UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	10/31/2017	9806892	009065-8132.US01	2029

97075 7590 10/11/2017

Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

The Patent Term Adjustment is 25 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

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

Denis Andreyevich Khotimsky, Westborough, MA;
ZTE Corporation, Shenzhen, CHINA
LiQuan Yuan, Shanghai, CHINA;
ZTE (USA) Inc., Austin, TX
DeZhi Zhang, Shanghai, CHINA;

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

Nokia of America Corporation *et al.*
Exhibit 1002
IPR2024-00899, USPN 9,806,892
1 of 362

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 | Confirmation No.: 2029

Filed: January 13, 2015 | Examiner: Jacob, Oommen

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS | Art Unit: 2637

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

RESPONSE TO NOTICE OF ALLOWANCE

In response to the Notice of Allowance mailed June 27, 2017, enclosed is a completed Issue Fee Transmittal Form PTOL-85b.

Comments on Examiner's Reasons for Allowance

It is recognized that in accordance with M.P.E.P. § 1302.14, the Examiner's reasons for allowance need not set forth all of the details as to why the claims are allowed. In the above-referenced application, it is not conceded that the Examiner's implied reasons for allowance are the only reasons for which the claims are allowable. Moreover, the Examiner does not assert, and it would not be conceded, that the Examiner's reasons have any bearing on the patentability of claims in any other applications directed to the disclosed subject matter.

In addition, each dependent claim stands on its own and may be allowable on its own merits. In particular, each dependent claim may be allowable on the basis of a combination of some of the features recited in the dependent claim and its base claim(s), which combination of features may not include all of the limitations identified in the Examiner's reasons for allowance.

The required fee is being paid by credit card. Please apply any additional charges or credits to Deposit Account No. 50-0665.

Respectfully submitted,

Date: September 25, 2017

/Vinay Sathe/
Vinay Sathe
Reg. No. 55,595

Perkins Coie LLP
P.O. Box 1247
Seattle, Washington 98111-1247
Telephone: (858) 720-5700
Facsimile: (206) 359-7198

PART B - FEE(S) TRANSMITTAL

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

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

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

97075 7590 06/27/2017

Perkins Coie LLP - SDO General
P.O. Box 1247
Seattle, Washington 98111-1247

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

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

TITLE OF INVENTION: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960.00	$0.00	$0.00	$960.00	09/27/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
JACOB, OOMMEN	2637	398-058000

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

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

1 Perkins Coie LLP
2
3

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

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

(A) NAME OF ASSIGNEE: ZTE Corporation; ZTE (USA) Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Shenzhen, P.R. China; Richardson, Texas

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

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

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- [ ] A check is enclosed.
- [X] Payment by credit card. Form PTO-2038 is attached.
- [X] The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 50-0665 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- [ ] Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- [ ] Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- [ ] Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature /Vinay Sathe/ Date September 25, 2017

Typed or printed name Vinay Sathe Registration No. 55,595

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

137059899.1

Electronic Patent Application Fee Transmittal

Application Number:	14414698
Filing Date:	13-Jan-2015
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Attorney Docket Number:	009065-8132.US01

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt	
EFS ID:	30467122
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	25-SEP-2017
Filing Date:	13-JAN-2015
Time Stamp:	17:45:37
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$960
RAM confirmation Number	092617INTEFSW17462300
Deposit Account	500665
Authorized User	Jennifer Payne
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)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	2017-09-25_IssueFee.pdf	213730 962a276da16301cac82e06806ca602d32b1edaec	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30910 0af1d3a6b7e68c173cdf0d71e28557ff1bfa80e3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	244640		

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

97075 7590 06/27/2017

Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	
ART UNIT	PAPER NUMBER
2637	

DATE MAILED: 06/27/2017

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

TITLE OF INVENTION: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	09/27/2017

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

97075 7590 06/27/2017
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

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

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

TITLE OF INVENTION: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	09/27/2017

EXAMINER	ART UNIT	CLASS-SUBCLASS
JACOB, OOMMEN	2637	398-058000

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

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

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

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

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

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

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

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Exhibit 1002
IPR2024-00899, USPN 9,806,892
10 of 362

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

97075 7590 06/27/2017

Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	
ART UNIT	PAPER NUMBER
2637	

DATE MAILED: 06/27/2017

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

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

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

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

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

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

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Notice of Allowability	Application No. 14/414,698	Applicant(s) KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	AIA (First Inventor to File) Status No

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

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

1. ☒ This communication is responsive to *04/07/2017*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1,2,4-8 and 10-17*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☒ All b) ☐ Some *c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

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

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/OOMMEN JACOB/
Primary Examiner, Art Unit 2637

Exhibit 1002
IPR2024-00899, USPN 9,806,892
13 of 362

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	**Art Unit**
	OOMMEN JACOB	2637

CPC							
Symbol						**Type**	**Version**
H04L		12	/	12		F	2013-01-01
H04B		10	/	272		I	2013-01-01
H04B		10	/	27		I	2013-01-01
H04Q		11	/	0067		I	2013-01-01
H04Q		2011	/	0079		A	2013-01-01
			/				
			/				
			/				
			/				
			/				
			/				
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			/				
			/				
			/				

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/OOMMEN JACOB/ Primary Examiner.Art Unit 2637	06/20/2017	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	**Art Unit**
	OOMMEN JACOB	2637

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
398	58	H	0	4	J	14 / 00 (2006.0)						
CROSS REFERENCE(S)		H	0	4	J	14 / 02 (2006.0)						
		H	0	4	B	10 / 08						

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
398	66	43	30	25	67

NONE (Assistant Examiner) (Date)	Total Claims Allowed: 15	
/OOMMEN JACOB/ Primary Examiner.Art Unit 2637 06/20/2017 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 5

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	**Art Unit**
	OOMMEN JACOB	2637

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

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

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 15	
/OOMMEN JACOB/ Primary Examiner.Art Unit 2637 06/20/2017 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 5

Exhibit 1002
IPR2024-00899, USPN 9,806,892
16 of 362

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BIB DATA SHEET

CONFIRMATION NO. 2029

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/414,698	01/13/2015 RULE	398	2637	009065-8132.US01

APPLICANTS
ZTE Corporation, Shenzhen, CHINA
ZTE (USA) Inc., Austin, TX

INVENTORS
Denis Andreyevich Khotimsky, Westborough, MA;
LiQuan Yuan, Shanghai, CHINA;
DeZhi Zhang, Shanghai, CHINA;

**** CONTINUING DATA ***************************
This application is a 371 of PCT/US2013/050533 07/15/2013

**** FOREIGN APPLICATIONS **************************
CHINA PCT/CN2012/078649 07/13/2012

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
04/18/2015

Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /OOMMEN JACOB/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		MA	16	17	5

ADDRESS
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247
UNITED STATES

TITLE
OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
2460	No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

BIB (Rev. 05/07).

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

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

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

CLAIM		DATE								
Final	Original	04/02/2016	09/15/2016	01/04/2017	06/20/2017					
	1	✓	✓	✓	=					
	2	✓	✓	✓	=					
	3	✓	✓	✓	-					
	4	✓	✓	✓	=					
	5	✓	✓	✓	=					
	6	✓	✓	✓	=					
	7	✓	✓	✓	=					
	8	✓	✓	✓	=					
	9	✓	✓	✓	-					
	10	✓	✓	✓	=					
	11	✓	✓	✓	=					
	12	✓	✓	✓	=					
	13	✓	✓	✓	=					
	14	✓	✓	✓	=					
	15	✓	✓	✓	=					
	16	✓	✓	✓	=					
	17	✓	✓	✓	=					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S108	16	alive with periodic$5 same OLT	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S109	68	((KHOTIMSKY near2 DENIS)(yuan near2 Liquan)(zhang near2 dezhi)).inv.	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S110	149	(ONU and OLT and (OFF sleep)).clm.	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S111	8	S109 and S110	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S112	2241	a105	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S113	36	alive same OLT	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S114	36	S113	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S115	7	alive same sleep same ONU	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S116	7	S115	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S117	194	listen with asleep	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S118	1103	398/58.ccls.	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S119	886	398/66.ccls.	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35
S120	736	398/43.ccls.	US-PGPUB; USPAT	OR	ON	2017/06/20 16:35

6/20/2017 4:44:57 PM
C:\Users\ojacob\Documents\EAST\Workspaces\14414698.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

CPC- SEARCHED		
Symbol	Date	Examiner
h04l12/12; h04b10/27	4/2/2016	OJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	66,43,58	4/2/2016	OJ

SEARCH NOTES		
Search Notes	Date	Examiner
east	4/2/2016	OJ
inventor name	4/2/2016	OJ
npl	9/15/2016	OJ
east	1/4/2017	OJ
east	6/20/2017	OJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
398	58,66,43	6/20/2017	OJ

	/OOMMEN JACOB/ Primary Examiner.Art Unit 2637

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 14/414,698	Filing Date 01/13/2015	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT 04/07/2017

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 15	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

LIE
SHAREILL COLES

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 Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 | Confirmation No.: 2029

Filed: January 13, 2015 | Examiner: Jacob, Oommen

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS | Art Unit: 2637

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

AMENDMENT IN RESPONSE TO NON-FINAL OFFICE ACTION

In response to the Office Action dated January 9, 2017, please amend the above-identified U.S. patent application as follows:

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

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

Electronic Acknowledgement Receipt

EFS ID:	28871364
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	07-APR-2017
Filing Date:	13-JAN-2015
Time Stamp:	19:52:07
Application Type:	U.S. National Stage under 35 USC 371

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		2017-04-07_ReplyOA.pdf	194968 3bd2be0443ed4acab51970d7684d7db2c27efa7c	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	7	11
	Claims	2	6
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	194968	

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

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

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

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

REMARKS

Claims 1, 6, 7, 12, and 16 have been amended. None of the previously presented claims have been cancelled. Claims 1, 2, 4-8, 10-17 remain pending.

Reconsideration and allowance of the application are respectfully requested.

Examiner Interview

The Applicant thanks Examiner Jacob for taking the time on March 28, 2017, to discuss over the phone the certain features of the present application as distinguished from the cited art. The Examiner agreed that Pfeiffer fails to teach or suggest the amended features of independent claims 1, 7, 12, and 16. The Applicant has amended claims consistent with the Applicant's discussion with the Examiner to advance prosecution of this case.

Claim Amendments

While respectfully disagreeing with the present rejections under 35 U.S.C. § 103, Independent Claims 1, 7, 12, and 16 have been amended to obviate the rejections for prosecution efficiency to put the application in condition for allowance. Specifically, Independent Claim 1 has been amended to recite in part "transitioning the ONU directly from the first state to the second state and transitioning the ONU directly from the second state to the first state, based on a power management rule." The support for these amendments is found in figures 5, 6, 7A and associated text of the instant application.

Claim 6 has been amended to correctly further define Independent Claim 1.

A. Rejection of Claims 1-2, 4-8, 10-13, 16-17 under 35 U.S.C. § 103

Claims 1-2, 4-8, 10-13, 16-17 are rejected under pre-AIA 35 U.S.C. 103(a) as allegedly being unpatentable over Skubic (US Publication No. 2012/0166819) in view of Pfeiffer (US Publication No. 2009/0201840) and further in view of ITU (ITU-T G.987.3 10/2010).

The Applicant respectfully disagrees with the Office's rejection for at least the reasons mentioned below.

i. Skubic in view of Pfeiffer and ITU does not teach or suggest at least the features associated with transitioning the ONU as recited in amended Independent Claims 1, 7, 12, and 16.

First, Pfeiffer fails to teach the following amended claim features of Independent Claim 1: "transitioning the ONU directly from the first state to the second state and transitioning the ONU directly from the second state to the first state." The Office rejected the previously presented Independent Claim 1 and alleged that "Pfeiffer Fig. 9, directly transitioning from 345 to 320 are based on the states." *See* Non-Final Office Action, p. 4 (Jan. 9, 2017). But, Pfeiffer nowhere teaches that the end node enters a listen state 345 ***directly*** from the sleep state 320. As shown in Figure 9 (reproduced below), Pfeiffer explicitly teaches that "[a]fter the sleep interval expires, the end node 30 re-enters the linked state 315." *See* Pfeiffer at [0044]. Further, the arrow between the listen state 345 and sleep state 320 is ***one-directional***, meaning that Pfeiffer teaches that the end node can enter sleep state directly from the listen state, but it ***cannot*** enter the listen state directly from the sleep state.

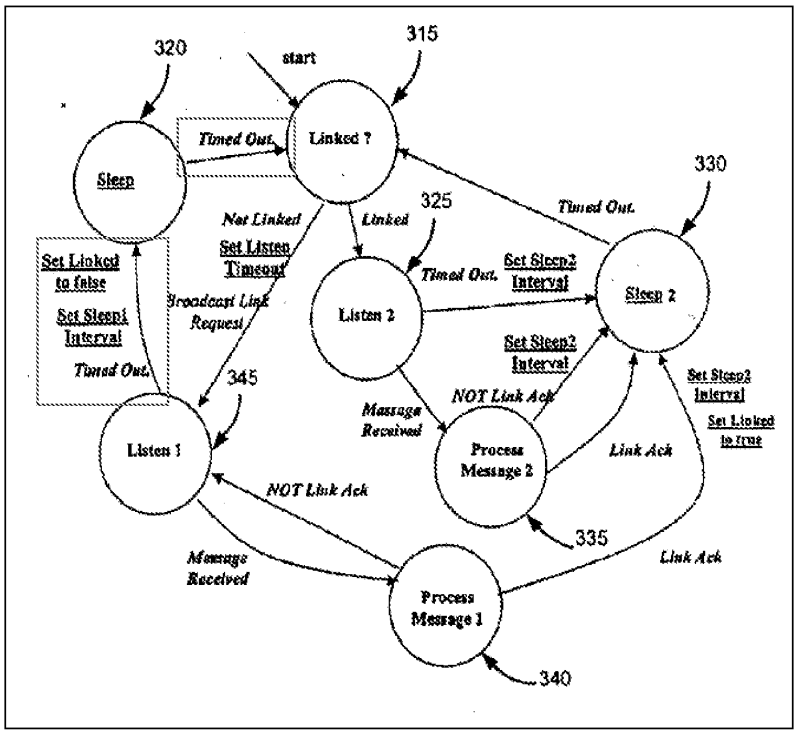


Figure 9 (annotated) from Pfeiffer

Second, both Skubic and ITU fails to teach the amended features of Independent Claim 1. In fact, the instant application explicitly distinguishes the amended claimed features from Skubic's state diagram as shown in Figure 2, and from the technology described in the ITU document. For instance, Figure 7A of the instant application is the same as Figure 2 of Skubic. The instant application describes Figure 7A as a "prior art state machine for ONU power management" with "no direct transition between the Doze Aware and the Sleep Aware states 704, 706." *See* Present Application at [0019], [0036]; *compare* Present Application at Figure 7A, *with* Skubic at Figure 2. Furthermore, the instant application explicitly distinguishes the "conventional ONUs" as described in Skubic and ITU by stating that they "lack the technology of directly transitioning between two low power consumption states without having to go through an active state (e.g., a full powered state)." *See* Present Application at [0036]. Indeed, the instant application recognizes that conventional ONU's "transition through the active state may increase the power consumed by the ONU, thereby undesirably reducing batter [*sic*] life" because they do not "directly transition[] between two low power consumption states." *See id.* Thus, both Skubic and ITU fails to teach or suggest the amended claim features of Independent Claim 1.

For at least the above provided reasons, the Applicant respectfully requests the Office to withdraw its rejections and to allow Independent Claim 1.

Independent Claims 7, 12, and 16 have been amended in a similar manner as Independent Claim 1, and are thus allowable for at least the same reasons as those provided above, and also on their own merits.

B. Rejection of Claims 14-15 under 35 U.S.C. § 103

Claims 14-15 are rejected under pre-AIA 35 U.S.C. 103(a) as allegedly being unpatentable over Skubic (US Publication No. 2012/0166819) in view of Ma (US Patent No. 7,756,972).

The Applicant respectfully disagrees with the Office's rejection for at least the reasons mentioned below.

i. Skubic in view of Ma does not teach or suggest that the periodic consent message allows the optical network unit to remain in either the first low power state or the second low power state of Independent Claim 14.

First, Skubic in view of Ma does not teach or suggest the features of the "periodic consent message" of Independent Claim 14. The Office acknowledges that Skubic does not expressly teach the above noted features. Like Skubic, Ma also fails to teach these features. For instance, while Ma teaches that "periodic keep alives" are initiated "to keep the inactive server powered up," (Ma at col. 8:63-9:2), Ma does not state whether an "inactive" state is a "low power state." In fact, Ma explicitly states that a server in an inactive state is still "powered up," just as the server is powered up in the active state. *See* Ma at col. 2:9-11, 8:63-9:2. Regarding the "inactive state," Ma simply teaches that a server in an inactive state is not "assigned requests for additional resource use." *See* Ma at col. 10:64-11:3. Thus, Ma's disclosure of "periodic keep alives" for a server in an "inactive" state does not disclose the claimed "periodic consent message" to allow the optical network unit to remain in either a first or a second "low power state."

Second, while Ma discloses another state known as the "low power standby state," Ma does not disclose whether Ma's "periodic keep alives" are sent to allow the server to remain in a low power state as claimed in Independent Claim 14. In fact, Ma teaches the opposite of this claimed feature. For instance, Ma explicitly teaches "***when the standby threshold is met, the keep-alives are not sent***." *See* Ma at col.9:38-40.

Thus, for at least the above provided reasons, the Applicant respectfully requests the Office to withdraw its rejections and to allow Independent Claim 14.

ii. Skubic in view of Ma does not teach or suggest the periodic consent message of Dependent Claim 15.

Dependent Claim 15 depends from Independent Claim 14 and is patentable over the above cited art at least for reasons similar to those provided for Independent Claim 14, and also on its own merits.

Conclusion

It is believed that all of the pending claims have been addressed. However, the absence of a reply to a specific rejection, issue or comment does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

No fee is believed to be due, however please apply any additional charges or credits to Deposit Account No. 50-0665.

Respectfully submitted,

Date: April 7, 2017

/Vinay Sathe/
Vinay Sathe
Reg. No. 55,595

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Seattle, Washington 98111-1247
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AMENDMENTS TO THE CLAIMS

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

Listing of Claims:

1. (Currently Amended) A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off;

transitioning the ONU directly ~~between~~ from the first state ~~and~~ to the second state and transitioning the ONU directly from the second state to the first state, based on a power management rule;

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

changing the power management rule based on the received power management message.

2. (Original) The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. (Cancelled).

4. (Original) The method of claim 1, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. (Original) The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

6. (Currently Amended) The method of claim 1, further comprising:

~~receiving, by the receiver, a power management message from an optical line terminal; and~~

performing the transitioning responsive to the received power management message and a local decision to change an operational state.

7. (Currently Amended) An optical communication apparatus in a passive optical network, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off;

means for transitioning the ONU directly ~~between~~ from the first state ~~and~~ to the second state and means for transitioning the ONU directly from the second state to the first state, based on a power management rule;

means for ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

means for receiving, by the receiver, a power management message from an optical line terminal; and

means for changing the power management rule based on the received power management message.

8. (Original) The apparatus of claim 7, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

9. (Cancelled).

10. (Original) The apparatus of claim 7, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

11. (Original) The apparatus of claim 7, further comprising:

means for receiving a power management message from an optical line terminal; and

means for performing the transitioning responsive to the received power management message and a local decision to change an operational state.

12. (Currently Amended) An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that uses the stored instructions to implement a method, comprising operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on; and operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

wherein the processor includes means for transitioning the ONU directly ~~between~~ from the first state ~~and~~ to the second state and means for transitioning the ONU directly from the second state to the first state, based on a power management rule;

wherein the processor uses stored instructions to ensure the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and changing the power management rule based on the received power management message.

13. (Previously Presented) The apparatus as in claim 12, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

14. (Previously Presented) An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off;

a transmitter configured to transmit the generated messages to the optical network unit;

wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state.

15. (Original) The optical line terminal as in claim 14, wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon expiration of at least one of the first time period and the second time period.

16. (Currently Amended) A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit, wherein the ONU is configured to transition ~~between~~ from the first low power mode ~~and~~ to the second low power mode and to transition from the second low power mode to the first low power mode based on a power management rule, and wherein the ONU changes a power management rule based on a received power management message;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode; and

the ONU configured to ensure that the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first low power mode or the second low power mode.

17. (Previously Presented) The system as in claim 16, wherein:

the OLT is configured to transmit the control message that includes the power management rule that specifies a first time period for operation in the first low power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

97075 7590 01/09/2017
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	

ART UNIT	PAPER NUMBER
2637	

NOTIFICATION DATE	DELIVERY MODE
01/09/2017	ELECTRONIC

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

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

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

patentprocurement@perkinscoie.com

Office Action Summary	Application No. 14/414,698	Applicant(s) KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *11/10/2016*.

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

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

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

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

Disposition of Claims*

5)☒ Claim(s) *1-17* 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) *1-17* 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 *01/13/2015* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

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

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

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

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

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

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

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

Attachment(s)

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

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

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

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Response to Arguments

2. Applicant's arguments filed 11/10/2016 with respect to claims 14-15 have been considered and are persuasive. However, the claims have been rejected in view of new grounds of rejection.

3. Applicant's arguments filed 11/10/2016 with respect to claims 1-13, 16-17 have been fully considered but they are not persuasive.

Applicant mainly argues on Page 9 lines 3-12:

> "Skubic's signaling fails to teach or suggest the changing of the power management rule based on the received power management message.... Skubic's disclosure related to updating the ONU's state machine also fails to teach or suggest the changing of the power management rule based on the received power management message"

Examiner respectfully disagrees. As explained in 35 USC 103 rejection below, Skubic ¶0028, ¶0032, ¶0038, ¶0033 discloses OLT monitors traffic, and effects changes in state machines. The state machine decides the power management conditions of the ONU. Further ¶0046 teaches an instruction is sent to the second node to operate with the selected value of the operational parameter. The control of power management can comprise selecting an operating state of the first/second node based on the service information. Instruction is sent to the second node to operate in the selected operational state. That is, the OLT signals to ONU to change

state transitions according to the power control settings. This means that power management rule for the ONU is changed.

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 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-2, 4-8, 10-13, 16-17 rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skubic [US PUB NO: 2012/0166819] in view of Pfeiffer [US PUB NO: 2009/0201840] and further in view of ITU-T G.987.3 10/2010.

As per claims 1, 7, 16

Skubic teaches a method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on (*Skubic Table 1 "Listen" ONU receiver is on; the transmitter is off)*

operating the ONU in a second state in which both the transmitter and the receiver are turned off (*Skubic ¶0004 "Asleep")* and

receiving, by the receiver, a power management message from an optical line terminal (OLT); (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10;*

signaling 34 sent between the ONU 10 and OLT 20") and changing the power management rule based on the received power management message (*Skubic ¶0028, ¶0033, ¶0038 discloses updating or optimizing power management functions based on monitored service information. Further in ¶0032 "Logic 53 triggers state transitions of the state machine 52 and alters power control settings 51". ¶ 0046 " At step 107, an instruction is sent to the second node ... with the selected value of the operational parameter. The control of power management can comprise selecting an operating state of the first/second node based on the service information ...an instruction is sent to the second node or a transceiver at the first node is controlled to operate in the selected operational state." These sections in Skubic means that power management rules of second node, i.e. ONU is changed based on received messages*)

Skubic does not expressly teach transitioning the ONU directly between the first state and the second state, based on a power management rule.

Pfeiffer teaches method for transitioning directly between the first state and the second state, based on a power management rule (*Pfeiffer Fig 9, directly transitioning from 345 to 320 are based on the states*).

At the time if invention it would have been obvious to a person of ordinary skill in the art to modify power management scheme as in Skubic by integrating transitioning from listen to sleep directly. Motivation would be to go to sleep mode if messages are not being received (*Pfeiffer ¶0045*).

Skubic in view of Pfeiffer does not expressly teach and ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

ITU-T G.987.3 teaches ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state (*ITU-T G.987. Table 16-2, Asleep and Listen state semantics*).

At the time if invention it would have been obvious to a person of ordinary skill in the art to modify power management scheme as in Skubic by integrating teachings from a standard. The motivation would be to comply with industry standards during manufacture and working of the ONUs.

As per claims 2, 8

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches operating the ONU in a third state in which both the transmitter and the receiver are turned on (*Skubic Table 1, "activeheld" or "activefree" states*).

As per claims 4, 10, 17

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state (*Skubic Fig 4, ¶0037 "Each counter records time spent in one of the power management modes... Power monitoring unit 35 can apply corrections to the recorded values held by the counters to account for factors such as propagation delay, grace periods etc" This means that item 35 monitors and specifies time periods)* and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period (*Skubic Fig 4, ¶0037 "Skubic ¶0032 "The state machine 31 has a set of states, and*

transitions between states, in response to events or signaling sent to the ONU 10 or received from the ONU 10, or to other events such as timer expiration or traffic activity").

As per claim 5

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claim 1 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state (*Skubic Fig 1 item 33, ¶0031 "The state machine 52 corresponding to each ONU 10 is updated in response to signaling messages 33, 34 between the ONU 10 and OLT 20"*).

As per claims 6, 11

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches receiving, by the receiver, a power management message from an optical line terminal; and performing the transitioning responsive to the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*) and a local decision to change an operational state (*Skubic ¶0032*).

As per claims 12-13

Claims 12-13 have limitations similar to claims 1-2 and are rejected for same reasons as above over Skubic in view of Pfeiffer and ITU-T G.987.3.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches an optical communication apparatus, comprising: a memory that stores processor-executable instructions; and a processor that uses the stored instructions to implement the method of claims 1, 4 (*Skubic ¶0012*).

5. Claims 14-15 rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skubic [US PUB NO: 2012/0166819] in view of Ma [US PAT NO: 7756972].

As per claim 14

Skubic teaches an optical line terminal (OLT) for operation in a passive optical network (PON) (*Skubic Fig 1 item 20*), the optical line terminal comprising:

a processor (*Skubic Fig 1 items 52/53*) configured to generate messages (*Skubic Fig 1 item 33*) for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off (*Skubic Fig 2 shows transitions. Skubic Table 1 "Listen" ONU receiver is on; the transmitter is off*) to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off (*Skubic Table 1 "Asleep" The ONU shuts down both its receiver and transmitter*);

a transmitter configured to transmit the generated messages to the optical network unit (*Skubic Fig 1 item TRx*);

wherein the generated messages comprises a consent message (*Skubic ¶0031 "The OLT 20 needs to periodically check whether inactivity of an ONU 10 is due to: (i) the ONU 10 being alive (and in a low-power mode) or (ii) the ONU 10 having failed. One way of performing this check is to exchange handshake signaling messages. Another way is by a "keep-alive" traffic exchange". The handshake signaling messages / keep alive traffic messages correspond to the claimed consent messages*).

Skubic does not expressly teach the message are periodic and allow the optical network unit to remain in either the first low power state or the second low power state.

Ma teaches teach the message are periodic (*Claim 15 line 18)* and allow the optical network unit to remain in either the first low power state or the second low power state (*Claim 15 lines 22-23 "wherein the periodic keep-alives do not place the inactive server into an active state" This means that device remains in the inactive state*).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify apparatus in Skubic by integrating use of keep alive signaling as in Ma. The motivation would be to prepare the device (*in this case the ONT in Skubic*) for assigning connections before it is activated (*Ma claim 15 lines 15-27*).

As per claim 15

Skubic in view of Ma teaches claim 14 as discussed above.

Skubic in view of Ma further teaches wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state (*Skubic Fig 4, ¶0037 "Each counter records time spent in one of the power management modes... Power monitoring unit 35 can apply corrections to the recorded values held by the counters to account for factors such as propagation delay, grace periods etc"*) and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon expiration of at least one of the first time period and the second time period (*Skubic ¶0032 "The state machine 31 has a set of states, and transitions between states, in response to events or signaling sent to the ONU 10 or received from the ONU 10, or to other events such as timer expiration or traffic activity"*).

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to OOMMEN JACOB whose telephone number is (571)270-5166. The examiner can normally be reached on Monday - Friday, 8:00 a.m. - 5:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID PAYNE can be reached on (571) 272-3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/OOMMEN JACOB/
Primary Examiner, Art Unit 2637

Notice of References Cited	Application/Control No. 14/414,698	Applicant(s)/Patent Under Reexamination KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	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-7,756,972 B2	07-2010	Ma; Kevin	G06F1/26	709/224
*	B	US-2012/0045210 A1	02-2012	KIM; Sung Chang	H04L41/0893	398/66
*	C	US-2012/0124444 A1	05-2012	Husted; Paul J.	H04W52/0216	714/748
*	D	US-2012/0128357 A1	05-2012	Mukai; Hiroaki	H04B10/272	398/58
*	E	US-2012/0141119 A1	06-2012	KONNO; SATOSHI	H04L12/12	398/25
*	F	US-2013/0007484 A1	01-2013	Gobriel; Sameh	G06F1/3209	713/320
*	G	US-2014/0193150 A1	07-2014	Mukai; Hiroaki	H04L12/44	398/67
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

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

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

CLAIM		DATE								
Final	Original	04/02/2016	09/15/2016	01/04/2017						
	1	✓	✓	✓						
	2	✓	✓	✓						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	✓	✓	✓						
	6	✓	✓	✓						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	✓	✓	✓						
	12	✓	✓	✓						
	13	✓	✓	✓						
	14	✓	✓	✓						
	15	✓	✓	✓						
	16	✓	✓	✓						
	17	✓	✓	✓						

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S50	21	LPM with periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:14
S51	62	low adj power with message with periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:15
S52	0	low adj power with meassage near2 periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:16
S53	0	low adj power same meassage near2 periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:16
S54	0	low adj power same meassage near3 periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:17
S55	0	low adj power same meassage with periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:17
S56	15	low adj power with message near2 periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 10:17
S57	20801	low adj power with allow	US-PGPUB; USPAT	OR	ON	2017/01/04 10:25
S58	5	low adj power with allow with message with OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 10:25
S59	2912	sleep near2 allow	US-PGPUB; USPAT	OR	ON	2017/01/04 10:27
S60	19	sleep near2 allow same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 10:27
S61	0	sleep near2 allow with periodic same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 10:29
S62	0	sleep near2 allow same periodic same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 10:30
S63	14	OLT and periodic same message same power	US-PGPUB; USPAT	OR	ON	2017/01/04 10:54
S64	6	OLT and periodic same message same sleep	US-PGPUB; USPAT	OR	ON	2017/01/04 10:55
S65	1	OLT same LPM	US-PGPUB;	OR	ON	2017/01/04 10:58

			USPAT			
S66	6524	OLT andLPM	US-PGPUB; USPAT	OR	ON	2017/01/04 10:58
S67	1	OLT and LPM	US-PGPUB; USPAT	OR	ON	2017/01/04 10:58
S68	8	OLT and LWI	US-PGPUB; USPAT	OR	ON	2017/01/04 10:58
S69	93	OLt same sleep same message	US-PGPUB; USPAT	OR	ON	2017/01/04 10:59
S70	1	(13/698509).APP.	USPAT; USOCR	OR	ON	2017/01/04 11:22
S71	8	("20080186892" | "20100111523" | "20120063770" | "20120128357" | "20120148246" | "20120177361" | "20140079396" | "8774621").PN. OR ("9240854").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/01/04 11:22
S72	1	(13/388087).APP.	USPAT; USOCR	OR	ON	2017/01/04 12:36
S73	15	("20090263127" | "20090268653" | "20100111523" | "20100118753" | "20120063770" | "20120148246" | "20140079396" | "20140086584" | "20140193150" | "7317688" | "8000602" | "8565601" | "8687960" | "8774621").PN. OR ("8934770").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2017/01/04 12:36
S74	26	OLt same sleep near2 allow$5	US-PGPUB; USPAT	OR	ON	2017/01/04 12:51
S75	34	OLt and sleep near2 allow$5	US-PGPUB; USPAT	OR	ON	2017/01/04 12:53
S76	8	S75 not S74	US-PGPUB; USPAT	OR	ON	2017/01/04 12:53
S77	16	OLt and sleep near2 permission	US-PGPUB; USPAT	OR	ON	2017/01/04 12:54
S78	63	sleep same doze same allow	US-PGPUB; USPAT	OR	ON	2017/01/04 13:27
S79	3	sleep same doze same allow same periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 13:27
S80	992	low near power near mode with message	US-PGPUB; USPAT	OR	ON	2017/01/04 13:38
S81	16	low near power near mode with message with periodic	US-PGPUB; USPAT	OR	ON	2017/01/04 13:38
S82	48	low near power near mode with keep near2 alive	US-PGPUB; USPAT	OR	ON	2017/01/04 13:40
S83	1	low near power near mode with keep near2	US-	OR	ON	2017/01/04

		alive with periodic	PGPUB; USPAT			13:40
S84	3	low near power near mode with keep near2 alive with periodic$5	US-PGPUB; USPAT	OR	ON	2017/01/04 13:40
S85	2871	keep near2 alive with periodic$5	US-PGPUB; USPAT	OR	ON	2017/01/04 13:41
S86	12	keep near2 alive with periodic$5 same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:41
S87	10893	alive with periodic$5 smae OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:42
S88	15	alive with periodic$5 same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:42
S89	4	alive same sleep same doze same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:43
S90	34	alive same OLT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:52
S91	861	alive same sleep	US-PGPUB; USPAT	OR	ON	2017/01/04 13:55
S92	1	alive same sleep same ONT	US-PGPUB; USPAT	OR	ON	2017/01/04 13:55
S93	6	alive same sleep same ONU	US-PGPUB; USPAT	OR	ON	2017/01/04 13:55
S94	16322	keep adj alive	US-PGPUB; USPAT	OR	ON	2017/01/04 16:10
S95	101	keep adj alive same power adj saving	US-PGPUB; USPAT	OR	ON	2017/01/04 16:11
S96	86581	keep adj alive with allowsame power adj saving	US-PGPUB; USPAT	OR	ON	2017/01/04 16:13
S97	2	keep adj alive with allow same power adj saving	US-PGPUB; USPAT	OR	ON	2017/01/04 16:13
S98	565	keep adj alive with allow	US-PGPUB; USPAT	OR	ON	2017/01/04 16:19
S99	103	keep adj alive with allow same power	US-PGPUB; USPAT	OR	ON	2017/01/04 16:19
S100	33	keep adj alive with allow same (doze sleep low$1power energy$1saving)	US-PGPUB; USPAT	OR	ON	2017/01/04 16:19
S101	371	keep adj alive same (doze sleep low$1power energy$1saving)	US-PGPUB; USPAT	OR	ON	2017/01/04 16:31

EAST Search History (Interference)

< This search history is empty>

1/ 4/ 2017 6:29:47 PM
C:\ Users\ ojacob\ Documents\ EAST\ Workspaces\ 14414698.wsp

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

CPC- SEARCHED		
Symbol	Date	Examiner
h04l12/12; h04b10/27	4/2/2016	OJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	66,43,58	4/2/2016	OJ

SEARCH NOTES		
Search Notes	Date	Examiner
east	4/2/2016	OJ
inventor name	4/2/2016	OJ
npl	9/15/2016	OJ
east	1/4/2017	OJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/OOMMEN JACOB/ Primary Examiner.Art Unit 2637

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	14/414,698	Filing Date	2015-01-13	Docket Number (if applicable)	009065-8132.US01	Art Unit	2637
First Named Inventor	Denis Andreyevich Khotimsky			Examiner Name	Jacob, Oommen		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, to any international application that does not comply with the requirements of 35 U.S.C. 371, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV.

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☐ Other _____

☐ Enclosed

☐ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

☒ The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 500665

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (07-14)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Vinay Sathe/	Date (YYYY-MM-DD)	2016-12-15
Name	Vinay Sathe	Registration Number	55595

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

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

Privacy Act Statement

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

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

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

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

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

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

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

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

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

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

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

Electronic Patent Application Fee Transmittal	
Application Number:	14414698
Filing Date:	13-Jan-2015
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Attorney Docket Number:	009065-8132.US01
Filed as Large Entity	

Filing Fees for U.S. National Stage under 35 USC 371

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($)
Miscellaneous:				
RCE- 1st Request	1801	1	1200	1200
		Total in USD ($)		**1200**

Electronic Acknowledgement Receipt	
EFS ID:	27811685
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	15-DEC-2016
Filing Date:	13-JAN-2015
Time Stamp:	17:54:39
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	121616INTEFSW17554000
Deposit Account	500665
Authorized User	Jennifer Payne
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)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	2016-12-15_RCE.PDF	1349880 520d3d214b6f73f603a80cc3d3b5f66126bc571c	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30838 feb673caf96baf62611c51dcc152360ce3b38467	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1380718		

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

97075 7590 11/30/2016

Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	

ART UNIT	PAPER NUMBER
2637	

NOTIFICATION DATE	DELIVERY MODE
11/30/2016	ELECTRONIC

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

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

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

patentprocurement@perkinscoie.com

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 14/414,698	**Applicant(s)** KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	**Art Unit** 2637	**AIA (First Inventor to File) Status** No

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

THE REPLY FILED 10 November 2016 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

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

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

NOTICE OF APPEAL

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

AMENDMENTS

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

AFFIDAVIT OR OTHER EVIDENCE

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

REQUEST FOR RECONSIDERATION/OTHER

12. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because:
See continuation regarding claims 14-15.
13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☐ Other: _____.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
Claim(s) allowed: 14-15.
Claim(s) objected to: .
Claim(s) rejected: 1-13,16 and 17.
Claim(s) withdrawn from consideration: .

/OOMMEN JACOB/
Primary Examiner, Art Unit 2637

Exhibit 1002
IPR2024-00899, USPN 9,806,892
60 of 362

Independent claims 1, 7, 12, 16 have been amended such as scope of claims have changed. Examiner requires further search to determine patentability of these claims.
Applicant arguments regarding claim 14 (arguments page 9-11), are considered persuasive, because it expressly requires "peiodic consent messages", not taught by references. Hence, claims 14-15 are allowed over prior art of record. the application is NOT in condition for allowance, because of other pending claims 1-13, 16-17.

Exhibit 1002
IPR2024-00899, USPN 9,806,892
61 of 362

DO NOT ENTER: /OJ/

Docket No.: 009065-8132.US01
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 | Confirmation No.: 2029

Filed: January 13, 2015 | Examiner: Jacob, Oommen

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS | Art Unit: 2637

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

AMENDMENT AFTER FINAL OFFICE ACTION

In response to the Office Action dated September 23, 2016, please amend the above-identified U.S. patent application as follows:

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

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

Exhibit 1002
IPR2024-00899, USPN 9,806,892
62 of 362

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 | Confirmation No.: 2029

Filed: January 13, 2015 | Examiner: Jacob, Oommen

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS | Art Unit: 2637

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

AMENDMENT AFTER FINAL OFFICE ACTION

In response to the Office Action dated September 23, 2016, please amend the above-identified U.S. patent application as follows:

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

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

AMENDMENTS TO THE CLAIMS

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

Listing of Claims:

1. (Currently Amended) A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off;

transitioning the ONU directly between the first state and the second state, based on a power management rule; [[and]]

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

changing the power management rule based on the received power management message.

2. (Original) The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. (Cancelled).

4. (Original) The method of claim 1, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. (Original) The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

6. (Original) The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal; and

performing the transitioning responsive to the received power management message and a local decision to change an operational state.

7. (Currently Amended) An optical communication apparatus in a passive optical network, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off;

means for transitioning the ONU directly between the first state and the second state, based on a power management rule; [[and]]

means for ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

means for receiving, by the receiver, a power management message from an optical line terminal; and

means for changing the power management rule based on the received power management message.

8. (Original) The apparatus of claim 7, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

9. (Cancelled).

10. (Original) The apparatus of claim 7, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

11. (Original) The apparatus of claim 7, further comprising:

means for receiving a power management message from an optical line terminal; and

means for performing the transitioning responsive to the received power management message and a local decision to change an operational state.

12. (Currently Amended) An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that uses the stored instructions to implement a method, comprising operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on; and operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

wherein the processor includes means for transitioning the ONU directly between the first state and the second state, based on a power management rule; [[and]]

wherein the processor uses stored instructions to ensure the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and changing the power management rule based on the received power management message.

13. (Currently Amended) The apparatus as in claim 12, ~~wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and configuring the power~~

~~management rule based on the received power management message,~~ wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

14. (Previously Presented) An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off;

a transmitter configured to transmit the generated messages to the optical network unit;

wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state.

15. (Original) The optical line terminal as in claim 14, wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon expiration of at least one of the first time period and the second time period.

16. (Currently Amended) A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit, wherein the ONU is configured to transition between the first low power mode and the second low power mode based on a power management rule, and wherein the ONU changes a power management rule based on a received power management message;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode; and

the ONU configured to ensure that the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first [[state]] low power mode or the second [[state]] low power mode.

17. (Currently Amended) The system as in claim 16, wherein:

the OLT is configured to transmit the control message that includes [[a]] the power management rule that specifies a first time period for operation in the first [[slow]] low power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

REMARKS

Independent Claims 1, 7, 12, and 16 have been amended. Dependent Claims 3 and 9 have been canceled. Dependent Claim 13 and 17 have been amended.

Claims 1-2, 4-8, 10-17 remain pending. Reconsideration and allowance of the application are respectfully requested.

Examiner Interview

The Applicant thanks Examiner Jacob for taking the time on November 3, 2016, to discuss over the phone the certain features of the present application as distinguished from the cited art. No conclusion was reached. The Applicant has amended claims consistent with the Examiner's comments to advance prosecution of this case.

Rejections under 35 U.S.C. § 103

Claims l-17 over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010

Claims l-17 stand rejected under pre-AIA 35 U.S.C. 103(a) over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010. The Office's rejection of Independent Claim 1 is respectfully traversed at least for reasons provided below.

Independent Claims 1 over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010

Independent Claim 1 has been amended to incorporate features of the original Dependent Claim 3 that was rejected under 35 U.S.C. 103(a) over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010. As discussed below, the traversal addresses the shortcomings of Pfeiffer, which was relied upon for the rejection of Dependent Claim 3 (now cancelled).

The amended Independent Claim 1 recites a method for optical communication that includes, among other features:

> 1. A method of optical communication in a passive optical network, comprising:
>
> operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;
>
> operating the ONU in a second state in which both the transmitter and the receiver are turned off;

transitioning the ONU directly between the first state and the second state, based on a power management rule; [[and]]

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state; and

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

changing the power management rule based on the received power management message.

In rejecting Dependent Claim 3 (now cancelled), the Office contends the following regarding the purported disclosure of Skubic:

> As per claims 3, 9, 14, 16
>
> Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.
>
> Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches receiving, by the receiver, a power management message from an optical line terminal (OLT); and configuring the power management rule based on the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*); wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state (*In view of applicant's arguments on Page 8, examiner interprets that applicant is referring to awake free state where normal allocations are periodically sent. ITU-T G.987. Table 16-5 teaches this awake free state*).

See Final Office Action at p. 4 (September 23, 2016). The Applicant respectfully disagrees with the Office's contention for at least the following reasons.

First, Skubic fails to teach or suggest that the power management rule is changed based on the received power management message. Skubic explains that an "ONU 10 can move between the possible states ***in response to stimuli, such as signalling*** received from … the OLT 20." Skubic at [0031]. Indeed, Skubic teaches that the ONU's state machine "transitions between states ***in response to … signalling 33 sent between the OLT 20 and ONU 10…***"

Skubic at [0031]. The signalling in Skubic, however, does not change any power management rule at least because the signalling from the OTL to the ONU only commands the ONU to transition between states and may not change the underlying rule. In other words, Skubic's signalling fails to teach or suggest the ***changing of the power management rule based on*** the received power management message.

Second, while Skubic teaches that the state machine of the ONU "is updated in response to signalling message 33, 34 between the ONU 10 and OLT 20," (Skubic at [0031]), Skubic fails to teach or suggest whether the updating of the ONU state machine relates to the claimed changing of the power management rule. Indeed, Skubic is silent on what the "update" represents. Thus, Skubic's disclosure related to updating the ONU's state machine also fails to teach or suggest the ***changing of the power management rule based on*** the received power management message. Further, the Office does not cite to Pfeiffer or ITU-T G.987.3 10/2010 for the features cited in the claim language above.

For at least the above mentioned reasons, Skubic in view of Pfeiffer and ITU-T G.987.3 10/2010 fails to teach or suggest that the configuring of the power management rule is based on the received power management message.

Independent Claims 7, 12, and 16 over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010

The Office's rejection of Independent Claims 7, 12, and 16 are respectfully traversed at least because Independent Claims 7, 12, and 16 have been amended in a similar manner to Independent Claim 1, and should be allowed for at least the same reasons as provided above, and also on their own merits.

Independent Claim 14 over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010

In rejecting Independent Claim 14, the Office contends the following regarding the purported disclosure of ITU-T G.987.3 10/2010:

> As per claims 3, 9, 14, 16
>
> Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.
>
> Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches receiving, by the receiver, a power management message from an optical line terminal (OLT); and configuring the power management rule based on the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*); wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state (*In view of applicant's arguments on Page 8, examiner interprets that applicant is referring to awake free state where normal allocations are periodically sent. ITU-T G.987. Table 16-5 teaches this awake free state*).

See Final Office Action at p. 4 (September 23, 2016). The Applicant respectfully disagrees with the Office's contention for at least the following reasons.

As an initial matter, the Office has failed to make a prima facie obviousness rejection for Independent Claims 14 and 16 at least because the ITU-T G.987 document does not state, as the Office contends, that "normal allocations are ***periodically*** sent" in the "awake free state." *See* Final Office Action at p. 4 (September 23, 2016) (reproduced above) (emphasis added). Contrary to the Office's contention, Table 16-5 of the ITU-T G.987 document states the following regarding the "awake free state":

AwakeFree	The OLT provides normal allocations to the ONU, forwards downstream traffic, and is ready to accept a power management transition indication from the ONU. On transition into this state, the OLT sends a Sleep_Allow (ON) PLOAM message, thus granting the ONU a permission to enter a low power state at its own discretion. The OLT expects a response to every bandwidth grant, and in case of missed allocation transitions to the AwakeForced state, where LOB$_i$ condition can be eventually declared. There are two stable state combinations involving the AwakeFree state of the OLT state machine: the ONU state machine can be either in the ActiveFree state or in the ActiveHeld state.

See ITU-T G.987.3 10/2010, p. 95 (Table 16-5).

