

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ARISTA NETWORKS, INC.,
Petitioner,

v.

CORRIGENT CORPORATION,
Patent Owner.

Case IPR2023-00839

Patent 9,118,602

DECLARATION OF GEORGE N. ROUSKAS, PH.D.

Table of Contents

I.	Introduction.....	1
II.	Qualifications	1
III.	Materials Considered	6
IV.	Level of Ordinary Skill in the Art.....	7
V.	Patent Law Standards	8
VI.	Claim Construction	11
VII.	The '602 Patent	12
VIII.	Ground 1: The Combination of RFC 3209 and Raz Does Not Render Obvious Claims 1-26.....	14
A.	Neither RFC 3209 Nor Raz Discloses or Renders Obvious a “LAG”	15
B.	A POSA Would Not Have Combined RFC 3209 and Raz	24
1.	RFC 3209 and Raz Are Directed to Different Problems and Solutions.....	26
2.	A POSA Would Not and Could Not Have Implemented Raz’s Teachings Between Two Network Devices (e.g., MPLS/LAG Switches) in RFC 3209	30
3.	RFC 3209’s and Raz’s Respective Assignment and Labeling Methods Are Incompatible	36
C.	Petitioner Fails to Establish a Motivation to Modify RFC 3209 with Raz to Arrive at the Claimed Inventions of the '602 Patent	39
D.	Petitioner Fails to Establish a Reasonable Expectation of Success	45
E.	Independent Claim 1	47
1.	The Alleged Combination Does Not Render Obvious the “LAG”	48

2.	The Alleged Combination Does Not Render Obvious Limitation 1.1: “assigning, by a first MPLS/LAG switch, a single physical tunnel port of a LAG to a network tunnel, wherein the single physical tunnel port of the LAG meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port of the LAG has a port serial number”	52
3.	The Alleged Combination Does Not Render Obvious Limitation 1.2: “dedicating a sub-set of bits in a data packet label prepared by the first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label”	60
4.	The Alleged Combination Does Not Render Obvious Limitation 1.3: “sending, by said first MPLS/LAG switch, the data packet label, in which said port serial number of said single physical tunnel port is encoded, to a preceding node” ...	63
5.	The Alleged Combination Does Not Render Obvious Limitation 1.4: “receiving from the preceding node, by said first MPLS/LAG switch, a data packet comprising said data packet label, in which said port serial number of said single physical tunnel port is encoded”	63
6.	The Alleged Combination Does Not Render Obvious Limitation 1.5: “sending said data packet from said first MPLS/LAG switch to a second MSPLS/LAG switch via said single physical tunnel port having the port serial number encoded in the data packet label”	66
F.	Independent Claim 15	71
1.	Limitation 15.1: “processor”	73
2.	Limitation 15.5: “mapper”	74
G.	Independent Claim 26	77
IX.	Ground 2: The Combination of RFC 3209, Raz, and Ferguson Does Not Render Obvious Claims 1-26	79

A.	Petitioner’s Ground 2 Relates to Raz and Ferguson, Not RFC 3209	80
B.	A POSA Would Not Have Modified RFC 3209 and Raz Based on Ferguson to Arrive at the Claimed Inventions of the ’602 Patent	81
C.	Petitioner Fails to Establish a Motivation to Modify RFC 3209 and Raz with Ferguson to Arrive at the Claimed Inventions of the ’602 Patent	89
D.	Petitioner Fails to Establish a Reasonable Expectation of Success ..	101
E.	Even if Raz is Modified Based on Ferguson as Petitioner Asserts, Ground 2 Fails	102
X.	Conclusion	103

I, George N. Rouskas, Ph.D., hereby declare as follows:

I. Introduction

1. The facts set forth below are known to me personally, and I have firsthand knowledge of them.

2. I make this Declaration in support of the Patent Owner's Response to the Petition for *inter partes* review ("IPR") of U.S. Patent No. 9,118,602 ("the '602 patent") (Ex.1001) in IPR2023-00839.

3. I have been retained by Steptoe & Johnson LLP on behalf of the Patent Owner, Corrigent Corporation ("Patent Owner" or "Corrigent").

4. I am being compensated for my professional consulting services in connection with this matter. My compensation is not dependent in any way on the contents of this Declaration, any further opinions or testimony I may provide, or on the outcome of this matter.

II. Qualifications

5. A summary of my qualifications is provided below and a complete identification of my qualifications is provided in my current curriculum vitae, which is attached hereto as Appendix A.

6. I am an expert in network communication systems and especially packet-switched network communication systems and the various fields therein, including Multi-Protocol Label Switching (MPLS) networks, link aggregation such

as with a Link Aggregation Group (LAG), and processing and transmission of packets within and between network devices such as routers and switches. I have been an expert in this area since prior to 1992. I have relied upon my training, knowledge, and experience in the relevant art to form my opinions in this matter.

7. I am an Alumni Distinguished Graduate Professor with Tenure in the Department of Computer Science at North Carolina State University (NC State), where I also serve as the Director of Graduate Programs. I am an experienced researcher and educator in the area of computer networking, with expertise in Internet architectures and protocols, Telecommunications, MPLS networks, network devices including routers, switches, gateways and servers, network topologies, network performance evaluation, routing and load balancing, network measurements, network and traffic engineering, and network design, provisioning, and optimization.

8. I have thirty-four years of experience in computer networking since I received my bachelor's degree in 1989. I have twenty-nine years of experience as a professor in the Department of Computer Science of NC State.

9. I have taught courses on computer networks, Internet protocols, data structures, computer performance evaluation, and queueing theory. In 1997, I created one of the world's first graduate level courses on Internet Protocols, which I continue to teach regularly, and in which I cover in depth topics related to TCP/IP

networking, including routing and switching, MPLS networks and label switching, client-server applications, load balancing and quality of service, and layer-2 protocols including Ethernet and link aggregation. In 2001 I developed an advanced graduate level course on optical networks in which, among other topics, I cover optical transport networks (OTN), SONET and RPR, wavelength (optical label) switching, and protection. Since 1994, I have taught a graduate level course in computer performance evaluation where I cover the application of simulation and queueing theory to evaluating the performance of computer networks with respect to throughput and response time.

10. In my career in this area, I have received numerous accolades for my contributions to computer networking, including being elected as Fellow of the IEEE in 2012. Other accolades include the Outstanding Service Award for the Optical Networking Technical Committee (ONTC) of the IEEE Communication Society (2019); the Joyce Hatch Service Award from the NC State Chapter of the Association for Computing Machinery/Association of Information Technology Professionals (ACM/AITP) (2018); the title of Distinguished Lecturer in the IEEE (2010-2012); an IBM Faculty Award (2007); the Best Paper Award for the International Workshop on End-to-End Virtualization and Grid Management (EVGM) (2007) (with C. Castillo and K. Harfoush); the Best Paper Award for the International Symposium on Communication Systems, Networks and Digital

Signal Processing (CSNDSP) (2006) (with B. Chen and R. Dutta); the ALCOA Foundation Engineering Research Achievement Award, NC State College of Engineering (2004); the Alumni Outstanding Research Award, NC State (2003); the CAREER Award from the National Science Foundation (1997); and the Graduate Research Award from the Georgia Tech College of Computing (1994).

11. I received my Ph.D. in Computer Science (Georgia Institute of Technology, 1994); M.S. in Computer Science (Georgia Institute of Technology, 1991); and B.S. in Computer Engineering (National Technical University of Athens, 1989).

12. In 2000-2001, while on Sabbatical from NC State, I worked as Network Architect for Vitesse Semiconductor, where I was responsible for the design of a then state-of-the-art 2.5 Gbps network processor for ATM networks.

13. My work as an academic began in 1994, when I joined NC State as an Assistant Professor. In 1999, I was promoted to Associate Professor with Tenure. In 2002, I was promoted to the position of Professor.

14. I have held visiting positions on the faculties of a number of international universities, including positions as a Distinguished Scientist at King Abdulaziz University (Saudi Arabia, 2013-2021); Visiting Professor at the Laboratoire d'Informatique University of Paris 6 (France, October 2012); Visiting Professor at the Universidad Tecnica Federico Santa Maria (Chile, December

2008); and Visiting Professor at the Laboratoire de Méthodes Informatiques University of Evry (France, July 2006, December 2002, June 2000).

15. I have received funding from numerous agencies, foundations, and companies for research on network design and optimization. The sources of funding for this research include the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the National Security Agency (NSA), Microsoft, IBM and Cisco.

16. I have served in a number of leadership roles for the IEEE, including as Chair of the IEEE Communications Society's Distinguished Lecturer Selection Committee (2016-2017); Vice Chair of the IEEE Communications Society's Technical and Educational Activities Council (2016-2017); and Chair of the IEEE Communications Society's Optical Networking Technical Committee (2016-2017).

17. I have served in various founding, editorial and leadership positions for publications in my area of expertise, including as founding Editor-in-Chief of IEEE Networking Letters (2018-2021); founding Editor-in-Chief, Elsevier Optical Switching and Networking Journal (2004-2017); Associate Editor, IEEE/OSA Journal of Communications and Networking (2010-2012); Co-Guest Editor, JCM Journal of Communications, Special Issue on the "Advances in Communications and Networking," vol. 6, no. 9, December 2011; Associate Editor, IEEE/ACM Transactions on Networking (2000-2004); Associate Editor, Computer Networks

(2001-2004); Associate Editor, Optical Networks (2000-2004); and Co-Guest Editor, IEEE Journal on Selected Areas in Communications, Special Issue on “Protocols for Next Generation Optical WDM Networks,” vol. 18, no. 10, October 2000.

18. I have graduated twenty-five Ph.D. students. Two have received Ph.D. dissertation awards, one has received an NSF Career award, one became an NSA Fellow, and two have been inducted in the NC State Computer Science Alumni Hall of Fame. Three of my former Ph.D. students became Assistant Professors upon graduation, and the rest joined significant technology companies or research institutes, including RENCi (UNC-Chapel Hill), IBM Research, Google, Facebook, Cisco, Oracle, Ericsson, Riverbed Technologies, Sprint, and Sierra Wireless, among others. I have also graduated twelve M.S. thesis students.

19. During the course of my career, I have had more than 220 scientific articles, three books, and ten book chapters published, which have collectively received more than 9,900 citations (Google Scholar, February 29, 2024). These are summarized in my curriculum vitae.

III. Materials Considered

20. The analysis provided in this Declaration is based on my education as well as my experience in this field. In addition to relying on my knowledge and experience in the relevant field, I have considered the documents described in this

Declaration, the evidence cited in the Petition and the supporting declaration of Dr. Min (Ex.1003), and the evidence being submitted with Patent Owner's Response.

IV. Level of Ordinary Skill in the Art

21. I understand that my analysis of the '602 patent and the interpretation of the claims of that patent must be done from the perspective of a person of ordinary skill in the art ("POSA") of the '602 patent as of the time of the priority date of the '602 patent. I understand that the priority date of the '602 patent is May 6, 2005, as the '602 patent claims priority to an application filed on that date. '602 patent at 1:5-15.

22. I understand that the hypothetical person of ordinary skill in the art is considered to have the normal skills and knowledge of a person in a certain technical field. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field. I also understand that "the person of ordinary skill" is a hypothetical person who is presumed to be aware of the universe of available prior art.

23. I also understand the level of ordinary skill in the art can be evidenced by the prior art. Accordingly, I have also considered the prior art discussed herein in determining the level of ordinary skill in the art.

24. In my opinion, a POSA with respect to the '602 patent would have had a bachelor's degree in electrical engineering, computer science, computer engineering or an equivalent, as well as at least two years of professional experience with computer networking, and a POSA would have had a working knowledge of hardware and software for packet-switched networking, MPLS and LAG. In my opinion, additional work experience could substitute for educational experience and vice versa. I understand that the Petition and Dr. Min's declaration purport to apply this same definition of a POSA.

V. Patent Law Standards

25. I understand that Petitioner has the burden to prove a proposition of unpatentability by a preponderance of the evidence. I further understand that Petitioner has asserted unpatentability on only obviousness grounds.

26. I understand that the first step in an obviousness analysis is to construe the claim and that the second step is to compare the properly construed claim to the prior art reference. I understand that in an IPR, claim terms "shall be construed using the same claim construction standard that would be used to construe the claim in a civil action ... , including construing the claim in

accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). I understand that this is also referred to as the *Phillips* standard as explained in the case *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). I have applied this standard in rendering my opinions herein. I am informed that this standard dictates that claim terms are given their ordinary and customary meaning, as would be understood by a POSA in the context of the entire disclosure or specification of the patent, unless the inventor, as a lexicographer, has set forth a special meaning for a term. I understand that a patent’s “specification” includes all the figures, discussion, and claims within the patent document.

27. I understand that the prior art must disclose the patented subject matter with sufficient detail such that its existence in the prior art reference would be understood by a POSA.

28. I understand that the test of obviousness is whether the claimed invention, as a whole, would have been obvious to a POSA as of the date of the invention in light of the prior art. I understand that the use of hindsight must be avoided when considering whether the alleged invention would have been obvious to a POSA.

29. I understand that the obviousness analysis involves several factual inquiries: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the art at the time of the invention; and (iv) the existence of objective indicia of nonobviousness (“secondary considerations”), such as unexpected results, long felt but unresolved need, failure of others, and industry skepticism followed by acceptance.

30. I understand that in order for a prior art reference to be relied upon as a basis for obviousness, the reference must be analogous art—that is, it must be in the same field of endeavor as the challenged patent or must be reasonably pertinent to the particular problem with which the challenged patent was concerned.

31. In connection with obviousness, I have been informed that there should be some reason or motivation that would have led a POSA to combine or modify the relevant prior-art teachings to obtain the claimed invention. I have been further informed that there should be explanation as to how the relevant prior art teachings would be modified or combined and work together to obtain the claimed invention. I have been further informed that a prior art reference must be considered in its entirety, including portions that would teach or lead away from the claimed invention.

32. Furthermore, I have been informed that there must be a reasonable expectation of success that a person having ordinary skill in the art would have

obtained the claimed invention based on the teachings of the prior art. I understand that in order to possess the requisite reasonable expectation of success in making the claimed invention as a whole, the POSA must be motivated to do more than merely vary all parameters with no indication of critical parameters or try all of a number of possible choices with no direction until successful. I understand that the prior art must provide more than a mere “general guidance” that seems to be a “promising field of experimentation.” I have been further informed that a reasonable expectation of success is separate from a motivation to modify or combine, and that obviousness requires a plausible rationale as to why the prior art references would have worked together.

33. I understand that it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

34. I understand that a dependent claim incorporates and thus includes all elements of the claim(s) from which it depends. I understand that for determining whether a dependent claim is anticipated or obvious, all elements of the dependent claim must be analyzed, including elements incorporated into the dependent claim based on its dependency from an independent claim.

VI. Claim Construction

35. I have reviewed the '602 patent and its prosecution history, as well as the materials referenced above in section III.

36. I understand that the Petition and Dr. Min’s declaration purport that no claim term requires express construction for purposes of this IPR. For purposes of my Declaration, I accept and adopt that position. I have applied the claim construction standards detailed above in rendering my opinions herein.

37. I also understand that in the context of the ’602 patent, a district court has previously construed the terms in the following table. Ex.2014 at 3-4. These constructions apply equally to my opinions herein.

Term	District Court’s Construction
“RSVP-TE” <i>’602 patent, claims 3, 15</i>	“RSVP-TE protocol described in IETF RFC 3209.”
Preamble <i>’602 patent, claim 15</i>	The preamble is not limiting.

VII. The ’602 Patent

38. I understand the ’602 patent to be directed to tunnel provisioning with link aggregation, particularly with respect to a link aggregation group (LAG) in a multi-protocol label switching (MPLS) network. ’602 patent at Title, Figs. 1A-1B, 1:17-3:29, claims 1-26. The ’602 patent describes multiprotocol label switching (1:25-67) and link aggregation (2:1-25), discloses embodiments of an MPLS network containing a LAG between two MPLS/LAG switches (e.g., Figs. 1A-1B, 3:40-45), and recites claims directed to methods and apparatuses for assigning and utilizing a single physical tunnel port of a LAG that connects MPLS/LAG switches

(e.g., claims 1, 15, 26). As recognized by the U.S. Patent and Trademark Office, the claimed inventions of the '602 patent were new and inventive at the time of the priority date. A POSA would have understood the claimed inventions of the '602 patent to improve the utilization and efficiency of a LAG in an MPLS network.

39. More specifically, independent claim 1 is directed to a method for assigning and utilizing a physical tunnel port in a Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, including, in part:

(limitation 1.1)¹ a “first MPLS/LAG switch” assigning a “single physical tunnel port of a LAG” to a “network tunnel”; (1.2 & 1.3) said “first MPLS/LAG switch” preparing and sending a “data packet label” to a “preceding node” with the port serial number of the assigned “single physical tunnel port” encoded in the “data packet label”; (1.4) said “first MPLS/LAG switch” receiving from the “preceding node” a “data packet” comprising said “data packet label”; and (1.5) said “first MPLS/LAG switch” sending said “data packet” “from said first MPLS/LAG switch to a second M[]PLS/LAG² switch via said single physical tunnel port.”

40. Independent claim 26 is a method claim similar to claim 1 and includes limitations similar to those of claim 1 noted above, plus additional

¹ For purposes of this Declaration, I use the same claim limitation numbering as the Petition.

² The claim term “second M[]PLS/LAG switch” in claims 1 and 26 is written corrected as “second MPLS/LAG switch” with alteration omitted throughout this Declaration.

limitation 26.1, which recites an initial step of the “first MPLS/LAG switch” receiving from the “preceding node” a “request message” that requests configuration of the “network tunnel,” requests the “data packet label” associated with said “network tunnel,” and specifies a “bandwidth requirement.”

41. Independent claim 15 is an apparatus claim similar to method claim 1 and recites an apparatus for assigning and utilizing a physical tunnel port in a Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, with the LAG connected to a second MPLS/LAG switch. Claim 15 first recites a “processor” configured to, in part: (15.2) assign a “single physical tunnel port of a LAG” to a “network tunnel”; and (15.2 & 15.3) publish a “[data] packet label” “upstream” with the port serial number of the assigned “single physical tunnel port” encoded in the “data packet label.” Claim 15 further recites a “mapper” configured to, in part: (15.6) receive a “data packet” from an “upstream node”; and (15.8) if said “data packet” contains said “data packet label,” then send said “data packet” “to the second MPLS/LAG switch via said single physical tunnel port.”

VIII. Ground 1: The Combination of RFC 3209 and Raz Does Not Render Obvious Claims 1-26

42. I understand that in Ground 1, Petitioner asserts that claims 1-26 are obvious over RFC 3209 (Ex.1010, “RFC 3209”) in view of Raz (Ex.1006, “Raz”). In my opinion, however, the alleged combination of RFC 3209 and Raz does not render obvious claims 1-26, including because (i) neither RFC 3209 nor Raz

discloses or renders obvious the claimed “LAG,” (ii) a POSA would not have combined RFC 3209 and Raz as Petitioner alleges, (iii) Petitioner has failed to establish a motivation to modify RFC 3209 with Raz to arrive at the claimed inventions of the ’602 patent, and (iv) Petitioner has failed to establish a reasonable expectation of success for any such modifications. Further, I explain below particular limitations of independent claims 1, 15, and 26 that the alleged combination of RFC 3209 and Raz does not render obvious.

A. Neither RFC 3209 Nor Raz Discloses or Renders Obvious a “LAG”

43. It is my opinion that neither RFC 3209 nor Raz discloses or renders obvious the claimed “LAG.”

44. Each independent claim of the ’602 patent recites a “LAG” (Link Aggregation Group) for communicating between a “first MPLS/LAG switch” and a “second MPLS/LAG switch,” and this LAG is implicated in nearly every claim limitation. Ex.1001 at claims 1, 15, 26. For example, independent claim 1 of the ’602 patent is a method claim that recites: “[1.0] A method for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, the method comprising the steps of:

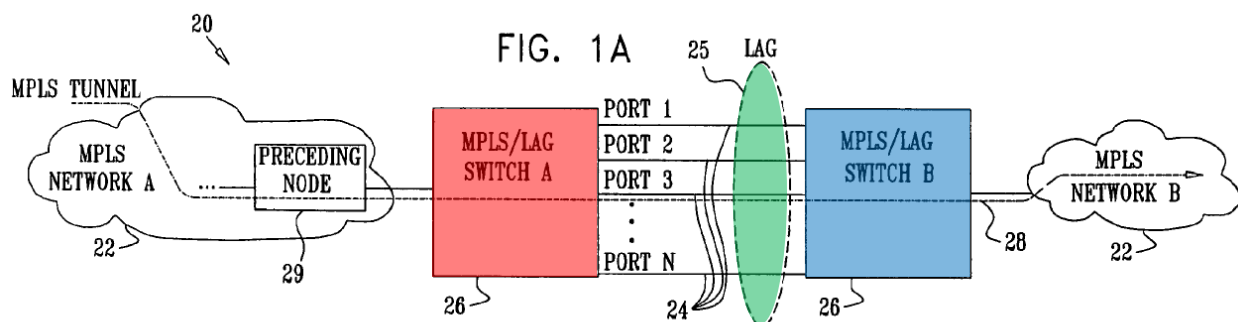
- [1.1] assigning, by a first MPLS/**LAG** switch, **a single physical tunnel port of a LAG** to a network tunnel, wherein **the single physical tunnel port of the LAG** meets a bandwidth requirement of the network tunnel, and wherein **said single physical tunnel port of the LAG** has a port serial number;
- [1.2] dedicating a sub-set of bits in a data packet label prepared by the first MPLS/**LAG** switch to encode said port serial number of **said single physical tunnel port of the LAG** into the data packet label;
- [1.3] sending, by said first MPLS/**LAG** switch, the data packet label, in which said port serial number of **said single physical tunnel port** is encoded, to a preceding node;
- [1.4] receiving from the preceding node, by said first MPLS/**LAG** switch, a data packet comprising said data packet label, in which said port serial number of **said single physical tunnel port** is encoded; and
- [1.5] sending said data packet from said first MPLS/**LAG** switch to a second M[]PLS/**LAG** switch via **said single physical tunnel port** having the port serial number encoded in the data packet label.”

(Emphases added)

45. It is my opinion that RFC 3209 does not disclose or render obvious a LAG. It is my understanding that Petitioner acknowledges this by not relying on RFC 3209 for the claimed “LAG.” The Petition instead relies entirely on Raz’s multiple subports as allegedly disclosing the claimed “LAG.” Pet. 11-13 (“subport of a LAG ... as taught by Raz”), 17-19 (“In addition to the disclosures and suggestions of RFC 3209, Raz discloses ... a link aggregation group (LAG)”); “LAG subports ... as taught by Raz”), 23-24 (“Raz discloses ... LAG subports”), 26-28 (“subports of a LAG as taught by Raz”), 31, 34-36 (“Raz’s LAG subport”),

50-53. But this is wrong, as a POSA would have understood that Raz’s supports do not disclose or render obvious the claimed “LAG.”

46. First, a POSA would have understood that a LAG is a group of network connections (or links) that are *between* two network components. This is evidenced by the ’602 patent, which explains that a LAG involves a group of “links between two endpoints in a data network,” and also by Petitioner’s Ferguson reference, which likewise states that “link aggregation” involves multiple interconnects “between ... two devices.” Ex.1001 at 2:1-5; Ex.1007 at 1:28-42. Below is an annotated version of ’602 patent Figure 1A that demonstrates how a LAG (green) is *between* a first MPLS/LAG switch (red) and second MPLS/LAG switch (blue), linking these two network devices together.



Ex.1001 at Fig. 1A (annotated), 3:58-4:34. Also, for example, Raz itself discloses “links,” such as links 28, 48, 60, and 68 depicted in Figures 1-3, as connections *between* LSRs. See Ex.1006 at Figs. 1-3, 6:67-7:5, 8:33-39, 9:39-40, Abstract, 6:34-38, 7:17-26, 7:39-42, 8:46-53. Ultimately, in accordance with the evidence

above, a POSA would have understood that the '602 patent claims recite a “LAG” connecting a “first MPLS/LAG switch” to a “second MPLS/LAG switch” for sending data packets *between* those two switches “via [a] single physical tunnel port” of the LAG. Ex.1001 at claims 1, 15, 26.

47. It is my opinion that Raz’s subports, however, are strictly *within* a single LSR and thus are not a group of links *between* two LSRs. Both Petitioner and its expert concede that Raz’s subports are “within” an LSR. Pet. 6, 17-18, 27, 54-56; Ex.1003 ¶96. A POSA would have understood that this is because Raz is directed to using multiple slow-speed processors—i.e., “subports”—*within* a network device such as an LSR for processing a *single* high-speed stream between LSRs. Ex.1006 at Abstract, 1:40-2:8, 6:24-33 (“The present invention provides a ... mechanism whereby a plurality of subports comprising slower speed processors are used to perform the packet processing for a higher speed packet stream.”), 6:51-54 (“[I]t is intended that the mechanism of the present invention be implemented in network devices such as routers (e.g., LSRs ...) making up the nodes in a network ...”), Figs. 1-3. Indeed, a POSA would have understood that Raz describes its subports as internal network processors, not links between two endpoints of a network. Ex.1006 at 1:40-59, 2:1-2, 2:5-6 (“a network processor or FPGA is used to implement the subport”), 6:25-29, 7:42-45, 7:59-64 (describing implementing the subports as “network processors” or “an FPGA” that can

“perform the [required] packet processing”), 10:22-23, Fig. 6 and 12:66-13:5 (referencing subports 128 and 130 as “network processors”).

48. A POSA would have understood that Raz’s Figures 1 and 3 demonstrate this. For example, below is an annotated version of Raz’s Figure 1, which demonstrates how Raz is directed to LSRs connected via a *single* high-speed (10G) link 28 (green), not a LAG, and Raz uses a plurality of slow-speed (1G) subports 14 *within* an LSR (red) for processing data that is received or sent via that single high-speed link 28.

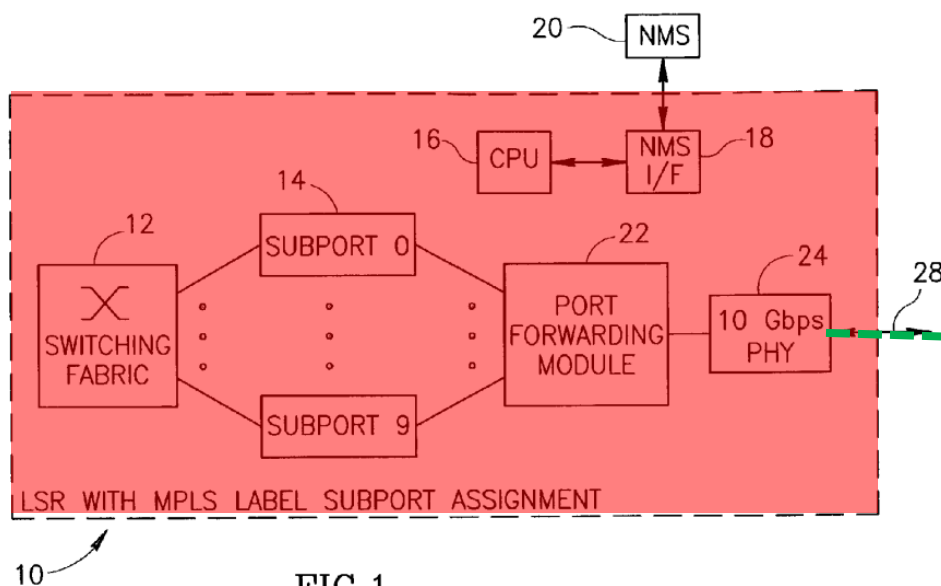


FIG.1

Ex.1006 at Fig. 1 (annotated), 6:65-7:10, 7:59-64. This is similarly demonstrated by Raz’s Figure 3, which shows pairs of LSRs each connected via a *single* high-speed (10G) link (60, 68), not a LAG, and with multiple subports contained *within* the LSRs on each side of those high-speed links for purposes of processing data

that is received or sent via those high-speed links. Ex.1006 at Fig. 3, 9:29-40.

Thus, in my opinion, a POSA would not have understood Raz's subports to constitute or suggest a LAG.

49. Second, a POSA would have understood that Raz's multiple subports are not "aggregated" in the sense of a LAG, such as according to the IEEE 802.3ad link aggregation standard³ referenced in the '602 patent. Ex.1001 at 2:1-17, 3:64-4:1. Ferguson similarly references this IEEE 803.ad standard for "link aggregation." Ex.1007 at 1:28-32. Specifically, the IEEE 802.3ad link aggregation standard states, in part:

Link Aggregation allows one or more links to be aggregated together to form a [LAG], such that a MAC Client can treat the [LAG] as if it were a single link. To this end, it specifies the establishment of DTE to DTE logical links, consisting of N parallel instances of full duplex point-to-point links operating at the same data rate.

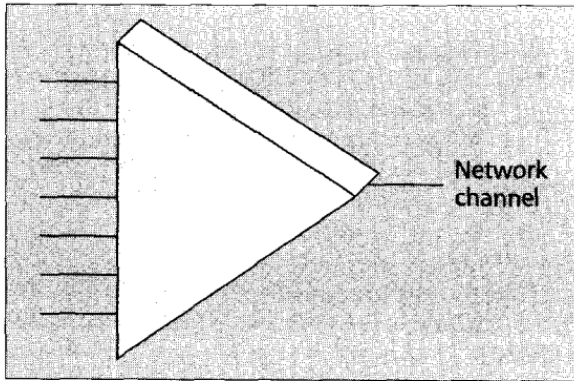
³ In my opinion, the IEEE 802.3ad LAG standard also reinforces the first point above that a LAG involves links *between* network devices and is different from, and unrelated to, internal device components such as Raz's subports. A POSA would have understood that the IEEE 802.3ad standard is concerned with Ethernet links between switches and that using the term LAG to refer to Raz's subports within a switch is invalid. First, there are no Ethernet links (or, more generally, communication links) within a switch. Second, no Ethernet frames exist or are communicated within a switch. As soon as an Ethernet frame is received by a switch, the MPLS packet it contains is extracted and stored and the Ethernet frame header and trailer are discarded after processing. Consequently, the Ethernet standards, including the IEEE 802.3ad link aggregation standard, are not applicable within a switch. Therefore, a POSA would have understood that Raz's subports within an LSR or switch could not constitute a LAG as defined in the IEEE 802.3ad standard or used in the '602 patent.

