US008130775C1

(12) EX PARTE REEXAMINATION CERTIFICATE (11976th)

United States Patent
Jounay et al.

(10) Number: US 8,130,775 C1
(45) Certificate Issued: Dec. 30, 2021

(54) **MECHANISM FOR PROTECTING A PSEUDO-WIRE**

(75) Inventors: **Frederic Jounay**, Pleumeur Bodou (FR); **Philippe Niger**, Lannion (FR); **Arnaud Cauvin**, Paris (FR)

(73) Assignee: **Monarch Networking Solutions**

Reexamination Request:
No. 90/014,701, Mar. 12, 2021

Reexamination Certificate for:

Patent No.:	**8,130,775**
Issued:	**Mar. 6, 2012**
Appl. No.:	**12/528,083**
PCT Filed:	**Feb. 26, 2008**
PCT No.:	**PCT/FR2008/050324**
§ 371 (c)(1), (2), (4) Date:	**Nov. 25, 2009**
PCT Pub. No.:	**WO2008/110735**
PCT Pub. Date:	**Sep. 18, 2008**

(30) **Foreign Application Priority Data**

Feb. 26, 2007 (FR) 07 53489

(51) **Int. Cl.**
H04L 12/707 (2013.01)
H04L 12/751 (2013.01)

(52) **U.S. Cl.**
CPC ***H04L 45/22*** (2013.01); ***H04L 45/10*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

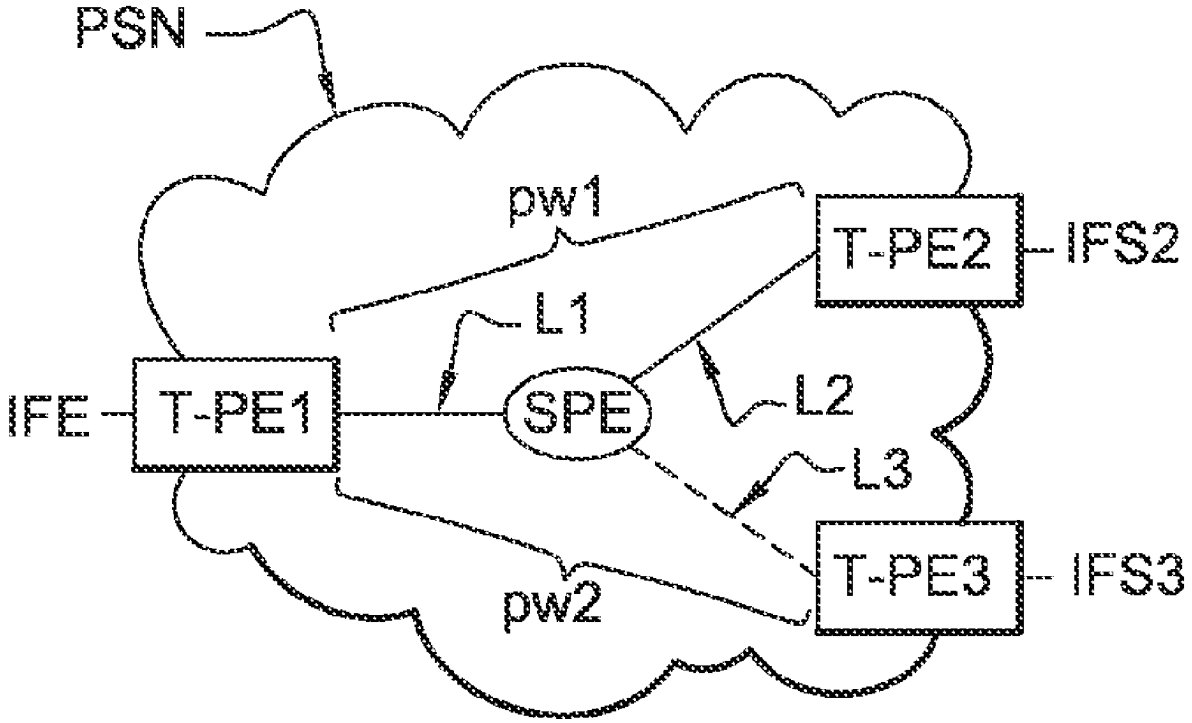
(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/014,701, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner — Mark Sager

(57) **ABSTRACT**

A method is provided for setting up at least two pseudo-wires able to broadcast a stream of data, wherein a first pseudo-wire is set up between an input router of a packet-switched network and first output router of the packet-switched network, and a second pseudo-wire is set up between the input router and a second output router of the packet-switched network. A first link of the first pseudo-wire is set up between the first output router and an intermediate router of the packet-switched network. A second link of the second pseudo-wire is set up between the second output router and the intermediate router. A third link of both pseudo-wires is set up between the intermediate router and the input router.



EX PARTE REEXAMINATION CERTIFICATE

NO AMENDMENTS HAVE BEEN MADE TO THE PATENT

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1** and **6** is confirmed.

Claims **2-5** and **7-9** were not reexamined.

* * * * *

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/014,701	03/12/2021	8130775	43614.399	4147

90471 7590 11/15/2021

Heim, Payne & Chorush, L.L.P.
1111 Bagby Street
Houston, TX 77002

EXAMINER	
SAGER, MARK ALAN	

ART UNIT	PAPER NUMBER
3992	

MAIL DATE	DELIVERY MODE
11/15/2021	PAPER

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

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

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(THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS)

HAYNES AND BOONE, LLP
IP SECTION
2323 VICTORY AVENUE
SUITE 700
DALLAS, TX 75219

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. *90/014,701* .

PATENT UNDER REEXAMINATION *8130775* .

ART UNIT *3992* .

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified *ex parte* reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the *ex parte* reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Notice of Intent to Issue Ex Parte Reexamination Certificate	**Control No.** 90/014,701	**Patent Under Reexamination** 8130775	
	Examiner MARK A SAGER	**Art Unit** 3992	**AIA Status** No

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

1. ☑ Prosecution on the merits is (or remains) closed in this *ex parte* reexamination proceeding. This proceeding is subject to reopening at the initiative of the Office or upon petition. *Cf.* 37 CFR 1.313(a). A Certificate will be issued in view of
   (a) ☑ Patent owner's communication(s) filed: 9/30/2021.
   (b) ☐ Patent owner's failure to file an appropriate timely response to the Office action mailed: _____.
   (c) ☐ Patent owner's failure to timely file an Appeal Brief (37 CFR 41.31).
   (d) ☐ The decision on appeal by the ☐ Board of Patent Appeals and Interferences ☐ Court dated _____
   (e) ☐ Other: _____.
2. The Reexamination Certificate will indicate the following:
   (a) Change in the Specification: ☐ Yes ☑ No
   (b) Change in the Drawing(s): ☐ Yes ☑ No
   (c) Status of the Claim(s):
      (1) Patent claim(s) confirmed: 1 and 6.
      (2) Patent claim(s) amended (including dependent on amended claim(s)): _____
      (3) Patent claim(s) canceled: _____.
      (4) Newly presented claim(s) patentable: _____.
      (5) Newly presented canceled claims: _____.
      (6) Patent claim(s) ☐ previously ☐ currently disclaimed: _____
      (7) Patent claim(s) not subject to reexamination: 2-5 and 7-9.
3. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
4. ☑ Note the attached statement of reasons for patentability and/or confirmation. Any comments considered necessary by patent owner regarding reasons for patentability and/or confirmation must be submitted promptly to avoid processing delays. Such submission(s) should be labeled: "Comments On Statement of Reasons for Patentability and/or Confirmation."
5. ☐ Note attached NOTICE OF REFERENCES CITED (PTO-892).
6. ☑ Note attached LIST OF REFERENCES CITED (PTO/SB/08 or PTO/SB/08 substitute).
7. ☐ The drawing correction request filed on _____ is: ☐approved ☐disapproved.
8. ☑ Acknowledgment is made of the priority claim under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☑ All b) ☐ Some* c) ☐None of the certified copies have
   ☐been received.
   ☐not been received.
   ☑been filed in Application No. 12/528083.
   ☐been filed in reexamination Control No. _____.
   ☐been received by the International Bureau in PCT Application No. _____.

   * Certified copies not received: _____.
9. ☑ Note attached Examiner's Amendment.
10. ☐ Note attached Interview Summary (PTO-474).
11. ☐ Other: _____.

All correspondence relating to this reexamination proceeding should be directed to the **Central Reexamination Unit** at the mail, FAX, or hand-carry addresses given at the end of this Office action.

/MARK SAGER/ Primary Examiner, Art Unit 3992	

cc: Requester (if third party requester)

Notice of Pre-AIA or AIA Status

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

2. This ex parte reexamination is a third party requested reexamination of challenged claims 1 and 6 of 8130775, that was granted per Order mailed 4/15/2021 with a first non-final action mailed 7/30/2021. This action replies to Patent Owner arguments having a declaration filed under 35 USC 132 in support of their opinion, filed 9/30/2021. Challenged claims 1 and 6 of patent 8130775 remain in this proceeding in accordance with Order; while any remarks directed to other non-challenged claims are not further considered herein. The claim status of claim 1 of "as issued" in cited Patent Owner reply is inaccurate since the claim status remains --Original--; while, claims 2-5 and 7-9 are not being reexamined so are ignored herein.

EXAMINER'S AMENDMENT

3. An examiner's amendment to the record to correct formal matter noted above regarding claim status appears below. The changes made by this examiner's amendment of administrative correction will be reflected in the reexamination certificate to issue in due course.

Claim 1, on line 1, replace claim status of "as issued" to --Original-- as follows:

1. (Original) A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Claim 6, on line 1, replace claim status of "as issued" to --Original-- as follows:

6. (Original) A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Declaration

4. **The Declaration by Henry Hough (Ex. 1003) under 37 CFR 1.68 filed Mar. 12, 2021** (signed July 6, 2020) has been reviewed and considered. Declarant states he was compensated for his opinion testimony (paragraph 002) to provide expert testimony based on his qualifications

(Ex. 1003, paragraph 007-026 and Ex. 1004, Curriculum Vitae) where his compensation s not contingent on the outcome of this reexam or the specifics of his testimony. The declaration has been considered for expert opinion regarding level of ordinary skill (paragraph 035), technology background (paragraphs 027-033), claim construction (049) and interpretation of what Aggarwal and Hussain references describe/teach to an artisan (paragraphs 051-155). This is only indicating that examiner has reviewed/considered the testimony. His opinion regarding interpretation of cited art is relied on herein to extent specifically stated below.

5. **The Declaration by Dr. Michael Mitzenmacher filed Sept 30, 2021** has been reviewed and considered. Declarant states he was compensated for his opinion testimony (paragraph 5) to provide expert testimony based on his qualifications (paragraph 6-11 Curriculum Vitae) where his compensation does not depend on the outcome of this proceeding and he has no other interest in this proceeding or the parties thereto. The declaration has been considered for expert opinion regarding level of ordinary skill (paragraph 31), technology background (paragraphs 32-39), claim construction (paragraphs 43-45) and interpretation of what Aggarwal and Hussain references describe/teach to an artisan (paragraphs 46-56). This is only indicating that examiner has reviewed/considered the testimony. His opinion regarding interpretation of cited art is relied on herein to extent specifically stated below.

Response to Arguments

6. Applicant's arguments, see pages , filed Sept. 30, 2021, with respect to patentability of challenged claims 1 and 6 have been fully considered and are persuasive. The rejection of challenged claims 1 and 6 has been withdrawn. However, for the record to be clear, the objective evidence of non-obviousness regarding Commercial Success (Patent Owner reply,

pages 50-51), Long Felt Need (*Id.*, pp 51-52), Failure of Others (*Id.*, pp 52-53) and Praise (Id., pp 53-54) fails to overcome the obviousness rejection so as to be persuasive for lacking nexus to claimed subject matter in challenged claims 1 and 6 of '775.

STATEMENT OF REASONS FOR PATENTABILITY AND/OR CONFIRMATION

7. The following is an examiner's statement of reasons for patentability and/or confirmation of the claims found patentable in this reexamination proceeding: lacking evidence to the contrary, with broadest reasonable interpretation of claims in light of the specification of the '775 patent, when the totality of evidence in record is taken as a whole, the totality of the evidence outweighs the obviousness of the proposed combination. For instance, arguments on pages 33-47, explain that the hypothetical combination of Aggarwal and Hussain fails to disclose or suggest a first, second and third pseudo-wire as recited in their method of setting up at least two pseudo-wires able to broadcast a data stream comprising setting up a first pseudo-wire comprising a first link, setting up a second pseudo-wire, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires, as particularly recited in challenged claim 1 and as similarly recited in challenged claim 6.

Any comments considered necessary by PATENT OWNER regarding the above statement must be submitted promptly to avoid processing delays. Such submission by the patent owner should be labeled: "Comments on Statement of Reasons for Patentability and/or Confirmation" and will be placed in the reexamination file.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MARK SAGER whose telephone number is (571)272-4454. The examiner can normally be reached on M-Th, 7:30am-4pm, EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Alexander Kosowski can be reached on (571)272-3744. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/MARK SAGER/
Reexamination Specialist, Art Unit 3992

Conferee:

/FRED O FERRIS III/
Reexamination Specialist, Art Unit 3992

/ALEXANDER J KOSOWSKI/
Supervisory Patent Examiner, Art Unit 3992

Reexamination	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Certificate Date	Certificate Number
		C1

Requester Correspondence Address: ☐ Patent Owner ☑ Third Party
HAYNES AND BOONE, LLP IP SECTION 2323 VICTORY AVENUE SUITE 700 DALLAS, TX 75219

LITIGATION REVIEW ☑	MAS (examiner initials)	(date)
Case Name		Director Initials
Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2-20-cv-00015 (E.D. Tex., filed Jan 21, 2020)		

COPENDING OFFICE PROCEEDINGS	
TYPE OF PROCEEDING	NUMBER

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	**Art Unit**
	MARK A SAGER	3992

CPC							
Symbol						**Type**	**Version**
H04L	/	45	/	22		F	2013-01-01
H04L	/	45	/	10		I	2013-01-01

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	2	
/MARK SAGER/ Primary Examiner, Art Unit 3992	03 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office

Part of Paper No.: 20211103

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04L	/	45	/	22

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	2	
/MARK SAGER/ Primary Examiner, Art Unit 3992	03 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office

Part of Paper No.: 20211103

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1														
	2														
	3														
	4														
	5														
	6														
	7														
	8														
	9														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	2	
/MARK SAGER/ Primary Examiner, Art Unit 3992	03 November 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3

U.S. Patent and Trademark Office

Part of Paper No.: 20211103

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

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

CLAIMS

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

CLAIM		DATE								
Final	Original	07/13/2021	11/03/2021							
	1	✓	=							
	2									
	3									
	4									
	5									
	6	✓	=							
	7									
	8									
	9									

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
Reviewed prosecution history of 8130775	03/25/2021	ms
Lit Search conducted 3/12/2021	03/25/2021	ms

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Bibliographic Data

Application No: 90/014,701

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /MARK SAGER/ Examiner's Signature [ ] Initials

Title: Mechanism For Protecting a Pseudo-wire

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/12/2021	370	3992	43614.399
RULE			

APPLICANTS

INVENTORS

8130775,

MONARCH NETWORKING SOLUTIONS, LLC, IRVINE, CA, UNITED STATES

THEODORNE M. FOSTER , HAYNES AND BOONE, LLP (3RD PTY. REQ.), DALLAS, TX, UNITED STATES

CONTINUING DATA

This application is a REX of 12528083 11/25/2009 PAT 8130775

12528083 is a 371 of PCT/FR08/50324 02/26/2008 *

(*) Data provided by applicant is not consistent with PTO record

FOREIGN APPLICATIONS

FRANCE FR0753489 02/26/2007

IF REQUIRED, FOREIGN LICENSE GRANTED**

STATE OR COUNTRY

ADDRESS

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1111 Bagby Street
Houston, TX 77002
UNITED STATES

FILING FEE RECEIVED

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

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	90014701
Filing Date	2021-03-12
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7590115	B1	2009-09-15	Aggarwal	
	2	7602702	B1	2009-10-13	Aggarwal	
	3	8160055	B1	2012-04-17	Nadeau	
	4	7283465	B2	2007-10-16	Zelig	
	5	8081563	B2	2011-12-20	Guichard	
	6	8868775	B2	2014-10-21	Filsfils	
	7	7940652	B1	2011-05-10	Pan	

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/MARK SAGER/ 11/03/2021

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.S./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	90014701
Filing Date	2021-03-12
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20070239891	A1	2007-10-11	Wainner	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	1983701	FR		2010-08-25	Papadimitriou		

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	AGGARWAL, Extensions to RSVP-TE for Point to Multipoint TE LSPs, IETF Network Working Group	
	2	GUICHARD, Definitive MPLS Network Designs, Cisco Press, 2005, pp. 41-46, 73-85, 104-115	
	3	MULEY, Pseudowire (PW) Redundancy, IETF Network Working Group, September 22, 2006	
	4	Jounay, Use Cases and signaling requirements for Point-to-Multipoint VPWS	

11/03/2021

/MARK SAGER/

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.S./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	5	Hussain, Fault-tolerant IP and MPLS Networks, 2004
	6	AGGARWAL, Extensions to Resource Reservation Protocol - Traffic Engineering (RSVP-TE) for Point-to-Multipoint TE Label Switched Paths (LSPs), IETF Network Working Group RFC 4875
	7	Declaration of Dr. Michael Mitzenmacher Regarding the Validity of U.S. Patent No. 8,130,775
	8	Monarch Networking Solutions LLC's Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	9	Exhibit A to Cisco Systems, Inc.'s Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	10	Claim Construction Memorandum and Order in Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2:20-cv-00015, Dkt. 128 (E.D. Tex.)
	11	Monarch Networking Solutions LLC's Opening Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	12	Cisco Systems, Inc.'s Responsive Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	13	Monarch Networking Solutions LLC's Reply Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	14	Jonathan P. Lang et al., "Link Management Protocol (LMP)," IETF RFC 4204
	15	M. Bocci & S. Bryant, "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge," IETF Network Working Group Internet Draft

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	16	Declaration on behalf of Cisco Systems, Inc.	
	17	L. Martini et al., "Encapsulation Methods for Transport of Asynchronous Transfer Mode (ATM) over MPLS Networks," IETF RFC 4717	
	18	Complaint for Patent Infringement in Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2:20-cv-00015, Dkt. 1 (E.D. Tex.)	
	19	Vishnuprakash Selvarajan and David Powers, "ASR 9000 VPLS Label Switched Multicast (LSM) Overview and Configuration Example," April 1, 2014, available at https://www.cisco.com/c/en/us/support/docs/routers/asr-9000-series-aggregation-services-routers/117570-configure-vpls-00.html	
	20	"Implementing Multipoint Layer 2 Services", available at https://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k-r6-2/lxvpn/configuration/guide/b-l2vpn-cg-asr9000-62x/b-l2vpn-cg-asr9000-62x_chapter_0110.html	
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	25	Expert Report of Kevin Jeffay Regarding Invalidity of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)	
	26	Supplemental Expert Report of Kevin Jeffay Regarding Invalidity of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

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	29	"Multicast VPN and DOCSIS 3.0 Multicast QoS Support", Multicast VPN and DOCSIS 3.0 Multicast QoS Support, available at https://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_layer2_layer3_vpn_xe17_2/m_multicast_vpn_qos_cbr_xe17_2.html
	30	"Multicast Virtual Private Networks", Cisco Systems, Inc., available at https://www.cisco.com/c/dam/en/us/support/docs/ip/ip-multicast/tcast_wp.pdf
	31	"BGP MVPN PE-PE Ingress Replication", IP Multicast: MVPN Configuration Guide, available at https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/ipmulti_mvpn/configuration/xe-16/imc-mvpn-xe-16-book/imc-bgp-mvpn-pe-pe-ingress-replication.pdf
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	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	38	Cisco Systems Inc. Preliminary Invalidity Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	39	Cisco Systems Inc. Amended Invalidity Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	40	Cisco Systems Inc. Subject Matter Eligibility Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	41	Cisco Systems Inc. Amended Subject Matter Eligibility Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	90014701
Filing Date	2021-04-15
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

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	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	1	Email string between Frederic Jounay and Luca Martini regarding P2MP VPWS requirements draft, dated February 14, 2007	☐
	2	Email between Frederic Jounay and Luca Martini regarding P2MP requirements draft, dated February 20, 2007	☐
	3	F. JOUNAY, ET AL., Use Cases and signaling requirements for Point-to-Multipoint VPWS draft-xxxx-12vpn-p2mp-vpws-requirements-00	☐

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Examiner Signature	/MARK SAGER/	Date Considered	11/03/2021

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Electronic Acknowledgement Receipt

EFS ID:	43921564
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	90471
Filer:	Christopher Lee Limbacher
Filer Authorized By:	
Attorney Docket Number:	43614.399
Receipt Date:	30-SEP-2021
Filing Date:	12-MAR-2021
Time Stamp:	21:09:35
Application Type:	Reexam (Patent Owner)

Payment information:

Submitted with Payment	no

File Listing:

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Electronic Acknowledgement Receipt

EFS ID:	43921418
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	90471
Filer:	Christopher Lee Limbacher
Filer Authorized By:	
Attorney Docket Number:	43614.399
Receipt Date:	30-SEP-2021
Filing Date:	12-MAR-2021
Time Stamp:	20:44:35
Application Type:	Reexam (Third Party)

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(Not for submission under 37 CFR 1.99)

Application Number	90014701
Filing Date	2021-03-12
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7590115	B1	2009-09-15	Aggarwal	
	2	7602702	B1	2009-10-13	Aggarwal	
	3	8160055	B1	2012-04-17	Nadeau	
	4	7283465	B2	2007-10-16	Zelig	
	5	8081563	B2	2011-12-20	Guichard	
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	Art Unit	3992
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	1	20070239891	A1	2007-10-11	Wainner	

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	1	1983701	FR		2010-08-25	Papadimitriou		

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	1	AGGARWAL, Extensions to RSVP-TE for Point to Multipoint TE LSPs, IETF Network Working Group	
	2	GUICHARD, Definitive MPLS Network Designs, Cisco Press, 2005, pp. 41-46, 73-85, 104-115	
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	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	5	Hussain, Fault-tolerant IP and MPLS Networks, 2004
	6	AGGARWAL, Extensions to Resource Reservation Protocol - Traffic Engineering (RSVP-TE) for Point-to-Multipoint TE Label Switched Paths (LSPs), IETF Network Working Group RFC 4875
	7	Declaration of Dr. Michael Mitzenmacher Regarding the Validity of U.S. Patent No. 8,130,775
	8	Monarch Networking Solutions LLC's Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	9	Exhibit A to Cisco Systems, Inc.'s Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	10	Claim Construction Memorandum and Order in Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2:20-cv-00015, Dkt. 128 (E.D. Tex.)
	11	Monarch Networking Solutions LLC's Opening Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	12	Cisco Systems, Inc.'s Responsive Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	13	Monarch Networking Solutions LLC's Reply Claim Construction Brief in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	14	Jonathan P. Lang et al., "Link Management Protocol (LMP)," IETF RFC 4204
	15	M. Bocci & S. Bryant, "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge," IETF Network Working Group Internet Draft

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	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	16	Declaration on behalf of Cisco Systems, Inc.
	17	L. Martini et al., "Encapsulation Methods for Transport of Asynchronous Transfer Mode (ATM) over MPLS Networks," IETF RFC 4717
	18	Complaint for Patent Infringement in Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2:20-cv-00015, Dkt. 1 (E.D. Tex.)
	19	Vishnuprakash Selvarajan and David Powers, "ASR 9000 VPLS Label Switched Multicast (LSM) Overview and Configuration Example," April 1, 2014, available at https://www.cisco.com/c/en/us/support/docs/routers/asr-9000-series-aggregation-services-routers/117570-configure-vpls-00.html
	20	"Implementing Multipoint Layer 2 Services", available at https://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k-r6-2/lxvpn/configuration/guide/b-l2vpn-cg-asr9000-62x/b-l2vpn-cg-asr9000-62x_chapter_0110.html
	21	"Deployment Considerations for Interconnecting Distributed Cloud Data Centers", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2015/pdf/TECDCT-2181.pdf
	22	"Understanding MPLS", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/apjc/docs/2015/pdf/BRKMPL-1101.pdf
	23	"Cisco Live", https://www.cisco.com/c/en/us/training-events/events-webinars/cisco-live.html, accessed September 8, 2021
	24	Expert Report of Kevin Jeffay Regarding Non-Infringement of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	25	Expert Report of Kevin Jeffay Regarding Invalidity of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	26	Supplemental Expert Report of Kevin Jeffay Regarding Invalidity of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	27	"Configuring Multicast Virtual Private Network", Multiprotocol Label Switching (MPLS) Configuration Guide, Cisco IOS XE Everest 16.6.1 (Catalyst 9500 Switches), available at https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9500/software/release/16-6/configuration_guide/mpls/b_166_mpls_9500_cg/b_165_mpls_9500_cg_chapter_010.pdf
	28	"Overview of the Multicast-VPN (MVPN)", Network Node Manager i Software 10.30, available at https://docs.microfocus.com/NNMi/10.30/Content/mpls/nmIntroOperatoroverview/nmMplsIntro0200mVPN.htm
	29	"Multicast VPN and DOCSIS 3.0 Multicast QoS Support", Multicast VPN and DOCSIS 3.0 Multicast QoS Support, available at https://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_layer2_layer3_vpn_xe17_2/m_multicast_vpn_qos_cbr_xe17_2.html
	30	"Multicast Virtual Private Networks", Cisco Systems, Inc., available at https://www.cisco.com/c/dam/en/us/support/docs/ip/ip-multicast/tcast_wp.pdf
	31	"BGP MVPN PE-PE Ingress Replication", IP Multicast: MVPN Configuration Guide, available at https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/ipmulti_mvpn/configuration/xe-16/imc-mvpn-xe-16-book/imc-bgp-mvpn-pe-pe-ingress-replication.pdf
	32	"Service Provider Programmable SDN Solution for the Metro Fabric, powered by Segment Routing and EVPN", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2018/pdf/BRKSPG-2518.pdf
	33	Sajassi et al., "BGP MPLS-Based Ethernet VPN", IETF RFC 7432
	34	Farinacci et al., "Generic Routing Encapsulation (GRE)", IETF RFC 2784
	35	"Layer 2 Ethernet over GRE", available at https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/cether/configuration/xe-16/ce-xe-16-book/ce-L2-EoGRE.pdf
	36	Lau et al., "Layer Two Tunneling Protocol - Version 3 (L2TPv3)", RFC 3931
	37	Jounay et al., "Requirements and Framework for Point-to-Multipoint Pseudowires over MPLS Packet Switched Networks", IETF RFC 7338

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
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	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	38	Cisco Systems Inc. Preliminary Invalidity Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	39	Cisco Systems Inc. Amended Invalidity Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	40	Cisco Systems Inc. Subject Matter Eligibility Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)
	41	Cisco Systems Inc. Amended Subject Matter Eligibility Contentions And '775 Exhibits in Monarch Networking Solutions LLC v. Cisco Systems Inc., No. 2:20-cv-00115-JRG (E.D. Tex.)

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Examiner Signature		Date Considered	

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-03-12
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Christopher L. Limbacher/	Date (YYYY-MM-DD)	2021-09-30
Name/Print	Christopher L. Limbacher	Registration Number	76,551

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Electronic Acknowledgement Receipt

EFS ID:	43920988
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	90471
Filer:	Christopher Lee Limbacher
Filer Authorized By:	
Attorney Docket Number:	43614.399
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Time Stamp:	19:43:21
Application Type:	Reexam (Third Party)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response after non-final action-owner timely	PatentOwnersResponsetoFirstOfficeAction_final.pdf	3399357 59667f47f02864869bd04771fb5c7d9a988ef845	no	55

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	775_IDS.pdf	1037193 b1de6e8972ffa066442d111aceeae230b17b0787	no	8
Warnings:					
Information:					
3	Non Patent Literature	775_Amended_SME_Contentions_and_Exhibits_final.pdf	1002950 8b9cccb4388e70b83dabcd01a4e887b01d2fcbc3	no	28
Warnings:					
Information:					
4	Non Patent Literature	775_AmendedInvalidityContentions_and_775_Exhibits_final.pdf	4949433 fb2dd511ebb81603c8be68569c3ae52e154058fd	no	511
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5	Non Patent Literature	775_PrelimInvalidityContentions_and_775_Exhibits_final.pdf	4799110 ff70ac4fb9cf71e5dbce33688c30a4a7ca4ea751	no	562
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6	Non Patent Literature	775_SME_Contentions_and_Exhibits.pdf	666819 91376a7c716f36f958be854c1b1a710c01d5341b	no	27
Warnings:					
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7	Non Patent Literature	20210112FINALJeffayOpeningInvalidityReport_final.pdf	6914237 a42ed60f9888455dce0418a25529b0a99de37faf	no	732
Warnings:					
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8	Non Patent Literature	20210130JeffaySupplementalInvalidityReport.pdf	290578 3af7a409294ca0a26584768165caec5eff4bd6b7	no	6
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Frederic Jounay *et al.* Reexamination Control No.: 90/014,701 U.S. Patent No.: 8,130,775 Reexamination Request Filed: March 12, 2021 For: MECHANISM FOR PROTECTING A PSEUDO-WIRE	Examiner: Sager, Mark Alan Technology Center/Art Unit: 3992 Attorney Docket No. 1127.0026

Attn: Mail Stop "*Ex Partes* Reexam"
Central Reexamination Unit
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United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

PATENT OWNER'S RESPONSE TO FIRST OFFICE ACTION

In response to the first office action mailed on July 30, 2021 (the "Office Action"), patent owner Monarch Networking Solutions LLC ("Monarch" or "Patent Owner"), presents the following remarks and respectfully requests the rejections presented in the Office Action be withdrawn and patentability of all challenged claims be confirmed. None of the asserted prior art references, either alone or in combination, teach the challenged claims of the '775 Patent. For example, none of the proposed grounds teaches a first and second pseudo-wire comprising a first link, said first link being shared by the first and second pseudo-wires. The validity of the challenged claims is further supported by the lack of motivation to combine the prior art, as well as the extensive objective evidence of non-obviousness.

Juniper Exhibit 1008, page 45

No fees are believed to be due. If the USPTO determines that an additional fee is required, the Director is hereby authorized to charge any appropriate fees that may be required by this paper, and to credit any overpayment, to Deposit Account No. 50-4592, Attorney Docket No. 1127.0026.

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TABLE OF EXHIBITS

Exhibit No.	Exhibit
2001	Declaration of Dr. Michael Mitzenmacher Regarding the Validity of U.S. Patent No. 8,130,775
2002	Monarch Networking Solutions LLC's Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2003	Exhibit A to Cisco Systems, Inc.'s Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2004	Claim Construction Memorandum and Order in *Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015, Dkt. 128 (E.D. Tex.)
2005	Monarch Networking Solutions LLC's Opening Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2006	Cisco Systems, Inc.'s Responsive Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2007	Monarch Networking Solutions LLC's Reply Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2008	Jonathan P. Lang et al., "Link Management Protocol (LMP)," IETF RFC 4204
2009	M. Bocci & S. Bryant, "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge," IETF Network Working Group Internet Draft
2010	Declaration on behalf of Cisco Systems, Inc.
2011	L. Martini et al., "Encapsulation Methods for Transport of Asynchronous Transfer Mode (ATM) over MPLS Networks," IETF RFC 4717
2012	Complaint for Patent Infringement in *Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015, Dkt. 1 (E.D. Tex.)
2013	Vishnuprakash Selvarajan and David Powers, "ASR 9000 VPLS Label Switched Multicast (LSM) Overview and Configuration Example," April 1, 2014, available at https://www.cisco.com/c/en/us/support/docs/routers/asr-9000-series-aggregation-services-routers/117570-configure-vpls-00.html
2014	"Implementing Multipoint Layer 2 Services", available at https://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k-r6-2/lxvpn/configuration/guide/b-l2vpn-cg-asr9000-62x/b-l2vpn-cg-asr9000-62x_chapter_0110.html
2015	"Deployment Considerations for Interconnecting Distributed Cloud Data Centers", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2015/pdf/TECDCT-2181.pdf
2016	"Understanding MPLS", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/apjc/docs/2015/pdf/BRKMPL-1101.pdf

2017	"Cisco Live", https://www.cisco.com/c/en/us/training-events/events-webinars/cisco-live.html, accessed September 8, 2021.
2018	Expert Report of Kevin Jeffay Regarding Non-Infringement of U.S. Patent Nos. 8,130,775; 9,451,844; and 9,019,965 in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
2019	"Configuring Multicast Virtual Private Network", Multiprotocol Label Switching (MPLS) Configuration Guide, Cisco IOS XE Everest 16.6.1 (Catalyst 9500 Switches), available at https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9500/software/release/16-6/configuration_guide/mpls/b_166_mpls_9500_cg/b_165_mpls_9500_cg_chapter_010.pdf
2020	"Overview of the Multicast-VPN (MVPN)", Network Node Manager i Software 10.30, available at https://docs.microfocus.com/NNMi/10.30/Content/mpls/nmIntroOperatoroverview/nmMplsIntro0200mVPN.htm
2021	"Multicast VPN and DOCSIS 3.0 Multicast QoS Support", Multicast VPN and DOCSIS 3.0 Multicast QoS Support, available at https://www.cisco.com/c/en/us/td/docs/cable/cbr/configuration/guide/b_layer2_layer3_vpn_xe17_2/m_multicast_vpn_qos_cbr_xe17_2.html
2022	"Multicast Virtual Private Networks", Cisco Systems, Inc., available at https://www.cisco.com/c/dam/en/us/support/docs/ip/ip-multicast/tcast_wp.pdf
2023	"BGP MVPN PE-PE Ingress Replication", IP Multicast: MVPN Configuration Guide, available at https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/ipmulti_mvpn/configuration/xe-16/imc-mvpn-xe-16-book/imc-bgp-mvpn-pe-pe-ingress-replication.pdf
2024	"Service Provider Programmable SDN Solution for the Metro Fabric, powered by Segment Routing and EVPN", Cisco live!, available at https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2018/pdf/BRKSPG-2518.pdf
2025	Sajassi et al., "BGP MPLS-Based Ethernet VPN", IETF RFC 7432
2026	Farinacci et al., "Generic Routing Encapsulation (GRE)", IETF RFC 2784
2027	"Layer 2 Ethernet over GRE", available at https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/cether/configuration/xe-16/ce-xe-16-book/ce-L2-EoGRE.pdf
2028	Lau et al., "Layer Two Tunneling Protocol - Version 3 (L2TPv3)", RFC 3931
2029	Jounay et al., "Requirements and Framework for Point-to-Multipoint Pseudowires over MPLS Packet Switched Networks", IETF RFC 7338

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2. Claim 1 37

[1.0] A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising: 37

[1.1] setting up a first pseudo-wire comprising a first link 39

[1.2] [a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and 42

[1.3] [a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and 43

[1.4] setting up a second pseudo-wire between said input router and a second 43

[1.5] wherein the second pseudo-wire comprises said first link and 43

[1.6] [wherein the second pseudo-wire comprises . . .] a third link set up between 43

[1.7] said first link being shared by the first and second pseudo-wires. 43

3. Claim 6 48

[6.0] A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for: 48

[6.1] setting up a first pseudo-wire comprising a first link 48

[6.2] [a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and 48

[6.3] [a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and 49

[6.4] setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, ... 49

[6.5] wherein the second pseudo-wire comprises said first link and 49

[6.6] [wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router, ... 49

[6.7] said first link being shared by the first and second pseudo-wires. 49

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I. THE CLAIMS

Below is the list of claims, as issued. No claims have been amended.

LISTING OF CLAIMS:

1. (as issued) A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

2. (as issued) The method according to claim 1, wherein the steps of setting up the first and second pseudo-wires are performed at the initiative of said input router by sending said intermediate router a message for setting-up said third link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire.

3. (as issued) A method of broadcasting a data streams over a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router

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of said packet-switched network and a second link set up between said intermediate router and a first output router of said packet-switched network, said method comprising:

a step of detecting a fault affecting the first output router; and

on reception of information on a fault affecting said first output router, a step of switching the data stream to a second pseudo-wire comprising said first link and a third link set up between said intermediate router and a second output router of said packet-switched network, said first link being shared by the first and second pseudo-wires.

4. (as issued) An intermediate router configured to be connected by a first link to an input router of a packet-switched network and by a second link to a first output router of said packet-switched network, said first and second links constituting a first pseudo-wire able to broadcast a data stream, the intermediate router comprising:

means for receiving a first message for setting up the first link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of a second output router of said network;

means for sending a second message for setting up said second link between said intermediate router and said first output router and a third message for setting up a third link between said intermediate router and said second output router, the second message including the identifier of said input router and the identifier of said first output router, the third message including the identifier of said input router and the identifier of said second output router, and said first and third links constituting a second pseudo-wire;

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means for configuring at least one switching table for said broadcasting with a parameter specifying that the second pseudo-wire is a back-up pseudo-wire, said parameter being included in the first set-up message.

5. (as issued) The intermediate router according to claim 4, wherein the intermediate router includes means for detecting a fault affecting said first output router and means for switching the stream of data from the second link to the third link.

6. (as issued) A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

7. (as issued) A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of broadcasting a

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data streams over a first pseudo-wire when said program is executed by a computer, wherein the first pseudo-wire comprises a first link set up between an input router of a packet-switched network and an intermediate router of said packet-switched network and a second link set up between said intermediate router and a first output router of said packet-switched network, the program code instructions comprising instructions for:

detecting a fault affecting the first output router; and on reception of information on a fault affecting said first output router, switching the data stream to a second pseudo-wire comprising said first link and a third link set up between said intermediate router and a second output router of said packet-switched network, said first link being shared by the first and second pseudo-wires.

8. (as issued) A method comprising:

generating a signal configured to be transmitted between an input router of a packet-switched network and an intermediate router of said packet-switched network, said signal carrying a message for setting up at least two pseudo-wires able to broadcast a stream of data, a first pseudo-wire being set up between said input router and a first output router of said packet-switched network, a second pseudo-wire being set up between said input router and a second output router of said packet-switched network, said set-up message including:

an identifier of said input router;

an identifier of said first output router; and

a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire; and transmitting the signal between the input router of the packet-switched network and the intermediate router of said packet-switched network.

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9. (as issued) The method according to claim 8, wherein the field further contains an identifier of said intermediate router.

II. Overview

A. Background

On March 12, 2021, Theodore Foster requested *ex parte* reexamination (the "Request") of U.S. Patent No. 8,130,775 (the "'775 Patent") on behalf of Cisco System, Inc. ("Cisco" or "Requester"), the real party in interest. The Request challenged only claims 1 and 6 of the '775 Patent (the "Challenged Claims"). The Office ordered reexamination of the Challenged Claims on April 15, 2021, and issued rejections of the Challenged Claims in a July 30, 2021 non-final office action. The Challenged Claims were rejected under pre-AIA 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 7,602,702 ("Aggarwal" or "Ex. 1005") in view of "Fault-Tolerant IP and MPLS Networks" ("Hussain" or "Ex. 1006").

Prior to the filing of the Request, Monarch had sued Cisco for infringement of the '775 Patent in *Monarch Networking Solutions LLC v. Cisco Systems, Inc. and Charter Communications, Inc.*, No. 2:20-cv-00015 (E.D. Tex.) (the "Parallel Litigation"). Cisco then challenged validity of the '775 Patent in *inter partes* review IPR2020-01226. The Patent Trials and Appeals Board ("PTAB") denied the IPR petition, finding the merits (based on the same Aggarwal and Hussain grounds) were not even strong enough to support exercising discretion to grant institution. IPR2020-01226, Paper 11 at 16-17 (Decision Denying Institution of *Inter Partes* Review). Cisco subsequently refashioned its IPR petition into the Request which resulted in this proceeding. After the Request was filed, Monarch and Cisco settled the Parallel Litigation. As a result, "Cisco has no further interest in the Reexamination" and does not oppose termination of this reexamination. *See* Ex. 2010 (Declaration on behalf of Cisco Systems, Inc.). Given that Requester Cisco is no

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longer interested in reexamination of the Challenged Claims, Patent Owner Monarch respectfully requests that the Office retract the Office Action as moot and terminate the reexamination proceeding. In the alternative, Monarch respectfully requests that all rejections be withdrawn and requests confirmation of the patentability of the Challenged Claims in light of the following remarks.

B. Claim Status

Issued claims 1-9 have not been amended. Claims 2-5 and 7-9 are not subject to reexamination. Claims 1 and 6 are pending before the Office for examination. For the reasons that follow, Monarch respectfully requests reconsideration and a confirmation of allowance of the previously issued claims.

III. '775 Patent Background

The '775 Patent was invented and developed by engineers at France Telecom in Paris, which was a leader and pioneer in networking technologies. The '775 Patent relates to improvements in packet-switched networks in which data is transmitted in the form of packets processed by network routers until those packets reach their destination. Technologies for use with packet-switched networks include, for example, so-called "pseudo-wires" as defined by the IETF Pseudo-Wire Emulation Edge-To-Edge (PWE3) group in the document RFC 3985. Such pseudo-wires emulate a point-to-point link between two pieces of equipment (*e.g.* routers) of a packet-switched network based on IP/MPLS technology and enable data packets to be transmitted that do not conform to the Internet Protocol, for example data packets implementing the ATM protocol. For example, when such a pseudo-wire has been set up between two routers, the input router is able to transmit a data stream routed via the pseudo-wire to the output router. In this case, the

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pseudo-wire includes a series of links beginning at the input router, passing through one or more intermediate routers, and terminating at the output router.

As one example where multiple pseudo-wires may be configured in the same network, the pseudowire emulation edge to edge working group ("PWE3") proposed a solution that backs up a first pseudo-wire set up between an input router and an output router by using a second pseudo-wire serving as a back-up pseudo-wire so that, in the event of a fault affecting the output router constituting one end of the first pseudo-wire, the data packets are routed by the back-up pseudo-wire to a different output router. When the input router detects a fault in the output router, it triggers switching of the data stream from the first pseudo-wire to the second pseudo-wire, thus routing the data to a different output router. However, this use of multiple pseudo-wires with redundant links has the disadvantage of consuming additional network resources, for example processing resources in the network equipment (storage capacity, computation capacity, etc.), signaling streams for setting-up two pseudo-wires and their associated links, and additional bandwidth, even though the pseudo-wires may share a portion of their paths. This increases the initial time required to set up the two pseudo-wires, and also increases the restore time in the event of a fault affecting an output router, with a negative impact on cost and quality of service.

The '775 Patent discloses and claims improved systems and methods for setting up at least two pseudo-wires in a manner that avoids or mitigates the drawbacks described above. Rather than set up two pseudo-wires, each composed of entirely separate links, the '775 Patent enables the two pseudo wires to effectively share a link for at least a portion of each pseudo-wire, thus reducing or eliminating consumption of extra network resources that would otherwise be required to set up an additional redundant link. For example, the '775 Patent teaches an embodiment in which a first pseudo-wire is set up between an input router of a packet-switched network and a first output

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router of said packet-switched network, and a second pseudo-wire is set up between the same input router and a second output router of the packet-switched network. In this configuration, a first link is configured between the input router and an intermediate router that is shared by both the first pseudo-wire and the second pseudo-wire. The first pseudo-wire also includes a second link set up between the intermediate router and the first output router, and the second pseudo-wire also includes a third link set up between the intermediate router and a second output router. This configuration is noteworthy in that a link is shared by the two pseudo-wires between the intermediate router and the input router.

The '775 Patent solution improves upon prior approaches because it optimizes the use of network resources, for example bandwidth, between the input router and the intermediate router by setting up between them a single link common to the two pseudo-wires. This solution is novel and distinct from prior approaches. This solution improves the operation of the network itself by making more efficient use of the network's resources. This solution also improves the functioning of the equipment that makes up the network, such as cables and routers, by reducing the extent to which their physical resources (e.g., bandwidth, processor speed, switching speed, data storage, power consumption, and heat dissipation) are taxed by excess signaling.

To further explain the state of the art and the '775 Patent invention, Monarch has submitted a declaration from Dr. Michael Mitzenmacher, Senior Professor of Computer Science at Harvard University (attached as Exhibit 2001). The following explanations of the state of the art and the '775 Patent invention from Dr. Mitzenmacher's declaration are reproduced below. *See* Ex. 2001 ¶¶ 32-42.

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A. State of the Art

In a packet-switched network (PSN), data is transmitted and routed in the form of packets, which are processed and forwarded by routers until the packets reach their destination. '775 Patent at 1:30-32. Various prior art techniques existed for routing these packets through the network, including multi-protocol label switching (MPLS). *Id.* at 1:34-36. MPLS works by adding labels to the headers of data packets; these labels contain information the routers can use to determine the next "hop" (*i.e.* the path to the next router) along which the packet can travel to reach its intended destination. *See id.* at 1:36-39. MPLS is discussed in RFC3031. Ex. 1036.

One limitation of MPLS is that it can only route a particular type of data packet: a packet that conforms to the Internet Protocol (IP). '775 Patent at 1:43-44. To address this limitation, the Internet Engineering Task Force (IETF) promulgated RFC3985, which describes a concept known as a "pseudo-wire" or "PW." *Id.* at 1:45-50; Ex. 1010. Pseudo-wires have the advantage of allowing non-IP packets (*e.g.* ATM protocol packets) to be transmitted and routed across a packet-switched network. '775 Patent at 1:49-52; *see also* Ex. 1010 at 17. Once a pseudo-wire has been set up, it can transmit a data stream across the packet-switched network, from an input router to an output router. '775 Patent at 1:53-2:2; Ex. 1010 at 3 ("PWs provide the following functions … [c]arriage of the encapsulated data across a PSN tunnel.").

It was known in the art that a network operator might want to set up two or more pseudo-wires within the same network. *See* '775 Patent at 2:3-27. For example, the operator may wish to set up a second pseudo-wire that acts as a "backup" in case the first pseudo-wire fails. *Id.* An example of this configuration is shown in Figure 2 of the '775 Patent:

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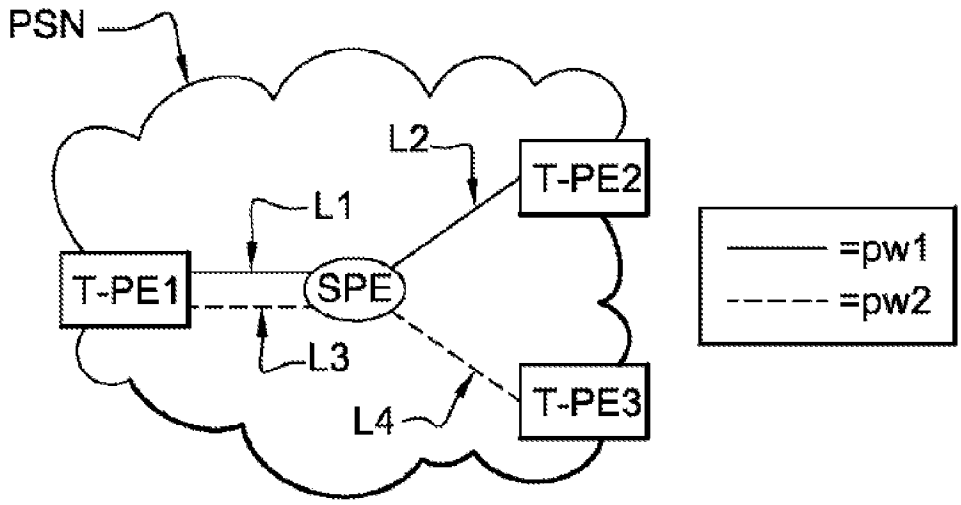
'775 Fig. 2 (Prior Art)



In Figure 2, a first pseudo-wire pw1 is set up across the PSN from input router T-PE1 to output router T-PE2. '775 Patent at 2:12-15. This pw1 consists of two links: L1 from input router T-PE1 to intermediate router SPE, and L2 from intermediate router SPE to output router T-PE2. *Id.* at 2:15-20.

In case of a fault affecting pw1 (*e.g.* a fault at link L2 or output router T-PE2), pw1 will cease to function properly, so a "backup" pseudo-wire pw2 is also set up across the PSN to ensure continuity of service. *See id.* at 2:20-23; 2:33-39. This pw2 goes from input router T-PE1 to output router T-PE3, and also consists of two links: L3 from input router T-PE1 to intermediate router SPE, and L4 from intermediate router SPE to output router T-PE3. *Id.* at 2:20-27. In the event of a fault affecting pw1, the PSN can relay a message indicating the fault to T-PE1, which can switch the data stream from pw1 to pw2 to bypass the fault. *Id.* at 2:33-39.

It was uniformly understood in the prior art that two pseudo-wires would always use different links and would not share any links between them. For example, RFC3985 states that a "PW is characterized as an ***unshared link*** or circuit of the chosen service." Ex. 1010 at 3 (emphasis added). Links were not shared even when the two pseudo-wires shared the same connection path

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between the same two routers; for example even though pw1 and pw2 share the same connection path between T-PE1 and SPE, they use two separate links L1 and L3 to traverse their common connection path. '775 Patent at Fig. 2. The '775 Patent explains that "[i]n the prior art, when a main pseudo-wire and a back-up pseudo-wire are set up between an input router and a first, respectively a second, output router, a link is set up between the input router and the intermediate router for each pseudo-wire, i.e. two links. The person skilled in the art has always considered a pseudo-wire as a point-to-point link set up between an input router and an output router, with the result that each input router/output router pair is associated with a pseudo-wire. Moreover, this kind of approach is recommended in the standards." *Id.* at 3:5-14.

As a result of this view in the prior art that pseudo-wires should use "unshared" links to traverse the PSN, network operators would set up multiple pseudo-wires in a configuration like the one shown in figure 2, in which the pseudo-wires are shaped like the letter "Y" (laying on its side) with a double-lined stem (representing the two unshared links from T-PE1 to SPE).

B. The '775 Patent Invention

The '775 Patent inventors recognized a drawback of the prior art "double-stem Y" approach shown, for example, in Fig. 2: "this kind of solution has the drawback of consuming network resources, for example processing resources in the network equipments (storage capacity, computation capacity, etc.), signaling streams for setting-up two pseudowires, and bandwidth, especially between the input router and the intermediate router." '775 Patent at 2:40-45.

The '775 Patent inventors realized this drawback of the prior art could be avoided with a "single-stem Y" configuration, in which the two pseudo-wires share the same link along their shared connection path. "Going against this received wisdom of the person skilled in the art, the inventors of the present application propose, in contrast, to share the link set up between the input

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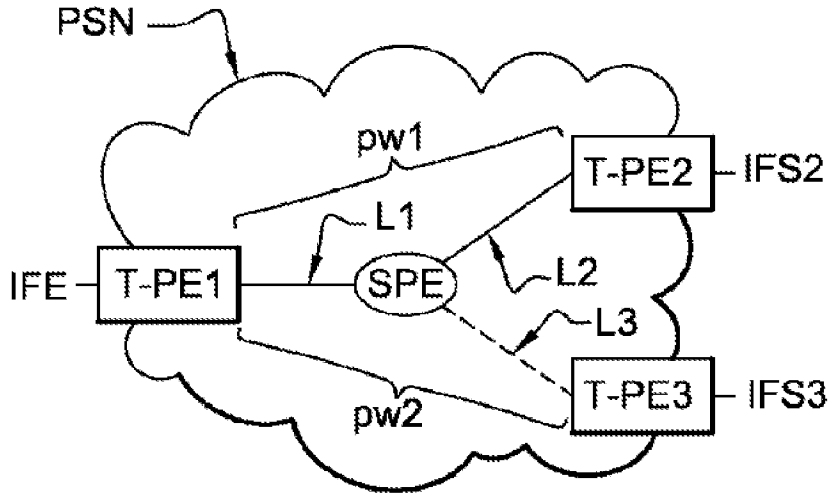
router and the intermediate router, which improves the use of network resources … Because the main pseudo-wire and the back-up pseudo-wire share the link set up between the input router and the intermediate router, the network resources that in the past were reserved for the back-up pseudo-wire are released and can be used in a manner closer to the optimum." *Id.* at 3:15-29. This novel approach is shown, for example, in '775 Patent Figure 3:

'775 Fig. 3



See also '775 Patent at 6:44-48 ("the first link L1 is shared by the two pseudowires pw1 and pw2. This optimizes the use of network resources, such as bandwidth, between the input router T-PE1 and the intermediate router S-PE, as only one link is set up between these two routers.").

IV. The Asserted References

Neither of the asserted references, either alone or in combination, teaches or renders obvious the Challenged Claims of the '775 Patent. For example, neither reference teaches setting up a first and second pseudo-wire that share a first a first link as required by both Challenged Claims. For further context, the following overview of the Aggarwal and Hussain references from Dr. Mitzenmacher's declaration is reproduced in this section. Ex. 2001 ¶¶ 46-53.

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A. Aggarwal

U.S. Patent No. 7,602,702 to Aggarwal ("**Aggarwal**") bears a purported filing date of February 10, 2005. Ex. 1005. Aggarwal is titled "Fast Reroute of Traffic Associated with a Point to Multi-Point Network Tunnel."

Aggarwal teaches "techniques for fast reroute of traffic associated with a point to multi-point (P2MP) tunnel." *Id.* at 1:62-64. The P2MP tunnel is set up using label switched paths, called "branch LSPs," between input and output routers. *Id.* at 2:2-3. These LSPs are set up using MPLS: "By utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched Path (LSP). An LSP defines a distinct path through the network to carry MPLS packets from the source device to a destination device." *Id.* at 1:34-37.

Aggarwal does not mention or discuss pseudo-wires at all. This makes sense, because Aggarwal is exclusively focused on using MPLS to route IP traffic across IP networks. *See, e.g.*, *id.* at 1:32-34 ("Multi-protocol Label Switching (MPLS) is a mechanism used to engineer traffic patterns within Internet Protocol (IP) networks."). Recall that one of the benefits of pseudo-wires is the ability to route non-IP traffic across a PSN. *See* '775 Patent at 1:49-52; *see also* Ex. 1010 at 17. Because of Aggarwal's exclusive focus on IP networks and using MPLS to route IP packets, the inventors of Aggarwal had no reason to consider or discuss pseudo-wires.

The Office Action cites to Aggarwal's Figure 5 embodiment and accompanying description. *See* Ex. 1005 at Fig. 5; 6:26-7:56. Figure 5 includes "Branch LSPs" 80 and 82, with Branch LSP 80 taking a path through the network from SPE router 60 to RPE Router 66, and Branch LSP 82 taking a path from SPE router 60 to RPE Router 68. *Id.* at 6:45-47.

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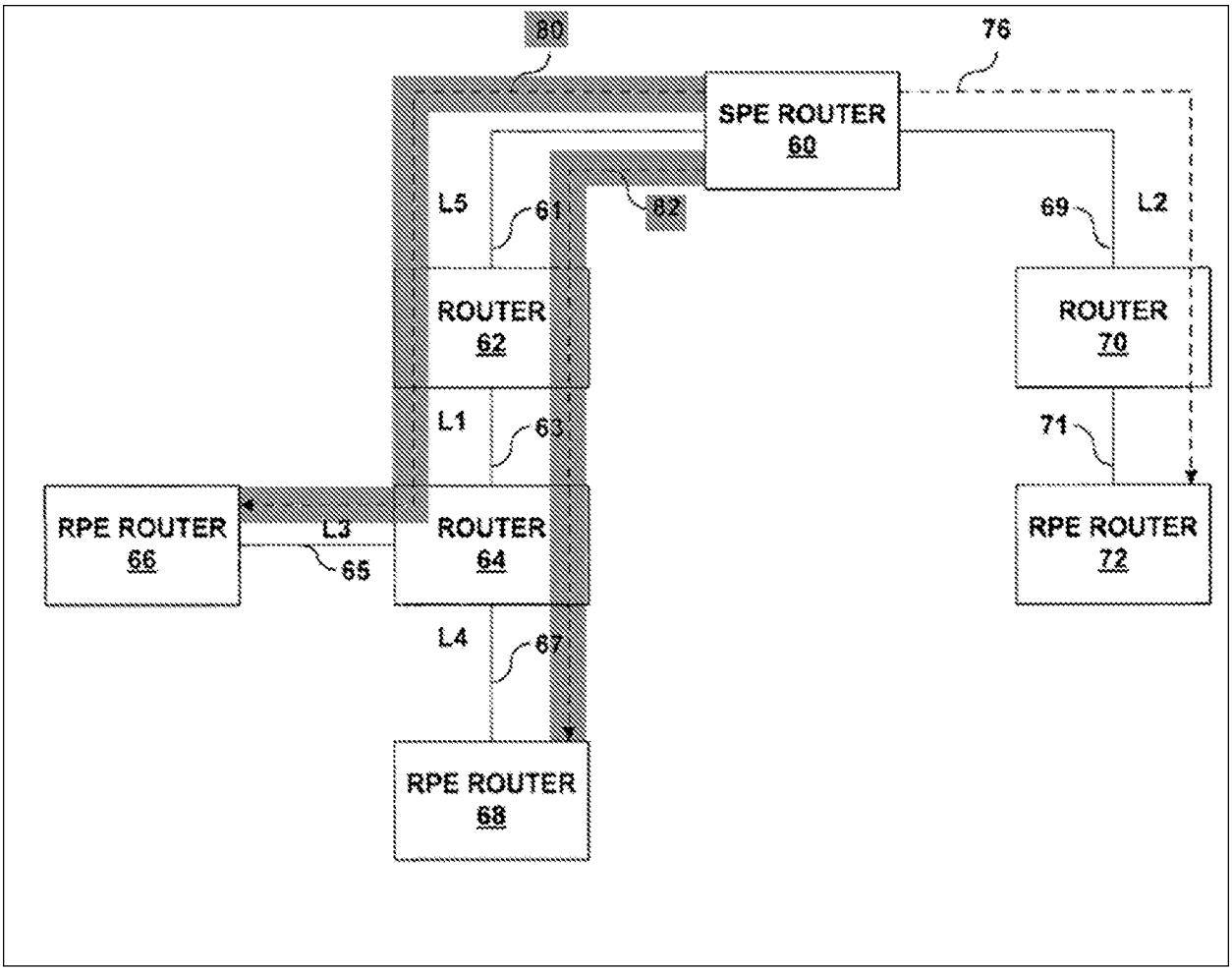

Ex. 1005 at Fig. 5 (highlighting added).

Aggarwal Figure 5 shows a "double-stem Y" configuration similar to the prior art depicted in '775 Patent Figure 2. Although Aggarwal's LSPs 80 and 82 share a portion of their connection path (from router 60 to router 64) they do not share any links along that path, as illustrated by the non-overlapping LSPs 80 and 82.

Aggarwal states that "Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60." Ex. 1005 at 6:47-49; *see also id.* at 6:40-42 ("These branch LSPs are computed to share the same links where possible as they belong to the same session."). However, as discussed in more detail below, Aggarwal does not use the term "link" in the same way as the '775 Patent, and therefore does not teach the shared link "single-stem Y" configuration shown, for example, in

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'775 Patent Figure 3 and recited in claims 1 and 6. Instead, Aggarwal describes a "link" as follows: "The term 'link' is often used to refer to the connection between two devices on a network. The link may be a physical medium, such as a copper wire, a coaxial cable, any of a host of different fiber optic lines or a wireless connection. In addition, network devices may define 'virtual' or 'logical' links, and map the virtual links to the physical links." Ex. 1005 at 1:22-27.

Accordingly, Aggarwal uses the term "link" to mean a connection path, and any two LSPs that share the same connection path are described by Aggarwal as sharing the same "link." This understanding is further confirmed by Aggarwal's repeated conflation of the concept of a "shared link" with a "shared path." *See, e.g.*, *id.* at 7:23-25 ("The next branch LSP may **follow the same path** as the first branch LSP up to a certain branch LSR."); *id.* at 7:50-56 ("When setting a P2MP LSP, a source router has a view of the entire network topology and can accordingly compute the **path** for each P2P LSP **sharing links where possible** with other branch LSPs belonging to the P2MPLSP. This can also be described as a P2MP constrained **shortest path first** (CSPF), where **a path to a destination router is set up as a P2P LSP**.").

In other words, Aggarwal teaches that the two Branch LSPs should be computed to use the "shortest path" through the network, which will typically result in these Branch LSPs sharing a portion of the same connection path between routers in the network (*e.g.* the paths 61 and 63 in Figure 5). This is akin to the prior art shown in Figure 2 of the '775 Patent in which pw1 and pw2 share the same path between the same devices (T-PE1 to SPE) without sharing any links. Aggarwal does not teach a "shared link" as that concept is used in the '775 Patent (*e.g.* the "single-stem Y" configuration of Fig. 3).

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B. Hussain

FAULT-TOLERANT IP AND MPLS NETWORKS by Iftekhar Hussain ("**Hussain**") is a textbook. Ex. 1006. It was purportedly published by Cisco Press in 2004.

Because Hussain is a textbook, it does not purport to improve upon the state of the art as of its publication date. Instead, Hussain describes how certain network technologies (including pseudo-wires) were understood to operate at that time. Accordingly, Hussain teaches that a pseudo-wire is "a mechanism that emulates the essential attributes of a service, such as FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex. 1006 at 272. Consistent with the prior art teaching of RFC3985 that a "PW is characterized as an **unshared link** or circuit of the chosen service" (Ex. 1010 at 3) (emphasis added), Hussain's PWs are separate from one another, with PWs distinguished, for example, by the use of separate labels. Ex. 1006 at 274-75 ("The demultiplexer [is used] to distinguish individual PWs within a single tunnel … the tunnel header and demultiplexer fields are based on MPLS labels.").

Because shared links between pseudo-wires were not known in the prior art, Hussain never discusses or teaches pseudo-wires sharing links. For example, Hussain illustrates two pseudo-wires taking different paths through the network without overlap:

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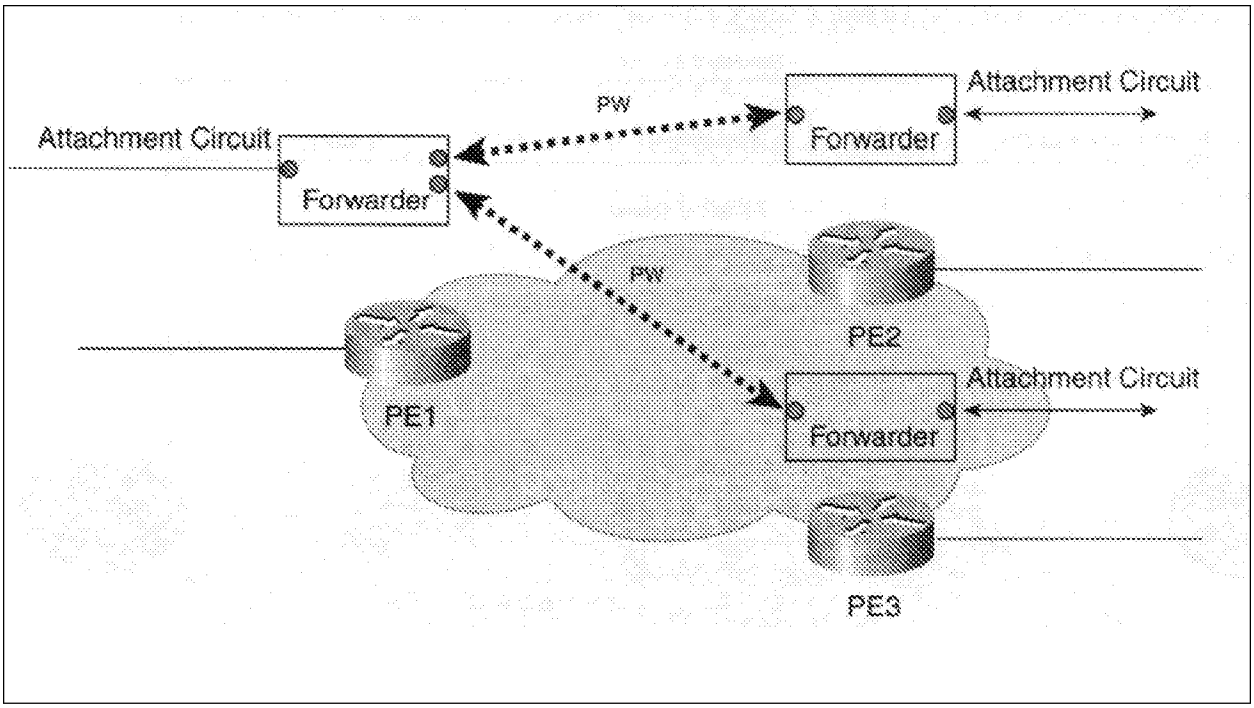

Ex. 1006 at 273.

Like Aggarwal, Hussain uses the term "link" differently than it is used in the '775 Patent. For example, Hussain states that "A VPN tunnel is a logical link between two devices such as PE routers that carries customer traffic across the backbone." Ex. 1006 at 255. Hussain also teaches that "multiple PWs may be carried in a single tunnel (which in the case of MPLS is an LSP)." Ex. 1006 at 197. Based on this, a POSITA would understand Hussain to teach that a tunnel is a link, and that multiple pseudo-wires may be carried inside a single tunnel link. A POSITA would further understand that a tunnel carrying multiple pseudo-wires is not the same as a shared link as the term is used in the '775 Patent. The links of Hussain comprise the pseudo-wires, while in the '775 Patent it is the pseudo-wires that comprise the links. *See, e.g.,* '775 Patent Claim 6 ("setting up a first **pseudo-wire comprising a first link**…"). A POSITA would also not have any reason to modify Hussain's pseudo-wires to comprise links—doing so would change the principle of operation of Hussain, essentially replacing the VPN tunnel of Hussain with pseudo-wires that carry other pseudo-wires.

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V. Claim Construction

The claims of the '775 Patent must be given their broadest reasonable construction in light of the specification as it would be interpreted by one of ordinary skill in the art:

> The Patent and Trademark Office ("PTO") determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction "in light of the specification as it would be interpreted by one of ordinary skill in the art." *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004). Indeed, the rules of the PTO require that application claims must "conform to the invention as set forth in the remainder of the specification and the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description." 37 C.F.R. § 1.75(d)(1). It is therefore entirely appropriate for a court, when conducting claim construction, to rely heavily on the written description for guidance as to the meaning of the claims.
>
> *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316-17 (Fed. Cir. 2005) (en banc)

Specifically, all challenged claims recite a first *link*, a second *link*, and a third *link*. Monarch, Requester Cisco, and the district court in the Parallel Litigation all recognized that the term *link* must be construed in light of the specification in order to determine the scope of the Challenged Claims. In the Parallel Litigation, Requester Cisco and Patent Owner Monarch proposed competing claim constructions for the term "link," and the Court issued a construction, as follows:

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Term[1]	Patent Owner Monarch's Proposal	Requester Cisco's Proposal	Court's Construction[2]
"link" (cls. 1, 6)	"a connection between an interface on a first device and an interface on a second device"	"part of a pseudo-wire (*i.e.*, a segment) with its own label that is used when broadcasting data streams"	"connection between an interface of a first router and an interface of a second router"

See Ex. 2002 at 9-10 (Monarch's proposed construction); Ex. 2003 at 12 (Cisco's proposed construction); Ex. 2004 at 33, 38 (Court's construction).

Similar to the Court's construction, under the broadest reasonable construction, the term "link" should be construed to mean "a connection between an interface on a first device and an interface on a second device."

A. The Construction of "Link"

Cisco's and Monarch's arguments about the proper construction of the term "link" are elaborated on in the attached claim construction briefing from the Parallel Litigation. Ex. 2005 at 15-17; Ex. 2006 at 15-17; Ex. 2007 at 5-6. Patent Owner summarizes its position as follows:

To minimize the duplicative nature of setting up and reserving processing resources along two different routing paths through the packet-switched network, the '775 Patent introduces the concept that two pseudo-wires can share a "link." This is required by all Challenged Claims, and

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[1] The parties originally proposed construing the larger phrase "link set up" but later agreed to construe only the term "link." Their proposed constructions did not change.

[2] The Court's construction substitutes the word "device" in Monarch's construction for the word "router." For purposes of this reexamination, these two constructions are equivalent because the devices in Aggarwal and Hussain are routers.

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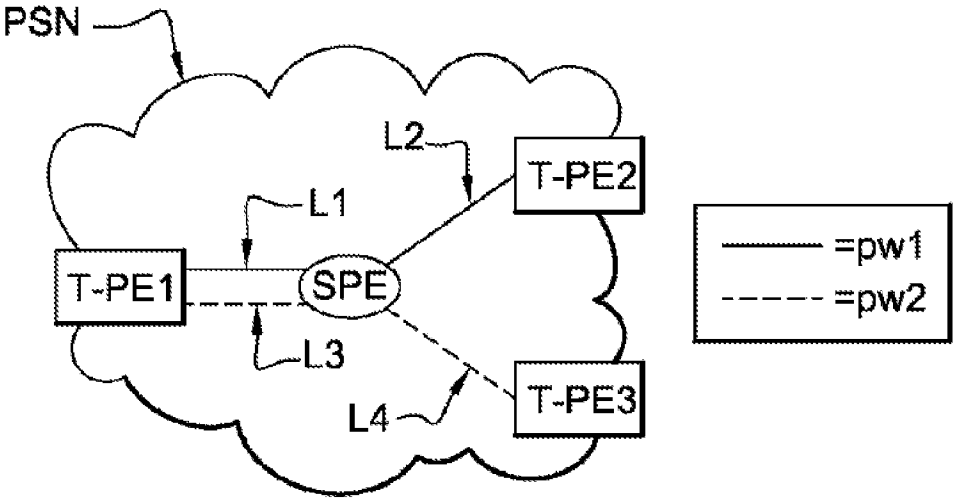
an example is shown by comparing the prior art approach of Figure 2 with the disclosed solution provided in Figure 3:

'775 Fig. 2 (Prior Art)



'775 Fig. 3

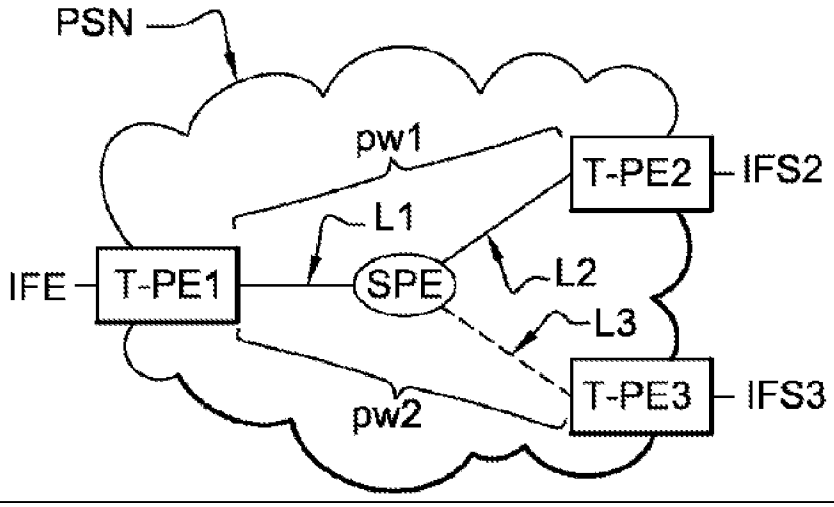


Figure 2 illustrates the prior art approach in which two pseudo-wires (pw1 and pw2) share a portion of their connection paths (the path from T-PE1 to SPE) but do not share any "links" because each pseudo-wire reserves its own separate link to traverse the shared path (links L1 and L3, respectively). *See* '775 Patent at 2:12-39. This prior art approach has the drawback of consuming additional network resources to set up and maintain two separate links along the same

path. *Id.* at 2:40-47. Figure 3 shows the '775 solution—instead of using two links along the shared path from T-PE1 to SPE, the two pseudo-wires instead share a single link (L1) along this path. *Id.* at 6:44-48. This solution optimizes the use of network resources by allowing the two pseudo-wires to share a link along their routing paths. *Id.* As Figures 2 and 3 show, a shared path is not necessarily the same thing as a shared link, and the same two routers can support multiple links between them (*e.g.* L1 and L3 in Fig. 2). Accordingly, it is important to give the term "link" a precise and clear meaning.

The specification gives examples that show the endpoints of a link each terminate on a particular interface on a device: "The packets sent to the first output router T-PE2 are directed to the **interface if2** of the intermediate router S-PE**. This interface if2 constitutes a first end of the link L2**." *Id.* at 8:5-8; *see also id.* at 6:60-7:2 ("the pseudowires pw1 and pw2 are set up at the initiative of the input router T-PE1 and setting them up is based on the exchange of set-up messages … [the] first set-up message includes an identifier SAII of the input router T-PE1 [and] **an identifier of an input interface IFE** associated with an equipment connected to the input router."). These examples show that in order to set up a link, one must identify both the device (*e.g.* SPE or T-PE1) and the particular interface (e.g. if2 or IFE) where the link will terminate on that device. As these examples show, a link is "a connection between an interface of a first router and an interface of a second router," and not merely any connection between two devices.

This plain meaning of "link" is supported by extrinsic evidence, such as IETF RFC4204, which defines "data link" as follows: "A data link is a pair of interfaces that are used to transfer user data." Ex. 2008 at 5; *see also id.* at 6 ("Port: An interface that terminates a data link.").

Cisco stated in its Responsive Claim Construction Brief in the Parallel Litigation: "The Court should reject Monarch's proposed construction because although **it is descriptive of a data**

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link, in general, it is not definitional regarding the types of links claimed in the '775 Patent. … So although **Cisco does not object to the concept of interfaces in the Court's construction**, the Court should not omit the critical aspects of Cisco's proposal that provide definition and come from the intrinsic record." Ex. 2006 at 17. In the quoted passage, Cisco told the district court that it believes additional limitations should be added to Monarch's construction because of allegedly "definitional" statements in the intrinsic record. However, Cisco also told the district court that both parties agree the proper construction of "link" should include "the concept of interfaces" even though Patent Owner and Cisco disagreed about other aspects of the construction.

Cisco's proposed construction attempts to re-define a "link" as a "segment." But the term "segment" has a different meaning from the term "link" to one skilled in the art. Ex. 2001 ¶ 45. Nothing in the specification equates a "link" with a "segment."

The only use of the term "segment" in the '775 Patent specification appears in citations to a prior art document titled "An Architecture for Multi-Segment Pseudo-Wire Emulation Edge-to-Edge." *See, e.g.*, '775 Patent at 2:1-2. Cisco cited this document as extrinsic evidence in the Parallel Litigation in support of its proposed construction. This document defines a "PW [pseuo-wire] Segment" as "A part of a single-segment or multi-segment PW, which is set up between two PE [provider edge] devices, T-PEs and/or S-PEs." Ex. 2009 at 6. In other words, this document says that a "segment" connects two "provider edge" devices, which are devices located at the edge of the network. For example, in figures 2 and 3, these would be the devices labeled T-PE1, T-PE2, and T-PE3, located at the edges of network labeled "PSN" (packet switched network). This extrinsic document further confirms this meaning of "segment" when it says "[s]cenarios are discussed where each **segment** of a given **edge-to-edge** emulated service **spans** a different provider's **PSN** [packet switched network]." *Id.* at 2.

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Thus a "segment" is different from a "link" as shown in Figures 2 and 3. The links in these figures (*e.g.* L1) do not "span" the entire PSN network from "edge-to-edge." Rather, links such as L1 span only part of the PSN (*e.g.* from T-PE1 to SPE) and do not go all the way from edge to edge. Cisco's proposed "segment" construction therefore contradicts Figures 2 and 3.

Cisco's proposed requirement that each link has "its own label" also unduly limits this term to a preferred embodiment. The '775 teaches embodiments in which each link is assigned a label (*e.g.*, '775 Patent at 7:25-26), but further teaches that the link can carry multiple different labels: "On reception of a data packet sent by the input router T-PE1, the intermediate router S-PE uses the label added to the packet by the input router to determine to which output interface if2, if3 to direct the data packet." *Id.* at 8:1-5. Accordingly, a packet traveling along link L1 from T-PE1 to SPE can have one of at least two different labels, indicating which of two interfaces (if2 or if3) the data packet should be directed to so it can be routed to the next link (L2 or L3). Thus, if Cisco's construction requires each link to have a single label, it would improperly exclude this embodiment, in which link L1 can carry at least two different labels.

Monarch's proposed construction of "link" to mean "a connection between an interface on a first device and an interface on a second device" is the broadest reasonable interpretation of the term. Monarch's proposed construction is broader than the construction adopted by the court (which required connection between "routers" specifically rather than the broader "devices"). Additionally, Requester Cisco acknowledged that Monarch's proposed construction "is descriptive of a data link, in general", again demonstrating that it is the broadest reasonable interpretation of the term link. Ex. 2006 at 17. The declaration of Dr. Mitzenmacher further supports Monarch's proposed construction of link. Ex. 2001 ¶¶ 43-45. Therefore, Monarch respectfully suggests that

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the proper construction of "link" is "a connection between an interface on a first device and an interface on a second device".

B. The Combination of Aggarwal and Hussain does not teach the Proper Construction of "Link"

As discussed above, both Requester Cisco and Patent Owner Monarch agreed the proper construction of "link" should include "the concept of interfaces."

Aggarwal does not disclose a "link" as "a connection between an interface on a first router and an interface on a second router." Instead, Aggarwal defines "link" differently: "The term 'link' is often used to refer to the connection between two devices on a network." Ex. 1005 at 1:22-27. This definition does not include the concept of interfaces. Instead, under the Aggarwal definition, two links that use different interfaces but that share the same physical path (*i.e.* the same "connection between two devices on a network") would be considered one link. For example, under the Aggarwal definition of "link," the two separate links L1 and L3 shown in Figure 2 of the '775 Patent would be considered one link because they share the same physical path between T-PE1 and SPE, *i.e.* they share the same "connection between two devices on a network." Accordingly, Aggarwal's definition of link is different from the narrower meaning of "link" in the '775 Patent. Aggarwal's definition would result in the '775 claims reading on prior art configurations such as Fig. 2 (with two links using different interfaces to traverse the same path). But that definition does not disclose the shared link configuration of Fig. 3, in which a shared link is defined by shared interfaces rather than merely a shared path. *See* Ex. 1001 at 8:5-8; *see also id.* at 6:60-7:2.

Hussain similarly fails to disclose a "link" as a "a connection between an interface on a first router and an interface on a second router." Hussain does not define what it means when it

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uses the term "link." But Hussain includes the following statement: "A VPN tunnel is a **logical link** between two devices such as PE routers that carries customer traffic across the backbone." Ex. 1006 at 255 (emphasis added). This description does not mention interfaces, and in fact Hussain never describes a link as being related to interfaces in any way. Accordingly, Hussain cannot disclose the claimed links.

C. The Combination of Aggarwal and Hussain does not teach Requester Cisco's Previously Proposed Construction of "Link"

Aggarwal and Hussain also fail to teach Cisco's previously proposed construction of "link" from the Parallel Litigation—"part of a pseudo-wire (*i.e.*, a segment) with its own label that is used when broadcasting data streams." Cisco told the district court: "The Court should reject Monarch's proposed construction because … it is not **definitional regarding the types of links claimed in the '775 Patent**. … the Court should not omit the **critical aspects of Cisco's proposal** that provide definition and come from the intrinsic record." Ex. 2006 at 17.

Aggarwal's "link" definition, cited above, does not include any of the limitations recited in Cisco's proposed construction. Ex. 1005 at 1:22-27. Aggarwal's links cannot possibly be "part of a pseudo-wire (*i.e.*, a segment)" because the words "pseudo-wire" and "segment" do not appear anywhere in Aggarwal. Moreover, the structure that Office Action identifies as the "first link" in Aggarwal does not have "its own label" but rather is shown with multiple different labels (L1 and L5) corresponding to different parts of the alleged "first link":

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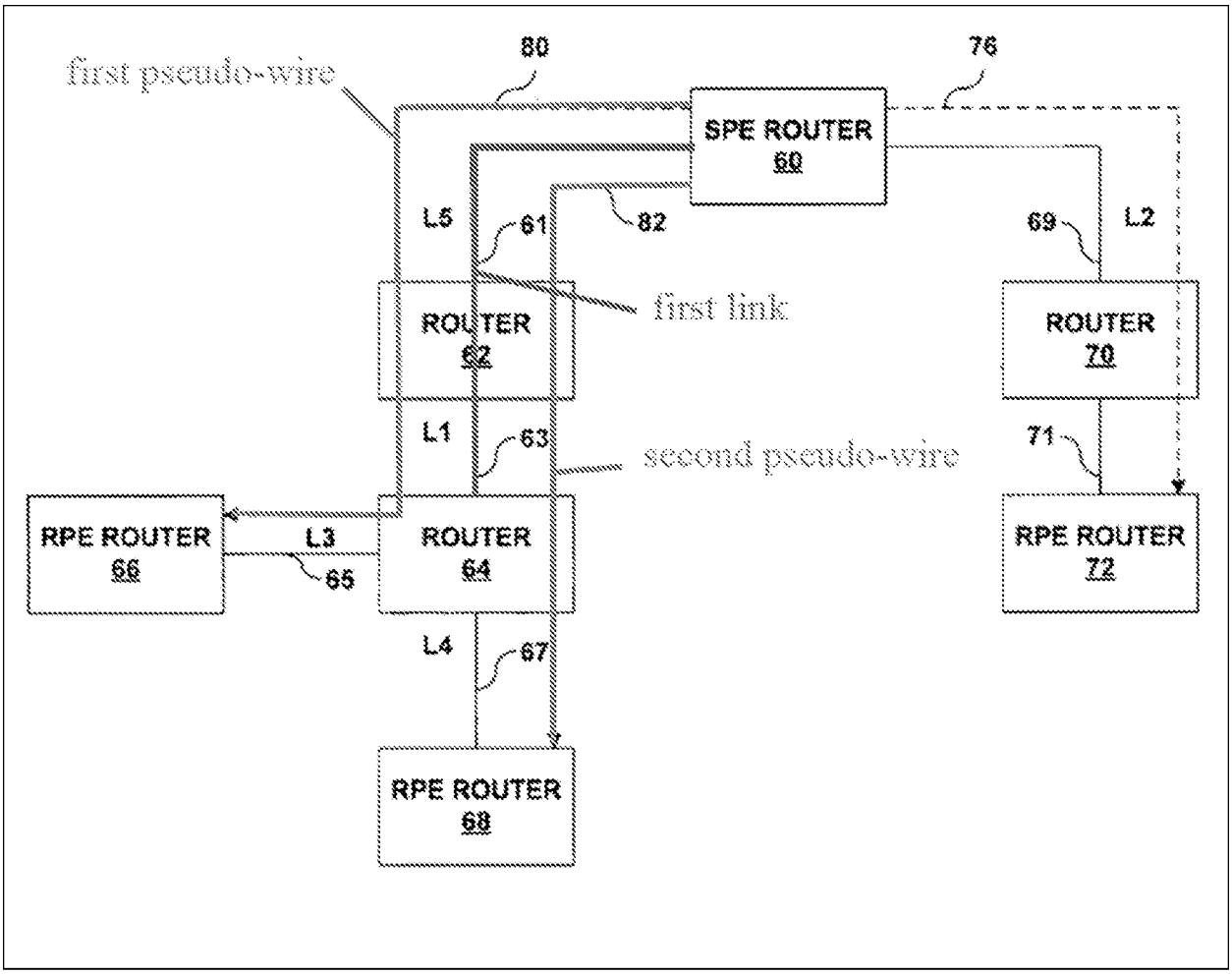

Office Action at 21 (annotations in original); *see also* Ex. 1005 at 50-59 (identifying L1 and L5 as different labels set up by different RESV messages). Accordingly, the alleged "links" of Aggarwal do not satisfy the limitations of even Cisco's proposed construction of "link."

Similarly, Hussain does not disclose the limitations in Cisco's own proposed construction. Hussain states: "A **VPN tunnel** is a **logical link** between two devices such as PE routers that carries customer traffic across the backbone." Ex. 1006 at 255 (emphasis added). Hussain further explains that "**PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel** in which an individual PW is identified based on the MPLS label." Ex. 1006 at 273. Thus, Hussain does not say that a "link" is "part of a pseudo-wire" as required by Cisco's construction, but rather says the opposite: Hussain says a tunnel is a type of link, and multiple pseudo-wires are nested inside the

tunnel link. In other words, Hussain says a single link comprises multiple pseudo-wires, not that a single pseudo wire comprises multiple links. *Compare* '775 Pat. Cl. 1 ("a first pseudo-wire comprising a first link … and a second link").

Hussain similarly fails to disclose that each link "has its own label." Rather, Hussain says that multiple pseudo-wires are nested inside of a link and "an individual PW is identified based on the MPLS label." Ex. 1006 at 273. Thus each link in Hussain carries multiple different labels, with each label corresponding to a different pseudo-wire nested inside that link. *See also id.* at 275 ("The demultiplexer [is used] to distinguish individual PWs within a single tunnel … demultiplexer fields are based on MPLS labels.").

Monarch does not agree with Cisco's previously proposed construction. However, as shown above and as discussed in further detail below, neither Aggarwal, nor Hussain, nor their combination discloses a "link," irrespective of which of the proposed constructions is applied.

VI. Remarks

A. No Claims would have been Obvious Based on Aggarwal and Hussain

The Office Action suggests that claims 1 and 6 would have been obvious based on Aggarwal and Hussain. Office Action at 5-6. However, Monarch respectfully rebuts the rejections, and requests the Office confirm the patentability of the Challenged Claims.

1. A POSITA would not have Combined Aggarwal and Hussain

A POSITA would not have been motivated to combine Aggarwal and Hussain in the manner identified in the Office Action. Explanations of why a POSITA would not have made the specific combinations are provided in this section as well as on a per limitation basis in the following sections. The Office Action suggests several general reasons why a POSITA "would

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have found it obvious to combine the teachings of Aggarwal and Hussain". Office Action at 9-16. Monarch respectfully disagrees, and requests reconsideration.

In general, a POSITA would not have looked to combine Aggarwal with the teachings of Hussain. Aggarwal is exclusively focused on using MPLS to route IP traffic across IP networks. *See, e.g.*, *id.* at 1:32-34 ("Multi-protocol Label Switching (MPLS) is a mechanism used to engineer traffic patterns within Internet Protocol (IP) networks."); Ex. 2001 ¶¶ 48, 64-68, 92. One of the primary reasons for the use of pseudo-wires is the need to route non-IP traffic across a packet switched network. *See* '775 Patent at 1:49-52; Ex. 2001 ¶¶ 34, 48, 64-68, 92, 97, 99, 101. Given the IP focused nature of Aggarwal, a POSITA would not have had no reason to look to Hussain for teachings on pseudo-wires, which can carry non-IP traffic. Ex. 2001 ¶¶ 34, 48, 64-68, 92, 97, 99, 101.

Furthermore, Aggarwal is focused on routing multicast traffic. *See generally* Aggarwal columns 3-4; Ex. 2001 ¶¶ 93, 95. The portions of Hussain submitted as Exhibit 1006 do not address multicast transmission. A POSITA also would not have been motivated to combine the multicast system of Aggarwal with the non-multicast teachings of Hussain.

The Office Action suggests:

- "A POSITA would have recognized that Aggarwal gives a general overview of LSPs. And, a POSITA would have looked to other resources that provide further implementation details for such LSPs." Office Action at 10.
- "A POSITA looking to implement Aggarwal's method would naturally refer to literature describing similar technology." Office Action at 10.

Regarding those first two points, mere similarity between the subject matter of Aggarwal and Hussain would not be sufficient do demonstrate a motivation to combine the references. "[A]

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statement of similarity [] does not constitute an articulated reasoning with rational underpinning as to why a POSITA would combine elements of one reference with another, and why a POSITA would modify the teachings of the references to arrive at the claimed invention." *William Wesley Carnes, Sr. Inc. v. Seabaord International Inc.*, IPR2019-00133, Paper 10 at 18 (PTAB May 8, 2019); *see also Polaris Indus. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1068 (Fed. Cir. 2018) ("We have observed that the prejudice of hindsight bias often overlooks that the genius of invention is often a combination of known elements which in hindsight seems preordained."(internal quotes and citations omitted)).

- "Hussain would have been an attractive option, as it describes implementing LSPs in the context of providing high availability and fault-tolerance." Office Action at 10.

None of the proposed modifications to Aggarwal would have improved the availability or fault tolerance of Aggarwal. The use of pseudo-wires does not, in and of itself, improve the availability or fault tolerance of an LSP or any other network component. Instead, it enables the ability to route non-IP traffic across a packet switched network. Ex. 2001 ¶¶ 34, 48, 64-68, 92, 97, 99, 101. A POSITA would not have looked to the pseudo-wire teachings of Hussain for benefits which pseudo-wires do not provide.

- "Hussain shows that implementing LSPs, such as Aggarwal's branch LSPs, with pseudo-wires was well-known. Thus, a POSITA implementing the teachings of Aggarwal would have been motivated to implement the teachings of Hussain to improve Aggarwal's LSPs with pseudo-wires that connect routers over an IP/MPLS backbone." Office Action at 11.

Even if the use of pseudo-wires was well-known, as discussed above a POSITA would not have looked to the pseudo-wires of Hussain to improve on Aggarwal, because of (for example) Aggarwal's exclusive focus on IP and multicast routing.

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- "A POSITA would have understood that implementing the LSPs of Aggarwal as pseudo-wires, as taught by Hussain, would improve network efficiency in line with Aggarwal's goals. Ex. 1003, paragraph 71." Office Action at 11.
- A POSITA would have been motivated to implement Aggarwal's LSPs as pseudo-wires to save network resources or because pseudo-wires permit broadcasting services. Office Action at 12.

Regarding these two points, a POSITA would not have looked to Hussain for these reasons because pseudo-wires do not provide any of these benefits. The Office Action cites to the Requester's Declarant for support (Ex. 1003 ¶ 71). But nothing discussed in that paragraph explains how the use of pseudo-wires in the prescribed manner would improve the network efficiency of Aggarwal. In fact, the opposite is true—the use of pseudo-wires results in an increase in overhead as the edges of the pseudo-wires must emulate certain characteristics inherent to non-IP based communication. Ex. 2001 ¶ 94.

Nor does the cited paragraph explain how the use of pseudo-wires would permit broadcasting services, or even why that would be desirable for the system of Aggarwal. As noted above, Aggarwal is focused specifically on supporting multicast routing. A POSITA would not understand "broadcasting" over pseudo-wires to be an improvement on multicasting—multicasting is used for specific technical scenarios, and a POSITA would need a specific reason to modify Aggarwal's use of multicasting. Ex. 2001 ¶ 95.

For at least the foregoing reasons (as well as for the limitation specific reasons discussed below), a POSITA would not have been motivated to combine Aggarwal with Hussain in the proposed manner.

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2. Claim 1

[1.0] A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:

The Office Action presents several different theories about what allegedly discloses the "setting up at least two pseudo-wires" limitations. First, the Office Action suggests that "Patent Owner stated Aggarwal's label switched paths are 'pseudo-wires' as recited in '775" in the Parallel Litigation. Second, the Office Action suggests that a POSITA would implement Aggarwal's branch LSPs as pseudo-wires. Office Action at 17 ("a POSITA would have found it obvious to implement Aggarwal's branch LSPs as pseudo-wires"). Third, the Office Action suggests that a POSITA would have implemented Hussain's pseudo-wires *within* Aggarwal's LSPs. *Id.* at 19 ("Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs").

First, Patent Owner Monarch never stated that Aggarwal's label switched paths are pseudo wires as recited in the '775 Patent (as suggested in the Office Action at 17). The paragraph from the district court litigation cited by the Office Action is reproduced below:

> 36. The ASR Series 9000 routers also support a feature called Virtual Private LAN Service (VPLS) Label Switched Multicast (LSM), which includes support for pseudo-wire configurations as claimed by the '775 Patent. The VPLS LSM solution employs point-to-multipoint (P2MP) label-switched paths (LSPs) in the MPLS core to carry broadcast, multicast, and unknown unicast traffic for a VPLS domain. The pseudo-wire configurations described by Cisco's documentation mirror those claimed by the '775 Patent

EX1017 ¶ 36 (Monarch's Complaint against Cisco for Patent Infringement). Aggarwal is never mentioned in the cited document. Furthermore, Monarch never asserted that MPLS label switching alone satisfies the claimed pseudo wires. Instead, Monarch asserted that a specific Cisco functionality (VPLS LSM) *includes support for* the claimed pseudo-wire configurations—that is, a specific configuration of a specific Cisco functionality infringes the '775 Patent, not *all uses* of

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MPLS label switched paths as suggested in the Office Action. Monarch therefore alleged that the accused Cisco VPLS LSM functionality included *both* pseudo-wires and LSPs; Monarch never alleged that LSPs are the same thing as pseudo-wires.

Furthermore, Aggarwal does not mention or discuss pseudo-wires at all. *See* Ex. 2001 ¶¶ 63-65. Aggarwal is exclusively focused on using MPLS to route IP traffic across IP networks. *See, e.g.*, '775 Patent at 1:32-34 ("Multi-protocol Label Switching (MPLS) is a mechanism used to engineer traffic patterns within Internet Protocol (IP) networks."). As noted in the '775 Patent, one of the benefits of pseudo-wires is the ability to route non-IP traffic across a PSN. *See* '775 Patent at 1:49-52. Because of Aggarwal's exclusive focus on IP networks and using MPLS to route IP packets, Aggarwal would have provided no reason to consider pseudo-wires.

Additionally, in the context of using a POSITA's knowledge to supply a missing limitation, the Federal Circuit considers whether "'the [missing] limitation in question [is] unusually simple and the technology particularly straightforward.'" *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1338 (Fed. Cir. 2020) (quoting *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1361-62 (Fed. Cir. 2016)). However, there is no evidence provided in the Office Action that it would have been unusually simple and straightforward "to implement Aggarwal's branch LSPs as pseudo-wires" or "to implement pseudo-wires *within* Aggarwal's branch LSPs." Office Action at 14-19; Ex. 1003 at ¶¶ 84-89. Aggarwal does not mention "pseudo-wires" at all, and Hussain does not mention "branch LSPs." As such, it would not have been particularly simple or straightforward to connect these concepts, nor would it have been simple or straightforward to figure out, from the teachings of these references, how to combine them. Ex. 2001 ¶ 96. The fact that the Office Action (and the Request) propose two alternative ways to combine a "pseudo-wire" and a "branch LSP" further demonstrates that the combination is not simple or straightforward.

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[1.1] setting up a first pseudo-wire comprising a first link

As discussed above in section V, incorporated by reference here, neither Patent Owner's (nor Requester Cisco's) construction of "link" is disclosed by Aggarwal or Hussain or their combination. Accordingly, Monarch respectfully requests reconsideration and a finding that the proposed ground does not teach this limitation.

Furthermore, the Office Action suggests that Aggarwal discloses "a first pseudo-wire comprising a first link" because "Branch LSPs 80 and 82 share links 63 and 61" and "links 61 and 63 either individually or together regard the claimed 'first link.'" Office Action at 21. Assuming for the sake of argument that those statements correctly characterize Aggarwal, at most that would show that Aggarwal teaches "a first **branch LSP** comprising a first link" but not "a first **pseudo-wire** comprising a first link" because Aggarwal does not mention pseudo-wires at all.

The teachings of Hussain also would not render this limitation obvious. Hussain states that "**multiple PWs** may be **carried in a single tunnel** (which in the case of MPLS is **an LSP**)" and teaches that a "**VPN tunnel is a logical link** between two devices such as PE routers." Ex. 1006 at 197, 255. Thus, Hussain teaches that a tunnel is a link, and that multiple PWs may be carried inside a single tunnel link. This means that Hussain does not teach "a first pseudo-wire comprising a first link [... and a second link]" but rather teaches the exact opposite: "a link comprising a pseudo-wire nested inside."[3]

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[3] As a matter of logic and common sense, "A comprises B" does not mean the same thing as "B comprises A." A face comprises eyes, but eyes do not comprise a face. The human race comprises Tom Hanks, but Tom Hanks does not comprise the human race.

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This understanding of Hussain is confirmed by Requester Cisco's Declarant, who states: "Hussain teaches implementing **pseudo-wires within a PE-to-PE tunnel**... Like Hussain's PE-to-PE tunnel, Aggarwal's **Branch LSPs are tunnels** between edge routers." Ex. 1003 at ¶ 75 (emphasis added). Thus, assuming for the sake of argument that the Declarant's statements are correct, Hussain's pseudo-wires would need to be implemented within links 61 and/or 63 of Aggarwal's Branch LSPs, such that links 61 and 63 comprise a pseudo-wire nested inside. But the opposite is required by this claim limitation: "a first pseudo-wire comprising a first link."

Additionally, a POSITA would have understood that combining Aggarwal and Hussain to arrive at this claim limitation would "change the principle of operation" of Hussain because Hussain's links comprise pseudo-wires and not the other way around. MPEP § 2143.01. As explained by Dr. Mitzenmacher, a pseudo-wire is a transport mechanism capable of transmitting non-IP traffic over a packet switched network. Ex. 2001 ¶ 56. A POSITA would not have any reason to modify Hussain's pseudo-wires to comprise links—doing so would change the principle of operation of Hussain, essentially replacing the VPN tunnel of Hussain with pseudo-wires that carry other pseudo-wires.

The Office Action suggests "it would have been obvious to an artisan to substitute one communication technique for the other to 'optimize packet replication and minimize state and intelligence in the core of the network.'" Office Action at 24 (citing Ex. 1005 at 3:40-42). However, modifying Aggarwal to (1) implement Aggarwal's branch LSPs as pseudo-wires or (2) implement pseudo-wires within Aggarwal's branch LSPs would not optimize packet replication or minimize state and intelligence in the core of the network.

First, neither change would optimize the packet replication taking place within the system described by Aggarwal. Aggarwal describes the use of P2MP TE LSPs to purportedly "optimize packet replication and minimize state and intelligence in the core of the network." Implementing

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those LSPs as pseudo-wires would not reduce the amount of packet replication any further than the unmodified system of Aggarwal—pseudo-wires merely provide the ability to transport non-IP based traffic across a packet switched network. Ex. 2001 ¶¶ 98-99. There is no further reduction in packet replication when pseudo-wires are added to an existing MPLS configuration. Instead, there is an increase in overhead as the edges of the pseudo-wires must emulate certain characteristics inherent to non-IP based communication. *Id.* Similarly, implementing pseudo-wires within the branch LSP's would not reduce packet replication. Again, the use of pseudo-wires can potentially provide additional capabilities for supporting non-IP based services within the LSPs, but none of those capabilities reduce packet replication. *Id.*

Second, neither change would minimize state and intelligence in the core of the network. Again, Aggarwal teaches that this reduction is the purported result of the use of P2MP TE LSPs. Implementing the LSPs as pseudo-wires or implementing pseudo-wires within the branch LSPs would do nothing to minimize state or intelligence in the core of the network. The pseudo-wires themselves carry IP and non-IP data meant for a destination at the edge of the network. Because of this, the pseudo-wire data is encapsulated in IP transmittable data that will not have an effect on the core network. For example, RFC 4717 (Exhibit 2011) describes "[a]n Asynchronous Transfer Mode (ATM) Pseudowire (PW) [] used to carry ATM cells over an MPLS network". Ex. 2011 at 1. RFC 4717 describes a system which uses encapsulation to transmit ATM PW data across a packet switched network. "It lists ATM-specific requirements and provides encapsulation formats and semantics for connecting ATM edge networks through a packet- switched network using MPLS." Ex. 2011 at 3. As a result, it merely "[u]s[es] the common packet-switched network infrastructure"—it does nothing to minimize the state or intelligence in the core of that network. Ex. 2011 at 3. Therefore, it would not have been obvious to an artisan to substitute one

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communication technique for the other to optimize packet replication and/or minimize state and intelligence in the core of the network because neither objective would be achieved by the subsystem. Ex. 2001 ¶¶ 100-102.

Furthermore, Aggarwal is exclusively focused on using MPLS to route IP traffic across IP networks. A POSITA would not have would have no reason to implement non-IP technology in the IP-focused system of Aggarwal. Ex. 2001 ¶¶ 34, 48, 64-68, 92, 97, 99, 101.

Therefore, even if a POSITA would have looked to Hussain to improve on Aggarwal (which Monarch does not concede), there is no evidence that a POSITA would have been motivated to make the proposed change to Aggarwal. Absent evidence of such a motivation, the proposed combination can only be attributed to improper hindsight reconstruction of the '775 Patent invention. Mere similarities in the subject matter of the references (such as discussions of MPLS) are insufficient to provide a motivation to combine. "[A] statement of similarity [] does not constitute an articulated reasoning with rational underpinning as to why a POSITA would combine elements of one reference with another, and why a POSITA would modify the teachings of the references to arrive at the claimed invention." *William Wesley Carnes, Sr. Inc. v. Seabaord International Inc.*, IPR2019-00133, Paper 10 at 18 (PTAB May 8, 2019); *see also Polaris Indus. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1068 (Fed. Cir. 2018) ("We have observed that the prejudice of hindsight bias often overlooks that the genius of invention is often a combination of known elements which in hindsight seems preordained."(internal quotes and citations omitted)).

[1.2] [a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and

As discussed above in section V, incorporated by reference here, when properly construed the "link" limitation is not disclosed by Aggarwal or Hussain or their combination.

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[1.3] [a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.1], which is incorporated by reference here.

[1.4] setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,

[1.5] wherein the second pseudo-wire comprises said first link and

[1.6] [wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,

These limitations are not taught by the proposed ground for the same reasons recited above regarding limitations [1.1] and [1.3], which are incorporated by reference here.

[1.7] said first link being shared by the first and second pseudo-wires.

As discussed above in section V, incorporated by reference here, when properly construed the "link" limitation is not disclosed by Aggarwal or Hussain or their combination.

The Office Action suggests that Aggarwal discloses this limitation because "Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60" as shown in Figure 5. Office Action at 35-36; *see also* Ex. 1005 at 6:47-49. However, Aggarwal is using the term "share links" differently from the meaning of "link being shared" in the '775 Patent.

As discussed above, the '775 Patent teaches that in the prior art, pseudo-wires might share the same connection path, but would not share links along that path. An example of this is shown in the prior art "double-stem Y" configuration of Fig. 2, in which the same connection path from T-PE1 to SPE is traversed by two different links, L1 and L3.

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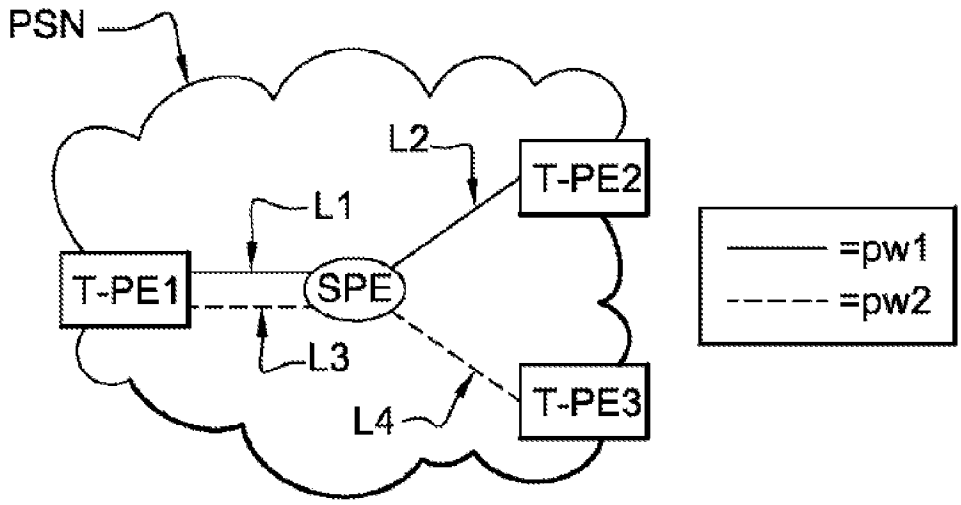
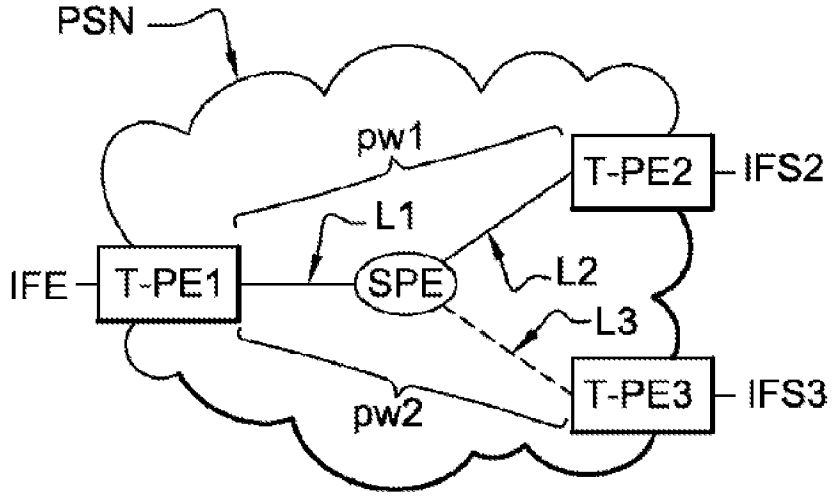
'775 Fig. 2 (Prior Art)



The '775 Patent teaches combining separate links along the shared connection path, thereby using a shared link (with a shared set of interfaces on T-PE1 and SPE). This results in the "single-stem Y" configuration shown for example in Figure 3. Shared link L1 in Figure 3 is an example of a "first link being shared by the first and second pseudo-wires" as required by limitation [1.7]. *See* Ex. 1001 at 6:44-45 (In Fig. 3 "the first link L1 is shared by the two pseudo-wires pw1 and pw2"); *see also id.* at 6:60-7:2; 8:5-8.

'775 Fig. 3



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Aggarwal explicitly states what it means when it uses the term "link": "The term 'link' is often used to refer to the connection between two devices on a network." Ex. 1005 at 1:22-27.

Aggarwal therefore defines a link broadly as a connection path between two devices. If multiple links share the same connection path between two devices, Aggarwal considers these links to be a single shared "link" because they share the same "connection between two devices." But, as shown in Figure 2 of the '775 Patent, this is not what the '775 Patent means by a "link being shared." Links L1 and L3 in Figure 2 traverse the same "connection between two devices on a network" but they are nevertheless different links, as taught by the '775 Patent. *See* '775 Patent at 2:12-39.

Accordingly, when Aggarwal says that "Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60," Aggarwal is referring to a double-stem Y configuration like the one shown in prior art Fig. 2, in which branch LSPs 80 and 82 share the same physical path or "connection between two devices on a network" but do not actually share any links. *See* Ex. 1005, 6:47-49. This is further shown by Aggarwal's conflation of the concept of a "link" and a "path" when describing Figure 5: "When setting a P2MP LSP, a source router has a view of the entire network topology and can accordingly compute the **path** for each P2P LSP **sharing links where possible** with other branch LSPs belonging to the P2MPLSP. This can also be described as a P2MP constrained **shortest path first** (CSPF), where **a path to a destination router is set up as a P2P LSP**." Ex. 1005 at 7:50-56; *see also id.* at 7:23-25 ("The next branch LSP may **follow the same path** as the first branch LSP up to a certain branch LSR.").

