其中针对基站10和无线通信设备12之间的下行链路而产生的信道质量信息在第一操作模式下不依赖于当前传播信道估计，而在第二模式下依赖于当前传播信道估计。因此，产生信道质量信息的第一模式可以在下行链路传播信道的估计不可靠的情况下使用，例如当无线通信设备12相对于基站10高速移动时，或者经受快衰落条件，或者当接收信号强度对于可靠信道估计而言过低。

在描述上述用于产生信道质量信息的方法的各种实施例之前，应该理解的是与产生信道质量信息相关联的处理逻辑能够完全在无线通信设备12中执行，完全在基站10中执行，或者通过使用基站10和无线通信设备12这二者而协作地执行。在所有这样的情况下，伴随的处理可以采用硬件、软件或其任意组合来实施。此外，应该理解的是基站10和无线通信设备12不局限于任何特定配置，它们也不局限于任何特定无线通信标准或协议。

例如，在一个或多个实施例中，无线通信设备12包括蜂窝无线电话或其他类型的移动站，其被配置用于与包括基站10的支持无线通信网络一起工作。在这样的实施例中，基站10可以包括被配置成提供高速下行链路分组接入（HSDPA）服务的宽带CDMA（WCDMA）基站。

相应地，无线通信设备12可以包括基于WCDMA的接入终端，所述基于WCDMA的接入终端被配置成向基站10提供信道质量信息或相关反馈，

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以支持对下行链路传送数据速率进行适配以改变无线通信设备12处的接收条件。然而，通常无线通信设备12可以包括移动站或其他类型的手机、寻呼机、便携式数字助理（PDA）、掌上型电脑或膝上型计算机，或供其中使用的无线通信模块，或者基本上任何其他类型的通信设备。

考虑到所述方法的宽的适用性，图2图示了产生信道质量信息的方法的一个实施例，其中应该理解的是所图示的处理步骤中的至少一些可以以与所图示的次序不同的次序来执行。此外，虽然图示为串行处理，但是所述方法的实际实施可以包括同时、并行处理，作为进行中的通信操作的一部分。而且，应该理解的是，所图示的处理可以在基站10、无线通信设备12中或在其某一组合中实施。

处理“开始”于确定是否在产生信道质量信息的第一模式下操作（步骤100）。如果第一模式被选择，则处理继续以根据不依赖信道估计的第一算法来产生信道质量信息（步骤102）。相反地，如果第一模式没有被选择，即第二操作模式被选择，则处理继续以根据依赖于信道估计的第二算法来产生信道质量信息（步骤104）。

在此处所讲授的至少一个实施例中，产生信道质量信息的第一模式在快衰落条件期间使用，或者每当条件使得无线通信设备12所获得的短期信道估计“不可靠”的时候。产生信道质量信息的第二模式在慢衰落条件期间使用，或者更一般地说，每当信道估计可靠时使用。换言之，当信道的短期估计不可靠时根据长期传播信道特性来产生信道质量信息。相反地，当信道估计可靠时根据短期传播信道特性来产生信道质量信息。

应该理解的是，在此考虑到用于评价信道估计可靠性的各种方法，并且应该理解的是在一个应用中被认为引起不可靠信道估计的条件在另一个应用中可能不这样认为。例如，短期信道估计的可靠性可以用衰落速度对链路适配控制滞后来审视。也就是说，可以根据信道条件相对于所进行的传送链路适配变化多快而认为信道估计的可靠性更高或更低。在一些实施例中，链路适配滞后-即报告的信道质量度量和相应的传送链路调整之间的时间－可以被用于影响是否在产生信道质量信息的过程中考虑短期传播信道条件或者在什么程度上考虑短期传播信道条件。

考虑到这样的变化，图3图示了用于确定是在图2的第一模式下还是在第二模式下操作的处理逻辑的一个实施例。模态选择处理“开始”于评估传播信道衰落条件（步骤106）。如将在稍后详细描述的那样，评估可以包

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括评价信道估计的可靠性以确定快衰落条件是否适用。在其他实施例中，快衰落可以通过评估移动性来识别，例如通过评估基站10和无线通信设备12之间的下行链路和/或上行链路信道上的传输的多普勒频移。当然，与短期信道估计的可靠性有关的其他指示器可以被使用。例如，某些服务区可能会使得信道估计本来就可疑，例如商业区或市区中的无线电扇区。

如果快衰落条件适用（步骤108），则信道质量产生在第一模式下操作，其中以不依赖于信道估计的方式来产生信道质量信息（步骤110）。相反地，如果快衰落条件不适用，则以依赖于信道估计的方式来产生信道质量信息（步骤112）。

图4图示了用于确定是在图2的第一模式下还是在第二模式下操作的处理逻辑的另一个实施例。模态选择处理“开始”于评估网络使用或负载条件（步骤114）。在轻负载的无线网络中，信道估计的可靠性以及所得到的信道质量信息能够折衷，即使传播信道衰落条件缓慢变化或者保持静态。例如，由于作为轻负载网络的特征的小区间干扰的突发和快速变化，信道质量以及由此在数据的实际传输期间实现的可支持的数据速率会与在传输之前所测量的可支持数据速率大不相同。

因此，如果网络是轻负载的（步骤116），则选择确定信道质量信息的第一模式是有利的（步骤118）。相反地，如果网络是更重负载的，或负载以另外方式更加稳定，则能够根据第二操作模式来确定信道质量信息（步骤119）。选择使用哪个操作模式用于信道质量信息确定能够被评估和/或应用于单独的无线通信设备12，或者能够被应用于网络的给定扇区或小区内的无线通信设备12的集合或子集。例如，第一模式可以被用于一些无线通信设备12，而第二模式可以被用于其他。例如，可以根据单独无线通信设备12的服务需求来设置对使用哪个模式的确定。

注意到，能够以对于无线通信设备12而言不透明或者透明的方式来实施模态选择。在一个实施例中，无线通信网络中的基站10能够指示多个无线通信设备12中的一个或多个设备反馈与优选操作模式相符合的信息。可替换地，根据网络负载条件，基站10能够接收支持第二操作模式的信息，但是能够选择忽略该信息中的支持在第一模式下操作的一些或全部。换言之，基站10可以选择不使用它所接收的全部反馈。

在一些情况下，支持第二模式下的操作所需的无线电资源成本与第一模式下的操作相比更高。比如，为了支持第二模式下的操作，与第一模式

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下的操作所需的相比，无线通信设备12必须更频繁地发送反馈以反映变化的传播信道条件。反馈量还可能更大以足够详细地描述传播信道条件以用于第二模式下的操作。反馈信道上的紧张（strain）还因以下事实而加剧：多个无线通信设备12同时向网络传送反馈信息。因此，仅仅基于传播信道条件考虑，即使当第二模式下的操作可行时第一操作模式也可能是优选的。

在一个或多个实施例中，信道质量信息确定考虑到与第二模式下的操作相关联的反馈信道上的可能较高的无线电资源成本。更具体地，第二操作模式能够为合同规定的特权（privileged）设备或服务而保留。给定通信设备12的特权级别能够从具有设备标识号的数据库得到参考。

能够根据第二模式下的操作为具有较高特权的设备确定信道质量信息。在考虑适当的操作模式中，服务的合同要求也会是一个因素。比如，对于具有严格的延迟或抖动要求的服务（例如分组语音服务）而言，如果根据第二模式下的操作来确定信道质量信息，则服务质量会更容易保持。

决定是根据第一还是第二操作模式来确定信道质量信息还可能适合于包括可分离组件的传输方案。这些类型的传输方案的非限制性例子包括多载波CDMA和正交频分复用（OFDM）传输。为了支持第二模式下的操作，反馈量会直接取决于可分离组件的数目，例如对于四载波CDMA而言有四个反馈值，或者对于具有80个频率资源单元的OFDM而言有80个值。对于将会占据全部组件或者大部分组件的大分组或数据单元，在第二模式而不是第一模式下操作的相对好处会明显小于就将占据小部分组件的小分组或数据单元而言的好处。为了节省无线电资源，因此有利的是在操作模式选择中将分组或数据单元长度作为因素包含进来。

在一个或多个实施例中，这样的操作通过利用用于表征无线通信设备的接收器类型在传播信道条件的范围内的性能的接收器性能数据而得以支持，以使得性能数据指示接收器在传播信道条件的范围内以及就特定传播信道条件而言的预期性能。针对信道质量信息确定（例如用于可支持的速率计算）而确定信道传播条件可能会被要求在第一和/或第二操作模式下进行操作。对于第一操作模式，长期信道传播条件被确定，并且在一个或多个实施例中，传播信道条件包括以下量中的一个或多个：信道衰落速度（例如，基于估计的多普勒频率、已知的移动速度、否定应答速率－即NACK速率）的表征；以及对与无线通信设备12相关联的传播信道的功率

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延迟分布（power delay profile PDP）的估计，假定PDP不随时间快速改变。

在一个或多个实施例中，长期传播信道条件的估计被用于以下处理动作中的任何一个或多个：构造可达到的（可支持的）数据速率的CDF；从与估计的长期传播信道条件最紧密匹配的CDF曲线的表格选择可达到的数据速率曲线CDF。因此，应该理解的是，在一个或多个实施例中，CDF曲线可以被预定义。在这样的实施例中，与无线通信设备12相关联的传播信道的长期表征和/或接收信号质量能够被用于沿预定义CDF曲线选择点或范围以识别无线通信设备12的信道质量信息－例如以识别可达到的数据速率。在一个或多个其他实施例中，所估计的长期传播信道条件被部分地或全部地用于构造一个或多个CDF曲线，所述CDF曲线然后能够被用于识别可达到的数据速率，例如，根据在无线通信设备12处所测量的信号质量。

更详细地，为了CDF曲线构造，PDP被考虑以已知量，并且延迟抽头（tap）（信道）系数值能够被产生并且被用于进一步确定给定PDP的传播信道实现。至少一个实施例根据导频或其他测量来估计传播信道系数，以便支持长期传播信道条件的表征。应该理解的是，可以根据需要或期望来使用用于传播信道估计的传统技术。注意到，信道系数的估计表示较长期的估计，而不是通常在第二操作模式下使用的短期的（瞬时）估计。

然而，无论如何，应该理解的是，CDF曲线表征特定接收器类型（一个或多个）的（预期）性能。图5图示了一种根据CDF曲线表征接收器性能的方法，但是应该理解的是其他方法可以被用于表征就长期和短期传播信道条件而言的接收器性能。

更详细地，图5图示了可以通过使用经验性测试、软件模拟、动态测量或其任何组合来执行的接收器性能表征方法的实施例。因为不同的接收器类型提供了不同的性能级别，所以这样的表征是针对与无线通信设备12相关联的特定接收器类型而进行的。（如果信道质量信息是由无线通信设备12产生的，则接收器性能数据能够被存储在无线通信设备12中。如果信道质量信息是在基站10中产生的，则基站10可以存储不同类型的接收器的表征数据，并且针对不同的无线通信设备使用适当的接收器性能数据集合。）

无论如何，处理开始于针对多个接收器输入信号质量值中每一个、针对多个调制和编码方案中的每一个以及针对多个传播信道实现中的每一个计算预期误差率（步骤120）。误差率可以被表示为例如误比特率（BER），

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误块率（BLER）、误帧率（FER）等等，并且表示误差率所采用的特定方式可以基于所涉及的数据传输类型。

如在此所使用的，除非另作说明，术语“接收器输入信号质量”表示就每个码片（chip）而言所接收的总信号能量E_T与噪声加干扰N_0之比。接收器输入信号质量的测量表示就包含在无线通信设备12内的接收器而言的“原始”输入信号质量，并且不依赖于接收器的干扰抑制和信号增益性能，因此不依赖于短期传播信道估计的准确度。此外，接收器输入信号质量测量对于简单和复杂的接收器结构而言是一样的，例如不管设备的接收器是简单的线性接收器还是复杂的非线性接收器都是一样的。

此外，如在此所使用的，术语“传播信道实现”表示传播信道抽头权重的特定组合。例如，传播信道的多个三抽头表征包括与不同的传播信道条件相对应的三个复抽头系数的不同组合。不同的传播信道实现可以基于固定功率延迟分布（PDP）。可替换地，给定快衰落实现可以被用于不同的PDP，并且不同的CDF可以被用于不同的PDP。

无论如何，每个传播信道实现可以被理解为表示基站10和无线通信设备12之间的传送链路的实际传播信道条件的特定假设。对于相同的输入信号质量，无线通信设备12对于不同的信道实现将表现出不同的输出信号质量。

对于每个接收器输入信号质量和每个调制和编码方案，接收器性能表征处理继续以：针对所计算的每一个误差率，计算就每个传播信道实现而言能够达到（支持）的数据速率（R）（步骤122）。可达到的数据速率，也被称为所支持的数据速率，表示能够被用于向无线通信设备12进行传送且同时仍满足限定的性能要求（例如BLER目标）的数据速率（R）。例如，如果计算出的误差率小于目标BLER，即BLER＜BLER（目标），则与调制和编码方案相对应的数据速率（R_{mcs}）能够是所支持的数据速率（$R = R_{mcs}$）。否则，所支持的数据速率会是0（R＝0）。如果ARQ被使用，则所支持的数据速率（R）能够被计算为$R = R_{mcs}$（1 - BLER），其中R_{mcs}是与调制和编码方案相对应的数据速率而BLER是计算出的误差率。如果HARQ被使用，则所支持的数据速率能够被计算为$R_{mcs}/(1+BLER)$。

处理继续以：针对每个接收器输入信号质量，计算与传播信道实现相对应的所支持数据速率的累积分布函数（CDF）（步骤124）。注意到，CDF曲线的产生可以是一次（one - time）过程，或者可以全部地或部分地是动

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态过程。例如，如先前所指出的，对与用于无线通信设备12的较长期传播信道条件有关的一个或多个参数的进行中的估计。同样，这样的参数能够包括但不局限于PDP、估计的信道系数、当前数据服务类型和/或数据特性（例如分组大小）、移动性/移动速率估计等中的任何一个或多个。

图6用图表描绘了根据图5的方法为最小均方误差（MMSE）接收器类型产生的接收器性能数据。更特别地，图6根据就假设的传播信道实现集合而言所支持数据速率的CDF而针对定义的数据速率点绘出了从-22 dB以2 dB增量步进到+12 dB的接收器输入信号质量（SNR）曲线。最左边的曲线对应于-22 dB的输入SNR，而最右边的曲线对应于+12 dB的输入SNR。图7描绘了联合检测（JD）接收器体系结构的类似性能表征数据，并且应该理解的是，用于无线通信设备12的特定接收器性能数据将会与其特定接收器类型相匹配。（此外，因为一些类型的接收器具有会引起不同性能特性的不同接收模式，所以在每个这样的模式下可以使用不同的接收器性能数据。）

在使用图6的性能曲线来确定信道质量信息的过程中，例如考虑较高移动速率的情形，其中信道衰落条件在传播信道条件被估计时的测量时间与基于那些信道估计的传送链路适配被执行时的传送时间之间在时间上（temporally）更加不相关。如果信道条件变化得比链路适配控制能够跟得上的速度更快，则链路适配-例如传送数据速率选择-应该基于通过路径增益和阴影所确定的统计传播特性，而不是基于信道估计。

给定无线通信设备12所测量的信号质量，能够根据期望CDF级别从接收器性能数据中的对应信号质量曲线中选择传送数据速率。例如，对于适当的SNR曲线选择第十个百分位数对应于就假设的传播信道实现的百分之九十而言能够达到的数据速率。要选择的特定值通常依赖于系统的特定性能要求，例如通过限定的性能要求（例如最大可容许的BLER）来确定。在一个或多个实施例中，信号质量表示如由无线通信设备所测量的或者如由网络求平均所得的长期信号质量－平均输入SNR。在其他实施例中，例如在信道估计可靠的情况下，瞬时或短期的接收器输入信号质量可以被使用。

在这两种情况下，上述方法有效地将性能表征曲线中的速率值量化为由量化的输入信号质量测量所表示的速率，这对于快速变化信道中的慢速链路适配而言是足够的。也就是，对于快衰落条件，信道质量信息可以作

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为数据速率选择来产生，所述数据速率选择基于从与无线通信设备12处的长期测量信号质量相对应的曲线选择SNR曲线，然后识别就限定的性能要求（例如限定的BLER限制）而言能够以期望概率达到的数据速率。实际上，该方法相当于基于将接收器输入信号质量测量映射到在短期传播信道特性的范围内能够以期望概率达到的数据速率选择、根据长期传播信道特性来产生信道质量信息。

当信道变得更加可靠时，例如当车辆速度变得更慢或者由于改进的路径增益而引起在接收器处的实际输入SNR变得更大时，信道质量信息产生过程能够被转变成其中产生更为精确的信息的模式，即这样的模式，其中在无线通信设备12处占优势的短期传播信道条件被明确地予以考虑。在快衰落期间被用于慢速适配的相同性能表征数据可以在慢衰落期间被用于快速适配。换言之，能够以分层方式将相同的接收器性能曲线用于慢速和快速链路适配。也就是说，信道质量度量能够被用于表征信道的长期特性，当信道变得更加可靠时能够针对快速链路适配来对其进行进一步表征。

用于完成上述操作的一种方法是针对每个输入信号质量（SNR）对信道状态值进行量化并且将量化值存储在码本中。对于在无线通信设备12处获得的信道估计和特定输入SNR，能够在码本中查找量化值，并且对应的数据速率被选择用于信道质量信息报告。

图8图示了分层的信道质量信息产生的一个实施例，其中用数据速率报告来产生信道质量信息。这样的处理可以在无线通信设备12处、在基站10处或者协作地执行。无论如何，处理开始于对传播信道条件进行评估（步骤130）。评估可以包括评估无线通信设备12所产生的短期传播信道估计以作为确定估计是否可靠的方法，或者可以包括检查多普勒频移等。

如果信道估计不可靠（步骤132），则通过使用接收器性能数据来选择所支持的数据速率，例如图6和7中所图示的那样。更特别地，如果信道估计不可靠，则所测量的接收器输入信号质量能够被映射到量化的SNR曲线之一，并且所支持的相应数据速率能够根据在用于产生性能数据的传播信道实现范围内达到该速率的期望概率来识别（步骤134）。第十百分位数选择意味着假设的传播信道实现的百分之九十都将以期望误差率性能支持选定数据速率。

因而，如果信道估计不可靠，则以一定概率（probabilistically）选择传送数据速率，而不是基于对在无线通信设备12处存在的短期传播信道条

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件的任何特定考虑。此外，在信道估计不可靠的情况下，用于选择适当的量化SNR曲线的接收器输入信号质量可以是长期（平均）接收器输入信号质量。可以在无线通信设备12处进行求平均，或者可以通过网络对无线通信设备12所报告的瞬时值求平均。

另一方面，如果信道估计可靠（步骤132），则所测量的接收器输入信号质量可以表示较短期（例如瞬时）测量。当然，仍然可以使用平均值。在两者中任一情况下，利用可靠信道估计的可用性，能够将接收器输入信号质量映射到量化的SNR曲线之一以及与信道估计相对应的约束范围的传播信道实现或特定传播信道实现（步骤136）。在该方法的一种变化中，能够针对长期和短期的SNR测量而存储不同的SNR/CDF曲线，其中不同的SNR曲线反映了不同的概率特性。然后，在操作中，根据是长期还是短期的SNR值正被使用来选择待使用的曲线集，其中长期或短期的SNR值的使用可以根据信道估计可靠性而转换。

该用于信道质量信息产生的分层法能够在无线通信设备12中实施，例如通过在设备12中包括适当配置的处理电路以及存储适当的接收器性能数据。图9图示了无线通信设备12的一个实施例，其被配置成用于执行通过使用接收器性能数据来产生信道质量信息的方法。所图示的实施例包括接收/发射天线20、开关（switch）/双工器21、接收器前端22、发射器24、基带（BB）控制器26、系统控制器28、输入/输出（I/O）接口电路30和用户接口（UI）32。

特别感兴趣的是信道质量信息产生，基带控制器26包括一个或多个处理电路40，其被配置用于信道质量信息产生，并且其能够直接或间接访问存储接收器性能数据的存储器42。所存储的数据可以包括数据结构，所述数据结构表示量化的SNR曲线以及就多个传播信道实现（例如1000个信道实现的集合）而言所支持的速率的对应CDF，例如在图6或7中所示的那样。然而，可以通过使用曲线拟合计算（例如多项式）来获得性能数据中的至少一些，并且应该理解的是在此考虑到用于存储和表示接收器性能数据的各种方法。

根据一个实施例，在操作中，无线通信设备12保存接收器输入信号质量的长期估计－平均SNR－并且还保存短期（瞬时）传播信道估计。如果传播信道估计不可靠，则无线通信设备12在信道质量信息产生的第一模式下操作。在第一模式下，无线通信设备12将所测量的平均接收器输入信号

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质量映射到以接收器性能数据表示的最紧密对应的接收器输入信号质量，然后使用该SNR曲线来识别在传播信道实现的范围内能够以期望概率支持的数据速率。因而，无线通信设备12采用以一定概率识别的更新的传送数据速率选择的形式将信道质量信息返回到基站10，而不考虑实际信道估计。基站10中的传送链路适配控制电路38使用所报告的数据速率选择来调整用于向无线通信设备12发送业务的传送数据速率。

如果传播信道估计可靠，则无线通信设备12在第二模式下操作。在第二模式下，选择与无线通信设备12所测量的平均接收器输入信号质量最紧密对应的接收器性能数据中的SNR值，并且还选择与当前信道估计最紧密对应的接收器性能数据中的传播信道实现或约束范围的传播信道实现。无线通信设备12因此使用接收器性能数据来识别就所测量的接收器输入信号质量和相应的信道估计而言能够支持的数据速率，并且将所识别的数据速率选择报告给基站10。

在第一和第二模式这二者下，基站10接收数据速率选择形式的信道质量信息，并且基站10针对去往无线通信设备12的前向链路传输而执行相应的传送数据速率调整。因而，是否在考虑到当前信道估计的情况下产生信道质量信息对于基站10而言可以是透明的。也就是说，从基站的角度看，链路适配可以透明地在第一和第二模式之间切换，而不需要明确的用信号通知（signaling）。然而，在一些实施例中，信道质量信息产生的模式可以被用信号通知或者以其他方式指示。例如，向基站10报告信道质量信息的速率可以根据信道质量信息是在第一还是在第二模式下产生而改变。

图10和图11图示了处理电路的实施例，所述处理电路可以被包含在无线通信设备12的基带控制器40中或者与之相关联，并且被用于实施在第一和第二模式下产生信道质量信息。特别地，图10图示了处理电路（一个或多个）40包括信道质量信息产生电路44，其在第一和第二模式下产生信道质量信息，例如速率选择数据。电路44可以被配置成提供对正被产生的信道质量信息的类型的指示，即，它可以指示它正在操作的模式。

处理电路（一个或多个）40还可以包括信道估计可靠性评估电路46和信道估计电路48，或者还可以与之相关联。信道估计可靠性评估电路46被配置成估计正由信道估计电路48产生的信道估计的可靠性，所述信道估计电路48根据接收到的信号和导频信息而产生瞬时传播信道估计。信道估计可靠性评估电路46尤其可以接收导频值和/或来自信道估计电路48的信道

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估计。可以根据可靠性评估电路46所输出的可靠性指示器输出来在第一和第二模式之间切换操作。

还注意到，信道质量信息产生电路44可以被配置成执行接收器输入信号质量测量，即E_T/N_O计算，或者另一个功能电路可以被包含以用于处理电路（一个或多个）40中的该用途。在该点上，应该理解的是处理电路（一个或多个）40的图示可以表示功能元件而不是实际电路元件。例如，处理电路（一个或多个）40可以包括基于微处理器的电路、FPGA、ASIC等中的全部或一部分。

继续对功能电路的描述，图11图示了在图10中描绘的信道质量信息产生电路44的一个实施例。能够很清楚看到，可靠性指示器驱动模式选择电路50，所述模式选择电路50选择源电路，所述源电路用于正被输出的信道质量信息。如果可靠性指示器指示信道估计不可靠，则模式选择电路50选择长期信道质量信息估计电路52作为源电路。长期信道质量信息估计电路52根据接收器输入信号质量的长期估计以及期望CDF概率通过使用接收器性能数据来选择所支持的数据速率。

相反地，如果可靠性指示器指示信道估计可靠，则模式选择电路50选择瞬时（短期的）信道质量信息估计电路54作为源电路。在一个实施例中，瞬时信道质量信息估计电路54根据接收器输入信号质量的长期估计以及信道估计通过使用接收器性能数据来选择所支持的数据速率。在另一个实施例中，通过计算接收器输出信号质量来产生瞬时信道质量信息。在这样的实施例中，在第一模式下通过使用接收器输入信号质量来确定信道质量信息，而在第二模式下通过使用接收器输出信号质量来确定信道质量信息。

无论如何，应该理解的是基站10能够被配置成基于无线通信设备反馈通道质量测量根据上述实施例中的任何一个来产生信道质量信息。例如，图12图示了可以被包含在基站10中的信道质量信息产生电路60和存储器62。存储器62存储一个或多个接收器类型的接收器性能数据，其中至少一个接收器性能数据集与在无线通信设备12中实施的接收器类型相匹配。

一般地说，在这样的实施例中，基站10包括一个或多个处理电路，所述一个或多个处理电路被配置成确定与无线通信设备12相对应的传送传播信道的信道质量信息。这种产生可以基于：在第一模式下，根据不依赖于无线通信设备12的信道估计的第一算法来产生信道质量信息，以及在第

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二模式下，根据依赖于信道估计的第二算法来产生信道质量信息。

在一个实施例中，在第一模式下，基站10至少接收无线通信设备12的接收器输入信号质量信息。如所描述的，第一算法可以包括将接收器输入信号质量映射到在传播信道实现的范围内能够以期望概率达到的数据速率。对于第二操作模式，基站10接收来自无线通信设备12的接收器输入信号质量信息和传播信道信息，例如量化的长期SNR值和量化的短期传播信道估计。

如果基站10存储了传播信道实现和SNR值的码本，则无线通信设备12只需返回与其测量相对应的码本索引。无论如何，第二算法可以包括将接收器输入信号质量映射到与传播信道估计相对应的就约束范围的传播信道实现而言或者就特定传播信道实现而言能够达到的数据速率。

因而，基站10能够被配置成在它接收到无线通信设备12的接收器输入信号质量信息而没有接收到相应信道估计的情况下选择在第一模式下操作。可替换地，无线通信设备12能够被配置成总是报告信道估计和信号质量，并且基站10能够被配置成根据对信道估计可靠性的评估来选择在第一或第二模式下操作。在至少一个实施例中，基站10根据确定无线通信设备12是否在快衰落条件下操作来选择模式。如果无线通信设备12在快衰落条件下操作，则基站10在第一模式下操作。如果无线通信设备12不在快衰落条件下操作，则基站10在第二模式下操作。当然，应该理解的是，可以针对基站10所支持的多个无线通信设备中的单独设备而独立地管理第一和第二操作模式。

此外，更一般地，应该理解的是如在此所描述的一个或多个实施例中所讲授的信道质量信息产生使用接收器性能数据基于对接收器性能数据的使用来确定信道质量信息度量，例如所支持的数据速率。接收器性能数据针对多个量化的接收器输入信号质量中的每一个来表征就传播信道实现而言所支持的数据速率。在第一操作模式下，在传播信道条件（例如所有假设的传播信道实现）的范围内能够以期望概率达到的数据速率被选择以用于与无线通信设备12所获得的测量相对应的接收器输入信号质量值。因而，不是在考虑到在无线通信设备12处占优势的瞬时信道条件的情况下设置数据速率，而是在考虑到长期信道条件的情况下以一定概率设置数据速率。因而，每当不能获得可靠的信道估计时就能够选择第一操作模式。

在其中可获得可靠的信道估计的第二操作模式下，通过使用与在无线

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通信设备12处获得的测量相对应的传播信道实现和接收器输入信号质量来选择数据速率。换言之，当短期传播信道条件的估计可靠时考虑那些条件。在这点上，在使用或不使用当前传播信道估计的情况下相同的接收器性能数据能够被用于产生信道质量信息度量。因而，便于修改传送链路适配以在慢速链路适配（即第一操作模式）和快速链路适配（即第二操作模式）之间进行切换。

当然，本发明不限于以上论述，并且其也不受附图的限制。事实上，本发明仅由以下权利要求以及它们的法定等同物来限定。

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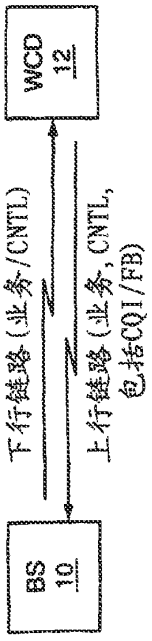


图 1

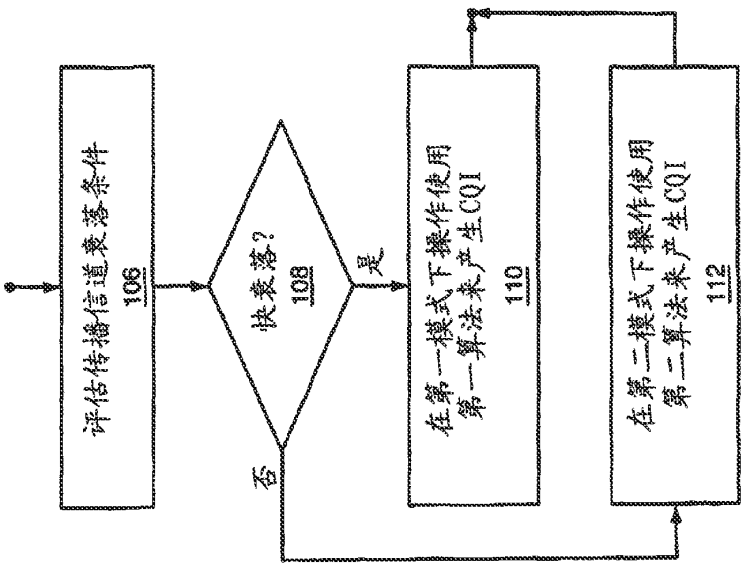


图 3

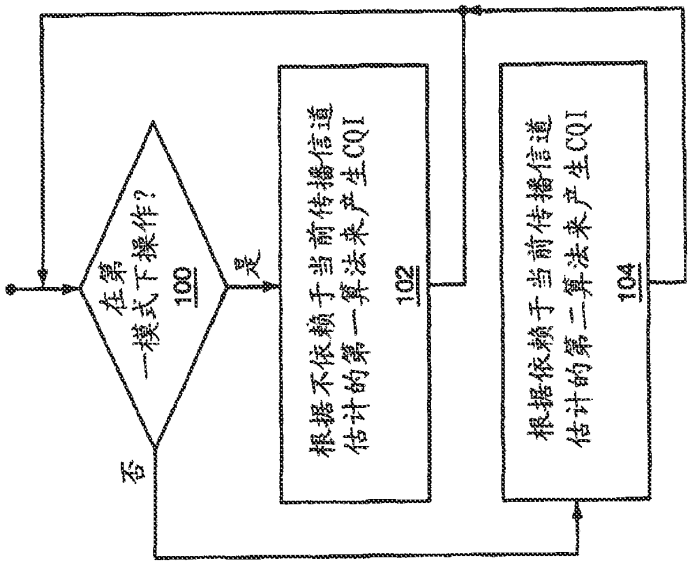


图 2

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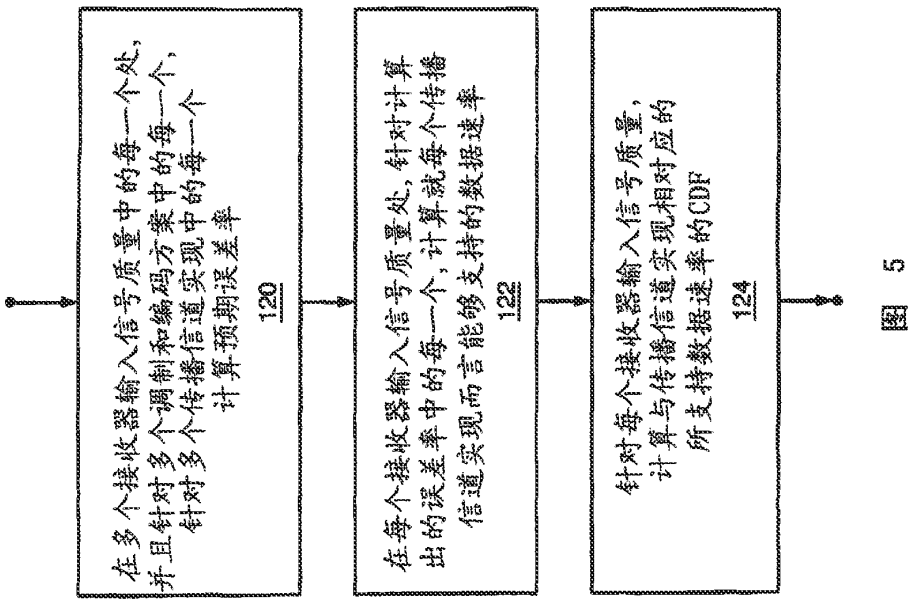


图 5

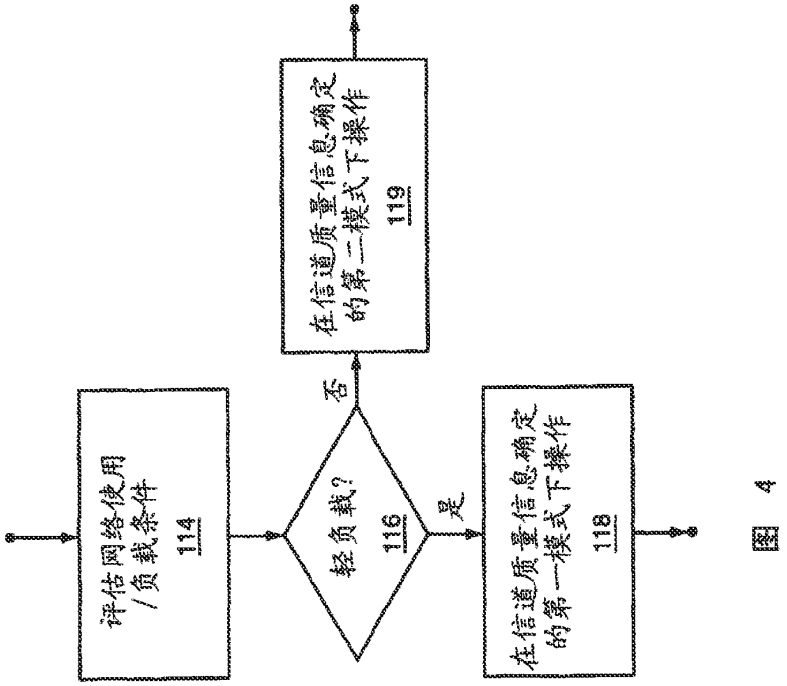


图 4

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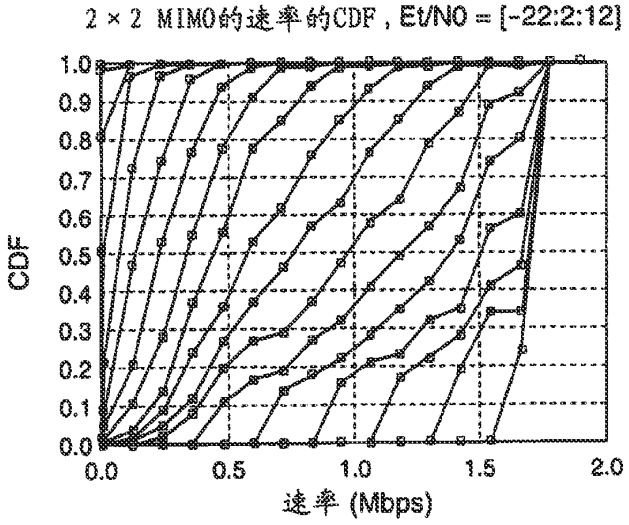


图 6

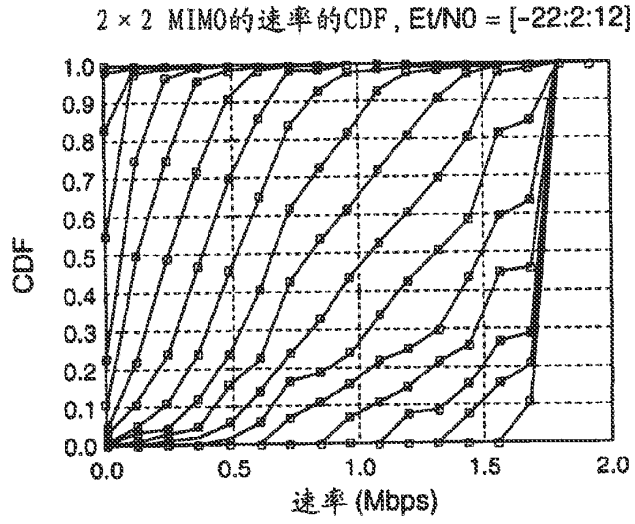


图 7

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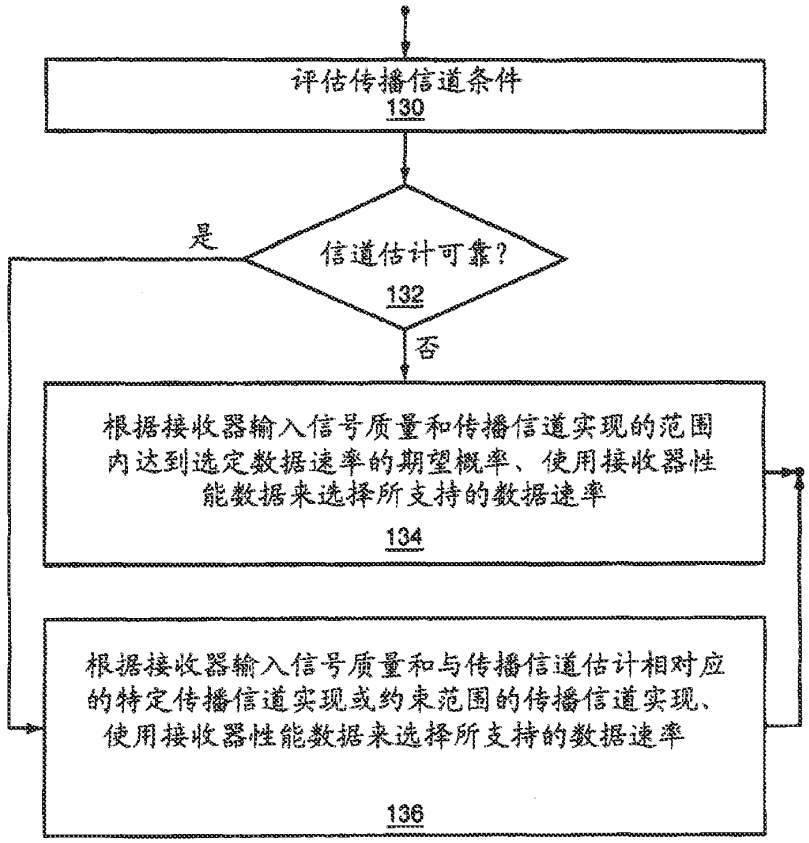


图 8

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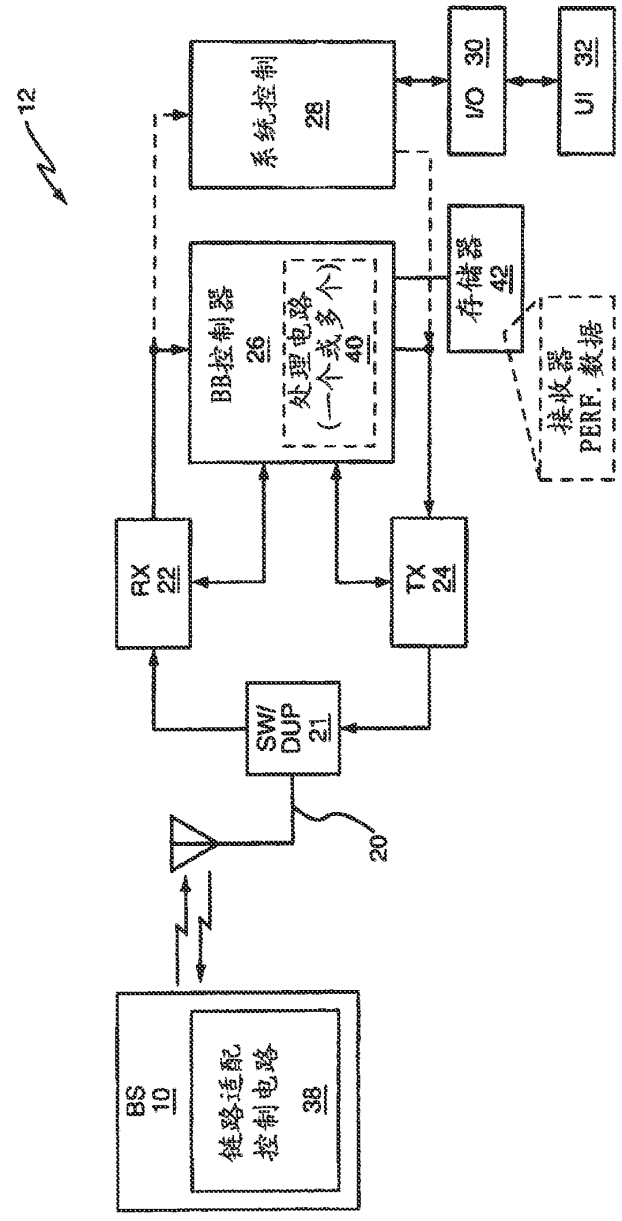


图 9

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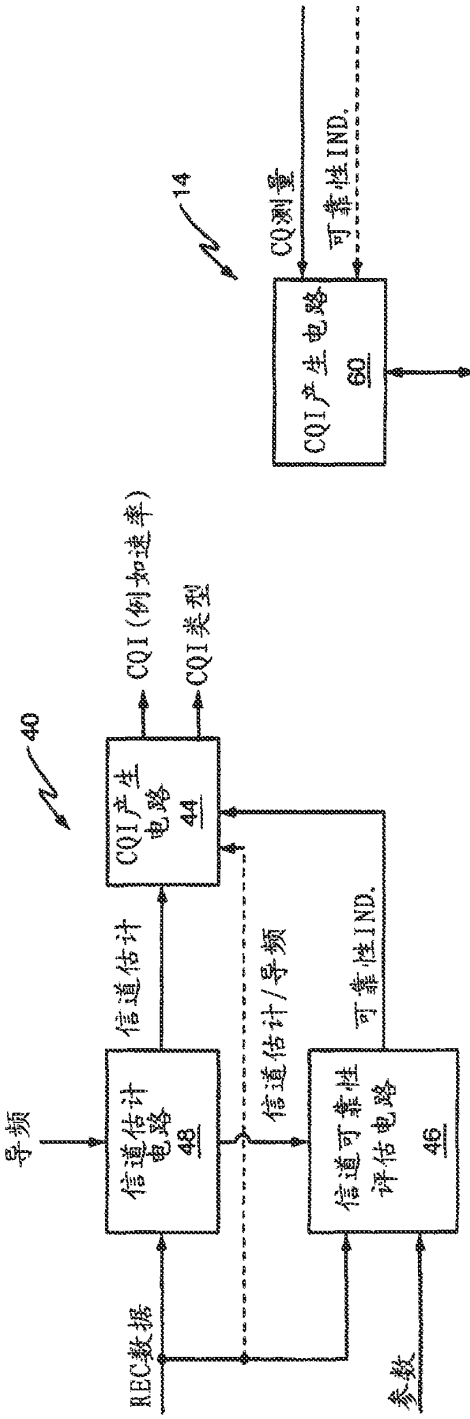


图 10

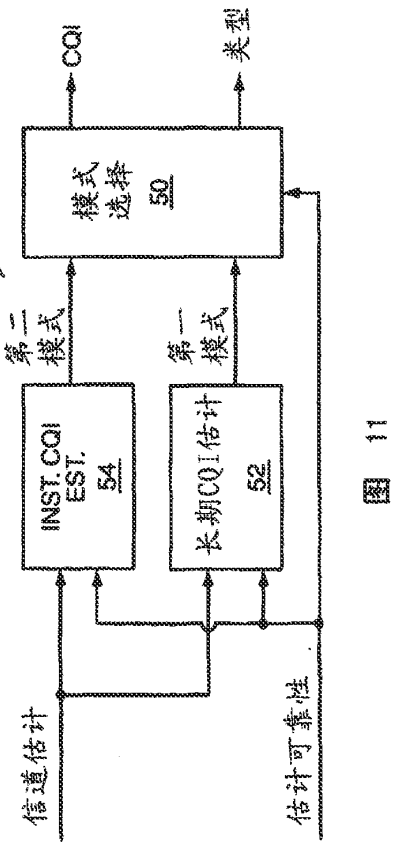


图 11

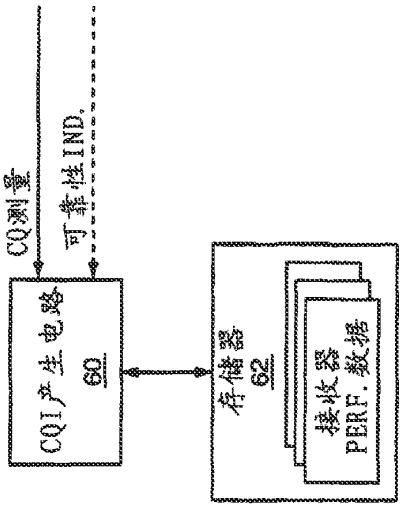


图 12

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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
29 November 2007 (29.11.2007)

PCT

(10) International Publication Number
WO 2007/136337 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/SE2007/050216

(22) International Filing Date: 4 April 2007 (04.04.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/438,921 23 May 2006 (23.05.2006) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, 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, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, 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, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

---- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

---- *without international search report and to be republished upon receipt of that report*

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(54) Title: METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

(57) Abstract: A method and apparatus for generating channel quality information, such as may be used for transmit link adaptation, provide different operating modes, such as a first mode that may be used when propagation channel estimates are not reliable, and a second mode that may be used when the propagation channel estimates are reliable. In one or more embodiments, channel quality information is generated using receiver performance informatio that characterizes receiver performance in terms of a defined channel quality metric, e.g., supported data rates, for different values of receiver input signal quality over a range of propagation channel realizations. Channel quality information can be generated by selecting channel quality metrics according to receiver input signal quality and a desired probability of meeting a defined performance requirement over a range of propagation channel realizations, or by selecting channel quality metrics according to receiver input signal quality and particularized propagation channel realizations.

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METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

BACKGROUND

The present invention generally relates to generating wireless communications, and particularly relates to generating channel quality information.

Channel quality information can be expressed in a number of ways, such as a channel quality indicator identifying the effective signal quality of a wireless communication receiver. The effective signal quality represents the benefits of any interference cancellation gains, diversity combining gains, coding gains, etc., that may be provided by the receiver. In other words, the output signal quality of a given receiver may be significantly better than the receiver's input signal quality, which generally is expressed as the "raw," uncompensated ratio of received signal energy to background noise and interference.

Those skilled in the wireless communications art will appreciate the value of generating channel quality information based on the output signal quality rather than the input signal quality, because the output signal quality better represents the actual signal quality bearing on the quality of demodulation and decoding performance. That is, assuming that the channel quality information is used for link adaptation, e.g., picking the modulation and coding scheme (MCS) that is appropriate for transmitting to the receiver, using input signal quality rather than output signal quality would result in chronically underutilizing the transmission link.

Accurately determining output signal quality as part of ongoing receiver operations is not, however, a straightforward proposition for some types of receivers. In particular, non-linear receivers generally have a complex relationship between input signal quality and output signal quality. Examples of non-linear receivers include multi-stage receivers employing successive interference cancellation, and joint-detection receivers.

Further, even assuming the calculability of output signal quality, such calculations may be inaccurate under some circumstances. For example, the performance achievable by a given receiver depends on a number of variables, including propagation channel conditions. Some channel conditions translate into better receiver performance than others. Thus, even for the same receiver input signal, the receiver output signal quality will vary as a function of changing channel conditions. If channel conditions are changing rapidly, or the input signal is too weak to make reliable channel estimates, reporting output signal quality, or some metric relating to output signal quality, may lead to control errors.

For example, a supporting base station may perform transmit link adaptation responsive to receiving channel quality information from a wireless communication device, that identifies the quality of the channel in terms of some metric, such as a channel quality indicator, a rate selection indicator, or the like. Thus, the base station can adjust the transmit data rate, for example, in accordance with the channel quality indicators reported by the device. This control

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mechanism works well if the actual channel conditions change slowly in comparison to the link adaptation control lag. However, performing link adaptation in consideration of actual propagation channel conditions becomes unreliable if those conditions change rapidly in comparison to the link adaptation control timing.

SUMMARY

According to one or more method and apparatus embodiments taught herein, different modes of operation are used for determining channel quality information for a wireless communication device, depending on, for example, the reliability of propagation channel estimates for the wireless communication device. For example, in one embodiment, channel quality information is determined in a first mode by mapping receiver input signal quality to a data rate that can be supported at a desired probability over a range of propagation channel realizations. A supported data rate may be defined as an allowable data rate that can be achieved with a desired performance requirement, e.g., Block Error Rate (BLER). Further, in the second mode, the channel quality information is determined by mapping receiver input signal quality to a data rate that can be supported for a particular propagation channel realization, or that can be supported for a constrained range of propagation channel conditions, corresponding to the current channel estimates obtained by the wireless communication device.

Thus, the first mode provides for generating channel quality information as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable, such as where the time lag associated with transmit link adaptation is large compared to the coherent time of propagation channel fading. Conversely, the second mode provides for generating channel quality information as a function of short-term propagation channel conditions when short-term propagation channel estimates are reliable. Modal operation can be driven by determining whether the channel estimates being generated by the wireless communication device are reliable. Reliability may be determined by evaluating the mobility—e.g., rate of movement, Doppler frequency, etc.—of the wireless communication device, or by evaluating the channel estimates.

With the above in mind, in one embodiment, a method of determining channel quality information for a transmit propagation channel associated with a wireless communication device comprises in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. Receiver performance data characterizing receiver performance for a type of receiver associated with the wireless communication device may be used to generate the channel quality feedback in the first and second modes, and such generation may be performed by the wireless communication device itself, or by a base station in a supporting wireless communication network.

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For example, a wireless communication device or a base station may comprise one or more processing circuits configured to determine channel quality information for one or more signals received by the wireless communication device, based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. The processing circuit(s) are, in one or more embodiments, configured to operate selectively in the first or second mode based on whether the channel estimates are reliable.

Complementing the above method of channel quality information generation, one embodiment of a receiver performance characterization method comprises, at each of a number of receiver input signal qualities, computing an error rate expected for each of a number of propagation channel realizations, and, for each of the error rates computed, computing a data rate that can be supported for each propagation channel realization at each receiver input signal quality, and, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations. Such performance characterization data may be stored by the wireless communication device, or by the supporting wireless communication network. Generally, the performance characterization data is specific for a receiver type, and different data can be stored for different receiver types. For example, a particular type of Generalized RAKE (G-RAKE) or other Minimum Mean Squared Error (MMSE) receiver would have different characterization data than would a particular type of Joint Detection (JD) receiver. Similarly, different performance characterization data can be stored for different transmit/reception modes (MISO, MIMO, etc.), even for the same receiver type.

A corresponding method of providing rate adaptation feedback from a wireless communication device to a supporting wireless communication network operates in a first mode by selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements obtained by the wireless communication device, and a desired probability of achieving the selected data rate for a range of propagation channel realizations. In the second mode, the channel quality information is generated using the receiver performance data by selecting a supported data rate according to receiver input signal quality and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to channel estimates obtained by the wireless communication device.

Of course, the present invention is not limited to the above features and advantages. Indeed, those skilled in the art will recognize additional features and advantages upon reading the following detailed description, and upon viewing the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a base station and a wireless communication device, such as a mobile station, wherein channel quality information is generated according to one or more method embodiments taught herein.

Fig. 2 is a logic flow diagram for one embodiment of processing logic for modal generation of channel quality information.

Fig. 3 is a logic flow diagram for one embodiment of selecting operating modes in the context of Fig. 2.

Fig. 4 is a logic flow diagram for another embodiment of selecting operating modes in the context of Fig. 2.

Fig. 5 is a logic flow diagram for one embodiment of a receiver performance characterization method.

Figs. 6 and 7 are graphs depicting receiver performance characterizations obtained by the receiver performance characterization method of Fig. 5, for different types of wireless communication device receivers.

Fig. 8 is a logic flow diagram for one embodiment of modally generating channel quality information using receiver performance data.

Fig. 9 is a block diagram for one embodiment of a wireless communication device that is configured to generate channel quality information.

Figs. 10 and 11 are block diagrams of embodiments of processing circuits used in generating channel quality information.

Fig. 12 is a block diagram of one embodiment of a base station that is configured to generate channel quality information based on receiving channel quality measurements for the wireless communication device.

DETAILED DESCRIPTION

Fig. 1 illustrates a base station 10 and a wireless communication device 12, wherein the channel quality information generated for the downlink between the base station 10 and the wireless communication device 12 is, in a first mode of operation, not dependent on current propagation channel estimates, and, in a second mode, is dependent on current propagation channel estimates. Thus, the first mode of generating channel quality information may be used where estimates of the downlink propagation channel are not reliable, such as when the wireless communication device 12 is moving at a high rate relative to the base station 10, or is otherwise experiencing fast fading conditions, or when the received signal strength is too low for reliable channel estimation.

Before describing various embodiments of the above method of generating channel quality information, it should be understood that the processing logic associated with generating the channel quality information can be performed wholly in the wireless communication

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device 12, wholly in the base station 10, or performed cooperatively using both the base station 10 and the wireless communication device 12. In all such cases, the attendant processing may be implemented in hardware, software, or any combination thereof. Moreover, it should be understood that the base station 10 and the wireless communication device 12 are not limited to any particular configuration, nor are they limited to any particular wireless communications standards or protocols.

For example, in one or more embodiments, the wireless communication device 12 comprises a cellular radiotelephone or other type of mobile station, configured for operation with a supporting wireless communication network that includes the base station 10. In such embodiments, the base station 10 may comprise a Wideband CDMA (WCDMA) base station configured to provide High Speed Downlink Packet Access (HSDPA) services.

Correspondingly, the wireless communication device 12 may comprise a WCDMA-based access terminal configured to provide channel quality information, or related feedback, to the base station 10, in support of adapting downlink transmit data rates to changing reception conditions at the wireless communication device 12. In general, however, the wireless communication device 12 may comprise a mobile station or other type of handset, a pager, a Portable Digital Assistant (PDA), a palmtop or laptop computer, or a wireless communication module for use therein, or essentially any other type of communication device.

Keeping the method's broad applicability in mind, Fig. 2 illustrates one embodiment of a method of generating channel quality information, wherein it should be understood that at least some of the illustrated processing steps may be performed in other than the illustrated order. Further, although illustrated as serial processing, actual implementation of the method may involve concurrent, parallel processing, as part of ongoing communication operations. Also, it should be understood that the illustrated processing may be implemented in the base station 10, the wireless communication device 12, or in some combination thereof.

Processing "begins" with a determination of whether to operate in a first mode of generating channel quality information (Step 100). If the first mode is selected, processing continues with generating channel quality information according to a first algorithm that does not depend on channel estimates (Step 102). Conversely, if the first mode is not selected, i.e., the second mode of operation is selected, processing continues with generating channel quality information according to a second algorithm that depends on channel estimates (Step 104).

In at least one embodiment taught herein, the first mode of generating channel quality information is used during fast fading conditions, or whenever conditions are such that the short-term channel estimates obtained by the wireless communication device 12 are "unreliable." The second mode of generating channel quality information is used during slow fading conditions, or, more generally, whenever the channel estimates are reliable. In other words, channel quality information is generated as a function of long-term propagation channel characteristics when short-term estimates of the channel are not reliable. Conversely, channel

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quality information is generated as a function of the short-term propagation channel characteristics when the channel estimates are reliable.

It should be understood that various methods of assessing channel estimation reliability are contemplated herein, and it should be understood that conditions deemed to give rise to unreliable channel estimations in one application may not be considered as such in another application. For example, the reliability of a short-term channel estimate may be viewed in terms of fading speed versus link adaptation control lag. That is, channel estimates may be deemed more or less reliable in dependence on how quickly channel conditions change relative to the transmit link adaptations being made. In some embodiments, the link adaptation lag—i.e., the time between a reported channel quality metric and the corresponding transmit link adjustment—may be used to influence whether, or to what extent, short-term propagation channel conditions are considered in generating channel quality information.

With such variations in mind, Fig. 3 illustrates one embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating propagation channel fading conditions (Step 106). As will be detailed later herein, the evaluation may comprise assessing the reliability of the channel estimates to determine whether fast-fading conditions apply. In other embodiments, fast-fading may be recognized by evaluating mobility, such as by evaluating the Doppler frequency shift of transmissions on the downlink and/or uplink channels between the base station 10 and the wireless communication device 12. Of course, other indicators bearing on the reliability of short-term channel estimates may be used. For example, certain service areas may make channel estimates inherently suspect, such as radio sectors in downtown or urban areas.

If fast fading conditions apply (Step 108), channel quality generation operates in the first mode, wherein channel quality information is generated in a manner that is not dependent on channel estimates (Step 110). Conversely, if fast fading conditions do not apply, channel quality information is generated in a manner that is dependent on channel estimates (Step 112).

Fig. 4 illustrates another embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating the network usage or load conditions (Step 114). In a lightly loaded wireless network, the reliability of the channel estimates and the derived channel quality information can be compromised even if the propagation channel fading conditions change slowly or remain static. For example, because of bursty and fast varying of inter-cell interference that is characteristic of a lightly load network, the channel quality and hence the supportable data rate realized during actual transmission of the data can be rather different than what was measured prior to the transmission.

Thus, if the network is lightly loaded (Step 116), it can be advantageous to select the first mode of determining channel quality information (Step 118). Conversely, if the network is more heavily loaded, or the loading is otherwise more stable, channel quality information can be

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determined according to the second mode of operation (Step 119). The selection of which operating mode to use for channel quality information determination can be evaluated and/or applied to individual wireless communication devices 12, or can be applied to sets or subsets of wireless communication devices 12, within a given sector or cell of the network. For example, the first mode may be used for some wireless communication devices 12, while the second mode may be used for others. The determination of which mode to use may be set according to the service needs of individual wireless communication devices 12, for example.

Note that this modal selection can be implemented in ways that are non-transparent or transparent to the wireless communication devices 12. In one embodiment, a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode. Alternatively, based on the network load conditions, the base station 10 can receive information supporting the second mode of operation, but can choose to ignore all or some of that information, in favor of operating in the first mode. In other words, the base station 10 may choose not to use all of the feedback that it receives.

In some circumstances, the radio resource cost required to support operation in the second mode is higher than that for operation in the first mode. For instance, to support operation in the second mode, feedback generally has to been sent by the wireless communication devices 12 more frequently than is required for operation in the first mode, to reflect changing propagation channel conditions. The amount of feedback also could be larger to describe the propagation channel conditions in sufficient detail for operation in the second mode. The strain on the feedback channel is further exacerbated by the fact that a plurality of wireless communication devices 12 simultaneously transmits feedback information to the network. Thus, the first mode of operation may be preferred even when operation in the second mode is viable, simply based on propagation channel condition considerations.

In one or more embodiments, channel quality information determination considers the potentially higher radio resource costs on the feedback channel associated with operation in the second mode. More particularly, the second mode of operation can be reserved for contractually privileged devices or services. The privilege level of a given communication device 12 can be referenced from a database with the identification number of the device. Channel quality information can be determined according to operation in the second mode for devices with higher privilege. The contractual requirement of a service can also be a factor in considering the appropriate operation mode. For instance, for services with stringent delay or jitter requirements such as packet voice services, the quality of service can be more easily maintained if channel quality information is determined according to operation in the second mode.

Deciding whether to determine channel quality information according to the first or second modes of operation also may be adapted to transmission schemes that consist of

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separable components. Non-limiting examples of these types of transmission schemes include multi-carrier CDMA and orthogonal frequency division multiplexing (OFDM) transmission. To support operation in the second mode, the amount of feedback can scale directly with the number of separable components, e.g., four feedback values for four-carrier CDMA or eighty values for OFDM with eighty frequency resource units. For large packets or data units that would occupy entire or large portions of the components, the relative benefits of operating in the second mode instead of the first mode can be significantly smaller than for small packets or data units that would occupy small portions of the components. To conserve radio resources, it is therefore advantageous to include packet or data unit lengths as a factor in operating mode selection.

Such operation is, in one or more embodiments, supported by the use of receiver performance data that characterizes the performance of the wireless communication device's receiver type over a range of propagation channel conditions, such that the performance data indicates the expected performance of the receiver over a range of propagation channel conditions, and for particularized propagation channel conditions. Determining channel propagation conditions for channel quality information determination—e.g., for supportable rate computation—may be required for operation in the first and/or second modes of operation. For the first operating mode, long-term channel propagation conditions are determined and, in one or more embodiments, the propagation channel conditions include one or more of the following quantities: a characterization of the fading speed of the channel (for example, based on the estimated Doppler frequency, known mobile speed, rate of negative acknowledgements - i.e. NACK rate, ...); and an estimate of the power delay profile (PDP) of the propagation channel associated with the wireless communication device 12, assuming that the PDP does not change quickly over time.

In one or more embodiments, the estimation of long-term propagation channel conditions is used for any one or more of the following processing actions: construction of a CDF of the achievable (supportable) data rates; selection of an achievable data rate curve CDF from a table of CDF curves that most closely matches the estimated long-term propagation channel conditions. Thus, it should be understood that in one or more embodiments, CDF curves may be predefined. In such embodiments, the received signal quality and/or long-term characterization of the propagation channel associated with the wireless communication device 12 can be used to select a point or range along a predefined CDF curve to identify channel quality information for the wireless communication device 12—e.g., to identify an achievable data rate. In one or more other embodiments, the long-term propagation channel conditions as estimated are used to partially or wholly construct one or more CDF curves, which can then be used to identify achievable data rates, for example, as a function of measured signal quality at the wireless communication device 12.

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In more detail, for purposes of CDF curve construction, the PDP is considered a known quantity, and estimates of the delay tap (channel) coefficient values can be generated and used to further determine the propagation channel realization for the given PDP. At least one embodiment estimates propagation channel coefficients based on pilot or other measurements, to support characterization of long-term propagation channel conditions. It should be understood that traditional techniques for propagation channel estimation may be used as needed or desired. Note that the estimation of channel coefficients represents a longer-term estimate, rather than the short-term (instantaneous) estimates that are generally used in the second mode of operation.

In any case, it should be understood that, however they are constructed, the CDF curves characterize the (expected) performance of a particular receiver type, or types. Fig. 5 illustrates one method of characterizing receiver performance based on CDF curves, but it should be understood that other methodology may be used to characterize receiver performance for long-term and short-term propagation channel conditions.

In more detail, Fig. 5 illustrates an embodiment of a receiver performance characterization method that may be performed using empirical testing, software simulation, dynamic measurements, or any combination thereof. Because different receiver types offer different levels of performance, such characterization is done for the particular receiver type associated with the wireless communication device 12. (If the channel quality information is generated by the wireless communication device 12, the receiver performance data can be stored in the wireless communication device 12. If the channel quality information is generated in the base station 10, the base station 10 may store characterization data for different types of receivers, and use the appropriate sets of receiver performance data for different wireless communication devices.)

In any case, processing begins by computing an expected error rate for each one in a number of receiver input signal quality values, for each one in a number of modulation and coding schemes, and for each one in a number of propagation channel realizations (Step 120). Error rate may be expressed, for example, as Bit Error Rate (BER), Block Error Rate (BLER), Frame Error Rate (FER), etc., and the particular manner in which error rate is expressed may be based on the type of data transmissions involved.

As used herein, unless otherwise noted, the term "receiver input signal quality" denotes the ratio of total received signal energy per chip, E_T, over the noise plus interference, N_0. Measurements of receiver input signal quality represent the "raw" input signal quality for the receiver embodied within the wireless communication device 12, and does not depend on the receiver's interference suppression and signal gain performance, and thus does not depend on the accuracy of short-term propagation channel estimates. Moreover, receiver input signal quality measurements are the same for simple and complex receiver structures, e.g., the same whether the device's receiver is a simple linear receiver, or a complex non-linear receiver.

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Further, as used herein, the term "propagation channel realization" represents a particular combination of propagation channel tap weights. For example, a plurality of three-tap characterizations of the propagation channel comprises different combinations of three complex tap coefficients, corresponding to different propagation channel conditions. The different propagation channel realizations may be based on a fixed Power Delay Profile (PDP). Alternatively, a given fast fading realization may be used for different PDPs, and different CDFs may be used for the different PDPs.

In any case, each propagation channel realization may be understood as representing a particular hypothesis of actual propagation channel conditions for the transmit link between the base station 10 and the wireless communication device 12. For the same input signal quality, the wireless communication device 12 will exhibit different output signal quality for different channel realizations.

For each receiver input signal quality and each modulation and coding scheme, receiver performance characterization processing continues by, for each of the error rates computed, computing the data rate (R) that can be achieved (supported) for each propagation channel realization (Step 122). The achievable data rate, also referred to as the supported data rate, represents the data rate (R) that can be used for transmitting to the wireless communication device 12 while still meeting a defined performance requirement, e.g., a BLER target. For example, if the computed error rate is less than the target BLER, i.e., BLER < BLER(target), the data rate (R_{mcs}) corresponding the modulation and coding scheme can be the supported data rate ($R = R_{mcs}$), otherwise the supported data rate can be zero ($R = 0$). If ARQ is used, then the supported data rate (R) can be calculated as $R = R_{mcs}(1\text{-BLER})$, where R_{mcs} is the data rate corresponding the modulation and coding scheme and BLER is the computed error rate. If HARQ is used, then the supported data rate can be calculated as $R_{mcs}/(1+\text{BLER})$.

Processing continues by, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations (Step 124). Note that the generation of CDF curves can be a one-time process, or can be wholly or partially a dynamic process. For example, as was noted earlier, ongoing estimation of one or more parameters bearing on the longer-term propagation channel conditions for the wireless communication device 12. Again, such parameters can include, but are not limited to, any one or more of the PDP, estimated channel coefficients, current data service type and/or data characteristics such as packet size, mobility/rate-of-travel estimates, etc.

Fig. 6 graphically depicts receiver performance data generated according to the method of Fig. 5 for a Minimum Mean Square Error (MMSE) receiver type. More particularly, Fig. 6 graphs receiver input signal quality (SNR) curves stepped from -22 dB to +12 dB in 2 dB increments over defined data rate points, according to the CDFs of the supported data rates for the hypothesized set of propagation channel realizations. The leftmost curve corresponds to

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input SNR of -22 dB, whereas the rightmost curve corresponds to input SNR of +12 dB. Fig. 7 depicts similar performance characterization data for a Joint Detection (JD) receiver architecture, and it should be understood that the particular receiver performance data used for the wireless communication device 12 would be matched to its particular receiver type. (Further, because some types of receivers have different reception modes that yield different performance characteristics, different receiver performance data can be used in each such mode.)

In determining channel quality information using the performance curves of Fig. 6, for example, consider the case of higher rates of travel, where the channel fading conditions become more temporally uncorrelated between the measurement time at which propagation channel conditions are estimated, and the transmit time at which transmit link adaptations based on those channel estimates are performed. If the channel conditions are changing more rapidly than link adaptation control can keep up with, link adaptation—e.g., transmit data rate selection—should be based on the statistical propagation characteristics determined by the path gain and shadowing, rather than based on the channel estimates.

Given signal quality measured by the wireless communication device 12, the transmit data rate can be selected from the corresponding signal quality curve in the receiver performance data, according to a desired CDF level. For example, choosing the tenth percentile for the appropriate SNR curve corresponds to the data rate achievable for ninety-percent of the hypothesized propagation channel realizations. The particular value to choose generally depends on the particular performance requirements of the system, such as determined by a defined performance requirement, like maximum tolerable BLER. In one or more embodiments, the signal quality represents a long-term signal quality—average input SNR—as measured by the wireless communication device, or as averaged by the network. In other embodiments, such as where channel estimates are reliable, the instantaneous or short-term receiver input signal quality may be used.

In either case, the above approach effectively quantizes the rate values in the performance characterization graph to the rates represented by quantized input signal quality measurements, which is sufficient for slow link adaptation in a rapidly varying channel. That is, for fast fading conditions, the channel quality information may be generated as data rate selections based on selecting an SNR curve from the graph corresponding to long-term measured signal quality at the wireless communication device 12, and then identifying the data rate that is achievable at a desired probability for the defined performance requirement, e.g., for a defined BLER limit. Effectively, the method amounts to generating channel quality information as a function of long-term propagation channel characteristics based on mapping a receiver input signal quality measurement to a data rate selection that is achievable at a desired probability over a range of short-term propagation channel characteristics.

