

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NOKIA OF AMERICA CORPORATION AND
AT&T SERVICES, INC.,
Petitioners,

v.

IARNACH TECHNOLOGIES, INC.,
PATENT OWNER.

CASE IPR2024-00899
PATENT 9,806,892

DECLARATION OF DR. KERRY I. LITVIN



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EXHIBIT LIST

No.	Brief Description
1001	U.S. Patent No. 9,806,892
1002	File History of U.S. Patent No. 9,806,892
1003	Declaration of Dr. Alexander V. Sergienko
1004	Curriculum Vitae of Dr. Alexander V. Sergienko
1005	Iarnach's Infringement Contentions for the '892 Patent in <i>Iarnach Techs. v. AT&T Corp., et al.</i> , Case No. 2:23-cv-0231-JRG (E.D. Tex.)
1006	M. Röger et al., "Optically Powered Fiber Networks" Optics Express, Vol. 16, No. 26 (Dec. 22, 2008)
1007	ITU-T Standard G.987.3 (2010)
1008	ITU-T Standard G.988 (2010)
1009	International Publication No. WO2013014483 to Ghazisaidi
1010	ITU-T Standard G.9807.1 (2023)
1011	Shing-Wa Wong et al., "Sleep Mode for Energy Saving PONs: Advantages and Drawbacks" 2009 IEEE Globecom Workshops (2009)
1012	Abhishek Dixit et al., "ONU power saving modes in next generation optical access networks: progress, efficiency and challenges" Optics Express, Vol. 20, No. 26 (Dec. 10, 2012)
1013	U.S. Patent No. 9,209,897 to Amitai
1014	U.S. Patent No. 8,873,969 to Hood
1015	European Patent Specification EP 2 710 813 B1 to Hood
1016	European Patent Specification EP 2 692 080 B1 to Hood
1017	European Patent Specification EP 2 333 989 B1 to Schmuck
1018	Declaration of Dr. Sylvia D. Hall-Ellis
1019	Curriculum Vitae of Dr. Sylvia D. Hall-Ellis
1020	Hall-Ellis Declaration Attachment 1A
1021	Hall-Ellis Declaration Attachment 2A
1022	Hall-Ellis Declaration Attachment 2B
1023	Hall-Ellis Declaration Attachment 2C
1024	Hall-Ellis Declaration Attachment 2D

No.	Brief Description
1025	Hall-Ellis Declaration Attachment 3A
1026	Hall-Ellis Declaration Attachment 3B
1027	Hall-Ellis Declaration Attachment 3C
1028	Hall-Ellis Declaration Attachment 3D
1029	Doc. No. 50, Docket Control Order, Iarnach Technologies Ltd. v. AT&T Corp. et al., No. 2:23-cv-00231 (E.D. Tex.)
1030	Doc. No. 31, Order Granting Nokia's Motion to Intervene, Iarnach Technologies Ltd. v. AT&T Corp. et al., No. 2:23-cv-00231 (E.D. Tex.)
1031	U.S. District Courts – Judicial Caseload Profile (Dec. 2023)
1032	Doc. No. 45, Agreed Docket Control Order, Iarnach Technologies Ltd. v. Verizon Communications, Inc. et al., No. 2:23-cv-00631 (E.D. Tex.)
1033	Doc. No. 1, Complaint, Iarnach Technologies Ltd. v. AT&T Corp. et al., No. 2:23-cv-00231 (E.D. Tex.)
1034	Doc. No. 1, Complaint, Iarnach Technologies Ltd. v. Verizon Communications, Inc. et al., No. 2:23-cv-00631 (E.D. Tex.)
1035	Doc. No. 114, Order Dismissing U.S. Patent No. 9,806,892, 2:23-cv-231 (E.D. Tex.)
2001	Declaration of Bruce Schofield in Support of Patent Owner's Preliminary Response
2002	Defendant's Invalidity Contentions, Iarnach Technologies Ltd. v. AT&T Services Inc. et al., Case No. 2:23-cv-00231 (E.D. Tex.) (served Dec. 7, 2023)
2003	Defendant's Invalidity Contentions, Iarnach Technologies Ltd. v. Verizon Business Network Services LLC et al., Case No. 2:23-cv-00631 (E.D. Tex.) (served May 6, 2024)
2004	Executed Summons for AT&T Services Inc., Iarnach Technologies Ltd. v. AT&T Services Inc. et al., Case No. 2:23-cv-00231, Dkt. No. 11 (E.D. Tex.)
2005	Federal Court Management Statistics–Profiles, <i>available at</i> https://www.uscourts.gov/sites/default/files/data_tables/fcms_na_distp_rofile0630.2024.pdf
2006	Declaration in Support of Motion for <i>Pro Hac Vice</i> Admission of Justin Chen

No.	Brief Description
2007	This Document, My Declaration in Support of Patent Owner's Response
2008	PCT/CN2012/078649 (filed July 13, 2012)
2009	WO 2014/012109 A1 (filed July 15, 2013) (published Jan. 16, 2013)
2010	Consent, Webster's New Universal Unabridged Dictionary (1983)

CLAIM LISTING

	Limitation
1A	1. A method of optical communication in a passive optical network, comprising:
1B	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;
1C	operating the ONU in a second state in which both the transmitter and the receiver are turned off;
1D	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;
1E	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
1F	receiving, by the receiver, a power management message from an optical line terminal (OLT); and
1G	changing the power management rule based on the received power management message.
2	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	3. 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.
4	4. 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.
5	5. The method of claim 1 , further comprising: performing the transitioning responsive to the received power management message and a local decision to change an operational state.

	Limitation
10A	10. An optical communication apparatus, comprising:
10B	a memory that stores processor-executable instructions; and
10C	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
10D	wherein the processor includes means for transitioning the ONU directly from the first state 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;
10E	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
10F	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.
11	11. The apparatus as in claim 10 , 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.
12A	12. An optical line terminal (OLT) for operation in a passive optical network (PON), the optical line terminal comprising:
12B	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;
12C	a transmitter configured to transmit the generated messages to the optical network unit;

	Limitation
12D	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.
13	13. The optical line terminal as in claim 12 , 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.
14A	14. A passive optical network (PON) communications system, comprising:
14B	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 from the first low power mode 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;
14C	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
14D	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.
15	15. The system as in claim 14 , 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.

I. INTRODUCTION

¶1. My name is Dr. Kerry I. Litvin. I have been retained by Iarnach Technologies, Inc. (“Patent Owner”) to provide my expert assessment and technical opinions in connection with the above captioned inter partes review (“IPR”) of U.S. Patent No. 9,806,892 (“’892 Patent” or “Patent-at-Issue”), Ex. 1001.

¶2. I understand that Nokia of America Corporation and AT&T Services, Inc. (“Petitioners”) filed a request for *inter partes* review of Claims 1–5 and 10–15 (“Challenged Claims”) of Patent No. 9,806,892 (“’892 Patent” or “Patent-at-Issue”) as obvious in light of combinations of references Petitioners refer to as G.987.3, Röger, G.988, and Ghazisaidi (“References”). Paper 18, Corrected Petition (“Pet.”) at 1. I also recognize Patent Owner filed a Preliminary Response. Paper 10, Preliminary Response (“Prem. Resp.”). I further appreciate that the Board instituted a trial. Paper 19 (“Inst. Dec.”).

¶3. Patent Owner is compensating me for my study and testimony in this case. This compensation is not contingent upon my performance, the outcome of this IPR, or any issues involved in or related to this IPR.

¶4. This declaration is based on information currently available to me. I reserve the right to expand, modify, or supplement my opinions if I become aware

of evidence or information that was not available for review at the time I drafted this declaration.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

¶5. I have attached my resume as Appendix A to this declaration. The resume includes a list of my qualifications and publications. Nonetheless, I now summarize my background related to the field of techniques for unified optical network unit (“ONU”) power management in passive optical network (“PON”) systems.

¶6. I am currently the President and Founder of H-Bar Omega, LLC, a high-technology consultancy with expertise in fiber optic telecommunications technologies, which serves the needs of clients in the legal and investment professions who have interests in this field of technology. I founded the H-Bar Omega, LLC consultancy in the spring of 2014.

¶7. Prior to this, from June 2011 through December 2013, I was a Principal Research and Development Engineer at Futurewei Technologies (also known as Huawei Technologies). I served directly under the company’s Vice President for Access Optical Network Research and Development. My focus was the development of new technologies for passive optical (unrepeated) access networks.

¶8. Prior to joining Futurewei, I was a Principal Staff Engineer at the Motorola Broadband Communications Sector (now part of CommScope, Inc.) from February 2000 through October 2010 and worked in the Advanced Optical Communications Technology Applied Research and Development Group. My focus there was the development of state-of-the-art fiber optic communications technologies for applications in both hybrid-fiber-coaxial access network infrastructure and passive optical networks.

¶9. I previously had served as a Staff Engineer working for the Lockheed Martin Missiles and Space Company from 1995 through 2000, developing cutting-edge microwave and millimeter-wave communications components and systems and also fiber optic signal distribution technologies all for applications onboard space-based platforms. This included acting as a principal engineer conducting the development of the first 60 GHz space-qualified power amplifier utilizing monolithic millimeter-wave integrated circuits.

¶10. I received my Ph.D. in Electrical Engineering (minor in Applied Physics) from Cornell University, Ithaca, NY in 1994. I was awarded an Arco Company Fellowship to support my first year of studies at Cornell. During my second year at Cornell University, I was named a Howard Hughes Doctoral Fellow, and the Hughes Aircraft Company then supported me during all subsequent years of study and research through to my graduation. My dissertation was entitled “Metal-

Semiconductor-Metal Photodiodes with applications in Monolithic Optical Receiver Circuits Capable of Detecting and Amplifying a Millimeter-Wave Modulation Signal Being Transmitted Via an Optical Carrier.”

¶11. I received my M.S. degree in Electrical Engineering from the California Institute of Technology (Caltech), Pasadena, CA in 1986. While at Caltech I was an Institute Fellow. My research was supervised by Professor David Rutledge and focused on microwave power combining in a quasi-optical free-space cavity.

¶12. In 1985, I received a B.S. degree in Electrical Engineering from Drexel University, Philadelphia, PA and graduated with high honors, in the top 2% of my class. My senior research project at Drexel concerned the optical control of a microwave oscillator.

¶13. Through education and work, I have gained extensive experience in all aspects of the design and implementation of fiber optic communications networks, subsystems, and components. This includes advanced research and development efforts in systems, components, and physical phenomena occurring within the fiber insofar as they impact the quality of the communications signals being transmitted. I have extensive hands-on laboratory experiment construction and test and measurement experience and have also developed various theoretical mathematical models to accurately predict the performance of optical communication systems using computer simulations. I have dealt directly with some of the largest

telecommunications service providers in designing optical networks and troubleshooting optical communications issues occurring in field-deployed in-service systems.