This double-stem Y configuration is illustrated even more clearly in Petitioner's annotated Figure 5 of Aggarwal:

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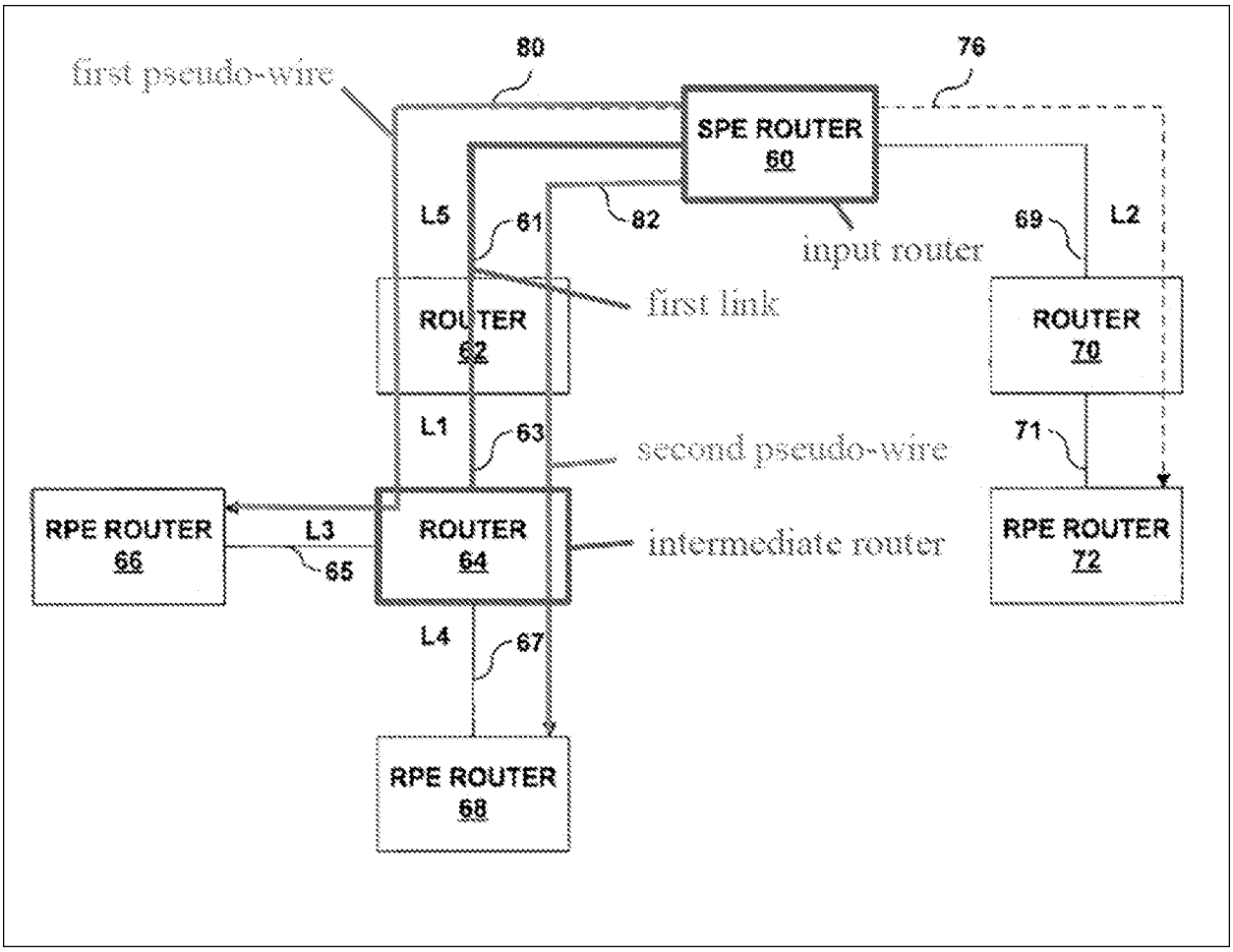

Office Action at 21 (Ex. 1005 at Fig. 5 with annotations). Figure 5 shows branch LSPs 80 and 82 (annotated as the purported "first pseudo-wire" and "second pseudo-wire") in a double-stem Y configuration like Figure 2 of the '775 Patent. There is no overlap between the first and second pseudo-wire lines. Aggarwal says Branch LSPs 80 and 82 share "links" because they share the same path along the connections 61 and 63 between devices 60, 62, and 64. This is consistent with Aggarwal's broad definition of a "link" as any "connection between two devices" and is also consistent with Aggarwal's conflation of the terms "link" and "path." But this is akin to '775 Patent Figure 2, in which two separate links L1 and L3 share the same connection path between devices T-PE1 and SPE.

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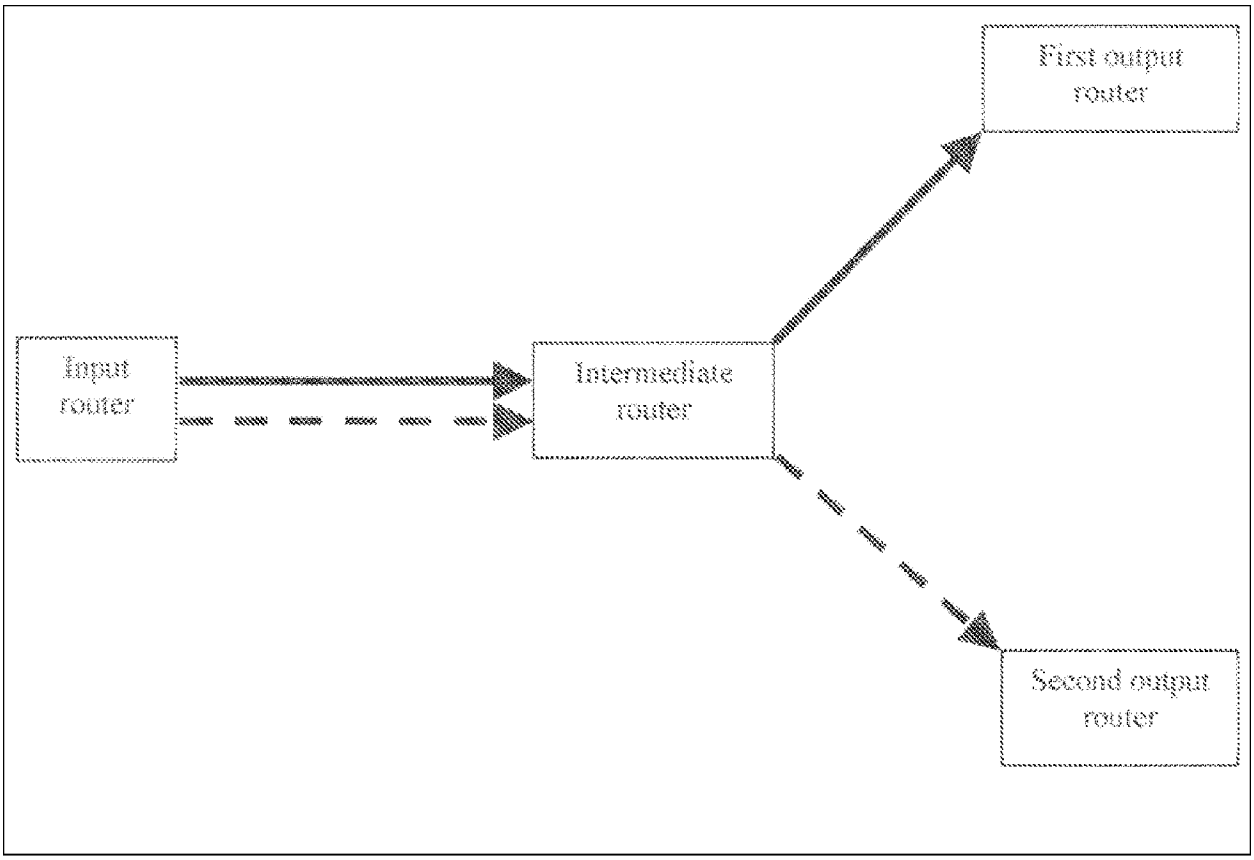
The fact that Aggarwal teaches the prior art double-stem Y configuration is further demonstrated by the admissions of Petitioner's Declarant. He states that "Aggarwal discusses taking 'advantage of a LSP hierarchy [LSP-HIER] while building P2MP LSPs.'… The figure created below illustrates a P2MP LSP tunnel with the branch LSPs from the figure above nested inside the tunnel." Ex. 1003 at ¶ 83. The Declarant then provides the following figure which purports to show how Aggarwal's Branch LSPs are configured:



Ex. 1003 at ¶ 83 (figure prepared by Petitioner's Declarant); *see also id.* at ¶ 82.

The Declarant's figure clearly shows Aggarwal's Branch LSPs in a double-stem Y configuration, just like Aggarwal's Figure 5 and the '775 Patent's prior art Figure 2. There is no overlap or "first link being shared" by the two Branch LSPs. Instead, the two Branch LSPs use

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different links to get from the Input Router to the Intermediate Router, even though they share the same connection path between those routers.

Accordingly, Aggarwal does not teach a "first link being shared" by Aggarwal's Branch LSPs. As discussed above, the Office Action suggests that a POSITA would have known to "implement Aggarwal's branch LSPs as pseudo-wires" or "implement pseudo-wires *within* Aggarwal's branch LSPs." Office Action at 17-19. Assuming for the sake of argument that such a combination is possible, the combination would not include a "first link being shared by the first and second pseudo-wires" because the pseudo-wires would use the same double-stem Y configuration as Aggarwal's Branch LSPs, and therefore would not share any links. *See also* Ex. 2001 ¶¶ 71-74.

3. Claim 6

[6.0] A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.0], which is incorporated by reference here.

[6.1] setting up a first pseudo-wire comprising a first link

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.1], which is incorporated by reference here.

[6.2] [a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.2], which is incorporated by reference here.

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[6.3] [a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.3], which is incorporated by reference here.

[6.4] setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.4], which is incorporated by reference here.

[6.5] wherein the second pseudo-wire comprises said first link and

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.5], which is incorporated by reference here.

[6.6] [wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.6], which is incorporated by reference here.

[6.7] said first link being shared by the first and second pseudo-wires.

This limitation is not taught by the proposed ground for the same reasons recited above regarding limitation [1.7], which is incorporated by reference here.

VII. Objective Evidence Demonstrates the '775 Patent was not Obvious

As discussed above, the asserted combination of Aggarwal and Hussain does not support a conclusion of obviousness. Even if it did, the evidence of secondary considerations compels a conclusion that the '775 Patent would not have been obvious in light of the asserted art.

"The objective indicia of non-obviousness play an important role as a guard against the statutorily proscribed hindsight reasoning in the obviousness analysis. Indeed, [the Federal Circuit]

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ha[s] held that 'evidence of secondary considerations may often be the most probative and cogent evidence in the record.'" *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1328 (Fed. Cir. 2016) (quoting *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538 (Fed. Cir. 1983)). Relevant secondary considerations include—for example—commercial success, long-felt need, failure of others, and industry praise. *See, e.g., Apple Inc. v. Samsung Elecs. Co., Ltd.*, 839 F.3d 1034, 1047-1048, 1052-53 (Fed. Cir. 2016).

In the Parallel Litigation, Monarch sued Requester Cisco for infringing the '775 Patent with its VPLS LSM technology. As outlined in the complaint for patent infringement (and shown in Cisco's own configuration documents), Cisco products—such as its ASR 9000 series routers—implemented the infringing functionality of the '775 Patent. Ex. 2012 ¶¶ 34-37, 119-141 (complaint for patent infringement by Cisco); Ex. 2013 (Cisco documentation detailing how to set up VPLS LSM in a manner infringing the '775 Patent); Ex. 2001 ¶¶ 104-105.

As shown below, the commercial success, long-felt need, and praise for commercial embodiments of the '775 Patent (such as the accused Cisco VPLS LSM technology), provide objective evidence demonstrating the non-obviousness of the '775 Patent. Furthermore, the failure of others to provide alternative solutions to the '775 Patent invention further reinforces its non-obviousness. *See* Ex. 2001 ¶¶ 104-123.

A. Commercial Success

The commercial success of Requester Cisco's products implementing the '775 Patent demonstrates that the claimed invention would not have been obvious. *See* Ex. 2001 ¶¶ 106-107.

- Cisco states: "VPLS is a widely-deployed [] technology" and VPLS LSM is needed to "overcome[] the drawbacks of ingress replication" which is (1) "bandwidth inefficient", (2) "can result in significant wasted link bandwidth when there is heavy

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broadcast and multicast VPLS traffic", and (3) "is also resource-intensive because the ingress PE router bears the full burden of the replication." Ex. 2013 at 2-3.

- Cisco notes: "VPLS Label Switched Multicast (LSM) is an effective multicast solution for overcoming the limitations of ingress replication." Ex. 2014 at 28.
- Cisco tells its customers to use "Optimized multicast forwarding with LSM." Ex. 2015 at slide 138.
- Benefits of LSM include "Efficient IP multicast traffic forwarding" and "Enabl[ing] MPLS traffic protection and BW control of IP multicast traffic." Ex. 2016 at slide 84.
- In addition, Cisco touted the advantages of VPLS LSM to its potential and existing customers at its major Cisco Live events. *See, e.g.,* Exs. 2015, 2016. Cisco Live is an event that is hosted by Cisco to provide education and training to existing and prospective customers of Cisco's products, including the router products that are alleged to infringe in this lawsuit. Cisco has stated that each year tens of thousands of IT and communications professionals attend Cisco Live events that are held around the world, with many more attending on-line. Ex. 2017. The fact that the VPLS LSM technology has been the focus of Cisco Live presentations shows the importance of this technology to Cisco's marketing efforts and its customer base. This is further evidence of the nexus between the commercial success of Cisco's routers and the VPLS LSM technology which infringes the '775 Patent.

B. Long-Felt Need

There was a long-felt, but unresolved need for a solution to the pseudo-wire problem identified by the '775 Patent. Ex. 2001 ¶ 108. Prior to the '775 Patent, data packets were often routed using Multi-Protocol Label Switching ("MPLS") technology, which had a number of

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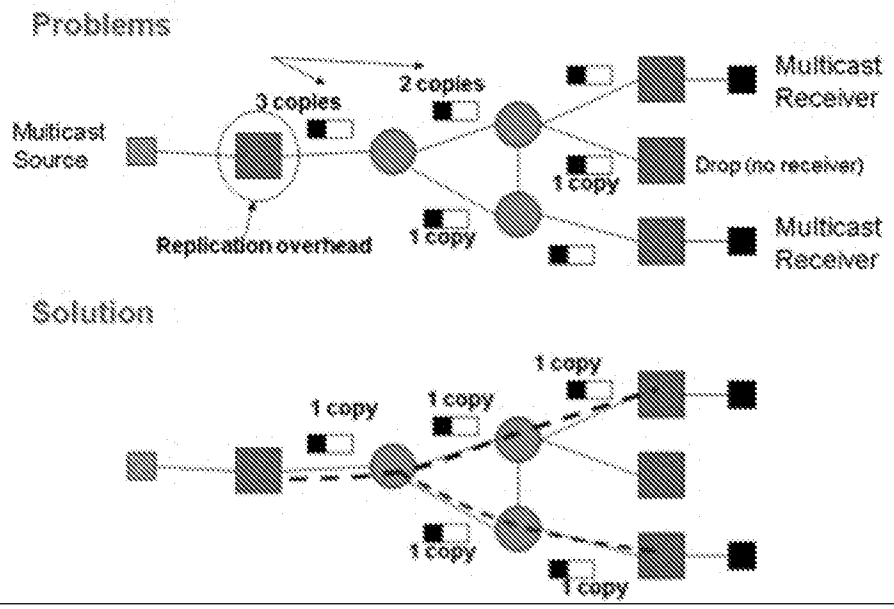
drawbacks— including limitations on the types of packets that could be routed. '775 Patent at 1:34-44. While those issues were partly resolved by Pseudo-Wire Emulation Edge-to-Edge ("PWE3") technology that defined a pseudo-wire concept for emulating a point-to-point link ('775 Patent at 1:45-52), there was still a need for more reliable and fault proof PWE3 techniques that required fewer resources and improved quality of service ('775 Patent 2:40-47). Requester Cisco acknowledged this long-felt need. Ex. 2013 at 2 ("Drawbacks of Ingress Replication"). Thus, there was a long-felt need for the pseudowire solution problem provided by the '775 Patent. For example, documents from Requester Cisco show that the '775 Patent provided a solution to the long felt problem of ingress replication:

Ex. 2013 at 2



C. Failure of Others

That others had tried to provide an acceptable solution to the problems identified in the '775 Patent further shows its non-obviousness. For example, in the Parallel Litigation, Cisco hired an expert to propose possible alternative to the inventions claimed in the '775 Patent, including at least the following technologies:

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- Multicast Virtual Private Network (MVPN);
- Ethernet Virtual Private Network (EVPN);
- Using ingress replication;
- Using tunnels without pseudo-wires;
- Using a single pseudo-wire instead of two pseudo-wires;
- Using a pseudo-wire with a single link instead of multiple links; and
- Using two pseudo-wires where the first link is not shared between the two pseudo-wires.

Ex. 2018 ¶ 744. However, Dr. Mitzenmacher evaluated each of those technologies and determined that none would have been acceptable alternatives to the '775 Patent. Ex. 2001 at ¶¶109-122. The fact that Cisco (one of the leading networking technology companies in the world) and its expert were unable to identify any non-infringing alternatives to the '775 Patent that would have been satisfactory to a POSITA demonstrates that others had tried and failed to provide an acceptable solution to the problems identified in the '775 Patent and provides further objective evidence of the non-obviousness of the '775 Patent.

D. Praise

The inventions of the '775 Patent have also received a great deal of praise, which further shows the non-obviousness of the claimed inventions. For example, Cisco has praised the VPLS LSM implementation of the '775 Patent:

- Cisco states: "VPLS is a widely-deployed [] technology" and VPLS LSM is needed to "overcome[] the drawbacks of ingress replication" which is (1) "bandwidth inefficient", (2) "can result in significant wasted link bandwidth when there is heavy

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broadcast and multicast VPLS traffic", and (3) "is also resource-intensive because the ingress PE router bears the full burden of the replication." Ex. 2013 at 2-3.

- Cisco notes: "VPLS Label Switched Multicast (LSM) is an effective multicast solution for overcoming the limitations of ingress replication." Ex. 2014 at 28.
- Cisco tells its customers to use "Optimized multicast forwarding with LSM." Ex. 2015 at slide 138.
- Benefits of LSM include "Efficient IP multicast traffic forwarding" and "Enabl[ing] MPLS traffic protection and BW control of IP multicast traffic." Ex. 2016 at slide 84.

VIII. Conclusion

For the foregoing reasons, Patent Owner respectfully requests that the Office find all Challenged Claims patentable.

Dated: September 30, 2021

Respectfully submitted,

By: */Christopher L. Limbacher/*
Michael F. Heim (Reg. No. 32,702)
Christopher L. Limbacher (Reg. No. 76,551)
Attorneys for Patent Owner
Monarch Networking Solutions LLC

Juniper Exhibit 1008, page 98

CERTIFICATE OF SERVICE

The undersigned certifies that a copy of the foregoing PATENT OWNER'S RESPONSE TO FIRST OFFICE ACTION was served via First Class Mail on:

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Dated: September 30, 2021

Respectfully submitted,

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Christopher L. Limbacher (Reg. No. 76,551)
Attorneys for Patent Owner
Monarch Networking Solutions LLC

CERTIFICATE OF EFS-WEB TRANSMISSION

I hereby certify that this correspondence is being transmitted via the U.S. Patent and Trademark Office (USPTO) electronic filing system (EFS-Web) to the USPTO on September 30, 2021.

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PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	90014701
Filing Date	2021-04-15
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
	Filing Date	2021-04-15
	First Named Inventor	Frederic Jounay
	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	1	Email string between Frederic Jounay and Luca Martini regarding P2MP VPWS requirements draft, dated February 14, 2007	☐
	2	Email between Frederic Jounay and Luca Martini regarding P2MP requirements draft, dated February 20, 2007	☐
	3	F. JOUNAY, ET AL., Use Cases and signaling requirements for Point-to-Multipoint VPWS draft-xxxx-12vpn-p2mp-vpws-requirements-00	☐

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	90014701
Filing Date	2021-04-15
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

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

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☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

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

Signature	/Christopher L. Limbacher/	Date (YYYY-MM-DD)	2021-08-03
Name/Print	Christopher L. Limbacher	Registration Number	76,551

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EFS ID:	43410704
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	90471
Filer:	Christopher Lee Limbacher
Filer Authorized By:	
Attorney Docket Number:	43614.399
Receipt Date:	03-AUG-2021
Filing Date:	12-MAR-2021
Time Stamp:	10:54:00
Application Type:	Reexam (Third Party)

Payment information:

Submitted with Payment	no

File Listing:

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1	Information Disclosure Statement (IDS) Form (SB08)	775_IDS.pdf	70850 91293f6ebf32ac071251ddd8829ac70385df7399	no	4

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/014,701	03/12/2021	8130775	43614.399	4147

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EXAMINER	
SAGER, MARK ALAN	

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

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

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EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. *90/014,701* .

PATENT UNDER REEXAMINATION *8130775* .

ART UNIT *3992* .

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified *ex parte* reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the *ex parte* reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Office Action in Ex Parte Reexamination	**Control No.** 90/014,701	**Patent Under Reexamination** 8130775	
	Examiner MARK A SAGER	**Art Unit** 3992	**AIA (FITF) Status** No

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

a. ☑ Responsive to the communication(s) filed on 15 June 2021.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

b. ☐ This action is made FINAL.

c. ☐ A statement under 37 CFR 1.530 has not been received from the patent owner.

A shortened statutory period for response to this action is set to expire 2 month(s) from the mailing date of this letter. Failure to respond within the period for response will result in termination of the proceeding and issuance of an *ex parte* reexamination certificate in accordance with this action. 37 CFR 1.550(d). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).** If the period for response specified above is less than thirty (30) days, a response within the statutory minimum of thirty (30) days will be considered timely.

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☐ Notice of References Cited by Examiner, PTO-892.
2. ☑ Information Disclosure Statement, PTO/SB/08.
3. ☐ Interview Summary, PTO-474.
4. ☐ _____.

Part II SUMMARY OF ACTION

1a. ☑ Claims 1 and 6 are subject to reexamination.

1b. ☑ Claims 2-5 and 7-9 are not subject to reexamination.

2. ☐ Claims _____ have been canceled in the present reexamination proceeding.

3. ☐ Claims _____ are patentable and/or confirmed.

4. ☑ Claims 1 and 6 are rejected.

5. ☐ Claims _____ are objected to.

6. ☐ The drawings, filed on _____ are acceptable.

7. ☐ The proposed drawing correction, filed on _____ has been (7a) ☐ approved (7b) ☐ disapproved.

8. ☑ Acknowledgment is made of the priority claim under 35 U.S.C. 119(a)-(d) or (f).

a) ☑ All b) ☐ Some* c) ☐ None of the certified copies have

1 ☐ been received.

2 ☐ not been received.

3 ☑ been filed in Application No. 12/528083.

4 ☐ been filed in reexamination Control No. _____.

5 ☐ been received by the International Bureau in PCT application No. _____.

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

9. ☐ Since the proceeding appears to be in condition for issuance of an *ex parte* reexamination certificate except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte* Quayle, 1935 C.D. 11, 453 O.G. 213.

10. ☐ Other: _____

cc: Requester (if third party requester)

Notice of Pre-AIA or AIA Status

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

2. This FAOM action regards claims 1 and 6 of 8130775 (hereafter '775) as granted in Order Decision mailed Apr. 15, 2021. Claims 2-5 and 7-9 are not subject of this reexamination.

Extensions of Time

3. Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not to parties in a reexamination proceeding. Additionally, 35 U.S.C. 305 requires that reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)). Extension of time in *ex parte* reexamination proceedings are provided for in 37 CFR 1.550(c).

Notification of Concurrent Proceedings

4. The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No. 8,130,775 throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

Amendment in Reexamination Proceedings

5. Patent owner is notified that any proposed amendment to the specification and/or claims in this reexamination proceeding must comply with 37 CFR 1.530(d)-(j), must be formally presented pursuant to 37 CFR 1.52(a) and (b), and must contain any fees required by 37 CFR 1.20(c).

Submissions

6. In order to insure full consideration of any amendments, affidavits or declarations or other documents as evidence of patentability, such documents must be submitted in response to

the first Office action on the merits (which does not result in a close of prosecution). Submissions after the second Office action on the merits, which is intended to be a final action, will be governed by the requirements of 37 CFR 1.116, after final rejection and by 37 CFR 41.33 after appeal, which will be strictly enforced.

Claim Construction

7. The claims under reexamination are given the broadest reasonable interpretation consistent with the specification. See *In re Yamamoto*, 740 F.2d 1569, 222 USPQ 934 (Fed. Cir. 1984). For claims of an expired patent, the standard for claim construction set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303, 75 USPQ2d 1321 (Fed. Cir. 2005) (words of a claim "are generally given their ordinary and customary meaning" as understood by a person of ordinary skill in the art at the time of the invention) would apply since expired claims are not subject to amendment. See MPEP § 2258(I)(G). We interpret claims of an unexpired patent using the broadest reasonable construction in light of the specification of the patent in which they appear. See 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144—45 (2016). In applying a broadest reasonable construction, claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. See *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

8. The '775 Patent has not expired. As noted above, unexpired patent claims in a reexamination are given the broadest reasonable interpretation consistent with its disclosure where claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. Accordingly, the challenged claims herein are given their "broadest reasonable interpretation consistent with the '775 specification." See MPEP § 2258; *In re Yamamoto*, 740 F.2d 1569, 222 USPQ 934

(Fed. Cir. 1984). As noted in the Order Granting reexamination, mailed April 15, 2021, the '775 Patent is the subject of related litigation; but, those proceedings have not reached a final decision.

Claim Limitations Important to Patentability

9. In view of the prosecution history with Applicant's remarks, claim amendments and the Examiner's reasons for allowance as summarized in the Order Granting reexamination, the following limitations (italicized emphasis added) from Challenged claim 1, as representative of the challenged subject matter herein, are deemed important to patentability as alleged as elements lacking in applied art by Applicant during examination to becoming '775:

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
>
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, *said first link being shared by the first and second pseudo-wires.*

Ex.1001, 12:14-27.

10. **The Declaration by Henry Hough (Ex. 1003) under 37 CFR 1.68 filed Mar. 12, 2021** (signed July 6, 2020) has been reviewed and considered. Declarant states he was compensated for his opinion testimony (paragraph 002) to provide expert testimony based on his qualifications (Ex. 1003, paragraph 007-026 and Ex. 1004, Curriculum Vitae) where his compensation s not contingent on the outcome of this reexam or the specifics of his testimony. The declaration has been considered for expert opinion regarding level of ordinary skill (paragraph 035), technology background (paragraphs 027-033), claim construction (049) and interpretation of what Aggarwal and Hussain references describe/teach to an artisan (paragraphs 051-155). This is only indicating

that examiner has reviewed/considered the testimony. His opinion regarding interpretation of cited art is relied on herein to extent specifically stated in a rejection below.

Claim Rejections - 35 USC § 103

11. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

12. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

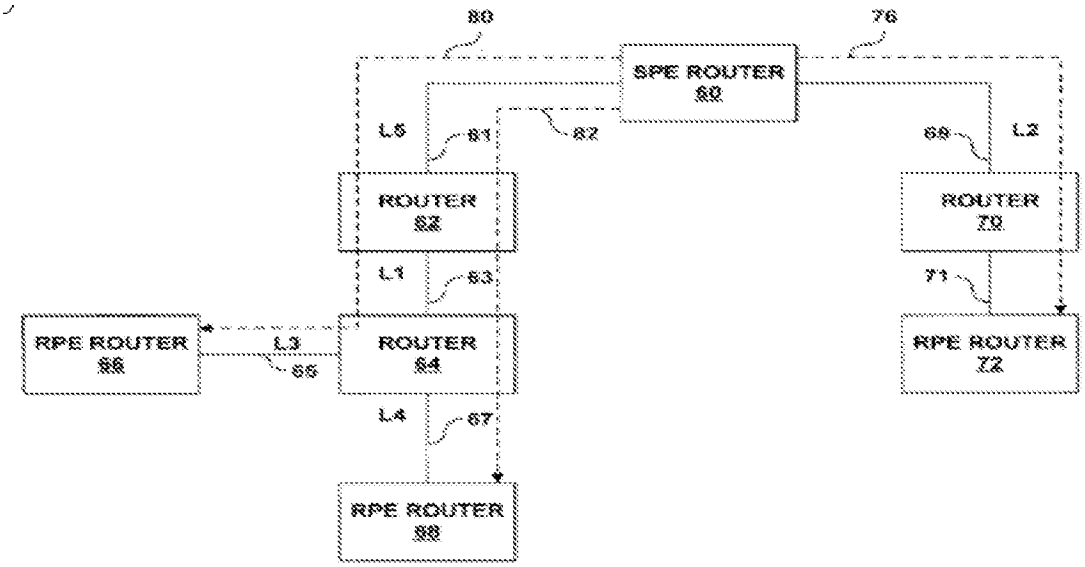
13. This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

14. **Claims 1 and 6 are rejected under pre-AIA 35 U.S.C. 103(a) as obvious over U.S. Patent No. 7602702 (hereafter "Aggarwal"), Ex. 1005, in view of "Fault-Tolerant IP and**

MPLS Networks" (1st ed. 2004) ("hereafter Hussain"), Ex. 1006. Lacking facts to the contrary, with broadest reasonable interpretation of the claimed invention noted above, although using different terminology, an artisan (e.g., a person of ordinary skill in the art, "POSITA") at the time of the invention would have interpreted Aggarwal as considered with Hussain's teachings renders the challenged claims unpatentable for reasons as discussed below.

1. ***Summary of Aggarwal***

Like the '775 patent, Aggarwal is generally directed to routing traffic "associated with a **point to multi-point (P2MP) tunnel**." Ex. 1005, 1:63-64. In particular, Aggarwal describes techniques for extending a resource reservation protocol "to be used for establishing P2MP TE [traffic engineering] tunnels." Ex.1005, 3:22-24. "[T]he extensions may be used to setup [point-to-point] P2P TE LSPs between source and receiver provider edge routers." Ex.1005, 3:27-28. "The P2P LSPs that are merged to form the P2MP LSPs are referred to as branch LSPs." Ex. 1005, 4:13-15. Aggarwal further describes how the branch LSPs may be nested within the P2MP tunnel using label stacking. See Ex.1005, 9:17-39, 9:61-10-3. Importantly, like the '775 patent, to accomplish using P2P tunnels to establish P2MP tunnels, "the P2P TE LSPs are appropriately **merged** by the network." Ex.1005, 3:29-31. As an example, these techniques are illustrated in Fig. 5, shown next.



Ex.1005, Fig. 5

Fig. 5 illustrates how "SPE [source provider edge] router 12 establishes a P2MP LSP between SPE router 12 and RPE [receiver provider edge] routers 66, 68, and 72." Ex.1005, 6:31-32. To do this, the SPE router 60 establishes a branch LSP 80 between the SPE router 60 and a first RPE router 66. See Ex. 1005, 6:44-47. LSP 80 includes links 61 and 63 between the SPE router and intermediate router 64, as well as link 65 between the intermediate router 64 and the first RPE router 66. Ex.1005, Fig. 5. Ex.1003, paragraph 55.

Additionally, the SPE router 60 establishes a branch LSP 82 between the SPE router 60 and a second RPE router 68. See Ex.1005, 6:44-47. LSP 82 includes links 61 and 63 between the SPE router 60 and intermediate router 64, as well as link 67 between the intermediate router 64 and the second RPE router 68. Ex. 1005, Fig. 5. Ex. 1003, paragraph 56.

Notably, "[t]hese branch LSPs are computed to **share the same links where possible** as they belong to the same session." Ex. 1005, 6:40-42. As such, "Branch LSPs 80 and 82 **share links 63 and 61** between router 64 and SPE router 60." Ex. 1005, 6:47-49. In other words, Aggarwal's technique "merges individual branch LSPs to form a P2MP LSP." Ex.1005, 7:4-5; Ex.1003, paragraph 57.

Aggarwal describes an application for this technology in "transmission of multicast traffic without run[ning] a multicast routing protocol on routers." Ex.1005, 4:32-34. Aggarwal shows an example of setting up a "P2MP LSP associated with" a particular "multicast group." Ex.1005, 6:34-35. In the example, multiple "branch LSPs" are established in "P2MP RSVP [resource reservation protocol] TE tunnels." Ex.1005, 6:26-43; Ex.1003, paragraph 58.

Aggarwal is analogous art to the '775 patent because it is both in the same field of endeavor and is directed to the same technical problem as the '775 patent. Both Aggarwal and the '775 patent are in the field of MPLS network traffic management. See Ex.1005, 1:7-9, 3:29-39; Ex.1001, 1:25-26, 1:34-36. And, Aggarwal is directed to the same technical problem as the '775 patent. Like the '775 patent, which describes "setting up ... a single link common to the two pseudo-wires," Aggarwal teaches that "Branch LSPS 80 and 82 share links 63 and 61." Ex.1001, 3:3-4; Ex.1005, 6:47-49; Ex.1003, paragraph 59.

2. ***Summary of Hussain***

Like Aggarwal and the '775 patent, Hussain relates to MPLS networks. In particular, Hussain is a book that provides additional implementation details and options for setting up LSPs within packet-switched networks such as those described by Aggarwal. In one example, Hussain describes setting up a tunnel between Provider Edge (PE) routers. Ex. 1006, 267. This tunnel is referred to as a PE-to-PE tunnel. *See id.* Hussain further teaches that several LSPs can be "nested" within the PE-to-PE tunnel. In particular, Hussain states that "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex. 1006, 273. Furthermore, Hussain teaches that such LSPs are applicable to a "point-to-multipoint L2VPN [Layer 2 Virtual Private Network]." Ex. 1006, 272. Ex. 1003, paragraph 60.

Hussain also describes a Virtual Private LAN Service (VPLS) in which multiple "point-to-point PWs [pseudo-wires]" are set up using Label Distribution Protocol (LDP). Ex. 1006, 276. This set up can be performed by "hardware and software components" of routers in a network. Hussain, 6. In particular, Hussain explains that "IP/MPLS control-plane software, the brain of a router, resides in the control processor card." Ex.1006, 8; Ex.1003, paragraph 61.

After a pseudo-wire is set up, data packets can be sent along the pseudowire. Hussain explains that "a Layer 2 frame" is encapsulated "in a pseudowire (PW) protocol data unit." Ex.1006, 272. The frame is then transported in the pseudo-wire "over a tunnel across the PSN [packet-switched network]" from one provider edge (PE) router to another. Ex.1006, 272; Ex.1003, paragraph 62.

Hussain also describes a Virtual Private LAN Service (VPLS), which provides "a point-to-multipoint service" across a packet-switched network that "emulates the performance of a LAN." Ex.1006, 275. A business using VPLS to interconnect multiple geographically distributed sites can take advantage of the features and benefits a conventional local-area network provides, such as "broadcast and unicast services." Ex.1006, 277; Ex.1003, paragraph 63.

3. ***Reasons to Combine Aggarwal and Hussain***

A POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because the combination is merely use of a known technique to improve similar methods in the same way. Specifically, it would have been obvious to a POSITA to apply Hussain's known technique of implementing LSPs as pseudo-wires to Aggarwal's similar LSPs within an MPLS network. Ex. 1003, paragraphs 64-66.

As mentioned above, Aggarwal describes establishing label switched paths (LSPs): "By utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched

Path (LSP)." Ex. 1005, 1:34-35. Aggarwal further notes that a "variety of protocols exist for establishing LSPs." Ex.1005, 1:45. Aggarwal describes both Resource Reservation Protocol with Traffic Engineering Extensions (RSVP-TE) and Label Distribution Protocol (LDP). See Ex.1005, 1:45-55. Aggarwal further teaches using RSVP-TE to establish point-to-multipoint (P2MP) LSP tunnels. See Ex.1005, 1:62-2:14; Ex. 1003, paragraph 66.

A POSITA would have recognized that Aggarwal gives a general overview of LSPs. And, a POSITA would have looked to other resources that provide further implementation details for such LSPs. Hussain provides a POSITA with just such details. Specifically, Hussain is directed to the design and deployment of high availability IP and MPLS network architectures. See Ex. 1006, title page. A POSITA looking to implement Aggarwal's method would naturally refer to literature describing similar technology. Therefore, a POSITA would have looked to other references—like Hussain—that further discuss establishing LSPs within an MPLS network. Moreover, Hussain would have been an attractive option, as it describes implementing LSPs in the context of providing high availability and fault-tolerance. Indeed, the title of Hussain is "Fault-tolerant IP and MPLS Networks." Thus, when implementing an MPLS network as taught by Aggarwal, a POSITA would have looked to a comprehensive guide for implementing such networks with fault-tolerance and high availability. Ex. 1003, paragraph 67.

Hussain notes that "[i]n MPLS, a tunnel corresponds to a *label-switched path* (LSP)." Ex. 1006, 255. Hussain further describes "PE-to-PE tunnels [that] can be established using LDP or RSVP-TE." Ex. 1006, 273. As explained above, a PE is a Provider Edge router. Further, like Aggarwal, Hussain describes point-to-multipoint services. See Ex. 1006, 272-73. Accordingly, like Aggarwal, Hussain describes establishing LSPs between routers. Ex. 1003, paragraph 68.

Hussain further describes a particular type of LSP that may be implemented, that is, implementing LSPs as pseudo-wires. Specifically, Hussain describes encapsulating a "frame in a *pseudowire* (PW) protocol data unit." Ex. 1006, 272. Hussain notes that a "PW is a mechanism that emulates the essential attributes of a service, such as FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over **IP and/or MPLS network**." Ex. 1006, 272. Hussain teaches that "PWs correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex. 1006, 273. "In the MPLS backbone, PEs are connected via PWs, which correspond to PE-to-PE LSPs that are established using LDP. In turn, PWs are multiplexed (nested) and transported over PE-to-PE tunnels." Ex. 1006, 274. Accordingly, Hussain shows that implementing LSPs, such as Aggarwal's branch LSPs, with pseudo-wires was well-known. Thus, a POSITA implementing the teachings of Aggarwal would have been motivated to implement the teachings of Hussain to improve Aggarwal's LSPs with pseudo-wires that connect routers over an IP/MPLS backbone. Ex. 1003, paragraph 69.

Furthermore, Hussain provides additional details to help support Aggarwal's teaching of sharing links. Specifically, as described above, Aggarwal is directed to merging point-to-point LSPs to form point-to-multipoint LSPs. Aggarwal teaches that an objective of such techniques is to "optimize packet replication and minimize state and intelligence in the core of the network, while performing P2MP TE." Ex.1005, 3:40-43. Aggarwal's techniques also seek to "reduce complexity." Ex.1005, 7:9-11. Ex.1003, paragraph 70.

A POSITA would have understood that implementing the LSPs of Aggarwal as pseudo-wires, as taught by Hussain, would improve network efficiency in line with Aggarwal's goals. Ex.1003, paragraph 71. The advantages of implementing an LSP as a pseudo-wire were obvious

and commonly known in the art before 2007. Hussain describes how with "the migration of legacy Layer 2 infrastructure over a converged packet-switched network," services such as Frame Relay (FR) and Asynchronous Transfer Mode (ATM) "are predominantly offered over an IP/MPLS backbone." Ex. 1006, 254. For example, "[a] PW [pseudo-wire] is a mechanism that emulates the essential attributes of a service, such a FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex. 1006, 272.

Contemporaneous documents confirm that network engineers were creating technology combinations like that suggested by the combination of Aggarwal's and Hussein's teachings. A prior art IETF document discusses "[a]n Ethernet multipoint Layer2 VPN service provided by MPLS" (e.g., similar to Hussein's VPLS) and explains that "if existing P2P TE LSPs are used as tunnels between PEs, any ingress PE must duplicate the frames and send them to the corresponding PEs," which would "waste the provider's network resources." Ex.1015, 15-16. Therefore, the IETF draft provides a potential solution, noting that "it might be desirable that P2MP MPLS TE LSPs are used for data transmission with an appropriate layer 2 encapsulation technique (**for example, pseudo wire**) instead of P2P MPLS TE LSPs, contributing in turn to savings of network resources." Ex. 1015, 16 (emphasis added). Further, pseudo-wires permit broadcasting services. Therefore, a POSITA would have been motivated to implement Aggarwal's LSPs as pseudo-wires. Ex. 1003, paragraph 71.

The results of applying Hussain's teachings of pseudo-wires to Aggarwal's branch LSPs would have been predictable because Hussain explicitly teaches establishing LSPs such as the ones described by Aggarwal as pseudo-wires. The combination of Aggarwal and Hussain would have yielded predictable results because, as discussed above, implementing LSPs as pseudo-wires was well known to successfully provide Layer 2 services over an MPLS network. A prior

art IETF document explains that "multicast-based services such as IP TV, DVB etc.," were becoming more popular, so IETF "Working Groups, such as MPLS and L2VPN, [had] begun to discuss the requirements and solutions for multicast." Ex. 1016, 2. The IETF draft acknowledged that the same "solutions are needed to support the multicast traffic over PW." Ex. 1016, 2. Therefore, the IETF draft proposed "procedures to transmit the multicast traffic using the unidirectional Pseudowires (PWs), and describe the corresponding extensions to Label Distribution Protocol (LDP)." Ex.1016, 2-3. A solution discussed was that "the PSN [packet-switched network] tunnel used to carry the point-to-multipoint PW (P2MP PW) may consist of a P2MP LSP, or multiple P2P and P2MP LSPs." Ex. 1016, 4. Therefore, a POSITA would have found it predictable to implement Aggarwal's LSPs as pseudo-wires. Ex. 1003, paragraph 72.

A POSITA would have had a reasonable expectation of success implementing the branch LSPs of Aggarwal as pseudo-wires because pseudo-wires were a known type of LSP. Ex. 1003, paragraph 73. Hussain describes how pseudo-wires correspond to LSPs nested in a PE-to-PE tunnel. Ex. 1006, 274. And, like Aggarwal's branch LSPs which are nested within Aggarwal's P2MP tunnels, Hussain's pseudo-wires are nested within a PE-to-PE tunnel. Therefore, a POSITA would have expected pseudo-wires to work well within Aggarwal's P2MP tunnel as they work in Hussain's PE-to-PE tunnel. Ex. 1003, paragraph 73.

Furthermore, because, pseudo-wires are a type of LSP, they operate in a similar manner. For example, Hussain teaches that pseudo-wires participate in data broadcasting by delivering Layer 2 data in a P2MP service. Ex. 1006, 276-77. Aggarwal also teaches that branch LSPs deliver multicast packets in a P2MP LSP tunnel. See Ex.1005, 3:31-35, 3:42-47, 6:26-35, Fig. 5. Additionally, Hussain teaches that pseudo-wires are created in packet-switched networks, such as MPLS. Ex. 1006, 275. Aggarwal also teaches that branch LSPs are created in MPLS networks

that perform label-switching on data packets. See Ex.1005, 3:32-35, 6:60-7:3. Finally, because both pseudo-wires and LSPs are created in MPLS networks, the same network routers and links may be used. Thus, there was a reasonable expectation of success in implementing the combination of Aggarwal and Hussain. Accordingly, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because doing so is merely use of a known technique (pseudo-wires) to improve similar methods (establishing branch LSPs) in the same way (to improve network efficiency). *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 415-21 (2007); Ex.1003, paragraph 74.

Alternatively, a POSITA would have found it obvious to implement pseudowires *within* Aggarwal's branch LSPs. In particular, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel: "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex. 1006, 273. Like Hussain's PE-to-PE tunnel, Aggarwal's Branch LSPs are tunnels between edge routers: Aggarwal describes techniques "for extending RSVP-TE to allow RSVP-TE to be used for establishing P2MP TE tunnels." Ex.1005, 3:22-24. Accordingly, it would have been obvious to implement pseudo-wires within Aggarwal's branch LSPs (tunnels), similar to how they are implemented in Hussain's PE-to-PE tunnels. As such, the pseudo-wires would be implemented as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82). A POSITA would have had a reasonable expectation of success and would have had predictable results for the same reasons mentioned above. Ex.1003, paragraph75.

Additionally, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because the combination merely applies a known technique to a known method ready for improvement to yield predictable results. As discussed above, a POSITA, when

considering the teachings of Aggarwal, would have also considered the teachings of Hussain because both are generally directed toward provision of P2MP services over MPLS networks. Moreover, Hussain provides additional implementation details for improving survivability and optimizing network resources. Therefore, a POSITA would have found the teachings of Hussain relevant. Ex. 1003, paragraph 76.

A POSITA would have been motivated to incorporate a particular technique into the method Aggarwal: implementing a branch LSP as a pseudo-wire. Ex. 1003, paragraph 77. Alternatively, a POSITA would have found it obvious to implement pseudowires within Aggarwal's branch LSPs as nested pseudo-wires. In either way, doing so would have improved the method of Aggarwal in the same way as using the technique improved Hussain. Ex. 1003, paragraph 77. And, as discussed above, the advantages of implementing an LSP as a pseudo-wire were commonly known in the art before 2007. And, as also discussed above, the combination of Aggarwal and Hussain would have yielded predictable results because implementing an LSP as a pseudo-wire was well known to successfully provide Layer 2 services over an MPLS network. And, a POSITA would have had a reasonable expectation of success using pseudo-wires as the branch LSPs because pseudo-wires are a type of LSP. Therefore, a POSITA would have been motivated to implement the branch LSPs as pseudo-wires. Ex. 1003, paragraph 77.

The combination of Aggarwal and Hussain represents applying a known technique (implementation of pseudo-wires) to a known method (implementing point-to-multipoint LSPs) ready for improvement to yield predictable results (pseudo-wires with shared links). Ex.1003, paragraph 78.

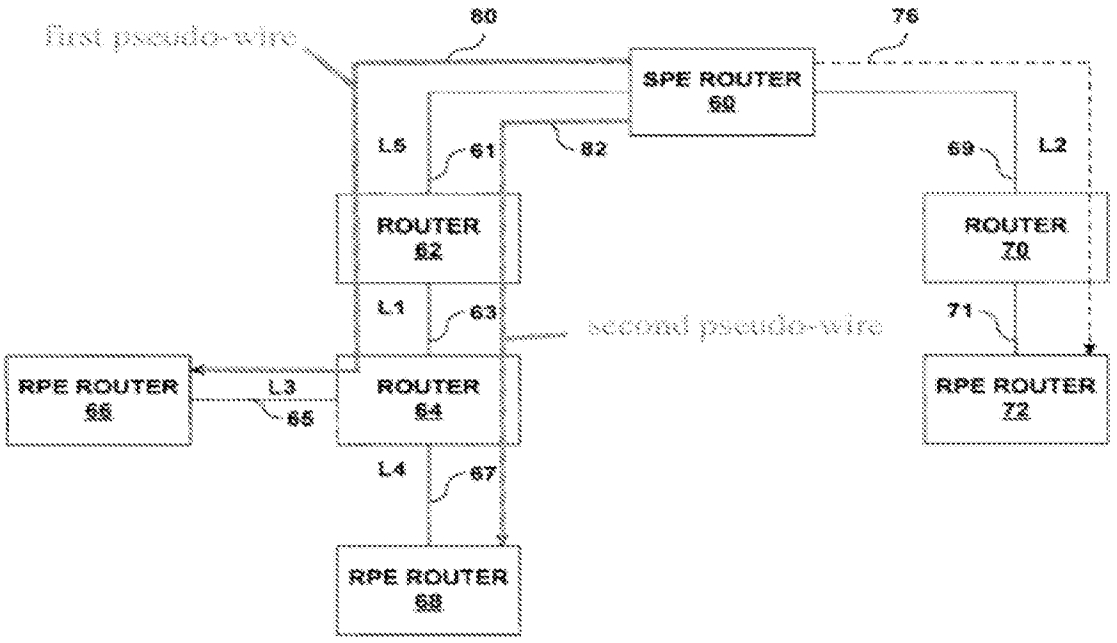
These proposed combinations permit but do not require physical incorporation of elements from Hussain into Aggarwal. *See In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012); Ex.1003, paragraph 79.

4. Claim 1

[1.0] A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

Aggarwal describes setting up branch Label Switched Paths (LSPs) 80 and 82 (interpreted to be obvious to implement the LSPs as "*at least two pseudo-wires*") – For the reasons explained above at Reasons to Combine Aggarwal and Hussain, and as elaborated below, a POSITA would have found it obvious to implement Aggarwal's LSPs as pseudo-wires. Ex.1003, paragraph 81, n.3.: "SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router 64." Ex.1005, 6:44-47. Aggarwal's Figure 5, as annotated below, illustrates the branch LSPs 80 and 82. Ex.1003, paragraphs 80-83.



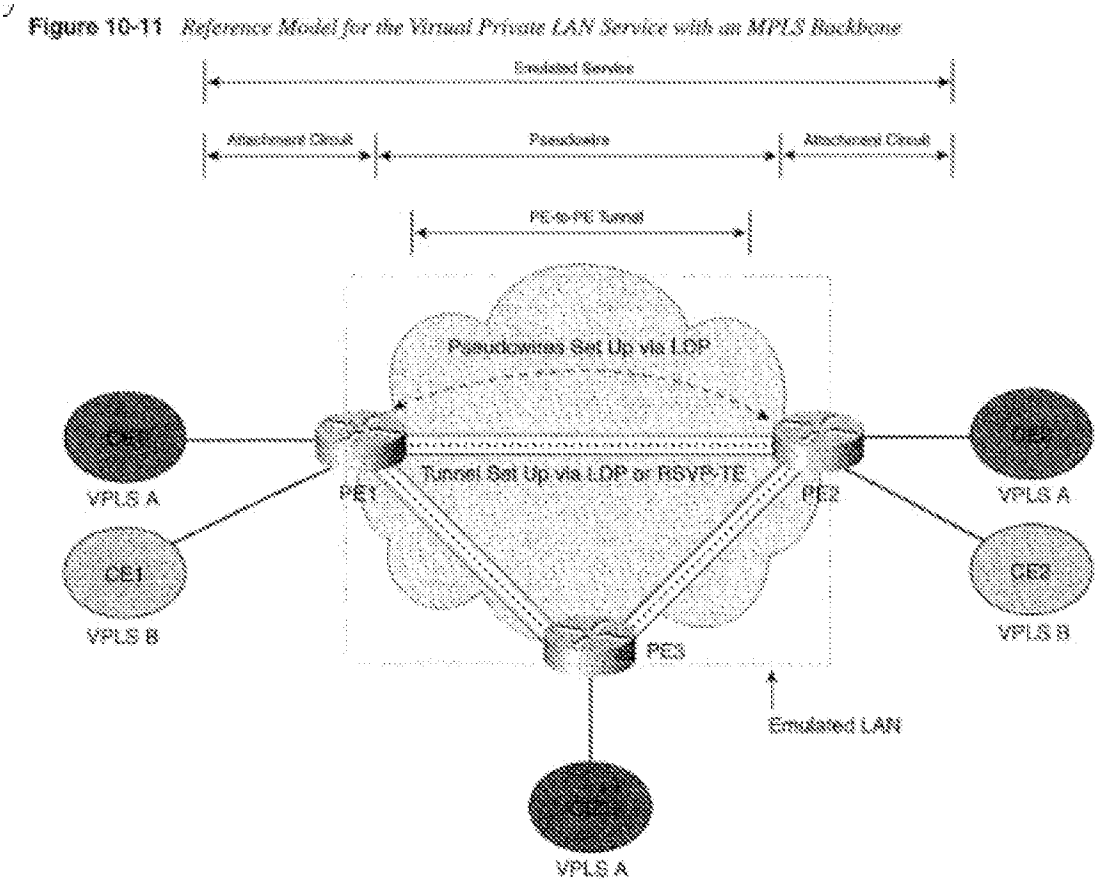
Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 81

In district court litigation, the Patent Owner has accused products using MPLS label switched paths—like those in Aggarwal—of implementing the claimed "pseudo-wires." See Ex. 1017, paragraph 36. Accordingly, Patent Owner stated Aggarwal's label switched paths are "pseudo-wires" as recited in '775.

Second, a POSITA would have found it obvious to implement Aggarwal's branch LSPs as pseudo-wires, as evidenced by Hussain. Hussain explicitly describes setting up LSPs as pseudo-wires via LDP. See Ex. 1006, 276; Ex.1003, paragraph 84.

In particular, Hussain describes how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provider edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). Ex. 1006, 276-77. Thus, setting up point-to-point pseudo-wires in a VPLS is a "*method of setting up at least two pseudo-wires*" as claimed. Ex. 1003, paragraph 85.

Figure 10-11 of Hussain illustrates that pseudo-wires are established as LSPs, since they are set up using label distribution protocol (LDP):



Ex. 1006, Fig. 10-11 at 276.

Hussain is deemed as relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. Since Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Relatedly, alternatively, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to a POSITA to implement Aggarwal's branch LSP's as pseudo-wires to improve network efficiency, consistent with Aggarwal's objective to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42; *see also* Reasons to Combine Aggarwal and Hussain above; Ex.1003, paragraph 88. By implementing the branch LSPs 80 and 82 as pseudo-wires, such LSPs teach the pseudo-wires as claimed. Ex. 1003, paragraphs 86-88.

Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs. As explained above at III.A.3, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel. Aggarwal's Branch LSPs are a type of tunnel between edge routers. Thus, a POSITA also would have found it obvious to implement pseudo-wires as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82). Ex.1003, paragraph 89.

Third, a POSITA would have found it obvious that Aggarwal's branch LSPs implemented as pseudo-wires as taught by Hussain would provide broadcast services. For example, Hussain explains that a VPLS "emulates the performance of a LAN." Ex. 1006, 275. Additionally, Hussain explains that a "LAN provides broadcast and unicast services." Ex. 1006, 277. Additionally, Hussain teaches that L2VPNs, including VPLS, "transport Layer 2 frames." Ex.1006, 273. A POSITA, therefore, would have understood that Layer 2 frames are a type of traffic that can be broadcast in a VPLS. Accordingly, a POSITA would have recognized that the branch LSPs 80 and 82 implemented as pseudo-wires can broadcast data streams. Ex. 1003, paragraph 90.

To the extent that Patent Owner would seek a narrower definition of "pseudo-wire" to include a specific definition, as described in RPC 3985 (Ex. 1001, 1:50; Ex.1010), a POSITA would have found it obvious that Hussain's reference to a pseudo-wire would refer to the same thing. Specifically, Hussain discussed pseudo-wires in the context of, and with citations to, IETP draft documents and RPCs discussing pseudo-wires. See e.g., Ex. 1006, 296-97 (citing, *inter alia*, Aggarwal et al., "Pseudo Wire (PW) Virtual Circuit Connection Verification (VCCV)," IETF Draft dated February 2004 (Ex. 1037), which at 13 cites Bryant, et al., "PWE3 Architecture," draft-ietf-pwe3-arch-06.txt (Oct. 2003) (Ex. 1038) which is an earlier draft of RFC 3985 (Ex. 1010)). Facts appear to show Rahul Aggarwal, co-author of Ex. 1037, appears to be the same individual who is the sole named inventor of the Aggarwal reference, Ex. 1005, which further confirms the relevance of Hussain's disclosure to Aggarwal's teachings and supports the obviousness of their combination. Accordingly, a POSITA would have expected Hussain's discussions of pseudo-wires to use that term as it is used in the IETF's RFC documents. Ex. 1003, paragraph 91.

Hussain teaches that L2VPNs, including VPLS, "transport Layer 2 frames." Ex. 1006, 273. A POSITA, therefore, would have understood that Layer 2 frames are a type of traffic that can be broadcast in a VPLS. Thus, the Layer 2 frames are "*a data stream.*" Ex. 1003, paragraph 92.

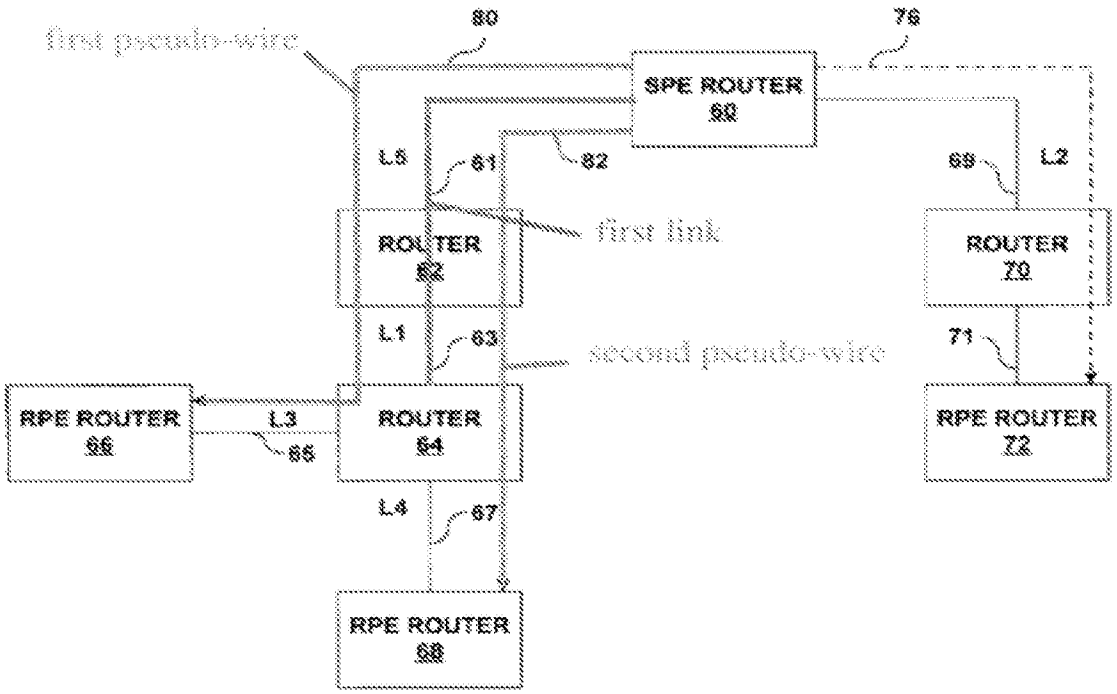
Thus, because Aggarwal teaches establishing branch LSPs, which can be implemented as pseudo-wires and provide broadcast services as taught by Hussain, the combination of Aggarwal and Hussain renders obvious "[*a*] *method of setting up at least two pseudo-wires able to broadcast a data stream*," as claimed. Ex.1003, paragraph 93.

[1.1] setting up a first pseudo-wire comprising a first link

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

First, Aggarwal teaches setting up a first branch LSP 80 (corresponding to a "*first pseudo-wire*"): "SPE router 60 also establishes **branch LSPs 80 and 82** with RPE routers 66 and 68, respectively, via router 62 and router 64." Ex. 1005, 6:45-47; see also 7:43-44 ("router 60 sets up branch LSP 80 to RPE router 66."). And, for the reasons described above at [1.0], Hussain shows that it would have been obvious to a POSITA to implement Aggarwal's branch LSP 80 as a pseudo-wire. Ex.1003, paragraphs 94-97; *see also supra*, Reasons to Combine Aggarwal and Hussain.

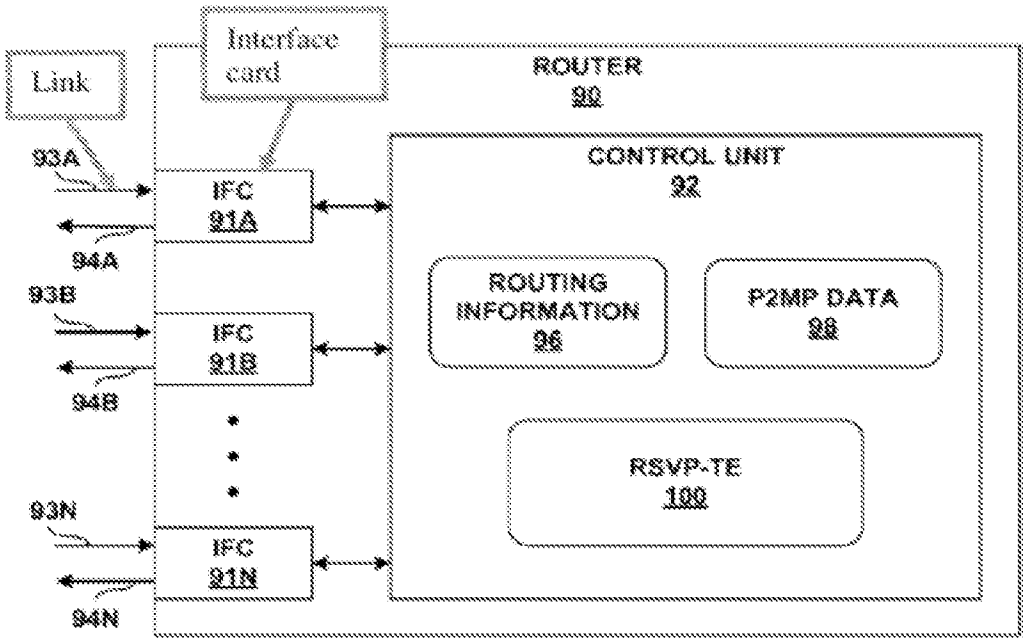
Second, Aggarwal teaches that the first branch LSP includes links 61 and 63 ("*first link*") – Examiner deems links 61 and 63 either individually or together regard the claimed "first link.": "As shown in FIG. 5, **Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Annotated Fig. 5 is shown below. Ex.1003, paragraph 98.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 98.

Aggarwal explains that "[t]he term 'link' is often used to refer to the connection between two devices on a network." Ex.1005, 1:22-23. The term includes "'virtual' or 'logical' links." Ex.1005, 1:25-27; Ex.1003, paragraph 99.

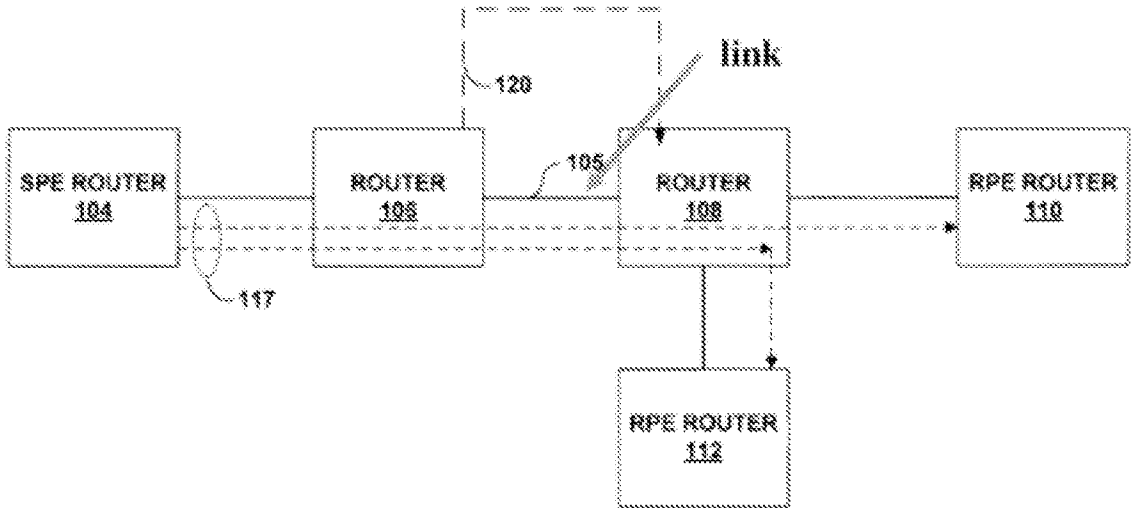
To the extent that the Patent Owner argues for the district court's claim construction of the term "link," Aggarwal teaches that a link connects to an interface on a router. For example, Aggarwal describes the interfaces of router 90, which it describes as representative of the other routers described. See Ex. 1005, 7:59-61. Aggarwal explains that "router 90 includes a set of interface cards (IFCs) 91A-91N ('IFCs 91) for communicating packets via inbound links 93A-93N ('inbound links 93) and outbounds links 94A-94N ('outbound links94)." Ex.1005, 8:3-7. Annotated Fig. 6 is shown below.



Ex.1005, Fig. 6 (annotated).

Aggarwal also illustrates in Fig. 7 that a "link" between two routers carries all traffic between those routers. Aggarwal explains that "**all branch LSPs that use a given link** [e.g.,

105] can be protected in the event of link failure by forwarding traffic" via tunnel 120. Ex.1005, 9:20-23.



Ex.1005, Fig. 7 (annotated).

Thus, Aggarwal uses the term "link" to refer to the physical interconnection of an interface card of one router to the interface card of another router, consistent with the district court's claim construction of "link" as a "connection between an interface of a first router and an interface of a second router."

Hussain supports Aggarwal's teaching of router interfaces: "Network-level fault tolerance involves the interaction of a node with other nodes through external interfaces." Ex. 1006, 253. Hussain explains that "[i]n the incoming direction, line cards receive packets from external interfaces and forward them to the switching fabric," and "[i]n the outgoing direction, line cards receive packets from the switching fabric and forward them to the outgoing interfaces." Ex. 1006, 8. Hussain describes that "label allocation and management can be implemented per interface or globally (platform wide)." Ex. 1006, 50.

As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the

Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

A POSITA implementing the method of setting up the first pseudo-wire would have understood that a link may consist of multiple hops and the limitation as recited is open-ended such that if fails to preclude multiple hops. Therefore, a POSITA would have found it obvious that "*a first link*" would extend from SPE router 60 to intermediate router 64. As illustrated in Figure 5 above, the first pseudo-wire comprises the first link. Ex. 1003, paragraph 100.

Either of Aggarwal's links 61 and 63 shown in Fig. 5 may be mapped to the claimed "first link." To the extent that a link is found to be a connection between pairs of routers that does not include intermediate routers (i.e., a construction not presently recited/required by claims), then a POSITA would understand that router 62 could be removed (and labels L5 and LI consolidated into a single label) in the example network in Figure 5 above. Ex. 1003, paragraph 101. A POSITA would have found it obvious to remove router 62 from the network of Figure 5, recognizing that there are no other routers other than router 60 and router 64 to which router 62 is connected, and that the system would perform better (no delays incurred in router 62), would be simpler to manage (fewer routers to configure and manage), and be cheaper to implement (no

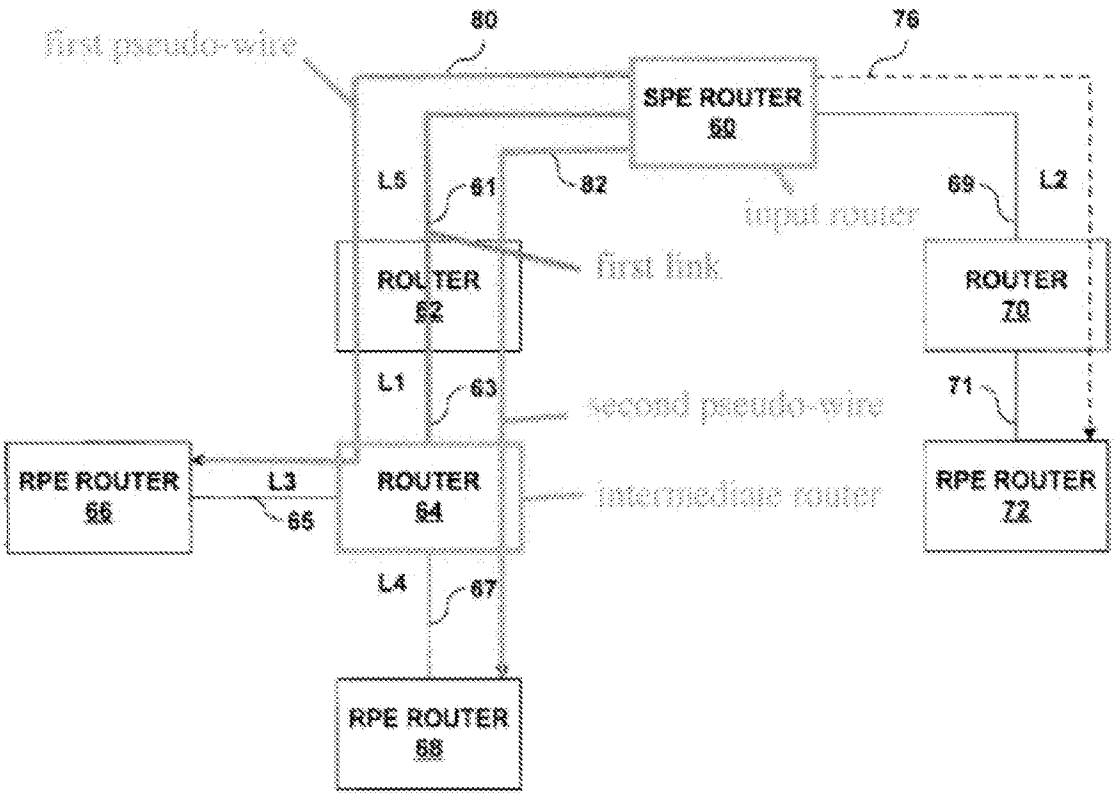
cost for installing and managing router 62). Ex. 1003, paragraph 101. Aggarwal illustrates this possibility by showing that in the path from source router 60 to receiver router 72, there is just one intermediate router 70. Ex.1005, Fig. 5; Ex.1003, paragraph 101.

Thus, because Aggarwal teaches a branch LSP 80 with links 61 and 63 between the router 64 and the SPE router 60, and a POSITA would have found it obvious to implement Aggarwal's branch LSP as a pseudo-wire as taught by Hussain; thereby, Aggarwal and Hussain render obvious "*setting up a first pseudo-wire comprising a first link*" as recited in the claim. Ex. 1003, paragraph 102.

[1.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

Lacking evidence to the contrary, Aggarwal describes this limitation or Aggarwal and Hussain render this limitation obvious.

First, as discussed in setting step above, Aggarwal teaches that links 61 and 63 (individually or collectively a '*first link*") are between SPE router 60 ("*input router*") and router 64 ("*intermediate router*"), as shown in annotated Fig. 5 below. Ex. 1003, paragraphs 103-14.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 104

SPE router 60 is an "*input router*" because it is described as a source provider edge router. In a different embodiment (Fig. 1), Aggarwal describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Ex.1005, 3:58-61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and a receiver provider edge (RPE) router 16A (destination network device) of subscriber network 18A." Ex.1005, 3:61-65. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the SPE routers and RPE routers in the embodiment of Fig. 5. Ex.1003,

paragraph 105. Accordingly, because the SPE receives traffic from a source network to be passed to a subscriber network, it is an input router. Ex. 1003, paragraph 105.

Furthermore, router 64 is an "*intermediate router*" because Aggarwal explicitly states that "[c]omputer network 58 also includes **intermediate routers** 62, **64**, 68, and 70." Ex. 1005, 6:30-31. Router 64 is positioned between the Source Provider Edge router 60 and Receiver Provider Edge (RPE) routers 66 and 68, and is thus situated at an *intermediate* position. Ex. 1003, paragraph 106.

Second, both the SPE router 60 and the intermediate router 64 are in a "*packet-switched network.*" Regarding the SPE routers, Aggarwal states that "[u]pon receiving an incoming packet, the router examines information within the packet and **forwards the packet** in accordance with the routing information." Ex.1005, 1:15-18. And Aggarwal notes that the P2MP LSPs are part of a LAN. See Ex. 1005, 6:60-7:3. A POSITA would have found it obvious for a LAN to be a packet-switched network. Ex. 1003, paragraphs 107-09.

Thus, because Aggarwal teaches links 61 and 63 between SPE router 60 and intermediate router 64, Aggarwal describes "[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network" as recited in the challenged claims. Ex. 1003, paragraph 110.

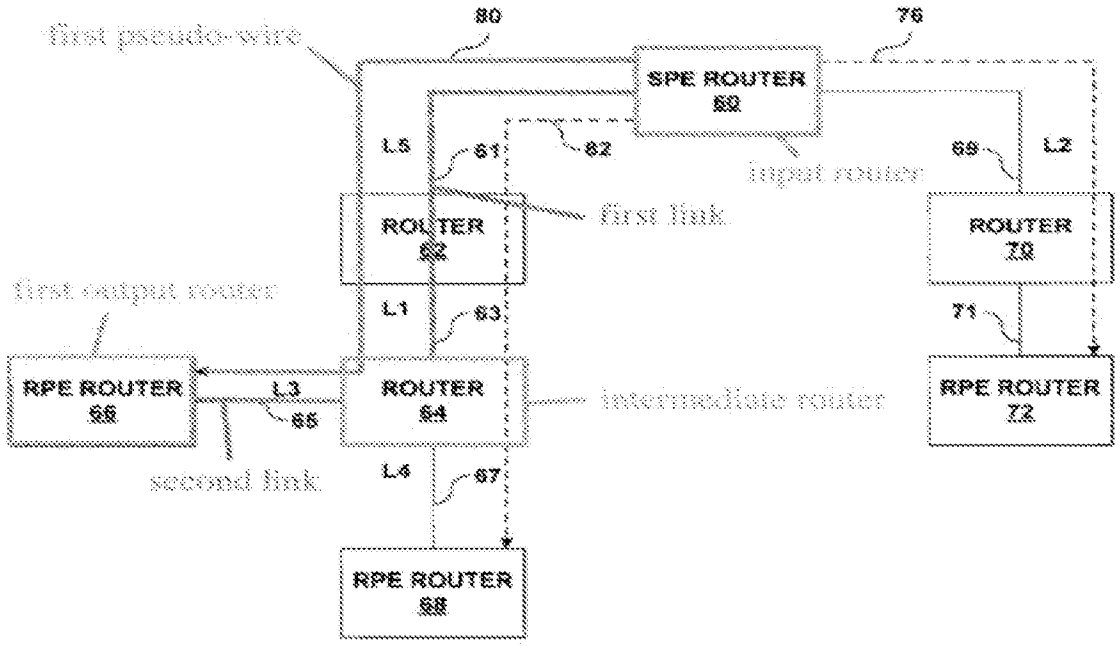
Alternatively, as noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt

variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

[1.3] ***[a first pseudo-wire comprising...] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

Lacking evidence to the contrary, Aggarwal describes this limitation or Aggarwal and Hussain render this limitation obvious.

First, Aggarwal's branch LSP 80 is a "*first pseudo-wire*" that traverses a path from SPE router 60 to RPE router 66. Additionally, Figure 5 illustrates that the branch LSP 80 includes a link 65 ("*second link*") from the intermediate router 64 to the RPE router 66. Ex.1003, paragraphs 111-12.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 112

The RPE Router 66 is an *output router* because it is described as a Receiver Provider Edge router. In a different embodiment (Fig. 1), Aggarwal describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Ex.1005, 3:58-61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and a **receiver provider edge (RPE) router 16A (destination network device)** of subscriber network 18A." Ex.1005, 3:61-64. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the SPE routers and RPE routers in the embodiment of Fig. 5. Ex.1003, paragraph 114. Accordingly, because the RPE provides traffic from a source network to a subscriber network, it is an "*output router*." Ex. 1003, paragraph 113-14.

Second, for the same reasons that the SPE router 60 and the intermediate router 64 are part of a packet-switched network as described above at [1.2], the RPE router 66 is also part of a packet-switched network. Ex. 1003, paragraph 115.

Thus, because Aggarwal teaches that branch LSP 80 includes a link 65 between the intermediate router 64 and RPE router 66, an artisan/POSITA would interpret Aggarwal describes *"[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network*," as claimed. Ex. 1003, paragraph 116.

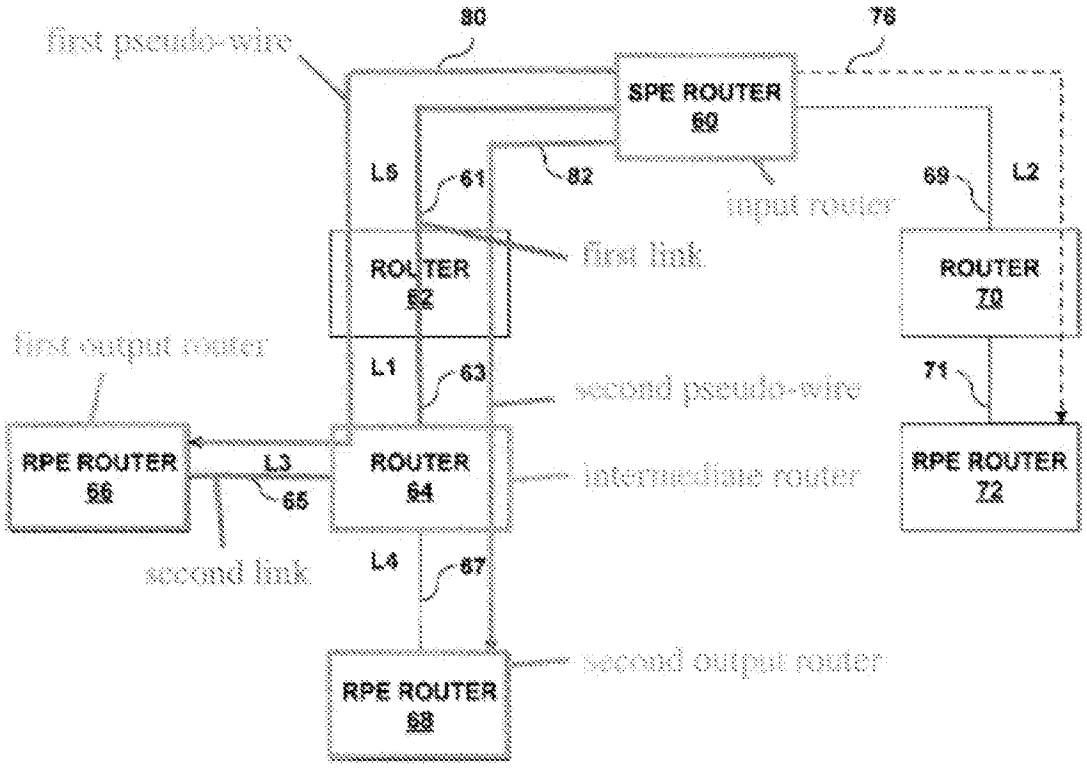
Alternatively, as noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with

which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

[1.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

First, Aggarwal teaches a branch LSP 82 (corresponding to a "*second pseudo-wire*") that extends between SPE router 60 and RPE router 68 ("*second output router*"). "SPE router 60 also establishes **branch LSPs 80 and 82** with RPE routers 66 and **68**, respectively, via router 62 and router 64." Ex. 1005, 6:45-47; see also 7:43-45 ("SPE router 60 sets up ... **branch LSP 82 to RPE router 68**"). And, for the reasons described above at [1.0], Hussain shows that it would have been obvious to a POSITA to implement Aggarwal's branch LSP 82 as a pseudo-wire as taught by Hussain. Ex.1003, paragraphs 117-21; *see also supra*, Reasons to Combine Aggarwal and Hussain.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 121

RPE router 68 is an *output router* for the same reasons that RPE 66 is an output router as described above at [1.3]. Furthermore, for the same reasons that the SPE router 60 and the intermediate router 64 are part of a *packet-switched network* as described above at [1.2], the RPE router 68 is also part of a *packet-switched network*. Ex. 1003, paragraphs 122-25.

As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this

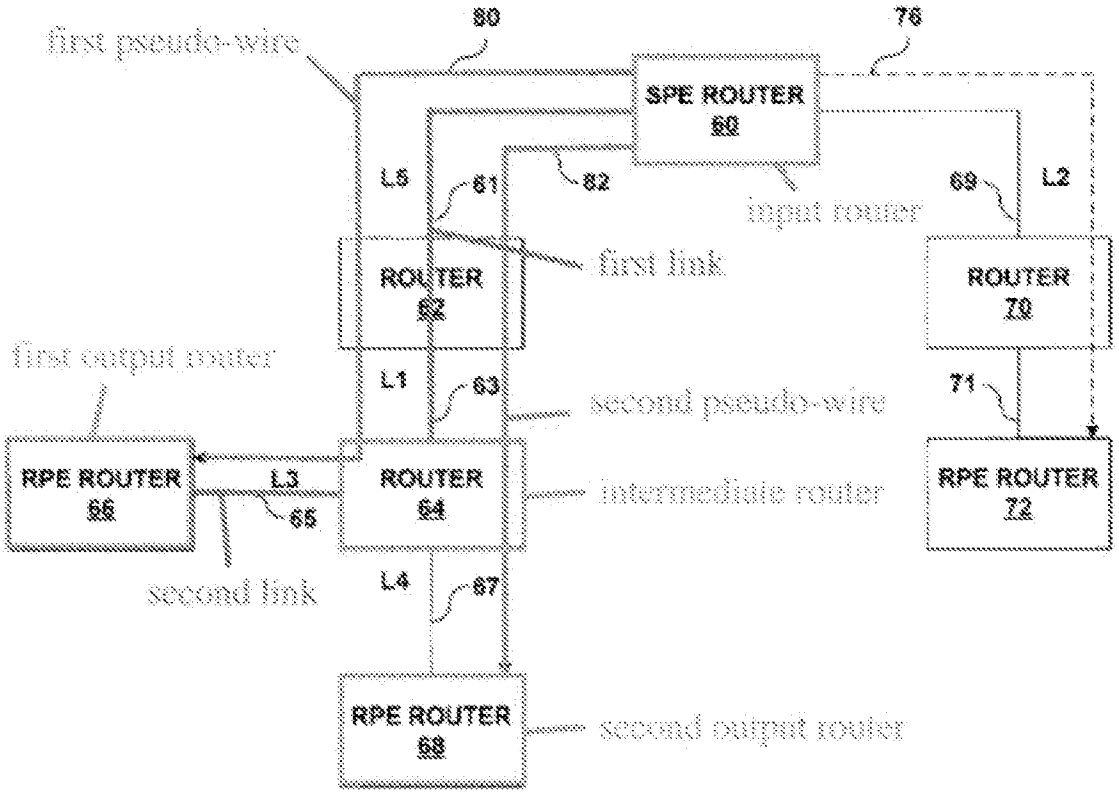
case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Thus, because Aggarwal teaches branch LSP 82 between SPE router 60 and RPE router 68, Aggarwal and Hussain render obvious "*setting up a second pseudo-wire between said input router and a second output router of the packet-switched network*," as claimed. Ex. 1003, paragraph 126.

[1.5] ***wherein the second pseudo-wire comprises said first link and***

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

As discussed above at [1.1] Aggarwal teaches that the branch LSP 82 (corresponding to the "*second pseudo-wire*") includes links 61 and 63 ('first link"): "As shown in FIG. 5, **Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Ex. 1005, 6:47-49. Annotated Fig. 5 is shown below. Ex. 1003, paragraphs 127-29.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 129

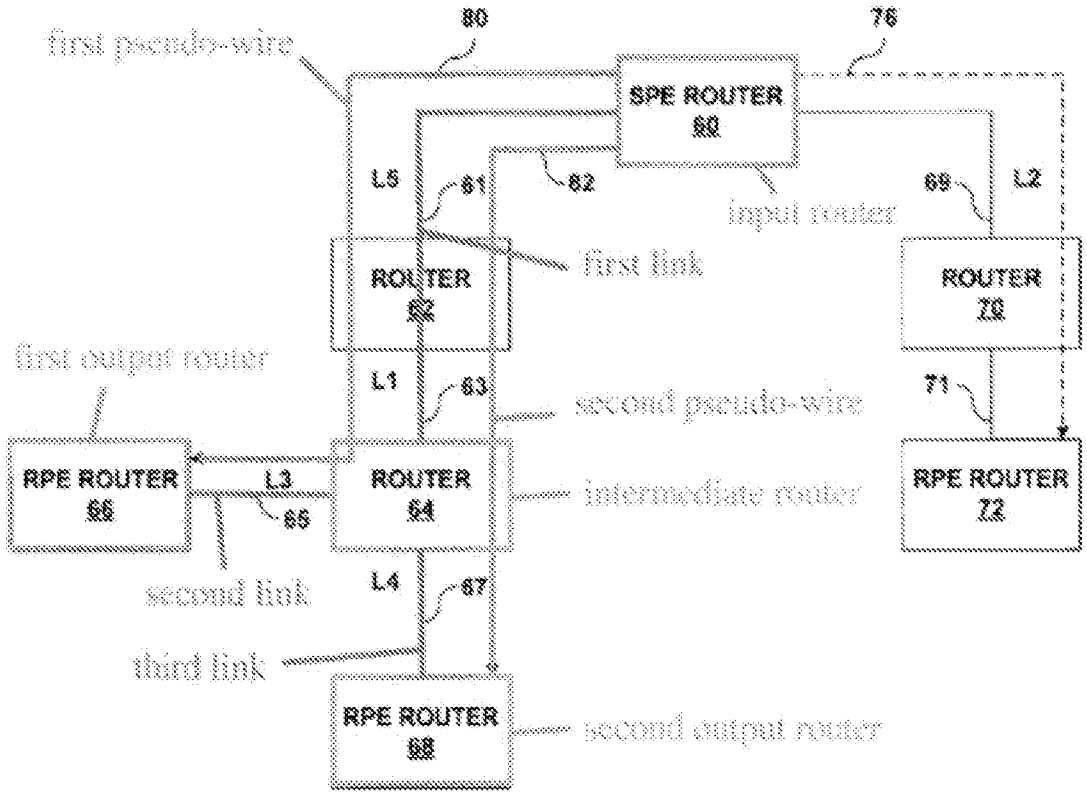
As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Thus, because Aggarwal teaches that branch LSP 82 includes links 61 and 63, Aggarwal and Hussain render obvious "*wherein the second pseudo-wire comprises said first link*," as claimed. Ex.1003, paragraphs 130-32.

[1.6] ***[wherein the second pseudo-wire comprises ...] a third link set up between said intermediate router and said second output router,***

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

First, Aggarwal's branch LSP 82 traverses a path from SPE router 60 to RPE router 68. Additionally, Figure 5 illustrates that the branch LSP 82 includes a link 67 ("*third link*") from the intermediate router 64 to the RPE router 68. Ex. 1003, paragraph 133-34. Annotated Fig. 5 illustrates the third link:



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 134

As illustrated in Figure 5 above, the second pseudo-wire comprises the third link. As discussed in [1.2], intermediate router 64 is "*an intermediate router*." As discussed in [1.4], RPE router 68 is a "*second output router*." Ex.1003, paragraph 135.

As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Thus, because Aggarwal teaches a link 67 between intermediate router 64 and RPE router 68, Aggarwal and Hussain render obvious "[*wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router*," as claimed. Ex.1003, paragraph 136.

[1.7] ***said first link being shared by the first and second pseudo-wires***.

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

As explained above at [1.1], the links 61 and 63 ('*first link*") are shared by Branch LSP 80 (corresponding to the '*first pseudo-wire*") and Branch LSP 82 (corresponding to the "*second*

pseudo-wire"). "**Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Aggarwal teaches that this sharing occurs by "merging the individual P2P LSPs and relying on MPLS label multicast." Ex.1005, 4:12-13; Ex.1003, paragraphs 137-38.

As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. For reasons noted above that Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Furthermore, as explained above at [1.0], Hussain shows that it would have been obvious to implement Aggarwal's branch LSPs as pseudo-wires as described by Hussain. Hussain also teaches that "tunnels are set up using LDP or RSVP-TE" and that "[m]ultiple PWs can be carried inside a single tunnel." Ex. 1006, 276; Ex.1003, paragraphs 139-142.

Thus, because Branch LSPs 80 and 82 share links 61 and 63, Aggarwal and Hussain render obvious "*said first link being shared by the first and second pseudo-wires*," as claimed. Ex.1003, paragraph 143.

5. Claim 6

[6.0] ***A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:***

Lacking evidence to the contrary, Aggarwal and Hussain render this limitation obvious.

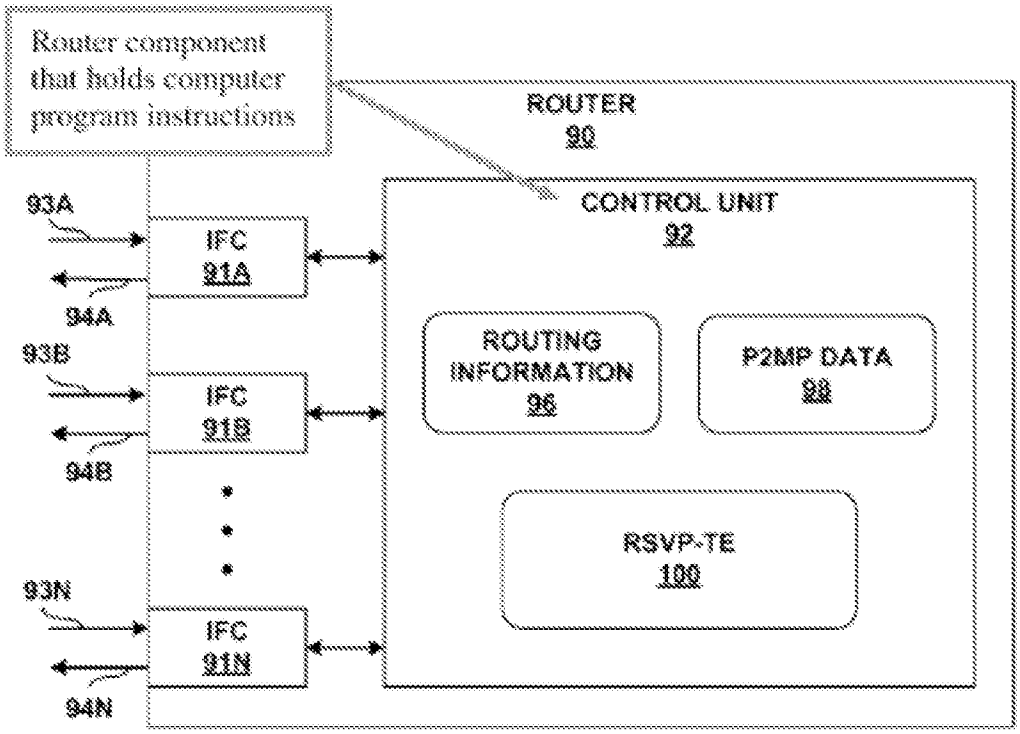
First, as discussed at [1.0], the combination of Aggarwal and Hussain renders obvious a "*a method of setting up at least two pseudo-wires able to broadcast a data stream*," as recited in challenged claims. Ex.1003, paragraph 144.

Second, a POSITA would have found it obvious for such method to be implemented by a computer program product stored on a computer-readable medium. Ex. 1003, paragraph 145. Aggarwal teaches that "[r]outing devices within a network, often referred to as routers, maintain routing information that describes available routes through the network." Ex. 1005, 1:13-15. Aggarwal provides additional details regarding Router 90, which it describes as representative of the other routers described. See Ex.1005, 7:59-61. Aggarwal explains that "[r]outer 90 further comprises a control unit 92 that maintains routing information 96." Ex.1005, 8:7-8. Regarding the control unit 92, Aggarwal states:

> Control unit 92 may be implemented solely in software, or hardware, or may be implemented as a combination of software, hardware, or firmware. For example, control unit 92 may include one or more processors which execute software instructions. In that case, the various software modules of control unit 92, such as RSVP-TE protocol 100, may comprise executable instructions stored on a computer-readable medium, such as computer memory or hard disk.

Ex.1005, 9:1-8; Ex.1003, paragraph 145.

Figure 6 of Aggarwal illustrates a network router containing computer program instructions for setting up label switched paths:



Ex.1005, Fig. 6 (annotated); Ex.1003, ¶ 146.

A POSITA, therefore, would have interpreted that SPE router 60, intermediate router 64, RPE router 66, and RPE router 68, which correspond to the claimed *input router*, *intermediate router*, *first output router*, and *second output router*, respectively, each contain "*computer code instructions*." Ex. 1003, paragraph 147.

As noted above, Hussain is deemed to be relevant prior art due to either being in the same field of endeavor or being reasonably pertinent to the particular problem with which the Applicant was faced. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The level of ordinary skill in the art is shown by the applied art herein. Since Aggarwal and Hussain each regard MPLS networks, in consideration consistent with US Supreme Court decision in KSR that 'known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art', in this case, it would have been obvious to an

artisan to substitute one communication technique for the other to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42.

Thus, Aggarwal and Hussain render obvious "*[a] computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudowires able to broadcast a data stream when said program is executed by a computer,*" as recited in challenged claim 6. Ex. 1003, paragraph 148.

[6.1] ***setting up a first pseudo-wire comprising a first link***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.1]. Ex. 1003, paragraph 149.

[6.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.2]. Ex. 1003, paragraph 150.

[6.3] ***[a first pseudo-wire comprising...] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.3]. Ex.1003, paragraph 151.

[6.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.4]. Ex. 1003, paragraph 152.

[6.5] ***wherein the second pseudo-wire comprises said first link and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.5]. Ex.1003, paragraph 153.

[6.6] ***[wherein the second pseudo-wire comprises ...] a third link set up between said intermediate router and said second output router,***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.6]. Ex. 1003, paragraph 154.

[6.7] ***said first link being shared by the first and second pseudo-wires.***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.7]. Ex. 1003, paragraph 155.

Conclusion

15. **All** correspondence relating to this ex parte reexamination proceeding should be directed:

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/Mark Sager/
Patent Reexamination Specialist, CRU
Art Unit 3992

Conferees:

/FRED O FERRIS III/
Reexamination Specialist, Art Unit 3992

/ALEXANDER J KOSOWSKI/
Supervisory Patent Examiner, Art Unit 3992

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

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

CLAIMS

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

CLAIM		DATE								
Final	Original	07/13/2021								
	1	✓								
	2	N								
	3	N								
	4	N								
	5	N								
	6	✓								
	7	N								
	8	N								
	9	N								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

CPC - Searched*		
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CPC Combination Sets - Searched*		
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Search Notes		
Search Notes	Date	Examiner
Reviewed prosecution history of 8130775	03/25/2021	ms
Lit Search conducted 3/12/2021	03/25/2021	ms

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	90014701
Filing Date	2021-04-15
First Named Inventor	Frederic Jounay
Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7590115	B1	2009-09-15	Aggarwal	
	2	7602702	B1	2009-10-13	Aggarwal	
	3	8160055	B1	2012-04-17	Nadeau	
	4	7283465	B2	2007-10-16	Zelig	
	5	8081563	B2	2011-12-20	Guichard	
	6	8868775	B2	2014-10-21	Filsfils	
	7	7940652	B1	2011-05-10	Pan	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20070239891	A1	2007-10-11	Wainner	

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	1	1983701	FR		2010-08-25	Papadimitriou		☐

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	1	AGGARWAL, Extensions to RSVP-TE for Point to Multipoint TE LSPs, IETF Network Working Group	☐
	2	GUICHARD, Definitive MPLS Network Designs, Cisco Press, 2005, pp. 41-46, 73-85, 104-115	☐
	3	MULEY, Pseudowire (PW) Redundancy, IETF Network Working Group, September 22, 2006	☐
	4	HUSSAIN, Fault-tolerant IP and MPLS Networks, 2004	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	90014701
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	Art Unit	3992
	Examiner Name	SAGER, MARK ALAN
	Attorney Docket Number	1127.0026

	5	AGGARWAL, Extensions to Resource Reservation Protocol - Traffic Engineering (RSVP-TE) for Point-to-Multipoint TE Label Switched Paths (LSPs), IETF Network Working Group RFC 4875	☐

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	1	AGGARWAL, Extensions to RSVP-TE for Point to Multipoint TE LSPs, IETF Network Working Group	☐
	2	GUICHARD, Definitive MPLS Network Designs, Cisco Press, 2005, pp. 41-46, 73-85, 104-115	☐
	3	MULEY, Pseudowire (PW) Redundancy, IETF Network Working Group, September 22, 2006	☐
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Art Unit	3992
Examiner Name	SAGER, MARK ALAN
Attorney Docket Number	1127.0026

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

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

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Signature	/Michael F. Heim/	Date (YYYY-MM-DD)	2021-06-15
Name/Print	Michael F. Heim	Registration Number	32,702

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EFS ID:	42996161
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	90471
Filer:	Michael F. Heim
Filer Authorized By:	
Attorney Docket Number:	43614.399
Receipt Date:	15-JUN-2021
Filing Date:	12-MAR-2021
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
90/014,701	03/12/2021	8130775	43614.399

CONFIRMATION NO. 4147

POWER OF ATTORNEY NOTICE

27367
WESTMAN CHAMPLIN & KOEHLER, P.A.
121 South Eighth Street
Suite 1100
Minneapolis, MN 55402

OC000000125370222

Date Mailed: 05/05/2021

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/26/2021.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

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

/pflewis/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
90/014,701	03/12/2021	8130775	43614.399

CONFIRMATION NO. 4147

90471
Heim, Payne & Chorush, L.L.P.
1111 Bagby Street
Houston, TX 77002

POA ACCEPTANCE LETTER

OC00000125370302

Date Mailed: 05/05/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/26/2021.

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

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

/pflewis/

PTO/AIA/81B (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REEXAMINATION OR SUPPLEMENTAL EXAMINATION -- PATENT OWNER POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS FOR REEXAMINATION OR SUPPLEMENTAL EXAMINATION AND PATENT

Control Number(s)	90/014,701
Filing Date(s)	March 12, 2021
First Named Inventor	Frederic Jounay
Title	Mechanism for Protecting a Pseudo-Wire
Patent Number	8,130,775
Examiner Name	Mark Alan Sager
Attorney Docket No(s)	1127-0020

I. Power of Attorney. This form may be used to change the Power of Attorney in a reexamination or supplemental examination proceeding (or multiple proceedings where merged). This form may also be used to change the Power of Attorney in the patent file; in such a case, a copy of this form will be placed in both the patent file and the reexamination or supplemental examination proceeding.

A. Revocation of Previous Power of Attorney. I hereby revoke all previous patent owner powers of attorney, if any, given:

☒ in the above-identified reexamination or supplemental examination proceeding control number(s) (more than one may be changed only if the proceedings are merged).

☐ in the file of the above-identified patent.

(check BOTH boxes if change in BOTH the patent file and the reexamination or supplemental examination proceeding is requested).

B. Designation of Power of Attorney.

☐ A Power of Attorney is submitted herewith.

OR

☐ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) to prosecute the proceeding(s)/patent identified above and selected in section I(A), and to transact all business in the United States Patent and Trademark Office connected therewith:

OR

☒ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the proceeding(s) identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number
Michael F. Heim	32,702
Christopher L. Limbacher	76,551

Authorization for the Power of Attorney is provided by the signature on page 2 of this form.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

II. Change of Correspondence Address

Please recognize or change the correspondence address for the above-identified reexamination or supplemental examination proceeding control number(s) (more than one may be changed **only** if they are merged proceedings) **and for the file of the above-identified patent** to be:

☐ The address associated with the above-identified Customer Number.

OR

☒ The address associated with the Customer Number identified in the box at right: 90471

OR

☒ Firm or Individual Name	Heim, Payne & Chorush, LLP				
Address	1111 Bagby Street, Suite 2100				
City	Houston	State	Texas	Zip	77002
Country	United States				
Telephone	713.221.2000	Email	mheim@hpcllp.com		

NOTE: THE CORRESPONDENCE ADDRESS FOR THE REEXAMINATION OR SUPPLEMENTAL EXAMINATION PROCEEDING CONTROL NUMBER(S) MUST BE THE SAME AS THAT FOR THE PATENT. SEE 37 CFR 1.33.

III. Authorization for Power of Attorney and (if selected) Change of Correspondence Address

I am the:

☐ Inventor, having ownership of the patent being reexamined.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) submitted herewith or filed on _____.

Signature of Inventor or Patent Owner	[signature]	Date	4/16/21
Name	Eric Lucas	Telephone	
Title and Company	President - Monroe Networking Solutions		

NOTE: Signatures of all the inventors or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted. *If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

PTO/AIA/96 (08-12)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: MONARCH NETWORKING SOLUTIONS LLC

Application No./Patent No.: 8,130,775 Filed/Issue Date: March 6, 2012

Titled: Mechanism for Protecting a Pseudo-Wire

Monarch Networking Solutions, a LLC

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Frederic Jounay, Philippe Niger and Arnaud Cauvin To: France Telecom

   The document was recorded in the United States Patent and Trademark Office at

   Reel 23572, Frame 0637, or for which a copy thereof is attached.

2. From: France Telecom To: Orange

   The document was recorded in the United States Patent and Trademark Office at

   Reel 044625, Frame 0361, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: Orange To: Transpacific IP Group Limited

The document was recorded in the United States Patent and Trademark Office at
Reel 044625, Frame 0315, or for which a copy thereof is attached.

4. From: Transpacific IP Group Limited To: Acacia Research Group LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 051192, Frame 0596, or for which a copy thereof is attached.

5. From: Acacia Research Group LLC To: Monarch Networking Solutions LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 051238, Frame 0718, or for which a copy thereof is attached.

6. From: Acacia Research Group LLC To: Starboard Value Intermediate Fund LP, as Collateral Agent

The document was recorded in the United States Patent and Trademark Office at
Reel 052853, Frame 0153, or for which a copy thereof is attached.

☑ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature	Date: 4/20/2021
Michael F. Heim	Reg. No. 32,702
Printed or Typed Name	Title or Registration Number

From: Monarch Networking Solutions LLC To: Starboard Value Intermediate Fund LP, as Collateral Agent

The document was recorded in the United States Patent and Trademark Office at

Reel 055100, Frame 0624, or for which a copy there. of is attached.

From: Starboard Value Intermediate Fund LP, as Collateral Agent To: Acacia Research Group LLC et al

The document was recorded in the United States Patent and Trademark Office at

Reel 053654, Frame 0254, or for which a copy thereof is attached.

From: Starboard Value Intermediate Fund LP, as Collateral Agent To: Monarch Networking Solutions LLC

The document was recorded in the United States Patent and Trademark Office at

Reel 055101, Frame 0608, or for which a copy there. of is attached.

Privacy Act Statement

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

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

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

UNITED STATES
PATENT AND TRADEMARK OFFICE

Assignment abstract of title for Application 12528083

Invention title/Inventor	Patent	Publication	Application	PCT	International registration
MECHANISM FOR PROTECTING A PSEUDO-WIRE Frederic Jounay, Philippe Niger, Arnaud Cauvin	8130775 Mar 06, 2012	20100098094 Apr 22, 2010	12528083 Nov 25, 2009		

Assignments (9 of 9 total)

Assignment 9

Reel/frame	Execution date	Date recorded	Properties	Pages
055101/0608	Jun 30, 2020	Jan 25, 2021	50	156

Conveyance
CORRECTIVE ASSIGNMENT TO CORRECT THE ASSIGNEE NAME PREVIOUSLY RECORDED ON REEL 053654 FRAME 0254. ASSIGNOR(S) HEREBY CONFIRMS THE RELEASE OF SECURITY INTEREST GRANTED PURSUANT TO THE PATENT SECURITY AGREEMENT PREVIOUSLYRECORDED.

Assignors
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

Assignment 8

Reel/frame	Execution date	Date recorded	Properties	Pages
053654/0254	Jun 30, 2020	Jul 08, 2020	3010	236

Conveyance
RELEASE OF SECURITY INTEREST IN PATENTS

Assignors
STARBOARD VALUE INTERMEDIATE FUND LP

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
ACACIA RESEARCH GROUP LLC
767 3RD AVE
6TH FLOOR
NEW YORK, NEW YORK 10017

AMERICAN VEHICULAR SCIENCES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

BONUTTI SKELETAL INNOVATIONS LLC
6136 FRISCO SQUARE BLVD

SUITE 400
FRISCO, TEXAS 75034

CELLULAR COMMUNICATIONS EQUIPMENT LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

INNOVATIVE DISPLAY TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

LIFEPORT SCIENCES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

LIMESTONE MEMORY SYSTEMS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

MOBILE ENHANCEMENT SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

NEXUS DISPLAY TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

PARTHENON UNIFIED MEMORY ARCHITECTURE LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

R2 SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

SAINT LAWRENCE COMMUNICATIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

STINGRAY IP SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

SUPER INTERCONNECT TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

TELECONFERENCE SYSTEMS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

UNIFICATION TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400

FRISCO, TEXAS 75034

Assignment 7

Reel/frame	Execution date	Date recorded	Properties	Pages
055100/0624	Jun 04, 2020	Jan 25, 2021	50	173

Conveyance
CORRECTIVE ASSIGNMENT TO CORRECT THE ASSIGNOR NAME PREVIOUSLY RECORDED ON REEL 052853 FRAME 0153. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY INTEREST GRANTED PURSUANT TO THE PATENT SECURITY AGREEMENT PREVIOUSLY RECORDED.

Assignors
MONARCH NETWORKING SOLUTIONS LLC

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT
777 THIRD AVENUE
18TH FLOOR
NEW YORK, NEW YORK 10017

Assignment 6

Reel/frame	Execution date	Date recorded	Properties	Pages
052853/0153	Jun 04, 2020	Jun 05, 2020	3010	252

Conveyance
PATENT SECURITY AGREEMENT

Assignors
ACACIA RESEARCH GROUP LLC
AMERICAN VEHICULAR SCIENCES LLC
BONUTTI SKELETAL INNOVATIONS LLC
CELLULAR COMMUNICATIONS EQUIPMENT LLC
INNOVATIVE DISPLAY TECHNOLOGIES LLC
LIFEPORT SCIENCES LLC
LIMESTONE MEMORY SYSTEMS LLC
MERTON ACQUISITION HOLDCO LLC
MOBILE ENHANCEMENT SOLUTIONS LLC
MONARCH NETWORKING SOLUTIONS LLC
NEXUS DISPLAY TECHNOLOGIES LLC
PARTHENON UNIFIED MEMORY ARCHITECTURE LLC
R2 SOLUTIONS LLC
SAINT LAWRENCE COMMUNICATIONS LLC
STINGRAY IP SOLUTIONS LLC
SUPER INTERCONNECT TECHNOLOGIES LLC
TELECONFERENCE SYSTEMS LLC
UNIFICATION TECHNOLOGIES LLC

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT
777 THIRD AVENUE
18TH FLOOR
NEW YORK, NEW YORK 10017

Assignment 5

Reel/frame	Execution date	Date recorded	Properties	Pages
051238/0718	Nov 18, 2019	Dec 10, 2019	53	34

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
ACACIA RESEARCH GROUP LLC

Correspondent
ROBERT ALLAN BULLWINKEL
1111 BAGBY ST, SUITE 2100
HOUSTON, TX 77002

Assignee
MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA, SUITE 550
IRVINE, CALIFORNIA 92614

Assignment 4

Reel/frame	Execution date	Date recorded	Properties	Pages
051192/0596	Mar 29, 2019	Dec 04, 2019	53	34

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
TRANSPACIFIC IP GROUP LIMITED

Correspondent
ROBERT ALLAN BULLWINKEL
1111 BAGBY ST, SUITE 2100
HOUSTON, TX 77002

Assignee
ACACIA RESEARCH GROUP LLC
6136 FRISCO SQ. BLVD. SUITE 400
FRISCO, TEXAS 75034

Assignment 3

Reel/frame	Execution date	Date recorded	Properties	Pages
044625/0315	Sep 21, 2017	Dec 08, 2017	52	39

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
ORANGE

Correspondent
DANIEL W JUFFERNBRUCH
PATENTS AND LICENSING LLC
28 BARRINGTON BOURNE
BARRINGTON, IL 60010-9605

Assignee
TRANSPACIFIC IP GROUP LIMITED
PO BOX 10008
WILLOW HOUSE, CRICKET SQUARE
GRAND CAYMAN KY1-1001
CAYMAN ISLANDS

Assignment 2

Reel/frame	Execution date	Date recorded	Properties	Pages
044625/0361	Jul 02, 2013	Dec 08, 2017	52	10

Conveyance
CHANGE OF NAME (SEE DOCUMENT FOR DETAILS).

Assignors
FRANCE TELECOM

Correspondent
DANIEL W JUFFERNBRUCH
PATENTS AND LICENSING LLC
28 BARRINGTON BOURNE
BARRINGTON, IL 60010-9605

Assignee
ORANGE
78 RUE OLIVIER DE SERRES
PARIS 75015

FRANCE

Assignment 1

Reel/frame	Execution date	Date recorded	Properties	Pages
023572/0637	Aug 25, 2009	Nov 25, 2009	1	3

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
JOUNAY, FREDERIC
NIGER, PHILIPPE
CAUVIN, ARNAUD

Assignee
FRANCE TELECOM
6, PLACE D'ALLERAY
PARIS 75015
FRANCE

Correspondent
DAVID D. BRUSH
900 SECOND AVENUE SOUTH
SUITE 1400
MINNEAPOLIS, MN 55402

Electronic Acknowledgement Receipt

EFS ID:	42553986
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	8130775
Customer Number:	27367
Filer:	Michael F. Heim
Filer Authorized By:	
Attorney Docket Number:	43614.399
Receipt Date:	26-APR-2021
Filing Date:	12-MAR-2021
Time Stamp:	15:50:15
Application Type:	Reexam (Third Party)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	20210420775ReexamPOA.pdf	984231 f644df8c8f70ae14b240718051406e6938bc69b5	no	2

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Information:					
2	CRF Statement Paper and CRF are the same	20210420775StatementUnder37CFR.pdf	277593 34d3d0d56b6e63ea007a6d09362fb1e03069db99	no	4
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	20210420775assignment.pdf	40578 d25ea0ad530ad6a8ef2fae649698dbbbfd0c61b7	no	5
Warnings:					
Information:					
		Total Files Size (in bytes):	1302402		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

OPAP
APR 23 2021
PATENT & TRADEMARK OFFICE

Reexp

PTO/AIA/818 (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

REEXAMINATION OR SUPPLEMENTAL EXAMINATION – PATENT OWNER POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS FOR REEXAMINATION OR SUPPLEMENTAL EXAMINATION AND PATENT

Control Number(s)	90/014,701
Filing Date(s)	March 12, 2021
First Named Inventor	Frederic Jounay
Title	Mechanism for Protecting a Pseudo-Wire
Patent Number	8,130,775
Examiner Name	Mark Alan Sager
Attorney Docket No(s)	1127-0020

I. Power of Attorney. This form may be used to change the Power of Attorney in a reexamination or supplemental examination proceeding (or multiple proceedings where merged). This form may also be used to change the Power of Attorney in the patent file; in such a case, a copy of this form will be placed in both the patent file and the reexamination or supplemental examination proceeding.