Ex.2012 at Abstract. A POSA would have understood that this differs from Raz because Raz says to “aggregate” the *output* of its multiple subports into a single high-speed packet stream, which a POSA would have understood to merely disclose multiplexing. Ex.1006 at Abstract, 6:36-38, 14:19-22, 1:1-8, 1:65-66; *see* Ex.2009 at 473; Ex.2010 at 43, Fig. 1; Ex.2011. A POSA would have understood that multiplexing was an operation that was common when multiple low-speed streams are combined for transmission over a single high-speed link, as in Raz. Ex.2009 at 473 (describing how “conventional multiplexing combines various independent low-speed channels from different sources into one high-speed link for ... transmission”); Ex.2010 at 43, Fig. 1. In my opinion, a POSA would have understood that Raz’s combining or multiplexing of subport streams into a single stream is the *opposite* of aggregating multiple parallel links into a group to form a LAG (known as *inverse* multiplexing) because with multiplexing, a single high-speed link is used to transmit packets from multiple low-speed tributary streams, whereas with link aggregation (inverse multiplexing), packets from a high-speed stream are spread across multiple low-speed links for transmission. *See* Ex.1006 at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:36-38, 14:19-22; Ex.1001 at 2:1-5; Ex.1007 at 1:28-42; Ex.2011⁴ (“While multiplexing combines multiple

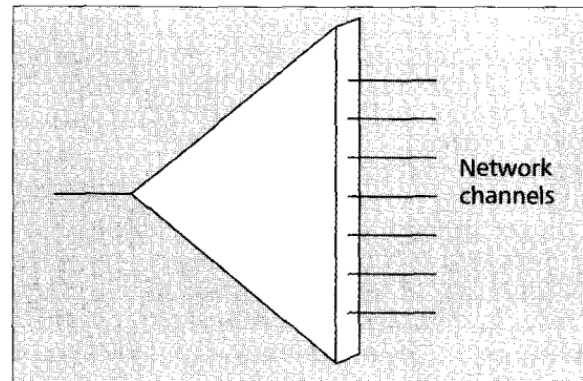
⁴ I note that while Exhibit 2011 does not constitute prior art to the ’602 patent, the substantive content in the first paragraph of Exhibit 2011—i.e., regarding multiplexing, Inverse Multiplexing for ATM (IMA), and the difference between

signals into a single signal, [inverse multiplexing] divides a data stream into multiple concurrent streams that are transmitted at the same time across separate channels”); Ex.2009 at Abstract, 473 (“Inverse Multiplex[ing] is the reverse of multiplexing, because it involves breaking a ... signal into a number of smaller and independent low-cost channels for transmission”); Ex.2010 at 43 (explaining that “multiplexing involves the aggregation of several independent channels into a high-data-rate network channel,” whereas “channel aggregation [i.e., inverse multiplexing] ... is the process of implementing a high-speed channel by splitting it into several network channels at lower speeds”), Figs. 1-2. Exhibit 2010 illustrates the fact that Raz’s multiplexing of subport outputs into a single stream for transmission across a single network link, as depicted below in Figure 1 of Exhibit 2010, is the opposite of inverse multiplexing, such as the claimed LAG, which contains multiple parallel network links, as depicted below in Figure 2 of Exhibit 2010.

multiplexing and IMA—was known by persons of ordinary skill in the art prior to the priority date of the ’602 patent, as demonstrated by Exhibit 2009, which shows that IMA is a technology that existed prior to the priority date and for which the definitions have not changed since then. Ex.2011; Ex.2009 at Abstract (explaining IMA technology), 473 (explaining the difference between multiplexing and inverse multiplexing, such as IMA).



■ Figure 1. Multiplexer symbol.



■ Figure 2. Inverse multiplexer.

Ex.2010 at Figs. 1-2.

50. Third, Raz references a “LAG (Link Aggregation Group)” in one place in Raz’s specification. Ex.1006 at 9:9-15. A POSA would have understood this to demonstrate that Raz distinguishes between a LAG and its own subports. Indeed, the portion of Raz that references a LAG does so to explain how to *repurpose* a commercially-available LAG-related switch to implement Raz’s subports within an LSR, stating: “*For example, some commercially available layer 2 switches can determine the destination port for a packet destined to a LAG This can be used for spreading the packets to the subports by using the layer-2 switch as the port-forwarding module*” Ex.1006 at 9:9-15. Notably, this portion of Raz describes using the commercially-available LAG-related switch to send packets to subports within an LSR, not to send packets between two LSRs via a LAG. *Id.* Based on this disclosure in Raz, a POSA would have understood that Raz’s subports are different from a LAG.

51. Fourth, Raz teaches to combine (i.e., multiplex) the output of its subports into a *single* high-speed packet stream before transmitting that data to another LSR, and in my opinion, a POSA would have understood this to teach away from using a LAG—i.e., a form of *inverse* multiplexing that uses *multiple* streams—between two LSRs. Ex.1006 at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:24-27, 6:36-38, 14:19-22; *see* Ex.2011; (explaining how multiplexing, such as in Raz, and inverse multiplexing, such as a LAG, are opposites); Ex.2009 at Abstract, 473 (same); Ex.2010 at 43, Figs. 1-2 (same). For example, based on the opposing natures of Raz’s multiplexing and the claimed LAG, a POSA would have been discouraged from, or led in a direction divergent from, using a LAG based on Raz.

B. A POSA Would Not Have Combined RFC 3209 and Raz

52. It is my opinion that a POSA would not have combined RFC 3209 and Raz as Petitioner alleges.

53. The challenged claims are directed to communicating between two MPLS/LAG switches via a single physical tunnel port of a LAG. A POSA would have understood that RFC 3209 is directed to communicating between network devices but does not include information regarding the links between devices or disclose or render obvious a LAG. *See, e.g.,* Ex.1010 at 1, 3-10. For this, I understand that Petitioner looks to Raz and asserts that Raz’s internal subports

constitute a LAG and that a POSA would have taken Raz’s internal subport provisioning mechanism and used it for external communication between devices in RFC 3209, by purportedly making Raz’s subports part of an “outgoing interface” that is not expressly disclosed in RFC 3209 but that Petitioner alleges would have been obvious based on the disclosures of RFC 3209 and other RFCs. Pet. 12-13 (alleging it obvious “for the outgoing interface of the LSR—which connects the LSR to another LSR—as rendered obvious by RFC 3209[,] to be a subport of a LAG ... as taught by Raz”), 19 (alleging it obvious “to apply Raz’s teaching of assigning a subport ... to the outgoing LSR interface which RFC 3209 renders obvious”), 22-23, 26-28, 34 (alleging it obvious “to implement Raz’s ... subport assignment disclosure to the LSR’s outgoing interface which connects an LSR to another LSR, as ... suggested by RFC 3209”).

54. As I explain in section VIII.A above, however, Raz’s subports do not constitute or render obvious a LAG. Regardless, as I explain below, it is my opinion that a POSA would not have combined RFC 3209 and Raz as Petitioner alleges because (1) the references are directed to different problems and solutions, (2) a POSA would not and could not have implemented Raz’s subport-related teachings between two network devices in RFC 3209, and (3) the respective assignment and labeling methods of RFC 3209 and Raz are incompatible.

1. RFC 3209 and Raz Are Directed to Different Problems and Solutions

55. In my opinion, a POSA would not have been motivated to combine RFC 3209 and Raz as alleged because RFC 3209, unlike Raz, is concerned with improving communication *between* nodes (e.g., LSRs) of a network. Ex.1010 at 1, 3-5 (providing for the creation of LSP tunnels through an MPLS network, e.g., for traffic engineering over MPLS and routing away from issues in the network), 8-10 (describing establishing an LSP tunnel along nodes of a network). A POSA would have understood that this distinction between Raz and RFC 3209 is demonstrated by how Raz and RFC 3209 treat processor speed. That is, a POSA would have understood that RFC 3209 deals with creating an LSP tunnel comprising a path of nodes in a network, and RFC 3209 assumes that the nodes each have sufficient processing capacity to handle the traffic transmitted along the links connecting those nodes. Ex.1010 at 8-10. In contrast, a POSA would have understood that Raz deals with how a node such as an LSR can handle a high-speed link using slow-speed internal processors (subports), which is not an issue in RFC 3209. Ex.1006 at Abstract, 1:40-2:3, 6:24-27, 14:6-8, 15:14-17, 16:27-29. Thus, a POSA would not have been motivated to use Raz to modify RFC 3209's method of provisioning an LSP tunnel *between* nodes of a network. At most, a POSA may have used Raz to modify the *internal* components and workings of the nodes in RFC 3209.

56. In my opinion, the different problems and solutions of RFC 3209 and Raz, and the lack of motivation for the alleged combination, is further demonstrated by the fact that RFC 3209 is specifically directed to improving MPLS network performance, but Raz's invention is directed to improving switch architecture of individual routers and is indifferent to, and outside the purview of, MPLS network engineering. A POSA would have understood that RFC 3209 is concerned with "extensions to RSVP for establishing label switched paths (LSPs) in MPLS networks." Ex.1010 at 3, 1. A POSA would have further understood that this establishing of a path, or tunnel, along nodes of an MPLS network is strictly **within the purview of the MPLS protocol**, which is concerned with making sure that packets are correctly routed between a source and destination and therefore must ensure that packets are correctly transmitted from node to node along the path. A POSA would have understood RFC 3209 to be aimed at improving the utilization and efficiency of an MPLS network. Ex.1010 at 1 (regarding "rout[ing] away from network failures, congestion, and bottlenecks"), 3 (stating "new features ... were motivated by the requirements for traffic engineering over MPLS," and RFC 3209 supports "rerouting of LSPs, preemption, and loop detection"), 4 ("traffic engineering ([i.e.,] performance optimization of operational networks) is ... an important application of this specification"), 5 (regarding using "explicit routing" for "traffic engineering," as "[e]xplicit routing can ... optimize

the utilization of network resources and enhance traffic oriented performance characteristics”), 8 (regarding using explicit routing to “dynamically reroute” an LSP tunnel, among other features).

57. A POSA would have understood that Raz, however, is concerned with packet processing within a switch and more specifically, processing data transmitted on a high-speed link when the LSR does not have a high-speed processor to handle it. Ex.1006 at Abstract, 1:40-2:3, 6:24-27. A POSA would have further understood that this operation *within* a switch is **outside the purview of MPLS** and does not improve utilization or efficiency of how an MPLS network handles a path, or tunnel, along nodes of the network. A POSA thus would not have been motivated to use Raz for improving such MPLS network engineering as taught in RFC 3209. Indeed, a POSA would have recognized that Raz teaches that its invention is not specifically directed or limited to MPLS networks. Ex.1006 at 2:27-32 (“It is important to note that the invention [of Raz] is not limited by the type of network in use,” and “applicable networks include” non-MPLS networks.), 6:46-50, 14:6-32. Further, a POSA would have recognized that to the extent Raz’s disclosures do involve MPLS, it is not to *improve* MPLS network engineering but rather merely to *accommodate* an MPLS network. Ex.1006 at 1:52-55 (disclosing that Raz sought an invention that would merely be “able to handle” the MPLS protocol), 2:3-5, 6:27-29.

58. Further, it is my opinion that a POSA would not have been motivated to modify RFC 3209 in view of Raz as Petitioner alleges because a POSA would have understood that the goal of RFC 3209, as an Internet standards protocol, is to “realize *interoperable* implementations” of the RSVP and MPLS protocols. Ex.1010 at 4 (emphasis added), 1, 3. A POSA also would have understood that modifying RFC 3209 to include the subport-related teachings of Raz, either within or between nodes, would result in a non-interoperable implementation. Thus, a POSA would not have been motivated to make such modification. That is, a POSA would have understood that RFC 3209, as well as the overall MPLS architecture, specifies communication between LSRs, with the goal of allowing vendors to innovate on switch architecture (internal to LSRs) while ensuring that LSRs of different vendors interoperate using standard protocols. *See* Ex.1010 at 1, 3-4. As a result, protocols such as RFC 3209 are separate and independent of the internal switch architecture, which is the topic of Raz. *See, e.g.,* Ex.1006 at Fig. 1, 3, 6. For example, Raz requires a downstream router to know that the upstream router implements subports internally and to dictate to the upstream router what subport to use. *See* Ex.1006 at 7:30-42, 9:29-58. This is antithetical to the principles of protocol standards such as RFC 3209 that are intended to be interoperable among different types of routers. Moreover, Raz discloses that its invention accommodates protocols such as MPLS, which shows that Raz’s

invention itself is not such an interoperable protocol. Ex.1006 at 1:52-55, 2:3-5, 6:27-29, 2:27-32, 6:46-50.

2. A POSA Would Not and Could Not Have Implemented Raz's Teachings Between Two Network Devices (e.g., MPLS/LAG Switches) in RFC 3209

59. It is my opinion that a POSA would not and could not have implemented Raz's subport-related teachings to apply to communications between two network devices in RFC 3209.

60. As I explain in section VIII.A above, the '602 patent independent claims involve a LAG *between* two network devices (specifically, MPLS/LAG switches), including sending a data packet from one MPLS/LAG switch to another MPLS/LAG switch via an assigned single physical tunnel port of the LAG. As I also explain in section VIII.A, Petitioner relies on Raz's subports for the claimed LAG, but a POSA would have understood that Raz teaches that its subports are strictly *within* a network device (e.g., LSR). Thus, I understand that Petitioner is left stretching Raz's disclosures by arguing it would have been obvious to apply Raz's subports and related teachings to communication *between* two LSRs of RFC 3209. *See* Pet. 19 ("Raz[] also applies to ... interfaces operating as links between LSRs"; "obvious to apply Raz ... to the outgoing LSR interface"), 27-28 (asserting that "[w]hile Raz discloses a method of assigning a ... subport within an LSR ... the same principles would also have been applied to the outgoing interface of the

LSR”; “obvious ... to assign ... [Raz’s] subport” for “connecting the LSR to another LSR”), 34-35 (asserting that “a POSITA [would] implement Raz’s ... subport assignment disclosure to the LSR’s outgoing interface which connects an LSR to another LSR” and “RFC 3209 in view of Raz ... renders obvious that the forwarding of the data packet [to the claimed ‘second MPLS/LAG switch’] is performed ‘via’ ... the assigned ... subport which was selected according to the teachings of Raz”), 50 (“Raz’s [subports] ... would have been obvious as a link connecting the instant node ... to another node further downstream”); *see also* Pet. 11-15 (“[A] POSITA would have been motivated to employ RFC 3209’s teachings ... in conjunction with Raz’s subport assignment functionality and related teachings.”).

61. However, in my opinion, a POSA would neither have been motivated nor capable of implementing Raz’s subport provisioning mechanism with respect to communication *between* two network devices, such as two nodes in RFC 3209 or two MPLS/LAG switches as recited in the challenged claims.

62. In my opinion, a POSA would have understood that Raz’s subport provisioning mechanism is specifically for *inside* a network device such as an LSR, and that Raz teaches away from applying its subport-related teachings externally between two LSRs. A POSA would have understood that Raz’s premise is that multiple “internal” circuits/processors are needed to keep up with a “high

speed packet stream,” and based on that premise, Raz provides a “forwarding and provisioning mechanism that enables a high speed packet stream to be processed by multiple processors that operate at a slower rate tha[n] the inbound packet stream.” Ex.1006 at 1:40-2:3, Abstract, 6:24-27. And Raz makes clear that those “slower rate” “multiple processors” (Ex.1006 at 1:56-59) refer to its subports. *See, e.g.,* Ex.1006 at 6:24-47 (“The present invention provides a subport forwarding and provisioning mechanism whereby a plurality of subports comprising slower speed processors are used to perform the packet processing for a higher speed packet stream.”). A POSA would have therefore understood that Raz is specifically directed to using multiple subports (i.e., processors) to increase the *internal* processing capacity of an LSR to match an external high-speed link between LSRs.

63. Indeed, a POSA would have understood this because Raz states that “it is intended that the mechanism of the present invention be implemented *in* network devices such as ... LSRs ... making up the nodes in a network” (Ex.1006 at 6:51-54)—i.e., Raz is intended to be implemented *within* an LSR, not between two LSRs. It is my opinion that these teachings would have discouraged a POSA from, or led a POSA in a direction divergent from, using Raz’s subport mechanism *between* LSRs, and thus, a POSA would not have used Raz for implementing a LAG *between* LSRs.

64. Also, in my opinion, because Raz states that the capacity of external links or streams between LSRs exceeds the capacity of internal processors, a POSA would not have been motivated to use multiple external links (e.g., a LAG) to increase the bandwidth between LSRs based on Raz because there is already sufficient capacity of external links. Ex.1006 at 1:40-51.

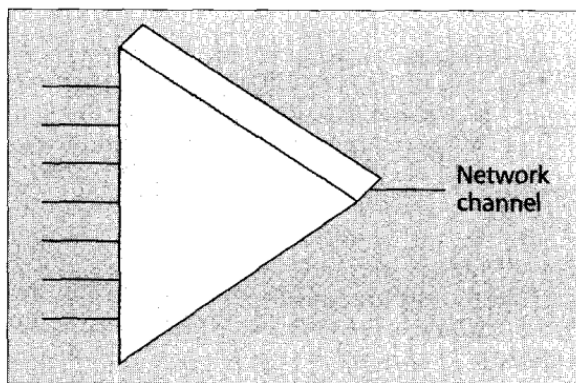
65. Moreover, even assuming that a POSA would have been motivated to add a LAG between two network nodes (e.g., LSRs) of RFC 3209 as Petitioner suggests (although, in my opinion, there was no such motivation), then a POSA would have understood that applying Raz's subport provisioning mechanism to communications between two such nodes would have rendered Raz's mechanism inoperable or unsatisfactory for its intended purpose.

66. For example, a POSA would have understood that Raz involves multiplexing (which Raz refers to as "aggregating") the outputs of its slow-speed subports into a single high-speed stream. Ex.1006 at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:24-27, 6:36-38, 14:19-22; *see* Ex.2009 at 473; Ex.2010 at 43, Fig. 1; Ex.2011. Indeed, Raz includes "Multiplexing" in its title and states that the "present invention" relates to a "link multiplexing mechanism." Ex.1006 at 1:1-8, 1:65-66. As explained by Exhibit 2009, "conventional multiplex[ing] combines various independent low-speed channels from different sources into one high-speed link," just as Raz combines the outputs of its low-

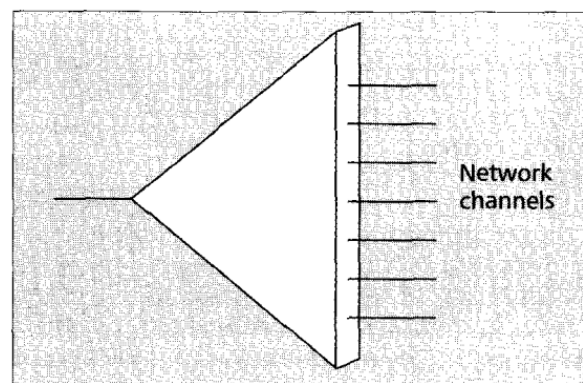
speed subports into one high-speed link. Ex.2009 at 473; *see also* Ex.2010 at 43 (“multiplexing involves the aggregation of several independent channels into a high-data-rate network channel”), Fig. 1; Ex.2011 (“multiplexing combines multiple signals into a single signal”).

67. But, in my opinion, a POSA would not have done this—i.e., used Raz’s multiplexing—with data transmitted over the various physical tunnel ports of a LAG between LSRs, and further, a POSA *could not* have performed this multiplexing with data transmitted over just a “single physical tunnel port” as recited in the challenged claims, as multiplexing constitutes combining multiple streams, as described above. Ex.2009 at 473; Ex.2010 at 43, Fig. 1; Ex.2011. In fact, a POSA would have understood that Raz’s multiplexing of subport outputs into a single stream is the *opposite* of a LAG, which is a form of *inverse* multiplexing. *See* Ex.2011 (“While multiplexing combines multiple signals into a single signal, [inverse multiplexing] divides a data stream into multiple concurrent streams that are transmitted at the same time across separate channels”); Ex.2009 at Abstract, 473 (“Inverse Multiplex[ing] is the reverse of multiplexing, because it involves breaking a ... signal into a number of smaller and independent low-cost channels for transmission”); Ex.2010 at 43 (explaining that “multiplexing involves the aggregation of several independent channels into a high-data-rate network channel,” whereas “channel aggregation [i.e., inverse multiplexing] ... is

the process of implementing a high-speed channel by splitting it into several network channels at lower speeds”), Figs. 1-2. Exhibit 2010 illustrates the fact that Raz’s multiplexing of subport outputs into a single stream for transmission across a single network link, as depicted below in Figure 1 of Exhibit 2010, is the opposite of inverse multiplexing, such as the claimed LAG, which contains multiple parallel network links, as depicted below in Figure 2 of Exhibit 2010.



■ **Figure 1.** *Multiplexer symbol.*



■ **Figure 2.** *Inverse multiplexer.*

Ex.2010 at Figs. 1-2.

68. As another example of why applying Raz’s subport provisioning mechanism to communications between two nodes of RFC 3209 would have rendered Raz’s mechanism inoperable or unsatisfactory for its intended purpose, a POSA would have understood that Raz’s forwarding and provisioning mechanism involves using the same subport for processing a data packet within LSRs on both sides of a link. Ex.1006 at Fig. 3, 2:15-16, 6:38-41, 7:20, 8:46-47. Indeed, Raz teaches that “[t]he selected subport is the same for both sides of a 10G link.”

Ex.1006 at 7:20, 8:46-47. This is demonstrated by Raz’s Figure 3, which shows

that the subport selected by LSR B (i.e., subport 0) is used by both LSR A and LSR B to process a packet sent from LSR A to LSR B, and the subport selected by LSR C (i.e., subport 1) is used by both LSR B and LSR C to process a packet sent from LSR B to LSR C. Ex.1006 at Fig. 3, 9:41-10:4. But a POSA would have understood that this cannot be done if Raz's subports constitute the outgoing interface for a link between LSRs, as Petitioner asserts. Pet. 28, 34-35. That is, if Raz's subports themselves constitute an outgoing interface for sending a data packet from one LSR to another LSR, then it is not possible to process the data packet with the same subport on both sides of the link as Raz teaches because the subports are not on both sides of the link.

69. I understand that the Petition asserts, in conclusory fashion, that “[e]ach of the components described by ... Raz would be operating as described in [that] respective reference[]” and that the “same principles” of Raz would also have been applied to transmission between two LSRs. Pet. 14, 27. As I explain above, however, in my opinion, this is not possible with Raz's teachings.

3. RFC 3209's and Raz's Respective Assignment and Labeling Methods Are Incompatible

70. It is my opinion that the assignment and labeling methods in RFC 3209 and Raz are incompatible.

71. I understand that the '602 patent independent claims involve a first MPLS/LAG switch (i) assigning a single physical tunnel port of a LAG, and

(ii) preparing a data packet label identifying that assigned single physical tunnel port (as in limitations 1.1 and 1.2, respectively). I also understand that Petitioner relies on the methods of both RFC 3209 and Raz for (i) and (ii). Pet. 21-32. But a POSA would have understood that the respective relied-upon teachings of RFC 3209 and Raz regarding such assignments and related labels are incompatible.

72. Regarding the claimed assignment, I understand that Petitioner relies on RFC 3209's explicit routing and Raz's subport provisioning mechanism. Pet. 21-29. Petitioner relies on RFC 3209's explicit routing as involving a given node (e.g., LSR) assigning the next hop—i.e., the next downstream LSR to which the given LSR will *send* packets via an *external* link. Pet. 21-23; Ex.1010 at 28-30, 9. In contrast, Raz's mechanism involves a given LSR assigning a subport for the previous hop—i.e., the *internal* subport for processing packets that the given LSR will *receive*. Ex.1006 at 7:26-29, 8:52-55, 7:30-45, 9:41-10:4, Figs. 1-3, 6. A POSA would have understood this from Raz because, in Raz, "it is the downstream (i.e. receiving) node that determines the subport it wants to receive the LSP on." Ex.1006 at 7:26-29. That is, a POSA would have understood Raz to teach that after a packet is received by a given LSR, the subport used for the next hop is not chosen by that given LSR but instead by the next downstream LSR. Ex.1006 at 2:18-20 ("The subports used on both sides of the next hop, however, are independent."), 6:43-45, 7:17-29, 8:44-55, 9:41-10:4. Therefore, in my opinion,

RFC 3209 and Raz have incompatible assignment methods, as RFC 3209's assignment of an outgoing interface or path is done by an upstream node that sends packets along that assigned path, whereas Raz's assignment of a subport is done by a downstream node that receives packets using that assigned subport.

73. Regarding the claimed preparation of a label that identifies the assignment, I understand that Petitioner relies on RFC 3209's alleged teaching that a given node creates a label that identifies the next hop to which that node will *send* packets. Pet. 29-31 (asserting that RFC 3209 teaches an LSR preparing a label identifying the "outgoing interface" for the "next hop"); *see* RFC 3209 at 5, 9-10, 17-18. But I understand that Petitioner also relies on Raz's contradictory teaching that a given LSR creates a label that identifies the subport via which that LSR will *receive* packets. Pet. 31-32 (describing Raz's LSR C preparing a label identifying the subport used to receive packets "from LSR B"); Ex.1006 at 7:18-45, 8:52-55, 9:41-10:4, Fig. 3. Indeed, a POSA would have understood that in Raz, when a given node creates a label, that label indicates which subport is used for packets *received* that by given node, not *sent* by that given node. Ex.1006 at 7:26-45, 9:41-10:4. Therefore, in my opinion, Petitioner relies upon incompatible labeling methods in RFC 3209 and Raz.

74. It is my opinion that the relevant teachings of RFC 3209 and Raz are thus incompatible. A POSA would have understood that even if Raz were

somehow modified to be implemented between LSRs rather than within LSRs, the assignment and labeling mechanisms of Raz and RFC 3209 would not have worked together. Indeed, as I explain in sections VIII.C and VIII.E below, based on my review, it is my opinion that Petitioner does not and cannot explain specifically how the assignment and labeling methods of these two references work together.

75. In my opinion, a POSA therefore would not have been motivated to combine RFC 3209 and Raz.

C. Petitioner Fails to Establish a Motivation to Modify RFC 3209 with Raz to Arrive at the Claimed Inventions of the '602 Patent

76. Based on my review of the Petition and evidence cited therein, it is my opinion that the Petition fails to establish that a POSA would have been motivated to modify RFC 3209 based on Raz at all, let alone to meet the independent claims of the '602 patent.

77. *First*, it is my opinion that section IX.A of the Petition (“Motivation to Combine RFC 3209 and Raz,” Pet. 9-15) does not address the specific limitations of the claims and thus does not and cannot establish a motivation to combine RFC 3209 with Raz to meet those claim limitations. For example, in section IX.A of the Petition, I understand that there is only a single mention of the claimed “single physical tunnel port” despite it being recited in every limitation of

claim 1, and there is no discussion of the claimed “preceding node” recited in limitations 1.3 and 1.4. Pet. 9-15.

78. **Second**, it is my opinion that section IX.A of the Petition does not explain specifically how the respective relied-upon teachings of RFC 3209 and Raz would purportedly be combined to work together. Instead, based on my review, I understand that Petitioner asserts in conclusory fashion: “to apply various techniques and implementation details disclosed in Raz to the [MPLS] network disclosed ... by RFC 3209” and “for the outgoing interface of the LSR ... as rendered obvious by RFC 3209 to be a subport of a LAG ... as taught by Raz.” Pet. 9, 12-13. But those assertions are inadequate in my opinion. For example, the claims recite a LAG between two MPLS/LAG switches, but based on my review, Petitioner fails to explain how Raz’s subport provisioning mechanism would purportedly be modified to implement Raz’s subports *between* two LSRs. Moreover, as I explain in section VIII.B.2 above, a POSA would not and could not have made such a modification. As another example, the claim limitations involve label allocation and distribution, but based on my review, Petitioner fails to explain how the label allocation and distribution protocols of RFC 3209 and Raz would work together. Moreover, as I explain in section VIII.B.3 above, a POSA would not and could not have made this modification.

79. Based on my review, I understand that Petitioner tries to avoid explaining how RFC 3209 and Raz would work together by stating simply that “[e]ach of the components described by RFC 3209 and Raz would be operating as described in their respective references.” Pet. 14. In my opinion, however, this is conclusory and wrong. For example, Raz describes operation of its subports *within* an LSR, whereas Petitioner argues that a POSA would have implemented Raz’s subports for external communications *between* LSRs in RFC 3209. *See* sections VIII.A, VIII.B.2 *supra*; Pet. 19, 27-28, 34-35, 50. Based on my review, I understand that Petitioner also tries to avoid explaining the combination of RFC 3209 and Raz by stating that “the modification to RFC 3209 would have been minor and required simply adding further specificity to its teachings.” Pet. 14-15. In my opinion, however, this is again conclusory and fails to explain specifically how RFC 3209 and Raz would operate together as Petitioner alleges.

80. ***Third***, it is my opinion that the alleged improvements asserted in section IX.A of the Petition are wrong. In section IX.A of the Petition, I understand that Petitioner argues various reasons that Raz’s techniques would purportedly improve RFC 3209’s MPLS network framework. Pet. 11-12. In my opinion, Petitioner’s first reason fails because it assumes that Raz’s subports are “an aggregated set of links ([LAG]).” Pet. 11. As I explain in section VIII.A, Raz’s subports are not a LAG, including because they are processors (not links)

and are not “aggregated” in the same sense as a LAG. In my opinion, Petitioner’s second reason fails because it assumes that Raz’s subports are “Ethernet ports.”

Pet. 11. Again, as I explain in section VIII.A, Raz’s subports are internal processors, not Ethernet ports. For support of Petitioner’s second reason, Petitioner cites Raz’s claim 7 (Pet. 11, citing Ex.1006 at 14:42-44), but a POSA would have understood that Raz’s claim 7 does not say that Raz’s subports are Ethernet ports. Instead, a POSA would have understood that Raz’s claim 7 teaches that a “high speed packet stream”—which results from aggregating the output of multiple internal subports into a “high speed packet stream” for transmission over an external link—comprises an Ethernet stream. Ex.1006 at 14:5-26, 14:42-44. In my opinion, Petitioner’s third reason (related to labels) fails because it ignores the incompatibility of RFC 3209’s and Raz’s respective labeling methods, as I explain in section VIII.B.3. Pet. 11. Further, in my opinion, a POSA would have understood that Petitioner’s first three reasons (Pet. 11) would not improve but rather restrict RFC 3209’s protocol and make it non-interoperable, which goes against RFC 3209’s teaching. Ex.1010 at 4.