In the ITU-T G.987 document, Table 16-5 states that the "OLT sends ***a*** Sleep_Allow (ON) PLOAM ***message***" to the ONU to permit the ONU "to enter a lower power state at its own discretion." *See* ITU-T G.987.3 10/2010, p. 95 (Table 16-5). The ITU-T G.987 document states that a ***single*** Sleep_Allow message is sent to the ONU when the ONU transitions to the "AwakeFree" state. In fact, the ITU-T G.987 document nowhere states that "normal allocations are ***periodically*** sent" in the "awake free state" as the Office contends. *See* Final Office Action at p. 4 (September 23, 2016) (reproduced above) (emphasis added). Thus, the disclosure of the "Sleep_Allow" message in ITU-T G.987 document fails to teach or suggest the claimed "generated message comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state." The Office does not cite to Skubic or Pfeiffer for the features cited in the claim language above.

For at least the above mentioned reasons, Skubic in view of Pfeiffer and ITU-T G.987.3 10/2010 fails to teach or suggest that the generated message comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state.

The remaining Dependent Claims are patentable over Skubic, Pfeiffer, and ITU-T G.987.3 10/2010 at least due to the dependency from claims 1, 7, 12, 14, and 16, and also on their own merits.

Conclusion

It is believed that all of the pending claims have been addressed. However, the absence of a reply to a specific rejection, issue or comment does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

No fee is believed to be due, however, please apply any charges or credits to Deposit Account No. 50-0665.

Respectfully submitted,

Date: November 10, 2016

/Vinay Sathe/
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Electronic Acknowledgement Receipt

EFS ID:	27480883
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	10-NOV-2016
Filing Date:	13-JAN-2015
Time Stamp:	20:32:30
Application Type:	U.S. National Stage under 35 USC 371

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		2016-11-10_ReplyFOA.pdf	263232 a438369670394614ac88bbbeb3ec610e82c68e02	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	12
Warnings:			
Information:			
	Total Files Size (in bytes):	263232	

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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.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/414,698	Filing Date 01/13/2015	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT 11/10/2016

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 15	Minus	** 17	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

LIE
ANTHONY TYSON

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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Doc Code: M865 or FALREQ.INTV

PTOL-413A (08-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Applicant Initiated Interview Request Form

Application No.: 14/414,698 First Named Applicant: Denis Andreyevich Khotimsky
Examiner: Jacob, Oommen Art Unit: 2637 Status of Application: Pending

Tentative Participants:
(1) Jacob, Oommen (2) Kevin Kantharia, Reg. 71071
(3) Vinay Sathe, Reg. 55595 (4)

Proposed Date of Interview: 11/3/2016 **Proposed Time:** 11.30 Am (AM/PM)

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

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

Issues To Be Discussed

Issues (Rej., Obj., etc)	Claims/ Fig. #s	Prior Art	Discussed	Agreed	Not Agreed
(1) 103	1, 3, 4	Skubic, Pfeiffer	[ ]	[ ]	[ ]
(2)			[ ]	[ ]	[ ]
(3)			[ ]	[ ]	[ ]
(4)			[ ]	[ ]	[ ]

[ ] Continuation Sheet Attached [✓] Proposed Amendment or Arguments Attached

Brief Description of Arguments to be Presented: Distinguish prior art and discuss potential claim amendments to advance prosecution. Applicant believes claims 3 and 4 are missing from prior art.

An interview was conducted on the above-identified application on 11/3/2016 at 8:30 a.m. PT/11:30 am ET

NOTE: This form should be completed and filed by applicant in advance of the interview (see MPEP § 713.01). If this form is signed by a registered practitioner not of record, the Office will accept this as an indication that he or she is authorized to conduct an interview on behalf of the principal (37 CFR 1.32(a)(3)) pursuant to 37 CFR 1.34. This is not a power of attorney to any above named practitioner. See the Instruction Sheet for this form, which is incorporated by reference. By signing this form, applicant or practitioner is certifying that he or she has read the Instruction Sheet. After the interview is conducted, applicant is advised to file a statement of the substance of this interview (37 CFR 1.133(b)) as soon as possible. This application will not be delayed from issue because of applicant's failure to submit a written record of this interview.

/Vinay Sathe/
Applicant/Applicant's Representative Signature

Examiner/SPE Signature

Vinay Sathe
Typed/Printed Name of Applicant or Representative

55,595
Registration Number, if applicable

This collection of information is required by 37 CFR 1.133. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 24 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Facsimile Cover Sheet

[redacted]

If there are any problems with this transmission, please call 858.720.5700

Date: ***November 3, 2016*** COVER SHEET & ***1*** PAGES

APPLICATION NUMBER: ***14/414,698***

ATTORNEY DOCKET NO.: ***009065-8132.US01***

Sender:	Telephone:	Facsimile:
Vinay Sathe, Perkins Coie LLP	858-720-5736	

Recipient:	Company:	Telephone:	Facsimile:
Examiner Jacob Oomen	United States Patent & Trademark Office		571-273-8300

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

97075 7590 09/23/2016
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	

ART UNIT	PAPER NUMBER
2637	

NOTIFICATION DATE	DELIVERY MODE
09/23/2016	ELECTRONIC

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

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

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

patentprocurement@perkinscoie.com

Office Action Summary	Application No. 14/414,698	Applicant(s) KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *07/07/2016*.

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

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

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

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

Disposition of Claims*

5)☒ Claim(s) *1-17* 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) *1-17* 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 *01/13/2015* 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 *04/13/2016*.

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

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Response to Arguments

II. Applicant's arguments with respect to claims 1-17 have been considered but are moot in view of new grounds of rejections. New reference has been applied to show the newly added limitations.

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 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

III. Claims1-17 rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skubic [US PUB NO: 2012/0166819] in view of Pfeiffer [US PUB NO: 2009/0201840] and further in view of ITU-T G.987.3 10/2010.

As per claims 1, 7

Skubic teaches a method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU

is turned off and a receiver of the ONU is turned on (*Skubic table 1 "Listen"*);

operating the ONU in a second state in which both the transmitter and the receiver are turned off (*Skubic table 1 "asleep"*); and

Skubic does not expressly teach transitioning the ONU directly between the first state and the second state, based on a power management rule.

Pfeiffer teaches method for transitioning directly between the first state and the second state, based on a power management rule (*Pfeiffer Fig 9, transitioning from 345 to 320 are based on the states*).

At the time if invention it would have been obvious to a person of ordinary skill in the art to modify power management scheme as in Skubic by integrating transitioning from listen to sleep directly. Motivation would be to go to sleep mode if messages are not being received (*Pfeiffer ¶0045*).

Skubic in view of Pfeiffer does not expressly teach and ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

ITU-T G.987.3 teaches ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state (*ITU-T G.987. Table 16-2, Asleep and Listen state semantics*).

At the time if invention it would have been obvious to a person of ordinary skill in the art to modify power management scheme as in Skubic by integrating teachings from a standard. The motivation would be to comply with industry standards during manufacture and working of the ONUs.

As per claims 2, 8

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches operating the ONU in a third state in which both the transmitter and the receiver are turned on (*Skubic Table 1, "activeheld" or "activefree" states*).

As per claims 3, 9, 14, 16

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches receiving, by the receiver, a power management message from an optical line terminal (OLT); and configuring the power management rule based on the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*); wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state (*In view of applicant's arguments on Page 8, examiner interprets that applicant is referring to awake free state where normal allocations are periodically sent. ITU-T G.987. Table 16-5 teaches this awake free state*).

As per claims 4, 10, 15, 17

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches wherein the power

management rule specifies a first time period for operation in the first state (*Pfeiffer Fig 9, ¶0045 "listen timeout"*) and a second time period for operation in the second state (*Skubic Fig 2 "Tsleep")* and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period (*Pfeiffer Fig 9, ¶0045 "If the listen timeout expires before the end node 30 receives a message, the second sleep interval is set and the end node 30 enters the second sleep state 330"*).

As per claim 5

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claim 1 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state (*Skubic Fig 1 item 33, ¶0031 "The state machine 52 corresponding to each ONU 10 is updated in response to signaling messages 33, 34 between the ONU 10 and OLT 20"*).

As per claims 6, 11

Skubic in view of Pfeiffer and ITU-T G.987.3 teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches receiving, by the receiver, a power management message from an optical line terminal; and performing the transitioning responsive to the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*) and a local decision to change an operational state (*Skubic ¶0032*).

As per claims 12-13

Claims 12-13 have limitations similar to claims 1-2 and are rejected for same reasons as

above over Skubic in view of Pfeiffer and ITU-T G.987.3.

Skubic in view of Pfeiffer and ITU-T G.987.3 further teaches an optical communication apparatus, comprising: a memory that stores processor-executable instructions; and a processor that uses the stored instructions to implement the method of claims 1, 4 (*Skubic ¶0012*).

Conclusion

IV. Any inquiry concerning this communication or earlier communications from the examiner should be directed to OOMMEN JACOB whose telephone number is (571)270-5166. The examiner can normally be reached on Monday - Friday, 8:00 a.m. - 5:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID PAYNE can be reached on (571) 272-3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/OOMMEN JACOB/

Primary Examiner, Art Unit 2637

Notice of References Cited	Application/Control No. 14/414,698	Applicant(s)/Patent Under Reexamination KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	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-				
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	ITU-T G987.3 10/2010
	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.

Exhibit 1002
IPR2024-00899, USPN 9,806,892
88 of 362

PTO/SB/08a (03-15)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	14414698
Filing Date	2015-01-13
First Named Inventor	Denis Andreyevich Khotimsky
Art Unit	2637
Examiner Name	Jacob, Oommen
Attorney Docket Number	009065-8132.US01

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 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]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /OJ/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	2637
	Examiner Name	Jacob, Oommen
	Attorney Docket Number	009065-8132.US01

	1	DHAINI, A., et al., "Toward Green Next-Generation Passive Optical Networks," IEEE Communications Magazine, 49 (11):94-101, November 2011.	
	2	Office Action mailed on March 8, 2016 for Japanese Application No. 2015-521885, filed July 15, 2013 (7 pages).	X

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

EXAMINER SIGNATURE

Examiner Signature	/Oommen Jacob/	Date Considered	09/15/2016

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

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /OJ/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	14414698
Filing Date	2015-01-13
First Named Inventor	Denis Andreyevich Khotimsky
Art Unit	2637
Examiner Name	Jacob, Oommen
Attorney Docket Number	009065-8132.US01

CERTIFICATION STATEMENT

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

X 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.

X 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	/Vinay Sathe/	Date (YYYY-MM-DD)	2016-04-13
Name/Print	Vinay Sathe	Registration Number	55595

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /OJ/

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /OJ/

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

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

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

CLAIM		DATE								
Final	Original	04/02/2016	09/15/2016							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
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	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

CPC- SEARCHED		
Symbol	Date	Examiner
h04l12/12; h04b10/27	4/2/2016	OJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	66,43,58	4/2/2016	OJ

SEARCH NOTES		
Search Notes	Date	Examiner
east	4/2/2016	OJ
inventor name	4/2/2016	OJ
npl	9/15/2016	OJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/OOMMEN JACOB/ Primary Examiner.Art Unit 2637

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 | Confirmation No.: 2029

Filed: January 13, 2015 | Examiner: Jacob, Oommen

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS | Art Unit: 2637

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

AMENDMENT IN RESPONSE TO NON-FINAL OFFICE ACTION

In response to the Office Action dated April 7, 2016, please amend the above-identified U.S. patent application as follows:

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

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

AMENDMENTS TO THE CLAIMS

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

Listing of Claims:

1. (Currently Amended) A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off; [[and]]

transitioning the ONU directly between the first state and the second state, based on a power management rule; and

ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

2. (Original) The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. (Original) The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

configuring the power management rule based on the received power management message.

4. (Original) The method of claim 1, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. (Original) The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

6. (Original) The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal; and

performing the transitioning responsive to the received power management message and a local decision to change an operational state.

7. (Currently Amended) An optical communication apparatus in a passive optical network, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off; [[and]]

means for transitioning the ONU directly between the first state and the second state, based on a power management rule; and

means for ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

8. (Original) The apparatus of claim 7, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

9. (Original) The apparatus of claim 7, comprising:

means for receiving, by the receiver, a power management message from an optical line terminal; and

means for configuring the power management rule based on the received power management message.

10. (Original) The apparatus of claim 7, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

11. (Original) The apparatus of claim 7, further comprising:

means for receiving a power management message from an optical line terminal; and

means for performing the transitioning responsive to the received power management message and a local decision to change an operational state.

12. (Currently Amended) An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that uses the stored instructions to implement a method, comprising operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on; and operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

wherein the processor includes means for transitioning the ONU directly between the first state and the second state, based on a power management rule; and

wherein the processor uses stored instructions to ensure the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

13. (Original) The apparatus as in claim 12, wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and configuring the power management rule based on the received power management message, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the

second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

14. (Currently Amended) An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off; [[and]]

a transmitter configured to transmit the generated messages to the optical network unit;

wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state.

15. (Original) The optical line terminal as in claim 14, wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon expiration of at least one of the first time period and the second time period.

16. (Currently Amended) A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode; and

the ONU configured to ensure that the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state.

17. (Original) The system as in claim 16, wherein:

the OLT is configured to transmit the control message that includes a power management rule that specifies a first time period for operation in the first slow power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

REMARKS

Claims 1, 7, 12, 14 and 16 have been amended. No claims have been canceled and no claims have been added as new dependent claims. Claims 1-17 remain pending.

Reconsideration and allowance of the application are respectfully requested.

Rejections under 35 U.S.C. § 103

Claims 1-17 over Skubic and Pfeffer

Claims l-17 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skubic [US PUB NO: 2012/0166819] in view of Pfeiffer [US PUB NO: 2009/0201840]. The above cited rejections are respectfully traversed at least because Skubic and Pfeiffer fail to disclose several claimed features.

Independent Claim 1 over Skubic and Pfeiffer

As an example, Independent claim 1 has been amended to further clarify the distinctions between the claimed subject matter and the prior art. Specifically, Independent Claim 1 as amended includes, among others, "ensuring the ONU is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state." This amendment finds support at least in Table 3, Figures 2, 3A, 4A, 5 and the related text of the instant application. No new matter has been added.

Regarding the amended feature of Independent Claim 1, Table 3 states that before exiting both the Asleep and Listen states, "the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control." *See* Present Application at Table 3. These features are neither taught nor suggested in Skubic or Pfeiffer. For instance, Skubic teaches that the power management control unit 50 "adapts the power management behaviour of ONU 1 to ensure that ONU 1 awakes to receive the traffic." *See* Skubic at [0040]. There is no disclosure in Skubic that the ONU is ensured to be awake "before exiting the first state or the second state" as recited in the amended Independent Claim 1. Further, Skubic teaches that Taware is the "[l]ocal timer at ONU, initialized to a value equal to or greater than Iaware once downstream ***synchronization is obtained upon entry*** to Aware

state." *See* Skubic at Table 3 (emphasis added). Here too, Skubic fails teach or suggest that the synchronization is obtained "before exiting the first state or the second state" as recited in the amended Independent Claim 1. Finally, there is no disclosure in Skubic of ensuring that the ONU is "capable of responding to both upstream and downstream traffic and control before exiting the first state or the second state."

Furthermore, one of skill in the art would not have combined Pfeiffer with Skubic at least because Pfeiffer is not reasonably pertinent to the problem faced by the inventor. For example, the Applicant of the instant application recognized that traditional standards of compliance in optical equipment required that the ONU could not go from one low power state directly to another low power state. Indeed, the traditional optical standards required that the ONU go from one low power state to another low power state ***by going through a full power mode***, for example, through the "ActiveHeld" state as disclosed in Skubic. *See* Skubic at Fig. 2. Unlike the problem faced by the Applicant of the instant application, Pfeiffer relates to "wireless networks designed for use in industrial environments" where no such problem or limitation existed for transitioning from one low power state to another low power state. *See* Pfeiffer at [0002]. Thus, Pfeiffer—a wireless reference—would not be reasonably pertinent to the instant application.

For at least the above failures of Skubic and Pfeiffer, Independent Claim 1 as amended is patentable under 35 USC 103.

<u>Independent Claim 14 over Skubic and Pfeiffer</u>

Independent claim 14 has also been amended to further clarify the distinctions between the claimed subject matter and the prior art. Specifically, Independent Claim 14 as amended includes, among others, "wherein the generated messages comprises a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state." This amendment finds support at least in Tables 1 and 6 and the related text of the instant application. No new matter has been added.

Regarding the amended feature of Independent Claim 14, Table 6 states that the OLT is aware that the ONU is in a low power mode and that "[u]pon transition to and periodically during the sojourn in [the LowPower] state, the OLT sends a LPM-Allow message to the ONU."

See Present Application at Table 6. Table 1 of the present application further describes the OLT low power management primitives where it states that the "LPM-Allow" primitive allows the "OLT [to] grant consent to ONU's transition into a lower power mode." See Present Application at Table 1. These features are neither taught nor suggested in Skubic or Pfeiffer. For instance, Skubic teaches OLT periodically checks whether the ONU is inactive due to "(i) the ONU 10 being alive (and in a low-power mode) or (ii) the ONU 10 having failed." *See* Skubic at [0031]. There is no disclosure in Skubic that the OLT transmits "a periodic consent message to allow the optical network unit to remain in either the first low power state or the second low power state" as recited in the amended Independent Claim 14. For at least the above provided reasons, Independent Claim 14 as amended is patentable under 35 USC 103.

Claims 2-13 and 15-17 over Skubic and Pfeiffer

Independent Claims 7, 12 and 16 have been amended in the similar manner as Claim 1. Thus, Independent Claims 7, 12 and 16 as amended are patentable under 35 USC 103 for at least the reasons provided above for Independent Claim 1.

The remaining Dependent Claims are patentable over Skubic and Pfeiffer at least due to the dependency from claims 1, 7, 12, 14, and 16, and also on their own merits.

Conclusion

It is believed that all of the pending claims have been addressed. However, the absence of a reply to a specific rejection, issue or comment does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

Please apply any charges or credits to Deposit Account No. 50-0665.

Respectfully submitted,

Date: July 7, 2016

/Vinay Sathe/
Vinay Sathe
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Electronic Acknowledgement Receipt

EFS ID:	26289528
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	07-JUL-2016
Filing Date:	13-JAN-2015
Time Stamp:	19:45:40
Application Type:	U.S. National Stage under 35 USC 371

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		2016-07-07_ReplyOA.pdf	157280 858768da68dc514045a1084425b600ed695c4685	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	6
	Applicant Arguments/Remarks Made in an Amendment	7	10
Warnings:			
Information:			
	Total Files Size (in bytes):	157280	

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New International Application Filed with the USPTO as a Receiving Office
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/414,698	Filing Date 01/13/2015	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

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

APPLICATION AS AMENDED – PART II

AMENDMENT 07/07/2016

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

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

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

LIE
KIM DOWNING

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/414,698	01/13/2015	2637	2460	009065-8132.US01	17	5

CONFIRMATION NO. 2029

CORRECTED FILING RECEIPT

97075
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

OC000000082378024

Date Mailed: 05/04/2016

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

Inventor(s)

Denis Andreyevich Khotimsky, Westborough, MA;
LiQuan Yuan, Shanghai, CHINA;
DeZhi Zhang, Shanghai, CHINA;

Applicant(s)

ZTE Corporation, Shenzhen, CHINA
ZTE (USA) Inc., Austin, TX

Power of Attorney: The patent practitioners associated with Customer Number 97075

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US2013/050533 07/15/2013

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
CHINA PCT/CN2012/078649 07/13/2012

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/414,698**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

Preliminary Class

398

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

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01

CONFIRMATION NO. 2029

97075
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

POA ACCEPTANCE LETTER

OC000000082377949

Date Mailed: 04/22/2016

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/13/2016.

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

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

/tgebre/

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

PTO/AIA/82A (07-13)
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Application Number	14/414,698
Filing Date	January 13, 2015
First Named Inventor	Denis Andreyevich Khotimsky
Title	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
Art Unit	2637
Examiner Name	Jacob, Oommen
Attorney Docket Number	009065-8132.US01

SIGNATURE of Applicant or Patent Practitioner

Signature	/Vinay Sathe/	Date (Optional)	April 13, 2016
Name	Vinay Sathe	Registration Number	55,595
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

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Application Number	Filing Date

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

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OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

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

ZTE Corporation

☐ 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	Xianyan Zhou	Date (Optional)	
Name	Xianyan Zhou		
Title	ZPR Director		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

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Application Number	14/414,698
Filing Date	January 13, 2015
First Named Inventor	Denis Andreyevich Khotimsky
Title	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
Art Unit	2637
Examiner Name	Jacob, Oommen
Attorney Docket Number	009065-8132.US01

SIGNATURE of Applicant or Patent Practitioner

Signature	/Vinay Sathe/	Date (Optional)	April 13, 2016
Name	Vinay Sathe	Registration Number	55,595
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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

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POWER OF ATTORNEY BY APPLICANT

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

Application Number	Filing Date

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

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 97075

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

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

ZTE (USA) Inc.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Jim Wang	Date (Optional)	
Name	Jim Wang		
Title	CLR		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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
	Denis	Andreyevich	Khotimsky	

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

City	Westborough	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

Address 1	27 Glen Street		
Address 2			
City	Westborough	State/Province	MA
Postal Code	01581	Country	US

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	LiQuan		Yuan	

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

City	Shanghai	Country of Residence	CN

Mailing Address of Inventor:

Address 1	#889 BiBo Road		
Address 2	Zhangjiang Hi-Tech Park		
City	Shanghai	State/Province	
Postal Code	201203	Country	CN

Inventor 3 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	DeZhi		Zhang	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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

City	Shanghai	Country of Residence i	CN

Mailing Address of Inventor:

Address 1	#889 BiBo Road		
Address 2	Zhangjiang Hi-Tech Park		
City	Shanghai	State/Province	
Postal Code	201203	Country i	CN

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	97075		
Email Address	patentprocurement@perkinscoie.com	Add Email	Remove Email

Application Information:

Title of the Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS		
Attorney Docket Number	009065-8132.US01	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	16	Suggested Figure for Publication (if any)	1

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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	97075		

Domestic Benefit/National Stage Information:

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

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/US2013/050633	2013-07-15

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

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(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[1] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[1]	Filing Date (YYYY-MM-DD)	Access Code[1] (if applicable)
PCT/CN2012/078649	WO	2012-07-13	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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

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

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

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If 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 World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

Applicant 1

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	ZTE Corporation		
Mailing Address Information For Applicant:			
Address 1	ZTE Plaza, No. 55 Keji South Road		
Address 2	Hi-Tech Industrial Park, Nanshan District		
City	Shenzhen	**State/Province**	
Country	CN	Postal Code	518057
Phone Number		Fax Number	
Email Address			

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

Applicant 2

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 :	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

If the Applicant is an Organization check here. ☒			
Organization Name	ZTE (USA) Inc.		
Mailing Address Information For Applicant:			
Address 1	~~55 Madison Avenue~~ 7000 North Mopac Expressway		
Address 2	~~Suite 160~~ 2nd Floor, Suite 2105		
City	~~Morristown~~ Austin	**State/Province**	~~NJ~~ TX
Country i	US	Postal Code	~~07960~~ 78731
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

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

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.

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

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.					
Signature	/Vinay Sathe/			Date (YYYY-MM-DD)	2016-04-13
First Name	Vinay	Last Name	Sathe	Registration Number	55595
Additional Signature may be generated within this form by selecting the Add button.					

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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 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 C o o p eration 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:	25481677
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	13-APR-2016
Filing Date:	13-JAN-2015
Time Stamp:	16:01:20
Application Type:	U.S. National Stage under 35 USC 371

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)	2016-04-13_IDS-SB08.PDF	1035081 a132b24f8ff7b231bc0d88d84b65452c4749c17c	no	4

Warnings:	
Information:	

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

2	Non Patent Literature	DHAINI.PDF	757985 42871638989cd991354a96211b490add5d50f2dc	no	8
Warnings:					
Information:					
3	Non Patent Literature	OA030816_JP00.PDF	163131 11337b4924f727fb0b1c6d114807c351d15cbe64	no	7
Warnings:					
Information:					
4	Power of Attorney	2016-04-13_POA.PDF	241554 157b3f20392c694957d7d35ba605f72e0d4f585d	no	4
Warnings:					
Information:					
5	Application Data Sheet	2016-04-13_ReplacementADS.pdf	807974 b670079541acb596c8f4aa35dadd7e9eba3d9f07	no	8
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
		Total Files Size (in bytes):	3005725		

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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.

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

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	2637
	Examiner Name	Jacob, Oommen
	Attorney Docket Number	009065-8132.US01

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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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	2637
	Examiner Name	Jacob, Oommen
	Attorney Docket Number	009065-8132.US01

	1	DHAINI, A., et al., "Toward Green Next-Generation Passive Optical Networks," IEEE Communications Magazine, 49 (11):94-101, November 2011.	
	2	Office Action mailed on March 8, 2016 for Japanese Application No. 2015-521885, filed July 15, 2013 (7 pages).	X

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

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

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	Examiner Name	Jacob, Oommen
	Attorney Docket Number	009065-8132.US01

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	/Vinay Sathe/	Date (YYYY-MM-DD)	2016-04-13
Name/Print	Vinay Sathe	Registration Number	55595

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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01	2029

97075 7590 04/07/2016
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

EXAMINER	
JACOB, OOMMEN	

ART UNIT	PAPER NUMBER
2637	

NOTIFICATION DATE	DELIVERY MODE
04/07/2016	ELECTRONIC

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

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

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

patentprocurement@perkinscoie.com

Office Action Summary	Application No. 14/414,698	Applicant(s) KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	AIA (First Inventor to File) Status No

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

Period for Reply

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

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

Status

1)☒ Responsive to communication(s) filed on *01/13/2015*.

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

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

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

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

Disposition of Claims*

5)☒ Claim(s) *1-17* 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) *1-17* 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 *01/13/2015* 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 *06/19/2015, 07/29/2015*.

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

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

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 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims1-17 rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skubic [US PUB NO: 2012/0166819] in view of Pfeiffer [US PUB NO: 2009/0201840].

As per claims 1, 7

Skubic teaches a method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on (*Skubic table 1 "Listen"*);

operating the ONU in a second state in which both the transmitter and the receiver are turned off (*Skubic table 1 "asleep"*); and

Skubic does not expressly teach transitioning the ONU directly between the first state and the second state, based on a power management rule.

Pfeiffer teaches method for transitioning directly between the first state and the second

state, based on a power management rule (*Pfeiffer Fig 9, transitioning from 345 to 320 are based on the states*).

At the time if invention it would have been obvious to a person of ordinary skill in the art to modify power management scheme as in Skubic by integrating transitioning from listen to sleep directly. Motivation would be to go to sleep mode if messages are not being received (*Pfeiffer ¶0045*).

As per claims 2, 8

Skubic in view of Pfeiffer teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer further teaches operating the ONU in a third state in which both the transmitter and the receiver are turned on (*Skubic Table 1, "activeheld" or "activefree" states*).

As per claims 3, 9, 14, 16

Skubic in view of Pfeiffer teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer further teaches receiving, by the receiver, a power management message from an optical line terminal (OLT); and configuring the power management rule based on the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*).

As per claims 4, 10, 15, 17

Skubic in view of Pfeiffer teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer further teaches wherein the power management rule specifies a

first time period for operation in the first state (*Pfeiffer Fig 9, ¶0045 "listen timeout"*) and a second time period for operation in the second state (*Skubic Fig 2 "Tsleep")* and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period (*Pfeiffer Fig 9, ¶0045 "If the listen timeout expires before the end node 30 receives a message, the second sleep interval is set and the end node 30 enters the second sleep state 330"*).

As per claim 5

Skubic in view of Pfeiffer teaches claim 1 as discussed above.

Skubic in view of Pfeiffer further teaches transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state (*Skubic Fig 1 item 33, ¶0031 "The state machine 52 corresponding to each ONU 10 is updated in response to signaling messages 33, 34 between the ONU 10 and OLT 20"*).

As per claims 6, 11

Skubic in view of Pfeiffer teaches claims 1, 7 as discussed above.

Skubic in view of Pfeiffer further teaches receiving, by the receiver, a power management message from an optical line terminal; and performing the transitioning responsive to the received power management message (*Skubic Fig 1, ¶0031 "Each state machine has a set of states, and transitions between states in response to one or more of: signaling 33 sent between the OLT 20 and ONU 10; signaling 34 sent between the ONU 10 and OLT 20"*) and a local decision to change an operational state (*Skubic ¶0032*).

As per claims 12-13

Claims 12-13 have limitations similar to claims 1-2 and are rejected for same reasons as above over Skubic in view of Pfeiffer.

Skubic in view of Pfeiffer further teaches an optical communication apparatus, comprising: a memory that stores processor-executable instructions; and a processor that uses the stored instructions to implement the method of claims 1, 4 (*Skubic ¶0012*).

Conclusion

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to OOMMEN JACOB whose telephone number is (571)270-5166. The examiner can normally be reached on Monday - Friday, 8:00 a.m. - 5:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID PAYNE can be reached on (571) 272-3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/OOMMEN JACOB/
Primary Examiner, Art Unit 2637

Notice of References Cited	Application/Control No. 14/414,698	Applicant(s)/Patent Under Reexamination KHOTIMSKY ET AL.	
	Examiner OOMMEN JACOB	Art Unit 2637	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-2012/0166819 A1	06-2012	Skubic; Bjorn	G06F1/3278	713/300
*	B	US-2015/0222440 A1	08-2015	Khotimsky; Denis Andreyevich	H04B10/272	398/58
*	C	US-2009/0201840 A1	08-2009	Pfeiffer, JR.; Loren K.	H04W8/005	370/310
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

CPC- SEARCHED		
Symbol	Date	Examiner
h04l12/12; h04b10/27	4/2/2016	OJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
398	66,43,58	4/2/2016	OJ

SEARCH NOTES		
Search Notes	Date	Examiner
east	4/2/2016	OJ
inventor name	4/2/2016	

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

	/OOMMEN JACOB/ Primary Examiner.Art Unit 2637

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CONFIRMATION NO. 2029

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/414,698	01/13/2015 RULE	398	2637	009065-8132.US01

APPLICANTS

ZTE Corporation, Shenzhen, CHINA
ZTE (USA) Inc., Morristown, NJ

INVENTORS

Denis Andreyevich Khotimsky, Westborough, MA;
LiQuan Yuan, Shanghai, CHINA;
DeZhi Zhang, Shanghai, CHINA;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/US2013/050533 07/15/2013

**** FOREIGN APPLICATIONS **************************

CHINA PCT/CN2012/078649 07/13/2012

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

04/18/2015

Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /OOMMEN JACOB/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		MA	16	17	5

ADDRESS

Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247
UNITED STATES

TITLE

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
2460	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

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	1	20120128357	A1	2012-05-24	Mukai et al.	
	2	20120166819	A1	2012-06-28	Skubic 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	European Search Report mailed on July 7, 2015 for European Application No. 13816034.6, filed July 15, 2013 (7 pages).	☐

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EXAMINER SIGNATURE

Examiner Signature	/Oommen Jacob/	Date Considered	04/02/2016

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OR

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Vinay Sathe/	Date (YYYY-MM-DD)	2015-07-29
Name/Print	Vinay Sathe	Registration Number	55595

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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	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	
	Examiner Name	
	Attorney Docket Number	009065-8132.US01

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	2	20100118753	A1	2010-05-13	Mandin et al.	
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	Examiner Name	
	Attorney Docket Number	009065-8132.US01

	1	2008/038981	WO	A1	2008-04-03	ELECTRONICS AND TELECOMM RESEARCH INSTITUTE		☐

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	1	International Search Report and Written Opinion mailed on October 22, 2013 for International Application No. PCT/US2013/050533, filed July 15, 2013 (10 pages).	☐
	2	ITU-T Telecommunication Standard Sector of ITU, "10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification," G.987.3, 131 pages, October 2010.	☐

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CERTIFICATION STATEMENT

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

OR

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

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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	/Hwa C. Lee 59747/	Date (YYYY-MM-DD)	2015-06-19
Name/Print	Hwa C. Lee	Registration Number	59747

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S22	181	listen with asleep	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S23	181	listen with asleep andONT	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S24	6	listen with asleep and ONU	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S25	6	listen with asleep same transitio$5	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S26	1088	398/58.ccls.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S27	883	398/66.ccls.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S28	731	398/43.ccls.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S29	2452	h04l12/12.cpc.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S30	941	h04b10/27.cpc.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S31	60	((KHOTIMSKY near2 DENIS)(yuan near2 Liquan)(zhang near2 dezhi)).inv.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S32	128	(ONU and OLT and (OFF sleep)).clm.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:22
S33	6	("20120163808" | "20100118753" | "20120128357" | "20120027411" | "20100111523" | "20120166819").PN.	US-PGPUB; USPAT	OR	ON	2016/04/02 16:24
S34	1	(13/219123).APP.	USPAT; USOCR	OR	ON	2016/04/02 16:24
S35	21	("20060093356" | "20070098406" | "20080019690" | "20080044177" | "20090123154" | "20110033180" | "20120039602" | "20120045201" | "20120045210" | "20120128357" | "20120263469" | "20130034356" | "20130077972" | "20130089328" | "20140029947" | "7391972" | "7778543" | "7840135" | "8064764" | "8249446").PN. OR ("8768163").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/04/02 16:24

S36	1	(13/388087).APP.	USPAT; USOCR	OR	ON	2016/04/02 16:24
S37	15	("20090263127" | "20090268653" | "20100111523" | "20100118753" | "20120063770" | "20120148246" | "20140079396" | "20140086584" | "20140193150" | "7317688" | "8000602" | "8565601" | "8687960" | "8774621").PN. OR ("8934770").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/04/02 16:24
S38	1	(12/692720).APP.	USPAT; USOCR	OR	ON	2016/04/02 16:25
S39	43	("20050097378" | "20060029389" | "20060093356" | "20060153238" | "20080195881" | "20080304519" | "20090067373" | "20090097428" | "20090119524" | "20090154355" | "20090201837" | "20090204827" | "20090204828" | "20090204836" | "20090282277" | "20090327506" | "20100023658" | "20100046543" | "20100080111" | "20100118753" | "5504606" | "6778550" | "6795450" | "7287175" | "7389528" | "7391746" | "7392412" | "7545813" | "7751711" | "7920597" | "7930373" | "8000602" | "8127164" | "8156359").PN. OR ("8275261").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2016/04/02 16:25

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14414698	KHOTIMSKY ET AL.
	Examiner	Art Unit
	OOMMEN JACOB	2637

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

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

CLAIM		DATE								
Final	Original	04/02/2016								
	1	✓								
	2	✓								
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	4	✓								
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/414,698	01/13/2015	Denis Andreyevich Khotimsky	009065-8132.US01

CONFIRMATION NO. 2029

97075
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

PUBLICATION NOTICE



Title:OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

Publication No.US-2015-0222440-A1
Publication Date:08/06/2015

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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	European Search Report mailed on July 7, 2015 for European Application No. 13816034.6, filed July 15, 2013 (7 pages).	☐

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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.

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.

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

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

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:	23061586
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	29-JUL-2015
Filing Date:	13-JAN-2015
Time Stamp:	16:48:47
Application Type:	U.S. National Stage under 35 USC 371

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)	2015-07-29_IDS-SB08.PDF	612229 ce422ea65b6c76a20dce3b91d83579803b1766e2	no	4

Warnings:	
Information:	

2	Non Patent Literature	EPSR070715_EP00.PDF	537844 d784ecf9bb95a1869ef6602594296c93580f0f3e	no	7

Warnings:	
Information:	
Total Files Size (in bytes):	1150073

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

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

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PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT3406866

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
DENIS ANDREYEVICH KHOTIMSKY	05/30/2015

RECEIVING PARTY DATA

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Internal Address:	SUITE 800
City:	RICHARDSON
State/Country:	TEXAS
Postal Code:	75080

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	14414698

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Address Line 4: SEATTLE, WASHINGTON 98111-1247

ATTORNEY DOCKET NUMBER:	009065-8132.US01
NAME OF SUBMITTER:	JENNIFER H. PAYNE
SIGNATURE:	/Jennifer H. Payne/
DATE SIGNED:	06/22/2015
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 3
source=2015-06-22_Assignment-ZTEUSA#page1.tif
source=2015-06-22_Assignment-ZTEUSA#page2.tif
source=2015-06-22_Assignment-ZTEUSA#page3.tif

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 Confirmation No.: 2029

Filed: January 13, 2015

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

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

DECLARATION AND ASSIGNMENT BY THE INVENTOR

I, Denis Andreyevich Khotimsky of Westborough, Massachusetts, hereby declare that:

I believe I am the sole original inventor or an original joint inventor of a claimed invention in a patent application entitled:

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

the specification of which:

☒ was filed at the U.S. Patent and Trademark Office on January 13, 2015, as Application Serial No. 14/414,698, and identified as Attorney Docket No. 009065-8132.US01.

☒ was described and claimed in PCT International Application No. PCT/US2013/050533 filed on July 15, 2013.

I believe the following persons are additional original joint inventors of the above-identified patent application:

LiQuan Yuan of Shanghai, P.R. China; and

DeZhi Zhang of Shanghai, P.R. China.

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

I have reviewed and understand the contents of the above-identified patent application including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I hereby acknowledge that any willful false statement made in the above declaration is punishable under 18 USC §1001 by fine or imprisonment of not more than five (5) years, or both.

ASSIGNMENT

I hereby assign to ZTE (USA) Inc., a corporation of New Jersey, having a place of business at 2425 North Central Expressway, Suite 800, Richardson, Texas 75080, and its successors and assigns (collectively hereinafter called "the Assignee"), the entire right, title and interest throughout the world in any and all inventions and improvements which are described in an application for United States Patent filed by me, entitled *OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS*, filed on January 13, 2015, and assigned U.S. Application Number 14/414,698.

This assignment includes the entire right, title and interest in said application, all legal equivalents thereof in any country, any and all United States and foreign patents, utility models, and design registrations granted for any of said inventions and improvements, including, but not limited to, all divisions, continuations, reissues, reexamination certificates, any and all certificates issued in any post-grant proceeding, and extensions of said applications and patents of the United States, foreign patents, utility models, and design registrations, and the right to claim priority based on the filing date of said application under the International Convention for the Protection of Industrial Property, the Patent Cooperation Treaty, the European Patent Convention, and all other treaties of like purposes, and the right to seek relief and recover all damages, including, but not limited to, a reasonable royalty, by reason of infringement or any other violation of patent or patent application rights. I authorize the Assignee to apply in all countries in my name or in the name of the Assignee for patents, utility models, design registrations and like rights of exclusion and for inventors' certificates for said inventions and improvements.

In addition, I hereby confirm the sale, assignment, and transfer to the Assignee of the entire right, title and interest throughout the world in said inventions and improvements that occurred by operation of an employment agreement between me and the Assignee existing at the time said inventions and improvements were made. Should I have any remaining interest, I

hereby sell, assign, and transfer any right, title and interest I may have in said inventions and improvements anywhere in the world to the Assignee.

The foregoing assignments, sale and transfer have been made for good and valuable consideration in accordance with the aforementioned employment agreement.

I hereby represent and covenant that no assignment, sale, agreement or encumbrance has been or will be made or entered into that would conflict with the assignment of said inventions and improvements to the Assignee.

I further covenant for myself and my respective heirs, legal representatives and assigns, to assist the Assignee in handling various procedures, tasks and documentation in connection with this assignment, including, but not limited to, providing to the Assignee promptly upon the request of the Assignee all pertinent facts and documents relating to said invention and improvements, and said patents, said legal equivalents or other legal instrument as may be known and accessible to me and testifying as to the same in any interference, litigation, or proceeding relating thereto, and promptly executing and delivering to the Assignee or its legal representative any and all papers, documents, instruments or affidavits in connection with obtaining, maintaining, issuing or enforcing said application, said inventions and improvements, and said patents, said equivalents and other legal instrument which may be necessary or desirable to carry out the purposes thereof.

I hereby authorize and request the Commissioner of Patents and Trademarks to issue one or more patents in the United States for said inventions and improvements to ZTE (USA) Inc. as assignee of the entire interest, for the sole use and benefit of Assignee, its successors and assigns.

I am competent to execute the above declaration and assignment. I hereby have duly executed the declaration and assignment below with my name.

Full name of inventor: DENIS ANDREYEVICH KHOTIMSKY
Inventor's signature: _____
Date: May 30, 2015

Perkins Coie LLP
P.O. Box 1247
Seattle, Washington 98111-1247
Telephone: (858) 720-5700
Facsimile: (206) 359-7198

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

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	
	Examiner Name	
	Attorney Docket Number	009065-8132.US01

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	1	20100111523	A1	2010-05-06	Hirth et al.	
	2	20100118753	A1	2010-05-13	Mandin et al.	
	3	20120027411	A1	2012-02-02	Gao et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	
	Examiner Name	
	Attorney Docket Number	009065-8132.US01

	1	2008/038981	WO	A1	2008-04-03	ELECTRONICS AND TELECOMM RESEARCH INSTITUTE		☐

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	1	International Search Report and Written Opinion mailed on October 22, 2013 for International Application No. PCT/US2013/050533, filed July 15, 2013 (10 pages).	☐
	2	ITU-T Telecommunication Standard Sector of ITU, "10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification," G.987.3, 131 pages, October 2010.	☐

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Examiner Signature		Date Considered	

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

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

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	Application Number	14414698
	Filing Date	2015-01-13
	First Named Inventor	Denis Andreyevich Khotimsky
	Art Unit	
	Examiner Name	
	Attorney Docket Number	009065-8132.US01

CERTIFICATION STATEMENT

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

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

OR

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Hwa C. Lee 59747/	Date (YYYY-MM-DD)	2015-06-19
Name/Print	Hwa C. Lee	Registration Number	59747

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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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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(72) Inventors; and

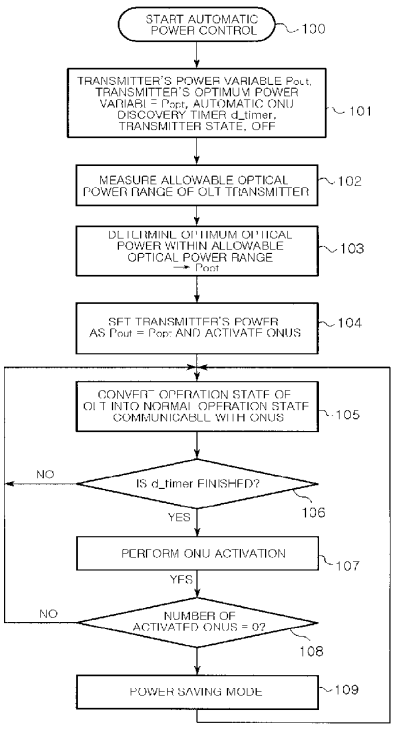
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(74) Agent: **C & S LOGOS PATENT AND LAW OFFICE**; 13th Floor, Seocho-Pyunghwa Building, 1451-34 Seocho-dong, Seocho-gu, Seoul 137-070 (KR).

(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, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: AUTOMATIC OPTICAL POWER CONTROL METHOD FOR OLT IN PON



(57) Abstract: Provided is an automatic optical power control method for an optical line terminal (OLT) of a passive optical network (PON). The automatic optical power control method includes at the OLT, measuring an allowable range of the optical power allowing a normal network operation on the PON, at the OLT, setting an optimum optical signal level within the measured allowable range of the optical power, and at the OLT, adjusting a power level of a transmitter to the set optimum optical signal level. Accordingly, an appropriate power level can be selected depending on an optical distribution network (ODN) structure to drive the transmitter. Also, when the entire optical network units are deactivated, a laser of the transmitter is turned off to thereby minimize unnecessary power consumption at the OLT.

WO 2008/038981 A1

(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).

Published:
— *with international search report*

Description

AUTOMATIC OPTICAL POWER CONTROL METHOD FOR OLT IN PON

Technical Field

[1] The present invention relates to a passive optical network (PON) system based on a time division multiple access (TDMA) mode, and more particularly, to an automatic optical power control method for an optical line terminal (OLT) in a TDMA-based PON.

[2]

Background Art

[3] PON technology is one of the fiber-to-the home (FTTH) technologies suggested to effectively provide a necessary band for a subscriber terminal. As illustrated in FIG. 4, a conventional PON is usually configured in a point-to-multipoint structure in which a plurality of optical network units (ONUs) 402 commonly share one OLT 401 through a passive device such as an optical distributor 403. Standardization association groups including International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) and Institute of Electrical and Electronics Engineers (IEEE) have standardized asynchronous transfer mode-passive optical network (ATM-PON), Ethernet passive optical network (E-PON) and Gigabit passive optical network (G-PON) as a FTTH network having such a PON structure.

[4] An optical transfer network between the OLT 401 and the corresponding ONUs 402 is called an optical distribution network (ODN), and the ODN is configured in a tree structure.

[5] If the ODN structure is formed in multiple steps, the OLT 401 and the individual ONUs 402 are spaced away from each other, or these two cases co-exist, a signal level is likely attenuated, and thus, maximum optical power is often required. For this reason, when data are transmitted from the OLT 401, it is generally mandated to use an optical signal at maximum power.

[6] However, because of the characteristics of the PON, which can have various ODN structures and variable distances to the ONUs, an optical signal at maximum power is usually unnecessary in most cases. Even though all of the ONUs 402 connected to the OLT 401 turn off during the operation of the PON, the OLT 401 transmits the optical signal, thereby increasing unnecessary power consumption.

[7] As one example of the conventional optical power control methods, Korean patent laid-open number 2005-0051997 disclosed on June 2, 2005 in the name of "Remote Power Control Apparatus and Method for PON System" proposes a method and

apparatus for remote controlling the intensity of a burst mode signal that ONUs transmit to an OLT in an E-PON. In detail, a signal intensity detector that detects the intensity of a received signal at a receiving unit of the OLT is provided to help the OLT to control an appropriate power intensity of an optical signal of each of the ONUs, so that the magnitude of the optical signal received at the OLT is uniform.