A. Revocation of Previous Power of Attorney. I hereby revoke all previous patent owner powers of attorney, if any, given:

☒ in the above-identified reexamination or supplemental examination proceeding control number(s) (more than one may be changed only if the proceedings are merged).

☐ in the file of the above-identified patent.

(check BOTH boxes if change in BOTH the patent file and the reexamination or supplemental examination proceeding is requested).

B. Designation of Power of Attorney.

☐ A Power of Attorney is submitted herewith.

OR

☐ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) to prosecute the proceeding(s)/patent identified above and selected in section I(A), and to transact all business in the United States Patent and Trademark Office connected therewith:

OR

☒ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the proceeding(s) identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number
Michael F. Heim	32,702
Christopher L. Limbacher	76,551

Authorization for the Power of Attorney is provided by the signature on page 2 of this form.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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

II. Change of Correspondence Address

Please recognize or change the correspondence address for the above-identified reexamination or supplemental examination proceeding control number(s) (more than one may be changed **only** if they are merged proceedings) **and for the file of the above-identified patent** to be:

☐ The address associated with the above-identified Customer Number.

OR

☒ The address associated with the Customer Number identified in the box at right: 90471

OR

☒ Firm or Individual Name	Heim, Payne & Chorush, LLP				
Address	1111 Bagby Street, Suite 2100				
City	Houston	State	Texas	Zip	77002
Country	United States				
Telephone	713.221.2000	Email	mheim@hpcllp.com		

NOTE: THE CORRESPONDENCE ADDRESS FOR THE REEXAMINATION OR SUPPLEMENTAL EXAMINATION PROCEEDING CONTROL NUMBER(S) MUST BE THE SAME AS THAT FOR THE PATENT. SEE 37 CFR 1.33.

III. Authorization for Power of Attorney and (if selected) Change of Correspondence Address

I am the:

☐ Inventor, having ownership of the patent being reexamined.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) submitted herewith or filed on _____.

Signature of Inventor or Patent Owner	[signature]	Date	4/16/21
Name	Eric Lucas	Telephone	
Title and Company	President - Mamma Networking Funding		

NOTE: Signatures of all the inventors or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted. *If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.*

OPAP
APR 2 8 2021
PATENT & TRADEMARK OFFICE

PTO/AIA/96 (08-12)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: MONARCH NETWORKING SOLUTIONS LLC

Application No./Patent No.: 8,130,775 Filed/Issue Date: March 6, 2012

Titled: Mechanism for Protecting a Pseudo-Wire

Monarch Networking Solutions, a LLC

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Frederic Jounay, Philippe Niger and Arnaud Cauvin To: France Telecom

The document was recorded in the United States Patent and Trademark Office at Reel 23572, Frame 0637, or for which a copy thereof is attached.

2. From: France Telecom To: Orange

The document was recorded in the United States Patent and Trademark Office at Reel 044625, Frame 0361, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

PTO/AIA/96 (08-12)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: Orange To: Transpacific IP Group Limited

The document was recorded in the United States Patent and Trademark Office at
Reel 044625, Frame 0315, or for which a copy thereof is attached.

4. From: Transpacific IP Group Limited To: Acacia Research Group LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 051192, Frame 0596, or for which a copy thereof is attached.

5. From: Acacia Research Group LLC To: Monarch Networking Solutions LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 051238, Frame 0718, or for which a copy thereof is attached.

6. From: Acacia Research Group LLC To: Starboard Value Intermediate Fund LP, as Collateral Agent

The document was recorded in the United States Patent and Trademark Office at
Reel 052853, Frame 0153, or for which a copy thereof is attached.

☑ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Michael F. Heim — 4/20/2021

Signature — Date

Michael F. Heim — Reg. No. 32,702

Printed or Typed Name — Title or Registration Number

From: Monarch Networking Solutions LLC To: Starboard Value Intermediate Fund LP, as Collateral Agent

The document was recorded in the United States Patent and Trademark Office at

Reel 055100, Frame 0624, or for which a copy there. of is attached.

From: Starboard Value Intermediate Fund LP, as Collateral Agent To: Acacia Research Group LLC et al

The document was recorded in the United States Patent and Trademark Office at

Reel 053654, Frame 0254, or for which a copy thereof is attached.

From: Starboard Value Intermediate Fund LP, as Collateral Agent To: Monarch Networking Solutions LLC

The document was recorded in the United States Patent and Trademark Office at

Reel 055101, Frame 0608, or for which a copy there. of is attached.

UNITED STATES
PATENT AND TRADEMARK OFFICE

Assignment abstract of title for Application 12528083

Invention title/Inventor	Patent	Publication	Application	PCT	International registration
MECHANISM FOR PROTECTING A PSEUDO-WIRE Frederic Jounay, Philippe Niger, Arnaud Cauvin	8130775 Mar 06, 2012	20100098094 Apr 22, 2010	12528083 Nov 25, 2009		

Assignments (9 of 9 total)

Assignment 9

Reel/frame	Execution date	Date recorded	Properties	Pages
055101/0608	Jun 30, 2020	Jan 25, 2021	50	156

Conveyance
CORRECTIVE ASSIGNMENT TO CORRECT THE ASSIGNEE NAME PREVIOUSLY RECORDED ON REEL 053654 FRAME 0254. ASSIGNOR(S) HEREBY CONFIRMS THE RELEASE OF SECURITY INTEREST GRANTED PURSUANT TO THE PATENT SECURITY AGREEMENT PREVIOUSLYRECORDED.

Assignors
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

Assignment 8

Reel/frame	Execution date	Date recorded	Properties	Pages
053654/0254	Jun 30, 2020	Jul 08, 2020	3010	236

Conveyance
RELEASE OF SECURITY INTEREST IN PATENTS

Assignors
STARBOARD VALUE INTERMEDIATE FUND LP

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
ACACIA RESEARCH GROUP LLC
767 3RD AVE
6TH FLOOR
NEW YORK, NEW YORK 10017

AMERICAN VEHICULAR SCIENCES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

BONUTTI SKELETAL INNOVATIONS LLC
6136 FRISCO SQUARE BLVD

SUITE 400
FRISCO, TEXAS 75034

CELLULAR COMMUNICATIONS EQUIPMENT LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

INNOVATIVE DISPLAY TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

LIFEPORT SCIENCES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

LIMESTONE MEMORY SYSTEMS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

MOBILE ENHANCEMENT SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA
SUITE 550
IRVINE, CALIFORNIA 92614

NEXUS DISPLAY TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

PARTHENON UNIFIED MEMORY ARCHITECTURE LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

R2 SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

SAINT LAWRENCE COMMUNICATIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

STINGRAY IP SOLUTIONS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

SUPER INTERCONNECT TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

TELECONFERENCE SYSTEMS LLC
6136 FRISCO SQUARE BLVD
SUITE 400
FRISCO, TEXAS 75034

UNIFICATION TECHNOLOGIES LLC
6136 FRISCO SQUARE BLVD
SUITE 400

FRISCO, TEXAS 75034

Assignment 7

Reel/frame	Execution date	Date recorded	Properties	Pages
055100/0624	Jun 04, 2020	Jan 25, 2021	50	173

Conveyance
CORRECTIVE ASSIGNMENT TO CORRECT THE ASSIGNOR NAME PREVIOUSLY RECORDED ON REEL 052853 FRAME 0153. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY INTEREST GRANTED PURSUANT TO THE PATENT SECURITY AGREEMENT PREVIOUSLY RECORDED.

Assignors
MONARCH NETWORKING SOLUTIONS LLC

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT
777 THIRD AVENUE
18TH FLOOR
NEW YORK, NEW YORK 10017

Assignment 6

Reel/frame	Execution date	Date recorded	Properties	Pages
052853/0153	Jun 04, 2020	Jun 05, 2020	3010	252

Conveyance
PATENT SECURITY AGREEMENT

Assignors
ACACIA RESEARCH GROUP LLC
AMERICAN VEHICULAR SCIENCES LLC
BONUTTI SKELETAL INNOVATIONS LLC
CELLULAR COMMUNICATIONS EQUIPMENT LLC
INNOVATIVE DISPLAY TECHNOLOGIES LLC
LIFEPORT SCIENCES LLC
LIMESTONE MEMORY SYSTEMS LLC
MERTON ACQUISITION HOLDCO LLC
MOBILE ENHANCEMENT SOLUTIONS LLC
MONARCH NETWORKING SOLUTIONS LLC
NEXUS DISPLAY TECHNOLOGIES LLC
PARTHENON UNIFIED MEMORY ARCHITECTURE LLC
R2 SOLUTIONS LLC
SAINT LAWRENCE COMMUNICATIONS LLC
STINGRAY IP SOLUTIONS LLC
SUPER INTERCONNECT TECHNOLOGIES LLC
TELECONFERENCE SYSTEMS LLC
UNIFICATION TECHNOLOGIES LLC

Correspondent
S. KAREFF C/O SCHULTE ROTH & ZABEL LLP
919 THIRD AVENUE
25TH FLOOR
NEW YORK, NY 10022

Assignee
STARBOARD VALUE INTERMEDIATE FUND LP, AS COLLATERAL AGENT
777 THIRD AVENUE
18TH FLOOR
NEW YORK, NEW YORK 10017

Assignment 5

Reel/frame	Execution date	Date recorded	Properties	Pages
051238/0718	Nov 18, 2019	Dec 10, 2019	53	34

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
ACACIA RESEARCH GROUP LLC

Correspondent
ROBERT ALLAN BULLWINKEL
1111 BAGBY ST, SUITE 2100
HOUSTON, TX 77002

Assignee
MONARCH NETWORKING SOLUTIONS LLC
4 PARK PLAZA, SUITE 550
IRVINE, CALIFORNIA 92614

Assignment 4

Reel/frame	Execution date	Date recorded	Properties	Pages
051192/0596	Mar 29, 2019	Dec 04, 2019	53	34

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
TRANSPACIFIC IP GROUP LIMITED

Correspondent
ROBERT ALLAN BULLWINKEL
1111 BAGBY ST, SUITE 2100
HOUSTON, TX 77002

Assignee
ACACIA RESEARCH GROUP LLC
6136 FRISCO SQ. BLVD. SUITE 400
FRISCO, TEXAS 75034

Assignment 3

Reel/frame	Execution date	Date recorded	Properties	Pages
044625/0315	Sep 21, 2017	Dec 08, 2017	52	39

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
ORANGE

Correspondent
DANIEL W JUFFERNBRUCH
PATENTS AND LICENSING LLC
28 BARRINGTON BOURNE
BARRINGTON, IL 60010-9605

Assignee
TRANSPACIFIC IP GROUP LIMITED
PO BOX 10008
WILLOW HOUSE, CRICKET SQUARE
GRAND CAYMAN KY1-1001
CAYMAN ISLANDS

Assignment 2

Reel/frame	Execution date	Date recorded	Properties	Pages
044625/0361	Jul 02, 2013	Dec 08, 2017	52	10

Conveyance
CHANGE OF NAME (SEE DOCUMENT FOR DETAILS).

Assignors
FRANCE TELECOM

Correspondent
DANIEL W JUFFERNBRUCH
PATENTS AND LICENSING LLC
28 BARRINGTON BOURNE
BARRINGTON, IL 60010-9605

Assignee
ORANGE
78 RUE OLIVIER DE SERRES
PARIS 75015

FRANCE

Assignment 1

Reel/frame	Execution date	Date recorded	Properties	Pages
023572/0637	Aug 25, 2009	Nov 25, 2009	1	3

Conveyance
ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignors
JOUNAY, FREDERIC
NIGER, PHILIPPE
CAUVIN, ARNAUD

Assignee
FRANCE TELECOM
6, PLACE D'ALLERAY
PARIS 75015
FRANCE

Correspondent
DAVID D. BRUSH
900 SECOND AVENUE SOUTH
SUITE 1400
MINNEAPOLIS, MN 55402

Privacy Act Statement

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/014,701	03/12/2021	8130775	43614.399	4147

27367 7590 04/15/2021

WESTMAN CHAMPLIN & KOEHLER, P.A.
121 South Eighth Street
Suite 1100
Minneapolis, MN 55402

EXAMINER	
SAGER, MARK ALAN	

ART UNIT	PAPER NUMBER
3992	

MAIL DATE	DELIVERY MODE
04/15/2021	PAPER

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

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(THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS)

HAYNES AND BOONE, LLP
IP SECTION
2323 VICTORY AVENUE
SUITE 700
DALLAS, TX 75219

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. *90/014,701* .

PATENT UNDER REEXAMINATION *8130775* .

ART UNIT *3992* .

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified *ex parte* reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the *ex parte* reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Order Granting Request For Ex Parte Reexamination	Control No. 90/014,701	Patent Under Reexamination 8130775	
	Examiner MARK A SAGER	Art Unit 3992	AIA (FITF) Status No

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

The request for *ex parte* reexamination filed 03/12/2021 has been considered and a determination has been made. An identification of the claims, the references relied upon, and the rationale supporting the determination are attached.

Attachments: a)☐ PTO-892, b)☑ PTO/SB/08, c)☐ Other: ____

1. ☑ The request for *ex parte* reexamination is GRANTED.

RESPONSE TIMES ARE SET AS FOLLOWS:

For Patent Owner's Statement (Optional): TWO MONTHS from the mailing date of this communication (37 CFR 1.530 (b)). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).**

For Requester's Reply (optional): TWO MONTHS from the **date of service** of any timely filed Patent Owner's Statement (37 CFR 1.535). **NO EXTENSION OF THIS TIME PERIOD IS PERMITTED.** If Patent Owner does not file a timely statement under 37 CFR 1.530(b), then no reply by requester is permitted.

/MARK SAGER/ Primary Examiner, Art Unit 3992		

cc:Requester (if third party requester)

Order Determination

Third Party Requester submitted a request for reexamination with a filing date of March 12, 2021, requesting reexamination of claim 1 and 6 of U.S. Patent No. 8,130,775 (hereinafter also referred to as '775). A substantial new question of patentability affecting claim 1 and 6 of U.S. Patent No. 8,130,775 in effect at this time is raised by the request for *ex parte* reexamination. Accordingly, claim 1 and 6 will be reexamined. For reference, numbered pages 5-10 discuss prosecution history; while, numbered pages 10-25 discuss the SNQs herein.

Extensions of Time

Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not to parties in a reexamination proceeding. Additionally, 35 U.S.C. 305 requires that reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)). Extension of time in *ex parte* reexamination proceedings are provided for in 37 CFR 1.550(c).

Notification of Concurrent Proceedings

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No. 8,130,775 throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

Amendment in Reexamination Proceedings

Patent owner is notified that any proposed amendment to the specification and/or claims in this reexamination proceeding must comply with 37 CFR 1.530(d)-(j), must be formally presented pursuant to 37 CFR 1.52(a) and (b), and must contain any fees required by 37 CFR 1.20(c).

Submissions

In order to insure full consideration of any amendments, affidavits or declarations or other documents as evidence of patentability, such documents must be submitted in response to the first Office action on the merits (which does not result in a close of prosecution). Submissions after the second Office action on the merits, which is intended to be a final action, will be governed by the requirements of 37 CFR 1.116, after final rejection and by 37 CFR 41.33 after appeal, which will be strictly enforced.

Waiver of Right to File Patent Owner Statement

In a reexamination proceeding, Patent Owner may waive the right under 37 C.F.R. 1.530 to file a Patent Owner Statement. The document needs to contain a statement that Patent Owner waives the right under 37 C.F.R. 1.530 to file a Patent Owner Statement and proof of service in the manner provided by 37 C.F.R. 1.248, if the request for reexamination was made by a third party requester, see 37 C.F.R 1.550(f). The Patent Owner may consider using the following statement in a document waiving the right to file a Patent Owner Statement:

WAIVER OF RIGHT TO FILE PATENT OWNER STATEMENT

Patent Owner waives the right under 37 C.F.R. 1.530 to file a Patent Owner Statement.

References Asserted as Raising a Substantial New Question

The asserted substantial new question of patentability (SNQP) regarding claim 1 and 6 of the '775 Patent is based upon the following references:

U.S. Patent No. 7,602,702 to Aggarwal ("Aggarwal")	Ex. 1005
"Fault-tolerant IP and MPLS Networks" by IFTEKHAR HUSSAIN ("Hussain), (1st ed. 2004)	Ex. 1006

Availability of Asserted References as Prior Art

Aggarwal was filed on February 10, 2005 and issued on October 13, 2009. Ex. 1005, Aggarwal at (22), (45). Accordingly, Aggarwal qualifies as prior art under 35 U.S.C. § 102(e) (pre-AIA). Aggarwal was not cited during the prosecution of the '775 Patent.

Fault-Tolerant IP and MPLS Networks by Iftekhar Hussain ("Hussain") was published by Cisco Press in 2004 and is prior art under 35 U.S.C. § 102(b). As testified by Dr. Ingrid Hsieh-Yee (Ex. 1014, Para. 1-52), Hussain was made searchable by the Library of Congress since at least October 25, 2002 and was thus available to the public at that time. Ex. 1014, 21-26. The copyright registration record (dated November 23, 2004) states the book published on November 19, 2004. Id., 27-29; see 17 U.S.C. § 410(c) (copyright registration is prima facie evidence of facts stated therein). Other libraries indicate the book was available before the priority date of the '775 patent. Id., 30-43. Further, Amazon.com shows at least three posted reviews of Hussain before May 1, 2005. Id., Para. 44-45. This indicates that the book was publicly available and viewed by interested persons. Hussain was also cited by other documents in 2005. Id., Para. 46. Hussain is thus prior art to the '775 patent under 35 U.S.C. § 102(b). Hussain was not cited during the prosecution of the '775 Patent. Each of the references listed in Request, as copied in Table above, is a publication, article or patent published prior to the effective priority of the '775 patent. The '775 patent is based on a PCT application filed February 26, 2008 and claims priority to a patent application filed in France on February 26, 2007. The national phase filing of the '775 patent was on November 25, 2009. Thus each cited reference is available as prior art.

Declaration of Henry Houth

The Declaration filed 3/12/2021, under 37 CFR 1.68, was reviewed but not further considered for this decision since it does not declare statement or evidence regarding a Substantial New Question of Patentability herein.

Summary of Prosecution History

The '775 patent is based on PCT patent application No. PCT/FR08/50324 filed February 26, 2008 and claims priority to French patent application No. FR0753489 filed on February 26, 2007. The national phase filing of the '775 patent was on November 25, 2009.

International Phase

After the filing of PCT/FR08/50324, an international search was conducted on March 23, 2009 and the resulting international search report was published on May 14, 2009. The search report identified four IETF draft documents as references. The first reference is by P. Pan et al., entitled "Pseudo Wire Protection", which was cited as an anticipatory reference for then pending claims 1-7. The second reference is by M. Bocci and S. Bryant, entitled "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge", which was cited as an anticipatory reference for then pending claims 1, 2, 4, and 6. The third reference is by E. Mannie and. Papadimitriou, entitled "Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS)", which is cited as defining the general state of the art for then pending claims 1, 2, 4, and 6. The fourth reference is by Luca Martini et al., entitled "Dynamic Placement of Multi Segment Pseudo Wires", which is cited as defining the general state of the art for then pending claims 1, 2, 4, and 6. No search was conducted on then pending claims 8 and

9 because they were found to contain non-patentable subject matter. The International Searching Authority ("ISA") also issued a written opinion (in French) analyzing the claims and discussing the prior art identified in the international search report. The ISA also issued an English translation of the written opinion. The Applicant submitted the original French version of the ISA's written opinion, but the '775 patent file history does not show that the Applicant ever filed the English translation with the Office. The written opinion found that then pending claims 1-7 lacked an inventive step.

National Phase

Reference to claim numbers below regard the claims as filed and subsequently amended as applicable. On August 21, 2009, a preliminary amendment was filed. The preliminary amendment of claim 1 changed language from "consists of" to "comprises." The preliminary amendment removed claim 6's dependency on claim 2 and made claim 6 an independent claim reciting the material previously provided by the dependency on claim 2. The national phase filing of the '775 patent was on November 25, 2009.

The Office issued its first and only Office action in the '775 prosecution on June 17, 2011. The Examiner did not discuss any of the prior art from the international search report or the written opinion issued by the ISA (which, again, appears to have been provided to the Office solely in French). The Examiner rejected claim 1 as being anticipated by U.S. Patent Publication No. 2008/0175234 to Li. To establish that the first link is shared by the first and second pseudo-wires, the Examiner relied on Li's disclosure that the "PW in the working PWG [Pseudo Wire Group] and the protective PWG is a single-segment PW or a multi-segment PW." The Examiner

rejected claim 6 as being anticipated by U.S. Patent Publication No. 2008/0089227 to Guichard et al. The Office action also includes U.S. Patent Publication No. 2007/023989 to Wainner et al. as prior art made of record but not relied upon. The Examiner also objected to claim 6 for reciting "the method comprising," when the claim is directed to a computer program product. The Examiner further rejected claim 6 under 35 U.S.C. 101 as being directed to a computer program product that doing not indicate "a non-transitory form."

In response to the Office action, the Applicant summarized an exemplary embodiment of the application, stating "[t]he present application teaches, for example, a method to setup at least two multi-segment pseudowires in a 'Y' shape, wherein one segment located between the input router and an intermediate router ('first link' in claim 1) is shared by first and second pseudowires." Without amending claim 1, the Applicant challenged the rejection over Li by arguing:

> "Li teaches a method and device to switch from a pseudowire in a group of working pseudowires to a pseudowire in a group of protective pseudowires. Pseudowires can be single- or multi-segment, and there is a one to one mapping established between pseudowires in the working group and pseudowires in the protective group. Li also teaches the necessary conditions to meet for switching."
>
> "Claim 1: Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire. The fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment. In Figure 2 of the present application, multi-segment pseudowires are shown as prior art."

It is noted Applicant argued "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire." It is also noted the Applicant further argued that "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment is not an indication that any of them share a segment." The Applicant amended claim 6

to include "non-transitory" and replaced the method comprising language with "the program code instructions comprising instructions for." The Applicant did not amend claim 6 in response to the rejection over Guichard. Instead, the Applicant argued that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Point]."

On December 30, 2011, the Examiner issued a notice of allowance, including an examiner's amendment that clarifies that the two pseudo-wires sharing the first link are the first and second pseudo-wires. The notice of allowance stated the reasons for allowance: "no prior art reference or combination of prior art reference disclose or suggest" "setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires."

IPR2020-01226 (hereafter '226 or first IPR)

A third party petition was filed on July 06, 2020 requesting a first inter partes review (IPR) of claims 1 and 6 of '775. In summary, the Petitioner for first IPR cited new prior art not previously of record. The Petitioner of the '226 IPR asserted the following grounds of unpatentability against the challenged claims of the '775 patent:

References	Challenged Claims
Aggarwal (US 7,602,702) and "Fault-tolerant IP and MPLS Networks" by IFTEKHAR HUSSAIN ("Hussain)	1 and 6

Challenged Claims

Both of the challenged claims 1 and 6 are independent claims, but the two "setting up" steps of claim 1 are duplicated in the computer program product of claim 6. Claims 1 and 6 are reproduced below:

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.
>
> 6. A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

In addition, the Petitioner identified the following district court proceeding related to the '775 patent: *Monarch Networking Solutions LLC v. Cisco Systems, Inc. and Charter Communications, Inc., No. 2:20~cv-00015 (E.D. Tex.) ("Eastern District of Texas").* The Patent Owner submitted their response that contends the Board should exercise discretion under 35 U. S. C. § 314(a) to deny institution of inter partes review due to the advanced stage of the underlying litigation in the United States District Court for the Eastern District of Texas. According to Patent Owner,

instituting an inter partes review "would needlessly duplicate" the district court action and "unnecessarily waste the Board's resources."

In response, the Board authorized the parties to submit supplemental briefing on the issue of discretionary denial under 35 U. S.C. § 314(a). The Board specifically requested the parties to address the factors set forth in *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, (precedential, designated May 5,2020) ("*Fintiv*"). *Id. Fintiv* provides several factors that balance considerations of system efficiency, fairness, and patent quality when a patent owner raises an argument for discretionary denial due to the advanced state of a parallel proceeding. These factors are:

1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
3. investment in the parallel proceeding by the court and the parties;
4. overlap between issues raised in the petition and in the parallel proceeding;
5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
6. other circumstances that impact the Board's exercise of discretion, including the merits. *Id.*

Having considered the parties' submissions, the Board determined that it was appropriate in this case to exercise their discretion to deny institution of inter partes review pursuant to 35 U.S.C. § 314(a) due to the advanced stage of the parallel district court litigation involving the challenged patent. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, (PTAB Mar. 20, 2020} (precedential) ("*Fintiv*"); *NHK. Spring Co. v. Intri-Plex Techs., Inc.*, IPR2018-00752, Paper 8 (PTAB Sept. 12, 2018) (precedential) ("NHK"). To be clear, after a holistic consideration of the relevant facts, the Board concluded that efficiency and integrity of the system are best served by denying institution. Thus, for the facts in IPR '226, the Board exercised their discretion under § 314(a) to

deny institution of *inter partes* review. The Board did not evaluate the merits of cited art against the challenged claims in their decision to not institute an IPR.

The SNQ Requirement

A printed publication raises a SNQ where there is a substantial likelihood that a reasonable examiner would consider the printed publication important in deciding whether or not the claim is patentable, unless the same SNQ has already been decided as to the claim in a final holding of invalidity by the Federal court system or by the Office in a previous examination. MPEP § 2242.

It is not sufficient that a request for reexamination merely proposes one or more rejections of a patent claim or claims as a basis for reexamination. It must first be demonstrated that a patent or printed publication that is relied upon in a proposed rejection presents a new, non-cumulative technological teaching that was not previously considered and discussed on the record during the prosecution of the application that resulted in the patent for which reexamination is requested, and during the prosecution of any other prior proceeding involving the patent for which reexamination is requested. MPEP § 2216.

The substantial new question of patentability may be based on art previously considered by the Office if the reference is presented in a new light or a different way that escaped review during earlier examination. MPEP § 2216.

Claim Limitations Important to Patentability

In view of the prosecution history discussed above, from representative claim 1 (copied below), a shared link is deemed important to patentability:

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
>
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Annotated Fig. 3 of '775, copied below, shows the elements of claim 1.

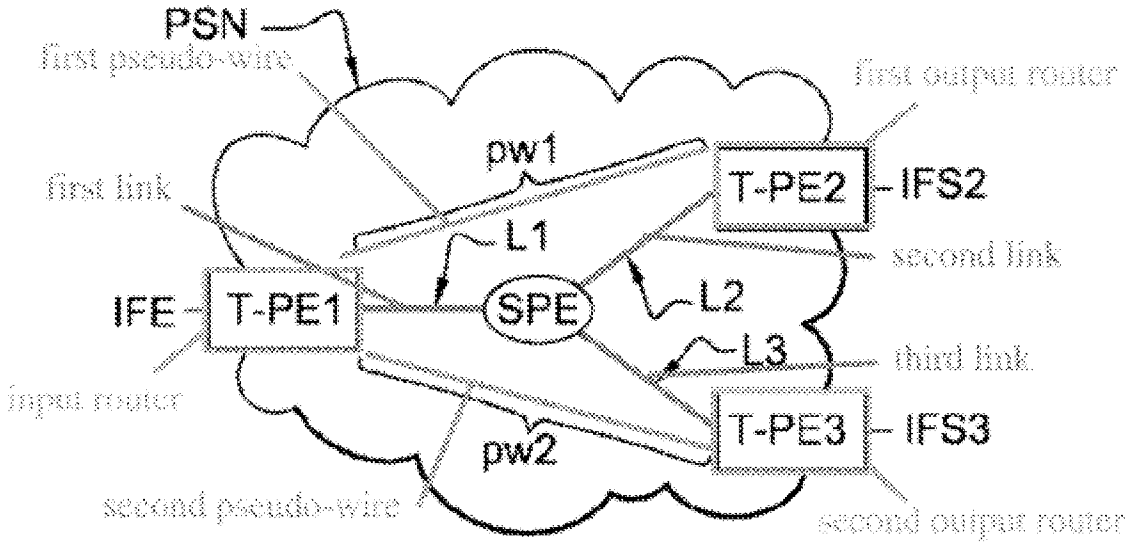


FIG. 3 (annotated) of 8,130,775.

This decision analyzes the claims according to their broadest reasonable interpretation in light of the specification. M.P.E.P. § 2258. The '775 patent describes, in part, communicating via two pseudo-wires that share a network link between a source router and an intermediate router. During the prosecution, as summarized above, the Applicant argued that the use of a shared link distinguished the '775 claims over the cited prior art.

As further background regarding subject matter of '775, the '775 patent relates to packet-switched networking, and more specifically, to "a method of setting up at least two pseudo-wires able to broadcast a data stream." See, e.g., '775, 1:24-25 & 2:54-55. The '775 patent admits that the prior art included techniques for setting up two pseudo-wires within a network. See, e.g., '775, 1:45-2:39 & Figs. 1-2. Figs. 1 and 2 of 8130775 are copied next.

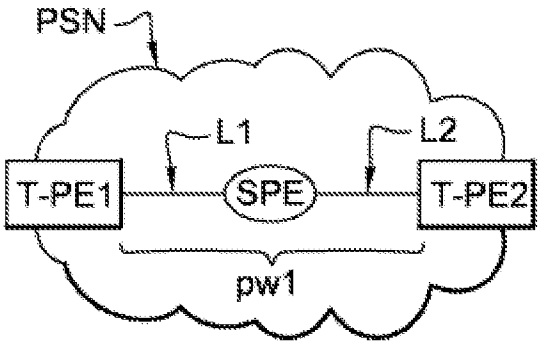
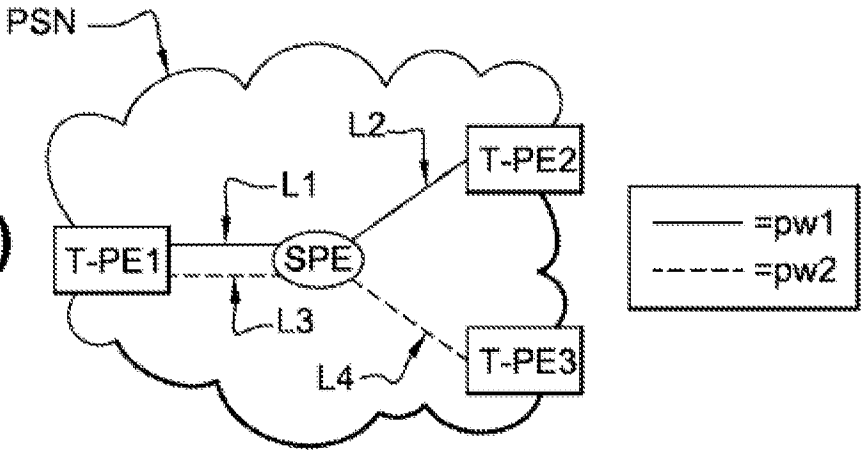


Fig. 1(AA)

Fig. 2(AA)



The purported advancement claimed in the '775 patent is for two pseudo-wires (pw1 and pw2) to share a common link (LI) between an input router (T-PE1) and an intermediate router (SPE). See, e.g., '775, 6:44-48, 2:65-67, 3:15-18. This concept is illustrated in annotated Figure 3 above. See, e.g., '775, 5:45-57.

This "shared link" aspect is further described by the following objective statements in '775 at 3:1-38.

> This optimizes the use of network resources, for example bandwidth, between the input router and the intermediate router by setting up between them a single link common to the two pseudo-wires. This solution has never been envisaged in the prior art. In the prior art, when a main pseudo-wire and a back-up pseudo-wire are set up between an input router and a first, respectively a second, output router, a link is set up between the input router and the intermediate router for each pseudo-wire, i.e. two links. The person skilled in the art has always considered a pseudo-wire as a point-to-point link set up between an input router and an output router, with the result that each input router/output router pair is associated with a pseudo-wire. Moreover, this kind of approach is recommended in the standards.
>
> Going against this received wisdom of the person skilled in the art, the inventors of the present application propose, in contrast, to share the link set up between the input router and the intermediate router, which improves the use of network resources and reduces the restore time in the event of a fault affecting the first output router. In the prior art, the back-up pseudo-wire, although used only to broadcast data in the event of a fault affecting the main pseudo-wire, reserves resources used to set it up over the whole of the network between the input router and the output router. Because the main pseudo-wire and the back-up pseudo-wire share the link set up between the input router and the intermediate router, the network resources that in the past were reserved for the back-up pseudo-wire are released and can be used in a manner closer to the optimum
>
> In this kind of embodiment, the first, second, and third links are not necessarily direct links between routers. For example, the second link set up between the intermediate router and the first output router can comprise one or more hops and possibly pass through one or more other intermediate routers before reaching the output router. The same applies to the link set up between the input router and the intermediate router and to the link set up between the intermediate router and the second output router.

SNQP/Reference Analysis

Attention is directed to MPEP 2216, i.e.:

> Under 35 U.S.C. 304, the Office must determine whether "a substantial new question of patentability" affecting any claim of the patent has been raised. 37 CFR 1.510(b)(1) requires that a request for ex parte reexamination include "a statement pointing out each substantial new question of patentability based on prior patents and printed publications." If such a new question is found, an order for ex parte reexamination of the patent is issued. **It is therefore important that**

the request clearly set forth in detail what the requester considers the "substantial new question of patentability" to be in view of prior patents and printed publications. The request must point out how any questions of patentability raised are substantially different from those raised in the previous examination of the patent before the Office.

It is not sufficient that a request for reexamination merely proposes one or more rejections of a patent claim or claims as a basis for reexamination. It must first be demonstrated that a patent or printed publication that is relied upon in a proposed rejection presents **a new, non-cumulative technological teaching** that was **not previously considered and discussed on the record during the prosecution of the application** that resulted in the patent for which reexamination is requested, **and during the prosecution of any other prior proceeding involving the patent for which reexamination is requested**. See also MPEP § 2242.

The legal standard for ordering ex parte reexamination, as set forth in 35 U.S.C.303(a), requires a substantial new question of patentability. The substantial new question of patentability may be based on art previously considered by the Office **if** the reference is presented in a **new light or a different way that escaped review during earlier examination**.

....

After the enactment of the Patent and Trademark Office Authorization Act of 2002 ("the 2002 Act"), a substantial new question of patentability can be raised by patents and printed publications "previously cited by or to the Office or considered by the Office" ("old art"). The 2002 Act did not negate the statutory requirement for a substantial new question of patentability that requires raising new questions about pre-existing technology. In the implementation of the 2002 Act, MPEP § 2242, subsection II.A. was revised. The revision permits raising a substantial new question of patentability based solely on old art, **but only if** the old art is "**presented/viewed in a new light, or in a different way, as compared with its use in the earlier concluded examination(s), in view of a material new argument or interpretation presented in the request**." Thus, a request may properly raise a substantial new question of patentability by raising a material new analysis of previously considered reference(s) under the rationales authorized by KSR.

Questions relating to grounds of rejection other than those based on prior art patents or printed publications should not be included in the request and will not be considered by the examiner if included. Examples of such questions that will not be considered are public use, on sale, and conduct by parties. (Emphasis added.)

Attention is also invited to MPEP 2242, I., i.e.:

> The presence or absence of "a substantial new question of patentability" determines whether or not reexamination is ordered. The meaning and scope of the term "a substantial new question of patentability" is not defined in the statute and must be developed to some extent on a case-by-case basis, using the case law to provide guidance as will be discussed in this section.
>
> If the prior art patents and printed publications raise a substantial question of patentability of at least one claim of the patent, then a substantial new question of patentability is present, **unless the same question of patentability has already been decided** by (A) a final holding of invalidity, after all appeals, or (B) by the Office in a previous examination or pending reexamination of the patent. A "previous examination" of the patent is: (A) the original examination of the application which matured into the patent; (B) the examination of the patent in a reissue application that has resulted in a reissue of the patent; or (C) the examination of the patent in an earlier pending or concluded reexamination. ....
>
> A prior art patent or printed publication raises a substantial question of patentability where there is a substantial likelihood that a reasonable examiner would consider the prior art patent or printed publication important in deciding whether or not the claim is patentable. If the prior art patents and/or publications would be considered important, then the examiner should find "a substantial new question of patentability" **unless the same question of patentability has already been decided as to the claim** in a final holding of invalidity by the Federal court system or **by the Office in a previous examination.** For example, the same question of patentability may have already been decided by the Office where the examiner finds the additional (newly provided) prior art patents or printed publications *are merely cumulative to* ***similar*** *prior art* already fully considered by the Office in a previous examination of the claim.
>
> For "a substantial new question of patentability" to be present, it is only necessary that: (A) the prior art patents and/or printed publications raise a substantial question of patentability regarding at least one claim, i.e., the teaching of the (prior art) patents and printed publications is such that a reasonable examiner would consider the teaching to be important in deciding whether or not the claim is patentable; **and** (B) the same question of patentability as to the claim has not been decided by the Office in a previous examination or pending reexamination of the patent or in a final holding of invalidity by the Federal Courts in a decision on the merits involving the claim. It is not necessary that a "prima facie" case of unpatentability exist as to the claim in order for "a substantial new question of patentability" to be present as to the claim....
> (Emphasis added.)

Attention is also invited to 2258.01:

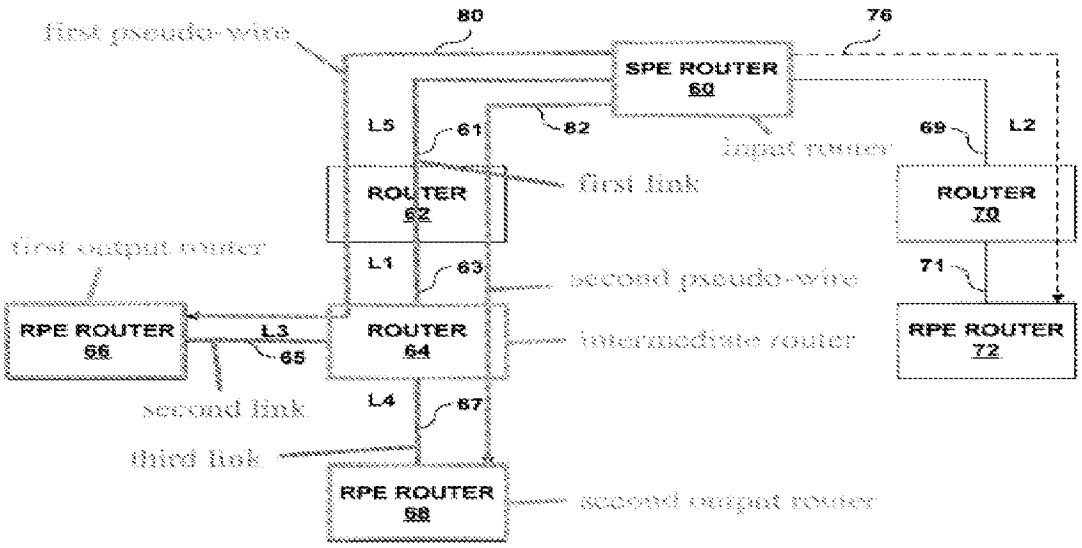
> …For purposes of reexamination, a cumulative reference that is repetitive is one that substantially reiterates verbatim the teachings of a reference that was either previously relied upon or discussed in a prior Office proceeding even though the title or the citation of the reference may be different….

Finally, see also MPEP 2247.

SNQP Raised in this Request

Requester asserts, in their Request at page 5 in section entitled "**I. CERTIFICATION REGARDING NO ESTOPPEL**," that "Cisco Systems, Inc. previously requested inter partes review of the '775 patent in IPR2020-01226, but the Patent Trial and Appeal Board exercised its discretion to deny institution based on the status of district court proceedings. See IPR2020-01226, Paper 11 at 3 (Mar. 4, 2021). Requester asserts no final written decision issued or will issue in that proceeding." At pages 5-6 in a section entitled "**II. STATEMENTS POINTING OUT EACH SUBSTANTIAL NEW QUESTION OF PATENTABILITY**," the Requester generally asserts the following regarding Aggarwal and Hussein:

> "Newly presented U.S. Patent No. 7,602,702 to Aggarwal ("Aggarwal," Ex. 1005) illustrates in Figure 5 the use of a shared link for two pseudo-wires."
>
> "Specifically, Figure 5 shows that pseudo-wires 80 and 82 share a common links 61 and 63. Aggarwal explains that it is desirable to "share the same links where possible." Ex. 1005, 6:40-42.



Aggarwal, Fig. 5 (Annotated) from Request.

"Fault-Tolerant IP and MPLS Networks by Iftekhar Hussain ("Hussain") similarly discloses that "[m]ultiple PWs [pseudo-wires] can be carried inside a single tunnel." Ex. 1006, 276. With multiple pseudo-wires carried in a single tunnel, the multiple pseudo-wires would share a link between routers."

Issue 1: Proposed SNQP Based on Aggarwal

Based on facts noted herein, a reasonable patent examiner would consider the teachings of U.S. Patent No. 7,602,702 to Aggarwal to be important regarding sharing a link limitation "*wherein the second pseudo-wire comprises said first link.*" Ex. 1005, Aggarwal at 6:40-49. The Request states "Aggarwal goes on to describe the claimed pseudo-wire limitation in that the Point-to-Multipoint (P2MP) Label Switched Path (LSP) includes branch LSPs. See, e.g., Aggarwal at 4:13-15." The Requester further states the following regarding Aggarwal:

"A substantial new question of patentability as to claims 1 and 6 is raised by Aggarwal. As mentioned above, the '775 patent claims recite in part, (1) a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network, and a second pseudo-wire between said input router and a second output router of the packet-switched network, (2) wherein the second pseudo-wire comprises said first link. For purposes of discussion, these will be referred to as the pseudo-wire limitation and the shared link limitation, respectively."

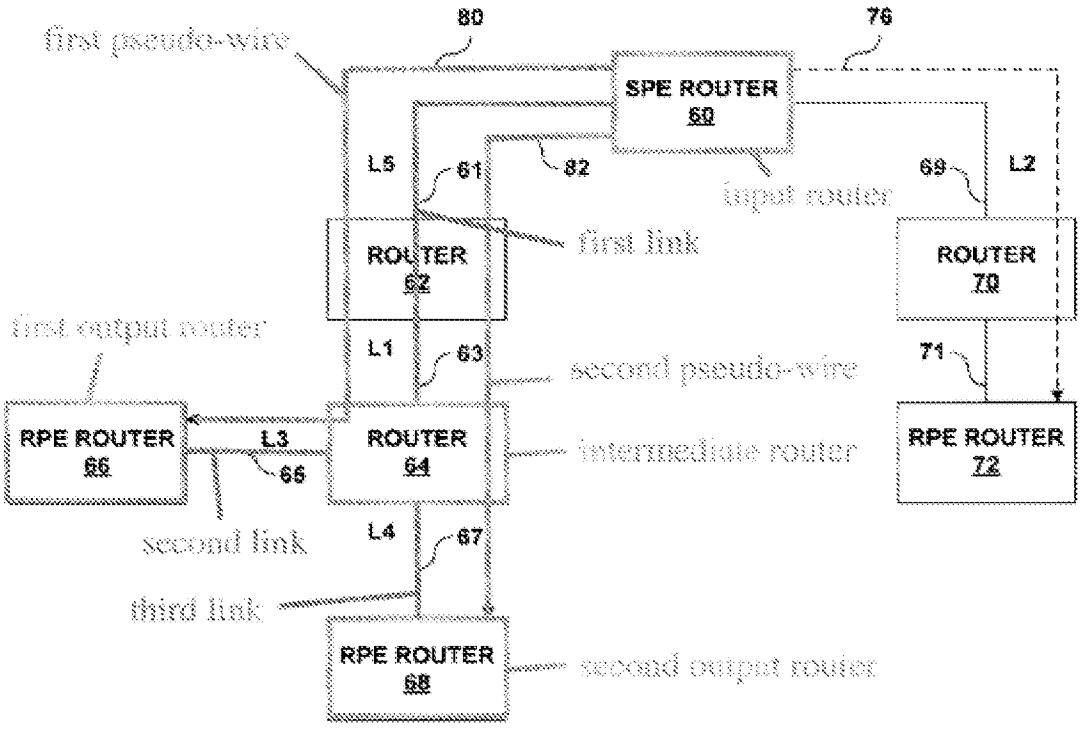
"As mentioned above in Section II.D., the Patent Owner argued in prosecution that "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire," and "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment."

"The Patent Owner also argued in prosecution that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Points]."

"In contrast to Li and Guichard, Aggarwal teaches that Label Switched Paths (LSPs) may share links." See, e.g., Aggarwal at 6:40-49.

"Aggarwal describes the claimed pseudo-wire limitation in that the Point-to-Multipoint (P2MP) Label Switched Path (LSP) includes branch LSPs. See, e.g., Aggarwal at 4:13-15.

"An example is illustrated in Fig. 5, of Aggarwal, shown below:"



Aggarwal, Fig. 5 (Annotated) from Request.

"Fig. 5 illustrates how "SPE [source provider edge] router 12 establishes a P2MP LSP between SPE router 12 and RPE [receiver provider edge] routers 66, 68, and 72." See, e.g., Aggarwal at 6:31-32.

> "To do this, the SPE router 60 establishes a branch LSP 80 between the SPE router 60 and a first RPE router 66. See Ex. 1005, 6:44-47. LSP 80 includes links 61 and 63 between the SPE router and intermediate router 64, as well as link 65 between the intermediate router 64 and the first RPE router 66." See, e.g., Aggarwal at Fig. 5.
>
> "Additionally, the SPE router 60 establishes a branch LSP 82 between the SPE router 60 and a second RPE router 68." See, e.g., Aggarwal at 6:44-47.
>
> "LSP 82 includes links 61 and 63 between the SPE router 60 and intermediate router 64, as well as link 67 between the intermediate router 64 and the second RPE router 68." See, e.g., Aggarwal at Fig. 5.
>
> "Aggarwal further describes the claimed shared link limitation in that the branch LSPs share links. Aggarwal's technique "merges individual branch LSPs to form a P2MP LSP." See, e.g., Aggarwal at 7:4-5.
>
> "For example, Aggarwal's "branch LSPs are computed to **share the same links where possible** as they belong to the same session." See, e.g., Aggarwal at 6:40-42.
>
> "In Aggarwal's Fig. 5, "Branch LSPs 80 and 82 **share links 63 and 61** between router 64 and SPE router 60." See, e.g., Aggarwal at 6:47-49.
>
> "Aggarwal explains that "[t]he term 'link' is often used to refer to the connection between two devices on a network." See, e.g., Aggarwal at 1:22.

Based on facts noted above, it is determined that a reasonable patent examiner would consider the teachings of U.S. Patent No. 7,602,702 to Aggarwal to be important regarding "*wherein the second pseudo-wire comprises said first link.*" A reasonable examiner would consider Aggarwal to be important in deciding whether or not the claim is patentable regarding the claimed shared-link feature in claim 1 and 6 of '775. Ex. 1005, Aggarwal at 6:40-49 and 7:4-5. Facts from prosecution noted above, show the Patent Owner asserted the "sharing a link" were not found in the references considered in the '083 application.

Similarly, based on facts noted above, it is determined that a reasonable patent examiner would consider the teachings of U.S. Patent No. 7,602,702 to Aggarwal to be important regarding "a

first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network" and "a second pseudo-wire between said input router and a second output router of the packet-switched network." A reasonable examiner would also consider Aggarwal to be important in deciding whether or not the claim is patentable regarding the claimed pseudo-wire feature, in claim 1 and 6 of '775. Ex. 1005, Aggarwal at 4:13-15 and 6:29-47 and Fig. 5.

Aggarwal was not cited/applied during an examination of '083 application, and the claims at issue herein are not the subject of a final holding by a Federal Court. Finally, although Aggarwal was cited/applied in Petition for IPR2020-01226, the Board exercised discretion under 35 USC 314(a) to deny instituting inter partes reexamination based primarily on *Fintiv* grounds without reaching the merits as to the claims challenged herein (i.e., claims 1 and 6). Therefore, a reasonable Examiner would have found the teachings of Aggarwal important in determining whether claims 1 and 6 are patentable because Aggarwal discloses a shared-link feature similar to the claimed sharing a link feature that the applicant argued to distinguish other prior art during prosecution. Also, a reasonable Examiner would consider Aggarwal important in deciding whether or not the claims 1 and 6 is patentable because Aggarwal describes a pseudo-wire feature with respect to Aggarwal describing a P2MP LSP arrangement in which two separate pseudo wires share a link between two routers in that the Point-to-Multipoint (P2MP) Label Switched Path (LSP) includes branch LSPs that regards the claimed two pseudowire feature herein. For each of the above facts, Aggarwal raises a substantial new question of patentability with respect to claims 1 and 6.

Issue 2: Proposed SNQP Based on Hussein

As mentioned above in discussion of Issue 1, the '775 patent claims recite in part, (1) *a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network, and a second pseudo-wire between said input router and a second output router of the packet-switched network*, (2) *wherein the second pseudo-wire comprises said first link*. For purposes of discussion below, these will be referred to as the pseudo-wire limitation and the shared link limitation, respectively.

Based on facts noted below, it is determined that a reasonable patent examiner would consider the teachings of U.S. Patent No. 7,602,702 to Hussain to be important regarding the claimed shared link limitation and the claimed pseudowire limitation. A reasonable patent examiner would consider the teachings of Hussain to be important in deciding whether or not claims 1 and 6 is patentable regarding the claimed pseudo-wire feature and the claimed shared link feature as recited in claims 1 and 6 of '775 based on facts as further detailed next.

As mentioned above, the Request states Patent Owner argued in prosecution that "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire," and "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment." The Patent Owner also argued in prosecution that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Points]."

In contrast to Li and Guichard, with regard to claimed shared link limitation, Hussain teaches that "[m]ultiple PWs [pseudo-wires] can be carried inside a single tunnel." Ex. 1006, 276. Hussain describes the claimed pseudo-wire limitation in that the point-to-point pseudo-wires can be set up between provider edges. Hussain teaches how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). Ex. 1006, 276-77. Hussain also teaches that pseudo-wires provide broadcast services. See Ex. 1006, 273-77.

Hussain further describes the claimed shared link limitation concerning nested pseudo-wires can be carried in the same tunnel. Hussain explains that "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex. 1006, 273. In particular, Hussain describes nesting multiple pseudo-wires "inside a single tunnel." Ex. 1006, 276.

Hussain was never cited during prosecution nor considered by the Examiner in any manner. A reasonable Examiner would have found the teachings of Hussain important to determine whether claims 1 and 6 are patentable because Hussain discloses the shared-link feature concerning the nested pseudo-wires can be carried "inside a single tunnel." The Patent Owner asserted the shared link feature was not found in the references considered in the '083 application. For these reasons, Hussain's disclosure of nesting multiple pseudo-wires inside a tunnel raises a substantial new question of patentability with respect to claims 1 and 6.

Based on facts noted above, it is also determined that a reasonable patent examiner would consider the teachings of Hussain to be important in deciding whether or not the claim is patentable regarding the claimed pseudowire element since Hussain teaches how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). For the above facts, a reasonable Examiner would consider Hussain important in deciding whether or not the claims 1 and 6 is patentable because Hussain describes a pseudowire feature.

Hussain was not cited/applied during an examination of '083 application, and the claims at issue herein are not the subject of a final holding by a Federal Court. Finally, although Hussain was cited/applied in Petition for IPR2020-01226, the Board exercised discretion under 35 USC 314(a) to deny instituting inter partes reexamination based primarily on *Fintiv* grounds without reaching the merits as to the claims challenged herein (i.e., claims 1 and 6). Therefore, a reasonable Examiner would have found the teachings of Hussain important in determining whether claims 1 and 6 are patentable because Hussain discloses a shared-link feature that regards the claimed sharing a link feature that the applicant argued to distinguish other prior art during prosecution. Also, a reasonable Examiner would consider Hussain important in deciding whether or not the claims 1 and 6 is patentable because Hussain describes how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP) that regards the claimed two pseudowire feature herein. For each of the above facts, Hussain raises a substantial new question of patentability with respect to claims 1 and 6.

Conclusion

Accordingly, as the findings above show that a substantial new question of patentability is present, reexamination is granted, see MPEP 2242. Claims 1 and 6 **will be** reexamined.

Correspondence

All correspondence relating to this ex parte reexamination proceeding should be directed:

By Mail to: Mail Stop *Ex Parte* Reexam

Central Reexamination Unit
Commissioner for Patents
United States Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

By FAX to: (571) 273-9900

Central Reexamination Unit

By hand: Customer Service Window

Randolph Building
401 Dulany Street
Alexandria, VA 22314

Registered users of EFS-Web may alternatively submit such correspondence via the electronic filing system EFS-Web, at https://efs.uspto.gov/efile/my portal/efs-registered. EFS-Web offers the benefit of quick submission to the particular area of the Office that needs to act on the correspondence. Also, EFS-Web submissions are "soft scanned" (i.e., electronically uploaded) directly into the official file for the reexamination proceeding, which offers parties the opportunity to review the content of their submissions after the "soft scanning" process is complete.

Any inquiry concerning this communication should be directed to the Central Reexamination Unit at telephone number 571-272-7705.

Other useful telephone numbers:

Reexamination Practice (571) 272-7703

Reexamination Facsimile Transmission No. (571) 273-9900

/Mark Sager/
Patent Reexamination Specialist, CRU
Art Unit 3992

Conferees:
/FRED O FERRIS III/
Reexamination Specialist, Art Unit 3992

/ALEXANDER J KOSOWSKI/
Supervisory Patent Examiner, Art Unit 3992

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Examiner	Art Unit
	MARK A SAGER	3992

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
Reviewed prosecution history of 8130775	03/25/2021	ms
Lit Search conducted 3/12/2021	03/25/2021	ms

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Reexamination	Application/Control No.	Applicant(s)/Patent Under Reexamination
	90/014,701	8130775
	Certificate Date	Certificate Number

Requester Correspondence Address: ☐ Patent Owner ☑ Third Party
HAYNES AND BOONE, LLP IP SECTION 2323 VICTORY AVENUE SUITE 700 DALLAS, TX 75219

LITIGATION REVIEW ☑	MAS (examiner initials)	(date)
Case Name		Director Initials
Monarch Networking Solutions LLC v. Cisco Systems, Inc., No. 2-20-cv-00015 (E.D. Tex., filed Jan 21, 2020)		

COPENDING OFFICE PROCEEDINGS	
TYPE OF PROCEEDING	NUMBER

In place of PTO-1449 Form	U. S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE			*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	In Ex Parte Reexamination of 8,130,775
				Filing Date	Herewith
				First Inventor Name	Frederic Jounay
				Art Unit	TBD
				Examiner Name	TBD
SHEET	1	OF	1	Attorney Docket Number	43614.399

U. S. PATENTS				
Examiner's Initials	**Cite No.**	**Document Number**	**Issue Date MM-DD-YYYY**	**Name of Patentee or Applicant of Cited Document**
/M.S./	Ex. 1005	7,602,702	10-13-2009	Aggarwal

U. S. PATENT APPLICATION PUBLICATIONS				
Examiner's Initials	**Cite No.**	**Document Number**	**Publication Date MM-DD-YYYY**	**Name of Patentee or Applicant of Cited Document**

FOREIGN PATENT DOCUMENTS					
Examiner's Initials	**Cite No.**	**Foreign Patent Document (Country Code – Number – Kind)**	**Publication Date MM-DD-YYYY**	**Patentee or Applicant of Cited Document**	**Translation Y/N**

NON-PATENT LITERATURE DOCUMENTS		
Examiner's Initials	**Cite No.**	**Include name of the author (in CAPITAL LETTERS), title of the article, title of the item, date, page(s), volume-issue number(s), publisher, city/country where published**
/M.S./	Ex. 1006	IFTEKHAR HUSSAIN, "Fault-tolerant IP and MPLS Networks" (1st ed. 2004)

Examiner Signature	/MARK SAGER/	Date Considered	03/31/2021

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/014,701	03/12/2021	8130775	43614.399	4147

27367 7590 03/22/2021
WESTMAN CHAMPLIN & KOEHLER, P.A.
121 South Eighth Street
Suite 1100
Minneapolis, MN 55402

EXAMINER	
SAGER, MARK ALAN	

ART UNIT	PAPER NUMBER
3992	

MAIL DATE	DELIVERY MODE
03/22/2021	PAPER

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

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

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(THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS)

HAYNES AND BOONE, LLP
IP SECTION
2323 VICTORY AVENUE
SUITE 700
DALLAS, TX 75219

EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO. *90/014,701* .

PATENT UNDER REEXAMINATION *8130775* .

ART UNIT *3992* .

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified *ex parte* reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the *ex parte* reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Ex Parte Reexamination Interview Summary – Pilot Program for Waiver of Patent Owner's Statement	Control No. 90/014,701	Patent Under Reexamination is Requested 8130775	
	Examiner MARK SAGER	Art Unit 3992	AIA (FITF) Status No

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

All participants (USPTO official and patent owner):

(1) SHANETTE BROWN (3) _____

(2) _____ (4) _____

Date of Telephonic Interview: 18 March 2021.

A. The USPTO official requested waiver of the patent owner's statement pursuant to the pilot program for waiver of patent owner's statement in *ex parte* reexamination proceedings.*

☐ The patent owner **agreed** to waive its right to file a patent owner's statement under 35 U.S.C. 304 in the event reexamination is ordered for the above-identified patent.

☐ The patent owner **did not agree** to waive its right to file a patent owner's statement under 35 U.S.C. 304 at this time.

☑ USPTO personnel were unable to reach the patent owner.**

B. The Patent Owner of record telephoned the Office and indicated they would like to participate in the pilot program for waiver of patent owner's statement in *ex parte* reexamination proceedings.*

☐ The Patent owner of record telephoned the Office and **agreed** to waive its right to file a patent owner's statement under 35 U.S.C. 304 in the event reexamination is ordered for the above-identified patent.

The patent owner is not required to file a written statement of this telephone communication under 37 CFR 1.560(b) or otherwise. However, any disagreement as to this interview summary must be brought to the immediate attention of the USPTO, and no later than one month from the mailing date of this interview summary. Extensions of time are governed by 37 CFR 1.550(c).

*For more information regarding this pilot program, see *Pilot Program for Waiver of Patent Owner's Statement in Ex Parte Reexamination Proceedings, 75 Fed. Reg.* 47269 (August 5, 2010), available on the USPTO Web site at http://www.uspto.gov/patents/law/notices/2010.jsp.

**The patent owner may contact the USPTO personnel at (571) 272-7705 or at the telephone number provided below if the patent owner decides to waive the right to file a patent owner's statement under 35 U.S.C. 304.

/SHANETTE BROWN/ (571)272-6632
Signature and telephone number of the USPTO official, who contacted, was contacted by, or attempted to contact the patent owner.

cc: Requester (if third party requester)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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REEXAM CONTROL NUMBER	FILING OR 371 (c) DATE	PATENT NUMBER
90/014,701	03/12/2021	8130775

CONFIRMATION NO. 4147

REEXAM ASSIGNMENT NOTICE

27367
WESTMAN CHAMPLIN & KOEHLER, P.A.
121 South Eighth Street
Suite 1100
Minneapolis, MN 55402

OC000000124115666

Date Mailed: 03/16/2021

NOTICE OF ASSIGNMENT OF REEXAMINATION REQUEST

The above-identified request for reexamination has been assigned to Art Unit 3992. All future correspondence to the proceeding should be identified by the control number listed above and directed to the assigned Art Unit.

A copy of this Notice is being sent to the latest attorney or agent of record in the patent file or to all owners of record. (See 37 CFR 1.33(c)). If the addressee is not, or does not represent, the current owner, he or she is required to forward all communications regarding this proceeding to the current owner(s). An attorney or agent receiving this communication who does not represent the current owner(s) may wish to seek to withdraw pursuant to 37 CFR 1.36 in order to avoid receiving future communications. If the address of the current owner(s) is unknown, this communication should be returned within the request to withdraw pursuant to Section 1.36.

NOTICE OF USPTO EX PARTE REEXAMINATION PATENT OWNER STATEMENT WAIVER PROGRAM

The USPTO has implemented a pilot program where, after a reexamination proceeding has been granted a filing date and before the examiner begins his or her review, the patent owner may orally waive the right to file a patent owner's statement. See *"Pilot Program for Waiver of Patent Owner's Statement in Ex Parte Reexamination Proceedings,"* 75 FR 47269 (August 5, 2010). One goal of the pilot program is to reduce the pendency of reexamination proceedings and improve the efficiency of the reexamination process.

Ordinarily when ex parte reexamination is ordered, the USPTO must wait until after the receipt of the patent owner's statement and the third party requester's reply, or after the expiration of the time period for filing the statement and reply (a period that can be as long as 5 to 6 months), before mailing a first determination of patentability. The USPTO's first determination of patentability is usually a first Office action on the merits or a Notice of Intent to Issue Reexamination Certificate (NIRC).

Under the pilot program, the patent owner's oral waiver allows the USPTO to act on the first determination of patentability immediately after determining that reexamination will be ordered, and in a suitable case issue the reexamination order and the first determination of patentability (which could be a NIRC if the claims under reexamination are confirmed) at the same time.

Benefits to the Patent Owner for participating in this pilot program include reduction in pendency.

To participate in this pilot program, Patent Owners may contact the USPTO's Central Reexamination Unit (CRU) at 571-272-7705. The USPTO will make the oral waiver of record in the reexamination file in an interview summary and a copy will be mailed to the patent owner and any third party requester.

cc: Third Party Requester(if any)
HAYNES AND BOONE, LLP (GENERAL)
IP SECTION
2323 VICTORY AVENUE SUITE 700
DALLAS, TX 75219

/pflewis/

Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900

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BIB DATA SHEET

CONFIRMATION NO. 4147

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
90/014,701	03/12/2021	370	3992	43614.399

APPLICANTS

INVENTORS

8130775, Residence Not Provided;
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THEODORNE M. FOSTER , HAYNES AND BOONE, LLP (3RD PTY. REQ.), DALLAS, TX;
HAYNES AND BOONE, LLP (GENERAL), DALLAS, TX

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

This application is a REX of 12/528,083 11/25/2009 PAT 8130775 *
which is a 371 of PCT/FR08/50324 02/26/2008
(*)Data provided by applicant is not consistent with PTO records.

**** FOREIGN APPLICATIONS ***************************

FRANCE 0753489 02/26/2007

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

Foreign Priority claimed ❑ Yes ❑ No 35 USC 119(a-d) conditions met ❑ Yes ❑ No Verified and Acknowledged _____ Examiner's Signature	❑ Met after Allowance _____ Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
				9	6

ADDRESS

WESTMAN CHAMPLIN & KOEHLER, P.A.
121 South Eighth Street
Suite 1100
Minneapolis, MN 55402
UNITED STATES

TITLE

Mechanism For Protecting a Pseudo-wire

FILING FEE RECEIVED		
12600	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other _____ ❑ Credit

Patent Assignment Abstract of Title

Total Assignments: 9

Application #: 12528083 **Filing Dt:** 11/25/2009 **Patent #:** 8130775 **Issue Dt:** 03/06/2012
PCT #: NONE **Intl Reg #:** **Publication #:** US20100098094 **Pub Dt:** 04/22/2010
Inventors: Frederic Jounay, Philippe Niger, Arnaud Cauvin
Title: MECHANISM FOR PROTECTING A PSEUDO-WIRE

Assignment: 1

Reel/Frame: 023572 / 0632 **Received:** 11/25/2009 **Recorded:** 11/25/2009 **Mailed:** 11/25/2009 **Pages:** 3
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).
Assignors: JOUNAY, FREDERIC **Exec Dt:** 09/03/2009
NIGER, PHILIPPE **Exec Dt:** 08/25/2009
CAUVIN, ARNAUD **Exec Dt:** 10/04/2009
Assignee: FRANCE TELECOM
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PARIS, FRANCE 75015
Correspondent: DAVID D. BRUSH
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SUITE 1400
MINNEAPOLIS, MN 55402

Assignment: 2

Reel/Frame: 044625 / 0361 **Received:** 12/08/2017 **Recorded:** 12/08/2017 **Mailed:** 01/17/2018 **Pages:** 10
Conveyance: CHANGE OF NAME (SEE DOCUMENT FOR DETAILS).
Assignor: FRANCE TELECOM **Exec Dt:** 07/02/2013
Assignee: ORANGE
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PARIS, FRANCE 75015
Correspondent: DANIEL W JUFFERNBRUCH
PATENTS AND LICENSING LLC
28 BARRINGTON BOURNE
BARRINGTON, IL 60010-9605

Assignment: 3

Reel/Frame: 044625 / 0315 **Received:** 12/08/2017 **Recorded:** 12/08/2017 **Mailed:** 01/17/2018 **Pages:** 39
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).
Assignor: ORANGE **Exec Dt:** 09/21/2017
Assignee: TRANSPACIFIC IP GROUP LIMITED
PO BOX 10008
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Correspondent: DANIEL W JUFFERNBRUCH
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BARRINGTON, IL 60010-9605

Assignment: 4

Reel/Frame: 051192 / 0596 **Received:** 12/04/2019 **Recorded:** 12/04/2019 **Mailed:** 12/06/2019 **Pages:** 34
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).
Assignor: TRANSPACIFIC IP GROUP LIMITED **Exec Dt:** 03/29/2019
Assignee: ACACIA RESEARCH GROUP LLC
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Assignment: 5

Reel/Frame: 051238 / 0718 **Received:** 12/10/2019 **Recorded:** 12/10/2019 **Mailed:** 12/12/2019 **Pages:** 34

Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

Assignor: ACACIA RESEARCH GROUP LLC **Exec Dt:** 11/18/2019

Assignee: MONARCH NETWORKING SOLUTIONS LLC
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Assignment: 6

Reel/Frame: 052853 / 0153 **Received:** 06/05/2020 **Recorded:** 06/05/2020 **Mailed:** 06/08/2020 **Pages:** 252

Conveyance: PATENT SECURITY AGREEMENT

Assignors: ACACIA RESEARCH GROUP LLC **Exec Dt:** 06/04/2020
AMERICAN VEHICULAR SCIENCES LLC **Exec Dt:** 06/04/2020
BONUTTI SKELETAL INNOVATIONS LLC **Exec Dt:** 06/04/2020
CELLULAR COMMUNICATIONS EQUIPMENT LLC **Exec Dt:** 06/04/2020
INNOVATIVE DISPLAY TECHNOLOGIES LLC **Exec Dt:** 06/04/2020
LIFEPORT SCIENCES LLC **Exec Dt:** 06/04/2020
LIMESTONE MEMORY SYSTEMS LLC **Exec Dt:** 06/04/2020
MERTON ACQUISITION HOLDCO LLC **Exec Dt:** 06/04/2020
MOBILE ENHANCEMENT SOLUTIONS LLC **Exec Dt:** 06/04/2020
MONARCH NETWORKING SOLUTIONS LLC **Exec Dt:** 06/04/2020
NEXUS DISPLAY TECHNOLOGIES LLC **Exec Dt:** 06/04/2020
PARTHENON UNIFIED MEMORY ARCHITECTURE LLC **Exec Dt:** 06/04/2020
R2 SOLUTIONS LLC **Exec Dt:** 06/04/2020
SAINT LAWRENCE COMMUNICATIONS LLC **Exec Dt:** 06/04/2020
STINGRAY IP SOLUTIONS LLC **Exec Dt:** 06/04/2020
SUPER INTERCONNECT TECHNOLOGIES LLC **Exec Dt:** 06/04/2020
TELECONFERENCE SYSTEMS LLC **Exec Dt:** 06/04/2020
UNIFICATION TECHNOLOGIES LLC **Exec Dt:** 06/04/2020

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Assignment: 7

Reel/Frame: 055100 / 0624 **Received:** 01/25/2021 **Recorded:** 01/25/2021 **Mailed:** 02/02/2021 **Pages:** 173

Conveyance: CORRECTIVE ASSIGNMENT TO CORRECT THE ASSIGNOR NAME PREVIOUSLY RECORDED ON REEL 052853 FRAME 0153. ASSIGNOR(S) HEREBY CONFIRMS THE SECURITY INTEREST GRANTED PURSUANT TO THE PATENT SECURITY AGREEMENT PREVIOUSLY RECORDED.

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Conveyance: RELEASE OF SECURITY INTEREST IN PATENTS

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Search Results as of: 03/15/2021 02:51 PM

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HAYNES AND BOONE, LLP (GENERAL)
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NOTICE OF REEXAMINATION REQUEST FILING DATE

(Third Party Requester)

Requester is hereby notified that the filing date of the request for reexamination is 03/12/2021, the date that the filing requirements of 37 CFR § 1.510 were received.

A decision on the request for reexamination will be mailed within three months from the filing date of the request for reexamination. (See 37 CFR 1.515(a)).

A copy of the Notice is being sent to the person identified by the requester as the patent owner. Further patent owner correspondence will be the latest attorney or agent of record in the patent file. (See 37 CFR 1.33). Any paper filed should include a reference to the present request for reexamination (by Reexamination Control Number).

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Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900

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To: EXAMINER	**From: Shanette Brown**
Location: CRU	**Location: CRU 3999 / REM 4C75**
Art Unit: 3999	**Phone: (571) 272-6632**
Date: 03/14/2021	**E-mail: Shanett.brown@uspto.gov**

Search Notes

U.S. Patent No. 8,130,775

1. Performed a KeyCite Search in Westlaw, which retrieves all history on the patent including any litigation.
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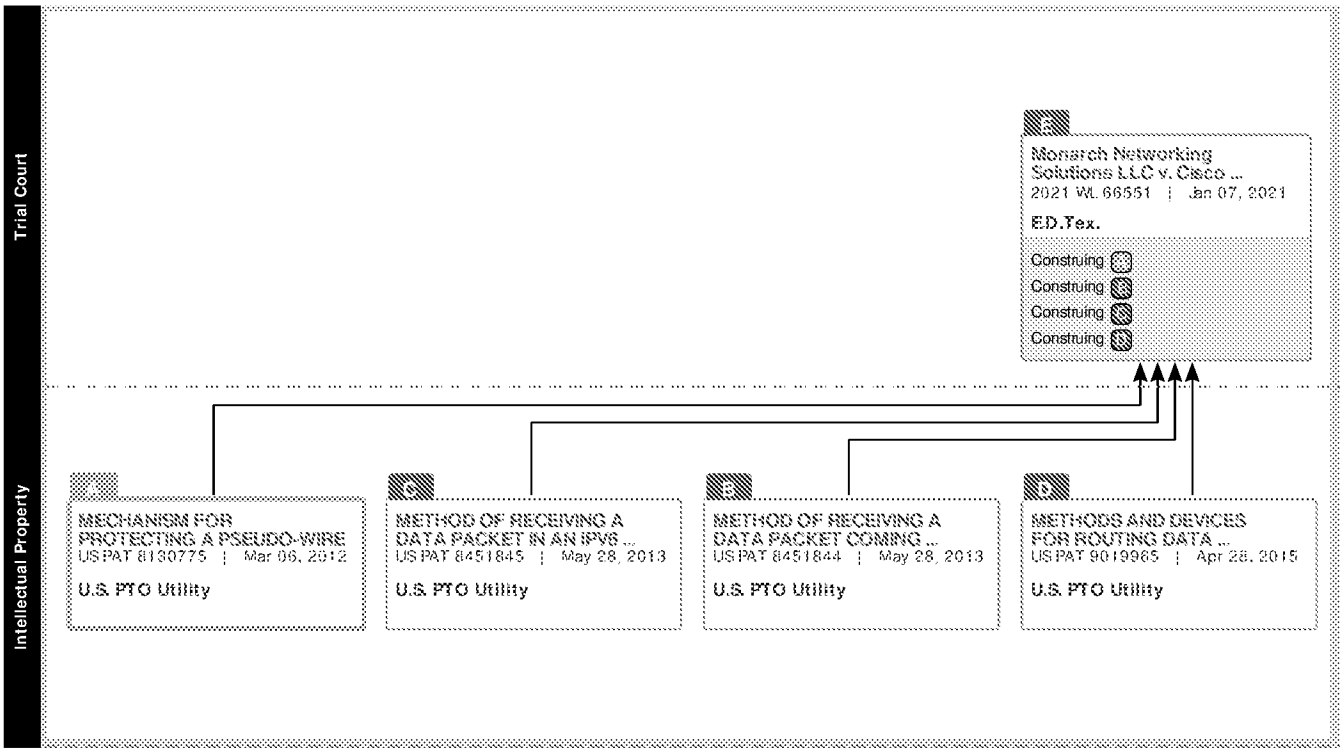

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History (9)

Direct History (8)

1. MECHANISM FOR PROTECTING A PSEUDO-WIRE Out Of Plan
US PAT 8130775 , U.S. PTO Utility , Mar. 06, 2012

Construed by

2. Monarch Networking Solutions LLC v. Cisco Systems, Inc.
2021 WL 66551 , E.D.Tex. , Jan. 07, 2021

3. METHOD OF RECEIVING A DATA PACKET COMING FROM AN IPV4 DOMAIN IN AN IPV6 DOMAIN, AN ASSOCIATED DEVICE, AND ASSOCIATED ACCESS EQUIPMENT Out Of Plan
US PAT 8451844 , U.S. PTO Utility , May 28, 2013

Construed by

4. Monarch Networking Solutions LLC v. Cisco Systems, Inc.
2021 WL 66551 , E.D.Tex. , Jan. 07, 2021

5. METHOD OF RECEIVING A DATA PACKET IN AN IPV6 DOMAIN, AN ASSOCIATED DEVICE AND AN ASSOCIATED HOME GATEWAY Out Of Plan
US PAT 8451845 , U.S. PTO Utility , May 28, 2013

Construed by

6. Monarch Networking Solutions LLC v. Cisco Systems, Inc.
2021 WL 66551 , E.D.Tex. , Jan. 07, 2021

7. METHODS AND DEVICES FOR ROUTING DATA PACKETS BETWEEN IPV4 AND IPV6 NETWORKS Out Of Plan
US PAT 9019965 , U.S. PTO Utility , Apr. 28, 2015

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8. Monarch Networking Solutions LLC v. Cisco Systems, Inc.
2021 WL 66551 , E.D.Tex. , Jan. 07, 2021

Related References (1)

9. Monarch Networking Solutions LLC v. Cisco Systems, Inc.
2020 WL 6749928 , E.D.Tex. , May 22, 2020

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US8130775B2 - Mechanism for protecting a pseudo-wire

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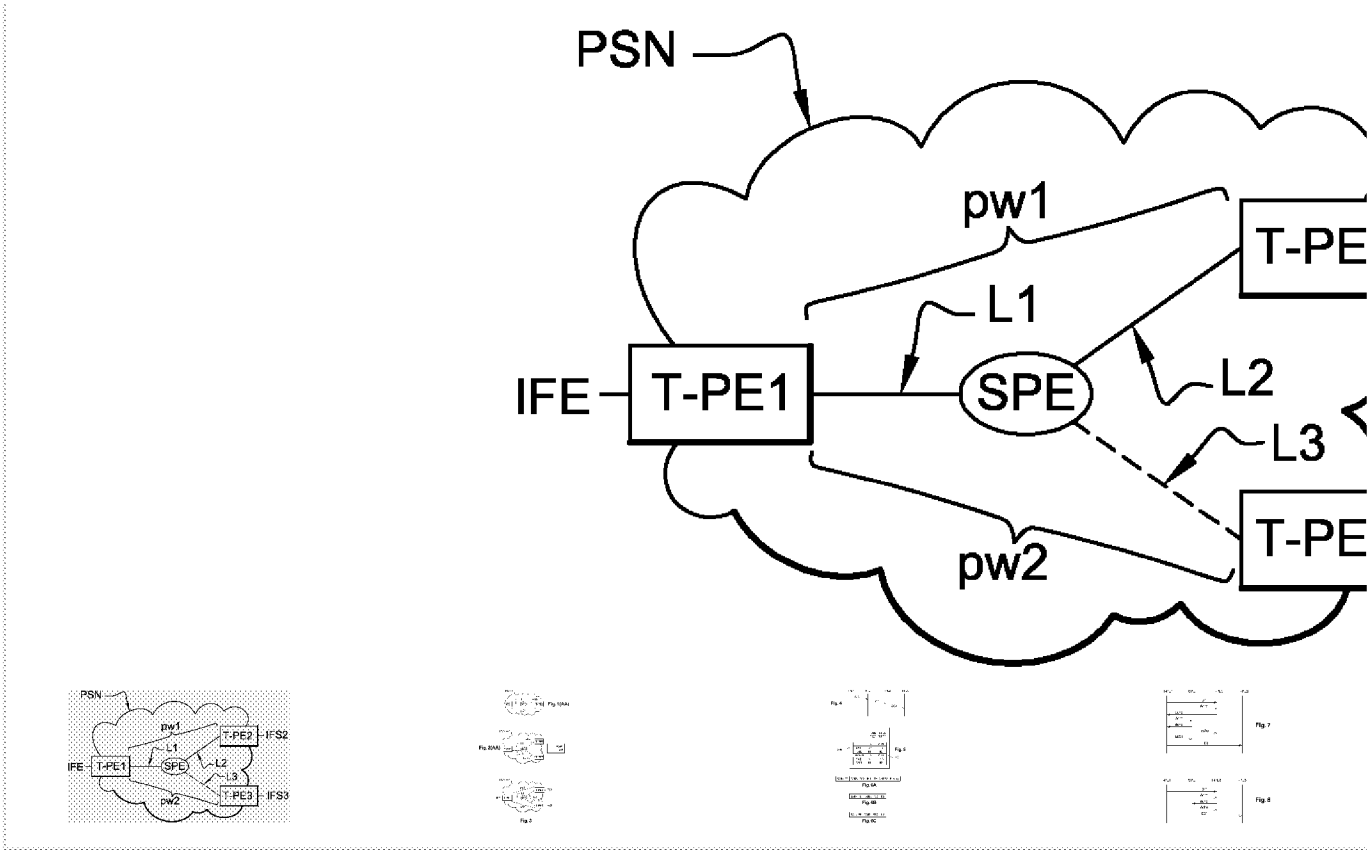

Abstract

A method is provided for setting up at least two pseudo-wires able to broadcast a stream of data, wherein a packet-switched network and first output router of the packet-switched network, and a second pseudo-wire router of the packet-switched network. A first link of the first pseudo-wire is set up between the first output switched network. A second link of the second pseudo-wire is set up between the second output router and wires is set up between the intermediate router and the input router.

Original

Claims

1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising: setting up between an input router of a packet-switched network and an intermediate router of the packet-switched network intermediate router and a first output router of the packet-switched network; and setting up a second pseudo output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and and said second output router, said first link being shared by the first and second pseudo-wires.

2. The method according to claim 1 , wherein the steps of setting up the first and second pseudo-wires are sending said intermediate router a message for setting-up said third link including an identifier of said input field containing an identifier of said second output router and a parameter specifying that the second pseudo

3. A method of broadcasting a data streams over a first pseudo-wire comprising a first link set up between intermediate router of said packet-switched network and a second link set up between said intermediate router network, said method comprising: a step of detecting a fault affecting the first output router; and on recept

router, a step of switching the data stream to a second pseudo-wire comprising said first link and a third lin second output router of said packet-switched network, said first link being shared by the first and second p

4. An intermediate router configured to be connected by a first link to an input router of a packet-switched said packet-switched network, said first and second links constituting a first pseudo-wire able to broadcast means for receiving a first message for setting up the first link including an identifier of said input router, a containing an identifier of a second output router of said network; means for sending a second message fo intermediate router and said first output router and a third message for setting up a third link between saic the second message including the identifier of said input router and the identifier of said first output route input router and the identifier of said second output router, and said first and third links constituting a secc switching table for said broadcasting with a parameter specifying that the second pseudo-wire is a back-up first set-up message.

5. The intermediate router according to claim 4 , wherein the intermediate router includes means for detec for switching the stream of data from the second link to the third link.

6. A computer program product stored on a non-transitory computer-readable medium and comprising pr setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a c instructions for: setting up a first pseudo-wire comprising a first link set up between an input router of a pa the packet-switched network and a second link set up between said intermediate router and a first output r a second pseudo-wire between said input router and a second output router of the packet-switched netwo first link and a third link set up between said intermediate router and said second output router, said first li

7. A computer program product stored on a non-transitory computer-readable medium and comprising pr broadcasting a data streams over a first pseudo-wire when said program is executed by a computer, where between an input router of a packet-switched network and an intermediate router of said packet-switched intermediate router and a first output router of said packet-switched network, the program code instructio affecting the first output router; and on reception of information on a fault affecting said first output route comprising said first link and a third link set up between said intermediate router and a second output rout being shared by the first and second pseudo-wires.

8. A method comprising: generating a signal configured to be transmitted between an input router of a pac said packet-switched network, said signal carrying a message for setting up at least two pseudo-wires able being set up between said input router and a first output router of said packet-switched network, a second and a second output router of said packet-switched network, said set-up message including: an identifier o router; and a field containing an identifier of said second output router and a parameter specifying that the transmitting the signal between the input router of the packet-switched network and the intermediate rout

9. The method according to claim 8 , wherein the field further contains an identifier of said intermediate rou

Original

Families

This section contains all family relations of this particular document. For more information about the differe refer to the Manual (Glossary/Families).

(https://worldwide.espacenet.com/publicationDetails/inpadocPatentFamily?CC=US&NR=8130775B2&KC=I

Extended (6)	Complete (6)	Main (6)	Domestic (2)	Application number	Publication

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				12528083 US12528083	US20100098094A
			2007-02-26	08762160 EP08762160	EP2127270B1
				08762160 EP08762160	EP2127270A2
			2007-02-26	FR08050324 WOFR08050324	WO2008110735A
				FR08050324 WOFR08050324	WO2008110735A

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Application is a Section 371 National Stage Application of International Application No. PCT/FR2(2008/110735 on Sep. 18, 2008, not in English.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] None.

THE NAMES OF PARTIES TO A JOINT RESEARCH AGREEMENT

[0003] None.

FIELD OF THE DISCLOSURE

[0004] The field of the disclosure is telecommunications, and more particularly packet-switched networks.

BACKGROUND OF THE DISCLOSURE

[0005] In a packet-switched network, data is transmitted in the form of packets processed by routers of the the packets for transmission constitute a data stream.

[0006] One example of a technology used for routing data packets in packet-switched networks is the multi technology adds one or more labels to the data packet headers, said labels containing information enablinç for a packet to reach its destination. The MPLS technology is described in more detail in Internet Engineerir

[0007] However, the MPLS protocol can process only packets conforming to the Internet Protocol (IP).

[0008] To alleviate this problem, the IETF Pseudo-Wire Emulation Edge-To-Edge (PWE3) standardization gro point-to-point link between two equipments of a packet-switched network based on the IP/MPLS technoloç 3985, enable data packets to be transmitted that do not conform to the Internet Protocol, for example data

[0009] Referring to FIG. 1, a pseudo-wire pw**1** is set up between a first router T-PE**1** at the edge of a packet-s at the edge of the network PSN. A first link L**1** that is part of the pseudo-wire pw**1** is set up between the first network PSN. A second link L**2** that is also part of the pseudo-wire pw**1** is set up between the intermediate r router T-PE**1** is called the input router and constitutes a first end of the pseudo-wire pw**1** and the second ro second end of the pseudo-wire pw**1**. Once the pseudo-wire pw**1** has been set up, the input router T-PE**1** trai to the output router T-PE**2**. This kind of pseudo-wire pw**1** is defined in more detail in the document "An Arcl Edge-to-Edge" (draft-ietf-pwe3-ms-pw-arch-02.txt).

[0010] To ensure continuity of service in the event of a fault affecting the output router, the working group pseudo-wire set up between the input router and the output router by a second pseudo-wire serving as a b affecting the output router constituting one end of the first pseudo-wire, the data packets are routed by the different output router.

[0011] Accordingly, referring to FIG. 2, a first pseudo-wire pw**1** is set up between an input router T-PE**1** at th output router T-PE**2** also at the edge of the network PSN. A first link L**1** that is part of the pseudo-wire pw**1** i intermediate router S-PE of the network PSN. A second link L**2** that is also part of the pseudo-wire pw**1** is se output router T-PE**2**. A second pseudo-wire pw**2** is then set up between the input router T-PE**1** constituting router T-PE**3** constituting a second end of the pseudo-wire. A first link L**3** that is part of the second pseudo-v intermediate router S-PE and a second link L**4** that is also part of the second pseudo-wire is set up between router T-PE**3**.

[0012] To ensure continuity of service, the input router T-PE**1** includes a function for detecting a fault affecti switching the data stream from the first pseudo-wire pw**1** to the second pseudo-wire pw**2**.

[0013] A fault affecting the first output router T-PE**2** is detected in the input router T-PE**1**, for example from the public switched network PSN to the input router T-PE**1**. Once informed of the fault, the input router T-PI pseudo-wire pw**1** to the second pseudo-wire pw**2**, thus routing the data to the output router T-PE**3**.

[0014] However, this kind of solution has the drawback of consuming network resources, for example proce capacity, computation capacity, etc.), signaling streams for setting-up two pseudo-wires, and bandwidth, es intermediate router. This increases the restore time in the event of a fault affecting an output router, with a

SUMMARY

[0015] The solution proposed in the context of an exemplary embodiment of the invention is free of those p

[0016] An embodiment is based on a method of setting up at least two pseudo-wires able to broadcast a da between an input router of a packet-switched network and a first output router of said packet-switched net input router and a second output router of said packet-switched network, a first link that is part of the first and an intermediate router of said packet-switched network, and a second link that is part of the second ps and said intermediate router.

[0017] This kind of setting up method is noteworthy in that a third link that is part of the two pseudo-wires i input router.

[0018] This optimizes the use of network resources, for example bandwidth, between the input router and t single link common to the two pseudo-wires. This solution has never been envisaged in the prior art. In the pseudo-wire are set up between an input router and a first, respectively a second, output router, a link is se router for each pseudo-wire, i.e. two links. The person skilled in the art has always considered a pseudo-wir router and an output router, with the result that each input router/output router pair is associated with a p recommended in the standards.

[0019] Going against this received wisdom of the person skilled in the art, the inventors of the present appl between the input router and the intermediate router, which improves the use of network resources and re the first output router. In the prior art, the back-up pseudo-wire, although used only to broadcast data in th

reserves resources used to set it up over the whole of the network between the input router and the output up pseudo-wire share the link set up between the input router and the intermediate router, the network re pseudo-wire are released and can be used in a manner closer to the optimum.

[0020] In this kind of embodiment, the first, second, and third links are not necessarily direct links between the intermediate router and the first output router can comprise one or more hops and possibly pass throu reaching the output router. The same applies to the link set up between the input router and the intermedi intermediate router and the second output router.

[0021] The data broadcast on the pseudo-wires can be payload data, for example an ATM stream transporti indicating detection of a fault affecting a network equipment. Accordingly, in the situation of exchanging se application makes the network equipments more responsive.

[0022] According to one feature of the method of an embodiment of the invention, the pseudo-wires are se said intermediate router a message for setting-up said third link including an identifier of said input router, containing an identifier of said second output router and a parameter specifying that the second pseudo-w

[0023] In this kind of embodiment, setting up the pseudo-wires is at the initiative of the input router. It is as invention, that in order to be able to initiate the setting up of the main and back-up pseudo-wires the input to reach the first and second output routers. By means of this information, the input router knows to which set-up message, which router is then considered the intermediate router. It is then necessary to configure maintenance. The parameter in the set-up message indicating that the second pseudo-wire is a back-up ps configured for subsequent broadcasting of data.

[0024] An embodiment of the invention also relates to a method of broadcasting data streams between an output router of said packet-switched network, wherein a data stream is broadcast on a first pseudo-wire c and an intermediate router of said packet-switched network and a second link set up between said interme including a step of detecting a fault affecting said first output router.

[0025] Moreover, a method of this kind includes a step, on reception by the intermediate router of informat a third link set up between said intermediate router and a second output router, said first link and said thir

[0026] An embodiment of this kind improves the restore time in the event of a fault affecting the first outpu as possible to the fault.

[0027] An embodiment of the invention further comprises a router adapted to be connected by a first link t a second link to a first output router of said packet-switched network, said first and second links constitutin the router being characterized in that it includes:

- means for receiving a first message for setting up the first link including an identifier of said in a field containing an identifier of a second output router of said network;
- means for sending a second message for setting up said second link between said router and s up a third link between said router and said second output router, the second message includi of said first output router, the third message including the identifier of said input router and th and third links constituting a second pseudo-wire;
- means for configuring at least one switching table for said broadcasting with a parameter spec pseudo-wire, said parameter being included in the first set-up message.

[0031] This kind of intermediate router is able, on reception of a set-up message sent by the input router, t between the input router and the output router and then its own link between the intermediate router and optimizes use of the resources of the network between the first router and the intermediate router, which i affecting the first output router.

[0032] According to another feature, the router of an embodiment of the invention includes means for dete means for switching the data stream from the second link to the third link.

[0033] Providing in the intermediate router a function for detecting a fault affecting the first output router a the restore time on detection of a fault affecting the first output router.

[0034] This improves the responsiveness of the network because detection occurs as close as possible to th router is detected more quickly, as the information does not have to cross the network as far as the input r switching the data stream also being a function of the intermediate router, switching the data stream to th and the second output router and with the first link constituting the back-up pseudo-wire, occurs faster be intermediate router.

[0035] This kind of solution reduces the quantity of data lost following a fault affecting the first output rout

[0036] An embodiment of the invention relates to a computer program product downloadable from a comn readable medium and/or executable by a processor, characterized in that it comprises program code instru embodiment of the invention when said program is executed by a computer.

[0037] An embodiment of the invention relates to a second computer program product downloadable from computer-readable medium and/or executable by a processor, characterized in that it comprises program method of an embodiment of the invention when said program is executed by a computer.

[0038] An embodiment of the invention relates finally to a signal adapted to be transmitted between an inp intermediate router of said packet-switched network, said signal carrying a message for setting up at least the first pseudo-wire being set up between said input router and a first output router of said packet-switch between said input router and a second output router of said packet-switched network, said set-up messag

- an identifier of said input router;
- an identifier of said first output router;
- a field containing an identifier of said second output router and a parameter specifying that th

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] Other features and advantages become apparent on reading the description of preferred embodim

[0043] FIG. 1 represents a pseudo-wire set up as in the prior art between an input router and an output rou

[0044] FIG. 2 represents a solution implemented in the prior art to ensure continuity of service in a packet-s

[0045] FIG. 3 represents two pseudo-wires set up by the method of an embodiment of the invention;

[0046] FIG. 4 is a timing diagram of the exchange of requests firstly between an input router and an interm secondly between the intermediate router and first and second output routers in order to set up pseudo-w

[0047] FIG. 5 represents diagrammatically routing and switching tables of an intermediate router of an emb

[0048] FIGS. 6A, **6**B, and **6**C represent set-up messages used in the setting-up method of an embodiment of

[0049] FIG. 7 is a timing diagram of the exchange of messages in a first embodiment of the invention firstly of a packet-switched network and secondly between the input router and first and second output routers w packet-switched network;

[0050] FIG. 8 is a timing diagram of the exchange of messages in a second embodiment of the invention firs router of a packet-switched network and secondly between the input router and first and second output ro in the packet-switched network;

[0051] FIG. 9 shows two pseudo-wires set up by a method conforming to a third embodiment of the inventi

[0052] FIG. 10 is a timing diagram of the exchange of requests firstly between a first edge router and intern secondly between the intermediate routers and second and third edge routers in order to set up pseudo-w embodiment of the invention;

[0053] FIGS. 11A, **11**B, **11**C represent set-up messages used in the method conforming to the third embodin

[0054] FIG. 12 is a timing diagram of the exchange of messages firstly between an edge router and an inter secondly between the intermediate router and second and third edge routers when broadcasting data on p accordance with the third embodiment of the invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0055] FIG. 3 represents a connection set up between an input router T-PE**1** and two output routers T-PE**2** a edge of a packet-switched network PSN.

[0056] Referring to this figure, a first link L**1** is set up between the input router T-PE**1** and an intermediate r up between the intermediate router S-PE and the first output router T-PE**2**. The first and second links consti between the input router T-PE**1** and the first output router T-PE**2**. The pseudo-wire pw**1** set up in this way is between the input router T-PE**1** and the first output router T-PE**2**.

[0057] A second pseudo-wire pw**2** is set up between the input router T-PE**1** and the second output router T- and a second link L**3** set up between the intermediate router S-PE and the second output router T-PE**3**.

[0058] Accordingly, the first link L**1** is shared by the two pseudo-wires pw**1** and pw**2**. This optimizes the use input router T-PE**1** and the intermediate router S-PE, as only one link is set up between these two routers.

[0059] One example of application of an embodiment of the invention is collecting traffic for a mobile netw connected to a first equipment such as a base station (not represented in the figures), for which it sends da network controller RNC connected to the output routers T-PE**2** and T-PE**3**.

[0060] FIG. 4 is a timing diagram of the exchange of messages between the input router T-PE**1**, the interme PE**3** when setting up the pseudo-wires pw**1** and pw**2**.

[0061] According to an embodiment of the invention, the pseudo-wires pw**1** and pw**2** are set up at the initia based on the exchange of set-up messages conforming to the label distribution protocol (LDP) as defined i a first set-up message SIG**1** is sent by the input router T-PE**1** to the intermediate router S-PE. This first set-u router T-PE**1**, an identifier of an input interface IFE associated with an equipment connected to the input ro an identifier of an output interface IFS**2** associated with an equipment connected to the first output router second output router T-PE**3**, an identifier of an output interface IFS**3** associated with an equipment connect parameter specifying that the second pseudo-wire is a back-up pseudo-wire. FIG. 6A shows one such settin

[0062] A forwarding equivalent class (FEC) consists of the pair {identifier SAII of input router T-PE**1**/associat router T-PE**2**/associated output interface IFS**2**}. This information is necessary for setting up a pseudo-wire. router T-PE**1**/associated input interface IFE and the identifier TAII**3**/associated output interface IFS of the fir

[0063] The first set-up message SIG**1** differs from a standard pseudo-wire set-up message because it includ second output router T-PE**3** and the "backup" parameter indicating the nature of the second pseudo-wire p

[0064] The set-up message SIG**1** also includes a label lb**11** associated with the first link L**1**. This label is used S-PE when broadcasting data streams. It is added by the input router T-PE**1** to each packet of data to be ser

[0065] Referring to FIG. 5, on reception of the first set-up message SIG**1**, the intermediate router S-PE extra identifier of the first output router T-PE**2**, and the information contained in the additional field of the messa router T-PE**3** and the "backup" parameter.

[0066] The intermediate router S-PE uses this information to fill in a switching table TC. This switching table label that must be inserted into the header of the message in order to perform the next hop and the outpu The "backup" parameter indicating the nature of the second pseudo-wire pw**2** is also entered into the swit

[0067] Once the switching table TC has been filled in, the intermediate router sends two set-up messages S first output router T-PE**2** and the set-up message SIG**3** is sent to the second output router T-PE**3**.

[0068] The message SIG**2** includes the identifier SAII of the input router T-PE**1**, the identifier of an input inte the input router, the identifier TAII**2** of the first output router T-PE**2**, the identifier of an output interfere IFS output router T-PE**2**, and the label lb**12** associated with the link L**2** and used when broadcasting data. FIG. 6

[0069] The message SIG**3** includes the identifier SAII of the input router T-PE**1**, the identifier of an input inte the input router, the identifier TAII**3** of the second output router T-PE**3**, the identifier of an output interface second output router T-PE**3**, and the label lb**13** associated with the link L**3** and used when broadcasting dat

[0070] Once the pseudo-wires pw**1** and pw**2** have been set up, data streams are broadcast between the inp

[0071] On reception of a data packet sent by the input router T-PE**1**, the intermediate router S-PE uses the l determine to which output interface if**2**, if**3** to direct the data packet, as a function of the information conta first output router T-PE**2** are directed to the interface if**2** of the intermediate router S-PE. This interface if**2** c packet is sent to the first output router T-PE**2**, the new label **1***b***2** is added to the packet.

[0072] FIG. 7 represents a timing diagram of the exchange of messages between the input router T-PE**1**, the PE**2**, and the second output router T-PE**3** when broadcasting data streams in a first embodiment of the inve

[0073] A data stream D**1** is sent by the input router T-PE**1** to the first output router T-PE**2**. This first data stre first pseudo-wire pw**1**.

[0074] To ensure continuity of service, the input router T-PE**1** includes a function for detecting a fault affecti kind of fault, the input router T-PE**1** regularly exchanges “echo” messages with the first output router T-PE**2**

[0075] If the input router does not receive a response to an “echo” message, it deduces that the first outpu

[0076] If the faulty router is the first output router T-PE**1**, it then sends the intermediate router S-PE a switc intermediate router S-PE switches the data streams to the link L**3**.

[0077] A data stream D**2** sent by the input router T-PE**1** following detection of a fault affecting the first outp pseudo-wire pw**2** and received by the second output router T-PE**3**.

[0078] FIG. 8 is a timing diagram of the exchange of messages between the input router T-PE**1**, the interme second output router T-PE**3** when broadcasting data streams in a second embodiment of the invention.

[0079] A data stream D**1**' is sent by the input router T-PE**1** to the first output router T-PE**2**. This data stream wire pw**1**.

[0080] To ensure continuity of service, the intermediate router S-PE includes a function for detecting a fault detect such a fault, the intermediate router S-PE regularly exchanges “echo” messages with the first output

[0081] If the intermediate router does not receive a response to its “echo” message, it deduces that the firs data streams coming from the input router T-PE**1** to the link L**3** and advises the input router T-PE**1** of this.

[0082] Thus a data stream D**2**' sent by the input router T-PE**1** after detection of the fault affecting the first o wire pw**2** and received by the second output router T-PE**3**.

[0083] FIG. 9 represents a packet-switched communications network PNS comprising a plurality of edge rou intermediate routers S-PE**1** to S-PE**5**. In such a network, a connection is set up between an input router T-PE PE**3**, each of these three routers being at the edge of a packet-switched network PSN.

[0084] Referring to this figure, a first link L**10** is set up between the input router T-PE**1** and a first intermedia between the first intermediate router S-PE**1** and a second intermediate router S-PE**4**. A third link L**12** is set u the first output router T-PE**2**. The first connection **10**, the second connection **11**, and the third connection **12** main pseudo-wire, setting up a connection between the input router T-PE**1** and the first output router T-PE**2** broadcast data streams divided into packets between the input router T-PE**1** and the first output router T-P

[0085] A second pseudo-wire pw**4**, called the back-up pseudo-wire, is set up between the input router T-PE**1** pw**4** consists of the first link L**10**, the second link L**11**, and a third link L**13** set up between a third intermedia

[0086] Accordingly, the link L**10** and the link L**11** are shared by the two pseudo-wires pw**3** and pw**4**. This opti between the input router T-PE**1** and the second intermediate router S-PE**4**.

[0087] FIG. 10 represents a timing diagram for the exchange of messages between the input router T-PE**1**, t S-PE**4**, and S-PE**5**, and the first and second output routers T-PE**2** and T-PE**3** when setting up the pseudo-wire

[0088] According to an embodiment of the invention, the pseudo-wires pw**3** and pw**4** are set up at the initia relies on the exchange of LDP set-up messages. Thus a first set-up message SIG**10** is sent by the input route set-up message includes an identifier SAII of the input router T-PE**1**, an identifier of an input interface IFE a router, an identifier TAII**2** of the first output router T-PE**2**, an identifier of an output interface IFS**2** associate router T-PE**2**, and a field containing an identifier TAII**3** of the second output router T-PE**3**, an identifier of an connected to the second output router T-PE**3**, a "backup" parameter specifying that the second pseudo-wir intermediate router S-PE**4** handling switching from the first pseudo-wire pw**3** to the second pseudo-wire pv that is part of the pseudo-wire pw**3**. FIG. 11A represents one such-set up message SIG**10**.

[0089] The set-up message SIG**10** can contain a plurality of identifiers of output routers to be reached in the wire pw**3**. Such a message contains as many "backup" parameters as there are output routers to be reache be set up.

[0090] A set-up message SIG**10** can also contain an additional field containing an explicit list of intermediate wire pw**3** must be set up.

[0091] The set-up message SIG**10** also contains a label lb**110**. This label is used by the input router T-PE**1** an broadcasting data streams from the intermediate router S-PE**1** to the input router T-PE**1**. It is added by the be sent to the input router T-PE**1**

[0092] On reception of the first set-up message SIG**10**, the intermediate router S-PE**1** extracts the identifier output router T-PE**2**, and where appropriate the explicit list of intermediate routers between which the links

[0093] The first intermediate router S-PE**1** uses this information to fill out an intermediate table. This interm indicating the label that must be inserted into the header of the message in order to perform the next hop streams.

[0094] Once the switching table has been filled out, the first intermediate router sends a second set-up mes

[0095] The hop that the set-up message SIG**11** must perform to reach the second intermediate router S-PE4 in the switching table TC of the intermediate router S-PE**1**

[0096] The set-up message SIG**10** can optionally also contain this kind of additional field for each back-up p intermediate routers between which the links of the pseudo-wires are set up.

[0097] The message SIG**11** is identical to the message SIG**10**; the label lb**112** to be used when broadcasting messages.

[0098] The information relating to the back-up pseudo-wire pw**4**, such as the identifier of the intermediate r pw**3** to the back-up pseudo-wire pw**4**, is sent from one intermediate router to another until it reaches the ir

[0099] On reception of this set-up message SIG**11**, the intermediate router S-PE**4** extracts the identifier of th router T-PE**2**, and where appropriate the explicit list of intermediate routers between which the links of the parameter indicating the nature of the second pseudo-wire pw**4** is also entered into the switching table.

[0100] Once the switching table of the intermediate router S-PE**4** has been filled out, said router sends two router T-PE**2** and the third intermediate router S-PE**5**, respectively.

[0101] The message SIG**12** contains the identifier SA**11** of the input router T-PE**1**, the identifier of an input ir to the input router, the identifier TA**112** of the first output router T-PE**2**, the identifier of an output interface first output router T-PE**2**, and the label lb**112** to be associated with the link L**12** and used when broadcasting

[0102] The message SIG**13** contains the identifier SAII of the input router T-PE**1**, the identifier of an input int the input router, the identifier TAII**3**, the identifier of an output interface IFS**3** associated with an equipment label lb**113** associated with the link L**13** to be set up and used when broadcasting data. FIG. 11C shows such of intermediate routers between which the links of the second pseudo-wire pw**4** must be set up to connect router T-PE**3**.

[0103] Once the pseudo-wires pw**3** and pw**4** have been set up, the data streams are broadcast between the

[0104] On reception of a data packet sent by the input router T-PE**1**, the first intermediate router S-PE**1** uses determine to which output interface if**2**, if**3** to direct the data packet, as a function of the information contai first output router T-PE**2** are directed to the interface if**2** of the first intermediate router S-PE**1**. This interfac data packet is sent to the second intermediate router S-PE**4**, the new label lb**11** is added to the data packet.

[0105] FIG. 12 is a timing diagram of the exchange of messages between the input router T-PE**1**, the first int router S-PE**4**, the third intermediate router S-PE**5**, the first output router T-PE**2**, and the second output route

[0106] A data stream D**1** is sent by the input router T-PE**1** to the first output router T-PE**2**. This data stream i pseudo-wire pw**3**.

[0107] To ensure continuity of service, the intermediate router S-PE**4** includes a function for detecting a faul a fault, the intermediate router S-PE**4** regularly exchanges “echo” messages with the first output router T-P

[0108] If the input router does not receive a response to its “echo” message, it deduces that the first output streams coming from the input router T-PE**1** onto the link L**12** and advises the input router T-PE**1** of this.

[0109] Accordingly, a data stream D'**1** sent by the input router T-PE**1** following detection of the a fault affect the second pseudo-wire pw**4** and received by the second output router T-PE**3**.

[0110] An embodiment of the invention also protects the network from a fault affecting one of the links of t routers of the network PSN.

[0111] For example, when setting up the first pseudo-wire pw**3**, the set-up message SIG**10** contains, in addit back-up pseudo-wire pw**4**, such as the identifier TAII**3** of the second output router T-PE**3**, the “backup” para PE**4**, additional information necessary for setting up a third or back-up pseudo-wire pw**5** (represented in da

[0112] This information consists of the identifier TAII**3** of the second output router T-PE**3**, the identifier of ar connected to the second output router T-PE**3**, a “backup” parameter specifying that the third pseudo-wire p intermediate router S-PE**5** effecting switching from the first pseudo-wire pw**3** to the third pseudo-wire pw**5** the pseudo-wire pw**3** or the intermediate router S-PE**4**.

[0113] Accordingly, if the intermediate router S-PE**1** detects a fault affecting the link L**11** or the intermediate and switches the data stream to be broadcast to the third pseudo-wire pw**5**.

[0114] Finally, an embodiment of the invention further includes a computer program, notably a computer p adapted to implement an embodiment of the invention. This program can use any programming language code intermediate between source code and object code, such as a partially-compiled form, or any other de embodiment of the invention.

[0115] The information medium can be any entity or device capable of storing the program. For example, th for example a CD ROM or a micro-electronic circuit ROM, or magnetic storage means, for example a floppy

[0116] Moreover, the information medium can be a transmissible medium such as an electrical or optical si cable, by radio or by other means. The program of an embodiment of the invention can in particular be dov

[0117] Although the present disclosure has been described with reference to one or more examples, worke made in form and detail without departing from the scope of the disclosure and/or the appended claims.

Classifications

IPC	CPC	US Class	ECLA
H04L12/28	H04L45/10 H04L45/22	370/401 379/242 710/316	H04L45/22 H04L45/10

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Legal information

Legal status

Event	Date	Description
Granted	2012-03-06	GRANTED
Filed	2008-02-26	FILED

Ownership

Date from	Date to	Name	Standardized
2019-11-18		MONARCH NETWORKING SOLUTIONS LLC	MONARCH NETWORKING SOLUTIC
2019-03-29	2019-11-18	ACACIA RESEARCH GROUP LLC	ACACIA RESEARCH GROUP
2017-09-21	2019-03-29	TRANSPACIFIC IP GROUP LIMITED	TRANSPACIFIC IP GROUP
2013-07-02	2017-09-21	ORANGE	ORANGE
2009-09-03	2013-07-02	FRANCE TELECOM	FRANCE TELECOM
2007-02-26	2009-08-25	NIGER, PHILIPPE	NIGER PHILIPPE
2007-02-26	2009-09-03	JOUNAY, FREDERIC	JOUNAY FREDERIC
2007-02-26	2009-10-04	CAUVIN, ARNAUD	CAUVIN ARNAUD
2007-02-26	2013-07-02	FRANCE TELECOM	FRANCE TELECOM

Payment status

Date	Status	Event code	Description

2019-08-30	Fee paid	M1552	PAYMENT OF MAINTENANCE FEE, 8TH YEAR, LARGE ENTITY.
2015-08-27	Fee paid	M1551	PAYMENT OF MAINTENANCE FEE, 4TH YEAR, LARGE ENTITY.