81. I understand that Petitioner’s fourth reason relates to reserving bandwidth (Pet. 12), as do several of Petitioner’s other arguments regarding motivation to combine. *See* Pet. 9-13. But, in my opinion, Petitioner’s fourth reason and Petitioner’s other bandwidth arguments fail to establish a motivation to

combine. This is because a POSA would have understood that RFC 3209 is concerned with reserving bandwidth of links between network devices, whereas Raz teaches reserving bandwidth of internal processors (subports) within network devices, which is different from and not compatible with RFC 3209's link bandwidth reservations. Ex.1010 at 10-11, 13; Ex.1006 at Abstract, Fig. 5, 1:40-2:3, 2:23-25, 6:24-27, 8:1-4, 11:60-12:9, 14:6-8; Pet. 54 (admitting "Raz discusses allocating the bandwidth of subports *within an LSR*"). That is, a POSA would have understood that RFC 3209 specifies reserving **link bandwidth**. Ex.1010 at 10 ("reserved bandwidth on a link"), 11 ("total reservation on a link," "reserved bandwidth on links," "a single reservation on a link"), 13 ("share resources along links"). A POSA would have understood that Raz's subports, on the other hand, are not links but processors within an LSR. *E.g.*, Ex.1006 at 2:1-8. Thus, a POSA would have understood that Raz's reservations are fundamentally different from and incompatible with the RFC 3209 link bandwidth reservations. For example, RFC 3209 discusses three link reservation styles, but Raz never does so because Raz is not related to link bandwidth reservations like RFC 3209. *See* Ex.1010 at 10-11 (sections 2.4 ("Reservation Styles"), 2.4.1 (FF style), 2.4.2 (WF style), 2.4.3 (SE style)).

82. I understand that Petitioner's fifth reason relates to rerouting and protection from link failures. Pet. 12. But, in my opinion, Petitioner's fifth reason

fails to establish a motivation to combine. This is because a POSA would have understood that RFC 3209 already discloses protection and rerouting, thus obviating the need for any such redundant teachings in Raz. Ex.1010 at 3, 7-8, 12-13, 32-34, 42-43, 46. That is, RFC 3209 already specifies protection from link failures, so any protection mechanism of Raz is redundant and does not represent an improvement. *See, e.g.*, Ex.1010 at 32-34 (regarding “local protection” and “local repair mechanism”); 12-13 (regarding “rerouting” traffic to bypass failures using the “make-or-break” concept). Moreover, in my opinion, Petitioner’s fifth reason fails because it is unsupported, as the only support cited for Petitioner’s fifth reason is from Raz’s *definitions* of rerouting and protection switching, not any relevant teaching of such methods in Raz. Pet. 11 (citing Ex.1006 at 5:20-28, 5:33-62).

83. ***Fourth***, it is my opinion that section IX.A of the Petition is not remedied by Petitioner’s analyses of the individual claim limitations in section IX.B of the Petition because, as I explain in section VIII.E below, those analyses likewise fail to establish motivation to modify RFC 3209 based on Raz to meet the specific claim limitations.

84. In sum, it is my opinion that the Petition fails to establish a motivation to modify RFC 3209 with Raz. Based on my review, Petitioner does not explain specifically why or how a POSA would have modified the particular teachings of

RFC 3209 and Raz to work together to meet all limitations of the independent claims.

D. Petitioner Fails to Establish a Reasonable Expectation of Success

85. Based on my review of the Petition and evidence cited therein, it is my opinion that the Petition does not contain persuasive argument or evidence that a POSA would have had a reasonable expectation of success for modifying RFC 3209 based on Raz to meet the challenged claims.

86. I have been informed that obviousness requires that a POSA would have had a reasonable expectation of success in modifying the prior art to meet the claims and that this reasonable expectation of success is separate from the requisite motivation to modify the prior art.

87. Based on my review, it is my opinion that Petitioner does not present any argument, much less a persuasive argument, regarding whether a POSA would have had a reasonable expectation of success in modifying RFC 3209 with Raz to meet the claims. I understand that there is no mention of any “reasonable expectation of success” in either the Petition or Dr. Min’s declaration, except for Dr. Min’s discussion of the applicable law. Ex.1003 ¶16.

88. I understand that the Petition does include a single instance of the words “expected success.” Pet. 14-15. But based on my review, this assertion relates to motivation to combine the references rather than the separate requirement

of a reasonable expectation of success. Regardless, in my opinion, the assertion is conclusory and wrong. It states that “[e]ach of the components described by RFC 3209 and Raz would be operating as described in their respective references” (Pet. 14-15), but a POSA would have understood that this is inaccurate because Raz describes operation of its subports *within* an LSR, whereas Petitioner argues that a POSA would have implemented Raz’s subports for external communications *between* LSRs in RFC 3209. *See* sections VIII.A, VIII.B.2 *supra*; Pet. 19, 27-28, 34-35, 50. Also, based on my review, I understand that the assertion relies on “the references themselves” but without any explanation or citation. Pet. 14-15. Also, it is my opinion that the assertion is unsupported because it relies only on a cited paragraph of Dr. Min’s declaration that does not contain any argument regarding a reasonable expectation of success. Pet. 14-15 (citing Ex.1003 ¶91).

89. Indeed, in my opinion, a POSA would not have had a reasonable expectation of success of modifying RFC 3209 based on Raz to meet the claims, including because a POSA would not have even had a reasonable expectation of success of somehow modifying Raz’s mechanism to apply to communications between two network devices of RFC 3209 to begin with. As I explain in section VIII.B.2 above, Raz’s mechanism involves several teachings that are incompatible with communications between network devices, and modifying of Raz to apply to such communications between network devices would render Raz inoperable or

unsatisfactory for its intended purpose (i.e., its purpose of provisioning data across subports *within* a single network device). Additionally, a POSA would not have had a reasonable expectation of success of somehow combining RFC 3209's and Raz's respective relied-upon teachings regarding assignments and labeling because, as I explain in section VIII.B.3 above, those teachings are incompatible.

E. Independent Claim 1

90. It is my opinion that Raz does not render obvious independent claim 1 of the '602 patent.

91. Independent claim 1 of the '602 patent is a method claim that recites:
“[1.0] A method for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, the method comprising the steps of:

- [1.1] assigning, by a first MPLS/LAG switch, a single physical tunnel port of a LAG to a network tunnel, wherein the single physical tunnel port of the LAG meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port of the LAG has a port serial number;
- [1.2] dedicating a sub-set of bits in a data packet label prepared by the first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [1.3] sending, by said first MPLS/LAG switch, the data packet label, in which said port serial number of said single physical tunnel port is encoded, to a preceding node;
- [1.4] receiving from the preceding node, by said first MPLS/LAG switch, a data packet comprising said data packet label, in which said port serial number of said single physical tunnel port is encoded; and

[1.5] sending said data packet from said first MPLS/LAG switch to a second M[]PLS/LAG switch via said single physical tunnel port having the port serial number encoded in the data packet label.”

92. As I explain in sections VIII.A-D above, the combination of RFC 3209 and Raz fails to render obvious the challenged claims because neither RFC 3209 nor Raz discloses or renders obvious the claimed “LAG,” a POSA would not have combined RFC 3209 and Raz as Petitioner alleges, and Petitioner fails to establish either a motivation to combine or a reasonable expectation of success. Further, discussed below are additional particular reasons why the combination of RFC 3209 and Raz fails to render obvious claim 1, including because Petitioner fails to establish why or how the relied-upon teachings of Raz and RFC 3209 would have been modified or worked together to meet the claim limitations.

1. The Alleged Combination Does Not Render Obvious the “LAG”

93. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious the claimed “LAG” recited in claim 1.

94. Based on my review, I understand that Petitioner addresses the claimed “LAG” in Petitioner’s analysis of limitation 1.0 (preamble).⁵ Pet. 15-19. I also understand that Petitioner does not rely on RFC 3209 for a LAG and instead

⁵ Note that my opinions herein do not suggest that claim 1’s preamble is limiting or consider it as limiting (it is not). I only address Petitioner’s analysis of limitation 1.0 (preamble) because that is where Petitioner addresses the claimed “LAG.”

alleges that the claimed “LAG” is taught by Raz’s subports. Pet. 17-19. As I already explain in section VIII.A above, however, Raz’s subports do not disclose or render obvious the claimed “LAG.” It is my opinion that Petitioner’s analysis of limitation 1.0 fails to change the fact that Raz’s subports do not disclose or render obvious the claimed “LAG.”⁶

95. I understand that Petitioner asserts that “Raz discloses ... a [LAG]” because Raz purportedly discloses “link aggregation to transport ... traffic within an LSR”—i.e., “[p]ackets ... are assigned to one of a plurality of subports for transportation through the LSR and then re-aggregated into the high-speed ... data stream to be forwarded to the next [LSR].” Pet. 17-18; *see also* Pet. 19 (alleging Raz teaches “using aggregation to communicate ... through LAG subports in an LSR”).

96. First, however, a POSA would have understood, as Petitioner’s assertion recognizes, that Raz’s subports are *within* a single LSR and thus are not a LAG, which is a group of links *between* two LSRs. Ex.1001 at Fig. 1A, 2:1-5, Ex.1007 at 1:28-42; section VIII.A *supra*. Second, a POSA would have understood that Raz’s subports are not links for packet “transportation” or “communicat[ion]” as Petitioner alleges but rather processors for *internally*

⁶ Based on my review, it is also my opinion that Petitioner’s analyses for limitations 1.2–1.5 likewise fail to establish that the alleged combination renders obvious a “LAG.”

processing a high-speed packet stream within an LSR. Ex.1006 at 1:40-59, 2:1-2, 2:5-6, 6:25-29, 7:42-45, 7:59-64, 10:22-23, 12:66-13:5. Third, Petitioner relies on Raz’s teaching of “aggregation,” but a POSA would have understood that this teaching—specifically, that the *outputs* of Raz’s subports/processors are aggregated into a single packet stream—is different from the meaning of “aggregation” in a LAG, which instead relates to aggregating links themselves into a single logical link. Ex.1006 at Abstract, 6:36-38, 14:19-22; Ex.1001 at 2:1-17, 3:64-4:1; Ex.1007 at 1:28-32; Ex.2012 at Abstract. In fact, as I explain in sections VIII.A and VIII.B.2, a POSA would have understood Raz’s aggregating of subport outputs to be multiplexing, which a POSA would have understood to be the opposite of aggregating multiple links to form a LAG, known as inverse multiplexing.

97. I understand that Petitioner also uses bold typeface to emphasize a reference to “LAG” in Raz. Pet. 18-19 (quoting Ex.1006 at 9:9-15). It is my opinion that this quoted portion of Raz (9:9-15), however, does not establish that Raz’s subports constitute a LAG. *See* section VIII.A *supra*. A POSA would have understood that Raz distinguishes between its subports and a LAG because “LAG” is never used to describe Raz’s subports and is mentioned only in relation to certain commercially-available switches discussed in the quoted portion (9:9-15). Indeed, a POSA would have understood that the quoted portion (9:9-15) describes

how such commercially-available LAG-related switches can be *repurposed* for use with Raz's subports within an LSR, which, in my opinion, further demonstrates that Raz distinguishes between its internal subports and a LAG.⁷

98. Additionally, it is my opinion that Petitioner fails to establish *why* or *how* a POSA would have modified Raz's subport mechanism, which is within an LSR, to instead be implemented as a LAG between LSRs, much less *why* or *how* Raz's modified mechanism would be combined and work together with the specific teachings of RFC 3209 (e.g., how their two distinct label methods would mesh). Based on my review, I understand that the Petition merely asserts, without explanation, that "[t]he concept ... taught by Raz[] also applies to communicating ... between LSRs," and that it would have been "obvious to apply Raz's teaching ... to the outgoing LSR interface" and "to use ... Ethernet link aggregation technology in implementing the ... techniques in RFC 3209 and Raz." Pet. 19. In my opinion, none of Petitioner's arguments explain *why* or *how* either of Raz or RFC 3209's methods would be modified in order to "apply Raz's teaching" of an internal mechanism to an external link in RFC 3209 as Petitioner asserts.

⁷ It is my opinion that reference to "LAG" in this quoted portion of Raz (9:9-15) is also irrelevant to Petitioner's arguments because it is specifically for Raz's Figure 2 embodiment that does not use MPLS labels, whereas Petitioner relies on the references' MPLS-related disclosures. Ex.1006 at Figs. 1-2, 8:15-9:15; Pet. 9-19.

99. Therefore, a POSA would have understood that the alleged combination of RFC 3209 and Raz fails to render obvious the claimed “LAG.” And because the alleged combination fails to render obvious the claimed “LAG,” the alleged combination thus fails to render obvious limitations 1.1–1.5, each of which recites the claimed “LAG” or the claimed “single physical tunnel port” of the “LAG.”

**2. The Alleged Combination Does Not Render Obvious
Limitation 1.1: “assigning, by a first MPLS/LAG switch, a single physical tunnel port of a LAG to a network tunnel, wherein the single physical tunnel port of the LAG meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port of the LAG has a port serial number”**

100. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious limitation 1.1.

101. I understand that Petitioner relies on the combination of RFC 3209 and Raz for “assigning ... a single physical tunnel port of a LAG” as recited in limitation 1.1, but in my opinion, a POSA would not have, and could not have, combined the relied-upon teachings of these two references to meet this limitation. Pet. 20-28.

102. It is my opinion that the relied-upon teachings in RFC 3209 and Raz are in direct conflict because a POSA would have understood that RFC 3209 teaches assigning an *external* path for *sending* packets on the next hop but Raz

teaches assigning *internal* subports used for *receiving* packets from the previous hop.

103. Based on my review, I understand that Petitioner relies on RFC 3209's **explicit routing** as teaching that "a given node (i.e., a given LSR, claimed 'first' MPLS switch) assigns the 'next hop,'" which is "the next path segment ... from the given node to an assigned next node." Pet. 21-22. This is because, as a POSA would have understood, RFC 3209 involves an RSVP Path message that is transmitted downstream from an initial node to a destination node to set up an LSP path, and RFC 3209's explicit routing works by incorporating an EXPLICIT_ROUTE object into that Path message, which allows a certain intermediate node along the path to determine the next hop, i.e., the next downstream node along the path. Ex.1010 at 1, 5, 8-9, 28-30. That is, for the relied-upon explicit routing in RFC 3209, a POSA would have understood that a given node (LSR) assigns an *external* path over which that node will *send* packets. The annotated version of Raz's Figure 3 below demonstrates this relied-upon teaching in RFC 3209. A POSA would have understood that according to RFC 3209's explicit routing, LSR B (red) would assign LSR C (yellow), and external link 68 thereto, as the next hop that LSR B would use for *externally sending* packets, as shown by the dashed green line.

assigning *internal* subports used for *receiving* packets by that LSR from the previous hop, not an *external* path for *sending* packets from that LSR to a next hop. Ex.1006 at 7:26-29 (“[T]he downstream (i.e. receiving) node ... determines the subport it wants to receive the LSP on.”), 8:52-55, 7:30-45, 9:41-10:4, Figs. 1-3, 6. As for the next hop, a POSA would have understood that Raz teaches that the subport used for the next hop is not chosen by that given LSR but instead by the next downstream LSR. Ex.1006 at 2:18-20 (“The subports used on both sides of the next hop, however, are independent.”), 6:43-45, 7:17-29, 8:44-55, 9:41-10:4.

105. The annotated version of Raz’s Figure 3 below demonstrates this. That is, the annotated version of Raz’s Figure 3 below illustrates Raz’s teaching that LSR B (red) assigns subport 0 for *internally* processing data packets *received* by LSR B from LSR A (yellow) (i.e., the previous hop), as shown by the dashed green line. Ex.1006 at 9:51-65, Fig. 3. A POSA would have understood that, in contrast to RFC 3209’s explicit routing, LSR B does not use its assigned subport 0 to *externally send* data packets downstream to LSR C (i.e., the next hop), because LSR C independently selects which subport is used for data sent from LSR B to LSR C.

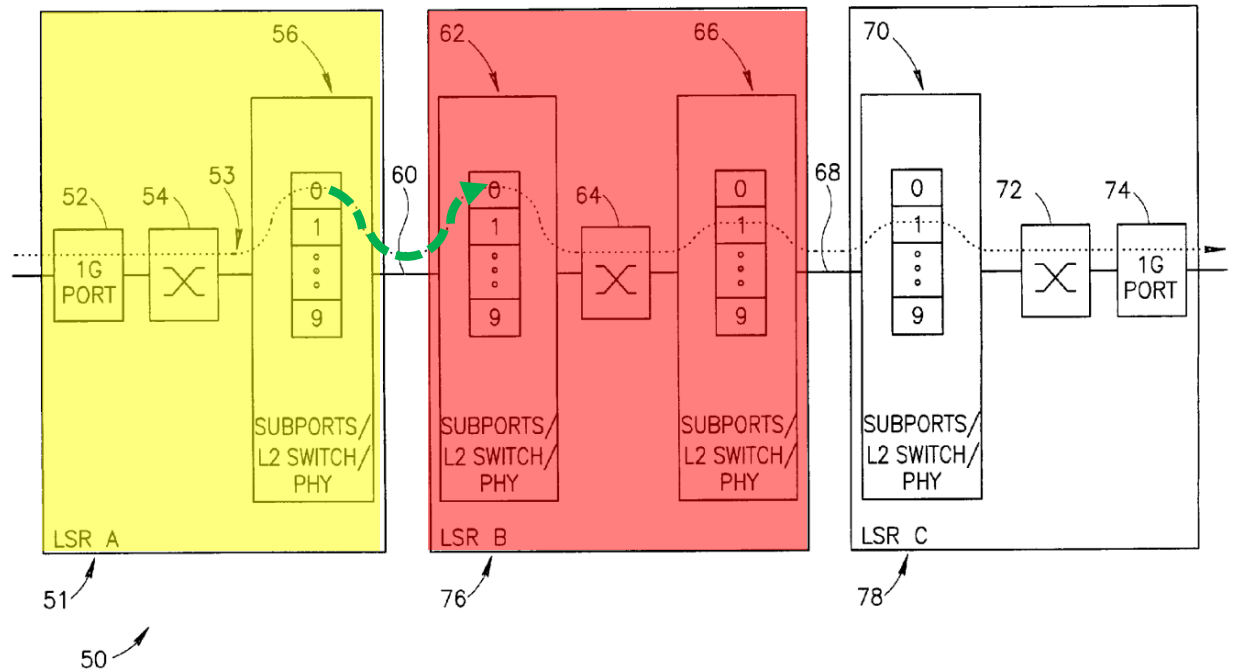


FIG.3

Ex.1006 at Fig. 3 (annotated), 9:29-10:4, 2:18-20, 6:43-45.

106. A POSA would have understood that this teaching in Raz is also demonstrated by Raz's example in column 7, involving exemplary LSRs A and B. In that example, as a POSA would have understood, Raz explains that when LSR B selects subport 3, subport 3 is used for *internal* processing of packets that LSR B *receives* from LSR A, not for *externally sending* packets to a downstream LSR. Ex.1006 at 7:30-45.

107. Therefore, it is my opinion that RFC 3209's explicit routing and Raz's subport provisioning work in opposite ways and are incompatible.

108. Indeed, based on my review, Petitioner fails to establish specifically *why* or *how* a POSA would have combined the relied-upon teachings of these

references. That is, in my opinion, Petitioner does not explain why or how Raz's subport provisioning mechanism would have been modified to apply to a LAG between two LSRs, as opposed to subports within LSRs as taught by Raz, much less why or how such a modified version of Raz's subport provisioning mechanism would have been combined and worked together with RFC 3209's relied-upon explicit routing process.

109. Based on my review, I understand that to argue that a POSA would have modified Raz's teachings to apply between two LSRs for limitation 1.1, Petitioner asserts only the following:

While Raz discloses ... assigning a ... subport within an LSR ... the same principles would also have been applied to the physical/outgoing interface of the LSR Raz teaches that a switching fabric within the LSR has an interface comprised of subports, and one of the subports ... is assigned to communicate packets ... through the LSR's switching fabric The same principles would have applied to forwarding packets between MPLS/LAG switches ... as taught by RFC 3209.

Pet. 27. But, in my opinion, this passage fails to explain why or how Raz's subport provisioning mechanism would have been used *between* LSRs. I understand that this passage concedes that Raz's method is for "*within* an LSR," yet instead of explaining specifically how Raz's method would be modified to apply to external communications *between* two LSRs, I understand that Petitioner merely states in conclusory and ambiguous fashion that Raz's "same principles" would have applied to such external communications. Pet. 27 (emphases added). Based on my

review, this passage also fails for additional reasons. First, I understand that this passage contains no citations or support. Pet. 27. Second, I understand that this passage refers to “MPLS/LAG switches ... as taught by RFC 3209,” but a POSA would have understood that RFC 3209 does not teach a LAG and therefore does not teach MPLS/*LAG* switches, which Petitioner acknowledges by relying instead on Raz for the claimed LAG. Pet. 11-13, 17-19, 23-24, 26-28. Third, I understand that this passage refers to “switching fabric,” but based on my review, there is no mention of such “switching fabric” elsewhere in the Petition for Ground 1. Also, I understand that this passage asserts that Raz’s “switching fabric within the LSR has an interface comprised of subports,” but a POSA would have understood that Raz’s Figure 1 shows that switching fabric 12 and subports 14 are separate and distinct components. Ex.1006 at Fig. 1.

110. In my opinion, Petitioner does not and cannot establish that Raz’s subport provisioning would have been modified to apply between LSRs because, as I explain in section VIII.B.2 above, a POSA would have understood that Raz’s internal operations are not compatible with communications between LSRs, particularly via a LAG, including because Raz teaches that the subports’ outputs are aggregated into a single stream for transmission between LSRs and that the same subport is used within both LSRs on respective sides of the link. Ex.1006 at

Abstract, Figs. 1-3, 2:11-16, 2:47-48, 2:63-64, 6:24-27, 6:36-41, 7:20, 8:46-47, 14:19-22.

111. It is my opinion that Petitioner also fails to explain why or how Raz's subport provisioning (either as described in Raz or as inexplicably modified to apply to a LAG between LSRs) would purportedly be combined and work together with RFC 3209's explicit routing. A POSA would have understood that RFC 3209 involves an RSVP Path message that is transmitted downstream from an initial node to a destination node to set up an LSP path, and RFC 3209's explicit routing (as relied upon by Petitioner) works by incorporating a EXPLICIT_ROUTE object into that Path message, which allows a certain intermediate node along the path determine the next hop, i.e., the next downstream node along the path. Ex.1010 at 1, 5, 8-9, 28-30. That is, a POSA would have understood that RFC 3209's explicit routing involves using an EXPLICIT_ROUTE object in an RSVP Path message for determining a path along LSRs in a network but not along a particular link between two LSRs, such as one of several links/ports of a LAG. Ex.1010 1, 5, 8-9, 28-30. I understand that Petitioner recognizes that RFC 3209's explicit routing would have to be modified to meet the limitation of "assigning, by a first MPLS/LAG switch, a single physical tunnel port of a LAG," but in my opinion, Petitioner does not explain why or how this would be done. I understand that Petitioner addresses motivation to combine the references for limitation 1.1 on Petition pages 27-28,

but based on my review, this passage contains: no citations to RFC 3209 or details regarding its explicit routing process; only one instance of citations to Raz and only for bandwidth-related disclosures, not its method of provisioning subports; and only a single mention of Raz’s “subport.”⁸ It is my opinion that Petitioner notably does not explain how an alleged “first MPLS/LAG switch” combines RFC 3209’s relied-upon explicit routing, which assigns a next hop, with Raz’s subport provisioning, which assigns a subport for a previous hop, because these two processes are incompatible, as explained above.

3. The Alleged Combination Does Not Render Obvious

Limitation 1.2: “dedicating a sub-set of bits in a data packet label prepared by the first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label”

112. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious limitation 1.2.

⁸ I understand that this passage quotes a non-asserted prior art reference (i.e., Ex.1021, “Rabie”) to argue that a POSA would have understood “that bundled links may connect LSRs together and that an LSP path ... might involve the choice of one of the component links in the bundle.” Pet. 28. First, in my opinion, this highlights that neither of the *asserted* references (RFC 3209 and Raz) actually discloses such “bundled links,” or a LAG, between two LSRs. *See* section VIII.A *supra*. Second, I understand that Rabie is cited only once in the Petition and is not asserted prior art. Regardless, in my opinion, Petitioner does not establish motivation for modifying RFC 3209 to include Rabie’s “bundled link,” including because Petitioner merely asserts what “may” or “might” happen (Pet. 28), and I have been informed that such a mere possibility is insufficient to establish a motivation to modify.

113. Limitation 1.2 recites that “the first MPLS/LAG switch”—i.e., the same MPLS/LAG switch that assigned the “single physical tunnel port of a LAG” in limitation 1.1—“prepare[s]” a “data packet label” that identifies the “single physical tunnel port of the LAG.” I understand that Petitioner relies on the combination of RFC 3209 and Raz for this limitation, but in my opinion, a POSA would not, and could not, have combined the relied-upon teachings of these two references to meet this limitation. Pet. 29-32.

114. For limitation 1.2, I understand that Petitioner asserts that RFC 3209 teaches a given LSR creating a label that identifies the “outgoing interface” for the assigned “next hop,” i.e., the next *downstream* LSR, to which that given LSR will *send* packets. Pet. 29-31 (“RFC 3209 discloses ... preparation of a data packet label by the LSR having assigned its outgoing interface to the LSP tunnel to encode an identifier for [its assigned *outgoing*] interface into the data packet label”; “each intermediate node assigns the path’s “*next hop*” and creates a label which it will use to identify traffic belonging to this LSP and determine *where to forward such traffic*”; “the label must ... identify the pre-assigned *next hop and corresponding outgoing interface*” (emphases added)).

115. I understand that Petitioner also relies on Raz’s teaching that a given LSR creates a label that identifies an assigned subport. Pet. 31-32. It is my opinion, however, that this relied-upon teaching of Raz directly contrasts

Petitioner's characterization of the relied-upon teaching of RFC 3209 because, as a POSA would have understood and as the Petition acknowledges, Raz teaches a given LSR creating a label that identifies an assigned subport that the given LSR will use to *receive* packets from an *upstream* LSR (previous hop), not *send* packets to a *downstream* LSR (next hop). Pet. 31 ("LSR C ... dedicates 'bits ... [to] indicate the subport' ... through which a packet should be sent from LSR B to LSR C" (citing Ex.1006 at 9:41-58, Figs. 3-4)); Ex.1006 at 7:18-45, 8:52-55, 9:41-10:4. Therefore, in my opinion, a POSA would have understood that RFC 3209 and Raz teach label processes for assigned paths and subports, respectively, that work in opposite ways and are incompatible.

116. Indeed, based on my review, Petitioner fails to establish specifically *why* or *how* a POSA would have combined the relied-upon teachings of these references. In fact, based on my review, I understand that Petitioner's analysis for limitation 1.2 contains no discussion of how the respective teachings of RFC 3209 and Raz would purportedly be combined, much less work together to meet limitation 1.2, because the first paragraph of Petitioner's analysis discusses only RFC 3209 (not Raz) and the second and last paragraph of Petitioner's analysis discusses only Raz (not RFC 3209). Pet. 29-31. Thus, in my opinion, Petitioner's analysis cannot establish a motivation to combine the two references.

4. The Alleged Combination Does Not Render Obvious
Limitation 1.3: “sending, by said first MPLS/LAG switch, the data packet label, in which said port serial number of said single physical tunnel port is encoded, to a preceding node”

117. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious limitation 1.3.

118. As with limitation 1.2, limitation 1.3 recites the “data packet label” that identifies the “single physical tunnel port” of the claimed LAG. For this, I understand that Petitioner relies on the combination of RFC 3209 and Raz. Pet. 32.

119. Based on my review, I understand that Petitioner’s analysis for limitation 1.3 contains no discussion regarding motivation to combine and instead relies on Petitioner’s analysis for limitation 1.2. Pet. 32. But as I explain above for limitation 1.2, it is my opinion that Petitioner fails to establish obviousness of limitation 1.2, including because, in my opinion, Petitioner does not and cannot to explain how the label-related teachings of Raz would purportedly work with those of RFC 3209. Petitioner’s argument for limitation 1.3 fails for the same reasons.

5. The Alleged Combination Does Not Render Obvious
Limitation 1.4: “receiving from the preceding node, by said first MPLS/LAG switch, a data packet comprising said data packet label, in which said port serial number of said single physical tunnel port is encoded”

120. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious limitation 1.4.

121. As with limitation 1.2, limitation 1.4 recites the “data packet label” that identifies the “single physical tunnel port” of the claimed LAG. I understand that Petitioner addresses this aspect of limitation 1.4 in the first paragraph of its limitation 1.4 analysis and relies on the combination of RFC 3209 and Raz. Pet. 32-33. Based on my review, I understand that Petitioner’s analysis, however, contains no discussion regarding motivation to combine the references to meet this limitation and instead relies on Petitioner’s analysis for limitation 1.2. Pet. 32-33. But as I explain above for limitation 1.2, it is my opinion that Petitioner fails to establish obviousness of limitation 1.2, including because, in my opinion, Petitioner does not and cannot explain specifically how the label-related teachings of Raz would purportedly work with those of RFC 3209. Petitioner’s argument for limitation 1.4 fails for the same reasons. While Petitioner asserts that RFC 3209’s “label value” identifies the *next hop* to which the given LSR will *send* the data packet (*see* Pet. 30-31, 32-33), a POSA would have understood that Raz’s label identifies a subport for the *previous hop* from which the given LSR will *receive* the data packet, not the next hop. *See* section VIII.E.3 *supra*. In my opinion, Petitioner cannot reconcile this incompatibility, and I understand that Petitioner therefore ignores it.

122. Limitation 1.4 further recites that the “data packet label” identifying the “single physical tunnel port” is contained in a data packet “receiv[ed] from the

preceding node, by said first MPLS/LAG switch.” For this, I understand that the second paragraph of Petitioner’s limitation 1.4 analysis asserts that “Raz’s technique is similar [to RFC 3209] insofar as the [given] LSR receives a packet from a previous node” with a “label indicating the ... subport over which the packet should be communicated.” Pet. 33. It is my opinion, however, that this assertion oversimplifies the references and fails to explain how their specific label-related teachings would work together. For example, a POSA would have understood that Raz does not disclose that a given LSR receives from a preceding LSR a data packet with a label indicating simply the “subport over which the packet should be communicated,” as Petitioner asserts (Pet. 33), but rather it specifically indicates the subport used for packets that the given LSR *receives*, not *sends*. Ex.1006 at 7:18-45, 8:52-55, 9:41-10:4. As I explain in section VIII.E.3 above, the relied-upon label-related teachings of the references are incompatible based on the details of those teachings. Based on my review, this incompatibility is evident from Petitioner’s own analysis for limitation 1.4, which asserts that when a given node (corresponding to the claimed “first MPLS/LAG switch”) receives a label from a preceding node, in RFC 3209 that label identifies the *next hop* (Pet. 33: receiving node uses label for “Next Hop Label Forwarding Entry”), but in Raz that label identifies a subport for the *previous hop* (Pet. 33: LSR B receives label indicating subport used for transmitting from LSR A to LSR B).