[8] As another example, Korean patent laid-open number 2005-0005602 disclosed on January 14, 2005 in the name of "Optical Signal Power Level Measuring Apparatus and OLT (Optical Line Termination) Having the Apparatus in Gigabit passive optical network" suggests an apparatus for measuring an optical signal power level in a G-PON and an OLT including the same apparatus. Due to the characteristics of the G-PON, optical power is adjusted when the optical power level of an ONU is out of a predetermined range, and not adjusted when the optical power level is within the predetermined range. On the basis of this fact, the intensity of an optical signal is not measured precisely but compared with a predetermined critical level. If necessary, an indication signal for adjusting the power level is generated.

[9] As described above, the optical power control in the typical PON proceeds by which the OLT adjusts the optical power at the ONU side to be in an appropriate range. Hence, a range of the optical signal that has to be processed at an OLT receiver decreases to reduce the power consumption and errors. However, optical power control at an OLT transmission side has not yet been suggested.

[10]

Disclosure of Invention

Technical Problem

[11] The present invention has been made to solve the foregoing problems of the prior art and it is therefore an object of certain embodiments of the present invention to provide an automatic optical power control method for an OLT in a PON allowing minimum power consumption at the OLT.

[12] Another object of the present invention is to provide an automatic optical power control method for an OLT in a PON controlling optical power by finding out an appropriate optical power level according to ODN structures different from each other and a distance between the OLT and an optical network by using software instead of hardware.

[13] Further another object of the preset invention is to provide an automatic optical power control method for an OLT in a PON capable of reducing unnecessary power consumption when network devices connected to the OLT are deactivated during the operation of the network devices.

[14]

Technical Solution

[15] According to an aspect of the present invention, there is provided a method for automatically controlling optical power in an OLT of a PON, the method comprising: measuring an allowable range of the optical power allowing a normal network operation on the PON, setting an optimum optical signal level within the measured allowable range of the optical power, and adjusting a power level of a transmitter to the set optimum optical signal level.

[16] The method may further comprise performing an ONU activation procedure of discovering ONUs operating in every predetermined period and registering the discovered ONUs when the OLT operates, checking the number of the activated ONUs after the ONU activation procedure, and performing a power saving mode of turning off power of the transmitter if the number of the activated ONUs is 0.

[17] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[18]

Advantageous Effects

[19] According to various embodiments of the present invention, in an OLT system based on a PON, particularly, a TDMA-based PON, an appropriate power level is selected according to an ODN structure of the corresponding PON, and an optical transmitter drives based on this selection. Furthermore, when all of the ONUs are not operating, a laser of the optical transmitter is turned off. As a result, unnecessary power consumption in the OLT can be minimized. Also, the power level of the OLT can be automatically controlled based on the operation of software without configuring an additional physical device or means, and thus, the automatic power level control can be implemented simply and cost-effectively in the conventional OLT.

[20]

Brief Description of the Drawings

[21] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[22] FIG. 1 is a flowchart to illustrate an overall procedure of an automatic optical power control method according to an embodiment of the present invention;

[23] FIG. 2 is a flowchart to illustrate a detailed procedure of measuring an allowable range of power in respect of the automatic optical power control method according to an embodiment of the present invention;

[24] FIG. 3 is a operational flowchart to illustrate a detailed power saving procedure in

respect of the automatic optical power control method according to an embodiment of the present invention; and

[25] FIG. 4 illustrates a configuration diagram of a typical PON.

[26]

Best Mode for Carrying Out the Invention

[27] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. It should be noted that those known functions and configurations related to the present invention will not be described in detail if it is determined that the detailed description thereof may make the scope of the present invention ambiguous.

[28] Also, like reference numerals denote like elements throughout different drawings.

[29] Hereinafter, a procedure of activating ONU(s) is the generally known mechanism applied to automatically discover the operating ONU(s) while being connected to a PON at an OLT side. Particularly, embodiments described herein are directed to adjust a power level of an OLT not to activate ONU(s) in order to automatically discover the ONUs. Thus, the ONU activation procedure will be not described in detail.

[30] FIG. 1 is a flowchart to illustrate an overall procedure of an automatic optical power control for an OLT in a PON according to an embodiment of the present invention.

[31] Particularly, an optical subscriber network with a TDMA-based PON structure will be mainly described in this embodiment illustrated in FIG. 1.

[32] The automatic optical power control method includes measuring an allowable range of optical power of the OLT in the PON (i.e., "power ranging mode", and selecting an optimum optical signal level within the allowable range of the optical power of the OLT and operating the PON. The automatic optical power control method may further include minimizing the power consumption when all of the ONUs turn off while the PON is operating (i.e., "power saving mode".

[33] With reference to FIG. 1, the automatic optical power control method will be described in detail.

[34] As mentioned above, the automatic optical power control method according to the present embodiment is implemented in the OLT of the TDMA-based PON. In detail, the automatic optical power control takes place at a control block controlling the operation of the OLT. Power is first applied to the OLT to initialize a system. During this procedure, the automatic optical power control can be instigated by a command from a network operator.

[35] In operation of 100, the automatic power control starts, and in operation of 101, variables necessary for the automatic power control and a state of an optical transmitter of the OLT are initialized.

[36] The variables for the automatic power control include a variable P_{out}, a variable P_{opt}, and a timer variable d_timer. The variable P_{out} indicates a power level of the OLT optical transmitter. The variable P_{opt} indicates an optimum power level of the OLT optical transmitter, and the timer variable d_timer estimates a period for discovering one or more than one new ONU at the OLT. The timer variable d_timer is initialized in every certain period of time T, and provides information on an automatic discovery period T for the new ONU. The variables P_{out} and P_{opt} and the time variable d_timer are initialized to a value of '0'. The OLT optical transmitter is initialized to an off state in which an optical signal is not transmitted.

[37] In operation of 102, an allowable range of optical power of the OLT in the current PON is measured. That is, the power ranging mode is performed. The allowable range of the optical power of the OLT is defined from a minimum power level at which power is in an on-state on the current PON, i.e., data can be transmitted to ONU(s) that can transmit and receive an optical signal to a maximum power level that the OLT optical transmitter can generate. A minimum power level of the allowable optical power range can be determined by repetitively performing an activation procedure of discovering one or more than one ONU while changing a power level of the optical transmitter and a deactivation procedure of canceling the discovered ONU(s) and comparing the number of the discovered ONU(s) at different power levels with each other. Preferably, the lowest power level at which the ONU(s) can be discovered as same as the number of the discovered ONU(s) at the maximum power level is set as the minimum power level. The operation 102 of measuring the allowable optical power range of the OLT will be better understood in FIG. 2.

[38] After the allowable optical power range of the OLT is measured, in operation of 103, an optimum optical power level is selected within the measured allowable range of the optical power so as to be set as a value of the variable P_{opt}. If the optimum optical power level is set based on the minimum power level within the allowable optical power range, the optimum optical power level include an offset value for the ONU(s) added after the optical power is set according to the present embodiment. That is, the optimum optical power level is set as $P_{opt}(dBm) = P(i) + P_{offset}$, where '1' is a power level, wherein 1=i=k, k being the maximum power level. Herein, P_{offset} is an offset power level for one or more than one ONU additionally connected to the PON after the optical power level of the OLT is set, and P_{offset} (dBm) is defined as 'Lmax X 0.2 dBm' as shown in FIG. 4. The reference label 'Lmax' is a maximum allowable distance (in kilometers) between one ONU located at the shortest distance from the OLT and another ONU located at the longest distance from the OLT, and is specifically set for each PON. The reference label '0.2' dBm is an amount of attenuation per unit distance (e.g., 1 Km) of an optical signal transmitted through the generally known optical

fibers. For instance, for the specification of the G-PON standardized by ITU-T, the maximum allowable distance between the ONU at the shorted distance and the other ONU at the longest distance is set as being approximately 20 Km, and in such a case, P_{offset} can be specifically set as being approximately 4 dBm.

[39] When the optimum power level is set based on calculation, if the P_{opt} value calculated as above is greater than the maximum power level P(k) at the OLT, the optimum power level is preferably determined as being $P_{opt} = P(k)$.

[40] In operation of 104, a power level of the optical transmitter is set as being the above determined P_{opt}. As similar to the general initial operation of the OLT, the ONU activation procedure is performed to discover one or more than one ONU connected to the PON. After the completion of the ONU activation procedure, data can be normally exchanged with the discovered ONU(s) in operation of 105. The OLT transmits data at the optimum optical power level determined in the previous operation of 103. According to these serial operations, the power level of the OLT is not set as the maximum optical power level, but in consideration of an ODN structure and the distance from the OLT to the corresponding ONU in the corresponding PON. As a result, unnecessary power consumption can be minimized and at the same time, stable communication with the corresponding ONU can be achieved.

[41] Additional operation may be further performed to reduce the unnecessary power consumption caused by the ONU(s) when the power turns on or off during the normal network operation in the PON.

[42] After the previous operation of 105, while the network operation is normally performed, it is checked whether the timer variable d_timer is finished in operation of 106.

[43] When the timer variable d_timer is finished after the elapse of the predetermined time period T, in operation of 107, the ONU activation procedure is performed again to confirm again the ONU(s) currently connected to the PON.

[44] In operation of 108, it is checked whether the number of the ONU(s) discovered after the previous operation of 107 is 0.

[45] If the number of the ONU(s) is not 0, even if the number of the ONU(s) in the current PON is 1, it is determined as being in the operation. Thus, the optical transmitter of the OLT continuously performs the normal operation. On the contrary, if the number of the discovered ONU(s) is 0, it is determined there is no ONU operating in the current PON as like the case that one or more than one ONU turns off. Based on this determination, in operation of 109, the power saving procedure is performed to turn off a laser of the optical transmitter in order to reduce the unnecessary power consumption. Preferably, if one of the ONUs is connected to the current PON while in the power saving mode, the ONU activation procedure is performed by truing on the

laser of the optical transmitter periodically to allow the normal operation. If one of the ONUs is discovered after the ONU activation procedure, the power saving mode is terminated, and the operation 105 resumes, that is, the normal network operation is performed. A flow of the operation at the power saving mode will be described in FIG. 3.

[46] As described above, by performing the operations 106 to 109, depending on the on or off state of the ONU(s), the OLT turns off the laser of the optical transmitter consuming the greatest power when all of the ONUs do not operate during the network operation, so that unnecessary power consumption can be minimized.

[47] FIG. 2 is a detailed flowchart to illustrate the operation 102 of measuring an allowable optical power level range for the automatic optical power control method described in FIG. 1.

[48] In the automatic optical power control method according to the present embodiment, those necessary variables for measuring the allowable range of the optical power are set and initialized in operation of 200 to measure the allowable range of the optical power.

[49] The necessary variables include a variable P(i) and a variable num_ONU(i). The variable P(i) indicates the intensity of an ith power level when a range of power that the optical transmitter of the OLT can generate is expressed in sequence. The variable num_ONU(i) sets the power of the optical transmitter of the OLT as the variable P(i) and indicating the number of the ONU(s) discovered while the ONU activation procedure is performed. Herein, 'i' denotes a value equal to or greater than 1 and equal to or less than k (i.e., $1 = i = k$), and 'k' denotes a maximum power level that the optical transmitter of the OLT can generate. Referring to these variables, the optical transmitter of the OLT can generate the power at approximately k level, and the variable P(k) can be explained as being the maximum power at the optical transmitter. Additionally, in operation of 200, 'i' is initialized to 'k'

[50] In operation of 201, the optical transmitter of the OLT turns on, and in operation of 202, the intensity of the power of the optical transmitter is adjusted at the variable P(i). At this time, since the 'i' is initialized to 'k' if the laser of the optical transmitter drives for the first time, the intensity of the power of the optical transmitter is adjusted to the maximum power.

[51] In operation of 203, the ONU activation procedure is performed to automatically discover one or more than one ONU using the optical transmitter whose power level is adjusted at the variable P(i), and the number of the discovered ONU(s) is stored as the variable num_ONU(i).

[52] In operation of 204, when the power level is at the P(i), it is checked whether the number num_ONU(i) of the discovered ONU(s) is 0 or not.

[53] If the variable num_ONU(i) is 0, especially, when i=k and the number of the discovered ONU(s) is 0, there is no operating ONU. Thus, in operation of 210, the laser of the optical transmitter is turned off, and in operation of 211, the automatic optical power control procedure is finished without further operations.

[54] If the number num_ONU(i) of the discovered ONU(s) is greater than 1, in operation of 205, a deactivation procedure in which all of the registered ONU(s) in the previous operation of 203 are canceled is performed.

[55] Furthermore, in operation of 206, it is checked whether the current value of 'i' is 1, or the number of the discovered ONU(s) at the power level of the current variable P(i) is less than that of the discovered ONUs at the maximum power level of the variable P(k) (i.e., num_ONU(k) > num_ONU(i)).

[56] If the above two conditions checked in the previous operation 206 are not satisfied, a value of 'i' is decreased by 1 in operation of 207, the operation 202 resumes.

[57] In contrast, if one of the two conditions is satisfied, in operation of 208, the maximum allowable optical power is set as the maximum power P(k) that the optical transmitter of the OLT can generate, and the minimum allowable optical power level is set as the current power level P(i). Afterwards, in operation of 209, the procedure of measuring the allowable range of the optical power level of the OLT is finished.

[58] FIG. 3 is a detailed flowchart to illustrate the operation of performing the power saving mode described in FIG. 1.

[59] After the operation 109, in operation of 300, variables necessary for performing the power saving mode are set. The variables include a variable P_{out}, a variable P_{opt}, a variable d_timer. The variable P_{out} is indicative of a power level of the current optical transmitter, and the variable P_{opt} is indicative of an optimum power level. The variable d_timer is an automatic ONU discovery timer variable for checking the connection of the ONU(s) to the PON. The variable P_{opt} is a value set in the previous operation 103, and the variable d_timer is set in every period of T. The variable d_timer is to check the period of confirming the connection or disconnection of the ONU(s) to the PON to perform the normal network operation when even one of the ONUs is connected thereto according to an on or off sate of the ONU(s) while in the power saving mode.

[60] In operation of 301, the laser of the optical transmitter is turned off to save power, and in operation of 302, the off-state of the laser is sustained until the variable d_timer is finished.

[61] When the period reaches a value of T as the variable d_timer is finished, in operation of 303, the laser of the optical transmitter is turned on, and the power level P_{out} is set as the optimum power level P_{opt}. In operation of 304, the ONU activation procedure is performed again to discover the ONU(s).

[62] After the completion of the ONU activation procedure, in operation of 305, it is

checked whether the number of the discovered ONU(s) due to the ONU activation procedure is 0. If no ONU is discovered, the operation 301 resumes, so that the power saving mode is sustained.

[63] In contrast, if the number of the discovered ONU(s) is not 0, meaning that one of the ONUs is newly connected to the PON, in operation of 306, the power saving mode is terminated to run the normal network operation. The operation 105 described in FIG. 1 resumes.

[64] While the power saving mode is sustained, the operations of 301 to 305 are repetitively performed.

[65] The above described automatic optical power control method can be implemented using software in the OLT system without configuring hardware additionally.

[66] While the present invention has been described with reference to the particular illustrative embodiments and the accompanying drawings, it is not to be limited thereto but will be defined by the appended claims. It is to be appreciated that those skilled in the art can substitute, change or modify the embodiments into various forms without departing from the scope and spirit of the present invention.

Claims

[1] A method for automatically controlling optical power in an OLT (optical line terminal) of a PON (passive optical network), the method comprising the steps of:
measuring an allowable range of the optical power allowing a normal network operation on the PON;
setting an optimum optical signal level within the measured allowable range of the optical power; and
adjusting a power level of a transmitter to the set optimum optical signal level.

[2] The method according to claim 1, further comprising:
performing an ONU (optical network unit) activation procedure of discovering ONUs operating in every predetermined period and registering the discovered ONUs when the OLT operates;
checking the number of the activated ONUs after the ONU activation procedure; and
performing a power saving mode of turning off power of the transmitter if the number of the activated ONUs is 0.

[3] The method according to claim 2 wherein the measuring an allowable range of the optical power comprises initiating the measurement in response to a command from an operator when the power is initially applied to the OLT and the OLT performs an initialization procedure starting.

[4] The method according to claim 2, wherein the measuring an allowable range of the optical power comprises:
performing the ONU activation procedure of discovering the ONUs for each power level; and
determining the allowable range of the optical power as being defined from a minimum power level at which the number of the discovered ONUs is substantially the same as that of the discovered ONUs at a maximum power level that the transmitter can generate to the maximum power level.

[5] The method according to claim 2, wherein the setting an optimum optical signal level comprises:
setting the optimum optical signal level at a minimum power level within the allowable range of the optical power; and
adding the set optimum optical signal level and an offset power level for ONUs to be additionally connected to the PON.

[6] The method according to claim 5, wherein the offset power level is defined as 'Lmax[Km] x 0.2 dBm' and the 'Lmax' being a maximum allowable distance

between an ONU located at the shortest distance from the OLT and an ONU located at the longest distance from the OLT in the corresponding PON.

[7] The method according to claim 2, wherein the performing a power saving mode comprises:
performing an activation procedure of turning on a laser of the transmitter in every period to discover the ONUs;
checking whether the number of the ONUs discovered at the activation procedure is 0; and
turning off the laser of the transmitter if the number of the discovered ONUs is 0, and terminating the power saving mode if the number of the discovered ONUs is not 0.

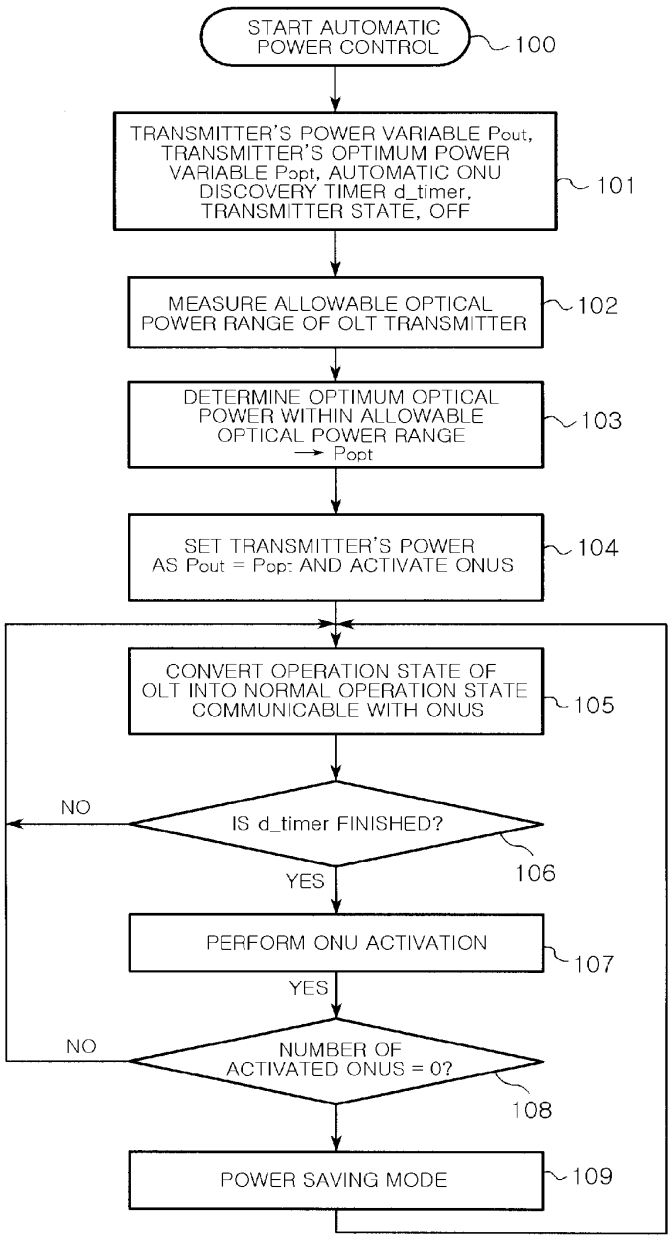
[8] The method according to claim 2, wherein the measuring an allowable range of the optical power comprises:
setting variables P(i) and num_ONU(i) and initializing the 'i' to 'k' wherein the variable P(i) indicates the intensity of an ith power and the variable num_ONU(i) indicates the number of the discovered ONUs at the power level of P(i), where $1 \leq i \leq k$, k being the maximum power level that the transmitter generates;
adjusting the power level of the transmitter to the variable P(i);
performing an activation procedure of discovering the ONUs through the transmitter having the adjusted power level of P(i) and storing the number of the discovered ONUs as the variable num_ONU(i);
performing a deactivation procedure of canceling the registration of the discovered ONUs;
checking whether the 'i' is 1, or the number num_ONU(i) of the ONUs discovered at the power level of P(i) is less than the number num_ONU(k) of the ONUs discovered at the maximum power level of P(k);
decreasing the 'i' by 1 if the 'i' is not 1 and the number num_ONU(i) of the discovered ONUs at the power level of P(i) is not less than the number num_ONU(k) of the ONUs discovered at the maximum power level of P(k) and performing again the adjusting the power level of the transmitter to the variable of P(i); and
setting the allowable range of the optical power as being in a range of P(i) to P(k) if the 'i' is 1 or the number num_ONU(i) of the discovered ONUs at the power level of P(i) is less than the number num_ONU(k) of the ONUs discovered at the maximum power level of P(k).

[9] The method according to claim 8, wherein the measuring an allowable range of the optical power further comprises:
checking whether the number of the discovered ONUs is 0 when the activation

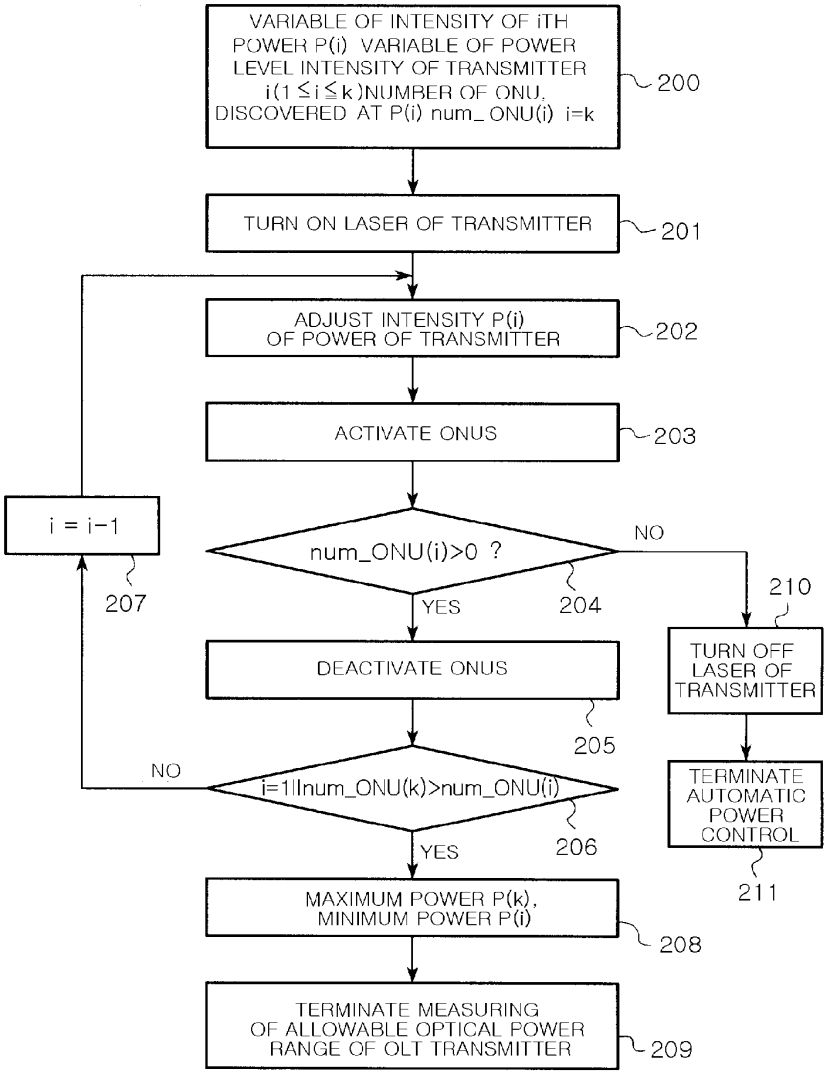
procedure is performed while the power level of the transmitter is adjusted to the variable of P(k); and

terminating the control of the optical power of the transmitter if the number of the discovered ONUs is 0.

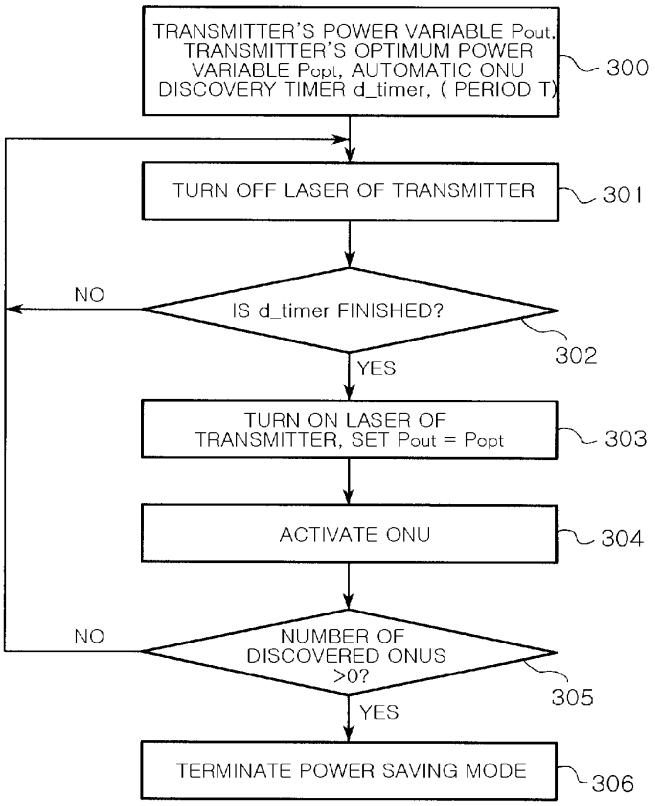
[Fig. 1]


START AUTOMATIC POWER CONTROL
100
TRANSMITTER'S POWER VARIABLE Pout, TRANSMITTER'S OPTIMUM POWER VARIABLE Popt, AUTOMATIC ONU DISCOVERY TIMER d_timer, TRANSMITTER STATE, OFF
101
MEASURE ALLOWABLE OPTICAL POWER RANGE OF OLT TRANSMITTER
102
DETERMINE OPTIMUM OPTICAL POWER WITHIN ALLOWABLE OPTICAL POWER RANGE → Popt
103
SET TRANSMITTER'S POWER AS Pout = Popt AND ACTIVATE ONUS
104
CONVERT OPERATION STATE OF OLT INTO NORMAL OPERATION STATE COMMUNICABLE WITH ONUS
105
NO
IS d_timer FINISHED?
106
YES
PERFORM ONU ACTIVATION
107
YES
NO
NUMBER OF ACTIVATED ONUS = 0?
108
POWER SAVING MODE
109

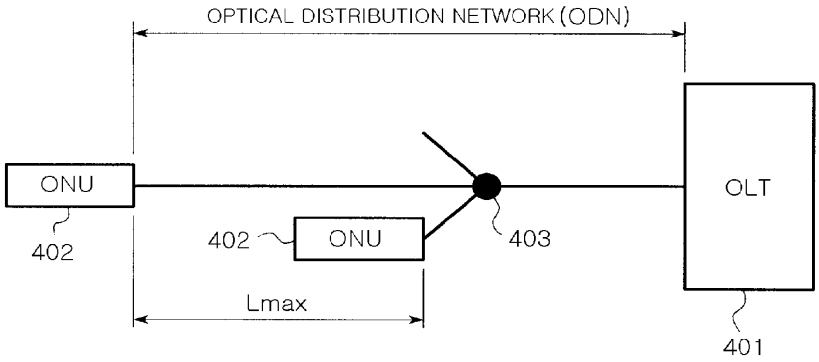
[Fig. 2]


VARIABLE OF INTENSITY OF iTH POWER P(i) VARIABLE OF POWER LEVEL INTENSITY OF TRANSMITTER i(1 ≤ i ≤ k)NUMBER OF ONU, DISCOVERED AT P(i) num_ONU(i) i=k
200
TURN ON LASER OF TRANSMITTER
201
ADJUST INTENSITY P(i) OF POWER OF TRANSMITTER
202
ACTIVATE ONUS
203
num_ONU(i)>0 ?
204
NO
YES
i = i-1
207
210
TURN OFF LASER OF TRANSMITTER
DEACTIVATE ONUS
205
TERMINATE AUTOMATIC POWER CONTROL
211
NO
i=1||num_ONU(k)>num_ONU(i)
206
YES
MAXIMUM POWER P(k), MINIMUM POWER P(i)
208
TERMINATE MEASURING OF ALLOWABLE OPTICAL POWER RANGE OF OLT TRANSMITTER
209

[Fig. 3]


TRANSMITTER'S POWER VARIABLE Pout, TRANSMITTER'S OPTIMUM POWER VARIABLE Popt, AUTOMATIC ONU DISCOVERY TIMER d_timer, (PERIOD T)
300
TURN OFF LASER OF TRANSMITTER
301
NO
IS d_timer FINISHED?
302
YES
TURN ON LASER OF TRANSMITTER, SET Pout = Popt
303
ACTIVATE ONU
304
NO
NUMBER OF DISCOVERED ONUS >0?
305
YES
TERMINATE POWER SAVING MODE
306

[Fig. 4]


OPTICAL DISTRIBUTION NETWORK (ODN)
ONU
402
402
ONU
403
OLT
Lmax
401

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/004678

A. CLASSIFICATION OF SUBJECT MATTER

H04B 10/13(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) :"PON, power, control, OLT, automatic"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-069501 A(FURUKAWA ELECTRIC CO LTD) 07 Mar. 2003 Abstract, Fig.9	1-9
A	JP 1998-163960 A (NEC ENG LTD , NEC CORP) 19 Jun. 1998 Abstract, Fig.1	1-9
A	KR 2006-027643 (KT CORPORATION) 28 Mar, 2006 Abstract, Fig.2	1-9
A	KR 2005-051997 (KT CORPORATION) 2 Jun. 2005 Abstract, Fig.2	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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
21 DECEMBER 2007 (21.12.2007)	**21 DECEMBER 2007 (21.12.2007)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer LEE, Jin Ick Telephone No. 82-42-481-5770

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2007/004678

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP15069501	07.03.2003	JP15069501	07.03.2003
		JP2003069501A2	07.03.2003
JP10163960	19.06.1998	EP00845882A2	03.06.1998
		EP0845882A2	03.06.1998
		EP845882A2	03.06.1998
		EP845882A3	19.05.1999
		JP10163960A2	19.06.1998
		JP10163960	19.06.1998
KR2006027643A	28.03.2006	None	
KR2005051997A	02.06.2005	None	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 009065-8132WO01	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2013/050533**	International filing date *(day/month/year)* **15 July 2013 (15.07.2013)**	(Earliest) Priority Date *(day/month/year)* 13 July 2012 (13.07.2012)
Applicant **ZTE CORPORATION et al**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/050533

A. CLASSIFICATION OF SUBJECT MATTER

H04B 10/25(2013.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B 10/25; H04B 10/13; G08C 17/02; H04B 10/08; G06F 1/32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: passive optical network, low, power, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0163808 A1 (GEUN YONG KIM et al.) 28 June 2012 See paragraphs 33-57, 64-82; and figure 4.	1-17
A	US 2010-0118753 A1 (JEFF MANDIN et al.) 13 May 2010 See paragraphs 27-38; and figure 3.	1-17
A	US 2012-0027411 A1 (HAI GAO et al.) 02 February 2012 See paragraphs 56-59; and figure 4.	1-17
A	WO 2008-038981 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 03 April 2008 See paragraphs 47-62; and figure 3.	1-17
A	US 2010-0111523 A1 (RYAN E. HIRTH et al.) 06 May 2010 See paragraphs 50-65; and figure 7.	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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
21 October 2013 (21.10.2013)	**22 October 2013 (22.10.2013)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
BYUN, Sung Cheal
Telephone No. +82-42-481-8262

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/050533

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012-0163808 A1	28/06/2012	KR 10-2012-0071577 A	03/07/2012
US 2010-0118753 A1	13/05/2010	CN 101562760 A	21/10/2009
		CN 101820349 A	01/09/2010
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US 2012-0027411 A1	02/02/2012	AT 544250 T	15/02/2012
		CN 101317333 A	03/12/2008
		CN 101317333 B	27/02/2013
		CN 1988502 A	27/06/2007
		DK 1801984 T3	21/05/2012
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		PT 1801984 E	07/05/2012
		US 2007-0140691 A1	21/06/2007
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		WO 2007-131457 A1	22/11/2007
WO 2008-038981 A1	03/04/2008	KR 10-0763530 B1	05/10/2007
		US 2010-0008667 A1	14/01/2010
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US 2010-0111523 A1	06/05/2010	CN 102204131 A	28/09/2011
		EP 2368332 A2	28/09/2011
		EP 2368332 A4	26/12/2012
		TW 201032501 A	01/09/2010
		US 8498534 B2	30/07/2013
		WO 2010-053671 A2	14/05/2010
		WO 2010-053671 A3	15/07/2010

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
AI BING

PERKINS COIE LLP P.O. BOX 1247 SEATTLE,
WASHINGTON 98111-1247 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**22 October 2013 (22.10.2013)**
Applicant's or agent's file reference 009065-8132WO01	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/050533	**15 July 2013 (15.07.2013)**	13 July 2012 (13.07.2012)

International Patent Classification (IPC) or both national classification and IPC
H04B 10/25(2013.01)i

Applicant
ZTE CORPORATION et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	21 October 2013 (21.10.2013)	BYUN, Sung Cheal Telephone No. +82-42-481-8262

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-17	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-17	NO
Industrial applicability (IA)	Claims	1-17	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following document:

D1: US 2012-0163808 A1 (GEUN YONG KIM et al.) 28 June 2012

2.1 Novelty (PCT Article 33(2)) and Inventive Step (PCT Article 33(3))

2.1.1 Claims 1-6

D1, which is considered to be the closest prior art to the subject matter of independent claim 1, discloses a method comprising: operating an optical network unit (ONU) in a dozing mode implying a period in which a transmitter is turned-off (see paragraph 37); and operating the optical network unit in a cyclic sleep mode implying a period in which both the transmitter and a receiver are turned-off (see paragraph 37). The technical feature of "transitioning the ONU directly between a first state and a second state, based on a power management rule" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an ITU-T is performing standardization for two modes, the dozing mode and the cyclic sleep mode under a recognition of the need to save power in the ONU (see paragraph 33). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 1. Accordingly, claim 1 would have been obvious over D1. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 2 depending on claim 1 is disclosed in D1 (an active interval implies a period in which both the transmitter and the receiver are turned-on; see paragraph 37). Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 3 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONT which receives an upstream bandwidth

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box No. V

allocation transmits a sleep request OFF message requesting the transition to the normal mode to the OLT; see paragraph 49). Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 4 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 5 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the OLT receives a sleep request OFF message transitions to the active state and transmits the sleep allow OFF message allowing the transition to the normal mode to the corresponding ONU; see paragraph 50). Therefore, claim 5 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 6 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (since the sleep allow ON message received in the active interval within the cyclic sleep mode is used to ask whether the ONU is normally operated or not, the ONU transmits an empty burst as an acknowledgement that the ONU is normally operated to the OLT, and then, transitions to the sleep mode; see paragraph 44). Therefore, claim 6 lacks an inventive step under PCT Article 33(3).

2.1.2 Claims 7-11

The features of independent apparatus claim 7 essentially correspond to those of method claim 1. Thus, the same reasoning as in claim 1 applies to claim 7. Therefore, claim 7 lacks an inventive step under PCT Article 33(3).

The additional features of claims 8-11 depending on claim 7 essentially correspond to those of claims 2-4 and 6, respectively. Accordingly, the same reasoning as in claims 2-4 and 6 applies to claims 8-11. Therefore, claims 8-11 lack an inventive step under PCT Article 33(3).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
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2.1.3 Claims 12-13

Claim 12 relates to an optical communication apparatus in accordance with claim 1 relating to a method. The apparatus of claim 12 comprises a memory; and a processor which uses stored instructions to implement the method that is the same as that defined in claim 1. As the features of claim 12 essentially correspond to the features of claim 1 except for the category, the same reasoning as in claim 1 applies to claim 12. Therefore, independent claim 12 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 13 depending on claim 12 can be easily derived by a person skilled in the art from the feature of D1 (an optical network unit (ONU) periodically turns on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns-on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 13 lacks an inventive step under PCT Article 33(3).

2.1.4 Claims 14-15

D1, which is considered to be the closest prior art to the subject matter of independent claim 14, discloses an optical line terminal (OLT) comprising a controller configured to control an operation of the OLT, wherein an ONU periodically turns on/off a receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off a transmitter and the receiver (cyclic sleep mode) and parameters associated with power saving include a sleep interval and an active interval (see paragraphs 37, 57, 82). The technical feature of "a transmitter configured to transmit the generated messages to the optical network unit (ONU)" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that the ONU receiving the sleep allow OFF message is switched into the normal mode and transmits the sleep request OFF message as the response for the sleep allow OFF message to the OLU (see paragraph 55). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 14. Accordingly, claim 14 would have been obvious over D1. Therefore, claim 14 lacks an inventive step under PCT Article 33(3).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Previous Page

The additional feature of claim 15 depending on claim 14 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 15 lacks an inventive step under PCT Article 33(3).

2.1.5 Claims 16-17

D1, which is considered to be the closest prior art to the subject matter of independent claim 16, discloses a passive optical network (PON) communications system comprising an optical network unit (ONU) periodically turning on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turning on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein the sleep interval implies a period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode (see paragraphs 37, 57). The technical feature of "an optical line terminal (OLT) configured to transmit a control message to the ONU" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an OLT transmits the sleep allow ON message allowing the transition to a next sleep mode to the ONT (see paragraph 43). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 16. Accordingly, claim 16 would have been obvious over D1. Therefore, claim 16 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 17 depending on claim 16 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 17 lacks an inventive step under PCT Article 33(3).

Continued on The Next Page

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
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2.2 Industrial Applicability (PCT Article 33(4))

Claims 1-17 are industrially applicable under PCT Article 33(4).

Electronic Acknowledgement Receipt

EFS ID:	22691616
Application Number:	14414698
International Application Number:	
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Hwa C. Lee/Jennifer Payne
Filer Authorized By:	Hwa C. Lee
Attorney Docket Number:	009065-8132.US01
Receipt Date:	19-JUN-2015
Filing Date:	13-JAN-2015
Time Stamp:	23:32:55
Application Type:	U.S. National Stage under 35 USC 371

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)	2015-06-19_IDS-SB08.PDF	612558 85515305f1a4248c5f75131b12e1b83e976977b4	no	4
Warnings:					
Information:					

2	Foreign Reference	WO2008038981.PDF	136086 39309c33d0282737fb9002b439011b89369a24b4	no	20
Warnings:					
Information:					
3	Non Patent Literature	ISRWO.PDF	1006831 1a66316f18bf2e50cbf9a9141e1d1178848b6e26	no	10
Warnings:					
Information:					
4	Non Patent Literature	ITUT_G9873.PDF	875832 621c9c2bf66c514cdefd7e2e9be85fb830c30422	no	131
Warnings:					
Information:					
			Total Files Size (in bytes):	2631307	

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 ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT3405764

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
LIQUAN YUAN	05/29/2015
DEZHI ZHANG	05/29/2015

RECEIVING PARTY DATA

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Internal Address:	HI-TECH INDUSTRIAL PARK, NANSHAN DISTRICT
City:	SHENZHEN
State/Country:	CHINA
Postal Code:	518057

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	14414698

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ATTORNEY DOCKET NUMBER:	009065-8132.US01
NAME OF SUBMITTER:	JENNIFER H. PAYNE
SIGNATURE:	/Jennifer H. Payne/
DATE SIGNED:	06/19/2015
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 6
source=2015-06-19_Declaration-Assignment_ZTECorp#page1.tif
source=2015-06-19_Declaration-Assignment_ZTECorp#page2.tif

source=2015-06-19_Declaration-Assignment_ZTECorp#page3.tif
source=2015-06-19_Declaration-Assignment_ZTECorp#page4.tif
source=2015-06-19_Declaration-Assignment_ZTECorp#page5.tif
source=2015-06-19_Declaration-Assignment_ZTECorp#page6.tif

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 Confirmation No.: 2029

Filed: January 13, 2015

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

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

DECLARATION AND ASSIGNMENT BY THE INVENTOR

I, LiQuan Yuan of Shanghai, P.R. China, hereby declare that:

I believe I am the sole original inventor or an original joint inventor of a claimed invention in a patent application entitled:

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

the specification of which:

☒ was filed at the U.S. Patent and Trademark Office on January 13, 2015, as Application Serial No. 14/414,698, and identified as Attorney Docket No. 009065-8132.US01.

☒ was described and claimed in PCT International Application No. PCT/US2013/050533 filed on July 15, 2013.

I believe the following persons are additional original joint inventors of the above-identified patent application:

Denis Andreyevich Khotimsky of Westborough, Massachusetts; and

DeZhi Zhang of Shanghai, P.R. China.

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

I have reviewed and understand the contents of the above-identified patent application including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I hereby acknowledge that any willful false statement made in the above declaration is punishable under 18 USC §1001 by fine or imprisonment of not more than five (5) years, or both.

ASSIGNMENT

I hereby assign to ZTE Corporation, a corporation of P.R. China, having a place of business at ZTE Plaza, No. 55 South Keji Road, Hi-Tech Industrial Park, Nanshan District, Shenzhen 518057, P.R. China, and its successors and assigns (collectively hereinafter called "the Assignee"), the entire right, title and interest throughout the world in any and all inventions and improvements which are described in an application for United States Patent filed by me, entitled *OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS*, filed on January 13, 2015, and assigned U.S. Application Number 14/414,698.

This assignment includes the entire right, title and interest in said application, all legal equivalents thereof in any country, any and all United States and foreign patents, utility models, and design registrations granted for any of said inventions and improvements, including, but not limited to, all divisions, continuations, reissues, reexamination certificates, any and all certificates issued in any post-grant proceeding, and extensions of said applications and patents of the United States, foreign patents, utility models, and design registrations, and the right to claim priority based on the filing date of said application under the International Convention for the Protection of Industrial Property, the Patent Cooperation Treaty, the European Patent Convention, and all other treaties of like purposes, and the right to seek relief and recover all damages, including, but not limited to, a reasonable royalty, by reason of infringement or any other violation of patent or patent application rights. I authorize the Assignee to apply in all countries in my name or in the name of the Assignee for patents, utility models, design registrations and like rights of exclusion and for inventors' certificates for said inventions and improvements.

In addition, I hereby confirm the sale, assignment, and transfer to the Assignee of the entire right, title and interest throughout the world in said inventions and improvements that occurred by operation of an employment agreement between me and the Assignee existing at the time said inventions and improvements were made. Should I have any remaining interest, I

hereby sell, assign, and transfer any right, title and interest I may have in said inventions and improvements anywhere in the world to the Assignee.

The foregoing assignments, sale and transfer have been made for good and valuable consideration in accordance with the aforementioned employment agreement.

I hereby represent and covenant that no assignment, sale, agreement or encumbrance has been or will be made or entered into that would conflict with the assignment of said inventions and improvements to the Assignee.

I further covenant for myself and my respective heirs, legal representatives and assigns, to assist the Assignee in handling various procedures, tasks and documentation in connection with this assignment, including, but not limited to, providing to the Assignee promptly upon the request of the Assignee all pertinent facts and documents relating to said invention and improvements, and said patents, said legal equivalents or other legal instrument as may be known and accessible to me and testifying as to the same in any interference, litigation, or proceeding relating thereto, and promptly executing and delivering to the Assignee or its legal representative any and all papers, documents, instruments or affidavits in connection with obtaining, maintaining, issuing or enforcing said application, said inventions and improvements, and said patents, said equivalents and other legal instrument which may be necessary or desirable to carry out the purposes thereof.

I hereby authorize and request the Commissioner of Patents and Trademarks to issue one or more patents in the United States for said inventions and improvements to ZTE Corporation as assignee of the entire interest, for the sole use and benefit of Assignee, its successors and assigns.

I am competent to execute the above declaration and assignment. I hereby have duly executed the declaration and assignment below with my name.

Full name of inventor: LIQUAN YUAN

Inventor's signature: Liquan Yuan

Date: 29/05/2015

Perkins Coie LLP
P.O. Box 1247
Seattle, Washington 98111-1247
Telephone: (858) 720-5700
Facsimile: (206) 359-7198

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Denis Andreyevich Khotimsky et al.

Application No.: 14/414,698 Confirmation No.: 2029

Filed: January 13, 2015

For: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

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

DECLARATION AND ASSIGNMENT BY THE INVENTOR

I, DeZhi Zhang of Shanghai, P.R. China, hereby declare that:

I believe I am the sole original inventor or an original joint inventor of a claimed invention in a patent application entitled:

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

the specification of which:

☒ was filed at the U.S. Patent and Trademark Office on January 13, 2015, as Application Serial No. 14/414,698, and identified as Attorney Docket No. 009065-8132.US01.

☒ was described and claimed in PCT International Application No. PCT/US2013/050533 filed on July 15, 2013.

I believe the following persons are additional original joint inventors of the above-identified patent application:

Denis Andreyevich Khotimsky of Westborough, Massachusetts; and

LiQuan Yuan of Shanghai, P.R. China.

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

I have reviewed and understand the contents of the above-identified patent application including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR §1.56.

I hereby acknowledge that any willful false statement made in the above declaration is punishable under 18 USC §1001 by fine or imprisonment of not more than five (5) years, or both.

ASSIGNMENT

I hereby assign to ZTE Corporation, a corporation of P.R. China, having a place of business at ZTE Plaza, No. 55 South Keji Road, Hi-Tech Industrial Park, Nanshan District, Shenzhen 518057, P.R. China, and its successors and assigns (collectively hereinafter called "the Assignee"), the entire right, title and interest throughout the world in any and all inventions and improvements which are described in an application for United States Patent filed by me, entitled *OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS*, filed on January 13, 2015, and assigned U.S. Application Number 14/414,698.