Litigation

Date	Docket number	Comments
2020-07-06	IPR2020-01226	Cisco Systems, Inc. V. Monarch Networking Solutions LLC, Filed July 6, 202(

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Citations

Citation type	Publication number	Citation relevance	Citation origin	Publication date	Title
backward	US20070239891A1		Cited by the examiner	2007-10-11	Method and apparatus multipoint distribution
backward	US20080089227A1		Cited by the examiner	2008-04-17	Protecting multi-segme
backward	US20080175234A1		Cited by the examiner	2008-07-24	METHOD AND DEVICE I SWITCHING OF PSEUD(SWITCHING NETWORK
forward	US20110176411A1			2011-07-21	METHOD FOR PROTECT
forward	US8724451B2			2014-05-13	Method for protecting

☐	forward	US9160655B2	2015-10-13	Method, system, and d pseudo wire
☐	forward	US9391882B2	2016-07-12	Method, system, and d pseudo wire
☐	forward	US20160294690A1	2016-10-06	METHOD, SYSTEM, ANI ESTABLISHING PSEUDC
☐	forward	US9912586B2	2018-03-06	Method, system, and d pseudo wire
☐	forward	US20120281702A1	2012-11-08	METHOD, SYSTEM, ANI ESTABLISHING PSEUDC
☐	forward	US20150188809A1	2015-07-02	METHOD, SYSTEM, ANI ESTABLISHING PSEUDC
☐	forward	US10666459B1	2020-05-26	System and method to interoperability betwee service (VPLS) and ethe network (EVPN) with al
☐	forward	US10862743B2	2020-12-08	Systems and methods switch based on signal segment pseudowires

Non-patent literature

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International Search Report for corresponding International Application No. PCT/FR2008/050324, filed Fe

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... Securities NA 30,961 8,067,198 By RSP 244 63,577 Total (Equity) 31,205 **8,130,775** SECTION 8 CORPORATE BONDS Quarterly Trend 8.1 Short-Term Bonds Yield down ...

2.

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Juniper Exhibit 1008, page 250

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent of Frederic Jounay *et al.*	§	REQUEST FOR *EX PARTE*
	§	REEXAMINATION
U.S. Patent No. 8,130,775 B2	§	
	§	Attorney Docket No.: 43614.399
Filed: February 26, 2008	§	
	§	
Issued: March 6, 2012	§	Customer No.: 27683
	§	
Title: Mechanism for Protecting a Pseudo-Wire	§	Real Party in Interest:
	§	Cisco Systems, Inc.
	§	

REQUESTER'S POWER OF ATTORNEY
PURSUANT TO 37 CFR 1.510(f)

Pursuant to 37 CFR 1.510(f) Requester, **CISCO SYSTEMS, INC.**, hereby appoints the Practitioner(s) associated with **Customer Number 27683**, as its attorney(s) to prosecute and to transact all business in the United States Patent and Trademark Office in connection with the above-identified request for *Ex Parte* Reexamination. Please recognize the correspondence address (including any electronic mail address) associated with **Customer Number 27683** for the above-identified *Ex Parte* Reexamination proceeding number to be the address associated with the appointed counsel(s).

The undersigned is authorized to sign this Power of Attorney on behalf of the Requester.

Executed on 3-10-21.

CISCO SYSTEMS, INC.

By: _____

Printed Name: Bill Talley

Title: Sr. Cyber Counsel

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent of Frederic Jounay et al.	§	REQUEST FOR *EX PARTE* REEXAMINATION
U.S. Patent No. 8,130,775	§	
Filed: February 26, 2008	§	Attorney Docket No.: 43614.399
Issued: March 6, 2012	§	Customer No.: 27683
Title: MECHANISM FOR PROTECTING A PSEUDO-WIRE	§	Real Party in Interest: Cisco Systems, Inc.

REQUEST FOR EX PARTE REEXAMINATION UNDER 35 U.S.C. §§ 302-306

Mail Stop *Ex Parte* Reexam
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Pursuant to the provisions of 35 U.S.C. §§ 302-306, Theodore M. Foster ("Requester") hereby requests an *ex parte* reexamination of claims 1 and 6 ("Challenged Claims") of United States Patent No. 8,130,775 ("the '775 patent," Ex.1001) that issued on March 6, 2012, to Jounay et al., resulting from a national phase filing on November 25, 2009. This request is made on behalf of Cisco Systems, Inc. ("Cisco"), the real party in interest.

The Requester hereby asserts that claims 1 and 6 of the '775 patent are invalid over prior art references that were not previously before the Patent Office,

and that raise substantial new questions of patentability. Requester therefore requests that an order for reexamination be issued, and that the PTO reject and cancel all claims.

The '775 patent is the subject of litigation, namely *Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2-20-cv-00015 (E.D. Tex., filed Jan 21, 2020). *See* Ex.1017, Ex.1018. No final judgment has been entered in the case.

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III. DETAILED EXPLANATION OF THE PERTINENCE AND MANNER OF APPLYING THE PRIOR ART REFERENCES TO EVERY CLAIM FOR WHICH REEXAMINATION IS REQUESTED 24

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A. Proposed Rejection #1: Claims 1 and 6 are obvious under 35 U.S.C. § 103(a) over Aggarwal and Hussain 24

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I. CERTIFICATION REGARDING NO ESTOPPEL

In accordance with 37 C.F.R. § 1.510(b)(6), the Requester hereby certifies that the estoppel provisions of 35 U.S.C. § 315(e)(1) or 35 U.S.C. § 325(e)(1) do not prohibit the requester from filing this *ex parte* reexamination request. Cisco Systems, Inc. previously requested *inter partes* review of the '775 patent in IPR2020-01226, but the Patent Trial and Appeal Board exercised its discretion to deny institution based on the status of district court proceedings. *See* IPR2020-01226, Paper 11 at 3 (Mar. 4, 2021). No final written decision issued or will issue in that proceeding.

II. STATEMENT POINTING OUT SUBSTANTIAL NEW QUESTIONS OF PATENTABILITY

A. Summary

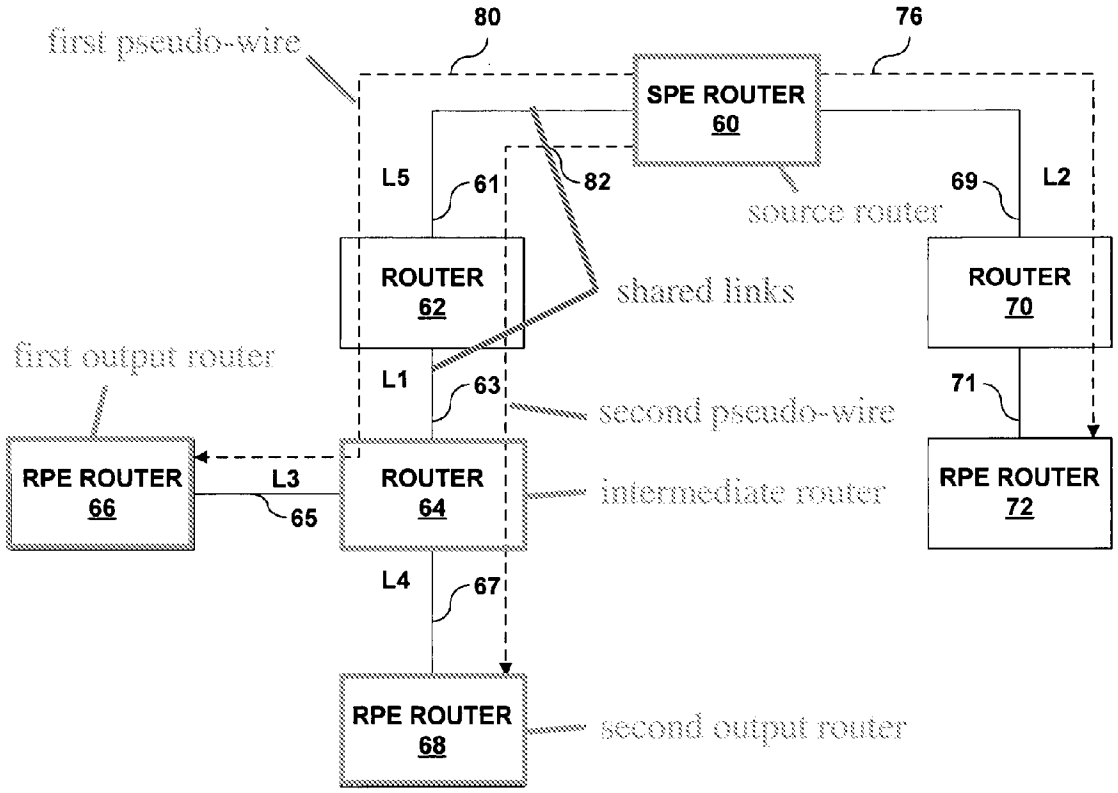
This Request presents a substantial new question of patentability for claims 1 and 6 of the '775 patent. This Request relies on references that have not been previously considered by the Office,[1] and which render obvious the challenged claims of the '775 patent.

The '775 patent describes, in part, communicating via two pseudo-wires that share a network link between a source router and an intermediate router. In prosecution, the Applicants argued that the use of a shared link distinguished the '775 claims over the cited prior art. *See* Ex.1002, 19, 38-40.

Newly presented U.S. Patent No. 7,602,702 to Aggarwal ("Aggarwal," Ex.1005) illustrates in Figure 5 the use of a shared link for two pseudo-wires.

[1] All of the prior art references relied upon in this request were submitted in IPR2020-01126, which was denied institution without an evaluation on the merits. *See* Ex.1024, 3.

Specifically, Figure 5 shows that pseudo-wires 80 and 82 share a common links 61 and 63. Aggarwal explains that it is desirable to "**share the same links where possible**." Ex.1005, 6:40-42. Aggarwal raises a substantial new question of patentability.



Ex.1005, Fig. 5, (annotated).

FAULT-TOLERANT IP AND MPLS NETWORKS by Iftekhar Hussain ("Hussain") similarly discloses that "[m]ultiple PWs [pseudo-wires] can be carried inside a single tunnel." Ex.1006, 276. With multiple pseudo-wires carried in a single tunnel, the multiple pseudo-wires would share a link between routers.

Neither Aggarwal nor Hussain were cited during prosecution of the '775 patent. *See generally* Ex.1002. As discussed further below, Aggarwal and Hussain each raise a substantial new question of patentability for claims 1 and 6.

As shown below and confirmed in the Declaration of Henry Houh (Ex.1003), the technology claimed in the '775 patent was not new. *See generally* Ex.1003. The references presented in this Request render obvious the Challenged Claims, which should be canceled for unpatentability.

B. Background on Multipath Label Switching (MPLS) technology

In the 1990s, engineers working at Cisco Systems, Inc. created tag switching as a technology to improve router performance. *See* Ex.1034; Ex.1035. Tag switching evolved and was subsequently standardized through the Internet Engineering Task Force under the name Multiprotocol Label Switching (MPLS). *See* Ex.1036. MPLS is used to engineer traffic patterns within IP networks. *See* Ex.1005, 1:31-34. In particular, MPLS allows a source device to request a specific path through a network. *See* Ex.1005, 34-37. Such path is referred to as a Label Switched Path (LSP). Ex.1003, ¶ 28; Ex.1005, 1:32-35.

LSPs may be established in a variety of manners. For example, an LSP may be implemented as a pseudo-wire. Ex.1006, 46, 274. A pseudo-wire defines the path through the MPLS network over which packets will flow. Ex.1006, 197, 274–75. Because IP packets are encapsulated at the input to the pseudo-wire and extracted at the output, they appear to "tunnel" through the MPLS network over the pseudo-wire. Tunnels are not limited to MPLS networks; traditional networks can perform tunneling by similarly encapsulating packets with headers that contain addressing information. Ex.1012, 757–58; Ex.1003, ¶¶ 29-30.

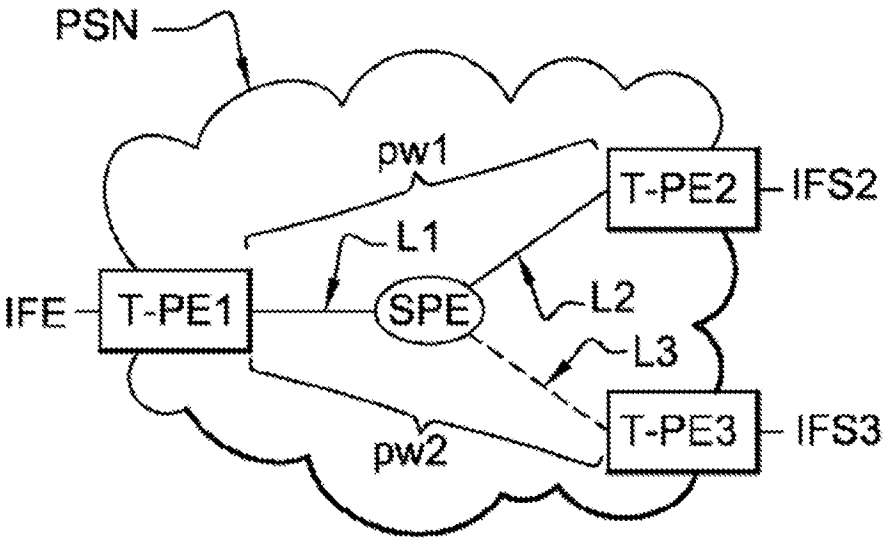
LSPs and pseudo-wires may be hierarchical. For example, it is possible to nest one tunnel within another. This is done by adding an additional layer of encapsulation. *See* Ex.1006, 255. Such encapsulation can be done through label stacking. *See* Ex.1005, 9:8-10:3. An LSP that is established within another LSP is referred to as a nested LSP. This allows multiple LSPs to be established through a

particular tunnel. Ex.1003, ¶ 31.

LSPs may also be point-to-point (P2P) or point-to-multipoint (P2MP). When an LSP has exactly one ingress and one egress, it is also known as a P2P LSP. Ex.1013, 485. When an LSP has exactly one ingress and multiple egresses, it is also known as a P2MP LSP. *Id.* For example, a multicast network allows for one computer to transmit to multiple computers simultaneously by sending only one stream—much like a television station transmits a single broadcast stream that any receiver can tune into—rather than sending a different P2P stream to each receiver. Such multicast packet transmissions are used by some IP-based cable television systems. Ex.1003, ¶¶ 32-33.

C. Overview of the '775 Patent

The '775 patent relates to packet-switched networking, and more specifically, to "a method of setting up at least two pseudo-wires able to broadcast a data stream." Ex.1001, 1:24-25 & 2:54-55. The '775 patent admits that the prior art included techniques for setting up two pseudo-wires within a network. *See, e.g.*, Ex.1001, 1:45-2:39 & Figs. 1-2. The purported advancement claimed in the '775 patent is for two pseudo-wires (pw1 and pw2) to share a common link (L1) between an input router (T-PE1) and an intermediate router (SPE). Ex.1001, 6:44-48, 2:65-67, 3:15-18. This concept is illustrated in Figure 3 below. Ex.1001, 5:45-57; Ex.1003, ¶¶ 43-44.



Ex.1001, Fig. 3

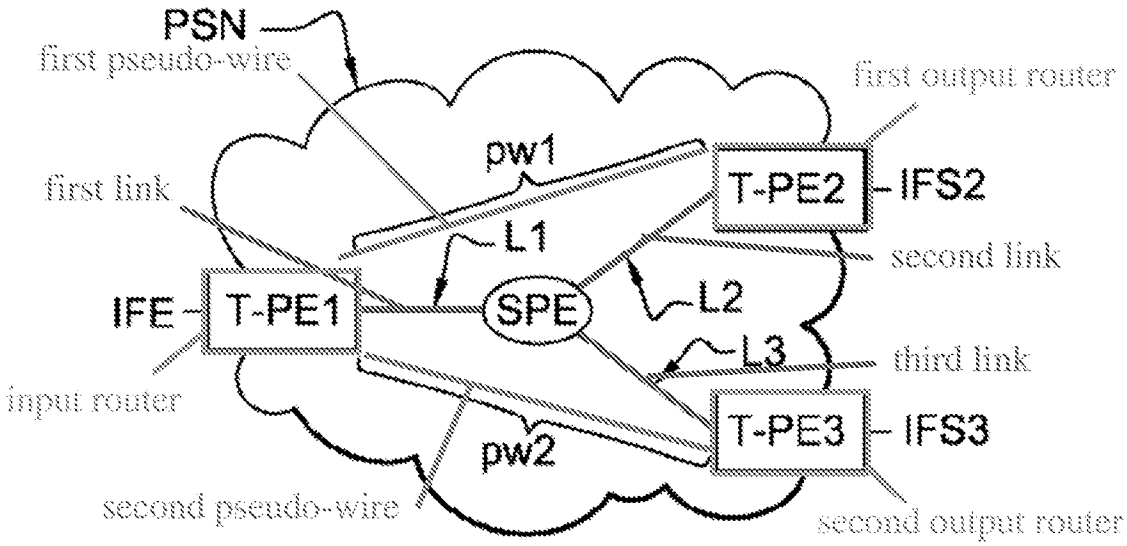
Aside from the shared link L1, the remainder of Figure 3 is identical to the admitted prior art technique shown in Figure 2. Ex.1003, ¶ 45.

Claim 1 is representative of the challenged subject matter:

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
>
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Ex.1001, 12:14-27.

Annotated Fig. 3 shows the elements of claim 1.



Ex.1001, Fig. 3 (annotated); Ex.1003, ¶¶ 46-47.

However, the concept of having pseudo-wires share links was already known to POSITAs, as will be shown in detail below. Ex.1003, ¶ 48.

D. Effective Priority Date of the '775 Patent

The '775 patent is based on a PCT application filed February 26, 2008 and claims priority to a patent application filed in France on February 26, 2007. The national phase filing of the '775 patent was on November 25, 2009. Determining whether the '775 patent is entitled to an earlier priority date is unnecessary in this proceeding, however, as all of the cited and relied-upon prior art predates February 2007. Accordingly, Requester has not undertaken a priority date analysis. Requester does not waive any right or opportunity it may have to dispute the priority date of the '775 patent in another forum where the issue is relevant.

E. Prosecution History and Reasons for Allowance of the '775 Patent

The '775 patent is based on PCT patent application No. PCT/FR08/50324 filed February 26, 2008 and claims priority to French patent application No. FR0753489 filed on February 26, 2007. The national phase filing of the '775 patent was on November 25, 2009.

1. International Phase

After the filing of PCT/FR08/50324, an international search was conducted on March 23, 2009 and the resulting international search report was published on May 14, 2009. The search report identified four IETF draft documents as references. The first reference is by P. Pan et al., entitled "Pseudo Wire Protection" ("Pan," Ex.1026), which was cited as an anticipatory reference for claims 1-7. *See* Ex.1002, 257. The second reference is by M. Bocci and S. Bryant, entitled "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge" ("Bocci," Ex.1027), which was cited as an anticipatory reference for claims 1, 2, 4, and 6. *See* Ex.1002, 258. The third reference is by E. Mannie and. Papadimitriou, entitled "Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS)" ("Mannie," Ex.1028), which is cited as defining the general state of the art for claims 1, 2, 4, and 6. *See* Ex.1002, 258. The fourth reference is by Luca Martini et al., entitled "Dynamic Placement of Multi Segment Pseudo Wires" ("Martini," Ex.1029), which is cited as defining the general state of the art for claims 1, 2, 4, and 6. *See* Ex.1002, 258. No search was conducted on claims 8 and 9 because they were found to contain non-patentable subject matter. *See* Ex.1002, 260.

The International Searching Authority ("ISA") also issued a written opinion (in French) analyzing the claims and discussing the prior art identified in the international search report. Ex.1002, 171-73. The ISA also issued an English translation of the written opinion. *See* Ex.1023. The Applicant submitted the original French version of the ISA's written opinion, but the '775 patent file history does not show that the Applicant ever filed the English translation with the Office. Ex.1002, 167-73. The written opinion found that claims 1-7 lacked an inventive step. Ex.1023, 6.

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The ISA identified Pan and Bocci as references. *Id.* The ISA determined that creating "multi-segment pseudo-links" was well known in the art. *Id.* The ISA referenced figures 4 and 5 of Bocci as showing sufficient "routers available to create 1, 2 or 3 pseudo-links sharing one or more segments." Ex.1023, 7. As a result, the ISA concluded that claim 1 covers "purely an engineering option," which "cannot be an inventive concept common with that of claim 3," resulting in a lack of unity. *Id.* The ISA also determined that the term "pseudo-link" lacks clarity. *Id.* The ISA further concluded that the subject matter of claim 1 "does not comprise any technical feature for solving" the problem experienced by "routers of pseudo-links in the case of a fault." *Id.*

The ISA determined that "PWs [pseudowires] are bidirectional" and concluded figure 4 of Pan may be reversed such that A is dual homed having A1 and A2 outputs, each having a link to B, and the link between B and C is shared. *See* Ex.1023, 8. The ISA concluded that selecting a "normal" path and a "backup" path is arbitrary. *Id.* The ISA also noted that Pan allows "fate sharing" for pseudo-wires, wherein a failure in the normal path would also be a failure in the backup path. *See id.* Thus, the ISA determined that claim 1 "lacks an inventive step" and "novelty." *Id.* The ISA cited Pan as teaching conventional protection techniques like "hot standby," where network failure results in routers switching to "pre established back up pseudo wires directly." *See* Ex.1023, 8-9. The ISA concluded that the subject matter of claims 5 and 7 similarly lack an inventive step. Ex.1023, 9. Finally, the ISA determined claims 2, 4, and 6 lack an inventive step based on Pan's disclosure that "the second pseudo-link is a backup pseudo-link." *Id.*

No opinion was provided for claims 8 and 9 because it was determined that they contained non-patentable subject matter by claiming a "signal." Ex.1023, 4.

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2. National Phase

On August 21, 2009, a preliminary amendment was filed. Ex.1002, 211. The preliminary amendment of claim 1 changed language from "consists of" to "comprises." Ex.1002, 214. The preliminary amendment removed claim 6's dependency on claim 2 and made claim 6 an independent claim reciting the material previously provided by the dependency on claim 2. Ex.1002, 214-16. The national phase filing of the '775 patent was on November 25, 2009. Ex.1002, 82.

The Office issued its first and only Office action in the '775 prosecution on June 17, 2011. The Examiner did not discuss any of the prior art from the international search report or the written opinion issued by the ISA (which, again, appears to have been provided to the Office solely in French). The Examiner rejected claim 1 as being anticipated by U.S. Patent Publication No. 2008/0175234 to Li. Ex.1002, 50. To establish that the first link is shared by the first and second pseudo-wires, the Examiner relied on Li's disclosure that the "PW in the working PWG [Pseudo Wire Group] and the protective PWG is a single-segment PW or a multi-segment PW." Ex.1002, 51. The Examiner rejected claim 6 as being anticipated by U.S. Patent Publication No. 2008/0089227 to Guichard et al. Ex.1002, 56. The Office action also includes U.S. Patent Publication No. 2007/023989 to Wainner et al. as prior art made of record but not relied upon. Ex.1002, 58-59. The Examiner also objected to claim 6 for reciting "the method comprising," when the claim is directed to a computer program product. Ex.1002, 47-48. The Examiner further rejected claim 6 under 35 U.S.C. 101 as being directed to a computer program product that doing not indicate "a non-transitory form." Ex.1002, 49-50.

In response to the Office action, the Applicant summarized an exemplary embodiment of the application, stating "[t]he present application teaches, for

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example, a method to setup at least two multi-segment pseudowires in a 'Y' shape, wherein one segment located between the input router and an intermediate router ('first link' in claim 1) is shared by first and second pseudowires." Ex.1002, 37. Without amending claim 1, the Applicant challenged the rejection over Li by arguing that "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire." Ex.1002, 38. The Applicant further stated that "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment." *Id.* The Applicant amended claim 6 to include "non-transitory" and replaced the method comprising language with "the program code instructions comprising instructions for." Ex.1002, 33-34, 36-37. The Applicant did not amend claim 6 in response to the rejection over Guichard. Ex.1002, 33-34. Instead, the Applicant argued that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Point]." Ex.1002, 39-40.

On December 30, 2011, the Examiner issued a notice of allowance, including an examiner's amendment that clarifies that the two pseudo-wires sharing the first link are the first and second pseudo-wires. Ex.1002, 14. The notice of allowance stated the reasons for allowance: "no prior art reference or combination of prior art reference disclose or suggest" "setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires." Ex.1002, 19. However, the concept of pseudo-wires sharing links was already known, as shown below.

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On July 6, 2020, Requester filed a petition for Inter Partes Review (IPR) of the '775 patent. Without addressing the prior art on the merits, the PTAB used its discretion to deny institution under 35 U.S.C. 314(a) due to the current state of the district court litigation. *See* Ex.1024.

F. Claim Construction

Requester notes that in the ongoing district court case (2-20-cv-00015, E.D. Tex.), the court has issued its claim construction order. *See* Ex.1025. In district court, claims are construed according to the "*Phillips* standard," as set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 83 Fed. Reg. 51340, 51341 (Oct. 11, 2018). This Request analyzes the claims according to their broadest reasonable interpretation in light of the specification. M.P.E.P. § 2258. The proposed constructions below are consistent with the constructions adopted by district court. Constructions are provided only to the extent necessary for this proceeding, that is, to show the unpatentability of the claims. *See Vivid Techs. v. Am. Science*, 200 F.3d 795, 803 (Fed. Cir. 1999) (construing terms "only to the extent necessary to resolve the controversy").

1. "link"

Claims 1 and 6 recite multiple "links." For example, claims 1 and 6 recite "a first link," "a second link," and "a third link."

Requester believes that for the purposes of the requested reexamination proceeding, the term "link" does not require formal construction, as it would generally be understood by those of skill in the art. And as discussed in the detailed prior art analysis below, the prior art cited and relied upon for the proposed rejections (Aggarwal, Ex.1005) uses the same term—"link"—to describe the network components that correspond to the claimed "links." Thus, no construction is necessary.

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During prosecution of the '775 patent, the Applicant argued that a link is a segment of a pseudowire. For example, in response to the only Office action, the Applicant stated that "[t]he present application teaches, for example, a method to setup at least two multi-segment pseudowires in a 'Y' shape, wherein one segment located between the input router and an intermediary router ('first link' in claim 1) is shared by first and second pseudowires." Ex.1002, 37. As another example, the Applicant stated in the response that "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment." *Id.* at 38.

The district court construed "link" to mean a "connection between an interface of a first router and an interface of a second router." *See* Ex.1025, 38. In IPR2020-1226, the Patent Owner argued that "link" should be construed to mean a "connection between an interface of a first router and an interface of a second router." Ex.1030, 17.[2] The Patent Owner also argued that "a shared path is not necessarily the same thing as a shared link, and the same two routers can support multiple links between them." Ex.1030, 20. None of these arguments or constructions is binding on the Patent Office, for at least the reason that the Office during a reexamination proceeding will apply the broadest reasonable interpretation to the claim language. M.P.E.P. § 2258 I.G. In contrast, the district court and IPR proceeding applied a *Phillips* construction standard. *See Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 83 Fed. Reg. 51340, 51341 (Oct. 11, 2018).

The district court construction of "link" is inconsistent with the broadest reasonable interpretation, as demonstrated by the Applicant's own arguments in

[2] Page numbers for Ex.1030 refer to the original pagination of the document.

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prosecution. For example, Applicants argued that a "link" is a segment of a pseudowire, making no mention of the interfaces recited in the district court's construction. Similarly, other contemporaneous documents addressing the identical technology explain that the "link" may refer either to a "physical medium" connecting two devices (akin to the district court's construction of connecting two interfaces) or to a "virtual" or "logical" link. Ex.1005, 1:22-31. To the extent that the Office determines that a formal construction of the term "link" is necessary in the requested reexamination proceeding, the Office should not adopt the district court's construction but should instead give the term its broadest reasonable interpretation.

G. Citation of Prior Art Patents and Printed Publications

In accordance with 37 C.F.R. § 1.510(b)(3), reexamination of claims 1 and 6 (the Challenged Claims) of the '775 patent is requested in view of the following references:

Ex.1005	U.S. Patent No. 7,602,702 to Aggarwal
Ex.1006	Iftekhar Hussain, "*Fault-tolerant IP and MPLS Networks*" (1st ed. 2004)

A detailed explanation of the pertinence and manner of applying the patents and printed publications to every claim for which reexamination is requested is set forth in Section III below.

H. Identification of Substantial New Questions of Patentability

In this request, substantial new questions (SNQs) of patentability are raised as set forth below. The detailed explanation will address the substantial new questions of patentability in a similar order.

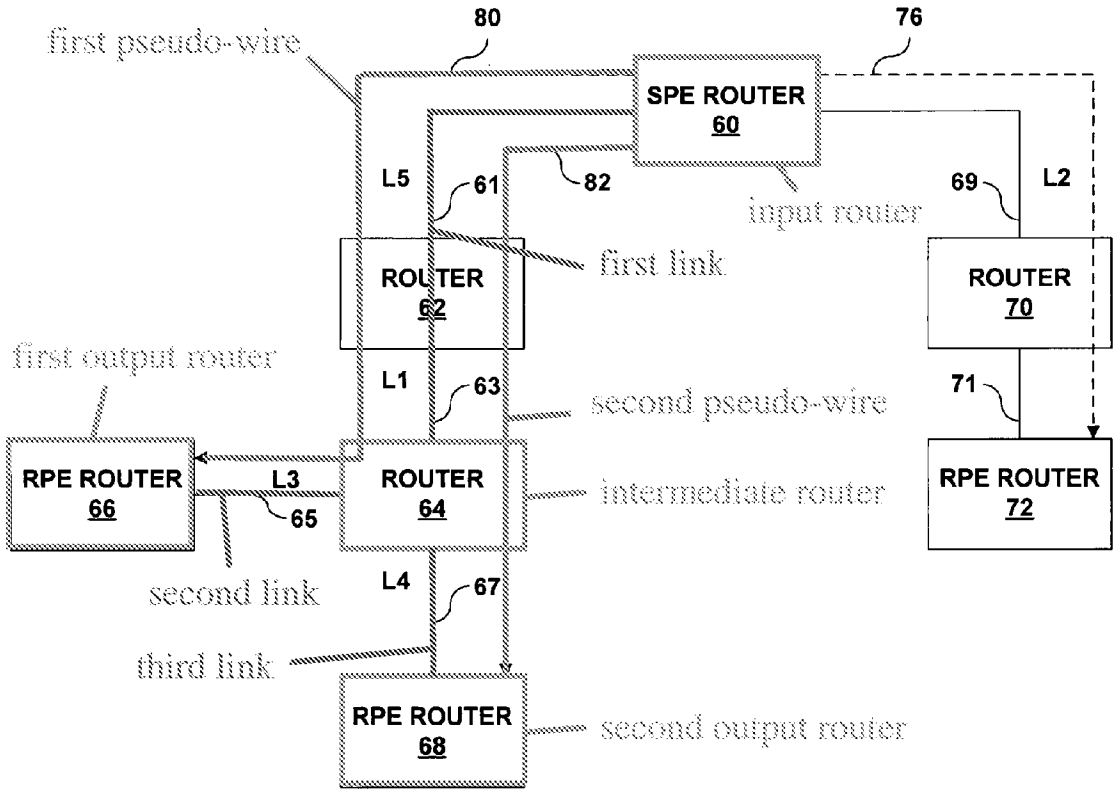
1. Aggarwal Presents a Substantial New Question of Patentability

U.S. Patent No. 7,602,702 to Aggarwal ("Aggarwal") was filed February 10, 2005. It issued and published on October 13, 2009. Ex.1005. Aggarwal is thus prior art to the '775 patent under 35 U.S.C. 102(e).

A substantial new question of patentability as to claims 1 and 6 is raised by Aggarwal. As mentioned above, the '775 patent claims recite in part, (1) a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network, and a second pseudo-wire between said input router and a second output router of the packet-switched network, (2) wherein the second pseudo-wire comprises said first link. For purposes of discussion, these will be referred to as the pseudo-wire limitation and the shared link limitation, respectively.

As mentioned above in Section II.D., the Patent Owner argued in prosecution that "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire," and "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment." Ex.1002, 38. The Patent Owner also argued in prosecution that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Points]." Ex.1002, 39-40.

In contrast to Li and Guichard, Aggarwal teaches that Label Switched Paths (LSPs) may share links. Ex.1005, 6:40-49. Aggarwal describes the claimed pseudo-wire limitation in that the Point-to-Multipoint (P2MP) Label Switched Path (LSP) includes branch LSPs. Ex.1005, 4:13-15. An example is illustrated in Fig. 5, shown below:



Ex.1005, Fig. 5, (annotated).

Fig. 5 illustrates how "SPE [source provider edge] router 12 establishes a P2MP LSP between SPE router 12 and RPE [receiver provider edge] routers 66, 68, and 72." Ex.1005, 6:31-32. To do this, the SPE router 60 establishes a branch LSP 80 between the SPE router 60 and a first RPE router 66. *See* Ex.1005, 6:44-47. LSP 80 includes links 61 and 63 between the SPE router and intermediate router 64, as well as link 65 between the intermediate router 64 and the first RPE router 66. Ex.1005, Fig. 5. Additionally, the SPE router 60 establishes a branch LSP 82 between the SPE router 60 and a second RPE router 68. *See* Ex.1005, 6:44-47. LSP 82 includes links 61 and 63 between the SPE router 60 and intermediate router 64, as well as link 67 between the intermediate router 64 and the second RPE router 68. Ex.1005, Fig. 5.

Aggarwal further describes the claimed shared link limitation in that the branch LSPs share links. Aggarwal's technique "merges individual branch LSPs to form a P2MP LSP." Ex.1005, 7:4-5. For example, Aggarwal's "branch LSPs are computed to **share the same links where possible** as they belong to the same session." Ex.1005, 6:40-42. In Aggarwal's Fig. 5, "Branch LSPs 80 and 82 **share links 63 and 61** between router 64 and SPE router 60." Ex.1005, 6:47-49. Aggarwal explains that "[t]he term 'link' is often used to refer to the connection between two devices on a network." Ex.1005, 1:22. The term includes "'virtual' or 'logical' links." Ex.1005, 1:25–27.

Aggarwal was never cited during prosecution nor considered by the Examiner. A reasonable Examiner would have found the teachings of Aggarwal important in determining whether claims 1 and 6 are patentable because Aggarwal discloses the shared-link feature that the applicants argued to distinguish other prior art during prosecution. A reasonable Examiner would consider Aggarwal important because Aggarwal describes a P2MP LSP arrangement in which two separate pseudowires share a link between two routers. For these reasons, the P2MP LSP in Aggarwal's Fig. 5 embodiment raises a substantial new question of patentability with respect to claims 1 and 6.

2. Hussain Presents a Substantial New Question of Patentability

FAULT-TOLERANT IP AND MPLS NETWORKS by Iftekhar Hussain ("**Hussain**") was published by Cisco Press in 2004 and is prior art under 35 U.S.C. § 102(b). As testified by Dr. Ingrid Hsieh-Yee (Ex.1014, ¶¶ 1-52), Hussain was made searchable by the Library of Congress since at least October 25, 2002 and was thus available to the public at that time. Ex.1014, ¶¶ 21-26. The copyright registration record (dated November 23, 2004) states the book published on

November 19, 2004. *Id.*, ¶¶ 27-29; *see* 17 U.S.C. § 410(c) (copyright registration is prima facie evidence of facts stated therein). Other libraries indicate the book was available before the priority date of the '775 patent. *Id.,* ¶¶ 30-43. Furthermore, Amazon.com shows at least three posted reviews of Hussain before May 1, 2005. *Id.,* ¶¶ 44-45. This indicates that the book was publicly available and viewed by interested persons. Hussain was also cited by other documents in 2005. *Id.,* ¶ 46. Hussain is thus prior art to the '775 patent under 35 U.S.C. § 102(b).

A substantial new question of patentability as to claims 1 and 6 is raised by Hussain. As mentioned above, the '775 patent claims recite in part, (1) a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network, and a second pseudo-wire between said input router and a second output router of the packet-switched network, (2) wherein the second pseudo-wire comprises said first link. For purposes of discussion, these will be referred to as the pseudo-wire limitation and the shared link limitation, respectively.

As mentioned above in Section II.D., the Patent Owner argued in prosecution that "Li does not teach a method wherein a first link is shared by the first pseudowire and the second pseudowire," and "[t]he fact that Li teaches a method by which working and protective pw can be single- or multi-segment (para. [0014], lines 1-2) is not an indication that any of them share a segment." Ex.1002, 38. The Patent Owner also argued in prosecution that Guichard does not teach "sharing a link" because "the choice of a backup path [] does not include a shared (and failed) PSP [Pseudowire Stitching Points]." Ex.1002, 39-40.

In contrast to Li and Guichard, Hussain teaches that "[m]ultiple PWs [pseudo-wires] can be carried inside a single tunnel." Ex.1006, 276. Hussain describes the claimed pseudo-wire limitation in that the point-to-point pseudo-

wires can be set up between provider edges. Hussain teaches how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). Ex.1006, 276–77. Hussain also teaches that pseudo-wires provide broadcast services. *See* Ex.1006, 273-77.

Hussain further describes the claimed shared link limitation in that the nested pseudo-wires can be carried in the same tunnel. Hussain explains that "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. In particular, Hussain describes nesting multiple pseudo-wires "inside a single tunnel." Ex.1006, 276.

Hussain was never cited during prosecution nor considered by the Examiner in any manner. A reasonable Examiner would have found the teachings of Hussain important to determine whether claims 1 and 6 are patentable because Hussain discloses the shared-link feature that the Applicant argued to distinguish other prior art during prosecution. A reasonable Examiner would consider Hussain important because Hussain describes nesting multiple pseudo-wires in a tunnel. For these reasons, Hussain's disclosure of nesting multiple pseudo-wires in a tunnel raises a substantial new question of patentability with respect to claims 1 and 6.

3. Additional cited references

Dr. Houh and this Request cite to a number of documents published by the Internet Engineering Task Force (IETF) as further evidence that a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain, in addition to the evidence within Aggarwal and Hussain. To the extent the Board determines that these IETF documents must qualify as prior art "printed publications" for the purposes for which they are cited, the documents do so

qualify. *See, e.g.,* Ex.1019, 6, ("RFCs can be obtained from a number of Internet hosts…"), 8 (IETF documents are "readily available to a wide audience"), 26 (IETF participants "shall publicly announce… every activity" relating to the standardization process); Ex.1003, ¶ 71, n. 1. Notably, the '775 patent itself acknowledges that IETF documents—including draft documents—were accessible, available, and known to the public. *See, e.g.,* Ex.1001, 1:40-42 (citing Request for Comments (RFC) 3031), 1:50 (citing RFC 3985), 1:66-2:2 (citing IETF draft document draft-ietf-pwe3-ms-pw-arch-02.txt); *see also* Ex.1006, 296-97 (citing various IETF RFCs and draft documents). The Board has repeatedly found that IETF documents, including RFCs, are "printed publications." *See, e.g., Apple, Inc. v. VirnetX, Inc.*, IPR2017-00337, Paper 31 at 46-47 (Requests for Comments are "precisely the type of documents whose main purpose is for public disclosure"); *Riot Games, Inc. v. Paltalk Holdings, Inc.*, IPR2018-00130, Paper 11 at 30-33 (PTAB May 15, 2018) (finding multiple RFCs to be printed publications).

Exhibit 1015 is a September 2004 document published by the IETF describing "a set of requirements for Point-to-Multipoint (P2MP) Traffic Engineered (TE) Multiprotocol Label Switching (MPLS) Label Switched Paths (LSPs)." Ex.1015, 1; *see also* Ex.1003, ¶ 71, n.1; Ex.1019, 8 (IETF draft documents are "readily available to a wide audience"); Ex.1020. A POSITA in the field of packet-switched networking would have reasonably relied upon such documents. Ex.1003, ¶ 71.

Exhibit 1016 is a February 21, 2006 document published by the IETF describing "the efficient transport of multicast-based services and the corresponding Label Distribution Protocol (LDP) protocol extensions and procedures." Ex.1016, 1; *see also* Ex.1003, ¶ 72, n.2; Ex.1019, 8 (IETF draft documents are "readily available to a wide audience"); Ex.1020. A POSITA in the

field of packet-switched networking would have reasonably relied upon such documents. Ex.1003, ¶ 71.

That IETF publications like Exhibits 1015 and 1016 were publicly available is also demonstrated by the '775 patent applicants' references to similar documents, both within the specification (Ex.1001, 1:40-2:2) and in an Information Disclosure Statement (IDS) (Ex.1002, 208).

III. DETAILED EXPLANATION OF THE PERTINENCE AND MANNER OF APPLYING THE PRIOR ART REFERENCES TO EVERY CLAIM FOR WHICH REEXAMINATION IS REQUESTED

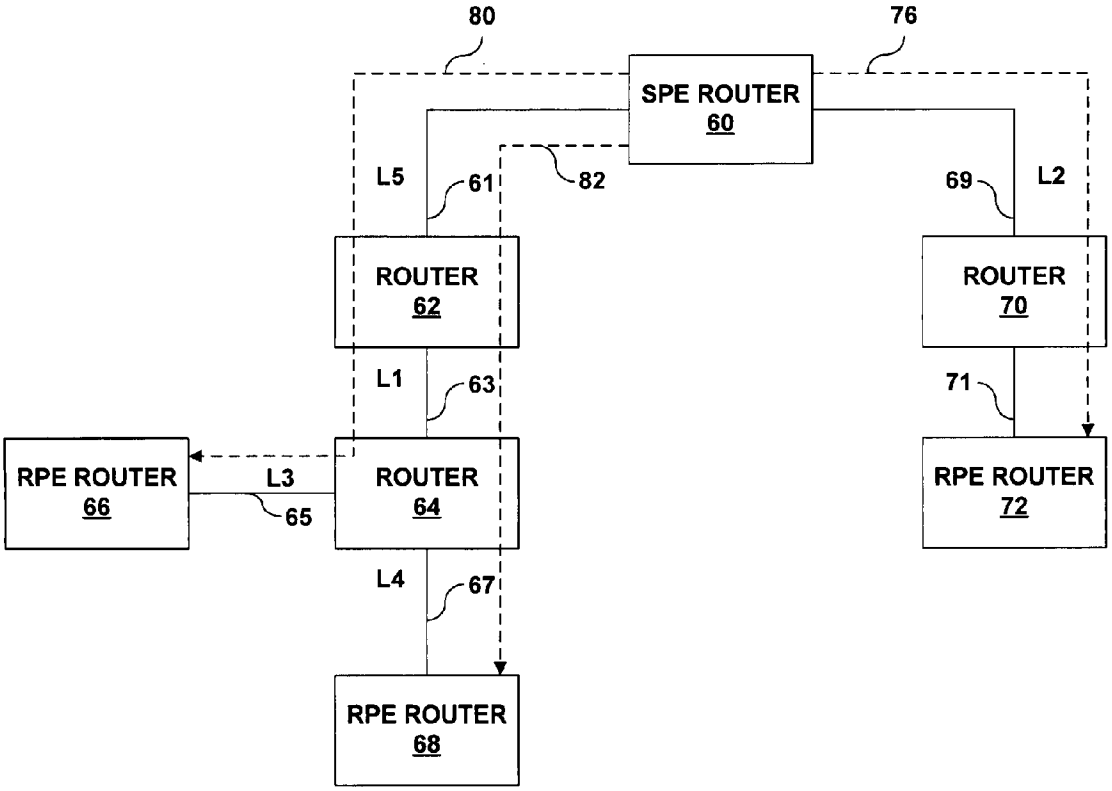
The proposed rejection detailed below shows how claims 1 and 6 are unpatentable. Ex.1003, ¶ 50.

A. Proposed Rejection #1: Claims 1 and 6 are obvious under 35 U.S.C. § 103(a) over Aggarwal and Hussain

1. Summary of Aggarwal

Like the '775 patent, Aggarwal is generally directed to routing traffic "associated with a **point to multi-point (P2MP) tunnel**." Ex.1005, 1:63-64. In particular, Aggarwal describes techniques for extending a resource reservation protocol "to be used for establishing P2MP TE [traffic engineering] tunnels." Ex.1005, 3:22-24. "[T]he extensions may be used to setup [point-to-point] P2P TE LSPs between source and receiver provider edge routers." Ex.1005, 3:27-28. "The P2P LSPs that are merged to form the P2MP LSPs are referred to as branch LSPs." Ex.1005, 4:13-15. Aggarwal further describes how the branch LSPs may be nested within the P2MP tunnel using label stacking. *See* Ex.1005, 9:17-39, 9:61-10-3. Importantly, like the '775 patent, to accomplish using P2P tunnels to establish P2MP tunnels, "the P2P TE LSPs are appropriately **merged** by the network." Ex.1005, 3:29-31. As an example, these techniques are illustrated in Fig. 5, shown

below. Ex.1003, ¶¶ 50-54.



Ex.1005, Fig. 5

Fig. 5 illustrates how "SPE [source provider edge] router 12 establishes a P2MP LSP between SPE router 12 and RPE [receiver provider edge] routers 66, 68, and 72." Ex.1005, 6:31-32. To do this, the SPE router 60 establishes a branch LSP 80 between the SPE router 60 and a first RPE router 66. *See* Ex.1005, 6:44-47. LSP 80 includes links 61 and 63 between the SPE router and intermediate router 64, as well as link 65 between the intermediate router 64 and the first RPE router 66. Ex.1005, Fig. 5. Ex.1003, ¶ 55.

Additionally, the SPE router 60 establishes a branch LSP 82 between the SPE router 60 and a second RPE router 68. *See* Ex.1005, 6:44-47. LSP 82 includes links 61 and 63 between the SPE router 60 and intermediate router 64, as well as

link 67 between the intermediate router 64 and the second RPE router 68. Ex.1005, Fig. 5. Ex.1003, ¶ 56.

Notably, "[t]hese branch LSPs are computed to **share the same links where possible** as they belong to the same session." Ex.1005, 6:40-42. As such, "Branch LSPs 80 and 82 **share links 63 and 61** between router 64 and SPE router 60." Ex.1005, 6:47-49. In other words, Aggarwal's technique "merges individual branch LSPs to form a P2MP LSP." Ex.1005, 7:4-5; Ex.1003, ¶ 57.

Aggarwal describes an application for this technology in "transmission of multicast traffic without run[ning] a multicast routing protocol on routers." Ex.1005, 4:32–34. Aggarwal shows an example of setting up a "P2MP LSP associated with" a particular "multicast group." Ex.1005, 6:34–35. In the example, multiple "branch LSPs" are established in "P2MP RSVP [resource reservation protocol] TE tunnels." Ex.1005, 6:26–43; Ex.1003, ¶ 58.

Aggarwal is analogous art to the '775 patent because it is both in the same field of endeavor and is directed to the same technical problem as the '775 patent. Both Aggarwal and the '775 patent are in the field of MPLS network traffic management. *See* Ex.1005, 1:7-9, 3:29-39; Ex.1001, 1:25-26, 1:34-36. And, Aggarwal is directed to the same technical problem as the '775 patent. Like the '775 patent, which describes "setting up … a single link common to the two pseudo-wires," Aggarwal teaches that "Branch LSPS 80 and 82 share links 63 and 61." Ex.1001, 3:3-4; Ex.1005, 6:47-49; Ex.1003, ¶ 59.

2. Summary of Hussain

Like Aggarwal and the '775 patent, Hussain relates to MPLS networks. In particular, Hussain is a book that provides additional implementation details and options for setting up LSPs within packet-switched networks such as those described by Aggarwal. In one example, Hussain describes setting up a tunnel

between Provider Edge (PE) routers. Ex.1006, 267. This tunnel is referred to as a PE-to-PE tunnel. *See id.* Hussain further teaches that several LSPs can be "nested" within the PE-to-PE tunnel. In particular, Hussain states that "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. Furthermore, Hussain teaches that such LSPs are applicable to a "point-to-multipoint L2VPN [Layer 2 Virtual Private Network]." Ex.1006, 272. Ex.1003, ¶ 60.

Hussain also describes a Virtual Private LAN Service (VPLS) in which multiple "point-to-point PWs [pseudo-wires]" are set up using Label Distribution Protocol (LDP). Ex.1006, 276. This set up can be performed by "hardware and software components" of routers in a network. Hussain, 6. In particular, Hussain explains that "IP/MPLS control-plane software, the brain of a router, resides in the control processor card." Ex.1006, 8; Ex.1003, ¶ 61.

After a pseudo-wire is set up, data packets can be sent along the pseudo-wire. Hussain explains that "a Layer 2 frame" is encapsulated "in a pseudowire (PW) protocol data unit." Ex.1006, 272. The frame is then transported in the pseudo-wire "over a tunnel across the PSN [packet-switched network]" from one provider edge (PE) router to another. Ex.1006, 272; Ex.1003, ¶ 62.

Hussain also describes a Virtual Private LAN Service (VPLS), which provides "a point-to-multipoint service" across a packet-switched network that "emulates the performance of a LAN." Ex.1006, 275. A business using VPLS to interconnect multiple geographically distributed sites can take advantage of the features and benefits a conventional local-area network provides, such as "broadcast and unicast services." Ex.1006, 277; Ex.1003, ¶ 63.

3. Reasons to Combine Aggarwal and Hussain

A POSITA would have found it obvious to combine the teachings of

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Aggarwal and Hussain because the combination is merely use of a known technique to improve similar methods in the same way. Specifically, it would have been obvious to a POSITA to apply Hussain's known technique of implementing LSPs as pseudo-wires to Aggarwal's similar LSPs within an MPLS network. Ex.1003, ¶¶ 64-66.

As mentioned above, Aggarwal describes establishing label switched paths (LSPs): "By utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched Path (LSP)." Ex.1005, 1:34-35. Aggarwal further notes that a "variety of protocols exist for establishing LSPs." Ex.1005, 1:45. Aggarwal describes both Resource Reservation Protocol with Traffic Engineering Extensions (RSVP-TE) and Label Distribution Protocol (LDP). *See* Ex.1005, 1:45-55. Aggarwal further teaches using RSVP-TE to establish point-to-multipoint (P2MP) LSP tunnels. *See* Ex.1005, 1:62-2:14; Ex.1003, ¶ 66.

A POSITA would have recognized that Aggarwal gives a general overview of LSPs. And, a POSITA would have looked to other resources that provide further implementation details for such LSPs. Hussain provides a POSITA with just such details. Specifically, Hussain is directed to the design and deployment of high availability IP and MPLS network architectures. *See* Ex.1006, title page. A POSITA looking to implement Aggarwal's method would naturally refer to literature describing similar technology. Therefore, a POSITA would have looked to other references—like Hussain—that further discuss establishing LSPs within an MPLS network. Moreover, Hussain would have been an attractive option, as it describes implementing LSPs in the context of providing high availability and fault-tolerance. Indeed, the title of Hussain is "Fault-tolerant IP and MPLS Networks." Thus, when implementing an MPLS network as taught by Aggarwal, a POSITA would have looked to a comprehensive guide for implementing such

networks with fault-tolerance and high availability. Ex.1003, ¶ 67.

Hussain notes that "[i]n MPLS, a tunnel corresponds to a *label-switched path* (LSP)." Ex.1006, 255. Hussain further describes "PE-to-PE tunnels [that] can be established using LDP or RSVP-TE." Ex.1006, 273. As explained above, a PE is a Provider Edge router. Further, like Aggarwal, Hussain describes point-to-multipoint services. *See* Ex.1006, 272-73. Accordingly, like Aggarwal, Hussain describes establishing LSPs between routers. Ex.1003, ¶ 68.

Hussain further describes a particular type of LSP that may be implemented, that is, implementing LSPs as pseudo-wires. Specifically, Hussain describes encapsulating a "frame in a *pseudowire* (PW) protocol data unit." Ex.1006, 272. Hussain notes that a "PW is a mechanism that emulates the essential attributes of a service, such as FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over **IP and/or MPLS network**." Ex.1006, 272. Hussain teaches that "PWs correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. "In the MPLS backbone, PEs are connected via PWs, which correspond to PE-to-PE LSPs that are established using LDP. In turn, PWs are multiplexed (nested) and transported over PE-to-PE tunnels." Ex.1006, 274. Accordingly, Hussain shows that implementing LSPs, such as Aggarwal's branch LSPs, with pseudo-wires was well-known. Thus, a POSITA implementing the teachings of Aggarwal would have been motivated to implement the teachings of Hussain to improve Aggarwal's LSPs with pseudo-wires that connect routers over an IP/MPLS backbone. Ex.1003, ¶ 69.

Furthermore, Hussain provides additional details to help support Aggarwal's teaching of sharing links. Specifically, as described above, Aggarwal is directed to merging point-to-point LSPs to form point-to-multipoint LSPs.

Aggarwal teaches that an objective of such techniques is to "optimize packet replication and minimize state and intelligence in the core of the network, while performing P2MP TE." Ex.1005, 3:40-43. Aggarwal's techniques also seek to "reduce complexity." Ex.1005, 7:9-11. Ex.1003, ¶ 70.

A POSITA would have understood that implementing the LSPs of Aggarwal as pseudo-wires, as taught by Hussain, would improve network efficiency in line with Aggarwal's goals. Ex.1003, ¶ 71. The advantages of implementing an LSP as a pseudo-wire were obvious and commonly known in the art before 2007. Hussain describes how with "the migration of legacy Layer 2 infrastructure over a converged packet-switched network," services such as Frame Relay (FR) and Asynchronous Transfer Mode (ATM) "are predominantly offered over an IP/MPLS backbone." Ex.1006, 254. For example, "[a] PW [pseudo-wire] is a mechanism that emulates the essential attributes of a service, such a FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex.1006, 272.

Contemporaneous documents confirm that network engineers were creating technology combinations like that suggested by the combination of Aggarwal's and Hussein's teachings. A prior art IETF document discusses "[a]n Ethernet multipoint Layer2 VPN service provided by MPLS" (e.g., similar to Hussein's VPLS) and explains that "if existing P2P TE LSPs are used as tunnels between PEs, any ingress PE must duplicate the frames and send them to the corresponding PEs," which would "waste the provider's network resources." Ex.1015, 15-16. Therefore, the IETF draft provides a potential solution, noting that "it might be desirable that P2MP MPLS TE LSPs are used for data transmission with an appropriate layer 2 encapsulation technique (**for example, pseudo wire**) instead of P2P MPLS TE LSPs, contributing in turn to savings of network resources."

Ex.1015, 16 (emphasis added). Further, pseudo-wires permit broadcasting services. Therefore, a POSITA would have been motivated to implement Aggarwal's LSPs as pseudo-wires. Ex.1003, ¶ 71.

The results of applying Hussain's teachings of pseudo-wires to Aggarwal's branch LSPs would have been predictable because Hussain explicitly teaches establishing LSPs such as the ones described by Aggarwal as pseudo-wires. The combination of Aggarwal and Hussain would have yielded predictable results because, as discussed above, implementing LSPs as pseudo-wires was well known to successfully provide Layer 2 services over an MPLS network. A prior art IETF document explains that "multicast-based services such as IP TV, DVB etc.," were becoming more popular, so IETF "Working Groups, such as MPLS and L2VPN, [had] begun to discuss the requirements and solutions for multicast." Ex.1016, 2. The IETF draft acknowledged that the same "solutions are needed to support the multicast traffic over PW." Ex.1016, 2. Therefore, the IETF draft proposed "procedures to transmit the multicast traffic using the unidirectional Pseudowires (PWs), and describe the corresponding extensions to Label Distribution Protocol (LDP)." Ex.1016, 2–3. A solution discussed was that "the PSN [packet-switched network] tunnel used to carry the point-to-multipoint PW (P2MP PW) may consist of a P2MP LSP, or multiple P2P and P2MP LSPs." Ex.1016, 4. Therefore, a POSITA would have found it predictable to implement Aggarwal's LSPs as pseudo-wires. Ex.1003, ¶ 72.

A POSITA would have had a reasonable expectation of success implementing the branch LSPs of Aggarwal as pseudo-wires because pseudo-wires were a known type of LSP. Ex.1003, ¶ 73. Hussain describes how pseudo-wires correspond to LSPs nested in a PE-to-PE tunnel. Ex.1006, 274. And, like Aggarwal's branch LSPs which are nested within Aggarwal's P2MP tunnels,

Hussain's pseudo-wires are nested within a PE-to-PE tunnel. Therefore, a POSITA would have expected pseudo-wires to work well within Aggarwal's P2MP tunnel as they work in Hussain's PE-to-PE tunnel. Ex.1003, ¶ 73.

Furthermore, because, pseudo-wires are a type of LSP, they operate in a similar manner. For example, Hussain teaches that pseudo-wires participate in data broadcasting by delivering Layer 2 data in a P2MP service. Ex.1006, 276-77. Aggarwal also teaches that branch LSPs deliver multicast packets in a P2MP LSP tunnel. See Ex.1005, 3:31–35, 3:42–47, 6:26–35, Fig. 5. Additionally, Hussain teaches that pseudo-wires are created in packet-switched networks, such as MPLS. Ex.1006, 275. Aggarwal also teaches that branch LSPs are created in MPLS networks that perform label-switching on data packets. See Ex.1005, 3:32–35, 6:60–7:3. Finally, because both pseudo-wires and LSPs are created in MPLS networks, the same network routers and links may be used. Thus, there was a reasonable expectation of success in implementing the combination of Aggarwal and Hussain. Accordingly, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because doing so is merely use of a known technique (pseudo-wires) to improve similar methods (establishing branch LSPs) in the same way (to improve network efficiency). *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 415-21 (2007); Ex.1003, ¶ 74.

Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs. In particular, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel: "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. Like Hussain's PE-to-PE tunnel, Aggarwal's Branch LSPs are tunnels between edge routers: Aggarwal describes techniques "for extending RSVP-TE to allow RSVP-TE to be used for establishing P2MP TE

tunnels." Ex.1005, 3:22-24. Accordingly, it would have been obvious to implement pseudo-wires within Aggarwal's branch LSPs (tunnels), similar to how they are implemented in Hussain's PE-to-PE tunnels. As such, the pseudo-wires would be implemented as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82). A POSITA would have had a reasonable expectation of success and would have had predictable results for the same reasons mentioned above. Ex.1003, ¶ 75.

Additionally, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because the combination merely applies a known technique to a known method ready for improvement to yield predictable results. As discussed above, a POSITA, when considering the teachings of Aggarwal, would have also considered the teachings of Hussain because both are generally directed toward provision of P2MP services over MPLS networks. Moreover, Hussain provides additional implementation details for improving survivability and optimizing network resources. Therefore, a POSITA would have found the teachings of Hussain relevant. Ex.1003, ¶ 76.

A POSITA would have been motivated to incorporate a particular technique into the method Aggarwal: implementing a branch LSP as a pseudo-wire. Ex.1003, ¶ 77. Alternatively, a POSITA would have found it obvious to implement pseudo-wires within Aggarwal's branch LSPs as nested pseudo-wires. In either way, doing so would have improved the method of Aggarwal in the same way as using the technique improved Hussain. Ex.1003, ¶ 77. And, as discussed above, the advantages of implementing an LSP as a pseudo-wire were commonly known in the art before 2007. And, as also discussed above, the combination of Aggarwal and Hussain would have yielded predictable results because implementing an LSP as a pseudo-wire was well known to successfully provide Layer 2 services over an

MPLS network. And, a POSITA would have had a reasonable expectation of success using pseudo-wires as the branch LSPs because pseudo-wires are a type of LSP. Therefore, a POSITA would have been motivated to implement the branch LSPs as pseudo-wires. Ex.1003, ¶ 77.

The combination of Aggarwal and Hussain represents applying a known technique (implementation of pseudo-wires) to a known method (implementing point-to-multipoint LSPs) ready for improvement to yield predictable results (pseudo-wires with shared links). Ex.1003, ¶ 78.

Requester's proposed combinations permit but do not require physical incorporation of elements from Hussain into Aggarwal. *See In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012); Ex.1003, ¶ 79.

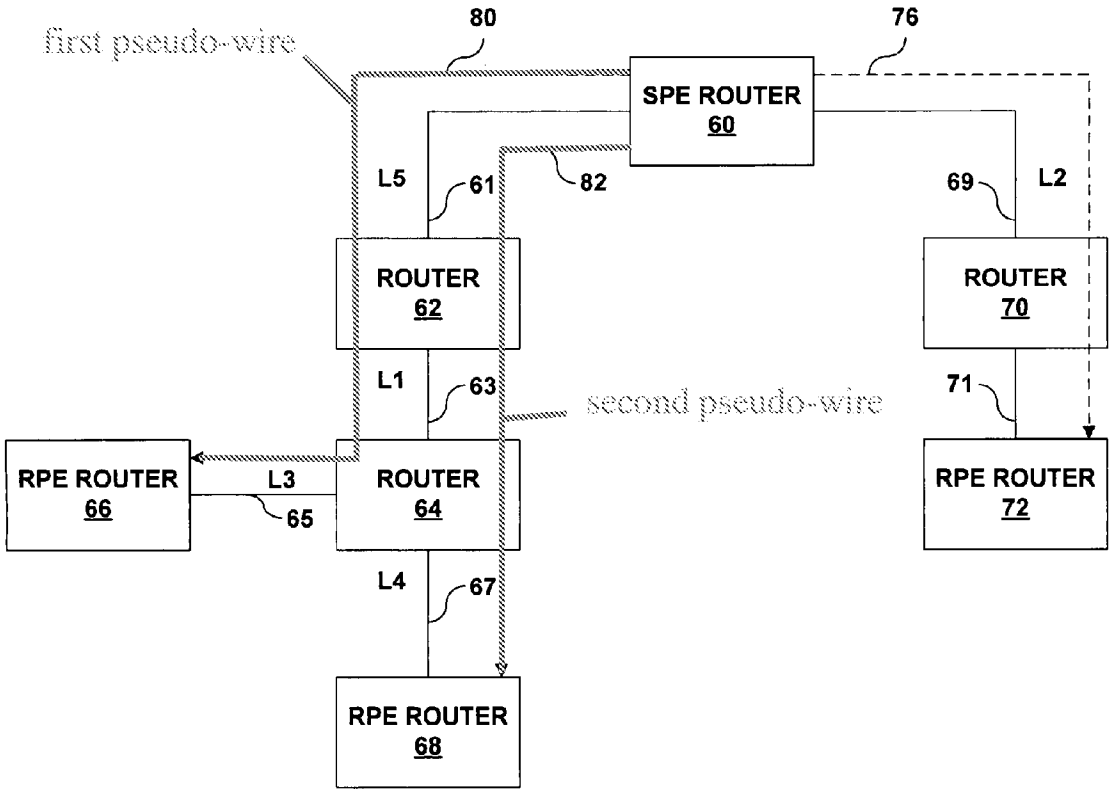
4. Claim 1

[1.0] ***A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:***

Aggarwal and Hussain render this limitation obvious.

First, Aggarwal teaches setting up branch Label Switched Paths (LSPs) 80 and 82 ("*at least two pseudo-wires*"):[3] "SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router 64." Ex.1005, 6:44-47. Aggarwal's Figure 5, below, illustrates the branch LSPs 80 and 82. Ex.1003, ¶¶ 80-83.

[3] For the reasons explained above at XI.E.3, and as elaborated below, a POSITA would have found it obvious to implement Aggarwal's LSPs as pseudo-wires. Ex.1003, ¶ 81, n.3.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 81

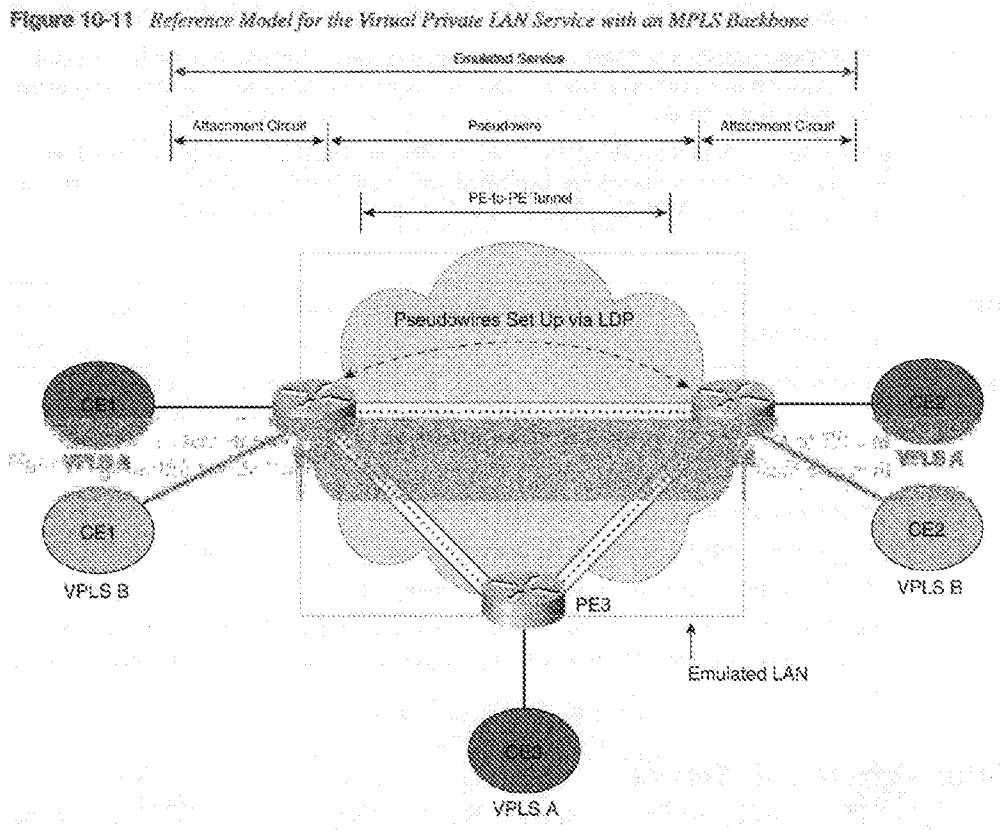
In district court litigation, the Patent Owner has accused products using MPLS label switched paths—like those in Aggarwal—of implementing the claimed "pseudo-wires." *See* Ex.1017, ¶ 36. Accordingly, Patent Owner concedes and cannot disclaim that Aggarwal's label switched paths are "pseudo-wires" as claimed.

Second, a POSITA would have found it obvious to implement Aggarwal's branch LSPs as pseudo-wires, as evidenced by Hussain. Hussain explicitly teaches setting up LSPs as pseudo-wires via LDP. *See* Ex.1006, 276; Ex.1003, ¶ 84.

In particular, Hussain teaches how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). Ex.1006, 276–77. Thus,

setting up point-to-point pseudo-wires in a VPLS is a "*method of setting up at least two pseudo-wires*" as claimed. Ex.1003, ¶ 85.

Figure 10-11 of Hussain illustrates that pseudo-wires are established as LSPs, since they are set up using label distribution protocol (LDP):



Ex.1006, Fig. 10-11 at 276.

A POSITA would have found it obvious to implement Aggarwal's branch LSP's as pseudo-wires to improve network efficiency, consistent with Aggarwal's objective to "optimize packet replication and minimize state and intelligence in the core of the network." Ex.1005, 3:40-42; *see also infra* III.A.3; Ex.1003, ¶ 88. By implementing the branch LSPs 80 and 82 as pseudo-wires, such LSPs teach the pseudo-wires as claimed. Ex.1003, ¶ 86-88.

Alternatively, a POSITA would have found it obvious to implement pseudo-

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wires *within* Aggarwal's branch LSPs. As explained above at III.A.3, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel. Aggarwal's Branch LSPs are a type of tunnel between edge routers. Thus, a POSITA also would have found it obvious to implement pseudo-wires as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82). Ex.1003, ¶ 89.

Third, a POSITA would have found it obvious that Aggarwal's branch LSPs implemented as pseudo-wires as taught by Hussain would provide broadcast services. For example, Hussain explains that a VPLS "emulates the performance of a LAN." Ex.1006, 275. Additionally, Hussain explains that a "LAN provides broadcast and unicast services." Ex.1006, 277. Additionally, Hussain teaches that L2VPNs, including VPLS, "transport Layer 2 frames." Ex.1006, 273. A POSITA, therefore, would have understood that Layer 2 frames are a type of traffic that can be broadcast in a VPLS. Accordingly, a POSITA would have recognized that the branch LSPs 80 and 82 implemented as pseudo-wires can broadcast data streams. Ex.1003, ¶ 90.

To the extent that Patent Owner would seek a narrower definition of "pseudo-wire" to include a specific definition, as described in RFC 3985 (Ex.1001, 1:50; Ex.1010), a POSITA would have found it obvious that Hussain's reference to a pseudo-wire would refer to the same thing. Specifically, Hussain discussed pseudo-wires in the context of, and with citations to, IETF draft documents and RFCs discussing pseudo-wires. *See e.g.,* Ex.1006, 296-97 (citing, *inter alia*, Aggarwal[4] et al., "Pseudo Wire (PW) Virtual Circuit Connection Verification

[4] Rahul Aggarwal, co-author of Ex.1037, appears to be the same individual who is the sole named inventor of the Aggarwal reference, Ex.1005, which further

(VCCV)," IETF Draft dated February 2004 (Ex.1037), which at 13 cites Bryant, *et al.*, "PWE3 Architecture," draft-ietf-pwe3-arch-06.txt (Oct. 2003) (Ex.1038) which is an earlier draft of RFC 3985 (Ex.1010)). Accordingly, a POSITA would have expected Hussain's discussions of pseudo-wires to use that term as it is used in the IETF's RFC documents. Ex.1003, ¶ 91.

Hussain teaches that L2VPNs, including VPLS, "transport Layer 2 frames." Ex.1006, 273. A POSITA, therefore, would have understood that Layer 2 frames are a type of traffic that can be broadcast in a VPLS. Thus, the Layer 2 frames are "*a data stream.*" Ex.1003, ¶ 92.

Thus, because Aggarwal teaches establishing branch LSPs, which can be implemented as pseudo-wires and provide broadcast services as taught by Hussain, the combination of Aggarwal and Hussain renders obvious "*[a] method of setting up at least two pseudo-wires able to broadcast a data stream*," as claimed. Ex.1003, ¶ 93.

[1.1] ***setting up a first pseudo-wire comprising a first link***

Aggarwal and Hussain render this limitation obvious.

First, Aggarwal teaches setting up a first branch LSP 80 (corresponding to a "*first pseudo-wire*"): "SPE router 60 also establishes **branch LSPs <u>80</u> and 82** with RPE routers 66 and 68, respectively, via router 62 and router 64." Ex.1005, 6:45-47; *see also* 7:43-44 ("router 60 sets up branch LSP 80 to RPE router 66."). And, for the reasons described above at [1.0], Hussain shows that it would have been obvious to a POSITA to implement Aggarwal's branch LSP 80 as a pseudo-wire. Ex.1003, ¶ 94-97; *see also supra*, § III.A.3.

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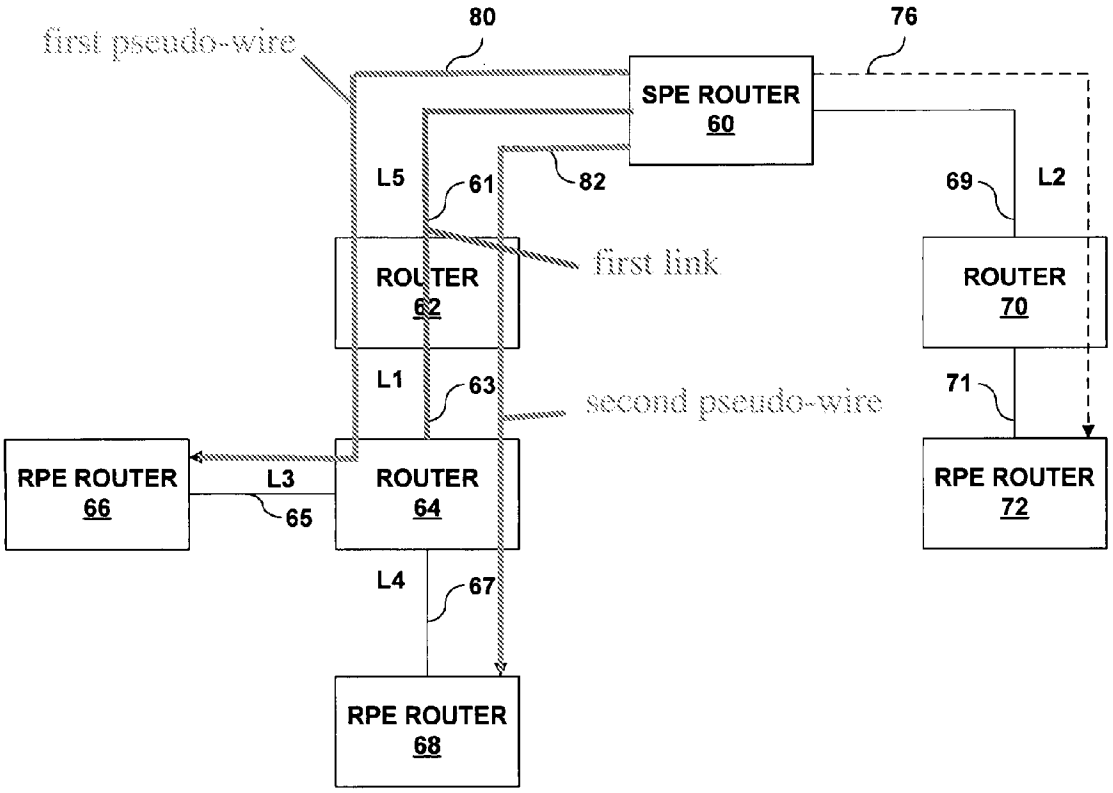
confirms the relevance of Hussain's disclosure to Aggarwal's teachings and supports the obviousness of their combination.

Second, Aggarwal teaches that the first branch LSP includes links 61 and 63 (*"first link"*)[5]: "As shown in FIG. 5, **Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Annotated Fig. 5 is shown below. Ex.1003, ¶ 98.



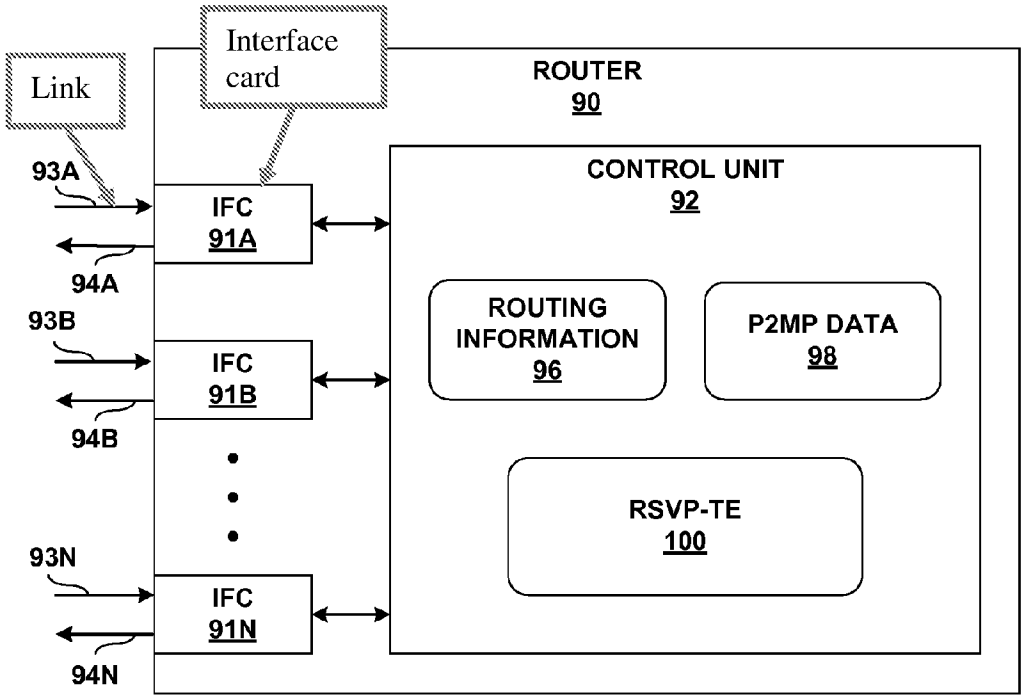
Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 98.

Aggarwal explains that "[t]he term 'link' is often used to refer to the connection between two devices on a network." Ex.1005, 1:22-23. The term includes "'virtual' or 'logical' links." Ex.1005, 1:25–27; Ex.1003, ¶ 99.

To the extent that the Patent Owner argues for, or the Office applies, the

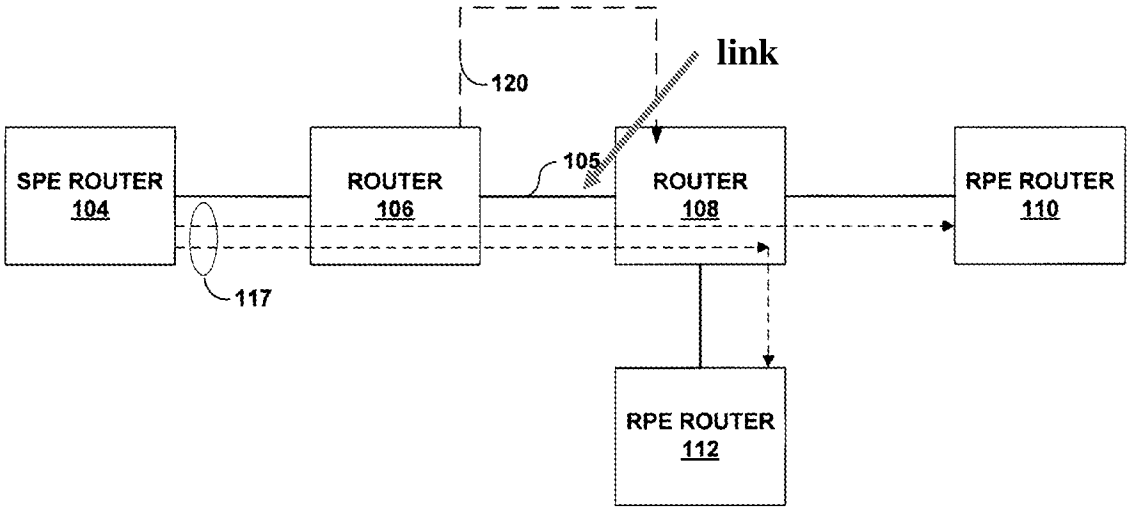
[5] Requester notes that links 61 and 63 either individually or together teach the claimed "first link."

district court's claim construction of the term "link," Aggarwal teaches that a link connects to an interface on a router. For example, Aggarwal describes the interfaces of router 90, which it describes as representative of the other routers described. *See* Ex.1005, 7:59–61. Aggarwal explains that "router 90 includes a set of interface cards (IFCs) 91A-91N ('IFCs 91) for communicating packets via inbound links 93A-93N ('inbound links 93) and outbounds links 94A-94N ('outbound links94)." Ex.1005, 8:3-7. Annotated Fig. 6 is shown below.



Ex.1005, Fig. 6 (annotated).

Aggarwal also illustrates in Fig. 7 that a "link" between two routers carries all traffic between those routers. Aggarwal explains that "**all branch LSPs that use a given link** [e.g., 105] can be protected in the event of link failure by forwarding traffic" via tunnel 120. Ex.1005, 9:20-23.



Ex.1005, Fig. 7 (annotated).

Thus, Aggarwal uses the term "link" to refer to the physical interconnection of an interface card of one router to the interface card of another router, consistent with the district court's claim construction of "link" as a "connection between an interface of a first router and an interface of a second router."

Hussain supports Aggarwal's teaching of router interfaces: "Network-level fault tolerance involves the interaction of a node with other nodes through external interfaces." Ex.1006, 253. Hussain explains that "[i]n the incoming direction, line cards receive packets from external interfaces and forward them to the switching fabric," and "[i]n the outgoing direction, line cards receive packets from the switching fabric and forward them to the outgoing interfaces." Ex.1006, 8. Hussain describes that "label allocation and management can be implemented per interface or globally (platform wide)." Ex.1006, 50.

A POSITA implementing the method of setting up the first pseudo-wire would have understood that a link may consist of multiple hops. Therefore, a POSITA would have found it obvious that "*a first link*" would extend from SPE router 60 to intermediate router 64. As illustrated in Figure 5 above, the first

pseudo-wire comprises the first link. Ex.1003, ¶ 100.

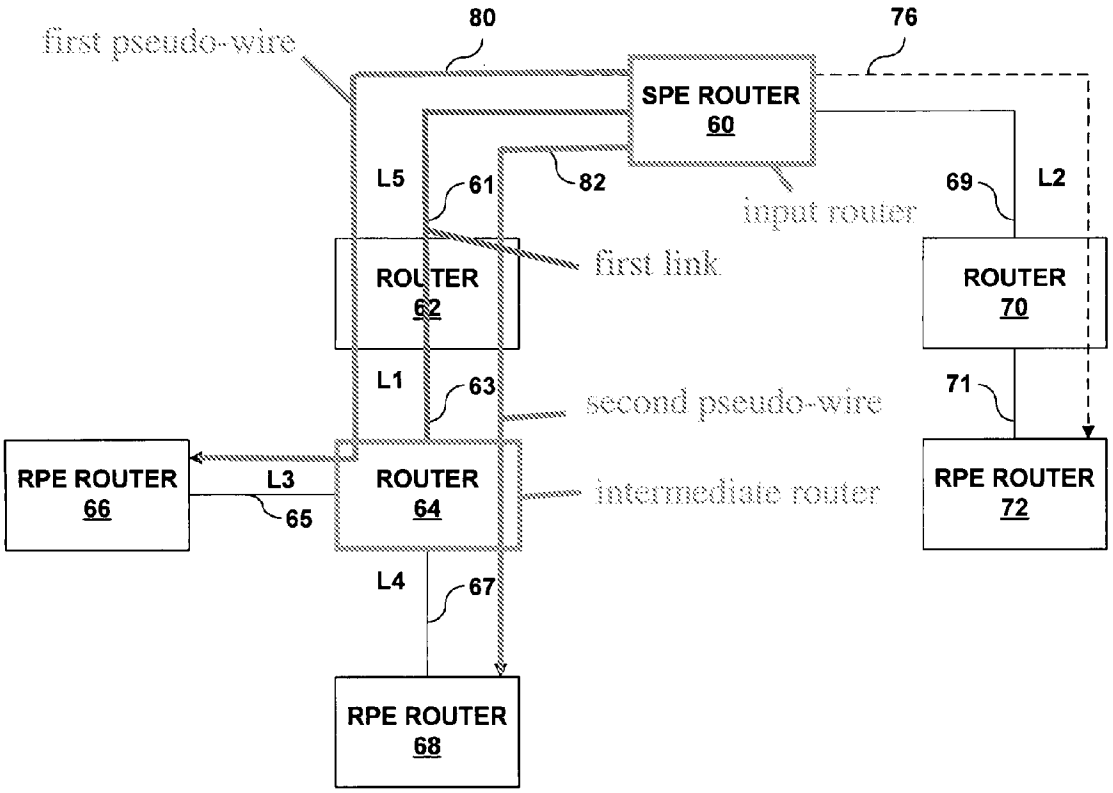
Either of Aggarwal's links 61 and 63 shown in Fig. 5 may be mapped to the claimed "first link." To the extent that a link is found to be a connection between pairs of routers that does not include intermediate routers, then a POSITA would understand that router 62 could be removed (and labels L5 and L1 consolidated into a single label) in the example network in Figure 5 above. Ex.1003, ¶ 101. A POSITA would have found it obvious to remove router 62 from the network of Figure 5, recognizing that there are no other routers other than router 60 and router 64 to which router 62 is connected, and that the system would perform better (no delays incurred in router 62), would be simpler to manage (fewer routers to configure and manage), and be cheaper to implement (no cost for installing and managing router 62). Ex.1003, ¶ 101. Aggarwal illustrates this possibility by showing that in the path from source router 60 to receiver router 72, there is just one intermediate router 70. Ex.1005, Fig. 5; Ex.1003, ¶ 101.

Thus, because Aggarwal teaches a branch LSP 80 with links 61 and 63 between the router 64 and the SPE router 60, and a POSITA would have found it obvious to implement Aggarwal's branch LSP as a pseudo-wire as taught by Hussain, Aggarwal and Hussain render obvious "*setting up a first pseudo-wire comprising a first link*" as recited in the claim. Ex.1003, ¶ 102.

[1.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

Aggarwal and Hussain render this limitation obvious.

First, as discussed in [1.1], Aggarwal teaches that links 61 and 63 (individually or collectively a "*first link*") are between SPE router 60 ("*input router*") and router 64 ("*intermediate router*"), as shown in annotated Fig. 5 below. Ex.1003, ¶¶ 103-14.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 104

SPE router 60 is an "*input router*" because it is described as a source provider edge router. In a different embodiment (Fig. 1), Aggarwal describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Ex.1005, 3:58-61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and a receiver provider edge (RPE) router 16A (destination network device) of subscriber network 18A." Ex.1005, 3:61-65. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the

SPE routers and RPE routers in the embodiment of Fig. 5. Ex.1003, ¶ 105. Accordingly, because the SPE receives traffic from a source network to be passed to a subscriber network, it is an input router. Ex.1003, ¶ 105.

Furthermore, router 64 is an "*intermediate router*" because Aggarwal explicitly states that "[c]omputer network 58 also includes **intermediate routers** 62, **64**, 68, and 70." Ex.1005, 6:30-31. Router 64 is positioned between the Source Provider Edge router 60 and Receiver Provider Edge (RPE) routers 66 and 68, and is thus situated at an *intermediate* position. Ex.1003, ¶ 106.

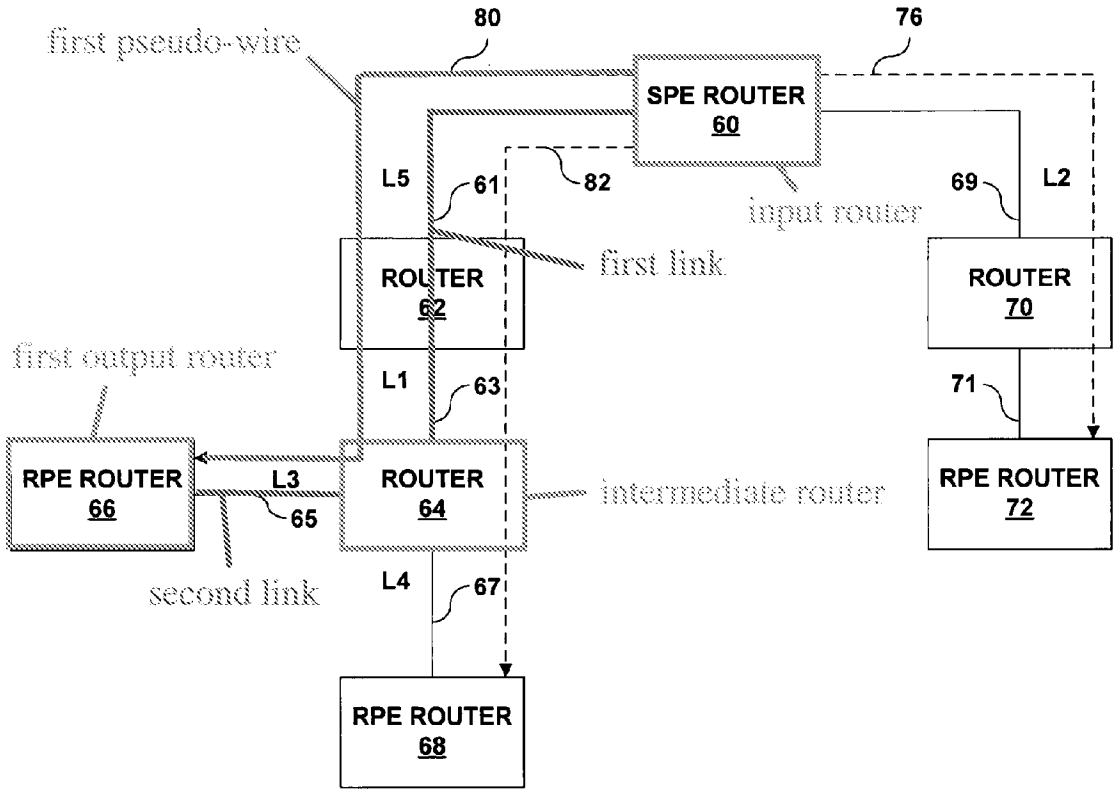
Second, both the SPE router 60 and the intermediate router 64 are in a "*packet-switched network*." Regarding the SPE routers, Aggarwal states that "[u]pon receiving an incoming packet, the router examines information within the packet and **forwards the packet** in accordance with the routing information." Ex.1005, 1:15-18. And Aggarwal notes that the P2MP LSPs are part of a LAN. *See* Ex.1005, 6:60-7:3. A POSITA would have found it obvious for a LAN to be a packet-switched network. Ex.1003, ¶¶ 107-09.

Thus, because Aggarwal teaches links 61 and 63 between SPE router 60 and intermediate router 64, Aggarwal renders obvious "[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network" as recited in the claim. Ex.1003, ¶ 110.

[1.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

Aggarwal and Hussain render this limitation obvious.

First, Aggarwal's branch LSP 80 is a "*first pseudo-wire*" that traverses a path from SPE router 60 to RPE router 66. Additionally, Figure 5 illustrates that the branch LSP 80 includes a link 65 ("*second link*") from the intermediate router 64 to the RPE router 66. Ex.1003, ¶¶ 111-12.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 112

The RPE Router 66 is an *output router* because it is described as a Receiver Provider Edge router. In a different embodiment (Fig. 1), Aggarwal describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Ex.1005, 3:58-61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and **a receiver provider edge (RPE) router 16A (destination network device)** of subscriber network 18A." Ex.1005, 3:61-64. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the

SPE routers and RPE routers in the embodiment of Fig. 5. Ex.1003, ¶ 114. Accordingly, because the RPE provides traffic from a source network to a subscriber network, it is an "*output router*." Ex.1003, ¶¶ 113-14.

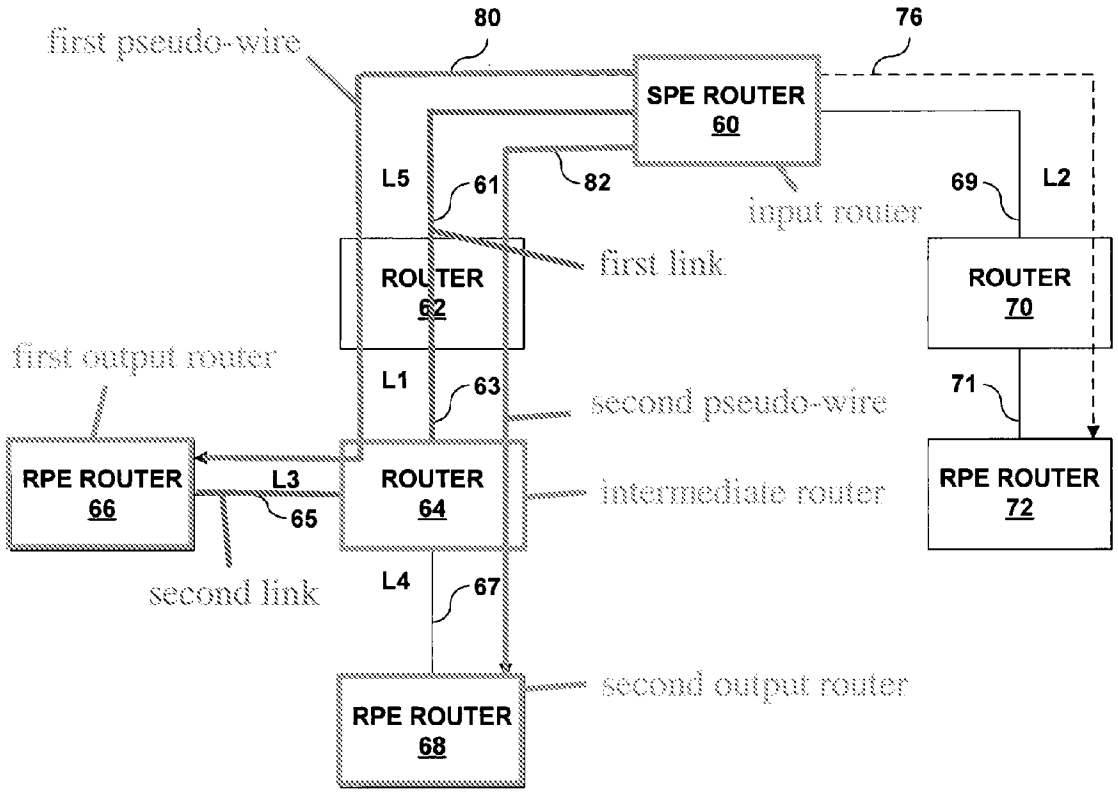
Second, for the same reasons that the SPE router 60 and the intermediate router 64 are part of a packet-switched network as described above at [1.2], the RPE router 66 is also part of a packet-switched network. Ex.1003, ¶ 115.

Thus, because Aggarwal teaches that branch LSP 80 includes a link 65 between the intermediate router 64 and RPE router 66, Aggarwal renders obvious "*[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network,*" as claimed. Ex.1003, ¶ 116.

[1.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

Aggarwal and Hussain render this limitation obvious.

First, Aggarwal teaches a branch LSP 82 (corresponding to a "*second pseudo-wire*") that extends between SPE router 60 and RPE router 68 ("*second output router*"). "SPE router 60 also establishes **branch LSPs 80 and 82** with RPE routers 66 and **68**, respectively, via router 62 and router 64." Ex.1005, 6:45-47; *see also* 7:43-45 ("SPE router 60 sets up … **branch LSP 82 to RPE router 68**"). And, for the reasons described above at [1.0], Hussain shows that it would have been obvious to a POSITA to implement Aggarwal's branch LSP 82 as a pseudo-wire as taught by Hussain. Ex.1003, ¶¶ 117-21; *see also supra*, § III.A.3.



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 121

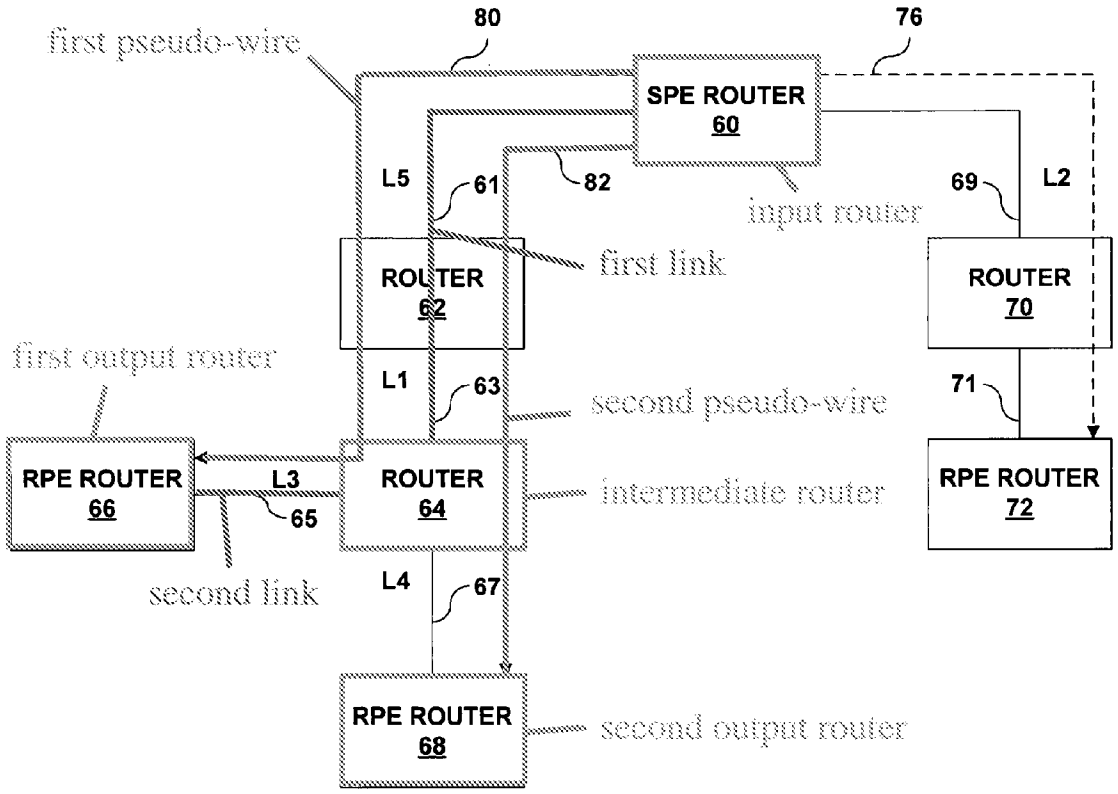
RPE router 68 is an *output router* for the same reasons that RPE 66 is an output router as described above at [1.3]. Furthermore, for the same reasons that the SPE router 60 and the intermediate router 64 are part of a *packet-switched network* as described above at [1.2], the RPE router 68 is also part of a *packet-switched network*. Ex.1003, ¶¶ 122-25.

Thus, because Aggarwal teaches branch LSP 82 between SPE router 60 and RPE router 68, Aggarwal and Hussain render obvious "*setting up a second pseudo-wire between said input router and a second output router of the packet-switched network*," as claimed. Ex.1003, ¶ 126.

[1.5] ***wherein the second pseudo-wire comprises said first link and***

Aggarwal and Hussain render this limitation obvious.

As discussed above at [1.1] Aggarwal teaches that the branch LSP 82 (corresponding to the "*second pseudo-wire*") includes links 61 and 63 ("*first link*"): "As shown in FIG. 5, **Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Ex.1005, 6:47-49. Annotated Fig. 5 is shown below. Ex.1003, ¶¶ 127-29.



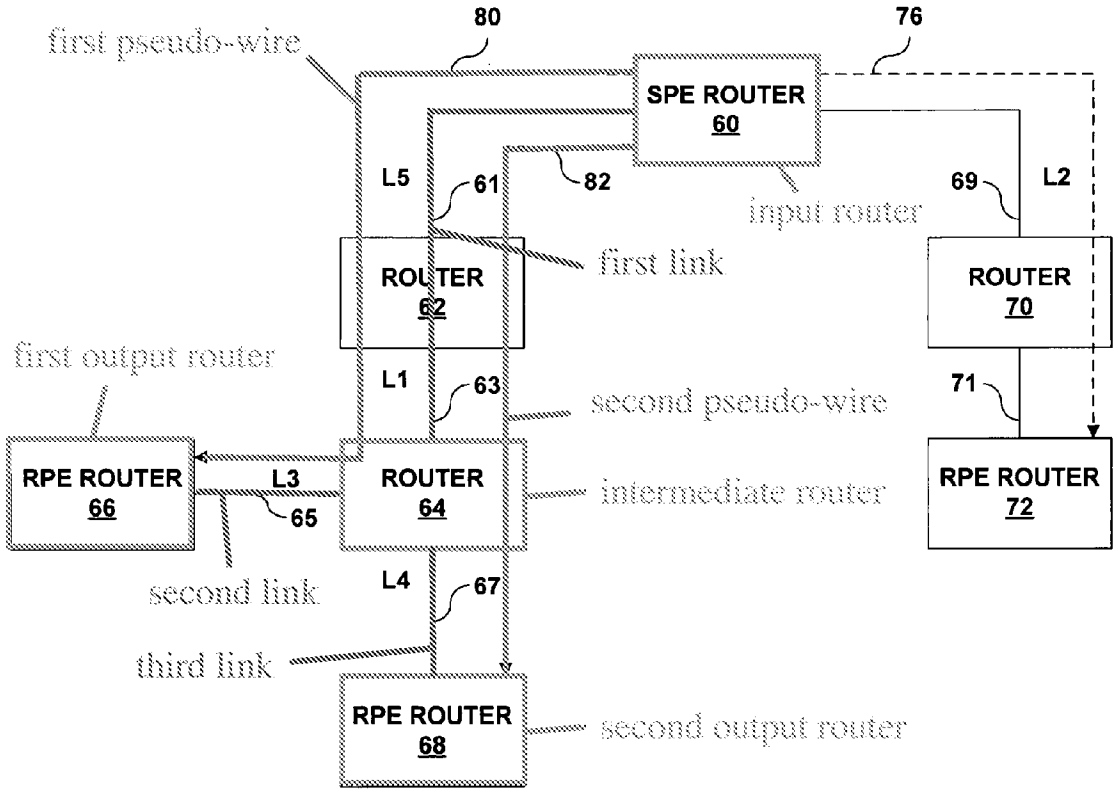
Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 129

Thus, because Aggarwal teaches that branch LSP 82 includes links 61 and 63, Aggarwal and Hussain render obvious "*wherein the second pseudo-wire comprises said first link*," as claimed. Ex.1003, ¶¶ 130-32.

[1.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

Aggarwal and Hussain render this limitation obvious.

First, Aggarwal's branch LSP 82 traverses a path from SPE router 60 to RPE router 68. Additionally, Figure 5 illustrates that the branch LSP 82 includes a link 67 ("*third link*") from the intermediate router 64 to the RPE router 68. Ex.1003, ¶¶ 133-34. Annotated Fig. 5 illustrates the third link:



Ex.1005, Fig. 5, (annotated); Ex.1003, ¶ 134

As illustrated in Figure 5 above, the second pseudo-wire comprises the third link. As discussed in [1.2], intermediate router 64 is "*an intermediate router.*" As discussed in [1.4], RPE router 68 is a "*second output router.*" Ex.1003, ¶ 135.

Thus, because Aggarwal teaches a link 67 between intermediate router 64 and RPE router 68, Aggarwal and Hussain render obvious "*[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router*," as claimed. Ex.1003, ¶ 136.

[1.7] ***said first link being shared by the first and second pseudo-wires.***

Aggarwal and Hussain render this limitation obvious.

As explained above at [1.1], the links 61 and 63 ("*first link*") are shared by Branch LSP 80 (corresponding to the "*first pseudo-wire*") and Branch LSP 82 (corresponding to the "*second pseudo-wire*"). "**Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Aggarwal teaches that this sharing occurs by "merging the individual P2P LSPs and relying on MPLS label multicast." Ex.1005, 4:12-13; Ex.1003, ¶¶ 137-38.

Furthermore, as explained above at [1.0], Hussain shows that it would have been obvious to implement Aggarwal's branch LSPs as pseudo-wires as described by Hussain. Hussain also teaches that "tunnels are set up using LDP or RSVP-TE" and that "[m]ultiple PWs can be carried inside a single tunnel." Ex.1006, 276; Ex.1003, ¶¶ 139-142.

Thus, because Branch LSPs 80 and 82 share links 61 and 63, Aggarwal and Hussain render obvious "*said first link being shared by the first and second pseudo-wires*," as claimed. Ex.1003, ¶ 143.

5. Claim 6

[6.0] ***A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:***

First, as discussed at [1.0], the combination of Aggarwal and Hussain renders obvious a "*a method of setting up at least two pseudo-wires able to broadcast a data stream*," as claimed. Ex.1003, ¶ 144.

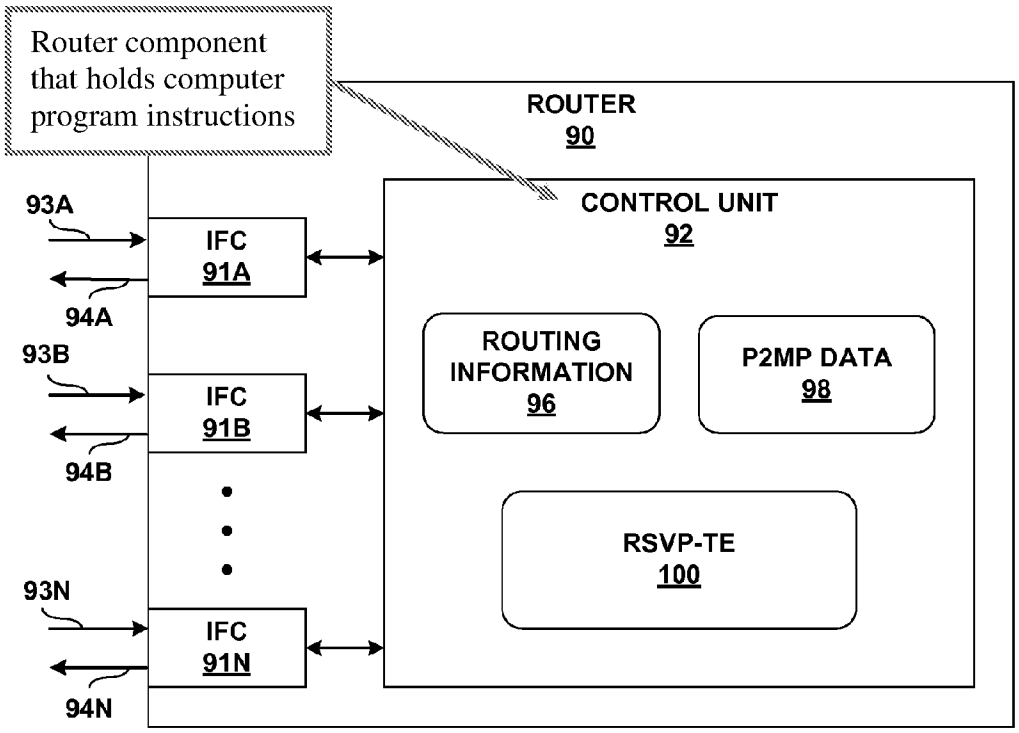
Second, a POSITA would have found it obvious for such method to be implemented by a computer program product stored on a computer-readable

medium. Ex.1003, ¶ 145. Aggarwal teaches that "[r]outing devices within a network, often referred to as routers, maintain routing information that describes available routes through the network." Ex.1005, 1:13–15. Aggarwal provides additional details regarding Router 90, which it describes as representative of the other routers described. *See* Ex.1005, 7:59–61. Aggarwal explains that "[r]outer 90 further comprises a control unit 92 that maintains routing information 96." Ex.1005, 8:7–8. Regarding the control unit 92, Aggarwal states:

> Control unit 92 may be implemented solely in software, or hardware, or may be implemented as a combination of software, hardware, or firmware. For example, control unit 92 may include one or more processors which execute software instructions. In that case, the various software modules of control unit 92, such as RSVP-TE protocol 100, may comprise executable instructions stored on a computer-readable medium, such as computer memory or hard disk.

Ex.1005, 9:1–8; Ex.1003, ¶ 145.

Figure 6 of Aggarwal illustrates a network router containing computer program instructions for setting up label switched paths:



Ex.1005, Fig. 6 (annotated); Ex.1003, ¶ 146.

A POSITA, therefore, would have found it obvious that SPE router 60, intermediate router 64, RPE router 66, and RPE router 68, which correspond to the claimed *input router*, *intermediate router*, *first output router*, and *second output router*, respectively, each contain "*computer code instructions*." Ex.1003, ¶ 147.

Thus, Aggarwal and Hussain render obvious "[a] computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer," as claimed. Ex.1003, ¶ 148.

[6.1] ***setting up a first pseudo-wire comprising a first link***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.1]. Ex.1003, ¶ 149.

[6.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.2]. Ex.1003, ¶ 150.

[6.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.3]. Ex.1003, ¶ 151.

[6.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.4]. Ex.1003, ¶ 152.

[6.5] ***wherein the second pseudo-wire comprises said first link and***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.5]. Ex.1003, ¶ 153.

[6.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.6]. Ex.1003, ¶ 154.

[6.7] ***said first link being shared by the first and second pseudo-wires.***

Aggarwal and Hussain render this limitation obvious for the reasons discussed in [1.7]. Ex.1003, ¶ 155.

IV. LIST OF EXHIBITS

Ex.1001	U.S. Patent No. 8,130,775
Ex.1002	Prosecution History of U.S. Patent No. 8,130,775
Ex.1003	Declaration of Henry Houh under 37 C.F.R. § 1.68
Ex.1004	*Curriculum Vitae* of Henry Houh
Ex.1005	U.S. Patent No. 7,602,702 to Aggarwal
Ex.1006	Iftekhar Hussain, "*Fault-tolerant IP and MPLS Networks*" (1st ed. 2004).
Ex.1007	Reserved.
Ex.1008	Reserved.
Ex.1009	Reserved.
Ex.1010	S. Bryant & P. Pate, "*Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture,*" IETF Request for Comments 3985 (March 2005).
Ex.1011	Reserved.
Ex.1012	Andrew S. Tanenbaum, "*Computer Networks*" (3rd ed. 1996).
Ex.1013	Ina Minei et al., "*MPLS-Enabled Applications: Emerging Developments and New Technologies*" (2d ed. 2008).
Ex.1014	Declaration of Dr. Ingrid Hsieh-Yee
Ex.1015	Yasukawa et al., "*Requirement for Multipoint Traffic Engineered MPLS LSPs*", IETF draft, September 2004.
Ex.1016	Haiyan Zhang, "*Pseudowire for Supporting Multicast Traffic*," IETF draft, February 21, 2006.
Ex.1017	*Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015 (E.D. Tex.), Complaint.