**6. The Alleged Combination Does Not Render Obvious
Limitation 1.5: “sending said data packet from said first
MPLS/LAG switch to a second MSPLS/LAG switch via said
single physical tunnel port having the port serial number
encoded in the data packet label”**

123. It is my opinion that the alleged combination of RFC 3209 and Raz does not render obvious limitation 1.5.

124. Limitation 1.5 recites sending the data packet *between* the first and second MPLS/LAG switches *via* the *single physical tunnel port of the LAG*. I understand that Petitioner relies upon Raz’s subport as the claimed “single physical tunnel port” of a LAG (Pet. 34-36), but as I explained in sections VIII.A and VIII.B.2, a POSA would have understood that Raz’s subports are *within* the LSR, Raz’s subports would not and could not have been implemented as a LAG *between* two LSRs, and Raz teaches transmitting packets between LSRs via a single high-speed link, not a LAG. Therefore, it is my opinion that Raz’s subport cannot be the conduit “via” which data is sent “from said first MPLS/LAG switch to a second MPLS/LAG switch,” as recited in limitation 1.5.

125. Even if a POSA were motivated and capable of applying Raz’s teachings to communications between LSRs, it is my opinion that the asserted combination would nonetheless fail to meet limitation 1.5.

126. Limitation 1.5 further requires that the “first MPLS/LAG switch” must “**send[]**” the data packet via the “single physical tunnel port” that is (i)

assigned by that first MPLS/LAG switch, per limitation 1.1, and (ii) identified in the label generated by that first MPLS/LAG switch, per limitation 1.2. For the alleged combination of RFC 3209 and Raz, based on my review, I understand that Petitioner asserts that **Raz’s subport** constitutes the claimed “single physical tunnel port” via which the packet is sent and relies on **Raz’s teachings** regarding both (i) assigning it and (ii) generating a label identifying it. Pet. 34-35 (alleging the packet is sent “‘via’ ... the assigned ... subport which was selected according to the teachings of Raz ... because it is the ... subport which Raz discloses is indicated in the data packet label”); *see also* Pet. 23-28, 31-32 (relying on Raz for limitations 1.1-1.2). That is, Petitioner asserts that a given LSR in RFC 3209 (i.e., alleged “first MPLS/LAG switch”) purportedly assigns a subport and generates a corresponding label according to Raz and then **sends** the claimed data packet via that subport.

127. A POSA would have understood that Raz, however, teaches that the LSR that assigns a subport and generates the label (i.e., the alleged “first MPLS/LAG switch”) does not then **send** packets via that assigned subport to a downstream LSR but instead uses it to **receive** packets. Ex.1006 at 7:26-29, 8:52-55, 7:30-45, 9:41-10:4. For example, a POSA would have understood this because, in Raz, “it is the downstream (i.e. receiving) node that determines the subport it wants to receive the LSP on.” Ex.1006 at 7:26-29. I understand that

Petitioner attempts to say that a given LSR in RFC 3209 would assign a subport according to Raz and use that assigned subport for the “next hop” (Pet. 34-35), but a POSA would have understood that Raz instead teaches that the subport for the “next hop” is not assigned by that given LSR but rather by the next downstream LSR. Ex.1006 at 2:18-20 (“The subports used on both sides of the next hop, however, are independent.”), 6:43-45, 7:17-29, 8:44-55, 9:41-10:4.

128. This is demonstrated by the annotated version of Raz’s Figure 3 below. It illustrates Raz’s teaching, as understood by a POSA, that LSR B (red) selects subport 0 and then *receives* a packet using that assigned subport 0 (dashed purple line), but LSR B does not *send* the packet downstream to LSR C via subport 0, as LSR C independently selects which subport is used for sending packets from LSR B to LSR C.

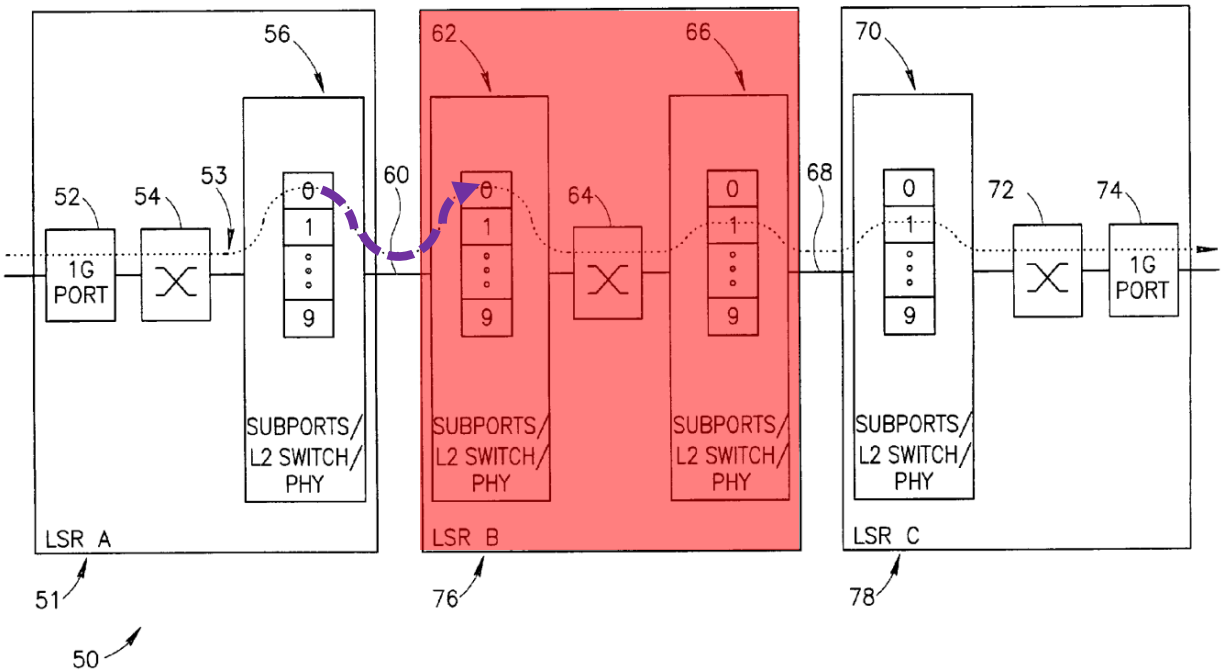


FIG.3

Ex.1006 at Fig. 3 (annotated), 9:29-10:4.

129. A POSA would have understood that this teaching in Raz is also demonstrated by Raz’s example in column 7, involving exemplary LSRs A and B. In that example, as a POSA would have understood, Raz explains that when LSR B selects subport 3 and generates a label indicating subport 3, then subport 3 is used for packets that LSR B *receives* from LSR A. Ex.1006 at 7:30-45. A POSA would have understood that LSR B does not use the assigned subport 3 to *send* packets to a downstream node.

130. Therefore, even if Raz’s subport mechanism was somehow implemented between LSRs in RFC 3209 such that a first LSR (i.e., alleged “first MPLS/LAG switch”) uses Raz’s teachings to assign a subport (i.e., alleged “single

physical tunnel port”) and prepare a “data packet label” identifying that assigned subport, as Petitioner asserts for limitations 1.1-1.2, it is my opinion that the first LSR would use that assigned subport for *receiving* a data packet, not *sending* it as recited in limitation 1.5.

131. I understand that the last paragraph of Petitioner’s limitation 1.5 analysis suggests that Raz teaches a first LSR sending a packet to a second LSR via the subport identified in the label created by the first LSR. Pet. 36. But it is my opinion that this mischaracterizes Raz and is wrong, as shown by the portions of Raz that Petitioner cites. Pet. 36 (citing Ex.1006 at 7:17-29, 9:29-58, Figs. 3-4, 14:23-26). First, Petitioner cites Raz at 7:17-29, but a POSA would have understood that this teaches that the “downstream (i.e. receiving) node” prepares a label identifying a subport for receiving packets, not sending. Next, Petitioner cites Raz at 9:29-58, but a POSA would have understood that this similarly teaches that LSRs B and C each prepare a label indicating a subport for receiving packets, not sending. Lastly, Petitioner quotes Raz at 14:23-26, which is a certain clause of Raz’s claim 1 that discloses “forwarding inbound packets ... received ... by said downstream node to a subport in accordance with the label.” But, in context, a POSA would have understood that this refers to the downstream/receiving LSR “forwarding” the received packets to a subport *within* the downstream/receiving LSR for processing, not forwarding the packets *via* the subport to some *subsequent*

LSR. Ex.1006 at 14:6-26. For example, Raz similarly uses the term “forward” in regard to Raz’s Figure 3 above, saying that “[a]t LSR B, the layer 2 switch **forwards** the packet to subport 0,” but a POSA would have understood that this means LSR B sends the packet to subport 0 *within* LSR B, not *via* subport 0 to LSR C. Ex.1006 at Fig. 3, 9:59-10:4.

132. Moreover, it is my opinion that Petitioner’s analysis for limitation 1.5 again fails to explain *why* or *how* the respective teachings of RFC 3209 and Raz would have been combined and worked together. Pet. 34-36. For example, despite Petitioner relying on Raz’s subport for the claimed “single physical tunnel port” and on Raz’s teachings regarding subport assignment and label preparation by the “first MPLS/LAG switch,” based on my review, Petitioner does not explain why or how Raz’s methods would be modified such that the “first MPLS/LAG switch” *sends* rather than *receives* a packet via the assigned subport, much less work together with the specific processes of RFC 3209. Indeed, I understand that there is no mention of “modify” in Petitioner’s limitation 1.5 analysis, and the only citations to Raz occur in the last paragraph of Petitioner’s analysis, which in turn does not discuss or cite RFC 3209. Pet. 34-36.

F. Independent Claim 15

133. It is my opinion that Raz does not render obvious independent claim 15 of the ’602 patent.

134. Independent claim 15 of the '602 patent is an apparatus claim that is similar to claim 1. Claim 15 recites: “[15.0] An apparatus for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) located downstream from a preceding node in a Multi-Protocol Label Switching (MPLS) network tunnel employing Resource Reservation Protocol Traffic Engineering (RSVP-TE) tunnel provisioning, the LAG having a first MPLS/LAG switch and a second MPLS/LAG switch, the apparatus comprising:

- [15.1] a processor, which is configured to:
 - [15.2] assign a single physical tunnel port of a LAG to a network tunnel, wherein said single physical tunnel port meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port has a port serial number;
 - [15.3] dedicate a sub-set of bits in a data packet label to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [15.4] publish said packet label upstream; and
- [15.5] a mapper, which is configured to:
 - [15.6] receive a data packet from an upstream node;
 - [15.7] detect said data packet label in said data packet; and
 - [15.8] if said data packet contains said data packet label, send said data packet to the second MPLS/LAG switch via said single physical tunnel port.”

135. As I explain in sections VIII.A-D above, the combination of RFC 3209 and Raz fails to render obvious the challenged claims because neither RFC 3209 nor Raz discloses or renders obvious the claimed “LAG,” a POSA would not

have combined RFC 3209 and Raz as Petitioner alleges, and Petitioner fails to establish either a motivation to combine or a reasonable expectation of success.

136. Additionally, it is my opinion that the combination of RFC 3209 and Raz fails to render obvious claim 15 for the same reasons discussed in section VIII.E above regarding claim 1, based on the similarity between claims 1 and 15 and the fact that Petitioner expressly relies on its analysis of limitations 1.0–1.5 for purposes of claim 15. Pet. 49-52.

137. Further, discussed below are additional particular reasons why the combination of RFC 3209 and Raz fails to render obvious claim 15.

1. Limitation 15.1: “processor”

138. Limitation 15.1 recites a “processor, which is configured to” perform limitations 15.2–15.4. It is my opinion that Petitioner’s analysis of limitation 15.1 is deficient because it consists of a single quote from Raz. Pet. 50-51. Petitioner’s analysis of limitation 15.1 contains no discussion of performing limitations 15.2–15.4 and also no discussion or citation of primary reference RFC 3209, much less any motivation to combine Raz’s teaching with RFC 3209. Pet. 50-51. Based on my review, Petitioner’s expert declaration is similarly deficient. *See* Ex.1003 ¶¶184-186. Further, in my opinion, Petitioner’s analyses of limitations 15.2–15.4 do not remedy Petitioner’s deficiency regarding limitation 15.1 because Petitioner’s analyses of limitation 15.2–15.4 contain no discussion. Pet. 51. That

is, Petitioner’s analyses of limitation 15.2–15.4 merely cross-reference Petitioner’s analyses for limitations 1.1–1.3 (Pet. 51), but limitations 1.1–1.3 do not recite or relate to a “processor” as in limitation 15.1. In my opinion, Petitioner has thus failed to meet its burden for limitation 15.1.

2. Limitation 15.5: “mapper”

139. Limitation 15.5 recites a “mapper, which is configured to” perform limitations 15.6–15.8. It is my opinion that Petitioner fails to establish that the combination of RFC 3209 and Raz discloses or renders obvious the claimed “mapper.”

140. Based on my review, I understand that Petitioner merely alleges that some vague mystery component within RFC 3209’s LSR constitutes the “mapper.” Pet. 51-52 (asserting that some unidentified “component” in the LSR “corresponds to the claimed ‘mapper’”). In my opinion, Petitioner thus does not specifically and sufficiently identify a “mapper” disclosed or rendered obvious by the prior art.

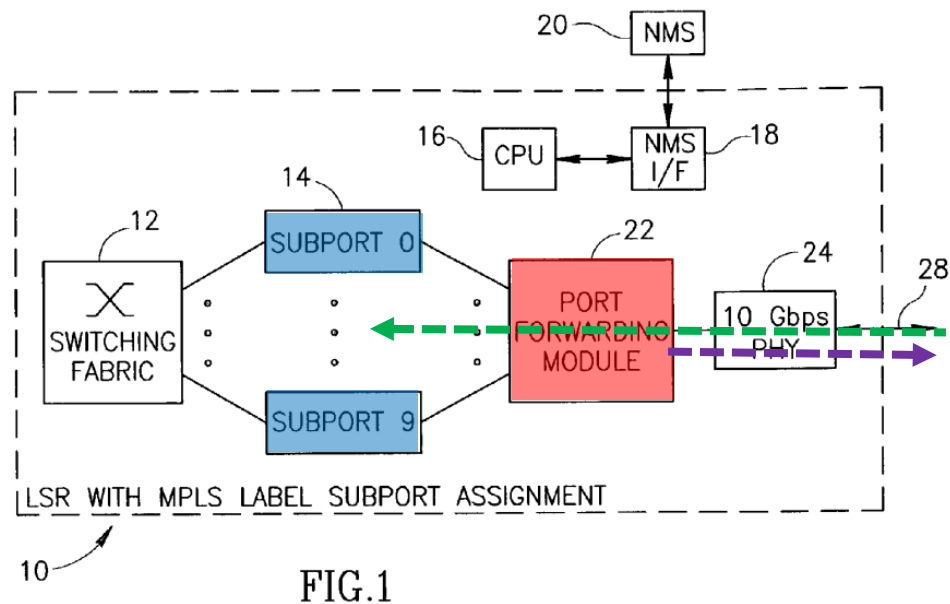
141. Moreover, I understand Petitioner’s reasoning is that RFC 3209’s LSR purportedly “performs the functions of the claimed ‘mapper’” (i.e., limitations 15.6–15.8) and therefore must comprise some single mystery component that performs these functions. Pet. 51. But even assuming RFC 3209’s LSR performs limitations 15.6–15.8, it is my opinion that Petitioner’s reasoning fails because a POSA would have understood that the LSR could just as well have multiple

separate components each configured to perform one of those limitations, not a single “mapper” configured to perform all of limitations 15.6–15.8 as recited in claim 15.

142. I understand that Petitioner’s expert declaration includes an additional alternative argument—i.e., that Raz’s “forwarding module” corresponds to the claimed “mapper.” Ex.1003 ¶197. I understand that this alternative argument in Petitioner’s expert declaration, however, is not included in the Petition. Pet. 51-52. Even if considered, it is my opinion that this alternative argument nonetheless fails because, in my opinion, Petitioner’s expert declaration contains no explanation of how Raz’s forwarding module is allegedly configured to perform limitations 15.6–15.8 or would allegedly be combined with primary reference RFC 3209. Ex.1003 ¶¶196-208. For example, a POSA would have understood that Raz’s forwarding module operates with subports *within* an LSR, and based on my review, Petitioner’s expert fails to explain how Raz’s forwarding module and related teachings would be modified to operate with subports purportedly implemented *between* LSRs as Petitioner argues. Ex.1006 at Fig. 1, 6:65-7:5, 7:30-52, Fig. 6, 12:61-13:5; Ex.1003 ¶¶196-208.

143. Indeed, it is my opinion that Raz’s forwarding module does not meet limitations 15.5–15.8 and cannot constitute the claimed “mapper,” as shown by the annotated versions of Raz’s Figures 1 and 6 below. As demonstrated by the

annotated versions of Raz’s Figures 1 and 6 below, a POSA would have understood the following: (i) if the forwarding module (red) “receive[s]” packets per limitation 15.6 (green dashed line), then it directs the packets to subports (blue) within the same LSR and does not send the packets to a different LSR per limitation 15.8; and (ii) if the forwarding module (red) handles packets being sent to a different LSR per limitation 15.8 (purple dashed line), then it does not send the packets via a subport (blue) as Petitioner alleges for limitation 15.8. Ex.1006 at Fig. 1, Fig. 6, 3:28-32, 7:39-45, 7:49-52, 12:66-12:1, 13:22-24, 16:43-53; Pet. 52, 34-36.



Ex.1006 at Fig. 1 (annotated).

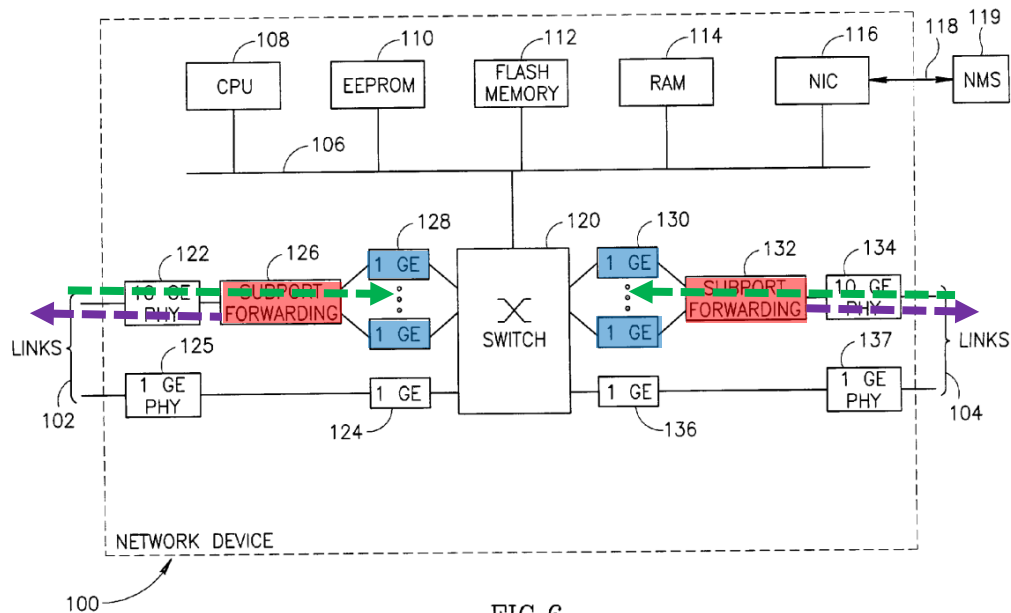


FIG. 6

Ex.1006 at Fig. 6 (annotated).

G. Independent Claim 26

144. It is my opinion that Raz does not render obvious independent claim 26 of the '602 patent.

145. Independent claim 26 of the '602 patent is a method claim that is similar to claim 1, as claim 26's limitations 26.2–26.6 are substantially similar to limitations 1.1–1.5, except that claim 26 includes an additional limitation not included in claim 1, i.e., limitation 26.1. Claim 26 recites: “[26.0] A method for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, the method comprising the steps of:

- [26.1] receiving from a preceding node located upstream from a first MPLS/LAG switch, at said first MPLS/LAG switch, a request message requesting configuration of a network tunnel, the message further requesting a data packet label associated with said network tunnel, said request message specifying a bandwidth requirement;
- [26.2] assigning, at the first MPLS/LAG switch, a single physical tunnel port of a LAG to the network tunnel wherein the single physical tunnel port of the LAG, which meets the specified bandwidth requirement, wherein said single physical tunnel port of said LAG has a port serial number;
- [26.3] dedicating a sub-set of bits in a data packet label prepared by said first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [26.4] sending, by said first MPLS/LAG switch, said data packet label, in which said port serial number of said single physical tunnel port is encoded, to the preceding node;
- [26.5] receiving from the preceding node, at said first MPLS/LAG switch, a data packet that includes said data packet label, in which said port serial number of said single physical tunnel port is encoded; and
- [26.6] sending said data packet from said first MPLS/LAG switch to a second MSPLS/LAG switch via said single physical tunnel port having the port serial number encoded in the data packet label.”

146. As I explain in sections VIII.A-D above, the combination of RFC 3209 and Raz fails to render obvious the challenged claims because neither RFC 3209 nor Raz discloses or renders obvious the claimed “LAG,” a POSA would not have combined RFC 3209 and Raz as Petitioner alleges, and Petitioner fails to establish either a motivation to combine or a reasonable expectation of success.

147. Additionally, it is my opinion that the combination of RFC 3209 and Raz fails to render obvious claim 26 for the same reasons discussed in section

VIII.E above regarding claim 1, based on the similarity between claims 1 and 26 and the fact that Petitioner expressly relies on its analysis of limitations 1.0–1.5 for purposes of claim 26. Pet. 52-53.

IX. Ground 2: The Combination of RFC 3209, Raz, and Ferguson Does Not Render Obvious Claims 1-26

148. I understand that in Ground 2, Petitioner asserts that claims 1-26 are obvious over RFC 3209, Raz, and Ferguson (Ex.1007, “Ferguson”). But the combination of RFC 3209, Raz, and Ferguson does not render obvious claims 1-26, including because (i) Petitioner’s Ground 2 relates to Raz and Ferguson, not primary reference RFC 3209, (ii) a POSA would not have modified RFC 3209 and Raz based on Ferguson to arrive at the claimed inventions of the ’602 patent, (iii) Petitioner has failed to establish a motivation to modify RFC 3209 and Raz with Ferguson to arrive at the claimed inventions of the ’602 patent, (iv) Petitioner has failed to establish a reasonable expectation of success for any such modifications, and (v) even if Raz is modified based on Ferguson as Petitioner asserts, the claims are not rendered obvious.

149. I understand that Petitioner’s Ground 2 purports to “incorporate[] by reference” its Ground 1 obviousness analysis. Pet. 53. Thus, I similarly incorporate by reference here into Ground 2 my analysis of Ground 1 in section VIII above.

A. Petitioner's Ground 2 Relates to Raz and Ferguson, Not RFC 3209

150. Based on my review, I understand that Ground 2 includes no discussion regarding the specific teachings of primary reference RFC 3209 or any modifications thereof to meet the claims. In my opinion, Ground 2 fails to establish obviousness of the challenged claims for this reason. Indeed, I understand that the Petition's entire section for Ground 2 includes only a single citation to RFC 3209, and this occurs in section X.A regarding motivation to combine, not section X.B regarding how the asserted combination purportedly meets the independent claims. Pet. 53-60 (citing Ex.1010 at 54).⁹

151. Based on my review, I understand that Ground 2 is instead exclusively about modifying secondary reference Raz based on tertiary reference Ferguson, specifically to modify Raz's mechanism for within an LSR to somehow apply between LSRs. Pet. 56-60. I understand that this is because Petitioner's Ground 2 analysis is largely copied from the petition in IPR2023-00447, in which Raz is the primary reference and the asserted combination is just Raz and Ferguson, without RFC 3209. *See Cisco Systems, Inc. v. Corrigent Corporation*, IPR2023-00447, Paper 1 at 1, 52-59 (PTAB Jan. 11, 2023) ("447 petition"). For example, I

⁹ Moreover, I understand that Petitioner's expert declaration cites RFC 3209 only three times for Ground 2 and only for the simple assertions that RFC involves MPLS and bandwidth availability. Ex.1003 ¶¶243-45.

understand that in the Petition here in this proceeding, sections X.A and X.B of the Petition for Ground 2 consist entirely of paragraphs from the '447 petition, including the same annotated figures, with only minor edits (e.g., to add mentions of RFC 3209 and adjust citations). *Compare* Pet. 53-56 with '447 petition at 56-59; *compare* Pet. 56-60 with '447 petition at 52-56.

B. A POSA Would Not Have Modified RFC 3209 and Raz Based on Ferguson to Arrive at the Claimed Inventions of the '602 Patent

152. As I explain in section IX.A, Petitioner argues in Ground 2 that Ferguson would be used to modify Raz, not RFC 3209. Pet. 56-60. Specifically, I understand that Petitioner argues that based on Ferguson, Raz's teachings regarding subports *within* an LSR could have been implemented *between* two MPLS/LAG switches, as recited in the challenged claims. Pet. 56-60 ("Ferguson teaches ... that the method ... disclosed in Raz could also be implemented *between* MPLS/LAG switches" (emphasis in original); "Ferguson would have taught ... that Raz's method of assigning a subport ... within the LSR could also be implemented ... between network devices"; "Thus, ... techniques disclosed in Raz ... could also be applied ... from ... one MPLS/LAG switch to ... another MPLS/LAG switch"). It is my opinion, however, that a POSA would not have been motivated to make this modification to Raz based on Ferguson. That is, in my opinion, a POSA would not have been motivated to modify Raz based on Ferguson to implement or apply Raz's method between two network devices, such

as between two MPLS/LAG switches, as recited in the challenged claims of the '602 patent.

153. First, as I explain in section VIII.B.2 above, it is my opinion that a POSA would not and could not have modified Raz to apply to communications between two network devices such as MPLS/LAG switches. For example, as I explain in that section, it is my opinion that Raz teaches away from applying its subport-related teachings externally between two network devices, and that applying Raz's method to communications between two network devices would have rendered Raz's method inoperable or unsatisfactory for its intended purpose. Those same opinions and analysis apply with respect to Ground 2. It is my opinion that despite Ferguson, a POSA still would not have modified Raz to arrive at the claimed inventions of the '602 patent. Also, based on my review, Petitioner does not rely on Ferguson to remedy those issues explained in section VIII.B.2, as Petitioner does not rely on modifying Raz to incorporate any elements of Ferguson but rather simply modifying Raz in the same manner as for Ground 1, just based on alleged motivations from Ferguson. *See* Pet. 53-60. Indeed, I understand that for Ground 2, the Petition "incorporate[s] by references" its "analysis of ... obviousness ... set forth in Ground 1." Pet. 53.

154. Second, it is my opinion that a POSA would not have been motivated to modify Raz’s teachings regarding subparts *within* an LSR to apply to communications *between* LSRs in view of Ferguson.

155. A POSA would have understood Ferguson describes techniques for distributing label switched packets of a single LSP across multiple physical interconnects of an aggregated link. Ex.1007 at Abstract, Figs. 1-2C, 1:57-63, 2:4-6, 2:40-47, 3:36-4:8, 6:15-31, claim 1. Ferguson teaches that packets may be distributed across multiple interconnects of an aggregated link based on, for example, the type of payloads in the packets. Ex.1007 at Abstract, 2:35-38, 3:16-18, 4:9-19, 4:45-5:24. Ferguson states its techniques may be used to “load balance” packets of a single LSP across multiple physical interconnects of an aggregated link. Ex.1007 at Abstract, 1:57-63, 2:54-57, 4:45-49. A POSA would have also understood that Ferguson further discloses that its distribution techniques may be applied to distribute packets of a common LSP across multiple paths within a network device, such as a router. Ex.1007 at 1:63-66, 5:61-6:9 (stating that “[a]though [Ferguson’s] techniques have been described in reference to” an external aggregated link, “[Ferguson’s] techniques may be readily applied to internal parallel data paths within a device”).

156. As I explain in section VIII.B.2 above, however, it is my opinion that a POSA would have understood that Raz is specifically and solely directed to a

provisioning mechanism for *inside* a network device such as an LSR and teaches away from applying its subport-related teachings to an external link between two LSRs. Ex.1006 at Abstract, 1:40-62, 6:24-27, 6:51-54. For example, a POSA would have understood that Raz is premised on solving a problem related to internal processing capacity of a network device, such as an LSR, by specifically and intentionally using its subports *within* the device. Ex.1006 at 1:40-2:3.

157. Additionally, it is my opinion that while Ferguson teaches that its own techniques for communications between routers may be applied within a router (Ex.1007 at 5:61-6:9), a POSA would not have understood, based on Ferguson, that the opposite is true for any teachings outside of Ferguson, such as the teachings of Raz. That is, despite Ferguson teaching that Ferguson's own techniques may apply within a router, a POSA would not have been motivated to take Raz's provisioning mechanism for within an LSR and attempt to apply it to communications between LSRs. This is because a POSA would have understood that Ferguson's teaching about applying techniques within a router is limited to Ferguson's own techniques and does not apply to Raz's techniques. Ex.1007 at 5:61-6:9. This is also because Ferguson's teaching is about taking techniques for communicating between routers and applying them to within a router, not taking techniques for within a router (such as Raz's mechanism) and applying them to communications between routers. Ex.1007 at 5:61-6:9.