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As the channel becomes more reliable, for example, when vehicle speeds become slower or actual input SNR at the receiver becomes larger due to improved path gain, the channel quality information generation process can be transitioned to a mode where more refined information is generated, i.e., a mode where the short-term propagation channel conditions prevailing at the wireless communication device 12 are explicitly considered. The same performance characterization data that was used for slow adaptation during fast fading may be used for fast adaptation during slow fading. In other words, the same receiver performance curves can be used for slow and fast link adaptation in a hierarchical manner. That is, channel quality metrics can be used to characterize the long-term properties of the channel, which can then be characterized further for fast link adaptation when the channel becomes more reliable.

One method for accomplishing the above operation is to quantize the channel state values for each input signal quality (SNR) and store the quantized values in a codebook. For specific input SNR and channel estimates obtained at the wireless communication device 12, the quantized values can be looked up in the codebook, and the corresponding data rate selected for channel quality information reporting.

Fig. 8 illustrates one embodiment of hierarchical channel quality information generation, wherein the channel quality information is generated in terms of data rate reports. Such processing may be performed at the wireless communication device 12, at the base station 10, or cooperatively. In any case, processing begins with evaluation of the propagation channel conditions (Step 130). Evaluation may comprise evaluating short-term propagation channel estimates being generated by the wireless communication device 12 as a means of determining whether the estimates are reliable, or may comprise checking Doppler shifts, etc.

If the channel estimates are not reliable (Step 132), a supported data rate is selected using receiver performance data, such as illustrated in Figs. 6 and 7. More particularly, if the channel estimates are not reliable, the measured receiver input signal quality can be mapped to one of the quantized SNR curves, and a corresponding supported data rate can be identified according to the desired probability of achieving that rate over the range of propagation channel realizations used to generate the performance data (Step 134). A tenth percentile selection means that ninety-percent of the hypothesized propagation channel realizations will support the selected data rate at the desired error rate performance.

As such, if the channel estimates are not reliable, the transmit data rate is selected probabilistically, rather than based on any specific consideration of the short-term propagation channel conditions existent at the wireless communication device 12. Further, in cases where the channel estimates are not reliable, the receiver input signal quality used to select the appropriate quantized SNR curve may be a long-term (average) receiver input signal quality. Averaging may be done at the wireless communication device 12, or instantaneous values reported by the wireless communication device 12 may be averaged by the network.

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On the other hand, if the channel estimates are reliable (Step 132), the measured receiver input signal quality may represent a shorter term, e.g., instantaneous, measurement. Of course, averaged values may still be used. In either case, with the availability of reliable channel estimates, the receiver input signal quality can be mapped to one of the quantized SNR curves and a particular propagation channel realization, or a constrained range of propagation channel realizations, corresponding to the channel estimates (Step 136). In one variation of this approach, different SNR/CDF curves can be stored for long-term and short-term SNR measurements, with the different SNR curves reflecting different probabilistic characteristics. Then, in operation, the set of curves to be used is selected depending on whether long-term or short-term SNR values are being used, which may switch as a function of channel estimate reliability.

This hierarchical approach to channel quality information generation can be implemented in the wireless communication device 12, such as by including appropriately configured processing circuits in the device 12, along with storing appropriate receiver performance data. Fig. 9 illustrates one embodiment of the wireless communication device 12, configured for carrying out a method of channel quality information generation using receiver performance data. The illustrated embodiment comprises a receive/transmit antenna 20, a switch/duplexer 21, a receiver front-end 22, a transmitter 24, a baseband (BB) controller 26, a system controller 28, input/output (I/O) interface circuits 30, and a user interface (UI) 32.

Of particular interest regarding channel quality information generation, the baseband controller 26 includes one or more processing circuits 40, which are configured for channel quality information generation, and which have access, direct or indirect, to a memory 42 storing receiver performance data. The stored data may comprise a data structure representing quantized SNR curves and corresponding CDFs of supported rates for a plurality of propagation channel realizations, e.g., a set of 1000 channel realizations, such as illustrated in Fig. 6 or 7. However, at least some of the performance data may be obtained using curve-fitting calculations—e.g., polynomials—and it should be understood that various methods of storing and representing receiver performance data are contemplated herein.

In operation according to one embodiment, the wireless communication device 12 maintains a long-term estimate of receiver input signal quality—average SNR—and further maintains short-term (instantaneous) propagation channel estimates. If the propagation channel estimates are not reliable, the wireless communication device 12 operates in a first mode of channel quality information generation. In the first mode, the wireless communication device 12 maps measured, average receiver input signal quality to the closest corresponding receiver input signal quality represented in the receiver performance data, and then uses that SNR curve to identify the data rate that can be supported at a desired probability over a range of propagation channel realizations. As such, the wireless communication device 12 returns channel quality information to the base station 10 in the form of updated transmit data rate

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selections that are identified probabilistically, without regard to the actual channel estimates. A transmit link adaptation control circuit 38 in the base station 10 uses the reported data rate selections to adjust the transmit data rate used to send traffic to the wireless communication device 12.

If the propagation channel estimates are reliable, the wireless communication device 12 operates in a second mode. In the second mode, the wireless communication device 12 selects the SNR value in the receiver performance data most closely corresponding to the average receiver input signal quality as measured by the wireless communication device 12, and further selects a propagation channel realization, or a constrained range of propagation channel realizations, in the receiver performance data that most closely corresponds with current channel estimates. The wireless communication device 12 thus uses the receiver performance data to identify the data rates that can be supported for measured receiver input signal quality and corresponding channel estimates, and reports the identified data rate selections to the base station 10.

In both the first and second modes, the base station 10 receives channel quality information in the form of data rate selections, and the base station 10 performs corresponding transmit data rate adjustments for forward link transmissions to the wireless communication device 12. As such, whether the channel quality information is being generated in consideration of current channel estimates may be transparent to the base station 10. That is, from the base station's perspective, link adaptation may transparently shift between the first and second modes, without need for explicit signaling. In some embodiments, however, the mode of channel quality information generation may be signaled, or otherwise indicated. For example, the rate at which channel quality information is reported to the base station 10 may change in dependence on whether channel quality information is being generated in the first or second modes.

Figs. 10 and 11 illustrate embodiments of processing circuits that may be included in, or associated with, the baseband controller 40 of the wireless communication device 12, and used to implement generation of channel quality information in the first and second modes. Fig. 10, in particular, illustrates the processing circuit(s) 40 as comprising a channel quality information generation circuit 44, which generates channel quality information, e.g., rate selection data, in first and second modes. The circuit 44 may be configured to provide an indication of the type of channel quality information being generated, i.e., it may indicate the mode that it is operating in.

The processing circuit(s) 40 may further include, or may further be associated with, a channel estimate reliability evaluation circuit 46 and a channel estimation circuit 48. The channel estimate reliability evaluation circuit 46 is configured to estimate the reliability of the channel estimates being generated by the channel estimation circuit 48, which generates instantaneous propagation channel estimates based on the received signal and pilot information. The channel estimate reliability evaluation circuit 46 may receive, among other

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things, the channel estimates from the channel estimation circuit 48 and/or the pilot values. Operation may be switched between the first and second modes based on the reliability indicator output by the reliability evaluation circuit 46.

Note, too, that the channel quality information generation circuit 44 may be configured to perform the receiver input signal quality measurements, i.e., the E_T/N_o calculations, or another functional circuit may be included for that purpose in the processing circuit(s) 40. On that point, it should be understood that illustrations of the processing circuit(s) 40 may represent functional rather than physical circuit elements. For example, the processing circuit(s) 40 may comprise all or a portion of a microprocessor-based circuit, an FPGA, ASIC, etc.

Continuing with function circuit descriptions, Fig. 11 illustrates one embodiment of the channel quality information generation circuit 44 that is depicted in Fig. 10. One sees that the reliability indicator drives a mode select circuit 50, which selects the source circuit for the channel quality information being output. If the reliability indicator indicates that the channel estimates are not reliable, the mode select circuit 50 selects a long-term channel quality information estimation circuit 52 as the source circuit. The long-term channel quality information estimation circuit 52 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and desired CDF probabilities.

Conversely, if the reliability indicator indicates that the channel estimates are reliable, the mode select circuit 50 selects an instantaneous (short-term) channel quality information estimation circuit 54 as the source circuit. In one embodiment, the instantaneous channel quality information estimation circuit 54 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and the channel estimates. In another embodiment, instantaneous channel quality information is generated by calculating receiver output signal quality. In such embodiments, channel quality information is determined in the first mode using receiver input signal quality, and determined in the second mode using receiver output signal quality.

In any case, it should be understood that the base station 10 can be configured to generate channel quality information according to any of the above embodiments, based on the wireless communication device feeding back channel quality measurements. For example, Fig. 12 illustrates a channel quality information generation circuit 60 and a memory 62, which may be included in the base station 10. The memory 62 stores receiver performance data for one or more receiver types, with at least one set of receiver performance data matching the type of receiver implemented in the wireless communication device 12.

More generally, in such embodiments, the base station 10 comprises one or more processing circuits configured to determine channel quality information for a transmit propagation channel corresponding to the wireless communication device 12. Such generation may be based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates for the wireless communication device 12,

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and in a second mode, generating channel quality information according to a second algorithm that depends on the channel estimates.

In one embodiment, in the first mode, the base station 10 receives at least receiver input signal quality information for the wireless communication device 12. As described, the first algorithm may comprise mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations. For the second mode of operation, the base station 10 receives receiver input signal quality information and propagation channel information from the wireless communication device 12—e.g., quantized long-term SNR values and quantized short-term propagation channel estimates.

If the base station 10 stores code books of SNR values and propagation channel realizations, the wireless communication device 12 need only return code book indices corresponding to its measurements. In any case, the second algorithm may comprise mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

As such, the base station 10 can be configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device 12 without receiving corresponding channel estimates. Alternatively, the wireless communication device 12 can be configured always to report channel estimates and signal quality, and the base station 10 can be configured to select operation in the first or second modes based on evaluating the reliability of the channel estimates. In at least one embodiment, the base station 10 selects the mode based on determining whether the wireless communication device 12 is operating in fast fading conditions. If the wireless communication device 12 is operating in fast fading conditions, the base station 10 operates in the first mode. If the wireless communication device 12 is not operating in fast fading conditions, the base station 10 operates in the second mode. Of course, it should be understood that first and second modes of operation may be managed independently for individual ones in a plurality of wireless communication devices being supported by the base station 10.

Further, and more generally, it should be understood that channel quality information generation as taught in one or more embodiments described herein uses receiver performance data to determine channel quality information metrics, such as supported data rates, based on using receiver performance data. The receiver performance data characterizes supported data rates in terms of propagation channel realizations, for each in a plurality of quantized receiver input signal qualities. In a first mode of operation, the data rate that can be achieved at a desired probability over a range of propagation channel conditions, e.g., all hypothesized propagation channel realizations, are selected for the receiver input signal quality value that corresponds to measurements obtained by the wireless communication device 12. As such, the data rate is not set in consideration of the instantaneous channel conditions prevailing at the

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wireless communication device 12, but rather set probabilistically, in consideration of the long-term channel conditions. As such, the first mode of operation can be selected whenever reliable channel estimates are not available.

In a second mode of operation, where reliable channel estimates are available, data rates are selected using receiver input signal qualities and propagation channel realizations corresponding to measurements obtained at the wireless communication device 12. In other words, short-term propagation channel conditions are considered when the estimates of those conditions are reliable. In this regard, the same receiver performance data can be used to generate channel quality information metrics with or without using current propagation channel estimates. As such, it is convenient to modify transmit link adaptation to switch between slow link adaptation—i.e., the first mode of operation—and fast link adaptation—i.e., the second mode of operation.

Of course, the present invention is not limited by the foregoing discussion, nor is it limited by the accompanying drawings. Indeed, the present invention is limited only by the following claims, and their legal equivalents.

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CLAIMS

What is claimed is:

1. A method of determining channel quality information for a transmit propagation channel associated with a wireless communication device (12), the method characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

2. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode as a function of propagation channel fading conditions.

3. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode responsive to evaluating a reliability of propagation channel estimates made by the wireless communication device (12).

4. The method of claim 1, wherein generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

5. The method of claim 4, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

6. The method of claim 5, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

7. The method of claim 6, further characterized by generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

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8. The method of claim 7, wherein generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) comprises generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

9. The method of claim 1, wherein generating channel quality information according to a second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

10. The method of claim 1, wherein the wireless communication device (12) generates the channel quality information as feedback for transmit link adaptation.

11. The method of claim 1, wherein the wireless communication device (12) generates channel quality measurements and a base station (10) in a supporting wireless communication network generates the channel quality information based on receiving the channel quality measurements.

12. The method of claim 11, wherein the channel quality measurements for the first mode comprise at least receiver input signal quality measurements, and wherein the channel quality measurements for the second mode comprise receiver input signal quality measurements and corresponding propagation channel estimates.

13. The method of claim 1, further characterized by storing receiver performance data for use in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

14. The method of claim 13, wherein generating the channel quality information according to the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

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15. The method of claim 13, wherein generating the channel quality information according to the second algorithm comprises selecting a receiver input signal quality corresponding to receiver input signal quality measurements made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

16. The method of claim 1, further characterized by selectively operating in the first and second modes as a function of at least one of (a) packet lengths of data to be transmitted by the wireless communication device (12), (b) delay requirements associated with packet data to be transmitted by the wireless communication device (12), (c) delay requirements associated with a communication service active at the wireless communication device (12), (d) identification of the wireless communication device (12), and (e) network usage or congestion levels.

17. A wireless communication device (12) comprising one or more processing circuits (40) configured to determine channel quality information for one or more signals received by the wireless communication device (12), operation of said one or more processing circuits for determining the channel quality information characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

18. The wireless communication device (12) of claim 17, wherein the one or more processing circuits (40) comprise a channel quality information generation circuit (44) that is configured to generate the channel quality information by selectively operating in the first and second modes.

19. The wireless communication device (12) of claim 18, wherein the one or more processing circuits (40) include a reliability evaluation circuit (46) to generate a reliability indicator indicating whether propagation channel estimates being generated at the wireless communication device (12) are reliable, and wherein the channel quality information generation circuit (44) is configured to select the first mode of operation if the reliability indicator indicates that the propagation channel estimates are not reliable, and to select the second mode of operation if the reliability indicator indicates that the channel estimates are reliable.

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20. The wireless communication device (12) of claim 17, wherein one or more processing circuits (40) are configured to determine whether to operate in the first mode or in the second mode according to a reliability of propagation channel estimates made by the wireless communication device (12).

21. The wireless communication device (12) of claim 17, wherein the first algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

22. The wireless communication device (12) of claim 21, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

23. The wireless communication device (12) of claim 22, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

24. The wireless communication device (12) of claim 23, wherein the one or more processing circuits (40) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

25. The wireless communication device (12) of claim 24, wherein the one or more processing circuits (4) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

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26. The wireless communication device (12) of claim 17, wherein the second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

27. The wireless communication device (12) of claim 17, wherein the wireless communication device (12) includes memory (42) storing receiver performance data for use by the one or more processing circuits (40) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

28. The wireless communication device (12) of claim 27, wherein the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

29. The wireless communication device (12) of claim 27, wherein the second algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

30. A base station (10) comprising one or more processing circuits (60) configured to determine channel quality information for a transmit propagation channel corresponding to a wireless communication device (12) associated with the base station (10), based on:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates for the wireless communication device (12); and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates for the wireless communication device (12).

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31. The base station (10) of claim 30, wherein, in the first mode, the base station (10) receives at least receiver input signal quality information for the wireless communication device (12), and wherein the first algorithm comprises mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations.

32. The base station (10) of claim 31, wherein the base station (10) is configured to map a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

33. The base station (10) of claim 32, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

34. The base station (10) of claim 33, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

35. The base station (10) of claim 34, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

36. The base station (10) of claim 30, wherein, in the second mode, the base station (10) receives receiver input signal quality information and propagation channel estimates for the wireless communication device (12), and wherein the second algorithm comprises mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel

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realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

37. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device (12) without receiving corresponding propagation channel estimates for the wireless communication device (12).

38. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it determines that propagation channel estimates for the wireless communication device (12) are not reliable.

39. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if the wireless communication device (12) is operating in fast fading conditions, and is configured to select operation in the second mode if the wireless communication device (12) is not operating in fast fading conditions.

40. The base station (10) of claim 30, wherein the base station (10) includes memory (62) storing receiver performance data for use by the one or more processing circuits (60) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

41. The base station (10) of claim 40, wherein the first algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identify a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

42. The base station (10) of claim 40, wherein the second algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), select a propagation channel realization or a constrained range of propagation channel realizations, corresponding to propagation channel estimates made by the wireless communication device (12), and identify a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

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43. A method of characterizing receiver performance, said method characterized by:

for each of a number of receiver input signal qualities and each of a number of modulation and coding schemes, computing an error rate expected for each of a number of propagation channel realizations;

for each of said receiver input signal qualities and each of said modulation and coding schemes, computing a data rate that can be supported for each propagation channel realization; and

for each receiver input signal quality, computing the cumulative distribution function of the supported data rates corresponding to the propagation channel realizations.

44. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization.

45. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs}(1\text{-BLER})$.

46. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs}/(1\text{-BLER})$.

47. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)).

48. The method of claim 47, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)) comprises determining R as $R = R_{mcs}$ if $BLER < BLER(target)$, and otherwise determining R as $R = 0$.

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49. A method of providing rate adaptation feedback from a wireless communication device (12) to a supporting wireless communication network characterized by storing receiver performance data determined according to the method of characterizing receiver performance of claim 43, and, in a first mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a desired probability of achieving the selected data rate for a range of propagation channel realizations, and, in a second mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to propagation channel estimates for the wireless communication device (12).

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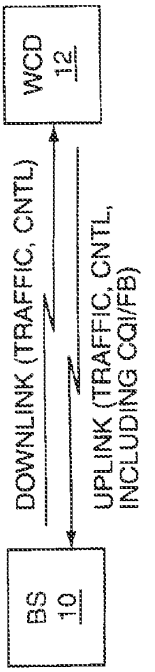


FIG. 1

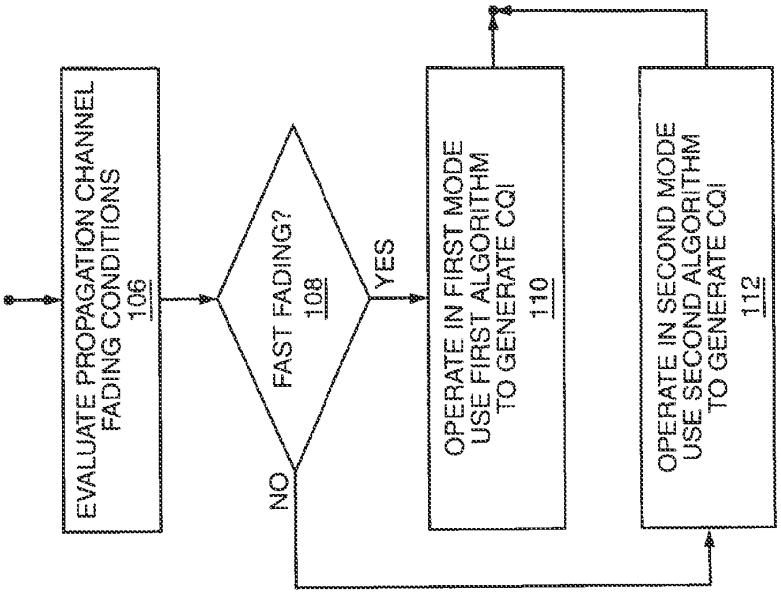


FIG. 3

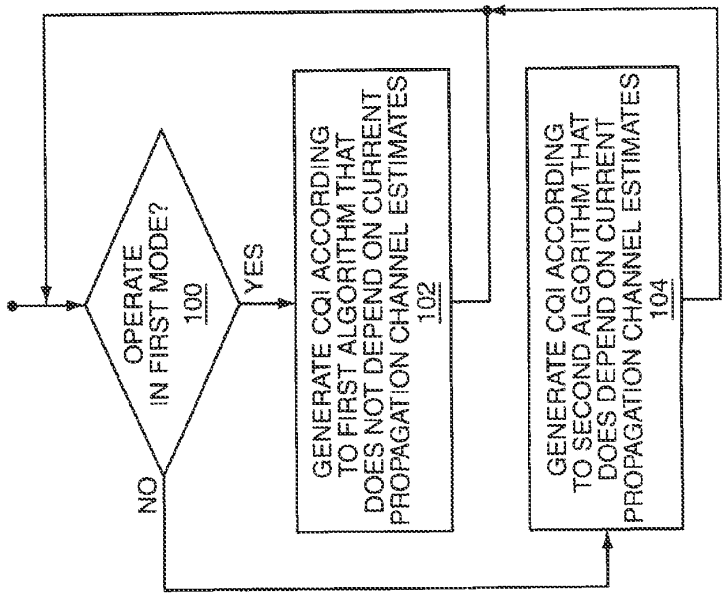


FIG. 2

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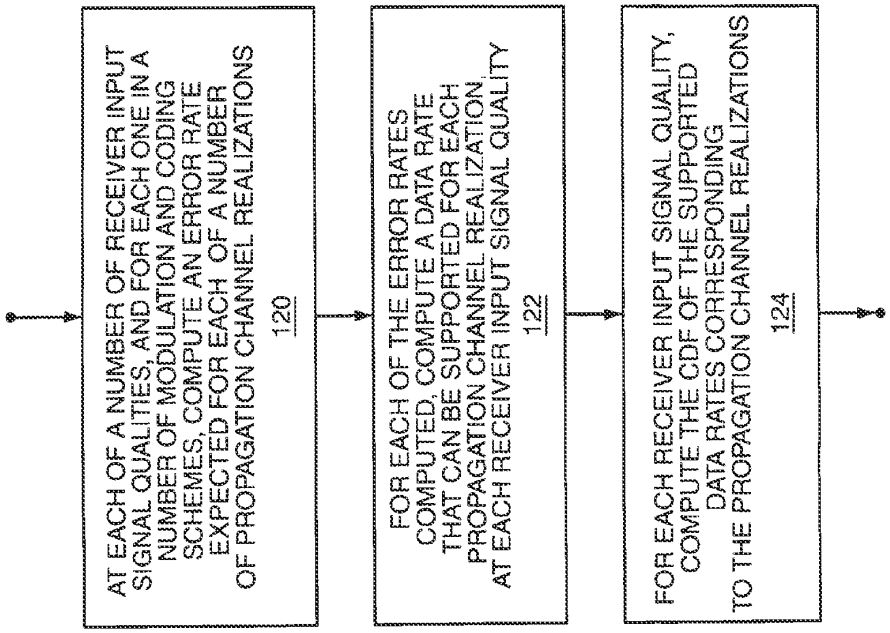


FIG. 5

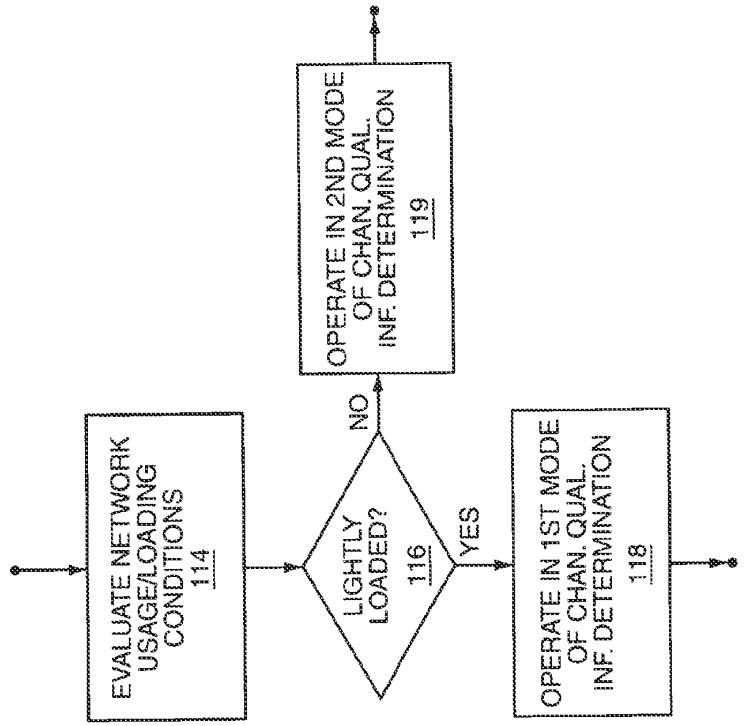


FIG. 4

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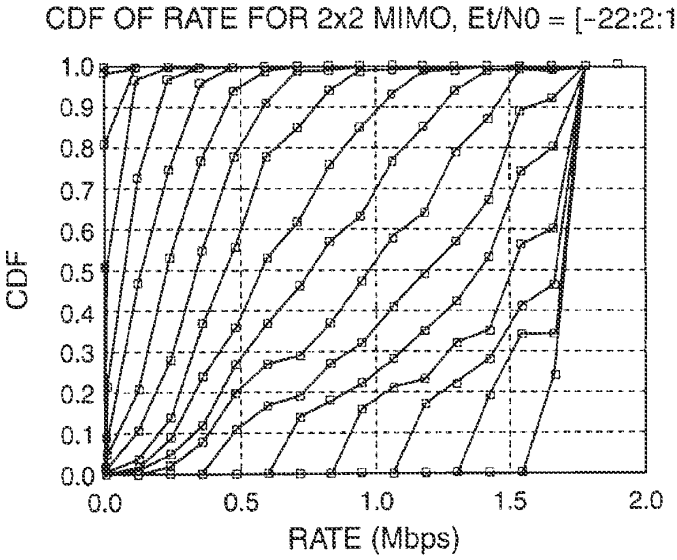


FIG. 6

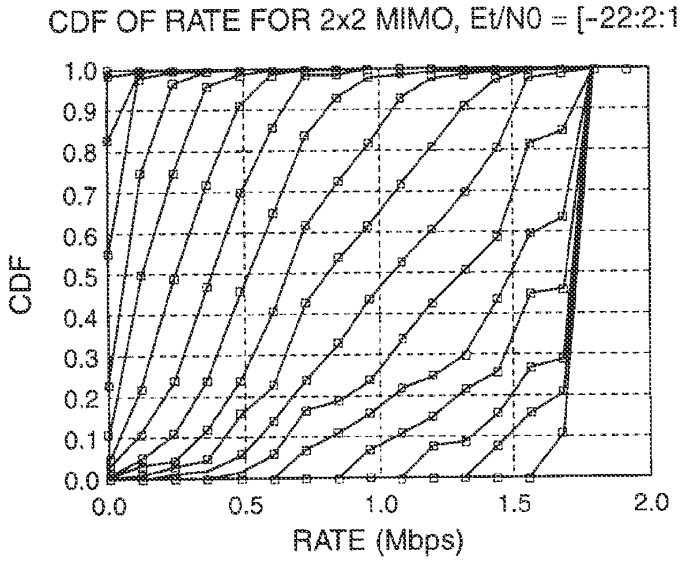


FIG. 7

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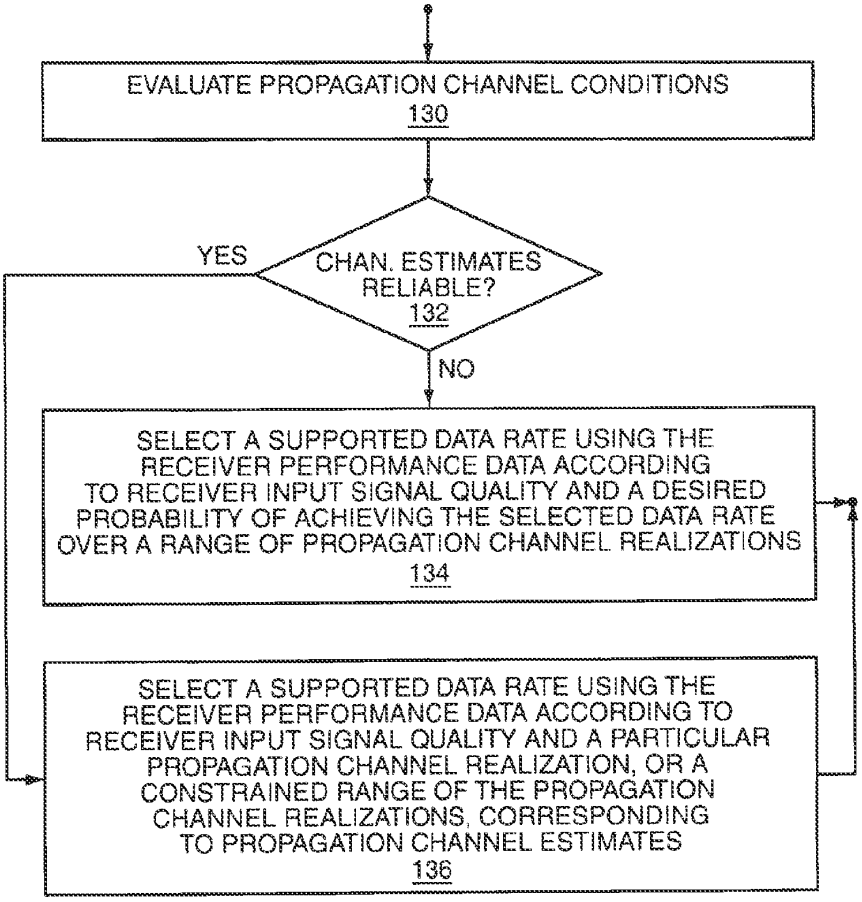


FIG. 8

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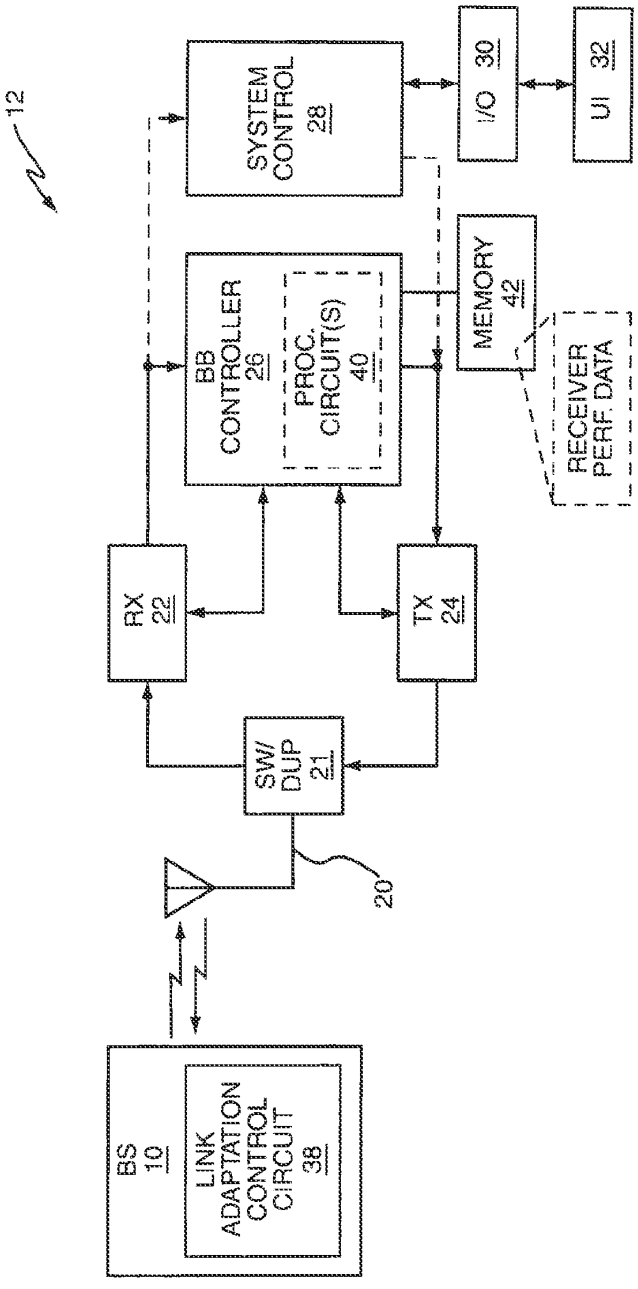


FIG. 9

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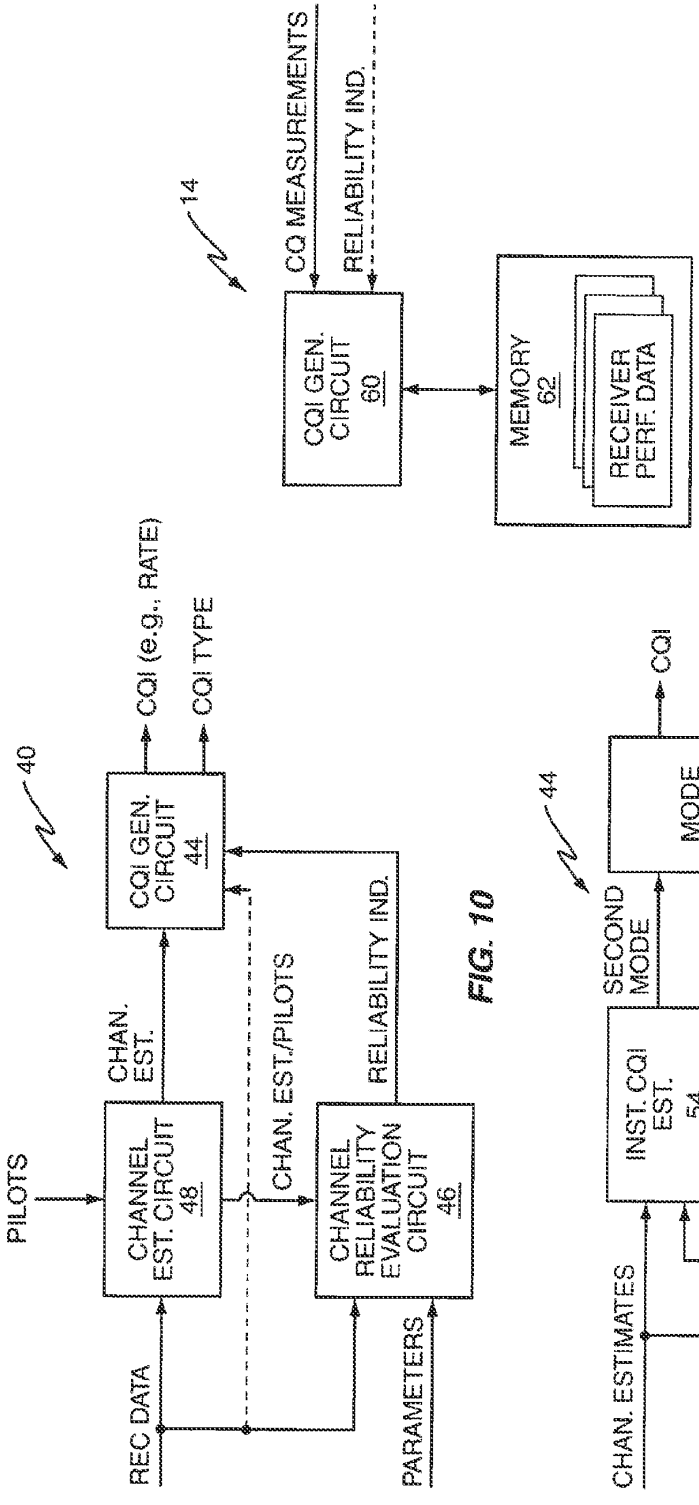


FIG. 10

FIG. 12

FIG. 11

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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
29 November 2007 (29.11.2007)

PCT

(10) International Publication Number
WO 2007/136337 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/SE2007/050216

(22) International Filing Date: 4 April 2007 (04.04.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/438,921 23 May 2006 (23.05.2006) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, 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, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, 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, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
---- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:
---- *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

(57) Abstract: A method and apparatus for generating channel quality information, such as may be used for transmit link adaptation, provide different operating modes, such as a first mode that may be used when propagation channel estimates are not reliable, and a second mode that may be used when the propagation channel estimates are reliable. In one or more embodiments, channel quality information is generated using receiver performance informatio that characterizes receiver performance in terms of a defined channel quality metric, e.g., supported data rates, for different values of receiver input signal quality over a range of propagation channel realizations. Channel quality information can be generated by selecting channel quality metrics according to receiver input signal quality and a desired probability of meeting a defined performance requirement over a range of propagation channel realizations, or by selecting channel quality metrics according to receiver input signal quality and particularized propagation channel realizations.

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METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

BACKGROUND

The present invention generally relates to generating wireless communications, and particularly relates to generating channel quality information.

Channel quality information can be expressed in a number of ways, such as a channel quality indicator identifying the effective signal quality of a wireless communication receiver. The effective signal quality represents the benefits of any interference cancellation gains, diversity combining gains, coding gains, etc., that may be provided by the receiver. In other words, the output signal quality of a given receiver may be significantly better than the receiver's input signal quality, which generally is expressed as the "raw," uncompensated ratio of received signal energy to background noise and interference.

Those skilled in the wireless communications art will appreciate the value of generating channel quality information based on the output signal quality rather than the input signal quality, because the output signal quality better represents the actual signal quality bearing on the quality of demodulation and decoding performance. That is, assuming that the channel quality information is used for link adaptation, e.g., picking the modulation and coding scheme (MCS) that is appropriate for transmitting to the receiver, using input signal quality rather than output signal quality would result in chronically underutilizing the transmission link.

Accurately determining output signal quality as part of ongoing receiver operations is not, however, a straightforward proposition for some types of receivers. In particular, non-linear receivers generally have a complex relationship between input signal quality and output signal quality. Examples of non-linear receivers include multi-stage receivers employing successive interference cancellation, and joint-detection receivers.

Further, even assuming the calculability of output signal quality, such calculations may be inaccurate under some circumstances. For example, the performance achievable by a given receiver depends on a number of variables, including propagation channel conditions. Some channel conditions translate into better receiver performance than others. Thus, even for the same receiver input signal, the receiver output signal quality will vary as a function of changing channel conditions. If channel conditions are changing rapidly, or the input signal is too weak to make reliable channel estimates, reporting output signal quality, or some metric relating to output signal quality, may lead to control errors.

For example, a supporting base station may perform transmit link adaptation responsive to receiving channel quality information from a wireless communication device, that identifies the quality of the channel in terms of some metric, such as a channel quality indicator, a rate selection indicator, or the like. Thus, the base station can adjust the transmit data rate, for example, in accordance with the channel quality indicators reported by the device. This control

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mechanism works well if the actual channel conditions change slowly in comparison to the link adaptation control lag. However, performing link adaptation in consideration of actual propagation channel conditions becomes unreliable if those conditions change rapidly in comparison to the link adaptation control timing.

SUMMARY

According to one or more method and apparatus embodiments taught herein, different modes of operation are used for determining channel quality information for a wireless communication device, depending on, for example, the reliability of propagation channel estimates for the wireless communication device. For example, in one embodiment, channel quality information is determined in a first mode by mapping receiver input signal quality to a data rate that can be supported at a desired probability over a range of propagation channel realizations. A supported data rate may be defined as an allowable data rate that can be achieved with a desired performance requirement, e.g., Block Error Rate (BLER). Further, in the second mode, the channel quality information is determined by mapping receiver input signal quality to a data rate that can be supported for a particular propagation channel realization, or that can be supported for a constrained range of propagation channel conditions, corresponding to the current channel estimates obtained by the wireless communication device.

Thus, the first mode provides for generating channel quality information as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable, such as where the time lag associated with transmit link adaptation is large compared to the coherent time of propagation channel fading. Conversely, the second mode provides for generating channel quality information as a function of short-term propagation channel conditions when short-term propagation channel estimates are reliable. Modal operation can be driven by determining whether the channel estimates being generated by the wireless communication device are reliable. Reliability may be determined by evaluating the mobility—e.g., rate of movement, Doppler frequency, etc.—of the wireless communication device, or by evaluating the channel estimates.

With the above in mind, in one embodiment, a method of determining channel quality information for a transmit propagation channel associated with a wireless communication device comprises in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. Receiver performance data characterizing receiver performance for a type of receiver associated with the wireless communication device may be used to generate the channel quality feedback in the first and second modes, and such generation may be performed by the wireless communication device itself, or by a base station in a supporting wireless communication network.

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For example, a wireless communication device or a base station may comprise one or more processing circuits configured to determine channel quality information for one or more signals received by the wireless communication device, based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. The processing circuit(s) are, in one or more embodiments, configured to operate selectively in the first or second mode based on whether the channel estimates are reliable.

Complementing the above method of channel quality information generation, one embodiment of a receiver performance characterization method comprises, at each of a number of receiver input signal qualities, computing an error rate expected for each of a number of propagation channel realizations, and, for each of the error rates computed, computing a data rate that can be supported for each propagation channel realization at each receiver input signal quality, and, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations. Such performance characterization data may be stored by the wireless communication device, or by the supporting wireless communication network. Generally, the performance characterization data is specific for a receiver type, and different data can be stored for different receiver types. For example, a particular type of Generalized RAKE (G-RAKE) or other Minimum Mean Squared Error (MMSE) receiver would have different characterization data than would a particular type of Joint Detection (JD) receiver. Similarly, different performance characterization data can be stored for different transmit/reception modes (MISO, MIMO, etc.), even for the same receiver type.

A corresponding method of providing rate adaptation feedback from a wireless communication device to a supporting wireless communication network operates in a first mode by selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements obtained by the wireless communication device, and a desired probability of achieving the selected data rate for a range of propagation channel realizations. In the second mode, the channel quality information is generated using the receiver performance data by selecting a supported data rate according to receiver input signal quality and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to channel estimates obtained by the wireless communication device.

Of course, the present invention is not limited to the above features and advantages. Indeed, those skilled in the art will recognize additional features and advantages upon reading the following detailed description, and upon viewing the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a base station and a wireless communication device, such as a mobile station, wherein channel quality information is generated according to one or more method embodiments taught herein.

Fig. 2 is a logic flow diagram for one embodiment of processing logic for modal generation of channel quality information.

Fig. 3 is a logic flow diagram for one embodiment of selecting operating modes in the context of Fig. 2.

Fig. 4 is a logic flow diagram for another embodiment of selecting operating modes in the context of Fig. 2.

Fig. 5 is a logic flow diagram for one embodiment of a receiver performance characterization method.

Figs. 6 and 7 are graphs depicting receiver performance characterizations obtained by the receiver performance characterization method of Fig. 5, for different types of wireless communication device receivers.

Fig. 8 is a logic flow diagram for one embodiment of modally generating channel quality information using receiver performance data.

Fig. 9 is a block diagram for one embodiment of a wireless communication device that is configured to generate channel quality information.

Figs. 10 and 11 are block diagrams of embodiments of processing circuits used in generating channel quality information.

Fig. 12 is a block diagram of one embodiment of a base station that is configured to generate channel quality information based on receiving channel quality measurements for the wireless communication device.

DETAILED DESCRIPTION

Fig. 1 illustrates a base station 10 and a wireless communication device 12, wherein the channel quality information generated for the downlink between the base station 10 and the wireless communication device 12 is, in a first mode of operation, not dependent on current propagation channel estimates, and, in a second mode, is dependent on current propagation channel estimates. Thus, the first mode of generating channel quality information may be used where estimates of the downlink propagation channel are not reliable, such as when the wireless communication device 12 is moving at a high rate relative to the base station 10, or is otherwise experiencing fast fading conditions, or when the received signal strength is too low for reliable channel estimation.

Before describing various embodiments of the above method of generating channel quality information, it should be understood that the processing logic associated with generating the channel quality information can be performed wholly in the wireless communication

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device 12, wholly in the base station 10, or performed cooperatively using both the base station 10 and the wireless communication device 12. In all such cases, the attendant processing may be implemented in hardware, software, or any combination thereof. Moreover, it should be understood that the base station 10 and the wireless communication device 12 are not limited to any particular configuration, nor are they limited to any particular wireless communications standards or protocols.

For example, in one or more embodiments, the wireless communication device 12 comprises a cellular radiotelephone or other type of mobile station, configured for operation with a supporting wireless communication network that includes the base station 10. In such embodiments, the base station 10 may comprise a Wideband CDMA (WCDMA) base station configured to provide High Speed Downlink Packet Access (HSDPA) services.

Correspondingly, the wireless communication device 12 may comprise a WCDMA-based access terminal configured to provide channel quality information, or related feedback, to the base station 10, in support of adapting downlink transmit data rates to changing reception conditions at the wireless communication device 12. In general, however, the wireless communication device 12 may comprise a mobile station or other type of handset, a pager, a Portable Digital Assistant (PDA), a palmtop or laptop computer, or a wireless communication module for use therein, or essentially any other type of communication device.

Keeping the method's broad applicability in mind, Fig. 2 illustrates one embodiment of a method of generating channel quality information, wherein it should be understood that at least some of the illustrated processing steps may be performed in other than the illustrated order. Further, although illustrated as serial processing, actual implementation of the method may involve concurrent, parallel processing, as part of ongoing communication operations. Also, it should be understood that the illustrated processing may be implemented in the base station 10, the wireless communication device 12, or in some combination thereof.

Processing "begins" with a determination of whether to operate in a first mode of generating channel quality information (Step 100). If the first mode is selected, processing continues with generating channel quality information according to a first algorithm that does not depend on channel estimates (Step 102). Conversely, if the first mode is not selected, i.e., the second mode of operation is selected, processing continues with generating channel quality information according to a second algorithm that depends on channel estimates (Step 104).

In at least one embodiment taught herein, the first mode of generating channel quality information is used during fast fading conditions, or whenever conditions are such that the short-term channel estimates obtained by the wireless communication device 12 are "unreliable." The second mode of generating channel quality information is used during slow fading conditions, or, more generally, whenever the channel estimates are reliable. In other words, channel quality information is generated as a function of long-term propagation channel characteristics when short-term estimates of the channel are not reliable. Conversely, channel

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quality information is generated as a function of the short-term propagation channel characteristics when the channel estimates are reliable.

It should be understood that various methods of assessing channel estimation reliability are contemplated herein, and it should be understood that conditions deemed to give rise to unreliable channel estimations in one application may not be considered as such in another application. For example, the reliability of a short-term channel estimate may be viewed in terms of fading speed versus link adaptation control lag. That is, channel estimates may be deemed more or less reliable in dependence on how quickly channel conditions change relative to the transmit link adaptations being made. In some embodiments, the link adaptation lag—i.e., the time between a reported channel quality metric and the corresponding transmit link adjustment—may be used to influence whether, or to what extent, short-term propagation channel conditions are considered in generating channel quality information.

With such variations in mind, Fig. 3 illustrates one embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating propagation channel fading conditions (Step 106). As will be detailed later herein, the evaluation may comprise assessing the reliability of the channel estimates to determine whether fast-fading conditions apply. In other embodiments, fast-fading may be recognized by evaluating mobility, such as by evaluating the Doppler frequency shift of transmissions on the downlink and/or uplink channels between the base station 10 and the wireless communication device 12. Of course, other indicators bearing on the reliability of short-term channel estimates may be used. For example, certain service areas may make channel estimates inherently suspect, such as radio sectors in downtown or urban areas.

If fast fading conditions apply (Step 108), channel quality generation operates in the first mode, wherein channel quality information is generated in a manner that is not dependent on channel estimates (Step 110). Conversely, if fast fading conditions do not apply, channel quality information is generated in a manner that is dependent on channel estimates (Step 112).

Fig. 4 illustrates another embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating the network usage or load conditions (Step 114). In a lightly loaded wireless network, the reliability of the channel estimates and the derived channel quality information can be compromised even if the propagation channel fading conditions change slowly or remain static. For example, because of bursty and fast varying of inter-cell interference that is characteristic of a lightly load network, the channel quality and hence the supportable data rate realized during actual transmission of the data can be rather different than what was measured prior to the transmission.

Thus, if the network is lightly loaded (Step 116), it can be advantageous to select the first mode of determining channel quality information (Step 118). Conversely, if the network is more heavily loaded, or the loading is otherwise more stable, channel quality information can be

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determined according to the second mode of operation (Step 119). The selection of which operating mode to use for channel quality information determination can be evaluated and/or applied to individual wireless communication devices 12, or can be applied to sets or subsets of wireless communication devices 12, within a given sector or cell of the network. For example, the first mode may be used for some wireless communication devices 12, while the second mode may be used for others. The determination of which mode to use may be set according to the service needs of individual wireless communication devices 12, for example.

Note that this modal selection can be implemented in ways that are non-transparent or transparent to the wireless communication devices 12. In one embodiment, a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode. Alternatively, based on the network load conditions, the base station 10 can receive information supporting the second mode of operation, but can choose to ignore all or some of that information, in favor of operating in the first mode. In other words, the base station 10 may choose not to use all of the feedback that it receives.

In some circumstances, the radio resource cost required to support operation in the second mode is higher than that for operation in the first mode. For instance, to support operation in the second mode, feedback generally has to been sent by the wireless communication devices 12 more frequently than is required for operation in the first mode, to reflect changing propagation channel conditions. The amount of feedback also could be larger to describe the propagation channel conditions in sufficient detail for operation in the second mode. The strain on the feedback channel is further exacerbated by the fact that a plurality of wireless communication devices 12 simultaneously transmits feedback information to the network. Thus, the first mode of operation may be preferred even when operation in the second mode is viable, simply based on propagation channel condition considerations.

In one or more embodiments, channel quality information determination considers the potentially higher radio resource costs on the feedback channel associated with operation in the second mode. More particularly, the second mode of operation can be reserved for contractually privileged devices or services. The privilege level of a given communication device 12 can be referenced from a database with the identification number of the device. Channel quality information can be determined according to operation in the second mode for devices with higher privilege. The contractual requirement of a service can also be a factor in considering the appropriate operation mode. For instance, for services with stringent delay or jitter requirements such as packet voice services, the quality of service can be more easily maintained if channel quality information is determined according to operation in the second mode.

Deciding whether to determine channel quality information according to the first or second modes of operation also may be adapted to transmission schemes that consist of

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separable components. Non-limiting examples of these types of transmission schemes include multi-carrier CDMA and orthogonal frequency division multiplexing (OFDM) transmission. To support operation in the second mode, the amount of feedback can scale directly with the number of separable components, e.g., four feedback values for four-carrier CDMA or eighty values for OFDM with eighty frequency resource units. For large packets or data units that would occupy entire or large portions of the components, the relative benefits of operating in the second mode instead of the first mode can be significantly smaller than for small packets or data units that would occupy small portions of the components. To conserve radio resources, it is therefore advantageous to include packet or data unit lengths as a factor in operating mode selection.

Such operation is, in one or more embodiments, supported by the use of receiver performance data that characterizes the performance of the wireless communication device's receiver type over a range of propagation channel conditions, such that the performance data indicates the expected performance of the receiver over a range of propagation channel conditions, and for particularized propagation channel conditions. Determining channel propagation conditions for channel quality information determination—e.g., for supportable rate computation—may be required for operation in the first and/or second modes of operation. For the first operating mode, long-term channel propagation conditions are determined and, in one or more embodiments, the propagation channel conditions include one or more of the following quantities: a characterization of the fading speed of the channel (for example, based on the estimated Doppler frequency, known mobile speed, rate of negative acknowledgements - i.e. NACK rate, ...); and an estimate of the power delay profile (PDP) of the propagation channel associated with the wireless communication device 12, assuming that the PDP does not change quickly over time.

In one or more embodiments, the estimation of long-term propagation channel conditions is used for any one or more of the following processing actions: construction of a CDF of the achievable (supportable) data rates; selection of an achievable data rate curve CDF from a table of CDF curves that most closely matches the estimated long-term propagation channel conditions. Thus, it should be understood that in one or more embodiments, CDF curves may be predefined. In such embodiments, the received signal quality and/or long-term characterization of the propagation channel associated with the wireless communication device 12 can be used to select a point or range along a predefined CDF curve to identify channel quality information for the wireless communication device 12—e.g., to identify an achievable data rate. In one or more other embodiments, the long-term propagation channel conditions as estimated are used to partially or wholly construct one or more CDF curves, which can then be used to identify achievable data rates, for example, as a function of measured signal quality at the wireless communication device 12.

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In more detail, for purposes of CDF curve construction, the PDP is considered a known quantity, and estimates of the delay tap (channel) coefficient values can be generated and used to further determine the propagation channel realization for the given PDP. At least one embodiment estimates propagation channel coefficients based on pilot or other measurements, to support characterization of long-term propagation channel conditions. It should be understood that traditional techniques for propagation channel estimation may be used as needed or desired. Note that the estimation of channel coefficients represents a longer-term estimate, rather than the short-term (instantaneous) estimates that are generally used in the second mode of operation.

In any case, it should be understood that, however they are constructed, the CDF curves characterize the (expected) performance of a particular receiver type, or types. Fig. 5 illustrates one method of characterizing receiver performance based on CDF curves, but it should be understood that other methodology may be used to characterize receiver performance for long-term and short-term propagation channel conditions.

In more detail, Fig. 5 illustrates an embodiment of a receiver performance characterization method that may be performed using empirical testing, software simulation, dynamic measurements, or any combination thereof. Because different receiver types offer different levels of performance, such characterization is done for the particular receiver type associated with the wireless communication device 12. (If the channel quality information is generated by the wireless communication device 12, the receiver performance data can be stored in the wireless communication device 12. If the channel quality information is generated in the base station 10, the base station 10 may store characterization data for different types of receivers, and use the appropriate sets of receiver performance data for different wireless communication devices.)

In any case, processing begins by computing an expected error rate for each one in a number of receiver input signal quality values, for each one in a number of modulation and coding schemes, and for each one in a number of propagation channel realizations (Step 120). Error rate may be expressed, for example, as Bit Error Rate (BER), Block Error Rate (BLER), Frame Error Rate (FER), etc., and the particular manner in which error rate is expressed may be based on the type of data transmissions involved.

As used herein, unless otherwise noted, the term "receiver input signal quality" denotes the ratio of total received signal energy per chip, E_T, over the noise plus interference, N_0. Measurements of receiver input signal quality represent the "raw" input signal quality for the receiver embodied within the wireless communication device 12, and does not depend on the receiver's interference suppression and signal gain performance, and thus does not depend on the accuracy of short-term propagation channel estimates. Moreover, receiver input signal quality measurements are the same for simple and complex receiver structures, e.g., the same whether the device's receiver is a simple linear receiver, or a complex non-linear receiver.

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Further, as used herein, the term "propagation channel realization" represents a particular combination of propagation channel tap weights. For example, a plurality of three-tap characterizations of the propagation channel comprises different combinations of three complex tap coefficients, corresponding to different propagation channel conditions. The different propagation channel realizations may be based on a fixed Power Delay Profile (PDP). Alternatively, a given fast fading realization may be used for different PDPs, and different CDFs may be used for the different PDPs.

In any case, each propagation channel realization may be understood as representing a particular hypothesis of actual propagation channel conditions for the transmit link between the base station 10 and the wireless communication device 12. For the same input signal quality, the wireless communication device 12 will exhibit different output signal quality for different channel realizations.

For each receiver input signal quality and each modulation and coding scheme, receiver performance characterization processing continues by, for each of the error rates computed, computing the data rate (R) that can be achieved (supported) for each propagation channel realization (Step 122). The achievable data rate, also referred to as the supported data rate, represents the data rate (R) that can be used for transmitting to the wireless communication device 12 while still meeting a defined performance requirement, e.g., a BLER target. For example, if the computed error rate is less than the target BLER, i.e., BLER < BLER(target), the data rate (R_{mcs}) corresponding the modulation and coding scheme can be the supported data rate ($R = R_{mcs}$), otherwise the supported data rate can be zero ($R = 0$). If ARQ is used, then the supported data rate (R) can be calculated as $R = R_{mcs}(1\text{-BLER})$, where R_{mcs} is the data rate corresponding the modulation and coding scheme and BLER is the computed error rate. If HARQ is used, then the supported data rate can be calculated as $R_{mcs}/(1+\text{BLER})$.

Processing continues by, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations (Step 124). Note that the generation of CDF curves can be a one-time process, or can be wholly or partially a dynamic process. For example, as was noted earlier, ongoing estimation of one or more parameters bearing on the longer-term propagation channel conditions for the wireless communication device 12. Again, such parameters can include, but are not limited to, any one or more of the PDP, estimated channel coefficients, current data service type and/or data characteristics such as packet size, mobility/rate-of-travel estimates, etc.

Fig. 6 graphically depicts receiver performance data generated according to the method of Fig. 5 for a Minimum Mean Square Error (MMSE) receiver type. More particularly, Fig. 6 graphs receiver input signal quality (SNR) curves stepped from -22 dB to +12 dB in 2 dB increments over defined data rate points, according to the CDFs of the supported data rates for the hypothesized set of propagation channel realizations. The leftmost curve corresponds to

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input SNR of -22 dB, whereas the rightmost curve corresponds to input SNR of +12 dB. Fig. 7 depicts similar performance characterization data for a Joint Detection (JD) receiver architecture, and it should be understood that the particular receiver performance data used for the wireless communication device 12 would be matched to its particular receiver type. (Further, because some types of receivers have different reception modes that yield different performance characteristics, different receiver performance data can be used in each such mode.)

In determining channel quality information using the performance curves of Fig. 6, for example, consider the case of higher rates of travel, where the channel fading conditions become more temporally uncorrelated between the measurement time at which propagation channel conditions are estimated, and the transmit time at which transmit link adaptations based on those channel estimates are performed. If the channel conditions are changing more rapidly than link adaptation control can keep up with, link adaptation—e.g., transmit data rate selection—should be based on the statistical propagation characteristics determined by the path gain and shadowing, rather than based on the channel estimates.

Given signal quality measured by the wireless communication device 12, the transmit data rate can be selected from the corresponding signal quality curve in the receiver performance data, according to a desired CDF level. For example, choosing the tenth percentile for the appropriate SNR curve corresponds to the data rate achievable for ninety-percent of the hypothesized propagation channel realizations. The particular value to choose generally depends on the particular performance requirements of the system, such as determined by a defined performance requirement, like maximum tolerable BLER. In one or more embodiments, the signal quality represents a long-term signal quality—average input SNR—as measured by the wireless communication device, or as averaged by the network. In other embodiments, such as where channel estimates are reliable, the instantaneous or short-term receiver input signal quality may be used.

In either case, the above approach effectively quantizes the rate values in the performance characterization graph to the rates represented by quantized input signal quality measurements, which is sufficient for slow link adaptation in a rapidly varying channel. That is, for fast fading conditions, the channel quality information may be generated as data rate selections based on selecting an SNR curve from the graph corresponding to long-term measured signal quality at the wireless communication device 12, and then identifying the data rate that is achievable at a desired probability for the defined performance requirement, e.g., for a defined BLER limit. Effectively, the method amounts to generating channel quality information as a function of long-term propagation channel characteristics based on mapping a receiver input signal quality measurement to a data rate selection that is achievable at a desired probability over a range of short-term propagation channel characteristics.

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As the channel becomes more reliable, for example, when vehicle speeds become slower or actual input SNR at the receiver becomes larger due to improved path gain, the channel quality information generation process can be transitioned to a mode where more refined information is generated, i.e., a mode where the short-term propagation channel conditions prevailing at the wireless communication device 12 are explicitly considered. The same performance characterization data that was used for slow adaptation during fast fading may be used for fast adaptation during slow fading. In other words, the same receiver performance curves can be used for slow and fast link adaptation in a hierarchical manner. That is, channel quality metrics can be used to characterize the long-term properties of the channel, which can then be characterized further for fast link adaptation when the channel becomes more reliable.

One method for accomplishing the above operation is to quantize the channel state values for each input signal quality (SNR) and store the quantized values in a codebook. For specific input SNR and channel estimates obtained at the wireless communication device 12, the quantized values can be looked up in the codebook, and the corresponding data rate selected for channel quality information reporting.

Fig. 8 illustrates one embodiment of hierarchical channel quality information generation, wherein the channel quality information is generated in terms of data rate reports. Such processing may be performed at the wireless communication device 12, at the base station 10, or cooperatively. In any case, processing begins with evaluation of the propagation channel conditions (Step 130). Evaluation may comprise evaluating short-term propagation channel estimates being generated by the wireless communication device 12 as a means of determining whether the estimates are reliable, or may comprise checking Doppler shifts, etc.

If the channel estimates are not reliable (Step 132), a supported data rate is selected using receiver performance data, such as illustrated in Figs. 6 and 7. More particularly, if the channel estimates are not reliable, the measured receiver input signal quality can be mapped to one of the quantized SNR curves, and a corresponding supported data rate can be identified according to the desired probability of achieving that rate over the range of propagation channel realizations used to generate the performance data (Step 134). A tenth percentile selection means that ninety-percent of the hypothesized propagation channel realizations will support the selected data rate at the desired error rate performance.

As such, if the channel estimates are not reliable, the transmit data rate is selected probabilistically, rather than based on any specific consideration of the short-term propagation channel conditions existent at the wireless communication device 12. Further, in cases where the channel estimates are not reliable, the receiver input signal quality used to select the appropriate quantized SNR curve may be a long-term (average) receiver input signal quality. Averaging may be done at the wireless communication device 12, or instantaneous values reported by the wireless communication device 12 may be averaged by the network.

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On the other hand, if the channel estimates are reliable (Step 132), the measured receiver input signal quality may represent a shorter term, e.g., instantaneous, measurement. Of course, averaged values may still be used. In either case, with the availability of reliable channel estimates, the receiver input signal quality can be mapped to one of the quantized SNR curves and a particular propagation channel realization, or a constrained range of propagation channel realizations, corresponding to the channel estimates (Step 136). In one variation of this approach, different SNR/CDF curves can be stored for long-term and short-term SNR measurements, with the different SNR curves reflecting different probabilistic characteristics. Then, in operation, the set of curves to be used is selected depending on whether long-term or short-term SNR values are being used, which may switch as a function of channel estimate reliability.

This hierarchical approach to channel quality information generation can be implemented in the wireless communication device 12, such as by including appropriately configured processing circuits in the device 12, along with storing appropriate receiver performance data. Fig. 9 illustrates one embodiment of the wireless communication device 12, configured for carrying out a method of channel quality information generation using receiver performance data. The illustrated embodiment comprises a receive/transmit antenna 20, a switch/duplexer 21, a receiver front-end 22, a transmitter 24, a baseband (BB) controller 26, a system controller 28, input/output (I/O) interface circuits 30, and a user interface (UI) 32.

Of particular interest regarding channel quality information generation, the baseband controller 26 includes one or more processing circuits 40, which are configured for channel quality information generation, and which have access, direct or indirect, to a memory 42 storing receiver performance data. The stored data may comprise a data structure representing quantized SNR curves and corresponding CDFs of supported rates for a plurality of propagation channel realizations, e.g., a set of 1000 channel realizations, such as illustrated in Fig. 6 or 7. However, at least some of the performance data may be obtained using curve-fitting calculations—e.g., polynomials—and it should be understood that various methods of storing and representing receiver performance data are contemplated herein.

In operation according to one embodiment, the wireless communication device 12 maintains a long-term estimate of receiver input signal quality—average SNR—and further maintains short-term (instantaneous) propagation channel estimates. If the propagation channel estimates are not reliable, the wireless communication device 12 operates in a first mode of channel quality information generation. In the first mode, the wireless communication device 12 maps measured, average receiver input signal quality to the closest corresponding receiver input signal quality represented in the receiver performance data, and then uses that SNR curve to identify the data rate that can be supported at a desired probability over a range of propagation channel realizations. As such, the wireless communication device 12 returns channel quality information to the base station 10 in the form of updated transmit data rate

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selections that are identified probabilistically, without regard to the actual channel estimates. A transmit link adaptation control circuit 38 in the base station 10 uses the reported data rate selections to adjust the transmit data rate used to send traffic to the wireless communication device 12.

If the propagation channel estimates are reliable, the wireless communication device 12 operates in a second mode. In the second mode, the wireless communication device 12 selects the SNR value in the receiver performance data most closely corresponding to the average receiver input signal quality as measured by the wireless communication device 12, and further selects a propagation channel realization, or a constrained range of propagation channel realizations, in the receiver performance data that most closely corresponds with current channel estimates. The wireless communication device 12 thus uses the receiver performance data to identify the data rates that can be supported for measured receiver input signal quality and corresponding channel estimates, and reports the identified data rate selections to the base station 10.

In both the first and second modes, the base station 10 receives channel quality information in the form of data rate selections, and the base station 10 performs corresponding transmit data rate adjustments for forward link transmissions to the wireless communication device 12. As such, whether the channel quality information is being generated in consideration of current channel estimates may be transparent to the base station 10. That is, from the base station's perspective, link adaptation may transparently shift between the first and second modes, without need for explicit signaling. In some embodiments, however, the mode of channel quality information generation may be signaled, or otherwise indicated. For example, the rate at which channel quality information is reported to the base station 10 may change in dependence on whether channel quality information is being generated in the first or second modes.

Figs. 10 and 11 illustrate embodiments of processing circuits that may be included in, or associated with, the baseband controller 40 of the wireless communication device 12, and used to implement generation of channel quality information in the first and second modes. Fig. 10, in particular, illustrates the processing circuit(s) 40 as comprising a channel quality information generation circuit 44, which generates channel quality information, e.g., rate selection data, in first and second modes. The circuit 44 may be configured to provide an indication of the type of channel quality information being generated, i.e., it may indicate the mode that it is operating in.

The processing circuit(s) 40 may further include, or may further be associated with, a channel estimate reliability evaluation circuit 46 and a channel estimation circuit 48. The channel estimate reliability evaluation circuit 46 is configured to estimate the reliability of the channel estimates being generated by the channel estimation circuit 48, which generates instantaneous propagation channel estimates based on the received signal and pilot information. The channel estimate reliability evaluation circuit 46 may receive, among other

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things, the channel estimates from the channel estimation circuit 48 and/or the pilot values. Operation may be switched between the first and second modes based on the reliability indicator output by the reliability evaluation circuit 46.

Note, too, that the channel quality information generation circuit 44 may be configured to perform the receiver input signal quality measurements, i.e., the E_T/N_o calculations, or another functional circuit may be included for that purpose in the processing circuit(s) 40. On that point, it should be understood that illustrations of the processing circuit(s) 40 may represent functional rather than physical circuit elements. For example, the processing circuit(s) 40 may comprise all or a portion of a microprocessor-based circuit, an FPGA, ASIC, etc.

Continuing with function circuit descriptions, Fig. 11 illustrates one embodiment of the channel quality information generation circuit 44 that is depicted in Fig. 10. One sees that the reliability indicator drives a mode select circuit 50, which selects the source circuit for the channel quality information being output. If the reliability indicator indicates that the channel estimates are not reliable, the mode select circuit 50 selects a long-term channel quality information estimation circuit 52 as the source circuit. The long-term channel quality information estimation circuit 52 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and desired CDF probabilities.

Conversely, if the reliability indicator indicates that the channel estimates are reliable, the mode select circuit 50 selects an instantaneous (short-term) channel quality information estimation circuit 54 as the source circuit. In one embodiment, the instantaneous channel quality information estimation circuit 54 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and the channel estimates. In another embodiment, instantaneous channel quality information is generated by calculating receiver output signal quality. In such embodiments, channel quality information is determined in the first mode using receiver input signal quality, and determined in the second mode using receiver output signal quality.

In any case, it should be understood that the base station 10 can be configured to generate channel quality information according to any of the above embodiments, based on the wireless communication device feeding back channel quality measurements. For example, Fig. 12 illustrates a channel quality information generation circuit 60 and a memory 62, which may be included in the base station 10. The memory 62 stores receiver performance data for one or more receiver types, with at least one set of receiver performance data matching the type of receiver implemented in the wireless communication device 12.

More generally, in such embodiments, the base station 10 comprises one or more processing circuits configured to determine channel quality information for a transmit propagation channel corresponding to the wireless communication device 12. Such generation may be based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates for the wireless communication device 12,

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and in a second mode, generating channel quality information according to a second algorithm that depends on the channel estimates.

In one embodiment, in the first mode, the base station 10 receives at least receiver input signal quality information for the wireless communication device 12. As described, the first algorithm may comprise mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations. For the second mode of operation, the base station 10 receives receiver input signal quality information and propagation channel information from the wireless communication device 12—e.g., quantized long-term SNR values and quantized short-term propagation channel estimates.

If the base station 10 stores code books of SNR values and propagation channel realizations, the wireless communication device 12 need only return code book indices corresponding to its measurements. In any case, the second algorithm may comprise mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

As such, the base station 10 can be configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device 12 without receiving corresponding channel estimates. Alternatively, the wireless communication device 12 can be configured always to report channel estimates and signal quality, and the base station 10 can be configured to select operation in the first or second modes based on evaluating the reliability of the channel estimates. In at least one embodiment, the base station 10 selects the mode based on determining whether the wireless communication device 12 is operating in fast fading conditions. If the wireless communication device 12 is operating in fast fading conditions, the base station 10 operates in the first mode. If the wireless communication device 12 is not operating in fast fading conditions, the base station 10 operates in the second mode. Of course, it should be understood that first and second modes of operation may be managed independently for individual ones in a plurality of wireless communication devices being supported by the base station 10.