¶14. I have presented my research findings over the years at professional conferences such as the Optical Fiber Communications Conference (“OFC”) and the International Microwave Symposium (“IMS”), as well as in refereed professional journals. In total, I have presented or published 13 such articles. Additionally, I have written many technically-extensive white papers on several topics directly related to fiber optic communications for the internal consumption of my colleagues on behalf of my former employers.

¶15. I am a member of both Tau Beta Pi (National Engineering Honor Society) and Eta Kappa Nu (National Electrical Engineering Honor Society).

¶16. I am listed as an inventor/co-inventor on many patents and patent applications, including the following issued patents related to the field of fiber optic communications technology:

Number	Title	Issued
EP 2,837,114	Raman Crosstalk Mitigation in a Multi-Wavelength System Utilizing an Optical Equalizing Signal Modulated with Composite Bandwidth-Limited Data Sources	July 27, 2016
9,118,388	Raman Crosstalk Mitigation in a Multi-Wavelength System Utilizing an Optical Equalizing Signal Modulated with Composite Bandwidth-Limited Data Sources	Aug. 25, 2015

Number	Title	Issued
8,666,260	Burst Mode Laser Transmitter having an Extremely Fast Response Time when Triggered from a Totally Off State	Mar. 4, 2014
8,391,723	Raman Back-Pumped Near Zero Dispersion CWDM System and Method	Mar. 5, 2013
CA 258,9851	Method and Apparatus for Reducing Crosstalk and Nonlinear Distortions Induced By Raman Interactions in a Wavelength Division Multiplexed (WDM) Optical Communication System	June 6, 2012
8,155,524	Method and Apparatus for Transmitting Multiple Channels in a Wavelength Division Multiplexed (WDM) Optical Communication System with Reduced Raman Crosstalk and Nonlinear Distortions	Apr. 10, 2012
7,920,795	Method and Apparatus for Transmitting Multiple Channels in a Wavelength Division Multiplexed (WDM) Optical Communication System with Reduced Raman Crosstalk and Nonlinear Distortions	Apr. 5, 2011
7,783,197	Method and Apparatus for Reducing Crosstalk in a DWDM Transmission System	Aug. 24, 2010
7,693,366	Aligned Narrowband Optical Filters having Flat Passbands and Comprising of Offset Cascaded Broadband Optical Filters	Apr. 6, 2010
7,418,205	Method and Apparatus for Controlling a Frequency Hopping Laser	Aug. 26, 2008
7,271,948	Method and Apparatus for Reducing Crosstalk and Nonlinear Distortions Induced By Raman Interactions in a Wavelength Division Multiplexed (WDM) Optical Communication System	Sept. 18, 2007
6,788,839	Time Slot Tunable All-Optical Packet Data Routing Switch	Sept. 7, 2004
6,671,426	Monolithic Integrated Terahertz Optical Asymmetric Demultiplexer	Dec. 30, 2003
6,650,800	Time Slot Tunable All-Optical Packet Data Demultiplexer	Nov. 18, 2003

III. RELEVANT TIME

¶17. I have been asked to assume that the Patent-at-Issue has an effective priority date of July 13, 2012 (“Effective Priority Date”).

¶18. To the extent that I cite exhibits created or published after the Effective Priority Date, I consider that the reference is still relevant to what a POSITA would have understood the point for which I cite the reference at or around the time of the invention.

IV. LEVEL OF ORDINARY SKILL IN THE ART

¶19. I understand that Petitioners have proposed that a person of ordinary skill in the art (“POSITA”) at the time of Effective Priority Date for the ’892 Patent “would have had at least a bachelor’s degree in electrical engineering, computer engineering, or similar discipline and had at least two years of experience with optical communications and networks: and “[a] person with a different degree but additional relevant experience could still qualify if the additional experience compensates for the different educational background.” Pet. at 3.

¶20. I further understand that Patent Owner has proposed a level similar, having a baseline of “at least a bachelor’s degree in electrical engineering, computer engineering, or similar discipline . . . and at least two years of experience with optical communications and networks.” Prem. Resp. at 11.

¶21. Given that I have been deeply involved with advanced research and engineering development of PON technology dating back to the early 2000's (starting with B-PON) and have also contributed inputs to the ITU PON standards committee, it is my opinion that I do qualify as a person of ordinary skill in the art at the relevant time under either of the above descriptions. In fact, I exceed this level of knowledge, experience, and education. So, I am qualified to provide an expert opinion in this proceeding.

¶22. Nonetheless, I have approached my analysis from the perspective of a POSITA as set forth by the Board as of the Effective Priority Date. *See* Inst. Dec. at 13–14.

¶23. My analysis would not change under either of the Parties' proposals.

V. MATERIALS CONSIDERED

¶24. Patent Owner's attorneys made available the material listed in the Exhibit List beginning on page i. I have cursorily reviewed the material; however, as will be seen in this report, my opinions are mainly based upon the Patent-at-Issue, the relevant Office Actions and Applicant Responses from the '892 Patent's file history, the Declaration of Dr. Alexander V. Sergienko, the References, the Corrected Petition, and the Institution Decision.

VI. RELEVANT LEGAL STANDARDS

¶25. Counsel for Patent Owner provided the legal standards to apply in connection with my patentability analysis. In preparing this report, I have tried to faithfully apply these legal standards to the Challenged Claims of the Patents-at-Issue. Below, I will describe the law that I applied in considering Petitioners' arguments for unpatentability of the asserted claims.

A. Person of Ordinary Skill in the Art

¶26. I understand that a number of factors should be considered in determining the level of ordinary skill in the art, including: (1) the educational background of those actively working in the field at the time the invention was made (and particularly of any person(s) who may have independently made the invention(s) at about the same time as the inventor(s)); (2) the type of problems encountered in the art; (3) the various ways that others sought to solve the existing problems; (4) the rapidity with which innovations were being made in the art at the time the invention was made; (5) the level of technological sophistication at the time the invention was made; (6) the educational level of the inventor; and (7) the teachings and disclosures of any references that, while not prior art to the invention(s), nonetheless contain teachings or disclosures of what the level of ordinary skill in the field may have been at the time the invention(s) was(were) made.

B. Anticipation (Not at Issue)

¶27. I understand that the Petition does not purport to show any of the References “anticipates” the Patent-at-Issue (i.e., teach each and every element set forth in the claim, either expressly or inherently, in a single prior art reference and disclose those elements arranged as in the claim, such that a person of ordinary skill in the art could practice the invention without undue experimentation). To the contrary, Petitioners only argue that the References render the Patent-at-Issue “obvious,” admitting that the References are all missing one or more of the claimed limitations.

C. Obviousness

¶28. It is my understanding that a patent claim is invalid as obvious if, even though the invention is not identically disclosed or described in the prior art, 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 the matter pertains. I also understand that the test for determining obviousness involves an assessment of (1) the scope and content of the prior art, (2) the differences between the prior art and the subject matter of the claims, (3) the level of ordinary skill in the art, and (4) objective indicia of non-obviousness, or so-called “secondary

considerations” (when there is evidence of such considerations). I understand that objective indicia of non-obviousness is not at issue in this proceeding.

¶29. I have been told that in making the assessment of differences between the prior art and the claimed subject matter, the analysis specifically requires consideration of the claimed invention as a whole. Because inventions typically are new combinations of existing principles or features, the “as a whole” instruction prevents evaluation of the invention part by part. Without this important requirement, an obviousness assessment might successfully break an invention into its component parts, then find a prior art reference corresponding to each component. This line of reasoning would import hindsight into the obviousness determination by using the invention as a roadmap to find its prior art components. Further, this improper method would discount the value of combining various existing features or principles in a new way to achieve a new result—often the essence of invention.

¶30. I have been told that a single reference can render a patent obvious if it would have been obvious to modify that reference to arrive at the patented invention.

¶31. I also understand that when two or more references are combined to assert that the combination renders the subject matter of the claims obvious, there must have been some motivation to combine the references; however, this motivation to combine need not be found explicitly in the references themselves, but

may also be found in the knowledge generally available to one of ordinary skill in the art, such as knowledge of a problem to be solved.

¶32. I understand that there is a need to anchor any obvious analysis in explanation of how a person of ordinary skill would select and apply the teachings of the references. That is, obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

¶33. Additionally, to show obviousness there must be some rationale or motivation to use any combination of the elements in the manner claimed, such as a need or problem known in the field of endeavor at the time of invention. Such a motivation need not be explicitly stated in a reference, but may be found implicitly in the prior art.

D. Dependent Claims

¶34. A dependent claim is construed to incorporate by reference all the limitations of the claim to which it refers and adds further limitations. As such, a dependent claim is “narrower” in scope than an independent claim from which it depends.

¶35. Therefore, even if an independent claim was found obvious, this does not necessarily mean that a dependent claim from the independent claim is also obvious, because the dependent claim necessarily adds limitations to the claims from

which it depends and may therefore not be subject to the same asserted grounds of invalidity. Conversely, however, if an independent claim is not obvious necessarily means a narrower dependent is also non-obvious.

E. Claim Construction

¶36. I understand that claim construction is a matter of law ultimately reserved for the Board to decide. However, absent a construction by the Board, claim terms are to be construed as having their ordinary and customary meaning to a person of ordinary skill in the art at the time of the invention in light of the patent specification and prosecution history. As such, I have applied the “ordinary and customary meaning” to terms not yet construed.

¶37. It has been explained to me that in claim construction, one should give primacy to the language of the claims, followed by the specification, which includes the drawings. Additionally, the prosecution history, while not literally within the patent document, serves as intrinsic evidence for purposes of claim construction.

¶38. And while the law emphasizes the importance of intrinsic evidence in claim construction, I may consult extrinsic evidence, such as expert and inventor testimony, dictionaries, and learned treatises that may shed useful light on the relevant art, with the understanding that extrinsic evidence is less significant than the intrinsic record in determining the legally operative meaning of claim language. Though, ultimately, the only meaning that matters in claim construction is the

meaning in the context of the patent, and, as such, it is an error to rely upon extrinsic evidence that contradicts the intrinsic record.