158. Additionally, it is my opinion that a POSA would not have been motivated to modify Raz based on Ferguson because Ferguson and Raz address different problems. As I explain in sections VIII.B.1-2, a POSA would have understood that Raz is concerned with processing capacity within an LSR and addresses the problem of how an LSR can handle a high-speed link using multiple slow-speed processors. Ex.1006 at Abstract, 1:40-2:3, 6:24-27, 14:6-8, 15:14-17, 16:27-29. A POSA would have understood that Ferguson, however, is directed to distributing packets across multiple paths or interconnects, for example, to achieve load balancing and decreased packet latency. Ex.1007 at Abstract, 1:57-63, 2:54-57, 4:45-60. A POSA would have understood that, unlike Raz, Ferguson assumes that routers have sufficient processing capacity to handle the data communications that Ferguson describes distributing. Indeed, a POSA would have understood that Ferguson references network devices, such as routers, having “high-speed” components, not low-speed processors like Raz’s subports. *E.g.*, Ex.1007 at 2:47-53 (“internal high-speed switching components”), 6:2-6 (“internal, high-speed switch fabrics”). Thus, it is my opinion that a POSA would not have looked to Ferguson when considering Raz and would not have been motivated to modify Raz based on Ferguson.

159. Even assuming that Raz and Ferguson address some common problem, it is my opinion that Raz and Ferguson use fundamentally different

methods. A POSA would have understood that Ferguson teaches distributing packets of a single common LSP across multiple paths or interconnects of an aggregated link. Ex.1007 at Abstract, Figs. 2A-2C, 1:57-66, 2:4-6, 2:27-34, 2:40-43, claim 1. But a POSA would have understood that Raz's provisioning mechanism, in contrast, teaches assigning all packets of a given LSP to the same particular subport in a group of subports, and different LSPs can be provisioned for different subports in the group. Ex.1006 at 7:17-19, 7:26-45, 8:56-58, 9:41-10:4, 11:36-38. This distinction between the methods of Ferguson and Raz is shown by the annotated versions of Ferguson's Figure 2A and Raz's Figure 1 below. These annotated figures demonstrate how Ferguson distributes packets of a common LSP (dashed green lines) among multiple paths of an aggregate interface, whereas Raz sends all packets of a given LSP (dashed green line) to a single subport (subport 0) of a group of subports and sends all packets of a different LSP (dashed red line) to another single subport (subport 9). Based on my review, Petitioner fails to address this fundamental difference between Ferguson and Raz. It is my opinion that, based on this difference between Ferguson and Raz, and others, a POSA would not have modified Raz's provisioning mechanism based on Ferguson.

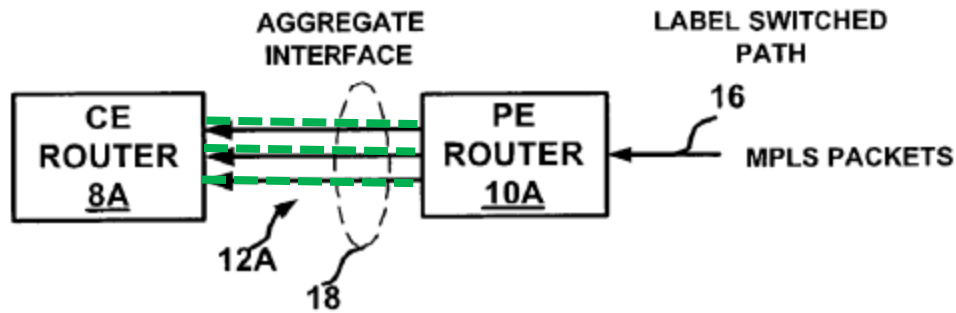


FIG. 2A

Ex.1007 at Fig. 2A (annotated).

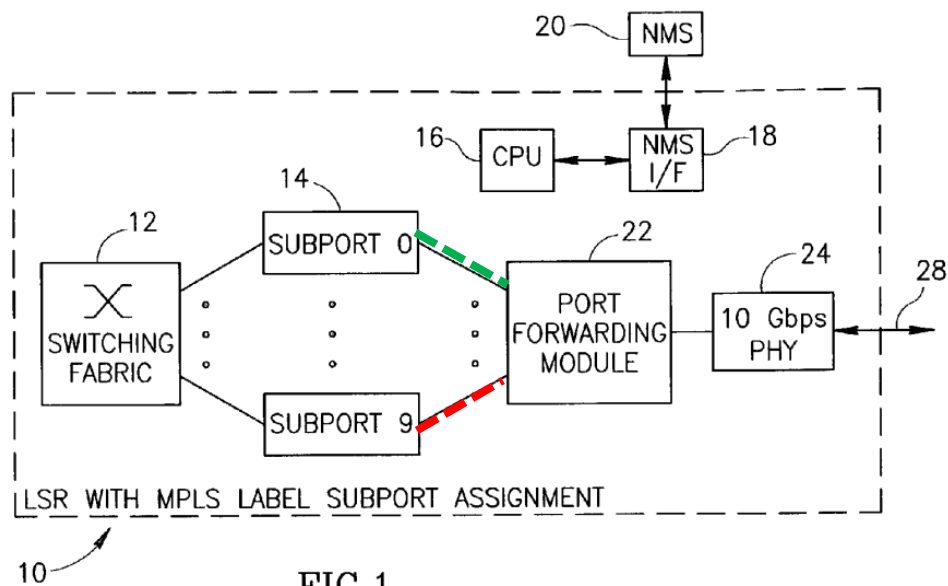


FIG.1

Ex.1006 at Fig. 1 (annotated).

160. Additionally, it is my opinion that Ferguson and Raz teach different methods regarding packet labels. Based on my review, Petitioner does not address the different methods of Ferguson and Raz regarding packet labels. A POSA would have understood that, as I explain for Ground 1, Raz emphasizes that its subport assignment and label generation comes from downstream, as Raz teaches

that a receiving LSR selects a subport, generates a label indicating that subport, and sends that label to an upstream device. Ex.1006 at 7:26-38, 8:52-55, 9:41-58. For example, for Raz's embodiment depicted in Figure 3, Raz teaches that LSR C selects subport 1 and sends upstream to LSR B a label indicating subport 1 for LSR B to use in transmitting a data packet to LSR C, and similarly, LSR B selects subport 0 and sends upstream to LSR A a label indicating subport 0 for LSR A to use in transmitting a data packet to LSR C. Ex.1006 at Fig. 3, 9:41-10:4. A POSA would have understood that Ferguson, however, does not include any such teachings. A POSA would have understood that Ferguson instead teaches that a given router transmits a packet based on the existing label(s) of that packet or selects and pre-pends its own label to the packet. *See* Ex.1007 at 2:4-26, 3:53-4:8, 8:29-57 (describing how CE router 8A "selects an appropriate MPLS label ... and pre-pends the label to the packet to form an MPLS packet," and "[o]ther [downstream] devices, such as PE routers 10, may make use of the labels to distribute the MPLS packets"). It is my opinion that this demonstrates a fundamental difference between Raz and Ferguson and that, based on this difference, a POSA would not have modified Raz's provisioning mechanism based on Ferguson.

161. Additionally, as I explain in section VIII.B.2, it is my opinion that a POSA would not have applied Raz's subport-related teachings to communications

between two MPLS/LAG switches because a POSA would have understood that such modification would have rendered Raz inoperable for its intended purpose, regardless of whether such modification was based on Ferguson.

C. Petitioner Fails to Establish a Motivation to Modify RFC 3209 and Raz with Ferguson to Arrive at the Claimed Inventions of the '602 Patent

162. Based on my review of the Petition and evidence cited therein, it is my opinion that the Petition fails to establish that a POSA would have been motivated to modify RFC 3209 and/or Raz at all based on Ferguson, let alone to meet the independent claims of the '602 patent. As I explain in section IX.A, Petitioner argues in Ground 2 that Raz, not RFC 3209, would have been modified based on Ferguson. Pet. 56-60. Based on my review, however, Petitioner fails to explain specifically *why* or *how* Raz would purportedly have been modified based on Ferguson, let alone how such a modified version of Raz would have been combined with RFC 3209 to meet the claim limitations.

163. Based on my review, Petitioner's analysis for Ground 2 is not tied to the claim limitations, as it does not perform a limitation-by-limitation analysis. Pet. 53-60. I understand that Petitioner's analysis for Ground 2 states that "[t]he analysis ... in Ground 1 [is] incorporated by reference," but Ground 1 does not include Ferguson like Ground 2. Pet. 53.

164. Also, it is my opinion that Petitioner’s analysis fails to explain why or how a POSA would have purportedly modified Raz based on Ferguson. Based on my review, I understand that the Petition does not mention “modify” at all and does not explain precisely *how* a POSA would have modified Raz’s forwarding and provisioning mechanism for subports *within* an LSR to apply to communications *between* two MPLS/LAG switches based on Ferguson. Pet. 53-60. Instead, based on my review, I understand that Petitioner’s Ground 2 merely argues that a POSA would have taken Raz’s techniques for using subports within a router and applied those techniques to communications between routers, without discussing how to do this. Pet. 53-60. It is my opinion that Petitioner’s analysis for Ground 2 thereby relies on an oversimplification of both Raz and the claim limitations, and this oversimplification highlights the deficiency in Petitioner’s analysis for Ground 2.

165. Below are my opinions regarding the various obviousness assertions in the Petition for the independent claims under Ground 2. *See* Pet. 53-60. These opinions are relevant and applicable regarding each of independent claims 1, 15, and 26 because I understand that Petitioner relies on the same obviousness analysis for all three of these independent claims under Ground 2. *Id.*

166. I understand that Petitioner asserts that Raz and Ferguson “solv[e] the same problem” and disclose “the same subject matter,” but based on my review,

Petitioner provides no explanation of this. Pet. 54. In fact, as I explain in section IX.B above, a POSA would have understood that Raz and Ferguson address different problems and use different contrasting solutions. For example, while Petitioner asserts that Ferguson’s disclosure of “a LAG to communicate ... between routers” is “the same subject matter as Raz,” a POSA would have understood this to be inaccurate because, as Petitioner itself acknowledges, Raz’s subport mechanism is for “within” a router, not between routers. Pet. 54, 56.

167. I understand that Petitioner next asserts that both Raz and Ferguson “are directed to ... ensuring enough bandwidth is available to communicate high-speed packet streams through an MPLS network.” Pet. 54-55. It is my opinion, however, that this assertion mischaracterizes Raz, as a POSA would have understood that Raz is not concerned with bandwidth for communicating high-speed streams through a network as Petitioner asserts but instead is concerned with the problem of processing capacity/bandwidth *within* a network device for handling high-speed streams communicated through the network. Ex.1006 at Abstract, 1:40-2:3, 6:24-27, 14:6-8, 15:14-17, 16:27-29; section VIII.B.1-2 *supra*. To the extent Raz discloses bandwidth allocation, in my opinion, it is with respect to allocating bandwidth of subports, which are *within* an LSR. Ex.1006 at Abstract (“allocating subport bandwidth”), Fig. 5 (“subport bandwidth allocation method”), 2:23-25, 8:1-4, 11:60-12:9. I understand that Petitioner even admits that

Raz concerns “allocating the bandwidth of subports *within an LSR.*” Pet. 54 (emphasis added).

168. I understand that Petitioner next asserts that “[a] POSITA would have understood from ... Ferguson that techniques ... to communicate data packets between routers ... are also applicable to the use of subports ... within the routers ..., and vice versa,” such that “a POSITA would have understood that the techniques disclosed in Raz ... would also have been applicable ... between routers.” Pet. 55-56. **First**, however, in my opinion, a POSA would have understood that Ferguson does not teach the “vice versa”—i.e., that a technique described for within a router is also applicable between routers. Based on my review, Petitioner cites no support for this “vice versa.” I understand that Petitioner cites Ex.1007 at 5:61-6:6 (and Ex.1003 ¶246, which also cites Ex.1007 at 5:61-6:6 for this “vice versa”), but a POSA would have understood that cited portion of Ferguson to show that Ferguson actually teaches the opposite of the alleged “vice versa” because that cited portion says that Ferguson’s techniques are “described in reference to” an external link between routers and “may be ... applied” to within a router. Ex.1007 at 5:61-6:6; Pet. 55-56. At most, a POSA would have understood that this disclosure in Ferguson teaches that Ferguson’s techniques can apply to both between and within routers. But in my opinion,

Ferguson does not describe techniques for within a router and then state that those techniques can be extended to apply between routers.

169. **Second**, regardless of whether Ferguson teaches the alleged “vice versa,” it is my opinion that a POSA would have understood that the relied-upon teaching in Ferguson (5:61-6:6) is about only Ferguson’s own techniques, not Raz or its subports and subport-related mechanism. *See* Ex.1007 at 5:61-6:6 (discussing “the techniques [that] have been described,” i.e., Ferguson’s techniques); Pet. 59 (acknowledging that this portion of Ferguson is about “[its] techniques,” i.e., Ferguson’s techniques). In my opinion, a POSA would not have understood this teaching in Ferguson to apply to Raz and would not have been motivated by this teaching in Ferguson to extend Raz’s mechanism for within a router to apply to between routers. Indeed, based on my review, I understand that in the paragraph on pages 55-56 of the Petition that contains the above-noted assertion, Petitioner fails to discuss any particulars of either Ferguson or Raz’s techniques, much less compare their particular techniques to explain why or how the disclosures regarding Ferguson’s techniques would also apply to Raz’s techniques. Pet. 55-56. For example, I understand that this paragraph of the Petition refers generically to “the techniques disclosed in Raz for using subports to transmit data packets within a router or switch,” with no analysis of the particulars of those techniques in Raz. Pet. 55-56. Further, based on my review, I understand

that neither this paragraph of the Petition nor the expert declaration paragraph cited for this assertion (Ex.1003 ¶246) contains a single cite to Raz. Pet. 55-56.

170. I understand that Petitioner next asserts that Ferguson “addresses the same concerns” as Raz. Pet. 56. But as I explain in section IX.B above, a POSA would have understood that Raz and Ferguson address different problems and use different contrasting solutions, including different methods regarding how to handle packets of a given LSP.

171. I understand that Petitioner next asserts that “Ferguson teaches a POSITA that [Raz’s] method of assigning a subport ... could also be implemented *between* MPLS/LAG switches.” Pet. 56 (citing Ex.1003 ¶¶250-51). But this assertion merely asserts a possibility of how Raz “could” be implemented, and I have been informed that such a mere possibility is insufficient to establish a motivation to modify Raz. Regardless, based on my review, I understand that neither Ferguson nor this assertion address the specific teachings of Raz, much less explain how a POSA would have purportedly applied Raz’s subport-related teachings to communications between switches. Indeed, based on my review, I understand that the cited paragraphs of Petitioner’s expert declaration (Ex.1003 ¶¶250-51) do not contain any citations or discussion regarding the specific teachings of Raz.

172. I understand that Petitioner next asserts that “a POSITA reviewing Ferguson” would have found it “desirable to implement the techniques in Raz for assigning a ... subport to assign a ... port to communicate packets along ‘physical interconnects’ between ‘two switches.’” Pet. 56-57 (citing Ferguson and Ex.1003 ¶250). Based on my review, however, this assertion (as with the previous assertion above) again fails to address the specific teachings of Raz and again relies on one of the same deficient paragraphs of Petitioner’s expert declaration (Ex.1003 ¶250), which, as noted above, fails to address the specific teachings of Raz. Indeed, based on my review, I understand that Petitioner fails to explain why the generic alleged modification “would be desirable” in connection with Raz. It is my opinion that a POSA would have understood Raz to teach away from the modification, as Raz is directed to a provisioning mechanism specifically for *inside* a network device, such that a POSA would have been discouraged from, or led in a direction divergent from, using Raz’s subport mechanism *between* LSRs. Pet. 56-57; Ex.1006 at Abstract, 1:40-62, 6:24-27, 6:51-54.

173. I understand that Petitioner next asserts that “[t]he teachings of Ferguson are compatible with and readily implementable ... with Raz.” Pet. 57. But it is my opinion that this assertion is conclusory and incorrect. Based on my review, I understand that this assertion is conclusory because it fails to identify or discuss in detail the referenced “teachings of Ferguson” or relevant teachings of

Raz, much less explain the alleged compatibility and implementation. *Id.* Also, it is my opinion that this assertion is false because, as explained in section IX.B, there are fundamental differences between the methods of Ferguson and Raz, including how the two references handle packets of a given LSP and use labels.

174. I understand that Petitioner next briefly addresses Ferguson’s “aggregate interface” of physical interconnects. Pet. 57-58. Based on my review, however, I understand that this discussion of Ferguson’s “aggregate interface” does not mention or address Raz, much less explain why or how a POSA would have purportedly been motivated to modify Raz based on Ferguson. Pet. 57-58.

175. I understand that Petitioner next asserts that “Ferguson would have taught a POSITA that Raz’s method of assigning a subport ... within the LSR could also be implemented ... between network devices.” Pet. 58-59 (citing Ex.1003 ¶¶251, 255-56). But this assertion merely asserts a possibility of how Raz “could” be implemented, and I have been informed that such a mere possibility is insufficient to establish a motivation to modify Raz. Also, based on my review, I understand that this assertion does not cite or address the specific teachings of Raz, nor do the relied-upon paragraphs of Petitioner’s expert declaration cited for this assertion (i.e., Ex.1003 ¶¶251, 255-56), which instead merely refer in an oversimplified way to Raz’s “techniques” for assigning subports or forwarding packets. Thus, based on my review, this assertion does not explain how a POSA

would have purportedly implemented Raz’s support-related method to communications between network devices as Petitioner asserts.

176. I understand that Petitioner’s next paragraph asserts that “Ferguson states that the techniques used ... *within* a router ... can also be applied ... *between* two routers.” Pet. 59 (emphases in original). **First**, however, it is my opinion that a POSA would have understood that Ferguson actually teaches the opposite, as Ferguson describes techniques for *between* routers and then says that those inter-router techniques also “may be ... applied” to *within* a router. Ex.1007 at 5:61-6:6. Based on my review, I understand that the remainder of Petitioner’s paragraph acknowledges this when it quotes the language from Ferguson. Pet. 59 (quoting Ex.1007 at 5:61-6:6). **Second**, it is my opinion that a POSA would have understood that, as Petitioner notes, Ferguson teaches this about “its” techniques, not Raz’s techniques. Pet. 59. A POSA would have understood that Ferguson does not cite, discuss, or relate to Raz’s techniques. Also, as I explain in section IX.B above, a POSA would have understood that there are fundamental differences between the techniques of Ferguson and Raz. **Third**, based on my review, I understand that this paragraph of the Petition contains no citation or discussion of Raz and also does not cite any support from Petitioner’s expert declaration. *See* Pet. 59. Ultimately, it is my opinion that although Ferguson’s teachings regarding communications between routers can also apply within a single router, a POSA

would have understood that this does not mean that the opposite is true for Raz—i.e., Ferguson’s disclosure does not mean that Raz’s teachings regarding communications within a single router can apply to communications between routers.

177. I understand that Petitioner’s next paragraph asserts that based on the “disclosures in Ferguson,” “a POSITA would have understood that the techniques disclosed in Raz for assigning ... subports” within an LSR “could also be applied” between LSRs. Pet. 59-60. But based on my review, I understand that this paragraph of the Petition contains no citation or discussion of Raz’s actual specific teachings, much less explains how Raz would purportedly be modified to apply between LSRs. *See* Pet. 59-60. Also, this assertion merely asserts a possibility of how Raz “could” be applied, and I have been informed that such a mere possibility is insufficient to establish a motivation to modify Raz. Moreover, it is my opinion that a POSA would not have understood Raz’s techniques to be applicable between LSRs based on Ferguson because, as I explain in section IX.B above, a POSA would have understood that there are fundamental differences between the methods of Ferguson and Raz.

178. I understand that Petitioner also asserts in that same paragraph that “packets are communicated *the same way* within a device as between devices.” Pet. 60 (emphasis added); *see also* Pet. 56 (“same techniques” for both inside and

between LSRs). I understand that Petitioner's expert declaration also makes the same argument. Ex.1003 ¶¶250-251, 263 ("same way"; "same techniques"). But it is my opinion that these assertions are conclusory and incorrect. Based on my review, I understand that neither Petitioner nor its expert explains *how* Raz's particular techniques for subports *within* an LSR would purportedly be applied "*the same way*" to communications *between* LSRs. Also, as I explain in sections VIII.E.1-2, VIII.A, and VIII.B.2, a POSA would have understood that Raz's subports are not for "communicat[ing]" but rather for internal processing, and also that Raz could not be applied the "same way" for both within and between LSRs. Ex.1006 at 1:40-59. Also, a POSA would have understood that Petitioner's assertion regarding "the same way" is not true. A POSA would have known that how packets are processed and move within a switch is different from how packet streams are communicated between switches, for at least three technical reasons:

- 1) As soon as an Ethernet frame containing an MPLS packet arrives at a switch, the Ethernet header and trailer is stripped off (an operation called "decapsulation") and only the MPLS packet is stored in a buffer (memory location) within the switch. Therefore, the MPLS packet stored in the switch is different than the Ethernet frame sent between switches.
- 2) Ethernet frames are serially transmitted bit-by-bit along each link; the Ethernet header and trailer are necessary so that the receiving switch will be able to determine where, in the stream of bits it receives, a frame starts and ends. Within a switch, on the other hand, there is no bit-by-bit transmission. Upon reception, each MPLS packet is stored individually in any memory location that is available at the time of its arrival; therefore, two MPLS packets

transmitted in back-to-back Ethernet frames on the same link may be stored in two different and unrelated memory locations upon reception. To “move” a packet within a switch, a processor reads the packet from one memory location and copies it to another. Therefore, the “subports” of Raz are *not* transmission links. The processor of a subport simply *reads* a packet from the memory location where Raz’s port forwarding module stored it.

3) When communicating an Ethernet frame on a link between switches, the upstream switch serially transmits the bits of the entire frame. Ethernet frames (and the MPLS packets they contain) are of variable length, and switching variable-length packets is slow. Therefore, switches operating at Gigabit speeds, such as the switches of Raz and of the ’602 patent, typically do not switch the MPLS packets in their entirety. Instead, at the input port they fragment the packets into small fixed-size cells and switch each cell separately; at the output port the cells are then reassembled into the original packet (in a buffer).

Overall, the way an MPLS packet “moves” within a switch from the input port (where it is received from an Ethernet frame) to the output port (where it is reassembled to be forwarded to the downstream switch as another Ethernet frame) is completely different from, and unrelated to, how Ethernet frames are communicated (via serial bit-by-bit transmission) between switches.

179. In sum, it is my opinion that the Petition fails to establish a motivation to modify RFC 3209 and Raz (specifically, Raz) with Ferguson. Based on my review, the Petition does not explain specifically why or how a POSA would have modified or combined the particular teachings of the references to meet all of the claim limitations.

D. Petitioner Fails to Establish a Reasonable Expectation of Success

180. Based on my review of the Petition and evidence cited therein, it is my opinion that the Petition does not contain persuasive argument or evidence that a POSA would have had a reasonable expectation of success for modifying RFC 3209 and Raz based on Ferguson to meet the challenged claims.

181. I have been informed that obviousness requires that a POSA would have had a reasonable expectation of success in modifying the prior art to meet the claims and that this reasonable expectation of success is separate from the requisite motivation to modify the prior art.

182. Based on my review, it is my opinion that Petitioner does not present any argument, much less a persuasive argument, regarding whether a POSA would have had a reasonable expectation of success in modifying RFC 3209 and Raz based on Ferguson (specifically, modifying Raz based on Ferguson and then combining that modified version of Raz with RFC 3209) to meet the claims. I understand that there is no mention of any “reasonable expectation of success” in either the Petition or Dr. Min’s declaration, except for Dr. Min’s discussion of the applicable law. Ex.1003 ¶16.

183. Indeed, in my opinion, a POSA would not have had a reasonable expectation of success of modifying Raz’s method based on Ferguson as alleged, as a POSA would not have had a reasonable expectation of success of somehow

applying Raz' method to communications between two network devices (such as the claimed MPLS/LAG switches) to begin with, even in view of Ferguson. As I explain in section VIII.B.2 above, for example, a POSA would have understood that Raz's method involves several teachings that are incompatible with communications between network devices, and modifying Raz to apply to such communications between network devices would render Raz inoperable or unsatisfactory for its intended purpose. A POSA would have understood that combining Raz with Ferguson as Petitioner asserts would not have cured these issues. Moreover, even if Raz were modified in view of Ferguson as Petitioner alleges, in my opinion, a POSA nonetheless would not have had a reasonable expectation of success of modifying RFC 3209 based on Raz to meet the claims. For example, a POSA would not have had a reasonable expectation of success of somehow combining RFC 3209's and Raz's respective relied-upon teachings regarding assignments and labeling because, as I explain in section VIII.B.3 above, those teachings are incompatible.

E. Even if Raz is Modified Based on Ferguson as Petitioner Asserts, Ground 2 Fails

184. I understand that Petitioner asserts for Ground 2 that Raz would have been modified in view of Ferguson to apply to communications between two MPLS/LAG switches via a LAG. Pet. 56-60. Even if a POSA were motivated and capable of somehow making this modification to Raz, however, it is my opinion

that Ground 2 nonetheless fails to render obvious the independent claims because such modification does not remedy the issues regarding combining Raz with RFC 3209 that I explain for Ground 1. *See* sections VIII.B.1, VIII.B.3, VIII.E.2-6 *supra*; *see also* sections VIII.F, VIII.G *supra* (explaining that claim 1 arguments also apply for claims 15 and 26). Indeed, as I explain in section IX.A above, Petitioner's Ground 2 does not address the specific teachings of RFC 3209 or modifications thereto. Thus, those issues and arguments for Ground 1 also apply for Ground 2.

185. Additionally, as I explain in section VIII.F, it is my opinion that Petitioner fails to establish obviousness of claim 15's limitations for Ground 1. Based on my review, I understand that Petitioner's analysis for Ground 2 does not specifically address those limitations (*see* Pet. 56-60) and therefore likewise fails to establish obviousness of claim 15.

186. Thus, even if Raz is modified based on Ferguson as Petitioner asserts for Ground 2, it is my opinion that the alleged combination of RFC 3209, Raz, and Ferguson nonetheless fails to meet the independent claims.

X. Conclusion

187. I hereby 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; and further that these statements were made with the

knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: February 29, 2024

A handwritten signature in dark ink, appearing to read "George Rouskas", written over a horizontal line.

George N. Rouskas, Ph.D.