Further, and more generally, it should be understood that channel quality information generation as taught in one or more embodiments described herein uses receiver performance data to determine channel quality information metrics, such as supported data rates, based on using receiver performance data. The receiver performance data characterizes supported data rates in terms of propagation channel realizations, for each in a plurality of quantized receiver input signal qualities. In a first mode of operation, the data rate that can be achieved at a desired probability over a range of propagation channel conditions, e.g., all hypothesized propagation channel realizations, are selected for the receiver input signal quality value that corresponds to measurements obtained by the wireless communication device 12. As such, the data rate is not set in consideration of the instantaneous channel conditions prevailing at the

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wireless communication device 12, but rather set probabilistically, in consideration of the long-term channel conditions. As such, the first mode of operation can be selected whenever reliable channel estimates are not available.

In a second mode of operation, where reliable channel estimates are available, data rates are selected using receiver input signal qualities and propagation channel realizations corresponding to measurements obtained at the wireless communication device 12. In other words, short-term propagation channel conditions are considered when the estimates of those conditions are reliable. In this regard, the same receiver performance data can be used to generate channel quality information metrics with or without using current propagation channel estimates. As such, it is convenient to modify transmit link adaptation to switch between slow link adaptation—i.e., the first mode of operation—and fast link adaptation—i.e., the second mode of operation.

Of course, the present invention is not limited by the foregoing discussion, nor is it limited by the accompanying drawings. Indeed, the present invention is limited only by the following claims, and their legal equivalents.

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CLAIMS

What is claimed is:

1. A method of determining channel quality information for a transmit propagation channel associated with a wireless communication device (12), the method characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

2. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode as a function of propagation channel fading conditions.

3. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode responsive to evaluating a reliability of propagation channel estimates made by the wireless communication device (12).

4. The method of claim 1, wherein generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

5. The method of claim 4, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

6. The method of claim 5, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

7. The method of claim 6, further characterized by generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

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8. The method of claim 7, wherein generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) comprises generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

9. The method of claim 1, wherein generating channel quality information according to a second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

10. The method of claim 1, wherein the wireless communication device (12) generates the channel quality information as feedback for transmit link adaptation.

11. The method of claim 1, wherein the wireless communication device (12) generates channel quality measurements and a base station (10) in a supporting wireless communication network generates the channel quality information based on receiving the channel quality measurements.

12. The method of claim 11, wherein the channel quality measurements for the first mode comprise at least receiver input signal quality measurements, and wherein the channel quality measurements for the second mode comprise receiver input signal quality measurements and corresponding propagation channel estimates.

13. The method of claim 1, further characterized by storing receiver performance data for use in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

14. The method of claim 13, wherein generating the channel quality information according to the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

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15. The method of claim 13, wherein generating the channel quality information according to the second algorithm comprises selecting a receiver input signal quality corresponding to receiver input signal quality measurements made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

16. The method of claim 1, further characterized by selectively operating in the first and second modes as a function of at least one of (a) packet lengths of data to be transmitted by the wireless communication device (12), (b) delay requirements associated with packet data to be transmitted by the wireless communication device (12), (c) delay requirements associated with a communication service active at the wireless communication device (12), (d) identification of the wireless communication device (12), and (e) network usage or congestion levels.

17. A wireless communication device (12) comprising one or more processing circuits (40) configured to determine channel quality information for one or more signals received by the wireless communication device (12), operation of said one or more processing circuits for determining the channel quality information characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

18. The wireless communication device (12) of claim 17, wherein the one or more processing circuits (40) comprise a channel quality information generation circuit (44) that is configured to generate the channel quality information by selectively operating in the first and second modes.

19. The wireless communication device (12) of claim 18, wherein the one or more processing circuits (40) include a reliability evaluation circuit (46) to generate a reliability indicator indicating whether propagation channel estimates being generated at the wireless communication device (12) are reliable, and wherein the channel quality information generation circuit (44) is configured to select the first mode of operation if the reliability indicator indicates that the propagation channel estimates are not reliable, and to select the second mode of operation if the reliability indicator indicates that the channel estimates are reliable.

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20. The wireless communication device (12) of claim 17, wherein one or more processing circuits (40) are configured to determine whether to operate in the first mode or in the second mode according to a reliability of propagation channel estimates made by the wireless communication device (12).

21. The wireless communication device (12) of claim 17, wherein the first algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

22. The wireless communication device (12) of claim 21, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

23. The wireless communication device (12) of claim 22, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

24. The wireless communication device (12) of claim 23, wherein the one or more processing circuits (40) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

25. The wireless communication device (12) of claim 24, wherein the one or more processing circuits (4) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

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26. The wireless communication device (12) of claim 17, wherein the second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

27. The wireless communication device (12) of claim 17, wherein the wireless communication device (12) includes memory (42) storing receiver performance data for use by the one or more processing circuits (40) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

28. The wireless communication device (12) of claim 27, wherein the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

29. The wireless communication device (12) of claim 27, wherein the second algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

30. A base station (10) comprising one or more processing circuits (60) configured to determine channel quality information for a transmit propagation channel corresponding to a wireless communication device (12) associated with the base station (10), based on:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates for the wireless communication device (12); and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates for the wireless communication device (12).

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31. The base station (10) of claim 30, wherein, in the first mode, the base station (10) receives at least receiver input signal quality information for the wireless communication device (12), and wherein the first algorithm comprises mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations.

32. The base station (10) of claim 31, wherein the base station (10) is configured to map a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

33. The base station (10) of claim 32, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

34. The base station (10) of claim 33, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

35. The base station (10) of claim 34, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

36. The base station (10) of claim 30, wherein, in the second mode, the base station (10) receives receiver input signal quality information and propagation channel estimates for the wireless communication device (12), and wherein the second algorithm comprises mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel

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realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

37. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device (12) without receiving corresponding propagation channel estimates for the wireless communication device (12).

38. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it determines that propagation channel estimates for the wireless communication device (12) are not reliable.

39. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if the wireless communication device (12) is operating in fast fading conditions, and is configured to select operation in the second mode if the wireless communication device (12) is not operating in fast fading conditions.

40. The base station (10) of claim 30, wherein the base station (10) includes memory (62) storing receiver performance data for use by the one or more processing circuits (60) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

41. The base station (10) of claim 40, wherein the first algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identify a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

42. The base station (10) of claim 40, wherein the second algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), select a propagation channel realization or a constrained range of propagation channel realizations, corresponding to propagation channel estimates made by the wireless communication device (12), and identify a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

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43. A method of characterizing receiver performance, said method characterized by:

for each of a number of receiver input signal qualities and each of a number of modulation and coding schemes, computing an error rate expected for each of a number of propagation channel realizations;

for each of said receiver input signal qualities and each of said modulation and coding schemes, computing a data rate that can be supported for each propagation channel realization; and

for each receiver input signal quality, computing the cumulative distribution function of the supported data rates corresponding to the propagation channel realizations.

44. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization.

45. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs}(1\text{-BLER})$.

46. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs}/(1\text{-BLER})$.

47. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)).

48. The method of claim 47, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)) comprises determining R as $R = R_{mcs}$ if BLER < BLER(target), and otherwise determining R as R = 0.

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49. A method of providing rate adaptation feedback from a wireless communication device (12) to a supporting wireless communication network characterized by storing receiver performance data determined according to the method of characterizing receiver performance of claim 43, and, in a first mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a desired probability of achieving the selected data rate for a range of propagation channel realizations, and, in a second mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to propagation channel estimates for the wireless communication device (12).

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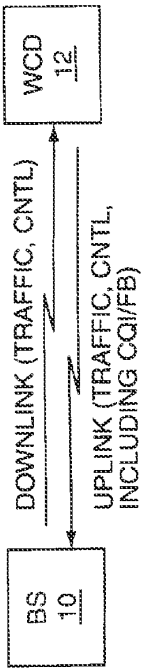


FIG. 1

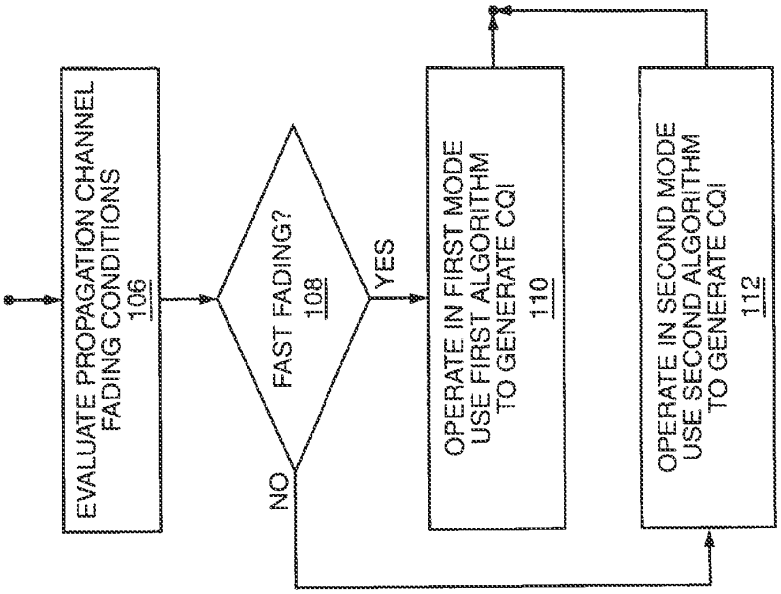


FIG. 3

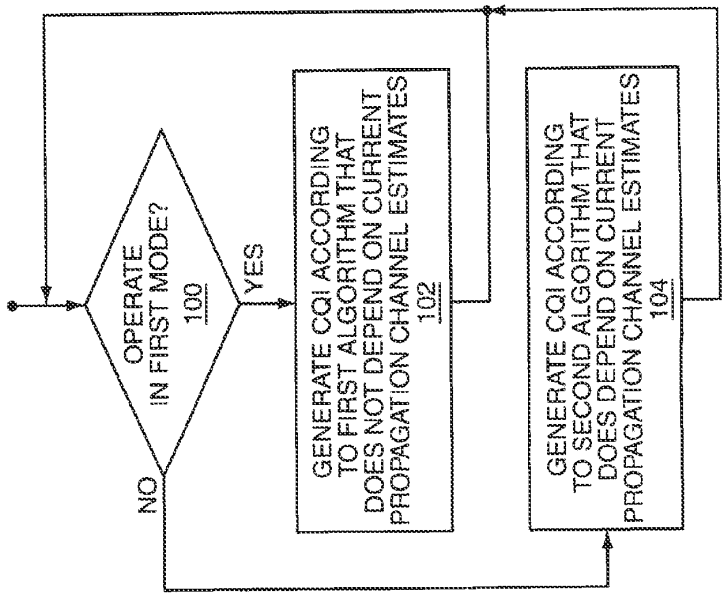


FIG. 2

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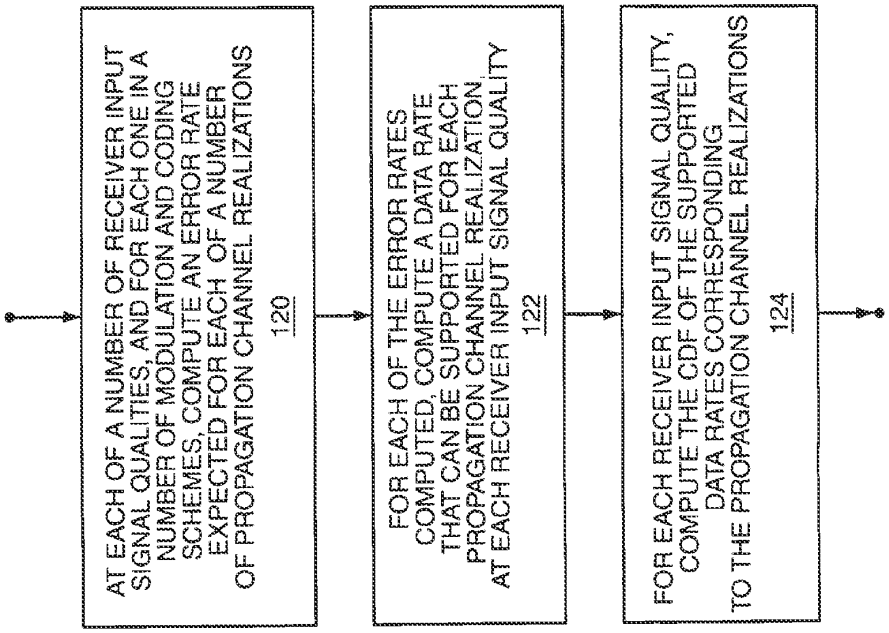


FIG. 5

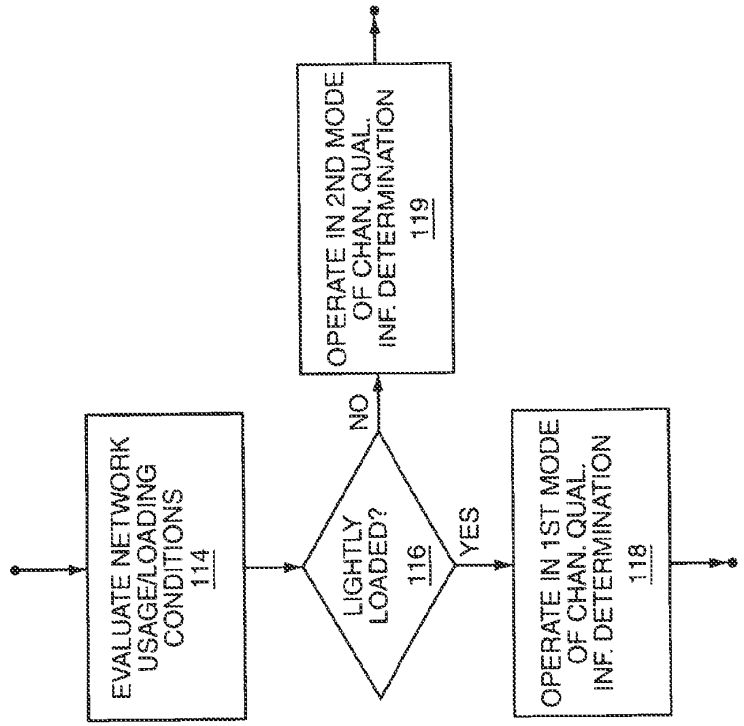


FIG. 4

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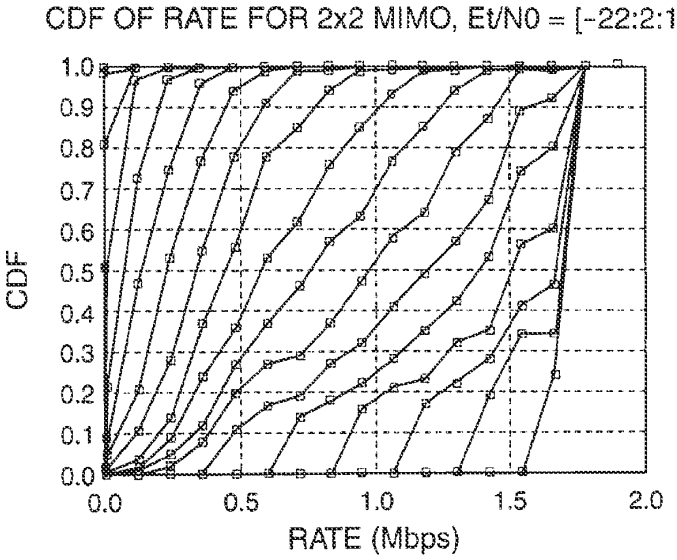


FIG. 6

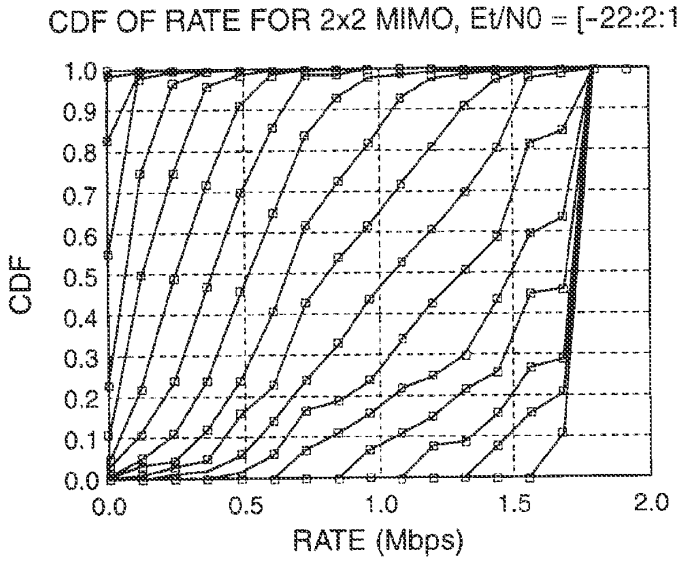


FIG. 7

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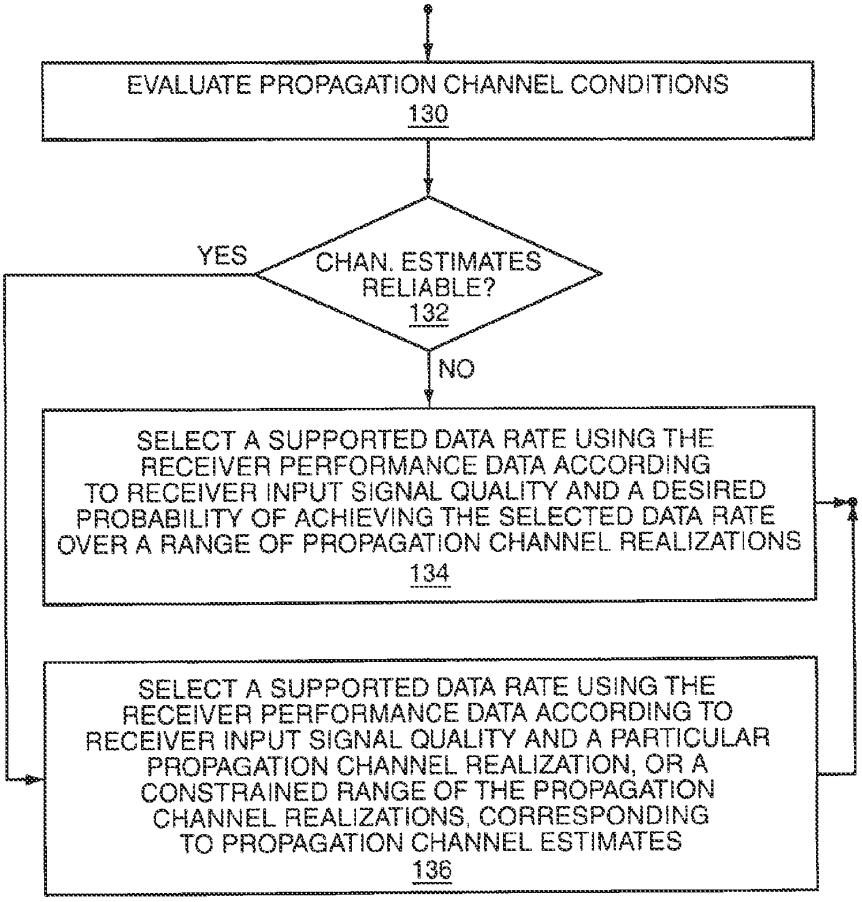


FIG. 8

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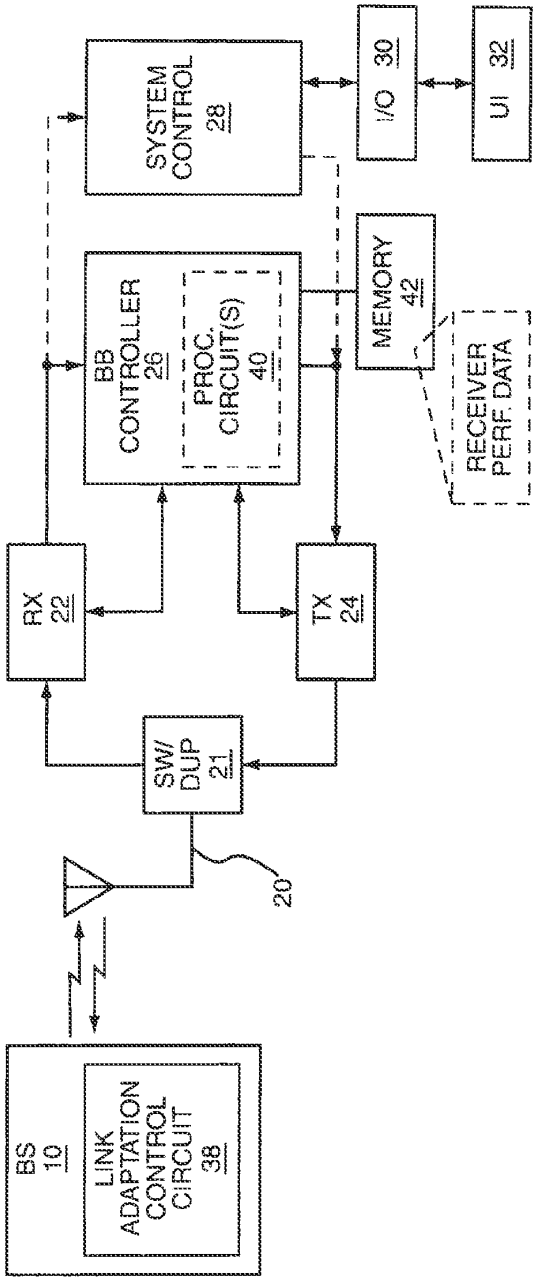


FIG. 9

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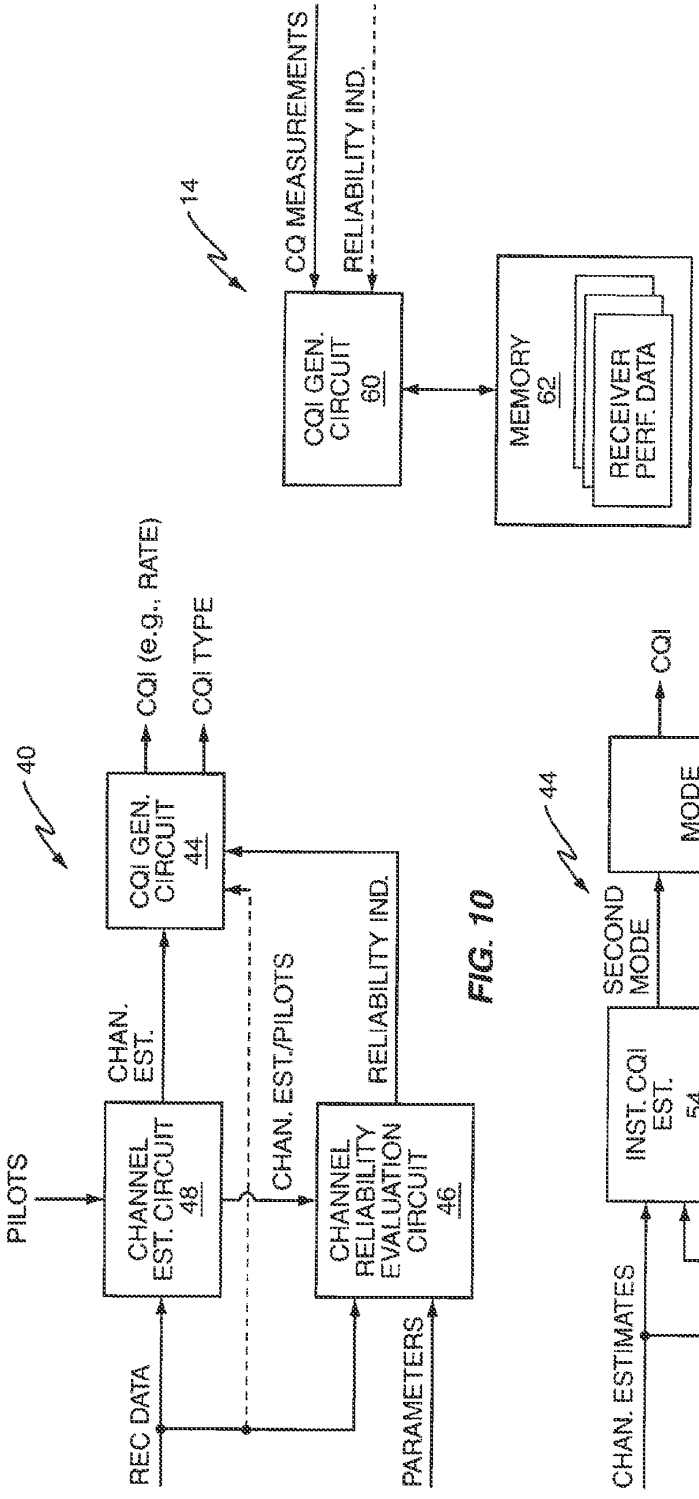


FIG. 10

FIG. 12

FIG. 11

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Electronic Acknowledgement Receipt

EFS ID:	45771571
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-MAY-2022
Filing Date:	23-NOV-2020
Time Stamp:	05:46:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	054USC_SIDS_FR1CN1.pdf	25944384 14bc8a7d4dbc5c2153acdb3a0f9f02e0ff53a1a5	no	20

Warnings:

Information:					
2	Foreign Reference	054USC_SIDS_FR2CN_2.pdf	10227450 ce9b787fafc355e9d006f5a114768463903dc692	no	13
Warnings:					
Information:					
3	Foreign Reference	054USC_SIDS_FR3_WO_1.pdf	18006014 51510021d0d4bf3b288785c94a8f61d25cdf4ae5	no	20
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4	Foreign Reference	054USC_SIDS_FR4_WO_2.pdf	16247124 87c887dc9ab7f31ffe02e8c5cc8f8680bed3a38b	no	24
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5	Foreign Reference	054USC_SIDS_FR5.pdf	3977836 eb594ca6755b2603a67adc1a05fbfdeac6530ad7	no	97
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6	Non Patent Literature	054USC_SIDS_NPL1.pdf	1726224 facbdad42f825aeed2dcec930d2001f64f95bc5b	no	2
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7	Non Patent Literature	054USC_SIDS_NPL2.pdf	120282 6cc818969433e9bb0c76e7e1bb476a0f59fc977e	no	2
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8	Non Patent Literature	054USC_SIDS_NPL3.pdf	9766721 8c60101888afe587073f9bff7263490cd50c2897	no	24
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9	Non Patent Literature	054USC_SIDS_NPL4.pdf	7499300 f11a259499badd4508c3459e5bb2bf887ce59305	no	10
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11	Non Patent Literature	054USC_SIDS_NPL6.pdf	1573230 c72e96f7683a170146895a743a18bc14a87d645d	no	1
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Information:					
		Total Files Size (in bytes):	112593437		

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New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04Q 7/00 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200680005801.0

[43] 公开日 2008 年 4 月 2 日

[11] 公开号 CN 101156458A

[22] 申请日 2006.1.30
[21] 申请号 200680005801.0
[30] 优先权
[32] 2005. 2.23 [33] US [31] 60/655,770
[32] 2005. 9.30 [33] US [31] 11/240,146
[86] 国际申请 PCT/US2006/004618 2006.1.30
[87] 国际公布 WO2006/091391 英 2006.8.31
[85] 进入国家阶段日期 2007.8.23
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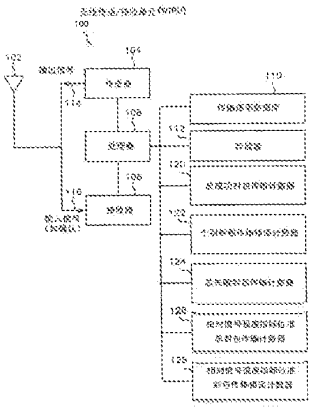
权利要求书 10 页 说明书 15 页 附图 7 页

[54] 发明名称

动态适应封包传输速率的无线通信方法及装置

[57] 摘要

一种由第一收发器(如无线传送/接收单元，存取点，节点)所使用的方法与装置，用以基于自第二收发器所接收信号为基础调整传送至该第二收发器的封包传输速率的方法及装置。一实施例中，传输封包错误率(TxPER)处理系用来调整封包传输速率。另一实施例中，相对信号强度指针(RSSI)为基础处理系用来决定于该第一收发器处自该第二收发器所接收封包的相对信号强度指针，以调整封包传输速率。另一实施例中，传输品质指针系于该第二收发器处测量且被传送至该第一收发器测量，其可以该品质指针为基础来驱动新封包传输速率。传输封包错误率及相对信号强度指针为基础处理可分别、组合或结合其它处理使用。



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1. 一种于一无线通信系统用于调整一无线传送/接收单元的一封包传输速率的方法，该无线通信系统包含复数无线传送/接收单元，该方法包含：

(a)该无线传送/接收单元的第一者决定一传送可用封包的一封包传输速率；

(b)该第一无线传送/接收单元以步骤(a)中所被选择的该传输速率将该封包传送至该无线传送/接收单元的一第二者；及

(c)该第一无线传送/接收单元以该传送封包为基础实施一相对信号强度指针训练处理。

2. 根据权利要求 1 的方法，其特征在于，进一步包含：

(d)该第一无线传送/接收单元决定在一预定时间区间内自该第二无线传送/接收单元所接收的至少一封包是否可获得至少一有效相对信号强度指针测量。

3. 根据权利要求 2 所述的方法，其特征在于，若步骤(d)的决定为肯定，则该方法进一步包含：

(e)该第一无线传送/接收单元决定该至少一可用相对信号强度指针测量的该相对信号强度指针位准；及

(f)该第一无线传送/接收单元决定于步骤(e)中所决定的该相对信号强度指针位准是否于该预定时间区间内先被该相对信号强度指针训练处理使用。

4. 根据权利要求 3 所述的方法，其特征在于，若步骤(f)的决定为肯定，则该方法进一步包含：

(g)该第一无线传送/接收单元设定该封包传输速率为依据该相对信号强度指针训练处理所决定针对该相对信号强度指针位准所建立的一较佳封包传输速率。

5. 根据权利要求 2 所述的方法，其特征在于，若步骤(d)的决定为否定，则该方法进一步包含：

(e)该第一无线传送/接收单元实施一传输封包错误率为基础处理来决定该封包传输速率。

6. 根据权利要求 3 所述的方法，其特征在于，若步骤(f)的决定为否定，则该方法进一步包含：

(g)该第一无线传送/接收单元实施一传输封包错误率为基础处理来决定该封包传输速率。

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7. 根据权利要求 1 所述的方法，其特征在于，该相对信号强度指针训练处理包含：

(i)若该第二无线传送/接收单元，将一确认(ACK)信息传送至该第一无线传送/接收单元，以响应接收由该第一无线传送/接收单元所传送的该封包，则该第一无线传送/接收单元决定该确认(ACK)信息的一相对信号强度指针测量的相对信号强度指针位准，及增加该相对信号强度指针位准的一总封包传输计数；及

(ii)该第一无线传送/接收单元更新该相对信号强度指针位准的一较佳封包传输速率。

8. 一种于无线通信系统中用于调整一存取点的封包传输速率的方法，其中该无线通信系统包含至少一该及存取点及至少一无线传送/接收单元，该方法包含：

(a)该存取点决定传送一可用封包的一封包传输速率；

(b)该存取点以步骤(a)中所选择的该传输速率传送该封包至该无线传送/接收单元；及

(c)该存取点以该传送封包为基础实施一相对信号强度指针训练处理。

9. 根据权利要求 8 所述的方法，其特征在于，进一步包含：

(d)该存取点决定在一预定时间区间内自该无线传送/接收单元所接受的至少一封包是否可获得至少一有效相对信号强度指针测量。

10. 根据权利要求 9 所述的方法，其特征在于，若步骤(d)的决定为肯定，则该方法进一步包含：

(e)该存取点决定该至少一有效相对信号强度指针测量的该相对信号强度指针位准；及

(f)该存取点决定被决定于步骤(e)中所决定的该相对信号强度指针位准是否于该预定时间区间内先由该相对信号强度指针训练处理所使用。

11. 根据权利要求 10 所述的方法，其特征在于，若步骤(f)的决定为肯定，则该方法进一步包含：

(g)该存取点设定该封包传输速率为依据该相对信号强度指针训练处理所决定为该相对信号强度指针位准所建立的一较佳封包传输速率。

12. 根据权利要求 9 所述的该方法，其特征在于，若步骤(d)的决定为否定，则该方法进一步包含：

(e)该存取点实施一传输封包错误率为基础处理来决定该封包传输速率。

13. 根据权利要求 10 所述的方法，其特征在于，若步骤(f)的决定为否定，则

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该方法进一步包含：

(g)该存取点实施传输封包错误率为基础处理来决定该封包传输速率。

14. 根据权利要求 8 所述的方法，其特征在于，相对信号强度指针训练处理系包含：

(i)若该无线传送/接收单元将一确认(ACK)信息传送至该存取点以响应接收由该存取点所传送的该封包，则该存取点决定该确认(ACK)信息的一相对信号强度指针测量的相对信号强度指针位准，及增加该相对信号强度指针位准的一总封包传输计数；及

(ii)该存取点更新该相对信号强度指针位准的较一佳封包传输速率。

15. 一种可调整一封包传输速率的存取点，该存取点包含：

(a)一处理器，可决定该存取点的一封包传输速率；及

(b)一传送器，以该处理器所决定的该速率传送一封包至一无线传送/接收单元，其中该处理器系可对该封包实施相对信号强度指针训练处理，并可决定在一预定时间区间内被接收自该无线传送/接收单元所接收的至少一封包是否可获得至少一相对信号强度指针测量。

16. 根据权利要求 15 所述的存取点，其特征在于，若一预定时间区间内自该无线传送/接收单元所接受的至少一封包可获得至少一相对信号强度指针测量，则该处理器决定该至少一可用相对信号强度指针测量的该相对信号强度指针位准，及决定该相对信号强度指针位准是否于该预定时间区间内先被该相对信号强度指针训练处理使用。

17. 根据权利要求 15 所述的存取点，其特征在于，若预定时间区间内被接收自该无线传送/接收单元所接受的至少一封包不可获得至少一相对信号强度指针测量，则该处理器实施一传输封包错误率为基础处理来决定该封包传输速率。

18. 根据权利要求 17 所述的存取点，其特征在于，若该相对信号强度指针位准于该预定时间区间内不先被该相对信号强度指针训练处理使用，则该处理器实施一传输封包错误率为基础处理来决定该封包传输速率。

19. 根据权利要求 17 所述的存取点，其特征在于，若该相对信号强度指针位准于该预定时间区间内先被该相对信号强度指针训练处理使用，则该处理器设定该封包传输速率为依据该相对信号强度指针训练处理所决定为该相对信号强度指针位准所建立的一较佳位准。

20. 根据权利要求 15 所述的存取点，其特征在于，若该无线传送/接收单元传

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送一确认(ACK)信息以响应接收由该存取点所传送的该封包，则该处理器决定该确认(ACK)信息的一相对信号强度指针测量的相对信号强度指针位准，及增加该相对信号强度指针位准的一总封包传输计数，及更新该相对信号强度指针位准的一较佳封包传输速率。

21. 根据权利要求 15 所述的存取点，其特征在于，若该有取点为接收到对该封包的一确认(ACK)信息以响应传送该封包，则该处理器决定在该预定时间区间内自该第二无线传送/接收单元所接受的任何封包是否可获得任何相对信号强度指针测量，若是，则决定该封包的一相对信号强度指针位准，及增加该相对信号强度指针位准的一总传输计数及一错误计数，及更新该相对信号强度指针位准的一较佳封包传输速率。

22. 一种并入一收发器中以用于可调整该收发器的封包传输速率的集成电路(IC)，该集成电路包含：

(a)一处理器，可决定该存取点的一封包传输速率；及

(b)一传送器，以该处理器所决定的该速率传送一封包至另一收发器，其中该处理器可对该封包实施一相对信号强度指针训练处理，并可决定在一预定时间区间内自该其它收发器所接收的至少一封包是否可获得至少一相对信号强度指针测量。

23. 根据权利要求 22 所述的集成电路，其特征在于，若一预定时间区间内自该其它收发器所接收的至少一封包可获得至少一相对信号强度指针测量，则该处理器决定该至少一可用相对信号强度指针测量的该相对信号强度指针位准，及可决定该相对信号强度指针位准是否于该预定时间区间内先被该相对信号强度指针训练处理使用。

24. 根据权利要求 22 所述的集成电路，其特征在于，若预定时间区间内自该其它收发器所接收的至少一封包不可获得至少一相对信号强度指针测量，则该处理器实施一传输封包错误率为基础处理来决定该封包传输速率。

25. 根据权利要求 24 所述的集成电路，其特征在于，若该相对信号强度指针位准于该预定时间区间内不先被该相对信号强度指针训练处理使用，则该处理器实施一传输封包错误率为基础处理来决定该封包传输速率。

26. 根据权利要求 24 所述的集成电路，其特征在于，若该相对信号强度指针位准于该预定时间区间内先被该相对信号强度指针训练处理使用，则该处理器设定该封包传输速率为依据该相对信号强度指针训练处理所决定针对该相对信号强度指针位准所建立的一较佳位准。

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27. 根据权利要求 22 所述的集成电路，其特征在于，若该其它收发器传送一确认(ACK)信息以响应接收该封包，则该处理器决定该确认(ACK)信息的一相对信号强度指针测量的相对信号强度指针位准，及增加该相对信号强度指针位准的一总封包传输计数，及更新该相对信号强度指针位准的一较佳封包传输速率。

28. 根据权利要求 22 所述的集成电路，其特征在于，若该收发器未接收到对该封包的一确认(ACK)信息以响应传送该封包，则该处理器决定该确认(ACK)信息的一相对信号强度指针测量的该相对信号强度指针位准，及更新该相对信号强度指针位准的一较佳封包传输速率。

29. 一种无线传送/接收单元，可调整该无线传送/接收单元经由一天线传送的一封包的封包传输速率，该无线传送/接收单元包含：

(a)一传送器，以特定封包传输速率传送至少一封包传送至一节点；

(b)一接收器，其从接收及确认该至少一封包接收的该节点接收一确认(ACK)信号；

(c)一处理器，其与该传送器及该接收器通信；

(d)一内存，其与该处理器通信；

(e)一传输速率数据库，其与该处理器通信；及

(f)复数封包传输计数器，其与该处理器通信。

30. 根据权利要求 29 所述的无线传送/接收单元，其特征在于，该特定封包传输速率系被初始设定为一预设速率。

31. 根据权利要求 29 所述的无线传送/接收单元，其特征在于，该封包传输计数器包含一总成功封包传输计数器及一个别封包传输错误计数器。

32. 根据权利要求 31 所述的无线传送/接收单元，其特征在于，当该接收器从该节点接收一确认(ACK)时，该总成功封包传输计数器会增加。

33. 根据权利要求 32 所述的无线传送/接收单元，其特征在于，当该接收器从该节点接收一确认(ACK)时，将该个别封包传输错误计数器重设为零。

34. 根据权利要求 33 所述的无线传送/接收单元，其特征在于，该封包传输计数器更包含一总失败封包传输计数器，而该处理器以该总成功封包传输计数器的一第一计数值及该总失败封包传输计数器的一第二计数值的加总为基础来调整该特定封包传输速率。

35. 根据权利要求 34 所述的无线传送/接收单元，其特征在于，若该加总大于等于封包传输速率增加所需的预定封包值，则该特定封包传输速率系被增加。

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36. 根据权利要求 35 所述的无线传送/接收单元，其特征在于，若该第二计数值对该第一计数值的比率小于一预定封包传输速率增加比率，则该特定封包传输速率系被增加。

37. 根据权利要求 29 所述的无线传送/接收单元，其特征在于，该封包传输计数器包含一总失败封包传输计数器及一个别封包传输错误计数器。

38. 根据权利要求 37 所述的无线传送/接收单元，其特征在于，当该接收器于传送该至少一封包至该节点时并不从该节点接收一确认(ACK)时，该总失败封包传输计数器及该个别封包传输错误计数器会增加。

39. 根据权利要求 38 所述的无线传送/接收单元，其特征在于，该特定封包传输速率系以该个别封包传输错误计数器的一计数值为基础，由该传输速率数据库所指定的一或多个支持速率步骤所降低。

40. 根据权利要求 29 所述的该无线传送/接收单元，其特征在于，该封包传输计数器包含一接收信号强度指针位准总封包传输计数器。

41. 根据权利要求 40 所述的无线传送/接收单元，其特征在于，若一相对信号强度指针训练处理不先用来决定该特定封包传输速率，则在传送该至少一封包至该节点后自该内存从该节点所被接收的一确认(ACK)的相对信号强度指针测量检索，该相对信号强度指针测量系由该处理器决定，而该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器会增加。

42. 根据权利要求 41 所述的无线传送/接收单元，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中进行更新。

43. 根据权利要求 40 所述的无线传送/接收单元，其特征在于，若一相对信号强度指针训练处理先用于决定该特定封包传输速率，则在传送该至少一封包至该节点后，自该内存从该节点所接收的一确认(ACK)的一相对信号强度指针测量检索，该相对信号强度指针测量由该处理器决定，而该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器会增加。

44. 根据权利要求 43 所述的无线传送/接收单元，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中进行更新。

45. 根据权利要求 40 所述的无线传送/接收单元，其特征在于，若一相对信号强度指针训练处理先被用来决定该特定封包传输速率，且不需从该节点接收一确认

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(ACK)而将该至少一封包传送至该节点后，该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器会增加。

46. 根据权利要求 45 所述的无线传送/接收单元，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中进行更新。

47. 根据权利要求 29 所述的无线传送/接收单元，其特征在于，该封包传输计数器包含一接收信号强度指针位准总封包传输计数器及一相对信号强度指针位准封包传输错误计数器。

48. 根据权利要求 47 所述的无线传送/接收单元，其特征在于，在传送该至少一封包至该节点后，从该节点所接收的一确认(ACK)的相对信号强度指针测量系被检索自该内存，而该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器系针对该确认(ACK)的相对信号强度指针位准而增加。

49. 根据权利要求 47 所述的无线传送/接收单元，其特征在于，若不需从该节点接收一确认(ACK)而将该至少一封包被传送至该节点后，决定在一最后最大持续期间内自该节点所接受的任何封包是否可获得任何相对信号强度指针测量，若是，则决定该测量的该相对信号强度指针位准，而该相对信号强度指针位准总封包传输计数器及该相对信号强度指针位准封包传输错误计数器会增加。

50. 根据权利要求 49 所述的无线传送/接收单元，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中进行更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦被于该内存中进行更新。

51. 根据权利要求 29 所述的无线传送/接收单元，其特征在于，该无线传送/接收单元以自该节点所接收的一速率指令为基础而设定该特定封包传输速率，及以该接收速率指令为基础传送封包。

52. 一种并入一无线传送/接收单元中的集成电路，该集成电路可调整该无线传送/接收单元经由一天线索传送的封包的一封包传输速率，该集成电路包含：

(a)一传送器，以一特定封包传输速率传送至少一封包至一节点；

(b)一接收器，用于从接收及确认该至少一封包接收的该节点接收一确认(ACK)信号；

(c)一处理器，其与该传送器及该接收器通信；

(d)一内存，其与该处理器通信；

(e)一传输速率数据库，其与该处理器通信；及

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(f)复数封包传输计数器，其与该处理器通信。

53. 根据权利要求 52 所述的集成电路，其特征在于，该特定封包传输速率系被初始设定为一预设速率。

54. 根据权利要求 52 所述的集成电路，其特征在于，该封包传输计数器包含一总成功封包传输计数器及一个别封包传输错误计数器。

55. 根据权利要求 54 所述的集成电路，其特征在于，当该接收器从该节点接收一确认(ACK)时，该总成功封包传输计数器会增加。

56. 根据权利要求 55 所述的集成电路，其特征在于，当该接收器从该节点接收一确认(ACK)时，将该个别封包传输错误计数器重设为零。

57. 根据权利要求 56 所述的集成电路，其特征在于，该封包传输计数器更包含一总失败封包传输计数器，而该处理器以该总成功封包传输计数器的一第一计数值及该总失败封包传输计数器的一第二计数值的加总为基础来调整该特定封包传输速率。

58. 根据权利要求 57 所述的集成电路，其特征在于，若该加总大于等于一封包传输速率增加所需的一预定封包值，则增加该特定封包传输速率。

59. 根据权利要求 58 的集成电路，其特征在于，若该第二计数值对该第一计数值的比率小于一预定封包传输速率增加比率，则增加该特定封包传输速率。

60. 根据权利要求 52 所述的集成电路，其特征在于，该封包传输计数器包含一总失败封包传输计数器及一个别封包传输错误计数器。

61. 根据权利要求 60 所述的集成电路，其特征在于，当该接收器于传送该至少一封包至该节点时并不从该节点接收一确认(ACK)时，该总失败封包传输计数器及该个别封包传输错误计数器会增加。

62. 根据权利要求 61 所述的集成电路，其特征在于，该特定封包传输速率系以该个别封包传输错误计数器的一计数值为基础，由该传输速率数据库所指定的一或更多个支持速率步骤所降低。

63. 根据权利要求 52 所述的集成电路，其特征在于，该封包传输计数器包含一接收信号强度指针位准总封包传输计数器。

64. 根据权利要求 63 所述的集成电路，其特征在于，若一相对信号强度指针训练处理不先用来决定该特定封包传输速率，则传送该至少一封包至该节点后自该内存从该节点所接收的一确认(ACK)的相对信号强度指针测量检索，该相对信号强度指针测量系该处理器决定，而该相对信号强度指针位准的该相对信号强度指针位准总封

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包传输计数器会增加。

65. 根据权利要求 64 所述的集成电路，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中更新。

66. 根据权利要求 63 所述的集成电路，其特征在于，若一相对信号强度指针训练处理先用于决定该特定封包传输速率，则在传送该至少一封包至该节点之后，自该内存从该节点所接收的一确认(ACK)的一相对信号强度指针测量检索，该相对信号强度指针测量由该处理器决定，而该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器会增加。

67. 根据权利要求 66 所述的集成电路，其特征在于，该相对信号强度指针位准的一封包错误率被于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中更新。

68. 根据权利要求 63 所述的集成电路，其特征在于，若相对信号强度指针训练处理先被用来决定该特定封包传输速率，且不需从该节点接收一确认(ACK)而将该至少一封包传送至该节点后，该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器会增加。

69. 根据权利要求 68 所述的集成电路，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中更新。

70. 根据权利要求 52 所述的集成电路，其特征在于，该封包传输计数器包含一接收信号强度指针位准总封包传输计数器及一相对信号强度指针位准封包传输错误计数器。

71. 根据权利要求 70 所述的集成电路，其特征在于，在传送该至少一封包至该节点后，从该节点所接收的一确认(ACK)的相对信号强度指针测量系被检索自该内存，而该相对信号强度指针位准的该相对信号强度指针位准总封包传输计数器系针对该确认(ACK)的相对信号强度指针位准而增加。

72. 根据权利要求 70 所述的集成电路，其特征在于，若不需从该节点接收一确认(ACK)而将该至少一封包传送至该节点后，决定在一最后最大持续期间内自该节点所接收的任何封包是否可获得任何相对信号强度指针测量，若是，则决定该测量的该相对信号强度指针位准，而该相对信号强度指针位准总封包传输计数器及该相对信号强度指针位准封包传输错误计数器会增加。

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73. 根据权利要求 72 所述的集成电路，其特征在于，该相对信号强度指针位准的一封包错误率系于该内存中更新，若该封包错误率稳定，则该相对信号强度指针位准的一较佳封包传输速率亦于该内存中更新。

74. 根据权利要求 52 所述的集成电路，其特征在于，该集成电路以自该节点所接收的一速率指令为基础而设定该特定封包传输速率，及以该接收速率指令为基础传送封包。

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动态适应封包传输速率的无线通信方法及装置

技术领域

本发明是有关无线通信系统中的数据传输。更特别是，本发明是有关动态适应封包传输速率以响应改变衰减条件。

背景技术

如无线局域网络(WLANs)的无线通信系统系熟知于技术领域中。通常，该系统包含收发器(也就是通信站(STAs))，其可传送及接收彼此间的无线通信信号。视系统类型而定，收发器可采用存取点(AP)，无线传送/接收单元(WTRU)，节点或类似者的型式。

图 1 显示一传统无线通信系统 10，其中存取点 12 可提供通信服务至复数无线传送/接收单元 14。存取点 12 可经由可选存取控制器(AC)16 与网络 18 通信，藉此提供附加网络服务至无线传送/接收单元 14，如对互联网或公共服务电话网络(PSTN)的存取。可替代是，存取点 12 可不需经由可选存取控制器 16 而与网络 18 直接通信。

理论上，系统 10 内所有连接均可以最高可达成传输速率操作使效能及全部系统容量最大化。然而，因为需接收器处相当高信号噪声比(SNRs)，所以并非总可以较高数据速率达到可接收品质。

视接收封包的收发器所察觉的信号噪声比情况而定，此创造对调整封包被传送的送率有利的情况。然而，系统 10 并不提供机构将被接收信号功率，信号噪声比或封包错误率(PER)型式表示的被察觉频道品质转移至封包源。因此，调整系统 10 中的存取点 12 及无线传送/接收单元 14 的传输速率的决定基础系被限制为局部传输状况。

发明内容

本发明是有关一种以第一收发器(如无线传送/接收单元，存取点，节点或类似者)接收来自第二收发器的信号为基础被该第一收发器用来调整被传送至该第二收发器的封包传输速率的方法及装置。一实施例中，传输封包错误率(TxPER)处理系被用来调整封包传输速率。另一实施例中，相对信号强度指针(RSSI)为基础处理系被使用，

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藉此被该第一收发器接收来自用该第二收发器的封包相对信号强度指针系被用来调整封包传输速率。另一实施例中，传输品质指针系系被测量于该第二收发器处且被传送至该第一收发器，其可以该品质指针为基础来驱动新封包传输速率。可选择是，该第二收发器可决定较佳封包传输速率并将其传送至该第一收发器，于是其可调整其封包传输速率。

虽然两不同决定封包传输速率的处理(也就是传输封包错误率处理及相对信号强度指针为基础处理在此被揭示，但这些处理可被个别使用，彼此连结使用，或与其它处理连结使用。

依据本发明，收发器可以收发器处的测量为基础从若干可用速率间选择较佳数据传输速率。这些测量系为被接收于该收发器处的封包被接收信号强度(Rx 功率)，及被该收发器传送的信号传输封包错误率，其可通过假设封包于每次其对应确认(ACK)不被接收自另一收发器时均错误来推断。该收发器可快速建立最佳可用数据传输速率而仍可维持可接受服务品质(QoS)。此后，该收发器可适应其传输速率以响应改变衰减条件。

附图说明

本发明可从以下较佳实施例说明及附图获得更详细了解，其中：

第 1 图显示传统无线通信系统；

图 2 为依据本发明配置的无线传送/接收单元方块图例；

图 3 为依据本发明实施的全部速率适应处理流程图；

图 4 为图 3 的全部速率适应处理的传输封包错误率为基础处理流程图；

图 5 为图 3 的全部速率适应处理的相对信号强度指针训练处理流程图；

图 6 为图 3 的全部速率适应处理的相对信号强度指针训练处理另一实施例流程图；及

图 7 为图 3 的全部速率适应处理的替代相对信号强度指针训练处理例。

缩写字表

ACK	确认
AP	存取点
BS	基地台

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CS	客户站
CTS	清理后送
MAC	媒体存取控制
NF	噪声指数
PER	封包错误率
Pwr	功率
QoS	服务品质
RSSI	相对信号强度指针
RTS	要求传送
Rx	接收
SNR	信号噪声比
STA	站
STA Tx	传送站
STA Rx	接收站
Tx	传送
TxPwr	传送功率
WLAN	无线局域网络

表 1

具体实施方式

此后，被使用的存取点名词者系包含但不限于基地台，B 节点，地址控制器，无线路由器或可提供无线传送/接收单元对该存取点连结的网络做无线存取的无线环境中的任何其它接介装置。

此后，被使用的无线传送/接收单元名词系包含但不限于客户站，使用者设备，站，行动站，固定或行动用户单元，呼叫器，或可操作于无线环境中的任何其它类型使用者装置。该无线传送/接收单元包含个人通信装置，如电话，视讯电话及具有网络连接的互联网备用电话。此外，该无线传送/接收单元包含可携式个人计算装置，如具有类似网络功能的无线调制解调器的个人数字助理(PDAs)及笔记型计算机。可携式或可改变位置的无线传送/接收单元系被称为行动单元。

此后，被使用的无线连接系被定义为彼此可传送及接收封包的一对节点间的无线通信。各无线连接系包含一对节点，其中封包的传送器及接收器角色系及时被前后交

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换于该节点之间。例如，以两无线传送/接收单元与单存取点通信的架构模式操作的无线通信系统系包含两无线连接。速率控制处理应驻留于各传送节点中，其目的系针对各主动无线连接决定各封包被传送的最佳速率。

较佳是，在此所说明的实施各传送器及接收器功能系可被并入如特定应用集成电路的单集成电路上。然而，该电路亦可轻易使用多分离组件及/或分离集成电路来实施。

在此所说明的特定传送器及接收器配置仅被提供为例证而不限制。熟练一般技术人士将了解符合本发明的其它变异及修改。

本发明是为促使收发器(也就是无线传送/接收单元，存取点，节点)依据各无线频道随时间改变传播情况被啮合一个或多无线连接来动态适应其传输速率。为了如此，本发明是视特定测量可用性及有效性而定依赖两处理来决定较佳传输速率。第一处理中，在此被称为传输封包错误率为基础处理的传输封包错误率系被用来决定最佳传输速率。可替代是，该最佳传输速率系以相对信号强度指针或与其传输功率相关，与被传送封包传输封包错误率相关连的其它被接收封包度量为基础来决定。相对信号强度指针系以在此被称为相对信号强度指针训练处理的处理被与传输封包错误率相关连。虽然相对信号强度指针被用于相对信号强度指针训练处理较佳实施例说明中，但替代实施例亦可使用如信号噪声比的其它度量。

图 2 为依据本发明配置的无线传送/接收单元 100 方块图例。在此被揭示用于无线传送/接收单元 100 的相同配置例亦可被并入存取点中。无线传送/接收单元 100 系包含至少一天线 102，一传送器 104，一接收器 106，一处理器 108，一传输速率数据库 110 及一内存 112。传送器系被配置以被选自被储存于传输速率数据库 110 中的复数可用传输速率的传输速率经由天线 102 传送输出信号 114。接收器 106 系被配置从天线 102 接收输入信号 116。处理器 108 系被耦合至传送器 104，接收器 106，传输速率数据库 110 及内存 112。处理器 108 系从该传输速率数据库 110 选择传输速率，及改变传送器 104 的目前传输速率为被选择速率。此选择可以输出信号 114 评价，输出信号 114 及输入信号 116 评价为基础，或其可以被接收于接收器 106 处的速率指令为基础。内存 112 系被用来针对输入信号 116 及/或输出信号 114，及/或针对被接收于接收器 106 处的速率指令来储存数据。处理器 108 系被配置处理被储存于内存 112 中的数据，并储存内存 112 中的该被处理数据结果以便进一步存取来选择及改变传送器 104 的传输速率。

无线传送/接收单元 100 进一步包含复数封包传输计数器，包含一总成功封包传

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输计数器 120，一个别封包传输错误计数器 122，一总失败封包传输计数器 124，一相对信号强度指针位准总封包传输计数器 126，及一相对信号强度指针位准封包传输错误计数器 128。封包传输计数器 120，122，124，126，及 128 的功能系可以个别基础或当作维持组通过一个或更多数据库，处理器，软件或类似者来实施。例如，多组封包传输计数器 120，122，124，126，及 128 及相关测量系可被维持来个别控制无线传送/接收单元 100 于特定通信链接上通信的各站，存取点，无线传送/接收单元或类似者相关连的封包传输速率。

说明本发明所实施处理之前系有利地定义被列示于下表 2 中的若干名词。虽然本发明处理将被说明于这些中，但应了解并不需使用这些名词；反的，该名词仅为说明该处理特性的便捷。一实施中，参数可被储存于内存中并如需要被更新，或可以任何适当方式被维持及更新。

参 数	说 明	例 子
最大持续期间	从传送器传送封包至的节点的测量或指令系有效的最大持续期间。最大持续期间参数较佳应表示频道的一致性时间。该被接收封包可为任何类型(如 DATA，ACK，RTS，CTS 或类似者)	100ms
可允许速率	被以上升顺序分类的传送器可支持的速率表列。可允许速率可通过被储存于内存中的向量来表示，其中向量各位置系对应特定速率。	IEEE 802.11a 的[6,9,12,18,24,36,48,54]Mbps
预设速率	当速率控制被激活时，应被传送器使用的速率。此可通过可允许速率向量起始指针来表示。	8(标示预设速率系为第 8 高支持速率，如 802.11a 系统中的 54Mbps)
目前速率	被传送器用来传送下一封包的速率。此可通过可允许速率向量目前指针来表示。	5(标示下一封包将以第 5 高支持速率，如 802.11a 系统中的 24Mbps 被传送)
最大速率指针	被支持的不同传输速率数量	8

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速率向下触发	调整传输速率以响应连续传输错误的预定模式或计划，针对再传输尝试，其标示该传输速率是否应被降低，而若是，其应被降低多少速率位准。该模式应被储存为向量。例如，IEEE 802.11a 系统中，[0,0,1,1,2,2,1,0]意指以 54Mbps 操作的无线传送/接收单元直到传输速率被降低一位准至 48Mbps 时的第三再传输(也就是三个错误之后)才不降低其传输速率。若错误产生，则该速率系于第四再传输被降低一位准至 36Mbps，且此后于第五(至 18 Mbps)及第六再传输(至 9 Mbps)降低两位准，且接着降低一位准(至 6 Mbps，最低支持速率)。	[0,0,1,1,2,2,1,0]
速率增加比率	失败对成功封包传输的最大允许比率	0.10
速率增加所需封包	自上次速率改变后必须被传送以允许传输速率增加的最大封包数	10
良好封包计数	传送至特定无线传送/接收单元的成功封包数。此计数系于速率改变被实施后被再初始化至零。	
不良封包计数	传送至特定无线传送/接收单元的失败封包数。此计数系于速率改变被实施后被再初始化至零。	
重试计数	给定封包的失败传送尝试数。当封包被成功传送时，此计数系被再初始化至零。	

表 2

图 3 为依据本发明实施的全部速率适应处理 300 流程图。传输速率系使用图 2 无线传送/接收单元 100 中的处理器 108 所实施的传输封包错误率为基础处理或相对信号强度指针为基础处理来决定。使用何处理的决定系以相对信号强度指针为基础处理先前是否以被训练，及特定相对信号强度指针位准是否可获得有效相对信号强度指针测量为基础。若是，相对信号强度指针为基础处理系被用来决定传输速率。否则，传输封包错误率为基础处理系被使用。任一例中，封包接着均以该处理的一所决定的速率传送，而封包传输的接续成功或失败系被用来动态训练相对信号强度指针为基础处理及调整传输速率。

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有效相对信号强度指针测量系被定义为预定持续期间(在此被指定为最大持续期间)内从传送器最后传送封包至的节点被接收的封包相对信号强度指针测量。最大持续期间系代表频道一致性时间。被接收封包可为任何类型，如 DATA，ACK，RTS，CTS 或类似者。

如图 3 所示，当第一站(也就是无线传送/接收单元 100)通过设定第一站的封包传输速率为预设速率准备第一次传送封包至第二站时，全部速率适应处理 300 激活(步骤 305)。当第一站具有封包传送至第二站(步骤 310)时，决定最后最大持续期间内是否具有任何可用于任何被接收自第二站的任何封包的有效相对信号强度指针测量(步骤 315)。

若该持续期间内并无任何封包被接收或无该测量可用于任何被接收封包，则传输封包错误率为基础处理系被实施来决定第一站的封包传输速率(步骤 320)，稍后其将被详述。

然而，若有效相对信号强度指针测量被决定可获得于步骤 315 中，则可用有效相对信号强度指针测量的相对信号强度指针位准决定系被执行(步骤 325)。步骤 325 中，若有效相对信号强度指针测量系被决定存在于一个以上相对信号强度指针位准，则代表性相对信号强度指针位准系被决定。该代表性相对信号强度指针位准可以最后相对信号强度指针值为基础，或可为静态(如平均值)，以若干相对信号强度指针值为基础，或以相对信号强度指针值结合其它值为基础。步骤 330 中，决定相对信号强度指针处理是否已于最后最大持续期间内被训练于此相对信号强度指针位准。若是，则第一站的封包传输速率系如该相对信号强度指针训练处理所决定被设定为该相对信号强度指针位准较佳速率(步骤 335)，该封包系被传送(步骤 340)且该相对信号强度指针训练处理系被实施(步骤 345)。当第一站具有另一封包传送至第二站时，处理 300 系返回步骤 310。如传输封包错误率为基础处理被说明后将被说明如下者，被传送封包成功或失败系被用来动态更新相对信号强度指针训练处理 345 所标示的较佳传输速率。

步骤 330 中，若决定相对信号强度指针处理于最后最大持续期间内不被训练于此相对信号强度指针位准，则传输封包错误率为基础处理被实施来决定第一站的封包传输速率(步骤 320)。封包接着被传送(步骤 340)，且该相对信号强度指针训练处理系被实施(步骤 345)。

图 4 为图 3 的全部速率适应处理 300 的传输封包错误率为基础处理 320 流程图。通常，依据传输封包错误率为基础处理 320，图 2 的无线传送/接收单元 100 中的传送器 104 系可通过反应其传送至一接收节点时所经历的传输事件来调整其封包传输

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速率。

若图 2 的无线传送/接收单元 100 的传送器 104 经历连续封包传输错误，则其封包传输速率系依据在此被指定为速率向下触发(Rate Down Trigger)的预定计划或模式而被降低。该速率向下触发可为被储存于图 2 的无线传送/接收单元 100 中的内存 112 中的一向量。各连续封包传输错误之后，该速率向下触发可指示封包传输速率是否应于下一封包再传输尝试之前被降低，且若是则有多少。若有，则该被指示速率降低接着被实施。封包传输速率系以此方式被降低直到封包被成功传送为止，或直到该封包传输速率被降低为预定最小封包传输速率为止。

例如，若无线传送/接收单元 100 被配置用于 IEEE 802.11a 系统中，则被以上升顺序步骤分类的被支持封包传输速率(也就是被支持封包传输速率位准)系为 6，9，12，18，24，36，48 及 54Mbps。该例中，[0，0，1，1，2，2，1，0] 的速率向下触发向量系指示无线传送/接收单元 100 直到第三再传输尝试之后(也就是特定封包三传输错误之后)才降低其封包传输速率，此点上，该封包传输速率将被降低一步。于是，若无线传送/接收单元 100 于第三传输错误之后以 54Mbps 操作，则传输速率将被降低一步至 48 Mbps，而封包将被再传输。若传输错误仍然产生，则第四再传输，速率接着被再降低一步至 36 Mbps，接着于第五(至 18 Mbps)及第六再传输(至 9 Mbps)被再降低两步，且接着降低一步(至 6 Mbps，最低支持速率)。

另一方面，若无线传送/接收单元 100 的传送器 104 经历一致连续封包传输错误，传送器 104 的传输速率系依据传输封包错误率为基础处理 320 被增加。该例中，针对被传送至接收节点的充份封包数量，当传送器 104 所经历的传输封包错误率下降低于特定门槛时，传输速率系被增加至下一支持步骤。

如图 4 所示，若确认(ACK)被接收(步骤 405)，则无线传送/接收单元 100 中的总成功封包传输计数器 120 系被增加，而无线传送/接收单元 100 中的个别封包传输错误计数器 122 系被重设为零(步骤 430)。如以下说明，这些计数器 120，122 系被用来决定传输速率是否应被增加。

若确认不被接收于步骤 405，则无线传送/接收单元 100 中的总失败封包传输计数器 124 系被增加，而个别封包传输错误计数器 122 亦被增加(步骤 410)。速率向下触发向量系被检验来决定封包传输速率是否应针对个别封包传输错误计数值被降低，而若是，有多少步骤(步骤 415)。若速率向下触发指示封包传输速率不应被降低，则相同封包系被准备再传输。然而，若速率向下触发于步骤 415 指示封包传输速率应被降低一或更多步，则封包传输速率系被降低速率向下触发所指示的步骤数，且总成功

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封包传输计数器 120 及总失败封包传输计数器 124 系被重设为零(步骤 420)。相同封包接着被准备以速率向下触发所指示的封包传输速率做再传输(步骤 425)。传输封包错误率为基础处理 320 可于通信对话期间被重复，直到封包传输速率等于最低支持传输速率或直到确认(ACK)被接收为止。

触动传输速率降低之前要求经历连续错误事件系导致倾向区隔不良信号情况所产生的错误事件及封包冲突所产生的错误事件。其亦促成较考虑封包错误事件数平均的准则为快的速率降低反应时间，并于已被实施速率降低不产生更可靠通信时提供附加传输速率降低。

当确认(ACK)被决定被接收以响应步骤 405 中的被传送封包时，总成功封包传输计数器 120 系被增加，而个别封包传输错误计数器 122 系被重设为零(步骤 430)。接着，决定传输速率增加是否可预期。通常，当传输速率增加时，导致传输错误的封包传输比例亦增加。较佳传输速率系为可被使用而仍达到可接受服务品质的最高支持速率。例如，该服务品质可被表示为传输封包错误率或传输错误对成功传输的比率。若传送器经历较维持可接受服务品质所需为低的传输错误对成功传输的比率，则传输速率增加可预期。

传输封包错误率为基础处理 320 可决定传输速率增加是否可通过第一加总总成功封包传输计数及总失败封包传输计数(也就是自传输开始或自最后封包传输速率改变之后找寻封包传输总数)来预期。此加总系被与门槛值相较(在此被标示为速率增加所需的封包)(步骤 435)。速率增加所需的封包系指出自速率增加被允许所产生最后封包传输速率改变发生之后必须被传送的最小封包数。若该加总不大于或等于速率增加所需的封包，则不允许任何封包传输速率调整且该封包传输速率不被增加。

若总成功封包传输计数及总失败封包传输计数加总大于或等于速率增加所需的封包(步骤 435)，则处理 320 可决定速率增加是否被保证。速率增加系被保证传输失败比例是否小于被允许维持可预期服务品质。例如，传输失败比例可通过决定传输失败对成功传输比率或以任何其它适当方式被指出。封包传输速率增加系被决定被保证总成功封包传输计数对总失败封包传输计数比率是否小于维持可接受服务品质所需者。维持可接受服务品质所需的比率系为一门槛(在此被指定为速率增加比率)。若总失败封包传输计数对总成功封包传输计数比率于步骤 440 被决定不小于速率增加比率，则封包传输速率增加不被保证，且封包传输速率不被调整。

然而，若总失败封包传输计数对总成功封包传输计数比率于步骤 440 被决定小于速率增加比率，则封包传输速率增加系被增加至次高步(也就是次高支持封包传输速

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率)，若可获得一者，而总成功封包传输计数器 120 及总失败封包传输计数器 124 系被重设为零(步骤 445)。通信对话期间，处理 25 可被重复直到最大支持传输速率被达成或确认(ACK)不被接收为止。

当通信进行于第一站(其中本发明被实施)及第二站之间时，相对信号强度指针处理系被动态训练于第一站处。当相对信号强度指针处理被训练时，该相对信号强度指针处理系较佳决定第一站的较佳传输速率。相对信号强度指针为基础速率适应处理系通过反应被接收于第一站处来自第二站的被接收封包功率变异来适应封包被第一站传送至第二站的封包传输速率。实施例中，被接收功率系被反映于被接收封包的测量相对信号强度指针中；然而，与该被接收功率相关的信号噪声比或其它度量亦可被使用。

相对信号强度指针为基础处理可动态地将被第一站传送至第二站的封包传输封包错误率与被接收于第一站处来自第二站的封包相对信号强度指针产生相关。此动态相关在此系被称为训练相对信号强度指针为基础处理。该相关系分别针对该第一站所使用的各支持传输速率所做。其有助于分为被接收信号功率预期范围分离位准。例如，若被接收信号功率预期范围为-97dBm 至-64dBm，则该范围可被轻易地分为 3dBm 所间隔的位准；如针对总共 12 分离功率位准的-97dBm 至-94dBm，-94dBm 至-91dBm，…-67dBm 至-64dBm。任何小于-97dBm 的被接收功率均可被组合一起为附加功率位准，而任何大于-64dBm 的被接收功率均可被组合一起为再另一功率位准。应了解该范围系从-97 至-64，该范围被分为 3dBm 所间隔的位准，而第 12 分离位准仅被用作例证且不做限制。传输封包错误率及被接收封包相对信号强度指针系通过针对从第一站被传送至第二站及从第二站被传送至第一站的各封包收集第一站测量及信息来决定。有关从第一站被传送至第二站的各封包被收集信息，系包含该封包被传送的传输速率及该传输是否成功(ACK(确认)被接收)或导致传输错误(ACK(确认)不被接收)。从此信息，传输封包错误率系被计算于被使用的各传输速率处。