This assignment includes the entire right, title and interest in said application, all legal equivalents thereof in any country, any and all United States and foreign patents, utility models, and design registrations granted for any of said inventions and improvements, including, but not limited to, all divisions, continuations, reissues, reexamination certificates, any and all certificates issued in any post-grant proceeding, and extensions of said applications and patents of the United States, foreign patents, utility models, and design registrations, and the right to claim priority based on the filing date of said application under the International Convention for the Protection of Industrial Property, the Patent Cooperation Treaty, the European Patent Convention, and all other treaties of like purposes, and the right to seek relief and recover all damages, including, but not limited to, a reasonable royalty, by reason of infringement or any other violation of patent or patent application rights. I authorize the Assignee to apply in all countries in my name or in the name of the Assignee for patents, utility models, design registrations and like rights of exclusion and for inventors' certificates for said inventions and improvements.

In addition, I hereby confirm the sale, assignment, and transfer to the Assignee of the entire right, title and interest throughout the world in said inventions and improvements that occurred by operation of an employment agreement between me and the Assignee existing at the time said inventions and improvements were made. Should I have any remaining interest, I

hereby sell, assign, and transfer any right, title and interest I may have in said inventions and improvements anywhere in the world to the Assignee.

The foregoing assignments, sale and transfer have been made for good and valuable consideration in accordance with the aforementioned employment agreement.

I hereby represent and covenant that no assignment, sale, agreement or encumbrance has been or will be made or entered into that would conflict with the assignment of said inventions and improvements to the Assignee.

I further covenant for myself and my respective heirs, legal representatives and assigns, to assist the Assignee in handling various procedures, tasks and documentation in connection with this assignment, including, but not limited to, providing to the Assignee promptly upon the request of the Assignee all pertinent facts and documents relating to said invention and improvements, and said patents, said legal equivalents or other legal instrument as may be known and accessible to me and testifying as to the same in any interference, litigation, or proceeding relating thereto, and promptly executing and delivering to the Assignee or its legal representative any and all papers, documents, instruments or affidavits in connection with obtaining, maintaining, issuing or enforcing said application, said inventions and improvements, and said patents, said equivalents and other legal instrument which may be necessary or desirable to carry out the purposes thereof.

I hereby authorize and request the Commissioner of Patents and Trademarks to issue one or more patents in the United States for said inventions and improvements to ZTE Corporation as assignee of the entire interest, for the sole use and benefit of Assignee, its successors and assigns.

I am competent to execute the above declaration and assignment. I hereby have duly executed the declaration and assignment below with my name.

Full name of inventor: DEZHI ZHANG

Inventor's signature: DEZHI ZHANG

Date: 2015.05.29

Perkins Coie LLP
P.O. Box 1247
Seattle, Washington 98111-1247
Telephone: (858) 720-5700
Facsimile: (206) 359-7198

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

U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
14/414,698	Denis Andreyevich Khotimsky	009065-8132.US01

97075
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

INTERNATIONAL APPLICATION NO.	
PCT/US2013/050533	
I.A. FILING DATE	PRIORITY DATE
07/15/2013	07/13/2012

CONFIRMATION NO. 2029
371 ACCEPTANCE LETTER

OC000000074702335

Date Mailed: 04/27/2015

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

01/13/2015
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Copy of the International Application filed on 01/13/2015
- Copy of the International Search Report filed on 01/13/2015
- U.S. Basic National Fees filed on 01/13/2015
- Priority Documents filed on 01/13/2015
- Authorization to Permit Access filed on 01/13/2015
- Application Data Sheet (37 CFR 1.76) filed on 01/13/2015

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.495(c).

- Properly executed inventor's oath or declaration for the following inventor(s) has not been submitted: **Denis Andreyevich Khotimsky**, **LiQuan Yuan**, and **DeZhi Zhang**

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

KAREN M WILLIAMS

Telephone: (571) 272-9075

FORM PCT/DO/EO/903 (371 Acceptance Notice)

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
14/414,698	01/13/2015		2460	009065-8132.US01	17	5

CONFIRMATION NO. 2029

97075
Perkins Coie LLP - SDO General
PO Box 1247
Seattle, WA 98111-1247

FILING RECEIPT

OC000000074702334

Date Mailed: 04/27/2015

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

Inventor(s)

Denis Andreyevich Khotimsky, Westborough, MA;
LiQuan Yuan, Shanghai, CHINA;
DeZhi Zhang, Shanghai, CHINA;

Applicant(s)

ZTE Corporation, Shenzhen, CHINA
ZTE (USA) Inc., Morristown, NJ

Power of Attorney: The patent practitioners associated with Customer Number 97075

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/US2013/050533 07/15/2013

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
CHINA PCT/CN2012/078649 07/13/2012

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 04/18/2015
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/414,698**
Projected Publication Date: 08/06/2015
Non-Publication Request: No
Early Publication Request: No

Title

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

Preliminary Class

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where

the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

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

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

NOT GRANTED

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

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/414,698

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	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A		N/A	N/A			N/A	480
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A		N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	17	minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5	minus 3 =	* 2				x 420 =	840
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	2320

APPLICATION AS AMENDED - PART II

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

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

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

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

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

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

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
14414698	

Applicant(s) Denis Khotimsky

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1					
2		1				
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Total Indep	5		0		0	
Total Depend	12	↵	0	↵	0	↵
Total Claims	17		0		0	

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	Indep	Depend	Indep	Depend	Indep	Depend
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PTO-1390 (06-13)
Approved for use through 6/30/2013. OMB 0651-0021
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.

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371		Attorney Docket No. 009065-8132.US01 U.S. Application No. (if known, see 37 CFR 1.5)
International Application No. PCT/US2013/050533	International Filing Date 15 July 2013	Priority Date Claimed 13 July 2012
Title of Invention OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS		
First Named Inventor Denis Andreyevich Khotimsky et al.		

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.

2. ☒ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).

3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).

4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☐ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).

6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).

7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

10. ☐ A preliminary amendment.

11. ☒ An Application Data Sheet under 37 CFR 1.76.

12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).

13. ☐ A power of attorney and/or change of address letter.

14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825.

15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____

16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/US2013/050533	009065-8132.US01

17. [x] Other items or information: International Search Report and Written Opinion (10 pages)

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. [x] Basic national fee (37 CFR 1.492(a)) **$280**	$ 280.00	
19. [x] Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$720**	$ 720.00	
20. [x] Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB..... **$480** All other situations..... **$600**	$ 480.00	
TOTAL OF 18, 19, and 20 =	$ 1,480.00	
[ ] Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof **$400**		
Total Sheets: 39 - 100 = / Extra Sheets: 0 / 50 = / Number of each addition 50 or fraction thereof (round **up** to a whole number): / RATE: x **$400**	$ 0.00	
Surcharge of **$140.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).	$ 140.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	17 - 20 =	0	x **$80**	$ 0.00	
Independent claims	5 - 3 =	2	x **$420**	$ 840.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$780**	$ 0.00	
Processing fee of **$140.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)).			+	$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				$ 2,460.00	
[ ] **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.				$ 0.00	
[ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.				$ 0.00	
TOTAL NATIONAL FEE =				$ 2,460.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property.			+	$ 0.00	
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a. [ ] A check in the amount of $ _____ to cover the above fees is enclosed.

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c. [x] The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 50-5252 as follows:

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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

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 1: 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**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

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[x] The address associated with Customer Number: 97075 **OR** [ ] Correspondence address below

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Signature	/Vinay Sathe/	Date	January 13, 2015
Name (Print/Type)	Vinay Sathe	Registration No. (Attorney/Agent)	55,595

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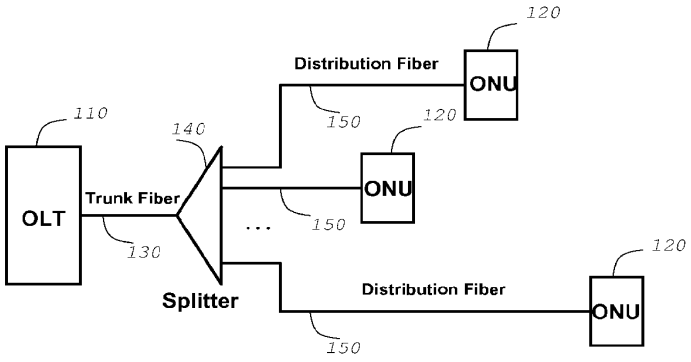


FIG. 1

(57) **Abstract**: Techniques for unified optical network unit power management in a passive optical network include operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on, operating the ONU in a second state in which both the transmitter and the receiver are turned off, and transitioning the ONU directly between the first state and the second state, based on a power management rule.

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OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent document claims the benefit of priority under the Paris Convention of International Patent Application No. PCT/CN2012/078649, filed on July 13, 2012, and entitled "METHOD AND APPARATUS FOR UNIFIED OPTICAL NETWORK UNIT (ONU) POWER MANAGEMENT IN A PASSIVE OPTICAL NETWORK (PON)." The disclosure of the before-mentioned application is incorporated by reference as part of this patent document.

BACKGROUND

[0002] This patent document relates to systems, devices, and techniques for data communications in a passive optical network. In one aspect, this document relates to power saving in an optical network unit (ONU) of a passive optical network (PON).

[0003] A PON is an optical network architecture based on point-to-multipoint (P2MP) topology in which a single optical fiber and multiple passive branching points are used to provide data communication services. A PON system can facilitate user access with a service provider communication facility to access telecommunication, information, entertainment, and other resources of the Internet. A PON system can include a central node, called an optical line terminal (OLT), which can be in connection with a single or multiple user nodes called ONUs via a passive optical distribution network (ODN). An OLT can be located at the access provider's communication facility (e.g., central office). An ONU can be located at or near the access user's premises. An ONU typically draws electrical power from the user's premises power supply network and may employ battery backup to support communication services in case of power outage.

[0004] Better power management techniques can help improve battery life of an ONU.

SUMMARY

[0005] Method and apparatus are disclosed that, in one beneficial aspect, are useful to reduce the power consumption of an optical network unit in a PON. Implementations described in this document can provide several advantages. For example, the disclosed techniques can

allow an access provider to guarantee lifeline services to customers by increasing the duration of operational time during power outages. The techniques can also be used to reduce the size and cost of the battery backup unit, reduce overall green-house gas emission and carbon footprint of the information and communication technologies based on passive optical networks, and so on.

[0006] In one example aspect, an optical communication method is disclosed. The method includes operating an ONU in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on, operating the ONU in a second state in which both the transmitter and the receiver are turned off and transitioning the ONU directly between the first state and the second state, based on a power management rule.

[0007] In another example aspect, a PON system is disclosed. The PON includes an ONU and an OLT. The ONU is operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit. The OLT is communicably coupled to the ONU and is configured to transmit a control message to the ONU to control at least one aspect of a transition of the ONU between the first low power mode and the second low power mode.

[0008] These, and other, features are further described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 depicts an example of a PON system.

[0010] FIG. 2 illustrates a power consumption profile of a conventional power management technique based on ONU dozing.

[0011] FIG. 3A illustrates a power consumption profile of a conventional power management technique based on cyclic sleeping.

[0012] FIG. 3B illustrates a power consumption profile of a conventional power management technique based on ONU dozing.

[0013] FIG. 3C illustrates a power consumption profile of a conventional power management technique based on cyclic sleeping.

[0014] FIG. 3D illustrates a double-nested cyclic profile that either includes cyclical sleeping or includes cyclical dozing.

[0015] FIG. 4A illustrates a power consumption profile of an embodiment of the disclosed unified ONU power management method.

[0016] FIG. 4B illustrates a power consumption profile of an embodiment of the disclosed unified ONU power management method, with sleep mode power consumption shown on the same chart.

[0017] FIG. 5 illustrates a state machine that governs ONU's behavior in an embodiment of the unified power management method.

[0018] FIG. 6 illustrates a state machine that governs OLT's behavior in an embodiment of the unified power management method.

[0019] FIG. 7A illustrates a prior art state machine for ONU power management.

[0020] FIG. 7B is an alternate way of representing the ONU state machine of FIG. 7A.

[0021] FIG. 7C is another embodiment of the ONU state machine of FIG. 7A.

[0022] FIG. 7D illustrates an OLT state machine for power management.

[0023] FIG. 7E illustrates an alternate embodiment of the OLT state machine depicted in FIG. 6.

[0024] FIG. 8 is a flow chart representation of a unified power management method.

[0025] FIG. 9 is a block diagram representation of a portion of an apparatus that implements unified power management technique disclosed in the document.

[0026] FIG. 10 is a flow chart representation of a process of operating an OLT.

[0027] FIG. 11 is a block diagram representation of a portion of an apparatus for optical communications.

DETAILED DESCRIPTION

[0028] Techniques for unified power management of an optical network unit (ONU) in which the ONU can transition between multiple low power states without having to transition to a high power state are disclosed. The terminology in the description that follows, to the extent used in the ITU-T XG-PON standards documents and not explicitly discussed in this document, is intended to be consistent with the ITU-T standards documents.

[0029] The techniques described in this document, in one beneficial aspect, are useful to reduce the power consumption of an optical network unit in a PON. Implementations described in this document can provide one or more advantages depending on specifics in certain applications. For example, the disclosed techniques can allow an access provider to guarantee lifeline services to customers by increasing the duration of operational time during power

outages. The techniques can also be used to reduce the size and cost of the battery backup unit, reduce overall green-house gas emission and carbon footprint of the information and communication technologies based on passive optical networks, and so on. The disclosed techniques are superior in terms of power saving efficiency to available prior state-of-the-art techniques. For example, the disclosed techniques are superior to a Dozing method implemented in some systems where the receiver is on for checking data while transmitter is off, at least due to substantially lower on average power level during the low power cycle. The disclosed technique is also superior to a cyclic sleep method implemented in some systems where both receiver and transmitter are off at least because of the decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle. In one beneficial aspect, the disclosed techniques allow ONUs to transition between a dozing state and a sleep state.

[0030] A PON system can use optical fiber to connect the user premises to the provider communication facility. The PON Optical Distribution Network (ODN) can include a point-to-multipoint (P2MP) optical fiber infrastructure where passive branching points can be represented by optical splitters are other similar passive optical devices. These passive ODN equipments can be deployed in street cabinets, closets, underground utility holes, cable chambers, and other installations and require no electrical power and little maintenance. The PON ODN can be attached to the OLT with a single strain of optical fiber.

[0031] FIG. 1 shows an exemplary PON system comprising an OLT 110, plurality of ONUs 120; and an ODN that comprises optical feeder fiber, or trunk fiber 130, a splitter 140, and multiple distribution fibers 150.

[0032] ONUs 120 can be deployed at or near user premises. An ONU is an active network element that typically draws electric power from the power supply network present at or near the access user's premises and in some cases is equipped with a battery-based power backup unit to allow limited operations in case of the power supply network failure. Conservation of the power consumed by an ONU is an operation requirement that can be associated with two objectives. First, the requirement is driven by the emergency services support under the power supply network failure and is targeted at the prolongation of the battery operation time or, alternatively, reduction of the size and cost of the battery. Second, the requirement focuses on

conserving power in regular (based on the power supply network) operations and minimizing the carbon dioxide emissions generated by information and communications technologies (ICTs).

[0033] Conventional standard-based PON systems, such as Ethernet PON (EPON), Broadband PON (BPON), Gigabit PON (G-PON) consider an ONU to be in a permanent link-layer association with the OLT: the ONU continuously listen to the downstream transmission over the P2MP optical channel and may be required to transmit protocol information upstream, even if there is no user data to exchange. Therefore, the ONU's optical transceiver continuously remains fully operational and fully powered. These conventional PON systems typically support only the basic, one-sided power conservation technique, such power shedding, characterized by powering off or reducing power to non-essential functions and services while maintaining a fully operational optical link.

[0034] Various advanced standard-based PON systems, such as 10 Gigabit/sec EPON (10G-PON), and 10 Gigabit/sec PON (XG-PON), employ protocol-based power-saving techniques based on a signalling mechanism between the OLT and the ONU to function properly. These techniques involve defining several power levels and specifying the cyclic behavior of an ONU which periodically switches between the full power level and one lower power level.

[0035] Besides the full power level, the standard-based 10 Gigabit/sec PON (XG-PON) system identifies the ONU Dozing power level, which is characterized by powering off of the ONU transmitter and the associated circuitry for substantial periods of time on the condition that the receiver remains continuously on, and the ONU Sleeping power level, which is characterized by both ONU transmitter and ONU receiver are turned off for substantial periods of time.

[0036] FIG. 7A shows the state machine behavior 700 of a PON ONU, as specified in one currently published PON standard (ITU-T G.987.3, 10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification, publication date October 2010). From the initial state "Active Free" 702, the ONU can either transition into a Sleep Aware state 704 or a Doze Aware state 706 (further described below). However, no direct transition between the Doze Aware and the Sleep Aware states 704, 706 are provided. Conventional ONUs therefore lack the technology of directly transitioning between two low power consumption states without having to go through an active state (e.g., a full powered state).

In one detrimental aspect, such a transition through the active state may increase the power consumed by the ONU, thereby undesirably reducing batter life.

[0037] FIG. 2 depicts example ONU power consumption profile, that is, the power P consumed by the ONU as a function of time t, in a case where ONU Dozing mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The dozing power level 210, which is lower than full power level 200, but substantially higher than zero (or sleep mode 220), is characterized by the ONU transmitter with the associated circuitry being powered off, and the transmitter remaining on. In other words, the ONU is in a "listen" mode to receive data or signals, but not in a "talk" mode to transmit data or signals. Two timing parameters, which can be configured into the ONU in advance, govern specific pattern of the power consumption: time interval 250 (T_{Doze}) is the maximum time an ONU can be allowed to abstain from upstream transmissions without being declared in violation of the protocol, while the time interval 260 (T_{Aware}) is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational. The longer the time interval 250 is with respect to time interval 260, the more efficient the technique is in relative terms. Since the ONU receiver remains continuously powered, the latency of detecting an external wake-up stimulus (a signal form the OLT to enter full power operation, in response, for example, to an incoming call) is close to that of full-power operation and is comparable to round-trip propagation delay. This is beneficial. The continuously powered ONU receiver may limit the overall power-saving efficiency.

[0038] FIG. 3A depicts example ONU power consumption profile, that is, the power P consumed by the ONU as a function of time t, when ONU Cyclic sleep mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being powered off, and is typically close to zero. Two configurable timing parameter govern specific pattern of the power consumption: time interval 270 (similar to T_{Aware}) is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational; time interval 280 (T_{Sleep}) is the maximum time an ONU can be allowed to abstain from upstream transmissions and from receiving downstream

traffic at the same time. While turning off both the transmitter and receiver is the most efficient way to save power, the latency of detecting an external wake-up stimulus may increase by as much as the time interval 280. Therefore, in order to maintain sufficiently short external wakeup latency, time interval 280 may be kept small, thus reducing the overall power efficiency.

[0039] Both the above discussed cyclic power management techniques (FIG. 2 and FIG. 3A) involve the ONU toggling between two power levels: the full power level and the Dozing level (FIG. 2) or between the full power level and the sleeping level (FIG. 3A). In some implementations, the power management behavior of an ONU may be configured by specifying two parameters: the maximum time in the lower power mode, and the minimum time in the full power mode. The values of the configuration parameters depend on the kind of services a system is expected to support, as well as the required availability of those services.

[0040] FIGS. 3B and 3C, respectively, provide another depiction of the dozing and sleep modes of operation, previously described, by explicitly showing the sleep state power level 220 in the charts.

[0041] FIG. 3D provides an illustrative representation that combines the above discussed sleep mode and dozing mode into a single graphical representation. An ONU alternates between the full power phase 351 and a lower power phase 353. While in in a low-power phase, an ONU alternates between two power consumption levels (depicted in inset 357): a full power level 359 and a low power level 361. In a pure doze mode, the ONU's latency in detecting an external wakeup stimulus is comparable to a round trip propagation delay, and the configured sojourn in a state with the low power level (Listen state) primarily depends on how long the OLT can afford to keep the ONU out-of touch. This value can be quite large and limited, for example, by the need to periodically adjust the equalization delay. In the cyclic sleep mode, the ONU's latency in detecting an external wakeup stimulus includes the sojourn in the low power state (Asleep state) and, therefore, the configured sojourn in a state with the low power level is substantially shorter – perhaps, by several orders of magnitude, compared with the doze case. Signals related to wake-up and sleep operations may be exchanged (355) at transitions between active phase 351 and power saving phase 353.

[0042] In one aspect, in some embodiments, the unified power management method disclosed in this document integrates the two cyclic power management techniques generally shown in FIGS. 7A, 2 and 3A, in a single unified behavior that involves ONU power

consumption alternating between at least three levels and is controlled by at least four timing parameters. Under this integration, when in a power saving mode, the ONU spends most of the time toggling between the Sleeping power level (with the lowest power consumption) and the Dozing power level (with the next lowest power consumption), only occasionally returning to the full-power level operation.

[0043] FIG. 4A shows one example power profile of the unified power management technique. In this example, the full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being power off, and is reasonably close to zero. The intermediate dozing power level 210 is characterized by the ONU transmitter with the associated circuitry being power off, and ONU receiver remaining on. Time interval 320 (similar to time intervals 260 and 270) is the minimum duration of the periodic bi-directional handshake between the OLT and the fully powered and operational ONU. Time interval 310 ($T_{LowPower}$) is the maximum allowed duration between consecutive bi-directional handshakes. Time interval 330 is the minimum time that the ONU listens to the downstream transmission in order to obtain any necessary signalling indications. Time interval 340 is the maximum time the ONU is allowed to abstain from upstream transmissions and from receiving downstream traffic at the same time.

[0044] As can be seen, the power reduction during the low power cycle depends on the ratio of time interval 310 to time interval 320, which can be made large, while the latency in response to an external stimulus depends on time interval 340, which can be relatively small. Therefore, in one advantageous aspect, the disclosed unified power management technique is superior in terms of power saving efficiency to both the Dozing method, due to substantially lower on average power level during the low power cycle, and the Cyclic Sleep method (as previously discussed with respect to FIGS. 2 and 3A), due to decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle.

[0045] It will be appreciated that the specific values of the time intervals 310, 320, 330 and 340 may be implementation-specific and may depend on operational considerations such as regulatory requirements, target time for battery life, and so on. For example, maximum dwell time in sleep state may be about 1 to 2 seconds, so that the ONU is responsive to an incoming

call within a couple of seconds. Similarly, maximum dwell time in the doze state may be relatively large (e.g., several tens of seconds or minutes, e.g., 2 minutes or 1 hour).

[0046] FIG. 4B is an alternative illustration of the power profile in a unified power management embodiment. Some implementation examples are provided below based the disclosed power management technology.

Low power mode signaling between OLT and ONU

[0047] In some implementations, the low power primitives specified in the following tables can be exchanged between OLT and ONU via appropriate management channel.

Table 1 – OLT Low power management primitives

Primitive	Semantics
LPM-Allow	OLT grants consent to ONU's transition into a low power mode
LPM-Disallow	OLT withdraws consent to ONU's transition into a low power mode

Table 2 – ONU Low power indication primitives

Primitive	Semantics
LPI-LowPower	ONU indicates its transition into a low power mode
LPI-Awake	ONU indicates its exit from a low power mode

ONU power management state machine

[0048] In some implementations, each ONU maintains an instance of the power management state machine that is characterized by the following states and the state transitions as shown in FIG. 5.

Table 3 – ONU power management states

State	Semantics
(1) ActiveHeld	A full power mode state in which full power operation is mandated by the OLT. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. Power management state transitions do not occur. The minimum sojourn in this state is enforced by the Thold timer. Both the OLT's consent and ONU's local decision are required for the ONU to enter a low power mode.
(2) ActiveFree	A full power mode state in which full power operation is at ONU's discretion. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. The OLT has consented to ONU's transition into a low power mode, which is now a subject to ONU's local decision. Upon transition into the Aware state (which is stipulated by the local stimulus ONU-LPC), the ONU sends an LPI-LowPower message to the OLT.
(3) Aware	A low power mode state allowing periodic bi-directional handshake between the OLT and ONU. Both ONU receiver and transmitter remain on. The ONU forwarding downstream traffic and responding to all bandwidth allocations. The sojourn in the state is parametrically controlled, if not truncated by the local stimulus ONU-WUC. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.
(4) Asleep	A low power mode state in which the ONU shuts down both its receiver and transmitter, retaining the ability to wake up on local stimulus ONU-WUC. The sojourn in the state is parametrically controlled, if not truncated by a local stimulus ONU-WUC. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

Table 3 – ONU power management states

State	Semantics
(5) Listen	A low power mode state in which the ONU has its transmitter off, but the receiver on. The ONU listens to the downstream signal and forwards downstream traffic, while retaining the ability to reactivate the transmitter on local stimulus ONU-WUC or upon receipt of LPM-Disallow message. The sojourn in the state is parametrically controlled if not truncated by a local stimulus ONU-WUC or LPM-Disallow message. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

[0049] In some implementations, an ONU maintains a pair of complementary, mutually exclusive internal conditions specified as follows.

Table 4 – ONU internal power conditions

Condition	Semantics
ONU-LPC	ONU Low Power Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU may go into low power mode.
ONU-WUC	ONU Wake-Up Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU must remain fully powered.

[0050] In some implementations, the ONU maintains the following timing parameters to control the ONU power management state machine and allows to specify the initial values of the timers as follows.

Table 5 – ONU timing parameters

Timer	Semantics
Thold	The minimum sojourn in the ActiveHeld state. The timer is initialised upon transition into the ActiveHeld state and blocks transition into the ActiveFree state until expiration.

Table 5 – ONU timing parameters

Timer	Semantics
Taware	The minimum sojourn in the Aware state, which defines the duration of the periodic bi-directional handshake between the OLT and an ONU in a low power mode. The timer is initialised upon transition into the Aware state; its expiration releases ONU's transition to either Asleep or Listen state.
Tlowpower (or Tlowp)	The maximum combined sojourn in the Asleep and Listen states between successive periodic bi-directional handshakes. The timer is initialised upon transition from the Aware state to either Asleep or Listen state; its expiration forces ONU's transition back to the Aware state.
Tsleep	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Asleep state; its expiration forces ONU's transition into the Listen state. To configure pure Sleep mode operation, the initial value is set to infinity with finite Tlisten and Tlowp initial values.
Tlisten	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Listen state; its expiration forces ONU's transition into the Asleep state. To configure pure Doze mode operation, the initial value is set to infinity with finite Tsleep and Tlowp initial values.

[0051] To support unified operation using three distinct power levels, in some implementations, the ONU timing parameters Tsleep and Tlisten are initialized each to a finite non-zero value, while Tlowpower is initialized to a finite value much larger than the initial values of either Tsleep or Tlisten. Then, during operation, values can be adjusted through parameter configuration to either Dozing or Cyclic Sleep modes. To implement Cyclic Sleep, timing parameter Tsleep may be initialized to infinity, timing parameter Tlisten may be initialized to zero, and timing parameter Tlowp may be initialized to finite non-zero value. To implement ONU Dozing, timing parameter Tlisten may be initialized to infinity, timing parameter Tsleep may be initialized to zero, and timing parameter Tlowp may be initialized to a finite non-zero value.

[0052] In the state diagram depicted in FIG. 5, the binary flag SleepOFF (SleepOn being its binary complement) is a matter of notational convenience which is used to indicate the operation of the machine in the ONU dozing mode. An alternative implementation could make a transition from Aware state upon expiration of the Taware timer unconditionally into the

Asleep state. In the ONU dozing mode, Tsleep is initialized to zero, and the transition to Listen would immediately follow.

OLT power management state machine

[0053] In some implementations, the OLT maintains an instance of the state machine for each subtending ONU that is characterized by the following states and the state transitions as shown in FIG. 6.

Table 6 – OLT power management states

State	Semantics
(1) AwakeForced	The OLT holds the ONU in a full power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.
(2) AwakeFree	The OLT consents to the ONU's transition into a low power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(3) LowPower	The OLT is aware that the ONU is in a low power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(4) Alerted	The OLT attempts to bring the ONU back into a full power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.

[0054] In some implementations, the OLT maintains a pair of complementary, mutually exclusive internal conditions for each subtending ONU specified as follows.

Table 7 – OLT internal power conditions

Condition	Semantics
OLT-LPC	OLT Low Power Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT consents to ONU going into a low power mode.
OLT-WUC	OLT Wake-Up Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT objects to ONU going into a low power mode.

[0055] In some implementations, the OLT maintains the following timing parameters to control an instance of the OLT power management state machine and allows to specify the initial values of the timers as follows.

Table 8 – OLT timing parameters

Timer	Semantics
Terr	The maximum allowed time between bi-directional handshakes between the OLT and the ONU in a low power mode. The timer is initialised upon transition into the LowPower state and is restarted each time OLT receives a transmission from the ONU. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.
Talerted	The maximum allowed time for the ONU to come out of the low power mode upon OLT's instruction to do so. The timer is initialised upon transition into the Alerted state. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.

[0056] Referring to FIGS. 7A through 7E, the present power management technology can improve power efficiency in the system shown in FIG. 7A.

[0057] FIG. 7B is an illustration of the ONU state machine in which the left side branch (sleep aware and asleep states) in FIG. 7A is eliminated to highlight low power aware operation.

[0058] FIG. 7C illustrates an expanded view of the internal semantics of the LowPower state to allow two alternating power levels (Receive or Rx on, and Rx off).

[0059] FIG. 7D is an example of a prior art OLT state machine. Note that the transition between sleep and doze states always goes through an awake state.

[0060] FIG. 7E is an alternate embodiment of the state machine depicted in FIG. 6. The state diagram in FIG. 7E uses the state diagram depicted in FIG. 7D and eliminates one of the two low power branches.

[0061] FIG. 8 is a flow chart representation of a unified power management method 800. The method 800 may be implemented on an ONU 120.

[0062] At 802, method 800 operates an ONU in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. For example, in some implementations, the first state may be the dozing state 210 discussed above.

[0063] At 804, method 800 operates the ONU in a second state in which both the transmitter and the receiver are turned off. In some implementations, the second state may correspond to the sleep state 220 discussed above.

[0064] At 806, method 800 directly transitions the ONU between the first state and the second state, based on a power management rule. Direct transition refers to changing the operational state of the ONU between the first and the second states without having to go through an intermediate third state in which the power utilized by the ONU increases (e.g., as in the Active state previously discussed). One power management rule may be based on the timing parameters that control how long the ONU can be in the first or the second mode (e.g., in sleep or dozing mode, as discussed previously). Other power management rules include transitioning based on a user input (e.g., phone going off the hook), responding incoming control messages from the OLT that specify entering or exiting the first and the second states, and so on.

[0065] FIG. 9 is a block diagram representation of an optical communications apparatus 900. The module 902 is for operating an optical network unit (ONU) in a first state (e.g., dozing) in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. The module 904 is for operating the ONU in a second state (e.g., sleep state) in which both the transmitter and the receiver are turned off. The module 906 is for transitioning the ONU directly between the first state and the second state, based on a power management rule. In some implementations, the transition may be achieved autonomously (i.e. without communication with an external network entity). In some implementations, the transition may be based on a message received from another network entity such as the OLT. In some implementations, the transition may be based on obtaining permission to transit from one low power mode to another low power

mode, obtained by sending a request message from the ONU to the OLT and receiving a corresponding grant message from the OLT.

[0066] FIG. 10 is a flow chart representation of a process 1000 of controlling operation of an optical network unit (ONU), operating in a passive optical network (PON).

[0067] At 1002, the process 1000 operates an OLT to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit.

[0068] At 1004, the process 1000 transmits the generated message from the OLT to the ONU. As previously discussed, the OLT may control the low power operation of ONUs by either explicitly providing control messages or by granting requests from the ONUs, e.g., transitioning from a dozing mode to a sleep mode. In some implementations, the process 1000 may further locally keep track of the state in which each ONU served by the OLT is.

[0069] FIG. 11 is a block diagram representation of an optical communications apparatus 1100. The module 1102 is for operating an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit. The module 1104 is for transmitting the generated message from the OLT to the ONU.

[0070] It will be appreciated that unified power management techniques are disclosed, allowing a device to extend battery life without unduly sacrificing responsiveness to communication requests. While the disclosed embodiments are with respect to the application to optical communications network, the disclosed techniques are equally applicable to other communications networks including wired and wireless networks.

[0071] The disclosed and other embodiments, modules and the functional operations described in this document can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this document and their structural equivalents, or in combinations of one or more of them. The disclosed and other embodiments can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer readable medium for execution by, or to control the operation of, data processing apparatus. The computer readable medium can be a machine-readable storage device, a machine-readable storage substrate, a

memory device, a composition of matter effecting a machine-readable propagated signal, or a combination of one or more them. The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them. A propagated signal is an artificially generated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal, that is generated to encode information for transmission to suitable receiver apparatus.

[0072] A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0073] The processes and logic flows described in this document can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

[0074] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are

a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Computer readable media suitable for storing computer program instructions and data include all forms of non volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0075] While this patent document contains many specifics, these should not be construed as limitations on the scope of an invention that is claimed or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this document in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or a variation of a sub-combination. Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results.

[0076] Only a few examples and implementations are disclosed. Variations, modifications, and enhancements to the described examples and implementations and other implementations can be made based on what is disclosed.

CLAIMS

What is claimed is:

1. A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

transitioning the ONU directly between the first state and the second state, based on a power management rule.

2. The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

configuring the power management rule based on the received power management message.

4. The method of claim 1, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

6. The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal; and

performing the transitioning responsive to the received power management message and a local decision to change an operational state.

7. An optical communication apparatus in a passive optical network, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

means for transitioning the ONU directly between the first state and the second state, based on a power management rule.

8. The apparatus of claim 7, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

9. The apparatus of claim 7, comprising:

means for receiving, by the receiver, a power management message from an optical line terminal; and

means for configuring the power management rule based on the received power management message.

10. The apparatus of claim 7, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

11. The apparatus of claim 7, further comprising:

means for receiving a power management message from an optical line terminal; and

means for performing the transitioning responsive to the received power management

message and a local decision to change an operational state.

12. An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that uses the stored instructions to implement a method, comprising operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on; and operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

wherein the processor includes means for transitioning the ONU directly between the first state and the second state, based on a power management rule.

13. The apparatus as in claim 12, wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and configuring the power management rule based on the received power management message, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

14. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off; and

a transmitter configured to transmit the generated messages to the optical network unit.

15. The optical line terminal as in claim 14, wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon

expiration of at least one of the first time period and the second time period.

16. A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode.

17. The system as in claim 16, wherein:

the OLT is configured to transmit the control message that includes a power management rule that specifies a first time period for operation in the first slow power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

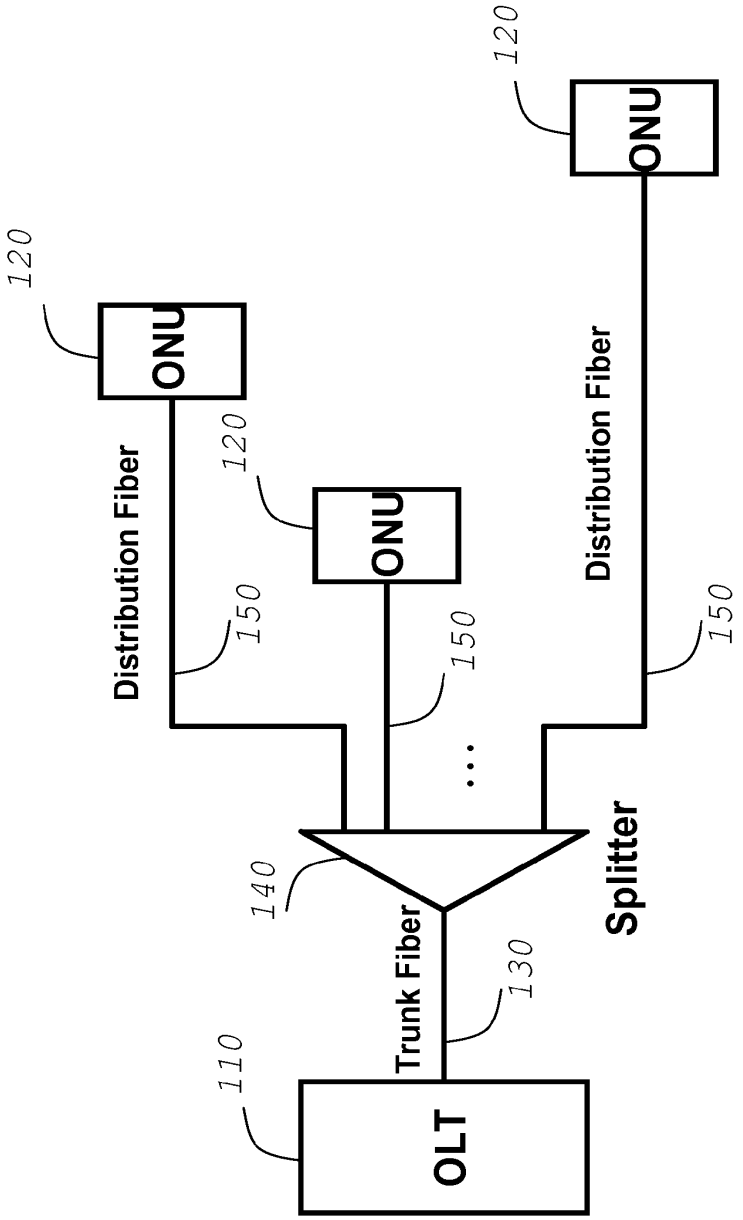

120
ONU
120
ONU
120
ONU
Distribution Fiber
Distribution Fiber
150
150
150
...
140
Splitter
Trunk Fiber
130
110
OLT

FIG. 1

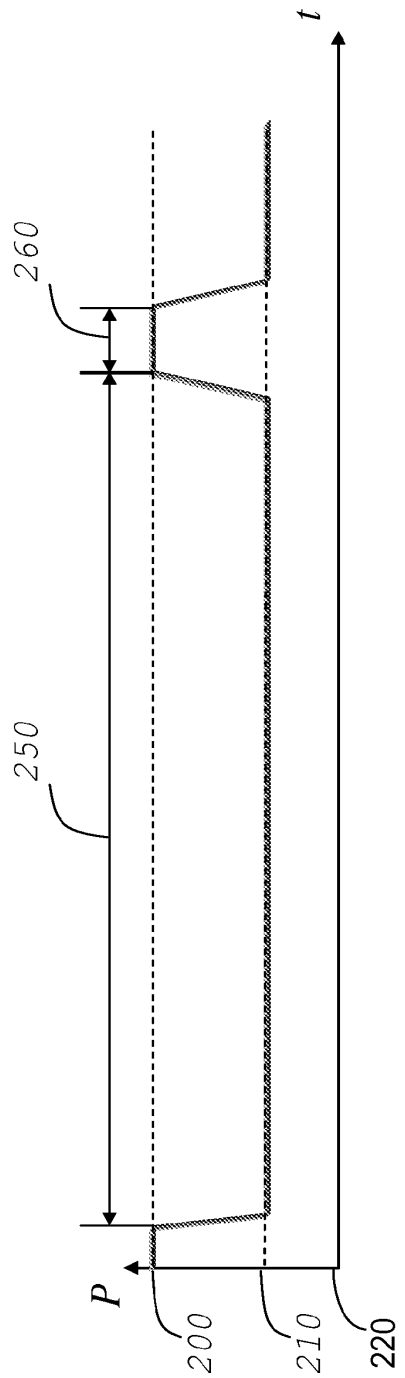


FIG. 2

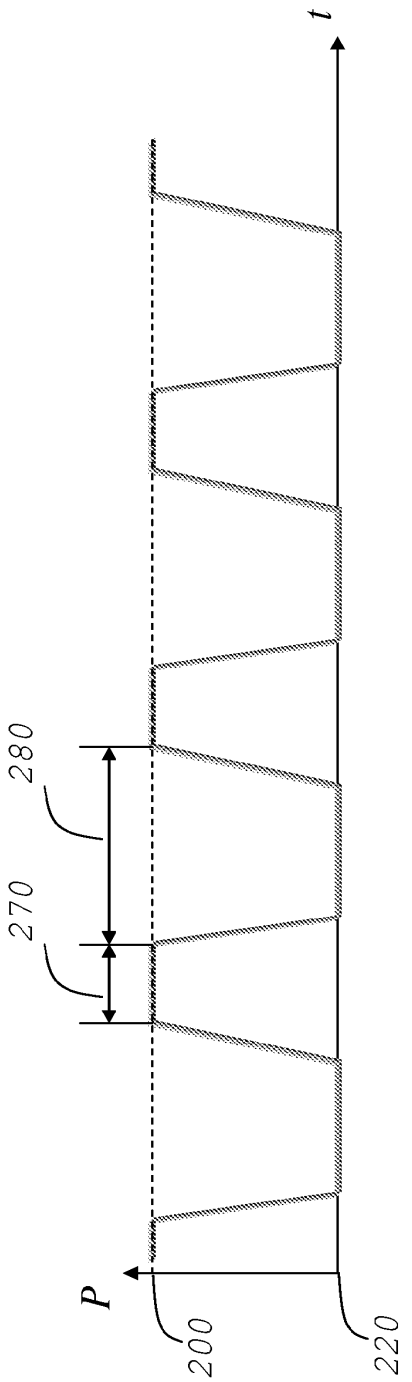


FIG. 3A

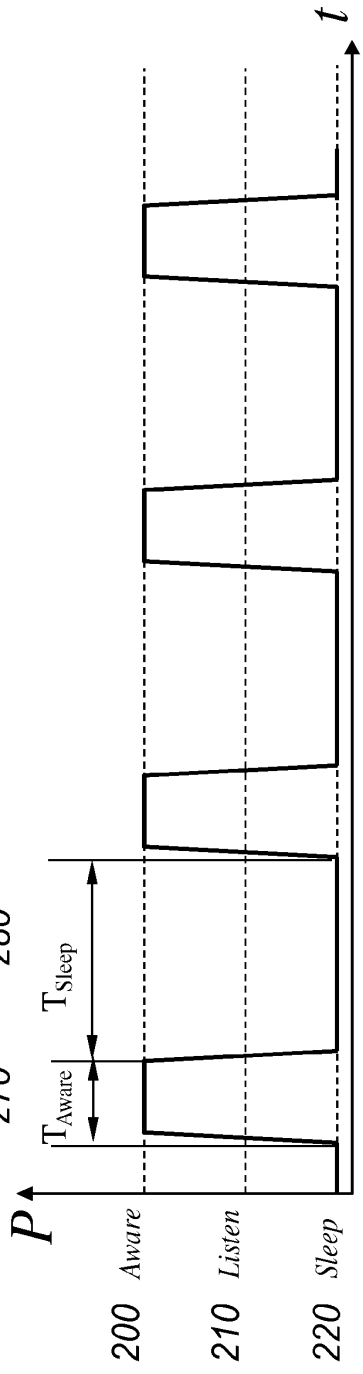

t
P
Aware
Listen
Sleep
200
210
220
270
280
T_Aware
T_Sleep

FIG. 3C

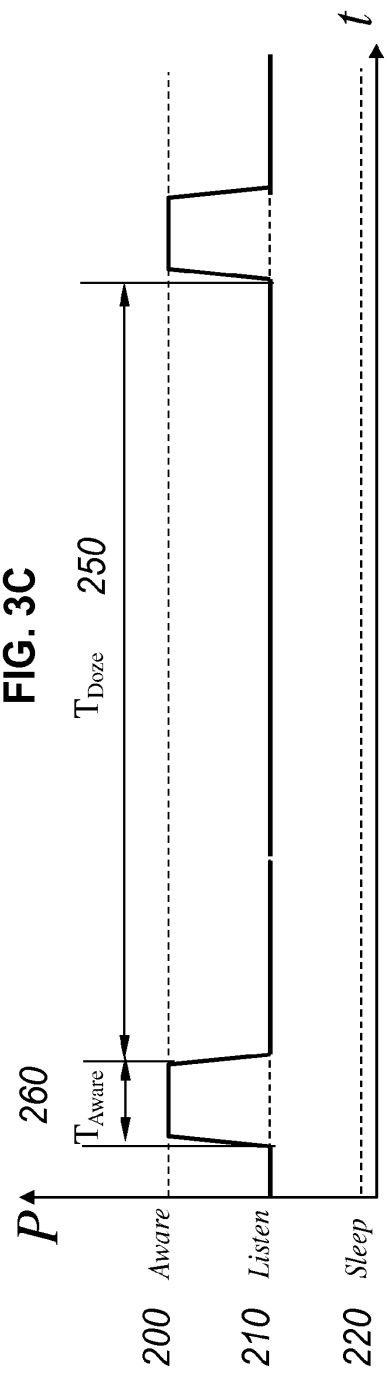

t
P
Aware
Listen
Sleep
200
210
220
260
250
T_Aware
T_Doze

FIG. 3B

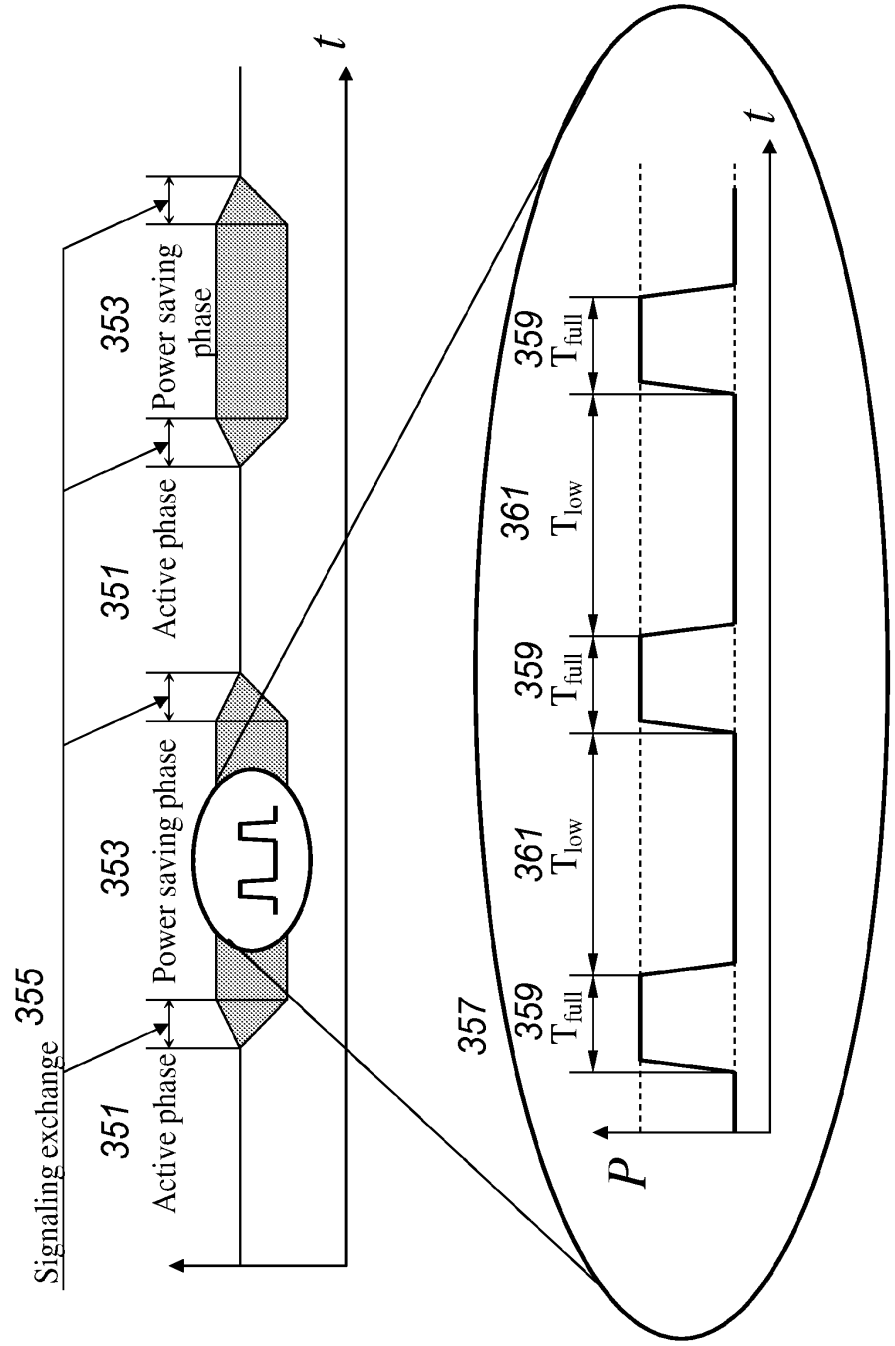

Signaling exchange
355
351
Active phase
353
Power saving phase
351
Active phase
353
Power saving phase
t
357
359
T_{full}
361
T_{low}
359
T_{full}
361
T_{low}
359
T_{full}
P
t