APPENDIX A

VITA

George N. Rouskas

Alumni Distinguished Graduate Professor

Department of Computer Science

North Carolina State University

Raleigh, NC 27695-8206

<http://rouskas.csc.ncsu.edu/>

February 2024

Education

Ph.D.	1994	Georgia Institute of Technology	Computer Science
M.S.	1991	Georgia Institute of Technology	Computer Science
B.S.	1989	National Technical University of Athens	Computer Engineering

Employment History

Alumni Distinguished Graduate Professor (Professor 2002-2018 Associate Professor 1999-2002 Assistant Professor 1994-1999)	Department of Computer Science North Carolina State University Raleigh, NC	1994-present
Director of Graduate Programs	Department of Computer Science	January 2014-present

Visiting Positions

Distinguished Scientist	King Abdulaziz University, Saudi Arabia	2013-2021
Visiting Professor	Laboratoire d'Informatique University of Paris 6, France	October 2012
Visiting Professor	Universidad Tecnica Federico Santa Maria, Chile	December 2008
Visiting Professor	Laboratoire de Méthodes Informatiques University of Evry, France	July 2006 December 2002 June 2000
Network Architect (Sabbatical)	Vitesse Semiconductor	August 2000-May 2001

Honors and Awards

OUTSTANDING SERVICE AWARD, Optical Networking Tech. Cmte (ONTC), IEEE Commun. Society, 2019

ALUMNI DISTINGUISHED GRADUATE PROFESSOR, NC State, 2018

JOYCE HATCH SERVICE AWARD, NC State Chapter of ACM/AITP, 2015

MOST RECEPTIVE GRADUATE PROFESSOR AWARD, NC State Chapter of ACM/AITP, 2014

FELLOW, INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE), 2012

CAROL MILLER GRADUATE LECTURER AWARD, NC State Chapter of ACM/AITP, 2012

IEEE DISTINGUISHED LECTURER, 2010-2011

OUTSTANDING SERVICE AWARD, IEEE GLOBECOM, 2010

IBM FACULTY AWARD, 2007

BEST PAPER AWARD, *EVGM Workshop*, 2007 (with C. Castillo and K. Harfoush)

BEST PAPER AWARD, *CSNDSP Symposium*, 2006 (with B. Chen and R. Dutta)

ALCOA FOUNDATION ENGINEERING RESEARCH ACHIEVEMENT AWARD, CoE, NC State, 2004

ACADEMY OF OUTSTANDING TEACHERS, NC State, 2004

ALUMNI OUTSTANDING RESEARCH AWARD, NC State, 2003

BEST PAPER AWARD, *SPIE Conference on All-Optical Networking*, 1998 (with I. Baldine)

CAREER AWARD, NATIONAL SCIENCE FOUNDATION (NSF), 1997

OUTSTANDING NEW TEACHER AWARD, Department of Computer Science, NC State, 1995

GRADUATE RESEARCH AWARD, College of Computing, Georgia Institute of Technology, 1994

I. Teaching and Mentoring

Courses Taught

- CSC 316 – DATA STRUCTURES (undergraduate)
- CSC 401 – COMPUTER NETWORKS (undergraduate)
- CSC/ECE 573 – INTERNET PROTOCOLS (graduate)
- CSC/ECE 579 – INTRODUCTION TO COMPUTER PERFORMANCE EVALUATION (graduate)
- CSC/ECE 772 – SURVIVABLE NETWORKS (graduate)
- CSC/ECE 778 – OPTICAL NETWORKS (graduate)

Visiting Scholars

4. DR. KAMAL JAMBI, 2018-19 (King Abdulaziz University, Jeddah, Saudi Arabia)
Research: *Machine Learning Applications to Network Control Plane*
3. DR. YU XIONG, 2016-2017 (Chongqing University of Posts and Telecommunications (CUPT), China)
Research: *Optical and Datacenter Networks*
2. DR. OMAR BATARFI, 2014-2015 (King Abdulaziz University, Jeddah, Saudi Arabia)
Research: *Visible Light Communications*
1. DR. EVRIPIDIS BAMPIS, 2005-2006 (Paris VI University, France)
Research: *Packet Scheduling*

Post Doctoral Fellows

3. DR. EMRE YETGINER, 2008-2009
Research: *Traffic Grooming for Green Optical Networking*
2. DR. A. HALIM ZAIM, 2001-2002
Research: *Implementation of Signaling Protocols for Optical Burst-Switched Networks*
1. DR. SRIDHAR RAMESH, 1999-2000
Research: *Performance Analysis of Wavelength Routed Networks*

Ph.D. Students Supervised – Graduated

25. LINGNAN GAO, 2019
Dissertation: *Resource Allocation in Virtual Network Environments*
Outstanding Research Award, 2019
Outstanding Teaching Assistant Award, 2016
24. SHIREESH BHAT, 2017
Dissertation: *Network Service Orchestration within the ChoiceNet Architecture*
23. RAMESH KRISHNAMURTHY, 2016
Dissertation: *A Framework for Evaluating Server Performance: Application to SIP Proxy Servers*

22. SAHAR TALEBI, 2015
Dissertation: *On Routing and Spectrum Assignment in Elastic Optical Networks*
21. AHMET CAN BABAOGLU, 2014
Dissertation: *Verification Services for the Choice-Based Internet of the Future*
20. HUI WANG, 2013
Dissertation: *Efficient Decomposition Techniques for Traffic Grooming Problems in Optical Networks*
19. ZEYU LIU, 2012
Dissertation: *On Routing and Wavelength Assignment in WDM Networks*
18. MOHAN IYER, 2010
Dissertation: *Providing Bandwidth on Demand Services Using Optical Network Design and the SILO Network Architecture*
Outstanding Teaching Assistant Award, 2009
17. QIAN LV (2010)
Dissertation: *Economic Models for Internet Tiered Services*
16. ANJING WANG, 2010
Dissertation: *Optimization of Silo Services for the Future Internet*
Outstanding Teaching Assistant Award, 2009
15. ZYAD DWEKAT 2009
Dissertation: *Practical Fair Queueing Schedulers: Simplification Through Quantization*
14. CLARIS CASTILLO, 2008
Dissertation: *Scheduling and Resource Management in Grids*
College of Engineering Nancy G. Pollock PhD Dissertation Award, 2008
Google Anita Borg Scholarship, 2007
Outstanding Teaching Assistant Award, 2006
13. LI YANG, 2006
Dissertation: *Congestion Control and Quality of Service (QoS) Provisions for Optical Burst Switched Networks*
12. BENSONG CHEN, 2005
Dissertation: *Hierarchical Traffic Grooming in Large-Scale WDM Networks*
Outstanding Teaching Assistant Award, 2004
11. JING TENG, 2004
Dissertation: *A Study of Optical Burst Switched Networks with the Jumpstart Just-In-Time Signaling Protocol*
10. LAURA E. JACKSON, 2003
Dissertation: *The Directional p-Median Problem with Applications to Traffic Quantization and Multi-processor Scheduling*
GAANN Fellow, 2000-2003
College of Engineering Nancy G. Pollock PhD Dissertation Award, 2004
9. YUFENG XIN, 2002
Dissertation: *Topology Design of Large-Scale Optical Networks*
8. LISONG XU, 2002
Dissertation: *Performance Analysis of Optical Burst Switched Networks*
NSF CAREER Award, 2007

7. RUDRA DUTTA, 2001
Dissertation: *Virtual Topology Design for Traffic Grooming in Optical WDM Networks*
6. A. HALIM ZAIM, 2001
Dissertation: *Computing Call Blocking Probabilities in LEO Satellite Networks*
5. YUHONG ZHU, 1999
Dissertation: *Computation of Blocking Probabilities in Wavelength Routing Networks*
4. ILYA BALDIN, 1998
Dissertation: *Dynamic Reconfiguration in Broadcast WDM Networks*
3. ZEYDY ORTIZ-LAUREANO, 1998
Dissertation: *Techniques to Support Multicast Traffic in Single-Hop WDM Optical Networks*
NSA Fellow, 1994-1998
2. M. WILLIAM (BILL) MCKINNON, 1997
Dissertation: *Performance Analysis of a Class of Photonic Interconnection Architectures*
1. SUPRIYA S. SHARMA, 1997
Dissertation: *Optimal Buffer Management for Shared Buffer ATM Switches*

Visiting Ph.D. Students

5. FENGXIAN TANG, 2019-2020 (Soochow University, China)
Research: *Optical Network Optimization*
4. WENZHE LI, 2017-2018 (Beijing University of Posts and Telecommunications, China)
Research: *Optical Networks on a Chip (ONoC)*
3. XIAOMIN LIU, 2011-2012 (Beihang University, China)
Research: *Ethernet Passive Optical Networks*
2. CHANG CAO, 2010-2011 (Beijing University of Posts and Telecommunications, China)
Research: *p-Cycle Protection in MPLS Networks*
1. ARUN VISWANATH, 2007-2008 (University of New South Wales, Australia)
Research: *Buffer Sizing in High-Speed Routers*

M.S. Students Supervised – Graduated

12. MANOJ VELLALA, 2008
Thesis: *Stack Composition for SILO Architecture*
11. SRIKRISHNA GIRISH KHARE, 2008
Thesis: *Linux Implementation of Tiered Service Fair Queueing (TSFQ) Scheduling Disciplines*
10. AJAY BABU AMUDALA BHASKER, 2006
Thesis: *Tiered-Service Fair Queueing (TSFQ): A Practical and Efficient Fair Queueing Algorithm*
9. NIKHIL BARADWAJ, 2005
Thesis: *Traffic Quantization and its Application to QoS Routing*
Graduate School Nancy G. Pollock MS Thesis Award, 2006

8. VIJAY IYER, 2002
Thesis: *A Simulation Study of Wavelength Assignment and Reservation Policies with Signaling Delays*
7. MRUGENDRA SINGHAI, 2002
Thesis: *Helios 2: An All-Optical Broadcast Local Area Network*
6. SUDHIN BENGARI, 2001
Thesis: *Differentiated Services Support for the Helios Optical WDM Testbed*
5. DHAVAL THAKER, 2001
Thesis: *Multicasting in a Partially Tunable Broadcast WDM Network*
4. JEFFREY J. STUCKEY, 1998
Thesis: *Worst-Case Cell Delay in an ATM Switch Using EDF Scheduling*
3. BRIAN K. HABERMAN, 1997
Thesis: *Cost, Delay, and Delay Variation Conscious Multicast Routing*
2. ILYA BALDIN, 1995
Thesis: *Multicast Routing With End-to-End Delay and Delay Variation Constraints*
1. VIJAY SIVARAMAN, 1995
Thesis: *TDM Schedules For Broadcast WDM Networks With Arbitrary Tuning Latencies*

II. Research and Scholarship

Books

3. ROUSKAS, G.N., RAMAMURTHY, B., SIVALINGAM, K.M. (editors). Next-Generation Internet Architectures and Protocols. Cambridge University Press, 2011.
2. ROUSKAS, G.N. Internet Tiered Services: Theory, Economics, and Quality of Service. Springer, 2009.
1. DUTTA, R., KAMAL, A., ROUSKAS, G.N. (editors). Traffic Grooming for Optical Networks: Foundations, Techniques, and Frontiers. Springer, 2008.

Book Chapters

10. SIMMONS, J., ROUSKAS, G.N., "Routing and Wavelength (Spectrum) Allocation." In Biswanath Mukherjee, Ioannis Tomkos, Massimo Tornatore, Peter Winzer, and Yongli Zhao (editors), *Springer Handbook of Optical Networks*, Springer, 2020.
9. FAYEZ, M., KATIB, I., ROUSKAS, G.N., FAHEEM, H.M., "Scheduling-Inspired Spectrum Assignment Algorithms for Mesh Elastic Optical Networks." In Aaron Striegel, Min Song and Kewei Sha (editors), *Advances in Computer Communications and Networks - From Green, Mobile, Pervasive Networking to Big Data Computing*, River Publishers, 2016.
8. ROUSKAS, G.N., DUTTA, R., "Hierarchical Traffic Grooming." In Rudra Dutta, Ahmed E. Kamal, and George N. Rouskas (editors), *Traffic Grooming for Optical Networks: Foundations, Techniques, and Frontiers*, Springer, 2008.
7. DUTTA, R., KAMAL, A.E., ROUSKAS, G.N., "Grooming Mechanisms in SONET/SDH and Next-Generation SONET/SDH." In Rudra Dutta, Ahmed E. Kamal, and George N. Rouskas (editors), *Traffic Grooming for Optical Networks: Foundations, Techniques, and Frontiers*, Springer, 2008.
6. DUTTA, R., KAMAL, A.E., ROUSKAS, G.N., "Introduction to Traffic Grooming." In Rudra Dutta, Ahmed E. Kamal, and George N. Rouskas (editors), *Traffic Grooming for Optical Networks: Foundations, Techniques, and Frontiers*, Springer, 2008.
5. ROUSKAS, G.N., XU, L., "Optical Packet Switching." In Krishna Sivalingam and Suresh Subramanian (editors), *Optical WDM Networks: Past Lessons and Path Ahead*, Kluwer, Norwell, Massachusetts, 2004.
4. ROUSKAS, G.N., "Optical Network Engineering." In Sudhir Dixit (editor), *IP over DWDM: Building the Next Generation Optical Internet*, John Wiley & Sons, Hoboken, New Jersey, pp. 299-327, 2003.
3. ROUSKAS, G.N., "Routing and Wavelength Assignment in Optical WDM Networks." In John Proakis (editor), *Wiley Encyclopedia of Telecommunications*, 2002.
2. ROUSKAS, G.N., DUTTA, R., "Design of Logical Topologies for Wavelength Routed Networks." In Krishna Sivalingam and Suresh Subramanian (editors), *Optical WDM Networks: Principles and Practice*, Kluwer, Norwell, Massachusetts, pp. 79-102, 2000.
1. ROUSKAS, G.N., "Scheduling Algorithms for Unicast, Multicast, and Broadcast." In Krishna Sivalingam and Suresh Subramanian (editors), *Optical WDM Networks: Principles and Practice*, Kluwer, Norwell, Massachusetts, pp. 171-188, 2000.

Journal Articles

87. LI, W., YUAN, G., WANG, Z., TAN, G., ZHANG, P., ROUSKAS, G.N., "Fast and Scalable All-Optical Network Architecture for Distributed Deep Learning." *IEEE/Optica Journal of Optical Communications and Networking*, 2024 (in press).
86. ROUSKAS, G.N., GUPTA, S., SHARMA, P. "Symmetry-Free Algorithm for Spectrum Allocation: Parallel Implementations and Evaluation [Invited]." *IEEE/Optica Journal of Optical Communications and Networking*, vol. 15, no. 10, pp. E40-E50, October 2023.
85. ROUSKAS, G.N. "A Symmetry-Free Spectrum Allocation Heuristic for Elastic Optical Networks." *Optical Switching and Networking*, vol. 49, May 2023.
84. ROUSKAS, G.N., BANDIKATLA, C., "Recursive First Fit: A Highly Parallel Optimal Solution to Spectrum Allocation." *IEEE/Optica Journal of Optical Communications and Networking*, vol. 14, no. 4, pp. 165-176, April 2022.
83. TANG, F., SHEN, G., ROUSKAS, G.N., "Crosstalk-Aware Shared Backup Path Protection in Multi-Core Fiber Elastic Optical Networks." *IEEE/OSA Journal of Lightwave Technology*, vol. 39, no. 10, pp. 3025-3036, May 15, 2021.
82. GAO, L., ROUSKAS, G.N., "Congestion Minimization for Service Chain Routing Problems with Path Length Considerations." *IEEE/ACM Transactions on Networking*, vol. 28, no. 6, pp. 2643-2656, December 2020.
81. TANG, F., LI, Y., SHEN, G., ROUSKAS, G.N., "Minimizing Inter-Core Crosstalk Jointly in Spatial, Frequency, and Time Domains for Scheduled Lightpath Demands in Multi-Core Fiber-based Elastic Optical Network." *IEEE/OSA Journal of Lightwave Technology*, vol. 38, no. 20, pp. 5695-5607, October 15, 2020.
80. FAYEZ, M., KATIB, I., ROUSKAS, G.N., GHARIB, T.F., KHALEED, H., FAHEEM, H.M., "Recursive Algorithm for Selecting Optimum Routing Tables to Solve Offline Routing and Spectrum Assignment Problem." *Ain Shams Engineering Journal*, vol. 11, no. 2, pp. 273-280, June 2020.
79. XIONG, Y., YAYA, Y., YE, Y., ROUSKAS, G.N., "A Machine Learning Approach to Mitigating Fragmentation and Crosstalk in Space Division Multiplexing Elastic Optical Networks." *Optical Fiber Technology*, vol. 50, pp. 99-107, July 2019.
78. LI, W., GUO, B., LI, X., ZHOU, Y, HUANG, S., ROUSKAS, G.N. "A Large-Scale Nesting Ring Multi-Chip Architecture for Manycore Processor Systems." *Optical Switching and Networking*, vol. 31, pp. 183-192, January 2019.
77. GAO, L., ROUSKAS, G.N., "A Spectral Clustering Approach to Network-Aware Virtual Request Partitioning." *Computer Networks*, vol. 139, pp. 70-80, July 2018.
76. BHAT, S., ROUSKAS, G.N., KATIB, I., "On Time Dependent Routing Algorithms for Open Marketplaces of Path Services with Support for In-Advance Path Reservation." *Computer Networks*, vol. 138, pp. 201-212, June 2018.
75. XIONG, Y., SHI, J., YAYA, Y., LV, Y., ROUSKAS, G.N., "Lightpath Management on SDN-Based Elastic Optical Networks with Power Consumption Considerations." *IEEE/OSA Journal of Lightwave Technology*, vol. 36, no. 9, pp. 1650-1660, May 2018.
74. XIONG, Y., LI, Y., ZHOU, B., WANG, R., ROUSKAS, G.N., "SDN Enabled Restoration with Triggered Precomputation in Elastic Optical Inter-Datacenter Networks." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 10, no. 1, pp. 24-34, January 2018.

73. BHAT, S., UDECHUKWU, R., DUTTA, R., ROUSKAS, G.N., "Network Service Orchestration in Heterogeneous 5G Networks using an Open Marketplace." *IET Networks*, 2017.
72. TALEBI, S., ROUSKAS, G.N., "On Distance-Adaptive Routing and Spectrum Assignment in Mesh Elastic Optical Networks." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 9, no. 5, pp. 456-465, May 2017.
71. TALEBI, S., KATIB, I., ROUSKAS, G.N., "Distance-Adaptive Routing and Spectrum Assignment in Rings." *IET Networks*, vol. 5, no. 3, pp. 64-70, May 2016.
70. TALEBI, S., BAMPIS, E., LUCARELLI, G., KATIB, I., ROUSKAS, G.N., "On Routing and Spectrum Assignment in Rings." *IEEE/OSA Journal of Lightwave Technology*, vol. 33, no. 1, pp. 151-160, January 1, 2015.
69. COULIBALY, ROUSKAS, G.N., ABD LATIF, M.S., RAZZAQUE, M.A., MANDALA, S., "QoS-Aware Ant-Based Route, Wavelength and Timeslot Assignment Algorithm for Optical Burst Switched Networks." *Transactions on Emerging Telecommunications Technologies*, 2015.
68. TALEBI, S., BAMPIS, E., LUCARELLI, G., KATIB, I., ROUSKAS, G.N., "Spectrum Assignment in Optical Networks: A Multiprocessor Scheduling Perspective." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 6, no. 8, pp. 754-763, August 2014.
67. WANG, H., ROUSKAS, G.N., "Hierarchical Traffic Grooming: A Tutorial." *Computer Networks*, vol. 69, pp. 147-156, August 2014.
66. YAYAH, A. A., COULIBALY, Y., ISMAIL, A. S., ROUSKAS, G.N., "Hybrid Offset-Time and Burst Assembly Algorithm (H-OTBA) for Delay Sensitive Applications Over Optical Burst Switching Networks." *International Journal of Communication Systems*, 2014.
65. WOLF, T., GRIFFIOEN, J., CALVERT, K., DUTTA, R., ROUSKAS, G.N., BALDINE, I., NAGURNEY, A., "ChoiceNet: Toward an Economy Plane for the Internet." *ACM Computer Communications Review*, vol. 44, no. 3, pp. 58-65, July 2014.
64. TALEBI, S., ALAM, F., KATIB, I., KHAMIS, M., KHALIFAH, R., ROUSKAS, G.N., "Spectrum Management Techniques for Elastic Optical Networks: A Survey." *Optical Switching and Networking*, vol. 13, no. 1, pp. 34-48, July 2014.
63. LIU, X., ROUSKAS, G.N., HE, F., XIONG, H., "MPCP with Look-Ahead for WDM EPON." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 6, no. 2, pp. 104-113, February 2014.
62. WANG, H., ROUSKAS, G.N., "Traffic Grooming in Optical Networks: Decomposition and Partial LP Relaxation." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 5, no. 8, pp. 825-835, August 2013.
61. CAO, C., ROUSKAS, G.N., WANG, J., TANG, X., "Hybrid FRR/p-Cycle Design for Link and Node Protection in MPLS Networks." *International Journal of Electronics and Communications*, vol. 67, no. 6, pp. 470-478, June 2013.
60. WANG, A., IYER, M., DUTTA, R., ROUSKAS, G.N., BALDINE, I., "Network Virtualization: Technologies, Perspectives, and Frontiers." *IEEE/OSA Journal of Lightwave Technology*, vol. 31, no. 4, pp. 523-537, February 15, 2013.
59. EL-BAWAB, T.S., ESFANDIARI, M., ROUSKAS, G.N., JAYASUMANA, A., EFFENBERGER, F., KAZOVSKY, L., KINCAID, M., MEDARD, M., FROST, V., BANIEWICZ, P., "Toward Specialized Undergraduate Telecommunication Engineering Education in the US." *IEEE Communications Magazine*, vol. 50, no. 9, pp. 3-4, September 2012.

58. VISWANATH, A., SIVARAMAN, V., ROUSKAS, G.N., "Anomalous Loss Performance for Mixed Real-Time and TCP Traffic in Routers with Very Small Buffers." *IEEE/ACM Transactions on Networking*, vol. 19, no. 4, pp. 933-946, August 2011.
57. YETGINER, E., ZEYU, L., ROUSKAS, G.N., "Fast Exact ILP Decompositions for Ring RWA." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 3, no. 7, pp. 577-586, July 2011. **OSA Spotlight on Optics, September 2011.**
56. DWEKAT, Z., ROUSKAS, G.N., "A Practical Fair Queueing Scheduler: Simplification Through Quantization." *Computer Networks*, vol. 55, no. 10, pp. 2392-2406, July 2011.
55. CASTILLO, C., ROUSKAS, G.N., HARFOUSH, K., "Online Algorithms for Advance Resource Reservations." *Journal of Parallel and Distributed Computing*, vol. 71, no. 7, pp. 963-973, July 2011.
54. TOUCH, J., BALDINE, I., DAY, J., DUTTA, R., FINN, G.F., FORD, B., JORDAN, S., MASSEY, D., MATTA, A., PAPADOPOULOS, C., REIHER, P., ROUSKAS, G.N., "A Dynamic Recursive Unified Internet Design (DRUID)." *Computer Networks*, vol. 55, no. 4, pp. 919-935, 10 March 2011.
53. KARMOUS-EDWARDS, G., POLITO, S.G., JUKAN, A., ROUSKAS, G.N., "A New Framework for GLIF Interdomain Resource Reservation Architecture (GIRRA)." *Annals of Telecommunications*, vol. 65, no. 11-12, pp. 1000-1001, November-December 2010.
52. CHEN, B., DUTTA, R., ROUSKAS, G.N., "Clustering for Hierarchical Traffic Grooming in Large Scale Mesh WDM Networks." *IEEE/OSA Journal of Optical Communications and Networking*, vol. 2, no. 8, pp. 502-514, August 2010.
51. LV, Q., ROUSKAS, G.N., "An Economic Model for Pricing Tiered Network Services." *Annals of Telecommunications*, vol. 65, no. 3-4, pp. 147-161, April 2010.
50. ROUSKAS, G.N., BARADWAJ, N., "On Bandwidth Tiered Service." *IEEE/ACM Transactions on Networking*, vol. 17, no. 6, pp. 1780-1793, December 2009.
49. KARMOUS-EDWARDS, G., VISWANATH, A., REEVES, D.S., BATTISTILLI, L., VEGESNA, P., ROUSKAS, G.N. "Edge-Reconfigurable Optical Networks (ERONs): Rationale, Network Design, and Evaluation." *IEEE/OSA Journal of Lightwave Technology*, vol. 27, no. 12, pp. 1837-1845, June 15, 2009.
48. CHEN, B., ROUSKAS, G.N., DUTTA, R., "On Hierarchical Traffic Grooming in WDM Networks." *IEEE/ACM Transactions on Networking*, vol. 16, no. 6, pp. 1226-1238, October 2008.
47. YANG, L., ROUSKAS, G.N., "Optimal Wavelength Sharing Policies in OBS Networks Subject to QoS Constraints." *IEEE Journal on Selected Areas in Communications*, supplement on *Optical Communications & Networking*, vol. 25, no. 9, pp. 40-49, December 2007.
46. JACKSON, L.E., ROUSKAS, G.N., STALLMAN, M.F., "The Directional p -Median Problem with Applications to Traffic Quantization and Multiprocessor Scheduling." *European Journal of Operational Research*, vol. 179, no. 3, pp. 1097-1108, June 2007.
45. YANG, L., ROUSKAS, G.N., "Generalized Wavelength Sharing Policies for Absolute QoS Guarantees in OBS Networks." *IEEE Journal on Selected Areas in Communications*, supplement on *Optical Communications & Networking*, vol. 25, no. 4, pp. 93-104, April 2007.
44. YANG, L., ROUSKAS, G.N., "Adaptive Path Selection in Optical Burst Switched Networks." *IEEE/OSA Journal of Lightwave Technology*, vol. 24, no. 8, pp. 3002-3011, August 2006.
43. HUANG, S., DUTTA, R., ROUSKAS, G.N., "Traffic Grooming in Path, Star, and Tree Networks: Complexity, Bounds, and Algorithms." *IEEE Journal on Selected Areas in Communications*, vol. 24, no. 4, pp. 66-82, April 2006.

42. TENG, J., ROUSKAS, G.N., "A Traffic Engineering Approach to Path Selection in OBS Networks." *OSA Journal of Optical Networking*, vol. 4, no. 11, pp. 759-777, November 2005.
41. TENG, J., ROUSKAS, G.N., "Wavelength Selection in OBS Networks Using Traffic Engineering and Priority-Based Concepts." *IEEE Journal on Selected Areas in Communications*, vol. 23, no. 8, pp. 1658-1669, August 2005.
40. CHEN, B., ROUSKAS, G.N., DUTTA, R., "Traffic Grooming in WDM Ring Networks To Minimize the Maximum Electronic Port Cost." *Optical Switching and Networking*, vol. 1, no. 2, pp. 1-18, May 2005.
39. TENG, J., ROUSKAS, G.N., "A Detailed Analysis and Performance Comparison of Wavelength Reservation Schemes for Optical Burst Switched Networks." *Photonic Network Communications*, vol. 9, no. 3, pp. 311-335, May 2005.
38. XIN, Y., ROUSKAS, G.N., "Light-Tree Routing Under Optical Power Budget Constraints." *OSA Journal of Optical Networking*, vol. 3, no. 5, pp. 282-302, May 2004.
37. XIN, Y., ROUSKAS, G.N., "A Study of Path Protection in Large-Scale Optical Networks." *Photonic Network Communications*, vol. 7, no. 3, pp. 267-278, May 2004.
36. BALDINE, I., ROUSKAS, G.N., PERROS, H.G., STEVENSON, D., "Multicast and QoS in the **Jumpstart** Architecture for WDM Burst-Switched Networks." *Optical Networks*, vol. 4, no. 6, pp. 68-80, November/December 2003.
35. JACKSON, L.E., ROUSKAS, G.N., "Optimal Quantization of Periodic Task Requests on Multiple Identical Processors." *IEEE Transactions on Parallel and Distributed Systems*, vol. 14, no. 8, pp. 795-806, August 2003.
34. ZAIM, A.H., PERROS, H.G., ROUSKAS, G.N., "Performance Analysis of LEO Satellite Networks." *IEEE Transactions on Vehicular Technology*, vol. 52, no. 3, pp. 622-636, May 2003.
33. XIN, Y., ROUSKAS, G.N., PERROS, H.G., "On the Physical and Logical Topology Design of Large-Scale Optical Networks." *IEEE/OSA Journal of Lightwave Technology*, vol. 21, no. 4, pp. 904-915, April 2003.
32. ZAIM, A.H., BALDINE, I., CASSADA, M., ROUSKAS, G.N., PERROS, H.G., STEVENSON, D., "The **Jumpstart** Just-In-Time Signaling Protocol: A Formal Description Using Extended Finite State Machines." *Optical Engineering*, vol. 42, no. 2, pp. 568-585, February 2003.
31. XU, L., ROUSKAS, G.N., PERROS, H.G., "A Simulation Study of Optical Burst Switching and Access Protocols for WDM Ring Networks." *Computer Networks*, vol. 41, no. 2, pp. 143-160, January 2003.
30. ROUSKAS, G.N., "Optical Layer Multicast: Rationale, Building Blocks, and Challenges." *IEEE Network*, vol. 17, no. 1, pp. 60-65, January/February 2003.
29. XU, L., PERROS, H.G., ROUSKAS, G.N., "Access Protocols for Optical Burst-Switched Ring Networks." *Information Sciences*, vol. 149, no. 1-2, pp. 75-81, January 2003.
28. DUTTA, R., ROUSKAS, G.N., "A Survey of Traffic Grooming Techniques for Optical WDM Networks." *IEEE Network*, vol. 16, no. 6, pp. 46-56, November/December 2002.
27. JACKSON, L.E., ROUSKAS, G.N., "Deterministic Preemptive Scheduling of Real Time Tasks." *IEEE Computer*, vol. 35, no. 5, pp. 72-79, May 2002.
26. BAMPIS, E., ROUSKAS, G.N., "The Scheduling and Wavelength Assignment Problem in Optical WDM Networks." *IEEE/OSA Journal of Lightwave Technology*, vol. 20, no. 5, pp. 782-789, May 2002.

25. RHEE, I., BALAGURU, N., ROUSKAS, G.N., "MTCP: Scalable TCP-like Congestion Control for Reliable Multicast." *Computer Networks*, vol. 38, no. 5, pp. 553-575, April 2002.
24. BALDINE, I., ROUSKAS, G.N., PERROS, H.G., STEVENSON, D., "Jumpstart: A Just-In-Time Signaling Architecture for WDM Burst-Switched Networks." *IEEE Communications*, vol. 40, no. 2, pp. 82-89, February 2002.
23. ZAIM, A.H., ROUSKAS, G.N., PERROS, H.G., "Computing Call Blocking Probabilities in LEO Satellite Networks: The Single Orbit Case." *IEEE Transactions on Vehicular Technology*, vol. 51, no. 2, pp. 332-347, March 2002.
22. DUTTA, R., ROUSKAS, G.N., "On Optimal Traffic Grooming in WDM Rings." *IEEE Journal on Selected Areas in Communications*, vol. 20, no. 1, pp. 110-121, January 2002.
21. RAMESH, S., ROUSKAS, G.N., PERROS, H.G., "Computing Blocking Probabilities in Multi-Class Wavelength Routing Networks with Multicast Calls." *IEEE Journal on Selected Areas in Communications*, vol. 20, no. 1, pp. 89-96, January 2002.
20. THAKER, D., ROUSKAS, G.N., "Multi-Destination Communication in Broadcast WDM Networks: A Survey." *Optical Networks*, vol. 3, no. 1, pp. 34-44, January/February 2002.
19. BALDINE, I., ROUSKAS, G.N., "Traffic Adaptive WDM Networks: A Study of Reconfiguration Issues." *IEEE/OSA Journal of Lightwave Technology*, vol. 19, no. 4, pp. 433-455, April 2001.
18. RAMESH, S., ROUSKAS, G.N., PERROS, H.G., "Computing Blocking Probabilities in Multi-Class Wavelength Routing Networks." *ACM Transactions on Modeling and Computer Simulation (TOMACS)*, vol. 10, no. 2, pp. 87-103, April 2001.
17. XU, L., PERROS, H.G., ROUSKAS, G.N., "A Survey of Optical Packet Switching and Optical Burst Switching Techniques." *IEEE Communications*, vol. 39, no. 1, pp. 136-142, January 2001.
16. ZHU, Y., ROUSKAS, G.N., PERROS, H.G., "A Path Decomposition Approach for Computing Blocking Probabilities in Wavelength Routing Networks." *IEEE/ACM Transactions on Networking*, vol. 8, no. 6, pp. 747-762, December 2000.
15. ZHU, Y., ROUSKAS, G.N., PERROS, H.G., "A Comparison of Allocation Policies in Wavelength Routing Networks." *Photonic Network Communications Journal*, vol. 2, no. 3, pp. 265-293, August 2000.
14. ORTIZ-LAUREANO, Z., ROUSKAS, G.N., PERROS, H.G., "Scheduling Combined Unicast and Multicast Traffic in Broadcast WDM Networks." *Photonic Network Communications Journal*, vol. 2, no. 2, pp. 135-154, May 2000.
13. SIVARAMAN, V., ROUSKAS, G.N., "A Reservation Protocol for Broadcast WDM Networks and Stability Analysis." *Computer Networks*, vol. 32, no. 2, pp. 211-277, February 2000.
12. DUTTA, R., ROUSKAS, G.N., "A Survey of Virtual Topology Design Algorithms for Wavelength Routed Networks." *Optical Networks*, vol. 1, no. 1, pp. 73-89, January 2000.
11. ORTIZ-LAUREANO, Z., ROUSKAS, G.N., PERROS, H.G., "Maximizing Multicast Throughput in WDM Networks with Tuning Latencies Using the Virtual Receiver Concept." *European Transactions on Telecommunications*, vol. 11, no. 1, pp. 63-72, January/February 2000.
10. MCKINNON, M.W., PERROS, H.G., ROUSKAS, G.N., "Performance Analysis of Broadcast WDM Networks Under IP Traffic." *Performance Evaluation*, vol. 36-37, pp. 333-358, August 1999.