Ex.1018	*Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015 (E.D. Tex.), Docket Control Order.
Ex.1019	S. Bradner, "*The Internet Standards Process – Revision 3*," IETF Request for Comments 2026 (Oct. 1996).
Ex.1020	Internet Archive Wayback Machine's archive of the IETF's Internet-Drafts Database Interface webpage, https://web.archive.org/web/20061008141657/https://datatracker.ietf.org/public/idindex.cgi (Oct. 8, 2006).
Ex.1021-1022	Reserved.
Ex.1023	English Translation of the Written Opinion of the International Searching Authority for PCT/FR08/50324.
Ex.1024	*Cisco Systems, Inc. v. Monarch Networking Solutions, Inc.*, IPR2020-01226, Decision Denying Institution of Inter Partes Review, Paper 11 (PTAB Mar. 4, 2021).
Ex.1025	*Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015 (E.D. Tex.), Claim Construction Order.
Ex.1026	P. Pan et al., "Pseudo Wire Protection," draft-pan-pwe3-protection-03.txt, IETF Internet Draft (July 2006).
Ex.1027	M. Bocci and S. Bryant, "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge," draft-ietf-pwe3-ms-pw-arch-02.txt, IETF Internet Draft (Oct. 2006).
Ex.1028	Eric Mannie and Dimitri Papadimitriou, "Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS)," draft-ietf-ccampl-gmpls-recovery-terminology-05.txt, IETF Internet Draft (Oct. 2004).
Ex.1029	Luca Martini et al., "Dynamic Placement of Multi Segment Pseudo Wires," draft-ietf-pwe3-dynamic-ms-pw-02.txt, IETF Internet Draft (Oct. 2006).

Ex.1030	*Cisco Systems, Inc. v. Monarch Networking Solutions, Inc.*, IPR2020-01226, Patent Owner's Preliminary Response, Paper 8 (PTAB Dec. 8, 2020).
Ex.1031-1033	Reserved.
Ex.1034	U.S. Patent No. 7,369,556 to Rekhter, et al.
Ex.1035	Rekhter, et al., "Cisco Systems' Tag Switching Architecture Overview," IETF Request for Comments 2105 (Feb. 1997).
Ex.1036	Rosen, et al., "Multiprotocol Label Switching Architecture Overview," IETF Request for Comments 3031 (Jan. 2001).
Ex.1037	Thomas Nadeau and Rahul Aggarwal, "Pseudo Wire (PW) Virtual Circuit Connection Verification (VCCV)," draft-ietf-pwe3-vccv-02.txt, IETF Internet Draft (Feb. 2004).
Ex.1038	Stewart Bryant and Prayson Pate, "PWE3 Architecture," draft-ietf-pwe3-arch-06.txt, IETF Internet Draft (Oct. 2003).

V. CONCLUSION

For the reasons set forth above, substantial new questions of patentability are raised in connection with claims 1 and 6 by this request for *ex parte* reexamination because claims 1 and 6 are rendered obvious in view of the above-listed prior art references. Therefore, Requester asks that this request for reexamination be granted and that claims 1 and 6 be canceled.

As identified in the attached Certificate of Service and in accordance with 37 C.F.R. §§ 1.33(c) and 1.510(b)(5), a copy of the present request, in its entirety, is being served to the address of the attorney or agent of record.

Please direct all correspondence in this matter to the undersigned.

Respectfully submitted,

/Theodore M. Foster/
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Dated: March 12, 2021
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Attorney Docket No.: 43614.399

CERTIFICATE OF TRANSMISSION
I hereby certify that this correspondence is being filed with the U.S. Patent and Trademark Office via EFS Web on March 12, 2021.

/Theresa Lowe/
Theresa Lowe

VI. CERTIFICATE OF SERVICE

The undersigned certifies that copies of the following,

(1) Request for Ex Parte Reexamination Transmittal Form;

(2) PTO 1449 Modified Form;

(3) Request for Ex Parte Reexamination Under 35 U.S.C. §§ 302-306; and

(4) Exhibits 1001-1006, 1010, 1012-1020, 1023-1030, and 1034-1038

in their entirety were served on:

Westman Champlin & Koehler, P.A.
121 South Eighth Street, Suite 1100
Minneapolis, MN 55402

the attorney of record for the assignee of U.S. Patent No. 8,130,775, in accordance with 37 C.F.R. § 1.510(b)(5), on the 12th day of March 2021.

/Theodore M. Foster/
Theodore M. Foster
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Juniper Exhibit 1008, page 309

Exhibit 1001

U.S. Patent No. 8,130,775 to Jounay *et al.*

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US008130775B2

(12) **United States Patent**
Jounay et al.

(10) **Patent No.: US 8,130,775 B2**
(45) **Date of Patent: Mar. 6, 2012**

(54) **MECHANISM FOR PROTECTING A PSEUDO-WIRE**

(75) Inventors: **Frederic Jounay**, Pleumeur Bodou (FR); **Philippe Niger**, Lannion (FR); **Arnaud Cauvin**, Paris (FR)

(73) Assignee: **France Telecom**, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 141 days.

(21) Appl. No.: **12/528,083**

(22) PCT Filed: **Feb. 26, 2008**

(86) PCT No.: **PCT/FR2008/050324**
§ 371 (c)(1),
(2), (4) Date: **Nov. 25, 2009**

(87) PCT Pub. No.: **WO2008/110735**
PCT Pub. Date: **Sep. 18, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 26, 2007 (FR) 07 53489

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/401**; 710/316; 379/242

(58) **Field of Classification Search** 370/401, 370/228, 389; 709/238
See application file for complete search history.

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M. Bocci (Alcatel); S. Bryant (Cisco Systems), "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge" IETF Standard-Working-Draft, Internet Engineering Task Force, IETF, vol. pwe3, No. 2, Oct. 20, 2006.
E. Mannie, D. Papadimitriou: "Recovery (Protection and Restoration) Terminology for Generalized Multi-Protocol Label Switching (GMPLS)" IETF Standard-Working-Draft, Internet Engineering Task Force, IETF, Oct. 5, 2004. L. Martini (Cisco Systems Inc); M. Bocci and F. Balus (Alcatel): "Dynamic Placement of Multi Segment Pseudo Wires" IETF Standard-Working-Draft, Internet Engineering Task Force, IETF, CH, vol. pwe3, No., Oct. 2, 2006.
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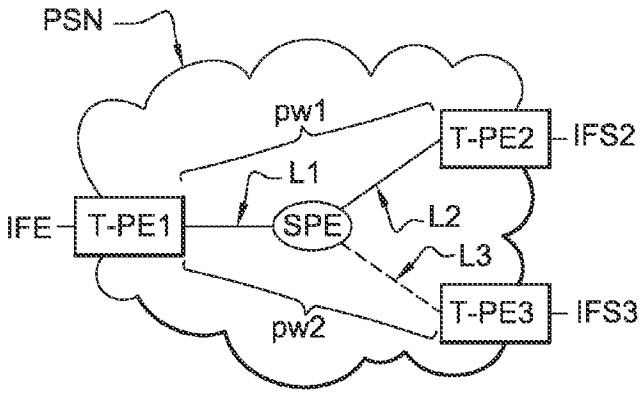
(57) **ABSTRACT**

A method is provided for setting up at least two pseudo-wires able to broadcast a stream of data, wherein a first pseudo-wire is set up between an input router of a packet-switched network and first output router of the packet-switched network, and a second pseudo-wire is set up between the input router and a second output router of the packet-switched network. A first link of the first pseudo-wire is set up between the first output router and an intermediate router of the packet-switched network. A second link of the second pseudo-wire is set up between the second output router and the intermediate router. A third link of both pseudo-wires is set up between the intermediate router and the input router.

9 Claims, 6 Drawing Sheets



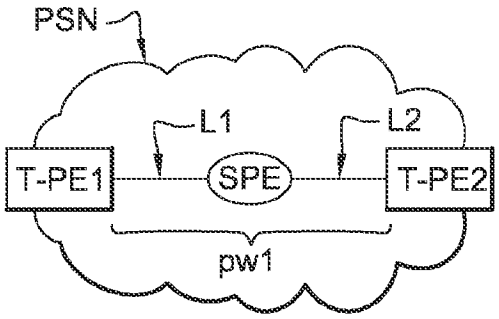
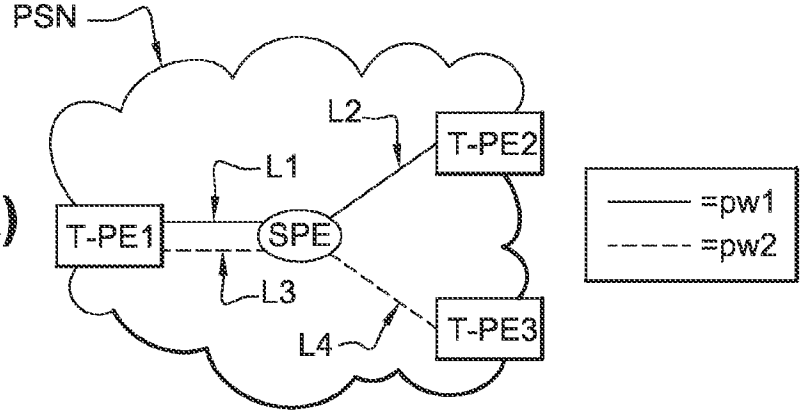


Fig. 1(AA)

Fig. 2(AA)



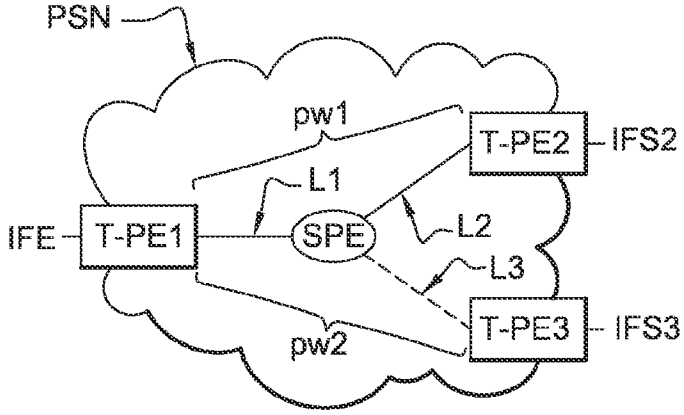


Fig. 3

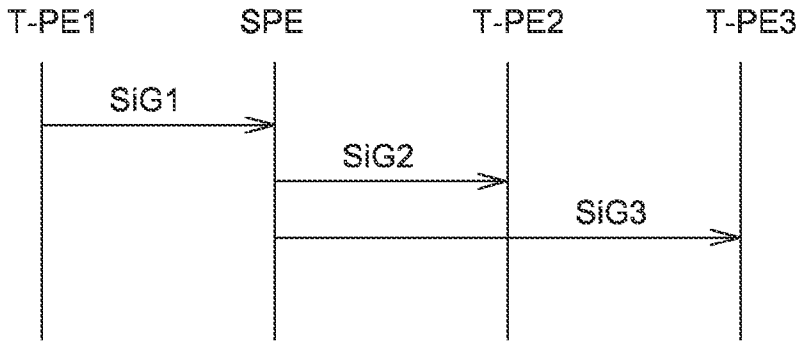


Fig. 4

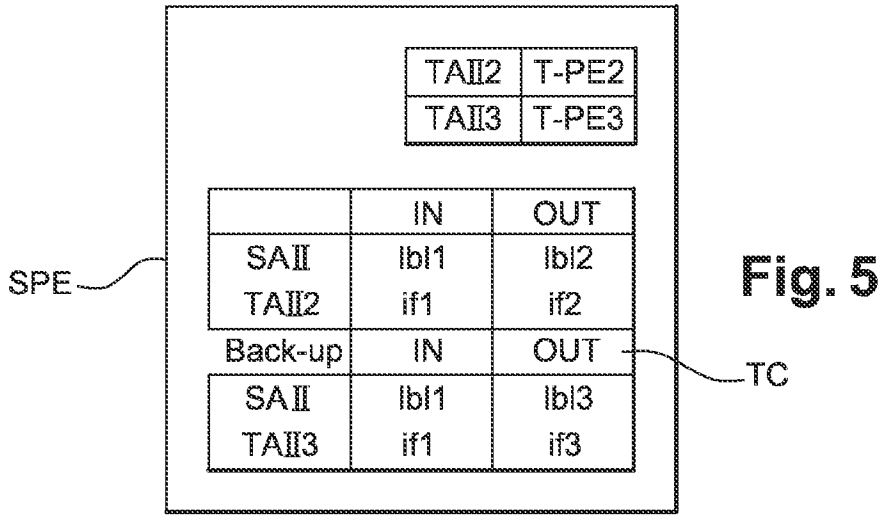


Fig. 5

SAII / IFE	TAII2 / IFS2	lbl1	TAII3 / IFS3	Back-up

Fig. 6A

SAII / IFE	TAII2 / IFS2	lbl2

Fig. 6B

SAII / IFE	TAII3 / IFS3	lbl3

Fig. 6C

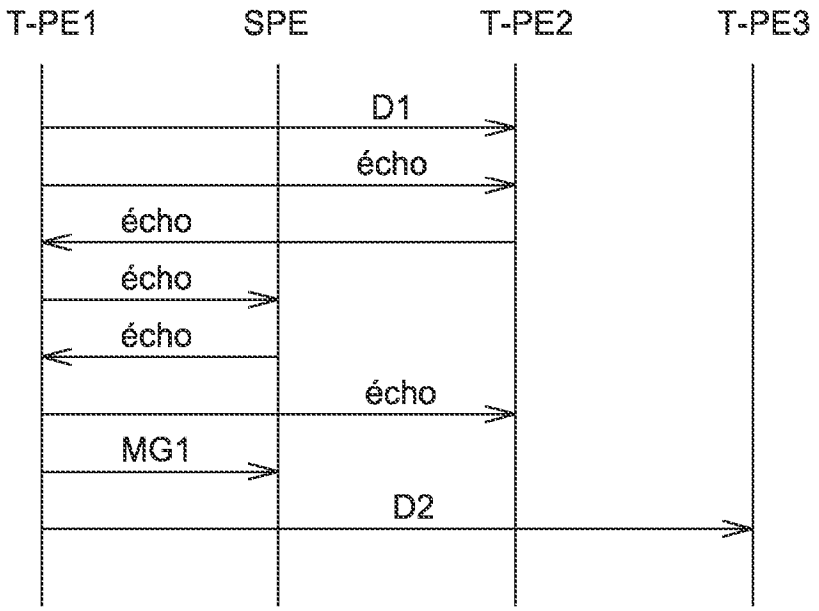

T-PE1
SPE
T-PE2
T-PE3
D1
écho
écho
écho
écho
écho
MG1
D2

Fig. 7

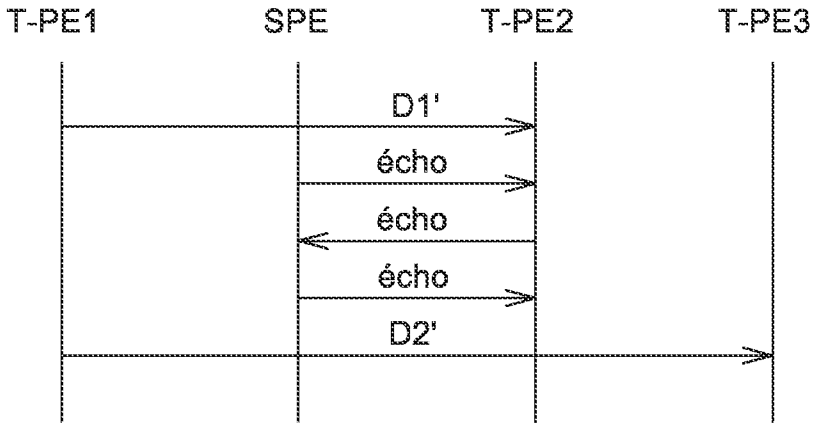

T-PE1
SPE
T-PE2
T-PE3
D1'
écho
écho
écho
D2'

Fig. 8

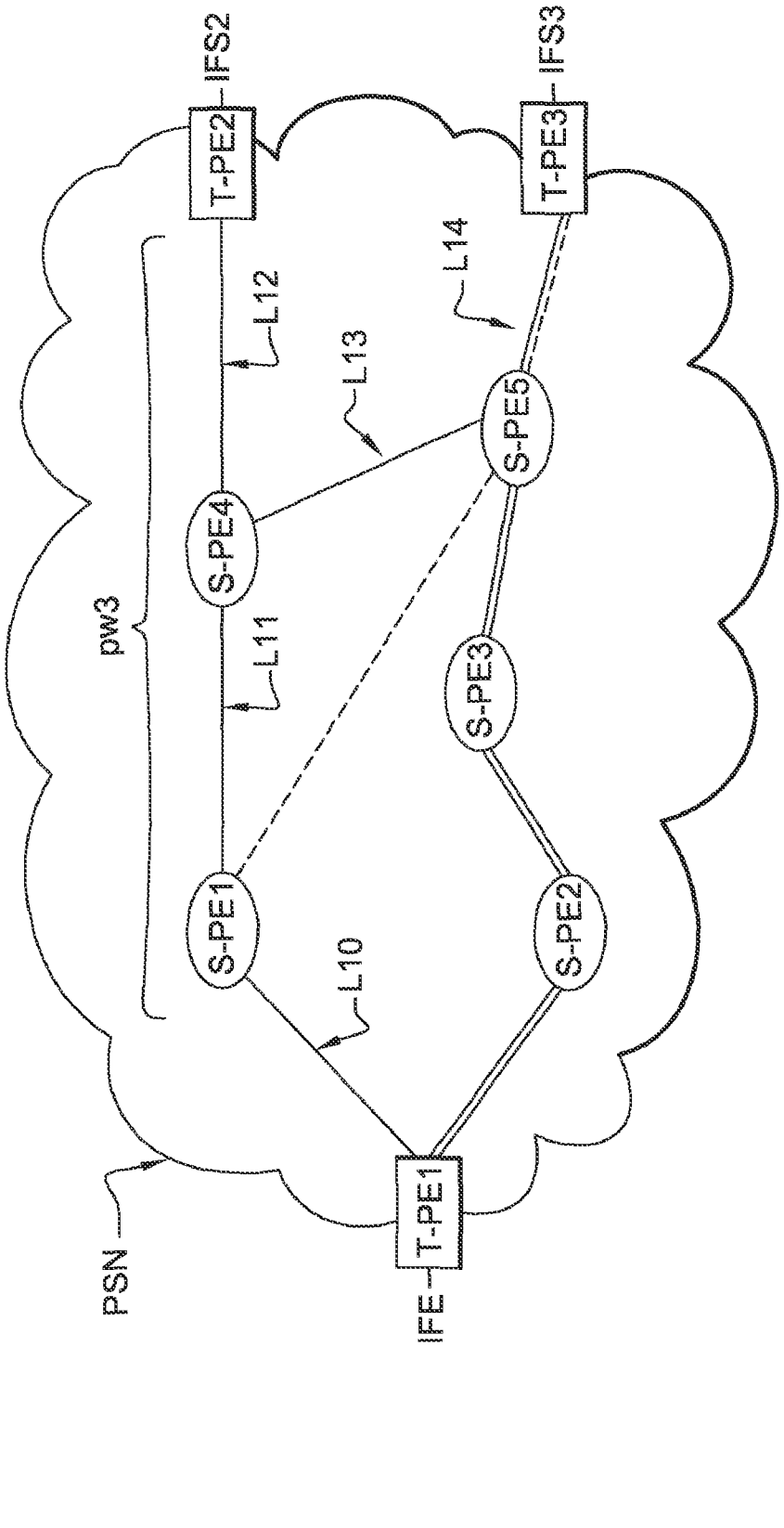

IFS2
IFS3
T-PE2
T-PE3
L12
L13
L14
S-PE5
S-PE4
pw3
L11
S-PE3
S-PE1
S-PE2
L10
PSN
T-PE1
IFE
=pw5

Fig. 9

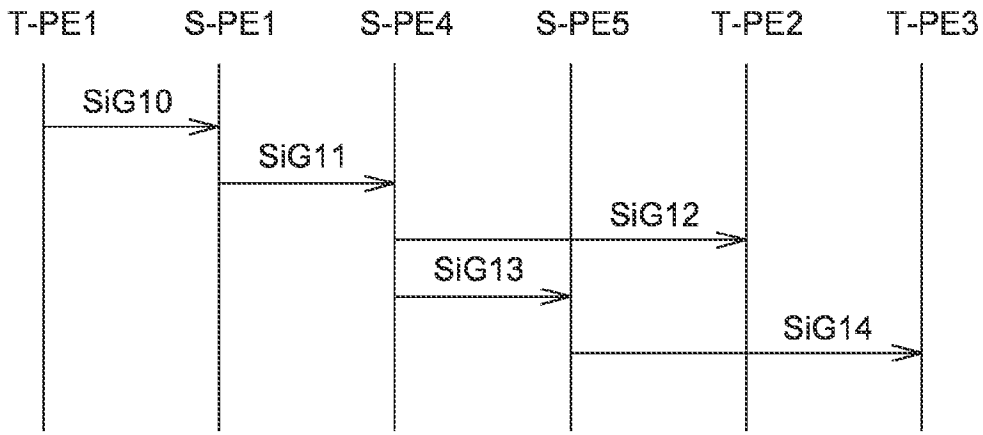


Fig. 10

SAII / IFe	TAII2 / IFS2	Ibl10	TAII3 / IFS3	Back-up	IdS-PE4

Fig. 11A

SAII / IFe	TAII2 / IFS2	Ibl12

Fig. 11B

SAII / IFe	TAII3 / IFS3	Ibl13

Fig. 11C

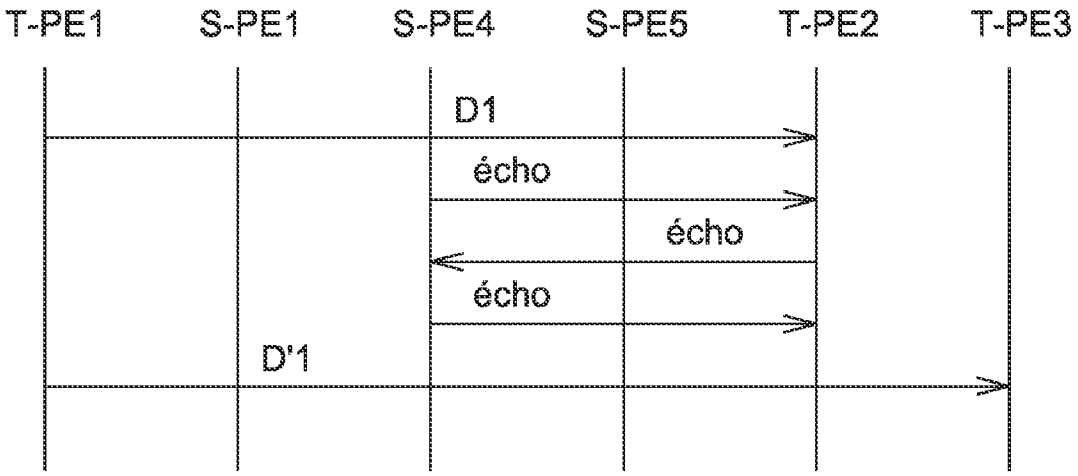


Fig. 12

MECHANISM FOR PROTECTING A PSEUDO-WIRE

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a Section 371 National Stage Application of International Application No. PCT/FR2008/050324, filed Feb. 26, 2008 and published as WO 2008/110735 on Sep. 18, 2008, not in English.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None.

THE NAMES OF PARTIES TO A JOINT RESEARCH AGREEMENT

None.

FIELD OF THE DISCLOSURE

The field of the disclosure is telecommunications, and more particularly packet-switched networks.

BACKGROUND OF THE DISCLOSURE

In a packet-switched network, data is transmitted in the form of packets processed by routers of the network until they reach their destination. Together the packets for transmission constitute a data stream.

One example of a technology used for routing data packets in packet-switched networks is the multi-protocol label switching (MPLS) technology. The MPLS technology adds one or more labels to the data packet headers, said labels containing information enabling the routers of the network to determine the next hop for a packet to reach its destination. The MPLS technology is described in more detail in Internet Engineering Task Force (IETF) Request For Comments (RFC) 3031.

However, the MPLS protocol can process only packets conforming to the Internet Protocol (IP).

To alleviate this problem, the IETF Pseudo-Wire Emulation Edge-To-Edge (PWE3) standardization group has defined a pseudo-wire concept for emulating a point-to-point link between two equipments of a packet-switched network based on the IP/MPLS technology. Such pseudo-wires, defined in the document RFC 3985, enable data packets to be transmitted that do not conform to the Internet Protocol, for example data packets conforming to the ATM protocol.

Referring to FIG. 1, a pseudo-wire pw1 is set up between a first router T-PE1 at the edge of a packet-switched network PSN and a second router T-PE2, also at the edge of the network PSN. A first link L1 that is part of the pseudo-wire pw1 is set up between the first router T-PE1 and an intermediate router S-PE of the network PSN. A second link L2 that is also part of the pseudo-wire pw1 is set up between the intermediate router S-PE and the second router T-PE2. The first router T-PE1 is called the input router and constitutes a first end of the pseudo-wire pw1 and the second router T-PE2 is called the output router and constitutes a second end of the pseudo-wire pw1. Once the pseudo-wire pw1 has been set up, the input router T-PE1 transmits a data stream routed via the pseudo-wire pw1 to the output router T-PE2. This kind of pseudo-wire pw1 is defined in more detail in the document

"An Architecture for Multi-Segment Pseudo-Wire Emulation Edge-to-Edge" (draft-ietf-pwe3-ms-pw-arch-02.txt).

To ensure continuity of service in the event of a fault affecting the output router, the working group PWE3 proposes a solution that backs up the first pseudo-wire set up between the input router and the output router by a second pseudo-wire serving as a back-up pseudo-wire so that, in the event of a fault affecting the output router constituting one end of the first pseudo-wire, the data packets are routed by the back-up pseudo-wire, one end of which consists of a different output router.

Accordingly, referring to FIG. 2, a first pseudo-wire pw1 is set up between an input router T-PE1 at the edge of a packet-switched network PSN and an output router T-PE2 also at the edge of the network PSN. A first link L1 that is part of the pseudo-wire pw1 is set up between the input router T-PE1 and an intermediate router S-PE of the network PSN. A second link L2 that is also part of the pseudo-wire pw1 is set up between the intermediate router S-PE and the output router T-PE2. A second pseudo-wire pw2 is then set up between the input router T-PE1 constituting a first end of the pseudo-wire and a second output router T-PE3 constituting a second end of the pseudo-wire. A first link L3 that is part of the second pseudo-wire is set up between the input router T-PE1 and the intermediate router S-PE and a second link L4 that is also part of the second pseudo-wire is set up between the intermediate router S-PE and the second output router T-PE3.

To ensure continuity of service, the input router T-PE1 includes a function for detecting a fault affecting the first output router T-PE2 and a function for switching the data stream from the first pseudo-wire pw1 to the second pseudo-wire pw2.

A fault affecting the first output router T-PE2 is detected in the input router T-PE1, for example from a message indicating the occurrence of a fault sent via the public switched network PSN to the input router T-PE1. Once informed of the fault, the input router T-PE1 triggers switching of the data stream from the first pseudo-wire pw1 to the second pseudo-wire pw2, thus routing the data to the output router T-PE3.

However, this kind of solution has the drawback of consuming network resources, for example processing resources in the network equipments (storage capacity, computation capacity, etc.), signaling streams for setting-up two pseudo-wires, and bandwidth, especially between the input router and the intermediate router. This increases the restore time in the event of a fault affecting an output router, with a negative impact on quality of service.

SUMMARY

The solution proposed in the context of an exemplary embodiment of the invention is free of those problems of the prior art.

An embodiment is based on a method of setting up at least two pseudo-wires able to broadcast a data stream wherein a first pseudo-wire is set up between an input router of a packet-switched network and a first output router of said packet-switched network, the second pseudo-wire is set up between said input router and a second output router of said packet-switched network, a first link that is part of the first pseudo-wire is set up between the first output router and an intermediate router of said packet-switched network, and a second link that is part of the second pseudo-wire is set up between said second output router and said intermediate router.

This kind of setting up method is noteworthy in that a third link that is part of the two pseudo-wires is set up between said intermediate router and said input router.

This optimizes the use of network resources, for example bandwidth, between the input router and the intermediate router by setting up between them a single link common to the two pseudo-wires. This solution has never been envisaged in the prior art. In the prior art, when a main pseudo-wire and a back-up pseudo-wire are set up between an input router and a first, respectively a second, output router, a link is set up between the input router and the intermediate router for each pseudo-wire, i.e. two links. The person skilled in the art has always considered a pseudo-wire as a point-to-point link set up between an input router and an output router, with the result that each input router/output router pair is associated with a pseudo-wire. Moreover, this kind of approach is recommended in the standards.

Going against this received wisdom of the person skilled in the art, the inventors of the present application propose, in contrast, to share the link set up between the input router and the intermediate router, which improves the use of network resources and reduces the restore time in the event of a fault affecting the first output router. In the prior art, the back-up pseudo-wire, although used only to broadcast data in the event of a fault affecting the main pseudo-wire, reserves resources used to set it up over the whole of the network between the input router and the output router. Because the main pseudo-wire and the back-up pseudo-wire share the link set up between the input router and the intermediate router, the network resources that in the past were reserved for the back-up pseudo-wire are released and can be used in a manner closer to the optimum.

In this kind of embodiment, the first, second, and third links are not necessarily direct links between routers. For example, the second link set up between the intermediate router and the first output router can comprise one or more hops and possibly pass through one or more other intermediate routers before reaching the output router. The same applies to the link set up between the input router and the intermediate router and to the link set up between the intermediate router and the second output router.

The data broadcast on the pseudo-wires can be payload data, for example an ATM stream transporting a service, or service data, for example a message indicating detection of a fault affecting a network equipment. Accordingly, in the situation of exchanging service data, the solution proposed in the present application makes the network equipments more responsive.

According to one feature of the method of an embodiment of the invention, the pseudo-wires are set up at the initiative of said input router by sending said intermediate router a message for setting-up said third link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire.

In this kind of embodiment, setting up the pseudo-wires is at the initiative of the input router. It is assumed, in the context of an embodiment of the invention, that in order to be able to initiate the setting up of the main and back-up pseudo-wires the input router has in a routing table information on the hops to reach the first and second output routers. By means of this information, the input router knows to which router of the network it must send the pseudo-wire set-up message, which router is then considered the intermediate router. It is then necessary to configure only the input router, which reduces network maintenance. The parameter in the set-up message indicating that the second pseudo-wire is a back-up pseudo-wire enables the intermediate router to be configured for subsequent broadcasting of data.

An embodiment of the invention also relates to a method of broadcasting data streams between an input router of a packet-switched network and a first output router of said packet-switched network, wherein a data stream is broadcast on a first pseudo-wire comprising a first link set up between said input router and an intermediate router of said packet-switched network and a second link set up between said intermediate router and said first output router, said method including a step of detecting a fault affecting said first output router.

Moreover, a method of this kind includes a step, on reception by the intermediate router of information relating to a fault, of switching the data stream to a third link set up between said intermediate router and a second output router, said first link and said third link constituting a second pseudo-wire.

An embodiment of this kind improves the restore time in the event of a fault affecting the first output router because the data stream is switched as close as possible to the fault.

An embodiment of the invention further comprises a router adapted to be connected by a first link to an input router of a packet-switched network and by a second link to a first output router of said packet-switched network, said first and second links constituting a first pseudo-wire able to broadcast a data stream, the router being characterized in that it includes:

- means for receiving a first message for setting up the first link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of a second output router of said network;
- means for sending a second message for setting up said second link between said router and said first output router and a third message for setting up a third link between said router and said second output router, the second message including the identifier of said input router and the identifier of said first output router, the third message including the identifier of said input router and the identifier of said second output router, and said first and third links constituting a second pseudo-wire;
- means for configuring at least one switching table for said broadcasting with a parameter specifying that the second pseudo-wire is a back-up pseudo-wire, said parameter being included in the first set-up message.

This kind of intermediate router is able, on reception of a set-up message sent by the input router, to set up two pseudo-wires having a shared link between the input router and the output router and then its own link between the intermediate router and a first, respectively a second, output router. This optimizes use of the resources of the network between the first router and the intermediate router, which improves the restore time on detection of a fault affecting the first output router.

According to another feature, the router of an embodiment of the invention includes means for detecting a fault affecting said first output router and means for switching the data stream from the second link to the third link.

Providing in the intermediate router a function for detecting a fault affecting the first output router and a function for switching the data stream improves the restore time on detection of a fault affecting the first output router.

This improves the responsiveness of the network because detection occurs as close as possible to the fault. Accordingly, a fault affecting the first output router is detected more quickly, as the information does not have to cross the network as far as the input router before being processed. The function for switching the data stream also being a function of the intermediate router, switching the data stream to the third link, set up between the intermediate router and the second output router and with the first link constituting the back-up

pseudo-wire, occurs faster because it is triggered on detection of the fault by the intermediate router.

This kind of solution reduces the quantity of data lost following a fault affecting the first output router.

An embodiment of the invention relates to a computer program product downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a processor, characterized in that it comprises program code instructions for implementing the setting-up method of an embodiment of the invention when said program is executed by a computer.

An embodiment of the invention relates to a second computer program product downloadable from a communications network and/or stored on a computer-readable medium and/or executable by a processor, characterized in that it comprises program code instructions for implementing the broadcasting method of an embodiment of the invention when said program is executed by a computer.

An embodiment of the invention relates finally to a signal adapted to be transmitted between an input router of a packet-switched network and an intermediate router of said packet-switched network, said signal carrying a message for setting up at least two pseudo-wires able to broadcast a stream of data, the first pseudo-wire being set up between said input router and a first output router of said packet-switched network, the second pseudo-wire being set up between said input router and a second output router of said packet-switched network, said set-up message including:

- an identifier of said input router;
- an identifier of said first output router;
- a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages become apparent on reading the description of preferred embodiments given with reference to the drawings, in which:

FIG. **1** represents a pseudo-wire set up as in the prior art between an input router and an output router of a packet-switched network;

FIG. **2** represents a solution implemented in the prior art to ensure continuity of service in a packet-switched network;

FIG. **3** represents two pseudo-wires set up by the method of an embodiment of the invention;

FIG. **4** is a timing diagram of the exchange of requests firstly between an input router and an intermediate router of a packet-switched network and secondly between the intermediate router and first and second output routers in order to set up pseudo-wires by the method of an embodiment of the invention;

FIG. **5** represents diagrammatically routing and switching tables of an intermediate router of an embodiment of the invention;

FIGS. **6**A, **6**B, and **6**C represent set-up messages used in the setting-up method of an embodiment of the invention;

FIG. **7** is a timing diagram of the exchange of messages in a first embodiment of the invention firstly between an input router and an intermediate router of a packet-switched network and secondly between the input router and first and second output routers when broadcasting data on pseudo-wires set up in the packet-switched network;

FIG. **8** is a timing diagram of the exchange of messages in a second embodiment of the invention firstly between an input router and an intermediate router of a packet-switched network and secondly between the input router and first and second output routers when broadcasting data on pseudo-wires set up in the packet-switched network;

FIG. **9** shows two pseudo-wires set up by a method conforming to a third embodiment of the invention;

FIG. **10** is a timing diagram of the exchange of requests firstly between a first edge router and intermediate routers of a packet-switched network and secondly between the intermediate routers and second and third edge routers in order to set up pseudo-wires by the method conforming to the third embodiment of the invention;

FIGS. **11**A, **11**B, **11**C represent set-up messages used in the method conforming to the third embodiment of the invention;

FIG. **12** is a timing diagram of the exchange of messages firstly between an edge router and an intermediate router of a packet-switched network and secondly between the intermediate router and second and third edge routers when broadcasting data on pseudo-wires set up in the packet-switched network in accordance with the third embodiment of the invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

FIG. **3** represents a connection set up between an input router T-PE**1** and two output routers T-PE**2** and T-PE**3**, each of these three routers being at the edge of a packet-switched network PSN.

Referring to this figure, a first link L**1** is set up between the input router T-PE**1** and an intermediate router S-PE of the network PSN. A second link L**2** is set up between the intermediate router S-PE and the first output router T-PE**2**. The first and second links constitute a first pseudo-wire pw**1** setting up a connection between the input router T-PE**1** and the first output router T-PE**2**. The pseudo-wire pw**1** set up in this way is used to broadcast data streams divided into packets between the input router T-PE**1** and the first output router T-PE**2**.

A second pseudo-wire pw**2** is set up between the input router T-PE**1** and the second output router T-PE**3**. The pseudo-wire pw**2** consists of the first link L**1** and a second link L**3** set up between the intermediate router S-PE and the second output router T-PE**3**.

Accordingly, the first link L**1** is shared by the two pseudo-wires pw**1** and pw**2**. This optimizes the use of network resources, such as bandwidth, between the input router T-PE**1** and the intermediate router S-PE, as only one link is set up between these two routers.

One example of application of an embodiment of the invention is collecting traffic for a mobile network. In this kind of example, the input router T-PE**1** is connected to a first equipment such as a base station (not represented in the figures), for which it sends data to other aggregation equipments such as a radio network controller RNC connected to the output routers T-PE**2** and T-PE**3**.

FIG. **4** is a timing diagram of the exchange of messages between the input router T-PE**1**, the intermediate router S-PE, and the output routers T-PE**2** and T-PE**3** when setting up the pseudo-wires pw**1** and pw**2**.

According to an embodiment of the invention, the pseudo-wires pw**1** and pw**2** are set up at the initiative of the input router T-PE**1** and setting them up is based on the exchange of set-up messages conforming to the label distribution protocol (LDP) as defined in the documents RFC 3036 and RFC 4477. Accordingly, a first set-up message SIG**1** is sent by the input router T-PE**1** to the intermediate router S-PE. This first set-up message includes an identifier SAII of the input router T-PE**1**,

Juniper Exhibit 1008, page 320

an identifier of an input interface IFE associated with an equipment connected to the input router, an identifier TAI2 of the first output router T-PE2, an identifier of an output interface IFS2 associated with an equipment connected to the first output router T-PE2, and a field containing an identifier TAI3 of the second output router T-PE3, an identifier of an output interface IFS3 associated with an equipment connected to the first output router T-PE3, and a "backup" parameter specifying that the second pseudo-wire is a back-up pseudo-wire. FIG. 6A shows one such setting up message SIG1.

A forwarding equivalent class (FEC) consists of the pair {identifier SAII of input router T-PE1/associated input interface IFE; identifier TAI2 of first output router T-PE2/associated output interface IFS2}. This information is necessary for setting up a pseudo-wire. The pair consisting of the identifier SAII of the input router T-PE1/associated input interface IFE and the identifier TAI3/associated output interface IFS of the first output router T-PE3 also constitutes an FEC.

The first set-up message SIG1 differs from a standard pseudo-wire set-up message because it includes additional data such as the identifier TAI3 of the second output router T-PE3 and the "backup" parameter indicating the nature of the second pseudo-wire pw2 to be set up.

The set-up message SIG1 also includes a label lb11 associated with the first link L1. This label is used by the input router T-PE1 and the intermediate router S-PE when broadcasting data streams. It is added by the input router T-PE1 to each packet of data to be sent to the first output router T-PE2.

Referring to FIG. 5, on reception of the first set-up message SIG1, the intermediate router S-PE extracts the identifier of the input router T-PE1, the identifier of the first output router T-PE2, and the information contained in the additional field of the message SIG1, namely the identifier of the second output router T-PE3 and the "backup" parameter.

The intermediate router S-PE uses this information to fill in a switching table TC. This switching table TC includes for a given FEC information indicating the label that must be inserted into the header of the message in order to perform the next hop and the output interface if2, if3 to which to direct the data streams. The "backup" parameter indicating the nature of the second pseudo-wire pw2 is also entered into the switching table TC.

Once the switching table TC has been filled in, the intermediate router sends two set-up messages SIG2 and SIG3. The set-up message SIG2 is sent to the first output router T-PE2 and the set-up message SIG3 is sent to the second output router T-PE3.

The message SIG2 includes the identifier SAII of the input router T-PE1, the identifier of an input interface IFE associated with an equipment connected to the input router, the identifier TAI2 of the first output router T-PE2, the identifier of an output interfere IFS2 associated with an equipment connected to the first output router T-PE2, and the label lb12 associated with the link L2 and used when broadcasting data. FIG. 6B shows a message of this kind.

The message SIG3 includes the identifier SAII of the input router T-PE1, the identifier of an input interface IFE associated with an equipment connected to the input router, the identifier TAI3 of the second output router T-PE3, the identifier of an output interface IFS3 associated with an equipment connected to the second output router T-PE3, and the label lb13 associated with the link L3 and used when broadcasting data. FIG. 6C shows a message of this kind.

Once the pseudo-wires pw1 and pw2 have been set up, data streams are broadcast between the input router T-PE1 and the first output router T-PE2.

On reception of a data packet sent by the input router T-PE1, the intermediate router S-PE uses the label added to the packet by the input router to determine to which output interface if2, if3 to direct the data packet, as a function of the information contained in the switching table TC. The packets sent to the first output router T-PE2 are directed to the interface if2 of the intermediate router S-PE. This interface if2 constitutes a first end of the link L2. Before the data packet is sent to the first output router T-PE2, the new label lb2 is added to the packet.

FIG. 7 represents a timing diagram of the exchange of messages between the input router T-PE1, the intermediate router S-PE, the first output router T-PE2, and the second output router T-PE3 when broadcasting data streams in a first embodiment of the invention.

A data stream D1 is sent by the input router T-PE1 to the first output router T-PE2. This first data stream is broadcast over the network PSN by means of the first pseudo-wire pw1.

To ensure continuity of service, the input router T-PE1 includes a function for detecting a fault affecting the first output router T-PE2. In order to detect this kind of fault, the input router T-PE1 regularly exchanges "echo" messages with the first output router T-PE2 and with the intermediate router S-PE.

If the input router does not receive a response to an "echo" message, it deduces that the first output router T-PE2 or the intermediate router S-PE is faulty.

If the faulty router is the first output router T-PE1, it then sends the intermediate router S-PE a switching message MG1. On reception of this message, the intermediate router S-PE switches the data streams to the link L3.

A data stream D2 sent by the input router T-PE1 following detection of a fault affecting the first output router T-PE2 is then broadcast by the second pseudo-wire pw2 and received by the second output router T-PE3.

FIG. 8 is a timing diagram of the exchange of messages between the input router T-PE1, the intermediate router S-PE, the first output router T-PE2, and the second output router T-PE3 when broadcasting data streams in a second embodiment of the invention.

A data stream D1' is sent by the input router T-PE1 to the first output router T-PE2. This data stream is broadcast over the network PSN by the first pseudo-wire pw1.

To ensure continuity of service, the intermediate router S-PE includes a function for detecting a fault affecting the first output router T-PE2. In order to detect such a fault, the intermediate router S-PE regularly exchanges "echo" messages with the first output router T-PE2.

If the intermediate router does not receive a response to its "echo" message, it deduces that the first output router T-PE2 is faulty. It then switches the data streams coming from the input router T-PE1 to the link L3 and advises the input router T-PE1 of this.

Thus a data stream D2' sent by the input router T-PE1 after detection of the fault affecting the first output router is then broadcast by the second pseudo-wire pw2 and received by the second output router T-PE3.

FIG. 9 represents a packet-switched communications network PNS comprising a plurality of edge routers T-PE1, T-PE2, and T-PE3 and a plurality of intermediate routers S-PE1 to S-PE5. In such a network, a connection is set up between an input router T-PE1 and first and second output routers T-PE2 and T-PE3, each of these three routers being at the edge of a packet-switched network PSN.

Referring to this figure, a first link L10 is set up between the input router T-PE1 and a first intermediate router S-PE1 of the PSN. A second link L11 is set up between the first interme-

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diate router S-PE1 and a second intermediate router S-PE4. A third link L12 is set up between the second intermediate router S-PE4 and the first output router T-PE2. The first connection 10, the second connection 11, and the third connection 12 constitute a first pseudo-wire pw3, referred to as the main pseudo-wire, setting up a connection between the input router T-PE1 and the first output router T-PE2. The pseudo-wire pw3 set up in this way is used to broadcast data streams divided into packets between the input router T-PE1 and the first output router T-PE2.

A second pseudo-wire pw4, called the back-up pseudo-wire, is set up between the input router T-PE1 and the second output router T-PE3. The pseudo-wire pw4 consists of the first link L10, the second link L11, and a third link L13 set up between a third intermediate router S-PE5 and the second output router T-PE3.

Accordingly, the link L10 and the link L11 are shared by the two pseudo-wires pw3 and pw4. This optimizes use of network resources, such as bandwidth, between the input router T-PE1 and the second intermediate router S-PE4.

FIG. 10 represents a timing diagram for the exchange of messages between the input router T-PE1, the first, second, and third intermediate routers S-PE1, S-PE4, and S-PE5, and the first and second output routers T-PE2 and T-PE3 when setting up the pseudo-wires pw3 and pw4.

According to an embodiment of the invention, the pseudo-wires pw3 and pw4 are set up at the initiative of the input router T-PE1 and setting them up relies on the exchange of LDP set-up messages. Thus a first set-up message SIG10 is sent by the input router T-PE1 to the first intermediate router S-PE1. This first set-up message includes an identifier SAI1 of the input router T-PE1, an identifier of an input interface IFE associated with an equipment connected to the input router, an identifier TAI2 of the first output router T-PE2, an identifier of an output interface IFS2 associated with an equipment connected to the first output router T-PE2, and a field containing an identifier TAI3 of the second output router T-PE3, an identifier of an output interface IFS3 associated with an equipment connected to the second output router T-PE3, a "backup" parameter specifying that the second pseudo-wire pw4 is a back-up pseudo-wire, and an identifier of an intermediate router S-PE4 handling switching from the first pseudo-wire pw3 to the second pseudo-wire pw4 in the event of a fault affecting the third link L12 that is part of the pseudo-wire pw3. FIG. 11A represents one such-set up message SIG10.

The set-up message SIG10 can contain a plurality of identifiers of output routers to be reached in the event of a fault affecting a link of the first pseudo-wire pw3. Such a message contains as many "backup" parameters as there are output routers to be reached and therefore as there are back-up pseudo-wires to be set up.

A set-up message SIG10 can also contain an additional field containing an explicit list of intermediate routers between which the links of the first pseudo-wire pw3 must be set up.

The set-up message SIG10 also contains a label lb110. This label is used by the input router T-PE1 and the first intermediate router S-PE1 when broadcasting data streams from the intermediate router S-PE1 to the input router T-PE1. It is added by the first intermediate router S-PE1 to each data packet to be sent to the input router T-PE1

On reception of the first set-up message SIG10, the intermediate router S-PE1 extracts the identifier of the input router T-PE1, the identifier of the first output router T-PE2, and where appropriate the explicit list of intermediate routers between which the links of the first pseudo-wire pw3 must be set up.

The first intermediate router S-PE1 uses this information to fill out an intermediate table. This intermediate table contains for a given FEC information indicating the label that must be inserted into the header of the message in order to perform the next hop and the output interface to which to direct the data streams.

Once the switching table has been filled out, the first intermediate router sends a second set-up message SIG11 to the second intermediate router S-PE4.

The hop that the set-up message SIG11 must perform to reach the second intermediate router S-PE4 is determined by the routing information contained in the switching table TC of the intermediate router S-PE1

The set-up message SIG10 can optionally also contain this kind of additional field for each back-up pseudo-wire to be set up, thus specifying the intermediate routers between which the links of the pseudo-wires are set up.

The message SIG11 is identical to the message SIG10; the label lb112 to be used when broadcasting data is the only thing that differs between the two messages.

The information relating to the back-up pseudo-wire pw4, such as the identifier of the intermediate router to effect switching from the first pseudo-wire pw3 to the back-up pseudo-wire pw4, is sent from one intermediate router to another until it reaches the intermediate router that is to effect the switching.

On reception of this set-up message SIG11, the intermediate router S-PE4 extracts the identifier of the input router T-PE1, the identifier of the first output router T-PE2, and where appropriate the explicit list of intermediate routers between which the links of the first pseudo-wire pw3 must be set up. The "backup" parameter indicating the nature of the second pseudo-wire pw4 is also entered into the switching table.

Once the switching table of the intermediate router S-PE4 has been filled out, said router sends two set-up messages SIG12 and SIG13 to the first output router T-PE2 and the third intermediate router S-PE5, respectively.

The message SIG12 contains the identifier SA11 of the input router T-PE1, the identifier of an input interface IFE associated with an equipment connected to the input router, the identifier TA112 of the first output router T-PE2, the identifier of an output interface IFS2 associated with an equipment connected to the first output router T-PE2, and the label lb112 to be associated with the link L12 and used when broadcasting data. FIG. 11B represents such a message.

The message SIG13 contains the identifier SAII of the input router T-PE1, the identifier of an input interface IFE associated with an equipment connected to the input router, the identifier TAII3, the identifier of an output interface IFS3 associated with an equipment connected to the second output router T-PE3, and the label lb113 associated with the link L13 to be set up and used when broadcasting data. FIG. 11C shows such a message. Such a message can contain an explicit list of intermediate routers between which the links of the second pseudo-wire pw4 must be set up to connect the intermediate router S-PE4 to the second output router T-PE3.

Once the pseudo-wires pw3 and pw4 have been set up, the data streams are broadcast between the input router T-PE1 and the first output router T-PE2.

On reception of a data packet sent by the input router T-PE1, the first intermediate router S-PE1 uses the label added to the packet by the router T-PE1 to determine to which output interface if2, if3 to direct the data packet, as a function

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of the information contained in the switching table TC. The packets sent to the first output router T-PE2 are directed to the interface if2 of the first intermediate router S-PE1. This interface if2 constitutes a first end of the link L10. Before the data packet is sent to the second intermediate router S-PE4, the new label lb11 is added to the data packet.

FIG. 12 is a timing diagram of the exchange of messages between the input router T-PE1, the first intermediate router S-PE1, the second intermediate router S-PE4, the third intermediate router S-PE5, the first output router T-PE2, and the second output router T-PE3 when broadcasting data streams.

A data stream D1 is sent by the input router T-PE1 to the first output router T-PE2. This data stream is broadcast over the network PSN by means of the first pseudo-wire pw3.

To ensure continuity of service, the intermediate router S-PE4 includes a function for detecting a fault affecting the first output router T-PE2. To detect such a fault, the intermediate router S-PE4 regularly exchanges "echo" messages with the first output router T-PE2.

If the input router does not receive a response to its "echo" message, it deduces that the first output router T-PE2 is faulty. It then switches the data streams coming from the input router T-PE1 onto the link L12 and advises the input router T-PE1 of this.

Accordingly, a data stream D'1 sent by the input router T-PE1 following detection of the a fault affecting the first output router T-PE2 is then broadcast by the second pseudo-wire pw4 and received by the second output router T-PE3.

An embodiment of the invention also protects the network from a fault affecting one of the links of the first pseudo-wire pw3 or one of the intermediate routers of the network PSN.

For example, when setting up the first pseudo-wire pw3, the set-up message SIG10 contains, in addition to the information necessary for setting up the back-up pseudo-wire pw4, such as the identifier TAII3 of the second output router T-PE3, the "backup" parameter, and the identifier of the intermediate router S-PE4, additional information necessary for setting up a third or back-up pseudo-wire pw5 (represented in dashed line in FIG. 9).

This information consists of the identifier TAII3 of the second output router T-PE3, the identifier of an output interface IFS3 associated with an equipment connected to the second output router T-PE3, a "backup" parameter specifying that the third pseudo-wire pw5 is a back-up pseudo-wire, and an identifier of an intermediate router S-PE5 effecting switching from the first pseudo-wire pw3 to the third pseudo-wire pw5 in the event of a fault affecting the second link L11 of the pseudo-wire pw3 or the intermediate router S-PE4.

Accordingly, if the intermediate router S-PE1 detects a fault affecting the link L11 or the intermediate router S-PE4, it advises the input router T-PE1 of this and switches the data stream to be broadcast to the third pseudo-wire pw5.

Finally, an embodiment of the invention further includes a computer program, notably a computer program on or in an information medium or memory, adapted to implement an embodiment of the invention. This program can use any programming language and take the form of source code, object code or a code intermediate between source code and object code, such as a partially-compiled form, or any other desirable form for implementing a method of an embodiment of the invention.

The information medium can be any entity or device capable of storing the program. For example, the medium can include storage means, such as a ROM, for example a CD ROM or a micro-electronic circuit ROM, or magnetic storage means, for example a floppy disk or a hard disk.

Moreover, the information medium can be a transmissible medium such as an electrical or optical signal, which can be routed via an electrical or optical cable, by radio or by other means. The program of an embodiment of the invention can in particular be downloaded over an Internet-type network.

Although the present disclosure has been described with reference to one or more examples, workers skilled in the art will recognize that changes may be made in form and detail without departing from the scope of the disclosure and/or the appended claims.

The invention claimed is:

1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

2. The method according to claim 1, wherein the steps of setting up the first and second pseudo-wires are performed at the initiative of said input router by sending said intermediate router a message for setting-up said third link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire.

3. A method of broadcasting a data streams over a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of said packet-switched network and a second link set up between said intermediate router and a first output router of said packet-switched network, said method comprising:

a step of detecting a fault affecting the first output router; and

on reception of information on a fault affecting said first output router, a step of switching the data stream to a second pseudo-wire comprising said first link and a third link set up between said intermediate router and a second output router of said packet-switched network, said first link being shared by the first and second pseudo-wires.

4. An intermediate router configured to be connected by a first link to an input router of a packet-switched network and by a second link to a first output router of said packet-switched network, said first and second links constituting a first pseudo-wire able to broadcast a data stream, the intermediate router comprising:

means for receiving a first message for setting up the first link including an identifier of said input router, an identifier of said first output router, and a field containing an identifier of a second output router of said network;

means for sending a second message for setting up said second link between said intermediate router and said first output router and a third message for setting up a third link between said intermediate router and said second output router, the second message including the identifier of said input router and the identifier of said first output router, the third message including the iden-

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tifier of said input router and the identifier of said second output router, and said first and third links constituting a second pseudo-wire;

means for configuring at least one switching table for said broadcasting with a parameter specifying that the second pseudo-wire is a back-up pseudo-wire, said parameter being included in the first set-up message.

5. The intermediate router according to claim **4**, wherein the intermediate router includes means for detecting a fault affecting said first output router and means for switching the stream of data from the second link to the third link.

6. A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:

setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

7. A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of broadcasting a data streams over a first pseudo-wire when said program is executed by a computer, wherein the first pseudo-wire comprises a first link set up between an input router of a packet-switched network and an intermediate router of said packet-switched network and a second link set up between said intermediate router and a first output router of said packet-switched network, the program code instructions comprising instructions for:

detecting a fault affecting the first output router; and on reception of information on a fault affecting said first output router, switching the data stream to a second pseudo-wire comprising said first link and a third link set up between said intermediate router and a second output router of said packet-switched network, said first link being shared by the first and second pseudo-wires.

8. A method comprising:

generating a signal configured to be transmitted between an input router of a packet-switched network and an intermediate router of said packet-switched network, said signal carrying a message for setting up at least two pseudo-wires able to broadcast a stream of data, a first pseudo-wire being set up between said input router and a first output router of said packet-switched network, a second pseudo-wire being set up between said input router and a second output router of said packet-switched network, said set-up message including:

an identifier of said input router;

an identifier of said first output router; and

a field containing an identifier of said second output router and a parameter specifying that the second pseudo-wire is a back-up pseudo-wire; and transmitting the signal between the input router of the packet-switched network and the intermediate router of said packet-switched network.

9. The method according to claim **8**, wherein the field further contains an identifier of said intermediate router.

* * * * *

Exhibit 1003

Declaration of Henry Houh under 37 C.F.R. § 1.68

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC.,

Petitioner

IPR2020-01226
U.S. Patent No. 8,130,775

DECLARATION OF HENRY HOUH, UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW

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I, Henry Houh, do hereby declare as follows:

I. Introduction

1. I am making this declaration at the request of Cisco Systems, Inc. in the matter of the *Inter Partes* Review of U.S. Patent No. 8,130,775 ("the '775 patent") to Jounay et al.

2. I am being compensated for my work in this matter at my standard hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

3. I have been asked to provide my opinions regarding whether claims 1 and 6 ("the Challenged Claims") of the '775 patent are unpatentable as they would have been obvious to a person having ordinary skill in the art ("POSITA") at the time of the alleged invention, in light of the prior art. It is my opinion that all of the limitations of claims 1 and 6 would have been obvious to a POSITA.

4. In the preparation of this declaration, I have studied:

a. the 8,130,775 patent, Ex. 1001;

b. the prosecution history of the '775 patent ("'775 File History"), Ex. 1002;

c. U.S. Patent No. 7,602,702 to Aggarwal ("Aggarwal"), Ex. 1005; and

d. Iftekhar Hussain, "*Fault-Tolerant IP and MPLS Networks*" (1st ed. 2004) ("Hussain"), Ex. 1006.

5. In forming the opinions expressed below, I have considered: the relevant legal standards, including the standard for obviousness; my own knowledge and experience based upon my work in the field of computer networking as described below; the documents listed above; any additional authoritative documents as cited in this declaration; and the below listed documents:

a. S. Bryant & P. Pate, "*Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture*," RFC 3985, March 2005 ("RFC 3985"), Ex. 1010;

b. Andrew S. Tanenbaum, "*Computer Networks*" (3rd ed. 1996) ("Tanenbaum"), Ex. 1012;

c. Ina Minei & Julian Lucek, "*MPLS-Enabled Applications: Emerging Developments and New Technologies*" (2d ed. 2008) ("Minei"), Ex. 1013;

d. Seisho Yasukawa, "*Requirements for Point to Multipoint Traffic Engineered MPLS LSPs*", draft-ietf-mpls-p2mp-requirement-04.txt ("Yasukawa"), Ex. 1015;

e. Haiyan Zhang et al., "*Pseudowire for Supporting Multicast Traffic*", draft-zhang-pwe3-pw-mcast-00.txt ("Zhang"), Ex. 1016;

f. S. Bradner, "*The Internet Standards Process – Revision 3*," Request for Comments 2026 (Oct. 1996) ("RFC 2026"), Ex. 1019; and

g. Internet Archive Wayback Machine's archive of the IETF's Internet-Drafts Database Interface webpage, taken on October 8, 2006, https://web.archive.org/web/20061008141657/https://datatracker.ietf.org/public/idindex.cgi, Ex. 1020.

6. Unless otherwise noted, all emphasis in any quoted material has been added.

II. Qualifications and Professional Experience

7. My complete qualifications and professional experience are described in my *Curriculum Vitae*, a copy of which can be found in Exhibit 1004. The following is a brief summary of my relevant qualifications and professional experience.

8. I received a Ph.D. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology ("MIT") in 1998. I also received a Master of Science degree in Electrical Engineering and Computer Science in 1991, a Bachelor of Science Degree in Electrical Engineering and Computer Science in 1989, and a Bachelor of Science Degree in Physics in 1990, all from MIT.

9. During my college studies, I focused on communications and data networking. I took specialized courses including graduate courses in telecommunications networks, optical communications, and data networking. I, along with other graduate students in a networking research group, maintained both the computer workstations and the networking devices in the research group.

10. I have worked in data networking and distributed multimedia streaming systems on several occasions. As part of my doctoral research at MIT from 1991-1998, I worked as a research assistant in the Telemedia Network Systems ("TNS") group at the Laboratory for Computer Science. The TNS group built a high-speed gigabit ATM network and applications which ran over the network, such as remote video capture (including audio), processing and display on computer terminals. In addition to helping design the core network components (such as the ATM switch), designing and building the high-speed ATM links, and designing and writing the device drivers for the interface cards, I also set up the group's web server, which at the time was one of the first several hundred web servers in existence. Our high-speed data network carried multimedia data including video and audio data within ATM cells.

11. Like all ATM networks, interconnection of various endpoints in our ATM system required the setup of end-to-end virtual circuits which required, for each ATM switch in the connection path, the switch's header remapping tables to be

configured for each virtual circuit required. I developed and implemented our system's protocol of controlling the content of these tables and the overall circuit setup.

12. The TNS group was the first group to initiate a remote video display over the World Wide Web. Vice President Al Gore visited our group in 1996 and received a demonstration of—and remotely drove—a radio-controlled toy car with a wireless video camera mounted on it; the video was encoded by TNS-designed hardware, streamed over the TNS-designed network and displayed using TNS-designed software.

13. I authored or co-authored twelve papers and conference presentations on our group's research. I also co-edited the final report of the gigabit networking research effort with Professor David Tennenhouse and Senior Research Scientist David Clark. David Clark is generally considered to be one of the fathers of the Internet Protocol and served as Chief Protocol Architect for the Internet. With its focus on networking, the group, including myself, set up and maintained the network and computer systems. These systems included the networking on the workstations and desktops, the distributed file system, desktops and workstations, setting up and maintaining the distributed file system (Network File System) and the authentication system (Network Information Service, formerly known as Yellow Pages). Our system allowed users to log into any of the group's workstations using their

username/password, which allowed for all of the user's files to be virtually mounted on that workstation as a networked home directory.

14. I defended and submitted my Ph.D. thesis, titled "Designing Networks for Tomorrow's Traffic," in January 1998. As part of my thesis research, I analyzed local-area and wide-area flows to show a more efficient method for routing packets in a network, based on traffic patterns at the time. My thesis involved analyzing flows of data in the network and the routing efficiencies gained by labeling the flows at the edge of the network, and routing the data based on the label instead of the IP destination address. My analysis included different methods of setting up the granularity of the flows for the most efficient use of routing resources. This type of label switching became popular with Multiprotocol Label Switching (MPLS) later implemented in various commercial routers. I gathered a large amount of network traffic, used publicly available network traces, and broke the traffic into different types of flows using various parameters for classifying the flows. My thesis also addressed real-time streamed audio and video. The network traffic that I analyzed was IP protocol traffic, including UDP and TCP.

15. I have been involved in Voice over Internet Protocol ("VoIP") data streaming technologies since 1997 and have specific experience in designing and testing VoIP networks.

16. From 1997 to 1999, I worked at NBX Corporation, which was acquired by 3Com Corporation in 1999. During this time, I was a Senior Scientist and Engineer working in IP Telephony. NBX delivered the world's first fully featured business telephone system to run over a data network, the NBX100. NBX was one of the first business phone systems to be configurable via a web interface. Users and administrators had access to varying levels of configuration for the phone system.

17. As part of my work at NBX, I designed the core audio reconstruction algorithms for the telephones which depacketized the voice data and reconstructed the audio. In addition, I designed the voice data packet transmission algorithms. I created a system to capture and analyze network packets sent by devices in the NBX system for aid in testing and debugging. I also designed and validated the core packet transport protocol used by the phone system. In addition, I designed and oversaw the development of the underlying transport protocol used by the NBX100 phone system for reliable packet transport. That transport protocol is still used by the NBX100 system and its successors and is estimated to be used hundreds of millions of times daily. I wrote NBX's first demonstration IP software stack, which added the capability for utilizing the NBX100 phone system on an IP network. NBX first demonstrated a phone in the NBX100 system working over the Internet in 1998 at a trade show in Las Vegas, for which I acquired, set up, and configured Virtual Private Network tunnels to carry the traffic. I was later the lead architect in designing NBX's

next-generation highly scalable system. After NBX was acquired by 3Com, I did some work with 3Com's cable equipment division, including demonstrating a working NBX IP phone system over 3Com's cable equipment infrastructure using an early version of DOCSIS at a trade show in 1999. The NBX100 was the market's leading business phone system to run on a data network for several years following its introduction. During that time, I became more familiar with the various standards relevant to Internet telephony as well as the problems which designers of commercial telephony operations were faced with in implementing VoIP.

18. I, along with two of NBX's founders, was awarded U.S. Patent No. 6,697,963 titled "Telecommunication Method for Ensuring On-Time Delivery of Packets Containing Time-Sensitive Data," for some of the work we did while at NBX.

19. After NBX, I worked at Teradyne, a test tool company primarily focused on semiconductors. Teradyne had recently acquired Hammer, a company that specialized in load and functional testing for telecommunications systems. The Hammer product is well known as a telecom test tool. Teradyne spun out Hammer and several other internal divisions into an independent company called Empirix. I became Chief Technologist of the Hammer division of Empirix. Empirix was a leader in VoIP network testing and monitoring.

20. At Empirix, I laid out a new multi-year product vision for data network testing, secured internal funding for the effort, and led a team to deliver a new technology platform to the market in February 2001. This new product, PacketSphere, initially emulated network behavior so that wide-area VoIP connections could be tested in a lab. A later release allowed PacketSphere to generate high volumes of VoIP calls, including media streams, and to monitor the quality of VoIP voice streams. PacketSphere was also used in the Storage Area Network area. Later, the core technology was added to other Empirix products such as Empirix's Hammer XMS to monitor thousands of VoIP media streams in real time to determine their quality. PacketSphere was Empirix's most successful new platform introduction at the time. Companies purchased the PacketSphere product to emulate an Internet Protocol network to see the effects of deploying their product on the Internet prior to launch. PacketSphere received several industry awards.

21. During my time at Empirix, I presented lectures on VoIP and data network testing to companies including Lucent Labs (formerly AT&T Bell Labs). I was also invited to present several guest lectures in a software engineering course at MIT. Since then, I have also participated twice as a unit lecturer (two weeks) in an experimental course that was taught by an Institute Professor (the highest award that a MIT Professor can achieve) and sponsored by the Chairman of the MIT Corporation (MIT's board of trustees).

22. From 2004 to 2008, I was employed by BBN Technologies Corp., a technology research and development company located in Cambridge, Massachusetts. BBN Technologies is a world-renowned company with expertise in acoustics, speech recognition, and communications technology. BBN Technologies staff have pioneered many internetworking technologies and Internet applications and have built some of the world's largest government and commercial data networks.

23. My duties and responsibilities at BBN Technologies generally included commercialization of the technologies developed by BBN Technologies, which included spinning off companies and growing commercial businesses in-house. More particularly, I was involved in utilizing the award-winning AVOKE STX speech recognition technology to create the public audio/video search engine EveryZing (formerly known as PodZinger) which was spun out into a stand-alone company now known as RAMP, Inc. PodZinger won the 2006 MITX Technology Award for best Web 2.0 Application and was also named the 2006 Forbes Favorite Video & Audio Search Engine, beating out Google, Yahoo, and other companies. After managing the creation of the initial prototype system, PodZinger built out a full streaming audio and video search solution when I was the Vice President of Operations and Technology there. I was also involved in the Boomerang Mobile Shooter Detection project as the Vice President of Engineering for the program. The

Boomerang system was deployed to Iraq and Afghanistan and was credited with saving many lives.

24. In 2012, I opened Einstein's Workshop, a 7,000 square foot facility for teaching science, technology, engineering, and math to children. I installed and configured the telephone system, designed and programmed the web site, and designed and configured the network, which has grown to roughly 100 computers, multiple WiFi access points, firewalls, multiple wireless networks, and multiple facilities. We also created an educational 3D Computer-Aided Design program, which we spun-out into a separate company, BlocksCAD. BlocksCAD has received grants from DARPA DSO and the USDA and has participated in the LearnLaunch, MIT Play Labs, and MassChallenge accelerator programs. BlocksCAD currently has over 90,000 registered users and 25,000 paid seats and is used in schools throughout the US.

25. From 1989 to 1990, I worked at AT&T Bell Laboratories on optical computers. This work generated six peer-reviewed papers, and multiple U.S. and European patent applications in which I was named as a co-author or inventor. I also interned at AT&T Bell Laboratories in 1987 and 1988. Additional relevant experience in the field of computer networking is listed in my *Curriculum Vitae*.

26. I am a named inventor on several patents and published patent applications that are related to VoIP technology including: U.S. Patent No.

6,967,963, entitled "Telecommunication Method for Ensuring On-Time Delivery of Packets Containing Time-Sensitive Data"; U.S. Patent Application Publication No. 20020015387, entitled "Voice Traffic Packet Capture and Analysis Tool for a Data Network"; U.S. Patent Application Publication No. 20020016708, entitled "Method and Apparatus for Utilizing a Network Processor as Part of a Test System"; U.S. Patent Application Publication No. 20020016937, entitled "Method and Apparatus for Utilizing a Network Processor as Part of a Test System"; and U.S. Patent No. 7,590,542, entitled "Method of Generating Test Scripts Using a Voice-Capable Markup Language."

III. Technology Background

27. In a traditional Internet Protocol router, each router makes a routing decision based on the destination IP address of every packet arriving at the router to determine which output port through which to forward the packet. Ex. 1006, 23–24. The routing decision is based on the longest prefix match of the destination IP address to the entries in the router's routing table. Ex. 1006, 26–28. This operation is somewhat complex, as there may be several routing table matches with different length prefix matches in the routing table. Ex. 1006, 26–28, 44. Each router through which a packet traverses must perform this routing table lookup operation. Ex. 1006, 23.

28. Routers are used to process packets passing between two different networks. For example, a router may pass packets between a private network and a public network. In many cases, packets are intended to be sent between two private networks through a public network. To do this, a "tunnel" is created between the routers of such private networks. There are a variety of mechanisms that are used to create tunnels. One example of such a mechanism is a Label Switched Path (LSP).

29. An LSP is an established path through a Multiprotocol Label Switching (MPLS) network. In a network using MPLS, routers at the edge of the MPLS network perform the route lookup on a packet to group the packet into a class of packets that will travel along the same path in the label-switched network, known as a forwarding equivalence class (FEC). Ex. 1006, 44–46. The FEC is used to apply a label to the packet. *Id.* The label is applied by encapsulating the original packet in new packet with a header that contains the label at the edge of an MPLS network. Ex. 1006, 45–46. A router that routes based on a label is known as a label switch router (LSR). Interior LSR routers (also known as transit LSRs) only route based on the applied label and not on the packet's destination IP address. Ex. 1006, 46. Route lookup based on the label is a much faster operation than a lookup based on the longest prefix match of the destination IP address. Ex. 1006, 52–53. Thus, a MPLS router can process more packets for the same processing power than a traditional IP router and, thus, can operate at faster packet input speeds and forward more data.

The packet's label may be reassigned as the labeled packet traverses nodes in the MPLS network. Ex. 1006, 45–46, 50–52. At the edge of the MPLS network, the packet header containing the label is removed, and the encapsulated IP packet is forwarded to the recipient. Ex. 1006, 46. The label applied at the input determines the path (i.e., LSP) to the output of the MPLS network based on the table entries of each interior MPLS router. Ex. 1006, 45–46.

30. LSPs may be established in a variety of manners. For example, an LSP may be implemented as a pseudo-wire. Ex. 1006, 46, 274. As an LSP, a pseudo-wire defines the path through the MPLS network over which packets will flow. Ex. 1006, 197, 274–75. Because IP packets are encapsulated at the input to the pseudo-wire and extracted at the output, they appear to "tunnel" through the MPLS network over the pseudo-wire. Such tunnels are not limited to MPLS networks; traditional networks can perform tunneling by similarly encapsulating packets with headers that contain addressing information. For example, the MBONE is a multicast overlay on top of the Internet, where tunnels are set up between multicast-enabled routers, allowing multicast packets to tunnel through other routers that are not multicast enabled. Tanenbaum, Ex. 1012, 757–58.

31. LSPs and pseudo-wires may be hierarchical. For example, it is possible to nest one tunnel within another. This is done by adding an additional layer of encapsulation. *See* Ex.1006, 255. An LSP that is established within another LSP is

referred to as a nested LSP. This allows multiple LSPs to be established through a particular tunnel.

32. When two computers communicate directly, it is known as a point-to-point (P2P) connection. When an LSP has exactly one ingress and one egress, it is also known as a P2P LSP. Minei, Ex. 1013, 485. When one computer sends data in one packet to multiple computers, it is known as a point-to-multipoint (P2MP) connection. When an LSP has exactly one ingress and multiple egresses, it is also known as a P2MP LSP. *Id.* For example, a multicast network allows for one computer to transmit to multiple computers simultaneously by sending only one stream—much like a television station transmits a single broadcast stream that any receiver can tune into—rather than sending a different P2P stream to each receiver. Such multicast packet transmissions are used by some IP-based cable television systems.

33. More generally, a Virtual Private LAN Service (VPLS) emulates the broadcast domain of a LAN, but over a wide area network and without "polluting" the public network with broadcast messages sent over the private LAN. Ex. 1006, 275–77. The services are provided by tunnels through the Internet (or any other intervening network) between the locations within the virtual private LAN. For example, this could apply to a company with two offices in different cities. *Id.* If a

third office is added to a VPLS, then the broadcast packets from any of the three offices must be broadcast to two other offices in a P2MP fashion. *Id.*

IV. Level of Ordinary Skill in the Art

34. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems.

35. A person of ordinary skill in the art ("POSITA") in the field of the '775 patent, as of its filing date of February 26, 2008, would have been someone knowledgeable and familiar with computer networking, multi-protocol label switch (MPLS) networking, packet encapsulation, packet routing, pseudo-wires, and multicast transmission. A POSITA would have had a bachelor's degree in computer science, computer engineering, or an equivalent, and three years of professional experience relating to computer networking. Lack of professional experience can be remedied by additional education, and vice versa.

36. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my experience and the understanding of a POSITA generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the field as of the priority

date of the '775 patent. Unless otherwise stated, when I provide my understanding and analysis below, it is consistent with the level of a POSITA prior to the priority date of the '775 patent.

V. Relevant Legal Standards

37. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the '775 patent, I am relying on certain basic legal principles that counsel have explained to me. These principles are discussed below.

38. I understand that prior art to the '775 patent includes patents and printed publications in the relevant art that predate the priority date of the alleged invention recited in the '775 patent. For purposes of this Declaration, I have been asked to assume that the priority date of the '775 patent cannot be earlier than its foreign application priority date of February 26, 2007.

39. I understand that a claim is unpatentable if it is either anticipated or rendered obvious by the prior art.

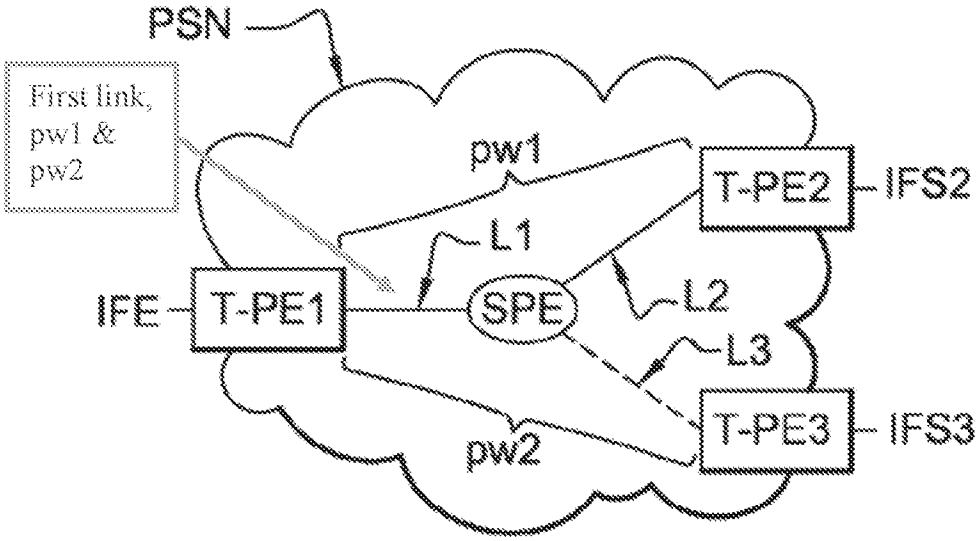
40. I have been informed by counsel that a patent claim is unpatentable as anticipated if each element of that claim is present either explicitly or inherently in a single prior art reference. I have also been informed that, to be an inherent disclosure, the prior art reference must necessarily disclose the limitation, and the fact that the reference might possibly practice or contain a claimed limitation is insufficient to establish that the reference inherently teaches the limitation.

41. I have been informed that a claimed invention is unpatentable for obviousness if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I have also been informed by counsel that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

42. I have been informed by counsel that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

VI. Overview of the '775 Patent

43. The '775 patent is directed to setting up pseudo-wires "for routing data packets in packet-switched networks." Ex. 1001, 1:34–35. In particular, the '775 patent explains setting up two pseudo-wires that share a link between an input router and an intermediate router. Ex. 1001, 6:25–45. Figure 3 of the '775 patent illustrates this concept:



Ex. 1001, Fig. 3 (annotated)

44. I note that the '775 patent explains that a POSITA would have known how to set up two pseudo-wires in a packet-switched network according to Figure 2 of the '775 patent:

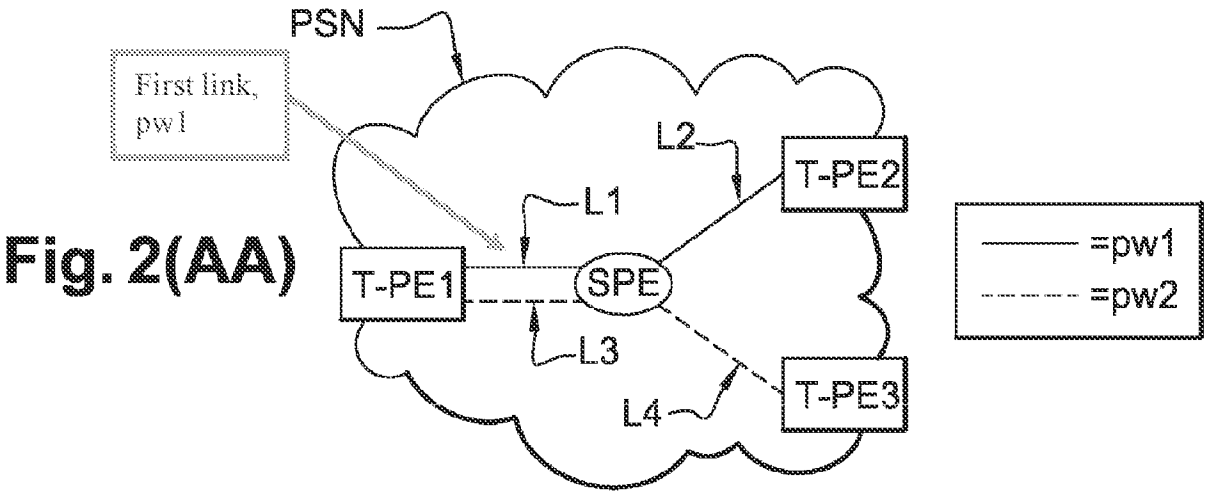


Fig. 2(AA)

Ex. 1001, Fig. 2

45. I note—and the '775 patent corroborates—that the only difference between Figures 2 and 3 of the '775 patent are that the two pseudo-wires share the first link extending from the input router to the intermediate router in Figure 3. *See* Ex. 1001, 2:12–27, Figs. 2–3.

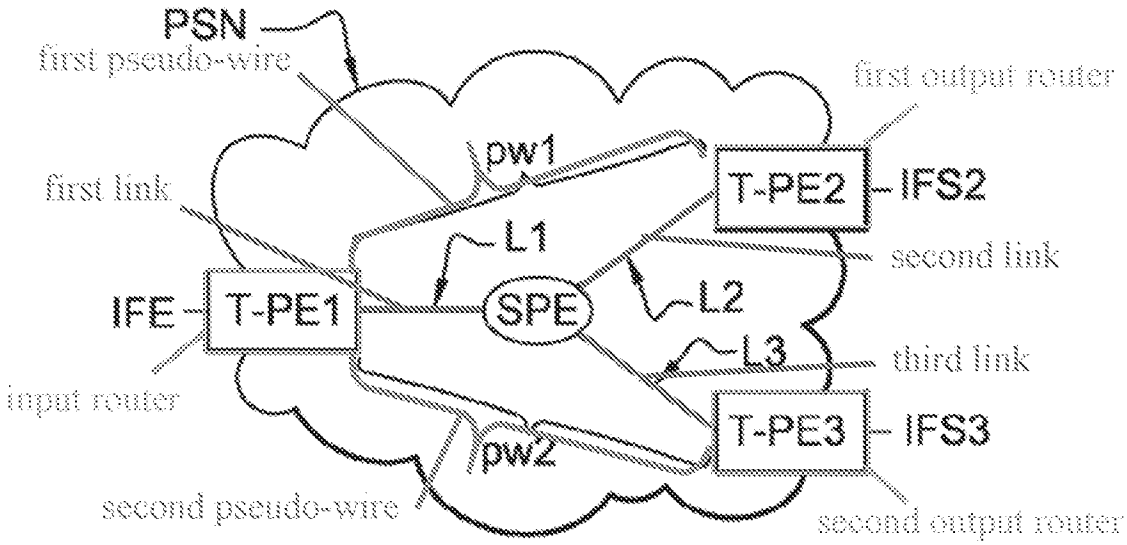
46. Representative independent claim 1 is reproduced below:

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and

setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Ex. 1001, 12:14–27.

47. Annotated Fig. 3 shows the elements of claim 1.



Ex. 1001, Fig. 3 (annotated).

48. However, the concept of having pseudo-wires share links was already known to POSITAs. As demonstrated in this declaration, there is nothing novel about the claims of the '775 patent since all the elements were taught in the prior art, and it would have been obvious to combine the relevant teachings as claimed well before 2007.

VII. Analysis of Claims 1 and 6

A. Claim Construction

49. It is my understanding that in order to properly evaluate the '775 patent, the terms of the claims must first be interpreted. It is my understanding that for the purposes of this *inter partes* review, the claim terms are given their ordinary and customary meaning as would have been understood by one of ordinary skill in the art in light of the specification and prosecution history, unless the inventor has set forth a special meaning for a term. It is my understanding that no claim term in the '775 patent requires express construction. Therefore, this declaration analyzes the claims according to their ordinary and customary meaning.

B. Ground 1: Claims 1 and 6 would have been obvious over Aggarwal and Hussain

50. It is my opinion that the subject matter of claims 1 and 6 would have been obvious to a POSITA in light of the disclosures of the prior art Aggarwal and Hussain references. The following describes how Aggarwal and Hussain render obvious each and every element of claims 1 and 6 of the '775 patent.

1. Summary of Aggarwal

51. Like the '775 patent, Aggarwal is generally directed to routing traffic "associated with a **point to multi-point (P2MP) tunnel**." Ex.1005, 1:63–64. In particular, Aggarwal describes techniques "for extending RSVP-TE to allow RSVP-TE to be used for establishing P2MP TE tunnels." Ex.1005, 3:22–24. "[T]he

extensions may be used to setup [point-to-point] P2P TE LSPs between source and receiver provider edge routers." Ex.1005, 3:27–28. "The P2P LSPs that are merged to form the P2MP LSPs are referred to as branch LSPs." Ex.1005, 4:13-15. Aggarwal further describes how the branch LSPs may be nested within the P2MP tunnel using label stacking. *See* Ex.1005, 9:17-39, 9:61-10-3. Importantly, like the '775 patent, to accomplish using P2P tunnels to establish P2MP tunnels, "the P2P TE LSPs are appropriately **merged** by the network." Ex.1005, 3:29–31.

52. In more detail, Aggarwal describes merging two P2P LSPs to form a P2MP LSP tunnel. The merged LSPs are referred to as P2MP LSPs and are made up of a number of branch LSPs: A "P2MP LSP tunnel has a plurality of branch LSPs." Ex. 1005, 2:11. Aggarwal further describes "establishing a branch LSP that forms a part of a point to multi-point (P2MP) label switched path (LSP) tunnel having a source and multiple destinations." Ex. 1005, 2:43–46.

53. As an example, these techniques are illustrated in Fig. 5, shown below.

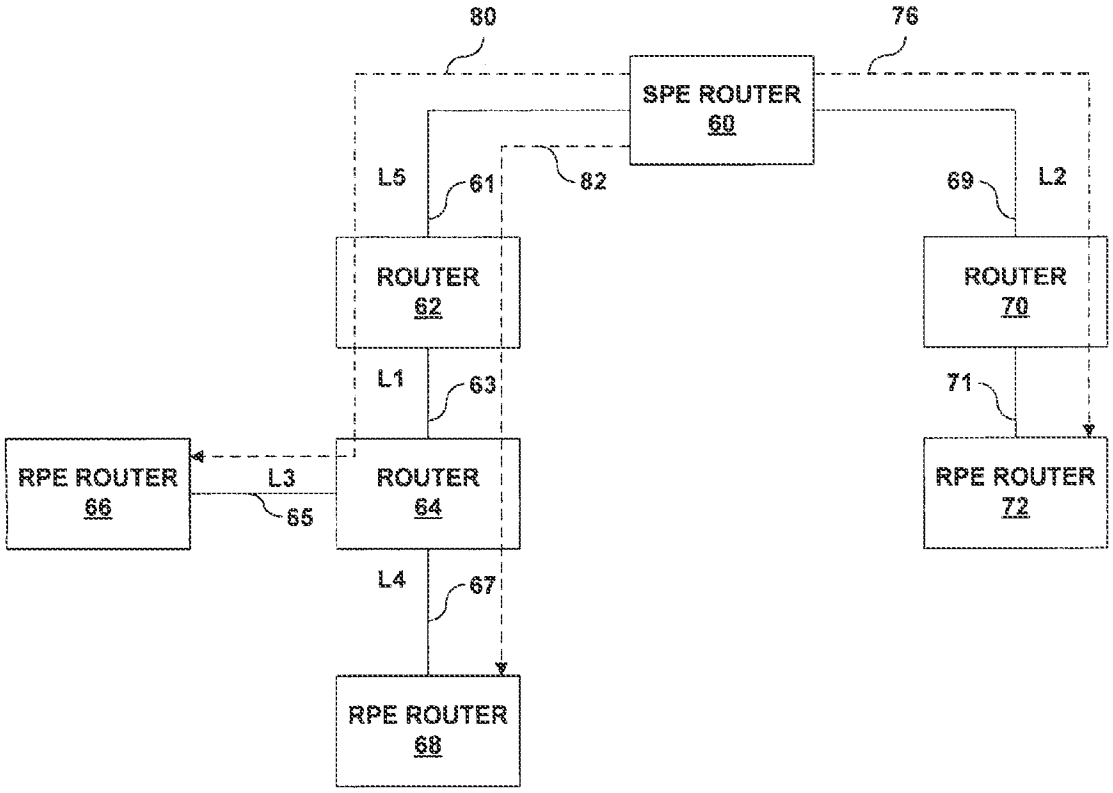


Fig. 5, (annotated)

54. Aggarwal explains an example set up of a P2MP LSP comprising multiple branch LSPs. Fig. 5 illustrates "a P2MP LSP between router 12 and RPE routers 66, 68, and 72." Ex. 1005, 6:31–32. In particular, Aggarwal explains that "[c]omputer network 58 includes a SPE [source provider edge] router 60, a RPE [receiver provider edge] router 66, a RPE router 68 and a RPE router 72." Ex. 1005, 6:28–29. Aggarwal further explains that '[c]omputer network 58 also includes intermediate routers 62, 64, 68, and 70." Ex. 1005, 6:30–31. Aggarwal discusses the

set up of "P2P [point-to-point] paths to reach RPE router 66, RPE router 68, and RPE router 72," starting at SPE router 60. Ex. 1005, 6:39–40.

55. Fig. 5 illustrates how "SPE router 12 establishes a P2MP LSP between SPE router 12 and RPE routers 66, 68, and 72." Ex.1005, 6:31–32. To do this, the SPE router 60 establishes a branch LSP 80 between the SPE router 60 and a first RPE router 66. See Ex.1005, 6:44–47. LSP 80 includes links 61 and 63 between the SPE router and intermediate router 64, as well as link 65 between the intermediate router 64 and the first RPE router 66. Ex.1005, Fig. 5.

56. Additionally, the SPE router 60 establishes a branch LSP 82 between the SPE router 60 and a second RPE router 68. See Ex.1005, 6:44–47. LSP 82 includes links 61 and 63 between the SPE router 60 and intermediate router 64, as well as link 67 between the intermediate router 64 and the second RPE router 68. Ex.1005, Fig. 5.

57. Notably, "[t]hese branch LSPs are computed to share the same links where possible as they belong to the same session." Ex.1005, 6:40–42. As such, "**Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Ex.1005, 6:47–49. In other words, "the extended RSVP-TE merges individual branch LSPs to form a P2MP LSP." Ex.1005, 7:4–5.

58. Aggarwal describes an application for this technology in "transmission of multicast traffic without run[ning] a multicast routing protocol on routers." Ex.

1005, 4:32–34. Aggarwal shows an example of setting up a "P2MP LSP associated with" a particular "multicast group." Ex. 1005, 6:34–35. In the example, multiple "branch LSPs" are established in "P2MP RSVP TE tunnels." Ex. 1005, 6:26–43.

59. Aggarwal discusses technology that is in the same field of endeavor as the '775 patent and targets the same problem as the '775 patent. Aggarwal—like the '775 patent—relates to MPLS network traffic management. *See* Ex. 1005, 1:7–9, 3:29–39; Ex. 1001, 1:25–26, 1:34–36. Finally, both Aggarwal and the '775 patent discuss sharing links in a MPLS network to conserver network resources. *See* Ex. 1001, 3:3–4; Ex. 1005, 6:47–49.

2. Summary of Hussain

60. Like Aggarwal and the '775 patent, Hussain relates to MPLS networks. In particular, Hussain is a book that provides additional implementation details and options for setting up LSPs within packet-switched networks such as those described by Aggarwal. In one example, Hussain describes setting up a tunnel between Provider Edge (PE) routers. Ex.1006, 267. This tunnel is referred to as a PE-to-PE tunnel. *See id.* Hussain further teaches that several LSPs can be "nested" within the PE-to-PE tunnel. In particular, Hussain states that "PWs [pseudowires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. Furthermore, Hussain teaches that such LSPs are

applicable to a "point-to-multipoint L2VPN [Layer 2 Virtual Private Network]." Ex. 1006, 272.

61. Hussain explains a Virtual Private LAN Service (VPLS) in which multiple "point-to-point PWs [pseudo-wires]" are set up using Label Distribution Protocol (LDP). Ex. 1006, 276. This set up can be performed by "hardware and software components" of routers in a network. Ex. 1006, 6. In particular, Hussain explains that "IP/MPLS control-plane software, the brain of a router, resides in the control processor card." Ex. 1006, 8.

62. After a pseudo-wire is set up, data packets can be sent along the pseudo-wire. Hussain explains that "a Layer 2 frame" is encapsulated "in a pseudowire (PW) protocol data unit." Ex. 1006, 272. The frame is then transported in the pseudo-wire "over a tunnel across the PSN [packet-switched network]" from one provider edge (PE) router to another. Ex. 1006, 272. In particular, Hussain describes pseudo-wires as "nested LSPs in the PE-to-PE tunnel." Ex. 1006, 273. This method of sending packets from one destination to another is called unicast.

63. Hussain teaches that VPLS is "a point-to-multipoint service" that "emulates the performance of a LAN." Ex. 1006, 275. Therefore, VPLS can take advantage of the benefits a conventional LAN provides, such as "broadcast and unicast services." Ex. 1006, 277.

3. Reasons to Combine Aggarwal and Hussain

64. A POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain for a number of reasons. First, the combination is merely the use of a known technique (implementing branch LSPs as pseudo-wires) to improve similar methods (setting up LSPs) in the same way. Second, the combination merely applies a known technique (implementing branch LSPs as pseudo-wires) to a known method (setting up LSPs) ready for improvement to yield predictable results.

65. **First**, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because the combination is merely the use of a known technique to improve similar methods in the same way. A POSITA would have been motivated to implement Aggarwal's LSPs as pseudo-wires as taught by Hussain. In other words, a POSITA would have found it obvious to apply Hussain's technique of implementing LSPs as pseudo-wires to Aggarwal's method of setting up similar LSPs.

66. As discussed above, Aggarwal explains that "[b]y utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched Path (LSP)." Ex. 1005, 1:34–35. Aggarwal further states that a "variety of protocols exist for establishing LSPs." Ex. 1005, 1:45. Aggarwal explains that either Label Distribution Protocol (LDP) or Resource Reservation Protocol with Traffic Engineering (RSVP-TE) may be used to set up an LSP. See Ex. 1005, 1:47–55. In

Juniper Exhibit 1008, page 355

addition, Aggarwal explains that RSVP-TE may be used to set up point-to-multipoint (P2MP) LSP tunnels. See Ex. 1005, 1:62–2:14.

67. A POSITA would have understood that Aggarwal provides an overview of LSPs. Therefore, a POSITA, when considering the teachings of Aggarwal, would have also considered the teachings of Hussain because Hussain further explains how to implement LSPs. Hussain is generally directed toward IP and MPLS network structures that provide high availability. *See* Ex. 1006, title page. A POSITA looking to implement Aggarwal's method would naturally refer to literature describing similar technology. Therefore, a POSITA would have looked to other references—like Hussain—that further discuss establishing LSPs within an MPLS network. Moreover, Hussain would have been an attractive option, as it describes implementing LSPs in the context of providing high availability and fault-tolerance. Indeed, the title of Hussain is "Fault-tolerant IP and MPLS Networks." Thus, when implementing an MPLS network as taught by Aggarwal, a POSITA would have looked to a comprehensive guide for implementing such networks with fault-tolerance and high availability.

68. Hussain explains that "[i]n MPLS, a tunnel corresponds to a *label-switched path* (LSP)." Ex. 1006, 253. Hussain also explains that "PE-to-PE tunnels can be established using LDP or RSVP-TE." Ex. 1006, 273. As explained above, a PE is a Provider Edge router. Similar to Aggarwal, Hussain describes point-to-

multipoint (P2MP) services. *See* Ex. 1006, 275. Therefore, Hussain discusses establishing LSPs between routers, just as Aggarwal does.

69. Hussain explains a particular type of LSP that may be implemented. In particular, Hussain describes implementing LSPs as pseudo-wires. Specifically, Hussain explains how Provider Edge routers encapsulate a "frame in a *pseudowire* (PW) protocol data unit." Ex. 1006, 272. Hussain explains that a "PW is a mechanism that emulates the essential attributes of a service, such as FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex. 1006, 272. Hussain explains that "PWs correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex. 1006, 273. Hussain explains that "[i]n the MPLS backbone, PEs are connected via PWs, which correspond to PE-to-PE LSPs that are established using LDP." Ex. 1006, 274. Additionally, Hussain explains that "PWs are multiplexed (nested) and transported over PE-to-PE tunnels." Ex. 1006, 274. Accordingly, Hussain shows that implementing LSPs, such as Aggarwal's branch LSPs, with pseudo-wires was well-known. Thus, a POSITA implementing the teachings of Aggarwal would have been motivated to implement the teachings of Hussain to improve Aggarwal's LSPs with pseudo-wires.

70. Hussain's teachings provide additional support for Aggarwal's discussion of sharing links. In particular, Aggarwal discusses merging point-to-point

LSPs to form point-to-multipoint LSP tunnels. Aggarwal explains the advantages of doing so include "optimiz[ing] packet replication and minimize[ing] state and intelligence in the core of the network, while performing P2MP TE." Ex. 1005, 3:40–43. Aggarwal's method also emphasizes "reduc[ing] complexity." Ex. 1005, 7:9–11.

71. A POSITA would have understood that implementing the LSPs of Aggarwal as pseudo-wires, as taught by Hussain, would improve network efficiency in line with Aggarwal's goals. The advantages of implementing LSPs as pseudowires were obvious and commonly known in the art before 2007. Hussain describes how with "the migration of legacy Layer 2 infrastructure over a converged packet-switched network," services such as Frame Relay (FR) and Asynchronous Transfer Mode (ATM) "are predominantly offered over an IP/MPLS backbone." Ex. 1006, 254. For example, "[a] PW [pseudo-wire] is a mechanism that emulates the essential attributes of a service, such a FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex. 1006, 272. A POSITA in the field of computer networking would have been familiar with the Internet Engineering Task Force (IETF) and its publications relating to the standardization of networking technologies, including MPLS. An IETF draft discusses the context of "[a]n Ethernet multipoint Layer2 VPN service provided by MPLS," and explains that "if existing P2P TE LSPs are used as tunnels between

PEs, any ingress PE must duplicate the frames and send them to the corresponding PEs," which would "waste the provider's network resources." Yasukawa,[1] 15.

[1] Yasukawa (Exhibit 1015) is a September 2004 draft document published by the Internet Engineering Task Force (IETF) describing "a set of requirements for Point-to-Multipoint (P2MP) Traffic Engineered (TE) Multiprotocol Label Switching (MPLS) Label Switched Paths (LSPs)." Yasukawa, 1. A POSITA in the field of computer networking would have relied upon the IETF and its publications relating to standardization of networking technologies. The IETF describes its publication and standardization processes in RFC 2026. In my personal experience, RFC 2026 accurately describes how the IETF made available to the public documents such as Yasukawa, including by posting the document on various well-known Internet hosts and publicly announcing their availability to interested persons via electronic mail mailing list. *See* RFC 2026 at 6, 8, 26. For example, IETF documents were (and are) available via the RFC Editor website at https://www.rfc-editor.org/ and the IETF Datatracker at https://datatracker.ietf.org/. Anyone involved with the Internet technical community during the 2000-2007 time period would have known where and how to obtain a copy of Yasukawa (e.g., from the IETF's Internet-Drafts Database at https://datatracker.ietf.org/public/idindex.cgi, which the Internet Archive has archived at

Therefore, the IETF draft provides a potential solution, noting that "it might be desirable that P2MP MPLS TE LSPs are used for data transmission with an appropriate layer 2 encapsulation technique (for example, pseudo wire) instead of P2P MPLS TE LSPs, contributing in turn to savings of network resources." Yasukawa, 16. Further, pseudo-wires permit broadcasting services. Therefore, a POSITA would have been motivated to implement Aggarwal's LSPs as pseudo-wires.

72. The results of applying Hussain's teachings of pseudo-wires to Aggarwal's LSPs would have been predictable because Hussain explicitly teaches establishing LSPs such as the ones described by Aggarwal as pseudo-wires. The combination of Aggarwal and Hussain would have yielded predictable results

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https://web.archive.org/web/20061008141657/https://datatracker.ietf.org/public/idindex.cgi (Exhibit 1020)). Furthermore, the document is included on the IETF MPLS Working Group's page found in the Web Archive page from October 17, 2004 at https://web.archive.org/web/20041017084603/http://www.ietf.org/html.charters/mpls-charter.html. A POSITA would have known how to navigate through the IETF pages to find the working group's page, which listed and linked to all of that group's active Internet-Drafts available at the time. The '775 patent itself refers to IETF documents in columns 1 and 2.

because, as discussed above, implementing LSPs as pseudo-wires was well known to successfully provide Layer 2 services over an MPLS network. One IETF draft explains that "multicast-based services such as IP TV, DVB etc.," were becoming more popular, so IETF "Working Groups, such as MPLS and L2VPN, [had] begun to discuss the requirements and solutions for multicast." Zhang, Ex. 1016[2], 2. The IETF draft acknowledged that the same "solutions are needed to support the multicast traffic over PW." Zhang, 2. Therefore, the IETF draft proposed "procedures to transmit the multicast traffic using the unidirectional Pseudowires (PWs), and describe the corresponding extensions to Label Distribution Protocol (LDP)." Zhang, Ex. 1016, 2–3. A solution the IETF draft discussed was that "the PSN [packet-switched network] tunnel used to carry the point-to-multipoint PW

[2] Zhang (Exhibit 1016) is a February 21, 2006 draft document published by the IETF describing "the efficient transport of multicast-based services and the corresponding Label Distribution Protocol (LDP) protocol extensions and procedures." Zhang, 1. Anyone involved with the Internet technical community during the 2000-2007 time period would have known where and how to obtain a copy of Zhang (e.g., from the IETF's Internet-Drafts Database at https://datatracker.ietf.org/public/idindex.cgi, which the Internet Archive has archived at https://web.archive.org/web/20061008141657/https://datatracker.ietf.org/public/idindex.cgi (Exhibit 1020)).

(P2MP PW) may consist of a P2MP LSP, or multiple P2P and P2MP LSPs." Zhang, 4. Therefore, a POSITA would find it predictable to implement Aggarwal's LSPs as pseudo-wires.

73. A POSITA would have had a reasonable expectation of success implementing the branch LSPs of Aggarwal as pseudo-wires because pseudo-wires were a known type of LSP. Hussain describes how pseudo-wires correspond to LSPs nested in an LSP tunnel. And, like Aggarwal's branch LSPs which are nested within Aggarwal's P2MP tunnels, Hussain's pseudowires are nested within a PE-to-PE tunnel. Therefore, a POSITA would have expected pseudo-wires to work well within Aggarwal's P2MP tunnel as they work in Hussain's PE-to-PE tunnel.

74. Furthermore, because pseudo-wires are a type of LSP, they operate in a similar manner. For example, Hussain teaches that pseudo-wires participate in data broadcasting by delivering Layer 2 data in a P2MP service. Ex. 1006, 277. Aggarwal also teaches that branch LSPs deliver multicast packets in a P2MP LSP tunnel. *See* Ex. 1005, 3:31–35, 3:42–47, 6:26–35, Fig. 5. Additionally, Hussain teaches that pseudo-wires are created in packet-switched networks, such as MPLS. Ex. 1006, 275. Aggarwal also teaches that branch LSPs are created in MPLS networks that perform label-switching on data packets. *See* Ex. 1005, 3:32–35, 6:60–7:3. Finally, because both pseudo-wires and LSPs are created in MPLS networks, the same network routers and links may be used. Thus, there was a reasonable expectation of

success in implementing the combination of Aggarwal and Hussain. As a result, a POSITA would have found claims 1 and 6 obvious because the combination of Aggarwal and Hussain is merely the use of a known technique (pseudo-wires) to improve similar methods (establishing LSPs) in the same way (to improve network efficiency).

75. Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs. In particular, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel: "PWs [pseudowires] correspond to nested LSPs in the PE-to-PE tunnel in which an individual PW is identified based on the MPLS label." Ex.1006, 273. Like Hussain's PE-to-PE tunnel, Aggarwal's Branch LSPs are tunnels between edge routers: Aggarwal describes techniques "for extending RSVP-TE to allow RSVP-TE to be used for establishing P2MP TE tunnels." Ex.1005, 3:22-24. Accordingly, it would have been obvious to implement pseudo-wires within Aggarwal's branch LSPs (tunnels), similar to how they are implemented in Hussain's PE-to-PE tunnels. As such, the pseudo-wires would be implemented as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82). Doing so would have had a reasonable expectation of success and would have had predictable results for the same reasons mentioned above.

76. **Second**, a POSITA would have found it obvious to combine the teachings of Aggarwal and Hussain because the combination merely applies a known technique to a known method ready for improvement to yield predictable results. As discussed under the first rationale, a POSITA would have understood that Aggarwal provides an overview of the set up and details of LSP tunnels in an MPLS network. Therefore, a POSITA, when considering the teachings of Aggarwal, would have also considered the teachings of Hussain because Hussain further explains P2MP services over MPLS networks.

77. Accordingly, a POSITA would have been motivated to incorporate Hussain's technique of implementing LSPs as pseudo-wires into Aggarwal's method of setting up LSPs. Alternatively, a POSITA would have found it obvious to implement pseudo-wires within Aggarwal's branch LSPs as nested pseudo-wires. In either way, doing so would have improved the method of Aggarwal in the same way as using the technique improved Hussain. And, as discussed above, the advantages of implementing an LSP as a pseudo-wire were obvious and commonly known in the art before 2007. As also discussed above, the combination of Aggarwal and Hussain would have yielded predictable results because implementing an LSP as a pseudo-wire was well known to successfully provide Layer 2 services over an MPLS network. As discussed above, a POSITA would have had a reasonable expectation of success using pseudo-wires as the branch LSPs because pseudo-wires are a type

of LSP. Therefore, a POSITA would have been motivated to implement the branch LSPs as pseudo-wires.

78. As a result, a POSITA would have found claims 1 and 6 obvious because the combination of Aggarwal and Hussain merely applies a known technique (pseudo-wires) to a known method (establishing LSPs) ready for improvement (network efficiency) to yield predictable results.

79. The proposed combinations permit but do not require physical incorporation of elements from Hussain into Aggarwal.

4. Claim 1

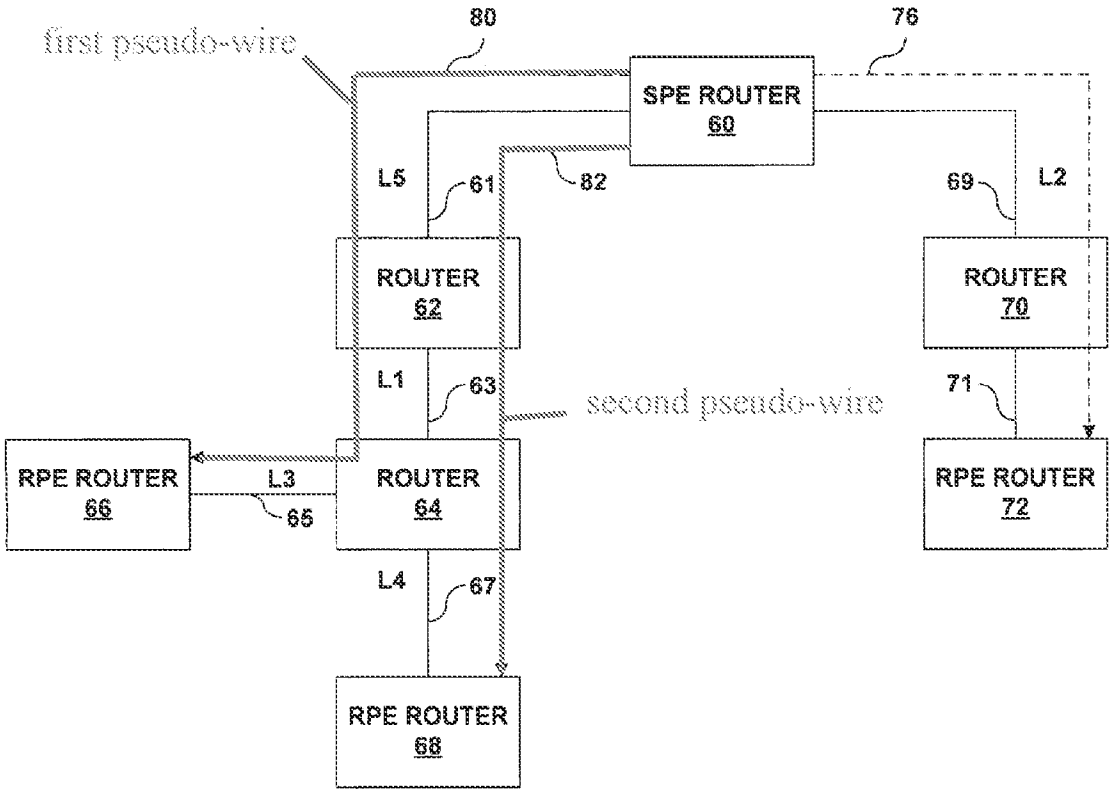
[1.0] ***A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:***

80. Aggarwal and Hussain render this limitation obvious.

81. **First,** Aggarwal teaches setting up branch Label Switched Paths (LSPs) 80 and 82 ("*at least two pseudo-wires*[3]"): "SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router

[3] For the reasons explained above at VII.B.3, and as will be elaborated on below, a POSITA would have found it obvious to implement Aggarwal's LSPs as pseudo-wires.