有关从第二站被传送至第一站的各封包被收集信息，系包含各被接收封包信号强度测量(如相对信号强度指针)及该封包被接收信息。相对信号强度指针测量系被视为仅于被指定最大持续时间一段长度有效。针对相对信号强度指针训练，应注意所有封包类型均可被使用(也就是 DATA，ACK，RTS，CTS 或类似者)。若一个以上封包于最大持续时间内被接收自第二站，则该处理可使用来自该最后被接收封包的相对信号强度指针或以若干封包为基础来计算统计值(如平均值)。由于封包被传送及 ACK(确认)被接收之间耗费简短时间，确认成功传输例中被传送封包的 ACK(确认)帧的相对信号强

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度指针测量系特别有关联。因此，第一实施例中，仅 ACK(确认)信号的相对信号强度指针被使用。

此实施例中，相对信号强度指针训练处理系有关被以被确认的相关传送封包传输速率接收的各 ACK(确认)的相对信号强度指针。若 ACK(确认)被接收，其相对信号强度指针被测量且其相对信号强度指针位准被决定，则该封包传输归属于所使用传输速率处的该相对信号强度指针位准。若无任何 ACK(确认)被接收，则传输错误系被假设。该例中，若相对信号强度指针处理不被用来选择传输速率，则该错误并不归属于任何特定相对信号强度指针位准。然而，若相对信号强度指针处理被用来选择传输速率，则被用来选择传输速率的该相对信号强度指针位准系被辨识，而该错误系归属于该相对信号强度指针位准及传输速率。运算被传送封包及传输错误总数系被维持各传输速率的各相对信号强度指针位准。各相对信号强度指针位准及传输速率的传输错误率系针对该相对信号强度指针位准及传输速率通过传输错误数除以封包传输数来计算。

图 5 为图 3 的全部速率适应处理 300 的相对信号强度指针训练处理 345 流程图。由于决定相对信号强度指针训练处理是否先被用来决定封包传输速率，所以相对信号强度指针训练处理系于封包被传送之后开始(步骤 505)。若否，则决定 ACK(确认)是否被接收以响应传送器封包(步骤 510)。若于步骤 510 决定无任何 ACK(确认)被接收，则无法归属该传输错误为特定相对信号强度指针位准，且相对信号强度指针训练处理 345 终止。若于步骤 510 决定 ACK(确认)被接收以响应该被传送封包，则 ACK(确认)的相对信号强度指针测量系被检索自无线传送/接收单元 100 中的内存 112，相对信号强度指针位准系通过处理器 108 决定，而相对信号强度指针位准总封包传输计数器 126 系针对该相对信号强度指针位准被增加(步骤 515)。

若于步骤 505 决定相对信号强度指针训练处理先被用来决定封包传输速率，则被该相对信号强度指针训练处理用来决定传输速率的相对信号强度指针位准系被辨识(步骤 520)。接着决定 ACK(确认)是否针对该被传送封包被接收(步骤 525)。若于步骤 525 决定 ACK(确认)不被接收，则相对信号强度指针位准总封包传输计数器 126 及相对信号强度指针位准封包传输错误计数器系针对该相对信号强度指针位准被增加(步骤 530)。若于步骤 525 决定 ACK(确认)被接收，则 ACK(确认)的相对信号强度指针测量系被检索自无线传送/接收单元 100 中的内存 112，ACK(确认)的相对信号强度指针位准系通过处理器 108 决定，而相对信号强度指针位准总封包传输计数器 126 系针对该 ACK(确认)的相对信号强度指针位准被增加(步骤 535)。

此信息系被用来针对所使用各传输速率计算各相对信号强度指针位准处的传输

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封包错误率(步骤 540)。此信息可被收集于如下表 3 的表中，其显示站用来传送封包例的各传输速率的传输封包错误率对相对信号强度指针统计值。

传输功率(dBm)(相对信号强度指针位准)	不同传输速率的传输封包错误率			
	速率 1 (如 1Mbps)	速率 2 (如 2Mbps)	…	速率 N (如 54Mbps)
-∞至-97	1.00	1.00	…	1.00
-97 至-94	0.64	0.92	…	1.00
-94 至-91	0.22	0.47	…	1.00
-91 至-88	0.07	0.18	…	1.00
-88 至-85	0.01	0.08	…	0.95
…	…	…	…	…
-70 至-67	0.00	0.00	…	0.15
-67 至-64	0.00	0.00	…	0.03
-64 至∞	0.00	0.00	…	0.00

表 3

如图 5 所示，给定相对信号强度指针位准及传输速率系于各新封包传输之后被更新(步骤 540)。若封包于第一次被传送及被再传送时被错误接收，则第二传输系被当作独特封包传输。成功传输事件中，数据库系使用 ACK(确认)帧的相对信号强度指针测量单独或结合被用来决定传输速率的相对信号强度指针来更新。若可获得复数有效相对信号强度指针测量，则最新者或统计值(如两个或更多最新测量平均)可被用来决定相对信号强度指针位准。然而，可有利地使用最后被接收 ACK(确认)的相对信号强度指针测量，因为其暂时接近该被传送封包。

相对信号强度指针为基础处理亦当作输入预期目标被传送封包错误率或最大允许封包错误率。目标被传送封包错误率对所有传输速率均相同，或其对不同速率有所不同。例如，表 3 中，最大允许封包错误率系被设定 0.10 给所有速率。因此，任何相对信号强度指针位准处的较佳传输速率系为具有不大于 0.10 的传输封包错误率的该位准处的最高传输速率。针对该有效传输封包错误率，必须存在充足测量数量来建立该封包错误率。

被接收用于相对信号强度指针位准建立有效传输封包错误率应为可配置数。例

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如，为了建立不大于 0.10 的传输封包错误率，至少 10 封包必须被接收。可替代是，传输封包错误率系较佳仅于被接收较佳封包数等于该传输封包错误率反向预期倍数之后才被视为稳定。例如，若该预期倍数为二且特定相对信号强度指针位准及传输速率的目标传输封包错误率值为 0.10，则为使传输封包错误率值被视为稳定，至少 2x(1/10)=20 封包必须被接收于该相对信号强度指针位准及传输速率。

表 3 中，粗字体值系标示各相对信号强度指针位准的较佳传输速率。例如，-88dBm 至-85dBm 的相对信号强度指针位准处，速率 1(1Mbps，具有 0.01 传输封包错误率)及速率 2(2Mbps，具有 0.08 传输封包错误率)均具有低于 0.10 最大可允许值的传输封包错误率。若次高速率(无图标)具有高于最大可允许(如 0.15)的封包错误率，则较佳传输速率系为速率 2，其为具有小于最大可允许的封包错误率的最高速率。相对信号强度指针很低(如表 3 中任何小于-91dBm 者)所以并无支持速率给予低于最大可允许封包错误率的传输封包错误率统计值例中，相对信号强度指针为基础处理应较佳使用一旗标来指示并无支持速率产生可接受传输封包错误率。该例中，因为传送封包较目标或最大可允许封包错误率所指示者可能产生错误，所以该封包不应被传送。可替代是，较佳传输速率可于传送封包之前被以最低支持速率设定。此信息可被归纳于下表，表 4。

传输功率(dBm)(相对信号强度指针位准)	较佳速率
-∞至-97	非旗标
-97 至-94	非旗标
-94 至-91	非旗标
-91 至-88	速率 1
-88 至-85	速率 2
…	…
-67 至-64	速率 N
-64 至∞	速率 N

表 4

如图 5 所示，传输封包错误率系针对相对信号强度指针位准及传输速率被计算，相对信号强度指针位准的较佳传输速率亦被决定如上(步骤 540)。获得传输速率对相对信号强度指针位准统计值并被决定对特定相对信号强度指针位准很稳定之后，相对信号强度指针为基础处理接着被用来调整传送器的传输速率。否则，传输封包错误率

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为基础处理被实施来决定传输速率。

图 6 为全部速率适应处理 300 的替代相对信号强度指针训练处理 345’流程图，该例中其通常假设传送器功率及频道情况对实质等于最大持续期间的时间区间维持实质固定。

封包被传送之后，系决定 ACK(确认)是否针对该被传送封包被接收(步骤 605)。若是，则 ACK(确认)信号的相对信号强度指针测量系被检索自无线传送/接收单元 100 中的内存 112，其相对信号强度指针位准系被决定，而相对信号强度指针位准传输计数系被增加(步骤 610)。传输封包错误率接着针对该相对信号强度指针位准被更新，决定该传输封包错误率是否对该相对信号强度指针位准很稳定，若是，该相对信号强度指针位准的较佳封包传输速率系被更新(步骤 615)。

若于步骤 605 决定该被传输封包不接收 ACK(确认)，则决定最后最大持续期间内任何被接收自该第二站的封包是否可获得相对信号强度指针测量(步骤 620)。若否，则无法将传输错误归属于特定相对信号强度指针位准，且处理 345’终止。然而，若于步骤 620 决定可获得一个或更多相对信号强度指针测量，则该测量的相对信号强度指针位准系被决定。若一个以上相对信号强度指针位准于步骤 625 被找出，则代表性相对信号强度指针位准系被决定，而相对信号强度指针位准总封包传输计数器 126 及相对信号强度指针位准封包传输错误计数器 128 系针对该相对信号强度指针位准系被增加。该相对信号强度指针位准的传输封包错误率接着被更新，且决定该传输封包错误率对该相对信号强度指针位准是否很稳定。若是，该相对信号强度指针位准的较佳封包传输速率系被更新(步骤 615)。

应注意，相对信号强度指针训练处理 345 及 345’系为正在进行的处理。传输封包错误率系依据第 5 或 6 图以遵循每封包传输的进入封包，或替代于每 N 封包传输之后，甚至于相对信号强度指针位准被视为”受训”之后的相对信号强度指针位准处被更新。旧统计值可较佳地于显著时间区间消逝之后自内存 112 被删除，或通过维持于内存中仅最后测量较佳数量(如 100)来使用。可替代是，被储存于内存 112 中的相对信号强度指针统计值可被定期冲刷，藉此相对信号强度指针训练处理 345 及 345’系从零重新开始。

依据图 7 所示本发明实施例中，传送至第二站的第一站系调整其传输速率以响应被接收自第二站的速率指令。此实施例系涉及于第二站测量，决定较佳速率，产生速率指令，传送速率指令至第一站，及于第一站实施较佳速率。可选择是，测量本身可被传送至第一站，其可决定较佳传输速率。被用来决定较佳速率的测量系可包含链接

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品质指针及/或其它测量，如被接收于第二站来自第一站的信号相对信号强度指针或信号噪声比。从第二站至第一站的速率指令系较佳被放置于被第二站传送至第一站的封包媒体存取控制标头中，但其亦可经由其它装置来传送，如帧的酬载或一个或更多专用封包中。

此实施系假设第二站已针对各被允许传输速率将达成预期服务品质(如封包错误率)所需敏感性(如信号噪声比)储存于内存中。此信息通过第二站获得的方法系可包含预先配置，训练或类似者，且超过本发明此实施范围。

针对第二站接收来自第一站的每封包(包含被寻址至非第二站的节点的封包)，第二站系测量及储存该封包的信号噪声比及其被接收的时间于内存中。此后，无论第二站何时需传送封包至第一站，其均需检查其内存来检视其是否已于最后最大持续期间内接收任何来自第一站的封包。若是，则第二站系从该信号噪声比测量产生统计值(如被接收于最大持续期间内的封包平均信号噪声比，或最新有效信号噪声比或类似者)，并将其与被储存于内存中的敏感性数字相比较。较佳速率系为该被产生信号噪声比统计值较达成预期服务品质所需信号噪声比为佳的最高速率。第二站接着编码该预期速率为传送至第一站的速率指令。

若第二站于最大持续期间中尚未接收来自第一站的封包，则第二站可设定较佳传输速率为预设速率；或为其成功接收封包的最后速率；或为被标示于其传送至第一站的最后速率指令中。可替代是，其可传送标示第二站并不提供第一站应使用的传输速率，因而留给第一站决定其传输速率的任务。第二站编码该预期速率或信号为速率指令，并将其传送至第一站。第一站接着储存最后速率指令及其被接收的时间于内存中，并于传送至第二站时实施它。

图 7 为传输速率指令被产生于第二站并传送至第一站的速率适应处理 700 流程图。当第一站具有一封包传送至第二站时(步骤 705)，其可检查其内存 112 来检视其是否已于最后最大持续期间内接收来自第二站的有效速率指令(步骤 710)。若是，第一站可依据被接收的最后速率指令来设定其传输速率。若不可获得有效速率指令，则第一站可如上述决定其自我传输速率(步骤 720)。封包接着被传送(步骤 725)。

虽然本发明的特性及组件被以特定组合说明于较佳实施例中，但各特性及组件系不需较佳实施例的其它特性及组件，或有或无本发明其它特性及组件的各种组合中被单独使用。

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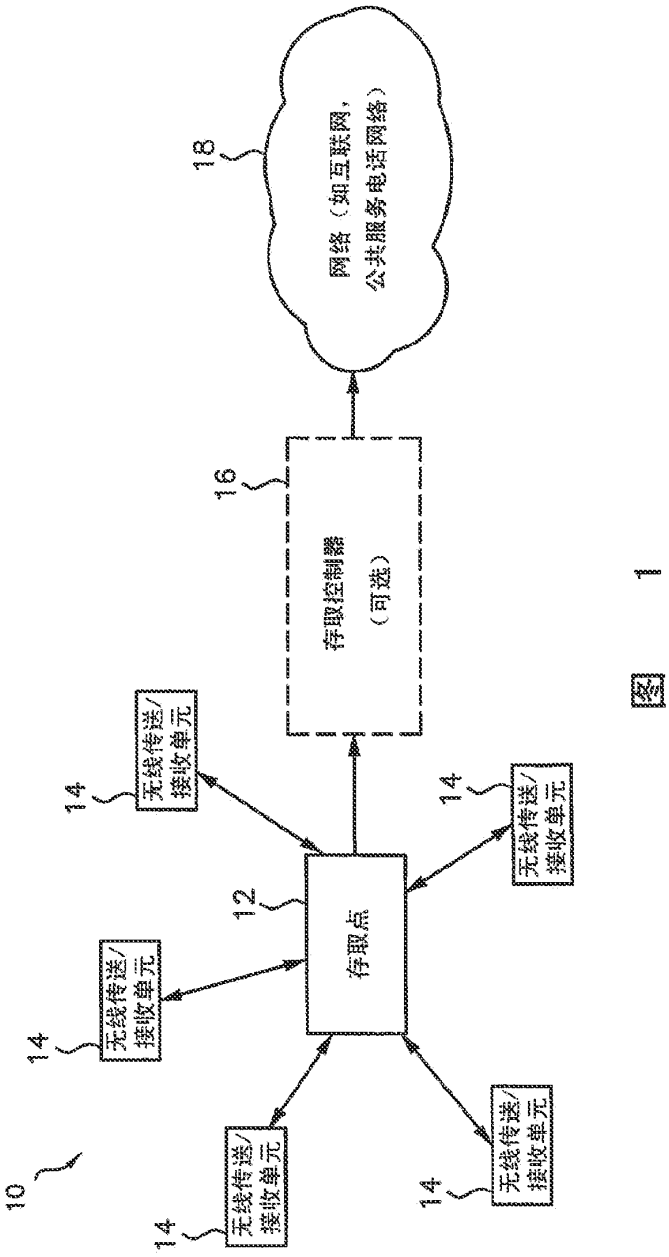


图 1

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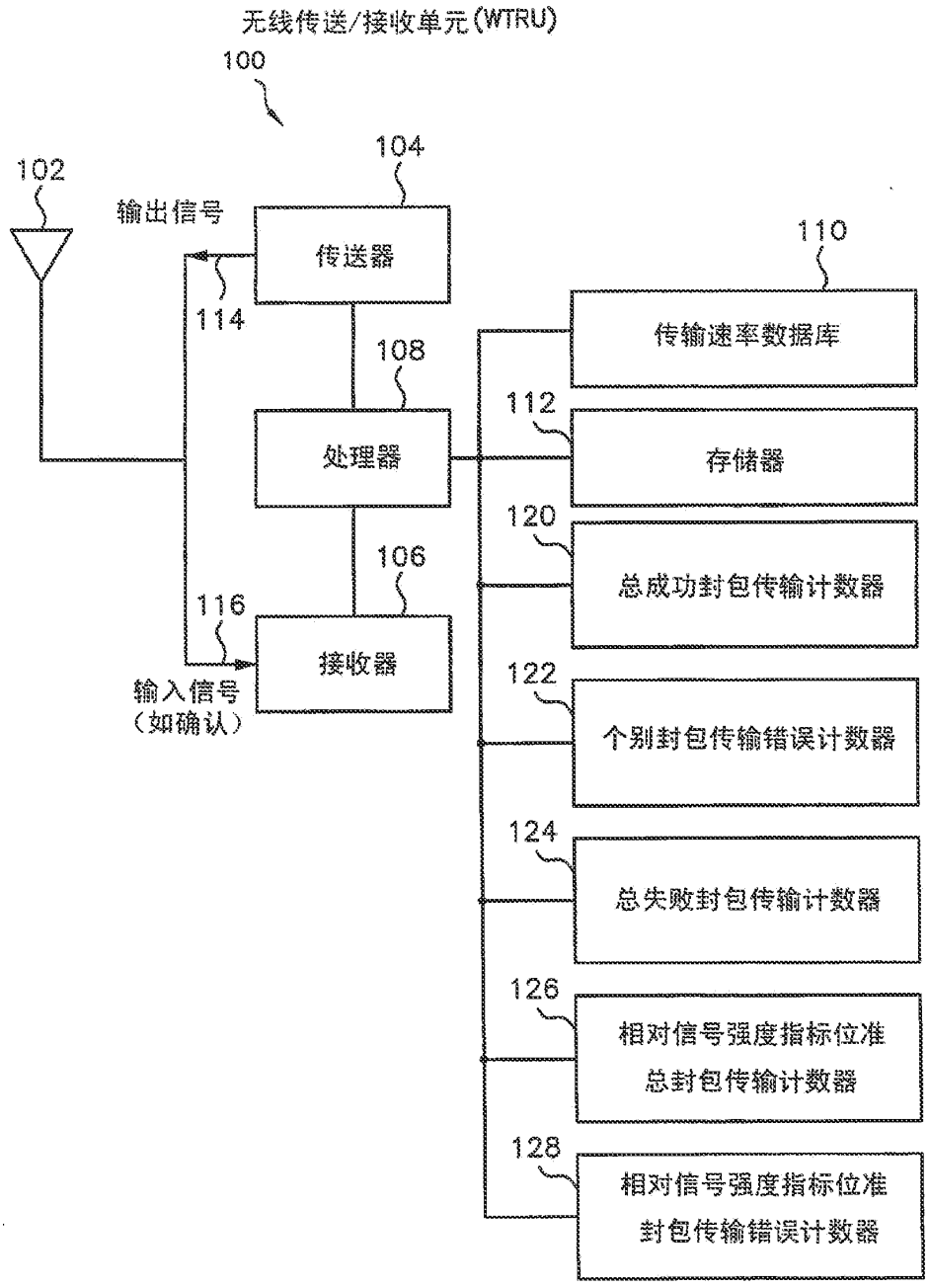


图 2

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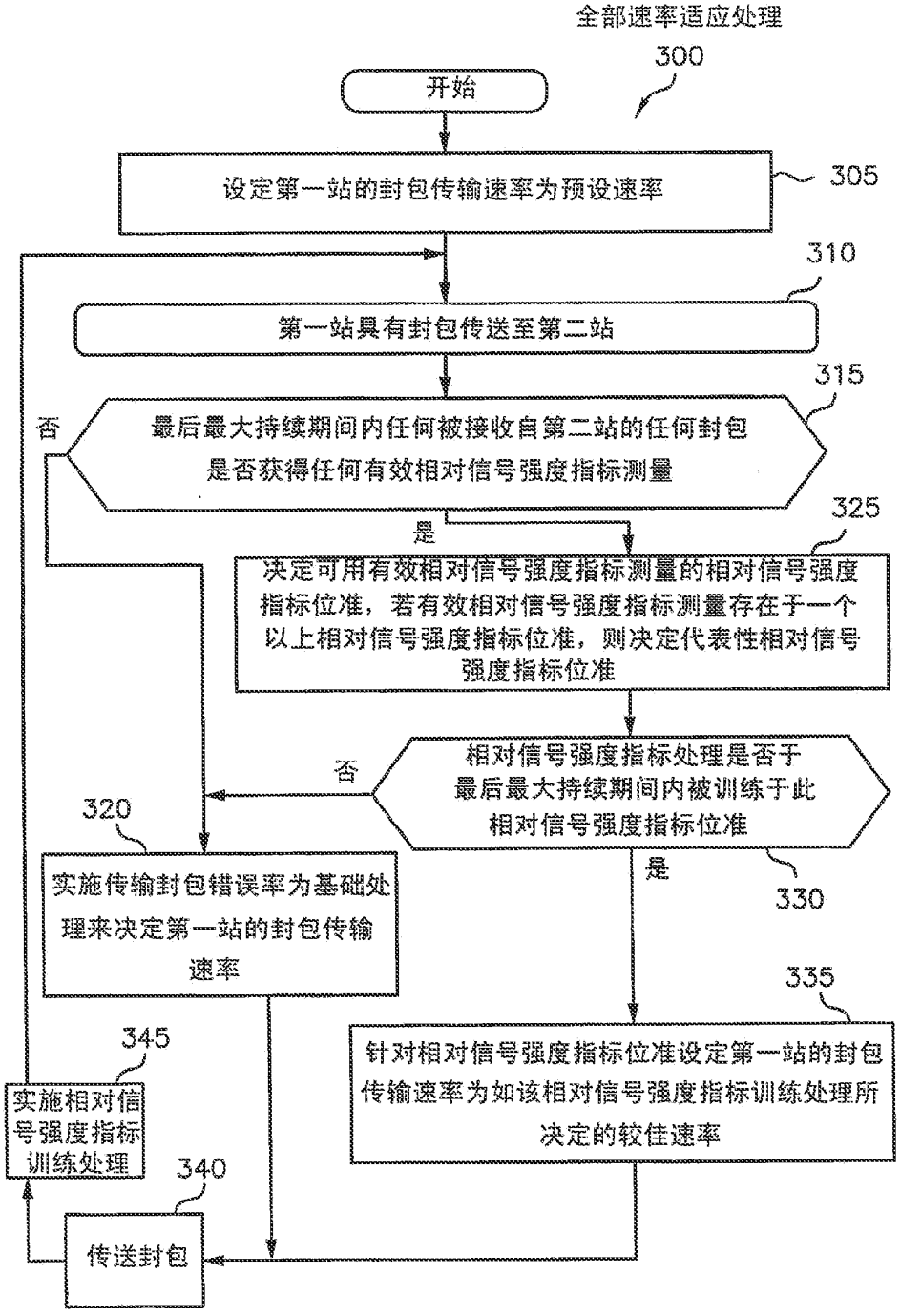


图 3

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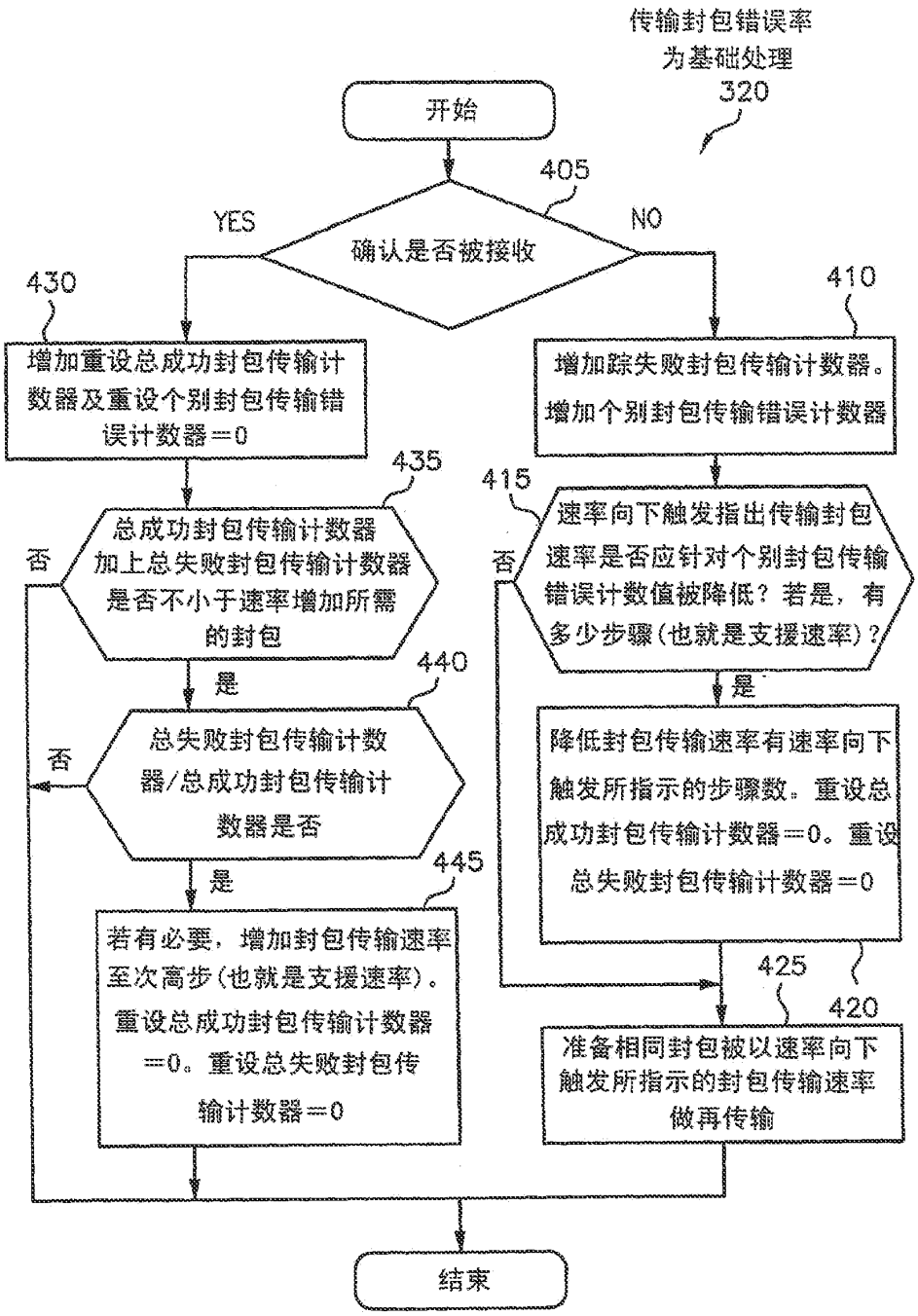


图 4

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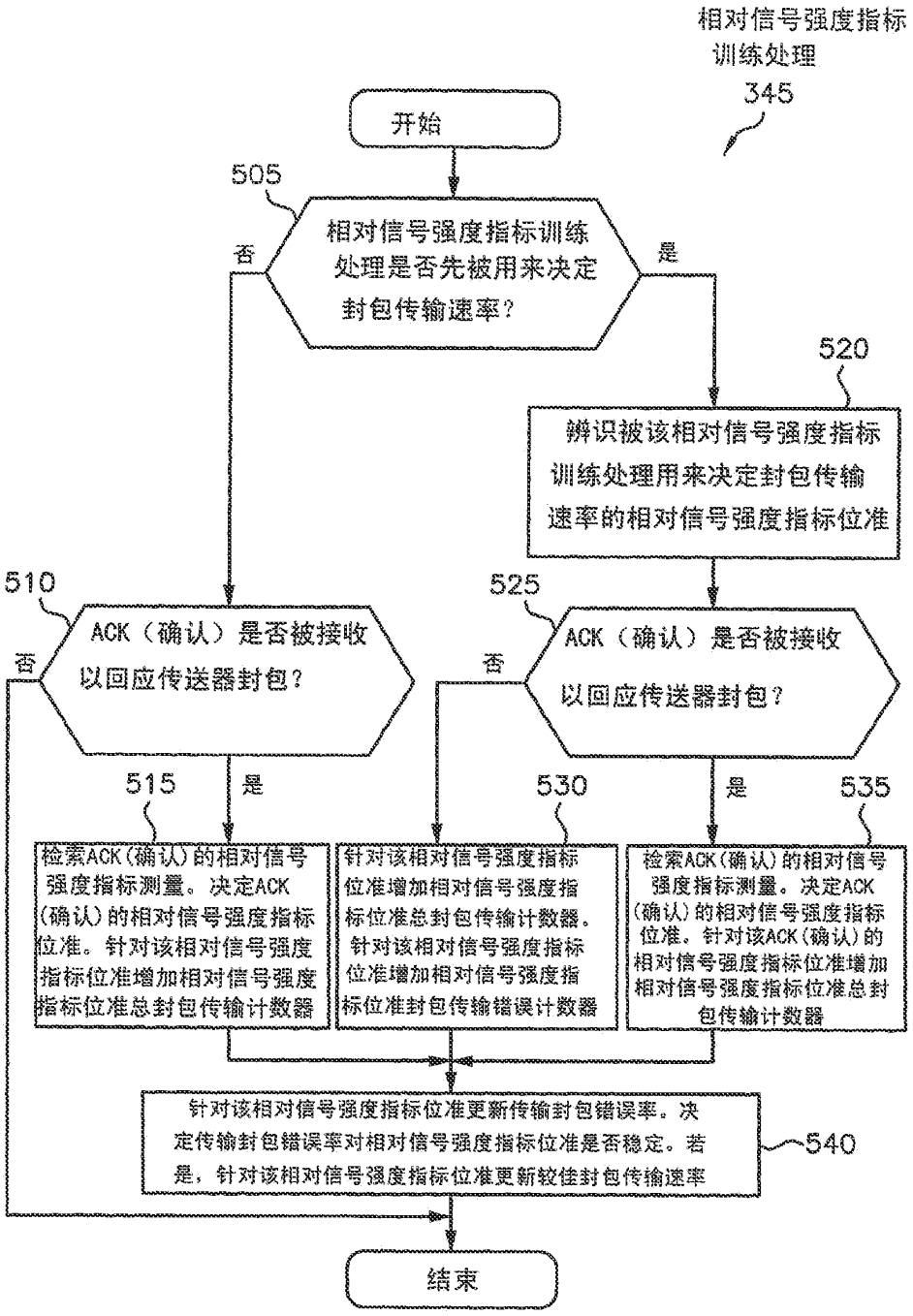


图 5

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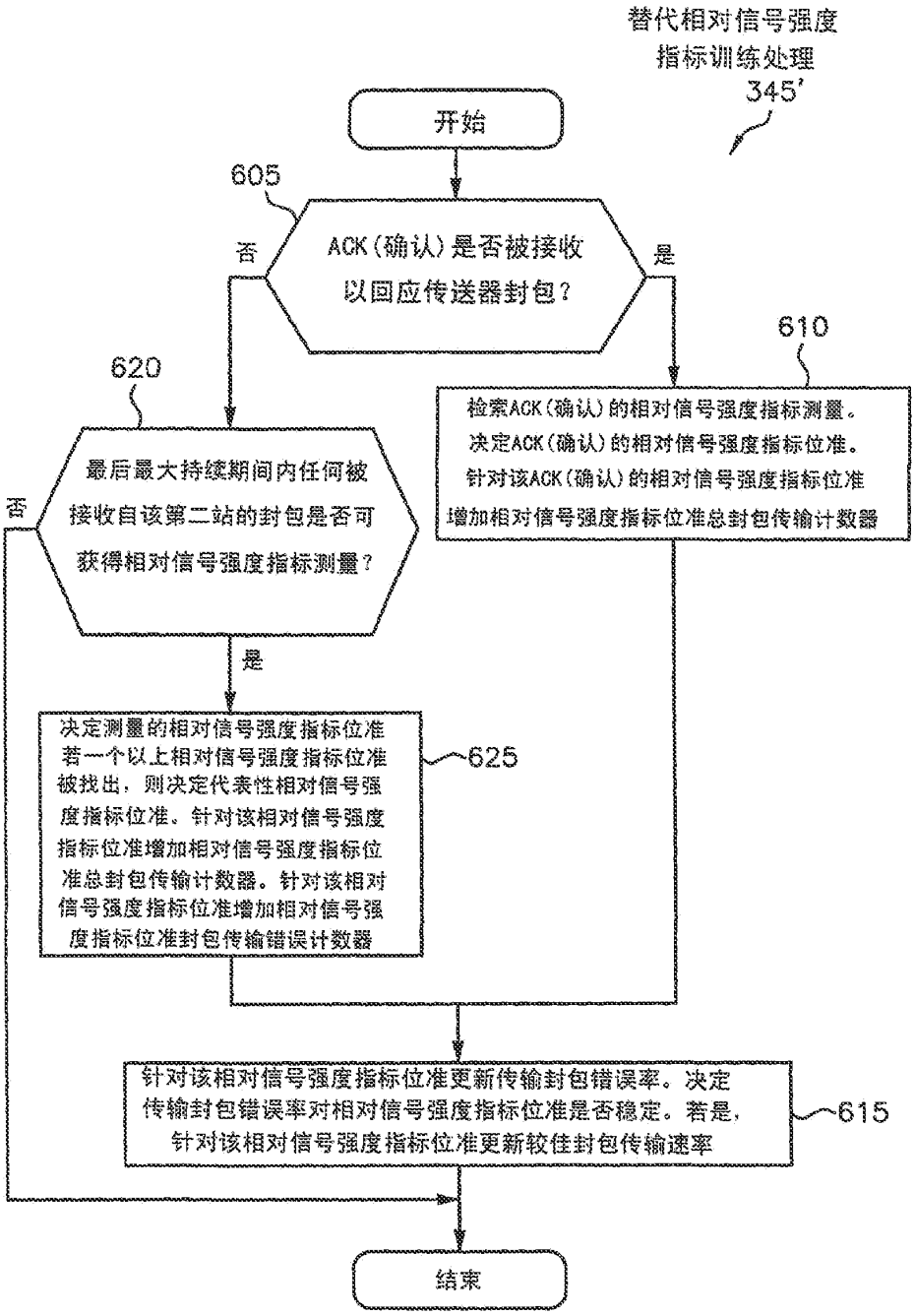


图 6

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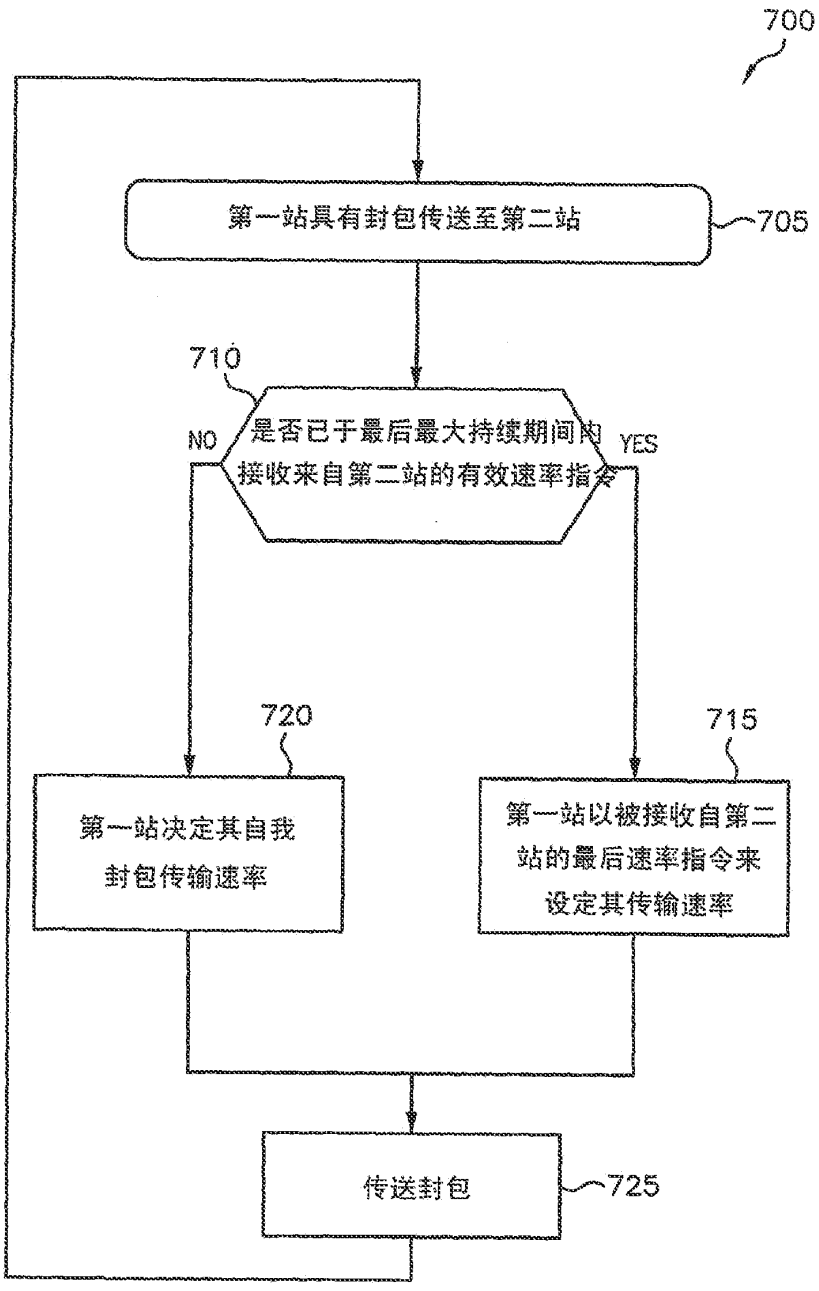


图 7

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Page #659

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 August 2006 (31.08.2006)

PCT

(10) International Publication Number
WO 2006/091391 A2

(51) International Patent Classification:
H04Q 7/00 (2006.01)

(21) International Application Number:
PCT/US2006/004618

(22) International Filing Date: 30 January 2006 (30.01.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/655,770 23 February 2005 (23.02.2005) US
11/240,146 30 September 2005 (30.09.2005) US

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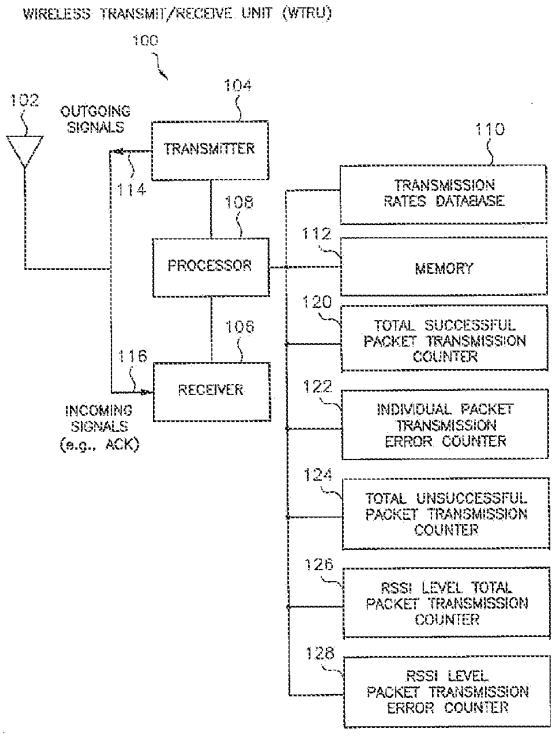
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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT,

[Continued on next page]

(54) Title: WIRELESS COMMUNICATION METHOD AND APPARATUS FOR DYNAMICALLY ADAPTING PACKET TRANSMISSION RATES



(57) Abstract: A method and apparatus for use by a first transceiver, (e.g., wireless transmit/receive unit (WTRU), access point (AP), node) for adjusting the transmission rate of packets transmitted to a second transceiver based on signals the first transceiver receives from the second transceiver. In one embodiment, a transmission packet error rate (Tx PER) process is used to adjust the packet transmission rate. In another embodiment, a relative signal strength indicator (RSSI)-based process is used to determine the RSSI of packets received at the first transceiver from the second transceiver for adjusting the packet transmission rate. In another embodiment, transmission quality indicators are measured at the second transceiver and are sent to the first transceiver, which derives a new packet transmission rate therefrom. The Tx PER and RSSI-based processes may be used individually, in combination, or in conjunction with other processes.

WO 2006/091391 A2

RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

[0001] WIRELESS COMMUNICATION METHOD AND APPARATUS FOR DYNAMICALLY ADAPTING PACKET TRANSMISSION RATES

[0002] FIELD OF INVENTION

[0003] The present invention is related to data transmission in a wireless communication system. More particularly, the present invention is related to dynamically adapting packet transmission rates in response to varying fading conditions.

[0004] BACKGROUND

[0005] Wireless communication systems, such as wireless local area networks (WLANs), are well known in the art. Generally, such systems comprise transceivers, (i.e., communication stations, (STAs)), which transmit and receive wireless communication signals between each other. Depending upon the type of system, transceivers may take the form of an access point (AP), a wireless transmit/receive unit (WTRU), a node or the like.

[0006] Figure 1 shows a conventional wireless communication system 10 in which an AP 12 provides communication services to a plurality of WTRUs 14. The AP 12 can communicate with a network 18 through an optional access controller (AC) 16, thereby providing additional network services to the WTRUs 14, such as access to the Internet or a public service telephone network (PSTN). Alternatively, the AP 12 can communicate directly with the network 18 without going through the AC 16.

[0007] Ideally, all connections within the system 10 should operate at the highest achievable transmission rate in order to maximize performance and overall system capacity. However, it is not always possible to achieve acceptable quality at higher data rates, since they require relatively higher signal-to-noise ratios (SNRs) at the receiver.

[0008] This creates a situation where it would be beneficial to adjust the rate at which packets are transmitted, depending on the SNR conditions that are perceived by a transceiver that receives the packet. However, system 10 does not provide a mechanism to transfer perceived channel quality in terms of received signal power, SNR or packet error rate (PER) to the source of the

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packets. Thus, the basis for decisions for adjusting the transmission rate of the AP 12 and the WTRUs 14 in the system 10 is limited to local transmission conditions.

[0009] SUMMARY

[0010] The present invention is related to a method and apparatus for use by a first transceiver, (e.g., WTRU, AP, node or the like), for adjusting the transmission rate of packets transmitted to a second transceiver based on signals the first transceiver receives from the second transceiver. In one embodiment, a transmission PER (Tx PER) process is used to adjust the packet transmission rate. In another embodiment, a relative signal strength indicator (RSSI)-based process is used whereby the RSSI of packets received at the first transceiver from the second transceiver is used to adjust the packet transmission rate. In another embodiment, transmission quality indicators are measured at the second transceiver and are sent to the first transceiver, which derives a new packet transmission rate based on the quality indicators. Optionally, the second transceiver determines a preferred packet transmission rate and sends it to the first transceiver, which adjusts its packet transmission rate accordingly.

[0011] Although two different processes, (i.e., a Tx PER process and an RSSI-bases process), for determining a packet transmission rate are disclosed herein, these processes may be used individually, used in conjunction with each other, or used in conjunction with other processes.

[0012] In accordance with the present invention, a transceiver selects a preferred data transmission rate from among several available rates, based on measurements made at the transceiver. Those measurements are the received signal strength (Rx power) of packets received at the transceiver, and the Tx PER of signals transmitted by the transceiver, which can be inferred by assuming that a packet is in error every time its corresponding acknowledgment (ACK) is not received from another transceiver. The transceiver can quickly establish the best data transmission rate available while maintaining an acceptable quality of service (QoS). The transceiver can

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thereafter adapt its transmission rate in response to changing fading conditions.

[0013] BRIEF DESCRIPTION OF THE DRAWINGS

[0014] A more detailed understanding of the invention may be had from the following description, given by way of example and to be understood in conjunction with the accompanying drawings wherein:

[0015] Figure 1 shows a conventional wireless communication system;

[0016] Figure 2 is an exemplary block diagram of a WTRU configured in accordance with the present invention;

[0017] Figure 3 is a flow diagram of an overall rate adaptation process implemented in accordance with the present invention;

[0018] Figure 4 is a flow diagram of a Tx PER-based process of the overall rate adaptation process of Figure 3;

[0019] Figure 5 is a flow diagram of an RSSI training process of the overall rate adaptation process of Figure 3;

[0020] Figure 6 is a flow diagram of an alternate embodiment of an RSSI training process of the overall rate adaptation process of Figure 3; and

[0021] Figure 7 is an example of an alternative RSSI training process of the overall rate adaptation process of Figure 3.

[0022] TABLE OF ACRONYMS

ACK	Acknowledgment Signal
AP	Access Point
BS	Base Station
CS	Client Station
CTS	Clear to Send
MAC	Media Access Control
NF	Noise Figure
PER	Packet Error Rate
Pwr	Power
QoS	Quality of Service
RSSI	Received Signal Strength Indicator
RTS	Request to Send
Rx	Receive
SNR	Signal-to-Noise Ratio
STA	Station

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STA Tx	Transmitting Station
STA Rx	Receiving Station
Tx	Transmit
TxPwr	Transmit Power
WLAN	Wireless Local Area Network

TABLE 1

[0023] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] The term AP as used hereinafter includes, but is not limited to, a base station, a Node B, a site controller, a wireless router or any other interfacing device in a wireless environment that provides WTRUs with wireless access to a network with which the AP is associated.

[0025] The term WTRU as used hereinafter includes, but is not limited to, a client station (CS), user equipment (UE), station (STA), mobile station, fixed or mobile subscriber unit, pager, or any other type of user device capable of operating in a wireless environment. Such WTRUs include personal communication devices, such as phones, video phones, and Internet ready phones that have network connections. In addition, WTRUs include portable personal computing devices, such as PDAs and notebook computers with wireless modems that have similar network capabilities. WTRUs that are portable or can otherwise change location are referred to as mobile units.

[0026] A wireless connection as used hereinafter is defined as a wireless communication between a pair of nodes that can transmit packets to, and receive packets from, each other. Each wireless connection comprises a pair of nodes wherein the roles of the transmitter and receiver of packets are switched back and forth in time between the nodes. For example, a wireless communication system operating in infrastructure mode where two WTRUs are communicating with a single AP consists of two wireless connections. A rate control process should reside in each transmitting node, whose purpose is to determine the optimal rate at which each packet is transmitted for each active wireless connection.

[0027] Preferably, the circuitry implementing the various transmitter and receiver functionality described herein may be incorporated on a single integrated circuit, such as an application specific integrated circuit (ASIC).

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However, the circuitry can also be readily implemented using multiple discrete components, and/or separate integrated circuits.

[0028] The specific transmitter and receiver configurations described herein are provided as examples only and not as limitations. Other variations and modifications consistent with the invention will be recognized by those of ordinary skill in the art.

[0029] The present invention is a novel apparatus and method that allows a transceiver, (i.e., a WTRU, AP, node), engaged in one or multiple wireless connections to dynamically adapt its transmission rate according to the time-varying propagation conditions of each wireless channel. In order to do so, the present invention relies on two processes to determine a preferred transmission rate, depending upon the availability and validity of certain measurements. In the first process, referred to herein as the Tx PER-based process, the Tx PER is used to determine the best transmission rate. Alternatively, the best transmission rate is determined based on the RSSI or other metric of received packets related to their Rx power, correlated with the Tx PER of transmitted packets. The RSSI is correlated with the Tx PER in a process referred to herein as the RSSI training process. Although the RSSI is used in the description of the preferred embodiment of the RSSI training process, alternative embodiments could use other metrics, such as a SNR.

[0030] Figure 2 is an exemplary block diagram of a WTRU 100 configured in accordance with the present invention. The same exemplary configuration disclosed herein for the WTRU 100 may also be incorporated in an AP. The WTRU 100 includes at least one antenna 102, a transmitter 104, a receiver 106, a processor 108, a transmission rates database 110, and a memory 112. The transmitter 104 is configured to send outgoing signals 114 via the antenna 102 at a transmission rate selected from a plurality of available transmission rates, which are stored in transmission rates database 110. The receiver 106 is configured to receive incoming signals 116 from the antenna 102. The processor 108 is coupled to the transmitter 104, the receiver 106, the transmission rates database 110 and the memory 112. The processor 108 selects a transmission rate from the transmission rates database 110 and

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changes the current transmission rate of the transmitter 104 to the selected rate. This selection can be based upon an evaluation of the incoming signals 114, upon an evaluation of both the incoming signals 114 and the outgoing signals 116, or it can be based upon a rate command received at the receiver 106. The memory 112 is used to store data with respect to the incoming signals 116 and/or outgoing signals 114, and/or with respect to rate commands received at the receiver 106. The processor 108 is configured to process the data stored in the memory 112, and store the results of the processed data in the memory 112 for future access to select and change the transmission rate of the transmitter 104.

[0031] The WTRU 100 further includes a plurality of packet transmission counters including a total successful packet transmission counter 120, an individual packet transmission error counter 122, a total unsuccessful packet transmission counter 124, an RSSI level total packet transmission counter 126, and an RSSI level packet transmission error counter 128. The functions of the packet transmission counters 120, 122, 124, 126 and 128 may be implemented by one or more of a database, a processor, software, or the like, on an individual basis or as a maintained set. For example, a plurality of sets of the packet transmission counters 120, 122, 124, 126 and 128 and associated measurements may be maintained to individually control the packet transmission rate associated with each STA, AP, WTRU or the like that the WTRU 100 communicates with over a particular communication link.

[0032] Before describing the processes implemented by the present invention, it is advantageous to define several terms, as listed in the following table, Table 2. Although the processes of the present invention will be described in these terms, it should be understood that it is not necessary to employ these terms; rather, the terms are simply a convenient way to describe aspects of the processes. In an implementation, parameters can be stored in memory and updated as needed, or can be maintained and updated in any appropriate manner.

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Parameter	Description	Example
Maximum Duration	The maximum duration for which a measurement or command from the node to which the transmitter is sending a packet is valid. The Maximum Duration parameter should preferably be representative of the coherence time of the channel. The received packet can be any type, (e.g., DATA, ACK, RTS, CTS, or the like).	100 ms
Allowable Rates	A list of the rates a transmitter is able to support, sorted in ascending order. The Allowable Rates can be represented by a vector stored in a memory, wherein each position of the vector corresponds to a particular rate.	[6,9,12,18,24,36,48, 54] Mbps for IEEE 802.11a
Default Rate	The rate that should be used by the transmitter when rate control is initialized. This can be represented by the initial index of an Allowable Rates vector.	8 (indicates the default rate is the 8th highest supported rate, e.g., 54 Mbps in an 802.11a system)
Current Rate	The rate to be used by the transmitter to send the next packet. This can be represented by the current index of an Allowable Rates vector.	5 (indicates the next packet will be transmitted at the 5th highest supported rate, e.g., 24 Mbps in an 802.11a system)
Maximum Rate Index	The number of different transmission rates supported.	8
Rate Down Trigger	A predetermined pattern or plan of adjusting the transmission rate in response to successive transmission errors which indicates, for each retransmission attempt, if the transmission rate should be decreased, and if so by how many rate levels it should be decreased. The pattern can be stored as a vector. For example, in an IEEE 802.11a system, [0,0,1,1,2,2,1,0] means that a WTRU operating at 54 Mbps would not decrease its transmission rate until the third retransmission (i.e., after three errors), at which time the transmission rate would be decreased by one level to 48 Mbps. If an error results, the rate would be decreased by one more level at the fourth retransmission to 36 Mbps, and thereafter by decrements of two levels for the 5th (to 18 Mbps) and 6th retransmissions (to 9 Mbps), and then by one level (to 6 Mbps, the lowest supported rate).	[0,0,1,1,2,2,1,0]
Rate Increase Ratio	The maximum allowable ratio of unsuccessful to successful packet transmissions.	0.10

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Parameter	Description	Example
Packets Needed For Rate Increase	Minimum number of packets which must have been transmitted since the last rate change, in order to permit a transmission rate increase.	10
Good Packet Count	Number of successful packet transmissions to a particular WTRU. This count is reinitialized to zero after a rate change is implemented.	
Bad Packet Count	Number of unsuccessful packet transmissions to a particular WTRU. This count is reinitialized to zero after a rate change is implemented.	
Retry Count	Number of unsuccessful transmission attempts for a given packet. This count is reinitialized to zero when the packet is successfully transmitted.	

TABLE 2

[0033] Figure 3 is a flow diagram of an overall rate adaptation process 300 implemented in accordance with the present invention. The transmission rate is determined using either a Tx PER-based process or an RSSI-based process, implemented by the processor 108 in the WTRU 100 of Figure 2. The determination of which process to use is based on whether the RSSI-based process has been previously trained, and whether a valid RSSI measurement is available at a particular RSSI level. If so, the RSSI-based process is used to determine the transmission rate. Otherwise, the Tx PER-based process is used. In either case, packets are then transmitted at a rate determined by one of the processes, and the subsequent success or failure of packet transmissions is used to dynamically train the RSSI-based process and to adjust the transmission rate.

[0034] A valid RSSI measurement is defined as the RSSI measurement of a packet that was received within a predetermined duration, (herein designated the *Maximum Duration*), from a node to which the transmitter recently sent a packet. The *Maximum Duration is* representative of the coherence time of the channel. The received packet can be of any type, e.g., DATA, ACK, RTS, CTS, or the like.

[0035] As shown in Figure 3, the overall rate adaptation process 300 starts when a first station, (i.e., WTRU 100), prepares to transmit a packet for the first time to a second station for the first time by setting the packet transmission rate of the first station to a default rate (step 305). When the

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first station has a packet to transmit to the second station, (step 310), a determination is made as to whether there are any valid RSSI measurements available for any packets that were received from the second station within the last *Maximum Duration* time period (step 315).

[0036] If no packets were received within the duration period or if no such measurements are available for any received packets, a Tx PER-based process is invoked to determine the packet transmission rate of the first station, (step 320), which will be described in detail hereinafter.

[0037] However, if valid RSSI measurements are determined to be available in step 315, a determination of the RSSI level of the available valid RSSI measurement is performed (step 325). If, in step 325, valid RSSI measurements are determined to exist for more than one RSSI level, a representative RSSI level is determined. The representative RSSI level can be based on the most recent RSSI value, or can be a statistic, (such as an average), based on several RSSI values, or based on RSSI values in conjunction with other values. In step 330, a determination of whether the RSSI process has been trained at this RSSI level within the last *Maximum Duration* time period is made. If so, the packet transmission rate of the first station is set to the preferred rate for that RSSI level, as determined by the RSSI training process, (step 335), the packet is transmitted (step 340) and an RSSI training process is invoked, (step 345). The process 300 returns to step 310 when the first station has another packet to transmit to the second station. The success or failure of transmitted packets is used to dynamically update the preferred transmission rate indicated by the RSSI training process 345, as will be described below after the Tx PER process is described.

[0038] If, in step 330, it is determined that the RSSI process was not trained at this RSSI level within the last *Maximum Duration* time period, the Tx PER-based process is invoked in order to determine the packet transmission rate of the first station, (step 320). The packet is then transmitted (step 340) and an RSSI training process is invoked (step 345).

[0039] Figure 4 is a flow diagram of the Tx PER-based process 320 of the overall rate adaptation process 300 of Figure 3. In general, according to the

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Tx PER-based process 320, the transmitter 104 of the WTRU 100 of Figure 2 adjusts its packet transmission rate by reacting to transmission events it experiences when transmitting to a receiving node.

[0040] If the transmitter 104 of the WTRU 100 of Figure 2 experiences successive packet transmission errors, its packet transmission rate is reduced according to a predetermined plan or pattern, herein designated as a Rate Down Trigger. The Rate Down Trigger can be a vector stored in the memory 112 in the WTRU 100 of Figure 2. The Rate Down Trigger indicates, after each successive packet transmission error, whether the packet transmission rate should be reduced before the next packet retransmission attempt, and if so by how much. The indicated rate reduction, if any, is then implemented. The packet transmission rate is reduced in this manner until a packet is successfully transmitted, or until the packet transmission rate is reduced to a predetermined minimum packet transmission rate.

[0041] For example, if the WTRU 100 is configured for use in an IEEE 802.11a system, the supported packet transmission rates, sorted in ascending ordered steps, (i.e., levels of supported packet transmission rates), are 6, 9, 12, 18, 24, 36, 48 and 54 Mbps. In that case, a Rate Down Trigger vector of [0,0,1,1,2,2,1,0] indicates that the WTRU 100 would not reduce its packet transmission rate until after third retransmission attempt, (i.e., after three transmission errors for a particular packet), at which point the packet transmission rate would be reduced by one step. Accordingly, if the WTRU 100 is operating at 54 Mbps after a third transmission error, the transmission rate would be reduced by one step to 48 Mbps, and the packet would be retransmitted again. If a transmission error still results, the rate would then be reduced by one more step for the fourth retransmission to 36 Mbps, then reduced by two more steps for each of the 5th (to 18 Mbps) and 6th retransmissions (to 9 Mbps), and then by one step (to 6 Mbps, the lowest supported rate).

[0042] If, on the other hand, the transmitter 104 of the WTRU 100 experiences consistently successful transmissions, the transmission rate of the transmitter 104 is increased in accordance with the Tx PER-based process

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320. In that case, the transmission rate is increased to the next supported step when the Tx PER experienced by the transmitter 104 drops below a certain threshold for a sufficient number of packets transmitted to a receiving node.

[0043] As shown in Figure 4, if an ACK is received, (step 405), the total successful packet transmission counter 120 in the WTRU 100 is incremented, and the individual packet transmission error counter 122 in the WTRU 100 is reset to zero, (step 430). These counters 120, 122 are used to determine whether the transmission rate should be increased, as will be described hereinafter.

[0044] If an ACK is not received at step 405, the total unsuccessful packet transmission counter 124 in the WTRU 100 is incremented, and the individual packet transmission error counter 122 is also incremented, (step 410). The Rate Down Trigger vector is examined to determine if the packet transmission rate should be reduced for the individual packet transmission error count value, and if so, by how many steps, (step 415). If the Rate Down Trigger indicates that the packet transmission rate should not be reduced, the same packet is prepared to be retransmitted. However, if the Rate Down Trigger indicates at step 415 that the packet transmission rate should be decreased by one or more steps, the packet transmission rate is reduced by the number of steps indicated by the Rate Down Trigger, and the total successful packet transmission counter 120 and the total unsuccessful packet transmission counter 124 are reset to zero, (step 420). The same packet is then prepared for retransmission at a packet transmission rate indicated by the Rate Down Trigger, (step 425). The Tx PER-based process 320 may be repeated during a communication session until either the packet transmission rate equals the lowest supported transmission rate, or until an ACK is received.

[0045] Requiring successive error events to be experienced before triggering a reduction in transmission rate results in a method that tends to discriminate error events caused by poor signal conditions from error events caused by packet collisions. It also allows a quicker rate reduction reaction

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time than criteria that consider an average of a number of packet error events, and provides additional transmission rate reductions when an already implemented rate reduction does not result in more reliable communications.

[0046] When an ACK is determined to have been received in response to a transmitted packet in step 405, the total successful packet transmission counter 120 is incremented and the individual packet transmission error counter 122 is reset to zero, (step 430). Then, it is determined whether a transmission rate increase is desirable. In general, the proportion of packet transmissions resulting in transmission errors increases as transmission rate increases. The preferred transmission rate is the highest supported rate that can be used while still achieving an acceptable quality of service. The quality of service can be expressed, for example, as a transmission packet error rate, or as the ratio of transmission errors to successful transmissions. A transmission rate increase is thus desirable if the transmitter experiences a lower ratio of transmission errors to successful transmissions than is needed to maintain an acceptable quality of service.

[0047] The Tx PER-based process 320 determines if a packet transmission rate increase is desirable by first summing the total successful packet transmission count and the total unsuccessful packet transmission count, (i.e., finding the total number of packet transmissions since transmissions began or since the last packet transmission rate change). This sum is compared to a threshold value, (herein designated as the Packets Needed For Rate Increase), (step 435). The Packets Needed For Rate Increase indicates the minimum number of packets that must have been transmitted since the last packet transmission rate change occurred for a rate increase to be permitted. If the sum is not greater than or equal to the Packets Needed For Rate Increase, no packet transmission rate adjustment is permitted, and the packet transmission rate is not increased.

[0048] If the sum of the total successful packet transmission count and the total unsuccessful packet transmission count is greater than or equal to the Packets Needed For Rate Increase, (step 435), the process 320 determines if a rate increase is warranted. A rate increase is warranted if the proportion

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of transmission failures is less than is allowed to maintain a desired QoS. The proportion of transmission failures can be indicated, for example, by determining the ratio of transmission failures to successful transmissions, or in any other appropriate manner. A packet transmission rate increase is determined to be warranted if the ratio of the total unsuccessful packet transmission count to the total successful packet transmission count is less than what is needed to maintain an acceptable QoS. The ratio needed to maintain an acceptable QoS is a threshold, (herein designated as the Rate Increase Ratio). If the ratio of the total unsuccessful packet transmission count to the total successful packet transmission count is determined at step 440 not to be less than the Rate Increase Ratio, a packet transmission rate increase is not warranted, and the packet transmission rate is not adjusted.

[0049] However, if the ratio of the total unsuccessful packet transmission count to the total successful packet transmission count is determined at step 440 to be less than the Rate Increase Ratio, the packet transmission rate is increased to the next higher step, (i.e., the next higher supported packet transmission rate), if one is available, and the total successful packet transmission counter 120 and the total unsuccessful packet transmission counter 124 are both reset to zero, (step 445). During a communication session, the process 25 may be repeated until either the maximum supported transmission rate is reached, or until an ACK is not received.

[0050] As communication proceeds between a first station (wherein the invention is implemented) and a second station, the RSSI process is dynamically trained at the first station. When the RSSI process is trained, it is preferably the RSSI process that determines the preferred transmission rate of the first station. The RSSI-based rate adaptation process adapts the packet transmission rate at which packets are sent by the first station to the second station by reacting to variations in the received power of packets received at the first station from the second station. In an exemplary embodiment, the received power is reflected in the measured RSSI of received

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packets; however an SNR or other metric related to the received power could also be used.

[0051] The RSSI-based process dynamically correlates the Tx PER of packets sent by the first station to the second station with the RSSI of packets received at the first station from the second station. This dynamic correlation is referred to herein as training the RSSI-based process. The correlation is done separately for each supported transmission rate used by the first station. It is helpful to divide into discrete levels the expected range of the power of the received signals. For example, if the expected range of received signal power is -97 dBm to -64 dBm, the range can be conveniently divided into levels separated by 3 dBm; e.g., -97 dBm to -94 dBm, -94 dBm to -91 dBm, ... -67 dBm to -64 dBm, for a total of 12 discrete power levels. Any received power less than -97 dBm can be grouped together into an additional power level, and any received power greater than -64 dBm can be grouped into yet another power level. It should be understood that the range from -97 to -64, the separation of the range into levels separated by 3 dBm, and the number 12 of discrete power levels are used only for illustration, and are not limitations.

[0052] The relationship between Tx PER and received packet RSSI is determined by collecting at the first station measurements and information for each packet sent from the first station to the second station and from the second station to the first station. Information collected regarding each packet sent from the first station to the second station includes the transmission rate at which the packet was sent, and whether the transmission was successful, (ACK received), or resulted in a transmission error, (ACK not received). From this information, the Tx PER is calculated at each transmission rate used.

[0053] Information collected regarding packets sent from the second station to the first station includes a measure of the signal strength of each received packet, (such as the RSSI), and the time the packet was received. An RSSI measurement is deemed valid only for a length of time designated the *Maximum Duration*. For RSSI training, it should be noted that all packet types can be used, (i.e. DATA, ACK, RTS, CTS, or the like). If more than one

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packet is received from the second station within the *Maximum Duration* period, the process can either use the RSSI from the last received packet, or calculate a statistic, (such as an average), based on several packets. The RSSI measurement of the ACK frame that acknowledged the transmitted packet in the case of a successful transmission is particularly relevant, due to the brief time elapsed between when a packet is sent and an ACK received. Therefore, in a first exemplary embodiment, only the RSSI of the ACK signal is used.

[0054] In this embodiment, the RSSI training process relates the RSSI of each ACK received with the transmission rate of the associated transmitted packet which is being acknowledged. If an ACK is received, its RSSI is measured and its RSSI level determined, and the packet transmission is attributed to that RSSI level at the transmission rate used. If no ACK is received, a transmission error is assumed. In that case, if the RSSI process was not used to choose the transmission rate, then the error is not attributed to any particular RSSI level. However, if the RSSI process was used to choose the transmission rate, then the RSSI level used to choose the transmission rate is identified, and the error is attributed to that RSSI level and transmission rate. A running total of the number of packets sent, and the number of transmission errors, is maintained for each RSSI level at each transmission rate. The Tx PER for each RSSI level and transmission rate is calculated by dividing the number of transmission errors by the number of packet transmissions for that RSSI level and transmission rate.

[0055] Figure 5 is a flow diagram of the RSSI training process 345 of the overall rate adaptation process 300 of Figure 3. The RSSI training process 345 begins after a packet is transmitted, with a determination of whether an RSSI training process was previously used to determine the packet transmission rate, (step 505). If not, a determination is made as to whether an ACK was received in response to a transmitter packet, (step 510). If, at step 510, it is determined that no ACK was received, then there is no way to attribute the transmission error to a particular RSSI level, and the RSSI training process 345 terminates. If, at step 510, it is determined that an ACK was received in response to the transmitted packet, the RSSI measurement of

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the ACK is retrieved from the memory 112 of the WTRU 100, the RSSI level is determined by the processor 108, and the RSSI level total packet transmission counter 126 is incremented for that RSSI level, (step 515).

[0056] If, at step 505, it is determined that the RSSI training process was previously used to determine the packet transmission rate, the RSSI level that was used by the RSSI training process to determine the transmission rate is identified, (step 520). It is then determined whether an ACK was received for the transmitted packet, (step 525). If it is determined at step 525 that an ACK was not received, both the RSSI level total packet transmission counter 126 and the RSSI level packet transmission error counter 128 are incremented for that RSSI level, (step 530). If it is determined at step 525 that an ACK was received, the RSSI measurement of the ACK is retrieved from the memory 112 of the WTRU 100, the RSSI level of the ACK is determined by the processor 108, and the RSSI level total packet transmission counter 126 is incremented for the RSSI level of the ACK, (step 535).

[0057] This information is used to calculate the Tx PER at each RSSI level, (step 540) for each transmission rate used. This information could be collected in a table, such as the following table, Table 3, which shows exemplary Tx PER vs. RSSI statistics for each of the transmission rates an exemplary STA uses to transmit packets.

Rx Power (dBm) (RSSI level)	Tx PER for different Transmission rates			
	Rate 1 (e.g. 1 Mbps)	Rate 2 (e.g. 2 Mbps)	...	Rate N (e.g. 54 Mbps)
-∞ to -97	1.00	1.00	...	1.00
-97 to -94	0.64	0.92	...	1.00
-94 to -91	0.22	0.47	...	1.00
-91 to -88	**0.07**	0.18	...	1.00
-88 to -85	0.01	**0.08**	...	0.95
...	...	...	...	...
-70 to -67	0.00	0.00	...	0.15
-67 to -64	0.00	0.00	...	**0.03**
-64 to ∞	0.00	0.00	...	0.00

TABLE 3

[0058] As shown in Figure 5, the Tx PER statistic of a given RSSI level and transmission rate is updated accordingly after each new packet

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transmission (step 540). If a packet was not received properly the first time it was transmitted and it was retransmitted, the second transmission is treated as a distinct packet transmission. In the event of a successful transmission, the database is updated using the RSSI measurement of the ACK frame, either alone or in combination with the RSSI that was used to determine the transmission rate. If multiple valid RSSI measurements are available, either the latest one, or a statistic, (such as an average of two or more of the most recent measurements), can be used to determine the RSSI level. However, it may be advantageous to use the RSSI measurement of the most recently received ACK, because of its close temporal proximity to the transmitted packet.

[0059] The RSSI-based process also uses as an input a desired target transmitted PER, or maximum allowed PER. The target transmitted PER can be the same for all transmission rates, or it can be different for different rates. For example, in Table 3, the maximum allowed Tx PER is set at 0.10 for all rates. Thus, the preferred transmission rate at any RSSI level is the highest transmission rate at that level with a Tx PER no greater than 0.10. For such a Tx PER to be valid, there must exist a sufficient number of measurements to establish such a PER.