9. BALDINE, I., ROUSKAS, G.N., "Reconfiguration and Dynamic Load Balancing in Broadcast WDM Networks." *Photonic Network Communications Journal*, vol. 1, no. 1, pp. 49-64, June 1999.
8. MCKINNON, M.W., ROUSKAS, G.N., PERROS, H.G., "Performance Analysis of a Photonic Single-Hop ATM Switch Architecture with Tunable Transmitters and Fixed Frequency Receivers." *Performance Evaluation*, vol. 33, no. 2, pp. 113-136, June 1998.
7. ROUSKAS, G.N., SIVARAMAN, V., "Packet Scheduling in Broadcast WDM Networks with Arbitrary Transceiver Tuning Latencies." *IEEE/ACM Transactions on Networking*, vol. 5, no. 3, pp. 359-370, June 1997.
6. ROUSKAS, G.N., BALDINE, I., "Multicast Routing with End-to-End Delay and Delay Variation Constraints." *IEEE Journal on Selected Areas in Communications*, vol. 15, no. 3, pp. 346-356, April 1997.
5. ROUSKAS, G.N., AMMAR, M.H., "Multi-Destination Communication Over Tunable-Receiver Single-Hop WDM Networks." *IEEE Journal on Selected Areas in Communications*, vol. 15, no. 3, pp. 501-511, April 1997.
4. ROUSKAS, G.N., AMMAR, M.H., "Minimizing Delay and Packet Loss in Single-Hop Lightwave WDM Networks Using TDM Schedules." *Journal of High Speed Networks*, vol. 5, no. 4, pp. 309-327, 1996.
3. ROUSKAS, G.N., AMMAR, M.H., "Analysis and Optimization of Transmission Schedules for Single-Hop WDM Networks." *IEEE/ACM Transactions on Networking*, vol. 3, no. 2, pp. 211-221, April 1995.
2. AMMAR, M.H., ROUSKAS, G.N., "On the Design of Protocols for Collecting Responses over a Multiple-Access Channel." *IEEE Transactions on Communications*, vol. 43, no. 2, pp. 412-420, February 1995.
1. ROUSKAS, G.N., AMMAR, M.H., "Dynamic Reconfiguration in Multihop WDM Networks." *Journal of High Speed Networks*, vol. 4, no. 3, pp. 221-238, 1995.

Conference Proceedings (refereed)

114. ROUSKAS, G.N., GHINAIYA, M., "A Universal Spectrum Symmetry-Free Algorithm for Routing and Spectrum Assignment (RSA)." *Proceedings of IEEE ICC 2024*, June 9-13, 2024, Denver, Colorado.
113. LI, W., YUAN, G., WANG, Z., TAN, G., ZHANG, P., ROUSKAS, G.N., "Accelerate Distributed Deep Learning with a Fast Reconfigurable Optical Network." *Proceedings of OFC 2024*, March 24-28, 2024, San Diego, California.
112. ROUSKAS, G.N., "First-Fit: A Universal Algorithm for Spectrum Assignment." *Proceedings of IEEE GLOBECOM 2023*, December 4-8, 2023, Kuala Lumpur, Malaysia.
111. PELLETIER, S., YU, R., ROUSKAS, G.N., LIU, J., "Qubit Recycling in Entanglement Distillation." *Proceedings of IEEE International Conference on Quantum Computing and Engineering (QCE) 2023*, September 17-22, 2023, Bellevue, WA.
110. ROUSKAS, G.N., GUPTA, S., SHARMA, P., "Experimental Evaluation of a Symmetry-Free Parallel Algorithm for Spectrum Allocation." *Proceedings of IEEE GLOBECOM 2022*, December 4-8, 2022, Rio de Janeiro, Brazil.
109. ROUSKAS, G.N., SHARMA, P., GUPTA, S., "Parameterized First Fit (PFF): Eliminating Symmetry in Spectrum Allocation." *Proceedings of IEEE GLOBECOM 2022*, December 4-8, 2022, Rio de Janeiro, Brazil.

108. ROUSKAS, G.N., BANDIKATLA, C., "Parameterized Exhaustive Routing with First Fit for RSA Problem Variants." *Proceedings of IEEE GLOBECOM 2021*, December 7-11, 2021, Madrid, Spain.
107. GAO, L., ROUSKAS, G.N., "Service Chain Rerouting for NFV Load Balancing." *Proceedings of IEEE GLOBECOM 2020*, December 7-11, 2020, Taipei, Taiwan.
106. FAYEZ, M., KATIB, I., ROUSKAS, G.N., GHARIB, T.F., AHMED, H.K., FAHEEM, H. M., "A Scalable Solution to Network Design Problems: Decomposition with Exhaustive Routing Search." *Proceedings of IEEE GLOBECOM 2020*, December 7-11, 2020, Taipei, Taiwan.
105. LI, W., GUO, B., YUAN, G., HUANG, S., ROUSKAS, G.N., "Application-Based Dynamically Reconfigurable Optical Network On Chip Architecture." *Proceedings of ECOC 2019*, September 22-26, 2019, Dublin, Ireland.
104. GAO, L., ROUSKAS, G.N., "On Congestion Minimization for Service Chain Routing Problems." *Proceedings of IEEE ICC 2019*, May 20-24, 2019, Shanghai, China.
103. FAYEZ, M., KATIB, I., ROUSKAS, G.N., GHARIB, T.F., KHALED, H., FAHEEM, H.M., "Performance Evaluation of Brute Force Techniques for Routing and Spectrum Assignment in Elastic Optical Network using MPI and CUDA." *Proceedings of International Conference on Computational Science and Computational Intelligence (CSCI 2018)*, December 13-15, 2018, Las Vegas, NV.
102. GAO, L., ROUSKAS, G.N., "Virtual Network Reconfiguration with Load Balancing and Migration Cost Considerations." *Proceedings of IEEE Infocom 2018*, April 15-19, 2018, Honolulu, Hawaii.
101. BHAT, S., ROUSKAS, G.N., "Service-Concatenation Routing With Applications to Network Functions Virtualization." *Proceedings of ICCCN 2017*, July 31-August 3, 2017, Vancouver, Canada.
100. XIONG, Y., SHI, J., LV, Y., ROUSKAS, G.N., "Power-Aware Lightpath Management for SDN-Based Elastic Optical Networks." *Proceedings of ICCCN 2017*, July 31-August 3, 2017, Vancouver, Canada.
99. BHAT, S., UDECHUKWU, R., DUTTA, R., ROUSKAS, G.N., "On Service Composition Algorithms for Open Marketplaces of Network Services." *Proceedings of EuCNC 2017*, June 12-15, 2017, Oulu, Finland.
98. TALEBI, S., ROUSKAS, G.N., KATIB, I., "Offline Distance-Adaptive Routing and Spectrum Assignment in Mesh Elastic Optical Networks." *Proceedings of IEEE GLOBECOM 2016*, December 4-8, 2016, Washington, DC.
97. XIONG, Y., ROUSKAS, G.N., "Exploiting SDN Principles for Extremely Fast Restoration in Elastic Optical Datacenter Networks," *Proceedings of IEEE GLOBECOM 2016*, December 4-8, 2016, Washington, DC.
96. UDECHUKWU, R., BHAT, S., DUTTA, R., ROUSKAS, G.N., "Language of Choice: On Embedding Choice-related Semantics in a Realizable Protocol." *Proceedings of the 37th IEEE Sarnoff Symposium*, September 19-21, 2016, Newark, New Jersey.
95. GAO, L., ROUSKAS, G.N., "Network-Aware Virtual Request Partitioning Based on Spectral Clustering." *Proceedings of ICCCN 2016*, August 1-4, 2016, Honolulu, Hawaii.
94. BHAT, S., ROUSKAS, G.N., "On Routing Algorithms for Open Marketplaces of Path Services." *Proceedings of IEEE ICC 2016*, May 23-27, 2016, Kuala Lumpur, Malaysia.
93. KRISHNAMURTHY, R., ROUSKAS, G.N., "Performance Evaluation of Multi-Core, Multi-Threaded SIP Proxy Servers (SPS)." *Proceedings of IEEE ICC 2016*, May 23-27, 2016, Kuala Lumpur, Malaysia.

92. BHAT, S., UDECHUKWU, R., DUTTA, R., ROUSKAS, G.N., "Inception to Application: A GENI based prototype of an Open Marketplace for Network Services." *Proceedings of IEEE INFOCOM 2016 Workshops*, April 2016, San Francisco, CA.
91. TALEBI, S., KATIB, I., ROUSKAS, G.N., "Offline Distance-Adaptive Routing and Spectrum Assignment (DA-RSA) in Rings." *Proceedings of IEEE GLOBECOM 2015*, December 6-10, 2015, San Diego, CA.
90. FAYEZ, M., KATIB, I., ROUSKAS, G.N., FAHEEM, H.M., "Spectrum Assignment in Mesh Elastic Optical Networks." *Proceedings of ICCCN 2015*, August 3-6, 2015, Las Vegas, NV.
89. CHEN, X., WOLF, T., GRIFFIOEN, J., ASCIGIL, O., DUTTA, R., ROUSKAS, G.N., BHAT, S., BALDIN, I., CALVERT, K., "Design of a Protocol to Enable Economic Transactions for Network Services." *Proceedings of IEEE ICC 2015*, June 8-12, 2015, London, UK.
88. KRISHNAMURTHY, R., ROUSKAS, G.N., "On the Impact of Scheduler Settings on the Performance of Multi-Threaded SIP Servers." *Proceedings of IEEE ICC 2015*, June 8-12, 2015, London, UK.
87. TALEBI, S., BAMPIS, E., LUCARELLI, G., KATIB, I., ROUSKAS, G.N., "The Spectrum Assignment (SA) Problem in Optical Networks: A Multiprocessor Scheduling Perspective." *Proceedings of the 18th Conference on Optical Network Design and Modeling (ONDM 2014)*, May 19-22, 2014, Stockholm, Sweden.
86. WANG, H., ROUSKAS, G.N., "Hierarchical Grooming in Optical Networks." *Proceedings of IEEE GLOBECOM 2013*, December 9-13, 2013, Atlanta, Georgia.
85. KRISHNAMURTHY, R., ROUSKAS, G.N., "Evaluation of SIP Proxy Server Performance: Packet-Level Measurements and Queuing Model." *Proceedings of IEEE ICC 2013*, June 9-13, 2013, Budapest, Hungary.
84. WANG, H., ROUSKAS, G.N., "An Efficient Algorithm for Solving Traffic Grooming Problems in Optical Networks." *Proceedings of IEEE ICC 2013*, June 9-13, 2013, Budapest, Hungary.
83. LIU, X., ROUSKAS, G.N., "MPCP- ℓ : Look-Ahead Enhanced MPCP for EPON." *Proceedings of IEEE ICC 2013*, June 9-13, 2013, Budapest, Hungary.
82. LIU, Z., ROUSKAS, G.N., "Scalable Optimal Traffic Grooming in WDM Rings Incorporating Fast RWA Formulation." *Proceedings of IEEE ICC 2013*, June 9-13, 2013, Budapest, Hungary.
81. LIU, Z., ROUSKAS, G.N., "Link Selection Algorithms for Link-Based ILPs and Applications to RWA in Mesh Networks." *Proceedings of the 17th Conference on Optical Network Design and Modeling (ONDM 2013)*, April 16-19, 2013, Brest, France.
80. LIU, Z., ROUSKAS, G.N., "A Fast Path-Based ILP Formulation for Offline RWA in Mesh Optical Networks." *Proceedings of IEEE GLOBECOM 2012*, December 3-7, 2012, Anaheim, California.
79. WOLF, T., GRIFFIOEN, J., CALVERT, K., DUTTA, R., ROUSKAS, G.N., BALDINE, I., NAGURNEY, A., "Choice as a Principle in Network Architecture." *Proceedings of ACM SIGCOMM 2012*, pp. 105-106, August 13-17, 2012, Helsinki, Finland.
78. CAO, C., ROUSKAS, G.N., "Hybrid FRR/ p -Cycle MPLS Link Protection Design." *Proceedings of IEEE GLOBECOM 2011*, December 5-9, 2011, Houston, Texas.
77. LV, Q., ROUSKAS, G.N., "On Optimal Tiered Structures for Network Service Bundles." *Proceedings of IEEE GLOBECOM 2011*, December 5-9, 2011, Houston, Texas.

76. WANG, H., ROUSKAS, G.N., "Flow Isolation in Optical Networks." *Proceedings of IEEE LANMAN 2011*, October 13-14, 2011, Chapel Hill, North Carolina.
75. DWEKAT, Z., ROUSKAS, G.N., "Worst-Case Fair Bin Sort Queuing (WBSQ): A Low Complexity Worst-Case Fair Scheduler." *Proceedings of IEEE ICC 2011*, June 5-9, 2011, Kyoto, Japan.
74. WANG, M.S., WANG, A., BATHULA, B.G., LAI, C.P., BALDINE, I., CHEN, C., MAJUMDER, D., GURKAN, D., ROUSKAS, G.N., DUTTA, R., BERGMAN, K., "Demonstration of QoS-Aware Video Streaming Over A Metro-Scale Optical Network Using A Cross-Layer Architectural Design." *Proceedings of OFC/NFOEC 2011*, paper no. NThC4, March 6-10, 2011, Los Angeles, California.
73. YETGINER, E., ZEYU, L., ROUSKAS, G.N., "RWA in Rings: An Efficient Formulation Based on Maximal Independent Set Decomposition." *Proceedings of IEEE LANMAN 2010*, May 5-7, 2010, Long Beach, New Jersey.
72. LV, Q., ROUSKAS, G.N., "Internet Service Tiering as a Market Segmentation Strategy." *Proceedings of IEEE GLOBECOM 2009*, November 30-December 4, 2009, Honolulu, Hawaii.
71. YETGINER, E., ROUSKAS, G.N., "Power Efficient Traffic Grooming in Optical WDM Networks." *Proceedings of IEEE GLOBECOM 2009*, November 30-December 4, 2009, Honolulu, Hawaii.
70. LV, Q., ROUSKAS, G.N., "An Economic Model for Pricing Tiered Network Services." *Proceedings of IEEE ICC 2007*, June 14-18, 2009, Dresden, Germany.
69. ROUSKAS, G.N., BULLARD, L., CRAIG, A.E., JOINES, J., MILLER, C., MILLER, T., RAUBENHEIMER, D., SILVERBERG, L., WIEBE, E., "Computing Across Curricula: The View of Industry Leaders." In *Proceedings of the 2009 ASEE Annual Conference & Exposition*, June 14-17, 2009, Austin, TX.
68. CASTILLO, C., ROUSKAS, G.N., HARFOUSH, K., "Resource Co-Allocation for Large-Scale Distributed Environments." In *Proceedings of the ACM International Symposium on High Performance Distributed Computing (HPDC 2009)*, June 11-13, 2009, Munich, Germany.
67. VISWANATH, A., SIVARAMAN, V., ROUSKAS, G.N., "Considerations for Sizing Buffers in Optical Packet Switched Networks." *Proceedings of IEEE INFOCOM 2009*, April 19-25, 2009, Rio de Janeiro, Brazil.
66. IYER, M., ROUSKAS, G.N., DUTTA, R., "A Hierarchical Model for Multigranular Optical Networks." In *Proceedings of IEEE BROADNETS 2008*, September 8-11, 2008, London, UK.
65. ROUSKAS, G.N., BULLARD, L., CRAIG, A.E., JOINES, J., MILLER, C., MILLER, T., RAUBENHEIMER, D., SILVERBERG, L., WIEBE, E., "Computing Across Curricula." In *Proceedings of the 2008 ASEE Annual Conference & Exposition*, June 22-25, 2008, Pittsburg, PA.
64. BALDINE, I., CHASE, J., ROUSKAS, G.N., DUTTA, R., "At-Scale Experimentation with Resource Virtualization in a Metro Optical Testbed." *Proceedings of the 2nd International Conference on the Virtual Computing Initiative (ICVCI 2)*, May 15-16, 2008, RTP, NC.
63. LV, Q., ROUSKAS, G.N., "On Optimal Sizing of Tiered Network Services." In *Proceedings of IEEE INFOCOM 2008 (miniconference)*, April 13-18, 2008, Phoenix, Arizona.
62. VISWANATH, A., SIVARAMAN, V., ROUSKAS, G.N., "Are Bigger Optical Buffers Necessarily Better." *Proceedings of IEEE INFOCOM 2008 Student Workshop*, April 13, 2008, Phoenix, Arizona.
61. CASTILLO, C., ROUSKAS, G.N., HARFOUSH, K., "Efficient QoS Resource Management for Heterogeneous Grids." In *Proceedings of the 21st IEEE International Parallel and Distributed Processing Symposium (IPDPS 2008)*, April 14-18, 2008, Miami, Florida.

60. VELLALA, M., WANG, A., ROUSKAS, G.N., DUTTA, R., BALDINE, I., STEVENSON, D., "A Composition Algorithm for the SILO Cross-Layer Optimization Service Architecture." *Proceedings of the Advanced Networks and Telecommunications Systems Conference (ANTS 2007)*, December 17-18, Mumbai, India.
59. STEVENSON, D., DUTTA, R., ROUSKAS, G.N., REEVES, D., BALDINE, I., "On the Suitability of Composable Services for a Next General Assurable Network." *Proceedings of MILCOM 2007*, October 29-31, Orlando, Florida.
58. CASTILLO, C., ROUSKAS, G.N., HARFOUSH, K., "Efficient Implementation of Best-Fit Scheduling for Advance Reservations and QoS in Grids." *Proceedings of the First IEEE/IFIP International Workshop on End-to-end Virtualization and Grid Management (EVGM 2007)*, October 29-30, 2007, San Jose, California. **Best Paper Award.**
57. BALDINE, I., VELLALA, M., WANG, A., ROUSKAS, G.N., DUTTA, R., STEVENSON, D., "A Unified Software Architecture to Enable Cross-Layer Design in the Future Internet." *Proceedings of IEEE ICCCN 2007* August 13-16, 2007, Honolulu, Hawaii.
56. ROUSKAS, G.N., BARADWAJ, N., "TDM Emulation in Packet-Switched Networks." In *Proceedings of IEEE ICC 2007*, June 24-28, 2007, Glasgow, Scotland.
55. ROUSKAS, G.N., DUTTA, R., BALDINE, I., BRAGG, A., STEVENSON, D., "The SILO Architecture for Services Integration, control, and Optimization for the Future Internet." In *Proceedings of IEEE ICC 2007*, June 24-28, 2007, Glasgow, Scotland.
54. DWEKAT, Z., ROUSKAS, G.N., "A Practical and Efficient Fair Implementation of W^2Q+ ." In *Proceedings of IEEE ICC 2007*, June 24-28, 2007, Glasgow, Scotland.
53. CHEN, B., DUTTA, R., ROUSKAS, G.N., "Clustering for Hierarchical Traffic Grooming in Large Scale Mesh WDM Networks." *Proceedings of the 11th Conference on Optical Network Design and Modeling (ONDM 2007)*, pp. 249-258, May 29-31, 2007, Athens, Greece.
52. ROUSKAS, G.N., BARADWAJ, N., "A Framework for Tiered Service in MPLS Networks." In *Proceedings of IEEE INFOCOM 2007*, pp. 1577-1585, May 6-12, 2007, Anchorage, Alaska.
51. CASTILLO, C., ROUSKAS, G.N., HARFOUSH, K., "On the Design of Online Scheduling Algorithms for Advance Reservations and QoS in Grids." In *Proceedings of the 21st IEEE International Parallel and Distributed Processing Symposium (IPDPS 2007)*, March 26-30, 2007, Long Beach, California.
50. YANG, L., ROUSKAS, G.N., "Dynamic Wavelength Sharing Policies for Absolute QoS in OBS Networks." In *Proceedings of IEEE GLOBECOM 2006*, November 27-December 1, 2005, San Jose, CA.
49. YANG, L., ROUSKAS, G.N., "A Framework for Absolute QoS Guarantees in Optical Burst Switched Networks." In *Proceedings of BROADNETS 2006*, pp. 167-176, October 1-5, 2006, San Jose, CA.
48. BENSONG, C., DUTTA, R., ROUSKAS, G.N., "Clustering Techniques for Hierarchical Grooming." In *Proceedings of the Fifth International Symposium on Communications Systems, Networks, and Digital Signal Processing (CSNDSP 2006)*, pp. 55-59, July 19-21, 2006, Patras, Greece. **Best Paper Award.**
47. CHEN, B., ROUSKAS, G.N., DUTTA, R., "A Framework for Hierarchical Traffic Grooming in WDM Networks of General Topology." In *Proceedings of BROADNETS 2005*, October 3-7, pp. 167-176, 2005, Boston, MA.
46. CHEN, B., ROUSKAS, G.N., DUTTA, R., "On the Application of K -Center Algorithms to Hierarchical Traffic Grooming." In *Proceedings of the Traffic Grooming Workshop 2005*, pp. 295-301, October 7, 2005, Boston, MA.

45. BALDINE, I., MEHROTRA, P., ROUSKAS, G.N., BRAGG, A., STEVENSON, D., "An Intra- and Inter-Domain Routing Architecture for Optical Burst Switched (OBS) Networks." In *Proceedings of the Fifth Workshop on Optical Burst/Packet Switching*, pp. 150-159, October 3, 2005, Boston, MA.
44. YANG, L., ROUSKAS, G.N., "Path Switching in Optical Burst Switched Networks." In *Proceedings of NETWORKING 2005*, LNCS 3462, pp. 406-418, May 2-6, 2005, Waterloo, Canada.
43. TENG, J., ROUSKAS, G.N., "Routing Optimization in Optical Burst Switched Networks." In *Proceedings of the 9th Conference on Optical Network Design and Modeling (ONDM 2005)*, pp. 1-10, February 7-9, 2005, Milan, Italy.
42. TENG, J., ROUSKAS, G.N., "On Wavelength Assignment in Optical Burst-Switched Networks." In *Proceedings of BROADNETS 2004*, pp. 24-33, October 25-29, 2004, San Jose, California.
41. XIN, Y., TENG, J., KARMOUS-EDWARDS, G., ROUSKAS, G.N., STEVENSON, D., "Fault Management with Fast Restoration for Optical Burst Switched Networks." In *Proceedings of BROADNETS 2004*, pp. 34-42, October 25-29, 2004, San Jose, California.
40. CHEN, B., ROUSKAS, G.N., DUTTA, R., "Traffic Grooming in WDM Star Networks." In *Proceedings of the Traffic Grooming Workshop 2004*, October 29, 2004, San Jose, California.
39. XIN, Y., TENG, J., KARMOUS-EDWARDS, G., ROUSKAS, G.N., STEVENSON, D., "A Novel Fast Restoration Mechanism for Optical Burst Switched Networks." In *Proceedings of the Third Workshop on Optical Burst Switching*, October 25, 2004, San Jose, California.
38. CHEN, B., ROUSKAS, G.N., DUTTA, R., "Traffic Grooming in WDM Ring Networks with the Min-Max Objective." In *Proceedings of NETWORKING 2004*, LNCS 3042, pp. 174-185, May 9-14, 2004, Athens, Greece.
37. XIN, Y., ROUSKAS, G.N., "Light-Tree Routing Under Optical Layer Power Constraints." *Proceedings of IEEE INFOCOM 2004*, pp. 2731-2742, March 7-11, 2004, Hong Kong.
36. DUTTA, R., HUANG, S., ROUSKAS, G.N., "On Optimal Traffic Grooming in Elemental Network Topologies." In *Proceedings of OPTICOMM 2003*, pp. 13-24, October 15-18, 2003, Dallas, Texas.
35. TENG, J., ROUSKAS, G.N., "A Comparison of the JIT, JET, and Horizon Wavelength Reservation Schemes on A Single OBS Node." In *Proceedings of the First International Workshop on Optical Burst Switching*, October 16, 2003, Dallas, Texas.
34. XU, L., PERROS, H.G., ROUSKAS, G.N., "Performance Analysis of an Edge Optical Burst Switching Node with A Large Number of Customers." In *Proceedings of the 18th International Teletraffic Congress (ITC 18)*, September 1-5, 2003, Berlin, Germany.
33. ROUSKAS, G.N., JACKSON, L.E., "Optimal Granularity of MPLS Tunnels." In *Proceedings of the 18th International Teletraffic Congress (ITC 18)*, September 1-5, 2003, Berlin, Germany.
32. DUTTA, R., HUANG, S., ROUSKAS, G.N., "Traffic Grooming in Path, Star, and Tree Networks: Complexity, Bounds, and Algorithms." In *Proceedings of ACM SIGMETRICS 2003*, pp. 298-299, June 10-14, 2003, San Diego, CA.
31. XU, L., PERROS, H.G., ROUSKAS, G.N., "A Queueing Network Model of an Edge Optical Burst Switching Node." In *Proceedings of IEEE INFOCOM 2003*, pp. 2019-2029, April 1-3, 2003, San Francisco, CA.
30. XIN, Y., ROUSKAS, G.N., PERROS, H.G., "Design of Large-Scale Optical Networks." In *Proceedings of the 14th IASTED International Conference on Parallel and Distributed Computing and Systems*, pp. 822-827, November 4-6, 2002, Cambridge MA.

29. XU, L., PERROS, H.G., ROUSKAS, G.N., "Performance Modeling of an Edge Optical Burst Switching Node." In *Proceedings of the 17th International Symposium on Computer and Information Sciences*, pp. 377-381, October 28-30, 2002, Orlando, FL.
28. ZAIM, A.H., BALDINE, I., CASSADA, M., ROUSKAS, G.N., PERROS, H.G., STEVENSON, D., "Formal Description of the **Jumpstart** Just-In-Time Signaling Protocol Using EFSM." In *Proceedings of OPTICOMM 2002*, pp. 160-173, July 29-31, 2002 Boston, MA.
27. ZAIM, A.H., PERROS, H.G., ROUSKAS, G.N., "Performance Analysis of LEO Satellite Networks." In *Proceedings of NETWORKING 2002*, LNCS 2345, pp. 790-801, Pisa, Italy, May 19-24, 2002.
26. XU, L., PERROS, H.G., ROUSKAS, G.N., "A Simulation Study of Access Protocols for Optical Burst-Switched Ring Networks." In *Proceedings of NETWORKING 2002*, LNCS 2345, pp. 863-874, Pisa, Italy, May 19-24, 2002.
25. BALDINE, I., JACKSON, L.E., ROUSKAS, G.N., "**Helios**: A Broadcast Optical Architecture." In *Proceedings of NETWORKING 2002*, LNCS 2345, pp. 887-898, Pisa, Italy, May 19-24, 2002.
24. BALDINE, I., ROUSKAS, G.N., PERROS, H.G., STEVENSON, D. "**Jumpstart**: A Just-In-Time Signaling Architecture for WDM Burst-Switched Networks." In *Proceedings of NETWORKING 2002*, LNCS 2345, pp. 1081-1086, Pisa, Italy, May 19-24, 2002.
23. ZAIM, A.H., ROUSKAS, G.N., PERROS, H.G., "Computing Call Blocking Probabilities in LEO Satellite Networks: The Single Orbit Case." In *Proceedings of the 17th International Teletraffic Congress (ITC 17)*, pp. 505-516, December 3-7, 2001, Salvador da Bahia, Brazil.
22. BAMPIS, E., ROUSKAS, G.N., "On Scheduling Problems with Applications to Packet-Switched Optical WDM Networks." In *Proceedings of OPTICOMM 2001*, pp. 163-172, August 19-24, Denver, Colorado.
21. DUTTA, R., ROUSKAS, G.N., "On Optimal Traffic Grooming in WDM Rings." In *Proceedings of ACM SIGMETRICS/PERFORMANCE 2001*, pp. 164-174, June 16-20, 2001, Cambridge, MA.
20. ZHU, Y., ROUSKAS, G.N., PERROS, H.G., "A Comparison of Allocation Policies in Wavelength Routing Networks." In *Proceedings of the SPIE conference on Terabit Optical Networking: Architecture, Control and Management Issues*, vol. 4123, pp. 64-72, November 6-7, 2000, Boston, MA.
19. RAMESH, S., ROUSKAS, G.N., PERROS, H.G., "Computing Blocking Probabilities in Multi-Class Wavelength Routing Networks." In *Proceedings of NETWORKING 2000*, LNCS 1815, pp. 176-188, May 14-19, 2000, Paris, France.
18. ZHU, Y., ROUSKAS, G.N., PERROS, H.G., "Blocking in Wavelength Routing Networks, Part II: Mesh Topologies." In *Proceedings of the 16th International Teletraffic Congress (ITC 16)*, pp. 1321-1330, June 7-11, 1999, Edinburgh, UK.
17. BALDINE, I., ROUSKAS, G.N., "Dynamic Reconfiguration Policies for Broadcast WDM Networks." In *Proceedings of IEEE INFOCOM '99*, pp. 313-320, March 21-25, 1999, New York.
16. ZHU, Y., ROUSKAS, G.N., PERROS, H.G., "Blocking in Wavelength Routing Networks, Part I: The Single Path Case." In *Proceedings of IEEE INFOCOM '99*, pp. 321-328, March 21-25, 1999, New York.
15. RHEE, I., BALAGURU, N., ROUSKAS, G.N., "MTCP: Scalable TCP-like Congestion Control for Reliable Multicast." In *Proceedings of IEEE INFOCOM '99*, pp. 1265-1273, March 21-25, 1999, New York.