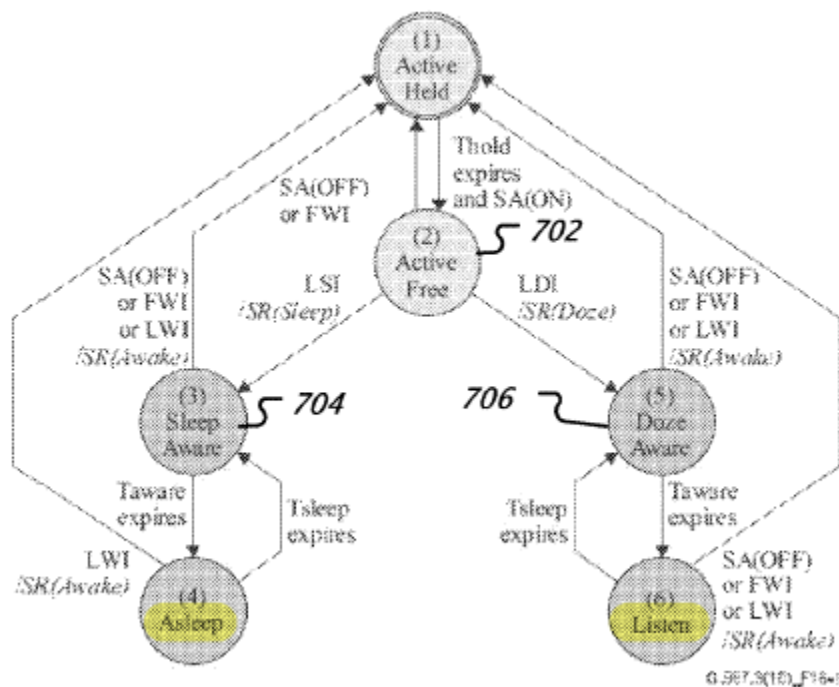
¶39. Additionally, I have been told that a patent applicant may elect to be a “lexicographer” by providing an explicit definition in the specification for a claim term. When this happens, the definition selected by the patent applicant controls. Such lexicography must, however, appear with reasonable clarity, deliberateness, and precision.

¶40. Finally, I have been told that it is best practice is not to construe a term that would result in the addition of a limitation already provided by the claim, and an interpretation of a claim that excludes all preferred embodiments in the specification is rarely, if ever, correct and would require highly persuasive evidentiary support.

VII. SHORT OVERVIEW OF THE PATENTED INVENTION

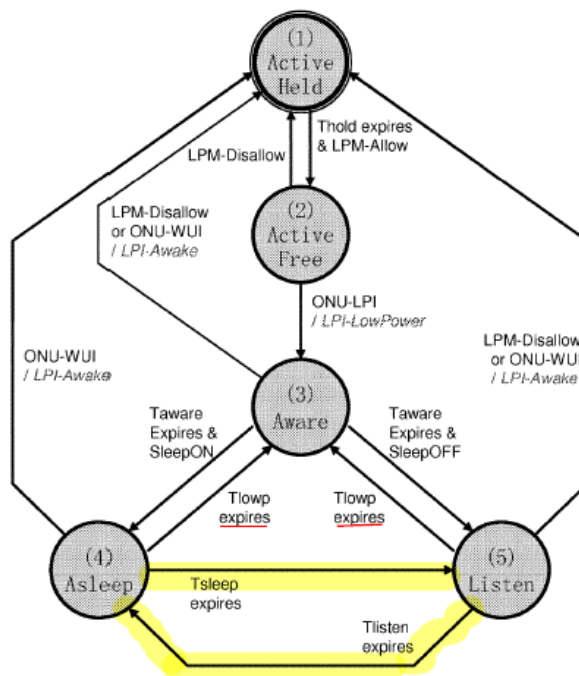
¶41. The Patent-at-Issue concerns techniques for unified ONU power management in a passive optical network. Ex. 1001 at abstract. To understand the invention one must understand the “first” and “second” states. The ’892 Patent specification and claims indicate that a first state is one where “a transmitter of the ONU is turned off and a receiver of the ONU is turned on,” e.g., a “dozing state.” *Id.* 12:22–26. And the second state is one “in which both the transmitter and the receiver are turned off,” e.g., a “sleep state.” *Id.* 12:27–30.

¶42. The '892 Patent recognizes that these asleep and dozing states are present in the prior art, such as the various advanced standard-based PON systems, such as Gigabit/sec EPON (10G-PON). *Id.* 4:8–14. The states in such standards are illustrated as follows.



Id. Fig. 7A (highlighting added). As seen, with the prior art PON standard, there is no direct transition from the Asleep state (4) and the Listen Doze state (6).

¶43. One aspect of the '892 Patent claimed invention provides for allowing such a direct transition, as illustrated below.



Id. Fig. 5 (highlighting added). A “[d]irect 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 . . .).” *Id.* 12:33–37.

¶44. The ’892 Patent further describes that that in one embodiment of the claimed invention, “[u]pon transition to and periodically during the sojourn in this [low power] state, the OLT sends a LPM-Allow message to the ONU.” Ex. 1001, Tbl. 6, at cols. 10–11 (row 3, LowPower).

VIII. SHORT DISCUSSION OF SELECT REFERENCES

A. G.987.3’s POWER ARCHITECTURE

¶45. ONU direct transitions between low power modes are not permitted within the confines of the G.987.3 (Ex. 1007) standard. There are only two mutually

exclusive low power modes that were adopted into the standard at the Effective Priority Date: doze mode and cyclic sleep mode (Ex. 1007 at 97).

1. Doze Mode

¶46. In the first low power mode, the doze mode, the ONU receiver is continually powered on while the transmitter is cycled between power off and power on. Thus, the Doze low power mode consists of two cyclic ONU states as depicted in figure 16-1 of G.987.3. The Listen state is when the ONU receiver is on and its transmitter is turned off.

¶47. The Listen state of the Doze mode persists for the duration of internal ONU timer T_{sleep} which is initiated each time the Listen state is entered. At the expiration of T_{sleep} the ONU turns on its transmitter thereby entering the Doze Aware state of figure 16-1 (also see Ex. 1007 table 16-1 at 98) and initiates internal timer T_{aware} . The ONU remains in the Doze Aware state for the duration of internal ONU timer T_{aware} (Ex. 1007 figure 16-1). At the expiration of timer T_{aware} , the ONU will transition back into the Listen mode by turning its transmitter off again (also see Ex. 1007 table 16-1) and starting timer T_{sleep} .

¶48. This cycling in the Doze mode between the Listen state and the Doze Aware state will continue in accordance with the timers T_{sleep} and T_{aware} until this low power mode is either interrupted or the permission to remain in a low power state is revoked by the OLT. For example, the interruption may come as the result

of a local wakeup indicator, LWI (such as a local stimulus from a device connected to the ONU for example a phone taken off hook or a webpage request etc. initiated by a human interaction), or by a forced wakeup indicator bit set, FWI, transmitted by the OLT within a bandwidth allocation to expedite the waking up of an ONU (Ex. 1007 at 30). Additionally, the ONU can be transitioned out of the low power Doze mode by the reception of a Sleep_Alow(off) PLOAM message transmitted by the OLT revoking the permission of an ONU to be in a low power state. Whenever an ONU exits a low power mode it will send a SleepRequest(Awake) PLOAM message to the OLT informing the OLT that it has transitioned to an active state.

¶49. Both the bandwidth map (which may contain a FWI bit set to 1) and the PLOAM messages (which may contain a SleepAware(on) or SleepAware(off) message) are transmitted as part of the downstream XGTC frame (Ex. 1007 at 28) header. A XGTC frame is transmitted regularly by the OLT. Each XGTC frame has a duration of 125 μ s (Ex. 1007 at 10).

¶50. An important feature of the Doze mode is that the ONU may, as result of its receiver being continually on during the Listen and DozeAware states of this mode, receive and forward downstream data traffic without interruption from the OLT to user CPE (see Ex. 1007 table 16-2 at 100).

2. Sleep Mode

¶51. The second low power mode that is permitted in G.987.3 (Ex. 1007 at 97) is the Cyclic Sleep mode. The Cyclic Sleep mode consists of two cyclic states: the Asleep state in which the ONU's receiver and transmitter are both turned off, and the Sleep Aware state in which the ONU's receiver and transmitter are both turned on. The duration of the Asleep state is determined by timer T_{sleep} and the duration of the Sleep Aware state is determined by timer T_{aware} in a way analogous to the Doze mode. The Cyclic Sleep mode will continue in accordance with the timers T_{sleep} and T_{aware} until this low power mode is either interrupted or the permission to remain in a low power state is revoked by the OLT, exactly as in the Doze mode explained above. Transition out of this mode will also be accompanied by the transmission of the SleepRequest(Awake) PLOAM message to the OLT.

¶52. It is important to note that unlike the Listen state of the Doze mode, an ONU in the Asleep state of the Cyclic Sleep mode is unable to receive and forward downstream traffic to user CPE because its receiver is turned off (see Ex. 1007 table 16-2 at 100).

3. Low Power Mode Objectives

¶53. Given the above, I conclude that the Doze low power mode is a desirable compromise between energy efficiency and uninterrupted downstream service delivery while the Cyclic Sleep mode emphasizes energy efficiency at the

expense of downstream service delivery. In fact, the standard (Ex. 1007 at 89) states: “All ITU-T G.987.3-compliant implementations are expected to support the doze mode. [Where,] [s]upport of the cyclic sleep mode is optional for both OLT and ONU.” Thus, a conscious choice had been made by the ITU standards body to require Doze mode in a clear preference of compromising between energy efficiency and downstream service delivery while still allowing for the higher energy efficient Cyclic Sleep mode to be implemented as an option if desired.

B. RÖGER

¶54. Petitioners reference Röger (Ex. 1006), an academic paper reporting on optically powered networks. Röger describes its environment as a network of optically powered devices (such as temperature sensors, humidity sensors, smoke detectors, security cameras, or video surveillance cameras operating at 15 FPS) (Ex. 1006 at 3, 4, 14) operating *over distances of just 200m and connected with multimode optical fiber* (Ex. 1006 at 4, 13).

¶55. That is, Röger’s system and method is intended for use where there is not a local source of wall (or battery) electrical power at the subscriber locations (Ex. 1006 at 2). Optically powered means the devices in question are not utilizing electrical wall power supplied by a utility but are instead being powered by the “service provider’s” downstream laser source.

¶56. In the case of Röger this optical energy source is an 810 nm high power laser (Ex. 1006 at 13) *which is incompatible with the single mode fiber deployed in telecommunications systems that normally reach tens of km.*

¶57. Knowing this to be the central focus of this paper, a POSITA, at the time, seeking to find new ways to make the ONUs of a telecommunications PON, that is intended to provide thousands of residential and SMB customers with high speed data services (G.987.3 is the XGPON standard: 10G downstream with 1G upstream and G.9807.1 is the XGSPON standard: 10G symmetric) over tens of kilometers (using single mode fiber), more electrical energy efficient would have been severely dissuaded from even delving into the Röger paper—if the POSITA did not dismiss it outright—as presenting a design concept that is too far afield from practicality so as to be an unrealistic academic endeavor.