FIG. 3D

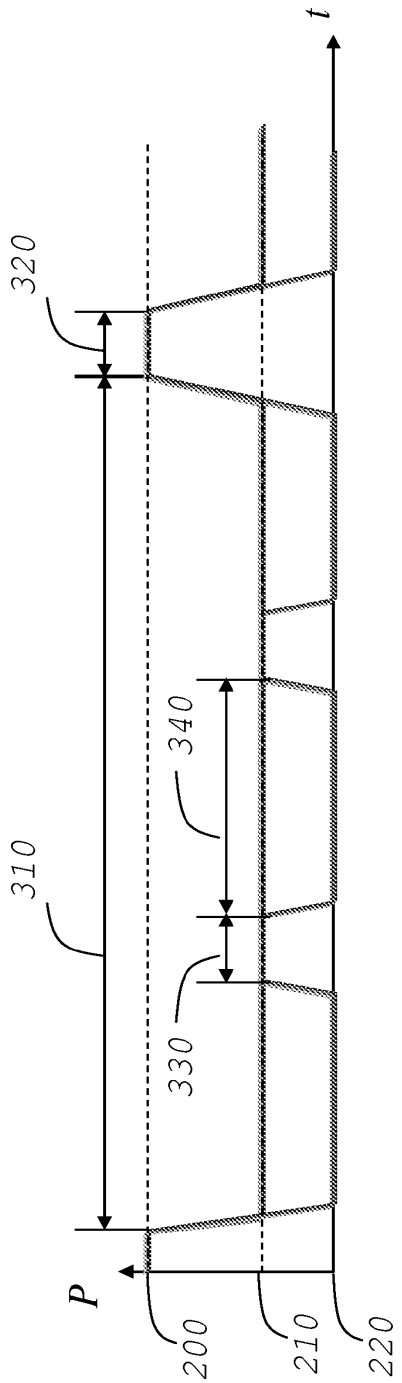


FIG. 4A

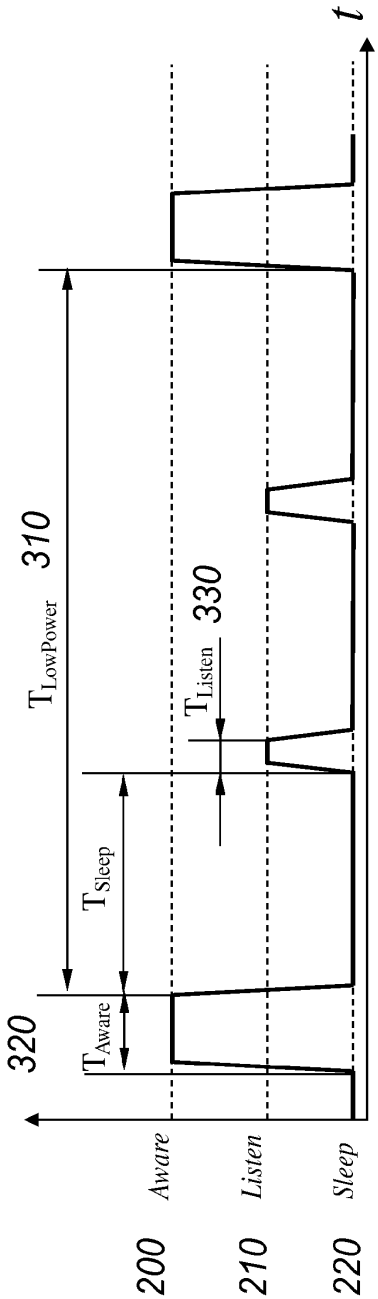

t
Aware
Listen
Sleep
200
210
220
320
T_{Aware}
T_{Sleep}
$T_{LowPower}$
310
T_{Listen}
330

FIG. 4B

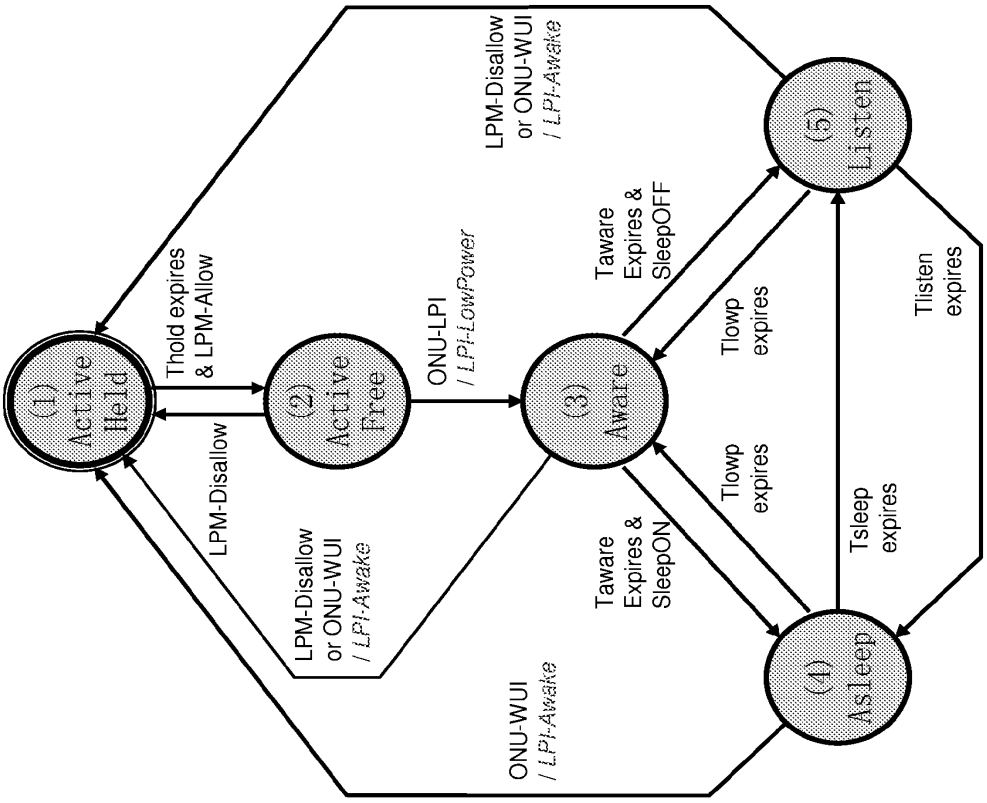

(1) Active Held
(2) Active Free
(3) Aware
(4) Asleep
(5) Listen
Thold expires & LPM-Allow
LPM-Disallow
ONU-LPI / LPI-LowPower
LPM-Disallow or ONU-WUI / LPI-Awake
LPM-Disallow or ONU-WUI / LPI-Awake
ONU-WUI / LPI-Awake
Taware Expires & SleepOFF
Taware Expires & SleepON
Tlowp expires
Tlowp expires
Tsleep expires
Tlisten expires

FIG. 5

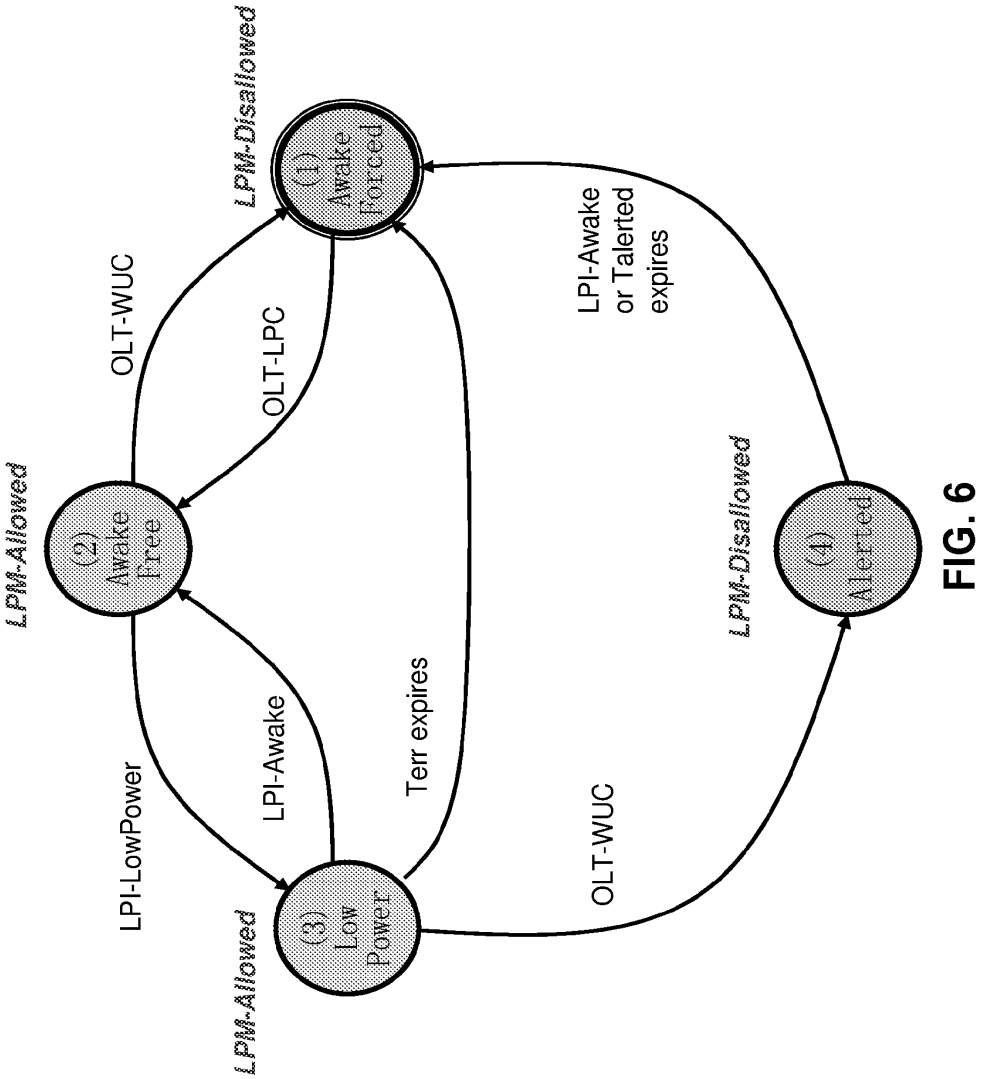

LPM-Disallowed
(1) Awake Forced
OLT-WUC
OLT-LPC
LPI-Awake or Talerted expires
LPM-Allowed
(2) Awake Free
LPI-LowPower
LPI-Awake
Terr expires
LPM-Disallowed
(4) Alerted
OLT-WUC
LPM-Allowed
(3) Low Power

FIG. 6

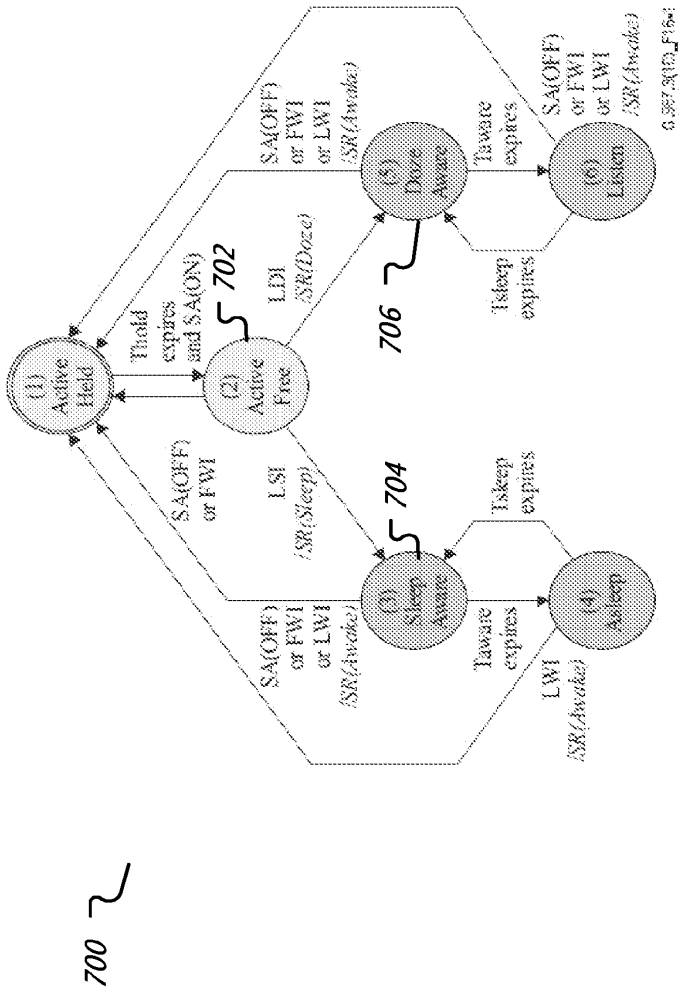

700
(1) Active Hold
(2) Active Free
(3) Doze Aware
(4) Asleep
(5) Sleep Aware
(6) Listen
Hold expires and SA(ON)
SA(OFF) or FWI
SA(OFF) or FWI or LWI (SR/Awake)
LDI (SR/Doze)
LSI (SR/Sleep)
Taware expires
Tsleep expires
LWI (SR/Awake)
702
704
706

FIG. 7A

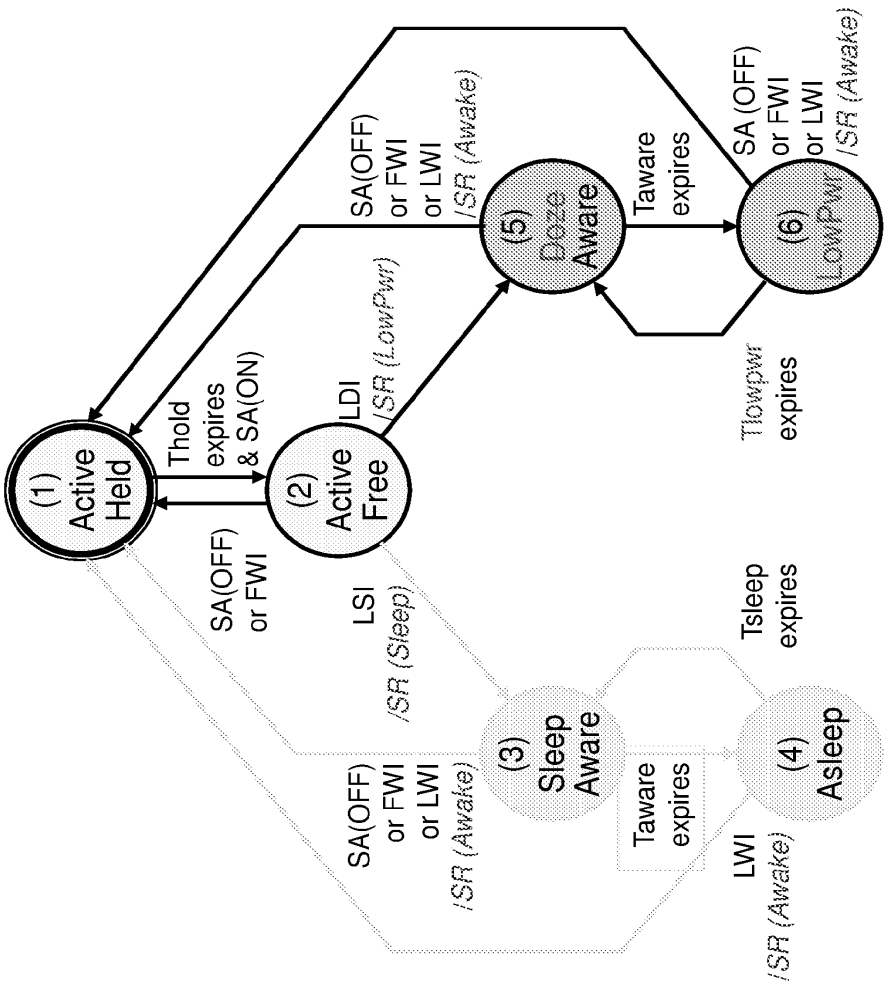

(1) Active Held
(2) Active Free
(3) Sleep Aware
(4) Asleep
(5) Doze Aware
(6) LowPwr
Thold expires & SA(ON)
SA(OFF) or FWI
LDI /SR (LowPwr)
LSI /SR (Sleep)
SA(OFF) or FWI or LWI /SR (Awake)
Taware expires
Tsleep expires
Towpwr expires
LWI /SR (Awake)

FIG. 7B

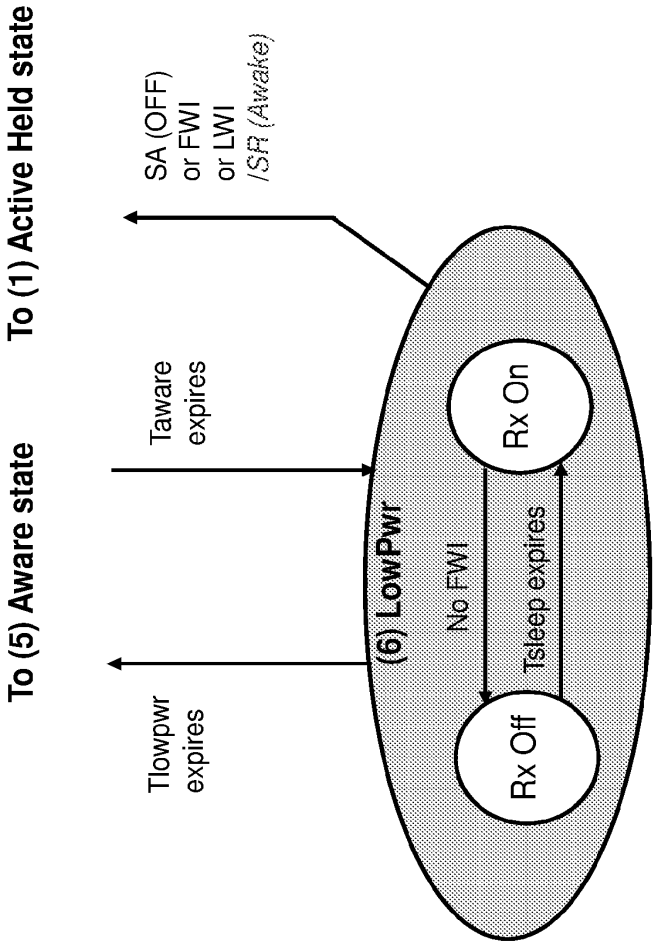

To (1) Active Held state
SA (OFF)
or FWI
or LWI
/SR (Awake)
Taware
expires
To (5) Aware state
Tlowpwr
expires
(6) LowPwr
No FWI
Tsleep expires
Rx On
Rx Off

FIG. 7C

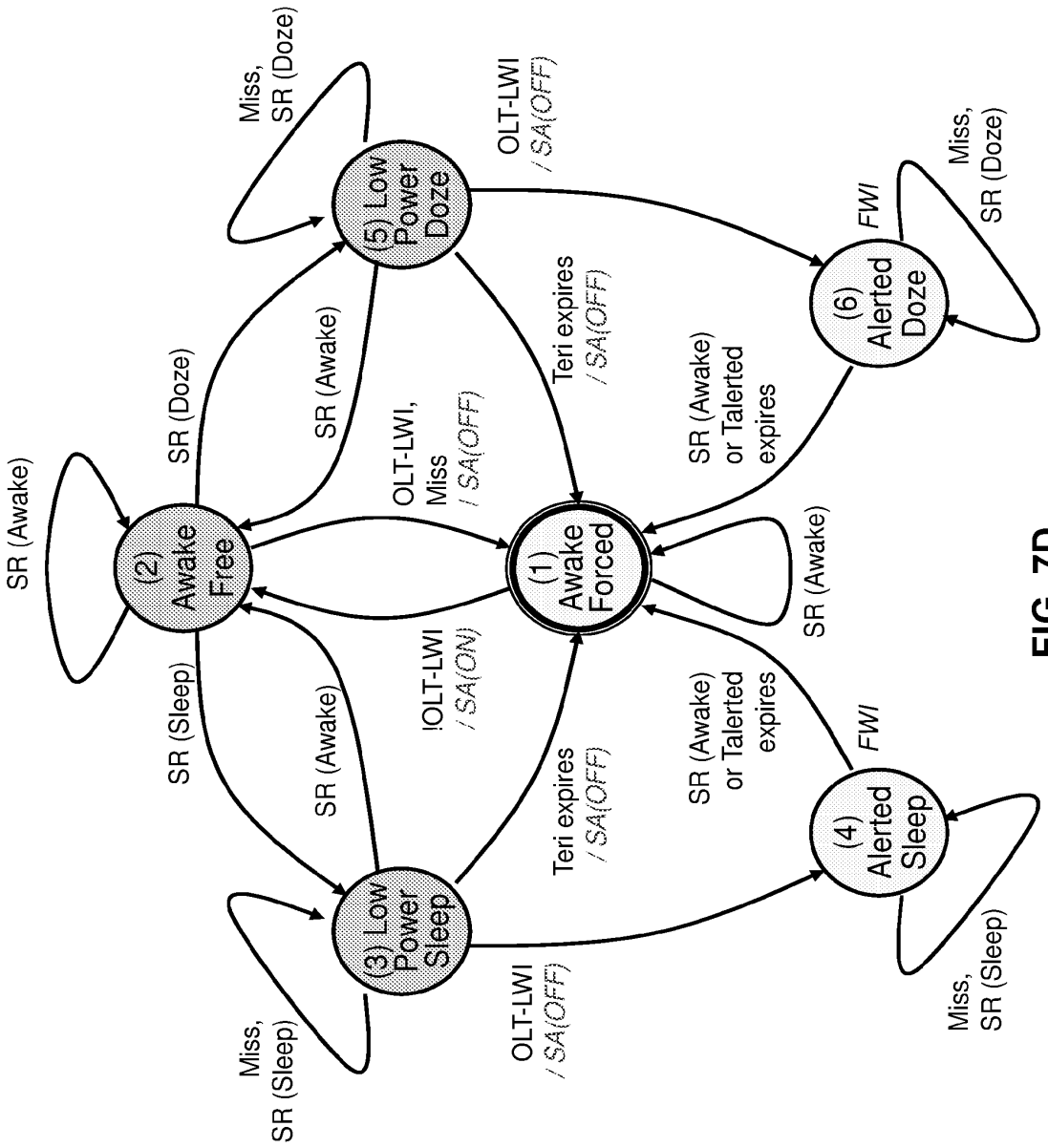

(1) Awake Forced
(2) Awake Free
(3) Low Power Sleep
(4) Alerted Sleep
(5) Low Power Doze
(6) Alerted Doze
SR (Awake)
SR (Doze)
SR (Awake)
OLT-LWI, Miss / SA(OFF)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
SR (Awake)
SR (Sleep)
SR (Awake)
!OLT-LWI / SA(ON)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
SR (Awake)
Miss, SR (Doze)
OLT-LWI / SA(OFF)
FWI
Miss, SR (Doze)
Miss, SR (Sleep)
OLT-LWI / SA(OFF)
FWI
Miss, SR (Sleep)

FIG. 7D

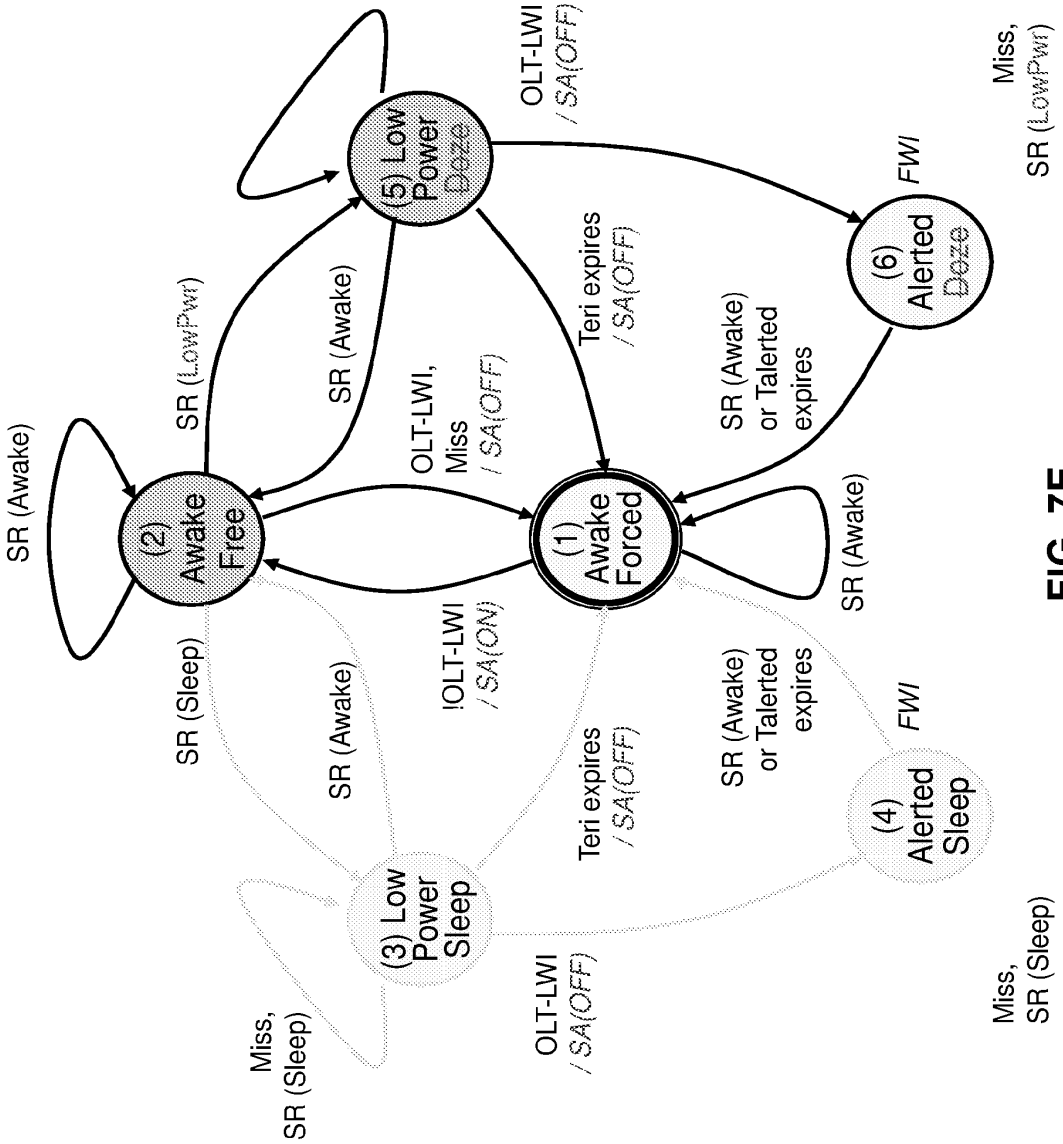

(1) Awake Forced
(2) Awake Free
(3) Low Power Sleep
(4) Alerted Sleep
(5) Low Power Doze
(6) Alerted Doze
SR (Awake)
SR (LowPwr)
SR (Awake)
OLT-LWI, Miss / SA(OFF)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
SR (Awake)
OLT-LWI / SA(OFF)
FWI
Miss, SR (LowPwr)
SR (Sleep)
SR (Awake)
!OLT-LWI / SA(ON)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
FWI
Miss, SR (Sleep)
OLT-LWI / SA(OFF)
Miss, SR (Sleep)

FIG. 7E

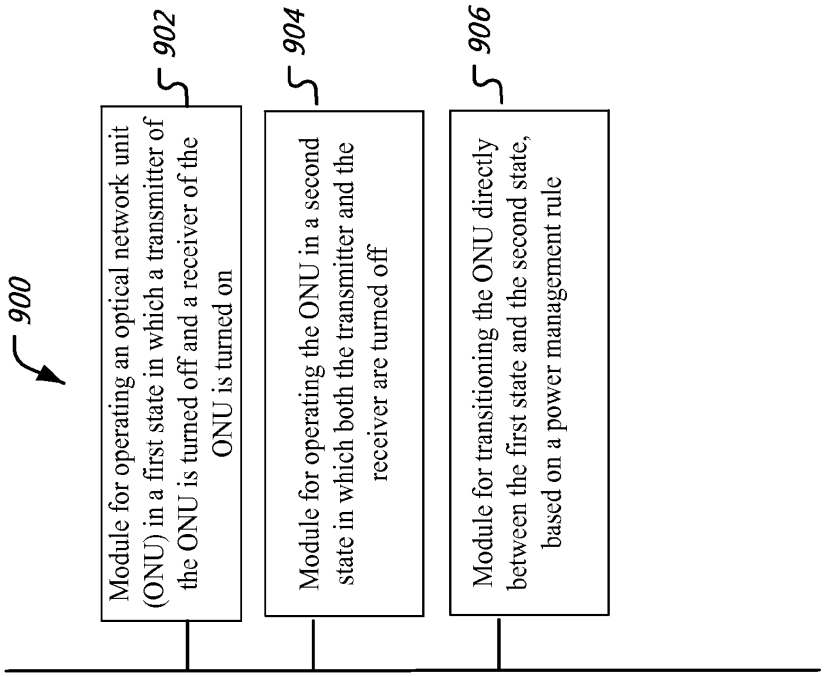

900
902
Module for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
904
Module for operating the ONU in a second state in which both the transmitter and the receiver are turned off
906
Module for transitioning the ONU directly between the first state and the second state, based on a power management rule

FIG. 9

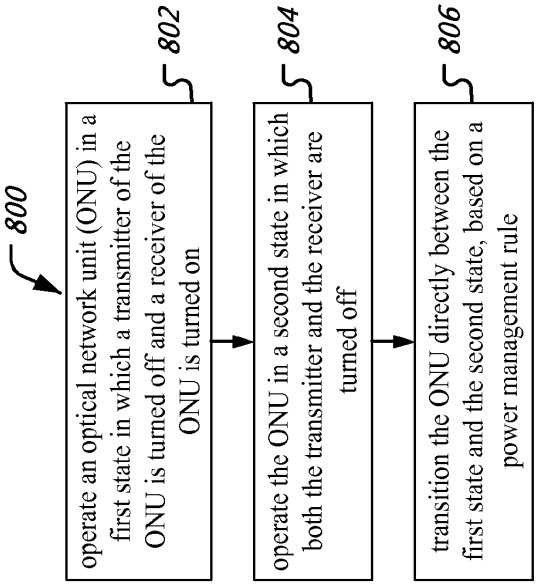

800
802
operate an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
804
operate the ONU in a second state in which both the transmitter and the receiver are turned off
806
transition the ONU directly between the first state and the second state, based on a power management rule

FIG. 8

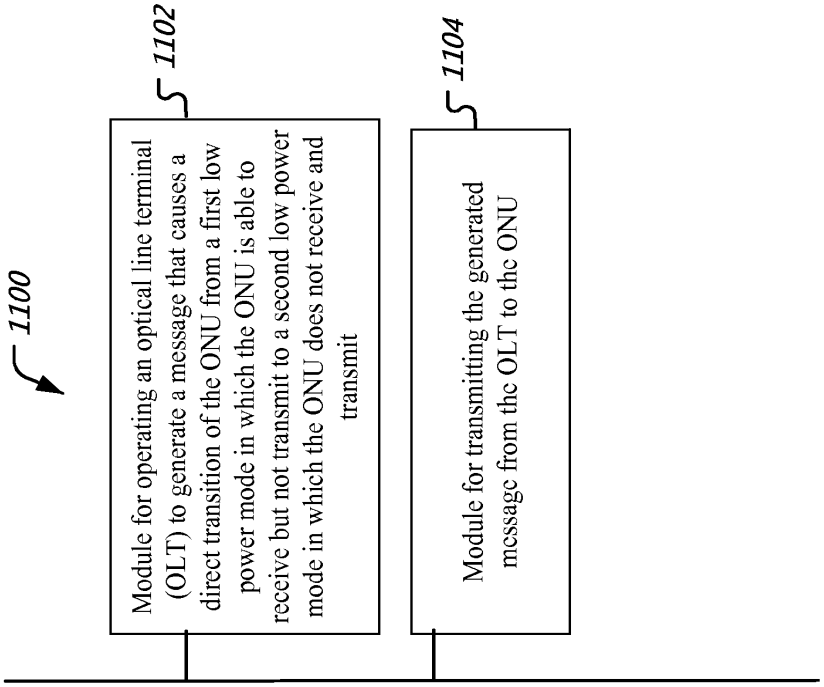

1100
1102
Module for operating an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit
1104
Module for transmitting the generated message from the OLT to the ONU

FIG. 11

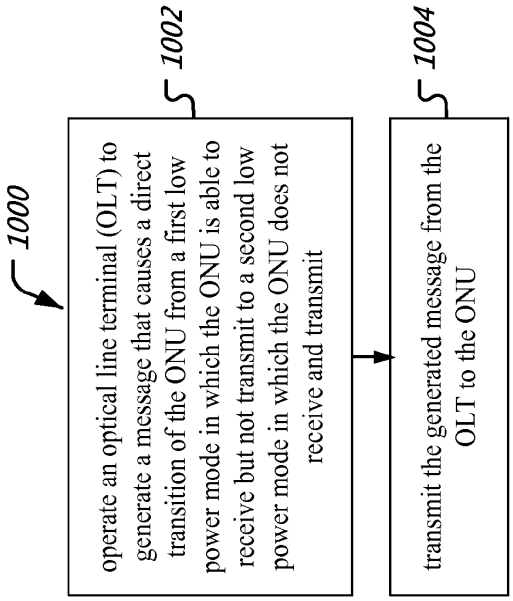

1000
1002
operate an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit
1004
transmit the generated message from the OLT to the ONU

FIG.10

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 009065-8132WO01	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2013/050533**	International filing date *(day/month/year)* **15 July 2013 (15.07.2013)**	(Earliest) Priority Date *(day/month/year)* 13 July 2012 (13.07.2012)
Applicant **ZTE CORPORATION et al**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/050533

A. CLASSIFICATION OF SUBJECT MATTER

H04B 10/25(2013.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B 10/25; H04B 10/13; G08C 17/02; H04B 10/08; G06F 1/32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: passive optical network, low, power, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0163808 A1 (GEUN YONG KIM et al.) 28 June 2012 See paragraphs 33-57, 64-82; and figure 4.	1-17
A	US 2010-0118753 A1 (JEFF MANDIN et al.) 13 May 2010 See paragraphs 27-38; and figure 3.	1-17
A	US 2012-0027411 A1 (HAI GAO et al.) 02 February 2012 See paragraphs 56-59; and figure 4.	1-17
A	WO 2008-038981 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 03 April 2008 See paragraphs 47-62; and figure 3.	1-17
A	US 2010-0111523 A1 (RYAN E. HIRTH et al.) 06 May 2010 See paragraphs 50-65; and figure 7.	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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
21 October 2013 (21.10.2013)	**22 October 2013 (22.10.2013)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
BYUN, Sung Cheal
Telephone No. +82-42-481-8262

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2013/050533

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012-0163808 A1	28/06/2012	KR 10-2012-0071577 A	03/07/2012
US 2010-0118753 A1	13/05/2010	CN 101562760 A	21/10/2009
		CN 101820349 A	01/09/2010
		JP 04903276 B2	28/03/2012
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		JP 2009-260970 A	05/11/2009
		JP 2010-213259 A	24/09/2010
		US 2009-0263127 A1	22/10/2009
		US 8000602 B2	16/08/2011
		US 8275261 B2	25/09/2012
US 2012-0027411 A1	02/02/2012	AT 544250 T	15/02/2012
		CN 101317333 A	03/12/2008
		CN 101317333 B	27/02/2013
		CN 1988502 A	27/06/2007
		DK 1801984 T3	21/05/2012
		EP 1801984 A1	27/06/2007
		EP 1801984 B1	01/02/2012
		ES 2381677 T3	30/05/2012
		PT 1801984 E	07/05/2012
		US 2007-0140691 A1	21/06/2007
		US 2013-0236179 A1	12/09/2013
		US 8073329 B2	06/12/2011
		US 8452178 B2	28/05/2013
		WO 2007-131457 A1	22/11/2007
WO 2008-038981 A1	03/04/2008	KR 10-0763530 B1	05/10/2007
		US 2010-0008667 A1	14/01/2010
		US 8139937 B2	20/03/2012
US 2010-0111523 A1	06/05/2010	CN 102204131 A	28/09/2011
		EP 2368332 A2	28/09/2011
		EP 2368332 A4	26/12/2012
		TW 201032501 A	01/09/2010
		US 8498534 B2	30/07/2013
		WO 2010-053671 A2	14/05/2010
		WO 2010-053671 A3	15/07/2010

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
AI BING

PERKINS COIE LLP P.O. BOX 1247 SEATTLE,
WASHINGTON 98111-1247 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**22 October 2013 (22.10.2013)**
Applicant's or agent's file reference 009065-8132WO01	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/050533	**15 July 2013 (15.07.2013)**	13 July 2012 (13.07.2012)

International Patent Classification (IPC) or both national classification and IPC
H04B 10/25(2013.01)i

Applicant
ZTE CORPORATION et al

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	21 October 2013 (21.10.2013)	BYUN, Sung Cheal Telephone No. +82-42-481-8262

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-17	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-17	NO
Industrial applicability (IA)	Claims	1-17	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following document:

D1: US 2012-0163808 A1 (GEUN YONG KIM et al.) 28 June 2012

2.1 Novelty (PCT Article 33(2)) and Inventive Step (PCT Article 33(3))

2.1.1 Claims 1-6

D1, which is considered to be the closest prior art to the subject matter of independent claim 1, discloses a method comprising: operating an optical network unit (ONU) in a dozing mode implying a period in which a transmitter is turned-off (see paragraph 37); and operating the optical network unit in a cyclic sleep mode implying a period in which both the transmitter and a receiver are turned-off (see paragraph 37). The technical feature of "transitioning the ONU directly between a first state and a second state, based on a power management rule" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an ITU-T is performing standardization for two modes, the dozing mode and the cyclic sleep mode under a recognition of the need to save power in the ONU (see paragraph 33). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 1. Accordingly, claim 1 would have been obvious over D1. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 2 depending on claim 1 is disclosed in D1 (an active interval implies a period in which both the transmitter and the receiver are turned-on; see paragraph 37). Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 3 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONT which receives an upstream bandwidth

Continued on Supplemental Box

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box No. V

allocation transmits a sleep request OFF message requesting the transition to the normal mode to the OLT; see paragraph 49). Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 4 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 5 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the OLT receives a sleep request OFF message transitions to the active state and transmits the sleep allow OFF message allowing the transition to the normal mode to the corresponding ONU; see paragraph 50). Therefore, claim 5 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 6 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (since the sleep allow ON message received in the active interval within the cyclic sleep mode is used to ask whether the ONU is normally operated or not, the ONU transmits an empty burst as an acknowledgement that the ONU is normally operated to the OLT, and then, transitions to the sleep mode; see paragraph 44). Therefore, claim 6 lacks an inventive step under PCT Article 33(3).

2.1.2 Claims 7-11

The features of independent apparatus claim 7 essentially correspond to those of method claim 1. Thus, the same reasoning as in claim 1 applies to claim 7. Therefore, claim 7 lacks an inventive step under PCT Article 33(3).

The additional features of claims 8-11 depending on claim 7 essentially correspond to those of claims 2-4 and 6, respectively. Accordingly, the same reasoning as in claims 2-4 and 6 applies to claims 8-11. Therefore, claims 8-11 lack an inventive step under PCT Article 33(3).

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Supplemental Box

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2.1.3 Claims 12-13

Claim 12 relates to an optical communication apparatus in accordance with claim 1 relating to a method. The apparatus of claim 12 comprises a memory; and a processor which uses stored instructions to implement the method that is the same as that defined in claim 1. As the features of claim 12 essentially correspond to the features of claim 1 except for the category, the same reasoning as in claim 1 applies to claim 12. Therefore, independent claim 12 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 13 depending on claim 12 can be easily derived by a person skilled in the art from the feature of D1 (an optical network unit (ONU) periodically turns on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns-on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 13 lacks an inventive step under PCT Article 33(3).

2.1.4 Claims 14-15

D1, which is considered to be the closest prior art to the subject matter of independent claim 14, discloses an optical line terminal (OLT) comprising a controller configured to control an operation of the OLT, wherein an ONU periodically turns on/off a receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off a transmitter and the receiver (cyclic sleep mode) and parameters associated with power saving include a sleep interval and an active interval (see paragraphs 37, 57, 82). The technical feature of "a transmitter configured to transmit the generated messages to the optical network unit (ONU)" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that the ONU receiving the sleep allow OFF message is switched into the normal mode and transmits the sleep request OFF message as the response for the sleep allow OFF message to the OLU (see paragraph 55). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 14. Accordingly, claim 14 would have been obvious over D1. Therefore, claim 14 lacks an inventive step under PCT Article 33(3).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Previous Page

The additional feature of claim 15 depending on claim 14 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 15 lacks an inventive step under PCT Article 33(3).

2.1.5 Claims 16-17

D1, which is considered to be the closest prior art to the subject matter of independent claim 16, discloses a passive optical network (PON) communications system comprising an optical network unit (ONU) periodically turning on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turning on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein the sleep interval implies a period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode (see paragraphs 37, 57). The technical feature of "an optical line terminal (OLT) configured to transmit a control message to the ONU" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an OLT transmits the sleep allow ON message allowing the transition to a next sleep mode to the ONT (see paragraph 43). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 16. Accordingly, claim 16 would have been obvious over D1. Therefore, claim 16 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 17 depending on claim 16 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 17 lacks an inventive step under PCT Article 33(3).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Previous Page

2.2 Industrial Applicability (PCT Article 33(4))

Claims 1-17 are industrially applicable under PCT Article 33(4).

PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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

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	Denis	Andreyevich	Khotimsky	

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Address 2	

City	Westborough	State/Province	MA
Postal Code	01581	Country i	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	LiQuan		Yuan	

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

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Mailing Address of Inventor:

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Address 2	Zhangjiang Hi-Tech Park

City	Shanghai	State/Province	
Postal Code	201203	Country i	CN

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	DeZhi		Zhang	

PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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

City	Shanghai	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	#889 BiBo Road		
Address 2	Zhangjiang Hi-Tech Park		
City	Shanghai	**State/Province**	
Postal Code	201203	**Country** [i]	CN

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	97075		
Email Address	patentprocurement@perkinscoie.com	Add Email	Remove Email

Application Information:

Title of the Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS		
Attorney Docket Number	009065-8132.US01	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	16	**Suggested Figure for Publication (if any)**	1

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 [i]

PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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	97075		

Domestic Benefit/National Stage Information:

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

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/US2013/050533	2013-07-15

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(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) [i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [i] (if applicable)
PCT/CN2012/078649	WO	2012-07-13	

PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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

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

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

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If 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 World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

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	ZTE Corporation		
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City	Shenzhen	**State/Province**	
Country [i]	CN	Postal Code	518057
Phone Number		Fax Number	
Email Address			

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

Applicant 2 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 :

PTO/AIA/14 (12-13)
Approved for use through 04/30/2017. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

If the Applicant is an Organization check here. ☒			
Organization Name	ZTE (USA) Inc.		
Mailing Address Information For Applicant:			
Address 1	55 Madison Avenue		
Address 2	Suite 160		
City	Morristown	**State/Province**	NJ
Country i	US	Postal Code	07960
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:

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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.

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

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

Mailing Address Information For Assignee including Non-Applicant Assignee:

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	009065-8132.US01
	Application Number	
Title of Invention	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS	

Signature:

Remove

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

Signature	/Vinay Sathe/			Date (YYYY-MM-DD)	2015-01-13
First Name	Vinay	Last Name	Sathe	Registration Number	55595

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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.**

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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)).