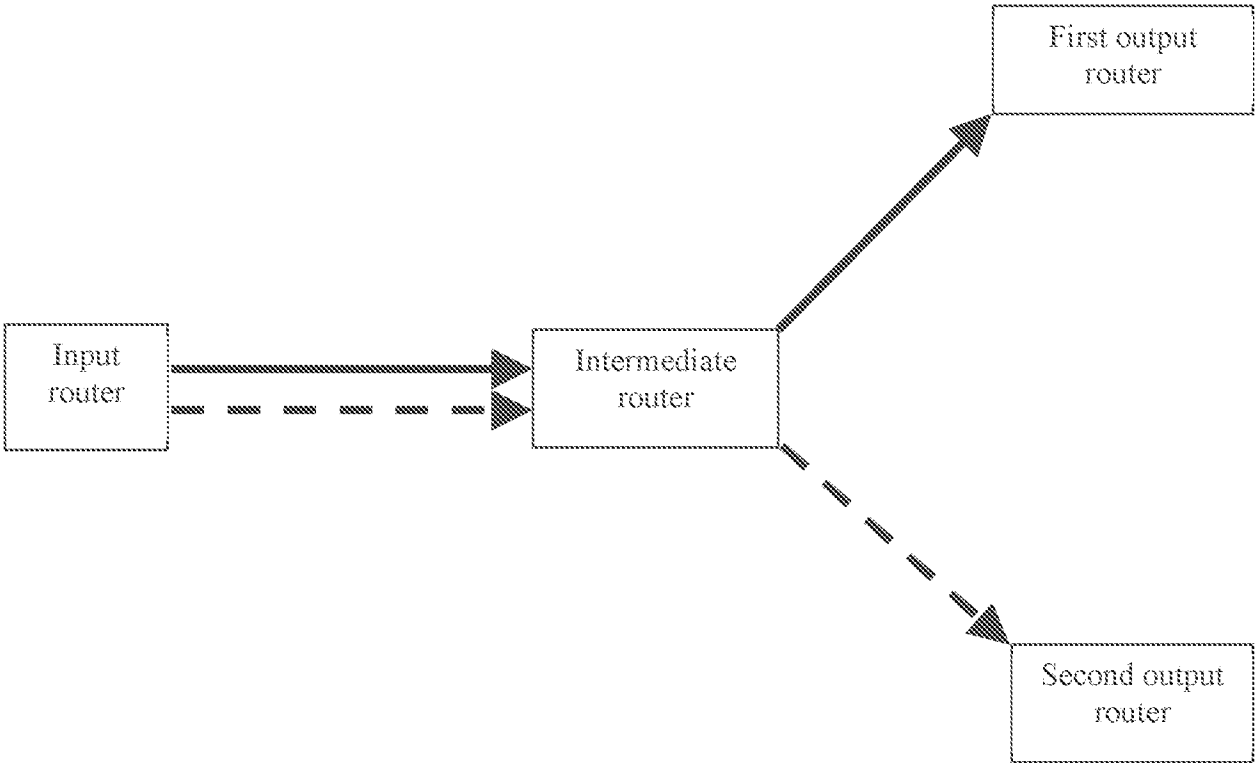
64." Ex. 1005, 6:43–47. Aggarwal's Figure 5, shown below, illustrates the branch LSPs 80 and 82.



Ex.1005, Fig. 5, (annotated)

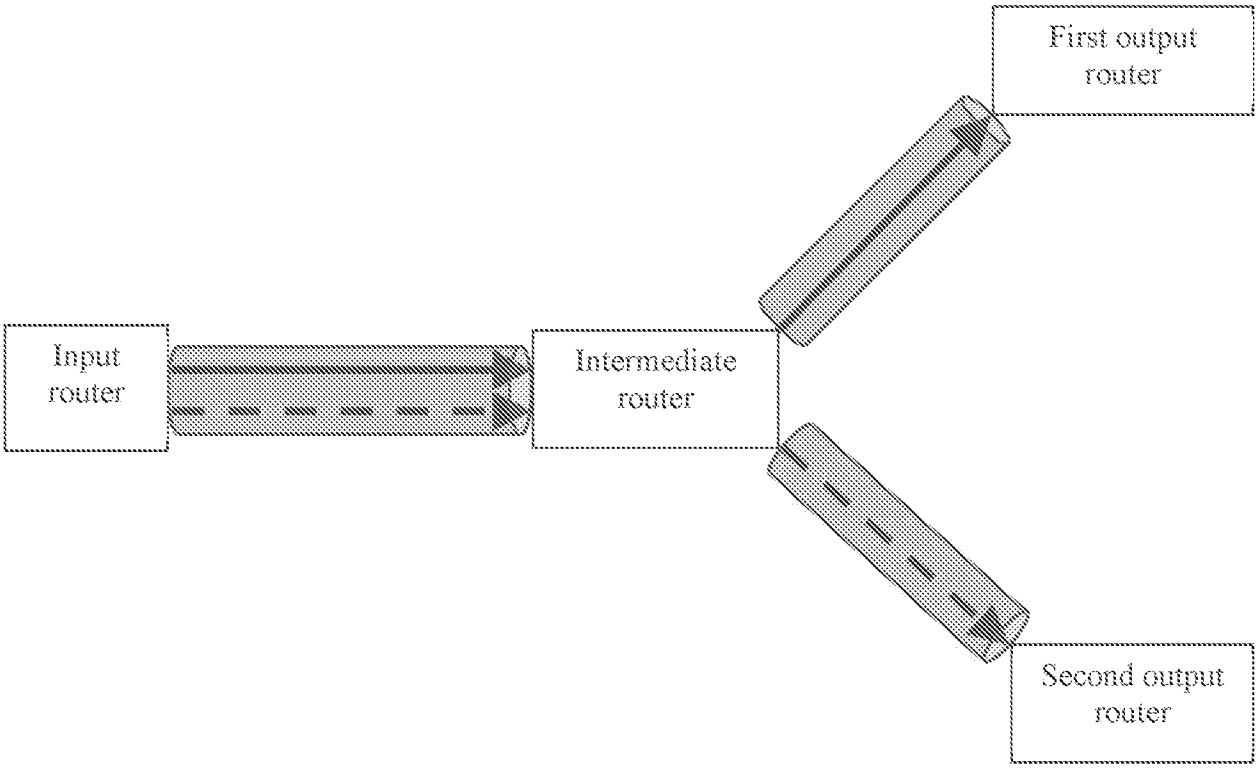
82. Aggarwal provides additional details regarding the LSPs. Aggarwal explains that branch LSPs are point-to-point; therefore, the LSPs have one source device and one destination device. *See* Ex. 1005, 4:1–3 ("Each of the P2P LSPs are built between SPE router 12 and one of RPE routers 16 over one or more router 14."), 1:35–37 ("An LSP defines a distinct path through the network to carry MPLS packets from the source device to a destination device."). Aggarwal explains that

"[t]he P2P [point-to-point] LSPs that are merged to form the P2MP LSPs are referred to as branch LSPs." Ex. 1005, 4:13–15. Aggarwal explains how the point-to-point path that a branch LSPs traverses includes intermediate routers. *See* Ex. 1005, 6:26–49. The figure created below illustrates branch LSPs. The solid line arrows (black) represent a first branch LSP, and the dashed line arrows (black) represent a second branch LSP. The figure illustrates how branch LSPs are point-to-point:



83. Aggarwal teaches that branch LSPs are nested in LSP tunnels, which are called point-to-multipoint (P2MP) LSP tunnels. *See* Ex. 1005, 8:39–41, 7:65–67. Specifically, Aggarwal indicates that "RSVP-TE [Resource Reservation Protocol-Traffic Engineering] protocol 100 provides signaling mechanisms for

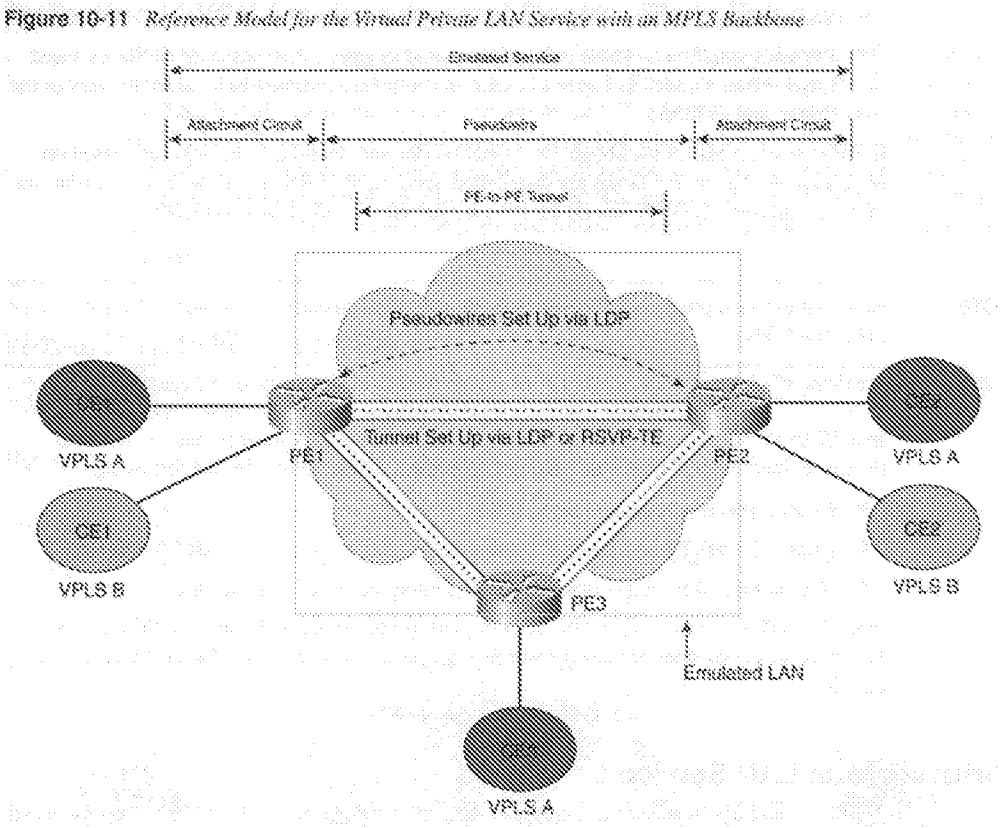
merging branch LSPs to form a P2MP LSP tunnel." Ex. 1005, 8:39–41. Aggarwal explains that there are "one or more branch LSPs [in] the P2MP LSP tunnel." Ex. 1005, 7:65–67. Aggarwal discusses taking "advantage of a LSP hierarchy [LSP-HIER] while building P2MP LSPs." Ex. 1005, 10:54–55. Therefore, a POSITA would have understood that the branch LSPs would have been nested in the P2MP LSP tunnel. The figure created below illustrates a P2MP LSP tunnel with the branch LSPs from the figure above nested inside the tunnel. The cylinders (blue) represent the P2MP LSP tunnel, the solid line arrows (black) represent a first branch LSP, and the dashed line arrows (black) represent a second branch LSP. The figure illustrates how the branch LSPs are nested within the P2MP LSP tunnel:



84. **Second**, a POSITA would have found it obvious to implement Aggarwal's branch LSPs as pseudo-wires, as evidenced by Hussain. Hussain explains setting up LSPs as pseudo-wires via LDP.

85. In particular, Hussain teaches how "[t]o set up a full mesh of point-to-point PWs [pseudo-wires]" between "all PEs [provide edges] in a VPLS [virtual private LAN service]" using label distribution protocol (LDP). Ex. 1006, 276–77. Thus, setting up point-to-point pseudo-wires in a VPLS is a "*method of setting up at least two pseudo-wires*."

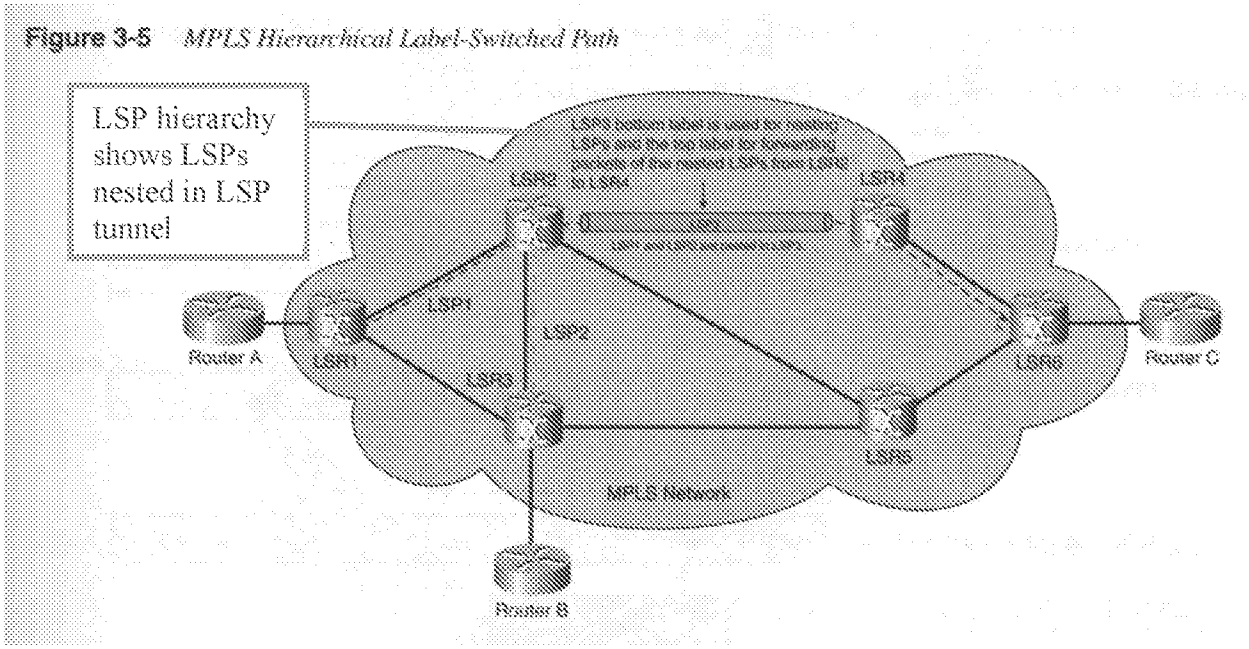
86. Figure 10-11 of Hussain illustrates that pseudo-wires are established as LSPs:



Ex. 1006, Fig. 10-11

87. Furthermore, Hussain teaches that a pseudo-wire is a type of label switched path (LSP). Hussain explains that "MPLS allows multiplexing (nesting) of LSPs within other LSPs." Ex. 1006, 267. When the type of MPLS network used is an L2VPN, then Hussain explains that "PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE [provider edge-to-provider edge] tunnel." Ex. 1006, 273; *see also id.* at 274. For Virtual Private LAN Service (VPLS) networks specifically, Hussain explains that "[m]ultiple PWs can be carried inside a single tunnel." Ex. 1006, 276. Hussain discusses how a "label-stack mechanism allows LSPs to be

nested within another LSP." Ex. 1006, 46. Specifically, Hussain explains that "[i]n the case of MPLS, a tunnel corresponds to a *label-switched path* (LSP) and a hierarchical tunnel corresponds to nesting multiple LSPs within a single LSP using label stack." Ex. 1006, 255. Figure 3-5 of Hussain illustrates how LSPs are nested within another LSP by using a hierarchical tunnel:



Ex. 1006, Fig. 3-5 (annotated)

88. A POSITA implementing Hussain's technique of implementing LSPs as pseudo-wires in the context of Aggarwal's similar LSPs would have found it obvious that the branch LSPs in the created figure illustrating Aggarwal's teachings above would be pseudo-wires. As discussed in [VII.C.3], a POSITA would have been so motivated because using pseudo-wires would improve network efficiency and further Aggarwal`s goal to "optimize packet replication and minimize state and

intelligence in the core of the network." Ex. 1005, 3:40–41; *see also* infra VII.C.3. Therefore, Aggarwal's explanation of branch LSPs, in view of Hussain's explanation of implementing LSPs as pseudo-wires, teaches the pseudo-wires as claimed.

89. Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs. As explained above at XI.C.3, Hussain teaches implementing pseudo-wires *within* a PE-to-PE tunnel. Aggarwal's Branch LSPs are a type of tunnel between edge routers. Thus, a POSITA also would have found it obvious to implement pseudo-wires as nested pseudo-wires within Aggarwal's LSPs (e.g., Branch LSPs 80 and 82).

90. **Third**, a POSITA would have found it obvious that Aggarwal's branch LSPs implemented as pseudo-wires as taught by Hussain would provide broadcast services. Hussain teaches that a VPLS permits data broadcasting services. Specifically, Hussain explains that a VPLS "emulates the performance of a LAN." Ex. 1006, 275. To the customers of a VPLS, "sending data through an L2VPN seems the same as being connected via a single LAN." Ex. 1006, 275. Additionally, Hussain explains that a "conventional LAN provides broadcast and unicast services." Ex. 1006, 277. Therefore, providing conventional LAN broadcast services "requires that each VPLS PE [provider edge] be able to perform" tasks such as "flood[ing] packets with unknown unicast destinations." Ex. 1006, 277. In

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particular, "VPLS allows frames from a single CE [customer edge] to be transmitted to multiple remote CEs." Ex. 1006, 275. Hussain explains "[i]n other words, VPLS is a point-to-multipoint service." Ex. 1006, 275. A POSITA, therefore, would have understood that a VPLS also provides broadcast services. Hussain teaches that "[a] PW [pseudo—wire] is a mechanism that emulates the essential attributes of a service." Ex. 1006, 272. Thus, a POSITA would have understood that the pseudo-wires that provide the VPLS would similarly be "*able to broadcast.*"

91. To the extent the term "pseudo-wire" includes a specific definition, as described in RFC 3895 (Ex.1001, 1:50), a POSITA would have found it obvious that Hussain's reference to a pseudo-wire would refer to the same thing. Specifically, Hussain regularly references IETF drafts and RFCs. *See e.g.,* Ex.1006, 296-97. Accordingly, a POSITA would have expected Hussain's discussion of pseudo-wires to use that term as it is used in the IETF and RFC documents.

92. Hussain teaches that L2VPNs, including VPLS, "transport Layer 2 frames." Ex. 1006, 273. A POSITA, therefore, would have understood that Layer 2 frames are a type of traffic that can be broadcast in a VPLS. Thus, the Layer 2 frames are "*a data stream.*"

93. Thus, because Aggarwal teaches establishing branch LSPs, which can be implemented as pseudo-wires and provide broadcast services as taught by

Hussain, the combination of Aggarwal and Hussain renders obvious "*[a] method of setting up at least two pseudo-wires able to broadcast a data stream*," as claimed.

[1.1] ***setting up a first pseudo-wire comprising a first link***

94. Aggarwal and Hussain render this limitation obvious.

95. As discussed in [1.0], Aggarwal, in view of Hussain, teaches that branch LSPs may be implemented as pseudo-wires.

96. Aggarwal teaches setting up a branch LSP ("*first pseudo-wire*"). In particular, Aggarwal provides an example of a branch LSP setup. In the example below, SPE router 60 is the ingress router, which sets up the branch LSP to egress router RPE router 66:

> FIG. 5 is a block diagram illustrating an exemplary computer network 58 in which P2MP RSVP TE tunnels have been established. Computer network 58 includes a SPE [source provider edge] router 60, a RPE [receiver provider edge] router 66, a RPE router 68 and a RPE router 72. Computer network 58 also includes intermediate routers 62, 64, 68, and 70. SPE router 12 establishes a P2MP LSP between SPE router 12 and RPE routers 66, 68, and 72.
>
> SPE router 60 first learns that RPE routers 66, 68, and 60 are interested in joining a P2MP LSP associated with a particular PID. For example, the PID may be a multicast group. SPE router 60 may learn of RPE routers 66, 68, and 72 at different points,

> though in this example it is assumed that SPE router 60 learns of the RPE routers at the same time. SPE router 12 then computes the P2P paths to reach RPE router 66, RPE router 68, and RPE router 72. These branch LSPs are computer to share the same links where possible as they belong to the same session.
>
> For example, SPE router 60 establishes branch LSP 76 to RPE router 72 via router 70. **SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router 64.** As shown in FIG. 5, Branch LSPs 80 and 82 share links 63 and 61 between routers 64 and SPE router 60.

Ex. 1005, 6:26–49 (emphasis added).

97. A POSITA would have found it obvious that branch LSP 80 from SPE router 60 to RPE router 66 discussed above would be "*a first pseudo-wire*," as claimed.

98. Additionally, Aggarwal teaches that the first branch LSP includes links 61 and 63 ("*first link*"): "As shown in FIG. 5, **Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Aggarwal illustrates in Figure 5 that the first pseudo-wire traverses a path from SPE router 60 to intermediate router 62 to intermediate router 64 to RPE router 66:

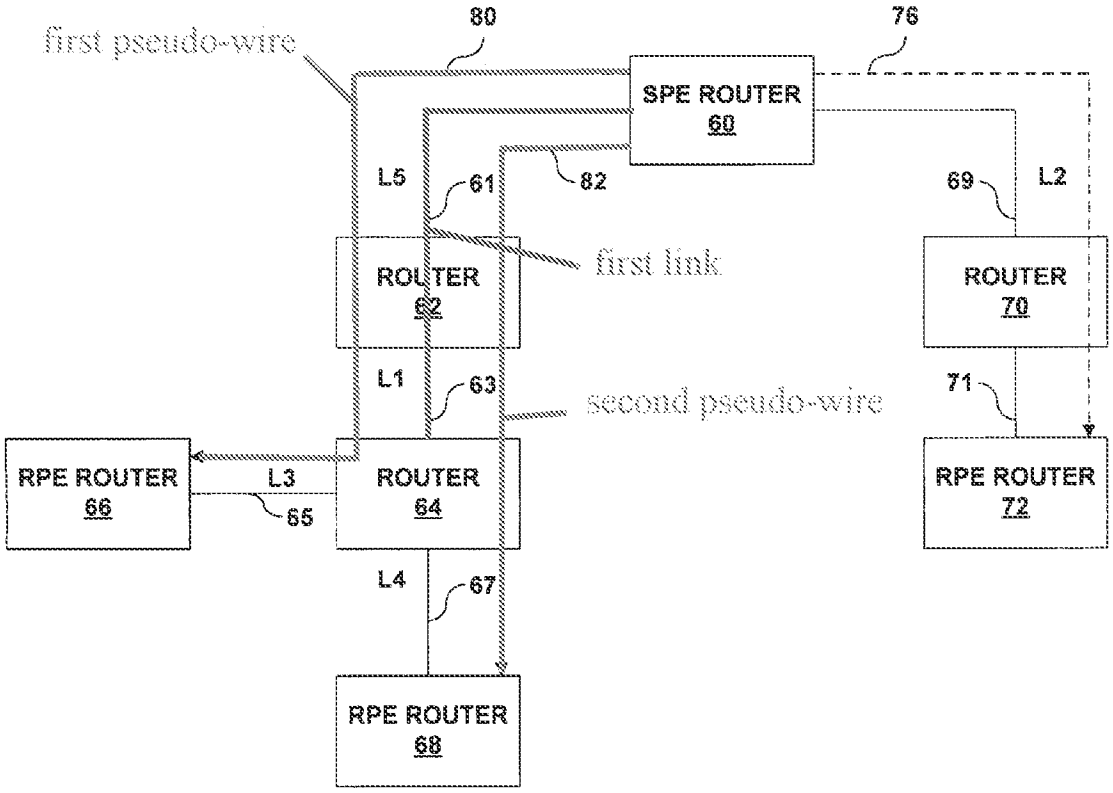

Fig. 5, (annotated)

99. Aggarwal explains that "[t]he term 'link' is often used to refer to the connection between two devices on a network." Ex. 1005, 1:22. The term includes "'virtual' or 'logical links.'" Ex. 1005, 1:25–27.

100. A POSITA implementing the method of setting up the first pseudo-wire would have understood that a link may consist of multiple hops. Therefore, a POSITA would have found it obvious that "*a first link*" would extend from SPE router 60 to intermediate router 64. As illustrated in Figure 5 above, the first pseudo-wire comprises the first link.

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101. To the extent that a link is found to be the connection between pairs of routers that do not include intermediate routers, a POSITA would understand that router 62 could be removed (and labels L5 and L1 consolidated into a single label) in the example network in Figure 5 above. A POSITA would have found it obvious to remove router 62 from the network of Figure 5, recognizing that there are no other routers other than router 60 and router 64 to which router 62 is connected, and that the system would perform better (no delays incurred in router 62), would be simpler to manage (fewer routers to configure and manage), and be cheaper to implement (no cost for installing and managing router 62). This possibility is explicitly shown by Aggarwal because there is no router between SPE router 60 and intermediate router 70. Specifically, there is another path in the network from SPE router 60 through intermediate router 70 to RPE router 72. A POSITA would have understood that the first pseudo-wire could have similarly included only one intermediate router (intermediate router 64). Therefore, a POSITA would have found it obvious to remove intermediate router 62 so that the first pseudo-wire mirrored the path taken on the right side of Figure 5 above.

102. Thus, because Aggarwal teaches a branch LSP 80 with links 61 and 63 between the router 64 and the SPE router 60, and a POSITA would have found it obvious to implement Aggarwal's branch LSP as a pseudo-wire as taught by

Hussain, Aggarwal and Hussain render obvious "*setting up a first pseudo-wire comprising a first link*," as claimed.

[1.2] *[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and*

103. Aggarwal and Hussain render this limitation obvious.

104. As discussed in [1.1], Aggarwal illustrates a first pseudo-wire comprising a first link from SPE router 60 ("*input router*") to intermediate router 64 ("*intermediate router*"). Figure 5 illustrates the first link:

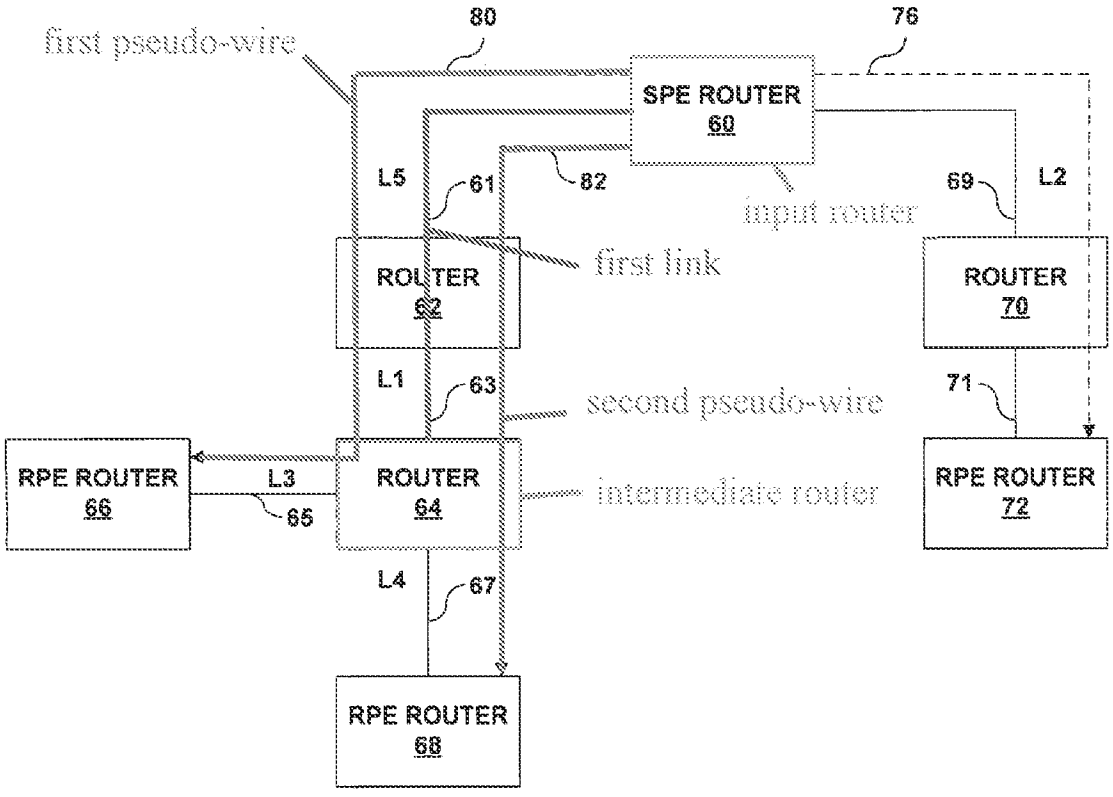


Fig. 5, (annotated)

105. Aggarwal explains that "[c]omputer network 58 includes a SPE [source provider edge] router 60." Ex. 1005, 6:28. SPE router 60 is an "*input router*" because it is described as a source provider edge router. In a different embodiment (Fig. 1), Aggarwal describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Ex.1005, 3:58–61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and a receiver provider edge (RPE) router 16A (destination network device) of subscriber network 18A." Ex.1005, 3:61–65. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the SPE routers and RPE routers in the embodiment of Fig. 5. Accordingly, because the SPE receives traffic from a source network to be passed to a subscriber network, it is an input router.

106. Furthermore, router 64 is an "*intermediate router*" because Aggarwal explicitly states that "[c]omputer network 58 also includes intermediate routers 62, 64, 68, and 70." Ex.1005, 6:30–31. And, router 64 is positioned between the Source Provider Edge router 60 and Receiver Provider Edge (RPE) routers 66 and 68, and

is thus intermediately positioned between SPE 60 and RPEs 66 and 68. Accordingly, intermediate router 64 is "*an intermediate router*" as claimed.

107. **Second,** both the SPE router 60 and the intermediate router 64 are in a "*packet-switched network*." Regarding the SPE routers, Aggarwal states that "[u]pon receiving an incoming **packet**, the routers examine information within the packet and forward the packet in accordance with the routing information." Ex.1005, 4:37–39. And, Aggarwal notes that the P2MP LSPs are part of a LAN. *See* Ex.1005, 6:60–7:3. A POSITA would have found it obvious for a LAN to be a packet-switched network.

108. In more detail, as discussed in [1.0], Hussain teaches that pseudo-wires provide a VPLS, which "emulates the performance of a LAN across a packet-switched network." Ex. 1006, 275. Hussain explains that a "packet-switched network consists of interconnected network elements, including routers, switches, and transport links." Ex. 1006, 11. Hussain describes how with "the migration of legacy Layer 2 infrastructure over a converged packet-switched network," services such as Frame Relay (FR) and Asynchronous Transfer Mode (ATM) "are predominantly offered over an IP/MPLS backbone." Ex. 1006, 254. In an MPLS network, each router examines a packet's "top label on the stack" when it arrives at the router. Ex. 1006, 45. When a packet is leaving the router, "several label-stack operations such as pop (remove the top label), swap (replace the top label with a

specified new label), and push (add a specified number of labels on the top of the stack) may be performed." Ex. 1006, 45. Hussain explains that "[a] router that supports MPLS is known as a label-switching router (LSR)." Ex. 1006, 45. In addition, "[t]he sequence of LSRs that a labeled packet traverses, starting at the ingress LSR and terminating at the egress LSR, is called the label-switched path (LSP)." Ex. 1006, 46.

109. As discussed, Aggarwal teaches branch LSP 80 including SPE router 60 and intermediate router 64, which are the first pseudo-wire, input router, and intermediate router, respectively. A POSITA, therefore, would have understood that the "input router" and "intermediate router" are part of a "*packet-switched network*," as claimed.

110. Thus, because Aggarwal teaches links 61 and 63 between SPE router 60 and intermediate router 64, Aggarwal renders obvious "*[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network*," as claimed.

[1.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

111. Aggarwal and Hussain render this limitation obvious.

112. As discussed in [1.1], Figure 5 of Aggarwal illustrates a first pseudo-wire traverses a path from SPE router 60 to intermediate router 62 to intermediate

router 64 to RPE router 66. Additionally, Figure 5 illustrates that the first pseudo-wire comprises a first link from SPE router 60 to intermediate router 64. Therefore, a POSITA would have found it obvious that "*a second link*" would extend from intermediate router 64 to RPE router 66.

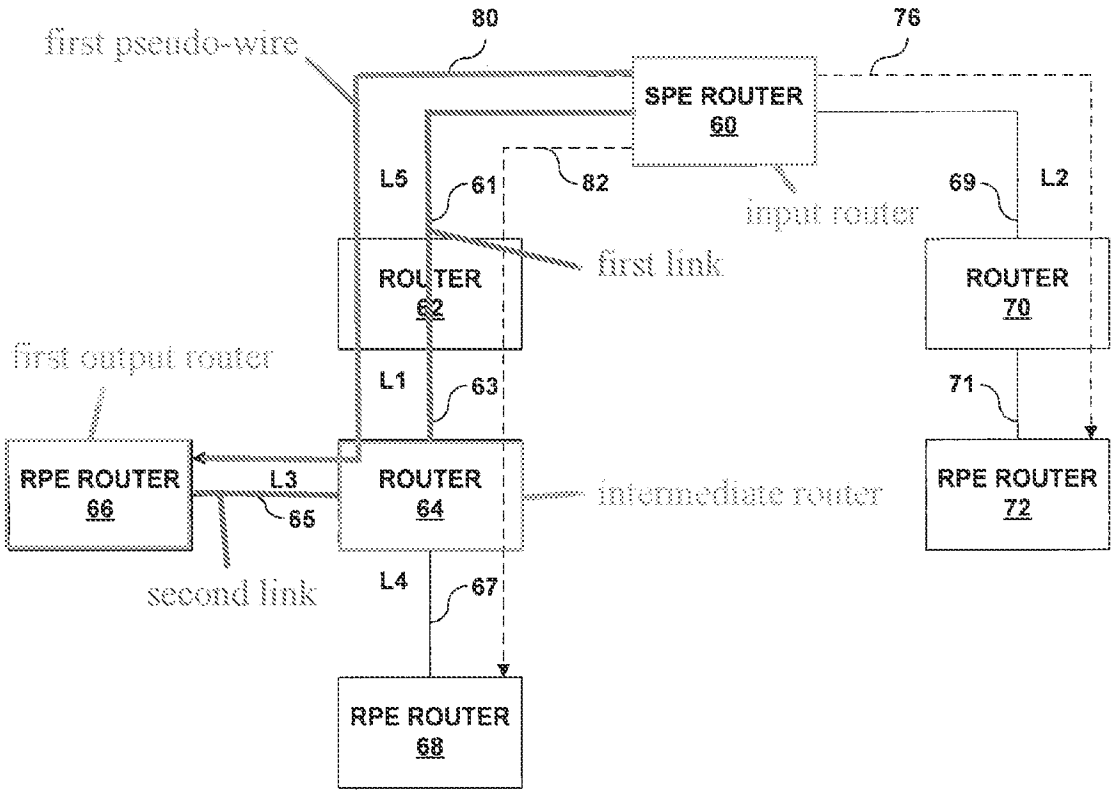


Fig. 5, (annotated)

113. As illustrated in Figure 5 above, the first pseudo-wire comprises the second link. As discussed in [1.2], intermediate router 4 is "*an intermediate router.*"

114. The RPE Router 66 is an output router because it is described as a Receiver Provider Edge router. In a different embodiment (Fig. 1), Aggarwal

describes the roles of the SPE routers and the RPE routers: "a source provider edge (SPE) router 12 (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network 10 and subscriber networks 18." Aggarwal, 3:58–61. "A P2P LSP 20A is established between SPE router 12 of source network 10 and **a receiver provider edge (RPE) router 16A (destination network device)** of subscriber network 18A." Ex.1005, 3:61–65. In other words, traffic enters the P2MP network at the source (SPE router) and exits at the receiver (RPE router). A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the SPE routers and RPE routers in the embodiment of Fig. 5. Accordingly, because the RPE provides traffic from a source network to a subscriber network, a POSITA would have understood that RPE router 66 would be "*a first output router*."

115. As discussed in [1.2], Aggarwal in view of Hussain teaches that the input router and intermediate router are part of "*a packet-switched network*." Therefore, a POSITA would have found it obvious that RPE router 66, the "*first output router*," is also a part of "*the packet-switched network*."

116. Thus, because Aggarwal teaches that branch LSP 80 includes a link 65 between the intermediate router 64 and RPE router 66, and Hussain teaches it would be obvious to implement the branch LSP as a pseudo-wire, the combination of Aggarwal and Hussain renders obvious "*[a first pseudo-wire comprising . . .] a*

second link set up between said intermediate router and a first output router of the packet-switched network," as claimed.

[1.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

117. Aggarwal and Hussain render this limitation obvious.

118. As discussed in [1.0], Aggarwal, in view of Hussain, teaches that branch LSPs may be implemented as pseudo-wires. And, as discussed in [1.1], Aggarwal teaches setting up a first pseudo-wire.

119. Additionally, Aggarwal teaches a branch LSP 82 ("*second pseudo-wire*") that extends between SPE router 60 and RPE router 68 ("*second output router*").:

> FIG. 5 is a block diagram illustrating an exemplary computer network 58 in which P2MP RSVP TE tunnels have been established. Computer network 58 includes a SPE [source provider edge] router 60, a RPE [receiver provider edge] router 66, a RPE router 68 and a RPE router 72. Computer network 58 also includes intermediate routers 62, 64, 68, and 70. SPE router 12 establishes a P2MP LSP between SPE router 12 and RPE routers 66, 68, and 72.
>
> SPE router 60 first learns that RPE routers 66, 68, and 60 are interested in joining a P2MP LSP associated with a particular PID. For example, the PID may be a multicast group. SPE router 60 may learn of RPE routers 66, 68, and 72 at different points,

> though in this example it is assumed that SPE router 60 learns of the RPE routers at the same time. SPE router 12 then computes the P2P paths to reach RPE router 66, RPE router 68, and RPE router 72. These branch LSPs are computer to share the same links where possible as they belong to the same session.
>
> For example, SPE router 60 establishes branch LSP 76 to RPE router 72 via router 70. **SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router 64.** As shown in FIG. 5, Branch LSPs 80 and 82 share links 63 and 61 between routers 64 and SPE router 60.

Ex. 1005, 6:26–49 (emphasis added).

120. A POSITA would have found it obvious that branch LSP 82 from SPE router 60 to RPE router 68 discussed above would be "*a second pseudo-wire*," as claimed.

121. Additionally, Aggarwal illustrates in Figure 5 that the second pseudo-wire traverses a path from SPE router 60 to intermediate router 62 to intermediate router 64 to RPE router 68:

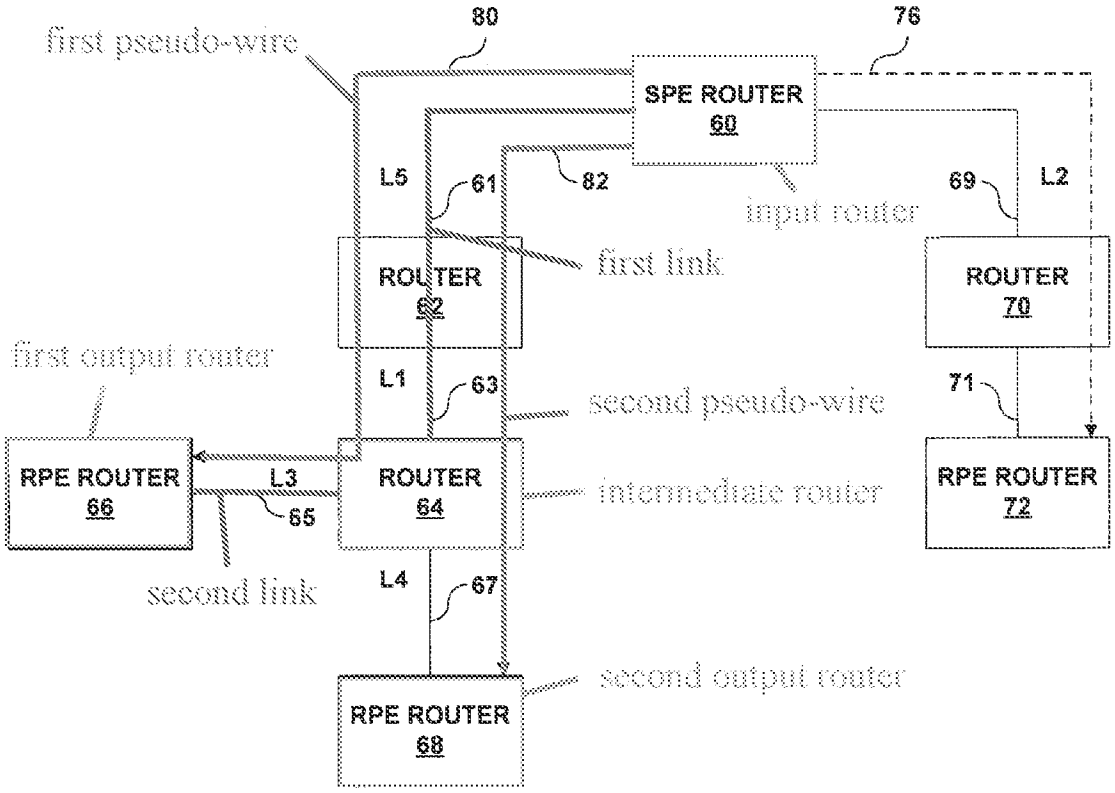


Fig. 5, (annotated)

122. As discussed in [1.2], SPE router 60 is "*an input router*."

123. As discussed in [1.3], RPE router 66 is "*a first output router*." Aggarwal also explains that "[c]omputer network 58 includes a SPE router 60, a RPE [receiver provider edge] router 66, a RPE router 68 and a RPE router 72." Ex. 1005, 6:28–29. Accordingly, a POSITA would have understood that RPE router 68 would be "*a second output router*."

124. As discussed in [1.2], Hussain teaches that pseudo-wires provide a VPLS, which "emulates the performance of a LAN across a packet-switched

network." Ex. 1006, 275. Hussain describes how with "the migration of legacy Layer 2 infrastructure over a converged packet-switched network," services such as Frame Relay (FR) and Asynchronous Transfer Mode (ATM) "are predominantly offered over an IP/MPLS backbone." Ex. 1006, 254. Hussain explains that MPLS networks are comprised of LSRs, and sequences of LSRs form LSPs. Ex. 1006, 45–46.

125. As discussed, Aggarwal teaches a branch LSP including SPE router 60 and RPE router 68, which are the second pseudo-wire, input router, and output router, respectively. Therefore, a POSITA would have found it obvious that RPE router 68, the "*second output router*," is also a part of "*the packet-switched network*."

126. Thus, because Aggarwal teaches branch LSP 82 between SPE router 60 and RPE router 68, Aggarwal and Hussain render obvious "*setting up a second pseudo-wire between said input router and a second output router of the packet-switched network*," as claimed.

[1.5] *wherein the second pseudo-wire comprises said first link and*

127. Aggarwal and Hussain render this limitation obvious.

128. As discussed in [1.4], Aggarwal in view of Hussain teaches "*a second pseudo-wire*" that traverses a path from SPE router 60 to intermediate router 62 to intermediate router 64 to RPE router 68.

129. As discussed in [1.1], Aggarwal illustrates "*a first link*" from SPE router 60 to intermediate router 64. Figure 5 illustrates the first link:

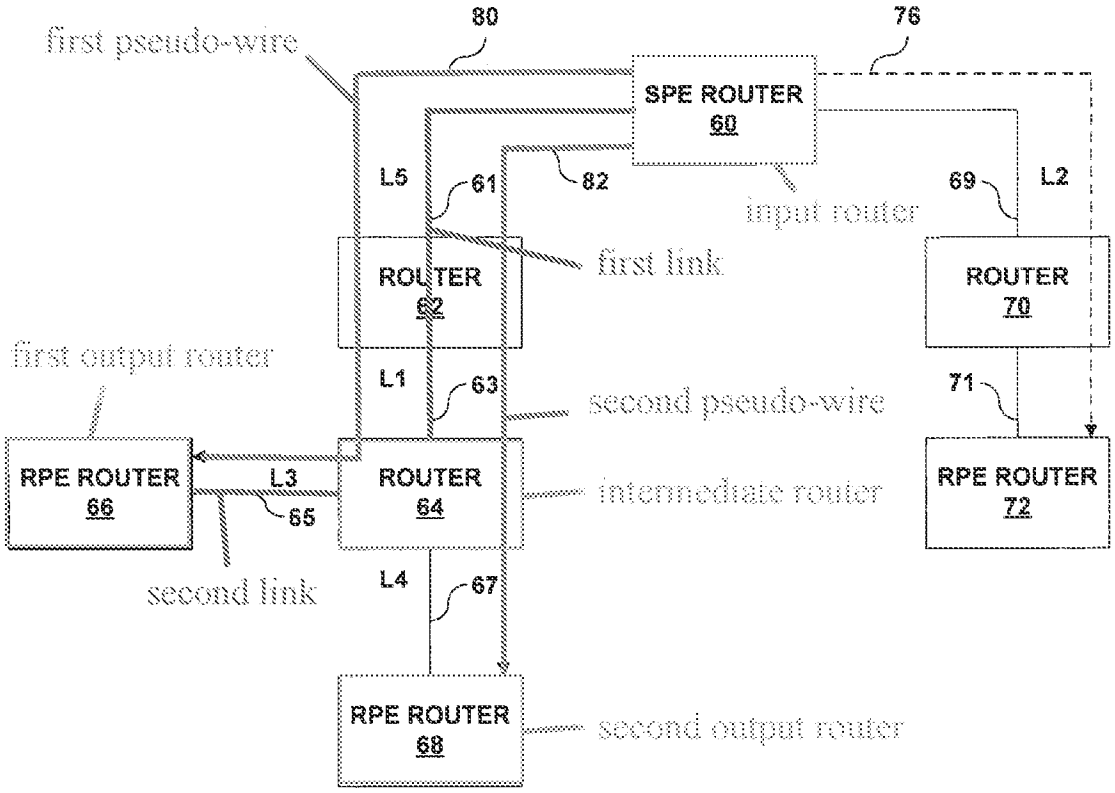


Fig. 5, (annotated)

130. As illustrated in Figure 5 above, the second pseudo-wire comprises the first link.

131. As discussed in [1.1], to the extent that a link is found to be the connection between pairs of routers that do not include intermediate routers, a POSITA would understand that router 62 could be removed (and labels L5 and L1 consolidated into a single label) in the example network in Figure 5 above. A POSITA would have found it obvious to remove router 62 from the network of Figure 5, recognizing that there are no other routers other than router 60 and router

64 to which router 62 is connected, and that the system would perform better (no delays incurred in router 62), would be simpler to manage (fewer routers to configure and manage), and be cheaper to implement (no cost for installing and managing router 62). Furthermore, there is another path in the network from SPE router 60 through intermediate router 70 to RPE router 72. A POSITA would have understood that the second pseudo-wire could have similarly included only one intermediate router (intermediate router 64). Therefore, a POSITA would have been motivated to remove intermediate router 62 so that the second pseudo-wire mirrored the path taken on the right side of Figure 5 above.

132. Thus, because Aggarwal teaches that branch LSP 82 includes links 61 and 63, and Hussain shows that it would be obvious to implement the LSP 82 as a pseudo-wire, Aggarwal and Hussain render obvious "*wherein the second pseudo-wire comprises said first link*," as claimed.

[1.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

133. Aggarwal and Hussain render this limitation obvious.

134. As discussed in [1.4], Figure 5 of Aggarwal illustrates a second pseudo-wire traverses a path from SPE router 60 to intermediate router 62 to intermediate router 64 to RPE router 68. As discussed in [1.1], Figure 5 illustrates a first link from SPE router 60 to intermediate router 64. As discussed in [1.3], Figure 5 illustrates a

second link from intermediate router 64 to RPE router 66. Therefore, a POSITA would have found it obvious that "*a third link*" 67 would extend from intermediate router 64 to RPE router 68. Figure 5 illustrates the third link:

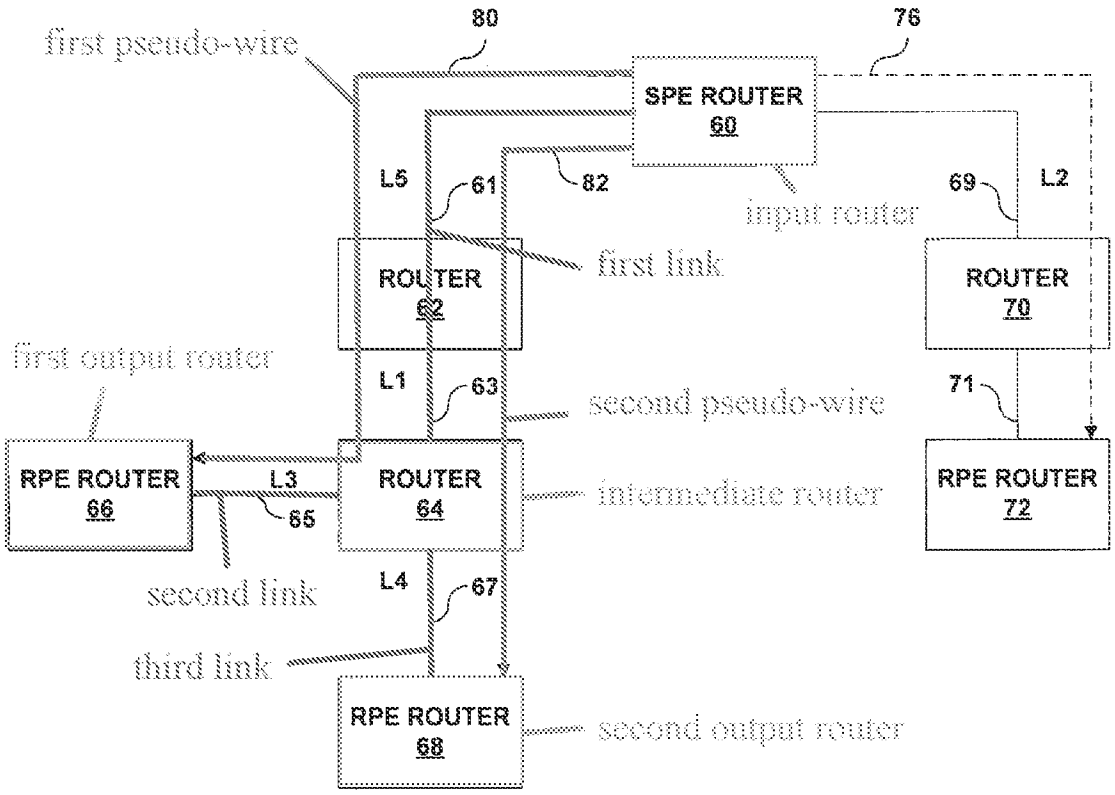


Fig. 5, (annotated)

135. As illustrated in Figure 5 above, the second pseudo-wire comprises the third link. As discussed in [1.2], intermediate router 64 is "*an intermediate router*." As discussed in [1.4], RPE router 68 is a "*second output router*."

136. Thus, because Aggarwal teaches a link 67 between intermediate router 64 and RPE router 68, and Hussain shows that it would have been obvious to implement the LSP as a pseudo-wire, Aggarwal and Hussain render obvious"*[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router*," as claimed.

[1.7] ***said first link being shared by the first and second pseudo-wires.***

137. Aggarwal and Hussain render this limitation obvious.

138. As explained above at [1.1], the links 61 and 63 ("*first link*") are shared by Branch LSP 80 ("*first pseudo-wire*") and Branch LSP 82 ("*second pseudo-wire*"). "**Branch LSPs 80 and 82 share links 63 and 61** between router 64 and SPE router 60." Aggarwal teaches that this sharing occurs by "merging the individual P2P LSPs and relying on MPLS label multicast." Ex.1005, 4:12–13.

139. Furthermore, as explained above at [1.0], Hussain shows that it would have been obvious to implement Aggarwal's branch LSPs as pseudo-wires as described by Hussain. Hussain also teaches that "tunnels are set up using LDP or RSVP-TE" and that "[m]ultiple PWs can be carried inside a single tunnel." Hussain, 276.

140. In more detail, as discussed in [1.1] and [1.4], Aggarwal in view of Hussain teaches a first pseudo-wire and a second pseudo-wire. Additionally, as discussed in [1.1], Aggarwal teaches that the first pseudo-wire comprises the first

link. Further, as discussed in [1.5], Aggarwal teaches that the second pseudo-wire comprises the first link.

141. Aggarwal teaches that multiple branch LSPs may share the same link when they are a part of the same P2MP LSP. Aggarwal explains that a "P2MP LSP tunnel has a plurality of branch LSPs." Ex. 1005, 2:11. In particular, Aggarwal provides an example of a multiple branch LSPs sharing a link in a P2MP LSP tunnel:

> **FIG. 5 is a block diagram illustrating an exemplary computer network 58 in which P2MP RSVP TE tunnels have been established.** Computer network 58 includes a SPE [source provider edge] router 60, a RPE [receiver provider edge] router 66, a RPE router 68 and a RPE router 72. Computer network 58 also includes intermediate routers 62, 64, 68, and 70. SPE router 12 establishes a **P2MP LSP** between SPE router 12 and RPE routers 66, 68, and 72.
>
> SPE router 60 first learns that RPE routers 66, 68, and 60 are interested in joining a P2MP LSP associated with a particular PID. For example, the PID may be a multicast group. SPE router 60 may learn of RPE routers 66, 68, and 72 at different points, though in this example it is assumed that SPE router 60 learns of the RPE routers at the same time. SPE router 12 then computes the P2P paths to reach RPE router 66, RPE router 68, and RPE router 72. **These branch LSPs are computer to share the same links where possible as they belong to the same session.**

> For example, SPE router 60 establishes branch LSP 76 to RPE router 72 via router 70. SPE router 60 also establishes branch LSPs 80 and 82 with RPE routers 66 and 68, respectively, via router 62 and router 64. **As shown in FIG. 5, Branch LSPs 80 and 82 share links 63 and 61 between routers 64 and SPE router 60.**

Ex. 1005, 6:26–49 (emphasis added).

142. Figure 5 of Aggarwal illustrates that the first and second pseudo-wires share the first link:

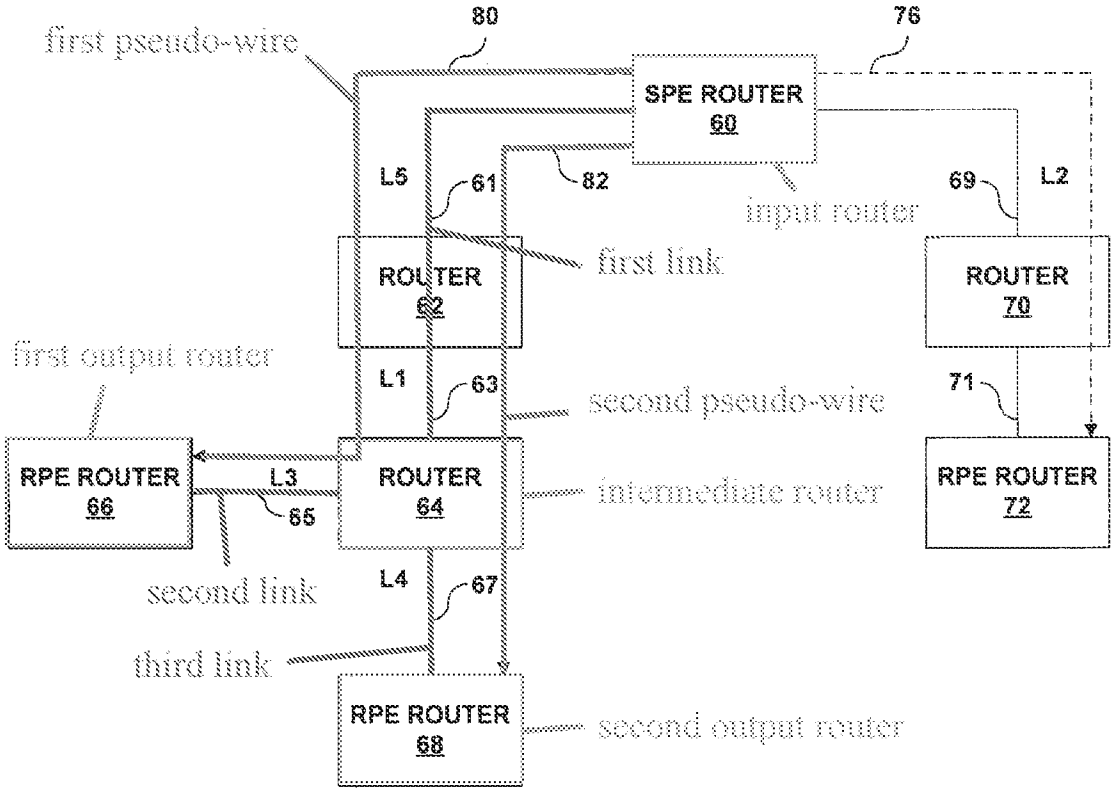


Fig. 5, (annotated)

143. Thus, because Aggarwal teaches links 61 and 63 between SPE router 60 and intermediate router 64 shared by pseudo-wires 80 and 82, Aggarwal and Hussain render obvious "*said first link being shared by the first and second pseudo-wires*," as claimed.

5. Claim 6

[6.0] ***A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:***

144. As discussed at [1.0], the prior art renders obvious a "*a method of setting up at least two pseudo-wires able to broadcast a data stream*," as claimed.

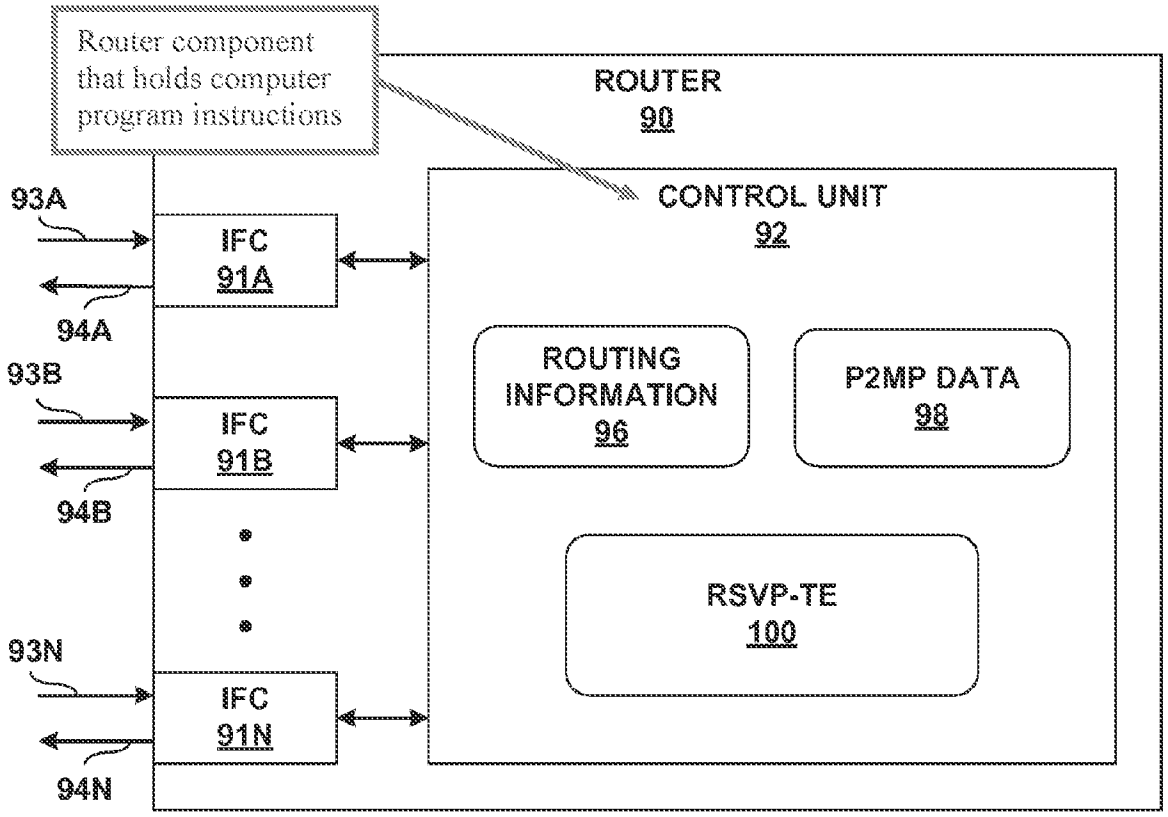
145. A POSITA would have found it obvious for such method to be implemented by a computer program product stored on a computer-readable medium. Aggarwal teaches that "[r]outing devices within a network, often referred to as routers, maintain routing information that describes available routes through the network." Ex. 1005, 1:13–15. Aggarwal indicates that "[r]outer 90 may, for example, represent any of the routers described herein." Ex. 1005, 7:59–61. Aggarwal explains that "[r]outer 90 further comprises a control unit 92 that maintains routing information 96." Ex. 1005, 8:7–8. Aggarwal teaches that "control unit 92 provides an operating environment for a resource reservation protocol 100 ("RSVP-TE protocol 100") executing within control unit 92," and "other protocols

may be executed within control unit 92, such as the label distribution protocol (LDP)." Ex. 1005, 8:21–26. Specifically, Aggarwal teaches that control unit 92 includes computer program code instructions:

> Control unit 92 may be implemented solely in software, or hardware, or may be implemented as a combination of **software, hardware, or firmware**. For example, control unit 92 may include one or more **processors which execute software instructions**. In that case, the various software modules of control unit 92, such as RSVP-TE protocol 100, may comprise **executable instructions stored on a computer-readable medium**, such as computer memory or hard disk.

Ex. 1005, 9:1–8.

146. Figure 6 of Aggarwal illustrates a network router containing computer program instructions for setting up label switched paths:



Ex. 1005, Fig. 6 (annotated)

147. A POSITA, therefore, would have found it obvious that SPE router 60, intermediate router 64, RPE router 66, and RPE router 68, which are input router, intermediate router, first output router, and second output router, respectively, each contain "*computer code instructions*."

148. Thus, Aggarwal and Hussain render obvious "*[a] computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two*

pseudo-wires able to broadcast a data stream when said program is executed by a computer," as claimed.

[6.1] ***setting up a first pseudo-wire comprising a first link***

149. This limitation is disclosed for the reasons discussed in [1.1].

[6.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

150. This limitation is disclosed for the reasons discussed in [1.2].

[6.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

151. This limitation is disclosed for the reasons discussed in [1.3].

[6.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

152. This limitation is disclosed for the reasons discussed in [1.4].

[6.5] ***wherein the second pseudo-wire comprises said first link and***

153. This limitation is disclosed for the reasons discussed in [1.5].

[6.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

154. This limitation is disclosed for the reasons discussed in [1.6].

[6.7] ***said first link being shared by the first and second pseudo-wires.***

155. This limitation is disclosed for the reasons discussed in [1.7].

VIII. Conclusion

156. This declaration and my opinions herein are made to the best of my knowledge and understanding, and based on the material available to me, at the time of signing this declaration. I declare that all statements made herein on 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 or Title 18 of the United States Code.

7/6/2020 — Date

Henry Houh — Henry Houh

Exhibit 1004

Curriculum Vitae of Henry Houh

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Henry H. Houh

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Education

Massachusetts Institute of Technology, Cambridge, MA

- PhD in Electrical Engineering and Computer Science, February 1998. "Designing Networks for Tomorrow's Traffic," thesis supervised by Professor David Tennenhouse and Professor John Guttag. GPA 4.7/5.0
- Master of Science in Electrical Engineering and Computer Science, February 1991. "Demonstration of a laser repetition rate multiplier," thesis. GPA 4.5/5.0
- Bachelor of Science in Electrical Engineering and Computer Science, June 1989. "Boundary element analysis of arbitrarily shaped dielectric structures," thesis. GPA 4.7/5.0
- Bachelor of Science in Physics, February 1990. GPA 4.7/5.0

Experience

BlocksCAD Inc. (H3XL spin-out)

- 2014 - present: Founder and member of Board of Directors. BlocksCAD is a visual Computer-Aided Design (CAD) program, designed to teach children mathematics and geometric visualization. BlocksCAD is being used in U.S. schools and worldwide in maker spaces, with 350,000+ users. BlocksCAD was selected to be part of the LearnLaunch 2017 Boost Accelerator, the MIT Play Labs 2018 Summer Accelerator, and the MassChallenge 2018 Boston Cohort. Recipient of DARPA DSO grant in 2014, and SBIR grant from the USDA in 2019.

H3XL Inc. d/b/a Einstein's Workshop (formerly Lexington Robotics)

- 2009 - present: Founder and President. Started local league providing science and engineering education programs based on LEGO Mindstorms, LEGO WeDo, and FIRST LEGO League. In 2012, grew program into a full science, technology, engineering and math enrichment program and creative/maker space, in 7,000 square feet of space. Serve 2,000+ kids and families annually. As of end of 2017, have delivered an estimated 120,000 student-instruction-hours of STEM courses. Principle Investigator for 2-year DARPA grant to improve 3D Computer Aided Design tool developed in-house for the purposes of teaching 8 year olds and up 3D CAD.

Houh Consulting Inc. / Independent Consultant

- 2009 - present: Technical consultant specializing in Social Networking, Web 2.0, Web Site Development, Data Networking, Optical Networking, Telecommunications, Media Streaming and Voice Over IP. Clients include: Akin Gump Strauss Hauer & Feld LLP, Arnold & Porter Kaye Scholer LLP, BBN, Baker Botts LLP, Barnes & Thornburg LLP, BBN Technologies, Beus Gilbert McGroder PLLC, Bracewell LLP, Christensen O'Connor Johnson Kindness PLLC,

Cooley LLP, Covington & Burling LLP, Cozen O'Connor P.C., DLA Piper, Davis Polk & Wardwell LLP, Desmarais LLP, Duane Morris LLP, Erise IP, P.A., Faegre Baker Daniels LLP, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP, Fish & Richardson P.C., Goldman Ismail Tomaselli Brennan & Baum LLP, Haynes and Boone, LLP, Kaye Scholer, Kellogg Huber Hanson Todd Evans & Figel PLLC, Kirkland & Ellis LLP, Klarquist Sparkman, LLP, McCarthy Tetrault LLP, McGuireWoods LLP, Morgan, Lewis & Bockius LLP, Munger Tolles & Olson LLP, Orrick, Herrington & Sutfliffe LLP, O'Melveny & Myers LLP, Orrick, Herrington & Sutcliffe LLP, Paul Hastings LLP, Paul, Weiss, Rifkind, Wharton & Garrison LLP, Perkins Coie LLP, Quinn Emanuel Urquhart & Sullivan, LLP, Sidley Austin LLP, Sterne, Kessler, Goldstein & Fox PLLC, Troutman Sanders LLP, Venable LLP, Weil, Gotshal & Manges LLP, Wiley Rein LLP, Wilmer Cutler Pickering Hale and Dorr LLP, and Winston & Strawn LLP.

Eons

- 2008 - 2009: Chief Technology Officer. Created product that Eons acquired from BBN Technologies. Integrated BBN product with Eons social networking platform and significantly increased the Eons group creation rate. Helped evaluate advertisement platform offerings and rolled out the "Boom Network" advertising network. Eons raised $32 million from General Catalyst Partners, Charles River Ventures, Sequoia Capital, and Intel Capital.

BBN Technologies

- 2007 - 2008: Delta Division, Vice President of Technology. Grew "Boomerang" counter-sniper project engineering team and significantly de-risked $10 million worth of product deliveries. Boomerang was a significant asset leading to the acquisition of BBN by Raytheon in 2009. Created new business plan and grew team; launched new fully-featured social networking web site in 5 months. Served as lead expert witness in patent infringement lawsuit, resulting in $58 million jury award to client; verdict for patents I testified on were upheld on appeal which resulted in a $120 million settlement.
- 2004 - 2007: Delta Division, Director of Technology, responsible for commercializing IP and creating new businesses. Hired and grew division's initial engineering team. Wrote three business plans, two of which are funded and active. For call center business plan, acted as general manager, hiring and managing engineering team, inside sales team, and identifying and recruiting a new general manager. Identified and recruited other key employees to Delta Division, including senior members of team leading to successful internal sales growth and spin-outs of projects. Contracted by BBN to BBN spin-out PodZinger as VP of Operations and Technology. Identified sales team for counter-sniper system, leading to $10 million dollars of new sales within 6 months and $100+ million in additional orders in the following two years.

PodZinger Inc. (BBN spin-out, also known as EveryZing and now RAMP)

- 2006: Vice President of Operations and Technology. Significantly upgraded capability of consumer-facing search site and redeployed web site from company to co-location facility. Identified key portions of infrastructure for upgrading and cost reduction. Helped write business plan, evaluating advertisement models of revenue. Hired in operations replacement and phased back to BBN.

Commonwealth Capital

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- 2004: Entrepreneur-in-residence (informally), performed technical due diligence on business plans, brainstormed ideas for new businesses with venture partner. With venture partner, left for portfolio company BBN to form core of commercialization team.

Empirix, Inc./Teradyne, Inc.

- 2001 - 2004: Chief Technologist, Engineering Manager, Web Application Test Group. Researched potential new product areas; developed product plan and prototype. Responsible for three new and existing products. Managed off-shore development team. Chief architect for all web testing products. Re-architected core testing product, helped write javascript interpreter. Provided technical vision for core product.
- 2000 - 2001: Chief Technologist, Communication Infrastructure Test Group. Responsible for incorporating new technology internally, tracking new technologies, technical evaluation of partnerships and potential acquisitions. Helped develop division strategy. Developed plans which formed core capabilities for successful new products introduced in 2004-5.
- 2000 - 2001: Engineering Manager, Communications Infrastructure Test Group. Execution of new product plan developed in prior role. Grew team from four existing engineers to team of over 30 on immediate team and over 40 on project. Delivered new platform in one year. Platform and derivatives accounted for large portion of booked products for the division within 2 years and is currently (2008) a key portion of new product offerings.
- 2000: Empirix was formed as a spin-out of Teradyne in January 2000. Reported to CEO in carve-out of Empirix from Teradyne.
- 1999: (Teradyne) Director of Business Development, Software Test Units. Reported directly to Chairman of the Board/Founder and then to general manager of software test unit (6 divisions of Teradyne). Evaluated and researched acquisition and partnership candidates. Internally assessed technology position in market and gaps in product lines. Worked with senior division staff to develop new product strategies. Attended internal Teradyne divisional board meetings. Chairman served as my mentor.

3Com Corporation/NBX Corporation

- 1999: Software Engineer 5. Continued work after 3Com acquisition of NBX. Built cross-division relationships for new products and research directions. NBX was acquired by 3Com in March 1999.
- 1997 - 1999: (NBX) Senior Scientist and Engineer. Work in IP Telephony. Architected next-generation product. Protocol design and validation for core protocol now used tens of millions of times daily. Led team in integration of IP protocols into current product. Designed audio reconstruction algorithms. Developed applications for bug analysis and diagnosis of system problems. Implementation of network simulator. Work on collaborative projects with external partners. Worked to identify gaps in product. Representative at numerous trade shows. Innovated novel methods of using product.

MIT Department of Electrical Engineering and Computer Science, Cambridge, MA

- 1991 - 1998: Research assistant, Telemedia Network Systems Group. Design, development, and implementation of Gigabit ATM network for distributed multimedia system. Studied host interface design issues. ATM network simulation.

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- Spring 1989, Fall 1990, Spring 1995: Teaching assistant, Computation Structures digital systems course. (Spring 1995 Head TA)
- 1988 - 1989: Head laboratory teaching assistant for Computation Structures. Responsibilities included writing and revising lab assignments, and maintaining the lab.
- 1987: Laboratory teaching assistant for Computation Structures.
- 1987: Design, construction, and programming of 16-bit computer.

Agora Technology Group, Incorporated

- 1994 - 1996: Founder and CEO. Conceived and oversaw development of targeted advertising-supported Web sites. Responsible for company's vision and direction. Attended the first two WWW Conferences, presenting a workshop and paper at the first, and appearing on the "Commercialization and Economics of the Web" panel and chairing the "Where Commercial Services and the Web Are Headed" panel at the second. Sold company intact, is currently an operating stand-alone company.

AT&T Bell Laboratories, Holmdel, NJ

- 1989 - 1990: Implementation of cascadable all-optical fiber logic gate. Modelocking of all-fiber erbium laser. Construction of modelocked laser repetition rate booster. Strong optics laboratory and fiber optic experience.
- Summer 1988, 1987: Research in integrated optics. Analysis of rectangular waveguides using microwave modeling. Fabrication of integrated optical components.

Honors

- MIT Alumni Association Great Dome Award, 2010, Baker 60th Anniversary Reunion Co-Chair (highest group award given by MIT Alumni Association)
- MIT Alumni Association Presidential Citation Award (now known as Great Dome), 2008, Member of MIT Chairman's Salon committee
- MIT Alumni Association Bronze Beaver Award, 2007 (highest individual award given by MIT Alumni Association)
- MIT Alumni Association Volunteer Honor Roll, February 2004
- MIT Alumni Association Lobdell Award, 1999
- Boston Museum of Science Gold Pin for 1000 hours of Volunteer Service, April 1999
- MIT Alumni Association Presidential Citation Award (now known as Great Dome), 1997, Member of Alumni Online Communications Committee

Patents and Patent Publications

- U.S. Patent #9,697,231, H. Houh, J. Stern, R. Spina, M. Meteer, "Methods and apparatus for providing virtual media channels based on media search," July 4, 2017.
- U.S. Patent #9,697,230, H. Houh, J. Stern, "Methods and apparatus for dynamic presentation of advertising, factual, and informational content using enhanced metadata in search-driven media applications," July 4, 2017. See also WO2007056485.
- U.S. Patent #7,975,296, L. Apfelbaum, H. Houh, T. Mayberry and G. Friedman, "Automated security threat testing of web pages," July 5, 2011. See also US20030159063, WO2003067405.

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- U.S. Patent #7,877,736, H. Houh and J. N. Stern, "Computer language interpretation and optimization for server testing," January 25, 2011. See also US20050138104, WO2005043300.
- U.S. Patent #7,801,910, H. Houh and J. N. Stern, "Method and apparatus for timed tagging of media content," September 21, 2010. See also US20070112837, US20090222442, WO2007056535.
- U.S. Patent #7,590,542, D. C. Williams, W. C. Hand, H. Houh, A. R. Seeley, "Method of Generating Test Scripts Using a Voice-Capable Markup Language," September 15, 2009. See also EP1530869, US20030212561, WO2003096663.
- U.S. Patent #6,967,963, H. H. Houh, P. Anderson, C. Gadda, "Telecommunication method for ensuring on-time delivery of packets containing time-sensitive data," November 22, 2005. See also EP1060400, WO2000033092, CA2318774.
- U.S. Patent #5,144,375, M. C. Gabriel, H. H. Houh, N. A. Whitaker, "Sagnac Optical Logic Gate," September 1, 1992. Also issued as European Patent # EP0456422, July 23, 1997, German Patent #DE69126913, August 28, 1997
- U.S. Patent Application Publication No. 20020015387, "Voice Traffic Packet Capture and Analysis Tool for a Data Network" (Abandoned in 2007)
- U.S. Patent Application Publication No. 20020016708, "Method and Apparatus for Utilizing a Network Processor as Part of a Test System" (Abandoned in 2007)
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- U.S. Patent Application Publication No. 20070106646, "User-directed navigation of multimedia search results" (Abandoned in 2009)
- U.S. Patent Application Publication No. 20070106660, "Method and apparatus for using confidence scores of enhanced metadata in search-driven media applications" (Abandoned in 2009)
- U.S. Patent Application Publication No. 20070106685, "Method and apparatus for updating speech recognition databases and reindexing audio and video content using the same" (Abandoned in 2015)
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- U.S. Patent Application 11/774,931, "Methods and apparatus for managing a social networking web site"
- U.S. Patent Application 11/774,947, "Methods and apparatus for organizing media files"
- U.S. Patent Application 11/774,956, "Methods and apparatus for managing an online event"
- U.S. Provisional Patent Application 61/086,909, "Measuring and ranking relationship activity"
- U.S. Provisional Patent Application 61/086,914, "Detecting media object commonality"
- U.S. Provisional Patent Application 61/086,904, "Message categorization based on message characteristics"
- U.S. Provisional Patent Application 61/086,905, "Photo tagging to request action"

Trials, Testimony and Depositions

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- Case No. 1:06CV682 (CMH/BRP), Verizon vs. Vonage, U.S. District Court for the Eastern District of Virginia, filed expert report, was deposed and testified at trial.
- Case No. 1:08CV157 (CMH/TRJ), Verizon vs. Cox, U.S. District Court for the Eastern District of Virginia, was deposed and testified at trial.
- Case No. 5:09-cv-476, Two-Way Media vs. AT&T, U.S. District Court for the Western District of Texas, filed expert report, testified at trial.
- Case No. 2:10-cv-248 (RAJ/FBS), ActiveVideo Networks vs. Verizon, U.S. District Court for the Eastern District of Virginia, filed expert report and was deposed as an expert witness.
- Case No. 1:11-cv-00880-TSE-JFA, Bear Creek Technologies, Inc. vs. Verizon Services Corp., et al, U.S. District Court for the Easter District of Virginia, was deposed as an expert witness.
- Case No. 3:10-CV-298-BBC, AlmondNet, Inc. vs. Microsoft Corp., U.S. District Court for the Western District of Wisconsin, filed expert report.
- Case No. 6:10-cv-00597, Guardian Media Technologies, Ltd. Vs. AT&T Operations, Inc. et al., U.S. District Court for the Eastern District of Texas, Tyler Division, filed expert report.
- Case No. ESCV2010-02282C, The Octopus Solution LLC v. Gary Brown et al., Essex, MA Superior Court, testified at trial.
- Investigation No. 337-TA-882, In the matter of Certain digital media devices, including televisions, Blu-ray disc players, home theater systems, tablets and mobile phones, components thereof and associated software, U.S. International Trade Commission, filed expert reports, was deposed and testified at hearing.
- Investigation No. 337-TA-995, In the matter of Certain communications or computing devices, and components thereof, U.S. International Trade Commission, filed expert reports, and was deposed.
- Case No. 8:12-cv-122-LES-TDT, Prism Technologies LLC v. AT&T Mobility LLC, U.S. District Court for the District of Nebraska, filed expert report, was deposed and testified at trial.
- Case No. 11-2684 (JWL), Sprint Communications Co., L.P., v. Comcast Cable Communications, LLC, et al., U.S. District Court for the District of Kansas, filed expert report and was deposed.
- Case No. 11-2686 (JWL), Sprint Communications Co., L.P., v. Time Warner Cable, Inc., et. al., LLC, et al., U.S. District Court for the District of Kansas, filed expert report, was deposed, and testified at trial.
- Case No. 12-487 (SLR), Cox Communications, Inc., et al., v. Sprint Communications Company L.P., et al., U.S. District Court for the District of Delaware, filed expert report and was deposed.
- Case IPR 2014-00039, Microsoft Corporation v. B.E. Technology LLC, U.S. Patent No. 6,628,314. Submitted declaration and cross-examined in deposition.
- Case IPR 2014-00086, Apple, Inc. v. Evolutionary Intelligence, LLC, U.S. Patent No. 7,010,536. Submitted declaration and cross-examined in deposition.
- Case No. 6:11-CV-421, Stragent, LLC v. Intel Corporation, U.S. District Court for the Eastern District of Texas, Tyler Division, deposed and testified at trial as a fact witness.
- IPR2014-01366, IPR2014-01367, IPR2014-01368, Samsung et al. v. Straight Path, submitted IPR declarations and was deposed.
- IPR2015-1006, IPR2015-1007, Cisco v. Straight Path, submitted IPR declarations.
- IPR2014-01457, IPR2014-01459, Microsoft v. Biscotti, submitted IPR declaration and was deposed.
- IPR2016-00302, Apple v. Nonend, submitted IPR declaration.
- IPR2014-00812, Yelp and Twitter v. Evolutionary Intelligence, submitted IPR declaration.
- IPR2015-00307, Cisco v. AIP, submitted IPR declaration.
- Microsoft v. Acacia, submitted IPR declaration.

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- IPR2015-00342, AT&T Mobility LLC and Cellco Partnership d/b/a Verizon Wireless v. Solocron, submitted IPR declaration.
- Mediatube v. Bell Canada, Canadian Federal Court, submitted expert report and testified at trial.
- CBM2016-00036, Google v. At Home Bondholder's Liquidating Trust, submitted CBM declaration.
- IPR2016-01198, IPR2016-01201, Apple, Inc. v. VoIP-Pal.com, Inc., submitted IPR declaration and was deposed.
- Case No. 3:14-cv-2824-VC, Trend Micro Incorporated v. Rpost Holdings, Inc., et al, submitted expert report and was deposed
- Akamai v. Limelight Networks, IPR2016-01631, IPR2016-01711, IPR2017-00249, IPR2017-00349, submitted IPR declarations and was deposed
- Hyperlync Technologies v. Verizon Sourcing, No. 650151/2015 New York Supreme Court, submitted declaration and was deposed
- Cascades Streaming Technologies v. Big Ten Networks, submitted expert reports and was deposed
- Klaustech, Inc. v. Google LLC., Case No. 4:10-CV-05899-JSW (N.D. Cal.), submitted expert report and was deposed
- Cisco v. Uniloc, IPR2017-00198, IPR2017-00058, submitted IPR declarations and was deposed.
- Cisco v. Uniloc, IPR2017-00597, submitted IPR declaration and was deposed
- Twitter v. Youtoo Technologies, LLC, IPR2017-01133, IPR2017-01131, submitted IPR declarations and was deposed
- Taser International Inc. (now Axon Enterprise, Inc.) v. Digital Ally Inc., IPR2017-00375, submitted IPR declaration and was deposed
- Taser International Inc. (now Axon Enterprise, Inc.) v. Digital Ally Inc., IPR2017-00376, IPR2017-00515, IPR2017-00775, submitted IPR declarations
- HTC Corporation v. IPA Technologies, IPR2018-00306, IPR2018-00307, submitted IPR declaration
- Hulu v. Soundview, IPR2018-00864, IPR2018-01023, submitted IPR declarations and was deposed
- XpertUniverse v. Cisco, 3:17-cv-3848, U.S. District Court for Northern District of California, submitted declaration in support of claim construction and was deposed
- Improved Search v. Microsoft, C.A. No. 16-cv-650-JFB-SRF (Del.), submitted declaration in support of claim construction
- Apple v. Uniloc, IPR2018-00361, IPR2018-00394, IPR2018-00395, IPR2019-00700, IPR2019-00701, IPR2019-01667, submitted IPR declarations
- LG Electronics v. Uniloc, submitted IPR declaration
- SRC Labs and Saint Regis Mohawk Tribe v. Microsoft, 2:18-cv-00321-JLR, U.S. District Court for Western District of Washington at Seattle, submitted declaration in support of claim construction and was deposed
- Verizon Wireless v. Barkan Wireless IP Holdings LP, submitted IPR declarations
- Verizon Wireless and Samsung Electronics America Inc. v. Barkan Wireless IP Holdings LP, IPR2019-199, IPR2019-200, IPR2019-234, IPR2019-631, IPR2019-632, submitted IPR declarations
- Samsung Electronics America Inc. v. Barkan Wireless IP Holdings LP, IPR2019-100, submitted IPR declaration
- Cisco Systems Inc. v. Meetrix IP LLC, IPR2019-539, IPR2019-540, IPR2019-541, IPR2019-542, IPR2019-543, IPR2019-544, submitted IPR declarations

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- GMG Products LLC v. Traeger Pellet Grills LLC, PGR2019-24, PGR2019-34, PGR2019-35, PGR2019-36, submitted PGR declaration and was deposed
- Uniloc 2017 LLC v. Google LLC, 2:18-cv-00502-JRG-RSP, U.S. District Court for the Eastern District of Texas, Marshall Division, submitted declaration in support of claim construction
- Microsoft Corporation v. Uniloc 2017 LLC, IPR2020-00102, IPR2020-00103, submitted IPR declarations
- Microsoft Corporation and HP Inc. v. Synkloud Technologies, LLC, IPR2020-00316, submitted IPR declaration
- Seven Networks, LLC v. Apple Inc, 2:19-cv-115-JRG, U.S. District Court for the Eastern District of Texas, Marshall Division, submitted declaration in support of claim construction
- Unified Patents Inc. v. Ortiz & Associates Consulting, LLC, IPR2019-00743, submitted IPR declaration
- Uniloc 2017 LLC v. Apple Inc., 3:19-cv-01905-JD, U.S. District Court for the Northern District of California, San Francisco Division, submitted declaration in support of claim construction and was deposed
- ClearPlay Inc. v. Dish Network LLC et al., 2:14-cv-00191, U.S. District Court for the District of Utah, Central Division, submitted expert report
- Samsung et al. v. Uniloc 2017 LLC et al., IPR2020-00701, submitted IPR declaration
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- CommScope Technologies LLC et al. v. Barkan Wireless IP Holdings LP et al., IPR2020-00827, IPR2020-00829, IPR2020-00831, IPR2020-00833, IPR2020-00835, IPR2020-00838, submitted IPR declarations

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- "ViewStation Applications: Implications for Network Traffic," C. J. Lindblad, D. Wetherall, W. Stasior, J. F. Adam, H. H. Houh, M. Ismert, D. Bacher, B. Phillips, and D. L. Tennenhouse, *IEEE Journal of Selected Areas in Communications*, 1995.
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- "Active Pages: Intelligent Nodes on the World Wide Web ," H. H. Houh, C. J. Lindblad, and D. J. Wetherall, Proceedings of the 1994 World Wide Web Conference, Geneva, Switzerland, May 1994.
- "Wavelength Division vs. Code Division Access Methods for Optical Networks," H. H. Houh, Area Exam Paper, May 1993.
- "Experience with the VuNet: A Network Architecture for a Distributed Multimedia System," J. F. Adam, H. H. Houh, D. L. Tennenhouse, Proceedings of the 18th Conference on Local Computer Networks, pp. 70-76, September 1993
- "The VudBoard: A Simple DMA Interface," H. H. Houh, Proceedings of the 4th Gigabit Minijam, January 1994.
- "A Software-Oriented Approach to the Design of Media Processing Environments," D. L. Tennenhouse, J. Adam, D. Carver, H. Houh, M. Ismert, C. Lindblad, W. Stasior, D. Weatherall, D. Bacher, and T. Chang., submitted to the International Conference on Multimedia Computing and Systems, May 1994.
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- "The Viewstation Collected Papers," D. L. Tennenhouse, J. Adam, C. Compton, A. Duda, D. Gifford, H. Houh, M. Ismert, C. Lindblad, W. Stasior, R. Weiss, D. Wetherall, D. Bacher, D. Carver, and T. Chang, MIT Laboratory for Computer Science Technical Report, MIT/LCS/TR-590, November 1993.
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Leadership, Activities and Interests

- Leadership
  - Discovery Museums (Acton, MA)
    - Science and Technology Advisory Council, 2012 - present
  - MIT Alumni Association Board of Directors

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- K-12 STEM Initiatives Co-chair, 2013 - 2017
- Awards Committee Chair, 2012 – 2014
- Awards Committee, 3 year term, 2011 - 2014
- Vice President, 2 year term, 2004 - 2006
- Board Member, 2 year term, 1997 - 1999

- MIT Club of Boston
  - Board of Directors, 2006 - 2011
  - K-12 Initiatives Chair, 2009 - 2012
  - VP of Communications, MIT Club of Boston, 2003 - 2006
  - Past-President, MIT Club of Boston, 2002 - 2003
  - President, MIT Club of Boston, 2001 - 2002
  - President-Elect, MIT Club of Boston, 2000 - 2001
  - VP of Programs, MIT Club of Boston, 1999 - 2000
  - Activities Super-Chair, MIT Club of Boston, 1998 - 1999
- MIT Enterprise Forum of Cambridge, Inc.
  - Past Chair, 2009 – 2011
  - In-NOW-vation Co-chair, 2010
  - Chair, 2007 - 2009
  - Vice Chair, 2005 - 2007
  - Executive Board Member, 2002 - 2011
  - Winter Workshop Co-Chair, February 2007 - conceived idea for conference, which sold-out and produced largest attendance numbers in recent memory
  - Spring Workshop Co-Chair, Spring 2004
  - Membership Committee Chair, Fall 2003 - 2006
  - 25th Anniversary Dinner Chair, Fall 2003
  - As Membership Chair and Board Member, started Special Interest Groups in 2004; a SIG won the MIT Presidential Citation award, the MIT Alumni Association's highest award for organizations, in 2006
- Estabrook Elementary School PTA
  - Advisory committee to the superintendent on PCB issue, 2010-2011
  - 4th Grade after-school science program co-organizer, 2010-2012
  - 4th and 5th Grade before-school Math Olympiad co-organizer, 2009-2013
  - 5th Grade BBQ and Yearbook Committee, 2011, 2013
  - Family Math Night volunteer, 2008-2012
- Tau Beta Pi National Engineering Honor Society
  - Advisor, MA B Chapter at MIT, 2003 - present
  - District Director (National Officer), Tau Beta Pi, New England Area, 1991 - 2003
  - President, MA B Chapter at MIT, Fall 1988 - Spring 1989
  - Laureate award, 1989
- MIT Class of 1989
  - Secretary, five consecutive 5 year terms, 1989 - 2014
  - 30-year Reunion Committee, 2019
  - 25-year Reunion Committee, 2014
  - 20-year Reunion Committee and Gift Committee, 2009
  - 15-year Reunion Committee and Gift Committee, 2004
  - 10-year Reunion Committee and Gift Committee, 1999
  - 5-year Reunion Committee, 1994
  - Interim Treasurer, 1993 - 1994

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        - Instituted annual senior class career fair, now raising over $100,000 annually for senior class activities, Fall 1988
    - Strong, consistent record of leadership dating to high school
- Acting
    - '21' (Sony Pictures), credited as "Chinatown Dealer," 2007, Kevin Spacey's movie about the MIT Blackjack Team inspired by "Bringing Down the House" by Ben Mezrich, opened nationwide on March 28, 2008. 21 was the number one movie in US for two weeks and number one globally for one week. 21 also topped the DVD sales, Blu-ray sales and DVD rental charts.
    - Spring Lake Theater Company, first New York-area off-broadway production of "A Chorus Line," played role of Mark, Summer 1990
- Former member of the MIT Blackjack team
- Producer for 10,000 Maniacs' 2013 album "Music from the Motion Picture"
- Executive Producer for 10,000 Maniacs' 2015 album "Twice Told Tales"
- Violist, violist, harpist, guitarist, singer, actor: played in many amateur/semi-professional groups including Reading Symphony Orchestra, MIT Summer Philharmonic Orchestra, Freisinger Chamber Orchestra, Merrimack Valley Philharmonic, Longwood Symphony, MIT Symphony, and Somerville Community Chorus
- Violist, "Coming Home" album by Karen Phillips, 2014
- Erdos-Bacon number of 7
- Erdos-Bacon-Sabbath number of 11

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Exhibit 1005

U.S. Patent No. 7,602,702 to Aggarwal

Customer No.: 000027683

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US007602702B1

(12) **United States Patent**
Aggarwal

(10) **Patent No.: US 7,602,702 B1**
(45) **Date of Patent: Oct. 13, 2009**

(54) **FAST REROUTE OF TRAFFIC ASSOCIATED WITH A POINT TO MULTI-POINT NETWORK TUNNEL**

(75) Inventor: **Rahul Aggarwal**, San Francisco, CA (US)

(73) Assignee: **Juniper Networks, Inc**, Sunnyvale, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 374 days.

(21) Appl. No.: **11/056,383**

(22) Filed: **Feb. 10, 2005**

(51) **Int. Cl.**

G01R 31/08	(2006.01)
H04H 20/71	(2008.01)
H04L 12/28	(2006.01)
H04J 3/26	(2006.01)
G06F 15/173	(2006.01)

(52) **U.S. Cl.** **370/217**; 370/221; 370/312; 370/390; 370/392; 370/432; 709/239

(58) **Field of Classification Search** 370/217, 370/221

See application file for complete search history.

(56) **References Cited**

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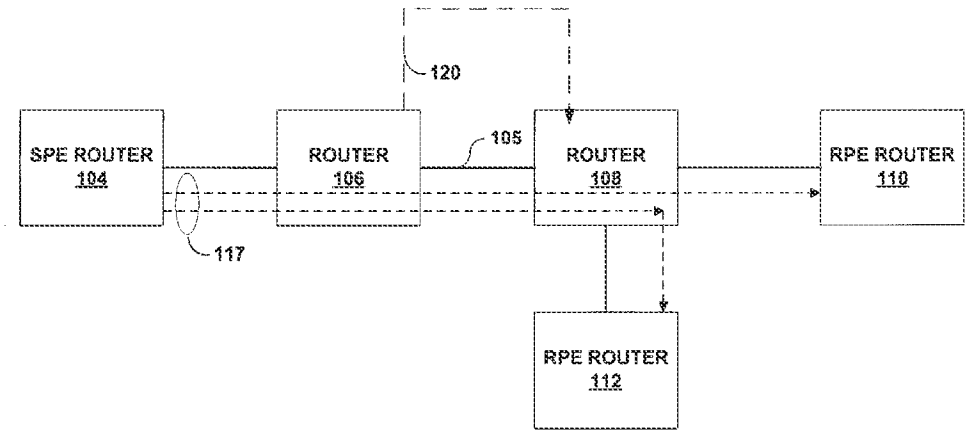
Assistant Examiner—Hicham B Foud
(74) *Attorney, Agent, or Firm*—Shumaker & Sieffert, P.A.

(57) **ABSTRACT**

Techniques are described for fast reroute of traffic associated with a point to multi-point (P2MP) tunnel. A system may, for example, include a source network device and a plurality of destination network devices. The system further includes a label switched path (LSP) tunnel from the source network device to the plurality of destination network devices. The LSP tunnel includes a plurality of branch LSPs and may include one or more bypass tunnel associated with one or more of the branch LSPs. In other configurations, the system may include a second LSP tunnel from the source network device to the plurality of destination network devices. The second LSP tunnel includes a plurality of detour branch LSPs, and each of the detour branch LSPs corresponds to a respective one of the branch LSPs for the first P2MP LSP tunnel.