¶58. The Röger paper presents what they call a “low-energy medium access control protocol” (LE-MAC) that “is designed specifically for optically powered devices” (Ex. 1006 at 8). The LE-MAC describes an efficient operation mode which incorporates transitions between four power states of an optically powered device.

¶59. First, the device (for example, an optically powered and optically networked humidity sensor) starts in a sleep state where both its receiver and transmitter are turned off. Next, the device transitions into a Wake up state in which only its receiver is turned on. It dwells in this state for a set amount of time listening

only for a downstream control signal from the central office, what Röger calls a rendezvous signal RV.

¶60. The RV signal, according to Röger, alerts the device that the central office wants to communicate with it at some time in the near future by providing it with a RV timestamp.

¶61. If no RV signal is received during the Wake up state the device reverts back to the sleep state until its next scheduled wake up. If an RV signal is received the device goes into what Röger calls a snooze state in which both its RX and TX are turned off, but a timer is set to the RV time where, upon expiration, the ONU turns on its RX and TX and it enters the Com state to communicate with the CO.

¶62. Once the communication is completed (transmitting a humidity measurement to the CO for example), it exits the Com state and reverts back to the sleep state.

IX. PLAIN AND ORDINARY MEANING OF “CONSENT”

¶63. The term “consent” is found in Limitation 12D, in the larger phrase “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” (emphasis added).

¶64. First, I note that the ’892 Patent teaches that in the LowPower state the “OLT is aware that the ONU is in a low power mode.” Ex. 1001, Tbl. 6, at cols. 10–

11. These low power modes are paradigmatically the doze/listen or sleep/asleep states. Further, the specification explains that “[u]pon transition to and periodically during the sojourn in this state, the OLT sends a LPM-Allow message to the ONU.”

Id. From this, a POSITA would understand that once the OLT recognizes the ONU is in a lower power state, for example from the ONU’s messaging, the OLT continues to periodically send LPM-Allow messages, “periodic consent messages,” *so that the ONU may “remain” in the low power state as claimed.*

¶65. Second, I note that a “periodic consent message” is not a term of art and does not have an accepted industry definition. Therefore, I also checked the everyday usage of the term, and find that it means, among other synonyms, “voluntary allowance” and “permission.” Ex. 2010. This is consistent with the specification’s usage. Therefore, this would redouble a POSITA’s understanding that the specification uses “consent” in a normal way, meaning “allow” and “permission.” And—in the larger context—the “consent message” serves the purpose of *permitting* the ONU to stay in the low power states.

X. OPINIONS REGARDING PETITIONERS' ARGUMENTS

A. The References Fail to Render Obvious Claims Requiring Direct Transitions from/to a First and Second State

[1D] 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

¶66. Above is a representative limitation that requires the ONU to transition “directly” from the first state to the second state and the reverse.

¶67. *First*, Petitioners argue that because G.987.3 recognizes “the possibility that the ONU does not receive downstream traffic from the OLT and allow[s] for extra response delays if the ONU can’t respond in a normal time” the ONU *must be* “performing direct transitions.” Corrected Petition at 11 (citing Ex. 1007 at 106; Ex. 1003 ¶69). I disagree.

¶68. Intermittent responses are normal in the low power states entered in from the active free state, so just because an ONU only provides intermittent responses does not mean the ONU entered either low power state from the other.

¶69. Indeed, the Sleep Aware state of the Cyclic Sleep low power mode and the Doze Aware state of the Doze low power mode are essentially the same insofar as the ONU transmitter and receiver are both turned on during each of these states and both states persist for the duration of timer T_{aware} (although T_{aware} may be set to

different duration values depending upon whether Cyclic Sleep or Doze is implemented).

¶70. In Cyclic Sleep, the transmitter and receiver are turned off during the Asleep state for the duration of T_{sleep} while in Doze the receiver is on and the transmitter is off for the duration of T_{sleep} in the Listen state (T_{sleep} may be set to different values depending upon whether Cyclic Sleep or Doze is implemented).

¶71. The OLT broadcasts a new downstream frame every 125 μs , any of which may require an upstream response from an ONU currently in an allowed low power mode. Should the OLT send a message requiring a response from an OLT in the Doze mode, it will have to wait no longer than round trip delay time (RTD) plus T_{sleep} (max wait time until the TX is turned on, as the ONU receiver is always on), plus the grant start time relative to the corresponding upstream burst frame associated with the OLT downstream frame (Ex. 1007 at 21), plus other tolerances.

¶72. Should the OLT send a message requiring a response from an OLT in the Cyclic Sleep mode while in the Asleep state (when it cannot be received by the ONU) it may have to wait as long as $\text{RTD} + T_{\text{sleep}}$ (max wait time duration until the ONU RX and TX are turned on) + 125 μs (time until the OLT can send another frame with the message), plus the grant start time relative to the corresponding

upstream burst frame associated with the OLT downstream frame (Ex. 1007 at 21), plus tolerances.

¶73. In either low power mode, a potentially delayed response (i.e. an intermittent response) from the ONU in said state is to be expected until the transmitter is turned on in the case of Doze or until the receiver and transmitter are turned on and the downstream frame is received in the case of Cyclic Sleep.

¶74. Additionally, the parameter T_{alerted} defined in table 16-1 (Ex. 1007 at 99) gives further indication of the expected intermittency (delay) in upstream response from an ONU in a low power state. T_{alerted} is the time the OLT will wait for an ONU, that it has tried to wake up, to respond before sending an FWI to it. If the ONU was in Cyclic Sleep, T_{alerted} is set to $I_{\text{transinit}} + \text{RTD} + \text{tolerances}$ and if the ONU was in Doze, T_{alerted} is set to $I_{\text{txinit}} + \text{RTD} + \text{tolerances}$. Tolerances cover items such as RX synchronization, bandwidth grant irregularities and processing time.

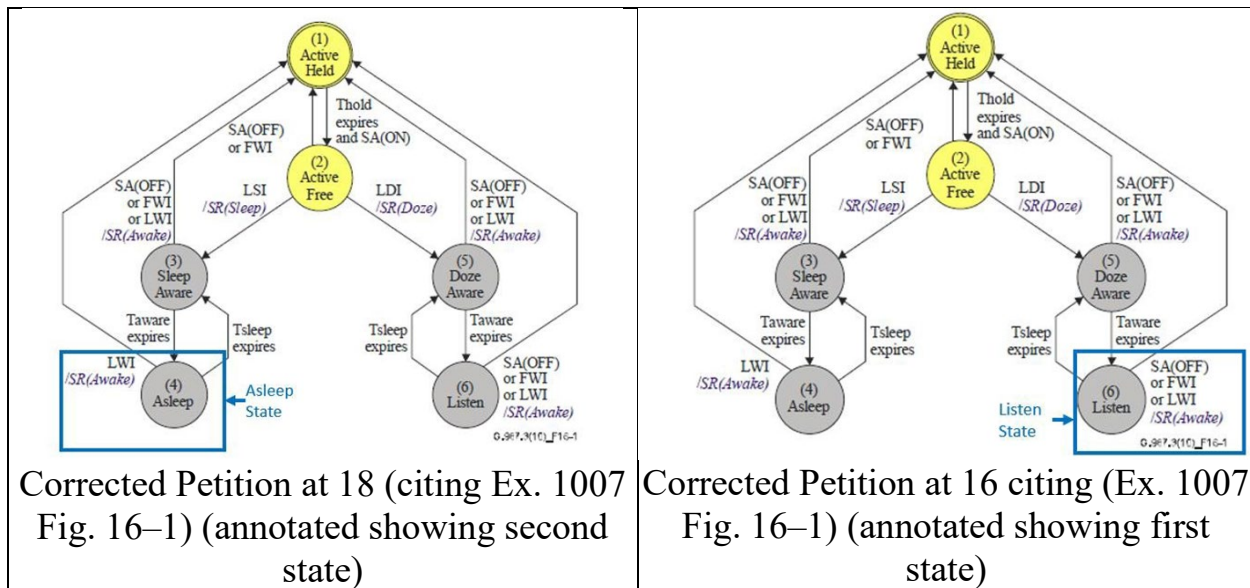
¶75. In either case, the intermittent responses do not indicate direct transitions as either is able to respond upstream to the OLT in its respective aware state (Doze Aware or Sleep Aware). As designed, the OLT will transmit allocations with frequency sufficient to ensure that an Aware ONU sees at least one, see DozeAware and SleepAware (Ex. 1007 Table 16-2 at 100). And the ONU will eventually respond upstream to the OLT in its respective aware state (Doze Aware or Sleep Aware).

¶76. Furthermore, as explained above when providing an overview of G.987.3's power architecture, see Section VIII.A, each of the two low power modes has its own distinct desirable attributes so that allowing a direct translation between these modes would have compromised these desirable distinctions practically and from the perspective of a POSITA at the time.

¶77. Indeed, as T_{alerted} is a parameter that: 1) is set internally to the OLT on a case-by-case basis, 2) must be set to a different value depending upon which low power mode the ONU is in and is also dependent upon the particular ONU design, and therefore 3) the OLT must be made aware of which particular ONU is in which low power state, provides additional compelling evidence in support of the fact that autonomous (without informing the OLT) direct transitions between the Cyclic Sleep-Asleep state and the Doze-Listen state are prohibited in G.987.3.

¶78. Indeed, as now discussed, G.987.3 specifically says such transitions are prohibited.

¶79. *Second*, Petitioners suggest that a POSITA would modify G.987.3 considering Röger to allow direct transitions between G.987.3's Listen (6) and Asleep (4) state, the states that Petitioners map to the claimed first and second states, as shown below.



Again, I disagree.

¶80. The standard disallows such transitions because the low power modes require close management by the TC layer support (EX. 1007 at 97). The OLT needs to know what low power mode the ONU is using in order to contemplate how it is to handle downstream data destined for the ONU. In Doze the OLT can continue to forward traffic while in Cyclic Sleep it must cache the data until the ONU wakes up.

¶81. Allowing direct transitions without notifying the OLT that this is occurring would create the opportunity to lose data and induce errors. At the time of G.987.3 (Ex. 1007), the framework simply could not manage such direct transitions between the Doze-Listen and the Cyclic Sleep-Asleep states. The only allowed modes that could be requested in accordance with G.987.3 (Ex. 1007) are Doze via SleepRequest(Doze) and Cyclic Sleep via SleepRequest(Sleep). In fact, note 2 of table 16-7 (Ex. 1007 at 105) clearly and unequivocally states that direct transitions

between the Doze mode and the Cyclic Sleep mode are disallowed. In fact, if an ONU, in error, attempted such a transition violation, the OLT will take it upon itself to wake up the ONU as this state transition was unmanageable at the time of G.987.3 (Ex. 1007).