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:	
Filing Date:	
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Attorney Docket Number:	009065-8132.US01

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	280	280
Natl Stage Search Fee - Report provided	1642	1	480	480
National Stage Exam - all other cases	1633	1	720	720
Pages:				
Claims:				
Independent claims in excess of 3	1614	2	420	840
Miscellaneous-Filing:				
Oath/Decl > 30 Mos From 371 commencement	1617	1	140	140

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2460**

Electronic Acknowledgement Receipt	
EFS ID:	21201481
Application Number:	14414698
International Application Number:	PCT/US2013/050533
Confirmation Number:	2029
Title of Invention:	OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS
First Named Inventor/Applicant Name:	Denis Andreyevich Khotimsky
Customer Number:	97075
Filer:	Vinay Padmakar Sathe/Jennifer Payne
Filer Authorized By:	Vinay Padmakar Sathe
Attorney Docket Number:	009065-8132.US01
Receipt Date:	13-JAN-2015
Filing Date:	
Time Stamp:	21:29:28
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$2460
RAM confirmation Number	5449
Deposit Account	505252
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2015-01-13_USNatlPhase.PDF	1397642 ea0d0ea977e9dd731604cf6a8fbc881f28d78253	yes	52

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal of New Application	1	3
Abstract	4	4
Specification	5	22
Claims	23	26
Drawings-only black and white line drawings	27	42
Documents submitted with 371 Applications	43	52

Warnings:

Information:

2	Application Data Sheet	2015-01-13_ADS.PDF	1895252 616a71f3e166ad3c6553efc9813e3d11fafe614a	no	8

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	38820 548ec0696a823712817b32706868e006d840a9fe	no	2

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Total Files Size (in bytes):	3331714

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

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

New International Application Filed with the USPTO as a Receiving Office
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US13/50533

中华人民共和国国家知识产权局
STATE INTELLECTUAL PROPERTY OFFICE
OF THE PEOPLE'S REPUBLIC OF CHINA

证　明
CERTIFICATE

本证明之附件是向中国专利局作为受理局提交的下列国际申请文件副本。

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY OF THE BELOW IDENTIFIED INTERNATIONAL APPLICATION THAT WAS FILED WITH THE CHINESE PATENT OFFICE AS RECEIVING OFFICE.

国 际 申 请 号： PCT/CN2012/078649

INTERNATIONAL APPLICATION NUMBER

国 际 申 请 日： 2012年07月13日

INTERNATIONAL FILING DATE

发明名称： METHOD AND APPARATUS FOR UNIFIED OPTICAL NETWORK UNIT (ONU) POWER MANAGEMENT IN A PASSIVE OPTICAL NETWORK (PON)

TITLE OF INVENTION

中华人民共和国国家知识产权局局长
COMMISSIONER OF THE STATE INTELLECTUAL PROPERTY OFFECE
OF THE PEOPLE'S REPUBLIC OF CHINA

2013 年 07 月 29 日

Print Out (Original in Electronic Form)

0	**For receiving Office use only**	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT-SAFE Version 3.51.053.229 MT/FOP 20120101/0.20.5.19
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	State Intellectual Property Office of the People's Republic of China (RO/CN)
0-7	**Applicant's or agent's file reference**	181203616
I	**Title of Invention**	METHOD AND APPARATUS FOR UNIFIED OPTICAL NETWORK UNIT (ONU) POWER MANAGEMENT IN A PASSIVE OPTICAL NETWORK (PON)
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States except US
II-4	Name	ZTE CORPORATION
II-5	Address	ZTE Plaza, No.55 Keji South Road Hi-Tech Industrial Park Nanshan Shenzhen, Guangdong 518057 China
II-6	State of nationality	CN
II-7	State of residence	CN
III-1	**Applicant and/or inventor**	
III-1-1	This person is	Applicant only
III-1-2	Applicant for	All designated States except US
III-1-4	Name	ZTE (USA) INC.
III-1-5	Address	55 Madison Avenue, Suite 160 Morristown, New Jersey 07960 United States of America
III-1-6	State of nationality	US
III-1-7	State of residence	US

III-2	**Applicant and/or inventor**	
III-2-1	This person is	Applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	KHOTIMSKY, Denis Andreyevich
III-2-5	Address	27 Glen Street Westborough Massachusetts 01581 United States of America
III-2-6	State of nationality	RU
III-2-7	State of residence	US
III-3	**Applicant and/or inventor**	
III-3-1	This person is	Applicant and inventor
III-3-2	Applicant for	US only
III-3-4	Name (LAST, First)	YUAN, Liquan
III-3-5	Address	#889 Bibo Road Zhangjiang Hi-Tech Park Pudong Shanghai 201203 China
III-3-6	State of nationality	CN
III-3-7	State of residence	CN
III-4	**Applicant and/or inventor**	
III-4-1	This person is	Applicant and inventor
III-4-2	Applicant for	US only
III-4-4	Name (LAST, First)	ZHANG, Dezhi
III-4-5	Address	#889 Bibo Road Zhangjiang Hi-Tech Park Pudong Shanghai 201203 China
III-4-6	State of nationality	CN
III-4-7	State of residence	CN

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
IV-1-1	Name	AFD CHINA INTELLECTUAL PROPERTY LAW OFFICE
IV-1-2	Address	Suite B 1601A, 8 Xue Qing Rd. Haidian Beijing 100192 China
IV-1-3	Telephone No.	+86-10-8273 0850
IV-1-4	Facsimile No.	+86-10-8273 0820
IV-1-5	e-mail	info@afdip.com
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications
IV-1-6	Agent's registration No.	11262
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority Claim**	NONE
VII-1	**International Searching Authority Chosen**	State Intellectual Property Office of the People's Republic of China (ISA/CN)

VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	–	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	–	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	–	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	–	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	–	

Print Out (Original in Electronic Form)

IX	Check list	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	5	✓
IX-2	Description	15	✓
IX-3	Claims	3	✓
IX-4	Abstract	1	✓
IX-5	Drawings	9	✓
IX-7	TOTAL	33	
	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	–	✓
IX-11	Copy of general power of attorney	–	Reference no. ZW0011043126
IX-11	Copy of general power of attorney	–	Reference no. ZW0012052468
IX-18	PCT-SAFE physical media	–	–
IX-20	**Figure of the drawings which should accompany the abstract**	8	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	(PKCS7 Digital Signature)	
X-1-1	Name	AFD CHINA INTELLECTUAL PROPERTY LAW OFFICE	
X-1-2	Name of signatory	LONG, Hong	
X-1-3	Capacity (if such capacity is not obvious from reading the request)	attorney	

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10-1	**Date of actual receipt of the purported international application**	
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/CN
10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	

METHOD AND APPARATUS FOR UNIFIED OPTICAL NETWORK UNIT (ONU) POWER MANAGEMENT IN A PASSIVE OPTICAL NETWORK (PON)

BACKGROUND

[0001] This document relates to systems, devices, and techniques for data communications in a passive optical network. In one aspect, this document relates to power saving methods in an optical network unit of a passive optical network.

[0002] A passive optical network (PON) is an optical network architecture based on point-to-multipoint (P2MP) topology in which a single optical fiber and multiple passive branching points are used to provide data communication services. A PON system can facilitate user access with a service provider communication facility to access telecommunication, information, entertainment, and other resources of the Internet. A PON system can include a central node, called an optical line terminal (OLT), which can be in connection with a single or multiple user nodes called optical network units (ONUs) via a passive optical distribution network (ODN). An OLT can be located at the access provider's communication facility (central office). An ONU can be located at or near the access user's premises. An ONU draws electrical power from the user's premises power supply network and may employ battery backup to support communication services in case of power outage.

[0003] Better power management techniques are desirable to improve battery life of an ONU.

SUMMARY

[0004] Method and apparatus are disclosed that, in one beneficial aspect, are useful to reduce the power consumption of an optical network unit in a PON. Implementations described in this document can potentially provide several advantages. For example, the disclosed method and apparatus can allow an access provider to guarantee the lifeline services to the customers for increased duration of operational time during power outages reduce the size and cost of the battery backup unit, reduce overall green-house gas emission and carbon footprint of the information and communication technologies based on passive optical networks, etc. The disclosed technique is superior in terms of power saving efficiency to available prior state-of-the-art techniques. For example, the disclosed technique is superior to the Dozing method, at least due to substantially lower on average power level during the low power cycle.

Exhibit 1002
IPR2024-00899, USPN 9,806,892
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The disclosed technique is also superior to the Cyclic Sleep method at least because of the decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle. In one beneficial aspect, the disclosed techniques allow ONUs to transition between a dozing state and a sleep state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 shows an exemplary PON system comprising an OLT 110, plurality of ONUs 120; and an ODN that comprises optical feeder fiber, or trunk fiber 130, splitter 140, and multiple distribution fibers 150.

[0006] Figure 2 illustrates a power consumption profile of a conventional power management technique based on ONU dozing.

[0007] Figure 3 illustrates a power consumption profile of a conventional power management technique based on cyclic sleeping.

[0008] Figure 4 illustrates a power consumption profile of an embodiment of the disclosed unified ONU power management method.

[0009] Figure 5 illustrates a state machine that governs ONU's behavior in an embodiment of the unified power management method.

[0010] Figure 6 illustrates a state machine that governs OLT's behavior in an embodiment of the unified power management method.

[0011] Figure 7 illustrates a prior art state machine for ONU power management.

[0012] Figure 8 is a flow chart representation of a unified power management method.

[0013] Figure 9 is a block diagram representation of a portion of an apparatus that implements unified power management technique disclosed in the document.

[0014] Figure 10 is a flow chart representation of a process of operating an OLT.

[0015] Figure 11 is a block diagram representation of a portion of an apparatus for optical communications.

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DETAILED DESCRIPTION

[0016] Techniques for unified power management of an optical network unit (ONU) in which the ONU can transition between multiple low power states without having to transition to a high power state are disclosed. In the description that follows, all terminology, to the extent used in the ITU-T XG-PON standards documents and not explicitly discussed in this document, is intended to be consistent wit the ITU-T standards documents.

[0017] A PON system can use optical fiber to connect the user premises to the provider communication facility. The PON Optical Distribution Network (ODN) can include a point-to-multipoint (P2MP) optical fiber infrastructure where passive branching points can be represented by optical splitters are other similar passive optical devices. These passive ODN equipments can be deployed in street cabinets, closets, underground utility holes, cable chambers, and other installations and require no electrical power and little maintenance. The PON ODN can be attached to the OLT with a single strain of optical fiber.

[0018] Optical network units (ONUs) can be deployed at or near user premises. An ONU is an active network element that draws electric power from the power supply network present at or near the access user's premises and in some cases is equipped with a battery-based power backup unit to allow limited operations in case of the power supply network failure. Conservation of the power consumed by an ONU is an operation requirement that can be associated with two objectives. First, the requirement is driven by the emergency services support under the power supply network failure and is targeted at the prolongation of the battery operation time or, alternatively, reduction of the size and cost of the battery. Second, the requirement focuses on conserving power in regular (based on the power supply network) operations and minimizing the carbon dioxide emissions generated by information and communications technologies (ICTs).

[0019] Conventional standard-based PON systems, such as Ethernet PON (EPON), Broadband PON (BPON), Gigabit PON (G-PON) consider an ONU to be in a permanent link-layer association with the OLT: the ONU continuously listen to the downstream transmission over the P2MP optical channel and may be required to transmit protocol information upstream, even if there is no user data to exchange. Therefore, the ONU's optical transceiver continuously remains fully operational and fully powered. These conventional PON systems typically support only the basic, one-sided power conservation technique, such power shedding, characterized by powering off or reducing power to non-essential functions and services while maintaining a fully operational optical link.

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[0020] The more advanced standard-based PON systems, such as 10 Gigabit/sec EPON (10G-PON), and 10 Gigabit/sec PON (XG-PON), introduced protocol-based power-saving techniques that employ a signalling mechanism between the OLT and the ONU to function properly. These techniques involve defining several power levels and specifying the cyclic behavior of an ONU which periodically switches between the full power level and one lower power level.

[0021] Besides the full power level, the standard-based 10 Gigabit/sec PON (XG-PON) system identifies the ONU Dozing power level, which is characterized by powering off of the ONU transmitter and the associated circuitry for substantial periods of time on the condition that the receiver remains continuously on, and the ONU Sleeping power level, which is characterized by both ONU transmitter and ONU receiver are turned off for substantial periods of time.

[0022] Figure 7 shows the state machine behavior 700 of a PON ONU, as specified in one currently published PON standard (ITU-T G.987.3, 10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification, publication date October 2010). From the initial state "Active Free" 702, the ONU can either transition into a Sleep Aware state 704 or a Doze Aware state 706 (further described below). However, no direct transition between the Doze Aware and the Sleep Aware states 704, 706 are provided. Conventional ONUs therefore lack the technology of directly transitioning between two low power consumption states without having to go through an active state (e.g., a full powered state). In one aspect, such a transition through the active state may increase the power consumed by the ONU, thereby undesirably reducing batter life.

[0023] Figure 2 depicts example ONU power consumption profile, that is, the power P consumed by the ONU as a function of time t, in case if ONU Dozing mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The dozing power level 210, which is lower than full power level 200, but substantially higher than zero, is characterized by the ONU transmitter with the associated circuitry being powered off, and the transmitter remaining on. Two timing parameter, which can be configured into the ONU in advance, govern specific pattern of the power consumption: time interval 250 is the maximum time an ONU can be allowed to abstain from upstream transmissions without being declared in violation of the protocol, while the time interval 260 is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational. The longer time interval 250 is with respect to time interval 260, the more

efficient the technique is in relative terms. Since the ONU receiver remain continuously powered, the latency of detecting an external wake-up stimulus (a signal form the OLT to enter full power operation, in response, for example, to an incoming call) is close to that of full-power operation and is comparable to round-trip propagation delay. The continuously powered ONU receiver may limit the overall power-saving efficiency.

[0024] Figure 3 depicts example ONU power consumption profile, that is, the power P consumed by the ONU as a function of time t, when ONU Cyclic sleep mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being powered off, and is typically close to zero. Two configurable timing parameter govern specific pattern of the power consumption: time interval 270 is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational; time interval 280 is the maximum time an ONU can be allowed to abstain from upstream transmissions and from receiving downstream traffic at the same time. While turning off both the transmitter and receiver is the most efficient way to save power, the latency of detecting an external wake-up stimulus may increase by as much as time interval 280. Therefore, in order to maintain short enough external wakeup latency, time interval 280 may be kept small, thus reducing the overall power efficiency.

[0025] Both the above discussed cyclic power management techniques (Figure 2 and Figure 3) involve the ONU toggling between two power levels: the full power level and the Dozing level (Figure 2) or between the full power level and the sleeping level (Figure 3). In some implementations, the power management behavior of an ONU may be configured by specifying two parameters: the maximum time in the lower power mode, and the minimum time in the full power mode. The values of the configuration parameters depend on the kind of services a system is expected to support, as well as the required availability of those services.

[0026] In one distinguishing aspect, in some embodiments, the unified power management method disclosed in this document integrates the two cyclic power management techniques generally shown in Figures 7, 2 and 3, in a single unified behavior that involves ONU power consumption alternating between at least three levels and is controlled by at least four timing parameters. When in a power saving mode, the ONU mostly toggles between the Sleeping power level (with the lowest power consumption) and the Dozing power level (with the next lowest power consumption), only occasionally returning to the full-power level operation.



[0027] With reference to Figure 4, in which one example power profile of the unified power management technique is depicted, the operation of the unified power management technique can be explained as follows. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being power off, and is reasonably close to zero. The intermediate dozing power level 210 is characterized by the ONU transmitter with the associated circuitry being power off, and ONU receiver remaining on. Time interval 320 (as time intervals 260 and 270) is the minimum duration of the periodic bi-directional handshake between the OLT and the fully powered and operational ONU. Time interval 310 is the maximum allowed duration between consecutive bi-directional handshakes. Time interval 330 is the minimum time that the ONU listens to the downstream transmission in order to obtain any necessary signalling indications. Time interval 340 is the maximum time the ONU is allowed to abstain from upstream transmissions and from receiving downstream traffic at the same time.

[0028] As can be seen, the power reduction during the low power cycle depends on the ratio of time interval 310 to time interval 320, which can be made large, while the latency in response to an external stimulus depends on time interval 340, which can be relatively small. Therefore, in one advantageous aspect, the disclosed unified power management technique is superior in terms of power saving efficiency to both the Dozing method, due to substantially lower on average power level during the low power cycle, and the Cyclic Sleep method (as previously discussed with respect to Figures 2 and 3), due to decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle.

[0029] It will be appreciated that the specific values of the time intervals 310, 320, 330 and 340 may be implementation-specific and may depend on operational considerations such as regulatory requirements, target time for battery life, and so on. For example, maximum dwell time in sleep state may be about 1 to 2 seconds, so that the ONU is responsive to an incoming call within a couple of seconds. Similarly, maximum dwell time in the doze state may be relatively large (e.g., several tens of seconds or minutes, e.g., 2 minutes or 1 hour).

IMPLEMENTATION EXAMPLES



Low power mode signaling between OLT and ONU

[0030] In some implementations, the low power primitives specified in the following tables can be exchanged between OLT and ONU via appropriate management channel.

Table 1 – OLT Low power management primitives

Primitive	Semantics
LPM-Allow	OLT grants consent to ONU's transition into a low power mode
LPM-Disallow	OLT withdraws consent to ONU's transition into a low power mode

Table 2 – ONU Low power indication primitives

Primitive	Semantics
LPI-LowPower	ONU indicates its transition into a low power mode
LPI-Awake	ONU indicates its exit from a low power mode

ONU power management state machine

[0031] In some implementations, each ONU maintains an instance of the power management state machine that is characterized by the following states and the state transitions as shown in Fig. 5.

Table 3 – ONU power management states

State	Semantics
(1) ActiveHeld	A full power mode state in which full power operation is mandated by the OLT. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. Power management state transitions do not occur. The minimum sojourn in this state is enforced by the Thold timer. Both the OLT's consent and ONU's local decision are required for the ONU to enter a low power mode.
(2) ActiveFree	A full power mode state in which full power operation is at ONU's discretion. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. The OLT has consented to ONU's transition into a low power mode, which is now a subject to ONU's local decision. Upon transition into the Aware state (which is stipulated by the local stimulus ONU-LPC), the ONU sends an LPI-LowPower message to the OLT.
(3) Aware	A low power mode state allowing periodic bi-directional handshake between the OLT and ONU. Both ONU receiver and transmitter remain on. The ONU forwarding downstream traffic and responding to all bandwidth allocations. The sojourn in the state is parametrically controlled, if not truncated by the local stimulus ONU-WUC. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.
(4) Asleep	A low power mode state in which the ONU shuts down both its receiver and transmitter, retaining the ability to wake up on local stimulus ONU-WUC. The sojourn in the state is parametrically controlled, if not truncated by a local stimulus ONU-WUC. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

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Table 3 – ONU power management states

State	Semantics
(5) Listen	A low power mode state in which the ONU has its transmitter off, but the receiver on. The ONU listens to the downstream signal and forwards downstream traffic, while retaining the ability to reactivate the transmitter on local stimulus ONU-WUC or upon receipt of LPM-Disallow message. The sojourn in the state is parametrically controlled if not truncated by a local stimulus ONU-WUC or LPM-Disallow message. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

[0032] In some implementations, an ONU maintains a pair of complementary, mutually exclusive internal conditions specified as follows.

Table 4 – ONU internal power conditions

Condition	Semantics
ONU-LPC	ONU Low Power Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU may go into low power mode.
ONU-WUC	ONU Wake-Up Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU must remain fully powered.

[0033] In some implementations, the ONU maintains the following timing parameters to control the ONU power management state machine and allows to specify the initial values of the timers as follows.

Table 5 – ONU timing parameters

Timer	Semantics
Thold	The minimum sojourn in the ActiveHeld state. The timer is initialised upon transition into the ActiveHeld state and blocks transition into the ActiveFree state until expiration.

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Table 5 – ONU timing parameters

Timer	Semantics
Taware	The minimum sojourn in the Aware state, which defines the duration of the periodic bi-directional handshake between the OLT and an ONU in a low power mode. The timer is initialised upon transition into the Aware state; its expiration releases ONU's transition to either Asleep or Listen state.
Tlowp	The maximum combined sojourn in the Asleep and Listen states between successive periodic bi-directional handshakes. The timer is initialised upon transition from the Aware state to either Asleep or Listen state; its expiration forces ONU's transition back to the Aware state.
Tsleep	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Asleep state; its expiration forces ONU's transition into the Listen state. To configure pure Sleep mode operation, the initial value is set to infinity with finite Tlisten and Tlowp initial values.
Tlisten	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Listen state; its expiration forces ONU's transition into the Asleep state. To configure pure Doze mode operation, the initial value is set to infinity with finite Tsleep and Tlowp initial values.

[0034] To support unified operation using three distinct power levels, in some implementations, the ONU timing parameters Tsleep and Tlisten are initialized each to a finite non-zero value, while Tlowp is initialized to a finite value much larger than the initial values of either Tsleep or Tlisten, The disclosed technique can be reduced through parameter configuration to either Dozing or Cyclic Sleep modes. To simulate Cyclic Sleep, timing parameter Tsleep is initialized to infinity, timing parameter Tlisten is initialized to zero, and timing parameter Tlowp is initialized to finite non-zero value. To simulate ONU Dozing, timing parameter Tlisten is initialized to infinity, timing parameter Tsleep is initialized to zero, and timing parameter Tlowp is initialized to finite non-zero value.

[0035] Note that in the implementation depicted in Figure 5, the binary flag SleepOFF (SleepOn being its binary complement) is a matter of notational convenience which is used to indicate the operation of the machine in the ONU dozing simulation mode. An alternative implementation could make a transition from Aware state upon expiration of the Taware timer unconditionally into the Asleep state. In the ONU dozing simulation mode, Tsleep is initialized to zero, and the transition to Listen would immediately follow.

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OLT power management state machine

[0036] In some implementations, the OLT maintains an instance of the state machine for each subtending ONU that is characterized by the following states and the state transitions as shown in Fig. 6.

Table 6 – OLT power management states

State	Semantics
(1) AwakeForced	The OLT holds the ONU in a full power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.
(2) AwakeFree	The OLT consents to the ONU's transition into a low power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(3) LowPower	The OLT is aware that the ONU is in a low power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(4) Alerted	The OLT attempts to bring the ONU back into a full power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.

[0037] In some implementations, the OLT maintains a pair of complementary, mutually exclusive internal conditions for each subtending ONU specified as follows.

Table 7 – OLT internal power conditions

Condition	Semantics
OLT-LPC	OLT Low Power Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT consents to ONU going into a low power mode.

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Table 7 – OLT internal power conditions

Condition	Semantics
OLT-WUC	OLT Wake-Up Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT objects to ONU going into a low power mode.

[0038] In some implementations, the OLT maintains the following timing parameters to control an instance of the OLT power management state machine and allows to specify the initial values of the timers as follows.

Table 8 – OLT timing parameters

Timer	Semantics
Terr	The maximum allowed time between bi-directional handshakes between the OLT and the ONU in a low power mode. The timer is initialised upon transition into the LowPower state and is restarted each time OLT receives a transmission from the ONU. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.
Talerted	The maximum allowed time for the ONU to come out of the low power mode upon OLT's instruction to do so. The timer is initialised upon transition into the Alerted state. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.

[0039] Figure 8 is a flow chart representation of a unified power management method 800. At 802, an optical network unit (ONU) is operated in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. For example, in some implementations, the first state may be the dozing state discussed above. At 804, the ONU is operated in a second state in which both the transmitter and the receiver are turned off. In some implementations, the second state may correspond to the sleep state discussed above. At 806, the ONU is directly transitioned between the first state and the second state, based on a power management rule. One power management rule may be based on the timing parameters that control how long the ONU can be in the sleep or dozing mode. Other power management rules include transitioning based on a user input (e.g., phone going off the hook), incoming control messages from the OLT, and so on.

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[0040] Figure 9 is a block diagram representation of an optical communications apparatus 900. The module 902 is for operating an optical network unit (ONU) in a first state (e.g., dozing) in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. The module 904 is for operating the ONU in a second state (e.g., sleep state) in which both the transmitter and the receiver are turned off. The module 906 is for transitioning the ONU directly between the first state and the second state, based on a power management rule. In some implementations, the transition may be achieved autonomously (i.e. without communication with an external network entity). In some implementations, the transition may be based on a message received from another network entity such as the OLT. In some implementations, the transition may be based on obtaining permission to transit from one low power mode to another low power mode, obtained by sending a request message from the ONU to the OLT and receiving a corresponding grant message from the OLT.

[0041] Figure 10 is a flow chart representation of a process 1000 of controlling operation of an optical network unit (ONU), operating in a passive optical network (PON). At 1002, an optical line terminal (OLT) is operated to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit. At 1004, the generated message is transmitted from the OLT to the ONU. As previously discussed, the OLT may control the low power operation of ONUs by either explicitly providing control messages or by granting requests from the ONUs, e.g., transitioning from a dozing mode to a sleep mode.

[0042] Figure 11 is a block diagram representation of an optical communications apparatus 1100. The module 1102 is for operating an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit. The module 1104 is for transmitting the generated message from the OLT to the ONU.

[0043] It will be appreciated that unified power management techniques are disclosed, allowing a device to extend battery life without unduly sacrificing responsiveness to communication requests. While the disclosed embodiments are with respect to the application to optical communications network, the disclosed techniques are equally applicable to other communications networks including wired and wireless networks.

[0044] The disclosed and other embodiments, modules and the functional operations described in this document can be implemented in digital electronic circuitry, or in computer



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software, firmware, or hardware, including the structures disclosed in this document and their structural equivalents, or in combinations of one or more of them. The disclosed and other embodiments can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer readable medium for execution by, or to control the operation of, data processing apparatus. The computer readable medium can be a machine-readable storage device, a machine-readable storage substrate, a memory device, a composition of matter effecting a machine-readable propagated signal, or a combination of one or more them. The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them. A propagated signal is an artificially generated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal, that is generated to encode information for transmission to suitable receiver apparatus.

[0045] A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0046] The processes and logic flows described in this document can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

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[0047] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Computer readable media suitable for storing computer program instructions and data include all forms of non volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0048] While this patent document contains many specifics, these should not be construed as limitations on the scope of an invention that is claimed or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this document in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or a variation of a sub-combination. Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results.

[0049] Only a few examples and implementations are disclosed. Variations, modifications, and enhancements to the described examples and implementations and other implementations can be made based on what is disclosed.

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CLAIMS

What is claimed is:

1. A method of optical communication, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

transitioning the ONU directly between the first state and the second state, based on a power management rule.

2. The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

configuring the power management rule based on the received power management message.

4. The method of claim 1, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. An optical communication apparatus, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

means for transitioning the ONU directly between the first state and the second state, based on a power management rule.

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6. The apparatus of claim 5, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

7. The apparatus of claim 5, wherein:

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

configuring the power management rule based on the received power management message.

8. The apparatus of claim 5, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

9. An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that used the stored instructions to implement a method, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

transitioning the ONU directly between the first state and the second state, based on a power management rule.

10. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling direct transition of an optical network unit from a first low power state to a second low power state; and

a transmitter configured to transmit the generated messages to the optical network unit.

11. A method of controlling operation of an optical network unit (ONU), operating in a passive optical network (PON), comprising:

operating an optical line terminal (OLT) to generate a message that causes a direct

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transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit;

transmitting the generated message from the OLT to the ONU.

12. A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode.

13. A power management technique, as disclosed in the present document.

14. An optical communications apparatus, as disclosed in the present document.

15. A computer-readable medium having instructions stored thereupon, the instructions, when executed, causing a processor to implement a process described in the present document.

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ABSTRACT

Techniques for unified optical network unit power management in a passive optical network include operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on, operating the ONU in a second state in which both the transmitter and the receiver are turned off, and transitioning the ONU directly between the first state and the second state, based on a power management rule.



Exhibit 1002
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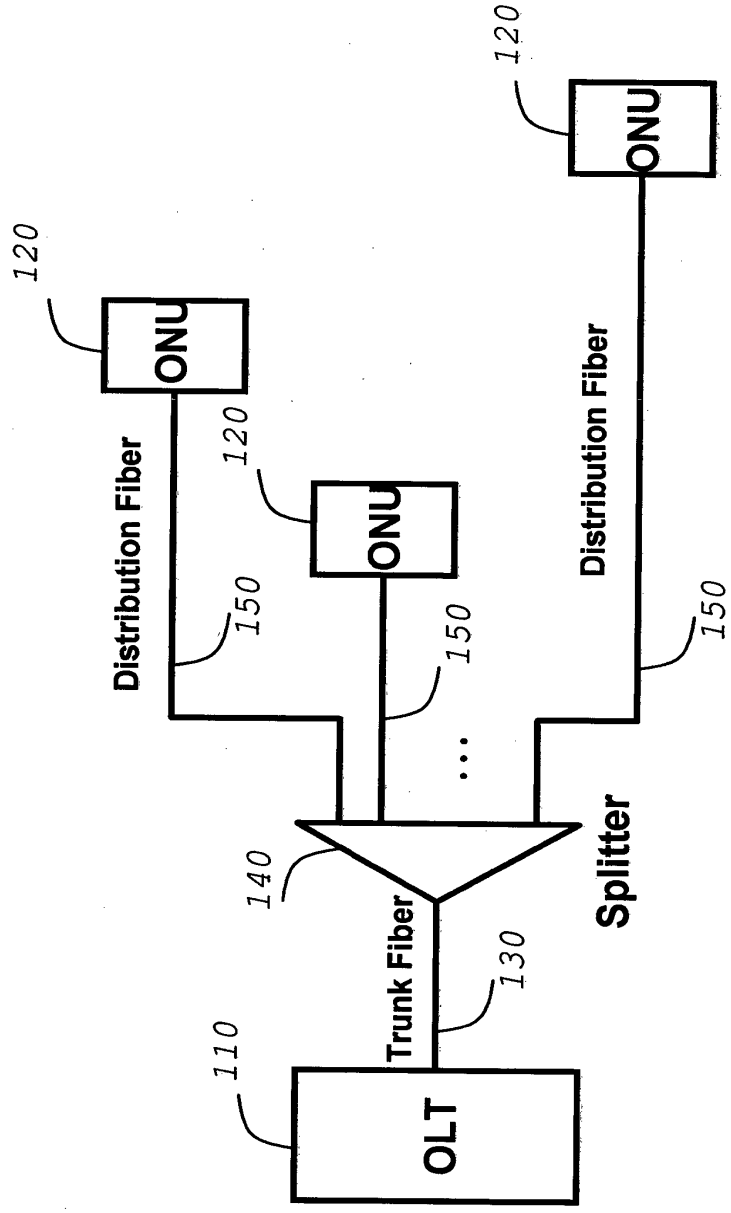


FIG. 1

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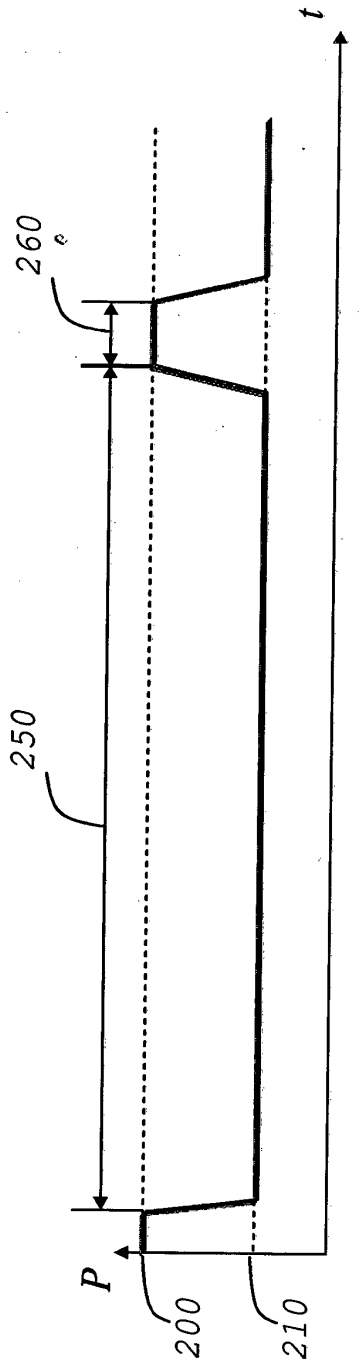


FIG. 2

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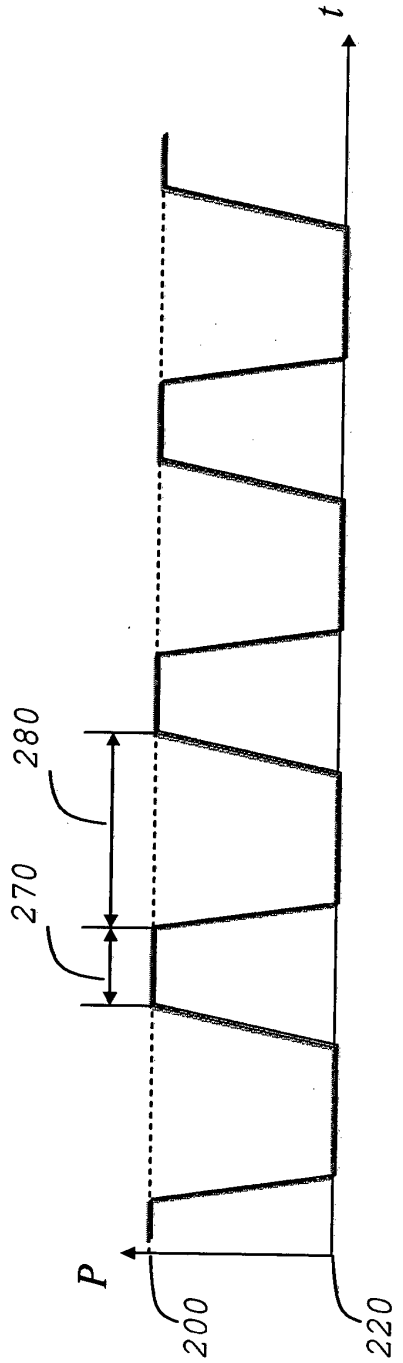


FIG. 3

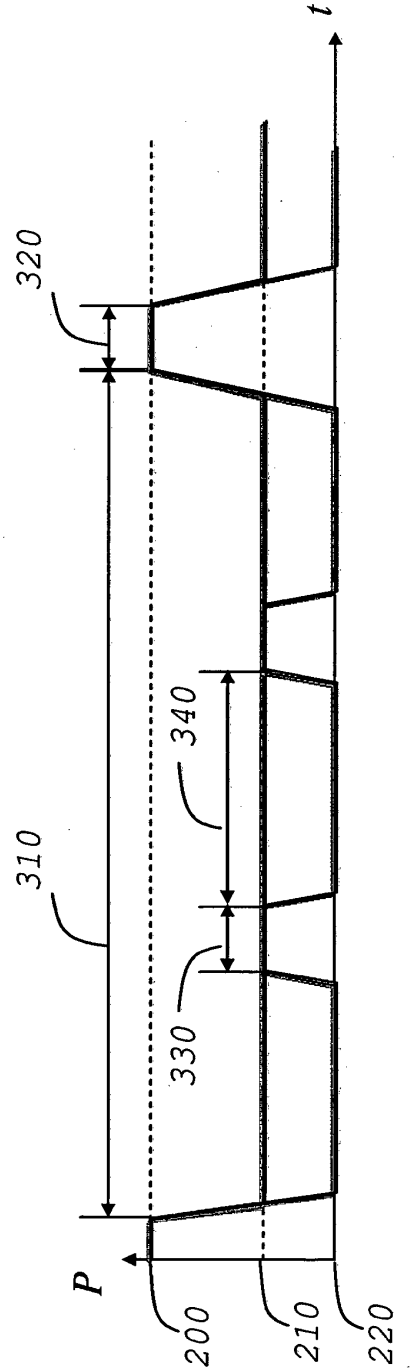


FIG. 4

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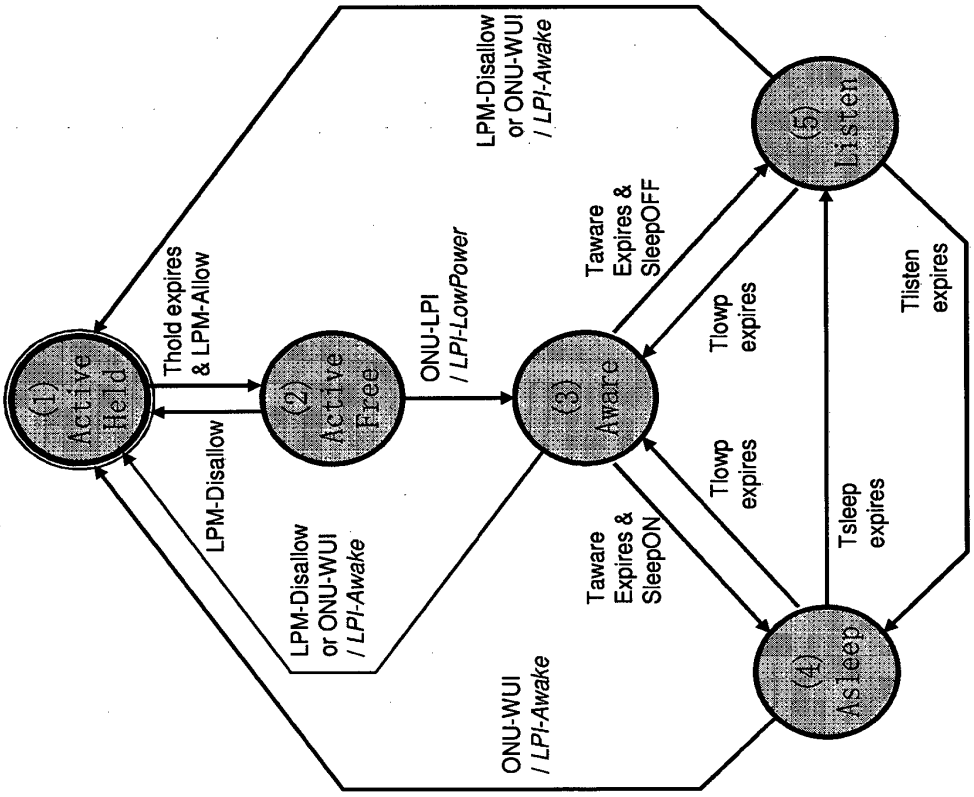

(1) Active Held
(2) Active Free
(3) Aware
(4) Asleep
(5) Listen
Thold expires & LPM-Allow
LPM-Disallow
ONU-LPI / LPI-LowPower
LPM-Disallow or ONU-WUI / LPI-Awake
LPM-Disallow or ONU-WUI / LPI-Awake
ONU-WUI / LPI-Awake
Taware Expires & SleepOFF
Taware Expires & SleepON
Tlowp expires
Tlowp expires
Tsleep expires
Tlisten expires

FIG. 5

6 / 9

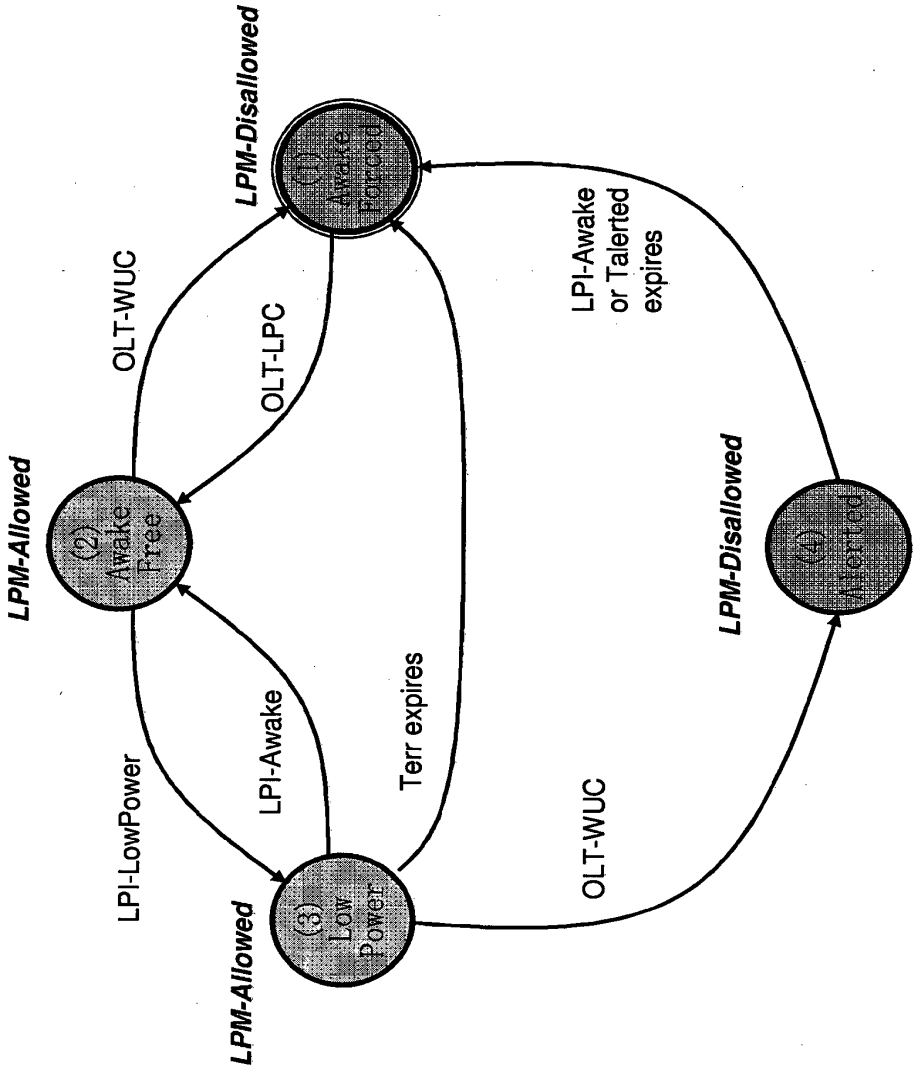

LPM-Disallowed
(1) Awake Forced
LPM-Allowed
(2) Awake Free
LPM-Allowed
(3) Low Power
LPM-Disallowed
(4) Alerted
OLT-WUC
OLT-LPC
LPI-LowPower
LPI-Awake
Terr expires
OLT-WUC
LPI-Awake or Talerted expires

FIG. 6

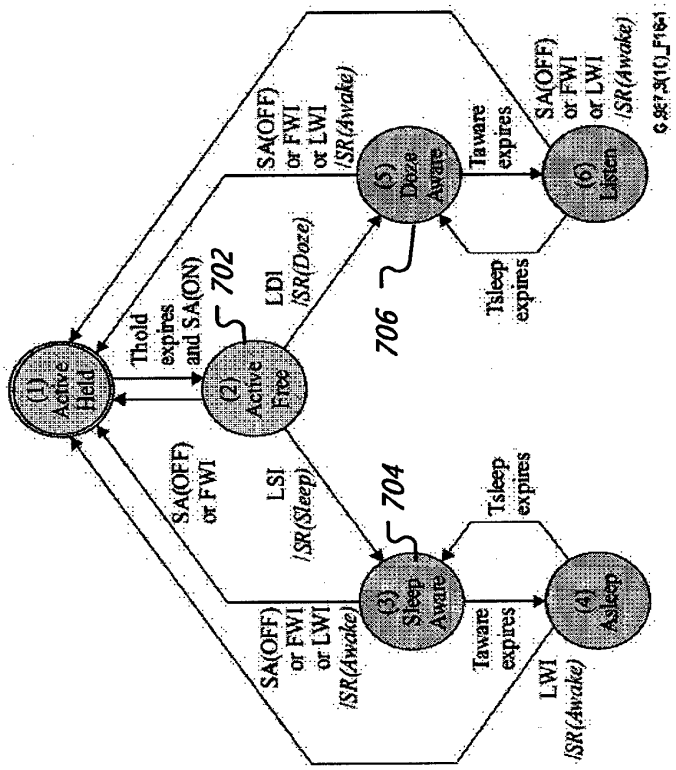

700
(1) Active Held
(2) Active Free
(3) Sleep Aware
(4) Asleep
(5) Doze Aware
(6) Listen
Thold expires and SA(ON)
SA(OFF) or FWI
LSI /SR(Sleep)
SA(OFF) or FWI or LWI /SR(Awake)
LDI /SR(Doze)
Tsleep expires
Taware expires
LWI /SR(Awake)
702
704
706

FIG. 7

900
Module for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
902
Module for operating the ONU in a second state in which both the transmitter and the receiver are turned off
904
Module for transitioning the ONU directly between the first state and the second state, based on a power management rule
906

FIG. 9

800
operate an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
802
operate the ONU in a second state in which both the transmitter and the receiver are turned off
804
transition the ONU directly between the first state and the second state, based on a power management rule
806

FIG. 8

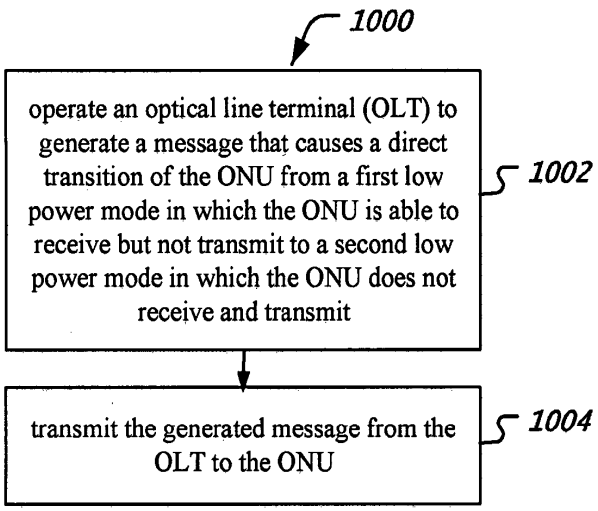


FIG.10

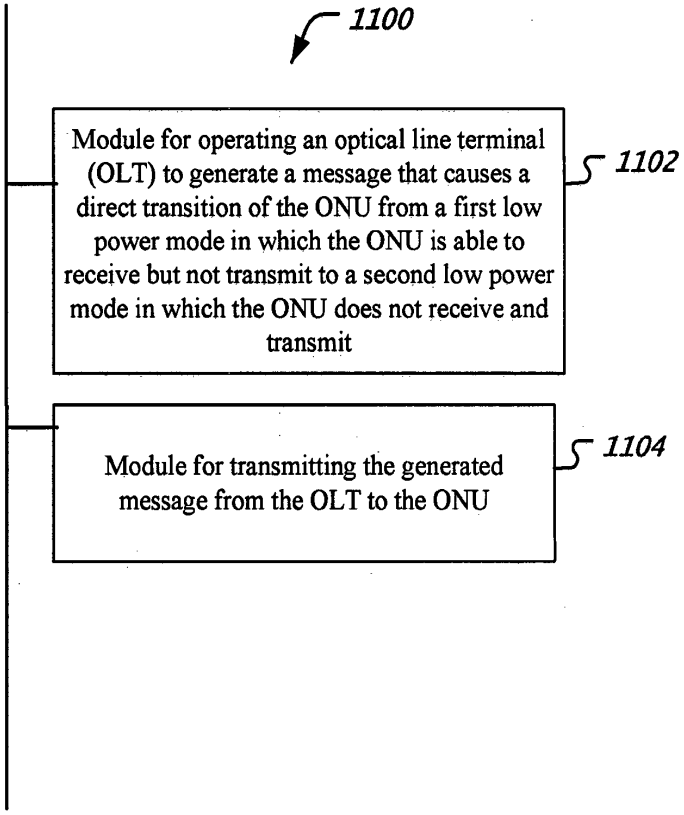


FIG. 11

Exhibit 1002
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WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/US2013/050533**
International filing date:		**15 July 2013 (15.07.2013)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**CN**
	Number:	**PCT/CN2012/078649**
	Filing date:	**13 July 2012 (13.07.2012)**
Date of receipt at the International Bureau:		**14 November 2013 (14.11.2013)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

34, chemin des Colombettes
1211 Geneva 20, Switzerland
www.wipo.int

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/US13/50533

International Application No.