[0060] The minimum number of packets received for an RSSI level that is required to establish a valid Tx PER should be a configurable number. For example, in order to establish a Tx PER no greater than 0.10, at least ten packets must have been received. Alternatively, a Tx PER is preferably deemed stable only after a preferred number of packets have been received equal to a desired multiple of the inverse of the Tx PER. For example, if the desired multiple is two and the target Tx PER value is 0.10 for a particular RSSI level and transmission rate, then in order for the Tx PER value to be deemed stable, at least 2 x (1/10) = 20 packets must be received at that RSSI level and transmission rate.

[0061] In Table 3, the values in bold indicate the preferred transmission rate for each RSSI level. For example, at the RSSI level of -88 dBm to -85 dBm, both Rate 1 (1 Mbps, with a PER of 0.01) and Rate 2 (2 Mbps, with a

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PER of 0.08) have a Tx PER lower than the maximum allowable value of 0.10. If the next higher rate (not shown) has a PER higher than the maximum allowed (e.g., 0.15) then the preferred transmission rate is Rate 2, which is the highest rate with a PER less than the maximum allowed. In the case where the RSSI is so low (e.g., anything less than -91 dBm in Table 3) that none of the supported rates gives a Tx PER statistic below the maximum allowed PER, then the RSSI-based process should preferably use a flag to indicate that no supported rate results in an acceptable Tx PER. In that case, the packet should not be transmitted, since sending the packet is more likely to result in a transmission error than is indicated by the target or maximum allowed PER. Alternatively, the preferred transmission rate can be set at the lowest supported rate before sending the packet. This information can be summarized as in the following table, Table 4.

Rx Power (dBm) (RSSI level)	Preferred Rate
-∞ to -97	None-Flag
-97 to -94	None-Flag
-94 to -91	None-Flag
-91 to -88	Rate 1
-88 to -85	Rate 2
...	...
-67 to -64	Rate N
-64 to ∞	Rate N

TABLE 4

[0062] As shown in Figure 5, after the Tx PER is calculated for an RSSI level and transmission rate, the preferred transmission rate for the RSSI level is also determined as described above, (step 540). After the transmission rate versus RSSI level statistics are obtained and determined to be stable for a particular RSSI level, the RSSI-based process is then used to adjust the transmission rate of a transmitter. Otherwise, the Tx PER-based process is invoked to determine the transmission rate.

[0063] Figure 6 is a flow diagram of an alternate RSSI training process 345' of the overall rate adaptation process 300 for which it is assumed that the transmitter power and the channel conditions remain substantially constant

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over time periods substantially equal to the *Maximum Duration* time period, as is commonly the case.

[0064] After a packet is transmitted, a determination is made as to whether an ACK was received for the transmitted packet, (step 605). If so, the RSSI measurement of the ACK signal is retrieved from the memory 112 of the WTRU 100, its RSSI level is determined, and the count of transmissions for the RSSI level is incremented, (step 610). The transmitted packet error rate (Tx PER) is then updated for the RSSI level, a determination is made if the Tx PER is stable for the RSSI level and, if so, the preferred packet transmission rate is updated for the RSSI level, (step 615).

[0065] If at step 605 it is determined that an ACK was not received for the transmitted packet, a determination is then made as to whether there are RSSI measurements available for any packets received from the second station within the last *Maximum Duration* time period, (step 620). If not, then there is no way to attribute the transmission error to a particular RSSI level, and the process 345' terminates. However, if it is determined at step 620 that there are one or more RSSI measurements available, the RSSI level of the measurements is determined. If more than one RSSI level is found at step 625, a representative RSSI level is determined, and the RSSI level total packet transmission counter 126 and the RSSI level packet transmission error counter 128 are incremented for the RSSI level. The Tx PER for the RSSI level is then updated, and a determination is made as to whether the Tx PER is stable for the RSSI level. If so, the preferred packet transmission rate for the RSSI level is updated (step 615).

[0066] It should be noted that the RSSI training processes 345 and 345' are ongoing processes. The Tx PER is updated according to Figure 5 or Figure 6 at the RSSI level of incoming packets following the transmission of every packet, or alternatively after the transmission of every N packets, even after an RSSI level is deemed "trained". Old statistics may be preferably deleted from the memory 112 after a significant period of time elapses, or using by maintaining in the memory only a preferred number of the most recent measurements, (e.g., 100). Alternatively, the RSSI statistics stored in the

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memory 112 may be periodically flushed-out whereby the RSSI training process 345 or 345' is restarted from scratch.

[0067] In an embodiment of the present invention shown in Figure 7, a first station transmitting to a second station adjusts its transmission rate in response to a rate command received from the second station. This embodiment involves taking measurements at the second station, determining therefrom a preferred rate, generating a rate command, sending the rate command to the first station, and implementing the preferred rate at the first station. Optionally, the measurements themselves can be sent to the first station, which determines therefrom a preferred transmission rate. The measurements used to determine the preferred rate can include link quality indicators and/or other measurements, such as the RSSI or SNR of signals received at the second station from the first station. The rate command from the second station to the first station is preferably located in a MAC header of a packet sent by the second station to the first station, but it can also be transmitted through other means, such as in a payload of a frame, or in one or more dedicated packets.

[0068] This implementation assumes that the second station has stored in memory the sensitivity, (e.g., SNR), needed to achieve a desired QoS, (e.g., PER), for each of the allowed transmission rates. The method by which this information is obtained by the second station can include pre-configuration, training, or the like, and is beyond the scope of this implementation of the invention.

[0069] For every packet that the second station receives from the first station, (including packets addressed to nodes other than the second station), the second station measures and stores in a memory the SNR of the packet and the time at which it was received. Thereafter, whenever the second station needs to send a packet to the first station, it checks its memory to see if it has received any packets from the first station within the last *Maximum Duration* period. If so, the second station generates a statistic from the SNR measurements (e.g. the average SNR of packets received within the last *Maximum Duration* period, or the most recent valid SNR, or the like) and

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compares it to the sensitivity figures stored in memory. The preferred rate is the highest rate for which the generated SNR statistic is better than the SNR needed to achieve the desired QoS. The second station then encodes the desired rate into a rate command, which it sends to the first station.

[0070] If the second station has not received packets from the first station in the last *Maximum Duration* period, the second station either sets the preferred transmission rate to a default rate; or to the last rate for which it had successfully received a packet; or to the rate indicated in the last rate command it sent to the first station. Alternatively, it can send a signal indicating the second station is not providing the transmission rate the first station should use, thus leaving to the first station the task of determining its transmission rate. The second station encodes the desired rate or signal into a rate command and sends it to the first station. The first station then stores in memory the latest rate command and the time it was received, and implements it when transmitting to the second station.

[0071] Figure 7 is a flowchart of a rate adaptation process 700 where transmission rate commands are generated at the second station and sent to the first station. When the first station has a packet to send to the second station, (step 705), it checks its memory 112 to see if it has received a valid rate command from the second station in the last *Maximum Duration* period, (step 710). If so, the first station sets its transmission rate in accordance with the latest rate command received, (step 715). If no valid rate command is available, the first station determines its own transmission rate as described above, (step 720). The packet is then transmitted, (step 725).

[0072] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone without the other features and elements, or in various other combinations with or without other features and elements of the present invention.

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CLAIMS

What is claimed is:

1. In a wireless communication system including a plurality of wireless transmit/receive units (WTRUs), a method for adjusting a packet transmission rate of a WTRU, the method comprising:

(a) a first one of the WTRUs determining a packet transmission rate for transmitting an available packet;

(b) the first WTRU transmitting the packet to a second one of the WTRUs at the transmission rate selected in step (a); and

(c) the first WTRU invoking a relative signal strength indicator (RSSI) training process based on the transmitted packet.

2. The method of claim 1 further comprising:

(d) the first WTRU determining whether or not there is at least one valid RSSI measurement available for at least one packet that was received from the second WTRU within a predetermined time period.

3. The method of claim 2 wherein if the determination of step (d) is positive, the method further comprising:

(e) the first WTRU determining the RSSI level of the at least one available RSSI measurement; and

(f) the first WTRU determining whether the RSSI level determined in step (e) was previously used by the RSSI training process within the predetermined time period.

4. The method of claim 3 wherein if the determination of step (f) is positive, the method further comprising:

(g) the first WTRU setting the packet transmission rate to a preferred packet transmission rate established for the RSSI level, as determined by the RSSI training process.

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5. The method of claim 2 wherein if the determination of step (d) is negative, the method further comprising:

(e) the first WTRU invoking a transmission packet error rate (PER)-based process to determine the packet transmission rate.

6. The method of claim 3 wherein if the determination of step (f) is negative, the method further comprising:

(g) the first WTRU invoking a transmission packet error rate (PER)-based process to determine the packet transmission rate.

7. The method of claim 1 wherein the RSSI training process comprises:

(i) if the second WTRU sent an acknowledgement (ACK) message to the first WTRU in response to receiving the packet transmitted by the first WTRU, the first WTRU determining the RSSI level of an RSSI measurement of the ACK message and incrementing a count of total packet transmissions for the RSSI level; and

(ii) the first WTRU updating a preferred packet transmission rate for the RSSI level.

8. In a wireless communication system including at least one access point (AP) and at least one wireless transmit/receive unit (WTRU), a method for adjusting a packet transmission rate of the AP, the method comprising:

(a) the AP determining a packet transmission rate for transmitting an available packet;

(b) the AP transmitting the packet to the WTRU at the transmission rate selected in step (a); and

(c) the AP invoking a relative signal strength indicator (RSSI) training process based on the transmitted packet.

9. The method of claim 8 further comprising:

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(d) the AP determining whether or not there is at least one valid RSSI measurement available for at least one packet that was received from the WTRU within a predetermined time period.

10. The method of claim 9 wherein if the determination of step (d) is positive, the method further comprising:

(e) the AP determining the RSSI level of the at least one valid RSSI measurement; and

(f) the AP determining whether the RSSI level determined in step (e) was previously used by the RSSI training process within the predetermined time period.

11. The method of claim 10 wherein if the determination of step (f) is positive, the method further comprising:

(g) the AP setting the packet transmission rate to a preferred packet transmission rate established for the RSSI level, as determined by the RSSI training process.

12. The method of claim 9 wherein if the determination of step (d) is negative, the method further comprising:

(e) the AP invoking a transmission packet error rate (PER)-based process to determine the packet transmission rate.

13. The method of claim 10 wherein if the determination of step (f) is negative, the method further comprising:

(g) the AP invoking a transmission packet error rate (PER)-based process to determine the packet transmission rate.

14. The method of claim 8 wherein the RSSI training process comprises:

(i) if the WTRU sent an acknowledgement (ACK) message to the AP in response to receiving the packet transmitted by the AP, the AP determining

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the RSSI level of an RSSI measurement of the ACK message and incrementing a count of total packet transmissions for the RSSI level; and

(ii) the AP updating a preferred packet transmission rate for the RSSI level.

15. An access point (AP) for adjusting a packet transmission rate, the AP comprising:

(a) a processor for determining the packet transmission rate of the AP; and

(b) a transmitter for transmitting a packet to a wireless transmit/receive unit (WTRU) at the rate determined by the processor, wherein the processor invokes a relative signal strength indicator (RSSI) training process on the packet and determines whether there is at least one RSSI measurement available for at least one packet that was received from the WTRU within a predetermined time period.

16. The AP of claim 15 wherein if there is at least one RSSI measurement available for at least one packet that was received from the WTRU within a predetermined time period, the processor determines the RSSI level of the at least one valid RSSI measurement and determines whether the RSSI level was previously used by the RSSI training process within the predetermined time period.

17. The AP of claim 15 wherein if there is not at least one RSSI measurement available for at least one packet that was received from the other WTRU within a predetermined time period, the processor invokes a transmission packet error rate (PER)-based process to determine the packet transmission rate.

18. The AP of claim 17 wherein if the RSSI level was not previously used by the RSSI training process within the predetermined time period, the

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processor invoking a transmission packet error rate (PER)-based process to determine the packet transmission rate.

19. The AP of claim 17 wherein if the RSSI level was previously used by the RSSI training process within the predetermined time period, the processor sets the packet transmission rate to a preferred level established for the RSSI level, as determined by the RSSI training process.

20. The AP of claim 15 wherein if the WTRU sent an acknowledgement (ACK) message in response to receiving the packet transmitted by the AP, the processor determines the RSSI level of an RSSI measurement of the ACK message, increments a count of transmissions for the RSSI level, and updates a preferred packet transmission rate for the RSSI level.

21. The AP of claim 15 wherein if an acknowledgement (ACK) message to the packet is not received by the AP in response to transmitting the packet, the processor determines whether there are any RSSI measurements available for any packets received from the second WTRU within the predetermined time period, and if so determines an RSSI level of said packets, and increments a count of total transmissions and a count of errors for the RSSI level, and updates a preferred packet transmission rate for the RSSI level.

22. An integrated circuit (IC) incorporated in a transceiver for adjusting the transceiver's packet transmission rate, the IC comprising:

(a) a processor for determining the packet transmission rate of the transceiver;

(b) a transmitter for transmitting a packet to another transceiver at the rate determined by the processor, wherein the processor invokes a relative signal strength indicator (RSSI) training process on the packet and determines whether there is at least one RSSI measurement available for at

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least one packet that was received from the other transceiver within a predetermined time period.

23. The IC of claim 22 wherein if there is at least one valid RSSI measurement available for at least one packet that was received from the other transceiver within a predetermined time period, the processor determines the RSSI level of the at least one valid RSSI measurement and determines whether the RSSI level was previously used by the RSSI training process within the predetermined time period.

24. The IC of claim 22 wherein if there is not at least one RSSI measurement available for at least one packet that was received from the other transceiver within a predetermined time period, the processor invokes a transmission packet error rate (PER)-based process to determine the packet transmission rate.

25. The IC of claim 24 wherein if the RSSI level was not previously used by the RSSI training process within the predetermined time period, the processor invokes a transmission packet error rate (PER)-based process to determine the packet transmission rate.

26. The IC of claim 24 wherein if the RSSI level was previously used by the RSSI training process within the predetermined time period, the processor sets the packet transmission rate to a preferred level established for the RSSI level, as determined by the RSSI training process.

27. The IC of claim 22 wherein if the other transceiver sent an acknowledgement (ACK) message in response to receiving the packet, the processor determines the RSSI level of an RSSI measurement of the ACK message, increments a count of transmissions for the RSSI level, and updates a preferred packet transmission rate for the RSSI level.

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28. The IC of claim 22 wherein if an acknowledgement (ACK) message to the packet is not received by the transceiver in response to transmitting the packet, the processor determines the RSSI level of an RSSI measurement of the ACK message, and updates a preferred packet transmission rate for the RSSI level.

29. A wireless transmit/receive unit (WTRU) for adjusting a packet transmission rate of packets the WTRU transmits via an antenna, the WTRU comprising:

(a) a transmitter for transmitting to a node at least one packet at a particular packet transmission rate;

(b) a receiver for receiving an acknowledgement (ACK) signal from the node that receives and acknowledges receipt of the at least one packet;

(c) a processor in communication with the transmitter and the receiver;

(d) a memory in communication with the processor;

(e) a transmission rates database in communication with the processor; and

(f) a plurality of packet transmission counters in communication with the processor.

30. The WTRU of claim 29 wherein the particular packet transmission rate is initially set to a default rate.

31. The WTRU of claim 29 wherein the packet transmission counters include a total successful packet transmission counter and an individual packet transmission error counter.

32. The WTRU of claim 31 wherein the total successful packet transmission counter is incremented when the receiver receives an ACK from the node.

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33. The WTRU of claim 32 wherein the individual packet transmission error counter is reset to zero when the receiver receives an ACK from the node.

34. The WTRU of claim 33 wherein the packet transmission counters further include a total unsuccessful packet transmission counter, and the processor determines whether to adjust the particular packet transmission rate based on the sum of a first count value of the total successful packet transmission counter and a second count value of the total unsuccessful packet transmission counter.

35. The WTRU of claim 34 wherein the particular packet transmission rate is increased if the sum is greater than equal to a predetermined number of packets need for a packet transmission rate increase.

36. The WTRU of claim 35 wherein the particular packet transmission rate is increased if the ratio of the second count value over the first count value is less than a predetermined packet transmission rate increase ratio.

37. The WTRU of claim 29 wherein the packet transmission counters include a total unsuccessful packet transmission counter and an individual packet transmission error counter.

38. The WTRU of claim 37 wherein the total unsuccessful packet transmission counter and the individual packet transmission error counter are incremented when the receiver does not receive an ACK from the node after transmitting the at least one packet to the node.

39. The WTRU of claim 38 wherein the particular packet transmission rate is reduced by one or more supported rate steps designated

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in the transmission rates database based on a count value of the individual packet transmission error counter.

40. The WTRU of claim 29 wherein the packet transmission counters include a received signal strength indicator (RSSI) level total packet transmission counter.

41. The WTRU of claim 40 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is retrieved from the memory if an RSSI training process was not previously used to determine the particular packet transmission rate, the RSSI measurement is determined by the processor and the RSSI level total packet transmission counter for the RSSI level is incremented.

42. The WTRU of claim 41 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

43. The WTRU of claim 40 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is retrieved from the memory if an RSSI training process was previously used to determine the particular packet transmission rate, the RSSI measurement is determined by the processor and the RSSI level total packet transmission counter for the RSSI level is incremented.

44. The WTRU of claim 43 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

45. The WTRU of claim 40 wherein the RSSI level total packet transmission counter for the RSSI level is incremented if an RSSI training process was previously used to determine the particular packet transmission

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rate, and after transmitting the at least one packet to the node without receiving an ACK from the node.

46. The WTRU of claim 45 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

47. The WTRU of claim 29 wherein the packet transmission counters include a received signal strength indicator (RSSI) level total packet transmission counter and an RSSI level packet transmission error counter.

48. The WTRU of claim 47 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is retrieved from the memory, and the RSSI level total packet transmission counter for the RSSI level is incremented for the RSSI level of the ACK.

49. The WTRU of claim 47 wherein if the at least one packet is transmitted to the node without receiving an ACK from the node, a determination is made as to whether there are any RSSI measurements available for any packets received from the node within a last maximum duration time period, and if so, the RSSI level of the measurements is determined and the RSSI level total packet transmission counter and the RSSI level packet transmission error counter are incremented.

50. The WTRU of claim 49 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

51. The WTRU of claim 29 wherein the WTRU sets the particular packet transmission rate based on a rate command received from the node, and transmits packets based on the received rate command.

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52. An integrated circuit (IC) incorporated in a wireless transmit/receive unit (WTRU), the IC for adjusting a packet transmission rate of packets the WTRU transmits via an antenna, the IC comprising:

(a) a transmitter for transmitting to a node at least one packet at a particular packet transmission rate;

(b) a receiver for receiving an acknowledgement (ACK) signal from the node that receives and acknowledges receipt of the at least one packet;

(c) a processor in communication with the transmitter and the receiver;

(d) a memory in communication with the processor;

(e) a transmission rates database in communication with the processor; and

(f) a plurality of packet transmission counters in communication with the processor.

53. The IC of claim 52 wherein the particular packet transmission rate is initially set to a default rate.

54. The IC of claim 52 wherein the packet transmission counters include a total successful packet transmission counter and an individual packet transmission error counter.

55. The IC of claim 54 wherein the total successful packet transmission counter is incremented when the receiver receives an ACK from the node.

56. The IC of claim 55 wherein the individual packet transmission error counter is reset to zero when the receiver receives an ACK from the node.

57. The IC of claim 56 wherein the packet transmission counters further include a total unsuccessful packet transmission counter, and the processor determines whether to adjust the particular packet transmission

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rate based on the sum of a first count value of the total successful packet transmission counter and a second count value of the total unsuccessful packet transmission counter.

58. The IC of claim 57 wherein the particular packet transmission rate is increased if the sum is greater than equal to a predetermined number of packets need for a packet transmission rate increase.

59. The IC of claim 58 wherein the particular packet transmission rate is increased if the ratio of the second count value over the first count value is less than a predetermined packet transmission rate increase ratio.

60. The IC of claim 52 wherein the packet transmission counters include a total unsuccessful packet transmission counter and an individual packet transmission error counter.

61. The IC of claim 60 wherein the total unsuccessful packet transmission counter and the individual packet transmission error counter are incremented when the receiver does not receive an ACK from the node after transmitting the at least one packet to the node.

62. The IC of claim 61 wherein the particular packet transmission rate is reduced by one or more supported rate steps designated in the transmission rates database based on a count value of the individual packet transmission error counter.

63. The IC of claim 52 wherein the packet transmission counters include a received signal strength indicator (RSSI) level total packet transmission counter.

64. The IC of claim 63 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is

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retrieved from the memory if an RSSI training process was not previously used to determine the particular packet transmission rate, the RSSI measurement is determined by the processor and the RSSI level total packet transmission counter for the RSSI level is incremented.

65. The IC of claim 64 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

66. The IC of claim 63 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is retrieved from the memory if an RSSI training process was previously used to determine the particular packet transmission rate, the RSSI measurement is determined by the processor and the RSSI level total packet transmission counter for the RSSI level is incremented.

67. The IC of claim 66 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

68. The IC of claim 63 wherein the RSSI level total packet transmission counter for the RSSI level is incremented if an RSSI training process was previously used to determine the particular packet transmission rate, and after transmitting the at least one packet to the node without receiving an ACK from the node.

69. The IC of claim 68 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

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70. The IC of claim 52 wherein the packet transmission counters include a received signal strength indicator (RSSI) level total packet transmission counter and an RSSI level packet transmission error counter.

71. The IC of claim 70 wherein an RSSI measurement of an ACK received from the node after transmitting the at least one packet to the node is retrieved from the memory, and the RSSI level total packet transmission counter for the RSSI level is incremented for the RSSI level of the ACK.

72. The IC of claim 70 wherein if the at least one packet is transmitted to the node without receiving an ACK from the node, a determination is made as to whether there are any RSSI measurements available for any packets received from the node within a last maximum duration time period, and if so, the RSSI level of the measurements is determined and the RSSI level total packet transmission counter and the RSSI level packet transmission error counter are incremented.

73. The IC of claim 72 wherein a packet error rate (PER) for the RSSI level is updated in the memory and, if the PER is stable, a preferred packet transmission rate for the RSSI level is also updated in the memory.

74. The IC of claim 52 wherein the IC sets the particular packet transmission rate based on a rate command received from the node, and transmits packets based on the received rate command.

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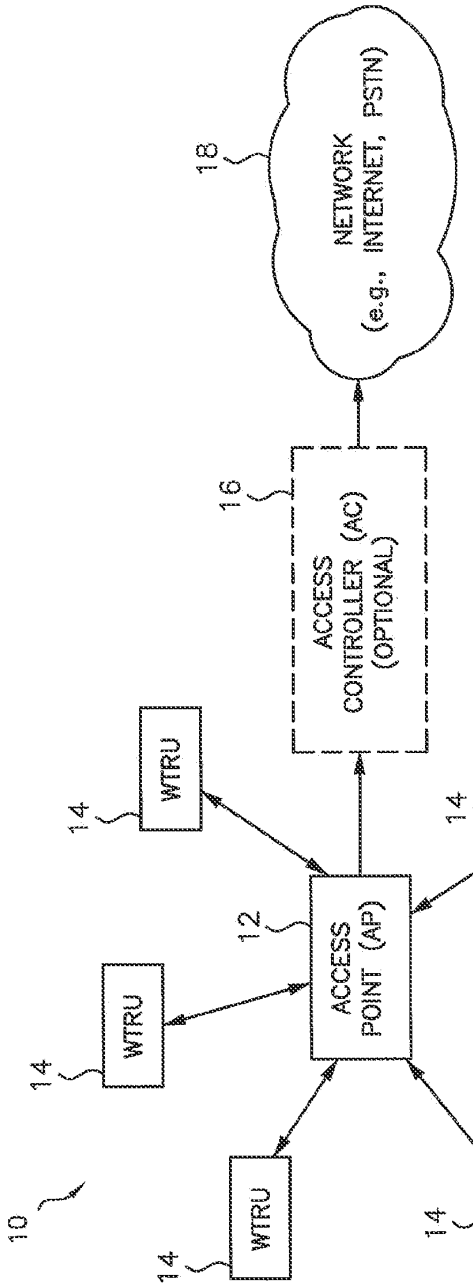


FIG. 1
(Prior Art)

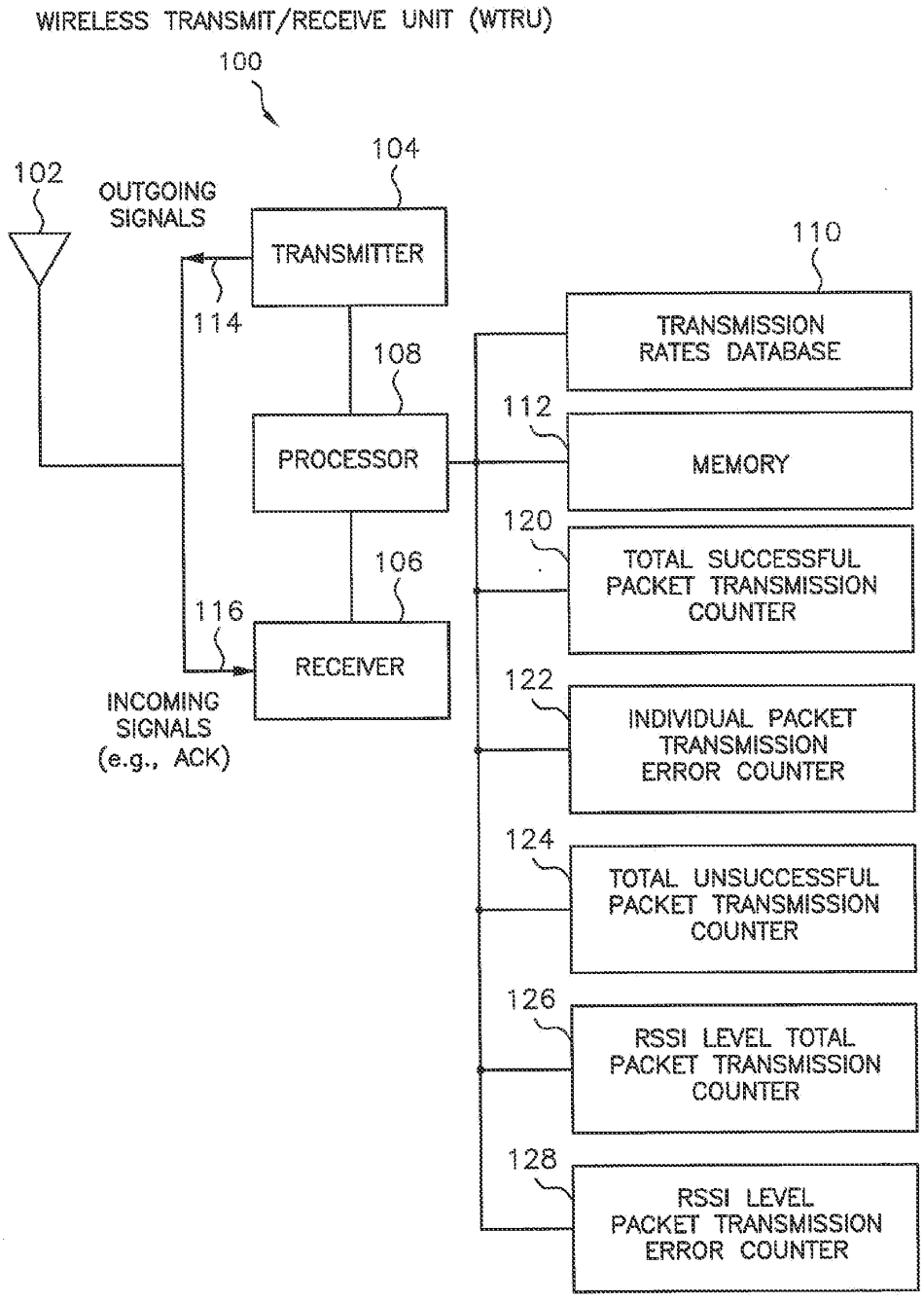


FIG. 2

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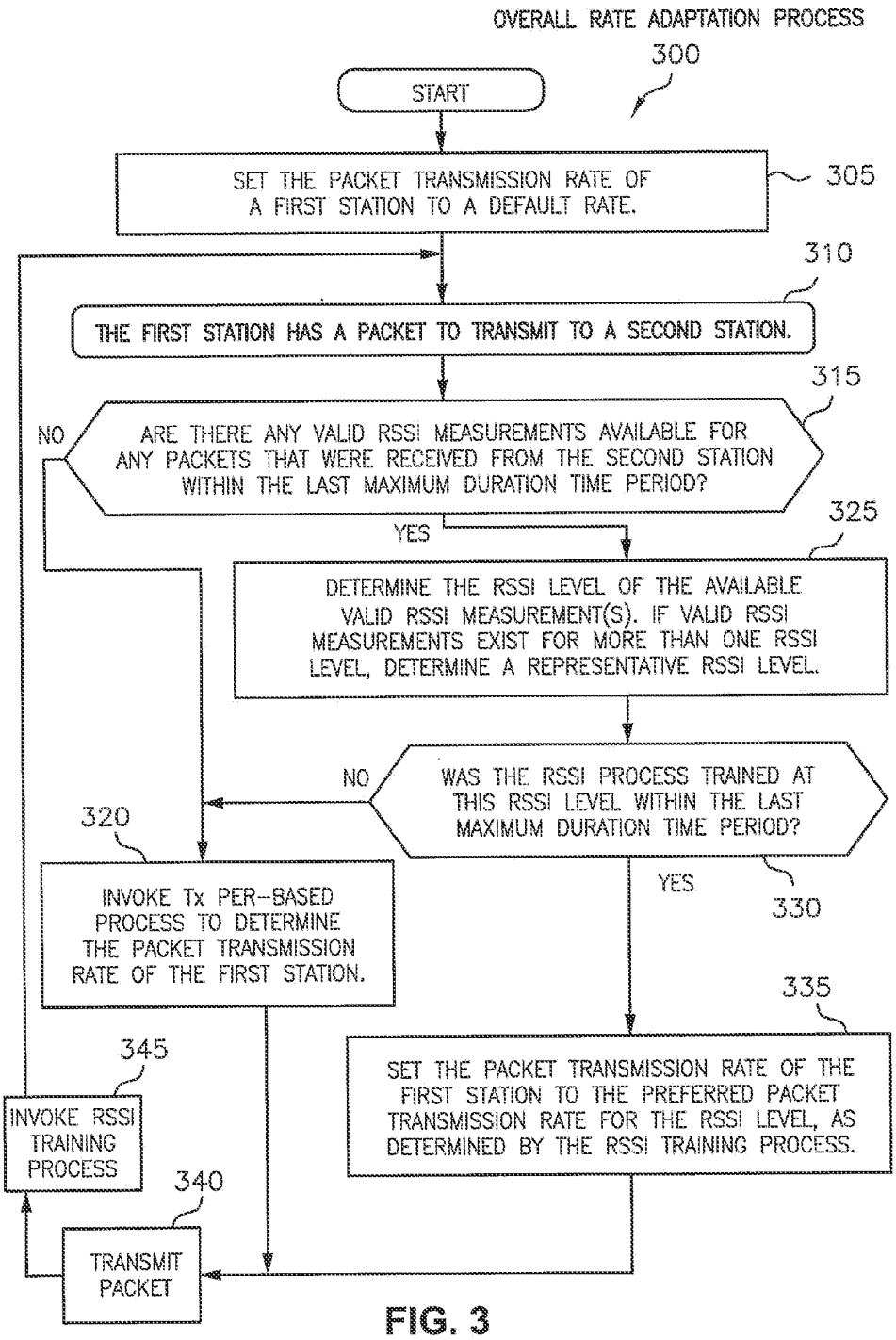


FIG. 3

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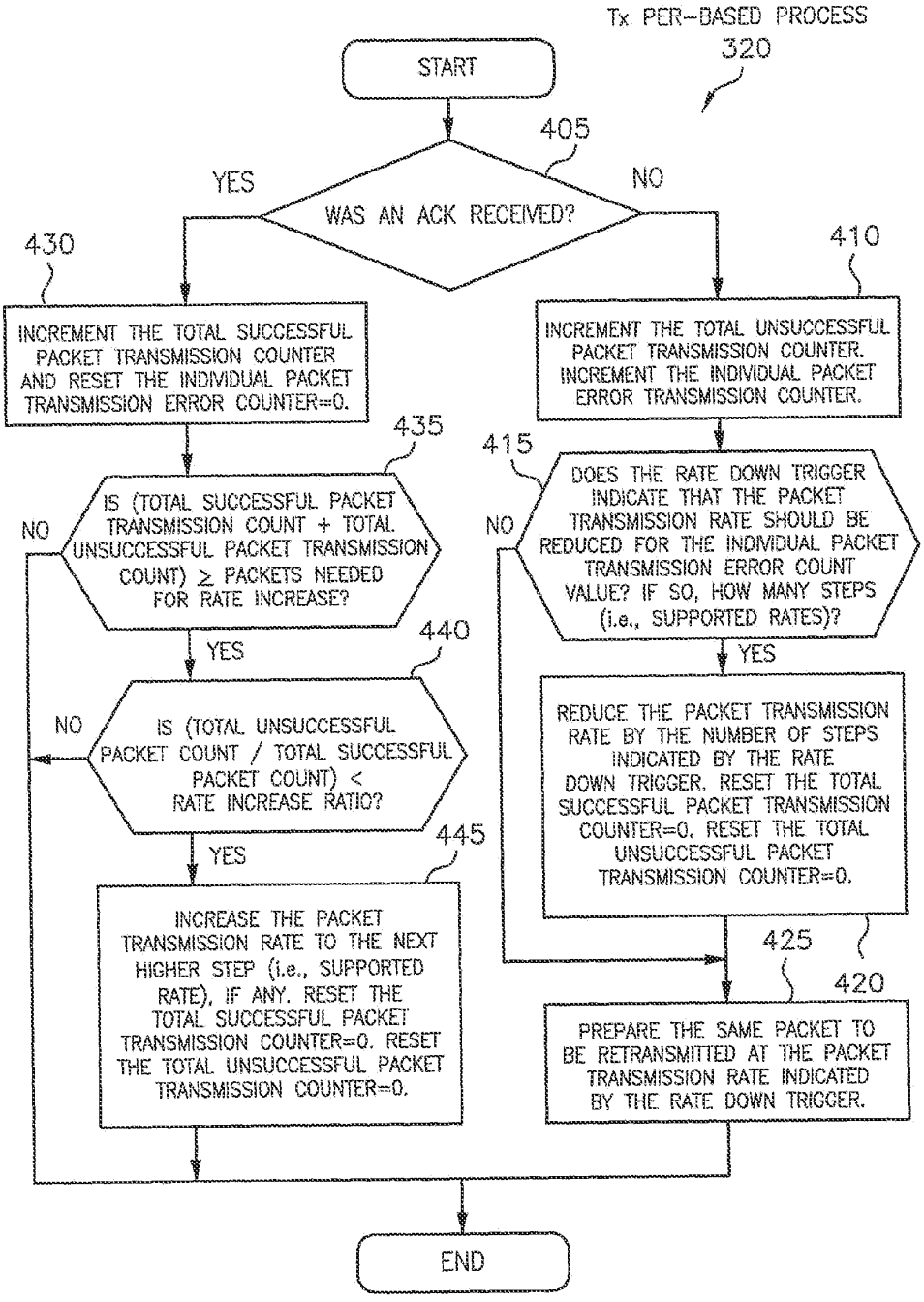


FIG. 4

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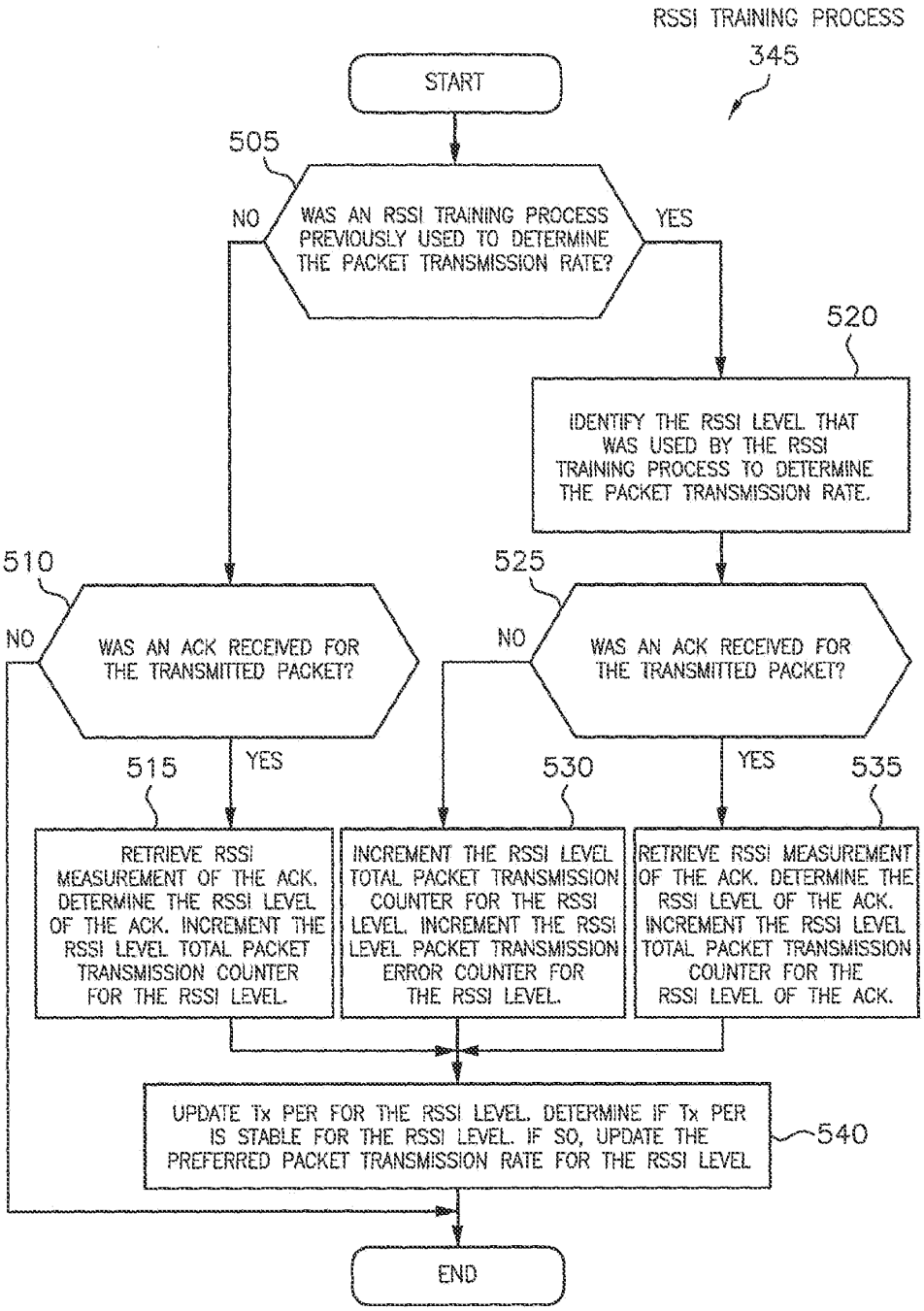

RSSI TRAINING PROCESS
345
START
505
WAS AN RSSI TRAINING PROCESS PREVIOUSLY USED TO DETERMINE THE PACKET TRANSMISSION RATE?
NO
YES
520
IDENTIFY THE RSSI LEVEL THAT WAS USED BY THE RSSI TRAINING PROCESS TO DETERMINE THE PACKET TRANSMISSION RATE.
510
WAS AN ACK RECEIVED FOR THE TRANSMITTED PACKET?
NO
YES
515
RETRIEVE RSSI MEASUREMENT OF THE ACK. DETERMINE THE RSSI LEVEL OF THE ACK. INCREMENT THE RSSI LEVEL TOTAL PACKET TRANSMISSION COUNTER FOR THE RSSI LEVEL.
525
WAS AN ACK RECEIVED FOR THE TRANSMITTED PACKET?
NO
YES
530
INCREMENT THE RSSI LEVEL TOTAL PACKET TRANSMISSION COUNTER FOR THE RSSI LEVEL. INCREMENT THE RSSI LEVEL PACKET TRANSMISSION ERROR COUNTER FOR THE RSSI LEVEL.
535
RETRIEVE RSSI MEASUREMENT OF THE ACK. DETERMINE THE RSSI LEVEL OF THE ACK. INCREMENT THE RSSI LEVEL TOTAL PACKET TRANSMISSION COUNTER FOR THE RSSI LEVEL OF THE ACK.
UPDATE Tx PER FOR THE RSSI LEVEL. DETERMINE IF Tx PER IS STABLE FOR THE RSSI LEVEL. IF SO, UPDATE THE PREFERRED PACKET TRANSMISSION RATE FOR THE RSSI LEVEL
540
END

FIG. 5

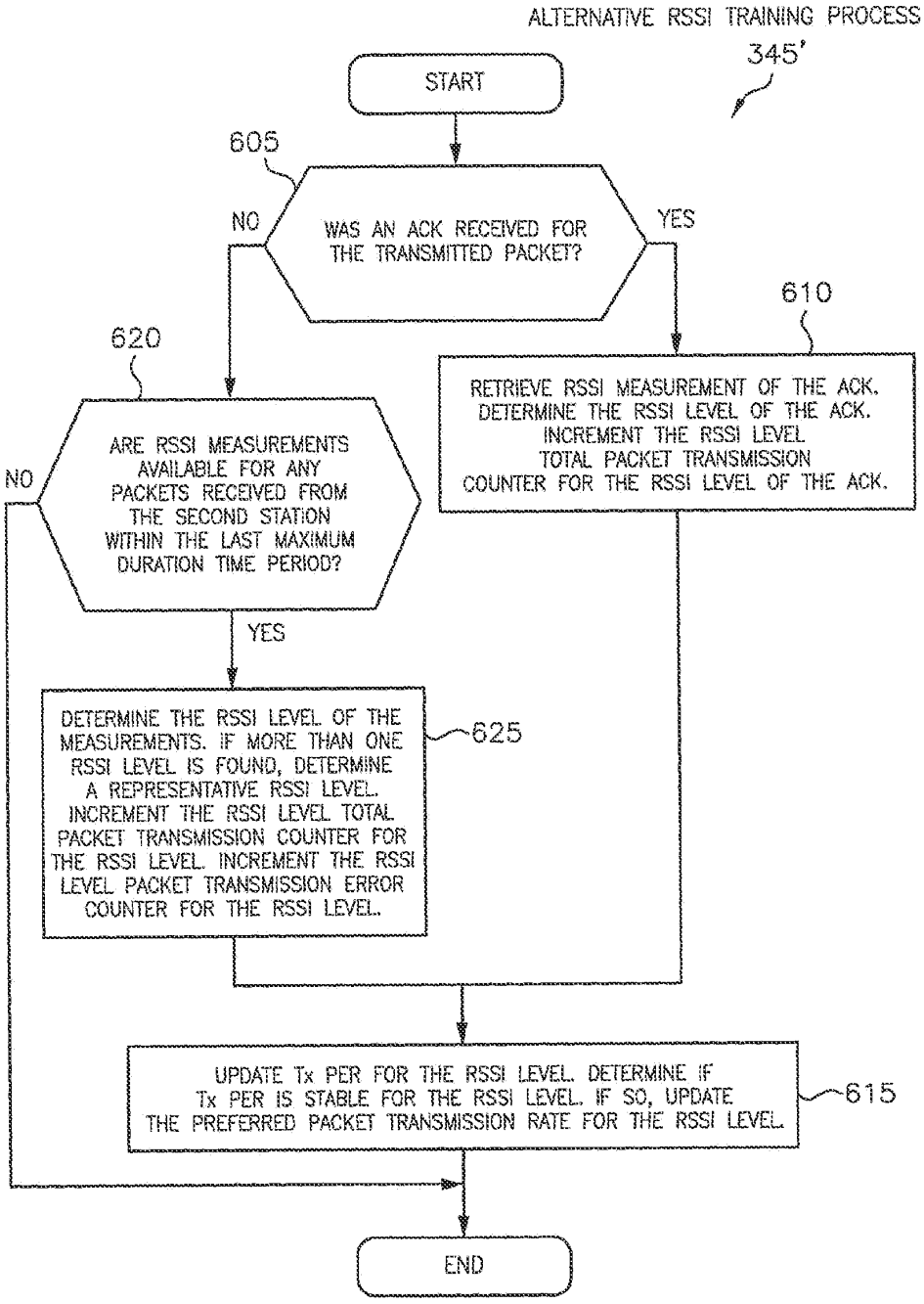

ALTERNATIVE RSSI TRAINING PROCESS
345'
START
605
WAS AN ACK RECEIVED FOR THE TRANSMITTED PACKET?
NO
YES
610
RETRIEVE RSSI MEASUREMENT OF THE ACK. DETERMINE THE RSSI LEVEL OF THE ACK. INCREMENT THE RSSI LEVEL TOTAL PACKET TRANSMISSION COUNTER FOR THE RSSI LEVEL OF THE ACK.
620
ARE RSSI MEASUREMENTS AVAILABLE FOR ANY PACKETS RECEIVED FROM THE SECOND STATION WITHIN THE LAST MAXIMUM DURATION TIME PERIOD?
NO
YES
DETERMINE THE RSSI LEVEL OF THE MEASUREMENTS. IF MORE THAN ONE RSSI LEVEL IS FOUND, DETERMINE A REPRESENTATIVE RSSI LEVEL. INCREMENT THE RSSI LEVEL TOTAL PACKET TRANSMISSION COUNTER FOR THE RSSI LEVEL. INCREMENT THE RSSI LEVEL PACKET TRANSMISSION ERROR COUNTER FOR THE RSSI LEVEL.
625
UPDATE Tx PER FOR THE RSSI LEVEL. DETERMINE IF Tx PER IS STABLE FOR THE RSSI LEVEL. IF SO, UPDATE THE PREFERRED PACKET TRANSMISSION RATE FOR THE RSSI LEVEL.
615
END

FIG. 6

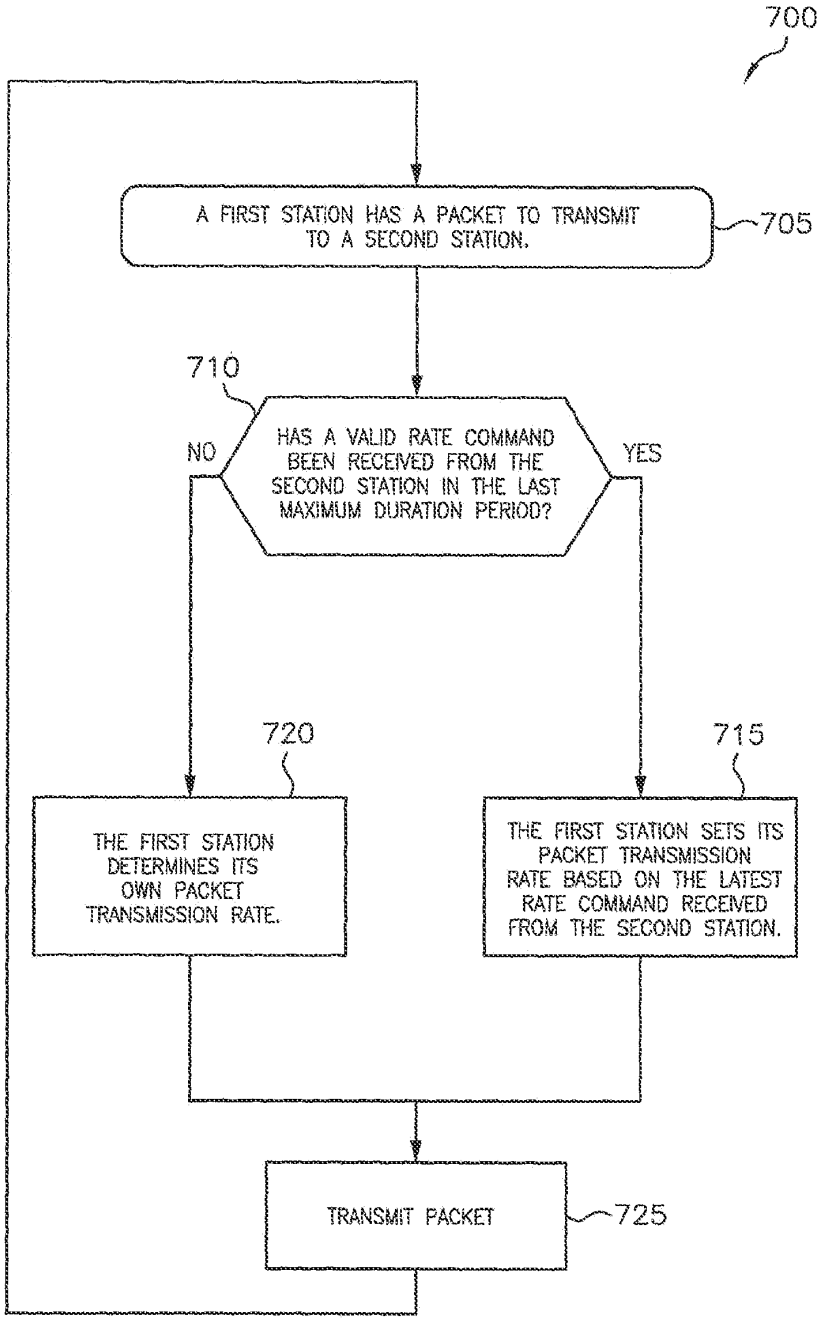


FIG. 7

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PTO/SB/08b (07-09)
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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 response filed 2/25/2022 in related European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD2], (3 pgs).	
	2	Australian office action response filed 12/1/2021 in related Australian patent application No. 2018200888, Attorney Docket No. [20145-055AUD3], (5 pgs).	
	3	European office action response filed 1/7/2022 in related European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (4 pgs).	

Examiner Signature		Date Considered	

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

Electronic Acknowledgement Receipt

EFS ID:	45087545
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:	25-FEB-2022
Filing Date:	23-NOV-2020
Time Stamp:	13:38:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	054USC_SIDS_Trans.pdf	26115 9a449a05da273944ea6b3b22eb985960d0d320ec	no	3

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	323883 e279c12dd2e5b96fe55e0fe6aec7838d69103b11	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	216653 52221b5cc50cfbc56a98fc18c2c2c9f563310435	no	3
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Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	48495 b2171d7305e8e43cf7ade901b944b54ef7dbede5	no	5
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL3.pdf	54374 4b51bf930c12c768fc9f122950f6de9dc1daf8bc	no	4
Warnings:					
Information:					
		Total Files Size (in bytes):	669520		

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 25, 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 #708

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 25, 2022

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

Charter Communications, Inc.
Exhibit 1006
Page #710

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	Notice of Allowance mailed 12/1/2021 in related US application No. 16/705,180, Attorney Docket No. [20145-055USC2], (15 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:	44748029
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:	14-JAN-2022
Filing Date:	23-NOV-2020
Time Stamp:	12:07:16
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	26099 fe996d05e18bd681303997eb8997fbd549063a34	no	3
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	323026 c29437501d895ca8d1cf0164391e23453a21c2d5	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	1681723 7aba50b6a093373af4d2357124c6b0ddec6e7924	no	15
Warnings:					
Information:					
			Total Files Size (in bytes):	2030848	

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: January 14, 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 #715

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: January 14, 2022

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

Charter Communications, Inc.
Exhibit 1006
Page #717

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 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	12/16/2021	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.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/JACQUELYN L WILLIAMS/
*** 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.

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (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.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

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

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 502776

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (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.

Signature of Registered U.S. Patent Practitioner			
Signature	/Michael V. North/	Date (YYYY-MM-DD)	2021-12-16
Name	Michael V. North	Registration Number	46963

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

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

Privacy Act Statement

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

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

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

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

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($)
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1360	1360
		Total in USD ($)		**1360**

Electronic Acknowledgement Receipt

EFS ID:	44542867
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:	16-DEC-2021
Filing Date:	23-NOV-2020
Time Stamp:	23:48:49
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1360
RAM confirmation Number	E2021BFN49120530
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 1.21 (Miscellaneous fees and charges) 37 CFR 1.20 (Post Issuance fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.16 (National application filing, search, and examination fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		054USC_AAResp_RCE.pdf	55637 edbf92d58c99011eb610475edf040ea6af4038c9	yes	9
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Request for Continued Examination (RCE)		1	1	
	Claims		2	5	
	Applicant Arguments/Remarks Made in an Amendment		6	9	
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	054USC_RCE.pdf	697710 40de0e50a42192659f947af1afecf4b1346fcee1	no	3
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38510 f393c6b7521d7fd89660aa187d6959b54c5337d5	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	791857		

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.

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 RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: December 16, 2021 By: /Domarina Alkhas/
Domarina Alkhas

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

RESPONSE TO FINAL OFFICE ACTION AND REQUEST FOR CONTINUED EXAMINATION (RCE) UNDER 37 CFR 1.114

Examiner Grijalva Lobos:

This Amendment is in response to the Final Office Action dated October 15, 2021 and subsequent Advisory Action dated November 29, 2021 having a shortened statutory response period expiring January 15, 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. Applicant thanks the Examiner for withdrawing the rejections of claims 1-23 under 35 U.S.C. § 112. On the basis of the following remarks, reconsideration and allowance of all pending claims is respectfully requested.

I. Re: Response to Arguments

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.

In the Advisory Action, the Examiner attempts 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, by alleging that the scope of the claimed invention, without context, would be "ambiguous" because "the specification fails to recite the claimed language of 'first interface', 'second interface', and 'third interface' and nothing in the specification remotely suggests three different interfaces." Advisory Action, p. 3. For support, the Examiner points to paragraphs [0081]-[0083] and Fig. 6 in the specification that show "a single interface connected to a memory." *Id.* Applicant respectfully disagrees.

First, Applicant's specification expressly states that the drawings and detailed "should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only." Specification, ¶ 8. Therefore, a person of ordinary skill in the art would not infer that Applicant intended to limit its claimed interfaces to the single "network interface" depicted in Fig. 6, or that "network interface 602" is even a single interface. As such, any perceived ambiguity is resolved in favor of Applicant's intent to not limit the claims to a single interface.

Second, Applicant's specification expressly 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." Specification, ¶ 37. From this, a person of ordinary skill in the art would conclude that Applicant's depiction of individual items in the drawings are

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merely explanatory and for the sole purpose of "understanding" rather than intended "to limit the invention to the specific embodiments." Any interpretation to the contrary would the violate express language of the specification and, thus, be unreasonable. Applicant notes that, for the same reason, the claims do not add any new matter.

Third, the Examiner asserts that "[r]eferring to each instance of a same device (in this case an interface) by different names is advantageous, and a common practice in the art when each instance performs different functionality, since it would help clarify what functionality the device is performing when the (instance of the) device is referenced a later point in the claims." Advisory Action, p. 3.

However, because referring to different interfaces (whether performing different functionality or not) would lead to the same result, the Examiner's example is unpersuasive and, thus, cannot support an interpretation against Applicant's express intent.

In the Advisory Action, the Examiner next argues that "[r]eciting that each instance is connected to a same memory would preclude assigning an interpretation where, for example, (an instance of) the interface is not connected to the memory when performing certain functionality. Therefore, a person of ordinary skill in the art would be persuaded to believe that what is being claimed is three different instances of a same interface." Advisory Action, p. 3.

However, this hypothetical is of no relevance since Applicant's do no such thing. Nowhere does Applicant claim that all interfaces are connected to the same memory except "when performing certain functionality." Therefore, this argument bears no weight. Contrary to the Examiner's conclusion a person of ordinary skill in the art would no reason to believe Applicant "claimed ... three different instances of a same interface."

Next, regarding Applicant's argument that "a person of skill in the art, familiar with the cannons of claim interpretation, would have no reason to believe that dependent claim 18 is broader than independent claim 1, i.e., that claim 1 comprises two interfaces that are the 'same interface,'" 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." However, from this the Examiner wrongly concludes that "claim 18 would improperly broaden it because it would ignore the fact that in claim 1 the interfaces are different, that is, for the interfaces to be the same they would not have to be different, which is contrary to that hypothetical claim 1." *Id.* (emphasis added).

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First, there is no contradiction in the fact that claim 1 is "broad enough" to include same interfaces or different interfaces and that claim 18 requires only same interfaces. In fact, this is exactly how the person of skill in the art familiar with the cannons of claim interpretation would interpret claims 1 and 18.

Second, assuming *arguendo* that an independent claim refers to first and second items as the same item, as the Examiner suggests, according to the cannons of claim interpretation, a subsequent dependent claim could not possibly broaden that claim by reciting items that are not the same (i.e., different items). For this reason alone, claims 1 and 18 cannot be reasonably interpreted in any other way than claim 18 being narrower than claim 1.

As an example, it is nothing unusual to claim, e.g., a "first direction" and "second direction" in an independent claim, such as claim 1, and saying that the first and second direction are the "same direction" as a dependent claim. No person of skill in the art would interpret such an exemplary dependent claim as being "broader" than the independent claim.

Finally, again assuming that the first and second items in claim 1 are the same item, since claim 18, by virtue of requiring different items, requires at least one additional item, claim 18 would be narrower than claim 1, and not broader. This is also true if the first and second items in claim 1 comprise different items, i.e., they are different or same items, whereas claims 18 is expressly limited to one item (i.e., the same item).

Overall, contrary to the Examiner's position a person of skill in the art would not view claims 1 and 18 as ambiguous and would have no trouble identifying claim 18 as the broader of the two claims.

Accordingly, Applicant respectfully requests that all rejections under 35 U.S.C. §102 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

Because the cited documents, separately and in combination, fail to teach or suggest at least one claim element for each of the pending claims, Applicant respectfully requests removal of the rejections of claims 1-23.

Applicant believes that sufficient reasons have been stated to place all of the pending claims in condition for allowance. Applicant also 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

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in order to avoid unnecessary and/or cumulative arguments. However, 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 shall also be 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 16, 2021

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

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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 11/29/2021

North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
11/29/2021	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

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 09 November 2021 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 37CFR 1.116 and 41.33(a)).
4. ☑ The amendments are not in compliance with 37CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicants reply has overcome the following rejection(s): _____
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☑ For purposes of appeal, the proposed amendment(s):(a) ☑ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

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

REQUEST FOR RECONSIDERATION/OTHER

12. ☑ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☑ Other: 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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Continuation of REQUEST FOR RECONSIDERATION/OTHER 12. The request for reconsideration has been considered but does NOT place the application in condition for allowance because: In page 6, of the response filed, applicant argues that Clark fails to teach or suggest "anything more than a single interface between the controller and the disclosed network of switches" because the interpretation given by the examiner in page 3 of the Office action dated 10/15/2021 is "misguided".

Initially applicant argues that "there is no logical reason why a person of ordinary skill in the art, after reading the claims and consulting the specification, would believe that applicant has enumerated three separate interfaces in the same claim [...] just to claim the same interface three times."

In response to the initial argument, the examiner disagrees. Indeed, a person of ordinary skill in the art would readily consult the specification and any remaining claim in order to determine the scope of the claimed invention, since without context, it would be ambiguous. A review of the specification reveals that the specification fails to recite the claimed language of "first interface", "second interface", and "third interface" and nothing in the specification remotely suggests three different interfaces. Instead, what is found in the specification, paragraphs [0081]-[0083], and Fig. 6, is a single interface connected to a memory. Claim 18 recites that any one of the first, second, or third interfaces may be the “same”. Furthermore, the present application is a continuation of Application No. 14/356,581 (now U.S. Patent No. 10,848,398) which equally fails to disclose three different interfaces. A continuation should not add any new matter. Referring to each instance of a same device (in this case an interface) by different names is advantageous, and a common practice in the art when each instance performs different functionality, since it would help clarify what functionality the device is performing when the (instance of the) device is referenced a later point in the claims. Reciting that each instance is connected to a same memory would preclude assigning an interpretation where, for example, (an instance of) the interface is not connected to the memory when performing certain functionality. Therefore, a person of ordinary skill in the art would be persuaded to believe that what is being claimed is three different instances of a same interface.

Applicant further argues that, as evidence that the three claimed interfaces are different is that claim 18 (which depends from claim 1) recites that "at least two interfaces within the first, second, and third interfaces are the same interface".

In response to the argument, the examiner respectfully disagrees. In fact, the existence of claim 18 proves applicant's argument wrong because dependent claims cannot broaden the scope of the claims from which they depend. Claim 18 suggests that the scope of claim 1 is broad enough to encompass the possibility of the first, second, and third (that is, all three) interfaces to be the same since the claim recites “at least”. If claim 1 was directed at 3 completely different interfaces (e.g. it explicitly recited that “the first interface is different than the second interface”), then claim 18 would improperly broaden it because it would ignore the fact that in claim 1 the interfaces are different, that is, for the interfaces to be the same they would not have to be different, which is contrary to that hypothetical claim 1.

Continuation of REQUEST FOR RECONSIDERATION/OTHER 14. Other: A new listing of claims was filed on 11/9/2021, however, the listing fails to cancel any claims and it doesn't appear that any claims have been amended or added. The new listing of claims has not been entered.

Notice of Non-Compliant Amendment (37 CFR 1.121)	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 amendment document filed on 11/09/2021 is considered non-compliant because it has failed to meet the requirements of 37 CFR 1.121 or 1.4. In order for the amendment document to be compliant, correction of the following item(s) is required.

THE FOLLOWING MARKED (X) ITEM(S) CAUSE THE AMENDMENT DOCUMENT TO BE NON-COMPLIANT:

- ☐ 1. Amendments to the specification:
  - ☐ A. Amended paragraph(s) do not include markings.
  - ☐ B. New paragraph(s) should not be underlined.
  - ☐ C. Other _____ .
- ☐ 2. Abstract:
  - ☐ A.Not presented on a separate sheet. 37 CFR 1.72.
  - ☐ B.Other _____ .
- ☐ 3. Amendments to the drawings:
  - ☐ A. The drawings are not properly identified in the top margin as "Replacement Sheet", "New Sheet", or "Annotated Sheet" as required by 37 CFR 1.121(d).
  - ☐ B. The practice of submitting proposed drawing correction has been eliminated. Replacement drawings showing amended figures, without markings, in compliance with 37 CFR 1.84 are required.
  - ☐ C. Other _____ .
- ☑ 4. Amendments to the claims:
  - ☐ A. A complete listing of all of the claims is not present.
  - ☐ B. The listing of claims does not include the text of all pending claims (including withdrawn claims)
  - ☐ C. Each claim has not been provided with the proper status identifier, and as such, the individual status of each claim cannot be identified. Note: the status of every claim must be indicated after its claim number by using one of the following status identifiers: (Original), (Currently amended), (Canceled), (Previously presented), (New), (Not entered), (Withdrawn) and (Withdrawn-currently amended).
  - ☐ D. The claims of this amendment paper have not been presented in ascending numerical order.
  - ☑ E. Other: See Continuation Sheet .
- ☐ 5. Other (e.g., the amendment is unsigned or not signed in accordance with 37 CFR 1.4):

  _____

For further explanation of the amendment format required by 37 CFR 1.121, see MPEP § 714.

TIME PERIODS FOR FILING A REPLY TO THIS NOTICE:

1. Applicant is given **no new time period if the non-compliant amendment is an** after-final amendment or an amendment filed after allowance. If applicant wishes to resubmit the non-compliant after-final amendment with corrections, the **entire corrected amendment** must be resubmitted.

2. Applicant is given **two months** from the mail date of this notice to supply the correction, if the non-compliant amendment is one of the following: a preliminary amendment, a non-final amendment (including a submission for a request for continued examination (RCE) under 37 CFR 1.114), a supplemental amendment filed within a suspension period under 37 CFR 1.103(a) or (c), and an amendment filed in response to a *Quayle* action. If any of above boxes 1. to 4. are checked, the correction required is only the **corrected section** of the non-compliant amendment in compliance with 37 CFR 1.121.

   Extensions of time are available under 37 CFR 1.136(a) only if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action.

   Failure to timely respond to this notice will result in:
   Abandonment of the application if the non-compliant amendment is a non-final amendment or an amendment filed in response to a *Quayle* action; or
   Non-entry of the amendment if the non-compliant amendment is a preliminary amendment or supplemental amendment.

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

Charter Communications, Inc.
Exhibit 1006
Page #739

Continuation of 4(e) Other: A new listing of claims was submitted on 11/9/2021, however, none of the claims have been canceled or appear to have been amended, and no new claims have been added

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: November 9, 2021 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 October 15, 2021, and having a shortened statutory response period expiring January 15, 2022. Accordingly, this paper is timely filed. Further examination and reconsideration are respectfully requested 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.

DO NOT ENTER: /B.D.G/

11/24/2021

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
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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	20140269300	A1	2014-09-18	Bennis	
	2	20140269269	A1	2014-09-18	Kovvali et al.	
	3	20180242191	A1	2018-08-23	Lundqvist et al.	
	4	20140280679	A1	2014-09-18	Dey et al.	
	5	20160242194	A1	2016-08-18	Mitola et al.	

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

	6	20190364457	A1	2019-11-28	Szilagyi 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]
	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	Non-Final office action mailed 8/31/2021 in related US patent application No. 15/845,977, Attorney Docket No. [20145-056USC], (42 pgs).	
	2	European office action mailed 10/26/2021 in related European patent application No. 18211162.5, Attorney Docket No. [20145-055EPD], (4 pgs).	
	3	Response to Canadian office action filed 9/23/2021 in related Canadian patent application No. 2855461, Attorney Docket No. [20145-054CA], (5 pgs).	
	4	European exam report mailed 9/10/2021 in related European patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (7 pgs).	
	5	Non-Final office action mailed 9/27/2021 in related US patent application No. 16/804,000, Attorney Docket No. [20145-117US], (39 pgs).	

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Page #743

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

	6	European office action mailed 9/22/2021 in related European patent application No. 11787994.0, Attorney Docket No. [20145-054EP], (7 pgs).	
	7	Response to non-final office action filed 11/8/2021 in related US patent application No. 16/705,180, Attorney Docket No. [20145-055USC2], (6 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.

Charter Communications, Inc.
Exhibit 1006
Page #744

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)	2021-11-09
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:	44244766
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:	09-NOV-2021
Filing Date:	23-NOV-2020
Time Stamp:	23:35:25
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	E2021A9N35451401
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 1.21 (Miscellaneous fees and charges) 37 CFR 1.20 (Post Issuance fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.16 (National application filing, search, and examination fees)

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	26151 89fcd7df35542b4aab68458ae1a4b0a3859da723	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08.pdf	612757 fdc5f9d6e7585aff11d3a7730dbec7a551756377	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	5148181 68e252a63099af038c0b6563308bb21a8d921b8a	no	42
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	205886 1d176e0e3a46d33ba619ebcad874787159ed1a75	no	4
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL3.pdf	93890 67bbd6a86d8ca7d47991c405cdc09faf3ce12fbf	no	5
Warnings:					
Information:					
6	Non Patent Literature	054USC_SIDS_NPL4.pdf	565255 c93348cf9272d33d7601cf9addac15b3294d8380	no	7
Warnings:					
Information:					

7	Non Patent Literature	054USC_SIDS_NPL5.pdf	2894071 b3908a414c4f2717a745e3c8139732598f77c98d	no	39
Warnings:					
Information:					
8	Non Patent Literature	054USC_SIDS_NPL6.pdf	511030 53f81d2cdf987e82a8a81509bb765d77231f1f3e	no	7
Warnings:					
Information:					
9	Non Patent Literature	054USC_SIDS_NPL7.pdf	44072 9b90ea3ae1794518e5bb98d2df5fe3c4c21473ad	no	6
Warnings:					
Information:					
10	Fee Worksheet (SB06)	fee-info.pdf	38503 7458d2e7e3d57e3ca9d3a66f2f8c2b82390fb9b4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	10139796		

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: November 9, 2021 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 #752

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: November 9, 2021

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

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 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	11/09/2021	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.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/DONNA D SMALLS LOGAN/
*** 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.

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: November 9, 2021 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 October 15, 2021, and having a shortened statutory response period expiring January 15, 2022. Accordingly, this paper is timely filed. Further examination and reconsideration are respectfully requested 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. Applicant thanks the Examiner for withdrawing the rejections of claims 1-23 under 35 U.S.C. § 112. On the basis of the following remarks, reconsideration and allowance of all pending claims is respectfully requested.

I. Re: Response to Arguments to Rejection of claims under 35 U.S.C. § 102

In the Office Action, the Examiner does not refute Applicant's argument that since the *Clark* document nowhere mentions or suggests that there exists anything more than a single interface between the controller and the disclosed network of switches, *Clark* fails to disclose expressly, impliedly, or inherently a server that comprises first, second, and third interfaces, and that a person of skill in the art would have no reason to assume otherwise.