12 Claims, 8 Drawing Sheets



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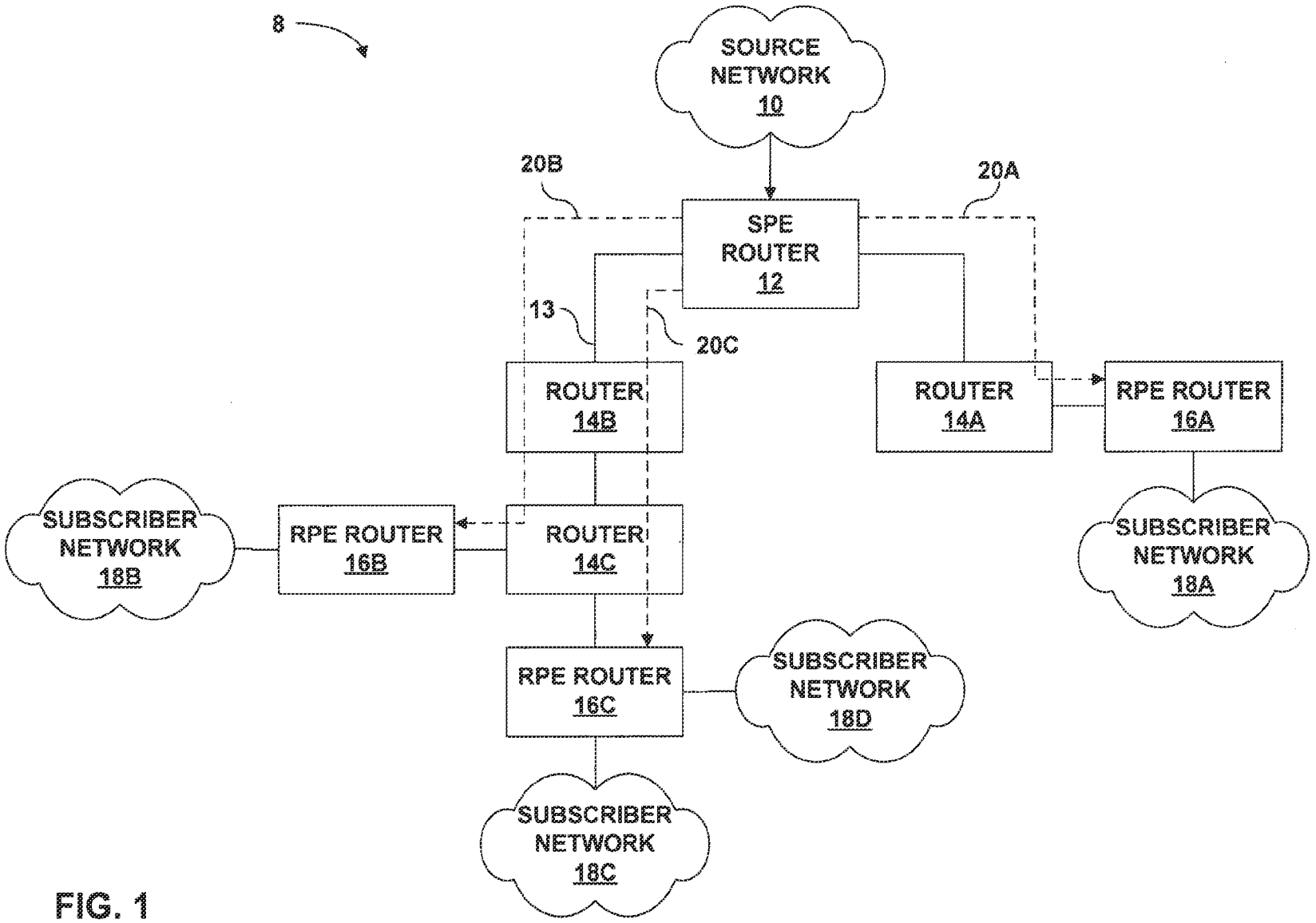

8
SOURCE NETWORK 10
20B
20A
SPE ROUTER 12
13
20C
ROUTER 14B
ROUTER 14A
RPE ROUTER 16A
SUBSCRIBER NETWORK 18B
RPE ROUTER 16B
ROUTER 14C
SUBSCRIBER NETWORK 18A
RPE ROUTER 16C
SUBSCRIBER NETWORK 18D
SUBSCRIBER NETWORK 18C

FIG. 1

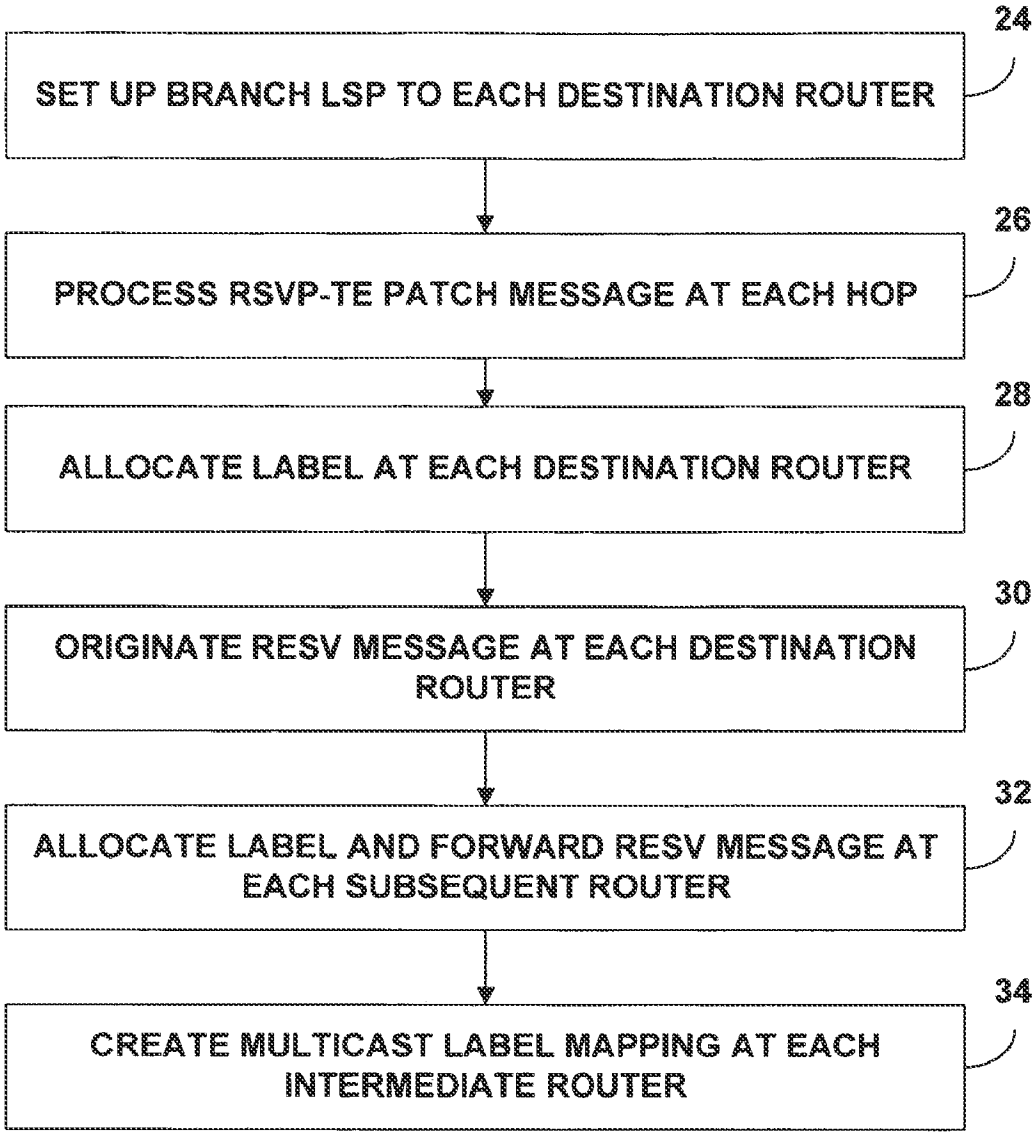

24
SET UP BRANCH LSP TO EACH DESTINATION ROUTER
26
PROCESS RSVP-TE PATCH MESSAGE AT EACH HOP
28
ALLOCATE LABEL AT EACH DESTINATION ROUTER
30
ORIGINATE RESV MESSAGE AT EACH DESTINATION ROUTER
32
ALLOCATE LABEL AND FORWARD RESV MESSAGE AT EACH SUBSEQUENT ROUTER
34
CREATE MULTICAST LABEL MAPPING AT EACH INTERMEDIATE ROUTER

FIG. 2

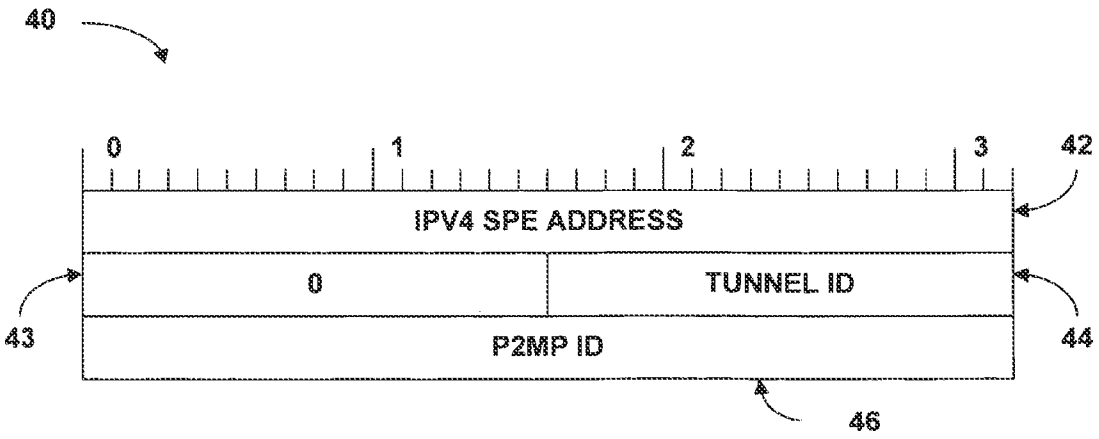

40
0
1
2
3
42
IPV4 SPE ADDRESS
0
TUNNEL ID
43
44
P2MP ID
46

FIG. 3

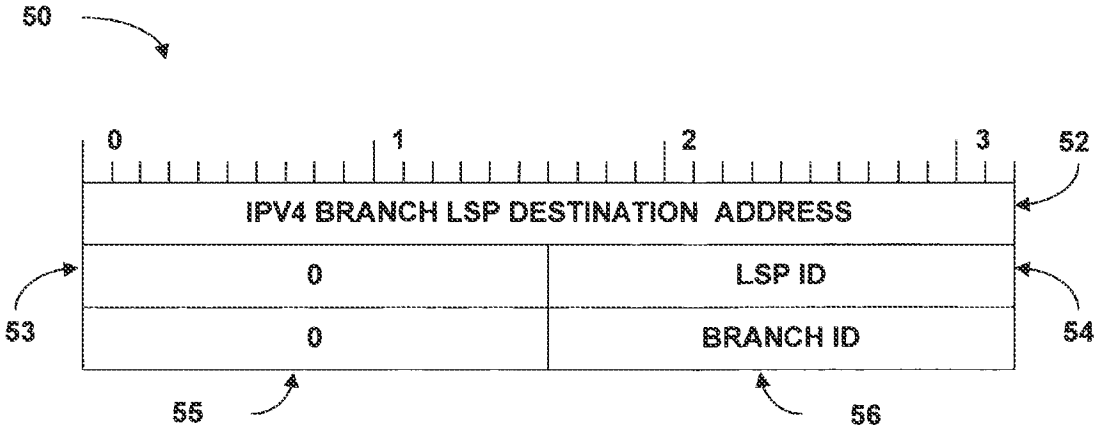

50
0
1
2
3
52
IPV4 BRANCH LSP DESTINATION ADDRESS
0
LSP ID
53
54
0
BRANCH ID
55
56

FIG. 4

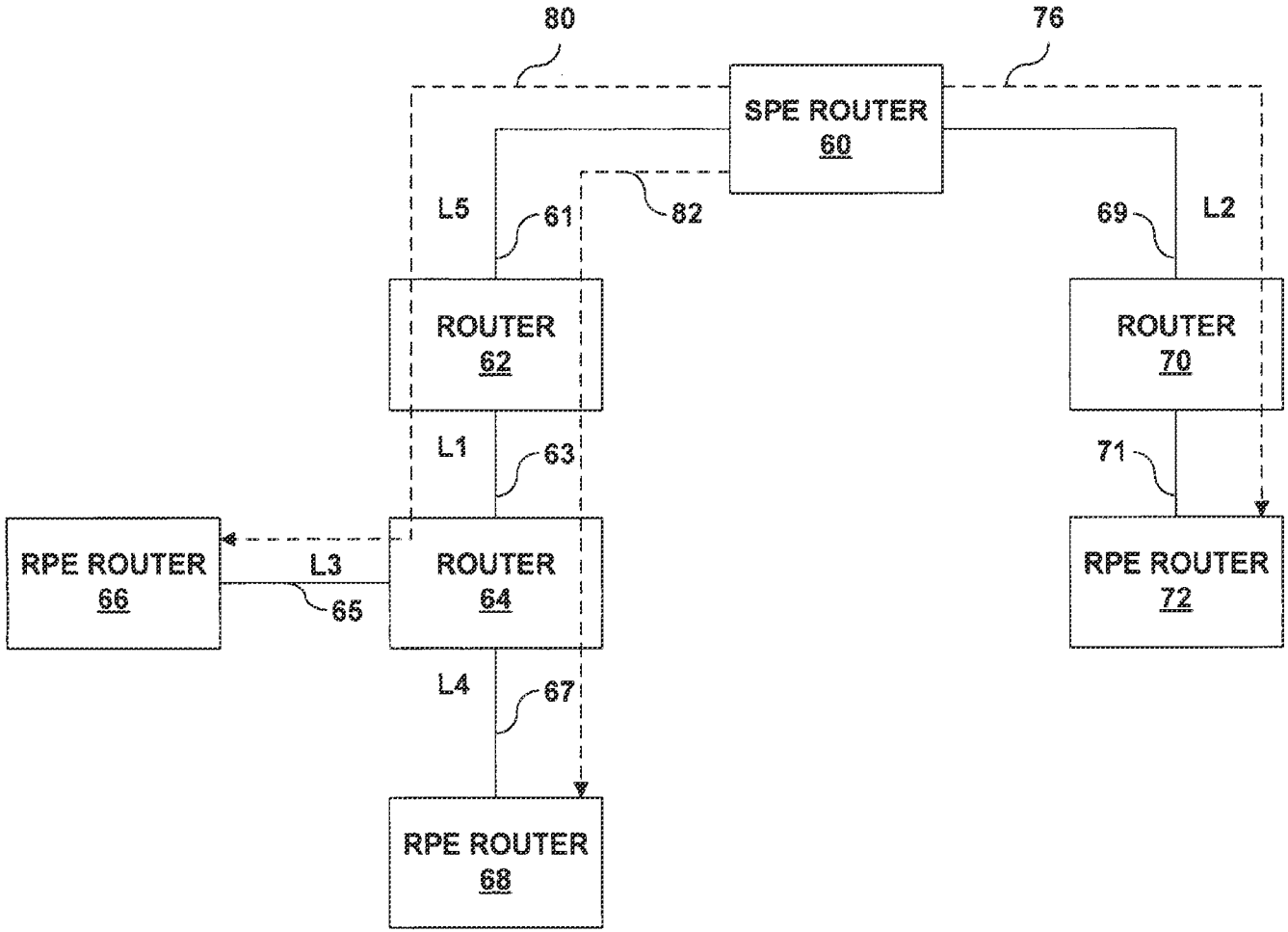

80
76
SPE ROUTER
60
L5
61
82
69
L2
ROUTER
62
ROUTER
70
L1
63
71
RPE ROUTER
66
L3
65
ROUTER
64
RPE ROUTER
72
L4
67
RPE ROUTER
68

FIG. 5

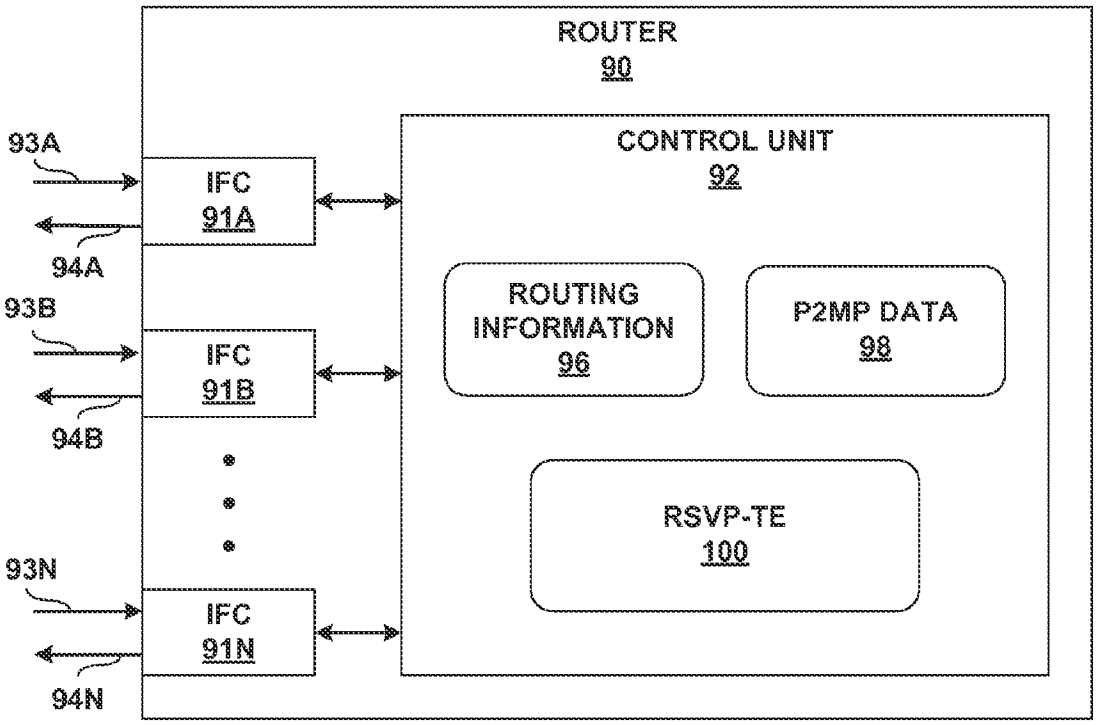

ROUTER
90
CONTROL UNIT
92
93A
IFC
91A
94A
93B
IFC
91B
94B
93N
IFC
91N
94N
ROUTING
INFORMATION
96
P2MP DATA
98
RSVP-TE
100

FIG. 6

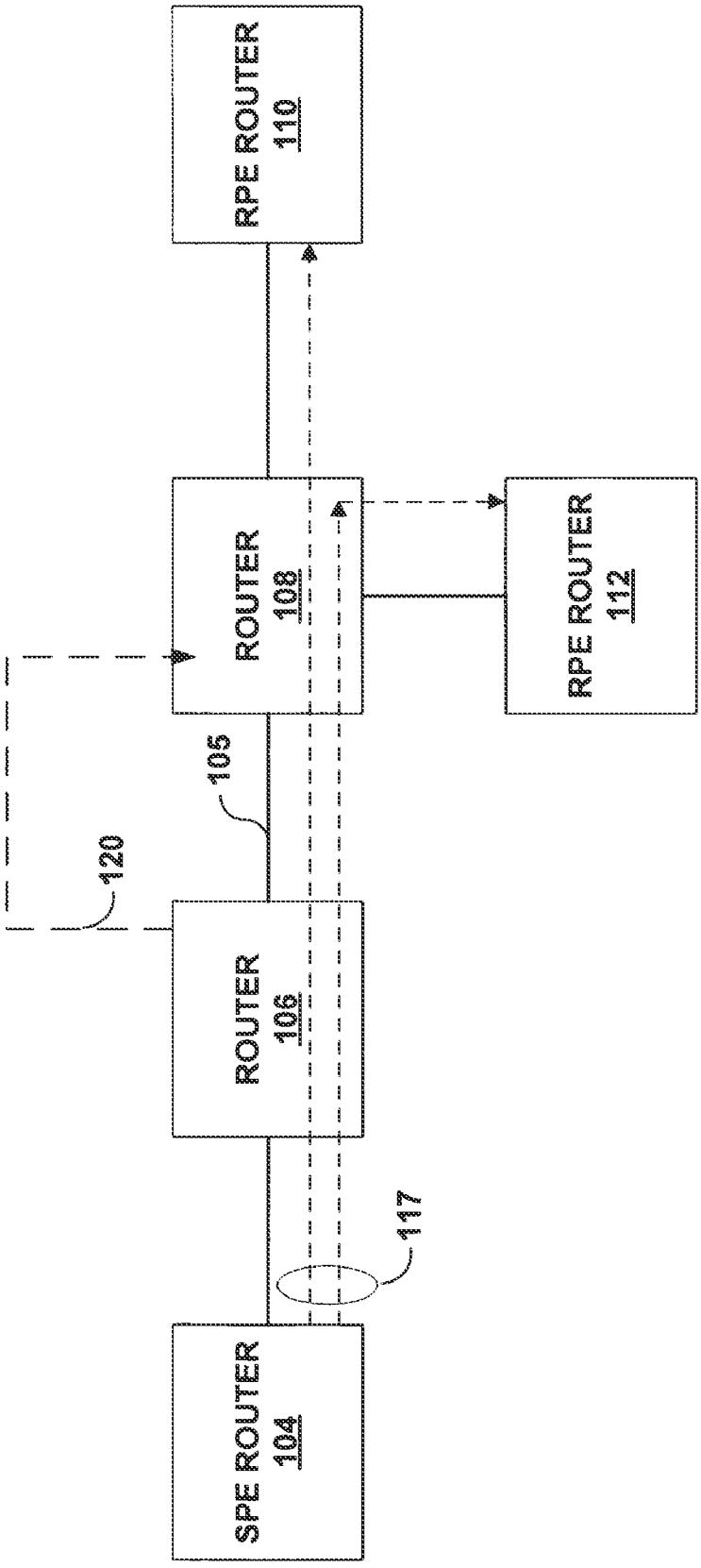

RPE ROUTER 110
ROUTER 108
RPE ROUTER 112
105
120
ROUTER 106
117
SPE ROUTER 104

FIG. 7

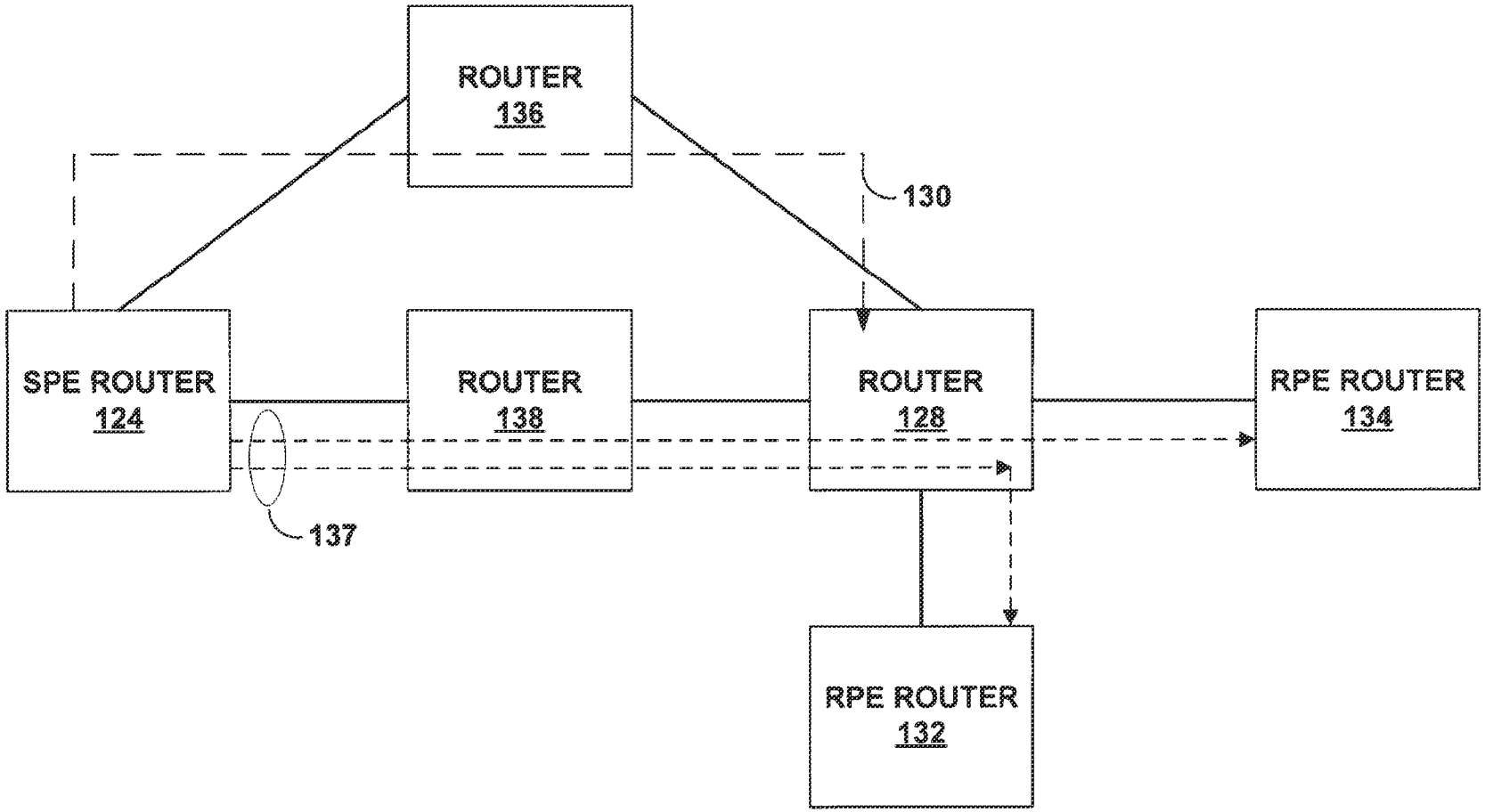

ROUTER
136
130
SPE ROUTER
124
ROUTER
138
ROUTER
128
RPE ROUTER
134
137
RPE ROUTER
132

FIG. 8

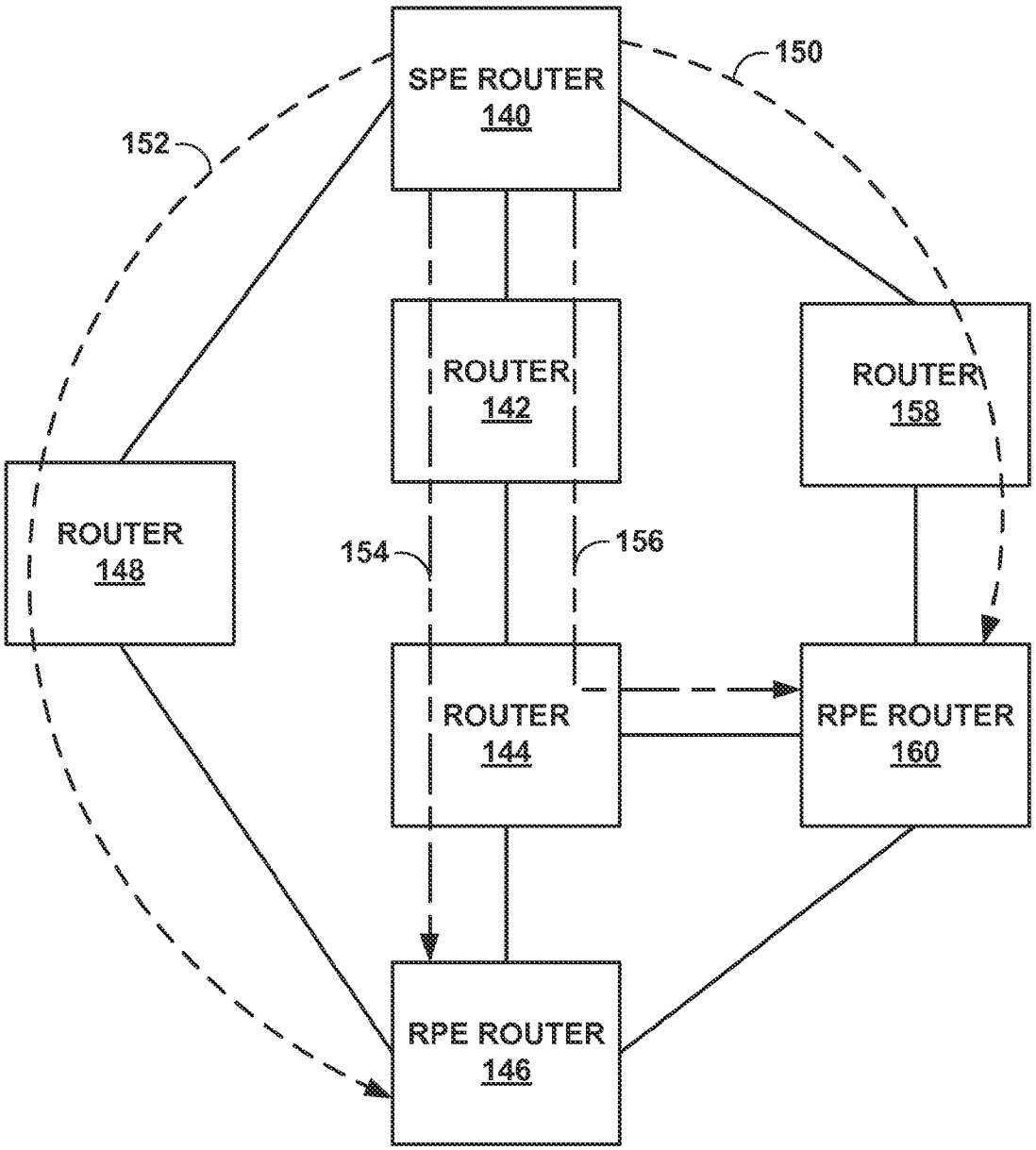

SPE ROUTER
140
150
152
ROUTER
142
ROUTER
158
ROUTER
148
154
156
ROUTER
144
RPE ROUTER
160
RPE ROUTER
146

FIG. 9

FAST REROUTE OF TRAFFIC ASSOCIATED WITH A POINT TO MULTI-POINT NETWORK TUNNEL

TECHNICAL FIELD

The invention relates to computer networks and, more particularly, to engineering traffic flows within computer network.

BACKGROUND

Routing devices within a network, often referred to as routers, maintain routing information that describe available routes through the network. Upon receiving an incoming packet, the router examines information within the packet and forwards the packet in accordance with the routing information. In order to maintain an accurate representation of the network, routers exchange routing information in accordance with one or more defined routing protocol, such as the Border Gateway Protocol (BGP).

The term "link" is often used to refer to the connection between two devices on a network. The link may be a physical medium, such as a copper wire, a coaxial cable, any of a host of different fiber optic lines or a wireless connection. In addition, network devices may define "virtual" or "logical" links, and map the virtual links to the physical links. As networks grow in size and complexity, the traffic on any given link, including peering links, may approach a maximum bandwidth capacity for the link, thereby leading to congestion and loss.

Multi-protocol Label Switching (MPLS) is a mechanism used to engineer traffic patterns within Internet Protocol (IP) networks. By utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched Path (LSP). An LSP defines a distinct path through the network to carry MPLS packets from the source device to a destination device. A short label associated with a particular LSP is affixed to packets that travel through the network via the LSP. Routers along the path cooperatively perform MPLS operations to forward the MPLS packets along the established path. LSPs may be used for a variety of traffic engineering purposes including bandwidth management and quality of service (QoS).

A variety of protocols exist for establishing LSPs. For example, one such protocol is the label distribution protocol (LDP). Another type of protocol is a resource reservation protocol, such as the Resource Reservation Protocol with Traffic Engineering extensions (RSVP-TE). RSVP-TE uses constraint information, such as bandwidth availability, to compute and establish LSPs within a network. RSVP-TE may use bandwidth availability information accumulated by a link-state interior routing protocol, such as the Intermediate System—Intermediate System (ISIS) protocol or the Open Shortest Path First (OSPF) protocol.

RSVP-TE defines mechanisms for setting up point to point (P2P) TE tunnels. Conventional mechanisms have not been defined for building point to multipoint (P2MP) TE tunnels.

SUMMARY

In general, the invention is directed to techniques for fast reroute of traffic associated with a point to multi-point (P2MP) tunnel. For example, techniques are describes for establishing a P2MP tunnel from a source to a plurality of destinations. In one described embodiment, the techniques utilize semantics of RSVP that RSVP-TE inherits to create a P2MP TE tree within a computer network. In particular, the extensions may be used to setup P2P TE "branch LSPs" between source and receiver provider edge routers. The P2P TE LSPs are merged by the network using RSVP semantics to result in a P2MP TE LSP. Techniques are described for addressing network events, such as link or node failures, to reroute traffic through bypass or detour tunnels associated with the P2MP TE LSP.

In one embodiment, a method comprises establishing a P2MP LSP tunnel having a source and multiple destinations, wherein the P2MP LSP tunnel has a plurality of branch LSPs. The method further comprises establishing the P2MP LSP tunnel to include a bypass tunnel associated with at least one of the branch LSPs.

In another embodiment, a method comprises establishing a P2MP LSP tunnel having a source and multiple destinations, wherein the LSP tunnel a plurality of branch LSPs. The method further comprises establishing a second P2MP LSP tunnel from the source to the multiple destinations, wherein the second P2MP LSP tunnel comprises a plurality of detour branch LSPs, and each of the detour branch LSPs corresponds to a respective one of the branch LSPs for the first P2MP LSP tunnel.

In another embodiment, a system comprises a source network device and a plurality of destination network devices. The system further includes a LSP tunnel from the source network device to the plurality of destination network devices. The LSP tunnel has at least two branch LSPs and includes a bypass tunnel associated with at least one of the branch LSPs.

In another embodiment, a system comprises a source network device and a plurality of destination network devices. The system further includes a first LSP tunnel from the source network device to the plurality of destination network devices, wherein the LSP tunnel a plurality of branch LSPs. The system further includes a second LSP tunnel from the source network device to the plurality of destination network devices, wherein the second LSP tunnel comprises a plurality of detour branch LSPs, and each of the detour branch LSP corresponds to a respective one of the branch LSPs for the first P2MP LSP tunnel.

In another embodiment, a computer-readable medium comprises instructions that cause a processor to establishing a branch LSP that forms a part of a point to multi-point (P2MP) label switched path (LSP) tunnel having a source and multiple destinations. The instructions further cause the processor to establish a bypass tunnel associated with the branch LSPs.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram illustrating an exemplary computer network having a point to multi-point (P2MP) label switch path (LSP).

FIG. **2** is a flowchart illustrating exemplary operation of the computer network in establishing the P2MP LSP.

FIG. **3** is a block diagram illustrating an exemplary new Resource Reservation Protocol with Traffic Engineering extensions (RSVP-TE) session object for use in establishing a point to multi-point (P2MP) label switch path (LSP).

FIG. **4** is a block diagram illustrating an exemplary P2MP branch LSP sender template object.

FIG. **5** is a block diagram illustrating a portion of the computer network of FIG. **1** in further detail.

FIG. **6** is a block diagram illustrating an exemplary router that utilizes a protocol that has been extended as described herein.

FIG. **7** is a block diagram illustrating an exemplary computer network in which a P2MP LSP includes a bypass tunnel.

FIG. **8** is a block diagram illustrating another exemplary computer network in which a P2MP LSP includes a bypass tunnel.

FIG. **9** is a block diagram of a network environment in which a first P2MP LSP and a second P2MP LSP have been established.

DETAILED DESCRIPTION

In general, this disclosure describes techniques for point to multipoint (P2MP) Traffic Engineering (TE). It is recognized herein that RSVP-TE is built on RSVP which does have mechanisms for supporting multiple receivers for the same session. Techniques are described herein for extending RSVP-TE to allow RSVP-TE to be used for establishing P2MP TE tunnels. In general, the techniques rely on semantics of RSVP that RSVP-TE inherits and utilize the semantics to create a P2MP TE tree within a computer network. In particular, the extensions may be used to setup P2P TE LSPs between source and receiver provider edge routers.

As described herein, the P2P TE LSPs are appropriately merged by the network using RSVP semantics to result in a P2MP TE LSP. The P2P LSPs may be initiated using RSVP-TE by the provider edge router attached to the source. The routers may utilize MPLS label forwarding information that is enhanced to support multicast of MPLS packets at nodes where the P2P LSPs merge. Further details on these techniques are described in Rahul Aggarwal et al., Establishing Point to Multipoint MPLS TE LSPs," Network Working Group, Internet Engineering Task Force (IETF), August 2004, hereby incorporated by reference.

One objective of the techniques is to optimize packet replication and minimize state and intelligence in the core of the network, while performing P2MP TE. As a result of the P2MP TE LSPs, routing devices within the network core need not run a multicast routing protocol to support multicast traffic. There can be various applications for P2MP TE LSPs described herein, and multicast is but one example.

FIG. **1** is a block diagram illustrating an exemplary computer network **8**. Computer network **8** utilizes a protocol that has been extended to allow fast reroute of a P2MP LSP established as described above. The fast reroute techniques described herein set up a bypass tunnel around a failed component within the P2MP LSP in order to maintain the flow of traffic between a source network **10** and subscriber networks **18**A-**18**B ("subscriber networks **18**"). Applying a single bypass tunnel to the P2MP LSP may protect several P2P LSPs within the P2MP LSP.

In the example of FIG. **1**, a source provider edge (SPE) router **12** (also referred to as a source network device) uses RSVP-TE to establish P2P LSPs to carry traffic between source network **10** and subscriber networks **18**. A P2P LSP **20**A is established between SPE router **12** of source network **10** and a receiver provider edge (RPE) router **16**A (destination network device) of subscriber network **18**A. A P2P LSP **20**B is also established between SPE router **12** and a RPE router **16**B of subscriber network **18**B, and a P2P TE LSP **20**C is established between SPE router **12** and RPE router **16**C of subscriber network **18**C. Each of the P2P LSPs are built between SPE router **12** and one of RPE routers **16** over one or more routers **14**.

The RSVP-TE extensions described above merge the established P2P LSPs **20**A-**20**C to create P2MP TE LSP **20**. P2MP LSP **20** may be set up such that each of RPE routers **16** is free to choose a desired Quality of Service (QoS) level. Furthermore, P2MP LSP **20** is mapped to SPE router **12** and a unique identifier for P2MP LSP **20** (referred to as a PID). In this manner, SPE router **12** maintains the flexibility to setup multiple P2P LSPs for the same PID.

P2MP LSP **20** is setup by merging the individual P2P LSPs and relying on MPLS label multicast. The P2P LSPs that are merged to form the P2MP LSPs are referred to as branch LSPs. The branch LSPs are initiated by SPE router **12**. Hence the solution is as efficient as trees setup by a multicast routing protocol in an Internet Protocol (IP) environment. However, this is achieved without burdening RSVP-TE with any of the mechanisms of a multicast routing protocol.

Source network **10** may comprise any public or private network or the Internet. As shown in FIG. **1**, computer network **8** includes subscriber networks **18**. Subscriber networks **18** may include local area networks (LANs) or wide area networks (WANs) that comprise a plurality of subscriber devices. The subscriber devices may include personal computers, laptops, workstations, personal digital assistants (PDAs), wireless devices, network-ready appliances, file servers, print servers or other devices that access source network **10** via SPE router **12**. In some cases, the subscriber devices request multicast streams, such as IPTV channels, from source network **10**. P2MP LSP **20** established between source network **10** and subscriber devices **18** enables transmission of multicast traffic without run a multicast routing protocol on routers **12**, **14**, and **16**.

SPE router **12**, routers **14**, and RPE routers **16** maintain routing information that describes available routes through computer network **8**. Upon receiving an incoming packet, the routers examine information within the packet and forward the packet in accordance with the routing information. In order to maintain an accurate representation of network **8**, the routers exchange routing information, e.g., bandwidth availability of links, in accordance with a defined routing protocol, such as an Interior Gateway Protocol (IGP).

The extended protocol described herein performs fast reroute of P2MP TE LSP **20** in the event of either a link or a node failure. For example, in the case where router **14**B fails, the fast reroute techniques may utilize a bypass tunnel (not shown in FIG. **1**) between SPE router **12** and router **14**C. As another example, in the case where a link **13** fails, the fast reroute techniques may build a bypass tunnel (not shown) between SPE router **12** and router **14**B. In either example, the bypass tunnel enables protection of both branch LSPs **20**B and **20**C.

FIG. **2** is a flowchart illustrating example operation of a router in establishing a P2MP LSP within a computer network. The operation is described in reference to computer network **8** of FIG. **1**. In this illustrated example, SPE router **12** is aware of RPE routers **16** interested in a given PID of P2MP LSP **20**. For instance, the PID may comprise a multicast group that RPE routers **16** are interested in joining. The flowchart of FIG. **2** illustrates exemplary procedures followed by SPE router **12** to setup P2MP LSP **20** mapped to the particular PID.

Initially, SPE router **12** establishes a RSVP-TE branch LSP (i.e., a P2P LSP) to each of receiving routers **16** that will be a destination for P2MP LSP **20** (**24**). In particular, source router **12** outputs a set of PATH messages to established the branch

LSPs that will be merged to form P2MP LSP **20**. Each branch LSP is associated with the same P2MP LSP **20**. Hence, each branch LSP can be "merged" with the other branch LSPs to form P2MP LSP **20**. As described below in reference to FIG. **3**, a new P2MP session object is introduced for this purpose.

When establishing the branch LSPs, each branch LSP is signaled with shared semantics. Hence another branch LSP belonging to the same session can share resources with this LSP. The session is determined based on the new RSVP-TE P2MP session object described below. Each branch LSP is identified using a new P2MP sender template, also described in further detail below. The PATH message for each branch LSP carries an explicit route object. Each one of intermediate routers **14** is able to processes the RSVP-TE PATH message in accordance with conventional RSVP-TE procedures (**26**).

Next, each RPE router **16** allocates an LSP label in response to the PATH message (**28**) and outputs a RESV message in response (**30**). Advantageously, each RPE router **16** may follow normal RSVP procedures while originating a RESV message. For example, each RPE router **16** can indicate a different QoS level in the RESV message from a QoS level specified in the PATH message as long as the new QoS level is lower. The RESV messages originated by the RPE routers **16** carry the labels allocated by the destination routers.

Intermediate routers **14** receive the RESV messages, allocate their own labels and pass the allocated labels in the RESV messages to the originating one of RPE routers **16** (**32**). Each of the RESV messages, for a given session, received from downstream routers that use the same interface to reach the upstream next hop are allocated the same label. This label may, therefore, be viewed as a "multicast label" in the example where the P2MP LSP is used to carry multicast traffic. This multicast label is associated by that node with all the labels received from downstream RESV messages for a given session. In other words, each node creates a multicast label mapping to associate the label with all the labels received from downstream RESV messages for that session (**34**). In this manner, P2MP LSP **20** may be established by merging branch LSP from SPE router **12** to the RPE routers **16**.

FIG. **3** is a block diagram illustrating an exemplary new RSVP-TE session object **40** for use in establishing a P2MP LSP. It may be possible to simply use a conventional RSVP-TE session object and indicate a P2MP LSP using session attributes. However, it is conceptually simpler and easier for an implementation to associate the semantics for P2MP MPLS with session object **40**. Session object **40** has a similar structure as the conventional P2P RSVP-TE session object. All branch LSPs of the P2MP LSP share the same session object.

In this example, session object **40** includes an IPv4 source router address **42**, a field **43** set to zero, a tunnel ID **44**, and a P2MP ID **46**. IPv4 source router address **42** comprises the IPv4 address of a source router, such as SPE router **12** (FIG. **1**). An implementation may use the source router ID as address **42**. The corresponding field in the conventional P2P RSVP-TE session object is the destination router address of the session. The destination router address of a P2MP branch LSP will be determined from a sender template described below.

Tunnel ID **44** comprises a 16-bit identifier used in the session that remains constant over the life of the tunnel. P2MP ID **46** comprises a 32-bit identifier used in the session that remains constant over the life of the tunnel. P2MP ID **46** encodes the PID associated with the P2MP LSP. In other embodiments, session object **40** may comprise an IPv6 source router address instead of IPv4 source router address **42** as illustrated in FIG. **3**.

FIG. **4** is a block diagram illustrating an exemplary P2MP branch LSP sender template object **50**. Sender template **50** identifies a particular branch LSP belonging to a P2MP LSP. Sender template **50** includes an IPv4 branch LSP destination address **52**, an LSP ID **54**, a branch ID **56**, and two fields **53**, **55** set to zero. Branch LSP destination address **52** comprises an IPv4 address of the destination router of the particular branch LSP. In other embodiments, sender template **50** may comprise an IPv6 branch LSP destination address instead of IPv4 branch LSP destination address **52** as illustrated in FIG. **4**.

LSP ID **54** comprises a 16-bit identifier that can be changed to allow a sender to share resources with itself. Thus multiple instances of the P2MP tunnel can be created, each with a different LSP ID. The instances can share resources with each other, but use different labels. The branch LSPs corresponding to a particular instance use the same LSP ID. Branch ID **56** comprises a 16-bit identifier that identifies a particular branch LSP. Different branch LSPs with the same LSP ID follow the label merge semantics described above to form a particular instance of the P2MP tunnel.

FIG. **5** is a block diagram illustrating an exemplary computer network **58** in which P2MP RSVP TE tunnels have been established. Computer network **58** includes a SPE router **60**, a RPE router **66**, a RPE router **68** and a RPE router **72**. Computer network **58** also includes intermediate routers **62**, **64**, **68**, and **70**. SPE router **12** establishes a P2MP LSP between SPE router **12** and RPE routers **66**, **68**, and **72**.

SPE router **60** first learns that RPE routers **66**, **68**, and **60** are interested in joining a P2MP LSP associated with a particular PID. For example, the PID may be a multicast group. SPE router **60** may learn of RPE routers **66**, **68**, and **72** at different points, though in this example it is assumed that SPE router **60** learns of the RPE routers at the same time. SPE router **12** then computes the P2P paths to reach RPE router **66**, RPE router **68**, and RPE router **72**. These branch LSPs are computed to share the same links where possible as they belong to the same session.

For example, SPE router **60** establishes branch LSP **76** to RPE router **72** via router **70**. SPE router **60** also establishes branch LSPs **80** and **82** with RPE routers **66** and **68**, respectively, via router **62** and router **64**. As shown in FIG. **5**, Branch LSPs **80** and **82** share links **63** and **61** between router **64** and SPE router **60**.

SPE router **60** sends a PATH message for each branch LSP. RPE routers **66**, **68**, and **72** respond with RESV messages. Router **64** receives a RESV message from RPE router **66** with label L3 and from RPE router **68** with label L4. Router **64** then allocates a label L1 and sends the RESV messages to router **62**. Router **64** also creates a multicast label mapping of (L1→{L3, L4}). Router **62** allocates a label L5 and sends the RESV messages to SPE router **60**, each with label L5. Router **62** creates a label mapping of {L5→L1}. SPE router **60** also receives a RESV from router **70** with a label of L2.

A sender on a LAN typically uses a different label for sending a packet to each node on the LAN that belongs to the P2MP LSP. Thus the sender performs packet replication. However, it may be desirable to avoid packet replication on a LAN by using the same label for sending a packet to multiple nodes belonging to the same P2MP LSP. Given the relatively small number of LANs in MPLS networks, using the different labels for each transmission of the same packet is not a prac-

tical problem. Furthermore, avoiding packet replication at the sender on a LAN requires significant complexity in the control plane.

As mentioned earlier, the extended RSVP-TE merges individual branch LSPs to form a P2MP LSP. A separate PATH message, with an explicit route object, is sent for each branch LSP. Hence RSVP-TE is not burdened with P2MP explicit routes. This has the advantage of keeping RSVP-TE procedures as close as possible to conventional TE procedures for P2P LSPs. This reduces complexity and makes it easier to enhance conventional and deployed RSVP-TE implementations to support P2MP TE LSPs. RSVP refresh reduction can be used to reduce the signaling overhead.

Non-adjacent signaling, described in more detail below, can be used to reduce PATH message processing and state on nodes that are along the common path of two or more branch LSPs. It is also described below how LSP hierarchy can be used to reduce P2MP control plane processing on transit label switch routers (LSRs).

As described above, a separate PATH message is processed for a branch LSP by each node along the explicit route of the branch LSP. This is indeed true for the first branch LSP to be setup along a given explicit route. The next branch LSP may follow the same path as the first branch LSP up to a certain branch LSR. There is no need for routers along this common path to process the PATH message corresponding to the second branch LSP.

The same holds true for successive branch LSPs. The P2MP LSP ingress can send the PATH message directly to the branch LSR where the second branch LSP branches from the first one. The explicit route object (ERO) will contain hops along the path beyond the branch LSR. Furthermore a Label Request object is not inserted in such a PATH message. This mechanism is also referred to as non-adjacent signaling. This is done by sending the PATH message directly to the branch LSR. Hence while sending the PATH message for a particular branch LSP, the P2MP ingress can determine the first branch LSR where the path of this branch LSP, branches from the existing P2MP LSP. It can then use non-adjacent signaling to send the PATH message to the branch LSR. The branch LSR in turn, will send the RESV message directly to the ingress.

Hence with respect to FIG. **5**, assume that SPE router **60** sets up branch LSP **80** to RPE router **66** first followed by branch LSP **82** to RPE router **68**. In this case the PATH message for branch LSP **82** to RPE router **68**, can be sent directly to router **64**, bypassing router **62**. This mechanism reduces PATH message processing and state along nodes that are on the common path of two or more branch LSPs.

When setting a P2MP LSP, a source router has a view of the entire network topology and can accordingly compute the path for each P2P LSP, sharing links where possible with other branch LSPs belonging to the P2MP LSP. This can also be described as a P2MP constrained shortest path first (CSPF), where a path to a destination router is set up as a P2P LSP.

FIG. **6** is a block diagram illustrating an exemplary router that utilizes a protocol that has been extended as described herein to reroute traffic associated with a P2MP LSP. Router **90** may, for example, represent any of the routers described herein. As an example, router **90** may comprise an ingress router associated with the P2MP LSP tunnel (i.e., a source network device), an egress router associated with the P2MP LSP tunnel (i.e., a destination network device) or an intermediate network device. In some embodiments, router **90** may be an intermediate network device associated with one or more branch LSPs of the P2MP LSP tunnel. Router **90** may, for example, operate as an ingress or egress for a bypass network tunnel associated with the branch LSPs.

In the example embodiment of FIG. **6**, router **90** includes a set of interface cards (IFCs) **91**A-**91**N ("IFCs **91**") for communicating packets via inbound links **93**A-**93**N ("inbound links **93**") and outbound links **94**A-**94**N ("outbound links **94**"). Router **90** further comprises a control unit **92** that maintains routing information **96**. Routing information **96** describes the topology of a network and, in particular, routes through the network. Routing information **96** may include, for example, route data that describes various routes within the network, and corresponding next hop data indicating appropriate neighboring devices within the network for each of the routes. Router **90** updates routing information **96** to accurately reflect the topology of the network. In general, when router **90** receives a packet via one of inbound links **93**, control unit **92** determines a destination and associated next hop for the packet in accordance with routing information **96** and outputs the packet on one of outbound links **94** based on the destination.

In the example of FIG. **6**, control unit **92** provides an operating environment for a resource reservation protocol **100** ("RSVP-TE protocol **100**") executing within control unit **92**. In other embodiments, other protocols may be executed within control unit **92**, such as the label distribution protocol (LDP). RSVP-TE protocol **100** receives resource reservation requests from other routing devices, and reserves the requested bandwidth on outbound links **94** for RSVP-TE traffic. In the event traffic needs to be rerouted around a network failure or a congested link, for example, a system administrator or software agent invokes RSVP-TE protocol **100** to traffic engineer a new path through the network and establish the LSP. Although described for exemplary purposes in reference to RSVP-TE, the principles described herein may by applied to extend other protocols, such as different constraint-based routing protocols.

RSVP-TE protocol **100** has been extended to support P2MP LSPs and the reroute techniques described herein. Consistent with the principles of the invention, RSVP-TE protocol **100** provides signaling mechanisms for merging branch LSPs to form a P2MP LSP tunnel and for rerouting traffic associated with the P2MP LSP tunnel. In certain embodiments, the reroute operations may be carried out automatically, i.e., without intervention by a system administrator or a software agent.

RSVP-TE protocol **100** maintains P2MP data **98**. Depending on the relation of router **90** to the P2MP LSP, P2MP data **98** may store one or more session identifiers, P2MP LSP identifiers and branch identifiers, as described above with respect to P2MP session objects **40** and RSVP-TE P2MP branch LSP sender template objects **50** of FIGS. **3** and **4**. In addition, P2MP data **98** may store P2MP-IDs (PIDS) that can be used to map a set of destination network devices to a P2MP tree of branch LSPs for a particular application. As another example, P2MP data **98** may store one or more labels allocated for the branch LSPs.

The architecture of router **90** illustrated in FIG. **6** is shown for exemplary purposes only. The invention is not limited to this architecture. In other embodiments, router **90** may be configured in a variety of ways. In one embodiment, for example, control unit **92** and its corresponding functionality may be distributed within IFCs **91**. In another embodiment, control unit **92** may include a routing engine that performs routing functions and maintains a routing information base (RIB), e.g., routing information **96**, and a forwarding engine that performs packet forwarding based on a forwarding information base (FIB) generated in accordance with the RIB.

Control unit **92** may be implemented solely in software, or hardware, or may be implemented as a combination of software, hardware, or firmware. For example, control unit **92** may include one or more processors which execute software instructions. In that case, the various software modules of control unit **92**, such as RSVP-TE protocol **100**, may comprise executable instructions stored on a computer-readable medium, such as computer memory or hard disk.

FIG. **7** is a block diagram illustrating an exemplary computer network in which a P2MP LSP includes a bypass tunnel. In this example, SPE router **104** acts as a source network device for a P2MP LSP tunnel **117** having branch LSPs that flow through router **106**, router **108**, RPE router **112** and RPE router **110**. P2MP LSP tunnel **117** is established to include two branch LSPs and a bypass tunnel **120** that provides protection from failure of link **105**.

If link protection is desired, one or more bypass tunnels, such as bypass tunnel **120**, may be used to protect the link between a "point of local repair" (PLR) (router **106**) and a next-hop along the link (router **108**). Thus, all branch LSPs that use a given link can be protected in the event of link failure by forwarding traffic associated with the branch LSPs through the bypass tunnel in the event of link failure. Note that all such branch LSPs belonging to a particular instance of a P2MP tunnel will share the same outgoing label on the link between the PLR and the next-hop. This is the P2MP LSP label on the link. Label stacking is used to send packets for each P2MP LSP in the bypass tunnel. The inner label is the P2MP LSP label allocated by the next hop. During failure, the PLR (router **106** in this example) sends PATH messages for each branch LSP that is effected to the "merge point" for the bypass tunnel (router **108** in this example). The PLR may use the sender template specific techniques described above to identify these PATH messages. Hence the PLR will set the branch LSP destination address to a local PLR address. The merge point for the bypass tunnel determines the protected branch LSP that match the specified identifier for the P2MP LSP (LSP-id) and the identifier for the particular branch LSP (branch-id).

FIG. **8** is a block diagram illustrating another exemplary computer network in which a P2MP LSP includes a bypass tunnel that provides node protection. In this example, SPE router **124** acts as a source network device for a P2MP LSP tunnel **137** having branch LSPs that flow through router **138**, router **128**, RPE router **132** and RPE router **134**. P2MP LSP tunnel **137** is established to include two branch LSPs and a bypass tunnel **130** that provides protection from failure of router **138**.

If node protection is desired, a bypass tunnel is established that bypasses the node to be protected (e.g., router **138** in this example). In particular, a first network device (router **124**) is identified associated with a set of the LSP branches. A second network device (router **128**) is selected that is downstream from the first network device and common to all of the LSP branches of the set of LSP branches flowing through the first network device. A bypass tunnel is established that originates at the first network device and terminates at the second network device. In the event a network event associated with at least one of the branch LSPs is detected (e.g., failure of router **138**), traffic is rerouted to flow through the bypass tunnel in response to the detected network event.

In this manner, constraint information is used to select a merge point for the bypass tunnel intersects the path of the protected branch LSPs somewhere downstream of the PLR. This constrains the set of branch LSPs being backed-up via that bypass tunnel to those that pass through a common downstream merge point. The merge point will allocate the same label to all such branch LSPs belonging to a particular instance of a P2MP tunnel. This will be the inner label used during label stacking.

FIG. **9** is a block diagram of a network environment in which a first P2MP LSP has been established that includes branch LSPs **150** and **152**. In addition, a second P2MP LSP has been defined that includes branch LSPs **154** and **156**. In this example, SPE router **140** acts as a source network device for the first P2MP LSP having branch LSP **150** that flows through router **158** and RPE router **160**, and branch LSP **152** that flows through router **148** and RPE router **146**. SPE router **140** also acts as a source network device for the second P2MP LSP having branch LSP **154** that flows through router **142**, router **144** and RPE router **146**, and branch LSP **156** that flows through router **142**, router **144** and RPE router **160**. Moreover, branch LSPs **154**, **156** of the second P2MP LSP are defined as detour branch LSPs. In particular, branch LSP **154** is a detour LSP for branch LSP **152** and branch LSP **156** is a detour LSP for branch LSP **150**. In this manner, two P2MP LSP tunnels having a common source and destinations may be defined, wherein the second P2MP LSP tunnel includes detour branch LSPs, and each of the detour branch LSPs corresponds to a respective one of the branch LSPs for the first P2MP LSP tunnel.

In the event a network event associated with at least one of the LSP branches of the first P2MP LSP tunnel is detected, traffic is rerouted to flow through the detour branch LSP of the second P2MP LSP tunnel corresponding to the LSP branch of the first P2MP LSP tunnel for which the network event is detected.

This may be viewed as a form of one-to-one backup that can be used to protect a particular branch LSP against link and next-hop failure. Protection may be used for one or more branch LSPs between the PLR and the next-hop. All the branch LSPs corresponding to the same instance of the P2MP tunnel, between the PLR and the next-hop share the same P2MP LSP label. All or some of these branch LSPs may be protected. The detour branch LSPs may or may not share labels, depending on the detour path. Thus, the set of outgoing labels and next-hops for a P2MP LSP that was using a single next-hop and label between the PLR and next-hop before protection, may change once protection is triggered.

The path-specific method may be used be used to identify a backup branch LSP. Hence the DETOUR object will be inserted in the backup PATH message. A backup branch LSP should be treated as belonging to a different P2MP tunnel instance other than the one specified by the LSP-id (as illustrated in FIG. **9**). Furthermore multiple backup branch LSPs should be treated as part of the same P2MP tunnel instance if they have the same LSP-id and the same DETOUR objects. Note that branch LSPs between different P2MP tunnel instances use different labels.

It is possible to take advantage of a LSP hierarchy [LSP-HIER] while building P2MP LSPs. One mechanism to do this is the use of P2P LSPs as links of the P2MP LSP. A P2P LSP can be advertised as a Forwarding Adjacency (FA) by the ingress of the P2P LSP. The FA can then be used by the headend of the P2MP LSP while computing the path of each branch LSP. If a FA is used by a branch LSP the corresponding ERO contains a list of objects up to the FA head-end followed by a loose object with the address of the FA tail-end. The FA head-end on receiving the branch LSP PATH message determines the FA from its Traffic Engineering Database (TED) and tunnels the PATH message over the FA. The FA tail-end on receiving the PATH message follows procedures specified in previous sections. The FA tail-end sends a RESV

message to the FA head-end with a P2MP LSP label. The RESV message is sent using the procedures in [LSP-HIER].

Transit label-switched routers (LSRs) along a FA, being used by a P2MP LSP, typically do not process control plane messages associated with the P2MP LSP. In fact they are not aware of these messages as they are tunneled over the FA. This reduces the amount of control plane processing required on these transit LSRs. Hence the use of P2P LSPs as FAs can increase the overall control plane scalability while setting up P2MP LSPs.

It's conceivable that some LSRs, in a network deploying P2MP MPLS TE, may not be capable of P2MP MPLS. The use of FAs allows P2MP LSPs to be built in such an environment. As mentioned above, transit LSRs along a FA typically do not process control plane messages associated with a P2MP LSP. Furthermore these LSRs also do not need to have P2MP MPLS data plane capability as they only need to process MPLS data plane packets belonging to the P2P LSP that is being used as a FA. Hence these LSRs do not need to support P2MP MPLS. It is to be noted that such LSRs typically are unable to act as branch points along the P2MP LSP.

Various embodiments of the invention have been described. Although the embodiments have been described in terms of packet-based systems and methods, any network and application-layer profiling data may be correlated for other types of networks without departing from the principles of the invention. These and other embodiments are within the scope of the following claims.

The invention claimed is:

1. A method comprising:

establishing, with a plurality of routing devices of a network, a point to multi-point (P2MP) label switched path (LSP) tunnel having a source and multiple destinations, wherein the P2MP LSP tunnel has a plurality of branch LSPs merged to form the P2MP LSP tunnel;

establishing the P2MP LSP tunnel to include a bypass tunnel associated with at least one of the branch LSPs;

receiving multicast traffic at the source of the P2MP LSP tunnel;

forwarding copies of the multicast traffic from the source to each of the destinations via the P2MP LSP tunnel;

forwarding at least a portion of the multicast traffic through the bypass tunnel;

detecting a network event associated with at least one of the branch LSPs; and

in response to the detected network event, rerouting the multicast traffic to flow through the bypass tunnel of the P2MP LSP, wherein rerouting the multicast traffic comprises:

outputting one or more messages from an ingress node associated with the bypass tunnel to a merge point where the bypass tunnel merges with the at least one of the branch LSPs of the P2MP LSP, wherein the messages include an identifier for the P2MP LSP tunnel and an identifier for the branch LSP for which the network event is detected;

receiving the messages at the merge point;

determining the branch LSP for which the network event was detected based on the identifier for the P2MP LSP tunnel and the identifier for the LSP branch; and

forwarding traffic to the multiple destinations based on the determination.

2. The method of claim 1, further comprising establishing the bypass tunnel to bypass a network link.

3. The method of claim 1, further comprising establishing the bypass tunnel to bypass a network device.

4. The method of claim 1, further comprising:

identifying a first network device associated with a set of the LSP branches;

selecting a second network device that is downstream from the first network device and common to all of the LSP branches of the set of LSP branches flowing through the first network device; and

establishing the bypass tunnel to originate at the first network device and terminate at the second network device.

5. The method of claim 1, wherein establishing a P2MP LSP tunnel comprises executing a resource reservation protocol to establish the P2MP LSP tunnel.

6. The method of claim 1, further comprising establishing a second P2MP LSP tunnel from the source to the multiple destinations, wherein the P2MP LSP tunnel has a plurality of detour branch LSPs, wherein each of the detour branch LSPs corresponds to a respective one of the branch LSPs for the first P2MP LSP.

7. A system comprising:

a source network device;

a plurality of destination network devices; and

a label switched path (LSP) tunnel from the source network device to the plurality of destination network devices, wherein the LSP tunnel has at least two branch LSPs merged to form the P2MP LSP tunnel and includes a bypass tunnel associated with at least one of the branch LSPs,

an ingress network device associated with the bypass tunnel, wherein the ingress network device detects a network event associated with at least one of the branch LSPs, and reroutes traffic to flow through the bypass tunnel in response to the detected network event,

wherein the ingress network device associated with the bypass tunnel is configured to output messages to a merge point where the bypass tunnel merges with the at least one of the branch LSPs of the P2MP LSP,

wherein the messages include an identifier for the P2MP LSP tunnel and an identifier for the branch LSP for which the network event is detected, and

wherein the merge point is configured to receive the messages, determine the branch LSP for which the network event was detected based on the identifier for the P2MP LSP tunnel and the identifier for the LSP branch; and forward traffic to the multiple destinations based on the determination.

8. The system of claim 7, wherein the bypass tunnel bypasses a network link associated with at least one of the branch LSPs.

9. The system of claim 7, wherein the bypass tunnel bypasses an intermediate network device associated with at least one of the branch LSPs.

10. The system of claim 7, wherein the bypass tunnel flows from a first network device associated with a set of the LSP branches to a second network device that is downstream from the first network device and common to all of the LSP branches of the set of LSP branches flowing through the first network device.

11. The system of claim 7, wherein the source network device outputs copies of multicast traffic to each of the destinations via the LSP tunnel, and at least a portion of the multicast traffic flows through the bypass tunnel.

12. The system of claim 7, wherein the source network device executes a resource reservation protocol to establish the LSP tunnel.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,602,702 B1
APPLICATION NO. : 11/056383
DATED : October 13, 2009
INVENTOR(S) : Rahul Aggarwal

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

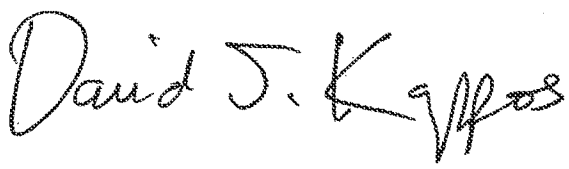
On the Title Page:

The first or sole Notice should read --

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 623 days.

Signed and Sealed this

Fifth Day of October, 2010



David J. Kappos
Director of the United States Patent and Trademark Office

Exhibit 1014

Declaration of Dr. Ingrid Hsieh-Yee

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC.

Petitioner,

v.

MONARCH NETWORKING SOLUTIONS, LLC

Patent Owner.

Case No.: IPR2020-01226
U.S. Patent No. 8,130,775

DECLARATION OF INGRID HSIEH-YEE, PH.D.

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I, Ingrid Hsieh-Yee, Ph.D., do hereby declare as follows:

1. I have been retained as an independent expert witness on behalf of CISCO Systems, Inc. for an *Inter Partes* Review ("IPR") proceeding before the United States Patent and Trademark Office ("PTO").

2. I am being compensated for my work in this matter at my accustomed hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not contingent on the results of my study, the substance of my opinions, or the outcome of this matter.

3. As an initial matter, I note that my usual research has been hampered by the coronavirus pandemic because libraries are closed. I reserve the right to supplement this declaration when physical copies may be readily accessed.

I. INTRODUCTION

A. Qualifications And Professional Experience

4. My complete qualifications and professional experience are described in my academic curriculum vitae (**Appendix 1**). The following is a brief summary of my relevant qualifications and professional experience.

5. I am currently a Professor in the Department of Library and Information Science at the Catholic University of America. I have experience working in an academic library, a medical library, and a legislative library and have been a

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professor for more than 25 years. I hold a Ph.D. in Library and Information Studies from the University of Wisconsin-Madison and a Masters in Library and Information Studies from the University of Wisconsin-Madison.

6. I am an expert on library cataloging and classification and have published two editions on this subject, *Organizing Audiovisual and Electronic Resources for Access: A Cataloging Guide* (2000 and 2006). I teach a variety of courses, including Cataloging and Classification, Advanced Cataloging and Classification, Organization of Internet Resources, Organization of Information, Digital Content Creation and Management, Internet Searches and Web Design, Information Literacy Instruction, Advanced Information Retrieval and Analysis Strategies, and The Information Professions in Society. My research interests cover cataloging and classification, information organization, metadata, information retrieval, information architecture, digital collections, scholarly communication, user interaction with information systems, and others.

7. I am very familiar with a library cataloging encoding standard known as the "Machine-Readable Cataloging" standard, also known as "MARC," which became the national standard for sharing bibliographic data in the United States by 1971 and the international standard by 1973. MARC is the primary communications protocol for the transfer and storage of bibliographic metadata in libraries. Experts in my field reasonably rely upon MARC records when forming their opinions.

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8. A MARC record consists of several fields, each of which contains specific data about the work. Each field is identified by a standardized, unique, three-digit code corresponding to the type of data that follows. **Appendix 2** is a true and correct copy of Parts VII to X of "Understanding MARC Bibliographic: Machine-Readable Cataloging" (http://www.loc.gov/marc/umb/um01to06.html) from the Library of Congress that explains commonly used MARC fields. For example, the personal author of the work is recorded in Field 100, the title is recorded in Field 245, publisher information is recorded in Field 260, the physical volume and characteristics of a publication are recorded in Field 300, and topical subjects are recorded in the 650 fields.

9. The Online Computer Library Center (OCLC) is the largest bibliographic network of the world, with more than 473 million records and thousands of member institutions (many of which are libraries of some type) in more than 100 countries. OCLC was founded in 1967 to promote and support library cooperation. According to the "Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Inc.," OCLC was created "to establish, maintain and operate a computerized library network and to promote the evolution of library use, of libraries themselves, and of librarianship, and to provide processes and products for the benefit of library users and libraries, including such objectives as increasing availability of library resources to individual library patrons and

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reducing the rate of rise of library per-unit costs, all for the fundamental public purpose of furthering ease of access to and use of the ever-expanding body of worldwide scientific, literary and educational knowledge and information" (source: https://www.oclc.org/content/dam/oclc/membership/articles-ofincorporation.pdf).

10. OCLC members can contribute original cataloging records in MARC to the system or derive cataloging records from existing records, an activity referred to as "copy cataloging." When an OCLC participating institution acquires a work, it can create an original MARC record for the work in OCLC's Connexion system (a system for catalogers to create and share MARC records), and the system will automatically generate a code for the date of record creation in the *yymmdd* format, and the creating library's OCLC symbol is recorded in subfield "a" of the 040 field. Once the MARC record is in Connexion, it becomes available to other OCLC members for adoption to their local online catalogs (*i.e.*, copy cataloging).

11. After a MARC record is created in Connexion, it also becomes searchable and viewable on WorldCat, which is a free web portal for users to explore more than 10,000 libraries worldwide. The record in WorldCat, however, is not presented in MARC fields. Instead, the data elements are labeled to help users interpret the record. Thus, the information stored in MARC records in Connexion is available to the interested public through the user-friendly WorldCat web portal.

12. WorldCat (http://www.worldcat.org) is "the world's largest network of

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library content and services" and its features are summarized in "What is WorldCat" (http://www.worldcat.org/whatis/default.jsp). WorldCat began operation in January 1998 as a free web portal to more than 10,000 library collections worldwide. Through WorldCat, users can search for information in their local libraries and libraries around the world. WorldCat allows users to search for books, CDs, videos, and many new types of digital content, such as audiobooks, in many languages. Users can also retrieve research materials and article citations with links to their full text. After an item is retrieved, WorldCat helps users identify a library nearby that holds the item or all the libraries that hold the item. WorldCat is an efficient way to explore the content held by more than 10,000 libraries around the world. WorldCat is publicly accessible, and there is no fee to perform a search on WorldCat.

13. Library online catalogs gained acceptance in the early 1980s and many libraries migrated their systems to the World Wide Web in the mid-1990s. Library online catalogs are based on MARC records that represent their collections in order to help the public understand what materials are publicly accessible in those libraries. Most libraries with online catalogs have made their catalogs freely available on the Web. These online catalogs offer user-friendly search interfaces. Strong user interest in keyword searches and the popularity of Google have led to the "googlization" of library search systems. As a result, many library catalogs now provide a single search box for users to conduct keyword searches, with additional

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support for searches by author, title, subject terms, and other data elements such as ISBN (International Standard Book Number). Library catalogs these days also offer features for users to narrow their search results by language, year, format, and other elements. Many libraries display MARC records on their online catalogs with labels for the data elements to help the public interpret MARC records. Many libraries also offer the option to display MARC records in MARC fields.

14. Libraries create MARC records for works they acquire, including books, serials, motion pictures, and publications in other formats. Monograph cataloging is fairly common in libraries, and most libraries make a newly cataloged monograph available to the public soon after the cataloging work is completed, usually within a week. Libraries can create original cataloging records or use an existing record in OCLC to create a copy cataloging record. As soon as the cataloging record is completed, it is added to the library's online catalog for users. If the record is an original record, it is also entered into OCLC WorldCat. If it is a copy cataloging record, the library's holding symbol is attached to the existing original record in OCLC WorldCat to facilitate searching and interlibrary loan. As for the book itself, a common practice is to process the book quickly to make it available for public use. In most academic libraries the processing of a new book takes no more than a week.

15. I am personally familiar with many online catalogs, databases, and

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search engines. In preparing for this declaration I used the following authoritative information systems to search for records:

- Amazon (https://www.amazon.com)
- Cambridge University Library online catalog (https://idiscover.lib.cam.ac.uk/)
- Google Scholar (https://scholar.google.com)
- Library of Congress online catalog (https://catalog.loc.gov)
- Texas A&M University Libraries online catalog (https://libcat.tamu.edu/vwebv/)
- United States Copyright Office public catalog (https://cocatalog.loc.gov/)
- WorldCat (free for public access on the Web) (https://www.worldcat.org)
- WorldCat on OCLC FirstSearch (https://firstsearch.oclc.org)

These records are identified and discussed in this declaration. Experts in the field reasonably rely on the data described herein to form their opinions.

B. Scope Of This Declaration

16. I have been asked to offer an opinion on the authenticity and public availability date of the following document:

> Hussain, I., (2004), *Fault-Tolerant IP and MPLS network*, Cisco Press, obtained from counsel, **Ex. 1006** ("*Hussain*").

C. Evidence Considered In Forming My Opinions

17. In the preparation of this declaration, I have reviewed the documents referenced below and any other documents I reference herein, and each of these is a type of material that experts in my field would reasonably rely upon when forming their opinions:

(1) Hussain, I., (2004), *Fault-Tolerant IP and MPLS network*, Cisco Press, obtained from counsel, **Ex. 1006** ("*Hussain*");

(2) MARC record for *Hussain*, available from the online catalog of the Library of Congress at https://lccn.loc.gov/2002115120 (select MARC Tags), accessed and obtained on June 13, 2020, **Appendix A**;

(3) Copyright registration record for *Hussain*, available from the public catalog of the U.S. Copyright Office at https://cocatalog.loc.gov/cgi bin/Pwebrecon.cgi?Search_Arg=Hussain%2C+Iftekhar&Search_Code=NALL&PID=Snd4x9TIP5GJDqWXHccsf1sGbjOWX&SEQ=20200613114648&CNT=25&HIST=1, accessed and obtained on June 13, 2020, **Appendix B**;

(4) WorldCat record for *Hussain*, available from WorldCat in OCLC First Search (subscription database, password required), accessed and obtained on June 13, 2020, **Appendix C**;

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(5) MARC record for *Hussain*, available from the online catalog of the Cambridge University Library at https://idiscover.lib.cam.ac.uk/permalink/f/16u99e0/44CAM_ALMA21302039830003606 (see "Display Source Record"), accessed and obtained on June 14, 2020, **Appendix D**;

(6) MARC record for *Hussain*, available from the online catalog of the Texas A&M University Libraries at https://libcat.tamu.edu/vwebv/staffView?searchId=682&recPointer=0&recCount=50&searchType=1&bibId=2566791, accessed and obtained on June 13, 2020, **Appendix E;**

(7) Reviews of *Hussain* on Amazon.com, available at https://www.amazon.com/Fault-Tolerant-MPLS-Networks-Iftekhar-Hussain/product-reviews/1587051265/ref=cm_cr_dp_d_show_all_btm?ie=UTF8&reviewerType=all_reviews, obtained and accessed on June 13, 2020, from Amazon.com, **Appendix F**.

II. AUTHENTICITY AND PUBLIC AVAILABILITY OF *HUSSAIN*

18. **Ex. 1006** is a true and correct copy of portions of *Fault-Tolerant IP and MPLS network* ("*Hussain*") by Iftekhar Hussain, published by Cisco Press in 2004,

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that I obtained from counsel. When I was asked to prepare this declaration, I searched WorldCat by the title of this book for records, and the search results informed me that Library of Congress held this title. I then searched their online catalog for records and the search results confirmed the holdings information. The library record shows the book's call number is "TK5105.573 . H87 2005," users can request it at the "Jefferson or Adams Building Reading Rooms," and the book's status is "Not Charged" (meaning available).

19. **Ex. 1006** is a true and correct copy of portions of *Hussain* that I obtained from counsel. **Ex. 1006** includes the cover, title page, copyright page, pages 6, 8, 11, 23–24, 26–28, 44–47, 50–53, 197, 254–55, 267, 272–77, and 296–97 of *Hussain* and page 316 (the last numbered page), spine and back cover. These pages are presented in this declaration to show the characteristics of *Hussain*. The Library of Congress copy of *Hussain* is not presented at this time because the Library of Congress is closed due to the coronavirus pandemic. Other holding libraries, such as the Cambridge University Library and the Texas A&M University Libraries are also closed. In case the copyright owner raises questions about library copies, I reserve the right to submit sample pages of *Hussain* from one of the holding libraries when libraries re-open.

20. The first page of **Ex. 1006** is the cover that shows "Fault-Tolerant IP and MPLS Networks" as the title, "Iftekhar Hussain" as the author, and Cisco Press

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as the publisher. The cover also shows a statement of "Design and deploy high availability IP and MPLS network architectures with this comprehensive guide." Page 2 of **Ex. 1006** is the title page that shows the same title and author information as the cover, and also shows Cisco Press is located in Indianapolis, Indiana. Page 3 is the copyright page that shows a copyright date of "2005" for this title and "Cisco Systems, Inc." as the copyright holder. It also shows "November 2004" as the first printing date, "2002115120" as the Library of Congress Cataloging-in-Publication Number, and "1-58705-126-5" as the ISBN (International Standard Book Number). Page 33 is the last numbered page of this title (internal page 316), and page 34 is the back cover that shows that this title is part of the "Networking Technology Series from Cisco Press." It also shows the same author, title and ISBN as the copyright page. Page 35 is the spine that shows the author's last name, title, publisher, and "Cisco Systems."

A. Library of Congress Record

21. **Appendix A** is a true and correct copy of the MARC record for *Hussain* that I personally identified, located, and obtained from the online catalog of the Library of Congress for this declaration. This is the type of record experts in my field would reasonably rely upon when forming their opinion.

22. The first six digits of Field 008 (**Appendix A**) show this MARC record was created on "021025" (*i.e.*, October 25, 2002). Field 906 shows the record is a

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"copycat" and "epcn" record. A Preassigned Control Number (PCN) is a Library of Congress Control Number "preassigned" to a given work prior to the its publication. PCNs are assigned to titles that are "most likely to be acquired by the Library of Congress as well as some other categories of books. The publisher prints the LCCN in the book and thereby facilitates cataloging and other book processing activities for libraries and book sellers who obtain copies of the book" (PCN Frequently Asked Questions at https://www.loc.gov/publish/pcn/faqs/#control). Field 955, a field tracking local cataloging activities, shows that the cataloging activities resumed in April 2005 after the published copy was received by the Library of Congress. It also shows that the cataloging work was concluded on "2005-07-22." Field 040 subfield "a" shows "UKM" as the creator of the original MARC record and subfield "d" shows "DLC" modified the record. According to the Directory of OCLC members, "UKM" is the library code for the British Library and "DLC" is the library code for the Library of Congress. These notes inform my opinion that the British Library created their MARC record and the Library of Congress used it as a basis for copy cataloging to enrich their 2002 record. Because of the status of the Library of Congress, the modified Library of Congress record with the original 2002 record creation date then replaced the British Library MARC record in OCLC.

23. Field 010 of the MARC record (**Appendix A**) shows "2002115120" as the Library of Congress Control Number (LCCN), Field 020 shows "1587051265"

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as the International Standard Book Number (ISBN), and Field 015 shows "GBA467009" as the British National Bibliography Number. The LCCN and ISBN match the numbers on the copyright page of **Ex. 1006**. Field 035 shows this record matches an OCLC record number "56658488" in OCLC WorldCat.

24. Field 245 of the MARC record shows "Fault-tolerant IP and MPLS networks" as the title and "Iftekhar Hussain" as the author, Field 260 shows Cisco Press of "Indianapolis, IN" published this book with a "2005" copyright date. Field 300 shows the front matter ends on page "xx" and the last numbered page is page "316." The series title found on the book's back cover is recorded in Field 490 as "Networking technology series," and the authorized heading for this series is recorded in Field 830 as "Cisco Press networking technology series." The author's name is entered in Field 100 to make it the primary access point for discovering this title. The title, author, publisher, copyright date, physical description, and series title match the information contained in **Ex. 1006**.

25. Field 050 shows *Hussain* is assigned a Library of Congress Classification (LCC) number of "TK5105.573," which is the class number for "MPLS" in the "Computer network protocols standards" category. Field 082 shows this book is also assigned a Dewey Decimal Classification (DDC) number of "004.6/2," which is the class number for "Interfacing and communications protocols." The subject matters of this book are also represented by four Library of

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Congress subject headings in Fields 650: "MPLS standard," "TCP/IP (Computer network protocol)," "Computer network architectures," and "Fault-tolerant computing."

26. This MARC record (**Appendix A**) shows that *Hussain* is a book that has been made searchable in the online catalog of the Library of Congress since October 25, 2002. Users interested in the topics of the book can find it by the classification numbers and subject terms assigned to it. Users can also find this book by its title, author, series title, LCCN and ISBN.

B. Copyright Registration Record

27. **Appendix B** is a true and correct copy of the copyright registration record for *Hussain* that I obtained from the public catalog of the United States Copyright Office in the Library of Congress. I obtained **Appendix B** by first accessing the http://www.copyright.gov/ website, selecting the hyperlink "Search Copyright Records," and performing a search by the book title to retrieve the record. I personally identified and located this record, which experts in my field would reasonably rely upon when forming their opinions.

28. The copyright registration record (**Appendix B**) shows that the title of this book is "Fault-tolerant IP and MPLS networks," and the author is "Iftekhar Hussain." The Notes field shows the book was "Cataloged from appl. only," meaning the data were provided by the publisher and the cataloger did not have the

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physical copy in hand. As a result, no physical description details are included in this record. The Copyright Claimant field shows "Cisco Systems, Inc." as the copyright holder. The Date of Publication field shows that the book was published on "2004-11-19" (*i.e.*, November 19, 2004), and the Registration Number / Date field shows the book was registered on "2004-11-23" (*i.e.*, November 13, 2004). The title, author, and copyright holder information match the information contained in **Ex. 1006**.

29. Taken together, the MARC record (**Appendix A**), the copyright registration record (**Appendix B**), and my understanding of the ordinary and customary cataloging and processing practices of libraries inform my opinion that the Library of Congress assigned a PCN to *Hussain* on October 25, 2002, and a preliminary record was created. *Hussain* was published on November 19, 2004, registered with the U.S. Copyright Office on November 23, 2004, and the Library of Congress completed the cataloging record for *Hussain* on July 22, 2005. Most libraries make newly cataloged books available for public access soon after the cataloging work is completed, usually on the same day or within a week. Considering the volume of materials the Library of Congress processes, the processing time may take longer than a week. It is therefore my opinion that *Hussain* would have been publicly accessible at the Library of Congress by October 22, 2005, which would be three months after the cataloging record was completed.

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C. WorldCat OCLC FirstSearch Record

30. To identify other libraries that hold *Hussain*, I searched WorldCat in OCLC FirstSearch for records and located a metadata record, presented as **Appendix C**, for this declaration. The WorldCat database in OCLC FirstSearch is different from the WorldCat portal in that the former is a subscription database that provides more bibliographic details than the latter, which is a Web portal free to the public. **Appendix C** is a true and correct copy of a metadata record for *Hussain*. I personally identified, located, and obtained this record from WorldCat in the OCLC FirstSearch system for this declaration. This is the type of record experts in my field would reasonably rely upon when forming their opinion.

31. The *Hussain* record that I identified and located from WorldCat OCLC FirstSearch (**Appendix C**) shows that 66 libraries around the world hold *Fault-Tolerant IP and MPLS Networks*. The title, author, publication detail, LCCN, 10-digit ISBN, series titles, LCC number, DDC number, and Library of Congress subject headings match the information contained in *Hussain* (**Ex. 1006**). The record entry date is "20021025" (*i.e.*, October 25, 2002) and the Accession No field shows an OCLC number of "56658488." The record date and the OCLC number are the same as the numbers in the Library of Congress MARC record (**Appendix A**). It is therefore my opinion that the Library of Congress created their cataloging record for *Hussain* on October 25, 2002, and the record was entered into OCLC. The record

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then became available for resource discovery, copy cataloging, interlibrary loan and other purposes for users and libraries. The WorldCat record (**Appendix C**) shows that more than 60 libraries around the world hold the same title. In addition, the WorldCat record (**Appendix C**) became freely available for searching in WorldCat, the free Web portal, which was launched on January 1, 1998.

D. Cambridge University Library Records

32. In my research for holding libraries of *Hussain* I also discovered the library of Cambridge University as a holding library, so I verified the holdings information in their online catalog. Because their system makes it difficult to save records cleanly, I obtained screenshots of the bibliographic and MARC records to produce **Appendix D**, which contains a true and correct copy of the bibliographic record and MARC record for *Hussain*. I personally identified, located, and obtained these records from the online catalog of the Cambridge University Library for this declaration. They are the types of records experts in my field would reasonably rely upon when forming their opinion.

33. Pages 1 to 3 of **Appendix D** is the bibliographic record for *Hussain* that shows the title, author, publisher, copyright date, and the availability of this title at the "Moore Library Main Library" with a call number of "TK5105.573 .H87 2005." It also shows "1587051265" as the ISBN and "Networking technology series" as the series statement.

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34. Page 4 of **Appendix D** is the MARC record for *Hussain*. The first six digits of Field 008 show that this MARC record was created on "021025" (*i.e.*, October 25, 2002). Subfield "a" of Field 040 shows that "Uk" was the creator of this record, Subfield "d" shows "DLC" modified the original MARC record, and Field 042 indicates this is an "lccopycat." Field 005 is a machine-generated code that shows the last time this MARC record was revised, and the code of "20050502" means the Cambridge University Library last revised this record on May 2, 2005. These data inform my opinion that the Cambridge University Library used the LC MARC record to create their copy cataloging record, and the Cambridge MARC record was last modified on May 2, 2005, meaning the record would have been in their online catalog by that time, and users would have been able to access *Hussain* by at least May 9, 2005.

35. Because the Cambridge MARC record is based on the LC MARC record, the LCCN (Field 010), British National Bibliography number (Field 015), national agency control number (Field 016), ISBN (field 020), DDC number (Field 082), author access point (Field 100), title (Field 245), publisher and copyright date (Field 260), physical description (Field 300), series titles (Fields 490 and 830) and subject headings (Fields 650) are the same as the data in the LC MARC record. A key difference is that the Cambridge University Library records the local call number in Field 090. Another difference is that in the Cambridge MARC record the access

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points in the author field, series field and subject heading fields include the sources of those headings, and several cross references are also included.

36. This MARC record (**Appendix D**) shows that *Hussain* is a book that has been made searchable in the catalog of the Cambridge University Library by at least May 2, 2005, when the cataloging record was last modified at that library. Users interested in this book can find it by the author, title, series and ISBN. It is the customary practice of libraries to make newly cataloged works available for public access soon after the cataloging is completed, usually within a week. Based on the record modification date in the MARC record (**Appendix D**), it is my opinion that *Hussain* became searchable in the catalog of the Cambridge University Library no later than May 2, 2005, and the physical copy would have been accessible to the public on that date or by May 0, 2005, which would be a week after the last time the MARC record was modified at the Cambridge University Library.

E. Texas A&M University Libraries Record

37. To further demonstrate public availability of *Hussain*, I searched *Fault-Tolerant IP and MPLS Networks* in WorldCat and the search results showed that the Texas A&M University Libraries also held this title. I then searched their online catalog and the search results confirmed the holdings information. The bibliographic record shows "TK5105.573 .H87 2005" as the call number of this book, which is stored in the "Evans Library Stacks," and its status is "Available."

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38. **Appendix E** is a true and correct copy of the MARC record for *Hussain* that I obtained from the online catalog of the Texas A&M University Libraries. I personally identified, located, and obtained this record. This is the type of record experts in my field would reasonably rely upon when forming their opinion.

39. The first six digits of Field 008 (**Appendix E**) show this MARC record was created on "040808" (*i.e.*, August 8, 2004). Subfield "a" of Field 040 shows that "UKM" created the original MARC record and subfield "d" shows that "TXA" modified the record for their library. According to the MARC Code List for Organizations (https://www.loc.gov/marc/organizations/org-search.php), "UKM" is the organization code for the British University, and "TXA" is the library code for the Texas A&M University Libraries. Field 948 shows *Hussain* was cataloged on "2005/5/26" (*i.e.*, May 26, 2005). These data inform my opinion that the Texas A&M Libraries used the MARC record created by the British Library to create their copy cataloging record on May 26, 2005.

40. Field 020 shows "1587051265" as the ISBN of this title, Field 015 shows "GBA467009" as the British National Bibliography Number, Field 016 shows "012991941" as the national bibliographic agency control number from the British Library, and Field 035 shows this record is linked to an OCLC record of "56658488," meaning it represents the same book represented by that OCLC record. These three numbers are identical to the data in the Library of Congress MARC

record (**Appendix A**), because the Library of Congress and the Texas A&M University Libraries both used the UKM record for copy cataloging. The OCLC number ("56658488") link these records in WorldCat and display them as holding libraries when users search for records for *Hussain*. The title and author statement in Field 245, the publisher information in Field 264, the copyright date in subfield "c" of Field 264, the series statement in Field 490 and the Field 500 note about a statement of the cover match the information contained in *Hussain* (**Ex. 1006**).

41. Field 050 shows *Hussain* is assigned a Library of Congress Classification (LCC) number of "TK5105.573," which is the class number for "MPLS" in the "Computer network protocols standards" category, and Field 082 shows it is also assigned a Dewey Decimal Classification (DDC) number of "004.62," which is the class number for "Interfacing and communications protocols." The subject matters are also represented by four Library of Congress subject headings: "TCP/IP (Computer network protocol)," "MPLS standard," "Computer network architectures," and "Fault-tolerant computing."

42. This MARC record (**Appendix E**) shows that *Hussain* is a book that has been made searchable at the online catalog of the Texas A&M University Libraries, and users interested in the topics of this title can find it by the LCC number, DDC number, and the Library of Congress subject headings assigned to it. Users can also find this book by its title, author, series title and ISBN.

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43. Based on the information above, it is my opinion that *Hussain* is a book that has been made available at the Texas A&M University Libraries, meaning that members of the public with an interest in the topics covered by this title would be able to search for and access this book. The library records show the book was cataloged on May 26, 2005, based on a British Library MARC record. It is the customary practice of libraries to make newly cataloged works available for public access soon after the cataloging is completed, usually within a week. It is therefore my opinion that *Hussain* would have become available for public access at the Texas A&M University Libraries on May 26, 2005, or no later than June 2, 2005, which would be a week after the cataloging work was completed.

F. Amazon Reviews of *Hussain*

44. **Appendix F** is a true and accurate copy of the product review pages for *Fault-Tolerant IP and MPLS network* that I obtained from Amazon.com. I searched for Amazon records for *Hussain* by the book's ISBN and obtained the review pages from the record for *Hussain*. This is the type of record experts in my field would reasonably rely upon when forming their opinion.

45. The top of **Appendix F** shows a header of "Amazon.com: Customer Reviews: Fault-Tolerant IP and MPLS Networks" and page 1 shows a thumbnail image of *Hussain* and customer ratings. The book has 5 reviews posted from 2005 to 2015. Four reviews were posted in 2005, and the earliest review was dated January

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20, 2005. These postings show that *Hussain* was available for public purchase and comments by January 20, 2005, when the earliest review was posted. The reviews posted in 2005 further support my opinion that *Hussain* would have been publicly available in 2005.

G. Actual Usage Record

46. Actual usage of a publication is by the publications that make reference to it. Google Scholar shows that *Hussain* was cited at least 41 times. Two citations published in 2005 are selected to demonstrate early usage: (1) Capello, A., Milani, S., Moriondo, C., Rossi, G., Salamandra, P., Perrone, M., & Barone, M. (2005, October), Non-stop forwarding behaviour and performance in high-end IP routers for ISP's backbone networks, in *DRCN 2005, Proceedings, 5th International Workshop on Design of Reliable Communication Networks, 2005.* (pp. 279-285), IEEE; and (2) Sanka, R. K. (2005). MPLS CREATION ON THE TOP OF DATA LINK LAYER. The earliest citation was published in October 2005, further supporting my opinion that *Hussain* was publicly accessible no later than October 2005 at the Library of Congress.

H. Summary of My Opinions on *Hussain*

47. Taken together, the Library of Congress MARC record (**Appendix A**), the copyright registration record (**Appendix B**), the WorldCat OCLC FirstSearch record (**Appendix C**), the Cambridge University Library record (**Appendix D**), the

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Texas A&M University Libraries record (**Appendix E**), and my understanding of the ordinary and customary cataloging and processing practices of libraries inform my opinion that the Library of Congress created a pre-publication record for *Hussain* (**Ex. 1006**) in October 15, 2002. After the book was published, the Library of Congress modified an existing British Library record for *Hussain* in 2005 and completed their cataloging work by July 22, 2005. The physical copy would have become publicly accessible no later than October 22, 2005, at the Library of Congress.

48. The LC MARC record in WorldCat was used by at least 60 libraries for resource discovery, copy cataloging, interlibrary loan and other purposes. The Cambridge University Library record shows they used the LC MARC record to create a copy cataloging record for their system and their record was last modified on May 2, 2005, making their record searchable at least by that time. The physical copy of *Hussain* would have been available to the public on that date or no later than a week later on May 9, 2005.

49. The Texas A&M University Libraries record shows they used the British Library record to create their copy cataloging record on May 26, 2005, making the record searchable on that date. The physical copy of *Hussain* would have become publicly accessible on that date or no later than June 2, 2005. Usage data show that the earliest citation of *Hussain* was an IEEE article published in October

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2005. Amazon reviews of *Hussain* show that four reviews of this title appeared in 2005, and the earliest one appeared on January 20, 2005.

III. CONCLUSION

50. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner or its expert(s) may raise and to take into account new information as it becomes available to me.

51. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case. If cross-examination is required of me, I will appear at a reasonable time and place to be agreed upon.

52. I hereby declare that all statements made herein on 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: 7-4-2020 Executed: Ingrid Hsieh-Yee

Ingrid Hsieh-Yee, Ph.D

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APPENDIX A

LIBRARY OF CONGRESS | CATALOG

Refine Your Search < 1 of 1 >

BOOK

Fault-tolerant IP and MPLS networks

Full Record MARC Tags

000		01231cam a2200349 a 4500
001		12982616
005		20050722161445.0
008		021025s2003 inua b 001 0 eng
906	___	|a 7 |b cbc |c copycat |d 2 |e epcn |f 20 |g y-gencatlg
925	0_	|a acquire |b 2 shelf copies |x policy default
955	___	|a jf04 2003-04-13 z-processor; |b jf17 2003-07-05; |e jf17 2003-07-05 to Dewey |a aa05 2003-07-22
010	___	|a 2002116120
040	___	|a UKM |c UKM |d C#P |d DLC
015	___	|a GBA467009 |2 bnb
016	7_	|a 012991941 |2 Uk
020	___	|a 1587051265 (bbk.)
035	___	|a (OCoLC)ocm50658488
042	___	|a lccopycat
050	00	|a TK5105.573 |b .H87 2003
082	00	|a 004.6/2 |2 22
100	1_	|a Hussain, Iftekhar.
245	10	|a Fault-tolerant IP and MPLS networks / |c Iftekhar Hussain.
260	___	|a Indianapolis, IN : |b Cisco Press, |c c2003.
300	___	|a xx, 316 p. : |b ill. ; |c 24 cm.
490	1_	|a Networking technology series
504	___	|a Includes bibliographical references and index.
650	_0	|a MPLS standard
650	_0	|a TCP/IP (Computer network protocol)
650	_0	|a Computer network architectures.
650	_0	|a Fault-tolerant computing.
830	_0	|a Cisco Press networking technology series.
955	___	|a pc22 2002-10-25 |a jf00 2003-04-19

Request this item | LC Find It | Item Availability

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Item Availability

CALL NUMBER:	TK5105.573 .H87 2005 Copy 1
Request in:	Jefferson or Adams Building Reading Rooms
Status:	Not Charged

CALL NUMBER:	TK5105.573 .H87 2005 FT MEADE Copy 2
Request in:	Jefferson or Adams Building Reading Rooms - STORED OFFSITE
Status:	Not Charged

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APPENDIX B

Copyright
United States Copyright Office

Library buildings are closed to the public until further notice, but the U.S. Copyright Office Catalog is available. More.

Help | Search | History | Titles | Start Over

Public Catalog

Copyright Catalog (1978 to present)
Search Request: Left Anchored Title = Fault-tolerant IP and MPLS Networks
Search Results: Displaying 1 of 1 entries

previous next

Labeled View

Fault-tolerant IP and MPLS networks / Iftekhar Hussain.

Type of Work: Text
Registration Number / Date: TX0006129170 / 2004-11-23
Title: Fault-tolerant IP and MPLS networks / Iftekhar Hussain.
Notes: Cataloged from appl. only.
Copyright Claimant: Cisco Systems, Inc.
Date of Creation: 2004
Date of Publication: 2004-11-19
Names: Hussain, Iftekhar
Cisco Systems, Inc.

previous next

Save, Print and Email (Help Page)
Select Download Format Full Record Format for Print/Save
Enter your email address: Email

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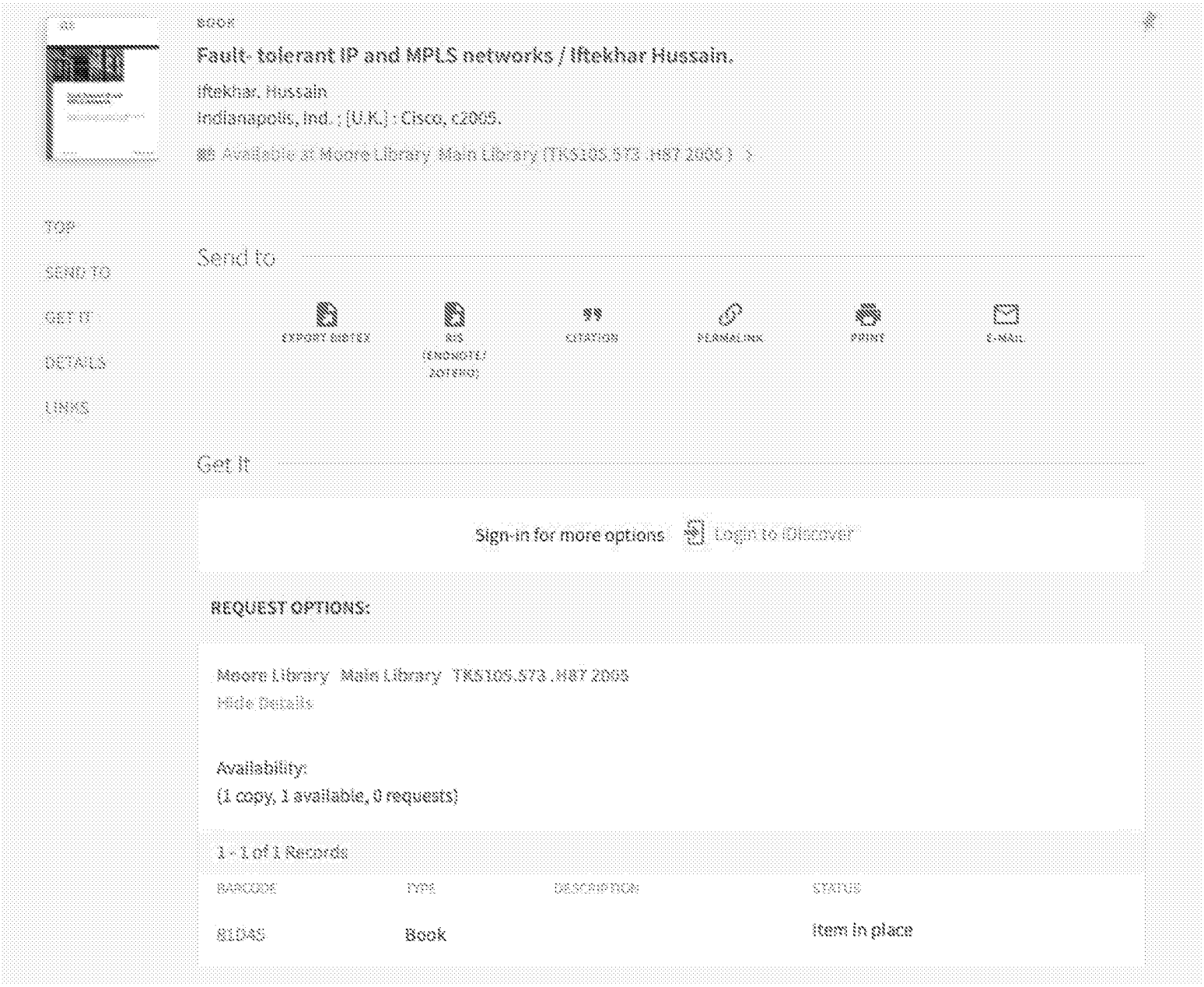
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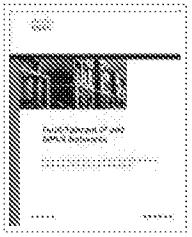

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245 10 |a Fault- tolerant IP and MPLS networks / |c Iftekhar Hussain.
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by Iftekhar Hussain

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Excellent reading! Perfect condition

Reviewed in the United States on April 21, 2015

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Rik Guyler

Excellent reference for Cisco high availability

Reviewed in the United States on April 27, 2005

Reviewer: Rik Guyler, Senior Network Engineer

Cisco Certifications Held: CCNA, CCDA, CCNP, CCDP

Iftekhar Hussain's Fault-Tolerant IP and MPLS Networks is worthy of consideration by anybody that works in a Service Provider environment. This reference, while not a configuration guide by any means, provides insight to the some of the design considerations of a Service Provider network.

The things I like about this book:

I found this book reasonably easy to read. The information was given in a clear and concise manner without a lot of fluff. With only 316 pages (including index), there was very little written that was not important to the topic. After having read dozens of technical books, this was a refreshing change of pace from the 1000+ page tomes that contain no more real content than this book does.

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The manner in which the book was written and published was very tidy and neat. It's been rather typical in my experience to find technical books riddled with errors but this book was not. In fact, I cannot recall seeing one error or maybe more accurately, I cannot recall catching one. Either way, this book was cleanly published.

I will not go into too much detail about the content as the name of the book speaks for itself. I will say that the content is right on track for what it claims and that provides a realistic look at various fault-tolerant mechanisms and practices designed for the Service Provider network. Not having a foundation in MPLS, I definitely learned where MPLS fits into the big picture with regard to high availability networks. Once again, this book is not a low level technical reference that will guide you to configuring your Cisco routers. It offers strictly a Network Architect's view of the technologies mentioned.

The things I do not like about this book:

I cannot honestly say that there is much I do not like about this book. I chose this book thinking that there would be more low level technical information such as configuration guidelines for the various technologies so I was somewhat disappointed that there was nothing like this. However, after reading this book, it clearly is a design and concepts book so I would have liked it to have said "Design" only rather than "Design and deploy" on the cover. A picky complaint for sure but valid nonetheless.

It is also worthwhile to mention (not a complaint) that while this book includes routing protocols such as BGP, OSPF and ISIS, it does not get into the functionality of these protocols except to discuss how they fit into a high availability design. The same can be said about MPLS. If you want detailed information on BGP, OSPF, ISIS or MPLS then you will need to look to other reference materials.

I highly recommend this book for everybody that wishes to learn more about some of the high availability features offered to Service Providers by Cisco.

3 people found this helpful

Helpful Comment Report abuse

A. Sardella

Stirring the Protocol Soup

Reviewed in the United States on March 29, 2005

This book describes a great many of the common scenarios involved in achieving resiliency in IP/MPLS core networks. With a heavy migration to converged, multiservice IP networks underway, network availability and reliability are extremely critical. Today's IP infrastructure continues to serve the needs of legacy applications along with new service offerings such as VoIP and other premium IP services that are rated based on performance (such as latency, jitter, and carrier-class availability). To deliver value-added IP services that are backed by Service Level Agreements (SLAs), the service provider's network must attain a very high level of service availability.

Triple play applications have carrier class requirements that include rigorous uptime requirements more commonly associated with diverse transport networks that may be SONET/SDH supporting ATM or frame relay. Expected of both legacy and emerging applications, these features include nonstop forwarding (NSF), graceful restart (GR), in-service software upgrade (ISSU), bidirectional forward detection (BFD), and traffic engineering (TE) with fast reroute (FRR). Failover times for redirected traffic is expected to be on the order of 50 ms for applications such as broadcast video, and the latency and jitter requirements of voice have only recently been associated with the capabilities of a routed infrastructure such as IP/MPLS. This book illustrates how to integrate these demanding applications into service provider core networks.

MPLS is a technology that requires a clean separation of the forwarding and control plane; although earlier routing platforms did not have this separation, modern routers do (interestingly, so does the book!). The control plane can thought of as the routing engine; it maintains peer relationships, runs routing protocols, builds the routing table, and creates the forwarding table, which it then exports to the forwarding plane to send the packets to their output interfaces. After an initial chapter that explains how to design for IP/MPLS uptime, Part I deals with the forwarding planes for both IP and MPLS. The main issue in terms of resiliency here is NSF, which is very important in carrier environments. Software is a common cause of network element failure and it is a huge boon to carriers when a routing platform can forward packets even while the control plane is in trouble. Failure is not an option in the service provider community, because any false step can severely damage a service provider's hard-earned reputation for delivering quality services.

Juniper Exhibit 1008, page 479

Part II covers the IP/MPLS control plane, where IP routing protocols and MPLS signaling protocols are run. The interior routing protocols covered are ISIS and OSPF; these are the most common IGPs for service providers. For these, and in fact for all of the control plane protocols, the issue is how to minimize the effect of a restart on the router's operation. Things get tricky here because Cisco routers may have very different characteristics in terms of being capable of NSF or GR, which is the ability of a router to quickly reestablish adjacencies after restarting. For instance, if one router is incapable of either NSF or GR, then you need to consider what type of high availability you will have based on the resiliency features of adjacent routers. Similar issues exist for BGP, and there are additional considerations based on speaker behavior and the settings of the BGP attributes.

On the MPLS control plane, the signaling protocols are BGP, LDP, and RSVP. Of course, both MPLS and the signaling protocol will be running on the control plane, so the issues get a little more complex as Cisco routers may vary as to whether both control plane protocols will support GR. These considerations have to be combined with the question of whether adjoining routers support NSF. There are similar issues for both LDP and RSVP-TE, and the book details ways to mitigate the effects of restarts on all of these protocols, as well as how to handle variances in the support of graceful restart or NSF on the routers in the topology.

Some key MPLS services are detailed in Part III, along with suggestions on how to ensure their high availability. Layer 2 and Layer 3 VPNs are discussed, both in point-to-point and point-to-multipoint modes. MPLS provides TE mechanisms to find backup paths for these critical services. For some real time services, such as voice or video running over these VPNs, fast reroute on the order 50 ms failover may be required. Core routing vendors have other mechanisms in order to speed up link detection and failover; one example is BFD. This section details these mechanisms as well as other ways to affect restoration of layers 1-3 based on MPLS signaling.

This book covers most the large number of scenarios that you need to consider in the service provider environment for high availability. Part of the reason why there are so many situations to consider is that it is fairly new for higher-layer protocols such as IP/MPLS to perform the instant failover that has traditionally been thought of as the purview of telco-quality Layer 1 services such as SONET/SDH. For working its way through the nuances of this protocol soup and the varied support there may be for failure characteristics from one router to the next, I would give this book five stars.

3 people found this helpful

Helpful Comment Report abuse

John Matlock

Comprehensively Covers a Major Point of Failure

Reviewed in the United States on January 20, 2005

This book should be of great interest to network engineers, system engineers, and technical managers who want to understand the fault-tolerent aspects of packet-switched networks and how they can effectively design and deploy high-availability IP/MPLS networks.

The cost of low availability is well known. Amazon announced that on one day just before Christmas they had averaged approximately 30 orders per second. A minute of down time on their system would then have resulted in the loss (hopefully just a delay) of about 200 orders.

This book is concerned not with the basic processing elements of a system, but with the edge and core routers that connect between the external communications system and the processing elements. It describes the theory, the accepted standards, and the practical aspects of designing a system that will continue to function despite failure of hardware or software components in the system.

One person found this helpful

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Robert Kiessling

Limited Scope

Reviewed in the United States on May 1, 2005

Previous reviews named a number of positive points, so I will not repeat those.

Juniper Exhibit 1008, page 480

Surprisingly, they miss the main issue I have with this book. It is limited in scope, delivering less than title or cover text suggest. It covers the specific issue of non-stop forwarding and routing protocol support for it.

Other important building blocks of highly available networks such as MPLS Fast-Reroute are only sketched in the last chapter.

A reasonable question to ask is: Given the protocol complexity, the fact that software failure is the main outage reason, and the "blackhole" period while control plane restarts, which is more reliable: a network structure with graceful restart, or one that deploys techniques like FRR or BFD to immediately reroute around a failed node?

The book unfortunately does not provide much material to answer this.

Another area that I would have liked to see is more implementation guides. Adjusting protocol parameters like timers forms an important part to improve operations. A book claiming to be a comprehensive guide to deploy high availability should discuss those, but this one does not.

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Shipping Rates & Policies
Amazon Prime
Returns & Replacements
Manage Your Content and Devices
Amazon Assistant
Help

English United States

Amazon Music
Stream millions of songs

Amazon Advertising
Find, attract, and engage customers

Amazon Drive
Cloud storage from Amazon

6pm
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eBooks
Books, art & collectibles

ACX
Audiobook Publishing Made Easy

Alexa
Actionable Analytics for the Web

Sell on Amazon
Start a Selling Account

Amazon Business
Everything For Your Business

Amazon Fresh
Groceries & More Right To Your Door

AmazonGlobal
Ship Orders Internationally

Home Services
Handpicked Pros Happiness Guarantee

Amazon Ignite
Sell your original Digital Educational Resources

Amazon Rapids
Fun stories for kids on the go

Amazon Web Services
Scalable Cloud Computing Services

Audible
Listen to Books & Original Audio Performances

Book Depository
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IMDb
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IMDbPro
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Amazon Photos
Unlimited Photo Storage Free With Prime

Prime Video Direct
Video Distribution Made Easy

Shopbop
Designer Fashion Brands

Amazon Warehouse
Great Deals on Quality Used Products

Whole Foods Market
America's Healthiest Grocery Store

Woot!
Deals and Shenanigans

Zappos
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Exhibit 1023

English Translation of the Written Opinion of the International Searching Authority for PCT/FR08/50324.

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TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS

PCT

RAPPORT PRÉLIMINAIRE INTERNATIONAL SUR LA BREVETABILITÉ

(chapitre I du Traité de coopération en matière de brevets)

(règle 44*bis* du PCT)

Référence du dossier du déposant ou du mandataire 06403-WO	**POUR SUITE À DONNER**	Voir le point 4 ci-dessous
Demande internationale no. PCT/FR2008/050324	Date du dépôt international *(jour/mois/année)* 26 February 2008 (26.02.2008)	Date de priorité *(jour/mois/année)* 26 February 2007 (26.02.2007)
Classification internationale des brevets (8^{e}edition, sauf indication d'une #dition ant#rieure) Voir les informations pertinentes dans le formulaire PCT/ISA/237		
Déposant FRANCE TELECOM		

1. Le présent rapport préliminaire international sur la brevetabilité (chapitre I) est établi par le Bureau international au nom de l'administration chargée de la recherche internationale selon la règle 44*bis*.1.a).

2. Ce RAPPORT comprend un total de 9 feuilles, y compris la présente feuille de couverture.

   Dans les feuilles jointes, toute référence à l'opinion écrite de l'administration chargée de la recherche internationale doit être entendue, à la place, comme une référence au rapport préliminaire international sur la brevetabilité (chapitre I).

3. Le présent rapport contient des indications relatives aux points suivants :

☒	Cadre n° I	Base de l'opinion
☐	Cadre n° II	Priorité
☒	Cadre n° III	Absence de formulation d'opinion quant à la nouveauté, l'activité inventive et la possibilité d'application industrielle
☒	Cadre n° IV	Absence d'unité de l'invention
☒	Cadre n° V	Déclaration motivée selon l'article 35.2) quant à la nouveauté, l'activité inventive et la possibilité d'application industrielle; citations et explications à l'appui de cette déclaration
☐	Cadre n° VI	Certains documents cités
☐	Cadre n° VII	Certaines irrégularités relevées dans la demande internationale
☐	Cadre n° VIII	Certaines observations relatives à la demande internationale

4. Le Bureau international communiquera le présent rapport aux offices désignés conformément aux règles 44*bis*.3.c) et 93*bis*.1 mais pas avant l'expiration du délai de 30 mois à compter de la date de priorité (règle 44*bis*.2), sauf si le déposant a présenté une requête expresse à cet égard en vertu de l'article 23.2).

	Date d'établissement du présent rapport 22 September 2009 (22.09.2009)
Bureau international de l'OMPI 34, chemin des Colombettes 1211 Geneva 20, Switzerland no de télécopieur +41 22 338 82 70	Fonctionnaire autorisé Beate Giffo-Schmitt e-mail: pt03.pct@wipo.int

Formulaire PCT/IB/373 (janvier 2004)

PATENT COOPERATION TREATY

TRANSLATION

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	see form PCT/ISA/210
Applicant's or agent's file reference: 06403-WO	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FR2008/050324	26.02.2008	26.02.2007

International Patent Classification (IPC) or both national classification and IPC
H04L12/56

Applicant
FRANCE TELECOM

1. This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☐ Box No. II — Priority
- ☒ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI — Certain documents cited
- ☐ Box No. VII — Certain defects in the international application
- ☐ Box No. VIII — Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/EP	Date of completion of this opinion	Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/FR2008/050324

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing

      ☐ contained in the international application as filed

      ☐ filed together with the international application in electronic form

      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/FR2008/050324

Box No. III **Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application

☒ claims Nos. 8, 9

because:

☐ the said international application, or the said claims Nos. _____ relate to the following subject matter which does not require an international search (*specify*):

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. _____ are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. _____ are so inadequately supported by the description that no meaningful opinion could be formed (*specify*):

On the subject matter of claims 8 and 9, which concerns a non-patentable "signal" (see reasons in the search report) (PCT Rule 67(v)).

☒ no international search report has been established for said claims Nos. 8, 9

☐ a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

☐ furnish a sequence listing on paper complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.

☐ furnish a sequence listing in electronic form complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in a form and manner acceptable to it.

☐ pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13*ter*.1(a) or (b).

☐ a meaningful opinion could not be formed without the tables related to the sequence listings; the applicant did not, within the prescribed time limit, furnish such tables in electronic form complying with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions, and such tables were not available to the International Searching Authority in a form and manner acceptable to it.

☐ the tables related to the nucleotide and/or amino acid sequence listing, if in electronic form only, do not comply with the technical requirements provided for in Annex C-*bis* of the Administrative Instructions.

☐ See Supplemental Box for further details.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/FR2008/050324

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:

   ☐ paid additional fees

   ☒ paid additional fees under protest and, where applicable, the protest fee

   ☐ paid additional fees under protest but the applicable protest fee was not paid

   ☐ not paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with

   ☒ not complied with for the following reasons:

4. Consequently, this opinion has been established in respect of the following parts of the international application:

   ☒ all parts

   ☐ the parts relating to claims Nos. _____

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/FR2008/050324

Box No. V **Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1, 2, 4, 6, 3, 5, 7	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1, 2, 4, 6, 3, 5, 7	NO
Industrial applicability (IA)	Claims	1, 2, 4, 6, 3, 5, 7	YES
	Claims		NO

2. Citations and explanations:

Documents cited in this opinion

D1: BOCCI ALCATEL S BRYANT CISCO SYSTEMS M: "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge; draft-ietf-pwe3-ms-pw-arch-02.txt" IETF STANDARD-WORKING-DRAFT, INTERNET ENGINEERING TASK FORCE, IETF, CH, vol. pwe3, no. 2, 20 October 2006 (2006-10-20), XP015048046 ISSN: 0000-0004 cited in the application

D2: PAN (HAMMERHEAD SYSTEMS) M BOCCI MUSTAPHA AISSAOUI (ALCATEL) FLORIN BALUS HAMID OULD-BRAHIM (NORTEL) P: "Pseudo Wire Protection; draft-pan-pwe3-protection-03.txt" IETF STANDARD-WORKING-DRAFT, INTERNET ENGINEERING TASK FORCE, IETF, CH, no. 3, 1 July 2006 (2006-07-01), XP015047198 ISSN: 0000-0004

1. Since it is known from D1, and this is acknowledged by the applicant on page 2, that it is part of standard practice of a person skilled in the art to create multi-segment pseudo-links, it is then a matter only of the requirement and/or

Box No. V — Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

the number of routers available to create 1, 2 or 3 pseudo-links sharing one or more segments (cf. D1, figures 4, 5), leading to the subject matter of claim 1 as being purely an engineering option (PCT Article 33(3)) and consequently cannot be an inventive concept common with that of claim 3 (*a posteriori* lack of unity (PCT Rule 13)).

As already indicated in the previous paragraph, the subject matter of claim 1 falls within the engineering options in the context of multi-segment pseudo-links and therefore its subject matter lacks an inventive step (PCT Article 33(3)).

2. In addition, the subject matter of claim 1 lacks clarity (PCT Article 6), the terminology "pseudo-link" being only clearly defined and framed by the definition given on page 1, lines 22-25, which must be included in any independent claim.

3. In addition, the subject matter of claim 1 does not solve any problem and is limited to wishing to construct pseudo-links, whereas it is clear that the subject matter of the application (pages 2 and 3) is to define a behaviour of the routers of pseudo-links in the case of a fault. As the invention appears to be directed towards this problem, and claim 1 does not comprise any technical feature for solving such a problem, it therefore lacks all the essential features for defining the invention, further aggravating the

Box No. V — Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

lack of clarity of its claimed subject matter (PCT Article 6).

4. D2 supports in figure 4 the assertion in paragraph 1.
This is because, as the PWs are bidirectional, the situation in figure 4 can therefore be reversed and in the context where A is attached by two points ("dual homed" in PW terminology) the link C(T-PE) - B(SP-PE) common to the two outputs B - T-PE(A,home 1) and B - T-PE (A,home 2) is obtained, in an identical manner, to within mirror symmetry, to figures 2 and 3 of the application.
D2 supports the above argument in relation to the engineering option indicated in paragraph 1 by the phrase "the working and backup pseudo wires may arrive on the same PE nodes (S-PE's)" which clearly indicates a pure arbitrary choice for determining the path taken by a "normal" path and a "backup" path.
The parameter on page 13, "F-Flag: Fate sharing allowed", finally demonstrates that it is arbitrary to choose common segments since the normal and backup paths may share their fate, "fate share".
The subject matter of claim 1 therefore lacks an inventive step (PCT Article 33(3)), and ultimately novelty with respect to D2.

5. In addition, D2 describes in paragraph 3.4 the conventional protection mode known as "hot standby" in which "Upon detection of network

Box No. V **Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

failure, the edge nodes will switch data traffic into pre established back up pseudo wires directly", which indicates clearly, in PW architecture, a step of switching the data stream to a third link (the "backup") as in claim 3. It is also implicit that there is reception of fault information for triggering the "hot standby" protection.

The subject matter of claim 1 also does not involve an inventive step (PCT Article 33(3)).

6. This reasoning applies, *mutatis mutandis*, to the subject matter of the corresponding claims 5 and 7, the subject matter of which lacks an inventive step.

7. D2 therefore discloses the fact the second pseudo-link is a backup pseudo-link as in claim 2 and the corresponding claims 4 and 6, the subject matter of which lacks an inventive step (PCT Article 33(3)).

Exhibit 1024

Cisco Systems, Inc. v. Monarch Networking Solutions, Inc., IPR2020-01226, Paper 11 (PTAB Mar. 4, 2021).

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Paper 11
Date: March 4, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC,
Petitioner,

v.

MONARCH NETWORKING SOLUTIONS LLC,
Patent Owner.

IPR2020-01226
Patent 8,130,775 B2

Before THU A. DANG, THOMAS L. GIANNETTI, and ROBERT J. WEINSCHENK, *Administrative Patent Judges.*

DANG, *Administrative Patent Judge.*

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background

Cisco Systems, Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1 and 6 (the "challenged claims") of U.S. Patent No. 8,130,775 B2 (Ex. 1001, "the '775 patent"). Paper 2 ("Pet."). Monarch Networking Solutions LLC ("Patent Owner") filed a Preliminary Response. Paper 8 ("Prelim. Resp."). Pursuant to our authorization, Petitioner filed a Reply to Patent Owner's Preliminary Response (Paper 9, "Pet. Prelim. Reply") and Patent Owner filed a Sur-reply (Paper 10, "PO Prelim. Sur-reply"), each directed to whether we should exercise our discretion to deny institution pursuant to 35 U.S.C. § 314(a).

Under 37 C.F.R. § 42.4(a), the Board has authority to determine whether to institute an *inter partes* review. We may institute an *inter partes* review if the information presented in the petition filed under 35 U.S.C. § 311, and any response filed under § 313, shows that there is a reasonable likelihood that Petitioner would prevail with respect to at least one of the claims challenged in the petition. The Board, however, has discretion to deny a petition even when a petitioner meets that threshold. *Id.*; *see, e.g.*, *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016) ("[T]he agency's decision to deny a petition is a matter committed to the Patent Office's discretion."); *see also* Patent Trial and Appeal Board Consolidated Trial Practice Guide (Nov. 2019) ("Consolidated TPG"), 55–63, available at https://www.uspto.gov/sites/default/files/documents/tpgnov.pdf (identifying considerations that may warrant exercise of this discretion). In particular, 35 U.S.C. § 314(a) permits the Board to deny institution under certain circumstances. *See Gen. Plastic Indus. Co. v. Canon Kabushiki Kaisha*,

IPR2016-01357, Paper 19 (PTAB Sept. 6, 2017) (precedential as to § II.B.4.i).

Having considered the parties' submissions, we determine that it is appropriate in this case to exercise our discretion to deny institution of *inter partes* review pursuant to 35 U.S.C. § 314(a) due to the advanced stage of the parallel district court litigation involving the challenged patent. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 5 (PTAB Mar. 20, 2020) (precedential) ("*Fintiv*"); *NHK Spring Co. v. Intri-Plex Techs., Inc.*, IPR2018-00752, Paper 8 (PTAB Sept. 12, 2018) (precedential) ("*NHK*").

B. Related Proceedings

Petitioner identifies the '775 patent as the subject of *Monarch Networking Solutions LLC v. Cisco Systems, Inc. and Charter Communications, Inc.*, No. 2:20-cv-00015 (E.D. Tex.) ("Eastern District of Texas litigation"). Pet. 7–8.