15 JUL 2013 (15.07.13)

International Filing Date

PCTINTERNATIONAL RO/USAPPLICATION

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 009065-8132.WO01

Box No. I TITLE OF INVENTION

OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

ZTE CORPORATION
ZTE Plaza, Keji South Road
Hi-Tech Industrial Park
Shenzhen 518057
People's Republic of China

Telephone No.

Facsimile No.

Applicant's registration No. with the Office

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent).

E-mail address:

State *(that is, country)* of nationality: CN

State *(that is, country)* of residence: CN

This person is applicant for the purposes of: ☒ all designated States ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

AI, Bing
Perkins Coie LLP
P.O. Box 1247
Seattle, Washington 98111-1247
United States of America

Telephone No. (858) 720-5700

Facsimile No. (858) 720-5799

Agent's registration No. with the Office 43,312

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).

E-mail address: patentprocurement@perkinscoie.com

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

ZTE (USA) INC.
55 Madison Avenue
Suite 160
Morristown, New Jersey 07960
United States of America

This person is:
[x] applicant only
[ ] applicant and inventor
[ ] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: [x] all designated States [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

KHOTIMSKY, Denis Andreyevich
27 Glen Street
Westborough, Massachusetts 01581
United States of America

This person is:
[ ] applicant only
[ ] applicant and inventor
[x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

YUAN, LiQuan
#889 BiBo Road
Zhangjiang Hi-Tech Park
Shanghai 201203
People's Republic of China

This person is:
[ ] applicant only
[ ] applicant and inventor
[x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

ZHANG, DeZhi
#889 BiBo Road
Zhangjiang Hi-Tech Park
Shanghai 201203
People's Republic of China

This person is:
[ ] applicant only
[ ] applicant and inventor
[x] inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: [ ] all designated States [ ] the States indicated in the Supplemental Box

[ ] Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection.

☐ JP Japan **is not designated** for any kind of national protection.

☐ KR Republic of Korea **is not designated** for any kind of national protection.

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM AND DOCUMENTS

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1) 13 July 2012 (13.07.2012)	PCT/CN12/78649			CN
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

Furnishing the priority document(s):

☒ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application(s) was filed with the Office which, for the purposes of this international application, is the receiving Office)* identified above as:

☒ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **International Bureau** is requested to obtain from a digital library a certified copy of the earlier application(s) identified above, using, where applicable, the access codes(s) indicated below *(if the earlier application(s) is available to it from a digital library):*

☐ item (1) access code _____ ☐ item (2) access code _____ ☐ item (3) access code _____ ☐ other, see Supplemental Box

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (_____). *(See also the Notes to Box No. VI; further information **must** be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authorities is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA / KR

Box No. IX CHECK LIST for EFS-Web filings – this sheet is only to be used when filing an international application with RO/US via **EFS-Web**

This international application **contains** the following:	Number of sheets
(a) request form PCT/RO/101 (including any declarations and supplemental sheets)	4
(b) description (excluding any sequence listing part of the description, see (f), below)	18
(c) claims	4
(d) abstract	1
(e) drawings (if any)	16
(f) sequence listing part of the description in the form of an **image file** (e.g. PDF)	
Total number of sheets (including the sequence listing part of the description if **filed as an image file**)	43

(g) Sequence listing part of the description

- [ ] Filed in the form of an **Annex C/ST.25 text file**
- [ ] WILL BE filed separately on physical data carrier(s), on the same day and in the form of an **Annex C/ST.25 text file**

Indicate type and number of physical data carrier(s)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):*	Number of items
1. [x] fee calculation sheet	1
2. [ ] original separate power of attorney	
3. [ ] original general power of attorney	
4. [ ] copy of general power of attorney; reference number: _____	
5. [ ] priority document(s) identified in Box No. VI as item(s): _____	
6. [ ] Translation of international application into *(language):*	
7. [ ] separate indications concerning deposited microorganism or other biological material	
8. [ ] *(only where item (f) is marked in the left column)* copy of the sequence listing in electronic form (Annex C/ST.25 text file) not forming part of the international application but **furnished only for the purposes of international search** under Rule 13*ter*	
9. [ ] *(only where item (f) is marked in the left column)* a statement confirming that "the information recorded in electronic form submitted under Rule 13*ter* is identical to the sequence listing as contained in the international application" as filed via EFS-Web	
10. [ ] copy of results of earlier search(es)(Rule 12*bis*.1(a))	
11. [ ] other *(specify):*	

Figure of the drawings which should accompany the abstract: FIG. 1

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

/Bing Ai, Reg. 43,312/
Bing Ai, Agent for Applicant(s)
PERKINS COIE LLP

Attorney Reg. No. (when applicable): 43,312

For receiving Office use only

1. Date of actual receipt of the purported international application:	15-07-2013	2. Drawings: [ ] received: [ ] not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority (if two or more are competent): ISA / KR	6. [ ] Transmittal of search copy delayed until search fee is paid.	

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 009065-8132WO01	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2013/050533	International filing date *(day/month/year)* 15 July 2013 (15.07.2013)	Priority date *(day/month/year)* 13 July 2012 (13.07.2012)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant ZTE CORPORATION		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 13 January 2015 (13.01.2015)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Agnès Wittmann-Regis e-mail: pt06.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
AI BING

PERKINS COIE LLP P.O. BOX 1247 SEATTLE,
WASHINGTON 98111-1247 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)*	**22 October 2013 (22.10.2013)**
Applicant's or agent's file reference 009065-8132WO01	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2013/050533	**15 July 2013 (15.07.2013)**	13 July 2012 (13.07.2012)

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

H04B 10/25(2013.01)i

Applicant

ZTE CORPORATION et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	21 October 2013 (21.10.2013)	BYUN, Sung Cheal Telephone No. +82-42-481-8262

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additioanl copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2013/050533

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-17	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-17	NO
Industrial applicability (IA)	Claims	1-17	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following document:

D1: US 2012-0163808 A1 (GEUN YONG KIM et al.) 28 June 2012

2.1 Novelty (PCT Article 33(2)) and Inventive Step (PCT Article 33(3))

2.1.1 Claims 1-6

D1, which is considered to be the closest prior art to the subject matter of independent claim 1, discloses a method comprising: operating an optical network unit (ONU) in a dozing mode implying a period in which a transmitter is turned-off (see paragraph 37); and operating the optical network unit in a cyclic sleep mode implying a period in which both the transmitter and a receiver are turned-off (see paragraph 37). The technical feature of "transitioning the ONU directly between a first state and a second state, based on a power management rule" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an ITU-T is performing standardization for two modes, the dozing mode and the cyclic sleep mode under a recognition of the need to save power in the ONU (see paragraph 33). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 1. Accordingly, claim 1 would have been obvious over D1. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 2 depending on claim 1 is disclosed in D1 (an active interval implies a period in which both the transmitter and the receiver are turned-on; see paragraph 37). Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 3 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONT which receives an upstream bandwidth

Continued on Supplemental Box

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Box No. V

allocation transmits a sleep request OFF message requesting the transition to the normal mode to the OLT; see paragraph 49). Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 4 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 5 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (the OLT receives a sleep request OFF message transitions to the active state and transmits the sleep allow OFF message allowing the transition to the normal mode to the corresponding ONU; see paragraph 50). Therefore, claim 5 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 6 depending on claim 1 can be easily derived by a person skilled in the art from the feature of D1 (since the sleep allow ON message received in the active interval within the cyclic sleep mode is used to ask whether the ONU is normally operated or not, the ONU transmits an empty burst as an acknowledgement that the ONU is normally operated to the OLT, and then, transitions to the sleep mode; see paragraph 44). Therefore, claim 6 lacks an inventive step under PCT Article 33(3).

2.1.2 Claims 7-11

The features of independent apparatus claim 7 essentially correspond to those of method claim 1. Thus, the same reasoning as in claim 1 applies to claim 7. Therefore, claim 7 lacks an inventive step under PCT Article 33(3).

The additional features of claims 8-11 depending on claim 7 essentially correspond to those of claims 2-4 and 6, respectively. Accordingly, the same reasoning as in claims 2-4 and 6 applies to claims 8-11. Therefore, claims 8-11 lack an inventive step under PCT Article 33(3).

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2.1.3 Claims 12-13

Claim 12 relates to an optical communication apparatus in accordance with claim 1 relating to a method. The apparatus of claim 12 comprises a memory; and a processor which uses stored instructions to implement the method that is the same as that defined in claim 1. As the features of claim 12 essentially correspond to the features of claim 1 except for the category, the same reasoning as in claim 1 applies to claim 12. Therefore, independent claim 12 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 13 depending on claim 12 can be easily derived by a person skilled in the art from the feature of D1 (an optical network unit (ONU) periodically turns on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turns-on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 13 lacks an inventive step under PCT Article 33(3).

2.1.4 Claims 14-15

D1, which is considered to be the closest prior art to the subject matter of independent claim 14, discloses an optical line terminal (OLT) comprising a controller configured to control an operation of the OLT, wherein an ONU periodically turns on/off a receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off a transmitter and the receiver (cyclic sleep mode) and parameters associated with power saving include a sleep interval and an active interval (see paragraphs 37, 57, 82). The technical feature of "a transmitter configured to transmit the generated messages to the optical network unit (ONU)" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that the ONU receiving the sleep allow OFF message is switched into the normal mode and transmits the sleep request OFF message as the response for the sleep allow OFF message to the OLU (see paragraph 55). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 14. Accordingly, claim 14 would have been obvious over D1. Therefore, claim 14 lacks an inventive step under PCT Article 33(3).

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The additional feature of claim 15 depending on claim 14 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 15 lacks an inventive step under PCT Article 33(3).

2.1.5 Claims 16-17

D1, which is considered to be the closest prior art to the subject matter of independent claim 16, discloses a passive optical network (PON) communications system comprising an optical network unit (ONU) periodically turning on/off a receiver through signaling between an OLT and the ONU (dozing mode) and simultaneously turning on/off a transmitter and the receiver (cyclic sleep mode), thereby saving the standby power, wherein the sleep interval implies a period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode (see paragraphs 37, 57). The technical feature of "an optical line terminal (OLT) configured to transmit a control message to the ONU" is not explicitly disclosed in D1. However, said feature is virtually suggested by the same document, considering that an OLT transmits the sleep allow ON message allowing the transition to a next sleep mode to the ONT (see paragraph 43). Thus, a person skilled in the art would easily conceive the idea of employing the feature of claim 16. Accordingly, claim 16 would have been obvious over D1. Therefore, claim 16 lacks an inventive step under PCT Article 33(3).

The additional feature of claim 17 depending on claim 16 can be easily derived by a person skilled in the art from the feature of D1 (the ONU periodically turns on/off the receiver through signaling between the OLT and the ONU (dozing mode) and simultaneously turns on/off the transmitter and the receiver (cyclic sleep mode), thereby saving standby power, wherein a sleep interval implies the period in which the transmitter is turned-off in the dozing mode and the period in which both the transmitter and the receiver are turned-off in the cyclic sleep mode; see paragraphs 37, 57). Therefore, claim 17 lacks an inventive step under PCT Article 33(3).

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2.2 Industrial Applicability (PCT Article 33(4))

Claims 1-17 are industrially applicable under PCT Article 33(4).

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(54) **Title**: OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

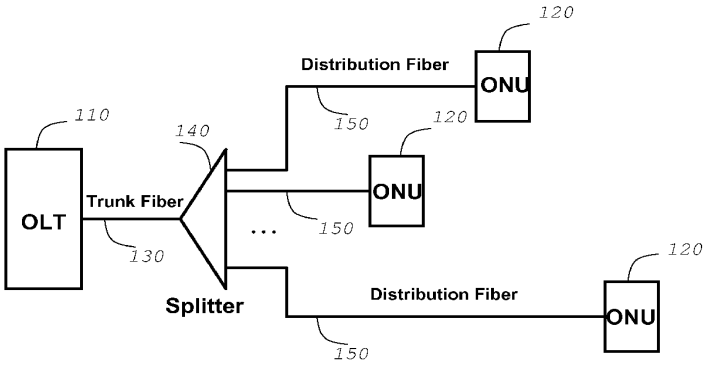


FIG. 1

(57) **Abstract**: Techniques for unified optical network unit power management in a passive optical network include operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on, operating the ONU in a second state in which both the transmitter and the receiver are turned off, and transitioning the ONU directly between the first state and the second state, based on a power management rule.

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OPTICAL NETWORK UNIT POWER MANAGEMENT IN PASSIVE OPTICAL NETWORKS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent document claims the benefit of priority under the Paris Convention of International Patent Application No. PCT/CN2012/078649, filed on July 13, 2012, and entitled "METHOD AND APPARATUS FOR UNIFIED OPTICAL NETWORK UNIT (ONU) POWER MANAGEMENT IN A PASSIVE OPTICAL NETWORK (PON)." The disclosure of the before-mentioned application is incorporated by reference as part of this patent document.

BACKGROUND

[0002] This patent document relates to systems, devices, and techniques for data communications in a passive optical network. In one aspect, this document relates to power saving in an optical network unit (ONU) of a passive optical network (PON).

[0003] A PON is an optical network architecture based on point-to-multipoint (P2MP) topology in which a single optical fiber and multiple passive branching points are used to provide data communication services. A PON system can facilitate user access with a service provider communication facility to access telecommunication, information, entertainment, and other resources of the Internet. A PON system can include a central node, called an optical line terminal (OLT), which can be in connection with a single or multiple user nodes called ONUs via a passive optical distribution network (ODN). An OLT can be located at the access provider's communication facility (e.g., central office). An ONU can be located at or near the access user's premises. An ONU typically draws electrical power from the user's premises power supply network and may employ battery backup to support communication services in case of power outage.

[0004] Better power management techniques can help improve battery life of an ONU.

SUMMARY

[0005] Method and apparatus are disclosed that, in one beneficial aspect, are useful to reduce the power consumption of an optical network unit in a PON. Implementations described in this document can provide several advantages. For example, the disclosed techniques can

allow an access provider to guarantee lifeline services to customers by increasing the duration of operational time during power outages. The techniques can also be used to reduce the size and cost of the battery backup unit, reduce overall green-house gas emission and carbon footprint of the information and communication technologies based on passive optical networks, and so on.

[0006] In one example aspect, an optical communication method is disclosed. The method includes operating an ONU in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on, operating the ONU in a second state in which both the transmitter and the receiver are turned off and transitioning the ONU directly between the first state and the second state, based on a power management rule.

[0007] In another example aspect, a PON system is disclosed. The PON includes an ONU and an OLT. The ONU is operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit. The OLT is communicably coupled to the ONU and is configured to transmit a control message to the ONU to control at least one aspect of a transition of the ONU between the first low power mode and the second low power mode.

[0008] These, and other, features are further described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 depicts an example of a PON system.

[0010] FIG. 2 illustrates a power consumption profile of a conventional power management technique based on ONU dozing.

[0011] FIG. 3A illustrates a power consumption profile of a conventional power management technique based on cyclic sleeping.

[0012] FIG. 3B illustrates a power consumption profile of a conventional power management technique based on ONU dozing.

[0013] FIG. 3C illustrates a power consumption profile of a conventional power management technique based on cyclic sleeping.

[0014] FIG. 3D illustrates a double-nested cyclic profile that either includes cyclical sleeping or includes cyclical dozing.

[0015] FIG. 4A illustrates a power consumption profile of an embodiment of the disclosed unified ONU power management method.

[0016] FIG. 4B illustrates a power consumption profile of an embodiment of the disclosed unified ONU power management method, with sleep mode power consumption shown on the same chart.

[0017] FIG. 5 illustrates a state machine that governs ONU's behavior in an embodiment of the unified power management method.

[0018] FIG. 6 illustrates a state machine that governs OLT's behavior in an embodiment of the unified power management method.

[0019] FIG. 7A illustrates a prior art state machine for ONU power management.

[0020] FIG. 7B is an alternate way of representing the ONU state machine of FIG. 7A.

[0021] FIG. 7C is another embodiment of the ONU state machine of FIG. 7A.

[0022] FIG. 7D illustrates an OLT state machine for power management.

[0023] FIG. 7E illustrates an alternate embodiment of the OLT state machine depicted in FIG. 6.

[0024] FIG. 8 is a flow chart representation of a unified power management method.

[0025] FIG. 9 is a block diagram representation of a portion of an apparatus that implements unified power management technique disclosed in the document.

[0026] FIG. 10 is a flow chart representation of a process of operating an OLT.

[0027] FIG. 11 is a block diagram representation of a portion of an apparatus for optical communications.

DETAILED DESCRIPTION

[0028] Techniques for unified power management of an optical network unit (ONU) in which the ONU can transition between multiple low power states without having to transition to a high power state are disclosed. The terminology in the description that follows, to the extent used in the ITU-T XG-PON standards documents and not explicitly discussed in this document, is intended to be consistent with the ITU-T standards documents.

[0029] The techniques described in this document, in one beneficial aspect, are useful to reduce the power consumption of an optical network unit in a PON. Implementations described in this document can provide one or more advantages depending on specifics in certain applications. For example, the disclosed techniques can allow an access provider to guarantee lifeline services to customers by increasing the duration of operational time during power

outages. The techniques can also be used to reduce the size and cost of the battery backup unit, reduce overall green-house gas emission and carbon footprint of the information and communication technologies based on passive optical networks, and so on. The disclosed techniques are superior in terms of power saving efficiency to available prior state-of-the-art techniques. For example, the disclosed techniques are superior to a Dozing method implemented in some systems where the receiver is on for checking data while transmitter is off, at least due to substantially lower on average power level during the low power cycle. The disclosed technique is also superior to a cyclic sleep method implemented in some systems where both receiver and transmitter are off at least because of the decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle. In one beneficial aspect, the disclosed techniques allow ONUs to transition between a dozing state and a sleep state.

[0030] A PON system can use optical fiber to connect the user premises to the provider communication facility. The PON Optical Distribution Network (ODN) can include a point-to-multipoint (P2MP) optical fiber infrastructure where passive branching points can be represented by optical splitters are other similar passive optical devices. These passive ODN equipments can be deployed in street cabinets, closets, underground utility holes, cable chambers, and other installations and require no electrical power and little maintenance. The PON ODN can be attached to the OLT with a single strain of optical fiber.

[0031] FIG. 1 shows an exemplary PON system comprising an OLT 110, plurality of ONUs 120; and an ODN that comprises optical feeder fiber, or trunk fiber 130, a splitter 140, and multiple distribution fibers 150.

[0032] ONUs 120 can be deployed at or near user premises. An ONU is an active network element that typically draws electric power from the power supply network present at or near the access user's premises and in some cases is equipped with a battery-based power backup unit to allow limited operations in case of the power supply network failure. Conservation of the power consumed by an ONU is an operation requirement that can be associated with two objectives. First, the requirement is driven by the emergency services support under the power supply network failure and is targeted at the prolongation of the battery operation time or, alternatively, reduction of the size and cost of the battery. Second, the requirement focuses on

conserving power in regular (based on the power supply network) operations and minimizing the carbon dioxide emissions generated by information and communications technologies (ICTs).

[0033] Conventional standard-based PON systems, such as Ethernet PON (EPON), Broadband PON (BPON), Gigabit PON (G-PON) consider an ONU to be in a permanent link-layer association with the OLT: the ONU continuously listen to the downstream transmission over the P2MP optical channel and may be required to transmit protocol information upstream, even if there is no user data to exchange. Therefore, the ONU's optical transceiver continuously remains fully operational and fully powered. These conventional PON systems typically support only the basic, one-sided power conservation technique, such power shedding, characterized by powering off or reducing power to non-essential functions and services while maintaining a fully operational optical link.

[0034] Various advanced standard-based PON systems, such as 10 Gigabit/sec EPON (10G-PON), and 10 Gigabit/sec PON (XG-PON), employ protocol-based power-saving techniques based on a signalling mechanism between the OLT and the ONU to function properly. These techniques involve defining several power levels and specifying the cyclic behavior of an ONU which periodically switches between the full power level and one lower power level.

[0035] Besides the full power level, the standard-based 10 Gigabit/sec PON (XG-PON) system identifies the ONU Dozing power level, which is characterized by powering off of the ONU transmitter and the associated circuitry for substantial periods of time on the condition that the receiver remains continuously on, and the ONU Sleeping power level, which is characterized by both ONU transmitter and ONU receiver are turned off for substantial periods of time.

[0036] FIG. 7A shows the state machine behavior 700 of a PON ONU, as specified in one currently published PON standard (ITU-T G.987.3, 10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification, publication date October 2010). From the initial state "Active Free" 702, the ONU can either transition into a Sleep Aware state 704 or a Doze Aware state 706 (further described below). However, no direct transition between the Doze Aware and the Sleep Aware states 704, 706 are provided. Conventional ONUs therefore lack the technology of directly transitioning between two low power consumption states without having to go through an active state (e.g., a full powered state).

In one detrimental aspect, such a transition through the active state may increase the power consumed by the ONU, thereby undesirably reducing batter life.

[0037] FIG. 2 depicts example ONU power consumption profile, that is, the power *P* consumed by the ONU as a function of time *t*, in a case where ONU Dozing mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The dozing power level 210, which is lower than full power level 200, but substantially higher than zero (or sleep mode 220), is characterized by the ONU transmitter with the associated circuitry being powered off, and the transmitter remaining on. In other words, the ONU is in a "listen" mode to receive data or signals, but not in a "talk" mode to transmit data or signals. Two timing parameters, which can be configured into the ONU in advance, govern specific pattern of the power consumption: time interval 250 (T_{Doze}) is the maximum time an ONU can be allowed to abstain from upstream transmissions without being declared in violation of the protocol, while the time interval 260 (T_{Aware}) is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational. The longer the time interval 250 is with respect to time interval 260, the more efficient the technique is in relative terms. Since the ONU receiver remains continuously powered, the latency of detecting an external wake-up stimulus (a signal form the OLT to enter full power operation, in response, for example, to an incoming call) is close to that of full-power operation and is comparable to round-trip propagation delay. This is beneficial. The continuously powered ONU receiver may limit the overall power-saving efficiency.

[0038] FIG. 3A depicts example ONU power consumption profile, that is, the power *P* consumed by the ONU as a function of time *t*, when ONU Cyclic sleep mode is implemented. The full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being powered off, and is typically close to zero. Two configurable timing parameter govern specific pattern of the power consumption: time interval 270 (similar to T_{Aware}) is the minimum time required for the OLT and ONU to perform periodic bi-directional handshake with both ONU transmitter and ONU receiver being fully powered and fully operational; time interval 280 (T_{Sleep}) is the maximum time an ONU can be allowed to abstain from upstream transmissions and from receiving downstream

traffic at the same time. While turning off both the transmitter and receiver is the most efficient way to save power, the latency of detecting an external wake-up stimulus may increase by as much as the time interval 280. Therefore, in order to maintain sufficiently short external wakeup latency, time interval 280 may be kept small, thus reducing the overall power efficiency.

[0039] Both the above discussed cyclic power management techniques (FIG. 2 and FIG. 3A) involve the ONU toggling between two power levels: the full power level and the Dozing level (FIG. 2) or between the full power level and the sleeping level (FIG. 3A). In some implementations, the power management behavior of an ONU may be configured by specifying two parameters: the maximum time in the lower power mode, and the minimum time in the full power mode. The values of the configuration parameters depend on the kind of services a system is expected to support, as well as the required availability of those services.

[0040] FIGS. 3B and 3C, respectively, provide another depiction of the dozing and sleep modes of operation, previously described, by explicitly showing the sleep state power level 220 in the charts.

[0041] FIG. 3D provides an illustrative representation that combines the above discussed sleep mode and dozing mode into a single graphical representation. An ONU alternates between the full power phase 351 and a lower power phase 353. While in in a low-power phase, an ONU alternates between two power consumption levels (depicted in inset 357): a full power level 359 and a low power level 361. In a pure doze mode, the ONU's latency in detecting an external wakeup stimulus is comparable to a round trip propagation delay, and the configured sojourn in a state with the low power level (Listen state) primarily depends on how long the OLT can afford to keep the ONU out-of touch. This value can be quite large and limited, for example, by the need to periodically adjust the equalization delay. In the cyclic sleep mode, the ONU's latency in detecting an external wakeup stimulus includes the sojourn in the low power state (Asleep state) and, therefore, the configured sojourn in a state with the low power level is substantially shorter – perhaps, by several orders of magnitude, compared with the doze case. Signals related to wake-up and sleep operations may be exchanged (355) at transitions between active phase 351 and power saving phase 353.

[0042] In one aspect, in some embodiments, the unified power management method disclosed in this document integrates the two cyclic power management techniques generally shown in FIGS. 7A, 2 and 3A, in a single unified behavior that involves ONU power

consumption alternating between at least three levels and is controlled by at least four timing parameters. Under this integration, when in a power saving mode, the ONU spends most of the time toggling between the Sleeping power level (with the lowest power consumption) and the Dozing power level (with the next lowest power consumption), only occasionally returning to the full-power level operation.

[0043] FIG. 4A shows one example power profile of the unified power management technique. In this example, the full power level 200 is characterized by both ONU receiver and ONU transmitter being power on with associated circuitry. The sleeping power level 220, is characterized by both the ONU transmitter and ONU receiver with the associated circuitry being power off, and is reasonably close to zero. The intermediate dozing power level 210 is characterized by the ONU transmitter with the associated circuitry being power off, and ONU receiver remaining on. Time interval 320 (similar to time intervals 260 and 270) is the minimum duration of the periodic bi-directional handshake between the OLT and the fully powered and operational ONU. Time interval 310 ($T_{LowPower}$) is the maximum allowed duration between consecutive bi-directional handshakes. Time interval 330 is the minimum time that the ONU listens to the downstream transmission in order to obtain any necessary signalling indications. Time interval 340 is the maximum time the ONU is allowed to abstain from upstream transmissions and from receiving downstream traffic at the same time.

[0044] As can be seen, the power reduction during the low power cycle depends on the ratio of time interval 310 to time interval 320, which can be made large, while the latency in response to an external stimulus depends on time interval 340, which can be relatively small. Therefore, in one advantageous aspect, the disclosed unified power management technique is superior in terms of power saving efficiency to both the Dozing method, due to substantially lower on average power level during the low power cycle, and the Cyclic Sleep method (as previously discussed with respect to FIGS. 2 and 3A), due to decoupling of the external stimulus latency from the power efficiency and, consequently, substantially larger possible relative duration of the low power cycle.

[0045] It will be appreciated that the specific values of the time intervals 310, 320, 330 and 340 may be implementation-specific and may depend on operational considerations such as regulatory requirements, target time for battery life, and so on. For example, maximum dwell time in sleep state may be about 1 to 2 seconds, so that the ONU is responsive to an incoming

call within a couple of seconds. Similarly, maximum dwell time in the doze state may be relatively large (e.g., several tens of seconds or minutes, e.g., 2 minutes or 1 hour).

[0046] FIG. 4B is an alternative illustration of the power profile in a unified power management embodiment. Some implementation examples are provided below based the disclosed power management technology.

Low power mode signaling between OLT and ONU

[0047] In some implementations, the low power primitives specified in the following tables can be exchanged between OLT and ONU via appropriate management channel.

Table 1 – OLT Low power management primitives

Primitive	Semantics
LPM-Allow	OLT grants consent to ONU's transition into a low power mode
LPM-Disallow	OLT withdraws consent to ONU's transition into a low power mode

Table 2 – ONU Low power indication primitives

Primitive	Semantics
LPI-LowPower	ONU indicates its transition into a low power mode
LPI-Awake	ONU indicates its exit from a low power mode

ONU power management state machine

[0048] In some implementations, each ONU maintains an instance of the power management state machine that is characterized by the following states and the state transitions as shown in FIG. 5.

Table 3 – ONU power management states

State	Semantics
(1) ActiveHeld	A full power mode state in which full power operation is mandated by the OLT. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. Power management state transitions do not occur. The minimum sojourn in this state is enforced by the Thold timer. Both the OLT's consent and ONU's local decision are required for the ONU to enter a low power mode.
(2) ActiveFree	A full power mode state in which full power operation is at ONU's discretion. The ONU is fully responsive, forwarding downstream traffic and responding to all bandwidth allocations. The OLT has consented to ONU's transition into a low power mode, which is now a subject to ONU's local decision. Upon transition into the Aware state (which is stipulated by the local stimulus ONU-LPC), the ONU sends an LPI-LowPower message to the OLT.
(3) Aware	A low power mode state allowing periodic bi-directional handshake between the OLT and ONU. Both ONU receiver and transmitter remain on. The ONU forwarding downstream traffic and responding to all bandwidth allocations. The sojourn in the state is parametrically controlled, if not truncated by the local stimulus ONU-WUC. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.
(4) Asleep	A low power mode state in which the ONU shuts down both its receiver and transmitter, retaining the ability to wake up on local stimulus ONU-WUC. The sojourn in the state is parametrically controlled, if not truncated by a local stimulus ONU-WUC. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

Table 3 – ONU power management states

State	Semantics
(5) Listen	A low power mode state in which the ONU has its transmitter off, but the receiver on. The ONU listens to the downstream signal and forwards downstream traffic, while retaining the ability to reactivate the transmitter on local stimulus ONU-WUC or upon receipt of LPM-Disallow message. The sojourn in the state is parametrically controlled if not truncated by a local stimulus ONU-WUC or LPM-Disallow message. Before exiting this state, the ONU ensures that it is fully powered up, synchronized, and capable of responding to both upstream and downstream traffic and control. The state transitions between the three low power states, Aware, Asleep, and Listen, do not involve any external signalling. Upon transition into the ActiveHeld state (which is forced by an LPM-Disallow message or a local stimulus ONU-WUC), the ONU sends an LPI-Awake message to the OLT.

[0049] In some implementations, an ONU maintains a pair of complementary, mutually exclusive internal conditions specified as follows.

Table 4 – ONU internal power conditions

Condition	Semantics
ONU-LPC	ONU Low Power Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU may go into low power mode.
ONU-WUC	ONU Wake-Up Condition is based on local dynamic operational and traffic load characteristics indicating that the ONU must remain fully powered.

[0050] In some implementations, the ONU maintains the following timing parameters to control the ONU power management state machine and allows to specify the initial values of the timers as follows.

Table 5 – ONU timing parameters

Timer	Semantics
Thold	The minimum sojourn in the ActiveHeld state. The timer is initialised upon transition into the ActiveHeld state and blocks transition into the ActiveFree state until expiration.

Table 5 – ONU timing parameters

Timer	Semantics
Taware	The minimum sojourn in the Aware state, which defines the duration of the periodic bi-directional handshake between the OLT and an ONU in a low power mode. The timer is initialised upon transition into the Aware state; its expiration releases ONU's transition to either Asleep or Listen state.
Tlowpower (or Tlowp)	The maximum combined sojourn in the Asleep and Listen states between successive periodic bi-directional handshakes. The timer is initialised upon transition from the Aware state to either Asleep or Listen state; its expiration forces ONU's transition back to the Aware state.
Tsleep	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Asleep state; its expiration forces ONU's transition into the Listen state. To configure pure Sleep mode operation, the initial value is set to infinity with finite Tlisten and Tlowp initial values.
Tlisten	The maximum sojourn in the Asleep state. The timer is initialised upon transition into the Listen state; its expiration forces ONU's transition into the Asleep state. To configure pure Doze mode operation, the initial value is set to infinity with finite Tsleep and Tlowp initial values.

[0051] To support unified operation using three distinct power levels, in some implementations, the ONU timing parameters Tsleep and Tlisten are initialized each to a finite non-zero value, while Tlowpower is initialized to a finite value much larger than the initial values of either Tsleep or Tlisten. Then, during operation, values can be adjusted through parameter configuration to either Dozing or Cyclic Sleep modes. To implement Cyclic Sleep, timing parameter Tsleep may be initialized to infinity, timing parameter Tlisten may be initialized to zero, and timing parameter Tlowp may be initialized to finite non-zero value. To implement ONU Dozing, timing parameter Tlisten may be initialized to infinity, timing parameter Tsleep may be initialized to zero, and timing parameter Tlowp may be initialized to a finite non-zero value.

[0052] In the state diagram depicted in FIG. 5, the binary flag SleepOFF (SleepOn being its binary complement) is a matter of notational convenience which is used to indicate the operation of the machine in the ONU dozing mode. An alternative implementation could make a transition from Aware state upon expiration of the Taware timer unconditionally into the

Asleep state. In the ONU dozing mode, Tsleep is initialized to zero, and the transition to Listen would immediately follow.

OLT power management state machine

[0053] In some implementations, the OLT maintains an instance of the state machine for each subtending ONU that is characterized by the following states and the state transitions as shown in FIG. 6.

Table 6 – OLT power management states

State	Semantics
(1) AwakeForced	The OLT holds the ONU in a full power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.
(2) AwakeFree	The OLT consents to the ONU's transition into a low power mode. The OLT provides normal allocations to ONU, forwards downstream traffic, and expects a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(3) LowPower	The OLT is aware that the ONU is in a low power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.
(4) Alerted	The OLT attempts to bring the ONU back into a full power mode. The OLT provides at least signalling allocations to ONU, optionally forwards downstream traffic, but does not expect a response to every bandwidth grant. Upon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Disallow message to the ONU.

[0054] In some implementations, the OLT maintains a pair of complementary, mutually exclusive internal conditions for each subtending ONU specified as follows.

Table 7 – OLT internal power conditions

Condition	Semantics
OLT-LPC	OLT Low Power Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT consents to ONU going into a low power mode.
OLT-WUC	OLT Wake-Up Condition for a given ONU is based on local dynamic operational and traffic load characteristics indicating that the OLT objects to ONU going into a low power mode.

[0055] In some implementations, the OLT maintains the following timing parameters to control an instance of the OLT power management state machine and allows to specify the initial values of the timers as follows.

Table 8 – OLT timing parameters

Timer	Semantics
Terr	The maximum allowed time between bi-directional handshakes between the OLT and the ONU in a low power mode. The timer is initialised upon transition into the LowPower state and is restarted each time OLT receives a transmission from the ONU. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.
Talerted	The maximum allowed time for the ONU to come out of the low power mode upon OLT's instruction to do so. The timer is initialised upon transition into the Alerted state. Expiration of the timer indicates a low power mode timing violation by the ONU, in which case the OLT executes a transition into AwakeForced to diagnose alleged loss of the ONU.

[0056] Referring to FIGS. 7A through 7E, the present power management technology can improve power efficiency in the system shown in FIG. 7A.

[0057] FIG. 7B is an illustration of the ONU state machine in which the left side branch (sleep aware and asleep states) in FIG. 7A is eliminated to highlight low power aware operation.

[0058] FIG. 7C illustrates an expanded view of the internal semantics of the LowPower state to allow two alternating power levels (Receive or Rx on, and Rx off).

[0059] FIG. 7D is an example of a prior art OLT state machine. Note that the transition between sleep and doze states always goes through an awake state.

[0060] FIG. 7E is an alternate embodiment of the state machine depicted in FIG. 6. The state diagram in FIG. 7E uses the state diagram depicted in FIG. 7D and eliminates one of the two low power branches.

[0061] FIG. 8 is a flow chart representation of a unified power management method 800. The method 800 may be implemented on an ONU 120.

[0062] At 802, method 800 operates an ONU in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. For example, in some implementations, the first state may be the dozing state 210 discussed above.

[0063] At 804, method 800 operates the ONU in a second state in which both the transmitter and the receiver are turned off. In some implementations, the second state may correspond to the sleep state 220 discussed above.

[0064] At 806, method 800 directly transitions the ONU between the first state and the second state, based on a power management rule. Direct transition refers to changing the operational state of the ONU between the first and the second states without having to go through an intermediate third state in which the power utilized by the ONU increases (e.g., as in the Active state previously discussed). One power management rule may be based on the timing parameters that control how long the ONU can be in the first or the second mode (e.g., in sleep or dozing mode, as discussed previously). Other power management rules include transitioning based on a user input (e.g., phone going off the hook), responding incoming control messages from the OLT that specify entering or exiting the first and the second states, and so on.

[0065] FIG. 9 is a block diagram representation of an optical communications apparatus 900. The module 902 is for operating an optical network unit (ONU) in a first state (e.g., dozing) in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on. The module 904 is for operating the ONU in a second state (e.g., sleep state) in which both the transmitter and the receiver are turned off. The module 906 is for transitioning the ONU directly between the first state and the second state, based on a power management rule. In some implementations, the transition may be achieved autonomously (i.e. without communication with an external network entity). In some implementations, the transition may be based on a message received from another network entity such as the OLT. In some implementations, the transition may be based on obtaining permission to transit from one low power mode to another low power

mode, obtained by sending a request message from the ONU to the OLT and receiving a corresponding grant message from the OLT.

[0066] FIG. 10 is a flow chart representation of a process 1000 of controlling operation of an optical network unit (ONU), operating in a passive optical network (PON).

[0067] At 1002, the process 1000 operates an OLT to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit.

[0068] At 1004, the process 1000 transmits the generated message from the OLT to the ONU. As previously discussed, the OLT may control the low power operation of ONUs by either explicitly providing control messages or by granting requests from the ONUs, e.g., transitioning from a dozing mode to a sleep mode. In some implementations, the process 1000 may further locally keep track of the state in which each ONU served by the OLT is.

[0069] FIG. 11 is a block diagram representation of an optical communications apparatus 1100. The module 1102 is for operating an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit. The module 1104 is for transmitting the generated message from the OLT to the ONU.

[0070] It will be appreciated that unified power management techniques are disclosed, allowing a device to extend battery life without unduly sacrificing responsiveness to communication requests. While the disclosed embodiments are with respect to the application to optical communications network, the disclosed techniques are equally applicable to other communications networks including wired and wireless networks.

[0071] The disclosed and other embodiments, modules and the functional operations described in this document can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this document and their structural equivalents, or in combinations of one or more of them. The disclosed and other embodiments can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer readable medium for execution by, or to control the operation of, data processing apparatus. The computer readable medium can be a machine-readable storage device, a machine-readable storage substrate, a

memory device, a composition of matter effecting a machine-readable propagated signal, or a combination of one or more them. The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them. A propagated signal is an artificially generated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal, that is generated to encode information for transmission to suitable receiver apparatus.

[0072] A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0073] The processes and logic flows described in this document can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

[0074] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are

a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. However, a computer need not have such devices. Computer readable media suitable for storing computer program instructions and data include all forms of non volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto optical disks; and CD ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0075] While this patent document contains many specifics, these should not be construed as limitations on the scope of an invention that is claimed or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this document in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or a variation of a sub-combination. Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results.

[0076] Only a few examples and implementations are disclosed. Variations, modifications, and enhancements to the described examples and implementations and other implementations can be made based on what is disclosed.

CLAIMS

What is claimed is:

1. A method of optical communication in a passive optical network, comprising:

operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

transitioning the ONU directly between the first state and the second state, based on a power management rule.

2. The method of claim 1, further comprising:

operating the ONU in a third state in which both the transmitter and the receiver are turned on.

3. The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal (OLT); and

configuring the power management rule based on the received power management message.

4. The method of claim 1, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

5. The method of claim 1, further comprising:

transmitting, to an optical line terminal, a message indicative of the transitioning between the first state and the second state.

6. The method of claim 1, further comprising:

receiving, by the receiver, a power management message from an optical line terminal; and

performing the transitioning responsive to the received power management message and a local decision to change an operational state.

7. An optical communication apparatus in a passive optical network, comprising:

means for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on;

means for operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

means for transitioning the ONU directly between the first state and the second state, based on a power management rule.

8. The apparatus of claim 7, further comprising:

means for operating the ONU in a third state in which both the transmitter and the receiver are turned on.

9. The apparatus of claim 7, comprising:

means for receiving, by the receiver, a power management message from an optical line terminal; and

means for configuring the power management rule based on the received power management message.

10. The apparatus of claim 7, wherein the power management rule includes a first time period for operation in the first state and a second time period for operation in the second state and wherein the means for transitioning performs a state transition upon expiration of at least one of the first time period and the second time period.

11. The apparatus of claim 7, further comprising:

means for receiving a power management message from an optical line terminal; and

means for performing the transitioning responsive to the received power management

message and a local decision to change an operational state.

12. An optical communication apparatus, comprising:

a memory that stores processor-executable instructions; and

a processor that uses the stored instructions to implement a method, comprising operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on; and operating the ONU in a second state in which both the transmitter and the receiver are turned off; and

wherein the processor includes means for transitioning the ONU directly between the first state and the second state, based on a power management rule.

13. The apparatus as in claim 12, wherein the processor further uses the stored instructions to implement the method by receiving, by the receiver, a power management message from an optical line terminal (OLT) and configuring the power management rule based on the received power management message, wherein the power management rule specifies a first time period for operation in the first state and a second time period for operation in the second state and wherein the transitioning is performed upon expiration of at least one of the first time period and the second time period.

14. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:

a processor configured to generate messages for controlling a transition of an optical network unit from a first low power state in which a receiver of the optical network unit is turned on but a transmitter of the optical network unit is turned off to a second low power state in which both the receiver and the transmitter of the optical network unit are turned off; and

a transmitter configured to transmit the generated messages to the optical network unit.

15. The optical line terminal as in claim 14, wherein the processor includes means for specifying a first time period for operation in the first low power state and a second time period for operation in the second low power state and wherein the transition of the optical network unit from the first low power state to the second low power state is controlled to occur upon

expiration of at least one of the first time period and the second time period.

16. A passive optical network (PON) communications system, comprising:

an optical network unit (ONU) operable in a first low power mode in which the ONU is able to receive but not transmit and a second low power mode in which the ONU is not able to either receive or transmit;

an optical line terminal (OLT) communicably coupled to the ONU, the OLT configured to transmit a control message to the ONU to control at least one aspect of transition of the ONU between the first low power mode and the second low power mode.

17. The system as in claim 16, wherein:

the OLT is configured to transmit the control message that includes a power management rule that specifies a first time period for operation in the first slow power state and a second time period for operation in the second low power state and to control the ONU to transition from the first low power state to the second low power state upon expiration of at least one of the first time period and the second time period.