¶82. Petitioners (Corrected Petition at 10) assert that note 2 of table 16-7 (Ex. 1007 at 105) applies only to the OLT with the implied meaning that direct transitions between the Doze mode and the Cyclic Sleep mode are disallowed only for the OLT but are otherwise not prohibited for the ONU (“there is no similar restriction on the ONU”). Note 2 of table 16-7 is repeated here in its entirety:

NOTE 2 – Direct transitions between Doze mode and Cyclic Sleep mode are disallowed. When the OLT receives a request to execute such a transition, it attempts to regain state machine synchronization by waking up the ONU. The transitions are not shown on the diagram for the sake of compactness.

This specifically states that “direct transitions between the Doze mode and the Cyclic Sleep mode are disallowed.” *This is referring to the ONU and not to the OLT.*

¶83. A POSITA knows this for many reasons. For example, the Petitioners ignore the next sentence which states that “when the OLT receives such a request to execute such a transition, [the OLT] attempts to regain state machine synchronization by waking up the ONU.” If this were applicable to some internal OLT power states there would be no need to involve the ONU to correct the problem; however, this is indeed only referring to the ONU itself.

¶84. For example, if an ONU somehow were to send consecutive SleepRequest(Doze) followed by SleepRequest(Sleep) PLOAM messages (or vice versa), and permission were already granted to enter one or other of the low power modes, then the OLT, upon receiving the second sleep request from the same ONU, would understand that an error occurred because a disallowed transition between Doze and Cyclic Sleep had been requested and it would then, as note 2 states, attempt to wake up the ONU.

¶85. Moreover, Petitioners' incorrect interpretation ignores the supervisory role that the OLT plays in managing the ONU power states. For purposes of managing the power saving modes of an ONU both the ONU and the OLT maintain corresponding power management state machines (see paragraph 87 below). Table 16-7 is referring to the corresponding power management state machine that the OLT maintains in order to manage the ONU's power mode transitions. ***It has nothing at all to do with the power modes of the OLT as the Petitioners would have one believe.***

¶86. Section 16 of G.987.3 is entitled "ONU power management" and does not address any topic related to any possible OLT power management that is internal to the OLT itself. In fact, internal OLT power management is a topic that is hardly discussed, if at all, in any of the relevant ITU standards.

¶87. To reiterate, G.987.3 (Ex. 1007) dictates that there are only two allowed ONU low power modes that are to be managed by the OLT (i.e. TC layer support) Doze and Cyclic sleep as discussed above (Ex. 1007 at 97). In order to control the power management behavior of a given ONU the OLT and ONU maintain a pair of corresponding power management state machines (Ex. 1007 at 98). The primary signaling mechanism used to coordinate the ONU and OLT state machines is based on the PLOAM messages. The standard then goes on to explicitly describe how these two modes are to be distinctly managed via the OLT. There is no mixing of these modes (i.e. direct transitions from the Cyclic Sleep-Asleep state to the Doze-Listen state).

¶88. A POSITA also would see that it is clearly evident that such transitions are not allowed from the ONU state diagram figure 16-1 (Ex. 1007 at 101) and also from the corresponding OLT state diagram figure 16-2 (Ex. 1007 at 104), as well as the associated PLOAM instruction sets that were in place to allow for OLT management of the ONU low power states. Figure 16-1 clearly does not indicate any allowed direct transitions between Cyclic Sleep-Asleep to Doze-Listen. Had there been such an allowed transition, a double arrow connecting line would have been drawn, but none is present.

¶89. Following the directed paths of figure 16-1, from the ONU perspective, the only allowed way to transition from either low power state (Cyclic Sleep-Asleep)

to the other (Doze-Listen) and back again is to transition first to the active-held and then to Active-Free and then into either of the Aware states of the low power modes, and then finally into the low power state. That is, Figure 16-2, does not allow for any direct transitions between the ONU Low power sleep state (Asleep) and the Low power doze state (Listen) as there are no lines directly connecting these two states on the diagram. Following the directed lines (i.e. arrows) from the OLT's management perspective the shortest path for the ONU to transition from a Low power sleep state to the Low power Doze state the ONU must at a minimum transition to an Awake free state first before transitioning to the Low power Doze. The reverse is true as well in transitioning from Low power doze to Low power sleep the ONU must at a minimum transition first to the Awake free state. Furthermore, these transitions would require that the ONU send Sleep Request PLOAM messages to the OLT and await permission to be granted before transitioning thereby precluding any direct autonomous transitions to or from the low power states.

¶90. Furthermore, any transition between a low power state and an active state requires the transmission of PLOAM communications with the OLT. Explicitly shown is that the ONU must send to the OLT a SleepRequest PLOAM message SR(Sleep) or SR(Doze) to request permission to enter one of the two respective low power modes.

¶91. All of the above thereby precludes any direct ONU transitions between the low power modes or their associated states. A POSITA would be sure that an ONU cannot enter into both low power modes simultaneously and it cannot subsequently be in both modes simultaneously.

¶92. Even if we look only at the OLT diagrams, my conclusion is the same. Figure 16-2 (Ex. 1007 at 104) *shows the corresponding power management state diagram for a given ONU from the perspective of its controlling OLT*. To be absolutely clear, **this is NOT** a power management state diagram for the OLT's own internal power management (OLT internal power management is not of concern here and is not addressed to any extent within G.987.3 Ex. 1007).

¶93. And, again, chapter 16 of G.987.3 (Ex. 1007 at 97 through 106) is entitled “**ONU power management.**” Any indication by the Petitioners that figure 16-2 somehow depicts the internal power states of the OLT itself, and their associated allowed transitions, is incorrect. This diagram depicts the allowed operation **of the ONU** from the OLT perspective and conveys no information concerning the internal power management of the OLT itself.

¶94. Indeed, the entire signaling architecture further shows that the power transitions being discussed concern the ONU. The corresponding PLOAM messages that are used to manage the ONU power states and coordinate the ONU power management state machine with that of the OLT are SleepRequest messages

sent by the ONU to the OLT to request a mode change and SleepAware messages send by the OLT to the ONU to grant a request to transition, deny a request to transition, or revoke a current low power mode status.

¶95. And these instructions further reflect the isolation between the Doze mode and the Cyclic Sleep mode. The Sleep_Request message is an upstream message sent from the ONU to the OLT to request permission from the ONU to allow a power savings mode transition. The details are given in Section 11.3.4.5 of G.987.3 (Ex. 1007 at 59) shown below.

11.3.4.5 Sleep_Request message

An ONU sends Sleep_Request to signal its intention to change power saving modes. Clause 16 defines the use and function of this message in detail.

Octet	Content	Description
1-2	ONU-ID	
3	0x10	Message type ID "Sleep_Request".
4	SeqNo	Always 0.
5	Activity_level	0- Sleep_Request (awake). 1- Sleep_Request (doze). Doze request, ONU receiver active – During low-power periods of doze mode, the ONU can receive downstream traffic. 2- Sleep_Request (sleep). Cyclic sleep request, ONU receiver inactive – During low-power periods of cyclic sleep mode, the ONU cannot receive downstream traffic. Other values reserved.
6-40	Padding	Set to 0x00 by the transmitter; treated as "don't care" by the receiver.
41-48	MIC	Message integrity check

¶96. As seen, there are only three distinct Sleep_Request options allowed as defined in octet 5 of the PLOAM message format: sending a 0 means the ONU is telling the OLT that it is now awake, sending a 1 means the ONU is requesting

permission to enter the Doze power saving mode, sending a 2 means the ONU is requesting permission to enter the Cyclic sleep mode. The OLT needs to know which of the low power modes the ONU is intending to enter, if given permission, because the particular low power state will determine if the OLT can still continue to send downstream data (Doze mode) or not (Cyclic Sleep mode) to the ONU in the low power mode.

¶97. And the Sleep_Aware message is a downstream message sent from the OLT to the ONU. The details of Sleep_Aware are given in 11.3.3.9 of G.987.3 (Ex. 1007 at 57) shown below.

11.3.3.9 Sleep_Allow message

The OLT sends Sleep_Allow to enable or disable sleep modes in real time. If it supports no form of sleep mode, or if no sleep mode is enabled via OMCI, the ONU silently discards this message. Clause 16 defines the use and function of this message in detail.

Octet	Content	Description
1-2	ONU-ID	Directed or broadcast ONU-ID. As a broadcast message, ONU-ID = 0x03FF.
3	0x12	Message type ID "Sleep_Allow".
4	SeqNo	Unicast or broadcast PLOAM sequence number, as appropriate.
5	0000 000A	This byte is a bit field with the following significance: A = 0-Sleep allowed OFF. A = 1-Sleep allowed ON. Other values reserved.
6-40	Padding	Set to 0x00 by the transmitter; treated as "don't care" by the receiver.
41-48	MIC	Message integrity check.

As laid-out, there are only two options defined in octet 5 of this message. If the OLT sends a 0 Sleep_Allowed(off), it means that the OLT is either denying

permission for an ONU (or group of ONUs) to enter a requested low power mode or the OLT is now revoking the permission of an ONU (or ONUs) currently in a low mode to remain in this mode (i.e. it is waking up the ONU(s)). If a 1 is transmitted it means that the OLT is granting permission to the ONU(s) to enter the requested low power modes (either Doze or Cyclic Sleep).

¶98. This information is also presented in tables 16-3 and (Ex. 1007 at 100) and 16-6 (Ex. 1007 at 103), shown below, in the context of the ONU and the corresponding OLT power management state machines figures 16-1(Ex. 1007 at 101) and 16-2 (Ex. 1007 at 104), respectively.

Table 16-3 – ONU state machine inputs

Input categories	Input	Semantics
PLOAM events	Sleep_Allow(ON)	The OLT grants permission to the ONU to exercise any power management mode and leaves the selection of doze or cyclic sleep mode to the ONU's discretion.
	Sleep_Allow(OFF)	The OLT withholds consent to exercise a power management mode.
Bit-indication event	Forced wake-up indication (FWI)	Transmitting FWI as a flag of an allocation structure, the OLT requires immediate wake-up and transition to a full power state.

Table 16-6 – OLT state machine inputs

Input categories	Input	Semantics
PLOAM events	SleepRequest(Doze)	The ONU informs the OLT of its intent to exercise the doze power management mode.
	SleepRequest(Sleep)	The ONU informs the OLT of its intent to exercise the cyclic sleep power management mode.
	SleepRequest(Awake)	The ONU informs the OLT of its intent to remain at full power.

¶99. In other words, the two power saving modes are intentionally kept separate and distinct by design and a POSITA would have had no motivation to combine the two low power modes into a third hybrid by allowing direct transitions between the low power states of each mode because a POSITA would have understood that such a combination that allows direct transitions would have destroyed the ONU's ability to receive and forward downstream traffic while in a low power state.