Instead, the Examiner attempts to rebut Applicant's argument, in essence, by re-interpreting Applicant's claimed "*sever comprising: a first interface ... a second interface ...; and a third interface*," as a server that has only a single interface. For support, the Examiner cites to paragraph 35 of the application, which mentions that "the use of the ordinal adjectives 'first,' 'second,' and 'third,' etc.' may be used to 'describe a common object' and to 'merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner'." Office Action, p. 3 (citing to Applicant's specification).

Based on this language alone, the Examiner concludes that "'a first interface' and 'a second interface', as recited by the claims, may refer to a common object as long as different instances of the common object are specified. For example, a first instance of an interface may be an interface at a time when the interface 'receives a first set of collected data', and a second instance of the interface may be the interface at a time when the interface 'receives a second set of collected data'." *Id.*

However, such an interpretation, which collapses three expressly claimed ***interfaces*** into the same interface is misguided for the following reasons: First, while the Examiner correctly states that the specification mentions that adjectives such as first, second, and third, ***may*** describe a common object and that they do not imply some type of sequence, there is no logical reason why a person of skill in the art, after reading the claims and consulting the specification, would believe

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that Applicant has enumerated three separate interfaces in the same claim, here claim 1, just to claim the same interface three times. As one example, a person of skill in the art it would not have no indication to believe that *a memory coupled to the first and second interfaces*, as required by claim 1, is supposed to mean "a memory coupled to the interface." Because a person of skill in the art would view such interpretation are contradictory to Applicant's intent, this interpretation is unreasonably "broad."

Second, the Examiner correctly states that "a connection to a communication channel 208 may be achieved using a single hardware interface due to the nature of the communication channel, which may be, for example, the Internet. Alternatively, the communication channel 208 may also be interpreted as an interface between the server and the APs." *Id.* (emphasis added).

However, what "may" be a possible or permissible implementation is not what claim 1 requires. To the contrary, claim 1 expressly requires three interfaces that a person skilled in the art would recognize Applicant's intent to claim three distinct and separate interfaces that are coupled to specific network components, such as communication units, memory, and processor, despite the possibility that that specification leaves the door open to allow for alternative embodiments.

Third, this is further evidenced by the fact that Applicant has specifically made provisions to claim such an alternative embodiment, namely, one in which "at least two interfaces within the first, second and third interfaces are the same interface." *See* claim 18. Therefore, a person of skill in the art, familiar with the cannons of claim interpretation, would have no reason to believe that dependent claim 18 is broader than independent claim 1, i.e., that claim 1 comprises two interfaces that are the "same interface."

Applicant respectfully submits that for the foregoing reasons the proffered claim interpretation is impermissibly broad and, thus, unreasonable. As such it cannot serve as a basis for a proper rejection under 35 U.S.C. § 103.

Finally, regarding, Applicant's argument that because *Clark* makes no mention or suggestion of a second network, *Clark* also fails to disclose *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*, as required by amended claim 1, the Examiner in essence argues that because (1) *Clark* discloses switches (2) "customer equipment devices connected to a switch form ... a LAN segment," and (3) "each LAN segment [is] connected to other LAN

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segments," and (4) "[a] LAN segment is a "network" in itself," *Clark* must be disclosing two different networks. Office Action, p. 4.

However, this argument breaks down at the very first step. Just because *Clark* discloses switches does not also imply that *Clark* discloses a "LAN segment"—whether impliedly or inherently. In the Office Action, the Examiner cites to "TRIPOID.COM 2002, page 1" to justify the leap from "switch" to "LAN segment." First, the Examiner correctly states that "[s]witches are data link layer devices that, like bridges, **enable** multiple physical LAN segments to be interconnected into a single larger network'." *Id.* (emphasis added). However, the mere fact that a switch can be used form a LAN segment does not mean that Clark discloses a LAN segment. In fact, nowhere do the words "LAN," "segment," or "LAN segment" appear anywhere in the *Clark* document.

As Applicant has mentioned in their previous response, the MPEP states that "[t]he fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic;" and that "[t]o establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' (citations omitted)."

Because anticipation under 35 U.S.C. § 102(b) cannot be established where one or more of the claimed limitations are missing from the cited reference, Applicant respectfully requests reconsideration and allowance of claim 1 and its dependent claims 2-4, 7-10, and 18.

Accordingly, Applicant respectfully requests that all rejections under 35 U.S.C. §102 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

Because the cited documents, separately and in combination, fail to teach or suggest at least one claim element for each of the pending claims, Applicant respectfully requests removal of the rejections of claims 1-23.

Applicant believes that sufficient reasons have been stated to place all of the pending claims in condition for allowance. Applicant also notes that at least some of the claims include additional claim elements that are missing from the cited documents; however, additional reasons

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and responses to additional rejections for the independent and dependent claims are not presented in order to avoid unnecessary and/or cumulative arguments. However, 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 shall also be 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: November 9, 2021

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

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Exhibit 1006
Page #764

Electronic Acknowledgement Receipt

EFS ID:	44240046
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:	09-NOV-2021
Filing Date:	23-NOV-2020
Time Stamp:	15:12:39
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		054USC_FOAR.pdf	60924 627c08cc15c2337b2f048e5d4aa89eaa4643db24	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	9
Warnings:			
Information:			
	Total Files Size (in bytes):	60924	

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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

146571 7590 10/15/2021

North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304

EXAMINER	
GRIJALVA LOBOS, BORIS D	

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
10/15/2021	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

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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 9/15/2021.

☐ 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) 1-20 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 7/26/2021, 8/24/2021.

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

4) ☐ Other: _____.

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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 Office action is in response to communications filed on 9/15/2021.

Claims 1-19 have been amended.

Claims 1-23 are pending.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 7/26/2021 and the IDS submitted on 8/24/2021 are being considered by the examiner.

Response to Arguments

Applicant's arguments filed on 9/15/2021, with respect to claims 1-18 have been fully considered but they are not persuasive. In the response filed, applicant argues in substance:

a) In pages 7-8, of the response filed, applicant argues that Clark et al. (US 5970064 A, hereinafter Clark) fails to teach or disclose the limitations reciting “a server comprising: a first interface” and “a second interface“ because Clark does not “suggest that there exists anything more than a single interface between the controller and the disclosed network of switches” and Clark merely shows “a single connection between the controller and the network of switches”.

In response to argument (a), the examiner respectfully disagrees.

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 examiner notes that, as recited in paragraph [0035] of the present application, “the use of the ordinal adjectives "first," "second," and "third," etc.” may be used to “describe a common object” and to “merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner”. That is, “a first interface” and “a second interface”, as recited by the claims, may refer to a common object as long as different instances of the common object are specified. For example, a first instance of an interface may be an interface at a time when the interface “receives a first set of collected data”, and a second instance of the interface may be the interface at a time when the interface “receives a second set of collected data”.

The specification of the present application does not appear to describe a single embodiment in which the first interface is a different device or object than the second interface. In fact, Fig. 2 and paragraph [0037] of the specification, as filed, appear to show the opposite because “multiple APs may be used in the WiFi communication system 200 which are operable to communicate with the server 204 via the Communication Channel 208” (underline for emphasis), where one of ordinary skill in the art

would readily understand that a connection to a communication channel 208 may be achieved using a single hardware interface due to the nature of the communication channel, which may be, for example, the Internet. Alternatively, the communication channel 208 may also be interpreted as an interface between the server and the APs, where the interface would be the Internet, and one of ordinary skill in the art would recognize that the Internet is a single entity.

Therefore, under the broadest reasonable interpretation standard, and in light of the specification, the terms "first interface" and "second interface" have been construed by the examiner as possibly encompassing different instances of a single or common interface, the instances differentiated by the function of the interface at a given time.

b) In page 8 of the response filed, applicant argues that Clark (US 5970064 A) fails to teach or disclose the limitations reciting "a first network" and "a second network" because Clark merely discloses a singular "communications network that comprises a set of switches" and "there is no mention or suggestion of a second network in the Clark document".

In response to argument (b), the examiner respectfully disagrees.

The argued "network of switches" of Clark, as illustrated by Fig. 2, refers exclusively to the network formed by connection the switches S1-S5 via links L1-L7 (see col. 6, lines 9-14). As shown in Fig. 2, switches S1-S5 may also each connect with customer equipment devices. As one of ordinary skill in the art would recognize, customer equipment devices connected to a switch form what is known in the art as a local area network (LAN) segment, each LAN segment connected to other LAN segments (managed by other switches) to form a single larger network (i.e., the "communications network" of Clark) – see LAN Segmentation, TRIPOD.COM, 2002, page 1, "Switches are data link layer devices that, like bridges, enable multiple physical LAN segments to be interconnected into a single larger network". A LAN segment is a "network" in itself because it is composed of a plurality of interconnected devices, all of which can (normally) communicate with each other. Therefore, under the Broadest Reasonable

Interpretation standard, and in view of paragraph [0038] of the specification of the present application, as filed (which clearly allow the claimed communication units to be devices such as switches), the first network and second network may be simply two different LAN segments (since that is what would be created in a case where the communication unit is a switch).

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

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

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to 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

Notice of References Cited	Application/Control No. 17/102,099	Applicant(s)/Patent Under Reexamination Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	Art Unit 2446	Page 1 of 1

U.S. PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	"LAN Segmentation", TRIPOD.COM (Year: 2002)
	V	
	W	
	X	

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

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Page #783

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							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
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	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	=							
	20	✓	=							
	21	✓	=							
	22	✓	=							
	23	✓	=							

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Page #784

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

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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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	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

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

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

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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
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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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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	20100034135	A1	2010-02-11	Kim et al.	
	2	20110128916	A1	2011-06-02	Kwon et al.	
	3	20140304408	A1	2014-10-09	Rhee	

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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]
	1	2013070232	WO	A1	2013-05-16	ASSIA, Inc.		

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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

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	1	Examination report 1. mailed May 27, 2021, in related Australian patent application No. 2020202897, Attorney Docket No. [20145-055AUD3], (7 pgs).	
	2	Office Action mailed July 9, 2021, in related Canadian patent application No. 2,855,461, Attorney Docket No. [20145-054CA], (3 pgs).	

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Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	10/09/2021

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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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See attached certification statement.

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

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2021-07-26
Name/Print	Michael North	Registration Number	46963

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(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
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	3	20060126613	A1	2006-06-15	Zweig	
	4	20030031180	A1	2003-02-13	Datta et al.	
	5	20100290465	A1	2010-11-18	Ankaiah et al.	

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	Attorney Docket Number	20145-054USC

	6	20110182182	A1	2011-07-28	Yang et al.	
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	2	Exam Report mailed 7/28/2021 in related patent application No. 18 211 162.5, Attorney Docket No. [20145-055EPD], (5 pgs).	
	3	Exam Report Response filed 8/20/2021 in related patent application No. 18 211 162.5, Attorney Docket No. [20145-055EPD], (16 pgs).	
	4	Exam Report No. 2 mailed 2/8/2021 in related patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (6 pgs).	

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	Examiner Name	GRIJALVA LOBOS, BORIS D
	Attorney Docket Number	20145-054USC

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Signature	/Michael North/	Date (YYYY-MM-DD)	2021-08-24
Name/Print	Michael North	Registration Number	46963

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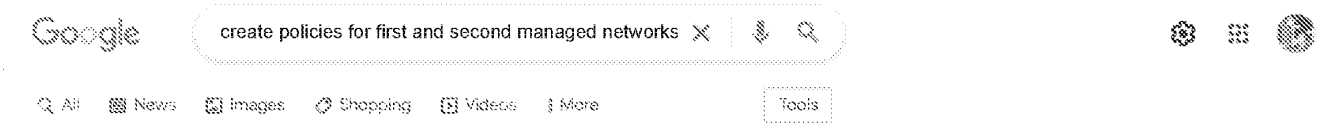
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Dec 2, 2007 — The following are general recommendations for creating a Strong Password: A Strong Password should ... Require a change of initial or "first-time" passwords.

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Dec 22, 2005 — The first of these protocols is Wired Equivalent Privacy (WEP). ... This standard defines rules for configuring an Ethernet network and also specifies how ...

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Apr 28, 2005 — The first tour was such a success that Monroe embarked on two others—one of the ... Second Bank of the United States shifting to more conservative policies.

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NIST Firewall Guide and Policy Recommendations

by J Wack · 2002 · Cited by 306 — ministrative, and management standards and guidelines for the ... networks with traffic, thereby creating distributed denial-of-service (DDOS) attacks7.

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Aug 15, 1996 — POLICY IN HEALTH CARE. INTRODUCTION ... Second, a physician network that falls outside ... or other expensive health care services do not create antitrust.

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Security - Academic Computing & Networking Services

Feb 3, 2011 — At CSU, the application called Duo Security is used to provide a second piece of ... IT security practices are specified in policies approved by the ITEC ...

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Switches also go one step further with LAN segmentation by allowing microsegmentation, which further segments the LAN by allowing individual hosts to be

https://www.configrouter.com › switch-lan-segmentatio...

What is Switch and LAN Segmentation? - Config Router

Mar 6, 2020 — The reason we use switches is in most cases to provide LAN segmentation. Switches and bridges are used to segment LAN and reduce collision ...

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What Is Network Segmentation? - Cisco

Segmentation works by controlling how traffic flows among the parts. You could choose to stop all traffic in one part from reaching another, or you can limit ...

https://www.hermit.cc › lan › segment

Part 11: Segmenting Local Area Networks - Hermit

Like bridges, switches can be used to segment a LAN. Unlike bridges, a major strength of switches is that they can handle multiple cross-segment communications ...

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Network Segmentation - an overview | ScienceDirect Topics

Newer Layer 2 switches provide the capability to implement ACLs at the port level as traffic enters the switch, allowing options to help improve VLAN security ...

https://flylib.com › books

Segmenting LANs with Switches - Flylib.com

Cisco Catalyst LAN Switching,2005, (isbn B00007FYCI), by Clark K., Hamilton K. ... These devices interconnected networks and segments together.

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Searches related to switches LAN segmentation

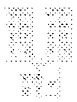
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Patents create policies for first and second managed networks

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Distributed firewall security system that extends across different cloud ...



US • US10484334B1 • Jaushin Lee • Zentera Systems, Inc.
Priority 2013-02-26 • Filed 2017-04-13 • Granted 2019-11-19 • Published 2019-11-19
An application profile is provided to manage security of an application deployed across two or more cloud computing networks. A user can define in the application profile first and second server groups, a cloud chamber as including the first and second server groups, and a computing flow to the ...

Software defined networking (sdn) controller orchestration and network ...



US • US20180278715A1 • Young Lee • Futurewei Technologies, Inc.
Priority 2013-04-05 • Filed 2018-05-14 • Published 2018-09-20
A data center interconnection (DCI) network may comprise a data center controller (DCC) managing a plurality of data centers (DCs) interconnected by a provider network managed by a network provider controller (NPC). The provider network may be an OpenFlow based software defined networking (SDN) ...

Methods and apparatus for managing network traffic



WO EP US IN • US8627463B2 • Matthew Strebe • L3 Communications Corporation
Priority 2012-01-24 • Filed 2013-01-23 • Granted 2014-03-18 • Published 2014-03-18
Methods, apparatus, and computer readable storage media reduce or eliminate network traffic meeting criteria. In some aspects, network traffic transmitted by one or more source nodes to one or more destination nodes may comprise a denial of service attack against the destination node(s). At least ...

Methods and apparatus to configure virtual private mobile networks for security



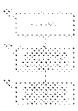
US • US10091279B2 • Arati Baliga • AT&T Intellectual Property I, L.P.
Priority 2011-06-21 • Filed 2016-06-27 • Granted 2018-09-04 • Published 2018-09-04
Methods and apparatus to configure virtual private mobile networks are disclosed. Example methods include provisioning a virtual private mobile network within a wireless network, and, after provisioning the virtual private mobile network, determining whether a first communication from a user ...

System and method for managing a network



WO EP US CN JP CA • JP5544222B2 • スターン、ロバート・ディー・クリアメス・ネットワークス・インコーポレーテッド
Priority 2004-04-15 • Filed 2012-04-02 • Granted 2014-07-16 • Published 2014-07-16
A method for providing network management comprising: Provisioning at least one configuration in the first network management device, wherein at least one configuration of the first network management device is changed and an activation key is generated; including, steps, In a management center, ...

Protecting networks from cyber attacks and overloading



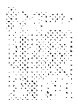
WO EP US AU CA • US10116602B2 • Sean Moore • Centripetal Networks, Inc.
Priority 2013-03-15 • Filed 2015-06-19 • Granted 2020-12-08 • Published 2020-12-08
Packets may be received by a packet security gateway. Responsive to a determination that an overload condition has occurred in one or more networks associated with the packet security gateway, a first group of packet filtering rules may be applied to at least some of the packets. Applying the ...

Secure cloud fabric to connect subnets in different network domains



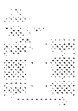
US • US9692802B2 • Jaushin Lee • Zentera Systems, Inc.
Priority 2013-02-26 • Filed 2014-07-23 • Granted 2017-07-04 • Published 2017-07-04
A secure virtual network platform connects two or more subnets in different or separate network domains. The secure virtual network can use the under layer physical networks in various domains as an IP forwarding fabric without changing any existing firewalls, security settings, or network ...

System and method for network level protection against malicious software



WO EP US CN JP AU • JP2015222591A • リライアンス・インカワイト、インコーポレイテッド
Priority 2010-07-28 • Filed 2015-07-02 • Published 2015-12-10
PROBLEM TO BE SOLVED: To provide a system and method for network level protection against malicious software.SOLUTION: A network protection device 140 creates a restriction rule to block a network traffic associated with software processes mapped to untrusted program files and prevents propagation ...

Management of unmanaged user accounts and tasks in a multi-account mobile ...



US • US10713388B2 • Nitin Desai • Citrix Systems, Inc.
Priority 2014-01-10 • Filed 2016-11-21 • Granted 2020-07-14 • Published 2020-07-14
Methods, systems, computer-readable media, and apparatuses for providing mobile application management (MAM) functionalities are presented. In some embodiments, a mobile device may initialize a partially managed application associated with a first managed user account and an unmanaged user account ...

System and method for secure control of resources of wireless mobile ...

WO EP US CN AU CA ES HK • US10223538B2 • Russell Norman Owen • Blackberry Limited

Charter Communications, Inc.
Exhibit 1006
Page #800

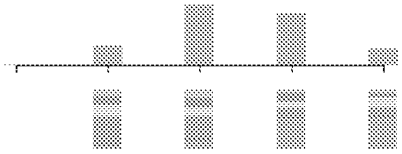


Priority 2002-08-19 • Filed 2019-05-17 • Granted 2021-05-04 • Published 2021-05-04

Systems and methods for secure control of a wireless mobile communication device are disclosed. Each of a plurality of domains includes at least one wireless mobile communication device asset. When a request to perform an operation affecting at least one of the assets is received, it is determined ..

« ‹ Page 3 › » About 140,652 results

Top 1000 results by filing date



Relative count of top 5 values

Assignees	Inventors	CPCs
Commvault Systems, Inc.		8.8%
Citrix Systems, Inc.		8.3%
Nicira, Inc.		4%
Cisco Technology, Inc.		3.6%
Amazon Technologies, Inc.		3%

Expand

Charter Communications, Inc.
Exhibit 1006
Page #801

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1,026	((access near1 point) (base near1 station) (wireless near1 LAN near1 device) (DSLAM) (gateway) (performance near1 device) DSL CPE (customer near1 premises near1 equipment) modem (in-home near1 powerline) (in-home coax) (HPNA) (metering near1 device) (LAN near3 appliance) (femtocell) (wifi near1 base) (repeater) STB STU (IP near2 TV) (IP near2 media near1 device) (gam$3 near1 console) gateway device computer router bridge switch) with ((transmit$4 send$3 forward$3 receiv$3) near5 policy) with operation	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 12:31
S2	84	((access near1 point) (base near1 station) (wireless near1 LAN near1 device) (DSLAM) (gateway) (performance near1 device) DSL CPE (customer near1 premises near1 equipment) modem (in-home near1 powerline) (in-home coax) (HPNA) (metering near1 device) (LAN near3 appliance) (femtocell) (wifi near1 base) (repeater) STB STU (IP near2 TV) (IP near2 media near1 device) (gam$3 near1 console) gateway device computer router bridge switch) with ((transmit$4 send$3 forward$3 receiv$3) near5 policy) with operation with (location time)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 12:48
S3	26,692	RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:31
S4	1,040	monitor$3 near3 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:32
S6	0	(monitor$3 near3 RSSI) with (adjust$3 near3 rate)	US-PGPUB; USPAT	OR	ON	2015/12/16 15:32

			; EPO; JPO			
S7	8	((transmit$3 send$3 receiv$3 forward$3 monitor$3) near3 RSSI) with (adjust$3 near3 rate)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:33
S8	26	((send$3 transmit$4 receiv$3 forward$3) near5 conditions near3 operation) with ((access near1 point) AP)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:26
S9	4,998	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:58
S10	3	(adaptation near1 algorithm) with ((real near1 time) real-time) with historical	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:58
S11	1	"14356581"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:14
S12	0	((send$3 transmit$4 forward$3 receiv$3) near3 policy) near20 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:39
S13	0	((send$3 transmit$4 forward$3 receiv$3) near3 policy) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:39
S14	31	((send$3 transmit$4 forward$3 receiv$3) near7 policy) with RSSI	US-PGPUB; USPAT	OR	ON	2015/12/17 20:39

			; EPO; JPO			
S15	1	(policy near1 server) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:59
S16	26	(policy near1 server) same2 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:59
S17	0	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S18	178	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S19	1	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S20	2	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) with AP	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:20
S21	7	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and (((access near1 point) AP) with server)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:20
S22	109	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2015/12/21 13:24

			; EPO; JPO			
S23	10	(rhee near1 wonjong) and policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 13:30
S24	58,484	(H04L7/00,0004 H04L12/00,14,16,24,2414,2415,2417-2419,2424-2426,2428-2433,2439,244-2442,2447,2464,2465,2468-247,2472,2473,2476,2478,26,2602,2618,2634-2642,2668-2678,2692 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; EPO; JPO	OR	ON	2015/12/21 15:17
S25	25	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and S24	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 15:17
S26	41	(rhee near1 wonjong) and S24	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 15:18
S27	1	"7840220".pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 16:50
S28	1,672,280	adaptation algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:55
S29	5,390	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:55

S30	394	(creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S31	0	((creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)) with policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S32	5	((creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)) same2 policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S33	13	(rhee near1 wonjong) and policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:17
S34	2,862	(generat$3 creat$3 develop$3) near10 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:18
S35	361	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:19
S36	0	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state)) with policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:19
S37	4	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state)) same2 policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20

S38	5,394	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20
S39	2	S35 and S38	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20
S40	5,784	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 14:02
S41	451	(transmit$4 send$3 receiv$3 forward$3 push$3) near5 (adaptation near1 algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 14:03
S42	4	"7840220".pn. "2007136337"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 15:43
S43	46	(policy near7 algorithm) and (communication near5 algorithm) and WIFI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 21:13
S44	0	S43 and S41	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 21:13
S51	33	("2006/0187885").URPN.	USPAT	OR	OFF	2018/10/19 20:09
S52	10,158	monitor$3 near7 (signal near1 strength)	US-PGPUB; USPAT	OR	OFF	2018/10/19 23:07

			; EPO; JPO			
S53	86,958	(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; EPO; JPO	OR	ON	2018/10/19 23:08
S54	335	S52 and S53	US-PGPUB; USPAT; EPO; JPO	OR	ON	2018/10/19 23:08
S55	38	("4161628" | "4229734" | "4279032" | "4430788" | "4558358" | "4694453" | "4730302" | "4799211" | "4816825" | "4860001" | "4890278" | "4896315" | "4926162" | "5048009" | "5115199").PN. OR ("5198805").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/10/19 23:11
S56	316	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 adapt$3)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:27
S57	58	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 adapt$5) not S56	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:33
S58	5	("2009/0059872").URPN.	USPAT	OR	OFF	2018/10/19 23:51
S59	1	("2012/0077533").URPN.	USPAT	OR	OFF	2018/10/19 23:54
S60	839	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 (adapt$5 chang$3 modif$3)) not (S56 S57)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:57
S61	433	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 (adapt$5 chang$3 modif$3)) and @AD<="20111110" not (S56 S57)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:04

S62	15	("2004/0223470").URPN.	USPAT	OR	OFF	2018/10/20 00:09
S63	31	remote$2 near3 manag$5 near3 QOS	USPAT	OR	OFF	2018/10/20 00:15
S64	6,276	S52 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:20
S65	1,349	RSSI and S64	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:21
S66	15	("2004/0223470").URPN.	USPAT	OR	OFF	2018/10/20 00:33
S67	89	("2007/0082677").URPN.	USPAT	OR	OFF	2018/10/20 00:40
S71	20	("20030031180" | "20030076784" | "20050261915" | "20060126613" | "20060187885" | "20070153807" | "20080186873" | "20090055900" | "20100290465" | "20110013529" | "20110110359" | "20110182182" | "20110273979" | "20120294310" | "5970064" | "5974106" | "6430612" | "7840220" | "8520586" | "8880666").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/20 23:05
S72	1	("20120151540").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/20 23:23
S73	7	("20160315976" | "20180248984" | "6469982" | "6618356" | "6678247" | "6680907" | "7864669").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/21 00:11
S74	3,178	(monitor$3 with ((real near1 time) real-time)) and (parameter with algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2019/01/27 14:58
S75	56	(monitor$3 with ((real near1 time) real-time)) and (parameter with algorithm) and (policy with (rule condition))	US-PGPUB; USPAT	OR	OFF	2019/01/27 14:59

			; EPO; JPO			
S83	2	"13995901"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/01/27 23:14
S84	3	("10057080" | "20160261490" | "8126011").PN.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:45
S85	3	("20080186873" | "6430612" | "9819595").PN.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:46
S86	238	(network near5 monitor$3) and (policy with (histor$4 near5 data)) and (communication near4 performance)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/07/26 17:56
S87	94,363	(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; EPO; JPO	OR	ON	2019/07/26 17:56
S88	68	S86 and S87	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/07/26 17:56
S97	111,342	monitor$3 near3 ((real near1 time) real-time)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:44
S98	911,536	(improv$3 increas$3) near5 (service qos quality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:47
S99	256,602	(histor$4 near4 data)	US-PGPUB;	OR	ON	2019/12/10 19:47

			USPAT; EPO; JPO			
S100	4,558	S97 and S98 and S99	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:47
S101	15,642	((improv$3 increas$3) near5 (service qos quality)) with (policy rules configuration)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:48
S102	228	S97 and S99 and S101	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:48
S103	891,108	(chang$3 updat$3 upgrad$3 transmit$4 receiv$3 forward$3 sent) near5 (policy rules configuration)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:36
S104	7,014	S97 and S99 and S103	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:37
S105	911,536	((improv$3 increas$3) near5 (service qos quality))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:37
S106	2,510	S104 and S105	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:38
S107	98,439	(H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-	US-PGPUB; USPAT	OR	ON	2019/12/10 20:38

		0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	; EPO; JPO			
S108	724	S106 and S107	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:38
S109	22,274,817	@AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:44
S110	191	S108 and S109	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:45
S111	6	("20030031180" | "20060126613" | "20080186873" | "20090147697" | "20110110359" | "20140304408").PN.	US-PGPUB; USPAT	OR	ON	2020/02/22 06:04
S112	144	(interference noise) with ((send$3 transmit$4 push$3 forward$3) near5 policy)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:07
S113	1,248	((send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:18
S114	1,119	((send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy) not S112	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:18
S115	100,577	(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; EPO; JPO	OR	ON	2020/02/22 06:18

S116	115	S114 and S115	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:19
S117	54	((avoid$3 reschedul$3) near3 (send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy) not (S112 S116)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:22
S123	2	("10530695" | "9819595").PN.	US-PGPUB; USPAT	OR	ON	2020/06/30 15:53
S124	8	("20080159124" | "20080186873" | "20090016358" | "20090201805" | "20090310528" | "20110182182" | "20110273979" | "20130077482").PN.	US-PGPUB; USPAT	OR	ON	2020/06/30 15:53
S125	3	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)) with (improv$3 near5 (performance quality)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 17:54
S126	104,560	(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; EPO; JPO	OR	ON	2020/06/30 17:54
S127	2,206	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 17:57
S128	224	S127 and S126	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 18:03
S131	104,560	(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	OR	ON	2020/06/30 21:16

			; EPO; JPO			
S132	2,206	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:16
S133	224	S132 and S131	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:16
S134	113,115	(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; EPO; JPO	OR	ON	2020/06/30 21:16
S135	22,276,145	@AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:17
S136	200	S133 and S135	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:21
S137	12	(S132 and S134 and S135) not S136	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:22
S161	27	(policy with (chang$3 switch$3) near6 band) same2 interference	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:37
S162	18	S161 and @AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 14:38

			; EPO; JPO			
S163	63	(policy with (chang$3 switch$3) near6 band) and interfer$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:39
S164	33	S163 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:41
S165	0	S164 not S163	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:52
S166	15	S164 not S162	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:52
S167	2,006	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:58
S168	1,444	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point) and band	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:59
S169	123,644	(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; EPO; JPO	OR	ON	2021/06/19 14:59
S170	60	S168 and S169	US-PGPUB; USPAT	OR	ON	2021/06/19 14:59

			; EPO; JPO			
S171	11	S170 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:59
S172	680	S168 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:04
S173	669	S172 not S171	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:05
S174	130	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point) and ((chang$3 modif$7 alter$3 switch$3) near3 band)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:24
S176	2,557	(adjust$3 modif$4 chang$3) near5 power near10 (AP (access near1 point))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:02
S177	41	SNR with (adjust$3 modif$4 chang$3) near5 power near10 (AP (access near1 point))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:06
S178	123,644	(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; EPO; JPO	OR	ON	2021/06/19 22:06
S179	20	S177 and @AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 22:06

			; EPO; JPO			
S180	83	((broadcast$3 publish$3 disseminat$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) with (performance near5 (threshold degrad$5 decreas$3 drop$4))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:46
S181	18	S180 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:52
S183	20	((broadcast$3 publish$3 disseminat$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 (parameter values adjustment)) with (performance near5 (threshold degrad$5 decreas$3 drop$4)) with ((access near1 point) AP)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:53
S184	20	((broadcast$3 publish$3 disseminat$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 (parameter values adjustment)) with (performance near5 (threshold degrad$5 decreas$3 drop$4)) with ((access near1 point) AP)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 23:23
S185	5	S184 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 23:24
S186	7	("20030031180" | "20060126613" | "20090180380" | "20090248835" | "20100290465" | "20110182182" | "20110273979").PN.	US-PGPUB; USPAT	OR	ON	2021/10/09 22:37
S187	126,669	(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; EPO; JPO	OR	ON	2021/10/09 22:38
S188	2,927	((broadcast$3 publish$3 disseminat$3 provid$3 send$3 sent relay$3 transmit$4 forward$3 push$3 deliver$3 dispatch$3	US-PGPUB;	OR	ON	2021/10/09 22:40

		convey$3 communicat$3 receiv$3 obtain$3) near5 (parameter values adjustment)) with (performance near5 (threshold degrad$5 decreas$3 drop$4))	USPAT ; EPO; JPO			
S189	2,991	((broadcast$3 publish$3 disseminat$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 (parameter values adjustment policy)) with (performance near5 (threshold degrad$5 decreas$3 drop$4))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/10/09 22:40
S190	477	S187 and S189	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/10/09 22:43
S191	173	S190 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/10/09 22:44

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S45	100	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S46	889	(policy with algorithm).clm.	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S47	1	S45 and S46	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S48	42,097	((transmission near1 control$4) (communication near1 algorithm)).clm.	US-PGPUB; USPAT	OR	ON	2017/12/20 20:55
S49	13	S46 and S48	US-PGPUB; USPAT	OR	ON	2017/12/20 20:55
S50	5	S48 and S45	US-PGPUB; USPAT	OR	ON	2017/12/20 20:56

S68	104	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2018/10/20 02:52
S69	106,792	((transmission near1 control$4) (communication near1 algorithm) policy).clm.	US-PGPUB; USPAT	OR	ON	2018/10/20 02:53
S70	7	S68 and S69	US-PGPUB; USPAT	OR	ON	2018/10/20 02:53
S76	105	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2019/01/27 14:41
S77	7,741	(monitor$3 with real-time).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:55
S78	2	S76 and S77	US-PGPUB; USPAT	OR	ON	2019/01/27 14:55
S79	37,017	(monitor$3 with parameter).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:56
S80	4	S76 and S79	US-PGPUB; USPAT	OR	ON	2019/01/27 14:56
S81	3,094	(policy and algorithm).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:57
S82	1	S76 and S81	US-PGPUB; USPAT	OR	ON	2019/01/27 14:57
S89	110	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2019/07/26 17:46
S90	25,771	(network near3 monitor$3).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:50
S91	1	S89 and S90	US-PGPUB; USPAT	OR	ON	2019/07/26 17:50
S92	1,397	(policy and (histor$4 near4 data)).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:52
S94	1	S92 and S89	US-PGPUB; USPAT	OR	ON	2019/07/26 17:52

S95	7,800	(communication near5 performance).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:53
S96	8	S89 and S95	US-PGPUB; USPAT	OR	ON	2019/07/26 17:53
S118	118	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S119	1,101	(policy with algorithm).clm.	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S120	1	S118 and S119	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S121	119,468	((transmission near1 control$4) (communication near1 algorithm) policy).clm.	US-PGPUB; USPAT	OR	ON	2020/02/23 09:13
S122	8	S118 and S121	US-PGPUB; USPAT	OR	ON	2020/02/23 09:13
S129	122	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/06/30 17:55
S138	122	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/06/30 20:49
S139	120	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:49
S140	175	(adaptive near1 spectrum near2 signal near1 alignment).as. (adaptive near1 spectrum near2 signal near1 alignment).aanm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:50
S141	0	(S138 S140) and S139	US-PGPUB; USPAT	OR	ON	2020/06/30 20:53
S142	1,398	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) and (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:53
S143	6	(S138 S140) and S142	US-PGPUB; USPAT	OR	ON	2020/06/30 20:55

S144	75,982	(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	2020/06/30 21:17
S145	9,004,209	@AD<="20111110"	US-PGPUB; USPAT	OR	ON	2020/06/30 21:17
S146	27,666	S144 and S145	US-PGPUB; USPAT	OR	ON	2020/06/30 21:23
S147	45	S146 and S142	US-PGPUB; USPAT	OR	ON	2020/06/30 21:23
S149	1,539	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) and (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S150	84,962	(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	2021/06/19 02:57
S151	9,005,504	@AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S152	27,700	S150 and S151	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S153	45	S152 and S149	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S154	121	(rhee near1 wonjong).in.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S156	176	"adaptive spectrum and signal alignment".as. "adaptive spectrum and signal alignment".aanm.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S157	83	S154 and S156	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S158	4	S153 and S157	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S159	1	"17102099"	US-PGPUB; USPAT	OR	ON	2021/06/19 03:02

S160	3	"14356581"	US-PGPUB; USPAT	OR	ON	2021/06/19 03:11
S192	1,581	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) and (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S193	87,465	(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	2021/10/09 22:40
S194	9,005,759	@AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S195	27,705	S193 and S194	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S196	45	S195 and S192	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S197	124	(rhee near1 wonjong).in.	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S198	178	"adaptive spectrum and signal alignment".as. "adaptive spectrum and signal alignment".aanm.	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S199	84	S197 and S198	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S200	4	S196 and S199	US-PGPUB; USPAT	OR	ON	2021/10/09 22:40
S201	14	((performance with policy) and (algorithm with parameter)).clm.	US-PGPUB; USPAT	OR	ON	2021/10/09 22:50
S202	2	S201 and (S197 S198)	US-PGPUB; USPAT	OR	ON	2021/10/09 22:50

10/9/2021 10:51:09 PM
C:\Users\bgrijalva\Documents\EAST\Workspaces\17102099.wsp

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 Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on the date shown below:

Dated: September 15, 2021 By: /Domarina Alkhas/
Domarina Alkhas

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

RESPONSE TO NON-FINAL OFFICE ACTION

Examiner Grijalva Lobos:

This Amendment is in response to the Non-Final Office Action dated June 25, 2021, and having a shortened statutory response period expiring September 25, 2021. Accordingly, this paper is timely filed. Further examination and reconsideration are respectfully requested 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. (Currently amended) A ~~remote~~ 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. (Currently amended) The ~~remote~~ server of claim 1 wherein the adjustment within the first network is an implementation of an algorithm.

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

4. (Currently amended) The ~~remote~~ 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.

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

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

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

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

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

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

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

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

receiving, by a ~~remote~~ 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 ~~remote~~ 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 ~~remote~~ 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.

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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 Non-Final Office Action, claims 1-23 were rejected. Claims 1-19 are amended herein.

Claims 1-19 are amended to clarify the claim language. Applicant notes that these amendments are 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. Response to Rejection of Claims 1-23 under 35 U.S.C. § 112

In the Office Action, claims 1-23 were rejected under 35 U.S.C. § 112(b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Office Action, p. 2-3.

In particular, the Examiner asserts that "the limitations recite the term 'remote server'. The term 'remote' is a relative term which renders the claim indefinite. The term "remote" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention." *Id.*

Applicant respectfully disagrees since a person skilled in the art, after consulting the specification, especially, the title, figure 2, and various locations mentioning the term "remote sever," would have a clear understanding what is meant by a remote sever.

Nevertheless, in the interest of compact prosecution, Applicant hereby amends claims 1-19 to clarify that the server may be any "dedicated server," whether remote or otherwise. Support for this amendment is provided, for example, in paragraph 29 of the specification.

Accordingly, Applicant respectfully requests that all rejections under 35 U.S.C. § 112 be withdrawn.

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II. Response to Rejection of Claims 1-4, 7-10, and 18 under 35 U.S.C. § 102

Claims 1-4, 7-10, and 18 were rejected under 35 U.S.C. § 102 as being anticipated in light of U.S. Pat. 5970064, issued to Timothy Ian James Clark et al (hereinafter, the "*Clark* document" or "*Clark*"). Office Action, p. 4. However, a review of the cited paragraphs fails to disclose at least one claim element in each of the rejected claims.

It is fundamental patent law that "[a] claim is anticipated **only if each and every element as set forth in the claim is found**, either expressly or inherently described, in a single prior art reference." MPEP §2131 (quoting *Verdegaal Bros. v. Union Oil Co. of Calif.*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987)) (emphasis added). "The identical invention must be shown in as complete detail as is contained in the . . . claim." *Id.* (quoting *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989)).

In the Office Action, the Examiner assets that *Clark* discloses a server comprising first, second, and third interfaces as claimed in the present application. Applicant respectfully disagrees for the following reasons:

First, even assuming that, as Examiner asserts, the "controller" in *Clark* could be reasonably interpreted as a "server" (or remote server), nowhere does the *Clark* document mention or suggest that there exists anything more than a single interface between the controller and the disclosed network of switches. In fact, given that each switch in *Clark* has knowledge of its nearest neighbor switch(es) and that all figures in *Clark* show a single connection between the controller and the network of switches, a person of skill in the art would have no reason to assume that the controller has more than the one and only interface shown in the figures or described in the accompanying text. *See*, *e.g.*, *Clark*, Introduction, figs. 1, 2.

Further, it is not inherent, nor can it be implied, that the controller *Clark* must have more than one interface. Indeed, within the MPEP, it is stated that "[t]he fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534 (Fed. Cir. 1993)," *see also* MPEP §2112 (IV). It is also stated that "[t]o establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may

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result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999), *see also* MPEP §2112 (IV).

Here, it is clear that the combination of neighboring switches establishes a manner of communication between the switches that allows each switch to communicate with the controller via a single common interface, namely, the one and only interface depicted in the figures in *Clark*. No additional undisclosed interfaces are necessary, nor is there any evidence of such necessity found in *Clark* or elsewhere.

Therefore, *Clark* fails to disclose at least the claim terms (1) "*a sever comprising: a first interface ... a second interface ...; and a third interface*," as required by claim 1 as amended.

Finally, although *Clark* discloses a communications network that comprises a set of switches, *Clark* refers to that communications network exclusively in the singular, i.e., as "a communications network" and "a network of switches." *See Clark*, figs. 1, 2 and descriptions thereof. In other words, there is no mention or suggestion of a second network in the *Clark* document.

Therefore, *Clark* also fails to disclose *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*, as required by amended claim 1.

Because anticipation under 35 U.S.C. § 102(b) cannot be established where one or more of the claimed limitations are missing from the cited reference, Applicant respectfully requests reconsideration and allowance of claim 1.

III. Response to Rejection of Claims 2-4, 7-10, and 18

It should be noted that Claims 2-4, 7-10, and 18 depend from independent claim 1, which comprises at least one claim element that was established above to be absent in the cited documents. Because by statute each dependent claim contains every element of the claim or claims from which it depends, Applicant notes that each of the dependent claims are also allowable for at least the same reasons as set forth regarding their respective independent claims. *See* 35 U.S.C. § 112(d) ("A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers."); *see also In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) (stating that if an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is also nonobvious).

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Accordingly, Applicant respectfully requests that all rejections under 35 U.S.C. §102 be withdrawn.

IV. Response to Rejection of Claims 5-6, 11-14, and 15-17 under 35 U.S.C. § 103

An asserted combination must teach or suggest each and every claim feature. *See In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974) (to establish *prima facie* obviousness of a claimed invention, all the claim features must be taught or suggested by the prior art). It remains well-settled law that obviousness under 35 U.S.C. § 103(a) requires at least a suggestion of all of the features in a claim. *See id.*; *see also In re Wada and Murphy* (citing *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003)). Because the cited documents fail to suggest or disclose at least one claim element for each of the pending claims, Applicant traverses these rejections.

In the Office Action, claims 5-6, 11-14, and 15-17 were rejected under 35 U.S.C. § 103 as being unpatentable in view of various references. However, these rejections are predicated on an improper characterization of *Clark*. Applicant respectfully points out that claims 5-6, 11-14, and 15-17 depend from one of independent claims 1, which comprise at least one claim element that was established above to be absent in *Clark*. Because the references either alone or in combination do not teach every claim limitation, there is no *prima facie* case of obviousness for claims 5-6, 11-14, and 15-17.

Accordingly, Applicant respectfully requests that the rejections under 35 U.S.C. § 103 also be withdrawn and that all pending claims 1-23 be allowed as currently amended.

V. Conclusion

Because the cited documents, separately and in combination, fail to teach or suggest at least one claim element for each of the pending claims, Applicant respectfully requests removal of the rejections of claims 1-23.

Applicant believes that sufficient reasons have been stated to place all of the pending claims in condition for allowance. Applicant also 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. However, 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

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Exhibit 1006
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cited documents were valid references. It shall also be 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: September 15, 2021

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

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Palo Alto, CA 94304
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Charter Communications, Inc.
Exhibit 1006
Page #832

Electronic Acknowledgement Receipt

EFS ID:	43770341
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:	15-SEP-2021
Filing Date:	23-NOV-2020
Time Stamp:	12:20:06
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		054USC_NFOAR.pdf	64423 519ba654a8a870f979855fc5f6f9975b6423f2e0	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	10
Warnings:			
Information:			
	Total Files Size (in bytes):	64423	

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New Applications Under 35 U.S.C. 111
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New International Application Filed with the USPTO as a Receiving Office
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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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/15/2021	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.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/JACQUELYN L WILLIAMS/
*** 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.

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
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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	20090248835	A1	2009-10-01	Panda et al.	
	2	20090180380	A1	2009-07-16	Prabhakar et al.	
	3	20060126613	A1	2006-06-15	Zweig	
	4	20030031180	A1	2003-02-13	Datta et al.	
	5	20100290465	A1	2010-11-18	Ankaiah et al.	

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

	6	20110182182	A1	2011-07-28	Yang et al.		
	7	20110273979	A1	2011-11-10	Grabelsky et al.		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Non-Final Office Action mailed 8/2/2021 in related patent application No. 16/705,180 filed 12/5/2019, Attorney Docket No. [20145-055USC2], (32 pgs).	
	2	Exam Report mailed 7/28/2021 in related patent application No. 18 211 162.5, Attorney Docket No. [20145-055EPD], (5 pgs).	
	3	Exam Report Response filed 8/20/2021 in related patent application No. 18 211 162.5, Attorney Docket No. [20145-055EPD], (16 pgs).	
	4	Exam Report No. 2 mailed 2/8/2021 in related patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (6 pgs).	

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Page #837

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

	5	Exam Report No. 2 Response filed 6/14/2021 in related patent application No. 18160805.0, Attorney Docket No. [20145-056EPD], (12 pgs).	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

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Exhibit 1006
Page #838

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)	2021-08-24
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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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.

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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.

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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.

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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:				
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:	43593027
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:	24-AUG-2021
Filing Date:	23-NOV-2020
Time Stamp:	20:25:54
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	E20218NK26193518
Deposit Account	502776
Authorized User	Domarina Alkhas
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37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	054USC_SIDS_Trans.pdf	26102 6713938e24bb19c9c9511913bd7b5fb98b040c35	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08.pdf	612664 442b3cb188734af72c8996b660727d2e2967fc20	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	2550329 ef7eccb6a946f34e848cddab546346d9a9061f73	no	32
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	313978 c594562164785f1e2c8e219f2acf2c9e5b074358	no	5
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL3.pdf	127864 a74a523bae61d8c9aabfd32ca127961bfba47851	no	16
Warnings:					
Information:					
6	Non Patent Literature	054USC_SIDS_NPL4.pdf	485597 d4d6b45b6d718ac9902b2b899ce2bd1afb6d7067	no	6
Warnings:					
Information:					

7	Non Patent Literature	054USC_SIDS_NPL5.pdf	457541 cd691c5db4d7bdfda3f137b753d7d55a53db28f4	no	12
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Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	38503 78867442967c32369678525890a1caf3cf43eb85	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	4612578	

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New International Application Filed with the USPTO as a Receiving Office
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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			

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Date: August 24, 2021 By: /Domarina Alkhas/
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Commissioner for Patents
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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").

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

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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 24, 2021

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

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	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	GRIJALVA LOBOS, BORIS D
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	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
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	1	Examination report 1. mailed May 27, 2021, in related Australian patent application No. 2020202897, Attorney Docket No. [20145-055AUD3], (7 pgs).	
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	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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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.

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

Signature	/Michael North/	Date (YYYY-MM-DD)	2021-07-26
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
16 May 2013 (16.05.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/070232 A1

(51) International Patent Classification:
H04L 1/00 (2006.01) *H04L 1/20* (2006.01)

(21) International Application Number:
PCT/US2011/060265

(22) International Filing Date:
10 November 2011 (10.11.2011)

(25) Filing Language: English

(26) Publication Language: English

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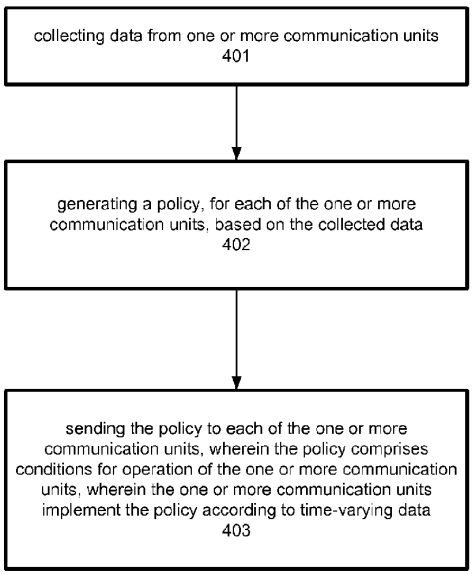
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[Continued on next page]

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

FIG. 4



(57) Abstract: Described herein are apparatus, system, and method for optimizing performance of one or more communication units by a remote server. The method comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time- varying data. The system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to perform the method discussed above.

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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

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

FIELD OF THE INVENTION

[0001] Embodiments of the invention relate generally to the field of communication systems. More particularly, embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server.

BACKGROUND

[0002] **Fig. 1** is an exemplary prior art communication system (CS) 100 with an access point (AP) 101 and one or more wireless stations $102_{1\text{-}N}$. The AP 101 exchanges user data with the one or more stations $102_{1\text{-}N}$ over wireless channels indicated by the arrows. The characteristics of the wireless channels and noise/interference are not constant and vary rapidly over time. For example, noise and interference levels from nearby noise/interference sources rapidly changes that cause the characteristics of the wireless environment to change. To cope with such rapid changes in the noise and interference levels, the CS 100 adapts transmission strategies to enhance performance of CS 100. One such known strategy is Adaptation Algorithm. The term "Adaptation Algorithm" herein refers to time-varying and environment-change-dependent transmission or control strategies for a CS. The adaptation algorithm is implemented in the AP 101 that adapts the wireless channels and noise/interference for communication with the one or more stations $102_{1\text{-}N}$.

[0003] For instance, the transmission rate of Institute of Electrical and Electronics Engineer (IEEE) 802.11g standard based WiFi communication system is rapidly adapted between 6Mbps and 54Mbps depending on the link quality and the rate selection method (also known as the rate adaptation algorithm) implemented in the WiFi communication system. Such rate adaptation algorithm within the WiFi communication system uses real-time data that are collected by the AP 101 of the WiFi communication system itself as an input to the adaptation algorithm 103, and a rate change in the link occurs when the real-time data meets a pre-defined criteria.

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[0004] A possible rate adaptation algorithm 103 is to change transmission rate of signals by the AP 101 within the WiFi communication system when the measured RSSI (Received Signal Strength Indication) becomes too large or too small for the current rate in use. Another possible adaptation algorithm 103 is to increase the transmission rate of signals by the AP 101 whenever packets are successfully received by the AP 101 and/or the one or more stations $102_{1\text{-}N}$ for M (e.g., 3) times and decrease rate whenever packets are unsuccessfully received for P (e.g., 2) times. While such adaptation algorithms 103 are required for WiFi communication systems to function properly, the rules and thresholds used by the methods are decided by a system designer of the WiFi communication system. Furthermore, a specific adaptation algorithm 103 is included in the firmware and loaded to the WiFi communication system. Hence, the adaption algorithm 103 is static in nature.

[0005] Therefore, the actual performance of the rate adaptation algorithm 103 is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and the WiFi communication system 100 may suffer from low performance due to non-ideal design of the static adaptation algorithm 103.

[0006] The impact of such differences in the assumptions can be significant in a large-scale deployment where many communication devices, such as AP's, independently operate. In such a deployment, every single communication environment is unique and the best adaptation method for each environment can be quite dependent on its own environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of the invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

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[0008] **Fig. 1** is a high level system of a typical communication system using a static adaptive algorithm.

[0009] **Fig. 2** is a system for optimizing performance of a WiFi communication system by a remote server, according to one embodiment of the invention.

[0010] **Fig. 3** is a system for optimizing performance of a Digital Subscriber Line (DSL) communication system by a remote server, according to one embodiment of the invention.

[0011] **Fig. 4** is a method performed by a remote server for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0012] **Fig. 5** is a method performed by the communication system for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0013] **Fig. 6** is a processor-based system having machine-readable storage medium with computer executable instructions for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

SUMMARY OF THE INVENTION

[0014] The following presents a simplified summary of the embodiments of the invention in order to provide a basic understanding of some aspects of the embodiments. This summary is not an extensive overview of the embodiments of the invention. It is intended to neither identify key or critical elements of the embodiments nor delineate the scope of the embodiments. Its sole purpose is to present some concepts of the embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0015] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. In one embodiment, the method for optimizing performance of one or more communication units by a remote server, comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of

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the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0016] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform the method for optimizing performance of one or more communication units by the remote server.

[0017] In one embodiment, the communications system comprises a WiFi Access Point or a Digital Subscriber Line Access Multiplexer (DSLAM) to perform a method for optimizing performance of one or more communication units coupled to the WiFi Access Point or the DSLAM. In one such embodiment, the method comprises: sending data from one or more communication units to a remote server; receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0018] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that, when executed, cause a processor, of the WiFi Access Point or the DSLAM, to perform the method for optimizing performance of one or more communication units discussed above.

[0019] In one embodiment, the apparatus comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from one or more communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0020] In one embodiment, the system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from the one or more

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communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0021] In one embodiment, the communication unit comprises: a transmitter to send data to a remote server; a receiver to receive a policy from the remote server, wherein the policy comprises conditions for operation of the communication unit; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0022] The embodiments of the invention are not limited to DSL or WiFi communication systems of the examples and embodiments above, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect the communication performance. The policy generated by the remote server can be a result of analyzing hundreds (or even millions) of similarly situated communication units, or any other expert knowledge made available to the remote server. Generally, a communication unit does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, a communication unit typically does not have access to historical data related to communications with other stations. Additionally, communication units may lose history data when there is power outage or user-initiated power cycling. The remote server resolves the above problems and provides an optimum policy for the communication units to use that can be based on analysis of a large amount of operational data of the communication units and other similarly situated communication units or any other expert knowledge.

[0023] While the summary of the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the following description. The embodiments of the invention are

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intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0024] The following description and the annexed drawings set forth in detail certain illustrative aspects of the embodiments of the invention. These aspects, however, are only indicative of the various ways in which the principles of the embodiments of the invention may be employed. The embodiments of the invention are intended to embrace all equivalents in the form of alternatives, modifications, and variations that fall within the broad scope of the appended claims. Other advantages and novel features of the embodiments of the invention will become apparent from the following detailed description of the embodiments of the invention when considered in conjunction with the drawings.

DETAILED DESCRIPTION

[0025] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. As mentioned in the background section, the actual performance of the communication unit could be dependent on the assumptions made by the designer of the communication system. In one example, as provided in the background section, the actual performance of the WiFi rate adaptation algorithm is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and a WiFi communication system might suffer from low performance due to non-ideal design of the adaptation algorithm.

[0026] To overcome the above problem, the embodiments herein describe a method, system and apparatus that analyzes real-time and history of operational data related to a communication system and provides rules and conditions for the communication system to improve its performance. The rules and conditions specify the characteristics of the real-time and historical operational data such that the communication unit can select and use the most desired adaptation algorithm to use. In one embodiment, a remote server (also called an optimization center) is operable to collect and process large amounts of data related to the communication system and determine rules and conditions for the communication system that will

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improve the performance of the communication system. In one embodiment, the remote server collects data periodically and provides updated rules and conditions periodically for the communication system to adapt so that it may improve its performance. The embodiments herein are not limited to a communication system but can be used for any type of communication system that needs to be updated over time to improve its performance to changing environments.

[0027] The term "performance" herein refers to a combination of factors including data rate, throughput, power consumption, power, error rate, latency, jitter, etc. Improving performance of the communication system includes increasing data rate, throughput, reducing error rate and latency, improving jitter, power consumption, etc for the communicating system.

[0028] The technical effect of the embodiments discussed herein is the improvement of performance of a communication system (e.g., WiFi, Digital Subscriber Line (DSL), etc) by providing the communication system with rules and conditions that were previously not conceivable by the communication system due to lack of information and processing power needed to generate the rules and conditions. In one embodiment, a dedicated server (also referred as "remote server" or "optimization center") may be used to collect operational data related to the communication system, where the operational data may not be accessible or storable by the communication system itself (e.g., data from other communication units or old data that cannot be stored due to memory limitations) process the operational data and provide rules and conditions that when adapted by the communication system causes the performance of the communication system to improve.

[0029] For example, the remote server is operable to perform a statistical analysis of hundreds (or even millions) of communication systems working in a similar environment as the communication system of interest. In one embodiment, the remote server is operable to indicate to the communication system of interest how it can improve its overall performance, for example, by aggressively choosing higher transmission rates as opposed to conservatively choosing lower transmission rates.

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[0030] In one embodiment, when the WiFi communication system has the capability to decode and execute a pre-defined pseudo-code, the remote server can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units. For example, the remote server develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory of an Access Point. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by a processor of the Access Point. In one embodiment, as the remote server becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units of the communication system.

[0031] In the following description, numerous details are discussed to provide a more thorough explanation of embodiments of the present invention. It will be apparent, however, to one skilled in the art, that embodiments of the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring embodiments of the present invention.

[0032] Note that in the corresponding drawings of the embodiments, signals are represented with lines. Some lines may be thicker, to indicate more constituent signal paths, and/or have arrows at one or more ends, to indicate primary information flow direction. Such indications are not intended to be limiting. Rather, the lines are used in connection with one or more exemplary embodiments to facilitate easier understanding of a circuit or a logical unit. Any represented signal, as dictated by design needs or preferences, may actually comprise one or more signals that may travel in either direction and may be implemented with any suitable type of signal scheme.

[0033] In the following description and claims, the term "coupled" and its derivatives may be used. The term "coupled" herein refers to two or more elements which are in direct contact (physically, electrically, magnetically, optically, etc.).

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The term "coupled" herein may also refer to two or more elements that are not in direct contact with each other, but still cooperate or interact with each other.

[0034] As used herein, unless otherwise specified the use of the ordinal adjectives "first," "second," and "third," etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner.

[0035] **Fig. 2** is a system 220 for optimizing performance of a WiFi communication system 200 by a remote server 204, according to one embodiment of the invention. In one embodiment, the communication system 200 is similar to the communication system of **Fig. 1**, but is operable to communicate with the remote server 204 (interchangeably referred to as an optimization center). In one embodiment, the WiFi communication system 200 includes an Access Point (AP) 201 which comprises a processor 209, memory 210, and an adaptation algorithm 203 (which may be stored in the memory 210). In one embodiment, the AP 201 is operable to communicate with one or more stations $202_{1\text{-}N}$, where N is an integer equal to or greater than 1, by WiFi signals $211_{1\text{-}N}$. The term "adaptation algorithm" is interchangeably referred to as "algorithm."

[0036] While 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. In the embodiments discussed herein the remote server 204 is not part of the communication system 200. In such an embodiment, the communication channel may be one of: the Internet, 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 Ethernet over Coax (DSL EOC) communications protocol; a cable control channel communications protocol; a powerline control channel communications protocol; a Command Line protocol (CLI); via a wireless device; or via a mobile device.

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[0037] In one embodiment, the logic unit representing AP 201 and/or the stations $202_{1\text{-}N}$ can be at least one of the following communication units: a base station; a wireless Local Area Network (LAN) device; a DSLAM; a gateway; a performance enhancement device; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home powerline device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi 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 Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0038] In one embodiment, the remote server 204 is operable to communicate with the AP 201 and/or with any or all of the stations $202_{1\text{-}N}$ via the communication Channel 208. In one embodiment the remote server 204 is a cloud server. In one embodiment, the remote server 204 comprises a processor 206, which may be one or more processors, a memory 207 for storing processor executable instructions, and a database 205 to manage data related to the communication system 200.

[0039] In one embodiment, the remote server 204 performs a method for optimizing performance of one or more communication units including the AP 201 and the stations $202_{1\text{-}N}$. In one embodiment, the remote server 204 is operable to collect data from the one or more communication units (AP 201 and/or the stations $202_{1\text{-}N}$). In one embodiment, the remote server 204 periodically collects data from the one or more communication units. The term "periodically" herein refers to regular intervals e.g., once a day, morning and evening of every day, etc.

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[0040] In one embodiment, the remote server 204 is operable to generate a policy, for each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) based on the collected data. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. Generally, an AP does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, an AP does not have access to historical data related to communication with other stations. Additionally, APs may lose data when there is power outage or user-initiated power cycling. The remove server 204 resolves the above problems and provides an optimum policy for the AP 201 to use based on analysis of large amount of operational data of the communication system 200 and other similarly situated communication systems.

[0041] Examples of similarly situated communication systems include communications systems having similar communication units. For example, an AP with same power, speed, and brand, and operating with similar (i.e., within 10%) number of stations. Similarly situated communication systems also include communications systems in different geographical areas.

[0042] In one embodiment, the remote server 204 transmits/sends the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) periodically. For example, the remote server 204 may transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) when the bandwidth usage of the AP 201 is low (e.g., the AP 201 is operating less than 50% of its capacity to serve communication units) so that it may implement the new policy sent by the remote server 204.

[0043] In one embodiment, the policy comprises rules and/or conditions for operation of the one or more communication units (AP 201 and/or the stations 202_{1-N}). For example, the policy comprises first and second algorithms for adapting the AP 201 to improve its performance. In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) implement the policy

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according to time-varying data. In one embodiment, the time-varying data comprises location information, current time, and operational data of the one or more communication units (AP 201 and/or the stations 202_{1-N}). In one embodiment, the location information is determined from a Global Positioning System (GPS) device or setup. The embodiments herein are not limited to two algorithms, but any number of algorithms may be used.

[0044] In one embodiment, the communication unit (AP 201 and/or the stations 202_{1-N}) comprises a transmitter to send data to the remote server 204; a receiver to receive a policy from the remote server 204; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data. The communication units generally do not have the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc. Therefore, the prior art communication units cannot use such information for improving their performance. The transmitter discussed above provides data to a central location, i.e. the remote server 204, that has the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc, so that it may use such information generate rules and conditions for operating the communication units with enhanced performance. These rules and conditions were previously not conceivable by the communication system (e.g., communication system of **Fig. 1**) due to lack of information and processing power needed to generate the rules and conditions. The remote server 204, after computing the rules and conditions, provides the rules and conditions to the processors of the communication units, wherein the processors executes their respective policies by implementing one of first and second algorithms based on the rules and/or conditions and time-varying data.

[0045] In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) are operable to receive the policy along with one of the first and second algorithms based on the conditions and/or the time-varying data, wherein the first and second algorithms did not exist in the one or more

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communication units (AP 201 and/or the stations 202_{1-N}) prior to being provided by the remove server 204. In such an embodiment, the remote server 204 installs a new algorithm 203 in the AP 201, where the new algorithm is executed by the processor 209 of the AP 201.

[0046] In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) are operable to receive the policy and implement one of first and second algorithms based on the rule and/or conditions and/or the time-varying data, wherein the first and second algorithms previously existed in the one or more communication units (AP 201 and/or the stations 202_{1-N}). In such an embodiment, the remote server provides recommendations to the communication units (AP 201 and/or the stations 202_{1-N}) to use either the first or second algorithm so the communication system 200 may improve its performance.

[0047] The conditions may include at least one of: choice of selecting one of the first or second algorithms based on current SNIR (Signal to Noise and Interference Ratio); choice of selecting one of the first or second algorithms based on current time; choice of selecting one of the first or second algorithms based on operational data of the one or more communication units; and choice of selecting one of the first or second algorithms based on location information. In other embodiments, other conditions may be used in conjunction or absence to the above listed conditions. The rules may include equations, when executed in the algorithms, will change how the conditions are evaluated by the algorithms.

[0048] In one embodiment, the remote server 204 generates the policy by performing analysis on the collected data, wherein the collected data comprises operational information and historical data about each of the one or more communication units. In one embodiment, the remote server 204 applies the analysis to generate conditions for when to implement one of the first and second algorithms. In one embodiment, the remote server 204 generates the policy by generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units (AP 201 and/or the stations 202_{1-N}).

[0049] In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a data rate according to a

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mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a data rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0050] The following is an exemplary embodiment showing the process of determining an optimum algorithm by the remote server 204. In one embodiment, the remote server 204 selects one of the first or second algorithms for the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to achieve optimal performance efficiency for the communication system 200. In one embodiment, first algorithm determines data transmission rates for the communication units based on RSSI while the second algorithm determines data transmission rates based on a number of consecutive successful transmissions and on a number of consecutive failed transmissions. As mentioned above, in one embodiment, the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) have the first and second algorithms previously stored, but do not know which algorithm is more efficiency for the communication system 200. In such an embodiment, the remote server 204 provides recommendations to the communication units about which algorithm to use.

[0051] In one embodiment, in the first algorithm the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) monitor the RSSI in real-time and adapts their transmission rates according to the instantaneous RSSI value using a mapping table (Table 1) as shown below.

RSSI value	Rate
-92dBm or below	6Mbps
-92dBm~-90dBm	9Mbps
-90dBm~-88dBm	12Mbps

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-88dBm~-86dBm	18Mbps
-86dBm~-84dBm	24Mbps
-84dBm~-82dBm	36Mbps
-82dBm~-80dBm	48Mbps
-80dBm or above	54Mbps

Table 1: RSSI to rate mapping for first algorithm

[0052] Table 1 is only shown as an example and a person skilled in the art would realize that the communication units may use different rates for different RSSI values other than the ones shown above.

[0053] In one embodiment, the second algorithm for the communication units (AP 201 and/or the stations 202_{1-N}) uses a higher data rate after K (e.g., 10) consecutive successful transmissions, and uses a lower data rate after M (e.g., 2) consecutive failed transmissions. In one embodiment, the communication units (AP 201 and/or the stations 202_{1-N}) provide to the remove server 204 operational data including RSSI, SNR, rate used for transmitting a packet, corresponding result on successful packet delivery, and other relevant data collected in real-time. In one embodiment, communication units (AP 201 and/or the stations 202_{1-N}) may accumulate such data within the communication units (AP 201 and/or the stations 202_{1-N}) and then send the accumulated data to the remote server 204. In one embodiment, the data transmitted to the remote server 204 is non-real-time data because it is sent after some time (e.g., end of the day).

[0054] In one embodiment, the remote server 204 stores such data in its database 205 and performs a full analysis based on all the stored data and any other knowledge available at the remote server 204. In one embodiment, the other knowledge includes similar statistics, as those provided by the communication units (AP 201 and/or the stations 202_{1-N}) to the remote server 204, from other similar communication units in other similar geographical localities.

[0055] In one embodiment, the remote server 204 determines the presence of intermittent high-power interference from other near-by WiFi systems. When

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other WiFis' high-power packets collide with the communication system 200's packet, the packet is lost regardless of the rate selection. In one embodiment, the remote server 204 determines that other noise or interference is never observed for the communication system 200, and concludes that it is best to adapt rates for the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) as a function of channel strength, or RSSI, only. In such an embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations $202_{1\text{-}N}$) asking the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to use the first algorithm all the time instead of the second algorithm.

[0056] In one embodiment, the remote server 204 determines that there is no high-power WiFi interference at all, but channel changes faster than typical static indoor wireless channel (possibly due to people moving around the AP 201). For example, the channel variation tends to be faster between noon and midnight. In such an embodiment, the remote server 204 concludes that it is best to use the second algorithm instead of the first algorithm by the communication units (AP 201 and/or the stations $202_{1\text{-}N}$). In one embodiment, the remote server 204 may determine optimum values for K and M to be used by the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) in different times of the day. For example, K=10 and M=1 between noon and midnight; and K=20 and M=2 between midnight and noon.

[0057] In one embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations $202_{1\text{-}N}$) asking communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to use the second algorithm with the optimized K and M values depending on time in the day. In case the WiFi communication system 200 is not capable of changing the values of K and M as a function of time, the remote server 204 can send two control signals per day, one at noon and another at midnight.

[0058] In one embodiment, when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (AP 201

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and/or the stations 202_{1-N}). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 210 of the AP 201. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 209 of the AP 201. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units (AP 201 and/or the stations 202_{1-N}) of the communication system 200.

[0059] **Fig. 3** is a system 320 for optimizing performance of a Digital Subscriber Line (DSL) communication system 300 by the remote server 204, according to one embodiment of the invention. The embodiment of **Fig. 3** is similar to the embodiment of **Fig. 2** in concept, but applicable for DSL systems. The embodiments of the invention are not limited to DSL or WiFi communication systems, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect communication performance.

[0060] In one embodiment, the DSL communication system 320 comprises a Digital Subscriber Line Access Multiplexer (DSLAM) 301 that connects to one or more Customer Premises Equipment (CPEs) 302_{1-N} by means of DSL signals 304_{1-N}, where N is an integer equal to or greater than 1. In one embodiment, the remote server 204 performs a method for optimizing performance of the one or more communication units including the DSLAM 301 and the CPEs 302_{1-N}. In one embodiment, the remote server 204 is operable to collect operational data from the one or more communication units (DSLAM 301 and/or the CPE 302_{1-N}). In one embodiment, the remote server 204 periodically collects operational data from the one or more communication units.