14. BALDINE, I., ROUSKAS, G.N., "On the Design of Dynamic Reconfiguration Policies for Broadcast WDM Networks." In *Proceedings of the SPIE conference on All-Optical Networking: Architecture, Control and Management Issues*, vol. 3531, pp. 146-157, November 3-5, 1998, Boston, MA. **Best Paper Award.**
13. MCKINNON, M.W., ROUSKAS, G.N., PERROS, H.G., "Queueing-Based Analysis of Broadcast Optical Networks." In *Proceedings of ACM SIGMETRICS/PERFORMANCE '98*, pp. 121-130, June 22-26, 1998, Madison, Wisconsin.
12. BALDINE, I., ROUSKAS, G.N., "Dynamic Load Balancing in Broadcast WDM Networks with Tuning Latencies." In *Proceedings of IEEE INFOCOM '98*, pp. 78-85, March 29-April 1, 1998, San Francisco, California.
11. ORTIZ-LAUREANO, Z., ROUSKAS, G.N., PERROS, H.G., "Scheduling Combined Unicast and Multicast Traffic in Broadcast WDM Networks." In *Proceedings of the 1998 IFIP Conference on Performance of Information and Communications Systems (PICS '98)*, pp. 137-150, May 25-28, 1998, Lund, Sweden.
10. ORTIZ-LAUREANO, Z., ROUSKAS, G.N., PERROS, H.G., "Scheduling of Multicast Traffic in Tunable-Receiver WDM Networks with Non-Negligible Tuning Latencies." In *Proceedings of ACM SIGCOMM '97*, pp. 301-310, September 16-18, 1997, Cannes, France.
9. SIVARAMAN, V., ROUSKAS, G.N., "HiPeR- ℓ : A High Performance Reservation Protocol with ℓ look-ahead for Broadcast WDM Networks." In *Proceedings of IEEE INFOCOM '97*, pp. 1272-1279, April 7-11, 1997, Kobe, Japan.
8. ROUSKAS, G.N., SIVARAMAN, V., "On the Design of Optimal TDM Schedules for Broadcast WDM Networks with Arbitrary Tuning Latencies." In *Proceedings of IEEE INFOCOM '96*, pp. 1217-1224, March 24-28, 1996, San Francisco, California.
7. ROUSKAS, G.N., BALDINE, I., "Multicast Routing with End-to-End Delay and Delay Variation Constraints." In *Proceedings of IEEE INFOCOM '96*, pp. 353-360, March 24-28, 1996, San Francisco, California.
6. ROUSKAS, G.N., AMMAR, M.H., "Minimizing Delay and Packet Loss in Single-Hop Lightwave WDM Networks Using TDM Schedules." In *Proceedings of IEEE ICC '95*, pp. 1267-1271, June 19-21, 1995, Seattle, Washington.
5. ROUSKAS, G.N., AMMAR, M.H., "Multi-Destination Communication Over Single-Hop Lightwave WDM Networks." In *Proceedings of IEEE INFOCOM '94*, pp. 1520-1527, June 14-16, 1994, Toronto, Ontario, Canada.
4. ROUSKAS, G.N., AMMAR, M.H., "Dynamic Reconfiguration in Multihop WDM Networks." In *Proceedings of ICCCN '94*, pp. 391-395, September 11-14, 1994, San Francisco, California.
3. ROUSKAS, G.N., AMMAR, M.H., "Analysis and Optimization of Transmission Schedules for Single-Hop WDM Networks." In *Proceedings of IEEE INFOCOM '93*, pp. 1342-1349, March 30 - April 1, 1993, San Francisco, California.
2. ROUSKAS, G.N., AMMAR, M.H., "On the Design of Dynamic Configuration Policies for Multihop WDM Networks." In *Proceedings of Photonics '93*, September 1993, Atlanta, GA.
1. AMMAR, M.H., ROUSKAS, G.N., "On the Design of Protocols for Collecting Responses over a Multiple-Access Channel." In *Proceedings of IEEE INFOCOM '91*, pp. 1490-1499, March 1991, Miami, Florida.

Conference Proceedings (invited)

18. ROUSKAS, G.N., BANDIKATLA, C., "Scalable Recursive First Fit: An Optimal Solution to the Spectrum Allocation Problem." *Proceedings of the 25th Conference on Optical Network Design and Modeling (ONDM 2018)*, June 28-July 1, 2021, Gothenburg, Sweden.
17. BHAT, S., ROUSKAS, G.N., "Open Marketplace and Service Orchestration for Virtual Optical Networks." *Proceedings of the 22nd Conference on Optical Network Design and Modeling (ONDM 2018)*, May 14-17, 2018, Dublin, Ireland.
16. TALEBI, S., FURQAN, A., KATIB, I., ROUSKAS, G.N., "Spectrum Assignment in Rings With Shortest Path Routing: Complexity and Approximation Algorithms." *Proceedings of the International Conference on Computing, Networking and Communications (ICNC 2015)*, February 16-19, 2015, Anaheim, California.
15. DUTTA, R., ROUSKAS, G.N., BALDIN, I., "Traffic Grooming: Balancing Choice and Service in Optical Networks." *Proceedings of Advanced Photonics for Communications*, July 13-17, 2014, San Diego, California.
14. DUTTA, R., ROUSKAS, G.N., BALDINE, I., "Converging Choice and Service in Future Commodity Optical Networks Using Traffic Grooming." *Proceedings of 15th International Conference on Transparent Optical Networks (ICTON 2013)*, June 23-27, 2013, Cartagena, Spain.
13. ROUSKAS, G.N., BALDINE, I., CALVERT, K., DUTTA, R., GRIFFIOEN, J., NAGURNEY, A., WOLF, T., "ChoiceNet: Network Innovation Through Choice." *Proceedings of the 17th Conference on Optical Network Design and Modeling (ONDM 2013)*, April 16-19, 2013, Brest, France.
12. WANG, H., LIU, Z., ROUSKAS, G.N., "Scalable Traffic Grooming in Optical Networks." *Proceedings of Asia Communications and Photonics Conference (ACP 2012)*, November 7-10, 2012, Guangzhou, China.
11. DUTTA, R., BALDINE, I., WANG, A., IYER, M., ROUSKAS, G.N., "Architectural Support for Internet Evolution and Innovation." *Proceedings of IEEE ANTS 2010*, December 16-18, 2010, Mumbai, India.
10. KARMOUS-EDWARDS, G., VISWANATH, A., REEVES, D.S., BATTISTILLI, L., VEGESNA, P., ROUSKAS, G.N. "ERONS: Dynamic Lightpath Networking via Overlay Control of Static Optical Connections." *Proceedings of the 11th Conference on Optical Network Design and Modeling (ONDM 2009)*, February 18-20, 2009, Braunschweig, Germany.
9. ROUSKAS, G.N., DUTTA, R., BALDINE, I. "A New Internet Architecture to Enable Software Defined Optics and Evolving Optical Switching Models." *Proceedings of the 8th Workshop on Optical Burst/Packet Switching (WOBS 2008)*, September 8, 2008, London, UK.
8. IYER, M., ROUSKAS, G.N., DUTTA, R., "Hierarchical Grooming in Multigranular Networks." *Proceedings of the Advanced Networks and Telecommunications Systems Conference (ANTS 2007)*, December 17-18, Mumbai, India.
7. ROUSKAS, G.N., "Tiered Service in Packet-Switched Networks." In *Proceedings of the IEEE Computer Communications Workshop*, February 5-7, 2006, Pittsburgh, PA.
6. ROUSKAS, G.N., "Multicast Routing Under Optical Layer Constraints." In *Proceedings of the IEEE Computer Communications Workshop*, October 13-16, 2002, Santa Fe, New Mexico.
5. ROUSKAS, G.N., "Jumpstart: A Just-in-Time Signaling Architecture for WDM Burst-Switched Networks." In *Proceedings of the IEEE LEOS Summer Topicals*, July 15-17, 2002, Mont Tremblant, Quebec, Canada.

4. XU, L., PERROS, H.G., ROUSKAS, G.N., "Access Protocols for Optical Burst-Switched Ring Networks." In *Proceedings of the 6th Joint Conference on Information Sciences (JCIS 2002)*, pp. 1287-1290, March 8-13, 2002, RTP, North Carolina.
3. DUTTA, R., ROUSKAS, G.N., "Bounds on Traffic Grooming in Star and Tree Networks." In *Proceedings of the 39th Allerton Conference on Communication, Control, and Computing*, October 3-5, Monticello, Illinois, 2001.
2. DUTTA, R., ROUSKAS, G.N., "Topology Design in WDM Rings to Minimize Electronic Routing: Efficient Computation of Tight Bounds." In *Proceedings of the 38th Allerton Conference on Communication, Control, and Computing*, pp. 1284-1293, October 4-6, Monticello, Illinois, 2000.
1. ROUSKAS, G.N., "A Comparison of Allocation Policies in Wavelength Routing Networks." In *Proceedings of the 37th Allerton Conference on Communication, Control, and Computing*, pp. 669-678, September 22-24, Monticello, Illinois, 1999.

Tutorials

4. ROUSKAS, G.N., "Tutorial on Network Virtualization." Presented at the *OFC 2012* Conference, March 2012, Los Angeles, California.
3. ROUSKAS, G.N., "Tutorial on Traffic Grooming and Multigranular Switching in Optical WDM Networks." Presented at the *NETWORKING 2004* Conference, May 9, 2004, Athens, Greece.
2. ROUSKAS, G.N., "Tutorial on Traffic Grooming and Multigranular Switching in Optical WDM Networks." Presented at the *IEEE INFOCOM 2004* Conference, March 7, 2004, Hong Kong.
1. ROUSKAS, G.N., PERROS, H.G., "Tutorial on Optical Networks." In E. Gregori *et al.*, (editors), *Advanced Lectures on Networking: Networking 2002 Tutorials*, Springer-Verlag LNCS 2497, pp. 155-193, 2002. Presented at the *NETWORKING 2002* Conference, May 19, 2002, Pisa, Italy.

Keynotes, Distinguished Lectures, and Panels

- Distinguished Lecture (virtual), Institute of Broadband Research and Innovation, Soochow University, China, October 2021.
- Distinguished Lecture (virtual), Istanbul Commerce University, Turkey, May 2021.
- Distinguished Lecture (virtual), Department of Computer and Information Sciences, Temple University, February 2021.
- Distinguished Lecture (virtual), School of Science, Beijing University of Posts and Telecommunications, Beijing, China, September 2020.
- Distinguished Lecture, CE Department, National Technical University of Athens, June 2019
- Distinguished Lecture, CSE Department, University at Buffalo, April 2019
- Panel on "Innovation Opportunities in Transport Networks from Network Analytics and Machine Learning." OFC 2019, March 2019.
- Panel on "Future Directions for IoT." IEEE MASS 2018, October 2018.
- Distinguished Lecture, East Carolina University, April 2017

- Distinguished Lecture, National Conference for Colleges of Computing (NC3), Jeddah, Saudi Arabia, February 2016
- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, April 2015
- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, February 2014
- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, May 2013
- CS Distinguished Lecture, Iowa State University, April 2012
- Panel on “Future Internet: Do We Need Fundamentally New Designs?.” IEEE LANMAN workshop, Chapel Hill, NC, October 2011
- Keynote, ICIIS Conference, Kandy, Sri Lanka, August 2011
- IEEE Distinguished Lecture, University of Colombo, Sri Lanka, August 2011
- IEEE Distinguished Lecture, University of Moratuwa, Sri Lanka, August 2011
- IEEE Distinguished Lecture, The University of West Indies, Kingston, Jamaica, May 2011
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Orlando, FL, May 2011
- IEEE Distinguished Lecture, University of Alabama at Huntsville, Huntsville, AL, May 2011
- IEEE Distinguished Lecture, University of Alabama at Birmingham, Birmingham, AL, October 2010
- IEEE Distinguished Lecture, Verizon, Temple Terrace, FL, October 2010
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Orlando, FL, October 2010
- IEEE Distinguished Lecture, AT&T Research, Middletown, NJ, August 2010
- IEEE Distinguished Lecture, DRS Technologies, Gaithersburg, MD, August 2010
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Baltimore, MD, August 2010
- Keynote, INFORMS Telecom, Montreal, Canada, May 2010
- Panel, OFC Conference, San Diego, CA, March 2010
- Keynote, Euro-NGI Conference, Aveiro, Portugal, July 2009
- Distinguished Lecture, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, November 2008
- Distinguished Presentation, IEEE ICCCN Conference, Saint Thomas, August 2008
- Keynote, 5th Workshop on Optimization of Optical Networks, Montreal, Canada, May 2008
- Panel, ONDM Conference, Vilanova i la Geltru, Spain, March 2008
- Panel, BROADNETS conference, San Jose, CA, October 2006
- Distinguished Lecture, University of Evry, France, July 2006
- Panel, UNC Teaching and Learning with Technology (TLT) conference, Chapel Hill, NC, March 2006
- Distinguished Lecture, Carleton University, Canada, December 2005
- Distiguished Lecture, National Technical University of Athens, Greece, June 2004
- Distiguished Lecture, Athens Institute of Technology, Greece, June 2004
- Distiguished Lecture, University of Patras, Greece, May 2004

Funded Research Proposals and Grants

CNS Core:Small:On Parallelizing Optical Network Design Problems:Towards Network Optimization as a Service (PI: Rouskas)
National Science Foundation
Amount: \$440,000, October 2019-September 2022

Graduate Industrial Traineeships (PI: Rouskas)
SAS, Genworth, RENCI
Amount: \$460,000, June 2014-May 2020

Cisco Internship Program (PIs: Rouskas, Ning)
Cisco
Amount: \$160,000, May 2011-December 2012

NeTS: Large: Collaborative Research: ChoiceNet: Network Innovation Through Choice (NC State PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$643,917 (total budget: \$2.732M), September 2011-December 2015

NeTS: Small: Computationally Scalable Aware Optical Network design (PI: Rouskas)
National Science Foundation
Amount: \$430,000, August 2011-July 2016

SURFnet GigaPort3 Research Plan (PIs: Rouskas, Karmous-Edwards)
SURFnet
Amount: \$280,000, July 2009-May 2012

GENI IMF: Integrated Measurement Framework and Tools for Cross Layer Experimentation (PIs: Dutta, Rouskas)
GENI Program Office
Amount: \$420,000, October 2009-September 2012

Edge Reconfigurable Optical Networks (ERONs) for High-Performance Applications (PIs: Rouskas, Reeves)
DARPA
Amount: \$250,000, July 2008- December 2009

CPATH-CB: Computing Across Curricula
National Science Foundation
Amount: \$275,000, July 2007-June 2010

An Intelligent Second-Life VCL-Based Computing Lab (PIs: Rouskas, Young)
IBM Faculty Award
\$30,000, July 2007

Lambda Scheduling for Grid Applications
NC State Center for Advanced Computing and Communication (CACC)
Amount: \$40,000, July 2007-June 2008

Learning with In-class Technology (LIT): The 15-Minute Learning Module Approach
NC State LITRE
Amount: \$8,000, June 2006-May 2007

Collaborative Research: NeTS-FIND: The SILO Architecture for Services Integration, controL, and Optimization for the Future Internet (PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$228,000 (total budget: \$408,000), September 2006-May 2010

Integration of Network Survivability Concepts in an MS in Computer Networking Curriculum (PIs: Dutta, Rouskas)
Microsoft Trustworthy Computing Curriculum
Amount: \$50,000, January 2006-December 2006

Traffic Quantization: A Formal Approach To Scalability in Packet-Switched Networks
National Science Foundation
Amount: \$357,000, September 2004-August 2009

A Formal Approach to Traffic Grooming in Optical Networks with General Topologies (PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$405,000, September 2003-August 2006

Transparent Optical Network Management and Routing with Just In Time Signaling (PIs: Rouskas, Perros)
NSA LTS
Amount: \$327,000 (total budget: \$1,350,000), January 2003-December 2004

Optical Network Lab Equipment
MCNC-RDI
Amount: \$640,000 (six Optera WDM switches with SONET and Gigabit Ethernet interfaces), August 2003

Engineering Online Student Access to Internet Lab
NC State DELTA
Amount: \$10,000, January 2003-June 2003

Access Protocols for Multicasting in an Optical Burst Switching Metro Ring (PIs: Perros, Rouskas)
Alcatel
Amount: \$45,000, January 2002-September 2003

Performance Analysis and Alternate Routing for Just In Time Optical Burst Switching Networks (PIs: Rouskas, Perros, Franzon)
NSA LTS
Amount: \$437,000 (total budget: \$1,500,000), January 2002-June 2003

Performance Evaluation of IPv6 Tunneling
IBM Faculty Award (PIs: Devetsikiotis, Rouskas)
Amount: \$40,000, July 2001

Research in Optical Burst Switching (PIs: Perros, Rouskas)
NC State Center for Advanced Computing and Communications (CACC)
Amount: \$43,000, July 2001-June 2002

Multicast Support for Just In Time Optical Burst Switching Networks (PIs: Rouskas, Perros)
NSA LTS
Amount: \$70,000 (total budget: \$500,000), October 2000-March 2001

Project: Optical Burst-Switched Ring Networks (PIs: Perros, Rouskas)
NC State Center for Advanced Computing and Communications (CACC)
Amount: \$35,000, July 2000-June 2001

Regional Testbed Optical Access Network for IP, Multicast, and Differentiated Services
DARPA Next Generation Internet (NGI) Program
Amount: \$214,000 (total budget: \$1,800,000), March 2000-March 2002

Networking Lab Equipment

HP U.S. University Equipment Grants

Amount: \$159,190 (50 HP Kayak workstations and 3 laser printers), December 1999

Internet Teaching Lab

CAIDA Internet Teaching Laboratories (ITL) Initiative

Amount: \$100,000 (4 Cisco Routers)i, October 1999

Performance Analysis of Wavelength Routed Wide Area Networks (PIs: Rouskas, Perros)

National Science Foundation

Amount: \$255,000, September 1998-August 2002

MTCP: TCP-like Congestion Control for Reliable Multicast (PIs: Rhee, Rouskas)

NC State Center for Advanced Computing and Communications (CACC)

Amount: \$78,000, July 1998-June 2000

Towards an All-Optical Network Infrastructure: Interconnection of Photonic WDM Broadcast-and-Select Local Area Networks

National Science Foundation (CAREER)

Amount: \$200,000, September 1997-August 2002

All-Optical Solutions to ATM Switching

NC State Center for Advanced Computing and Communications (CACC)

Amount: \$40,000, July 1995-June 1996

Multicasting for Multimedia Applications

NC State Faculty Development and Research Support

Amount: \$5,000, January 1995-June 1995

III. Leadership and Service

Society Memberships

FELLOW, Institute of Electrical and Electronics Engineers, Communications Society

MEMBER, Association for Computing Machinery, also Special Interest Group on Computer Communications

IEEE Leadership

CHAIR, IEEE Communications Society Distinguished Lecturer Selection Committee, 2016-2017

VICE CHAIR, IEEE Communications Society Technical and Educational Activities Council, 2016-2017

VICE CHAIR, IEEE Communications Society TCs Recertification Committee, 2016-2017

CHAIR, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2016-2017

VICE CHAIR, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2014-2015

SECRETARY, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2012-2013

Technical Journal Leadership

FOUNDING EDITOR-IN-CHIEF, *IEEE Networking Letters*, 2018-2021

FOUNDING EDITOR-IN-CHIEF, *Optical Switching and Networking*, Elsevier, 2004-2017

Conference Committee Leadership

AWARDS CHAIR, *IEEE GLOBECOM 2023*, Kuala Lumpur, Malaysia, December 4-8, 2024.

EXECUTIVE CHAIR, *ICCCN 2023*, Honolulu, Hawaii, July 24-26, 2023.

MEMBER, STEERING COMMITTEE, *OFC Conference*, 2018-2023

EXECUTIVE CHAIR, *ICCCN 2022*, Honolulu, Hawaii (virtual conference), July 25-27, 2022.

TPC CO-CHAIR, *DRCN 2022*, Vilanova, Spain, March 28-31, 2022.

TPC CO-CHAIR, *IEEE MeditCom 2021*, Athens, Greece, September 7-10, 2021.

GENERAL CHAIR, *ICCCN 2021*, Athens, Greece (virtual conference), July 19-22, 2021.

CHAIR, STEERING COMMITTEE, *IEEE LANMAN*, 2015-2018

GENERAL CO-CHAIR, *IEEE MASS 2018*, Chengdu, China, October 9-12, 2018.

PROGRAM CO-CHAIR, *IEEE ICC 2017, Optical Networks and Systems (ONS) Symposium*, Paris, France, May 21-25, 2017.

GENERAL CO-CHAIR, *IEEE ICNP 2014*, Raleigh, NC, October 21-24, 2014.

GENERAL CHAIR, *ICCCN 2013*, Nassau, Bahamas, July 30-August 2, 2013.

PROGRAM CO-CHAIR, *ICCCN 2011*, Maui, Hawaii, August 1-4, 2011.

PROGRAM CO-CHAIR, *IEEE Globecom 2010, Optical Networks and Systems (ONS) Symposium*, Miami, FL, November 28-December 3, 2010.

PROGRAM CO-CHAIR, *ICCCN 2009, Internet Services, Systems and Applications (ISSA) Track*, San Francisco, CA, August 2-6, 2009.

GENERAL CO-CHAIR, *International Conference on Broadband Communications, Networks, and Systems (BROADNETS 2007)*, Raleigh, NC, September 10-13, 2007

GENERAL CO-CHAIR, *14th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2005)*, Chania, Crete, Greece, September 18-21, 2005.

PROGRAM CO-CHAIR, *Workshop on Traffic Grooming (WTG 2004)*, October 29, 2004, San Jose, CA

TECHNICAL PROGRAM CHAIR, *13th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2004)*, April 25-28, 2004, San Francisco, CA

TECHNICAL PROGRAM CO-CHAIR, *IFIP Networking 2004*, May 9-14, 2004, Athens, Greece

Editorial and Review Work for Technical Journals and Publishers

ASSOCIATE EDITOR, *IEEE/OSA Journal of Communications and Networking*, 2010-2012

CO-GUEST EDITOR, *JCM Journal of Communications*, Special Issue on the “Advances in Communications and Networking,” vol. 6, no. 9, December 2011.

ASSOCIATE EDITOR, *IEEE/ACM Transactions on Networking*, 2000-2004

ASSOCIATE EDITOR, *Computer Networks*, 2001-2004

ASSOCIATE EDITOR, *Optical Networks*, 2000-2004

CO-GUEST EDITOR, *IEEE Journal on Selected Areas in Communications*, Special Issue on “Protocols for Next Generation Optical WDM Networks,” vol. 18, no. 10, October 2000.

REVIEWER, Morgan Kaufmann, John Wiley and Sons, Cambridge University Press, Springer, IEEE Transactions on Networking, IEEE Transactions on Computers, IEEE Transactions on Communications, IEEE/OSA Journal of Lightwave Technology, IEEE/OSA Journal of Optical Communications and Networking, IEEE Journal on Selected Areas in Communications, Computer Networks Journal, International Journal of Performance Evaluation, European Transactions on Telecommunications, Photonic Network Communications Journal, IEEE Computer Magazine, IEEE Communications Magazine, IEEE Network Magazine, and numerous conferences

PROPOSAL REVIEW PANELIST, National Science Foundation – on numerous occasions

Conference Program Committees

IEEE GLOBECOM: 2003-2023

IEEE ICC: 2003-2023

IEEE LANMAN: 2007-2023

IEEE INFOCOM: 2007-2013, 2004, 1996-1998
ONDM: 2014-2023, 2009, 2005
IFIP NETWORKING: 2023, 2019, 2005-2012
OSA NETWORKS: 2017-2019
OFC/NFOEC: 2008-2010
Euro NGI: 2008-2011
EuCNC: 2015-2017
ACM CoNEXT Cloud Assisted Networking: 2016-2017
TEMU: 2012-2016
Networks: 2008-2016
DRCN: 2019-2021, 2015, 2011
NOC: 2014-2015
IEEE NFV-SDN: 2015
ITC: 2013
IEEE ICNP: 2013, 2008, 1997
ICCCN: 2012, 2006
ICNC: 2020, 2012
IEEE ANTS: 2011, 2009, 2008
RNDM: 2010-2011
ACP: 2010
ReArch Workshop: 2009-2010
INFORMS Telecom: 2010
WOBS: 2009, 2003-2005
BROADNETS: 2004-2006
IEEE HPSR Workshop: 2019, 2003-2005
OPTiCOMM: 2000-2003
SPIE Conference on All-Optical Networking: 1998-1999

NC State: University Committees

MEMBER, Administrative Board of the Graduate School (ABGS), 2016-2018
JUDGE, Graduate Student Research Symposium, 2018, 2014
MEMBER, Microsoft Research Faculty Fellowship Review Committee, 2012-2013
MEMBER, DELTA IDEA grant review committee, 2004-2005
MEMBER, DELTA Advisory Committee, 2003-2005
CHAIR, DELTA Subcommittee on Intellectual Property, 2003-2005
MEMBER, Alumni Outstanding Research Awards Selection Committee, 2004

NC State: College of Engineering Committees

MEMBER, University Faculty Scholar Selection Committee, 2012-2014
MEMBER, ALCOA Awards Committee, 2012-2013
MEMBER, College Reappointment, Promotion, and Tenure (RPT) Committee, 2008-2011
textscMember, College Research Committee, 2007-2008
MEMBER, CSC Head Search Committee, 2004-2006
MEMBER, Engineering Online Advisory Committee, 2003-2005
MEMBER, CSC Review Survey Committee, 1998-1999
MEMBER, Admissions Standards Committee, MS in Computer Networking, 1998-1999

NC State: Department of Computer Science Committees

CHAIR, Networking faculty search committee, 2021-2022
MEMBER, Reappointment, Promotion, and Tenure (RPT) Committee, 2017-present
CHAIR, Strategic Planning Committee, 2009-2012
MEMBER, Graduate Student Admissions Committee, 2011-2012
MEMBER, Awards Committee, 2009-2012
MEMBER, Faculty Recruiting Committee, 2008-2009
COURSE COORDINATOR, CSC 316 (Data Structures), 2005-2017
MEMBER, Computing Infrastructure Committee, 2006-2010
CHAIR, Minority Recruiting Committee, 2006-2007
MEMBER, Committee for External Evaluation Visit, Fall 2004
MEMBER, Strategic Planning Committee, 2003-2004
MEMBER, Research Productivity Committee, 2003-2004

MEMBER, Strategic Planning Committee, 2002-2005

CHAIR, Faculty Recruiting Committee, 2001-2002

CHAIR, Faculty Recruiting Committee, 2000-2001

PEER EVALUATOR, 23 teaching evaluations, 1999-present

MEMBER, Graduate Student Admissions Committee, 1996-1998

MEMBER, PhD Qualifying Exam Committee, 1994-1996

NC State: Operations Research and ECE Committees

MEMBER, OR Graduate Student Admissions Committee, 2012-2013, 2005-2007

MEMBER, ECE Faculty Recruiting Committee, 1999-2000

Other National and International Activities

MEMBER, International Advisory Committee, Scuola Superiore Sant'Anna, Pisa, Italy, 2013-2014

MEMBER, Committee of Visitors (CoV), DoE Networking Research Program, 2011

MEMBER, Best Paper Award Committees

IEEE ICC, 2021

IEEE/OSA Journal of Optical Communications and Networking, Charles Kao Award, 2015-2017

IEEE ICC, 2016

ICNC, 2015

ACP, 2012, 2009

IEEE INFOCOM, 2011

IEEE ANTS, 2010

IEEE FELLOW NOMINATOR, four cases, 2018-present

IEEE FELLOW REFERENCE, 19 cases, 2012-present

EXTERNAL REVIEWER for the promotion to Full Professor, 26 cases, 2004-present

EXTERNAL REVIEWER for the promotion to Associate Professor with tenure, 29 cases, 2000-present

George N. Rouskas
Technical Expert Experience

Cisco Systems et al. v. Corrigent Corp, IPR2023-00168.

Cisco Systems v. Corrigent Corp, IPR2023-00447.

Arista Networks v. Corrigent Corp, IPR2023-00839.

Evaluated two families of patents relating to link aggregation and network latency evaluation, respectively, analyzed prior art and petitioner's arguments, prepared expert declarations, assisted with the patent owner (Corrigent) reply, provided deposition testimony, and assisted with patent owner sur-reply.

MPH Technologies OY v. Apple Inc., United States District Court for the Northern District of California, Civil Action No. 3:18-cv-05935.

Involved in all aspects of litigation including: development of infringement charts for a wide range of products, prior art and invalidity analysis for a number of products, claim construction, deposition of opposing experts, source code inspection and analysis, and infringement under the doctrine of equivalents. Ongoing.

Epic v. IngenioShare, IPR2022-00202, IPR2022-000291, IPR2022-000294, IPR2022-000295.

Evaluated a family of patents relating to portal-based Internet communications, analyzed prior art and petitioner's arguments, prepared expert declarations, assisted with the patent owner (IngenioShare) reply, provided deposition testimony (over two days), and assisted with oral argument preparations. IngenioShare won all four IPRs. Infringement case ongoing.

Microsoft/Apple v. Zipit, IPR2021-01129, IPR2021-01130, IPR2021-01131.

Evaluated a family of patents relating to instant messaging, analyzed prior art and petitioner's arguments, prepared expert declarations, assisted with the patent owner (Zipit) reply and sur-reply, provided deposition testimony, and assisted with oral argument preparations. Settled with Microsoft. Infringement case against Apple ongoing.

Huawei Technologies v. Verizon, IPR2021-00616, IPR-2021-00616.

Evaluated one family of patents relating to optical transport network (OTN) technologies and prepared expert declarations on behalf of plaintiff Huawei Technologies. Settled.

Verizon v. Huawei Technologies, IPR2020-01292, IPR-2020-1291, IPR2020-01290, IPR2020-01278.

Evaluated two families of patents relating to optical transport network (OTN) technologies, prepared expert declarations, and assisted with the patent owner (Huawei Technologies) reply. Institution of IPR denied.

Apple Inc v. MPH Technologies OY, IPR2019-00819, IPR2019-00820, IPR2019-00821, IPR2019-00823, IPR2019-00824, IPR2019-00826.

Evaluated two families of patents relating to secure messaging, VPN, and secure mobility protocols, prepared expert declarations, assisted with the patent owner (MPH) reply, sur-reply, and oral arguments, and provided deposition testimony (twice). MPH won all six IPRs.

Mears Technologies, Inc. v. Verizon Services Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:14-cv-00937.

Mears Technologies, Inc. v. AT&T Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:14-cv-00938.

Mears Technologies, Inc. v. Finisar Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:13-cv-00376.

Evaluated one patent (relating to optical switching), developed infringement charts, carried out prior art and invalidity analysis and claim construction, prepared expert declarations, and provided deposition testimony on behalf of plaintiff Mears Technologies. Also developed infringement charts for products by several other companies.

Brixham Solutions LTD v. Juniper Networks, Inc., United States District Court for the Northern District of California, Civil Action No. 3:13-cv-00616-JCS.

Evaluated a portfolio of more than ten patents (relating to pseudowires, Ethernet services, protection and restoration, routing and switching), developed infringement charts, carried out prior art and invalidity analysis and claim construction, prepared expert declarations, and provided deposition testimony on behalf of plaintiff Brixham Solutions LTD.

Alberta Communications Research Centre v. AT&T Services Corp., United States District Court, District of New Jersey, Civil Action No. 3:09-03883

Alberta Telecommunications Research Centre v. Verizon Communications, Inc., United States District Court, District of New Jersey, Civil Action No. 3:10-01132

Verizon Services Corp. v. Alberta Telecommunications Research Centre, United States

District Court, District of New Jersey, Civil Action No. 3:11-01378

Telecommunications Research Laboratories, et al. v. Qwest Communications Company, LLC, et al., United States District Court, District of New Jersey, Civil Action No. 1:12-00581

Evaluated of a portfolio of eighteen patents in the optical networking field (including SONET ring networks, protection switching, and virtual connections), participated in mediation proceedings, developed infringement charts for a wide range of products, carried out prior art and invalidity analysis and claim construction, prepared expert declarations, and provided deposition testimony (three times) on behalf of plaintiff Alberta Communications Research Centre.