¶100. Petitioners incorrectly proclaim (Corrected Petition at 23) "when an ONU receives a Sleep_Allow (on) PLOAM event, the ONU has discretion to exercise any power management mode including doze or sleep mode, which would in no way preclude the ONU from alternating between a doze mode and a sleep mode..." This is a reference to the table below.

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.
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But, as discussed above, there are only two allowed power management modes Doze or Cyclic Sleep and direct transitions between the two low power states (Listen and Asleep) are not permitted for all the reasons explained above. In

table 16-3 “any power management mode” means either Doze or Cyclic Sleep, there are no other choices and the ONU via the SleepRequest PLOAM message must still inform which power saving mode it intends to utilize.

Table 16-5 (Ex. 1007 at 103) uses similar language to the Petitioners but here again “at its own discretion” still only means a choice of exactly two low power modes, either Doze or Cyclic Sleep.

¶101. Petitioners also bring in the argument that the same note appears in the XGS-PON specification G.9807.1 (02/2023) (Ex. 1010) making all of the same incorrect interpretations as was done for G.987.3 above with regard to table 16-7 note 2 (Ex. 1010 on 258). Indeed, even though a third low power mode had been introduced, the “watchful sleep” mode, G.9807.1 still maintained the Doze and Cyclic Sleep modes. With Watchfull sleep came an additional SleepRequst option, SleepRequest(Wsleep) (Ex. 1010 at 236). Regardless, direct (ONU) transitions between Doze and Cyclic sleep are still prohibited, as in note 2. If an ONU wishes to enter the hybrid Watchful sleep mode it must expressly request permission to do so from the OLT with the SleepRequest(WSleep) upstream PLOAM message, not present in the older relied-upon reference, G.987.3.

¶102. Thus, the OLT must be informed of the low power mode the ONU intends to enter be it Doze, Cyclic Sleep, or now Watchful Sleep because the OLT must be able to anticipate the abilities (or lack thereof) of the ONU to process

downstream traffic and messages while in its chosen low power mode. That is, the ONU can autonomously select only one of the allowed low power modes it wishes to enter but it must also inform the OLT of its intents and then receive permission from the OLT to enter the requested power saving mode before actually doing so.

¶103. Just as in G.987.3, G.9807.1 states that TC layer support (i.e. OLT management) is required for the Doze mode, the Cyclic Sleep mode, and also the Watchful Sleep mode (Ex. 1010 at 230).

¶104. Hence the Petitioners' assertions that the ONU can somehow transition between Doze and Cyclic Sleep modes without the involvement of the OLT "the responsibility of the internal ONU management" (Corrected Petition at 10–11) are not correct.

¶105. *Third*, Petitioners argue that "[t]his modification to direct transitions would have been driven by a well-known problem in the field, reducing power consumption." Corrected Petition 12 (citing Ex. 1003 ¶70). I disagree.

¶106. G.987.3 was already clearly desirous of achieving the lowest power OLT expenditure possible, stating "[f]or a variety of reasons, it is desirable to reduce the power consumed by an ONU *as much as possible*." (Ex. 1007 at 97). However, as explained in my overview of G.987.3's power architecture—see Section VIII.A above—the architects still consciously chose to restrict direct transitions between

the Cyclic Sleep and Doze modes, because the Cyclic Sleep mode already achieved the highest level of power savings and the doze mode was a compromise that provided for higher performance at the cost of higher power by continuing to allow data traffic (opposed to just wake up signals) to flow downstream.

¶107. And, as previously explained, G.987.3 is architected such that the OLT relies upon the ONU not silently slipping between the low power states (one where it can get data traffic and one where it cannot). Given that it is not possible for the ONU to “noisily” directly transition (i.e., let the OLT know of the direct transition), because the TX is off in the beginning and end states and turning the transmitter on would mean the ONU was in some intermediate state (i.e., no direct transition), the direct transition between these states is simply incompatible with G.987.3’s fundamental design.

¶108. *Fourth*, Petitioners argue that direct transitions were obvious because of the “limited numbers of power states and scenarios for an ONU to transition between them.” Corrected Petition at 11–12. I disagree. The small number of power states and transitions in such an important specification actually means that there is no conceivable way the standards body did not consider the proposed transition, and given that it is not allowed, means that the prohibition was a conscious and reasoned design choice.

¶109. With regard to the number of possible power states that the ONU receiver and transmitter could theoretically take on in the scenario of power savings and data communications each could be: a) continually on or b), continually off or c) cycled on and off. This leads to nine possibilities. Considering power efficiency, one would immediately disregard the three combinations where the transmitter is continually on. Considering link connectivity, one would also disregard any combination where the receiver is continually off. This leaves four potential candidates: A) receiver always on & transmitter always off, B) receiver always on & transmitter cycled on/off, C) receiver cycled on/off & transmitter always off, D) receiver cycled on/off & transmitter cycled on/off. The Doze mode corresponds to B, the Cyclic Sleep mode corresponds to D, and the patent claim states corresponds to C.

¶110. With so few realistic power saving options the ITU standard body undoubtedly considered all of them, including the direct transition from Doze-Listen and Cyclic Sleep -Asleep. That this is not allowed means the ITU had rejected the notion. In fact, we know this to be the case as note 2 of table 16-7 (Ex. 1007, at 105) explicitly points this out “Direct transitions between Doze mode and Cyclic Sleep mode are disallowed.”

¶111. *Fifth*, Petitioners argue that G.987.3 would implement their advocated direct transition in view of Röger because “[a]dvancements in chip speed . . . made

it more practical to periodically turn on and off a receiver while a transmitter remained off in an ONU.” Corrected Petition at 12–13. Implicit in Petitioners’ argument is that the reason G.987.3 disallowed transitions from the Asleep to Listen states was that G.987.3 viewed the time it took to turn on a receiver as unacceptable. I disagree.

¶112. The speed of receiver turn-on as suggested by the Petitioners in referencing Röger was simply not a concern. This is evident as G.987.3 already allows for direct transitions from the Cyclic Sleep-Asleep state (RX off and TX off) to Cyclic Sleep- Sleep Aware state (RX on and TX on) and also allows direct transitions from the Cyclic Sleep-Asleep state to the Active Held State (RX on and TX on). This shows that at the time of G.987.3 (Ex1007), transceiver, receiver, and transmitter turn-on times were not of concern. See figure 16-1 ONU state transition diagram (Ex. 1007 at 101) and table 16-2 ONU power management states (Ex. 1007 at 100).

¶113. Additionally, G.987.3 defines time parameters $I_{transinit}$ and I_{txinit} which are respectively: the complete transceiver initialization time (the time required for the ONU to gain full functionality when leaving the Asleep state turning on both RX and TX) and the transmitter initialization time (time required for the ONU to gain full functionality when leaving the Listen state turning on its TX with the RX already on). These are design parameters supplied by the manufacturer of the ONU. Both

are measured in units of 125 μ s PHY frames and a value of zero indicates that the ONU can respond to any bandwidth grants *without delay*, table 16-1 (Ex. 1007 at 98–99).

¶114. Hence, ONU receiver turn-on response speed was not of concern, however, maintaining a distinct Doze mode which provides a compromise between service delivery and energy efficiency vs a Cyclic Sleep mode which emphasizes energy efficiency was the driving force in keeping these modes separate without ONU autonomous direct transitions.

¶115. *Sixth*, and finally, Petitioners say that because Röger’s ONUs directly transitions between a wakeup/receive state (that Petitioners map to a “first state”) and a snooze/sleep mode (that Petitioners map to a “second state”), a POSITA would and could modify G.987.3 to have an ONU alternate between the Listen and Asleep States. I disagree.

¶116. Petitioners fail to recognize that G.987.3, as discussed above, intentionally separates Doze from Cyclic sleep in order to allow, in the case of Doze, downstream traffic to flow and be forwarded to CPE connected to the ONU, or, in the case of Cyclic Sleep, a higher level of energy efficiency. Allowing direct transitions would destroy the ONUs ability to receive downstream data while in a low power state.

¶117. Furthermore, mapping the Röger Wake up state to the Doze-Listen state is an incompatible mapping, because the Doze mode allows for the continual reception of all downstream data traffic from the OLT as intended by G.987.3. While Röger's Wake up state can only listen for the RV control signal and has no ability to continually forward downstream data in Wake Up as in Doze.

¶118. The Röger LE-MAC really has no need for this ability as it is a design for a network of inanimate sensors as opposed to a telecommunications network that is designed to service residential and SMB customers with abundant human interactions. The Röger LE-MAC requires the device, even upon receiving a RV signal, to turn its RX and TX off and then wait (snooze) until the RV time has passed before powering up to enter the Com state. This is required because Röger is focused on optically powered devices requiring the conservation of every last photon of energy.

¶119. Such devices are not, for example, processing streaming data such as IPTV and thus can be shut down without loss of information or interruption of service to a human subscriber prior to establishing communications with its CO. This transition to the Röger snooze state is unlike G.987.3 where reception of a SleepAware(off) or a LWI or a FWI would immediately put the ONU into an Active Held state (Ex. 1007 at 100, 101) with both its RX and TX turned on and fully ready to respond. A G.987.3 ONU in a Doze mode can transition to Active Held without

losing any downstream data while a device in Röger would have to, upon receiving an RV signal, first turn itself off, wait the RV time and then turn its RX and TX on rendering it unable to continually receive any type of downstream signals or data during the snooze state. There is no parallel to Doze mode in Röger. This alone, would direct a POSITA away from following Röger's LE-MAC.

¶120. Röger's functionality would actually detract from the functionality and flexibility of the two low power modes established in the XGPON standards (Ex. 1007). In G.987.3, the ONU has some autonomy in that it can decide whether to enter a Doze mode where it can receive downstream traffic by sending a SleepRequest(Doze) message or a Cyclic Sleep mode by sending a SleepRequest(Sleep) message. Based on this the OLT knows whether or not to send any downstream traffic to the ONU in an energy saving mode. The ONU can also wake itself up and alert the OLT of its intentions by transmitting a SleepRequest(Awake) message and transition out of either energy saving mode.

¶121. In contrast, no such autonomy exists within the Röger framework where the downstream devices are slaves to the CO and cannot communicate upstream until a RV signal has been received. Again, this is because Röger is focused on a network of sensors and other devices that do not directly interact with human beings unlike the case of G.987.3 XGPON that is designed to provide human driven data services at 10G and 1G rates.