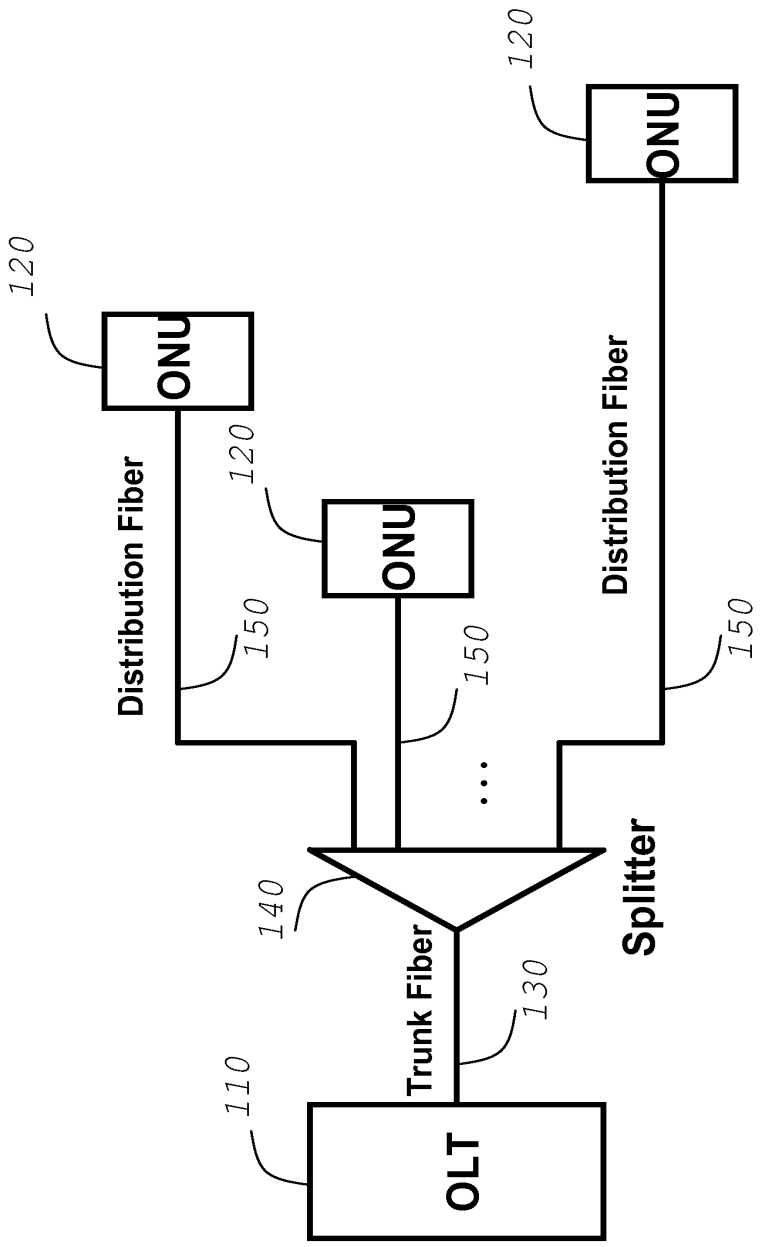

120
ONU
120
ONU
120
ONU
Distribution Fiber
Distribution Fiber
150
150
150
...
140
Splitter
Trunk Fiber
130
110
OLT

FIG. 1

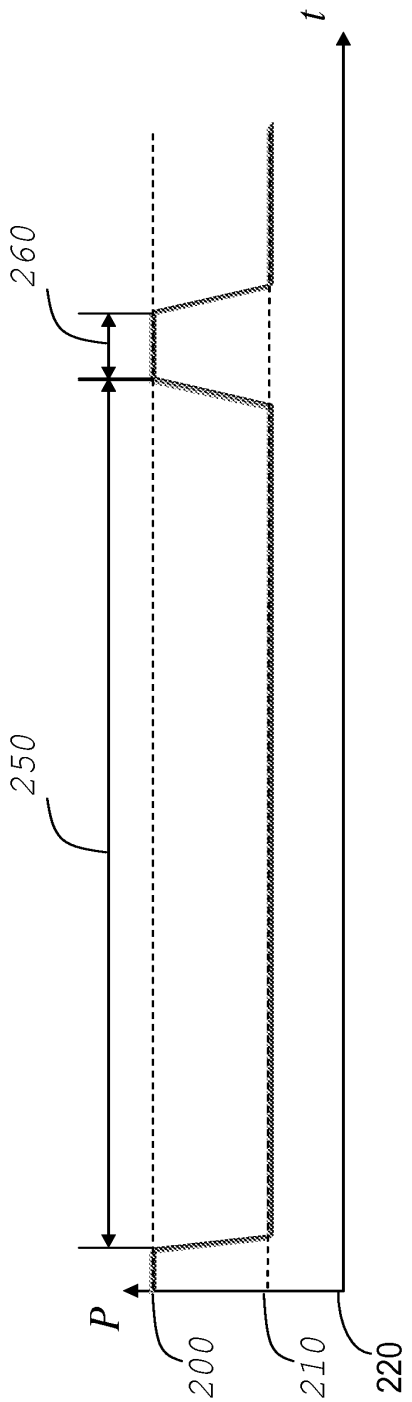


FIG. 2

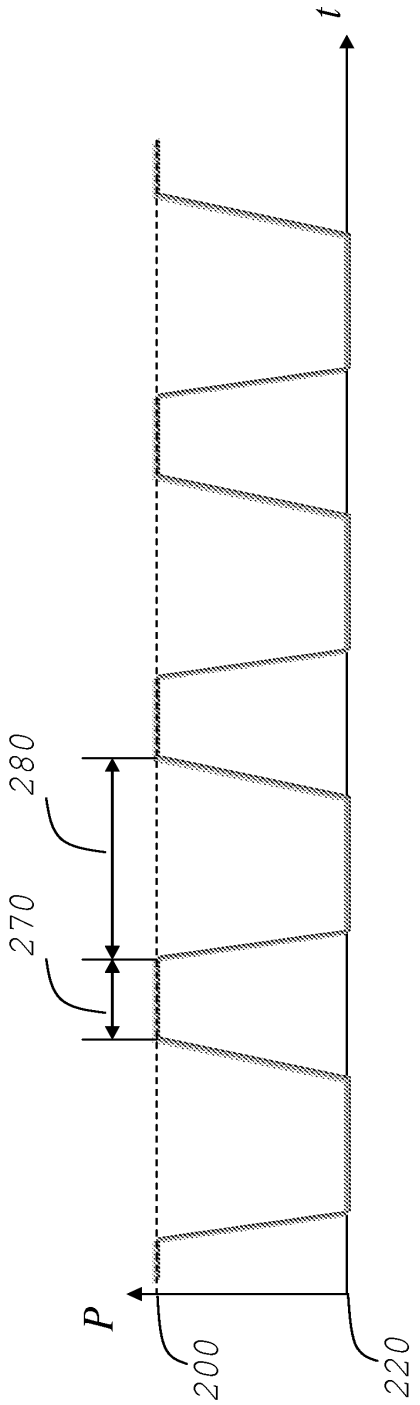


FIG. 3A

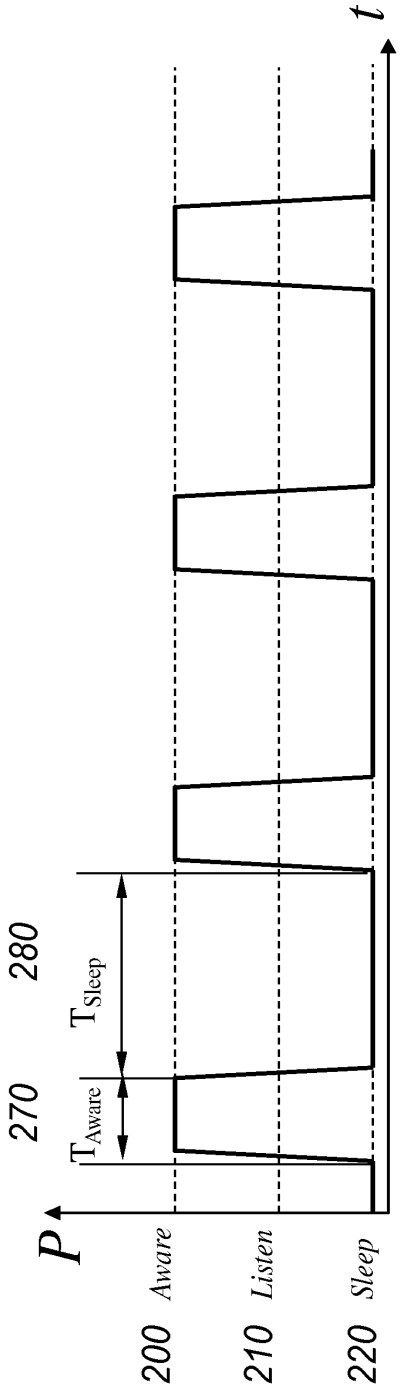

t
280
T_Sleep
270
T_Aware
P
Aware
Listen
Sleep
200
210
220

FIG. 3C

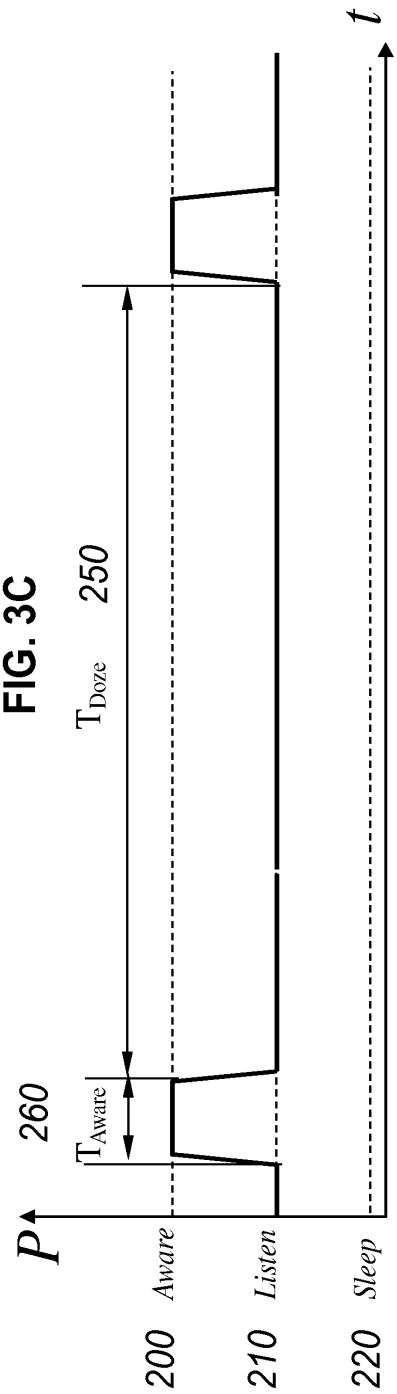

t
250
T_Doze
260
T_Aware
P
Aware
Listen
Sleep
200
210
220

FIG. 3B

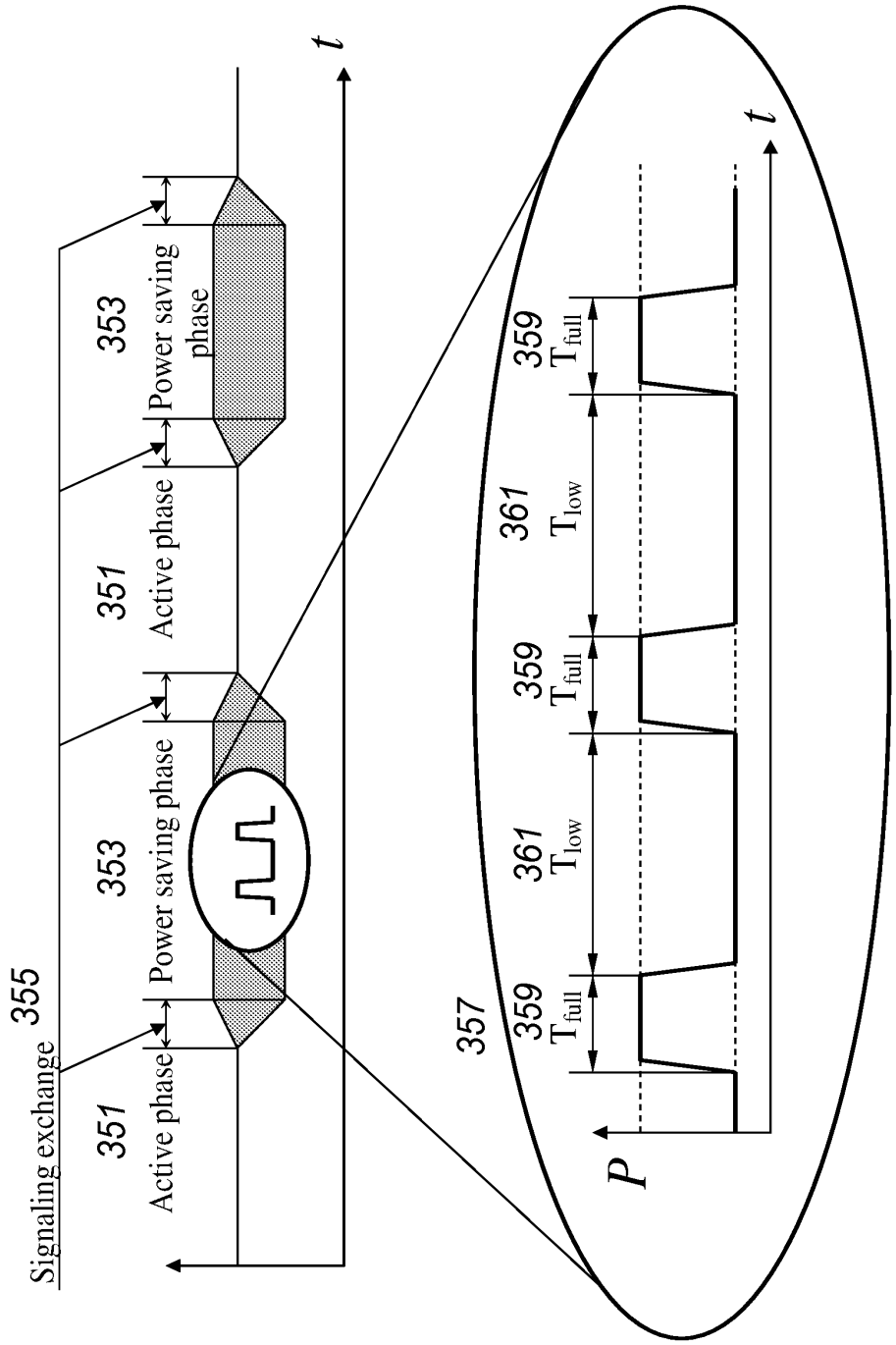

Signaling exchange
355
351
Active phase
353
Power saving phase
351
Active phase
353
Power saving phase
t
357
359
T_{full}
361
T_{low}
359
T_{full}
361
T_{low}
359
T_{full}
P
t

FIG. 3D

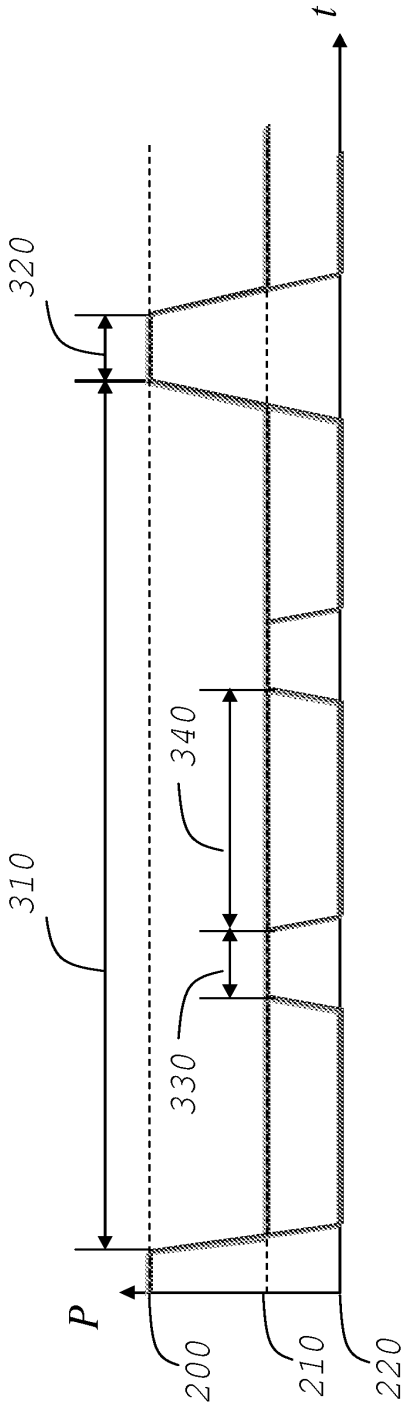


FIG. 4A

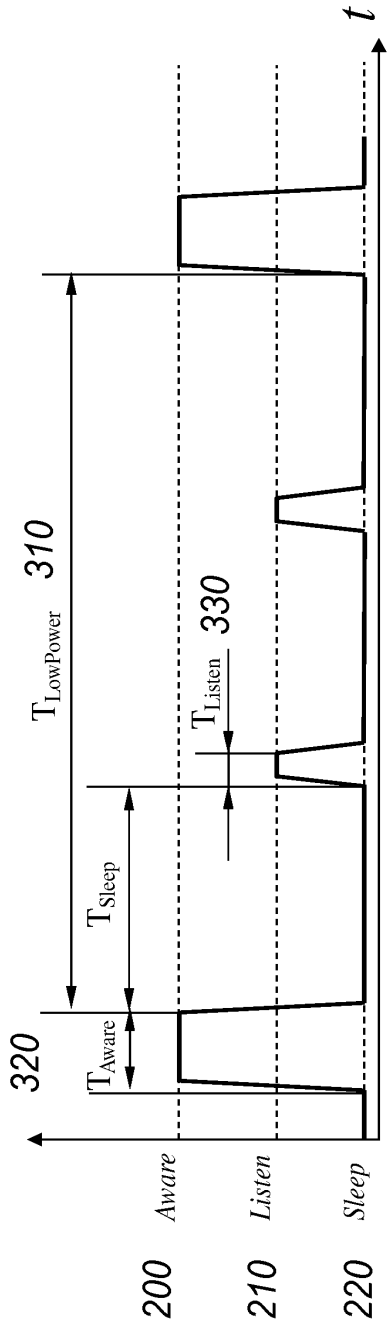

t
200
210
220
Aware
Listen
Sleep
320
310
330
T_{Aware}
T_{Sleep}
T_{Listen}
$T_{LowPower}$

FIG. 4B

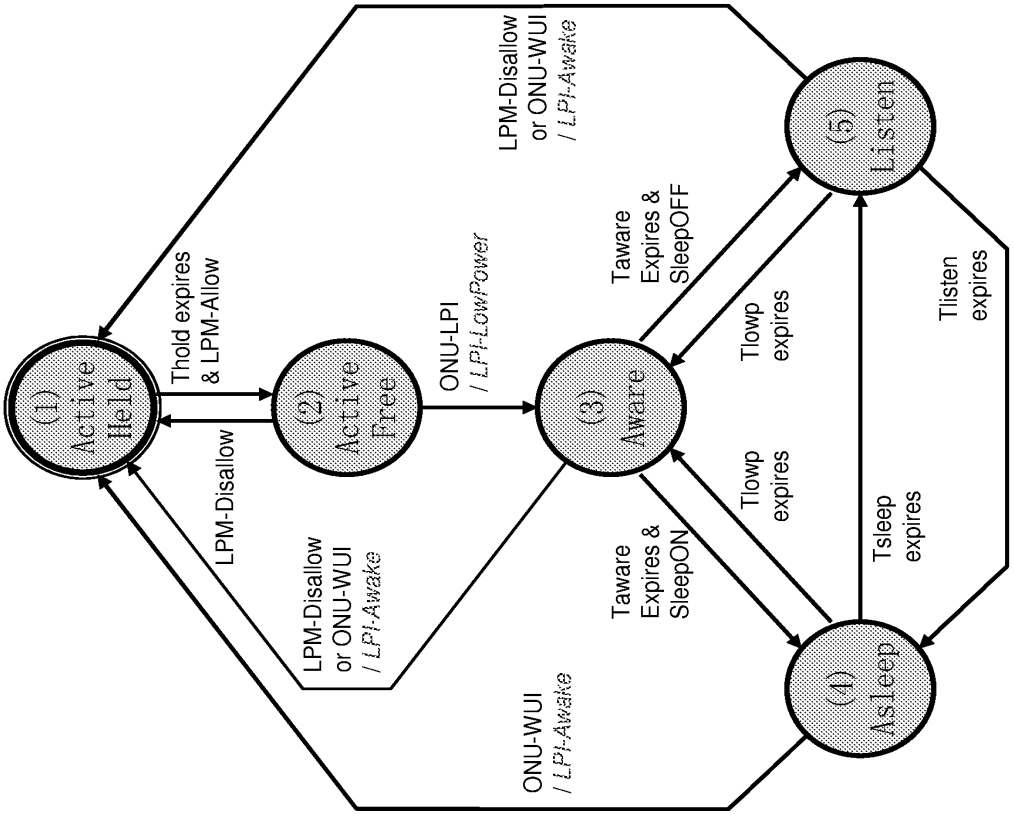

(1) Active Held
(2) Active Free
(3) Aware
(4) Asleep
(5) Listen
Thold expires & LPM-Allow
LPM-Disallow
ONU-LPI / LPI-LowPower
LPM-Disallow or ONU-WUI / LPI-Awake
LPM-Disallow or ONU-WUI / LPI-Awake
ONU-WUI / LPI-Awake
Taware Expires & SleepOFF
Taware Expires & SleepON
Tlowp expires
Tlowp expires
Tsleep expires
Tlisten expires

FIG. 5

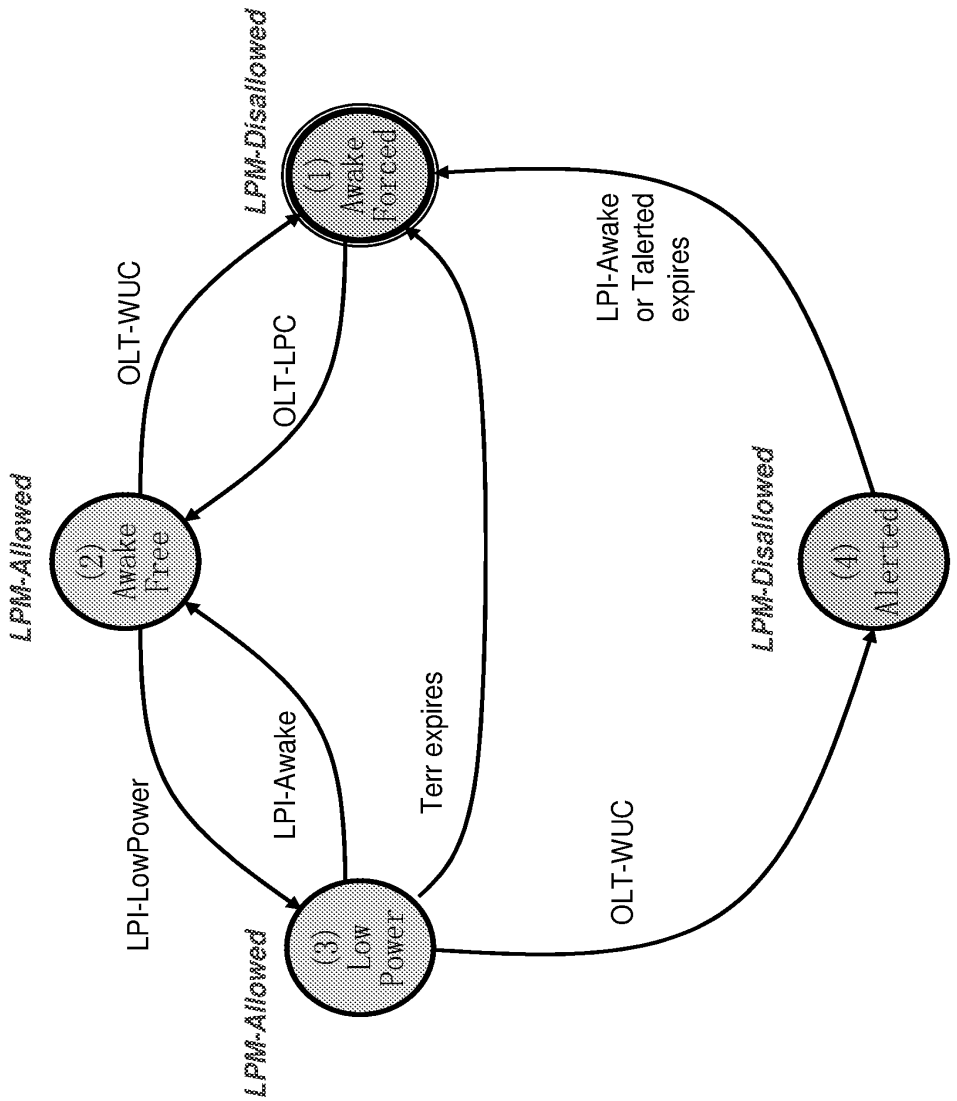

LPM-Disallowed
(1) Awake Forced
LPM-Allowed
(2) Awake Free
LPM-Allowed
(3) Low Power
LPM-Disallowed
(4) Alerted
OLT-WUC
OLT-LPC
LPI-LowPower
LPI-Awake
Terr expires
LPI-Awake or Talerted expires
OLT-WUC

FIG. 6

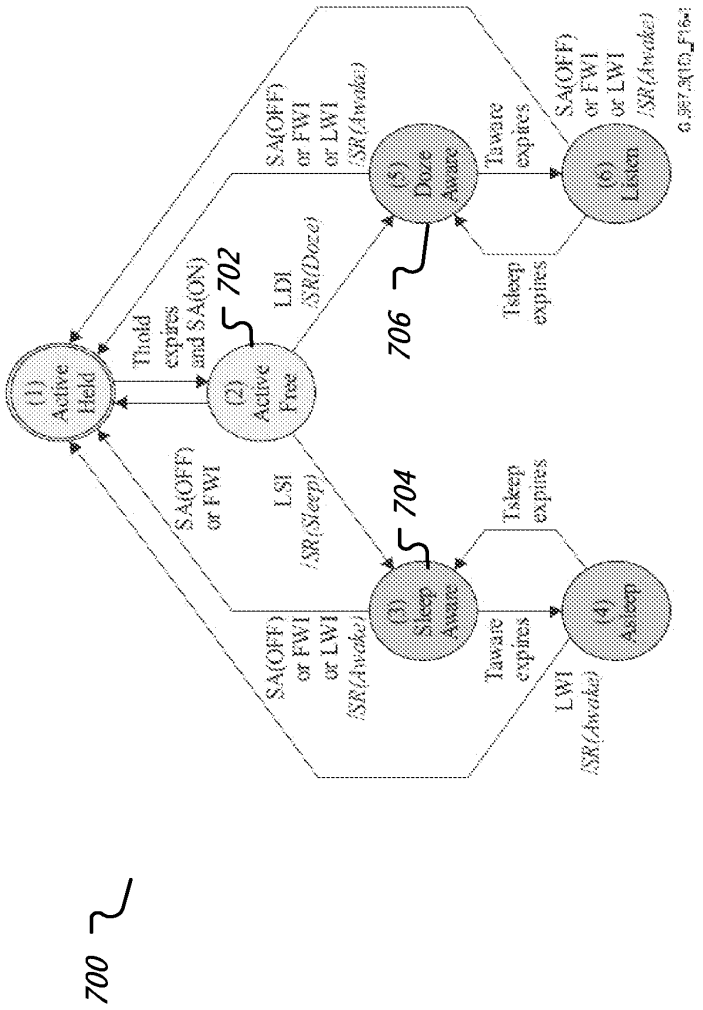

700
(1) Active Held
(2) Active Free
(3) Doze Aware
(4) Asleep
(5) Sleep Aware
(6) Listen
Thold expires and SA(ON)
LDI (SR(Doze)
SA(OFF) or FWI or LWI (SR(Awake)
Taware expires
Tdoze expires
SA(OFF) or FWI
LSI (SR(Sleep)
Tsleep expires
LWI (SR(Awake)
702
704
706

FIG. 7A

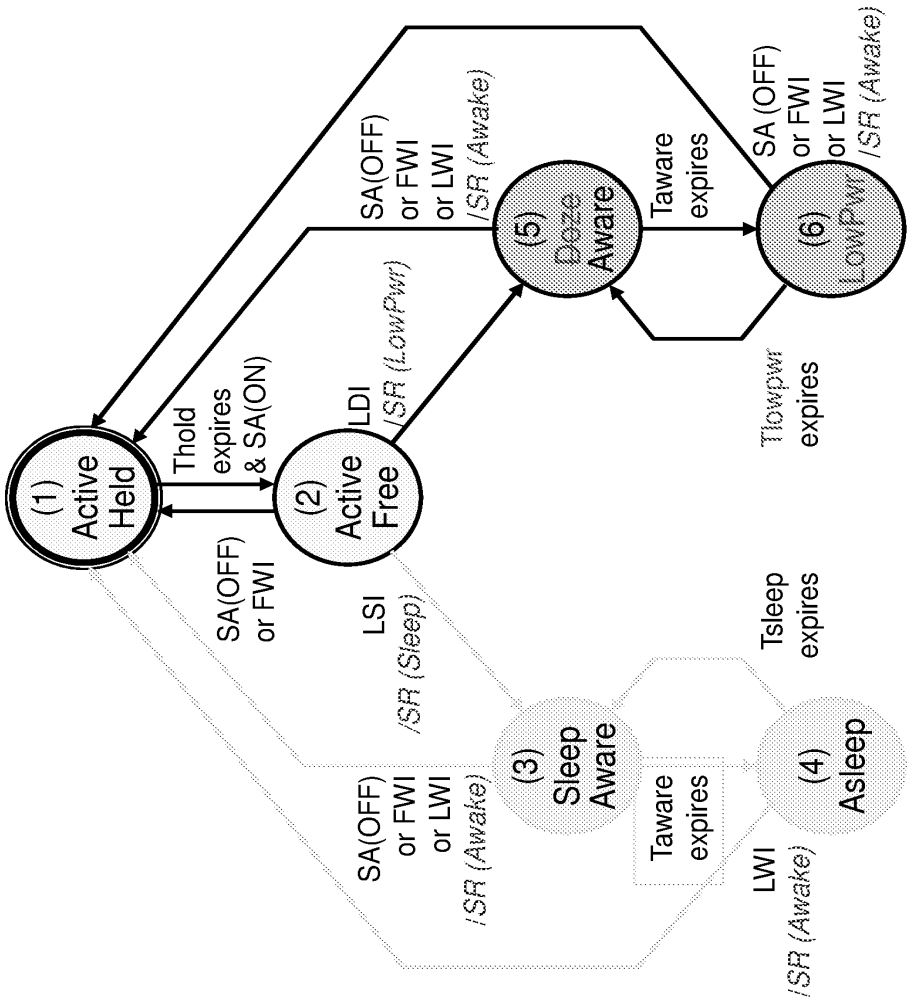

(1) Active Held
(2) Active Free
(3) Sleep Aware
(4) Asleep
(5) Doze Aware
(6) LowPwr
Thold expires & SA(ON)
SA(OFF) or FWI
LDI /SR (LowPwr)
LSI /SR (Sleep)
SA(OFF) or FWI or LWI /SR (Awake)
Taware expires
Tsleep expires
LWI /SR (Awake)
Towpwr expires
SA(OFF) or FWI or LWI /SR (Awake)
Taware expires
SA(OFF) or FWI or LWI /SR (Awake)

FIG. 7B

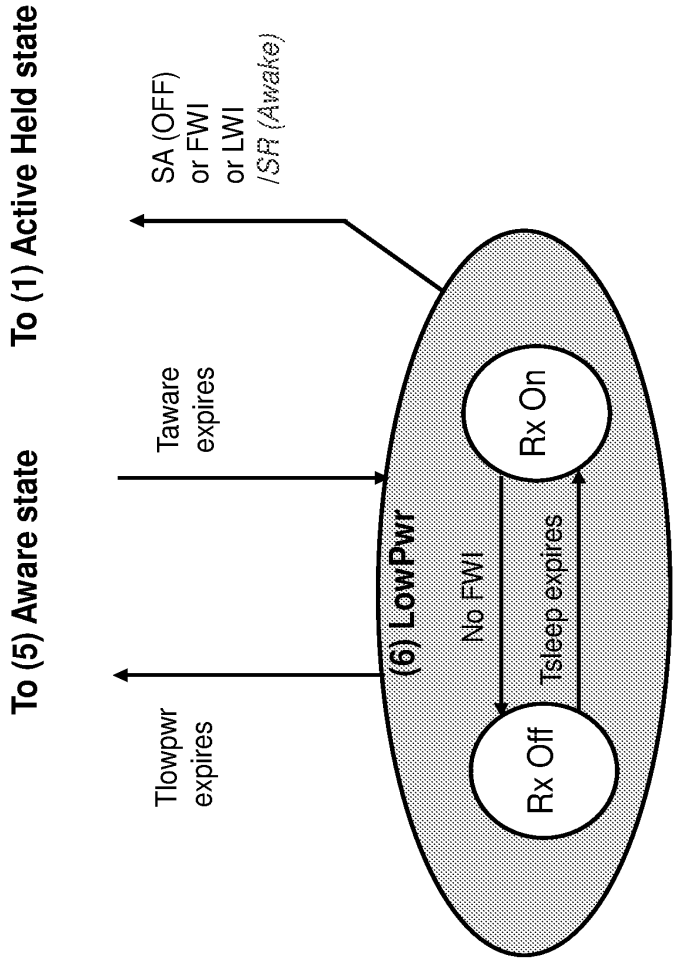

To (1) Active Held state
SA (OFF)
or FWI
or LWI
/SR (Awake)
Taware
expires
To (5) Aware state
Tlowpwr
expires
(6) LowPwr
No FWI
Rx On
Tsleep expires
Rx Off

FIG. 7C

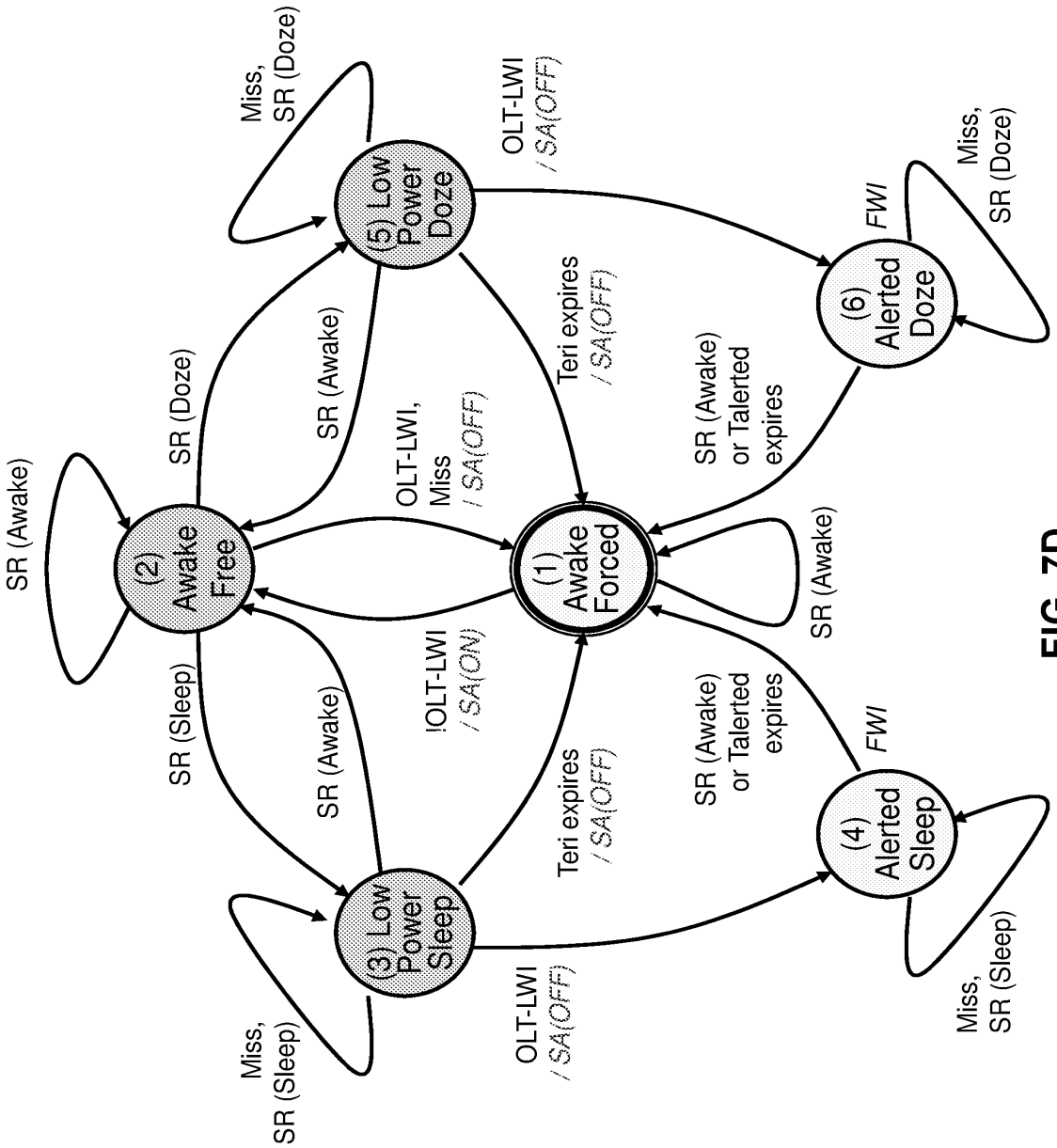

(1) Awake Forced
(2) Awake Free
(3) Low Power Sleep
(4) Alerted Sleep
(5) Low Power Doze
(6) Alerted Doze
SR (Awake)
SR (Doze)
SR (Awake)
OLT-LWI, Miss / SA(OFF)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
SR (Awake)
SR (Sleep)
SR (Awake)
!OLT-LWI / SA(ON)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
FWI
Miss, SR (Doze)
OLT-LWI / SA(OFF)
FWI
Miss, SR (Doze)
Miss, SR (Sleep)
OLT-LWI / SA(OFF)
Miss, SR (Sleep)

FIG. 7D

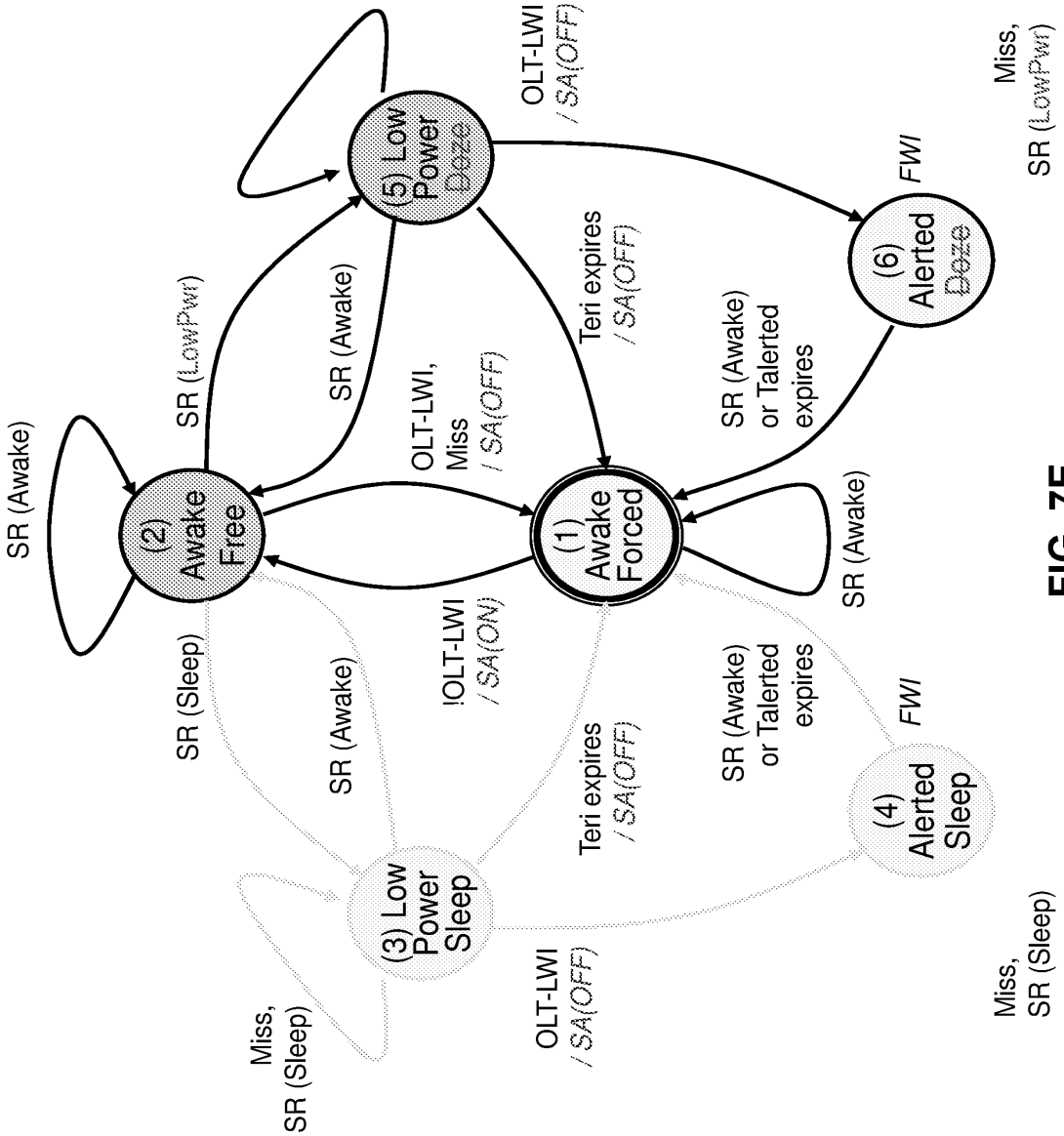

(1) Awake Forced
(2) Awake Free
(3) Low Power Sleep
(4) Alerted Sleep
(5) Low Power Doze
(6) Alerted Doze
SR (Awake)
SR (LowPwr)
SR (Awake)
OLT-LWI, Miss / SA(OFF)
Teri expires / SA(OFF)
OLT-LWI / SA(OFF)
FWI
Miss, SR (LowPwr)
SR (Awake) or Talerted expires
SR (Awake)
SR (Sleep)
SR (Awake)
!OLT-LWI / SA(ON)
Teri expires / SA(OFF)
SR (Awake) or Talerted expires
FWI
OLT-LWI / SA(OFF)
Miss, SR (Sleep)
Miss, SR (Sleep)

FIG. 7E

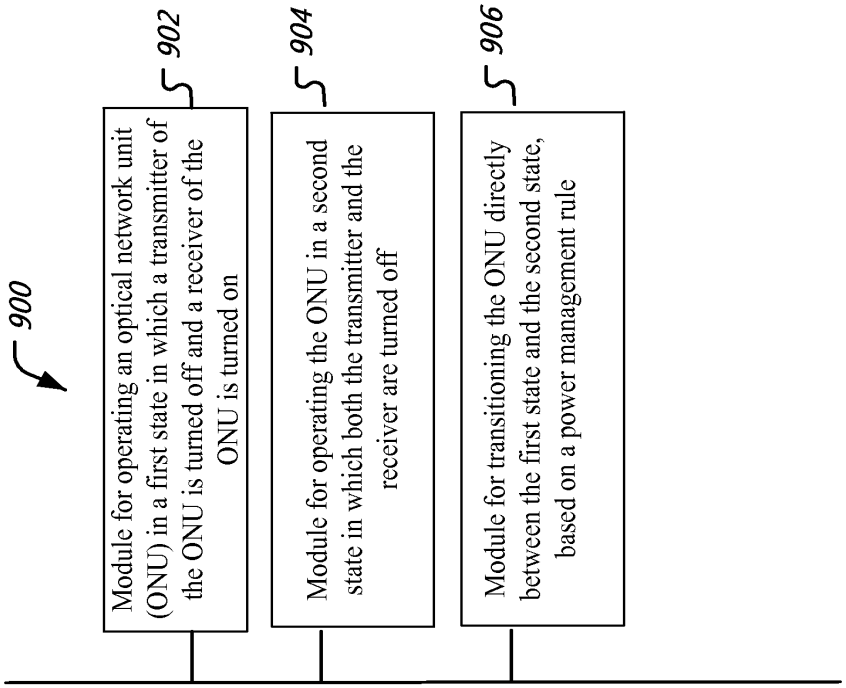

900
Module for operating an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
902
Module for operating the ONU in a second state in which both the transmitter and the receiver are turned off
904
Module for transitioning the ONU directly between the first state and the second state, based on a power management rule
906

FIG. 9

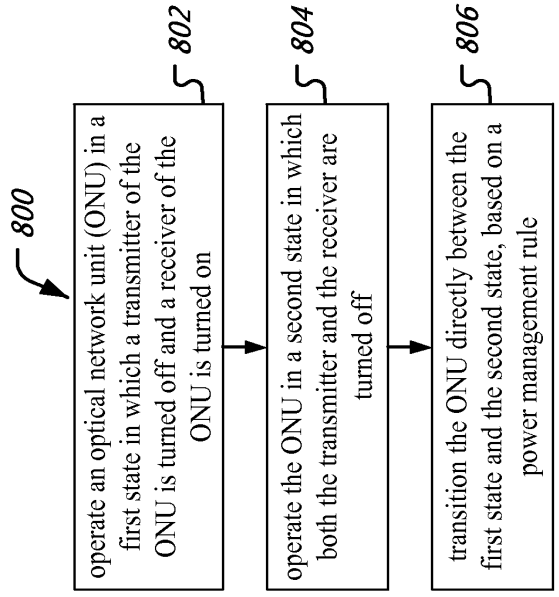

800
operate an optical network unit (ONU) in a first state in which a transmitter of the ONU is turned off and a receiver of the ONU is turned on
802
operate the ONU in a second state in which both the transmitter and the receiver are turned off
804
transition the ONU directly between the first state and the second state, based on a power management rule
806

FIG. 8

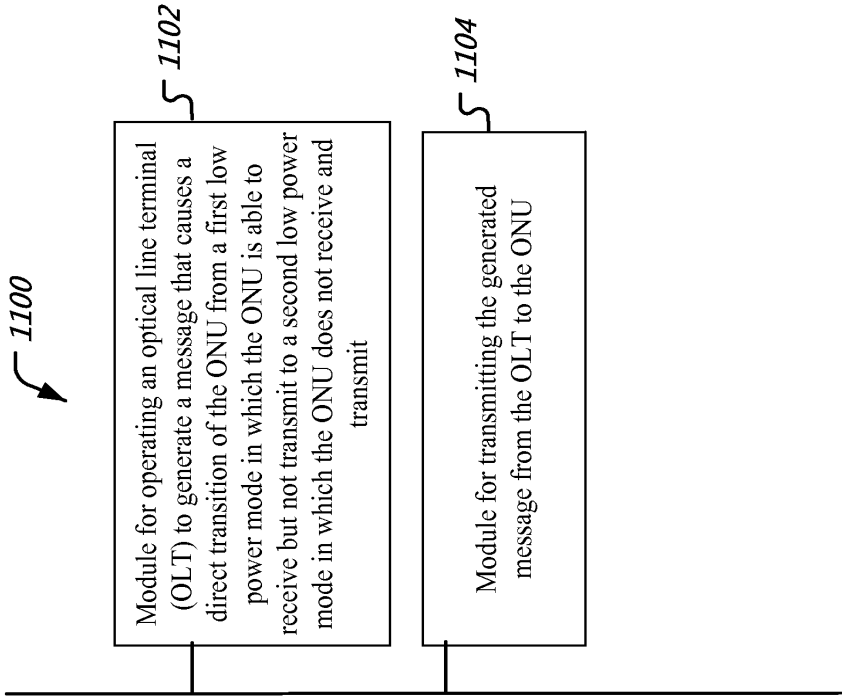

1100
1102
Module for operating an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit
1104
Module for transmitting the generated message from the OLT to the ONU

FIG. 11

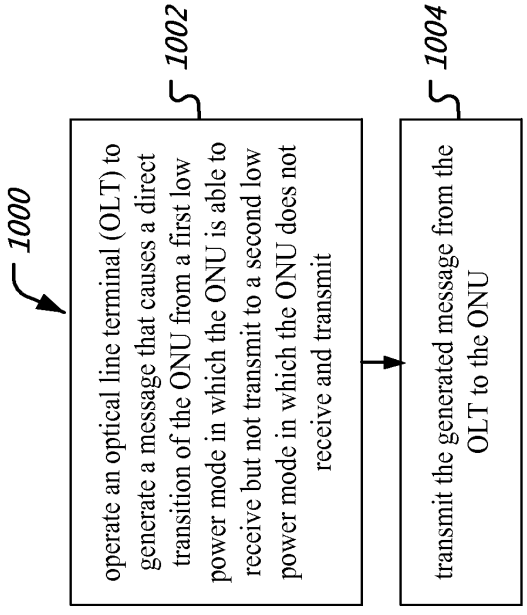

1000
1002
operate an optical line terminal (OLT) to generate a message that causes a direct transition of the ONU from a first low power mode in which the ONU is able to receive but not transmit to a second low power mode in which the ONU does not receive and transmit
1004
transmit the generated message from the OLT to the ONU

FIG.10