[0061] In one embodiment, the operational data collected by the remote server 204 includes at least one of: band preference indication; margin cap mode

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indication; indication that margin per tone should be kept smaller than the maximum SNR (Signal to Noise Ratio) margin; service priorities pertaining to net data rate; service priorities pertaining to excess margin; service priorities pertaining to excess margin per tone; service priorities pertaining to delay; service priorities pertaining to impulse noise protection; indication of loading algorithms used with a first DSL system; indication of power allocation algorithms used with the first DSL system; maximum attainable data rate; current data rate; margin; channel attenuation per tone; average attenuation; quiet line noise per tone; active line noise per tone; SNR per tone; transmitted PSD per tone; downstream power back-off shaped parameters (DPBOSHAPED); upstream power back-off shaped parameters (UPBOSHAPED); echo response; band preference; margin cap mode; Forward Error Correction (FEC) count; code violation count; errored seconds; severely errored seconds; number of retraining count; current delay; error distributions; current impulse noise protection; or FEC and interleaving parameters. The above listed operational data is not an exclusive list. More operational data may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0062] In one embodiment, the remote server 204 collects configuration parameters associated with the one or more communication units. The configuration parameters include at least one of: maximum nominal power spectral density (MAXNOMPSD); maximum nominal aggregate transmit power (MAXNOMATP); power cutback (PCB); DPBOSHAPED; UPBOSHAPED; fine gains; gi; transmit spectral scaling factors; tssi; power spectral density mask (PSDMASK); power spectral density level; maximum received power (MAXRXPWR); upstream power "back-off" parameters (UPBOKLE); margin cap mode; carrier mask (CARMASK); minimum impulse noise protection (MININP); maximum delay (MAXDELAY); target margin (TARSNRM); minimum SNR margin (MINSNRM); maximum SNR margin (MAXSNRM); band preference indication (PREFBAND); target data rate; minimum data rate; maximum data rate; FEC and interleaving parameters; per tone bit cap (BCAP[n]); per tone target margin (TARSNRM[n]); reference noise (REFNOISE). The above listed configuration parameters is not an exclusive list. More configuration parameters

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may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0063] As discussed with reference to **Fig. 2**, the remote server 204 of **Fig. 3** is operable to generate a policy, for each of the one or more communication units (DSLAM 301 and/or the stations $302_{1\text{-}N}$), based on the collected operational data, according to one embodiment. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (DSLAM 301 and/or the CPE $302_{1\text{-}N}$). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. The DSLAM 301 does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, DSLAM 301 does not have access to historical data related to communication with other CPEs connected to other DSLAMs. Additionally, DSLAM 301 may loose data when there is power outage or user-initiated power cycling. The remote server 204 resolves the above problems and provides an optimum policy for the DSLAM 301 to use based on analysis of large amount of operational data of the communication system 300 and other similarly situated communication systems. The optimum policy can be determined based on expert knowledge outside of the communication system where the expert knowledge can be obtained from lab testing, simulation or any other research methods. The policy can be adaptively modified even after the full deployment of the communication system, and hence does not suffer from limited knowledge that is used at the time of manufacturing the communication system. In the embodiments discussed herein the remote server 204 is not part of the communication system 300.

[0064] In one embodiment, when the DSL communication system 300 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (DSLAM 301 and/or the CPEs $302_{1\text{-}N}$). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its

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communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 310 of the DSLAM 301. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 309 of the DSLAM 301. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication units to use one or more of them by sending a proper pseudo-code to the communication units (DSLAM 301 and/or the CPEs $302_{1\text{-}N}$) of the communication system 300.

[0065] Following is an exemplary embodiment of how the remote server 204 can improve the performance of a DSL system. In DSL systems, for example the system 300, downstream (DS) margin is an important line performance metric that can be monitored by CPEs $302_{1\text{-}N}$ in real-time. In general, a higher margin indicates an exponentially smaller chance of errors for the delivery of video or data packets over DSL links $304_{1\text{-}N}$. When the margin becomes very small, typically below 0dB, the link will experience errors that can cause serious impacts on packet delivery to the CPEs $302_{1\text{-}N}$. To prevent continuation of such an unreliable link quality over a long time, CPEs $302_{1\text{-}N}$ can initiate a retraining procedure and improve the operation conditions. The retraining procedure may take 20 to 60 seconds. In one embodiment, the above feature of DSL systems is implemented by CPEs $302_{1\text{-}N}$ monitoring DS margins and initializing a retraining process when the margin becomes below a pre-configured threshold value 'T.' Conventionally, 'T' is set to 0dB and controlled via the DSL line's profile.

[0066] The remote server 204 may collect operational and performance data of the DSL system 300, analyze the historical data (operational and performance data) associated with the DSL system 300, and determine the best estimated value of 'T' for each line and applies the value to each line.

[0067] The term "line" herein refers to a communication link (wired or wireless) between the DSLAM 301 and the corresponding CPE. The value of 'T' may be analyzed per-line basis by the remote server 204. Different values of 'T' can be applied by the remote server 204 to different DSL lines depending on their historical and environmental characteristics.

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[0068] Each CPE among the CPEs $302_{1\text{-}N}$ applies an algorithm to tune its performance. For example, the CPE applies a rule and/or condition to adapt the value of 'T' in real-time as a function of the real-time data (operational and performance) that is available in the corresponding CPE. The CPEs $302_{1\text{-}N}$ are operable to apply the following rules and conditions. If video traffic is observed by the CPE over the line for more than t_1 (e.g., 1 minute), then the CPE updates the value of 'T' to 'T_1' (e.g., 2dB). Such a rule allows the CPE to react fast on pixelization problems associated with video traffic. In this example, the conditions are the choice of 't_1' and 'T_1', while the rule is the "if, then" equation. Typically each retraining process of the CPE causes discontinuation/interruption of video and data services for a short time (e.g., 10~45 seconds), but such an interruption can be preferable to a persistent pixelization problem of the video traffic for several minutes or more. If no video traffic is observed by the CPE for more than 't_2' (e.g., 10 minutes) then the CPE updates the value of 'T' to 'T_2' (e.g., 0dB). In this example, the conditions are the choice of 't_2' and 'T_2,' while the rule is the "if, then" equation. This rule allows the CPE to reduce the chance of initiating a retraining process that can interrupt data traffic. Data service is more resilient to errors compared to video traffic, and the errors that can happen for a small margin (e.g., 0~2dB) are likely tolerable for data traffic.

[0069] The above example of the rule and/or condition involves real-time monitoring of the data of the DSL system 300 and real-time adaptation algorithm within the DSL system 300. In some embodiments, the data of the DSL system 300 may not be entirely in real-time but the data update may be frequent enough (e.g., 5 minutes) to behave like real-time data.

[0070] In one embodiment, the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' used by the rules/conditions discussed above are not statically kept in the DSL system 300, but optimized by the remote server 204. In one embodiment, the CPE continues to keep its rule/condition, but the parameters of the rules, i.e. the threshold values (conditions) 't_1,' 't_2,' 'T_1' and 'T_2,' are updated in the CPEs $302_{1\text{-}N}$ by the remote server 204. In such an embodiment, the remote server 204 collects and

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analyzes historical operational data and any side information (e.g., data from other similarly situated DSL systems) that is available at the remote server 204.

[0071] Continuing with the exemplary embodiment discussed above, the remote server 204 will choose 'T_1'= 0dB for a DSL line if pixelization has hardly happened even for margins between 0 and 2dB in the historical operational data, but will choose 'T_1'= 4dB if pixelization always occurred and continued for several minutes for margins between 0 and 4B. Such long-term adaptation of the rules by remote server 204 allows the DSL system 300 to perform at its optimum ability under all circumstances. In one embodiment, the switching of modes discussed above happens in real-time or very frequently, but the update of threshold values or rules to be used by the CPEs $302_{1\text{-}N}$ happens at a much lower frequency. In one embodiment, the remote server transmits the updated policy (with new threshold values) to the DSL system 300 a once per day.

[0072] While the embodiments of **Fig. 3** are discussed in terms of margin and video traffic in the DSL system 300, the embodiments can be applied to any DSL or other communication system adaptation algorithm that reacts in real-time to other data parameters without changing the essence of the embodiments of the invention.

[0073] **Fig. 4** is a method 400 performed by a remote server for optimizing performance of a communication system, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 4** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 4** is illustrated with reference to the embodiments of **Figs. 2-3**.

[0074] At block 401, the remote server 204 collects data (operational and/or performance data) from the one or more communication units. As discussed above, the communication units in **Fig. 2** are AP 201 and/or the stations $202_{1\text{-}N}$ while communication units in **Fig. 3** are DSLAM 301 and/or the CPE $302_{1\text{-}N}$. In one embodiment, the communication units are at least one of a base station; a wireless LAN device; a DSLAM; a gateway; a performance enhancement device; a DSL

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CPE modem; an in-home powerline device; a HPNA based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a STB/STU customer electronics device; an 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 Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0075] At block 402, the remote server 204 generates a policy, for each of the one or more communication units based on the collected data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0076] With reference to **Fig. 3**, the policy may comprise rules and conditions such as the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' for the DSL system 300 and equations that use these threshold values. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0077] At block 403, the remote server 204 sends the policy to each of the one or more communication units, wherein the one or more communication units

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implement the policy according to time-varying data (data collected by the communication units of the communication systems).

[0078] **Fig. 5** is a method 500 performed by a communication system for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 5** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 5** is illustrated with reference to the embodiments of **Figs. 2-3**. So as to avoid repetitiveness, only the processes performed by the communication units are discussed.

[0079] At block 501, the one or more communication units send data to the remote server 204. The data may be operational data, performance data, or any other time-varying data. At block 502, the one or more communication units receive a policy generated by the remove server 204, wherein the policy comprises rules and/or conditions for operation of the one or more communication units. At block 503, the one or more communication units execute the policy sent by the remote server 204 to implement an algorithm based on the rules and/or conditions and time-varying data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms. With reference to **Fig. 3**, the policy may comprise rules and conditions

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such as the threshold values t_1, t_2, T_1 and T_2 for the DSL system 300. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0080] **Fig. 6** is a processor-based system 600 having machine-readable storage medium with computer executable instructions 604 for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Machine-readable storage medium is one of 207, 210, or 310 (collectively referred to as "207/201/310"). The computer/machine-readable/executable instructions are executed by a processor (e.g., processor 206 of the remote server, or processors 209 and 309 of the AP 201 or DSLAM 301 respectively). Elements of embodiments are also provided as a machine-readable medium for storing the computer-executable instructions (e.g., instructions to implement the flowcharts of **Figs. 4-5** and other processes discussed in the description).

[0081] In one embodiment, the processor-based system 600 further comprises a database 601 to store data used by the instructions 604. In one embodiment, the processor-based system includes a network interface 602 to communicate with other devices. In one embodiment, the components of the processor-based system 600 communicate with one another via a network bus 603.

[0082] The machine-readable storage medium 207/210/310 may include, but is not limited to, flash memory, optical disks, hard disk drive (HDD), Solid State Drive (SSD), CD-Read Only Memory (CD-ROMs), DVD ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or other type of machine-readable media suitable for storing electronic or computer-executable instructions. For example, embodiments of the invention may be downloaded as a computer program (e.g., BIOS) which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals via a communication link (e.g., a modem or network connection).

[0083] Reference in the specification to "an embodiment," "one embodiment," "some embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments. The

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various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments. If the specification states a component, feature, structure, or characteristic "may," "might," or "could" be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the elements. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

[0084] While the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the foregoing description.

[0085] For example, the embodiments discussed above can apply to a communication system comprising a performance enhancement device. A performance enhancement device may comprise a signal conditioning device, a diagnostic and remedy guidance device, or a noise cancellation device. A noise cancellation device, among other things, acts to cancel noise and interference present on the DSL line, either autonomously or in conjunction with commands from the remote server. In one embodiment, the performance enhancement device is communicatively coupled to the remote server 204 via the Communication Channel 208. In such an embodiment, impulse noise cancellation feature of the performance enhancement device may be turned on and off based on the real-time observation of noise, and the actual algorithm for deciding on-off can be distributed where long-term thresholds/rules and conditions are calculated by the remote server 204 and transmitted to the performance enhancement device. In one embodiment, the remote server 204 forces the actual transition in the performance enhancement device as a function of real-time observation of the noise data.

[0086] Another alternative embodiment related to a WiFi system is described as follows. In a typical WiFi communication system, Carrier Sense Multiple Access (CSMA) protocol is used for multiple access. Due to the nature of wireless channel, some of the stations (clients) might not be able to hear each other while both can reach the AP with strong power. This phenomenon is known as

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Hidden Node problem. One way to resolve this problem is to schedule the data transmission using Request to Send (RTS) and Clear to Send (CTS) mechanisms. Such a use of RTS/CTS incurs overhead in channel usage, but prevents disastrous packet collisions by the two stations.

[0087] In one embodiment, the remote server 204 collects operational and performance data of the WiFi AP 201 (and other APs) and/or stations $202_{1\text{-}N}$. In one embodiment, the remote server 204 analyzes the historical data and determines the best value for each AP (on or off) and applies the value to each AP. In one embodiment, the value is analyzed per-AP by the remote server 204, and therefore different values can be applied to different APs depending on their data characteristics.

[0088] In one embodiment, each AP is operable to apply a rule with conditions to adapt RTS/CTS on/off in real-time as a function of real-time data available to the local AP. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is detected for more than t_1 (e.g., 1 minute), the AP turns on RTS/CTS. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is not detected for more than t_2 (e.g., 10 minutes), then the AP turns off RTS/CTS.

[0089] In the above embodiment, two or more operation modes are described in context of a local communication device (e.g., AP) selecting the operation mode to use in real-time. In one embodiment, the selection of the operation mode is a function of the real-time data that is locally available. In other embodiments, the data might not be in real-time but the data update may be frequent enough for this idea to consider the data as real-time.

[0090] In one embodiment, the rules and/or conditions e.g., the threshold values 't_1', and 't_2,' and equations applying them, are not statically kept as in AP, but optimized by the remote server 204. In one embodiment, the threshold values 't_1', and 't_2,' and/or the equations are updated by the remote server 204 using historical data and any side information that is available at the remote server side. In the above alternative embodiment, RTS/CTS was involved, however, the essence of the embodiments can be applied to any WiFi adaptation algorithm that reacts in

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real-time to other data parameters. WiFi adaptation algorithms include control of fragmentation, channels, association, etc.

[0091] The embodiments of the invention are intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0092] An abstract is provided that will allow the reader to ascertain the nature and gist of the technical disclosure. The abstract is submitted with the understanding that it will not be used to limit the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

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CLAIMS

We claim:

1. A method for optimizing performance of one or more communication units by a remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

2. The method of claim 1, wherein the policy further comprises first and second algorithms.

3. The method of claim 2, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

4. The method of claim 1, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

5. The method of claim 1, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

6. The method of claim 1, wherein generating the policy comprises:

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generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

7. The method of claim 1, wherein collecting data from the one or more communication units is performed periodically.

8. The method of claim 1, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi 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;

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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.

9. The method of claim 1, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

10. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform a method for optimizing performance of one or more communication units by the remote server, the method comprising:
collecting data from the one or more communication units;
generating a policy, for each of the one or more communication units, based on the collected data; and
sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

11. The machine-readable storage medium of claim 10, wherein the policy further comprises first and second algorithms.

12. The machine-readable storage medium of claim 11, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

13. The machine-readable storage medium of claim 10, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

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14. The machine-readable storage medium of claim 10, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

15. The machine-readable storage medium of claim 10, wherein generating the policy comprises:

generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

16. The machine-readable storage medium of claim 10, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

17. A method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

18. The method of claim 17, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

19. The method of claim 17, wherein the first and second algorithms previously existed in the one or more communication units.

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20. The method of claim 17, wherein the policy further comprises the first and second algorithms.

21. The method of claim 20, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

22. The method of claim 17, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

23. The method of claim 17, wherein the remote server resides in a cloud.

24. The method of claim 17, wherein sending data from one or more communication units to the remote server is performed periodically.

25. The method of claim 17, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;

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an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi 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 Ethernet connected router;
an Ethernet connected wireless bridge;
an Ethernet connected network bridge; and
an Ethernet connected network switch.

26. The method of claim 17, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

27. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor to perform a method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

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28. The machine-readable storage medium of claim 27, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

29. The machine-readable storage medium of claim 27, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

30. The machine-readable storage medium of claim 27, wherein the first and second algorithms previously existed in the one or more communication units.

31. The machine-readable storage medium of claim 27, wherein the policy further comprises the first and second algorithms.

32. The machine-readable storage medium of claim 31, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

33. The machine-readable storage medium of claim 27, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

34. An apparatus comprising:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from one or more communication units;

generate a policy, for each of the one or more communication

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units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

35. The apparatus of claim 34, wherein the policy further comprises first and second algorithms.

36. The apparatus of claim 35, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

37. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions and the time-varying data.

38. The apparatus of claim 37, wherein the time-varying data comprises location information, current time, and operational data of the one or more communication units.

39. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

40. The apparatus of claim 34, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

41. The apparatus of claim 34, wherein processor to collect data periodically for

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analysis from the one or more communication units.

42. The apparatus of claim 34, wherein the one or more communication units comprise at least one of:

an access point (AP);

a base station;

a wireless LAN device;

a DSLAM;

a gateway;

a performance enhancement device;

a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;

an in-home powerline device;

a Home Phoneline Network Alliance (HPNA) based device;

an in-home coax distribution device;

a G.hn (Global Home Networking Standard) compatible device;

an in-home metering communication device;

an in-home appliance communicatively interfaced with the LAN;

a wireless femtocell base station;

a wireless WiFi 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 Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

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an Ethernet connected network switch.

43. The apparatus of claim 34, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

44. A system comprising:

one or more communication units; and

a server operable to communicate with the one or more communication units, wherein the server comprises:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from the one or more communication units;

generate a policy, for each of the one or more communication units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

45. The system of claim 44, wherein the policy further comprises first and second algorithms.

46. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

47. The system of claim 44, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more

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communication units.

48. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

49. The system of claim 44, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

50. The system of claim 44, wherein processor to collect data periodically for analysis from the one or more communication units.

51. The system of claim 44, wherein the one or more communication units comprise at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;

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a wireless WiFi 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 Ethernet connected router;
an Ethernet connected wireless bridge;
an Ethernet connected network bridge; and
an Ethernet connected network switch.

52. The system of claim 44, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

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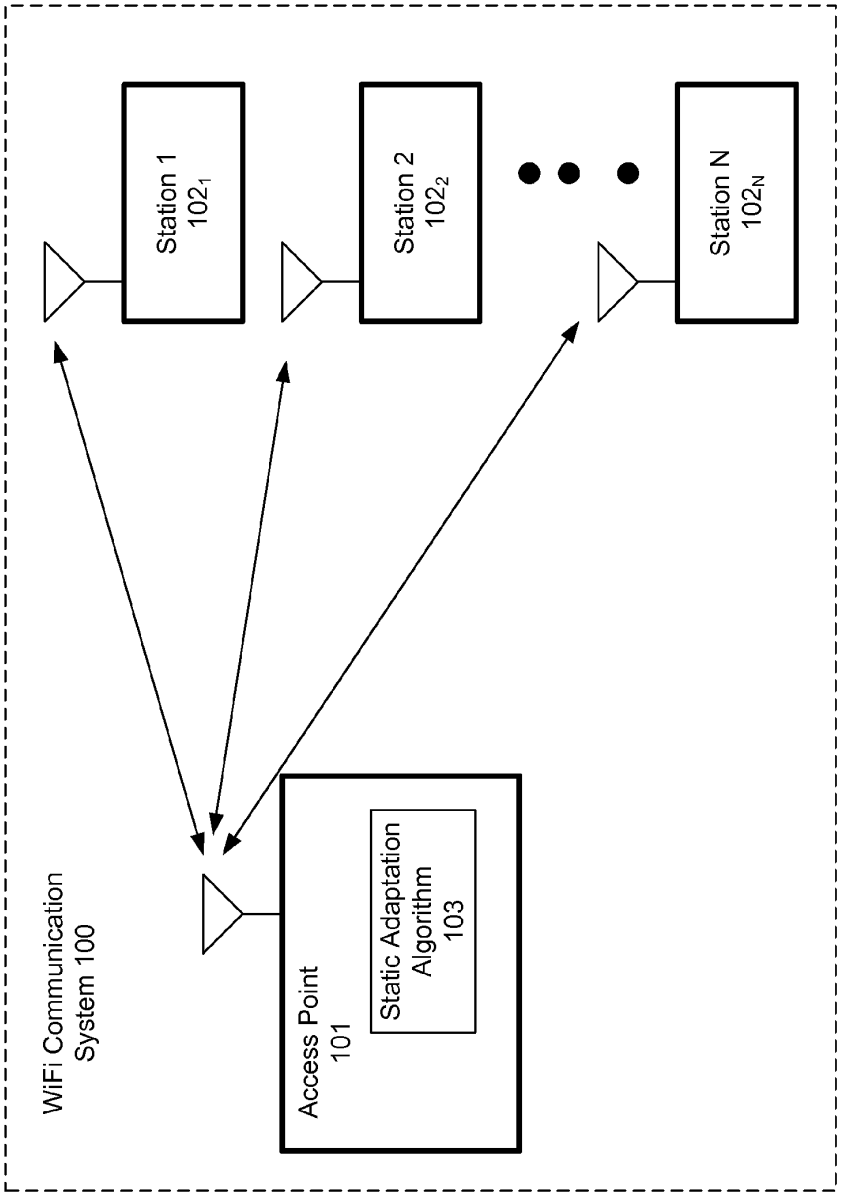


FIG. 1 (prior Art)

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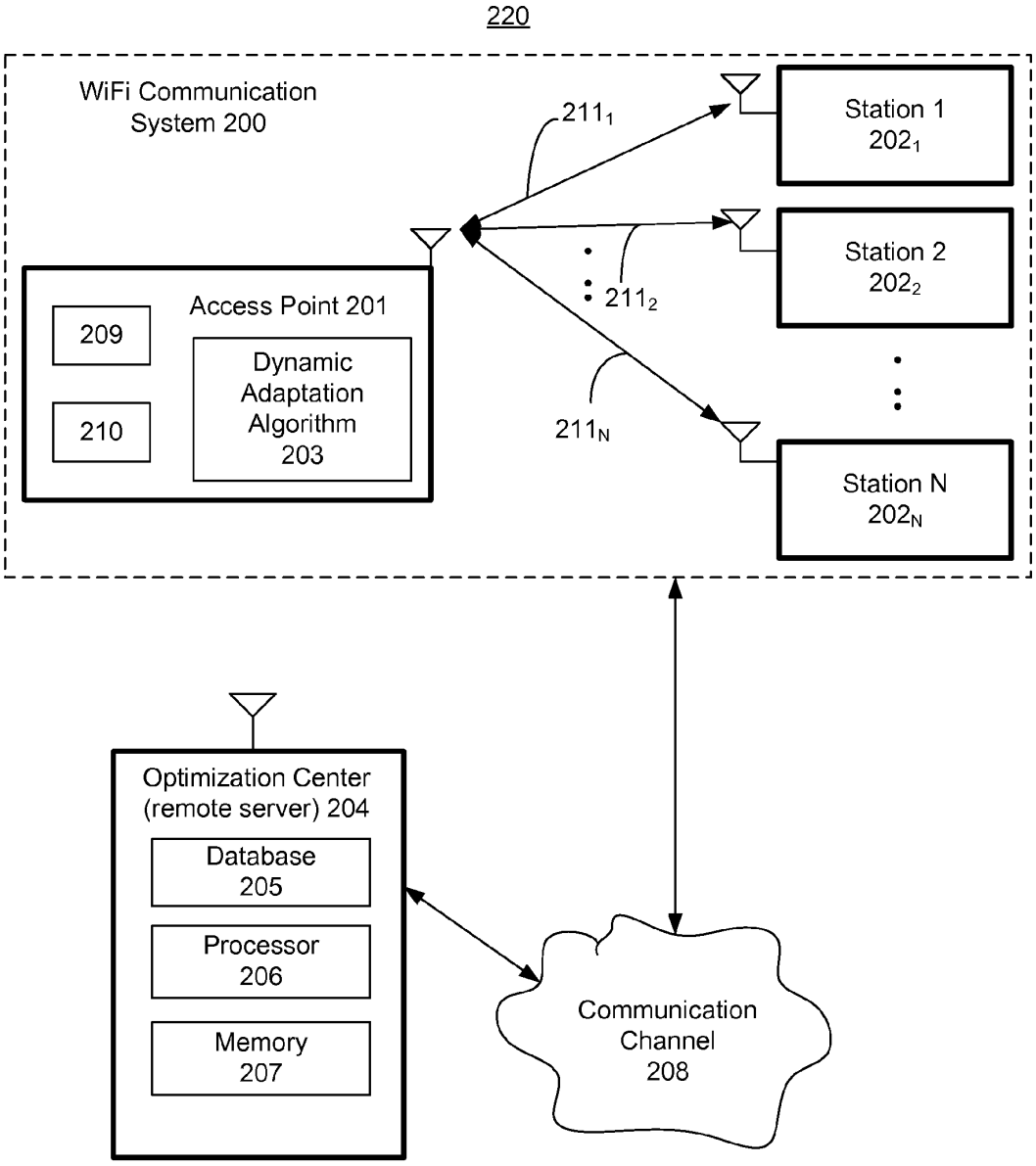


FIG. 2

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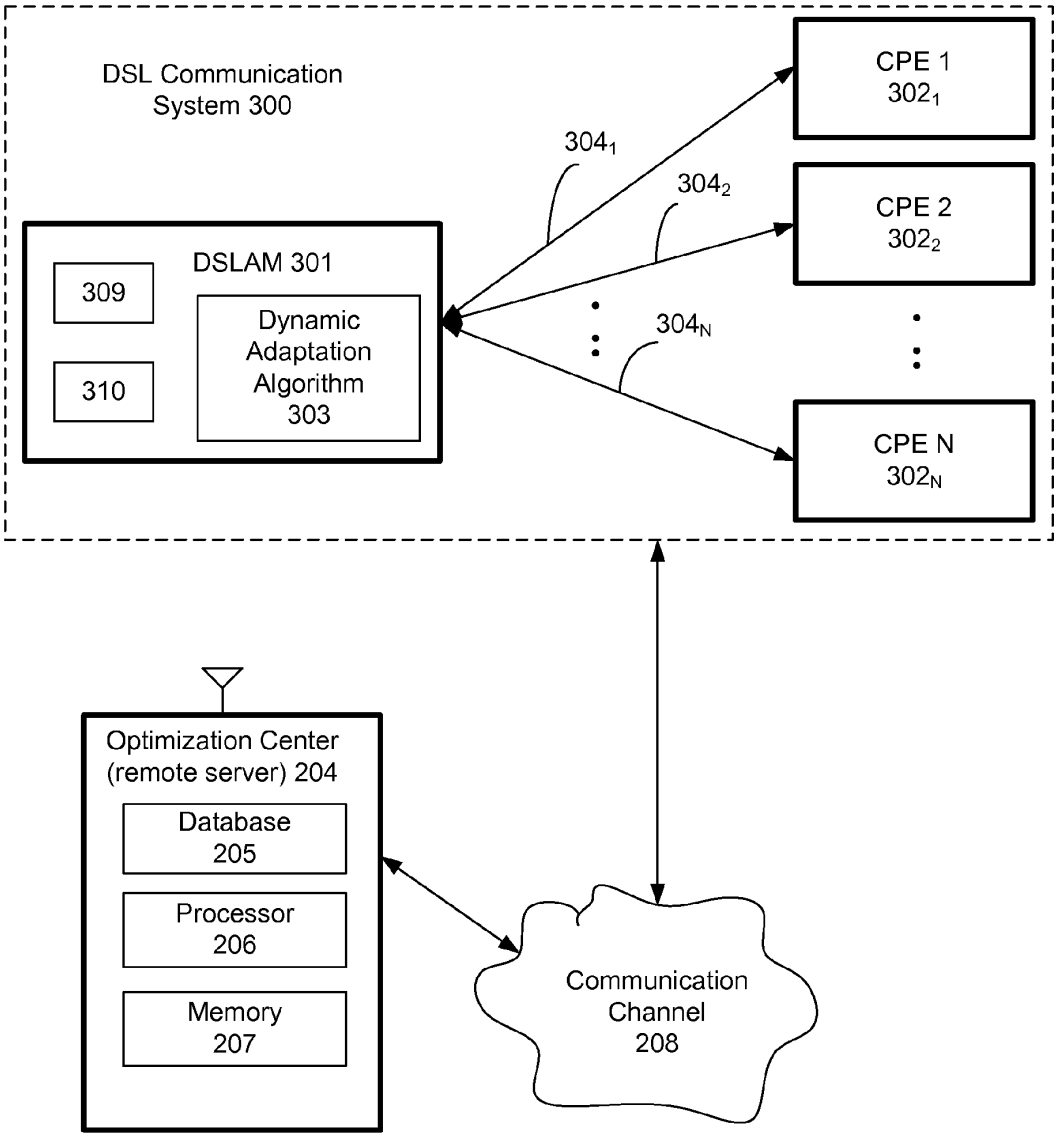


FIG. 3

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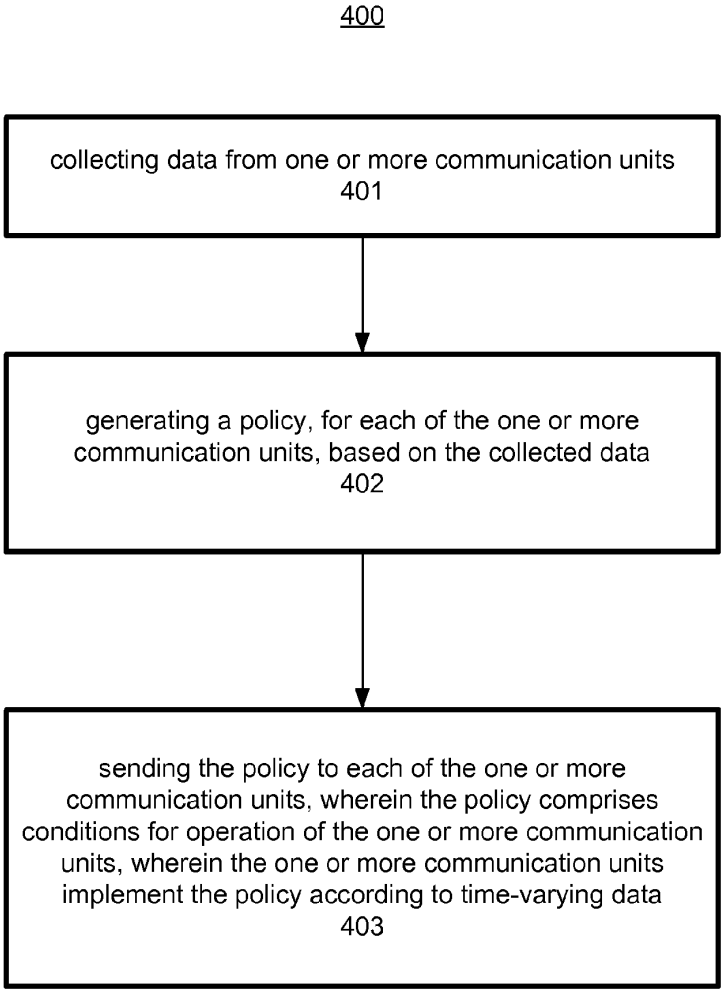


FIG. 4

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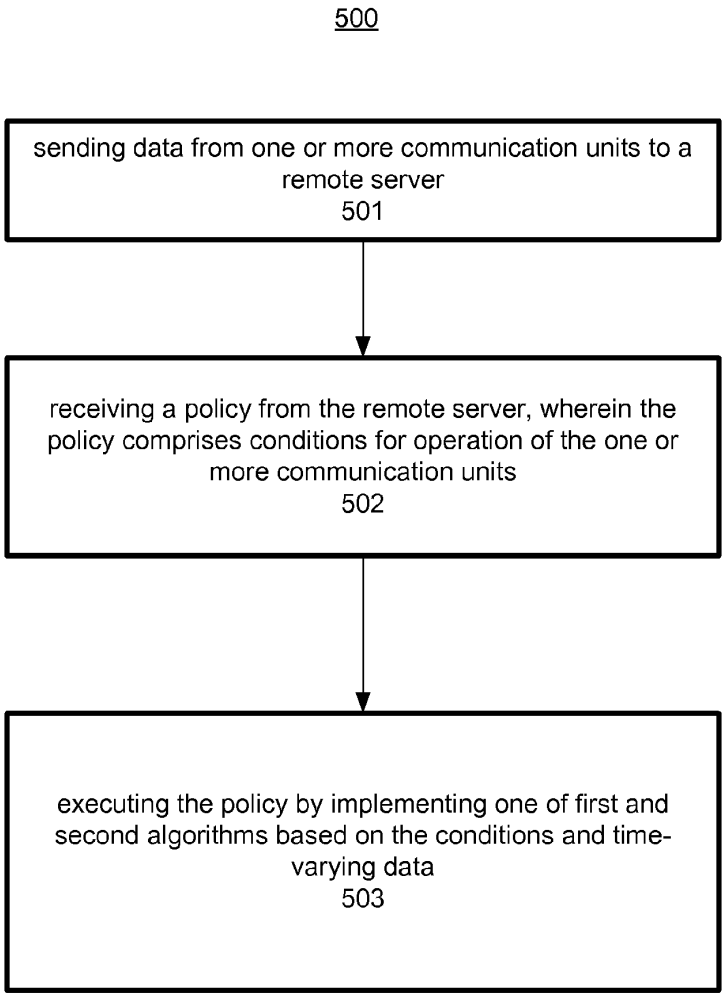


FIG. 5

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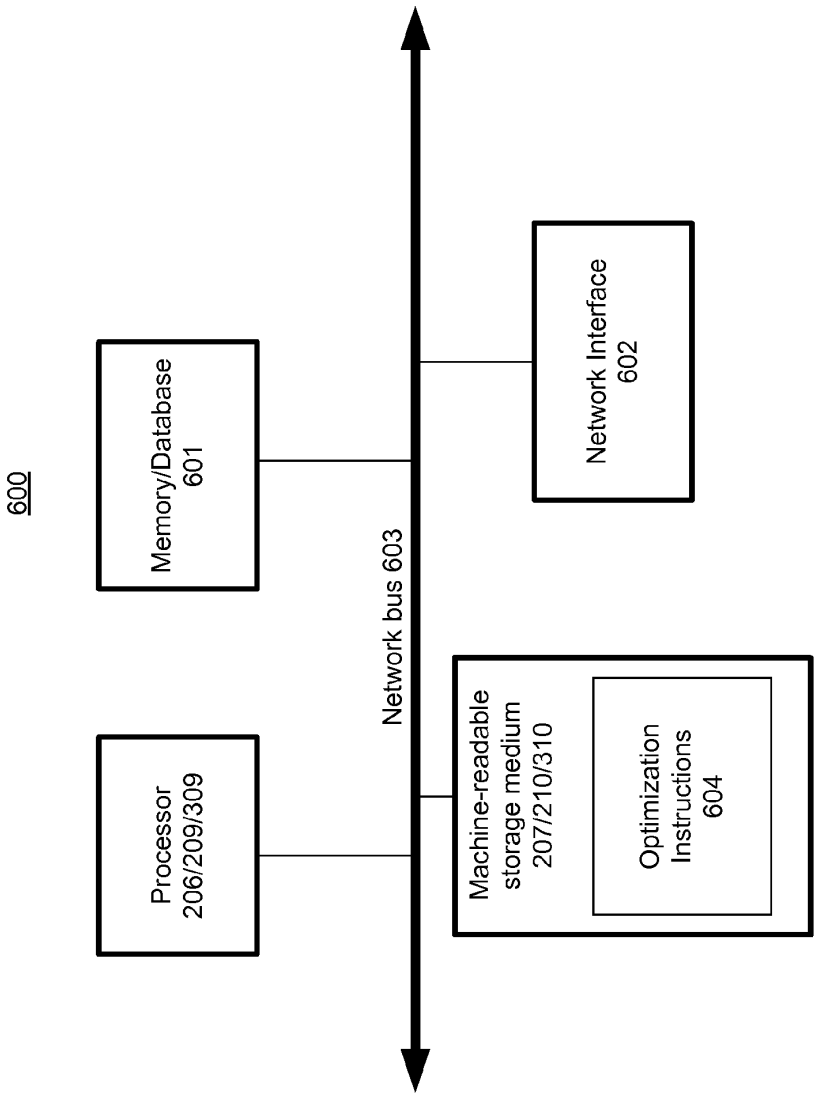


FIG. 6

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/00 H04L1/20
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 practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29) page 2, lines 7-9,19-24 page 4, lines 27-35 page 5, lines 7-18,23-25 page 5, line 32 - page 6, line 2 page 6, lines 17-22 page 7, lines 9-12,28-30 page 8, lines 17-37 page 12, lines 1-5 page 16, lines 21-28 claim 39 figure 1 -/--	1-5, 7-14, 16-21, 23-25, 27, 29-39, 41-48, 50-52

[X] Further documents are listed in the continuation of Box C. [X] 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
13 June 2012	21/06/2012

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	Meister, Mark

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.

X	US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
	column 5, lines 13-31 column 5, line 62 - column 6, line 47 column 6, line 54 - column 7, line 6 column 7, line 19 - column 8, line 11 figures 2,3	

A	WO 2011/079612 A1 (ZTE CORP [CN]; ZHANG QINGHONG [CN]; LI HANG [CN]) 7 July 2011 (2011-07-07) the whole document	1-52
L	-& EP 2 426 983 A1 (ZTE CORP [CN]) 7 March 2012 (2012-03-07) paragraphs [0004] - [0010] paragraphs [0012], [0013] paragraphs [0020] - [0024] paragraph [0026] paragraphs [0034] - [0036] figure 1	1-52

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/060265

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007136337 A2	29-11-2007	CN 101449503 A	03-06-2009
		EP 2020111 A2	04-02-2009
		JP 2009538559 A	05-11-2009
		TW 200805931 A	16-01-2008
		US 2007275665 A1	29-11-2007
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		WO 2007136337 A2	29-11-2007
US 7840220 B1	23-11-2010	NONE	
WO 2011079612 A1	07-07-2011	AU 2010338867 A1	22-12-2011
		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011
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		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011

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Electronic Acknowledgement Receipt

EFS ID:	43337415
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:	26-JUL-2021
Filing Date:	23-NOV-2020
Time Stamp:	02:55:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	054USC_SIDS_Trans.pdf	26146 ad176b6ff236562b44b399305c3092afa393aa58	no	3

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08.pdf	612371 9a36ddc003bcdfe490280f8563658342e7cdee3e	no	4
Warnings:					
Information:					
3	Foreign Reference	054USC_SIDS_FR1.pdf	4011778 376486131a68865be4b88d7f78deaad2a3c78020	no	51
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL1.pdf	231538 18093344394d5f9ebab34bcc04f429fbabd69a52	no	7
Warnings:					
Information:					
5	Non Patent Literature	054USC_SIDS_NPL2.pdf	172019 076add3136deeb7c85b77cc7d05241b1359fd2a7	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	5053852		

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: July 26, 2021 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.

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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):

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☐ 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 26, 2021

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

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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 06/25/2021

North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304

EXAMINER
GRIJALVA LOBOS, BORIS D

ART UNIT	PAPER NUMBER
2446	

NOTIFICATION DATE	DELIVERY MODE
06/25/2021	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

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 11/23/2020.

☐ 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) _____ is/are allowed.

7) ☑ Claim(s) 1-23 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 11/23/2020 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 3/26/2021, 2/26/2021, 12/4/2020.

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

4) ☐ Other: _____.

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

This Office action is in response to communications filed on 11/23/2020.

Claims 1-23 are pending.

DETAILED ACTION

Specification

The use of the term WI-FI, which is a trade name or a mark used in commerce, has been noted in this application (including the claims, e.g. see claim 11). The term should be accompanied by the generic terminology; furthermore the term should be capitalized wherever it appears or, where appropriate, include a proper symbol indicating use in commerce such as ™, SM , or ® following the term.

Although the use of trade names and marks used in commerce (i.e., trademarks, service marks, certification marks, and collective marks) are permissible in patent applications, the proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as commercial marks.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-23 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

Regarding claims 1 and 19, the limitations recite the term “remote server”. The term "remote" is a relative term which renders the claim indefinite. The term "remote" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. For examination purposes, the term “remote server” has been interpreted as any server that is not any of the communication units in the claim.

Regarding claims 2-18 and 20-23, the limitations invoke, by reference, all of the limitations of claims 1 and 19, respectively. Therefore, claims 2-18 are rejected for the same reasons as set forth in claim 1, above.

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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 remote 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 would be allowable if they are amended or clarified via arguments to overcome 35 USC 112 rejections set forth above.

Conclusion

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 on 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 an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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

Notice of References Cited	Application/Control No. 17/102,099	Applicant(s)/Patent Under Reexamination Rhee, Wonjong	
	Examiner BORIS D GRIJALVA LOBOS	Art Unit 2446	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20100167771-A1	07-2010	Raghothaman; Balaji	H04B17/318	455/501
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

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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

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
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

/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**
H04L1	0019,20	06/18/2021	BGL
H04L41	06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038	06/18/2021	BGL
H04L43	04,08-0817,0876-10,16	06/18/2021	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
	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								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
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	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								
	21	✓								
	22	✓								
	23	✓								

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1,026	((access near1 point) (base near1 station) (wireless near1 LAN near1 device) (DSLAM) (gateway) (performance near1 device) DSL CPE (customer near1 premises near1 equipment) modem (in-home near1 powerline) (in-home coax) (HPNA) (metering near1 device) (LAN near3 appliance) (femtocell) (wifi near1 base) (repeater) STB STU (IP near2 TV) (IP near2 media near1 device) (gam$3 near1 console) gateway device computer router bridge switch) with ((transmit$4 send$3 forward$3 receiv$3) near5 policy) with operation	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 12:31
S2	84	((access near1 point) (base near1 station) (wireless near1 LAN near1 device) (DSLAM) (gateway) (performance near1 device) DSL CPE (customer near1 premises near1 equipment) modem (in-home near1 powerline) (in-home coax) (HPNA) (metering near1 device) (LAN near3 appliance) (femtocell) (wifi near1 base) (repeater) STB STU (IP near2 TV) (IP near2 media near1 device) (gam$3 near1 console) gateway device computer router bridge switch) with ((transmit$4 send$3 forward$3 receiv$3) near5 policy) with operation with (location time)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 12:48
S3	26,692	RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:31
S4	1,040	monitor$3 near3 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:32
S6	0	(monitor$3 near3 RSSI) with (adjust$3 near3 rate)	US-PGPUB; USPAT	OR	ON	2015/12/16 15:32

			; EPO; JPO			
S7	8	((transmit$3 send$3 receiv$3 forward$3 monitor$3) near3 RSSI) with (adjust$3 near3 rate)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/16 15:33
S8	26	((send$3 transmit$4 receiv$3 forward$3) near5 conditions near3 operation) with ((access near1 point) AP)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:26
S9	4,998	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:58
S10	3	(adaptation near1 algorithm) with ((real near1 time) real-time) with historical	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 18:58
S11	1	"14356581"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:14
S12	0	((send$3 transmit$4 forward$3 receiv$3) near3 policy) near20 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:39
S13	0	((send$3 transmit$4 forward$3 receiv$3) near3 policy) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:39
S14	31	((send$3 transmit$4 forward$3 receiv$3) near7 policy) with RSSI	US-PGPUB; USPAT	OR	ON	2015/12/17 20:39

			; EPO; JPO			
S15	1	(policy near1 server) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:59
S16	26	(policy near1 server) same2 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/17 20:59
S17	0	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) with RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S18	178	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S19	1	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:19
S20	2	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) with AP	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:20
S21	7	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and (((access near1 point) AP) with server)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/18 18:20
S22	109	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2015/12/21 13:24

			; EPO; JPO			
S23	10	(rhee near1 wonjong) and policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 13:30
S24	58,484	(H04L7/00,0004 H04L12/00,14,16,24,2414,2415,2417-2419,2424-2426,2428-2433,2439,244-2442,2447,2464,2465,2468-247,2472,2473,2476,2478,26,2602,2618,2634-2642,2668-2678,2692 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; EPO; JPO	OR	ON	2015/12/21 15:17
S25	25	((transmit$3 send$3 receiv$3 forward$3) near5 policy near5 algorithms) and S24	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 15:17
S26	41	(rhee near1 wonjong) and S24	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 15:18
S27	1	"7840220".pn.	US-PGPUB; USPAT; EPO; JPO	OR	ON	2015/12/21 16:50
S28	1,672,280	adaptation algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:55
S29	5,390	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:55

S30	394	(creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S31	0	((creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)) with policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S32	5	((creat$3 generat$3 comput$3 calculat$3) near5 (adaptation near1 algorithm)) same2 policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/14 19:56
S33	13	(rhee near1 wonjong) and policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:17
S34	2,862	(generat$3 creat$3 develop$3) near10 RSSI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:18
S35	361	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:19
S36	0	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state)) with policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:19
S37	4	((generat$3 creat$3 develop$3) near10 RSSI) with ((observ$3 collect$3 obtain$3 receiv$3 detect$3) near5 (data status information state)) same2 policy	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20

S38	5,394	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20
S39	2	S35 and S38	US-PGPUB; USPAT; EPO; JPO	OR	ON	2016/11/16 17:20
S40	5,784	adaptation near1 algorithm	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 14:02
S41	451	(transmit$4 send$3 receiv$3 forward$3 push$3) near5 (adaptation near1 algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 14:03
S42	4	"7840220".pn. "2007136337"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 15:43
S43	46	(policy near7 algorithm) and (communication near5 algorithm) and WIFI	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 21:13
S44	0	S43 and S41	US-PGPUB; USPAT; EPO; JPO	OR	ON	2017/12/20 21:13
S51	33	("2006/0187885").URPN.	USPAT	OR	OFF	2018/10/19 20:09
S52	10,158	monitor$3 near7 (signal near1 strength)	US-PGPUB; USPAT	OR	OFF	2018/10/19 23:07

			; EPO; JPO			
S53	86,958	(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; EPO; JPO	OR	ON	2018/10/19 23:08
S54	335	S52 and S53	US-PGPUB; USPAT; EPO; JPO	OR	ON	2018/10/19 23:08
S55	38	("4161628" | "4229734" | "4279032" | "4430788" | "4558358" | "4694453" | "4730302" | "4799211" | "4816825" | "4860001" | "4890278" | "4896315" | "4926162" | "5048009" | "5115199").PN. OR ("5198805").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/10/19 23:11
S56	316	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 adapt$3)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:27
S57	58	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 adapt$5) not S56	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:33
S58	5	("2009/0059872").URPN.	USPAT	OR	OFF	2018/10/19 23:51
S59	1	("2012/0077533").URPN.	USPAT	OR	OFF	2018/10/19 23:54
S60	839	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 (adapt$5 chang$3 modif$3)) not (S56 S57)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/19 23:57
S61	433	(monitor$3 near7 (signal near1 strength)) and (dynamic$4 near5 (adapt$5 chang$3 modif$3)) and @AD<="20111110" not (S56 S57)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:04

S62	15	("2004/0223470").URPN.	USPAT	OR	OFF	2018/10/20 00:09
S63	31	remote$2 near3 manag$5 near3 QOS	USPAT	OR	OFF	2018/10/20 00:15
S64	6,276	S52 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:20
S65	1,349	RSSI and S64	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2018/10/20 00:21
S66	15	("2004/0223470").URPN.	USPAT	OR	OFF	2018/10/20 00:33
S67	89	("2007/0082677").URPN.	USPAT	OR	OFF	2018/10/20 00:40
S71	20	("20030031180" | "20030076784" | "20050261915" | "20060126613" | "20060187885" | "20070153807" | "20080186873" | "20090055900" | "20100290465" | "20110013529" | "20110110359" | "20110182182" | "20110273979" | "20120294310" | "5970064" | "5974106" | "6430612" | "7840220" | "8520586" | "8880666").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/20 23:05
S72	1	("20120151540").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/20 23:23
S73	7	("20160315976" | "20180248984" | "6469982" | "6618356" | "6678247" | "6680907" | "7864669").PN.	US-PGPUB; USPAT	OR	OFF	2018/10/21 00:11
S74	3,178	(monitor$3 with ((real near1 time) real-time)) and (parameter with algorithm)	US-PGPUB; USPAT; EPO; JPO	OR	OFF	2019/01/27 14:58
S75	56	(monitor$3 with ((real near1 time) real-time)) and (parameter with algorithm) and (policy with (rule condition))	US-PGPUB; USPAT	OR	OFF	2019/01/27 14:59

			; EPO; JPO			
S83	2	"13995901"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/01/27 23:14
S84	3	("10057080" | "20160261490" | "8126011").PN.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:45
S85	3	("20080186873" | "6430612" | "9819595").PN.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:46
S86	238	(network near5 monitor$3) and (policy with (histor$4 near5 data)) and (communication near4 performance)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/07/26 17:56
S87	94,363	(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; EPO; JPO	OR	ON	2019/07/26 17:56
S88	68	S86 and S87	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/07/26 17:56
S97	111,342	monitor$3 near3 ((real near1 time) real-time)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:44
S98	911,536	(improv$3 increas$3) near5 (service qos quality)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:47
S99	256,602	(histor$4 near4 data)	US-PGPUB;	OR	ON	2019/12/10 19:47

			USPAT; EPO; JPO			
S100	4,558	S97 and S98 and S99	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:47
S101	15,642	((improv$3 increas$3) near5 (service qos quality)) with (policy rules configuration)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:48
S102	228	S97 and S99 and S101	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 19:48
S103	891,108	(chang$3 updat$3 upgrad$3 transmit$4 receiv$3 forward$3 sent) near5 (policy rules configuration)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:36
S104	7,014	S97 and S99 and S103	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:37
S105	911,536	((improv$3 increas$3) near5 (service qos quality))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:37
S106	2,510	S104 and S105	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:38
S107	98,439	(H04L7/00,0004 H04L41/00,06,08-0806,0813-0836,085-0859,0866-0869,50-5016,5035,5038 H04L43/00,04,08-	US-PGPUB; USPAT	OR	ON	2019/12/10 20:38

		0817,0876-10,16 H04L47/00,10,11,12,28,29,32).cpc.	; EPO; JPO			
S108	724	S106 and S107	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:38
S109	22,274,817	@AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:44
S110	191	S108 and S109	US-PGPUB; USPAT; EPO; JPO	OR	ON	2019/12/10 20:45
S111	6	("20030031180" | "20060126613" | "20080186873" | "20090147697" | "20110110359" | "20140304408").PN.	US-PGPUB; USPAT	OR	ON	2020/02/22 06:04
S112	144	(interference noise) with ((send$3 transmit$4 push$3 forward$3) near5 policy)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:07
S113	1,248	((send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:18
S114	1,119	((send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy) not S112	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:18
S115	100,577	(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; EPO; JPO	OR	ON	2020/02/22 06:18

S116	115	S114 and S115	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:19
S117	54	((avoid$3 reschedul$3) near3 (send$3 transmit$4 push$3 forward$3) near7 (interference noise)) and ((send$3 transmit$4 push$3 forward$3) near5 policy) not (S112 S116)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/02/22 06:22
S123	2	("10530695" | "9819595").PN.	US-PGPUB; USPAT	OR	ON	2020/06/30 15:53
S124	8	("20080159124" | "20080186873" | "20090016358" | "20090201805" | "20090310528" | "20110182182" | "20110273979" | "20130077482").PN.	US-PGPUB; USPAT	OR	ON	2020/06/30 15:53
S125	3	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)) with (improv$3 near5 (performance quality)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 17:54
S126	104,560	(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; EPO; JPO	OR	ON	2020/06/30 17:54
S127	2,206	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 17:57
S128	224	S127 and S126	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 18:03
S131	104,560	(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	OR	ON	2020/06/30 21:16

			; EPO; JPO			
S132	2,206	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm)))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:16
S133	224	S132 and S131	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:16
S134	113,115	(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; EPO; JPO	OR	ON	2020/06/30 21:16
S135	22,276,145	@AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:17
S136	200	S133 and S135	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:21
S137	12	(S132 and S134 and S135) not S136	US-PGPUB; USPAT; EPO; JPO	OR	ON	2020/06/30 21:22
S161	27	(policy with (chang$3 switch$3) near6 band) same2 interference	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:37
S162	18	S161 and @AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 14:38

			; EPO; JPO			
S163	63	(policy with (chang$3 switch$3) near6 band) and interfer$4	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:39
S164	33	S163 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:41
S165	0	S164 not S163	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:52
S166	15	S164 not S162	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:52
S167	2,006	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:58
S168	1,444	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point) and band	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:59
S169	123,644	(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; EPO; JPO	OR	ON	2021/06/19 14:59
S170	60	S168 and S169	US-PGPUB; USPAT	OR	ON	2021/06/19 14:59

			; EPO; JPO			
S171	11	S170 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 14:59
S172	680	S168 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:04
S173	669	S172 not S171	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:05
S174	130	((reduc$3 minimiz$3 eliminat$3) near5 interference) with (access near1 point) and ((chang$3 modif$7 alter$3 switch$3) near3 band)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 15:24
S176	2,557	(adjust$3 modif$4 chang$3) near5 power near10 (AP (access near1 point))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:02
S177	41	SNR with (adjust$3 modif$4 chang$3) near5 power near10 (AP (access near1 point))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:06
S178	123,644	(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; EPO; JPO	OR	ON	2021/06/19 22:06
S179	20	S177 and @AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 22:06

			; EPO; JPO			
S180	83	((broadcast$3 publish$3 disseminat$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) with (performance near5 (threshold degrad$5 decreas$3 drop$4))	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:46
S181	18	S180 and @AD<="20111110"	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:52
S183	20	((broadcast$3 publish$3 disseminat$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 (parameter values adjustment)) with (performance near5 (threshold degrad$5 decreas$3 drop$4)) with ((access near1 point) AP)	US-PGPUB; USPAT; EPO; JPO	OR	ON	2021/06/19 22:53

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S45	100	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S46	889	(policy with algorithm).clm.	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S47	1	S45 and S46	US-PGPUB; USPAT	OR	ON	2017/12/20 20:54
S48	42,097	((transmission near1 control$4) (communication near1 algorithm)).clm.	US-PGPUB; USPAT	OR	ON	2017/12/20 20:55
S49	13	S46 and S48	US-PGPUB; USPAT	OR	ON	2017/12/20 20:55
S50	5	S48 and S45	US-PGPUB; USPAT	OR	ON	2017/12/20 20:56
S68	104	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2018/10/20 02:52

S69	106,792	((transmission near1 control$4) (communication near1 algorithm) policy).clm.	US-PGPUB; USPAT	OR	ON	2018/10/20 02:53
S70	7	S68 and S69	US-PGPUB; USPAT	OR	ON	2018/10/20 02:53
S76	105	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2019/01/27 14:41
S77	7,741	(monitor$3 with real-time).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:55
S78	2	S76 and S77	US-PGPUB; USPAT	OR	ON	2019/01/27 14:55
S79	37,017	(monitor$3 with parameter).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:56
S80	4	S76 and S79	US-PGPUB; USPAT	OR	ON	2019/01/27 14:56
S81	3,094	(policy and algorithm).clm.	US-PGPUB; USPAT	OR	ON	2019/01/27 14:57
S82	1	S76 and S81	US-PGPUB; USPAT	OR	ON	2019/01/27 14:57
S89	110	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2019/07/26 17:46
S90	25,771	(network near3 monitor$3).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:50
S91	1	S89 and S90	US-PGPUB; USPAT	OR	ON	2019/07/26 17:50
S92	1,397	(policy and (histor$4 near4 data)).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:52
S94	1	S92 and S89	US-PGPUB; USPAT	OR	ON	2019/07/26 17:52
S95	7,800	(communication near5 performance).clm.	US-PGPUB; USPAT	OR	ON	2019/07/26 17:53

S96	8	S89 and S95	US-PGPUB; USPAT	OR	ON	2019/07/26 17:53
S118	118	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S119	1,101	(policy with algorithm).clm.	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S120	1	S118 and S119	US-PGPUB; USPAT	OR	ON	2020/02/23 09:12
S121	119,468	((transmission near1 control$4) (communication near1 algorithm) policy).clm.	US-PGPUB; USPAT	OR	ON	2020/02/23 09:13
S122	8	S118 and S121	US-PGPUB; USPAT	OR	ON	2020/02/23 09:13
S129	122	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/06/30 17:55
S138	122	rhee near1 wonjong	US-PGPUB; USPAT	OR	ON	2020/06/30 20:49
S139	120	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) same2 (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:49
S140	175	(adaptive near1 spectrum near2 signal near1 alignment).as. (adaptive near1 spectrum near2 signal near1 alignment).aanm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:50
S141	0	(S138 S140) and S139	US-PGPUB; USPAT	OR	ON	2020/06/30 20:53
S142	1,398	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) and (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2020/06/30 20:53
S143	6	(S138 S140) and S142	US-PGPUB; USPAT	OR	ON	2020/06/30 20:55
S144	75,982	(H04L1/0019,20 H04L41/06,08-0806,0813-0836,085-0859,0866-	US-PGPUB; USPAT	OR	ON	2020/06/30 21:17

		0869,50-5016,5035,5038 H04L43/04,08-0817,0876-10,16).cpc.				
S145	9,004,209	@AD<="20111110"	US-PGPUB; USPAT	OR	ON	2020/06/30 21:17
S146	27,666	S144 and S145	US-PGPUB; USPAT	OR	ON	2020/06/30 21:23
S147	45	S146 and S142	US-PGPUB; USPAT	OR	ON	2020/06/30 21:23
S149	1,539	((detect$3 determin$3 identif$4 observ$3 encounter$3 recogniz$3 diagnos$3) near5 noise) and (((send$3 transmit$4 forward$3) near5 (policy configuration algorithm))).clm.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S150	84,962	(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	2021/06/19 02:57
S151	9,005,504	@AD<="20111110"	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S152	27,700	S150 and S151	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S153	45	S152 and S149	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S154	121	(rhee near1 wonjong).in.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:57
S156	176	"adaptive spectrum and signal alignment".as. "adaptive spectrum and signal alignment".aanm.	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S157	83	S154 and S156	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S158	4	S153 and S157	US-PGPUB; USPAT	OR	ON	2021/06/19 02:59
S159	1	"17102099"	US-PGPUB; USPAT	OR	ON	2021/06/19 03:02
S160	3	"14356581"	US-PGPUB; USPAT	OR	ON	2021/06/19 03:11

6/19/2021 11:11:21 PM
C:\Users\bgrijalva\Documents\EAST\Workspaces\17102099.wsp

Patents | transmit a policy to access points degradation of service

System and Method for Performing Network Selection



EP US • EP2900016B1 • John Fitzpatrick • Openet Telecom Ltd.
Priority 2014-01-28 • Filed 2015-01-26 • Granted 2018-10-24 • Published 2018-10-24
A method of automatically selecting a wireless communication network for a user equipment device (102), comprising: generating in a processor of a network selection policy server (116) an enhanced network selection rule that includes information suitable for causing the user equipment device (102) ...

Providing service based on quality of service resources in a long term ...



WO US • US9288831B2 • Karthika Paladugu • Qualcomm Incorporated
Priority 2012-08-31 • Filed 2013-08-28 • Granted 2016-03-15 • Published 2016-03-15
In an embodiment, an apparatus (e.g., a client device or a server) sends, to a Long Term Evolution (LTE) network component, a request to setup a Quality of Service (QoS) bearer with a threshold level of QoS to support the communication session for the client device. The apparatus permits the ...

Increased visibility during order management in a network-based supply chain ...



US • US10311778B2 • Michael G. Mikurak • Accenture Global Services Limited
Priority 1999-11-22 • Filed 2014-02-07 • Granted 2018-07-03 • Published 2018-07-03
The present application is a divisional of U.S. application Ser. No. 13/525,910, filed Jun. 18, 2012, which is a divisional of U.S. application Ser. No. 10/407,895 (now U.S. Pat. No. 8,271,336), filed Apr. 4, 2003, which is a continuation-in-part of U.S. application Ser. No. 09/447,887, filed Nov.

Real-time scalable wireless switching network



US • US7933233B2 • Sanjay M. Gidwani • Sanjay M. Gidwani
Priority 2004-11-18 • Filed 2004-11-18 • Granted 2011-04-26 • Published 2011-04-26
A real-time scalable wireless switching network is described herein. In one embodiment, an exemplary network architecture includes, but is not limited to, a first access point coupled to a wired network, where the first access point is capable of communicating with one or more mobile nodes over a ...

Access point grouping based on performance and location



WO EP US CN • US10015682B2 • David Townend • British Telecommunications Public Limited Company
Priority 2014-03-31 • Filed 2015-03-26 • Granted 2018-07-03 • Published 2018-07-03
In a system of wireless access point routing devices each creating a wireless network, a management server monitors the performance of the wireless networks to identify performance degradation. Any wireless networks experiencing performance degradation are grouped by region to determine whether a ...

Controlling mobile device communications on a roaming network based on device ...



US • US9253663B2 • Gregory G. Raleigh • Headwater Partners I Llc
Priority 2009-01-28 • Filed 2013-12-10 • Granted 2016-02-02 • Published 2016-02-02
A device that determines an aspect of a service policy based on a state of the device, and applies the service policy. The state is based on a user interaction, or a lack of user interaction, with the device. The service policy applies a first control to a first activity over a roaming network and ...

Enterprise wireless local area network switching system



EP US DE • EP1420553B1 • Kar Wing Edward Lor • Broadcom Corporation
Priority 2002-10-08 • Filed 2003-10-08 • Granted 2006-01-04 • Published 2006-01-04
A process of controlling a flow of data in an enterprise wireless local area network (101) providing wireless access to the wireless network (101) by wireless devices (120-129), said process comprising: receiving data from a wireless device (120-129) by a network device, through one access point (...

Self-organized fleets of autonomous vehicles to optimize future mobility and ...

US • US10401852B2 • Nuno Alexandre Tavares Coutinho • Veniam, Inc.
Priority 2017-06-27 • Filed 2018-03-16 • Granted 2019-09-03 • Published 2019-09-03
Communication network architectures, systems and methods for supporting a network of mobile nodes. As a non-limiting example, various aspects of this disclosure provide autonomous vehicle network architectures, systems, and methods for supporting a dynamically configurable network of autonomous ...

System and method for internal networking, data optimization and dynamic ...



US • US9277482B2 • Sateesh K. Addepalli • Cisco Technology, Inc
Priority 2011-01-14 • Filed 2014-04-01 • Granted 2016-03-01 • Published 2016-03-01
A system includes an on-board unit (OBU) in communication with an internal subsystem in a vehicle on at least one Ethernet network and a node on a wireless network. A method in one embodiment includes receiving a message on the Ethernet network in the vehicle, encapsulating the message to ...

The device and method of congestion control for user equipment auxiliary

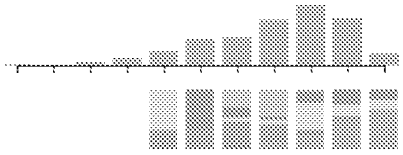
WO EP US CN JP KR • CN110402553B • A M [redacted] • [redacted]
Priority 2017-02-01 • Filed 2018-02-01 • Granted 2019-08-16 • Published 2019-08-16

Charter Communications, Inc.
Exhibit 1006
Page #947

The application combines the QoE improved in RAN congestion, provides method for wireless communications, device and computer program product.In one example, communication equipment is configured as: indicating the Quality Control Indicators (QCI) by carrying each application in the multiple ...

« ‹ Page 3 › » About 198,528 results

Top 1000 results by filing date



Relative count of top 5 values

Assignees	Inventors	CPCs
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Charter Communications, Inc.
Exhibit 1006
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	17102099
Filing Date	2020-11-22
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	~~Unassigned~~ Grijalva Lobos, Boris
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	Notice of Allowance mailed March 15, 2021, in related Canadian patent application No. 3,034,504, Attorney Docket No. [20145-055CAD], (1 pg).	

Examiner Signature	/BORIS D GRIJALVA LOBOS/	Date Considered	06/19/2021

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https://www.ncn.net › ncnAcceptableUsePolicy

Acceptable Use Policy - Northwest Communications

Mar 18, 2004 -- Northwest's Acceptable Use Policy is intended to help enhance the use of the Internet ... Using the Services to transmit any material (by email uploading, downloading, ... Using the Services to discriminate against, victimize, harass, degrade or ...
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Hotwire Communications' High-Speed Internet Acceptable ...

Jun 17, 2009 -- Hotwire Communications' Acceptable Use Policy is intended to enhance the use of the ... control over the content of any website, electronic mail transmission, ... interfere with, or otherwise disrupt or cause a performance degradation, ... Internet service provider or for any business enterprise or purpose, or as an end-point on.

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On the Enhancement of IEEE 802.11 Overlapping APs ...

by GZ Papadopoulos · 2011 · Cited by 1 -- easily understood, the OBSS problem may severely degrade the network performance. Having in mind ... enhance the performance of overlapping Access Points (APs) in IEEE 802.11 WLANs ... Group Addressed Transmission Service (GATS) . ... either accepts or rejects the request based on an admission control policy.

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WiLine Service Agreement Terms and Conditions

Jun 7, 2010 -- posted policies or rules applicable to Services which may be posted at any time. ... point. The date that WiLine notifies Customer that a Service is available is the "Activation ... of the Service Address listed above or controls use of and access to the ... submit a Service Non-Availability Notice, and make a written request (the ...

http://www.oatioasis.com › PNM_OATT_9-26-15 PDF

OPEN ACCESS TRANSMISSION TARIFF Public Service ...

Jun 8, 2007 -- Public Service Company of New Mexico - PNM Open Access Transmission Tariff - Open Access ... Short-Term Firm Point-To-Point Transmission Service ... all rules, standards and practices that (i) relate to the terms and conditions of transmission ... other unforeseen condition threatens to impair or degrade the reliability of its.

https://www.connection.com › brands › xirrus › 1... PDF

Optimize Your Wi-Fi Network

Oct 15, 2011 -- changed in recent years--from an overlay access network ... increase in use of bandwidth-hungry video, and not just for ... business-critical applications perform without degradation ... application control to each Xirrus Array/AP results in a uniquely ... "The ability of the Xirrus system to support a BYOD policy was vital when.

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

Amazon Elasticache FAQs - Amazon Web Service

Aug 23, 2011 -- Amazon ElastiCache is a web service that makes it easy to deploy and run Memcached ... and popular tools that you use today with your existing Memcached or Redis ... for a given week, it will be initiated and completed at some point during the 60 ... There is no charge for data transfer between Amazon EC2 and Amazon ...

https://www.eia.gov › tools › glossary

Glossary - US Energy Information Administration (EIA)

Feb 12, 2011 -- ... deratings include high cooling water temperatures, equipment degradation, and ... The boiling point and specific gravity are higher for diesel fuels than for gasoline. ... For

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Exhibit 1006
Page #951

those end-use customers who are served at transmission voltages, the ... Energy Policy Act of 1992 (EPACT). This legislation creates a new class of ...

https://www.cse.wustl.edu › ~jain › ftp › energy_mgmt

Power Management in Wireless Networks

Apr 24, 2006 — The work presented covers topics ranging from the use of energy harvesting ... not explicitly define a policy for implementing a transmission power control policy; ... that allow the video quality to become slightly degraded have been explored in ... a beacon message is sent from the access point to each wireless station in ...

https://www.sciencedirect.com › topics › computer-science

Signal Strength - an overview | ScienceDirect Topics

Mar 7, 2005 — We use decibel measurements because signal strengths vary logarithmically, not linearly. ... Placing the antenna too high will cause the main lobe to pass over the ... The FCC has relaxed the rules on EIRP limits for Point-to-Point (PtP) systems. ... that the system will not work or performance will be severely degraded.

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Page #952

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

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	17102099
Filing Date	2020-11-22
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	~~Unassigned~~ Grijalva Lobos, Boris
Attorney Docket Number	20145-054USC

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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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	20050182848	A1	2005-08-18	McNeil, JR. et al.	
	2	20080159124	A1	2008-07-03	Sasaki	
	3	20080186873	A1	2008-08-07	Pujet et al.	
	4	20090016358	A1	2009-01-15	Lee	
	5	20090201805	A1	2009-08-13	Began et al.	

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	Examiner Name	Unassigned Grijalva Lobos, Boris
	Attorney Docket Number	20145-054USC

	6	20090310528	A1	2009-12-17	Tamura	
	7	20110182182	A1	2011-07-28	Yang et al.	
	8	20110273979	A1	2011-11-10	Grabelsky et al.	
	9	20130077482	A1	2013-03-28	Krishna et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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	1	Non-Final Office Action mailed 12/4/2020 in related US Patent Application No. 15/845,977 filed 12/18/2017, Attorney Docket No. [20145-056USC], (45 pgs).	

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	Filing Date	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	17102099
	Filing Date	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	~~Unassigned~~ Srijalva Lobos, Boris
	Attorney Docket Number	20145-054USC

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Signature	/Michael North/	Date (YYYY-MM-DD)	2020-12-04
Name/Print	Michael North	Registration Number	46963

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

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Application Number	17102099
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First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	~~Unassigned~~ Grijalva Lobos, Boris
Attorney Docket Number	20145-054USC

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	1	5970064	A	1999-10-19	Clark et al.	

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	1	20060187885	A1	2006-08-24	Roy et al.	
	2	20090207730	A1	2009-08-20	Stamoulis et al.	

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	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	xxxxxxxx Grijalva Lobos, Boris Unassigned
	Attorney Docket Number	20145-054USC

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	1	CA Office Action mailed October 2, 2020 in related Canadian patent application No. 2,855,461, Attorney Docket No. [20145-054CA], (4 pgs).	
	2	CA Office Action Response filed February 2, 2021 in related Canadian patent application No. 2,855,461, Attorney Docket No. [20145-054CA], (12 pgs).	