¶122. The Petitioners, in insisting on combining Röger with G.987.3 as motivation to allow direct autonomous transitions between the low power states Doze-Listen and Cyclic Sleep-Asleep, miss that such modification would ruin the functionalities established in G.987.3, because: 1) the ability of the ONU to receive downstream data traffic while in a low power mode would be lost since this transition would turn off its receiver for a period of time, 2) the ability of the OLT to manage the low power modes is broken since the OLT is not informed of the transitions taking place, given G.987.3 dictates that the low power modes be managed by the TC layer (via the OLT) (Ex. 1007 at 97), 3) the OLT will not know if it can send downstream data or not (it would not be able to be received by the ONU in this direct transition mode), and 4) OLT timing capabilities for FWI transmission as per T_{alerted} (EX. 1007 at 99) would be broken.

¶123. There is never a need to send downstream data during Röger's Wake Up, Sleep, or Snooze states. The Röger CO knows not to send downstream communications data (other than to possibly attempt to send an RV control signal during Wake Up) when the device is in any of these three states. As per the Röger LE-MAC design, the CO will only send such data after it first commanded the device to enter the Com state, by first sending it the RV control signal ahead of time while it was in the Wake Up state and then waiting the precise RV time. Hence the CO commanded the downstream device (such as an optically powered remote sensor) to

go into either the Snooze state with the transmission of an RV control signal or the Sleep state by not sending an RV control signal (which effectively commands the device to transition back into the Sleep state until the next wake up time). The device will not/cannot awaken and enter the Com state on its own. This is unlike an XGPON ONU of G.987.3 which can receive a local wakeup indicator (LWI) and awaken of its own volition into an active state. A downstream device in Röger must always wait until the CO commands the device to do so with the transmission of the RV control signal whereby it will immediately snooze (not awaken) until the RV time passes and then awaken into the Com state.

¶124. While in the Com state it will be able to conduct two-way data communications with the CO, receiving any downstream data the CO passes to it and sending information upstream to the CO. By design of the Röger LE-MAC, upon conclusion of the Com state transactions the device immediately goes back into the sleep state to conserve energy. This too is unlike G.987.3 where if the ONU should ever want to enter a low power mode it will notify the OLT of its desired intentions to do so by sending a SleepRequset(Doze or Sleep) message and then await OLT permission via a SleepAllow(On) message.

¶125. The transitions between Röger's Wake Up-to-Snooze-to-Com states only works because Röger demands that a precise timer be set within the device, during the Snooze state, to measure the RV time duration that it was commanded to

wait by the CO until entering the Com state. This is unlike G.987.3 where the sojourn of the two states of either allowed low power mode of an ONU are controlled by two preset internal timers (T_{sleep} and T_{aware}), the durations of which are not dictated by the OLT upon entrance into the low power mode.

¶126. In fact, T_{sleep} and T_{aware} are set by the ONU, not the OLT, and are not even known to the OLT (Ex 1007 table 16-1 at 98). Hence, Röger's CO is always controlling every aspect of the downstream device's power state and the device cannot ever receive downstream data, other than a single RV control signal, until it is fully awake in the Com state.

¶127. Rather, with G.987.3, the ONU sends a SleepRequest(Doze) message informing the OLT that it, the ONU, will enter this mode, if granted permission, and would therefore be able to continually receive downstream data traffic for the duration of its stay in this low power mode.

¶128. In sum, it is clear that Röger can transition directly between the Wake Up state and either the Snooze or Sleep states because Röger's design is not like G.987.3's that has a Doze mode that can receive downstream data. The two fundamental designs are incompatible, a POSITA would know this, and a POSITA would see that Röger's design does not allow a G.987.3 ONU to seamlessly transition between the Cyclic Sleep-Asleep state and the Doze-Listen state as this would destroy the ability of the ONU to continually receive data in a low power

mode as intended by design of the G.987.3 Doze mode and it would also inhibit TC layer management via the OLT that is also required by G.987.3 (Ex 1007).

B. The References Fail to Render Obvious Claims Requiring Periodic Consent Messages to Allow the ONU to remain in the Claimed First/Second Low Power States

[12D] 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.

¶129. For this limitation, Petitioners argue that G.987.3 teaches the OLT sends Sleep_Allow(on) messages periodically, or would be modified to do so, to allow the ONU to remain in one of the two lower power states. Corrected Petition at 62. I disagree.

¶130. Petitioners’ belief stems from the partial quote from G.987.3 (Ex. 1007 at 106) which states in full:

The OLT is permitted to send unidirectional management transmissions at any time, including Profile, Deactivate_ONU-ID, Disable_Serial_Number, and Sleep_Allow PLOAM messages. The OLT must be prepared for the possibility that a sleeping ONU does not receive the transmission.

¶131. However, in the first paragraph of this same page of G.987.3 (Ex. 1007 at 106), the specification also states that “[t]he OLT is responsible for understanding when the ONU can be expected to receive downstream management traffic, or to deal with the possibility that the ONU does not receive such traffic.” Because the OLT knows, for example, that an ONU in Cyclic Sleep mode may not be able to receive downstream management messages (i.e. during the Asleep state) under

G.987.3's framework the OLT, therefore: 1) does not, and would not, transmit repeated consent messages, Sleep_Allow(on), to the ONU since the ONU is already in the low power mode, and 2) it may, in order to wake up this ONU, need to send repeated SleepAllow(off) messages until the ONU is able to receive this instruction revoking its permission to remain in the low power mode. A PSOITA would understand that it would be pointless to transmit repeated consent messages, SleepAware(on), to the ONU since it is already in the low power mode. In this case, it would only make sense to send the SleepAllow(off) message revoking the permission of the ONU to be in the low power mode. Additionally, if the ONU is in a low power mode it has already informed the OLT which mode it has selected, the OLT knows the ONU is in that low power mode. Within the framework of G.987.3, once an ONU has been granted permission to enter a low power mode that it has selected (either Doze or Cyclic Sleep) it remains in this mode until directed to do otherwise (either locally or by the OLT). There is no need for the OLT to periodically remind the ONU that it has been given consent to be in its current low power mode; the ONU will not "forget" this fact. The Sleep_Allow(on) consent message need only be sent one time to an ONU by the OLT to give permission for that ONU to enter into a low power mode.

¶132. Also, as noted in the above quoted text, the Sleep_Allow messages are unidirectional, meaning there is no expected Sleep_Allow reply back to the OLT

from the ONU receiving a Sleep_Allow(on or off) instruction. An ONU transitioning out of a low power mode will transmit a Sleep_Request(Awake) PLOAM message to the OLT informing it of the ONU's transition to an active state. Having not subsequently received a Sleep_Request(Awake) message from an ONU that had previously been given consent to enter a low power mode, the OLT would know that the ONU must still be in this mode. There is no need to issue repeated consent instructions to keep the ONU in the low power mode. Hence a POSITA would not conclude that periodic consent messages would ever need to be sent within the context of G.987.3, because doing so would be pointless and waste both downstream bandwidth and the OLT's resources.

¶133. Further, the Petitioners fail to acknowledge that the downstream Sleep_Allow PLOAM message has two variants Sleep_Allow(on) and Sleep_Allow(off). One or the other must be sent by the OLT. Sleep_Allow(on) grants permission (consent) to the ONU to enter a low power mode that it has selected/requested via either a SleepRequest(Doze) or SleepRequest(Sleep) upstream PLOAM message (either Doze or Cyclic Sleep) while Sleep_Allow(off) either denies permission for the ONU to enter one of these requested low power modes, or revokes the permission of the ONU to remain in a low power mode. Upon receiving a SleepAllow(off) message, an ONU that is currently in a low power mode, must wake up and transition into an active state. Section 11.3.3.9 of G.987.3

(Ex. 1007 at 57) provides the details of the Sleep_Allow PLOAM message, octet 5 must be set to either 0 for Sleep_Allow(off) or 1 for Sleep_Allow(on) as shown below.

11.3.3.9 Sleep_Allow message

The OLT sends Sleep_Allow to enable or disable sleep modes in real time. If it supports no form of sleep mode, or if no sleep mode is enabled via OMCI, the ONU silently discards this message. Clause 16 defines the use and function of this message in detail.

Octet	Content	Description
1-2	ONU-ID	Directed or broadcast ONU-ID. As a broadcast message, ONU-ID = 0x03FF.
3	0x12	Message type ID "Sleep_Allow".
4	SeqNo	Unicast or broadcast PLOAM sequence number, as appropriate.
5	0000 000A	This byte is a bit field with the following significance: A = 0-Sleep allowed OFF. A = 1-Sleep allowed ON. Other values reserved.
6-40	Padding	Set to 0x00 by the transmitter; treated as "don't care" by the receiver.
41-48	MIC	Message integrity check.

¶134. Table 16-3 and (Ex. 1007 at 100) provides additional descriptions of the two Sleep_Allow variants:

Table 16-3 – ONU state machine inputs

Input categories	Input	Semantics
PLOAM events	Sleep_Allow(ON)	The OLT grants permission to the ONU to exercise any power management mode and leaves the selection of doze or cyclic sleep mode to the ONU's discretion.
	Sleep_Allow(OFF)	The OLT withholds consent to exercise a power management mode.
Bit-indication event	Forced wake-up indication (FWI)	Transmitting FWI as a flag of an allocation structure, the OLT requires immediate wake-up and transition to a full power state.

¶135. With this information and considering the discussion above, not only would a POSITA not conclude that periodic consent messages would ever need to be sent within the context of G.987.3, a POSITA would also conclude that, quite to

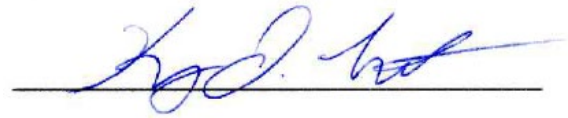
the contrary, a consent message would only need to be sent one time and instead it is the prohibition /revocation message such as G.987.3 Sleep_Allow(*off*) that may need to be sent more than one time until an ONU in the Cyclic Sleep-Asleep state transitions to the Cyclic Sleep-SleepAware state where it is able to receive and process this message revoking its permission to remain in this low power state and must wake up to an active state (Active Held to Active Free). There are no motivating factors within the operational context of the G.987.3 standard (Ex. 1007) that would lead a POSITA to infer in any way that a low power mode consent instruction, i.e. Sleep_Allow(on), would ever need to be, or should ever be, transmitted periodically by the OLT to an ONU to allow it (the ONU) to remain in its current low power mode, the mode comprising of two states (for Doze mode: the Listen and DozeAware states, for Cyclic Sleep mode: the Asleep and Sleep Aware states).

XI. DECLARATION

¶136. I recognize that this declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board (“PTAB”) of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination on the subject matter of this declaration. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted under the rules and as specified by the PTAB.

¶137. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. Further, these statements are made with the knowledge that willful false statements are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on March 6, 2025 at Huntingdon Valley, Montgomery County, PA.



Dr. Kerry I. Litvin

APPENDIX A—RÉSUMÉ

KERRY I. LITVIN, PH.D.**1874 PINE ROAD, HUNTINGDON VALLEY, PA 19006-7940****+1.267.625.6478 Kerry@HBarOmegaLLC.com www.HBarOmegaLLC.com****<http://www.linkedin.com/pub/kerry-litvin/10/996/543>**

Results-driven intellectual property technical expert and technology development leader with visionary foresight, a keen eye towards new innovations, and solving difficult problems. Extensive optical network architecture, optical transport, optical sub-systems, and component expertise within the broadband cable and telecommunications industry. Demonstrated ability to advance the state-of-the-art in all of these areas. "Go to" person when building relationships with customers and suppliers in order to achieve technologically based business goals. Strong background in Fiber Optic Engineering, TV Signal Transmission Over Fiber, Electrical Engineering, Applied Physics, RF/Microwave/Millimeter-Wave/Wireless Engineering, Mathematical Modeling, Technical Due-Diligence, and Intellectual Property Matters. 14 issued patents.

AREAS of OPTICAL EXPERTISE

- DWDM and CWDM Optical Networks
- FTTH/PON
- QAM TV Transmission Over Optical Fiber
- BC/NC Video Overlay Architecture
- RFOG
- Optical Transport
- Polarization Multiplexing
- Commercial Transport/Ethernet Over Fiber
- Broadband HFC Products & Architecture
- Dispersion and Dispersion Compensation
- Nonlinear Optical Distortions/Raman Effects
- CSO, CTB, CNR, Distortion Analysis
- Optical Layer Monitoring OTDR/OFDR
- Polarization Mode Dispersion

PROFESSIONAL EXPERIENCE & CAREER ACCOMPLISHMENTS**H-Bar Omega LLC, Huntingdon Valley, PA****6/2014-Present*****Founder and President***

Independent consultancy providing technological due diligence support to investment managers at private equity firms, venture capital firms, hedge funds, and other private or public financial institutions all with keen monetary interests in cutting-edge and/or commodity: 1) optical communication devices, components, and technologies, 2) optical sensing devices, components, and technologies, 3) fiber optic telecommunications networking systems and technologies, and 4) broadband fiber optic, wired, or wireless communication components, subsystems, and networks.

- *Extensively involved with intellectual property law matters in all areas and aspects of optical fiber communications technologies, broadband communications technologies, optical sensor and instrumentation technologies, and photonics.*
- *Patent litigation expert analysis and consulting in all aspects of fiber optic and broadband communications networks, systems, components, and instrumentation. Extensive inter partes review (IPR) experience in fiber optic communications.*
- *Provided technical evaluations of approximately 3000 patents to date regarding both IP portfolio asset valuation and the potential for patent infringement including creating evidence of use (claim) charts as required.*

The consultancy was founded to:

- Completely address the financial community's needs to fully understand the implications of potential high-technology investment opportunities from expert technological, engineering, and scientific perspectives so that any investment decisions can be made in an entirely informed and unbiased manner.
- Provide expert technical and engineering support to direct industry participants; by servicing the broadband/fiber-optic/telecommunications/high-technology industries; including providing technical, engineering, and regulatory support to industry players both on the equipment manufacturer and the service provider sides of this market equation.
- Assist litigants with expert witness support in all related legal and/or regulatory matters in cases pertinent to the expertise of the consultancy.

HUAWEI TECHNOLOGIES COMPANY, Ltd. (d.b.a. Futurewei), Bridgewater, NJ

6/2011-12/2013

Principal Research and Development Engineer, Access Optical Network Product Line

Responsible for overseeing and initiating innovative technology advances applicable to passive optical network (PON) communication system architectures. Report directly to the VP of R&D for Access Optical Networks. Charged with leading a worldwide engineering staff in a variety of applied research and development efforts related to fiber optic data and video transport technologies. Subject matter expert in mathematical and system modeling of optical communication networks, subsystem components, and devices.

- Developed system models and hardware for coherent PON architectures.
- Developed system models and hardware for dynamic spectrum managed PON architectures.
- Developed system models and hardware for wavelength division multiplexed PON architectures.
- Developed system models and hardware for self-seeded colorless PON transmitter technology.
- Developed Coherent OFDR technology for optical metrology and optical network integrity monitoring.
- Developed Raman Crosstalk Mitigation technology allowing for TV signal video overlay with 10G data transport on PONs.
- Successfully supported various FSAN and ITU standards initiatives promoted by Huawei/Futurewei.

ARRIS (formerly MOTOROLA MOBILITY / HOME), Horsham, PA

2000-2010

Principal Staff Engineer: Advanced Optical Communications Technology Applied R&D

Responsible for overseeing and initiating innovative technology developments applicable to broadband optical communication networks deployed by traditional cable industry MSO's and telecommunication industry service providers. Subject matter expert in optical communication networks, subsystem components, and devices. Lead engineers and technician staff in a variety of applied research and development efforts related to fiber optic and photonic communication technology. Advised senior management.

- Pioneered CWDM fiber deep architecture and technology that, for the first time ever, allowed multiple near zero dispersion 13xx nm broadcast signals to co-propagate on a single fiber network with minimal Raman crosstalk. This reduces cost and complexity for MSO's while expanding network capacity and reach enhancing the potential for increased revenues with an expedient return on investment.
- Invented a methodology for selecting DWDM optical channel wavelengths that minimizes four-wave mixing crosstalk in fiber-deep networks allowing MSO's to increase network capacity while minimizing the impact on signal quality.
- Awarded multiple patents for inventions related to all-optical "networks/architectures of the future."
- Recipient of two corporate "Bravo Awards" for excellence in technical contributions.
- Provided key insights and developed methodologies to counteract the impacts of fiber nonlinear effects and dispersion on analog and QAM signals in broadcast/narrowcast overlay HFC networks. These inputs were critical to ultimately achieving promised industry leading network performance goals for major MSO customers. The measures increased both reach and signal splits enhancing the network economy of scales.
- Diagnosed the limitations and impacts of the original FTTH/PON architectures with regard to optical signal transmission in both the upstream and downstream paths. Resulted in adjusting the standard upstream data transmission rate from OC-3 to OC-12 in order to minimize the crosstalk impact on analog video transmission.
- Acted in an expert "behind-the-scenes" advisory role to senior management providing critical technical and scientific insights and strategic guidance when addressing MSO and other customer concerns regarding potential future products and network architecture proposals. Responded to customer requests for proposals or requests for information.
- Advised on issues impacting customer field installed equipment. Key player in providing assistance to field engineers and MSO's in resolving system failures and difficult to diagnose subpar optical performance problems that arose unexpectedly.
- Managed optical component vendors to ensure optimal price and performance points were met.
- Responsible for technological due diligence with regard to start-up company investment prospects.
- Responsible for intellectual property rights reviews and provided expert advice to corporate IP attorneys.
- When Motorola was named as a defendant, in a patent infringement lawsuit brought by British Telecom, I provided detailed technical support work for the Motorola corporate I.P. legal team to bolster the company's defense. I provided extensive technical/engineering/scientific analytical support to General Instruments (Motorola) corporate legal/IP department in the form of written reports and presentations to the defense team. British Telecom (BT) accused General Instruments/Motorola (and other companies) of integrating their patented technology for removing or suppressing stimulated Brillouin scattering (SBS) into optical transmitters in violation of their patent rights. US4560246A US4560246B1 The final outcome was a negotiated licensing agreement for incorporating this technology into the commercial optical transmitters being sold to their customers at that time.

LOCKHEED MARTIN MISSILES AND SPACE, Newtown, PA**1995-2000*****Staff Engineer: Millimeter-Wave, Microwave, and Photonic Component Design***

Responsible for the design of military grade space qualified satellite communication hardware for a variety of U.S. government agency customers. Also responsible for the analysis of the end-of-life and expected worst case performance of a 60 GHz secure satellite cross-link. Additional functions included a substantial effort in applied IR&D and proposal authoring and presentations in the area of optical DWDM distribution of microwave signals on-board spacecraft.

- Developed the first 60 GHz space qualified power amplifier utilizing monolithic millimeter-wave integrated circuit technology for the ACSS military satellite program. This implementation provided substantial cost reductions to the U.S. military while also significantly increasing the life expectancy and reliability of the amplifier. Subsequently, the useful lifetime of the entire satellite communications constellation was positively impacted.
- Developed fiber optic communication/data links for satellite payload applications.
- As a Kaizen team member, provided manufacturing continuous process improvement innovations which lead to higher first run yields and reduced production and re-engineering costs on custom manufactured hybrid microwave and millimeter-wave circuits.

HUGHES RESEARCH LABORATORIES (HRL), Malibu, CA**1989-1994*****Howard Hughes Doctoral Fellow***

The extremely competitive Howard Hughes doctoral fellowship supported my Ph.D. studies at Cornell University. As part of the fellowship program I spent regular periods of time as a fulltime researcher working at HRL in the area of monolithic microwave and millimeter-wave integrated circuit design, modeling, fabrication, and laboratory evaluation using material systems such as AlInAs/GaInAs on InP. These efforts lead to world class performance in the areas of millimeter-wave amplifier gain and noise figure.

- Developed ultra low-noise monolithic millimeter-wave and microwave integrated circuit amplifiers having world record noise performance (0.78 dB @ 12 GHz, < 1.2 dB up to 14 GHz).
- Developed monolithic millimeter-wave integrated circuit amplifiers with 8 dB gain at 55 GHz.

EDUCATION**Cornell University, Ithaca, NY*****Ph.D. in Electrical Engineering with a minor in Applied Physics*****Howard Hughes Doctoral Fellow**

Dissertation: "Metal-Semiconductor-Metal Photodiodes With Applications in Monolithic Optical Receiver Circuits Capable of Detecting and Amplifying a Millimeter-Wave Modulation Signal Being Transmitted Via an Optical Carrier"

Advisors: Professor Lester F. Eastman (chair), Professor Harold Craighead, Dr. Richard Compton

California Institute of Technology, Pasadena, CA***M.S. in Electrical Engineering*****Institute Graduate Fellow**

Research Project: Microwave power combining by placing an array of Gunn diode sources in a quasi-optical free-space cavity.

Advisor: Professor David Rutledge

Drexel University, Philadelphia, PA***B.S. in Electrical Engineering***

GPA 3.8 on a 4.0 scale, graduated with high honors, top 2%.

Senior Advisors: Professors Peter Herczfeld and Afshin Daryoush

HONOR SOCIETY MEMBERSHIPS

- Eta Kappa Nu (National Electrical Engineering Honor Society)
- Tau Beta Pi (National Engineering Honor Society)