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Name/Print	Michael North	Registration Number	46963

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CONFIRMATION NO. 1038

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
17/102,099	11/23/2020	709	2446	20145-054USC

APPLICANTS
ASSIA SPE, LLC, Wilmington, DE;

INVENTORS
Wonjong Rhee, San Francisco, CA;

**** CONTINUING DATA ***************************
This application is a CON of 14/356,581 05/06/2014 PAT 10848398
which is a 371 of PCT/US2011/060265 11/10/2011

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
12/03/2020

Foreign Priority claimed ❑ Yes ☑ No 35 USC 119(a-d) conditions met ❑ Yes ☑ No Verified and Acknowledged /BORIS D GRIJALVA LOBOS/ Examiner's Signature	❑ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	6	23	2

ADDRESS
North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304
UNITED STATES

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

FILING FEE RECEIVED		
2120	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other _____ ❑ Credit

PTO/SB/08b (07-09)
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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	17102099
Filing Date	2020-11-22
First Named Inventor	Wonjong Rhee
Art Unit	2446
Examiner Name	Unassigned
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	Notice of Allowance mailed March 15, 2021, in related Canadian patent application No. 3,034,504, Attorney Docket No. [20145-055CAD], (1 pg).	

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.**

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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.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	42288508
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:	26-MAR-2021
Filing Date:	23-NOV-2020
Time Stamp:	01:57:46
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	25901 f8c24421b638043f7ee5c899c572c3be9a0a b1d7	no	3
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08b.pdf	325434 d45dc9e52390071f3a867cf0c07b7cb9883b66f4	no	2
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	160665 96343a642c90b22661a2c497166c2c1943f0db4f	no	1
Warnings:					
Information:					
		Total Files Size (in bytes):	512000		

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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	:	Unassigned			
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: March 25, 2021 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner:

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 #967

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: March 25, 2021

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

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Page #969

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/102,099	11/23/2020	Wonjong Rhee	20145-054USC

CONFIRMATION NO. 1038

146571
North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304

PUBLICATION NOTICE

OC00000124011846

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

Publication No.US-2021-0075703-A1
Publication Date:03/11/2021

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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Exhibit 1006
Page #970

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	Unassigned
	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	5970064	A	1999-10-19	Clark et al.	

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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	20060187885	A1	2006-08-24	Roy et al.	
	2	20090207730	A1	2009-08-20	Stamoulis et al.	

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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	Unassigned
	Attorney Docket Number	20145-054USC

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	CA Office Action mailed October 2, 2020 in related Canadian patent application No. 2,855,461, Attorney Docket No. [20145-054CA], (4 pgs).	
	2	CA Office Action Response filed February 2, 2021 in related Canadian patent application No. 2,855,461, Attorney Docket No. [20145-054CA], (12 pgs).	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-23
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	Unassigned
	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)	2021-02-26
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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Charter Communications, Inc.
Exhibit 1006
Page #974

Electronic Acknowledgement Receipt

EFS ID:	42039961
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:	26-FEB-2021
Filing Date:	23-NOV-2020
Time Stamp:	16:18:57
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	25916 debe23ea8dcd7cab843a6cf9b2c7467c1fbd a33b	no	3
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08.pdf	612201 9400ef2a02a2462239ff5742510f40ede25970cd	no	4
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	777046 1f721be21bc50d0ea25d85f7d6abfb00762b4545	no	4
Warnings:					
Information:					
4	Non Patent Literature	054USC_SIDS_NPL2.pdf	302915 986db41d367046deab3e57881ad802b1d9627f43	no	12
Warnings:					
Information:					
			Total Files Size (in bytes):	1718078	

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

New International Application Filed with the USPTO as a Receiving Office

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

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	:	Unassigned			
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 26, 2021 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner:

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 #977

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 26, 2021

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

Charter Communications, Inc.
Exhibit 1006
Page #979

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	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	Unassigned
	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	20050182848	A1	2005-08-18	McNeil, JR. et al.	
	2	20080159124	A1	2008-07-03	Sasaki	
	3	20080186873	A1	2008-08-07	Pujet et al.	
	4	20090016358	A1	2009-01-15	Lee	
	5	20090201805	A1	2009-08-13	Began et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	Unassigned
	Attorney Docket Number	20145-054USC

	6	20090310528	A1	2009-12-17	Tamura	
	7	20110182182	A1	2011-07-28	Yang et al.	
	8	20110273979	A1	2011-11-10	Grabelsky et al.	
	9	20130077482	A1	2013-03-28	Krishna 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]	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							

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	Non-Final Office Action mailed 12/4/2020 in related US Patent Application No. 15/845,977 filed 12/18/2017, Attorney Docket No. [20145-056USC], (45 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	Unassigned
	Attorney Docket Number	20145-054USC

[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.

Charter Communications, Inc.
Exhibit 1006
Page #982

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17102099
	Filing Date	2020-11-22
	First Named Inventor	Wonjong Rhee
	Art Unit	2446
	Examiner Name	Unassigned
	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)	2020-12-04
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 Acknowledgement Receipt

EFS ID:	41303191
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:	04-DEC-2020
Filing Date:	23-NOV-2020
Time Stamp:	18:10:44
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	25944 ec55e22edc2ca649986fe9e63fc2e2785bf0e99c	no	3
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	054USC_SIDS_SB08.pdf	612685 f3932f5e349fbbede31f424ffa76f09d3b1cf2af	no	5
Warnings:					
Information:					
3	Non Patent Literature	054USC_SIDS_NPL1.pdf	3608322 6307fbbb3a2ea15385d44f6f7a9de096f81547bc	no	45
Warnings:					
Information:					
			Total Files Size (in bytes):	4246951	

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	:	11-22-2020			
Title	:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER			
Art Unit	:	2446			
Examiner	:	Unassigned			
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: December 4, 2020 By: /Domarina Alkhas/
Domarina Alkhas

INFORMATION DISCLOSURE STATEMENT

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

Dear Examiner:

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 #987

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: December 4, 2020

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

Charter Communications, Inc.
Exhibit 1006
Page #989

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/102,099	11/23/2020	2414	2120	20145-054USC	23	2

CONFIRMATION NO. 1038

FILING RECEIPT

146571
North Weber & Baugh LLP - ASSIA
3260 Hillview Avenue, 1st Floor
Palo Alto, CA 94304

OC000000121783961

Date Mailed: 12/04/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Wonjong Rhee, San Francisco, CA;

Applicant(s)

ASSIA SPE, LLC, Wilmington, DE;

Assignment For Published Patent Application

ASSIA SPE, LLC, Wilmington, DE

Power of Attorney: The patent practitioners associated with Customer Number 146571

Domestic Priority data as claimed by applicant

This application is a CON of 14/356,581 05/06/2014 PAT 10848398
which is a 371 of PCT/US2011/060265 11/10/2011

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

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Charter Communications, Inc.
Exhibit 1006
Page #990

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

If Required, Foreign Filing License Granted: 12/03/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/102,099**

Projected Publication Date: 03/11/2021

Non-Publication Request: No

Early Publication Request: No

Title

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

Preliminary Class

370

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

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

Charter Communications, Inc.
Exhibit 1006
Page #991

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

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/102,099

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3			OR	x 100 =	300
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2120

APPLICATION AS AMENDED - PART II

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

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

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

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

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

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

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Application Number	
Filing Date	November 23, 2020
First Named Inventor	Wonjong RHEE
Title	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
Art Unit	
Examiner Name	
Attorney Docket Number	20145-054USC

SIGNATURE of Applicant or Patent Practitioner

Signature	/Michael V. North/	Date (Optional)	2020-11-23
Name	Michael V. North	Registration Number	46963
Title (if Applicant is a juristic entity)	Patent Attorney		
Applicant Name (if Applicant is a juristic entity)	ASSIA SPE, LLC		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

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

Application Number	Filing Date

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Telephone		Email			

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

ASSIA SPE, LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	
Name	John M. Cioffi		
Title	Chief Executive Officer		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

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

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

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

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

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

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Wongjong Rhee DocuSigned by: Date (Optional) :_____

Signature: Wongjong Rhee 55DE5812E33E485...

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

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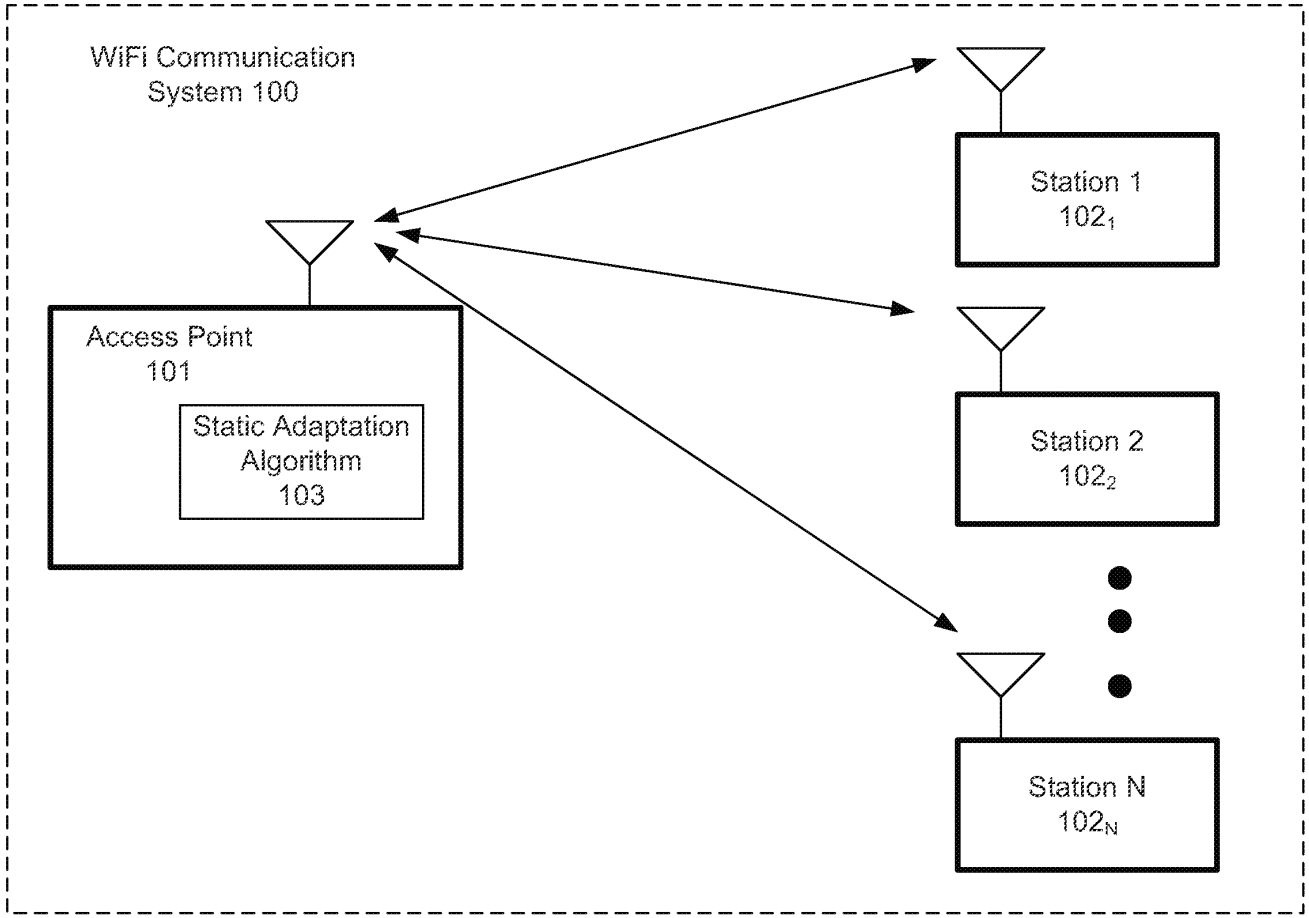


FIG. 1 (prior Art)

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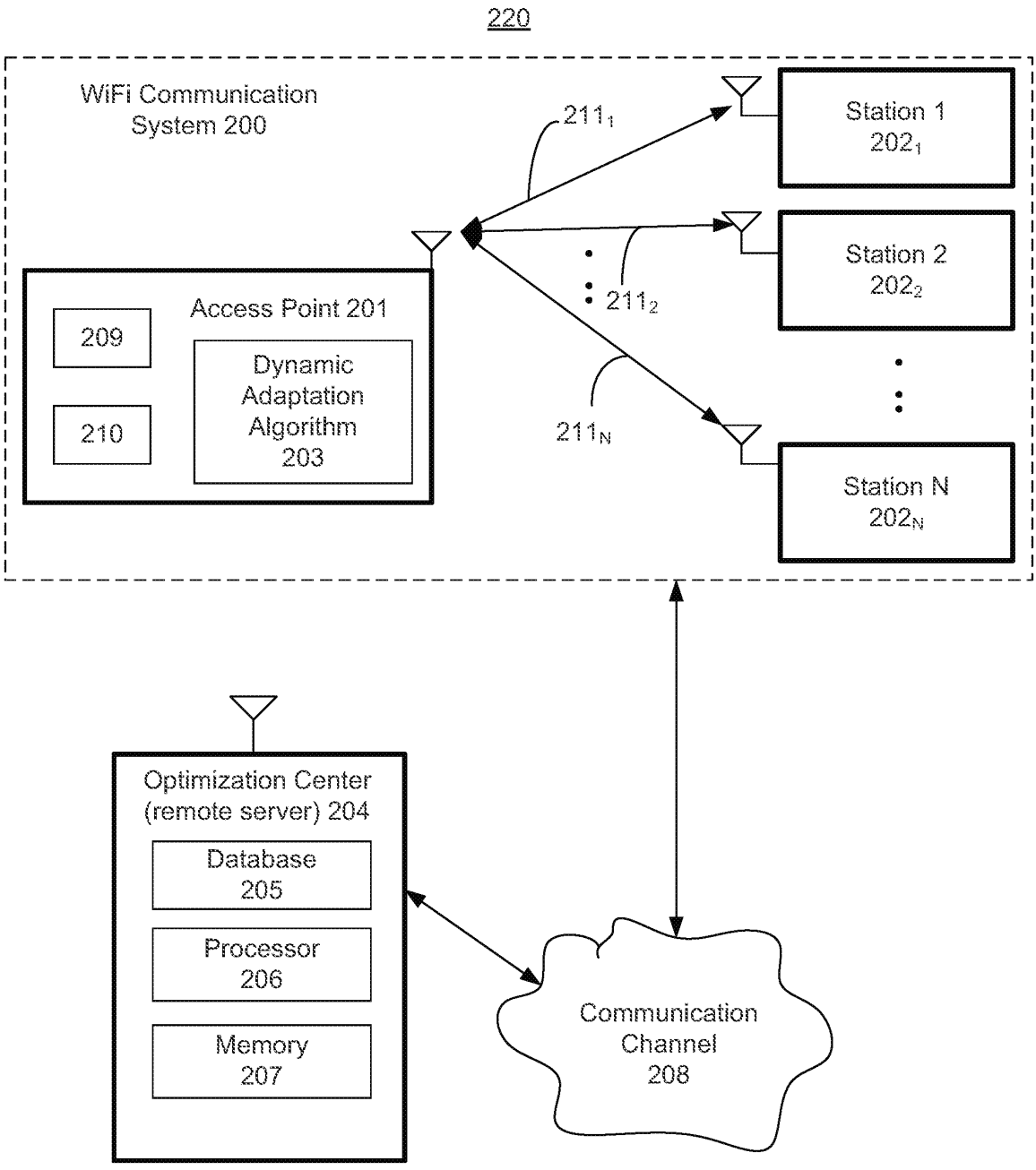


FIG. 2

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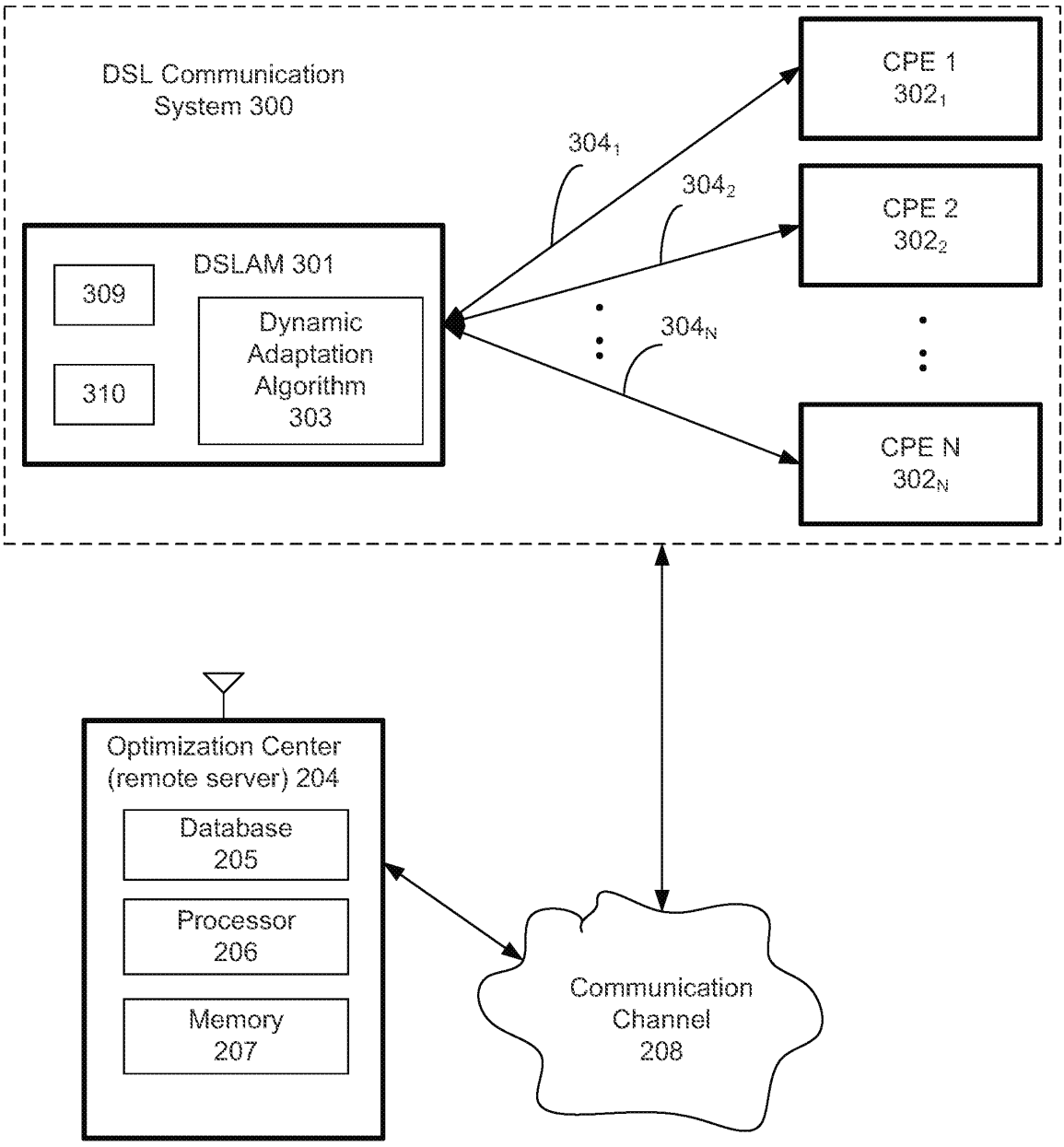


FIG. 3

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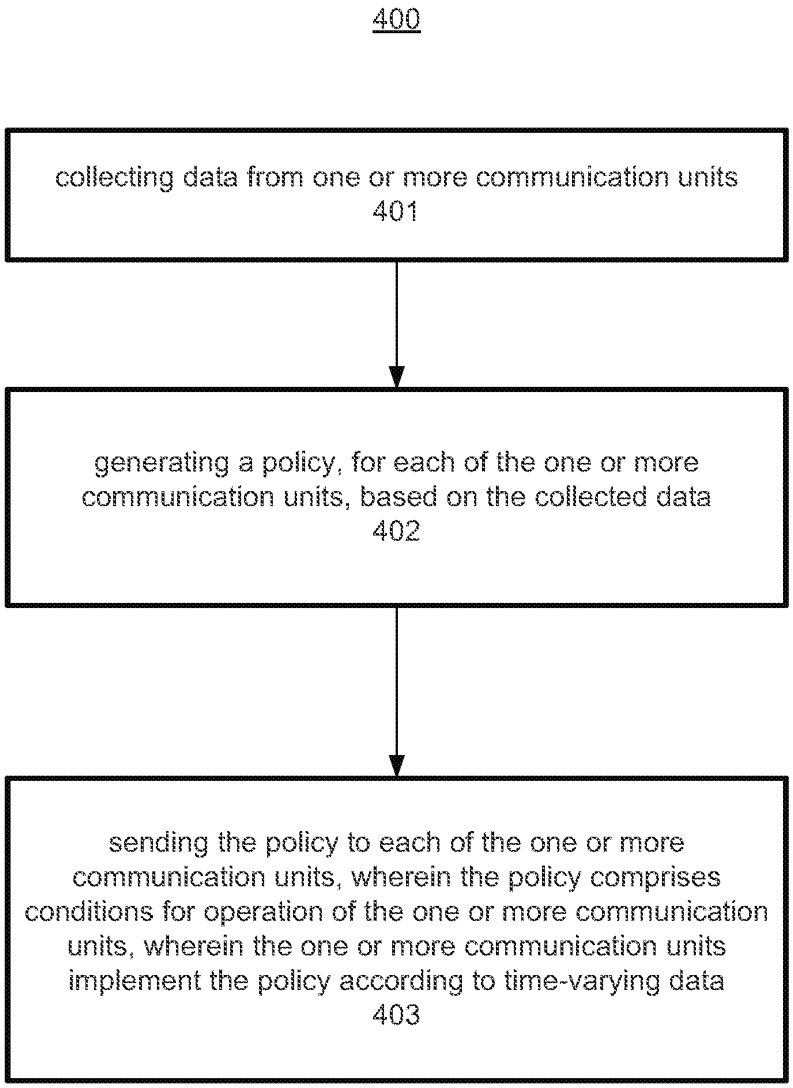


FIG. 4

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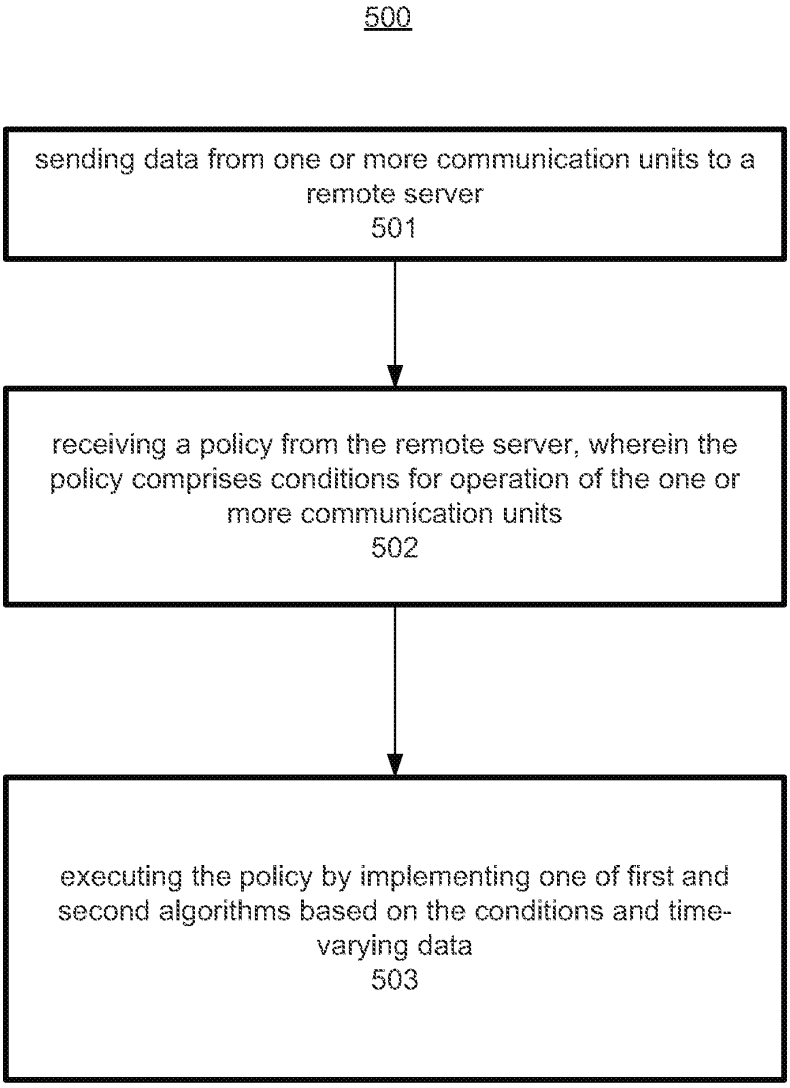


FIG. 5

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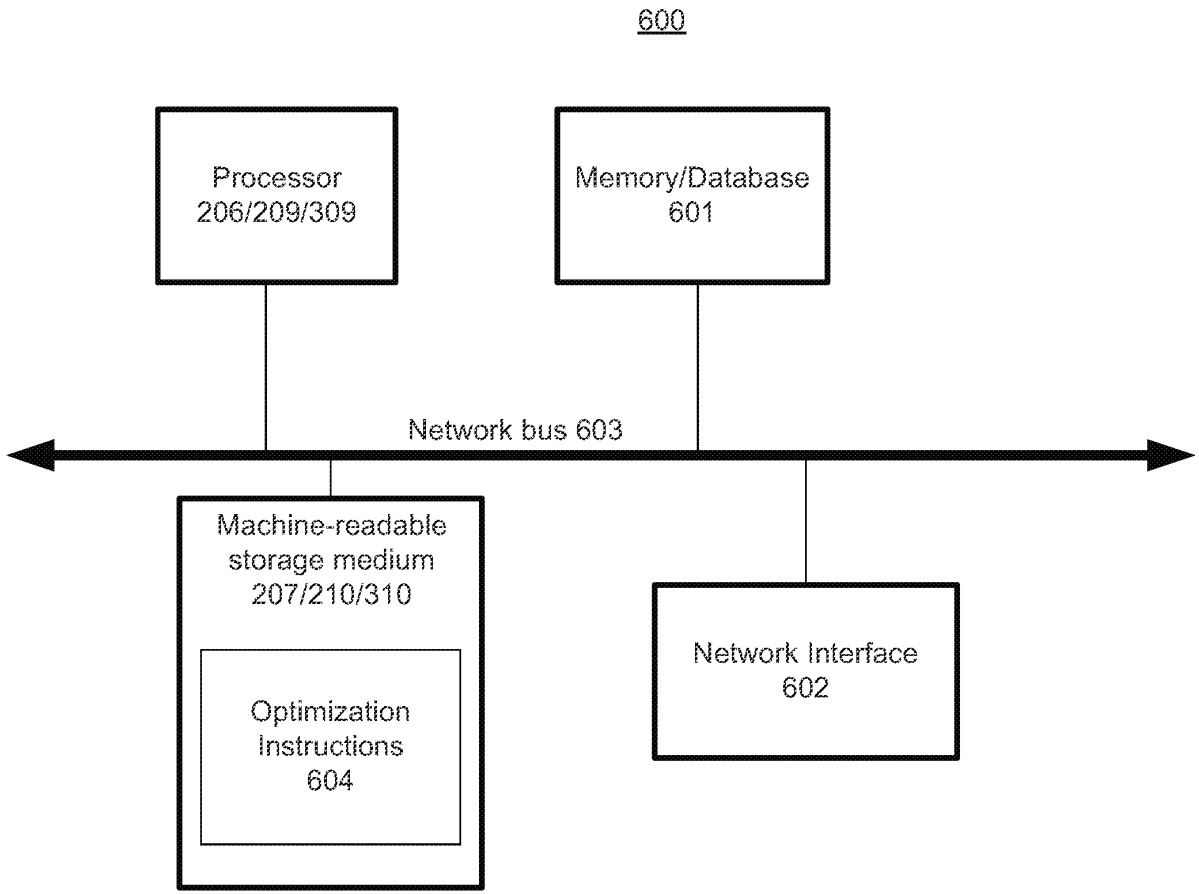


FIG. 6

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ABSTRACT

Described herein are apparatus, system, and method for optimizing performance of one or more communication units by a remote server. The method comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data. The system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to perform the method discussed above.

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CLAIMS

WHAT IS CLAIMED IS:

1. A remote 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. The remote server of claim 1 wherein the adjustment within the first network is an implementation of an algorithm.

3. The remote server of claim 1 where in the adjustment within the first network is a change in a parameter value.

4. The remote 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. The remote server of claim 4 wherein the at least one policy adjusts channel transmission characteristics of at least one wireless channel within the first network.

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6. The remote 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. The remote server of claim 1 wherein the first and second sets of collected data comprise historical data.

8. The remote 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. The remote server of claim 8 wherein the first pre-defined time and the second pre-defined time are different.

10. The remote server of claim 8 wherein the first policy adjustment and the second policy adjustment are different.

11. The remote server of claim 1 wherein the first and second communication units are Wi-Fi access points.

12. The remote server of claim 1 wherein the first and second communication units are cellular base stations.

13. The remote server of claim 12 wherein the first communication unit is a small cell base station.

14. The remote server of claim 1 wherein the first and second sets of collected data comprise RSSI measurements collected within the first and second networks.

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15. The remote server of claim 14 wherein the at least one policy adjusts a transmission rate of at least one channel within the first network.

16. The remote 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. The remote 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. The remote server of claim 1 wherein at least two interfaces within the first, second and third interfaces are the same interface.

19. A method for managing a plurality of networks, the method comprising:

receiving, by a remote 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 remote 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 remote 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. 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. The method of claim 19 wherein the one or more communication units comprise a Wi-Fi access point.

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

23. 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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METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

INVENTOR

Wongjong Rhee

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of and claims priority to previously filed and co-pending US Patent Application No. 14/356,581, entitled "METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER" naming as inventor Wonjong Rhee, and filed May 6, 2014, which is the 371 national phase of International Patent Application No. PCT/US2011/060265, entitled "METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER" naming as inventor Wonjong Rhee, and filed November 10, 2011, which applications are hereby incorporated by reference in their entireties.

FIELD OF INVENTION

[0002] Embodiments of the invention relate generally to the field of communication systems. More particularly, embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server.

BACKGROUND

[0003] FIG. 1 is an exemplary prior art communication system (CS) 100 with an access point (AP) 101 and one or more wireless stations 102.sub.1-N. The AP 101 exchanges user data with the one or more stations 102.sub.1-N over wireless channels indicated by the arrows. The

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characteristics of the wireless channels and noise/interference are not constant and vary rapidly over time. For example, noise and interference levels from nearby noise/interference sources rapidly changes that cause the characteristics of the wireless environment to change. To cope with such rapid changes in the noise and interference levels, the CS 100 adapts transmission strategies to enhance performance of CS 100. One such known strategy is Adaptation Algorithm. The term "Adaptation Algorithm" herein refers to time-varying and environment-change-dependent transmission or control strategies for a CS. The adaptation algorithm is implemented in the AP 101 that adapts the wireless channels and noise/interference for communication with the one or more stations 102.sub.1-N.

[0004] For instance, the transmission rate of Institute of Electrical and Electronics Engineer (IEEE) 802.11g standard based WiFi communication system is rapidly adapted between 6 Mbps and 54 Mbps depending on the link quality and the rate selection method (also known as the rate adaptation algorithm) implemented in the WiFi communication system. Such rate adaptation algorithm within the WiFi communication system uses real-time data that are collected by the AP 101 of the WiFi communication system itself as an input to the adaptation algorithm 103, and a rate change in the link occurs when the real-time data meets a pre-defined criteria.

[0005] A possible rate adaptation algorithm 103 is to change transmission rate of signals by the AP 101 within the WiFi communication system when the measured RSSI (Received Signal Strength Indication) becomes too large or too small for the current rate in use. Another possible adaptation algorithm 103 is to increase the transmission rate of signals by the AP 101 whenever packets are successfully received by the AP 101 and/or the one or more stations 102.sub.1-N for M (e.g., 3) times and decrease rate whenever packets are unsuccessfully received for P (e.g., 2) times. While such adaptation algorithms 103 are required for WiFi

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communication systems to function properly, the rules and thresholds used by the methods are decided by a system designer of the WiFi communication system. Furthermore, a specific adaptation algorithm 103 is included in the firmware and loaded to the WiFi communication system. Hence, the adaption algorithm 103 is static in nature.

[0006] Therefore, the actual performance of the rate adaptation algorithm 103 is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and the WiFi communication system 100 may suffer from low performance due to non-ideal design of the static adaptation algorithm 103.

[0007] The impact of such differences in the assumptions can be significant in a large-scale deployment where many communication devices, such as AP's, independently operate. In such a deployment, every single communication environment is unique and the best adaptation method for each environment can be quite dependent on its own environment..

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BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Embodiments of the invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0009] FIG. 1 is a high level system of a typical communication system using a static adaptive algorithm.

[0010] FIG. 2 is a system for optimizing performance of a WiFi communication system by a remote server, according to one embodiment of the invention.

[0011] FIG. 3 is a system for optimizing performance of a Digital Subscriber Line (DSL) communication system by a remote server, according to one embodiment of the invention.

[0012] FIG. 4 is a method performed by a remote server for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0013] FIG. 5 is a method performed by the communication system for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0014] FIG. 6 is a processor-based system having machine-readable storage medium with computer executable instructions for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

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SUMMARY OF THE INVENTION

[0015] The following presents a simplified summary of the embodiments of the invention in order to provide a basic understanding of some aspects of the embodiments. This summary is not an extensive overview of the embodiments of the invention. It is intended to neither identify key or critical elements of the embodiments nor delineate the scope of the embodiments. Its sole purpose is to present some concepts of the embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0016] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. In one embodiment, the method for optimizing performance of one or more communication units by a remote server, comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0017] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform the method for optimizing performance of one or more communication units by the remote server.

[0018] In one embodiment, the communications system comprises a WiFi Access Point or a Digital Subscriber Line Access Multiplexer (DSLAM) to perform a method for optimizing performance of one or more communication units coupled to the WiFi Access Point or the DSLAM. In one such embodiment, the method comprises: sending data from one or more communication units to a remote server; receiving a policy from the remote server, wherein the

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policy comprises conditions for operation of the one or more communication units; and executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0019] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that, when executed, cause a processor, of the WiFi Access Point or the DSLAM, to perform the method for optimizing performance of one or more communication units discussed above.

[0020] In one embodiment, the apparatus comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from one or more communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0021] In one embodiment, the system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from the one or more communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0022] In one embodiment, the communication unit comprises: a transmitter to send data to a remote server; a receiver to receive a policy from the remote server, wherein the policy comprises conditions for operation of the communication unit; and a processor to execute the

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policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0023] The embodiments of the invention are not limited to DSL or WiFi communication systems of the examples and embodiments above, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect the communication performance. The policy generated by the remote server can be a result of analyzing hundreds (or even millions) of similarly situated communication units, or any other expert knowledge made available to the remote server. Generally, a communication unit does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, a communication unit typically does not have access to historical data related to communications with other stations. Additionally, communication units may lose history data when there is power outage or user-initiated power cycling. The remote server resolves the above problems and provides an optimum policy for the communication units to use that can be based on analysis of a large amount of operational data of the communication units and other similarly situated communication units or any other expert knowledge.

[0024] While the summary of the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the following description. The embodiments of the invention are intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0025] The following description and the annexed drawings set forth in detail certain illustrative aspects of the embodiments of the invention. These aspects, however, are only

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indicative of the various ways in which the principles of the embodiments of the invention may be employed. The embodiments of the invention are intended to embrace all equivalents in the form of alternatives, modifications, and variations that fall within the broad scope of the appended claims. Other advantages and novel features of the embodiments of the invention will become apparent from the following detailed description of the embodiments of the invention when considered in conjunction with the drawings.

DETAILED DESCRIPTION

[0026] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. As mentioned in the background section, the actual performance of the communication unit could be dependent on the assumptions made by the designer of the communication system. In one example, as provided in the background section, the actual performance of the WiFi rate adaptation algorithm is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and a WiFi communication system might suffer from low performance due to non-ideal design of the adaptation algorithm.

[0027] To overcome the above problem, the embodiments herein describe a method, system and apparatus that analyzes real-time and history of operational data related to a communication system and provides rules and conditions for the communication system to improve its performance. The rules and conditions specify the characteristics of the real-time and historical operational data such that the communication unit can select and use the most desired adaptation algorithm to use. In one embodiment, a remote server (also called an optimization

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center) is operable to collect and process large amounts of data related to the communication system and determine rules and conditions for the communication system that will improve the performance of the communication system. In one embodiment, the remote server collects data periodically and provides updated rules and conditions periodically for the communication system to adapt so that it may improve its performance. The embodiments herein are not limited to a communication system but can be used for any type of communication system that needs to be updated over time to improve its performance to changing environments.

[0028] The term "performance" herein refers to a combination of factors including data rate, throughput, power consumption, power, error rate, latency, jitter, etc. Improving performance of the communication system includes increasing data rate, throughput, reducing error rate and latency, improving jitter, power consumption, etc for the communicating system.

[0029] The technical effect of the embodiments discussed herein is the improvement of performance of a communication system (e.g., WiFi, Digital Subscriber Line (DSL), etc) by providing the communication system with rules and conditions that were previously not conceivable by the communication system due to lack of information and processing power needed to generate the rules and conditions. In one embodiment, a dedicated server (also referred as "remote server" or "optimization center") may be used to collect operational data related to the communication system, where the operational data may not be accessible or storable by the communication system itself (e.g., data from other communication units or old data that cannot be stored due to memory limitations) process the operational data and provide rules and conditions that when adapted by the communication system causes the performance of the communication system to improve.

[0030] For example, the remote server is operable to perform a statistical analysis of hundreds (or even millions) of communication systems working in a similar environment as the

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communication system of interest. In one embodiment, the remote server is operable to indicate to the communication system of interest how it can improve its overall performance, for example, by aggressively choosing higher transmission rates as opposed to conservatively choosing lower transmission rates.

[0031] In one embodiment, when the WiFi communication system has the capability to decode and execute a pre-defined pseudo-code, the remote server can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units. For example, the remote server develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory of an Access Point. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by a processor of the Access Point. In one embodiment, as the remote server becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units of the communication system.

[0032] In the following description, numerous details are discussed to provide a more thorough explanation of embodiments of the present invention. It will be apparent, however, to one skilled in the art, that embodiments of the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring embodiments of the present invention.

[0033] Note that in the corresponding drawings of the embodiments, signals are represented with lines. Some lines may be thicker, to indicate more constituent signal paths, and/or have arrows at one or more ends, to indicate primary information flow direction. Such

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indications are not intended to be limiting. Rather, the lines are used in connection with one or more exemplary embodiments to facilitate easier understanding of a circuit or a logical unit. Any represented signal, as dictated by design needs or preferences, may actually comprise one or more signals that may travel in either direction and may be implemented with any suitable type of signal scheme.

[0034] In the following description and claims, the term "coupled" and its derivatives may be used. The term "coupled" herein refers to two or more elements which are in direct contact (physically, electrically, magnetically, optically, etc.). The term "coupled" herein may also refer to two or more elements that are not in direct contact with each other, but still cooperate or interact with each other.

[0035] As used herein, unless otherwise specified the use of the ordinal adjectives "first," "second," and "third," etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner.

[0036] FIG. 2 is a system 220 for optimizing performance of a WiFi communication system 200 by a remote server 204, according to one embodiment of the invention. In one embodiment, the communication system 200 is similar to the communication system of FIG. 1, but is operable to communicate with the remote server 204 (interchangeably referred to as an optimization center). In one embodiment, the WiFi communication system 200 includes an Access Point (AP) 201 which comprises a processor 209, memory 210, and an adaptation algorithm 203 (which may be stored in the memory 210). In one embodiment, the AP 201 is operable to communicate with one or more stations 202.sub.1-N, where N is an integer equal to or greater than 1, by WiFi signals 211.sub.1-N. The term "adaptation algorithm" is interchangeably referred to as "algorithm."

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[0037] While 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. In the embodiments discussed herein the remote server 204 is not part of the communication system 200. In such an embodiment, the communication channel may be one of: the Internet, 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 Ethernet over Coax (DSL EOC) communications protocol; a cable control channel communications protocol; a powerline control channel communications protocol; a Command Line protocol (CLI); via a wireless device; or via a mobile device.

[0038] In one embodiment, the logic unit representing AP 201 and/or the stations 202.sub.1-N can be at least one of the following communication units: a base station; a wireless Local Area Network (LAN) device; a DSLAM; a gateway; a performance enhancement device; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home powerline device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi 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 Ethernet connected

router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0039] In one embodiment, 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. In one embodiment the remote server 204 is a cloud server. In one embodiment, the remote server 204 comprises a processor 206, which may be one or more processors, a memory 207 for storing processor executable instructions, and a database 205 to manage data related to the communication system 200.

[0040] In one embodiment, the remote server 204 performs a method for optimizing performance of one or more communication units including the AP 201 and the stations 202.sub.1-N. In one embodiment, the remote server 204 is operable to collect data from the one or more communication units (AP 201 and/or the stations 202.sub.1-N). In one embodiment, the remote server 204 periodically collects data from the one or more communication units. The term "periodically" herein refers to regular intervals e.g., once a day, morning and evening of every day, etc.

[0041] In one embodiment, the remote server 204 is operable to generate a policy, for each of the one or more communication units (AP 201 and/or the stations 202.sub.1-N) based on the collected data. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202.sub.1-N). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. Generally, an AP does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, an AP does not have access to historical data related to communication with other stations. Additionally, APs may lose data when there is

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power outage or user-initiated power cycling. The remove server 204 resolves the above problems and provides an optimum policy for the AP 201 to use based on analysis of large amount of operational data of the communication system 200 and other similarly situated communication systems.

[0042] Examples of similarly situated communication systems include communications systems having similar communication units. For example, an AP with same power, speed, and brand, and operating with similar (i.e., within 10%) number of stations. Similarly situated communication systems also include communications systems in different geographical areas.

[0043] In one embodiment, the remote server 204 transmits/sends the policy to each of the one or more communication units (AP 201 and/or the stations 202.sub.1-N) periodically. For example, the remote server 204 may transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202.sub.1-N) when the bandwidth usage of the AP 201 is low (e.g., the AP 201 is operating less than 50% of its capacity to serve communication units) so that it may implement the new policy sent by the remote server 204.

[0044] In one embodiment, the policy comprises rules and/or conditions for operation of the one or more communication units (AP 201 and/or the stations 202.sub.1-N). For example, the policy comprises first and second algorithms for adapting the AP 201 to improve its performance. In one embodiment, the one or more communication units (AP 201 and/or the stations 202.sub.1-N) implement the policy according to time-varying data. In one embodiment, the time-varying data comprises location information, current time, and operational data of the one or more communication units (AP 201 and/or the stations 202.sub.1-N). In one embodiment, the location information is determined from a Global Positioning System (GPS) device or setup. The embodiments herein are not limited to two algorithms, but any number of algorithms may be used.

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[0045] In one embodiment, the communication unit (AP 201 and/or the stations 202.sub.1-N) comprises a transmitter to send data to the remote server 204; a receiver to receive a policy from the remote server 204; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data. The communication units generally do not have the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc. Therefore, the prior art communication units cannot use such information for improving their performance. The transmitter discussed above provides data to a central location, i.e. the remote server 204, that has the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc, so that it may use such information generate rules and conditions for operating the communication units with enhanced performance. These rules and conditions were previously not conceivable by the communication system (e.g., communication system of FIG. 1) due to lack of information and processing power needed to generate the rules and conditions. The remote server 204, after computing the rules and conditions, provides the rules and conditions to the processors of the communication units, wherein the processors executes their respective policies by implementing one of first and second algorithms based on the rules and/or conditions and time-varying data.

[0046] In one embodiment, the one or more communication units (AP 201 and/or the stations 202.sub.1-N) are operable to receive the policy along with one of the first and second algorithms based on the conditions and/or the time-varying data, wherein the first and second algorithms did not exist in the one or more communication units (AP 201 and/or the stations 202.sub.1-N) prior to being provided by the remove server 204. In such an embodiment, the

remote server 204 installs a new algorithm 203 in the AP 201, where the new algorithm is executed by the processor 209 of the AP 201.

[0047] In one embodiment, the one or more communication units (AP 201 and/or the stations 202.sub.1-N) are operable to receive the policy and implement one of first and second algorithms based on the rule and/or conditions and/or the time-varying data, wherein the first and second algorithms previously existed in the one or more communication units (AP 201 and/or the stations 202.sub.1-N). In such an embodiment, the remote server provides recommendations to the communication units (AP 201 and/or the stations 202.sub.1-N) to use either the first or second algorithm so the communication system 200 may improve its performance.

[0048] The conditions may include at least one of: choice of selecting one of the first or second algorithms based on current SNIR (Signal to Noise and Interference Ratio); choice of selecting one of the first or second algorithms based on current time; choice of selecting one of the first or second algorithms based on operational data of the one or more communication units; and choice of selecting one of the first or second algorithms based on location information. In other embodiments, other conditions may be used in conjunction or absence to the above listed conditions. The rules may include equations, when executed in the algorithms, will change how the conditions are evaluated by the algorithms.

[0049] In one embodiment, the remote server 204 generates the policy by performing analysis on the collected data, wherein the collected data comprises operational information and historical data about each of the one or more communication units. In one embodiment, the remote server 204 applies the analysis to generate conditions for when to implement one of the first and second algorithms. In one embodiment, the remote server 204 generates the policy by generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units (AP 201 and/or the stations 202.sub.1-N).

[0050] In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a data rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a data rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0051] The following is an exemplary embodiment showing the process of determining an optimum algorithm by the remote server 204. In one embodiment, the remote server 204 selects one of the first or second algorithms for the communication units (AP 201 and/or the stations 202.sub.1-N) to achieve optimal performance efficiency for the communication system 200. In one embodiment, first algorithm determines data transmission rates for the communication units based on RSSI while the second algorithm determines data transmission rates based on a number of consecutive successful transmissions and on a number of consecutive failed transmissions. As mentioned above, in one embodiment, the communication units (AP 201 and/or the stations 202.sub.1-N) have the first and second algorithms previously stored, but do not know which algorithm is more efficiency for the communication system 200. In such an embodiment, the remote server 204 provides recommendations to the communication units about which algorithm to use.

[0052] In one embodiment, in the first algorithm the communication units (AP 201 and/or the stations 202.sub.1-N) monitor the RSSI in real-time and adapts their transmission rates according to the instantaneous RSSI value using a mapping table (Table 1) as shown below.

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TABLE-US-00001 TABLE 1 RSSI to rate mapping for first algorithm RSSI value Rate -92 dBm or below 6 Mbps -92 dBm~-90 dBm 9 Mbps -90 dBm~-88 dBm 12 Mbps -88 dBm~-86 dBm 18 Mbps -86 dBm~-84 dBm 24 Mbps -84 dBm~-82 dBm 36 Mbps -82 dBm~-80 dBm 48 Mbps -80 dBm or above 54 Mbps

[0053] Table 1 is only shown as an example and a person skilled in the art would realize that the communication units may use different rates for different RSSI values other than the ones shown above.

[0054] In one embodiment, the second algorithm for the communication units (AP 201 and/or the stations 202.sub.1-N) uses a higher data rate after K (e.g., 10) consecutive successful transmissions, and uses a lower data rate after M (e.g., 2) consecutive failed transmissions. In one embodiment, the communication units (AP 201 and/or the stations 202.sub.1-N) provide to the remove server 204 operational data including RSSI, SNR, rate used for transmitting a packet, corresponding result on successful packet delivery, and other relevant data collected in real-time. In one embodiment, communication units (AP 201 and/or the stations 202.sub.1-N) may accumulate such data within the communication units (AP 201 and/or the stations 202.sub.1-N) and then send the accumulated data to the remote server 204. In one embodiment, the data transmitted to the remote server 204 is non-real-time data because it is sent after some time (e.g., end of the day).

[0055] In one embodiment, the remote server 204 stores such data in its database 205 and performs a full analysis based on all the stored data and any other knowledge available at the remote server 204. In one embodiment, the other knowledge includes similar statistics, as those provided by the communication units (AP 201 and/or the stations 202.sub.1-N) to the remote server 204, from other similar communication units in other similar geographical localities.

[0056] In one embodiment, the remote server 204 determines the presence of intermittent high-power interference from other near-by WiFi systems. When other WiFis' high-power packets collide with the communication system 200's packet, the packet is lost regardless of the rate selection. In one embodiment, the remote server 204 determines that other noise or interference is never observed for the communication system 200, and concludes that it is best to adapt rates for the communication units (AP 201 and/or the stations 202.sub.1-N) as a function of channel strength, or RSSI, only. In such an embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations 202.sub.1-N) asking the communication units (AP 201 and/or the stations 202.sub.1-N) to use the first algorithm all the time instead of the second algorithm.

[0057] In one embodiment, the remote server 204 determines that there is no high-power WiFi interference at all, but channel changes faster than typical static indoor wireless channel (possibly due to people moving around the AP 201). For example, the channel variation tends to be faster between noon and midnight. In such an embodiment, the remote server 204 concludes that it is best to use the second algorithm instead of the first algorithm by the communication units (AP 201 and/or the stations 202.sub.1-N). In one embodiment, the remote server 204 may determine optimum values for K and M to be used by the communication units (AP 201 and/or the stations 202.sub.1-N) in different times of the day. For example, K=10 and M=1 between noon and midnight; and K=20 and M=2 between midnight and noon.

[0058] In one embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations 202.sub.1-N) asking communication units (AP 201 and/or the stations 202.sub.1-N) to use the second algorithm with the optimized K and M values depending on time in the day. In case the WiFi communication system 200 is not capable

of changing the values of K and M as a function of time, the remote server 204 can send two control signals per day, one at noon and another at midnight.

[0059] In one embodiment, when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (AP 201 and/or the stations 202.sub.1-N). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 210 of the AP 201. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 209 of the AP 201. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units (AP 201 and/or the stations 202.sub.1-N) of the communication system 200.

[0060] FIG. 3 is a system 320 for optimizing performance of a Digital Subscriber Line (DSL) communication system 300 by the remote server 204, according to one embodiment of the invention. The embodiment of FIG. 3 is similar to the embodiment of FIG. 2 in concept, but applicable for DSL systems. The embodiments of the invention are not limited to DSL or WiFi communication systems, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect communication performance.

[0061] In one embodiment, the DSL communication system 320 comprises a Digital Subscriber Line Access Multiplexer (DSLAM) 301 that connects to one or more Customer Premises Equipment (CPEs) 302.sub.1-N by means of DSL signals 304.sub.1-N, where N is an

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integer equal to or greater than 1. In one embodiment, the remote server 204 performs a method for optimizing performance of the one or more communication units including the DSLAM 301 and the CPEs 302.sub.1-N. In one embodiment, the remote server 204 is operable to collect operational data from the one or more communication units (DSLAM 301 and/or the CPE 302.sub.1-N). In one embodiment, the remote server 204 periodically collects operational data from the one or more communication units.

[0062] In one embodiment, the operational data collected by the remote server 204 includes at least one of: band preference indication; margin cap mode indication; indication that margin per tone should be kept smaller than the maximum SNR (Signal to Noise Ratio) margin; service priorities pertaining to net data rate; service priorities pertaining to excess margin; service priorities pertaining to excess margin per tone; service priorities pertaining to delay; service priorities pertaining to impulse noise protection; indication of loading algorithms used with a first DSL system; indication of power allocation algorithms used with the first DSL system; maximum attainable data rate; current data rate; margin; channel attenuation per tone; average attenuation; quiet line noise per tone; active line noise per tone; SNR per tone; transmitted PSD per tone; downstream power back-off shaped parameters (DPBOSHAPED); upstream power back-off shaped parameters (UPBOSHAPED); echo response; band preference; margin cap mode; Forward Error Correction (FEC) count; code violation count; errored seconds; severely errored seconds; number of retraining count; current delay; error distributions; current impulse noise protection; or FEC and interleaving parameters. The above listed operational data is not an exclusive list. More operational data may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0063] In one embodiment, the remote server 204 collects configuration parameters associated with the one or more communication units. The configuration parameters include at

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least one of: maximum nominal power spectral density (MAXNOMPSD); maximum nominal aggregate transmit power (MAXNOMATP); power cutback (PCB); DPBOSHAPED; UPBOSHAPED; fine gains; gi; transmit spectral scaling factors; tssi; power spectral density mask (PSDMASK); power spectral density level; maximum received power (MAXRXPWR); upstream power "back-off" parameters (UPBOKLE); margin cap mode; carrier mask (CARMASK); minimum impulse noise protection (MININP); maximum delay (MAXDELAY); target margin (TARSNRM); minimum SNR margin (MINSNRM); maximum SNR margin (MAXSNRM); band preference indication (PREFBAND); target data rate; minimum data rate; maximum data rate; FEC and interleaving parameters; per tone bit cap (BCAP[n]); per tone target margin (TARSNRM[n]); reference noise (REFNOISE). The above listed configuration parameters is not an exclusive list. More configuration parameters may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0064] As discussed with reference to FIG. 2, the remote server 204 of FIG. 3 is operable to generate a policy, for each of the one or more communication units (DSLAM 301 and/or the stations 302.sub.1-N), based on the collected operational data, according to one embodiment. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (DSLAM 301 and/or the CPE 302.sub.1-N). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. The DSLAM 301 does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, DSLAM 301 does not have access to historical data related to communication with other CPEs connected to other DSLAMs. Additionally, DSLAM 301 may loose data when there is power outage or user-initiated power cycling. The remote server 204 resolves the above problems and provides an optimum policy for the DSLAM 301 to use based

on analysis of large amount of operational data of the communication system 300 and other similarly situated communication systems. The optimum policy can be determined based on expert knowledge outside of the communication system where the expert knowledge can be obtained from lab testing, simulation or any other research methods. The policy can be adaptively modified even after the full deployment of the communication system, and hence does not suffer from limited knowledge that is used at the time of manufacturing the communication system. In the embodiments discussed herein the remote server 204 is not part of the communication system 300.

[0065] In one embodiment, when the DSL communication system 300 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (DSLAM 301 and/or the CPEs 302.sub.1-N). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 310 of the DSLAM 301. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 309 of the DSLAM 301. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication units to use one or more of them by sending a proper pseudo-code to the communication units (DSLAM 301 and/or the CPEs 302.sub.1-N) of the communication system 300.

[0066] Following is an exemplary embodiment of how the remote server 204 can improve the performance of a DSL system. In DSL systems, for example the system 300, downstream (DS) margin is an important line performance metric that can be monitored by CPEs 302.sub.1-N in real-time. In general, a higher margin indicates an exponentially smaller chance

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of errors for the delivery of video or data packets over DSL links 304.sub.1-N. When the margin becomes very small, typically below 0 dB, the link will experience errors that can cause serious impacts on packet delivery to the CPEs 302.sub.1-N. To prevent continuation of such an unreliable link quality over a long time, CPEs 302.sub.1-N can initiate a retraining procedure and improve the operation conditions. The retraining procedure may take 20 to 60 seconds. In one embodiment, the above feature of DSL systems is implemented by CPEs 302.sub.1-N monitoring DS margins and initializing a retraining process when the margin becomes below a pre-configured threshold value `T.` Conventionally, `T` is set to 0 dB and controlled via the DSL line's profile.

[0067] The remote server 204 may collect operational and performance data of the DSL system 300, analyze the historical data (operational and performance data) associated with the DSL system 300, and determine the best estimated value of `T` for each line and applies the value to each line.

[0068] The term "line" herein refers to a communication link (wired or wireless) between the DSLAM 301 and the corresponding CPE. The value of `T` may be analyzed per-line basis by the remote server 204. Different values of `T` can be applied by the remote server 204 to different DSL lines depending on their historical and environmental characteristics.

[0069] Each CPE among the CPEs 302.sub.1-N applies an algorithm to tune its performance. For example, the CPE applies a rule and/or condition to adapt the value of `T` in real-time as a function of the real-time data (operational and performance) that is available in the corresponding CPE. The CPEs 302.sub.1-N are operable to apply the following rules and conditions. If video traffic is observed by the CPE over the line for more than t.sub.1 (e.g., 1 minute), then the CPE updates the value of `T` to `T.sub.1` (e.g., 2 dB). Such a rule allows the CPE to react fast on pixelization problems associated with video traffic. In this example, the

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conditions are the choice of `t.sub.1` and `T.sub.1`, while the rule is the "if, then" equation. Typically each retraining process of the CPE causes discontinuation/interruption of video and data services for a short time (e.g., 10-45 seconds), but such an interruption can be preferable to a persistent pixelization problem of the video traffic for several minutes or more. If no video traffic is observed by the CPE for more than `t.sub.2` (e.g., 10 minutes) then the CPE updates the value of `T` to `T.sub.2` (e.g., 0 dB). In this example, the conditions are the choice of `t.sub.2` and `T.sub.2,` while the rule is the "if, then" equation. This rule allows the CPE to reduce the chance of initiating a retraining process that can interrupt data traffic. Data service is more resilient to errors compared to video traffic, and the errors that can happen for a small margin (e.g., 0-2 dB) are likely tolerable for data traffic.

[0070] The above example of the rule and/or condition involves real-time monitoring of the data of the DSL system 300 and real-time adaptation algorithm within the DSL system 300. In some embodiments, the data of the DSL system 300 may not be entirely in real-time but the data update may be frequent enough (e.g., 5 minutes) to behave like real-time data.

[0071] In one embodiment, the threshold values `t.sub.1,` `t.sub.2,` `T.sub.1` and `T.sub.2` used by the rules/conditions discussed above are not statically kept in the DSL system 300, but optimized by the remote server 204. In one embodiment, the CPE continues to keep its rule/condition, but the parameters of the rules, i.e. the threshold values (conditions) `t.sub.1,` `t.sub.2,` `T.sub.1` and `T.sub.2,` are updated in the CPEs 302.sub.1-N by the remote server 204. In such an embodiment, the remote server 204 collects and analyzes historical operational data and any side information (e.g., data from other similarly situated DSL systems) that is available at the remote server 204.

[0072] Continuing with the exemplary embodiment discussed above, the remote server 204 will choose `T.sub.1`=0 dB for a DSL line if pixelization has hardly happened even for

margins between 0 and 2 dB in the historical operational data, but will choose `T.sub.1`=4 dB if pixelization always occurred and continued for several minutes for margins between 0 and 4 B. Such long-term adaptation of the rules by remote server 204 allows the DSL system 300 to perform at its optimum ability under all circumstances. In one embodiment, the switching of modes discussed above happens in real-time or very frequently, but the update of threshold values or rules to be used by the CPEs 302.sub.1-N happens at a much lower frequency. In one embodiment, the remote server transmits the updated policy (with new threshold values) to the DSL system 300 a once per day.

[0073] While the embodiments of FIG. 3 are discussed in terms of margin and video traffic in the DSL system 300, the embodiments can be applied to any DSL or other communication system adaptation algorithm that reacts in real-time to other data parameters without changing the essence of the embodiments of the invention.

[0074] FIG. 4 is a method 400 performed by a remote server for optimizing performance of a communication system, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to FIG. 4 are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of FIG. 4 is illustrated with reference to the embodiments of FIGS. 2-3.

[0075] At block 401, the remote server 204 collects data (operational and/or performance data) from the one or more communication units. As discussed above, the communication units in FIG. 2 are AP 201 and/or the stations 202.sub.1-N while communication units in FIG. 3 are DSLAM 301 and/or the CPE 302.sub.1-N. In one embodiment, the communication units are at least one of a base station; a wireless LAN device; a DSLAM; a gateway; a performance enhancement device; a DSL CPE modem; an in-home powerline device; a HPNA based device;

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an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a STB/STU customer electronics device; an 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 Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0076] At block 402, the remote server 204 generates a policy, for each of the one or more communication units based on the collected data. As discussed above, the policy with reference to FIG. 2 comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0077] With reference to FIG. 3, the policy may comprise rules and conditions such as the threshold values `t.sub.1,` `t.sub.2,` `T.sub.1` and `T.sub.2` for the DSL system 300 and

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equations that use these threshold values. Other policies may be used for the above systems of FIGS. 2-3 and for other systems.

[0078] At block 403, the remote server 204 sends the policy to each of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data (data collected by the communication units of the communication systems).

[0079] FIG. 5 is a method 500 performed by a communication system for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to FIG. 5 are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of FIG. 5 is illustrated with reference to the embodiments of FIGS. 2-3. So as to avoid repetitiveness, only the processes performed by the communication units are discussed.

[0080] At block 501, the one or more communication units send data to the remote server 204. The data may be operational data, performance data, or any other time-varying data. At block 502, the one or more communication units receive a policy generated by the remove server 204, wherein the policy comprises rules and/or conditions for operation of the one or more communication units. At block 503, the one or more communication units execute the policy sent by the remote server 204 to implement an algorithm based on the rules and/or conditions and time-varying data. As discussed above, the policy with reference to FIG. 2 comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the

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one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms. With reference to FIG. 3, the policy may comprise rules and conditions such as the threshold values t.sub.1, t.sub.2, T.sub.1 and T.sub.2 for the DSL system 300. Other policies may be used for the above systems of FIGS. 2-3 and for other systems.

[0081] FIG. 6 is a processor-based system 600 having machine-readable storage medium with computer executable instructions 604 for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Machine-readable storage medium is one of 207, 210, or 310 (collectively referred to as "207/201/310"). The computer/machine-readable/executable instructions are executed by a processor (e.g., processor 206 of the remote server, or processors 209 and 309 of the AP 201 or DSLAM 301 respectively). Elements of embodiments are also provided as a machine-readable medium for storing the computer-executable instructions (e.g., instructions to implement the flowcharts of FIGS. 4-5 and other processes discussed in the description).

[0082] In one embodiment, the processor-based system 600 further comprises a database 601 to store data used by the instructions 604. In one embodiment, the processor-based system includes a network interface 602 to communicate with other devices. In one embodiment, the components of the processor-based system 600 communicate with one another via a network bus 603.

[0083] The machine-readable storage medium 207/210/310 may include, but is not limited to, flash memory, optical disks, hard disk drive (HDD), Solid State Drive (SSD), CD-

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Read Only Memory (CD-ROMs), DVD ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or other type of machine-readable media suitable for storing electronic or computer-executable instructions. For example, embodiments of the invention may be downloaded as a computer program (e.g., BIOS) which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals via a communication link (e.g., a modem or network connection).

[0084] Reference in the specification to "an embodiment," "one embodiment," "some embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments. The various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments. If the specification states a component, feature, structure, or characteristic "may," "might," or "could" be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the elements. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

[0085] While the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the foregoing description.

[0086] For example, the embodiments discussed above can apply to a communication system comprising a performance enhancement device. A performance enhancement device may comprise a signal conditioning device, a diagnostic and remedy guidance device, or a noise cancellation device. A noise cancellation device, among other things, acts to cancel noise and

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interference present on the DSL line, either autonomously or in conjunction with commands from the remote server. In one embodiment, the performance enhancement device is communicatively coupled to the remote server 204 via the Communication Channel 208. In such an embodiment, impulse noise cancellation feature of the performance enhancement device may be turned on and off based on the real-time observation of noise, and the actual algorithm for deciding on-off can be distributed where long-term thresholds/rules and conditions are calculated by the remote server 204 and transmitted to the performance enhancement device. In one embodiment, the remote server 204 forces the actual transition in the performance enhancement device as a function of real-time observation of the noise data.

[0087] Another alternative embodiment related to a WiFi system is described as follows. In a typical WiFi communication system, Carrier Sense Multiple Access (CSMA) protocol is used for multiple access. Due to the nature of wireless channel, some of the stations (clients) might not be able to hear each other while both can reach the AP with strong power. This phenomenon is known as Hidden Node problem. One way to resolve this problem is to schedule the data transmission using Request to Send (RTS) and Clear to Send (CTS) mechanisms. Such a use of RTS/CTS incurs overhead in channel usage, but prevents disastrous packet collisions by the two stations.

[0088] In one embodiment, the remote server 204 collects operational and performance data of the WiFi AP 201 (and other APs) and/or stations 202.sub.1-N. In one embodiment, the remote server 204 analyzes the historical data and determines the best value for each AP (on or off) and applies the value to each AP. In one embodiment, the value is analyzed per-AP by the remote server 204, and therefore different values can be applied to different APs depending on their data characteristics.

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[0089] In one embodiment, each AP is operable to apply a rule with conditions to adapt RTS/CTS on/off in real-time as a function of real-time data available to the local AP. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is detected for more than t.sub.1 (e.g., 1 minute), the AP turns on RTS/CTS. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is not detected for more than t.sub.2 (e.g., 10 minutes), then the AP turns off RTS/CTS.

[0090] In the above embodiment, two or more operation modes are described in context of a local communication device (e.g., AP) selecting the operation mode to use in real-time. In one embodiment, the selection of the operation mode is a function of the real-time data that is locally available. In other embodiments, the data might not be in real-time but the data update may be frequent enough for this idea to consider the data as real-time.

[0091] In one embodiment, the rules and/or conditions e.g., the threshold values `t.sub.1`, and `t.sub.2,` and equations applying them, are not statically kept as in AP, but optimized by the remote server 204. In one embodiment, the threshold values `t.sub.1`, and `t.sub.2,` and/or the equations are updated by the remote server 204 using historical data and any side information that is available at the remote server side. In the above alternative embodiment, RTS/CTS was involved, however, the essence of the embodiments can be applied to any WiFi adaptation algorithm that reacts in real-time to other data parameters. WiFi adaptation algorithms include control of fragmentation, channels, association, etc.

[0092] The embodiments of the invention are intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0093] An abstract is provided that will allow the reader to ascertain the nature and gist of the technical disclosure. The abstract is submitted with the understanding that it will not be

used to limit the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wongjong 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:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	3	100	300
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2120**

Electronic Acknowledgement Receipt

EFS ID:	41204770
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:	Wongjong Rhee
Customer Number:	146571
Filer:	Michael V. North/Domarina Alkhas
Filer Authorized By:	Michael V. North
Attorney Docket Number:	20145-054USC
Receipt Date:	23-NOV-2020
Filing Date:	
Time Stamp:	18:16:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2120
RAM confirmation Number	E2020AMI17226979
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	Application Data Sheet	054USC_ADS.pdf	1256088 f65ac093ab127326d81e149dd047c45d2a42abe7	no	8
Warnings:					
Information:					
2	Power of Attorney	054USC_POA.pdf	1214272 27ffa003b03af7d0b370c29d23cc2702ccaec4e0	no	2
Warnings:					
Information:					
3	Oath or Declaration filed	054USC_Decl.pdf	125109 76cea124a12fb1c8416ae73e92901f734f017a63	no	1
Warnings:					
Information:					
4	Drawings-only black and white line drawings	054USC_Figs.pdf	36421 a36be0b1596ce22b0f14582b4f02057887ac5602	no	6
Warnings:					
Information:					
5		054USC_PatApp.pdf	178844 695e51998f21697765c5553e8db814abc8b66ef9	yes	38

Multipart Description/PDF files in .zip description

Document Description	Start	End
Abstract	38	38
Claims	34	37
Specification	1	33

Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	36875 373f38fdb0a55e1556fa1fa0a5e7de3cfd2b2f73	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2847609		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Wonjong		Rhee	

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

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San Francisco	CA	94158	US

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

Correspondence Information:

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

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

Customer Number	146571		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Attorney Docket Number	20145-054USC	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	Suggested Figure for Publication (if any)	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	146571		

Domestic Benefit/National Stage Information:

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

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	14356581	2014-05-06

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Prior Application Status: Patented — Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14356581	a 371 of international	PCTUS2011060265	2011-11-10	10848398	2020-11-24

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. — Add

Foreign Priority Information:

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

Remove

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

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

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

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

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Applicant Information:

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

Applicant 1 — Remove

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	ASSIA SPE, LLC		
Mailing Address Information For Applicant:			
Address 1	1209 Orange St.		
Address 2			
City	Wilmington	**State/Province**	DE
Country	US	Postal Code	19801
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

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

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Approved for use through 11/30/2020. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
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Assignee 1

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

Remove

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

Organization Name	ASSIA SPE, LLC

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	1209 Orange St.		
Address 2			
City	Wilmington	**State/Province**	DE
Country i	US	Postal Code	19801
Phone Number		Fax Number	
Email Address			

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

Signature:

Remove

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

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

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

Signature	/Michael North/			Date (YYYY-MM-DD)	2020-11-23
First Name	/Michael	Last Name	North	Registration Number	46963

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20145-054USC
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

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

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

Charter Communications, Inc.
Exhibit 1006
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