C. The '775 Patent

The '775 patent, titled "Mechanism for Protecting a Pseudo-wire," issued on March 6, 2012, from Application No. 12/528,083, filed on February 26, 2008. Ex. 1001, codes (54), (45), (22).

The '775 patent is directed to routing data packets in packet-switched networks, wherein labels are added to data packet headers with information that enable network routers to determine the next hop for a packet to reach its destination. *See* Ex. 1001, 1:30–39. The '775 patent recognizes that pseudo-wires have been used to emulate a point-to-point link between two devices of a packet-switched network. *Id.* at 1:45–49. The prior art packet-switched network is depicted in Figure 2, reproduced below:

Fig. 2(AA)

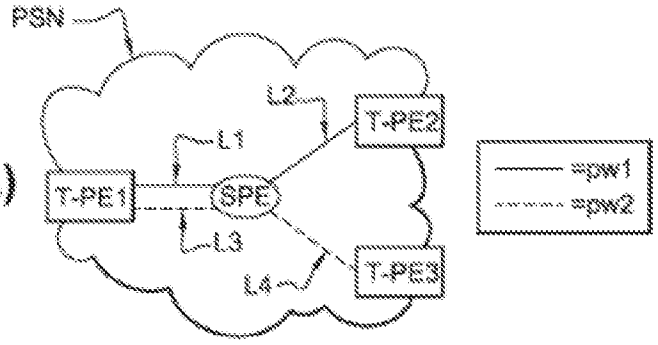

Figure 1 shows prior-art packet-switched network PSN, in which first pseudo-wire pw1 is set up between input router T-PE1 at one edge of network PSN and output router T-PE2 at another edge of network PSN. *Id.* at 2:12–17. First link L1 that is part of pseudo-wire pw1 is set up between input router T-PE1 and intermediate router SPE of network PSN, while second link L2 that is also part of pseudo-wire pw1 is set up between intermediate router SPE and output router T-PE2. *Id.* at 2:15–20. Second pseudo-wire pw2 is then set up between input router T-PE1 constituting a first end of pseudo-wire pw2 and second output router T-PE3 constituting a second end of pseudo-wire pw2. *Id.* at 2:20–23. First link L3 that is part of second pseudo-wire pw2 is set up between input router T-PE1 and intermediate router SPE, while second link L4 that is also part of second pseudo-wire pw2 is set up between intermediate router SPE and output router T-PE3. *Id.* at 2:23–27. According to the '775 patent, prior-art PSN network shown in Figure 1 has the drawback of consuming network resources that increases the restore time in the event of a fault affecting an output router, with a negative impact on quality of service. *Id.* at 2:40–47. Accordingly, the '775 patent proposes setting up two pseudo-wires to broadcast a data stream (*id.* at 2:54–60), wherein, to optimize the use of network resources, for example bandwidth, a single link common to the two

Juniper Exhibit 1008, page 497

pseudo-wires are is set up between the input router and the intermediate router. *Id.* at 3:1–5.

Figure 3 is reproduced below:

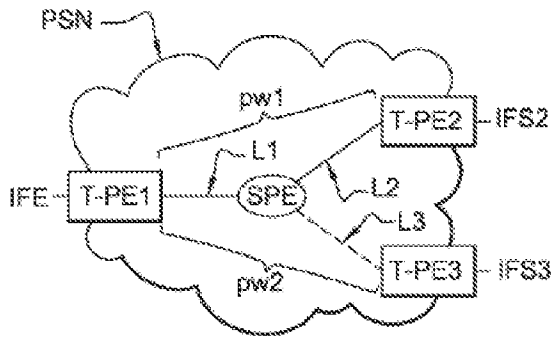

Fig. 3

Figure 3 represents a connection set up between input router T-PE1 and intermediate routers T-PE2 and T-PE3, each of these three routers being at an edge of network PSN. *Id.* at 6:25–28. As shown in Figure 3, first link L1 is set up between input router T-PE1 and intermediate router SPE, and second link L2 is set up between intermediate router SPE and first output router T-PE2, wherein first and second links L1, L2 constitute first pseudo-wire pw1 setting up a connection between input router T-PE1 and first output router T-PE2. *Id.* at 6:29–38. Second pseudo-wire pw2 is set up between input router T-PE1 and second output router T-PE3, wherein second pseudo-wire pw2 consists of first link L1 and second link L3 set up between intermediate router SPE and second output router T-PE3. *Id.* at 6:39–43. Accordingly, first link L1 is shared by pseudo-wires pw1 and pw2. *Id.* at 6:44–45.

D. The Challenged Claims

Both of the challenged claims 1 and 6 are independent claims. Claim 1 is illustrative, and is reproduced below:

Juniper Exhibit 1008, page 498

> 1. A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:
>
> setting up a first pseudo-wire comprising a first link set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and a second link set up between said intermediate router and a first output router of the packet-switched network; and
>
> setting up a second pseudo-wire between said input router and a second output router of the packet-switched network, wherein the second pseudo-wire comprises said first link and a third link set up between said intermediate router and said second output router, said first link being shared by the first and second pseudo-wires.

Ex. 1001, 12:14–27.

E. Asserted Grounds of Unpatentability

Petitioner challenges the patentability of claims 1 and 6 of the '775 patent on the following ground (Pet. 3):

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 6	103(a)	Aggarwal,[1] Hussain,[2]

Petitioner relies on the Declaration of Henry Houh, Ph.D. (Ex. 1003) in support of its unpatentability contentions.

[1] U.S. Patent No. 7,602,702 B1, issued October 13, 2009, filed February 10, 2005 (Ex. 1005, "Aggarwal").

[2] Hussain, Iftekhar, "Fault-Tolerant IP and MPLS Network," Cisco Press, printed November 2004 (Ex. 1006, "Hussein").

Juniper Exhibit 1008, page 499

II. ANALYSIS

A. Discretion Under 35 U.S.C. § 314(a)

Institution of an *inter partes* review is discretionary. Section 314(a) of title 35 of the United States Code provides that "[t]he Director may not authorize an *inter partes* review to be instituted unless the Director determines that the information presented in the petition . . . and any response . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." The U.S. Supreme Court has explained that because § 314 includes no mandate to institute review, "the agency's decision to deny a petition is a matter committed to the Patent Office's discretion." *Cuozzo*, 136 S. Ct. at 2140; *see also Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1367 (Fed. Cir. 2016) (explaining that under § 314(a), "the PTO is permitted, but never compelled, to institute an IPR proceeding"). The Director has delegated this authority under § 314(a) to the Board. 37 C.F.R. § 42.4(a) ("The Board institutes the trial on behalf of the Director.").

In this proceeding, Patent Owner argues that we should exercise our discretion under 35 U.S.C. § 314(a) to deny institution in this case because "it would be an inefficient duplication of ongoing litigation." Prelim. Resp. 45. In particular, according to Patent Owner, "[g]iven the advanced state of [the district court] litigation, which addresses the same issues raised in the instant Petition, the Board should deny institution." *Id.*

In determining whether to exercise our discretion, we are guided by the Board's precedential decision in *NHK*. There, the Board found that the "advanced state of the district court proceeding," in which the "same prior art and arguments" were presented by Petitioner, expert discovery was

scheduled to end in less than two months, and a jury trial was scheduled to begin in six months, was a "factor that weighs in favor of denying" the petition under § 314(a). *NHK*, IPR2018-00752, Paper 8 at 20. The Board determined that "[i]nstitution of an *inter partes* review under these circumstances would not be consistent with 'an objective of the AIA . . . to provide an effective and efficient alternative to district court litigation.'" *Id.* (citing *Gen. Plastic Indus.*, IPR2016-01357, Paper 19 at 16–17).

"[T]he Board's cases addressing earlier trial dates as a basis for denial under NHK have sought to balance considerations such as system efficiency, fairness, and patent quality." *Fintiv*, Paper 11 at 5. When applying *NHK*, the Board has balanced the following non-exclusive factors (herein "*Fintiv* factors"):

> 1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
>
> 2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
>
> 3. investment in the parallel proceeding by the court and the parties;
>
> 4. overlap between issues raised in the petition and in the parallel proceeding;
>
> 5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
>
> 6. other circumstances that impact the Board's exercise of discretion, including the merits.

Id. at 5–6.

We discuss the parties' arguments in the context of considering the above factors.

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1. Whether a stay exists or is likely to be granted if a proceeding is instituted

Petitioner points out that neither party to the district court case has requested a stay. Pet. 19. Petitioner argues that "given that a motion to stay has not yet been filed, the Board should not infer the outcome of that motion." *Id.* at 20. Patent Owner counters that Judge Gilstrap is the presiding judge in the district court case, and "it is unlikely that Judge Gilstrap would grant a stay in the parallel proceeding." Prelim. Resp. 46–47. According to Patent Owner, "it would be March 8, 2021 before the parties know whether institution will occur," wherein, "[b]y that point, . . . Monarch will have already incurred the majority of expenses associated with the litigation – which Judge Gilstrap has previously found to be sufficiently showing of prejudice." *Id.* at 47 (citing *Solas OLED Ltd. v. Samsung Display Co.*, No. 2:19-CV-00152-JRG, 2020 U.S. Dist. LEXIS 125973, at *4–6 (E.D. Tex. July 17, 2020)).

On the present record, neither party has produced evidence that a stay has been requested or that the district court has considered a stay in the parallel litigation. Further, a judge determines whether to grant a stay based on the facts of each specific case as presented in the briefs by the parties. Although Patent Owner cites to the presiding Judge's finding in another proceeding (Prelim. Resp. 47), we decline to infer, based on actions taken in different cases with different facts, how the district court would rule should a stay be requested by the parties in the parallel litigation. *Fintiv* at 12. Thus, we find that this factor does not weigh for or against exercising discretion to deny institution under § 314(a).

2. Proximity of the court's trial date to the Board's projected statutory deadline for a final written decision

The parties agree that the trial in the Eastern District of Texas currently is scheduled to begin on June 7, 2021. *See* Prelim. Resp. 48; Pet. Prelim. Reply 2. However, Petitioner expresses its concern about the uncertainty of the June 7, 2021 trial date due to the COVID-19 pandemic as well as the district court's backlog. Pet. Prelim. Reply 2–3. In particular, Petitioner argues that "the rescheduled June 7, 2021 trial date is still not guaranteed because Judge Gilstrap currently has six other trials scheduled for jury selection on that same date," and that "in the January-May 2021 period, Judge Gilstrap has more than 60 trials scheduled." *Id.* at 3 (citing Ex. 1042, 2; Ex. 1043, 1; Ex. 1044, 1; Ex. 1045, 1; Ex. 1046, 1; Ex. 1047, 1; Ex. 1048, 1–34).

Furthermore, Petitioner argues that a motion to transfer the district court case to Northern District of California is currently pending. Pet. Prelim. Reply 3. According to Petitioner, if the motion is granted, the Northern District of California would set a new case schedule, including a new trial date. *Id.* Thus, Petitioner argues that the pending motion to transfer adds uncertainty to the June 7 trial date. *Id.*

Patent Owner counters that a final written decision in this matter "would likely issue in March 2022 – well after the likely conclusion of the litigation in June 2021." Prelim. Resp. 48. According to Patent Owner, as of the filing date of the Preliminary Sur-reply of January 14, 2021, "the parties are one month away from completing discovery." PO Prelim. Sur-reply 2 (citing Ex. 2010, 3). Thus, Patent Owner contends that any "hypothetical scenarios" suggested by Petitioner, including Petitioner's "speculat[ion] that a motion to transfer might influence the timing," could

not "reasonably be expected to result in a nine-month delay of the trial date." *Id.* at 3.

Generally, if a district court's trial date is substantially earlier than the projected statutory deadline, the Board has weighed this factor in favor of exercising authority to deny institution under § 314(a). *Fintiv* at 9. We note that there is some uncertainty that the jury trial will occur on June 7, 2021. First, as Petitioner contends, a motion to transfer the district court case to Northern District of California is currently pending. Pet. Prelim. Reply 3. We decline to speculate, though, whether the district court will grant that motion..

Further, as Petitioner points out, there are six other trials scheduled for jury selection on June 7, 2021, in the Eastern District of Texas. Pet. Prelim. Reply 2–3. Although at least some of those trials will not occur on June 7, 2021, we decline to speculate as to which trials will not occur on that date.

Additionally, given the substantial nine-month gap between the scheduled June 7 trial date (and the other potential dates proposed by Patent Owner) and March 2022 (the likely date for any final written decision in this proceeding), even if the trial date were postponed substantially, it appears unlikely, on the present record, that the trial would occur after a final written decision in this proceeding.

Accordingly, on the record before us, this factor weighs in favor of exercising our discretion to deny institution pursuant to § 314(a).

3. Investment in the parallel proceeding by the district court and the parties

We consider now the amount and type of work already completed in the parallel litigation by the court and the parties at the time of the institution decision. *See Fintiv* at 9.

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The Eastern District of Texas issued a claim construction order on January 7, 2021. Ex. 2013 (Claim Construction Memorandum and Order). Fact discovery currently is scheduled to have closed on January 12, 2021, expert discovery currently is scheduled to have closed on February 19, 2021, and dispositive motions currently are scheduled to have been filed by February 24, 2021. Ex. 2010 (First Amended Docket Control Order).[3] As Patent Owner contends, by the time this institution decision issues, "the parties likely will have received the [district court's] claim construction order, completed discovery, and filed all dispositive motions." Prelim. Resp. 49. According to Patent Owner, both the district court and the parties have "already made significant investments in the litigation, and most pretrial matters likely will be disposed before any decision on institution issues." In particular, Patent Owner contends that Petitioner "has already submitted its 694-page invalidity expert report in the district court case," wherein "all discovery will conclude by February 19, 2021 – likely well before the Board issues its institution decision." PO Prelim. Sur-reply 3 (emphasis omitted).

As set forth in *Fintiv*, "district court claim construction orders may indicate that the court and parties have invested sufficient time in the parallel proceeding to favor denial." *Fintiv* at 10. "This investment factor is related to the trial date factor, in that more work completed by the parties and court in the parallel proceeding tends to support the argument[] that the parallel proceeding is more advanced, a stay may be less likely, and instituting would lead to duplicative costs." *Id.*

However, Petitioner's timing in filing the Petition is also relevant to this factor. If the evidence shows that a petitioner filed its petition

[3] Neither party has advised us of any changes to the schedule.

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expeditiously, such as promptly after becoming aware of the claims being asserted, this fact has weighed against denying institution. *Fintiv* at 11 (citing *Intel Corp. v. VLSI Tech. LLC*, IPR2019-01192, Paper 15 at 12–13 (PTAB Jan. 9, 2020); *Illumina Inc. v. Natera, Inc.*, IPR2019-01201, Paper 19 at 8 (PTAB Dec. 18, 2019)). Here, Petitioner contends that it "diligently reviewed prior art and prepared this Petition upon being informed on May 4, 2020 of the claims of the '775 Patent asserted by Patent Owner against Petitioner" whereas "Petitioner worked diligently to prepare and file this Petition in about two months." Pet. 19–20.

Although we do not find that Petitioner unreasonably delayed filing the Petition, we do find that the parties already have invested significantly in the Eastern District of Texas litigation. As noted above, the district court claim construction order issued on January 7, 2021, fact discovery currently is scheduled to have closed on January 12, 2021, expert discovery currently is scheduled to have closed on February 19, 2021, and dispositive motions are scheduled to have been filed by February 24, 2021.

We also find that the investment made by the parties in the district court litigation relating to issues of patent validity overlap with the issues in this *inter partes* proceeding. First, the claim construction issues addressed by the court overlap with the issues in this proceeding. For example, the district court made a finding with respect to the term "link" in claims 1–7 of the '775 patent, and, in this proceeding, Patent Owner contends that neither of the prior art relied upon by Petitioner discloses a "link." Ex. 2013, 35; Prelim. Resp. 28.

Furthermore, the same prior art at issue here is also at issue in the district court. *See* Pet. 21; Prelim. Resp. 49. Expert discovery is scheduled to have closed on February 19, 2021 (prior to the issuance of this Decision),

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and the parties already have invested significant resources in preparing expert reports on overlapping invalidity issues. *See* PO Prelim. Sur-reply 3 ("Cisco has already submitted its 694-page invalidity expert report").

Weighing the facts in this particular case, including the time invested by the parties and the district court in the parallel litigation, the extent to which the investment in the district court proceeding relates to issues of patent validity, and the timing of the filing of the Petition, we find that this factor weighs in favor of exercising our discretion to deny institution pursuant to § 314(a).

4. Overlap between issues raised in the Petition and in the parallel proceeding

This factor evaluates "concerns of inefficiency and the possibility of conflicting decisions" when substantially identical prior art is submitted in both the district court and the *inter partes* review proceedings. *Fintiv* at 12.

Patent Owner points out Petitioner "concedes" that "Petitioner asserted the exact same invalidity grounds in the parallel proceeding." Prelim. Resp. 49 (citing Pet. 21). However, Patent Owner also acknowledges that Petitioner represents that it plans to withdraw the overlapping grounds from the district court litigation if the Board issues a decision granting institution. *Id.* at 49–50.

In particular, as set forth in its Preliminary Reply, Petitioner explains that it "stipulated not to pursue in the district court proceeding the same invalidity grounds raised in the Petition, if the Board institutes trial." Pet. Prelim. Reply 5. According to Petitioner, "[t]his stipulation eliminates any overlap between this proceeding and the district court proceeding, if the Board institutes review." *Id.* at 5 (citing *Fintiv* at 12–13). Petitioner contends that "[o]ther panels have found that such stipulations avoid

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'overlap' between the proceedings, which weighs in favor of institution." *Id.* (citing *Sand Revolution II, LLC v. Cont'l Intermodal Grp.–Trucking LLC*, IPR2019-01393, Paper 24 at 12 (PTAB June 16, 2020) (informative) ("*Sand*"); *NanoCellect Biomedical, Inc. v. Cytonome/ST, LLC*, IPR2020-00551, Paper 19 at 23 (PTAB Aug. 27, 2020); *Apple Inc. v. SEVEN Networks, LLC*, IPR2020-00285, Paper 10 at 22 (PTAB July 28, 2020)).

In its Sur-reply, Patent Owner asserts that Petitioner "only offered to 'cease asserting in the district court litigation the combination of references on which trial is instituted for the claims on which trial is instituted, while trial is instituted.'" PO Prelim. Sur-reply 4 (citing Pet. 21–22). According to Patent Owner, "[s]uch a narrow stipulation favors exercising discretionary denial." *Id.* (citing *Sotera Wireless, Inc. v. Masimo Corporation*, IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020) ("*Sotera*")). That is, according to Patent Owner, what is important is whether the "Petitioner broadly stipulates to not pursue '*any ground* raised or that could have been reasonably raised.'" *Id.* (quoting *Sotera* at 19). Patent Owner contends that "Petitioner's overly narrow stipulation does little to 'address[] concerns of duplicative efforts and potentially conflicting decisions' in the litigation." *Id.* (alteration in original).

As Patent Owner points out, Petitioner is asserting the "exact same invalidity grounds" here as in the district court. Prelim. Resp. 49; *see* Pet. 21. However, Petitioner's stipulation mitigates, to some degree, the concerns over duplicative efforts between the district court and the Board, as well as concerns over potentially conflicting decisions.

Given the facts here that Petitioner's stipulation reduces concerns regarding overlapping issues, this factor weighs marginally against discretionary denial under § 314(a).

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5. Identity of Petitioner and the defendant in the underlying litigation

"If a petitioner is unrelated to a defendant in an earlier court proceeding, the Board has weighed this fact against exercising discretion." *Fintiv* at 13–14. Both parties acknowledge that Petitioner here is the defendant in the underlying litigation. Pet. 22; Prelim. Resp. 50. Therefore, we find that this factor weighs in favor of exercising our discretion to deny institution pursuant to § 314(a).

6. Other circumstances that impact the Board's exercise of discretion, including the merits

As indicated in *Fintiv*, a balanced assessment of factors may include consideration of the merits. *Fintiv* at 14–15. Here, the parties make arguments related to the merits of Petitioner's unpatentability challenges. Pet. 22; Prelim. Resp. 50; Pet. Prelim. Reply 6; PO Prelim. Sur-reply 4. In particular, Petitioner contends that claims 1 and 6 of the '775 patent are obvious over the teachings of Aggarwal and Hussain. Pet. 16. Patent Owner responds that "the merits of this Petition are particularly weak" wherein "Petitioner has not shown that Aggarwal or Hussain, alone or in combination, disclose a 'link' or a 'link being shared' within the meaning of the '775 Patent claims." Prelim. Resp. 50.

The decision whether to exercise discretion to deny institution under § 314(a) is based on "a balanced assessment of all relevant circumstances in the case, including the merits." Consolidated TPG 58. We have reviewed Petitioner's unpatentability arguments in the Petition and Reply, and Patent Owner's arguments in the Preliminary Response and Sur-reply. Based on the limited record before us, we do not find that the merits outweigh the

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other *Fintiv* factors. Thus, we find that this factor does not weigh for or against exercising discretion to deny institution under § 314(a).

7. Conclusion on discretionary denial under § 314(a)

As noted in *Fintiv*, we consider the above six factors when taking "a holistic view of whether efficiency and integrity of the system are best served by denying or instituting review." *Fintiv* at 6. We recognize that weighing the *Fintiv* factors in this proceeding is a close call. However, based on the particular circumstances of this case, we determine that instituting an *inter partes* review would be an inefficient use of Board resources. As discussed above, while factor 4 weighs marginally against denying institution, factors 2, 3 and 5 weigh more significantly in favor of denying institution, with factors 1 and 6 being neutral. On balance, after a holistic consideration of the relevant facts, we are persuaded to exercise our discretion pursuant to § 314(a) to deny institution.

III. CONCLUSION

For the foregoing reasons, we exercise our discretion pursuant to 35 U.S.C. § 314(a) to deny institution of *inter partes* review.

IV. ORDER

For the reasons given, it is

ORDERED that the Petition (Paper 2) is denied as to the challenged claims of the '775 patent; and

FURTHER ORDERED that no *inter partes* review is instituted.

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Exhibit 1030

Cisco Systems, Inc. v. Monarch Networking Solutions, Inc., IPR2020-01226, Paper 9 (PTAB Jan. 4, 2021).

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC.,
Petitioner,

v.

MONARCH NETWORKING SOLUTIONS LLC,
Patent Owner.

Case IPR2020-01226
Patent 8,130,775

PATENT OWNER'S PRELIMINARY RESPONSE UNDER 37 C.F.R. § 42.107 TO PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,130,775

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EXHIBIT LIST

Patent Owner's Exhibits

Exhibit	Description
EX2001	Affidavit in Support of Motion for Pro Hac Vice Admission of Alden G. Harris
EX2002	Monarch Networking Solutions LLC's Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2003	Exhibit A to Cisco Systems, Inc.'s Preliminary Claim Constructions and Extrinsic Evidence (P.R. 4-2) in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2004	Court's Preliminary Claim Constructions in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2005	Monarch Networking Solutions LLC's Opening Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2006	Cisco Systems, Inc.'s Responsive Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2007	Monarch Networking Solutions LLC's Reply Claim Construction Brief in *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.)
EX2008	Jonathan P. Lang et al., "Link Management Protocol (LMP)," IETF RFC 4204
EX2009	M. Bocci & S. Bryant, "An Architecture for Multi-Segment Pseudo Wire Emulation Edge-to-Edge," IETF Network Working Group Internet Draft
EX2010	First Amended Docket Control Order, *Monarch Networking Solutions LLC v. Cisco Systems, Inc.*, No. 2:20-cv-00015-JRG, Dkt. No. 123 (E.D. Tex. Dec. 7, 2020).

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37 C.F.R. § 42.51 18

I. Introduction

Patent Owner Monarch Networking Solutions LLC ("Monarch," "Patent Owner," or "PO") respectfully requests that the Board refuse to institute *inter partes* review of U.S. Patent No. 8,130,775 (Ex.1001, hereinafter "the '775 Patent") because Cisco Systems, Inc. ("Cisco" or "Petitioner") has not shown a reasonable likelihood of prevailing on claims 1 and 6 of the '775 Patent. In addition, the Board should exercise its discretion and deny institution because the Petition (Paper 2, "Pet.") is duplicative of positions advanced by Petitioner in the ongoing litigation regarding the same Patent.

II. Summary of the Argument

This Preliminary Response identifies four fundamental flaws in the Petition where either no facts are disputed or the issue is a pure question of law. Each of these four flaws independently warrants denial. Accordingly, the Board can deny Cisco's Petition at this preliminary stage without the need to weigh disputed facts or assess the credibility of witnesses.[1]

First, Monarch and Cisco proposed competing constructions of the term "link" in the parallel district court proceeding. Cisco's Petition does not even attempt

[1] If the Board institutes trial, Patent Owner will also dispute Cisco's factual allegations and will support its positions with expert testimony.

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to show that either party's construction of "link" is met under Ground 1. In fact, neither Aggarwal nor Hussain (alone or in combination) disclose either party's proposed construction of the term "link." In light of Cisco's failure of proof on the "link" term, and in light of the fact that Aggarwal and Hussain do not satisfy either party's construction of "link," Cisco has not demonstrated a reasonable likelihood of success. The Board can therefore deny the petition without the need to weigh disputed facts or construe the claims.

Second, neither Aggarwal nor Hussain nor their combination discloses a "first link being shared by the first and second pseudo-wires" as required by claims 1 and 6. This is shown below, in Section VIII.A.2.[1.7], through the admissions of Cisco's own Declarant, in addition to the teachings of Aggarwal and Hussain. Because Cisco's Declarant's admissions demonstrate that this limitation is not met by Aggarwal and Hussain, the Board can deny the Petition without the need to find facts or weigh the credibility of competing expert testimony.

Third, the Petition fails to meet the particularity requirement of 35 U.S.C. § 312(a)(3). Petitioner initially argues that "Claims 1 and 6 are obvious under 35 U.S.C. § 103(a) over Aggarwal and Hussain." Pet. at 23. However, Petitioner also relies on additional grounds, including a POSITA's knowledge. *See, e.g.*, Pet. at 38, 43. The Petition therefore fails to allege Ground 1 with the requisite particularity.

Because § 312(a)(3) imposes a legal requirement (about which there are no disputed facts), the Board can deny institution without any fact-finding.

Fourth, the Board should exercise its discretion to deny institution because it would be an inefficient duplication of ongoing litigation under § 314(a). The parties do not meaningfully dispute any facts regarding the parallel proceeding, including the fact that the same alleged prior art is asserted in the parallel proceeding and trial in the parallel proceeding is set to occur months before any final written decision will issue. This determination is committed to the sound discretion of the Board.

III. Note

Patent Owner cites to exhibits' original page numbers where possible. Emphasis in quoted material has been added throughout, unless otherwise noted.

IV. Background

A. State of the Art

In a packet-switched network (PSN), data is transmitted and routed in the form of packets, which are processed and forwarded by routers until the packets reach their destination. '775 Patent at 1:30-32. Various prior art techniques existed for routing these packets through the network, including multi-protocol label switching (MPLS). *Id.* at 1:34-36. MPLS works by adding labels to the headers of data packets; these labels contain information the routers can use to determine the next "hop" (*i.e.*

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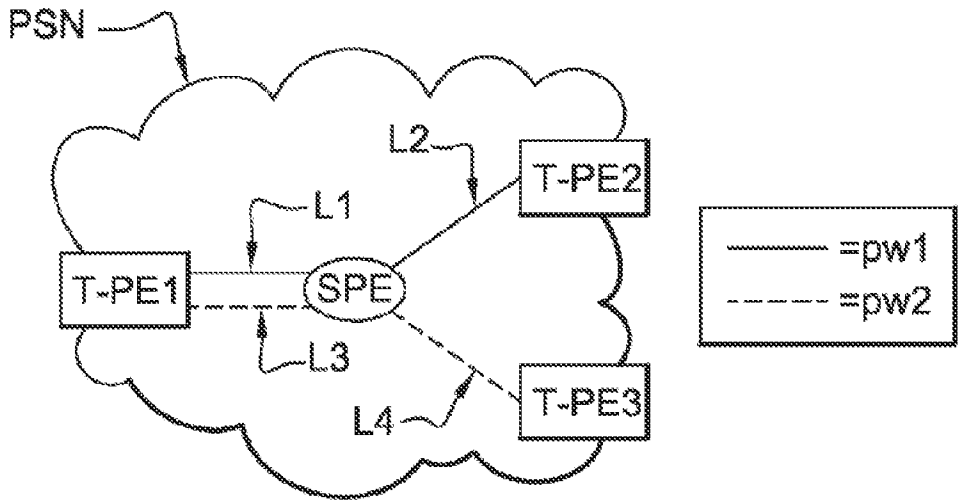
the path to the next router) along which the packet can travel to reach its intended destination. *See id.* at 1:36-39. MPLS is discussed in RFC3031. Ex.1036.

One limitation of MPLS is that it can only route a particular type of data packet: a packet that conforms to the Internet Protocol (IP). '775 Patent at 1:43-44. To address this limitation, the Internet Engineering Task Force (IETF) promulgated RFC3985, which describes a concept known as a "pseudo-wire" or "PW." *Id.* at 1:45-50; Ex.1010. Pseudo-wires have the advantage of allowing non-IP packets (*e.g.* ATM protocol packets) to be transmitted and routed across a packet-switched network. '775 Patent at 1:49-52; *see also* Ex.1010 at 17. Once a pseudo-wire has been set up, it can transmit a data stream across the packet-switched network, from an input router to an output router. '775 Patent at 1:53-2:2; Ex.1010 at 3 ("PWs provide the following functions … [c]arriage of the encapsulated data across a PSN tunnel.").

It was known in the art that a network operator might want to set up two or more pseudo-wires within the same network. *See* '775 Patent at 2:3-27. For example, the operator may wish to set up a second pseudo-wire that acts as a "backup" in case the first pseudo-wire fails. *Id.* An example of this configuration is shown in Figure 2 of the '775 Patent:

'775 Fig. 2 (Prior Art)



In Figure 2, a first pseudo-wire pw1 is set up across the PSN from input router T-PE1 to output router T-PE2. '775 Patent at 2:12-15. This pw1 consists of two links: L1 from input router T-PE1 to intermediate router SPE, and L2 from intermediate router SPE to output router T-PE2. *Id.* at 2:15-20.

In case of a fault affecting pw1 (*e.g.* a fault at link L2 or output router T-PE2), pw1 will cease to function properly, so a "backup" pseudo-wire pw2 is also set up across the PSN to ensure continuity of service. *See id.* at 2:20-23; 2:33-39. This pw2 goes from input router T-PE1 to output router T-PE3, and also consists of two links: L3 from input router T-PE1 to intermediate router SPE, and L4 from intermediate router SPE to output router T-PE3. *Id.* at 2:20-27. In the event of a fault affecting pw1, the PSN can relay a message indicating the fault to T-PE1, which can switch the data stream from pw1 to pw2 to bypass the fault. *Id.* at 2:33-39.

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It was uniformly understood in the prior art that two pseudo-wires would always use different links and would not share any links between them. For example, RFC3985 states that a "PW is characterized as an **unshared link** or circuit of the chosen service." Ex.1010 at 3. Links were not shared even when the two pseudo-wires shared the same connection path between the same two routers; for example even though pw1 and pw2 share the same connection path between T-PE1 and SPE, they use two separate links L1 and L3 to traverse their common connection path. '775 Patent at Fig. 2. The '775 Patent explains that "In the prior art, when a main pseudo-wire and a back-up pseudo-wire are set up between an input router and a first, respectively a second, output router, **a link is set up between the input router and the intermediate router for each pseudo-wire, i.e. two links**. The person skilled in the art has always considered a pseudo-wire as a point-to-point link set up between an input router and an output router, with the result that each input router/output router pair is associated with a pseudo-wire. Moreover, this kind of approach is recommended in the standards." *Id.* at 3:5-14.

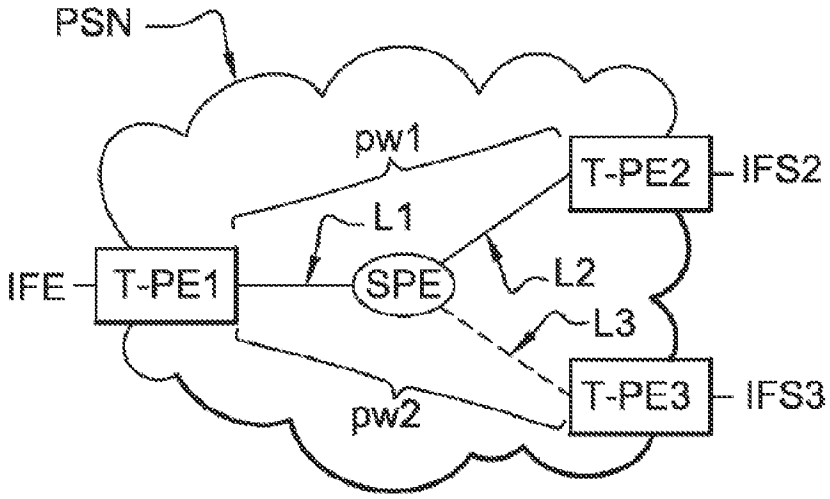
As a result of this view in the prior art that pseudo-wires should use "unshared" links to traverse the PSN, network operators would set up multiple pseudo-wires in a configuration like the one shown in figure 2, in which the pseudo-wires are shaped like the letter "Y" (laying on its side) with a double-lined stem (representing the two unshared links from T-PE1 to SPE).

B. The '775 Patent Invention

The '775 Patent inventors recognized a drawback of the prior art "double-stem Y" approach shown, for example, in Fig. 2: "this kind of solution has the drawback of consuming network resources, for example processing resources in the network equipments (storage capacity, computation capacity, etc.), signaling streams for setting-up two pseudowires, and bandwidth, especially between the input router and the intermediate router." '775 Patent at 2:40-45.

The '775 Patent inventors realized this drawback of the prior art could be avoided with a "single-stem Y" configuration, in which the two pseudo-wires share the same link along their shared connection path. "Going against this received wisdom of the person skilled in the art, the inventors of the present application propose, in contrast, to **share the link** set up between the input router and the intermediate router, which improves the use of network resources … Because the main pseudo-wire and the back-up pseudo-wire **share the link** set up between the input router and the intermediate router, the network resources that in the past were reserved for the back-up pseudo-wire are released and can be used in a manner closer to the optimum." *Id.* at 3:15-29. This novel approach is shown, for example, in '775 Patent Figure 3:

'775 Fig. 3



See also '775 Patent at 6:44-48 ("the first link L1 is shared by the two pseudowires pw1 and pw2. This optimizes the use of network resources, such as bandwidth, between the input router T-PE1 and the intermediate router S-PE, as only one link is set up between these two routers.").

C. Petitioner's References

1. Aggarwal

U.S. Patent No. 7,602,702 to Aggarwal ("**Aggarwal**") bears a purported filing date of February 10, 2005. Ex.1005. Aggarwal is titled "Fast Reroute of Traffic Associated with a Point to Multi-Point Network Tunnel."

Aggarwal teaches "techniques for fast reroute of traffic associated with a point to multi-point (P2MP) tunnel." *Id.* at 1:62-64. The P2MP tunnel is set up using label switched paths, called "branch LSPs," between input and output routers. *Id.* at 2:2-3. These LSPs are set up using MPLS: "By utilizing MPLS, a source device can request a path through a network, i.e., a Label Switched Path (LSP). An LSP defines

a distinct path through the network to carry MPLS packets from the source device to a destination device." *Id.* at 1:34-37.

Aggarwal does not mention or discuss pseudo-wires at all. This makes sense, because Aggarwal is exclusively focused on using MPLS to route IP traffic across IP networks. *See, e.g.*, *id.* at 1:32-34 ("Multi-protocol Label Switching (MPLS) is a mechanism used to engineer traffic patterns within Internet Protocol (IP) networks."). Recall that one of the benefits of pseudo-wires is the ability to route non-IP traffic across a PSN. *See* '775 Patent at 1:49-52; *see also* Ex.1010 at 17. Because of Aggarwal's exclusive focus on IP networks and using MPLS to route IP packets, the inventors of Aggarwal had no reason to consider or discuss pseudo-wires.

Petitioner cites to Aggarwal's Figure 5 embodiment and accompanying description. *See* Ex.1005 at Fig. 5; 6:26-7:56. Figure 5 includes "Branch LSPs" 80 and 82, with Branch LSP 80 taking a path through the network from SPE router 60 to RPE Router 66, and Branch LSP 82 taking a path from SPE router 60 to RPE Router 68. *Id.* at 6:45-47.

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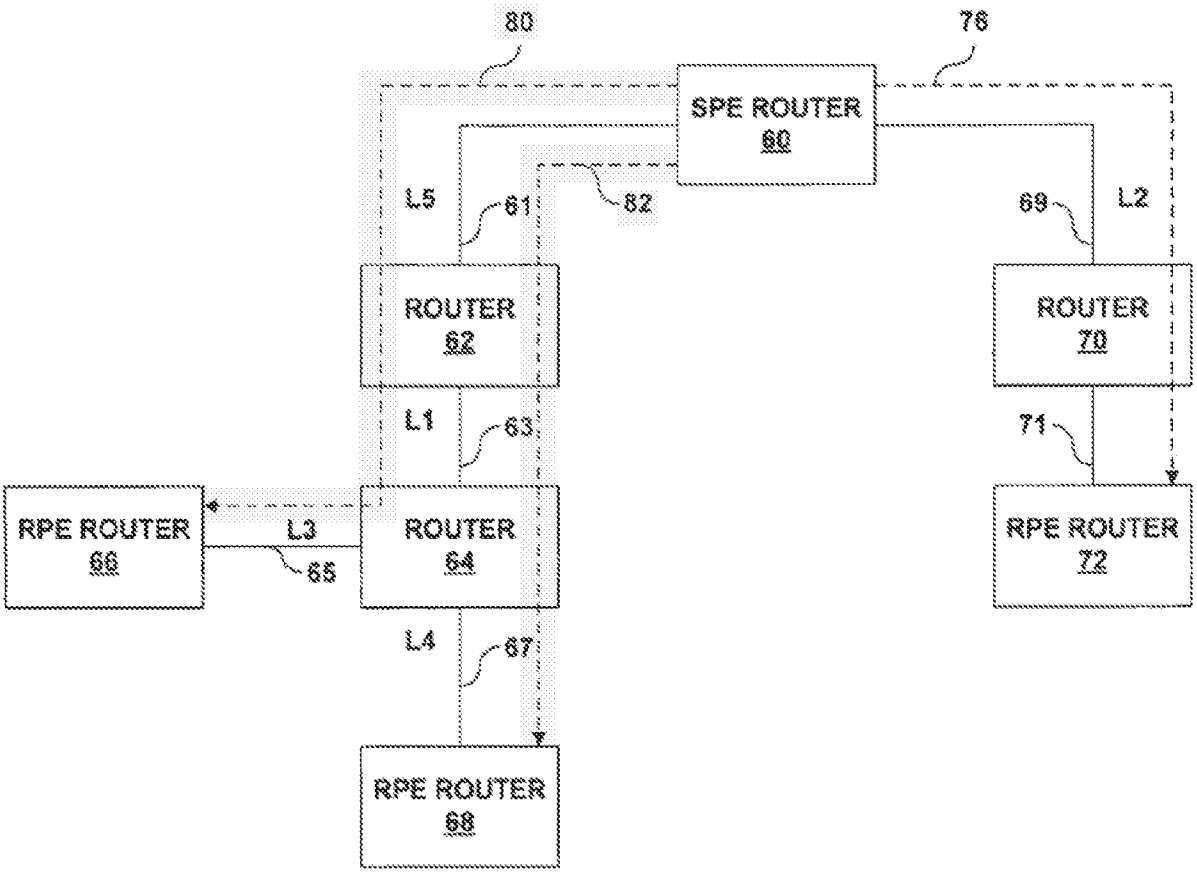

Ex.1005 at Fig. 5 (highlighting added).

Aggarwal Figure 5 shows a "double-stem Y" configuration similar to the prior art depicted in '775 Patent Figure 2. Although Aggarwal's LSPs 80 and 82 share a portion of their connection path (from router 60 to router 64) they do not share any links along that path, as illustrated by the non-overlapping LSPs 80 and 82.

Aggarwal states that "Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60." Ex.1005 at 6:47-49; *see also id.* at 6:40-42 ("These branch LSPs are computed to share the same links where possible as they belong to the same session."). However, as discussed in more detail below, Aggarwal does not

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use the term "link" in the same way as the '775 Patent, and therefore does not teach the shared link "single-stem Y" configuration shown, for example, in '775 Patent Figure 3 and recited in claims 1 and 6. Instead, Aggarwal describes a "link" as follows: "The term 'link' is often used to refer to the connection between two devices on a network. The link may be a physical medium, such as a copper wire, a coaxial cable, any of a host of different fiber optic lines or a wireless connection. In addition, network devices may define 'virtual' or 'logical' links, and map the virtual links to the physical links." Ex.1005 at 1:22-27.

Accordingly, Aggarwal uses the term "link" to mean a connection path, and any two LSPs that share the same connection path are described by Aggarwal as sharing the same "link." This understanding is further confirmed by Aggarwal's repeated conflation of the concept of a "shared link" with a "shared path." *See, e.g.*, *id.* at 7:23-25 ("The next branch LSP may **follow the same path** as the first branch LSP up to a certain branch LSR."); *id.* at 7:50-56 ("When setting a P2MP LSP, a source router has a view of the entire network topology and can accordingly compute the **path** for each P2P LSP **sharing links where possible** with other branch LSPs belonging to the P2MPLSP. This can also be described as a P2MP constrained **shortest path first** (CSPF), where **a path to a destination router is set up as a P2P LSP**.").

In other words, Aggarwal teaches that the two Branch LSPs should be computed to use the "shortest path" through the network, which will typically result in these Branch LSPs sharing a portion of the same connection path between routers in the network (*e.g.* the paths 61 and 63 in Figure 5). This is akin to the prior art shown in Figure 2 of the '775 Patent in which pw1 and pw2 share the same path between the same devices (T-PE1 to SPE) without sharing any links. Aggarwal does not teach a "shared link" as that concept is used in the '775 Patent (*e.g.* the "single-stem Y" configuration of Fig. 3).

2. Hussain

FAULT-TOLERANT IP AND MPLS NETWORKS by Iftekhar Hussain ("**Hussain**") is a textbook. Ex.1006. It was purportedly published by Cisco Press in 2004.

Because Hussain is a textbook, it does not purport to improve upon the state of the art as of its publication date. Instead, Hussain describes how certain network technologies (including pseudo-wires) were understood to operate at that time.

Accordingly, Hussain teaches that a pseudo-wire is "a mechanism that emulates the essential attributes of a service, such as FR, ATM, Ethernet, Time Division Multiplexing [TDM], and SONET/SDH over IP and/or MPLS network." Ex.1006 at 272. Consistent with the prior art teaching of RFC3985 that a "PW is characterized as an **unshared link** or circuit of the chosen service" (Ex.1010 at 3), Hussain's PWs are separate from one another, with PWs distinguished, for example,

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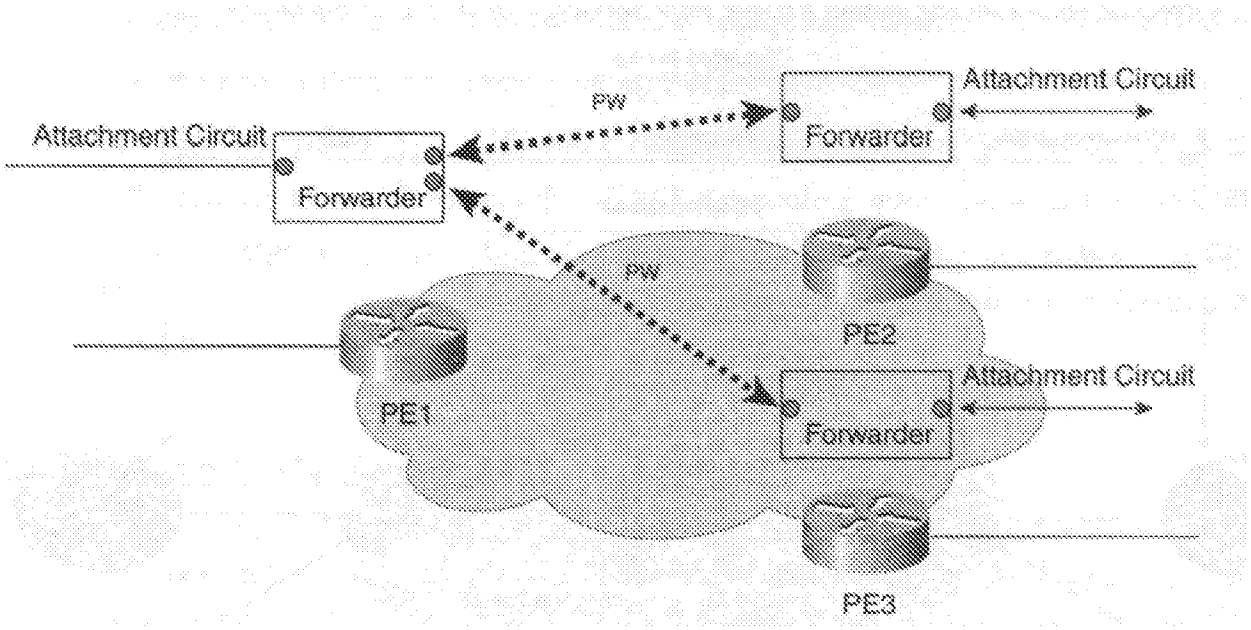
by the use of separate labels. Ex.1006 at 274-75 ("The demultiplexer [is used] to distinguish individual PWs within a single tunnel … the tunnel header and demultiplexer fields are based on MPLS labels.").

Because shared links between pseudo-wires were not known in the prior art, Hussain never discusses or teaches pseudo-wires sharing links. For example, Hussain illustrates two pseudo-wires taking different paths through the network without overlap:



Ex.1006 at 273.

D. The Parallel Proceeding

Patent Owner asserted the '775 Patent against Petitioner Cisco in parallel proceeding *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00115-JRG (E.D. Tex.–Judge Rodney Gilstrap), filed Jan. 21, 2020. Monarch also

asserted three additional patents (not related to the '775 Patent) in that parallel proceeding: U.S. Pat. Nos. 8,451,844; 8,451,845; and 9,019,965.

Monarch and Cisco proposed competing constructions for one '775 Patent claim term in the parallel proceeding: the term "link." The parties' positions regarding that term are discussed in more detail below.

V. Legal Standards

An IPR should not be instituted unless Petitioner has shown a likelihood of success on the invalidity grounds *presented in the petition*. *See In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Cir. 2016) ("[T]he Board must base its decision on arguments that were advanced by a party, and to which the opposing party was given a chance to respond.").

"In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech.*, Inc., 815 F.3d 1356, 1363 (Fed. Cir. 2016) (petitions must identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim"); 35 U.S.C. § 312(a)(3). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

"To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific

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reasoning, based on evidence of record, to support the legal conclusion of obviousness." *In re Magnum Oil Tools Int'l*, 829 F.3d at 1380. The obviousness inquiry requires considering whether one of skill in the art "would have been motivated to combine the prior art to achieve the claimed invention." *In re NuVasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016) (quoting *In re Warsaw Orthopedic, Inc.*, 832 F.3d 1327, 1333 (Fed. Cir. 2016)). "[T]he factual inquiry whether to combine references must be thorough and searching…" *Id.*

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." MPEP § 2143.01 (citing *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959)).

VI. Level of Ordinary Skill in the Art

For purposes of this Preliminary Response, Patent Owner does not contest Petitioner's recitation of the level of skill in the art, because even under Petitioner's proposed level of skill Petitioner has failed to demonstrate a reasonable likelihood of success. Patent Owner reserves the right to propose its own definition of a person of ordinary skill in the art ("POSITA") in the future if necessary.

VII. Claim Construction

Claims are construed according to *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). *See* 37 C.F.R. § 42.100(b). "Any prior claim construction

determination concerning a term of the claim in a civil action…will be considered." *Id.*

Petitioner did not propose any claim constructions in this IPR. However, in the parallel proceeding, Petitioner and Patent Owner proposed competing claim constructions for the term "link," and the Court issued a preliminary construction, as follows:

Term[2]	Patent Owner Monarch's Proposal	Petitioner Cisco's Proposal	Court's Preliminary Construction[3]
"link" (cls. 1, 6)	"a connection between an interface on a first device and an interface on a second device"	"part of a pseudo-wire (*i.e.*, a segment) with its own label that is used when broadcasting data streams"	"connection between an interface of a first router and an interface of a second router"

See Ex.2002 at 9-10 (Monarch's proposed construction); Ex.2003 at 12 (Cisco's proposed construction); Ex.2004 at 1 (court's preliminary construction).

Because the meaning of the term "link" is disputed by Petitioner in the parallel proceeding and is relevant to the issues presented in this IPR, the Board

[2] The parties originally proposed construing the larger phrase "link set up" but later agreed to construe only the term "link." Their proposed constructions did not change.

[3] The Court's preliminary construction substitutes the word "device" in Monarch's construction for the word "router." For purposes of this IPR, these two constructions are equivalent because the devices in Aggarwal and Hussain are routers.

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should construe this term. Patent Owner respectfully requests that the Board follow the guidance provided by the district court and construe the term "link" to mean "a connection between an interface on a first router and an interface on a second router."

Patent Owner's proposed construction (and the court's preliminary construction) of the term "link" in the parallel proceeding—a "connection between an interface of a first router and an interface of a second router"—is the correct construction and should be adopted by the Board. Under this construction of "link," and as explained in more detail below, the Petition should be denied because Petitioner has not shown that the combination of Aggarwal and Hussain discloses a "link."

However, even under the construction advanced by Petitioner in the parallel district court proceeding, the Petition should still be denied because Petitioner has not shown that the combination of Aggarwal and Hussain discloses a "link" under that construction either.

Accordingly, irrespective of which construction the Board adopts, the Petition should be denied.

It is also noteworthy that Petitioner did not notify the Board of either party's "link" claim construction positions in the parallel proceeding, nor did Petitioner notify the Board of the Court's preliminary construction of this term. "Parties and individuals involved in the proceeding have a duty of candor and good faith to the

Office during the course of a proceeding." 37 C.F.R. § 42.11; *see also* 37 C.F.R. § 42.51(b)(1)(iii) ("a party must serve relevant information that is inconsistent with a position advanced by the party during the proceeding"). In particular, as shown below, Petitioner Cisco's own proposed claim construction of "link" in the parallel proceeding is inconsistent with Cisco's positions in the Petition. Cisco had a duty of candor to notify the Board about its inconsistent position in the parallel proceeding, but did not.

A. The Proper Construction of "Link"

The parties' arguments about the proper construction of the term "link" are elaborated in the attached claim construction briefing from the parallel proceeding. Ex.2005 at 15-17; Ex.2006 at 15-17; Ex.2007 at 5-6. Patent Owner summarizes its position as follows:

To minimize the duplicative nature of setting up and reserving processing resources along two different routing paths through the packet-switched network, the '775 Patent introduces the concept that two pseudo-wires can share a "link." This is required by all asserted claims, and an example is shown by comparing the prior art approach of Figure 2 with the disclosed solution provided in Figure 3:

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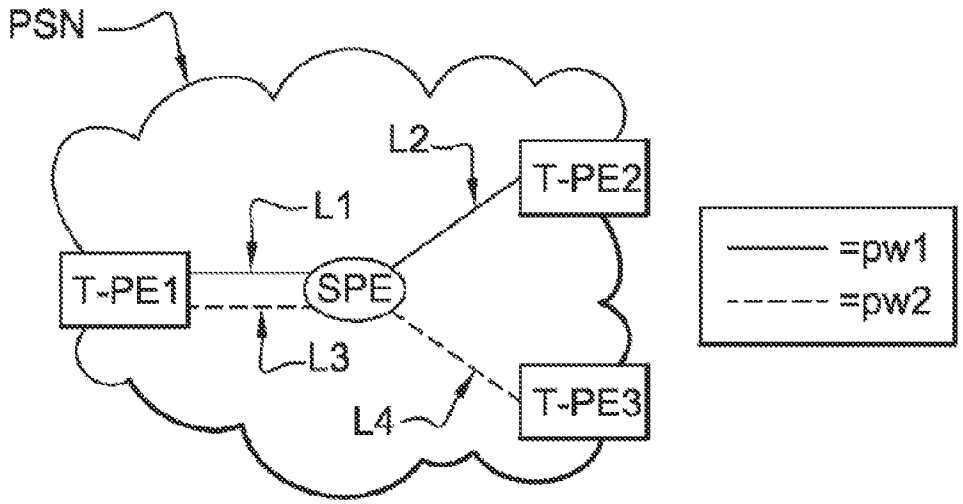
'775 Fig. 2 (Prior Art)



'775 Fig. 3

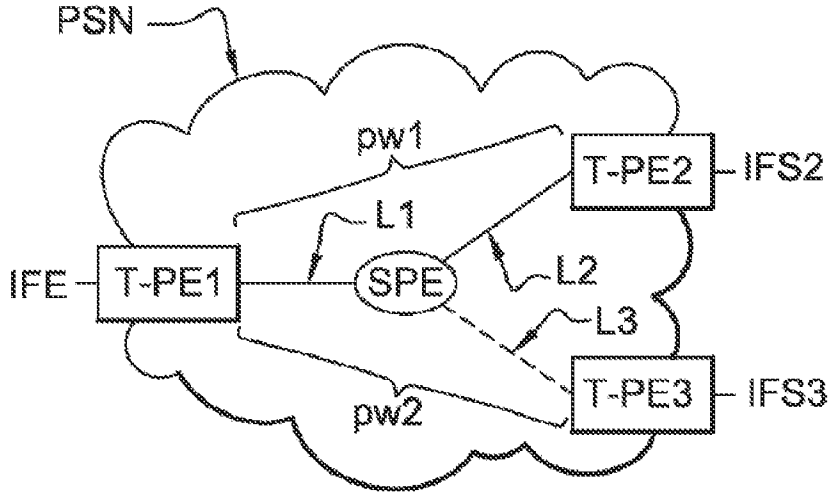


Figure 2 illustrates the prior art approach in which two pseudo-wires (pw1 and pw2) share a portion of their connection paths (the path from T-PE1 to SPE) but do not share any "links" because each pseudo-wire reserves its own separate link to traverse the shared path (links L1 and L3, respectively). *See* Ex.1001 at 2:12-39. This prior art approach has the drawback of consuming additional network resources

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to set up and maintain two separate links along the same path. *Id.* at 2:40-47. Figure 3 shows the '775 solution—instead of using two links along the shared path from T-PE1 to SPE, the two pseudo-wires instead share a single link (L1) along this path. *Id.* at 6:44-48. This solution optimizes the use of network resources by allowing the two pseudo-wires to share a link along their routing paths. *Id.* As Figures 2 and 3 show, a shared path is not necessarily the same thing as a shared link, and the same two routers can support multiple links between them (*e.g.* L1 and L3 in Fig. 2). Accordingly, it is important to give the term "link" a precise and clear meaning.

The specification gives examples that show the endpoints of a link each terminate on a particular interface on a device: "The packets sent to the first output router T-PE2 are directed to the **interface if2** of the intermediate router S-PE**. This interface if2 constitutes a first end of the link L2**." *Id.* at 8:5-8; *see also id.* at 6:60-7:2 ("the pseudowires pw1 and pw2 are set up at the initiative of the input router T-PE1 and setting them up is based on the exchange of set-up messages … [the] first set-up message includes an identifier SAII of the input router T-PE1 [and] **an identifier of an input interface IFE** associated with an equipment connected to the input router."). These examples show that in order to set up a link, one must identify both the device (*e.g.* SPE or T-PE1) and the particular interface (e.g. if2 or IFE) where the link will terminate on that device. As these examples show, a link is "a

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connection between an interface of a first router and an interface of a second router," and not merely any connection between two devices.

This plain meaning of "link" is supported by extrinsic evidence, such as IETF RFC4204, which defines "data link" as follows: "A data link is a pair of interfaces that are used to transfer user data." Ex.2008 at 5; *see also id.* at 6 ("Port: An interface that terminates a data link.").

Cisco stated in its Responsive Claim Construction Brief in the parallel litigation: "The Court should reject Monarch's proposed construction because although **it is descriptive of a data link, in general**, it is not definitional regarding the types of links claimed in the '775 Patent. … So although **Cisco does not object to the concept of interfaces in the Court's construction**, the Court should not omit the critical aspects of Cisco's proposal that provide definition and come from the intrinsic record." Ex. 2006 at 17. In the quoted passage, Cisco told the district court that it believes additional limitations should be added to Monarch's construction because of allegedly "definitional" statements in the intrinsic record. However, Cisco also told the district court that both parties agree the proper construction of "link" should include "the concept of interfaces" even though Patent Owner and Petitioner disagree about other aspects of the construction.

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Cisco's proposed construction attempts to re-define a "link" as a "segment." But the term "segment" has a different meaning from the term "link" to one skilled in the art. Nothing in the specification equates a "link" with a "segment."

The only use of the term "segment" in the '775 Patent specification appears in citations to a prior art document titled "An Architecture for Multi-Segment Pseudo-Wire Emulation Edge-to-Edge." *See, e.g.*, '775 Patent at 2:1-2. Cisco cited this document as extrinsic evidence in the parallel proceeding in support of its proposed construction. This document defines a "PW [pseuo-wire] Segment" as "A part of a single-segment or multi-segment PW, which is set up between two PE [provider edge] devices, T-PEs and/or S-PEs." Ex.2009 at 6. In other words, this document says that a "segment" connects two "provider edge" devices, which are devices located at the edge of the network. For example, in figures 2 and 3, these would be the devices labeled T-PE1, T-PE2, and T-PE3, located at the edges of network labeled "PSN" (packet switched network). This extrinsic document further confirms this meaning of "segment" when it says "[s]cenarios are discussed where each **segment** of a given **edge-to-edge** emulated service **spans** a different provider's **PSN** [packet switched network]." *Id.* at 2.

Thus a "segment" is different from a "link" as shown in Figures 2 and 3. The links in these figures (*e.g.* L1) do not "span" the entire PSN network from "edge-to-edge." Rather, links such as L1 span only part of the PSN (*e.g.* from T-PE1 to SPE)

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and do not go all the way from edge to edge. Cisco's proposed "segment" construction therefore contradicts Figures 2 and 3.

Cisco's proposed requirement that each link has "its own label" also unduly limits this term to a preferred embodiment. The '775 teaches embodiments in which each link is assigned a label (*e.g.*, '775 Patent at 7:25-26), but further teaches that the link can carry multiple different labels: "On reception of a data packet sent by the input router T-PE1, the intermediate router S-PE uses the label added to the packet by the input router to determine to which output interface if2, if3 to direct the data packet." *Id.* at 8:1-5. Accordingly, a packet traveling along link L1 from T-PE1 to SPE can have one of at least two different labels, indicating which of two interfaces (if2 or if3) the data packet should be directed to so it can be routed to the next link (L2 or L3). Thus, if Cisco's construction requires each link to have a single label, it would improperly exclude this embodiment, in which link L1 can carry at least two different labels.

B. Cisco's Petition Fails Under the Proper Construction of "Link"

Cisco's Petition fails to show a reasonable likelihood of success under Patent Owner's proposed construction, which has been adopted by the district court in its tentative Order. As discussed above, both parties agree the proper construction of "link" should include "the concept of interfaces." However, Cisco's Petition does not discuss interfaces at all. The word "interface" does not appear anywhere in

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Cisco's arguments in the Petition or the corresponding portions of the Declaration.[4] Thus, Petitioner cannot meet its burden to show that the prior art discloses a "link" that is a "connection between an interface of a first router and an interface of a second router" because Petitioner never attempts to show that the "interface" limitations are met in its Petition. The Petition thus is fundamentally deficient.

Aggarwal does not disclose a "link" as "a connection between an interface on a first router and an interface on a second router." Instead, Aggarwal defines "link" differently: "The term 'link' is often used to refer to the connection between two devices on a network." Ex.1005 at 1:22-27. This definition does not include the concept of interfaces. Instead, under the Aggarwal definition, two links that use different interfaces but that share the same physical path (*i.e.* the same "connection between two devices on a network") would be considered one link. For example, under the Aggarwal definition of "link," the two separate links L1 and L3 shown in

[4] The word "interface" appears exactly once in Cisco's Petition because this word is part of the title of Ex. 1020. Pet. at 5. The petition never discusses or presents any arguments about interfaces. The term "interface" appears exactly three times in the Declaration of Henry Houh, once when citing Ex. 1020, and twice in his "Qualifications and Professional Experience" section. Ex. 1003 at 5, 6, 9. He offers no opinions about "interfaces" when discussing the alleged prior art or Ground 1.

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Figure 2 of the '775 Patent would be considered one link because they share the same physical path between T-PE1 and SPE, *i.e.* they share the same "connection between two devices on a network." Accordingly, Aggarwal's definition of link is different from the narrower meaning of "link" in the '775 Patent. Aggarwal's definition would result in the '775 claims reading on prior art configurations such as Fig. 2 (with two links using different interfaces to traverse the same path). But that definition does not disclose the shared link configuration of Fig. 3, in which a shared link is defined by shared interfaces rather than merely a shared path. *See* Ex.1001 at 8:5-8; *see also id.* at 6:60-7:2.

Hussain similarly fails to disclose a "link" as a "a connection between an interface on a first router and an interface on a second router." Hussain does not define what it means when it uses the term "link." But Hussain includes the following statement: "A VPN tunnel is a **logical link** between two devices such as PE routers that carries customer traffic across the backbone." Ex.1006 at 255 (emphasis added). This description does not mention interfaces, and in fact Hussain never describes a link as being related to interfaces in any way. Accordingly, Petitioner has not shown, and cannot show, that Hussain discloses this limitation.

C. Cisco's Petition Fails Under Petitioner's Own Construction of "Link"

The situation is even worse for Petitioner if the Board adopts Petitioner's proposed construction of "link" from the parallel proceeding—"part of a pseudo-

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wire (*i.e.*, a segment) with its own label that is used when broadcasting data streams." Petitioner told the district court: "The Court should reject Monarch's proposed construction because … it is not **definitional regarding the types of links claimed in the '775 Patent**. … the Court should not omit the **critical aspects of Cisco's proposal** that provide definition and come from the intrinsic record." Ex. 2006 at 17. Yet the Petition and Declaration never mention this allegedly "critical" and "definitional" proposed claim construction, nor does the Petition attempt to show it is satisfied.

Aggarwal's "link" definition, cited above, does not include any of the limitations recited in Cisco's proposed construction. Ex.1005 at 1:22-27. Aggarwal's links cannot possibly be "part of a pseudo-wire (*i.e.*, a segment)" because the words "pseudo-wire" and "segment" do not appear anywhere in Aggarwal. Moreover, the structure that Petitioner identifies as the "first link" in Aggarwal does not have "its own label" but rather is shown with multiple different labels (L1 and L5) corresponding to different parts of the alleged "first link":

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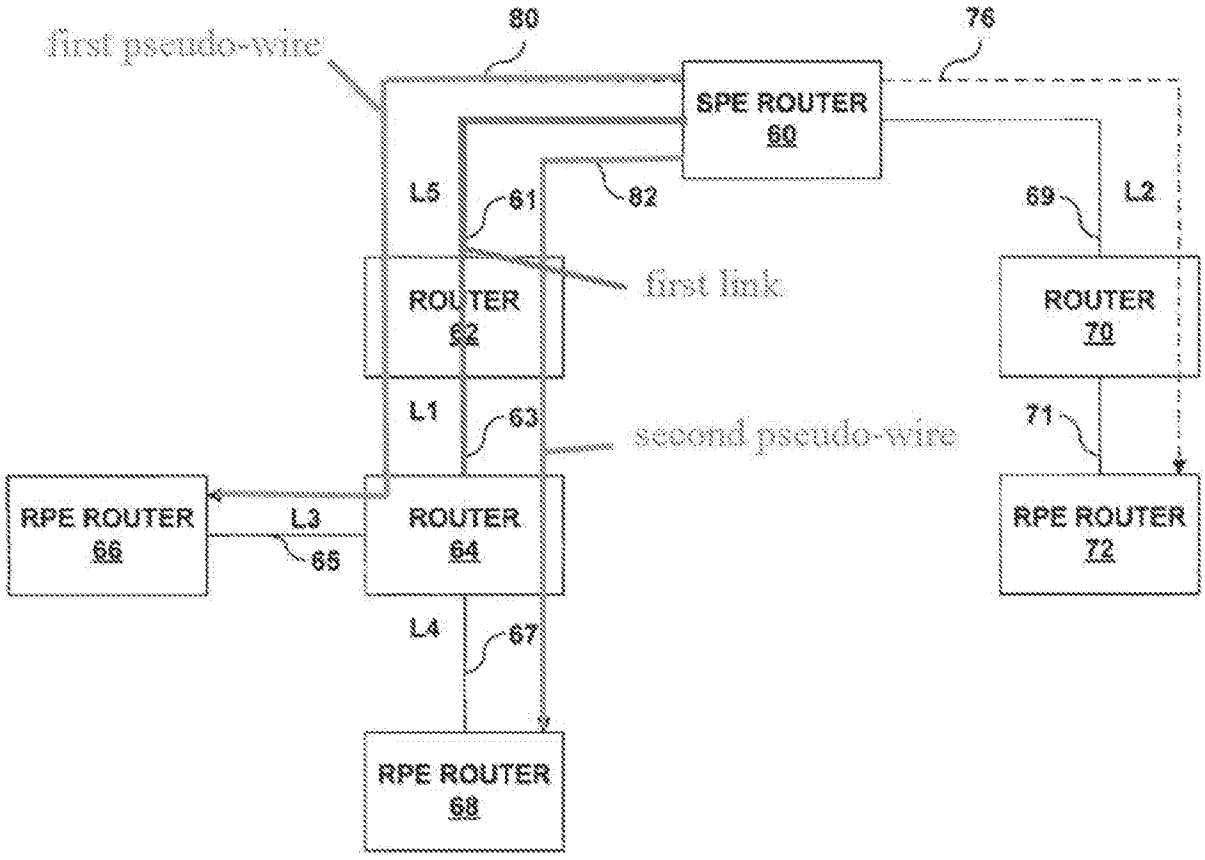

Pet. at 42 (Petitioner's annotations shown); *see also* Ex.1005 at 50-59 (identifying L1 and L5 as different labels set up by different RESV messages). Accordingly, the alleged "links" of Aggarwal do not satisfy the limitations of Petitioner's own proposed construction of "link."

Similarly, Hussain does not disclose the limitations in Cisco's own proposed construction. Hussain states: "A **VPN tunnel** is a **logical link** between two devices such as PE routers that carries customer traffic across the backbone." Ex.1006 at 255 (emphasis added). Hussain further explains that "**PWs [pseudo-wires] correspond to nested LSPs in the PE-to-PE tunnel** in which an individual PW is identified

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based on the MPLS label." Ex.1006 at 273. Thus, Hussain does not say that a "link" is "part of a pseudo-wire" as required by Cisco's construction, but rather says the opposite: Hussain says a tunnel is a type of link, and multiple pseudo-wires are nested inside the tunnel link. In other words, Hussain says a single link comprises multiple pseudo-wires, not that a single pseudo wire comprises multiple links. *Compare* '775 Pat. Cl. 1 ("a first pseudo-wire comprising a first link … and a second link").

Hussain similarly fails to disclose that each link "has its own label." Rather, Hussain says that multiple pseudo-wires are nested inside of a link and "an individual PW is identified based on the MPLS label." Ex.1006 at 273. Thus each link in Hussain carries multiple different labels, with each label corresponding to a different pseudo-wire nested inside that link. *See also id.* at 275 ("The demultiplexer [is used] to distinguish individual PWs within a single tunnel … demultiplexer fields are based on MPLS labels.").

As shown above and as discussed in further detail below under Ground 1, neither Aggarwal, nor Hussain, nor their combination discloses a "link," irrespective of whether the Board adopts Patent Owner's construction or Petitioner's construction of "link" from the parallel litigation. For this reason, the Petition should be denied.

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VIII. Argument

A. Ground 1: No Claims are Obvious based on Aggarwal and Hussain

Petitioner argues that claims 1 and 6 are obvious based on Aggarwal and Hussain. Pet. at 16, 23. Ground 1 is the only ground asserted by Petitioner. Petitioner has not shown a reasonable likelihood of success on the merits with regard to its patentability challenge.

1. Petitioner has not asserted its grounds for invalidity with particularity.

35 U.S.C. § 312(a)(3) requires that the Petitioner identify the grounds for each claim challenged with particularity. Petitioner initially argues that "Claims 1 and 6 are obvious under 35 U.S.C. § 103(a) over Aggarwal and Hussain" Pet. at 23. However, Petitioner also relies on additional grounds, including a POSITA's knowledge. *See, e.g.*, Pet. at 38 ("A POSITA would have found it obvious to implement Aggarwal's branch LSP's as pseudo-wires to improve network efficiency"); *id.* at 43 ("a POSITA would understand that router 62 could be removed (and labels L5 and L1 consolidated into a single label) in the example network in Figure 5 above"). Because it is not clear whether Petitioner's Ground 1 is based solely on Aggarwal and Hussain, or whether it is actually Aggarwal in view of Hussain and in further view of a POSITA's knowledge, Petitioner has failed the particularity requirement that "the petition identifies, in writing and with particularity, each claim challenged, [and] the grounds on which the challenge to

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each claim is based…" Even if Patent Owner could infer what Petitioner's intention was, the Board cannot institute on grounds other than those specifically proposed by Petitioner. *See Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1336 (Fed. Cir. 2020). Thus, Petitioner has failed to show a reasonable likelihood of success for Ground 1.

2. Claim 1

[1.0] ***A method of setting up at least two pseudo-wires able to broadcast a data stream, comprising:***

Cisco presents two different theories about what allegedly discloses the "setting up at least two pseudo-wires" limitations. First, Cisco says that a POSITA would implement Aggarwal's branch LSPs as pseudo-wires. Pet. at 37 ("a POSITA would have found it obvious to implement Aggarwal's branch LSPs as pseudo-wires"). Second, Cisco says that a POSITA would implement Hussain's pseudo-wires *within* Aggarwal's LSPs. *Id.* at 39 ("Alternatively, a POSITA would have found it obvious to implement pseudo-wires *within* Aggarwal's branch LSPs").

As noted above, both of these argument fail because they purport to rely on the knowledge of a POSITA to supply the "setting up at least two pseudo-wires" claim limitation, but Petitioner did not identify the knowledge of a POSITA as a basis for Ground 1. Accordingly, the Petition fails the particularity requirement of 35 U.S.C. § 312(a)(3).

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Additionally, in the context of using a POSITA's knowledge to supply a missing limitation, the Federal Circuit considers whether "'the [missing] limitation in question [is] unusually simple and the technology particularly straightforward.'" *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1338 (Fed. Cir. 2020) (quoting *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1361-62 (Fed. Cir. 2016)). Petitioner and Petitioner's Declarant have provided no evidence or argument that it would have been unusually simple and straightforward "to implement Aggarwal's branch LSPs as pseudo-wires" or "to implement pseudo-wires *within* Aggarwal's branch LSPs." Pet. at 37-39; Ex.1003 at ¶¶ 84-89. Aggarwal does not mention "pseudo-wires" at all, and Hussain does not mention "branch LSPs." As such, it would not have been particularly simple or straightforward to connect these concepts, nor would it have been simple or straightforward to figure out, from the teachings of these references, how to combine them. The fact that Cisco proposes two alternative ways to combine a "pseudo-wire" and a "branch LSP" demonstrates that the combination is not simple or straightforward.

[1.1] ***setting up a first pseudo-wire comprising a first link***

As discussed above in section VII, incorporated by reference here, neither Patent Owner's nor Petitioner's proposed construction of "link" is disclosed by Aggarwal or Hussain or their combination. The Petition does not attempt to show

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that either construction of "link" is met. Accordingly, Petitioner has not shown a reasonable likelihood of success on this limitation.

Cisco improperly relies on the knowledge of a POSITA to supply this limitation. *See, e.g.* Pet. at 42 ("A POSITA implementing the method of setting up the first pseudo-wire would have understood that a link may consist of multiple hops. Therefore, a POSITA would have found it obvious that 'a first link' would extend from SPE router 60 to intermediate router 64."); *id.* at 43 ("To the extent that a link is found to be the connection between pairs of routers that do not include intermediate routers, a POSITA would understand that router 62 could be removed (and labels L5 and L1 consolidated into a single label) in the example network in Figure 5 above."). Petitioner did not identify the knowledge of a POSITA as a basis for Ground 1. Accordingly, the Petition fails the particularity requirement of 35 U.S.C. § 312(a)(3).

Petitioner argues that Aggarwal discloses "a first pseudo-wire comprising a first link" because "Branch LSPs 80 and 82 share links 63 and 61" and "links 61 and 63 either individually or together teach the claimed 'first link.'" Pet at 41. Assuming *arguendo* that Petitioner's statements correctly characterize Aggarwal, Petitioner has at most shown that Aggarwal teaches "a first **branch LSP** comprising a first link" but not "a first **pseudo-wire** comprising a first link" because Aggarwal does not mention pseudo-wires at all.

To supply the pseudo-wire limitation, Petitioner would need to rely on Hussain. But Petitioner does provide any citations to Hussain (Ex.1006) in its analysis of this limitation. Pet at 41-43.

Hussain states that "**multiple PWs** may be **carried in a single tunnel** (which in the case of MPLS is **an LSP**)" and teaches that a "**VPN tunnel is a logical link** between two devices such as PE routers." Ex.1006 at 197, 255. Thus, Hussain teaches that a tunnel is a link, and that multiple PWs may be carried inside a single tunnel link. This means that Hussain does not teach "a first pseudo-wire comprising a first link [… and a second link]" but rather teaches the exact opposite: "a link comprising a pseudo-wire nested inside."[5]

This understanding of Hussain is confirmed by Petitioner's Declarant, who states: "Hussain teaches implementing **pseudo-wires within a PE-to-PE tunnel**… Like Hussain's PE-to-PE tunnel, Aggarwal's **Branch LSPs are tunnels** between edge routers." Ex.1003 at ¶ 75. Thus, assuming *arguendo* that the Declarant's statements are correct, Hussain's pseudo-wires would need to be implemented

[5] As a matter of logic and common sense, "A comprises B" does not mean the same thing as "B comprises A." A face comprises eyes, but eyes do not comprise a face. The human race comprises Tom Hanks, but Tom Hanks does not comprise the human race.

within links 61 and/or 63 of Aggarwal's Branch LSPs, such that links 61 and 63 comprise a pseudo-wire nested inside. But the opposite is required by this claim limitation: "a first pseudo-wire comprising a first link."

Petitioner has not attempted to show how a POSITA would combine Aggarwal and Hussain to arrive at this claim limitation. To do so would "change the principle of operation" of Hussain because Hussain's links comprise pseudo-wires and not the other way around. MPEP § 2143.01.

Accordingly, Petitioner has not shown a reasonable likelihood of prevailing on this limitation.

[1.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

As discussed above in section VII, incorporated by reference here, neither Patent Owner's nor Petitioner's proposed construction of "link" is disclosed by Aggarwal or Hussain or their combination. The Petition does not attempt to show that either construction of "link" is met. Accordingly, Petitioner has not shown a reasonable likelihood of success on this limitation.

[1.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

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Petitioner fails to show a reasonable likelihood of success on this limitation for the same reasons recited above regarding limitation [1.1], which is incorporated by reference here. Those reasons are summarized as follows:

First, Petitioner has not shown that Aggarwal, Hussain, or their combination disclose a "link" under either party's proposed construction of this term.

Second, Petitioner improperly relies on the alleged knowledge of a POSITA. *See, e.g.*, Pet. at 48 ("A POSITA would have recognized that the description of SPE routers and RPE routers in the embodiment of Fig. 1 would have applied to the SPE routers and RPE routers in the embodiment of Fig. 5."). Accordingly, the Petition fails the particularity requirement of 35 U.S.C. § 312(a)(3).

Third, because Aggarwal does not mention pseudo-wires at all, Petitioner would need to rely on Hussain to supply the "pseudo-wire" portion of this limitation, but Petitioner never cites to Hussain (Ex.1006) in its analysis of this limitation. Pet at 46-48.

Fourth, Hussain could not supply this limitation because Hussain teaches that links comprise pseudo-wires, not that pseudo-wires comprise links. *See, e.g.*, Ex.1006 at 197, 255. Further, Petitioner has not attempted to show how a POSITA would combine Aggarwal and Hussain to arrive at this claim limitation. To do so would "change the principle of operation" of Hussain because Hussain's links comprise pseudo-wires and not the other way around. MPEP § 2143.01.

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[1.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

[1.5] ***wherein the second pseudo-wire comprises said first link and***

[1.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

Petitioner fails to show a reasonable likelihood of success on these limitations [1.4], [1.5], and [1.6] for the same reasons recited above regarding limitations [1.1] and [1.3], which are incorporated by reference here. Those reasons are summarized as follows:

First, Petitioner has not shown that Aggarwal, Hussain, or their combination disclose a "link" under either party's proposed construction of this term.

Second, Petitioner improperly relies on the alleged knowledge of a POSITA. *See, e.g.*, Pet. at 49-50 (citing to sections [1.1] and [1.3] in which Petitioner improperly relied on the alleged knowledge of a POSITA). Accordingly, the Petition fails the particularity requirement of 35 U.S.C. § 312(a)(3).

Third, because Aggarwal does not mention pseudo-wires at all, Petitioner would need to rely on Hussain to supply the "pseudo-wire" portion of this limitation, but Petitioner never cites to Hussain (Ex.1006) in its analysis of this limitation. Pet at 48-53.

Fourth, Hussain could not supply this limitation because Hussain teaches that links comprise pseudo-wires, not that pseudo-wires comprise links. *See, e.g.*,

Ex.1006 at 197, 255. Petitioner has not attempted to show how a POSITA would combine Aggarwal and Hussain to arrive at this claim limitation. To do so would "change the principle of operation" of Hussain because Hussain's links comprise pseudo-wires and not the other way around. MPEP § 2143.01.

[1.7] ***said first link being shared by the first and second pseudo-wires.***

As discussed above in section VII, incorporated by reference here, Petitioner has not shown that Aggarwal, Hussain, or their combination disclose a "link" under either party's proposed construction of this term.

Petitioner states that Aggarwal discloses this limitation because "Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60" as shown in Figure 5. Pet. at 53; *see also* Ex.1005, 6:47-49. However, Aggarwal is using the term "share links" differently from the meaning of "link being shared" in the '775 Patent.

As discussed above, the '775 Patent teaches that in the prior art, pseudo-wires might share the same connection path, but would not share links along that path. An example of this is shown in the prior art "double-stem Y" configuration of Fig. 2, in which the same connection path from T-PE1 to SPE is traversed by two different links, L1 and L3.

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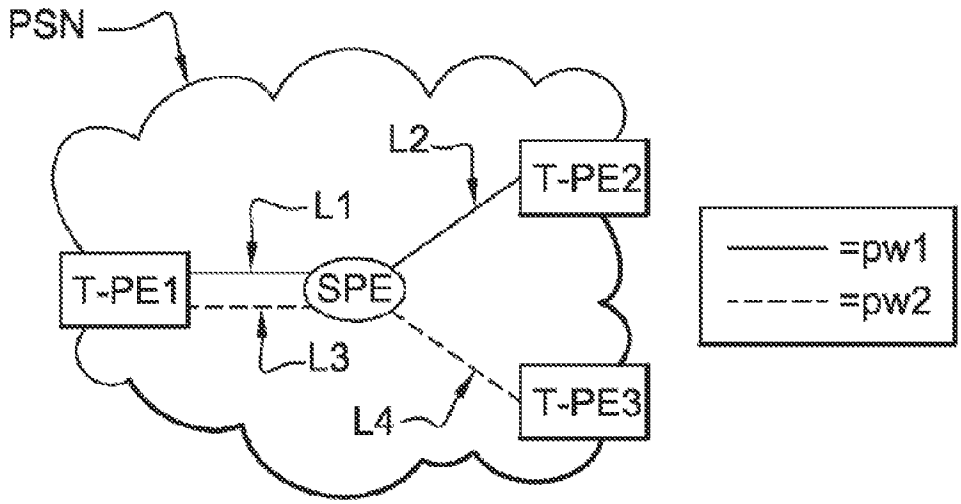
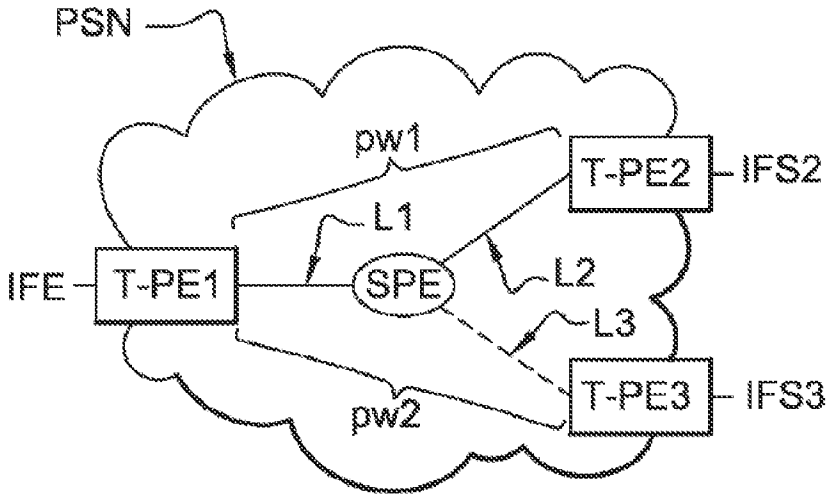
'775 Fig. 2 (Prior Art)



The '775 Patent teaches combining separate links along the shared connection path, thereby using a shared link (with a shared set of interfaces on T-PE1 and SPE). This results in the "single-stem Y" configuration shown for example in Figure 3. Shared link L1 in Figure 3 is an example of a "first link being shared by the first and second pseudo-wires" as required by limitation [1.7]. *See* Ex.1001 at 6:44-45 (In Fig. 3 "the first link L1 is shared by the two pseudo-wires pw1 and pw2"); *see also id.* at 6:60-7:2; 8:5-8.

’775 Fig. 3



Aggarwal explicitly states what it means when it uses the term “link”: “The term ‘link’ is often used to refer to the connection between two devices on a network.” Ex.1005 at 1:22-27.

Aggarwal therefore defines a link broadly as a connection path between two devices. If multiple links share the same connection path between two devices, Aggarwal considers these links to be a single shared “link” because they share the same “connection between two devices.” But, as shown in Figure 2 of the ’775 Patent, this is not what the ’775 Patent means by a “link being shared.” Links L1 and L3 in Figure 2 traverse the same “connection between two devices on a network” but they are nevertheless different links, as taught by the ’775 Patent. *See* ’775 Patent at 2:12-39.

Accordingly, when Aggarwal says that “Branch LSPs 80 and 82 **share links** 63 and 61 between router 64 and SPE router 60,” Aggarwal is referring to a double-

stem Y configuration like the one shown in prior art Fig. 2, in which branch LSPs 80 and 82 share the same physical path or "connection between two devices on a network" but do not actually share any links. *See* Ex.1005, 6:47-49. This is further shown by Aggarwal's conflation of the concept of a "link" and a "path" when describing Figure 5: "When setting a P2MP LSP, a source router has a view of the entire network topology and can accordingly compute the **path** for each P2P LSP **sharing links where possible** with other branch LSPs belonging to the P2MPLSP. This can also be described as a P2MP constrained **shortest path first** (CSPF), where **a path to a destination router is set up as a P2P LSP**." Ex.1005 at 7:50-56; *see also id.* at 7:23-25 ("The next branch LSP may **follow the same path** as the first branch LSP up to a certain branch LSR.").

This double-stem Y configuration is illustrated even more clearly in Petitioner's annotated Figure 5 of Aggarwal:

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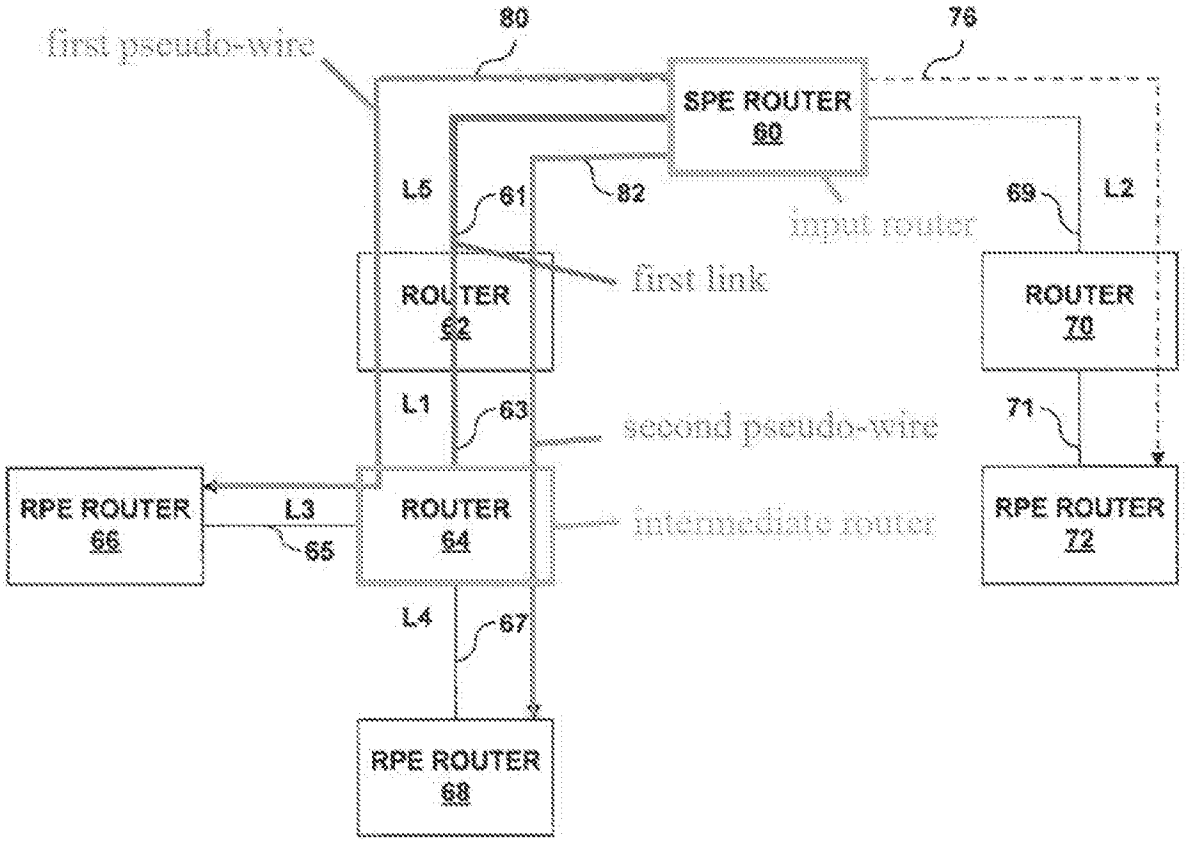

Pet. at 44 (Ex.1005 at Fig. 5 with Petitioner's annotations). Figure 5 shows branch LSPs 80 and 82 (in red) in a double-stem Y configuration like Figure 2 of the '775 Patent. There is no overlap between the two red lines. Aggarwal says Branch LSPs 80 and 82 share "links" because they share the same path along the connections 61 and 63 between devices 60, 62, and 64. This is consistent with Aggarwal's broad definition of a "link" as any "connection between two devices" and is also consistent with Aggarwal's conflation of the terms "link" and "path." But this is akin to '775 Patent Figure 2, in which two separate links L1 and L3 share the same connection path between devices T-PE1 and SPE.

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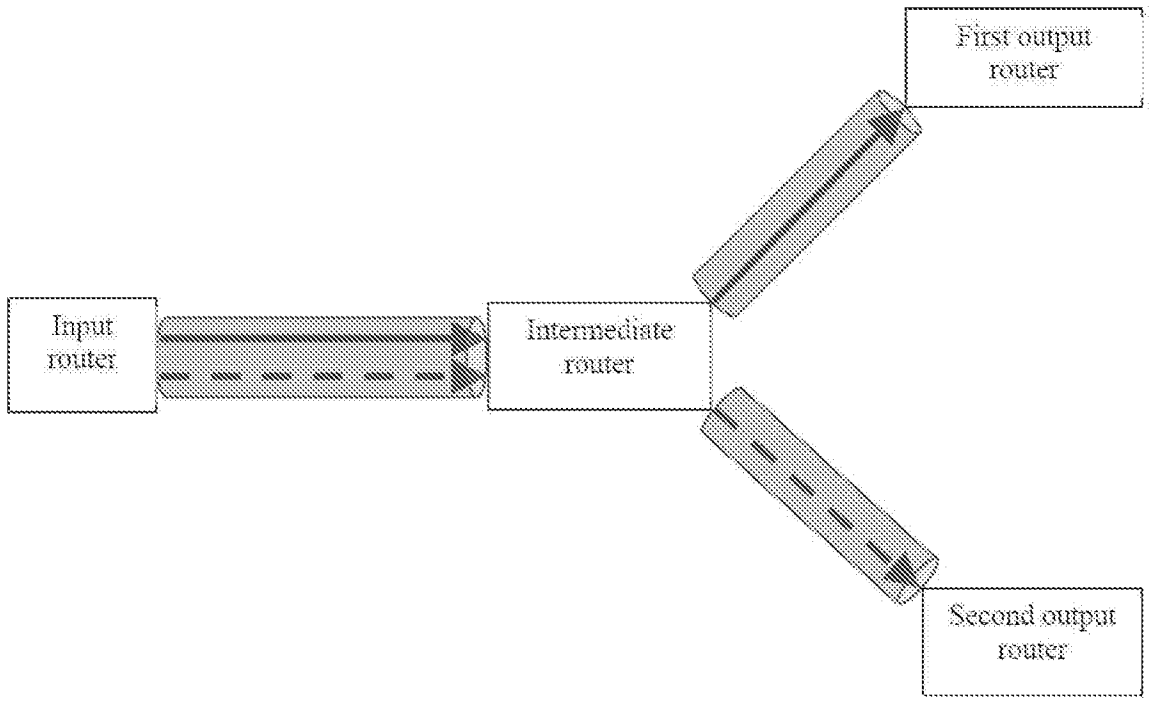
The fact that Aggarwal teaches the prior art double-stem Y configuration is further demonstrated by the admissions of Petitioner's Declarant. He states that "Aggarwal discusses taking 'advantage of a LSP hierarchy [LSP-HIER] while building P2MP LSPs.'… The figure created below illustrates a P2MP LSP tunnel with the branch LSPs from the figure above nested inside the tunnel." Ex.1003 at ¶ 83. The Declarant then provides the following figure which purports to show how Aggarwal's Branch LSPs are configured:



Ex.1003 at ¶ 83 (figure prepared by Petitioner's Declarant); *see also id.* at ¶ 82.

The Declarant's figure clearly shows Aggarwal's Branch LSPs in a double-stem Y configuration, just like Aggarwal's Figure 5 and the '775 Patent's prior art Figure 2. There is no overlap or "first link being shared" by the two Branch LSPs.

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Instead, the two Branch LSPs use different links to get from the Input Router to the Intermediate Router, even though they share the same connection path between those routers.

Accordingly, Aggarwal does not teach a "first link being shared" by Aggarwal's Branch LSPs. As discussed above, Petitioner argues that a POSITA would have known to "implement Aggarwal's branch LSPs as pseudo-wires" or "implement pseudo-wires *within* Aggarwal's branch LSPs." Pet. at 37-39. Assuming *arguendo* that such a combination is possible, the combination would not include a "first link being shared by the first and second pseudo-wires" because the pseudo-wires would use the same double-stem Y configuration as Aggarwal's Branch LSPs, and therefore would not share any links.

Accordingly, Petitioner has not shown a reasonable likelihood of prevailing on this limitation.

3. Claim 6

[6.0] ***A computer program product stored on a non-transitory computer-readable medium and comprising program code instructions for implementing a method of setting up at least two pseudo-wires able to broadcast a data stream when said program is executed by a computer, the program code instructions comprising instructions for:***

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Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.0], incorporated here by reference.

[6.1] ***setting up a first pseudo-wire comprising a first link***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.1], incorporated here by reference.

[6.2] ***[a first link] set up between an input router of a packet-switched network and an intermediate router of the packet-switched network and***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.2], incorporated here by reference.

[6.3] ***[a first pseudo-wire comprising . . .] a second link set up between said intermediate router and a first output router of the packet-switched network; and***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.3], incorporated here by reference.

[6.4] ***setting up a second pseudo-wire between said input router and a second output router of the packet-switched network,***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.4], incorporated here by reference.

[6.5] ***wherein the second pseudo-wire comprises said first link and***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.5], incorporated here by reference.

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[6.6] ***[wherein the second pseudo-wire comprises . . .] a third link set up between said intermediate router and said second output router,***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.6], incorporated here by reference.

[6.7] ***said first link being shared by the first and second pseudo-wires.***

Petitioner has not shown a reasonable likelihood of success on this limitation for the same reasons discussed in [1.7], incorporated here by reference.

B. The Board should deny institution under § 314(a)

Patent Owner asserted the '775 Patent against Petitioner Cisco in the parallel proceeding *Monarch Networking Solutions LLC v. Cisco Systems Inc.*, No. 2:20-cv-00015-JRG (E.D. Tex.–Judge Rodney Gilstrap), filed Jan. 21, 2020. Given the advanced state of that litigation, which addresses the same issues raised in the instant Petition, the Board should deny institution because it would be an inefficient duplication of ongoing litigation. Under § 314(a), the Director has discretion to deny institution. *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2140 (2016).

The Board considers the presence and status of parallel district court litigation in determining whether to deny institution. *See NHK Spring Co. Ltd. v. Intri-Plex Techs. Inc.*, IPR2018-00752, Paper 8 at 20 (P.T.A.B. Sept. 12, 2018) (precedential); *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 15 (P.T.A.B. May 13, 2020); *see also General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-

01357, Paper 19 at 16-17 (P.T.A.B. Sept. 6, 2017) ("[W]e recognize that an objective of the AIA is to provide an effective and efficient alternative to district court litigation . . . ."). *Fintiv* "sets forth factors that balance considerations of system efficiency, fairness, and patent quality when a patent owner raises an argument for discretionary denial due to the advanced state of a parallel proceeding." *Apple*, IPR2020-00019, Paper 15 at 7 (citing *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 5-6 (P.T.A.B. Mar. 20, 2020) (precedential)). The factors are:

1. whether the court granted a stay or evidence exists that one may be granted if a proceeding is instituted;
2. proximity of the court's trial date to the Board's projected statutory deadline for a final written decision;
3. investment in the parallel proceeding by the court and the parties;
4. overlap between issues raised in the petition and in the parallel proceeding;
5. whether the petitioner and the defendant in the parallel proceeding are the same party; and
6. other circumstances that impact the Board's exercise of discretion, including the merits.

Id. These factors favor a discretionary denial under § 314(a).

Factor 1: The parallel proceeding is ongoing in front of Judge Gilstrap in the Eastern District of Texas. "District courts [in EDTX] typically consider three factors when determining whether to grant a stay pending inter partes review of a patent in suit: (1) whether the stay will unduly prejudice the nonmoving party, (2) whether the proceedings before the court have reached an advanced stage, including whether discovery is complete and a trial date has been set, and (3) whether the stay will

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likely result in simplifying the case before the court." *Solas OLED Ltd. v. Samsung Display Co.*, No. 2:19-CV-00152-JRG, 2020 U.S. Dist. LEXIS 125973, at *3 (E.D. Tex. July 17, 2020). Based on these factors, it is unlikely that Judge Gilstrap would grant a stay in the parallel proceeding.

First, a stay would unduly prejudice Monarch. Monarch's Preliminary Response deadline is December 8, 2020. If an institution decision issues three months after that date (*see* 35 U.S.C. § 314(b)), it would be March 8, 2021 before the parties know whether institution will occur. By that point, both fact and expert discovery will be completed, meaning that Monarch will have already incurred the majority of expenses associated with the litigation—which Judge Gilstrap has previously found to be a sufficient showing of prejudice. *See Solas*, 2020 U.S. Dist. LEXIS 125973, at *4-6.

At the request of the parties, the District Court recently issued an amended Docket Control Order extending all remaining case deadlines by approximately 30 days. *See* Ex.2010. Thus, fact discovery closes on January 14, 2021, and expert discovery concludes by February 19, 2021. *See id.* at 3. Even after amendment of the Docket Control Order, these dates occur well before the likely date for an institution decision, and expenses relating to fact and expert discovery already will have been incurred by the parties.

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Second, by the time of an institution decision the parallel proceeding will have reached an advanced stage. As noted above, all discovery will be completed by approximately February 19, 2021. Jury Selection is scheduled for early June 7, 2021. *See* Ex.2010 at 1. Judge Gilstrap has held that even when a party is diligent about filing an IPR, if claim construction has been completed and all discovery is closed, then the factor still favors denial of a stay. *See Solas*, 2020 U.S. Dist. LEXIS 125973, at *6-7.

Third, any simplification of issues would be minimal, because four patents and twenty-nine claims are asserted in the parallel proceeding. Of those twenty-nine asserted claims, only two claims are asserted from the '775 Patent. Even if this proceeding would slightly simplify issues for trial, Judge Gilstrap has held that factor alone does not outweigh the prejudice to the non-moving party and the advanced stage of the proceeding. *See Solas*, 2020 U.S. Dist. LEXIS 125973, at *7-9. Thus, it is unlikely that a stay would be granted if institution occurred, and this factor favors denial.

Factor 2: Trial is scheduled to start on June 7, 2021. Ex.2010 at 1. If the Board reaches its institution decision within three months of receiving the preliminary response, 35 U.S.C. § 314(b), and issues a final written decision within 1 year of institution, 35 U.S.C. § 316(a)(11), a final written decision would likely issue in March 2022—well after the likely conclusion of the litigation in June 2021. This

factor favors denial, even if the trial date is further extended as Petitioner hypothesizes.[6]

Factor 3: For the same reasons discussed above, this factor also favors denial. By the time the institution decision issues, the parties likely will have received the Court's claim construction order, completed discovery, and filed all dispositive motions. Both the Court and the parties have already made significant investments in the litigation, and most pretrial matters likely will be disposed of before any decision on institution issues. Thus, this factor favors denial.

Factor 4: As Petitioner concedes, Petitioner asserted the exact same invalidity grounds in the parallel proceeding. Pet. at 21. Petitioner further explains that it plans to withdraw the overlapping grounds from the district court litigation only if the Petition is instituted, *see id.*, which means the parties will continue to litigate the asserted grounds in the parallel proceeding at least through the submission of expert

[6] Petitioner cites two cases for the proposition that the Board declines to guess whether a district court will grant a stay. *See* Pet. at 30 (citing *Intel Corp. v. VLSI Tech. LLC*, IPR2020-00158, Paper 16, at 7 (PTAB May 20, 2020) and *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 15, at 12 (PTAB May 13, 2020)). Applying that same rationale, the Board should likewise decline to guess whether a court will modify the trial date for a co-pending litigation.

reports and dispositive motions—creating significant overlap between the proceedings. Because of this significant overlap, this factor weighs in favor of discretionary denial.

Factor 5: Petitioner is the Defendant in the parallel litigation. This factor favors denial.

Factor 6: As discussed above, the merits of this Petition are particularly weak. In particular, Petitioner has not shown that Aggarwal or Hussain, alone or in combination, disclose a "link" or a "link being shared" within the meaning of the '775 Patent claims. Therefore, this factor favors denial.

On balance, the *Fintiv* factors favor discretionary denial because costly litigation discovery will be complete approximately one month from the filing of this Preliminary Response.

IX. Conclusion

PO respectfully requests that the Board refuse to institute *inter partes* review for the reasons stated herein.

Dated: December 8, 2020

Respectfully submitted,

By: */Michael F. Heim/*
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CERTIFICATE OF SERVICE

The undersigned certifies that pursuant to 37 C.F.R. § 42.6(e), a copy of the foregoing PATENT OWNER'S PRELIMINARY RESPONSE UNDER 37 C.F.R. § 42.107 TO PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 8,130,775 was served via email to lead and backup counsel of record for Petitioners as follows:

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Dated: December 8, 2020

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned hereby certifies that this brief complies with the type-volume limitation of 37 C.F.R. § 42.24 because this brief contains 10,219 words.

Dated: December 8, 2020

Respectfully submitted,

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Exhibit 1034

U.S. Patent No. 7,369,556 to Rekhter, et al.

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US007369556B1

(12) **United States Patent**
Rekhter et al.

(10) **Patent No.: US 7,369,556 B1**
(45) **Date of Patent: May 6, 2008**

(54) **ROUTER FOR VIRTUAL PRIVATE NETWORK EMPLOYING TAG SWITCHING**

(75) Inventors: **Yakov Rekhter**, New Rochelle, NY (US); **Eric C. Rosen**, Arlington, MA (US)

(73) Assignee: **Cisco Technology, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 979 days.

(21) Appl. No.: **10/302,201**

(22) Filed: **Nov. 22, 2002**

Related U.S. Application Data

(63) Continuation of application No. 09/217,976, filed on Dec. 21, 1998, now Pat. No. 6,526,056, which is a continuation of application No. 08/997,343, filed on Dec. 23, 1997, now Pat. No. 6,339,595.

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/392**; 370/400; 370/410

(58) **Field of Classification Search** ..... None
See application file for complete search history.

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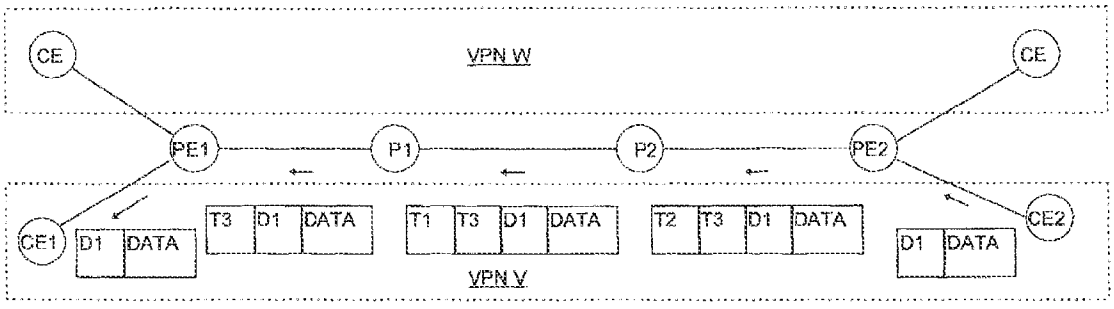
(Continued)

Primary Examiner—Andrew C. Lee
(74) *Attorney, Agent, or Firm*—Cesari and McKenna LLP

(57) **ABSTRACT**

A service provider's routers (PE1, P1, P2, PE2) provide connections between and share routing information with routers (CE1, CE2) of a customer virtual private network (VPN) as well as routers of other customers' VPNs, which may have overlapping address spaces. A service provider's edge router (PE1) informed by the customer's router (CE1) that it will forward packets to a given prefix notifies the other edge router (PE2) that PE1 can forward packets to that address prefix if the destination is in the VPN to which CE1 belongs. PE1 also tells PE2 to tag any thus-destined packets with a particular tag T3. PE2 stores this information in a forwarding information base that it separately keeps for that VPN so that when PE2 receives from a router CE2 in the same VPN a packet whose destination address has that prefix, it tags the packet as requested. But PE2 also tags it with a tag T2 that the router P2 to which PE2 first sends it has asked PE2 to apply to packets to be sent to PE1. P2 routes the packet in accordance with T2, sending it to P1 after replacing T2 with a tag T1 that P1 has similarly asked P2 to use. P1 removes T1 from the packet and forwards it in accordance with T1 to PE1, which in turn removes T3 from the packet and forwards it in accordance with T3 to CE1. In this manner, only the edge routers need to maintain separate routing information for separate VPNs.

27 Claims, 24 Drawing Sheets



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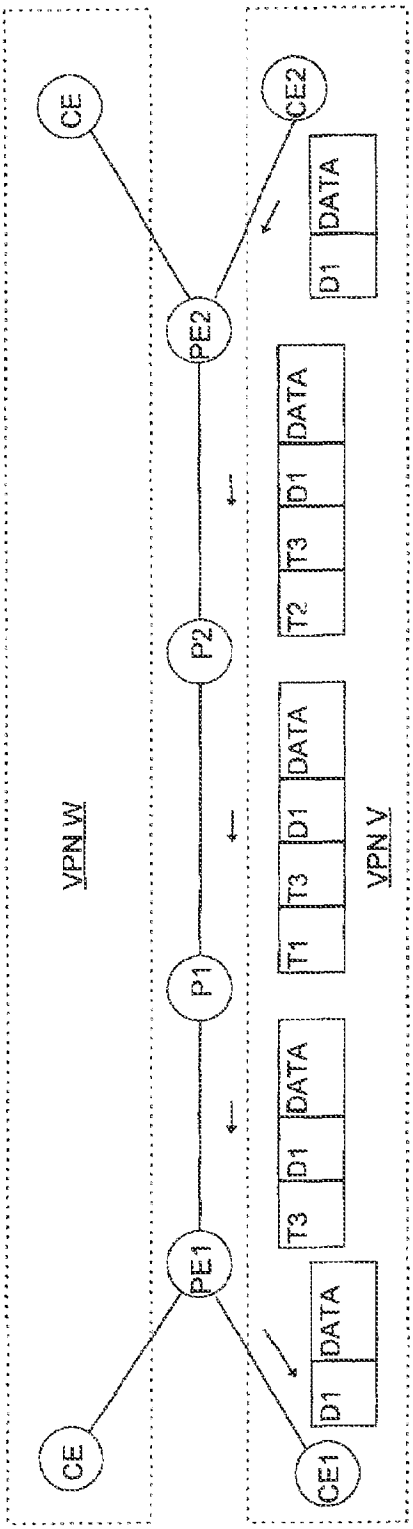

VPN W
VPN V
CE
CE
CE1
CE2
PE1
PE2
P1
P2
T1
T2
T3
T3
T3
D1
DATA

FIG. 1

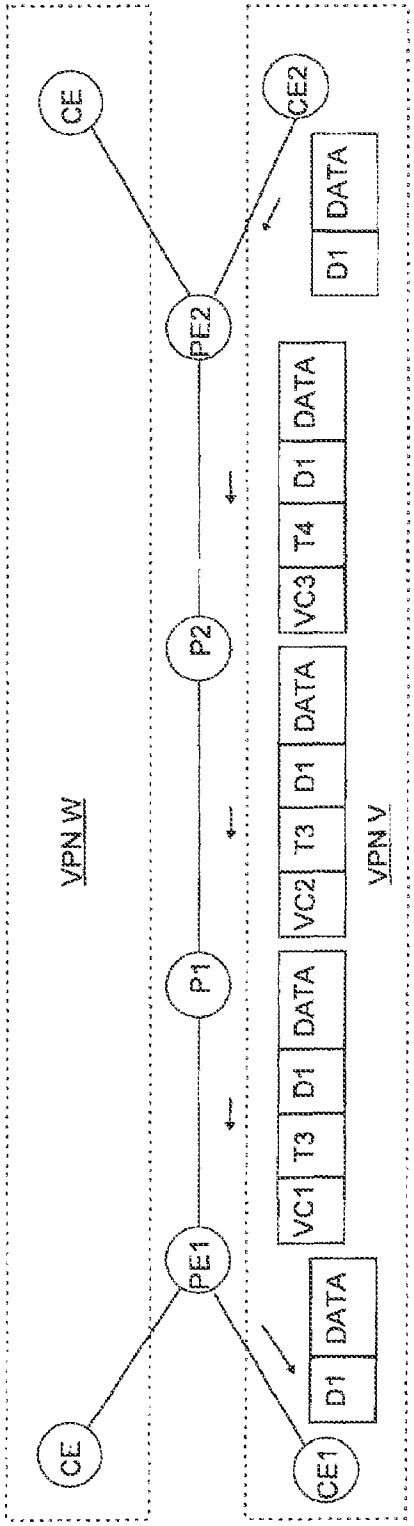

VPN W
VPN V
CE
CE
CE1
CE2
PE1
PE2
P1
P2
VC1
VC2
VC3
T3
T4
D1
DATA

FIG. 7

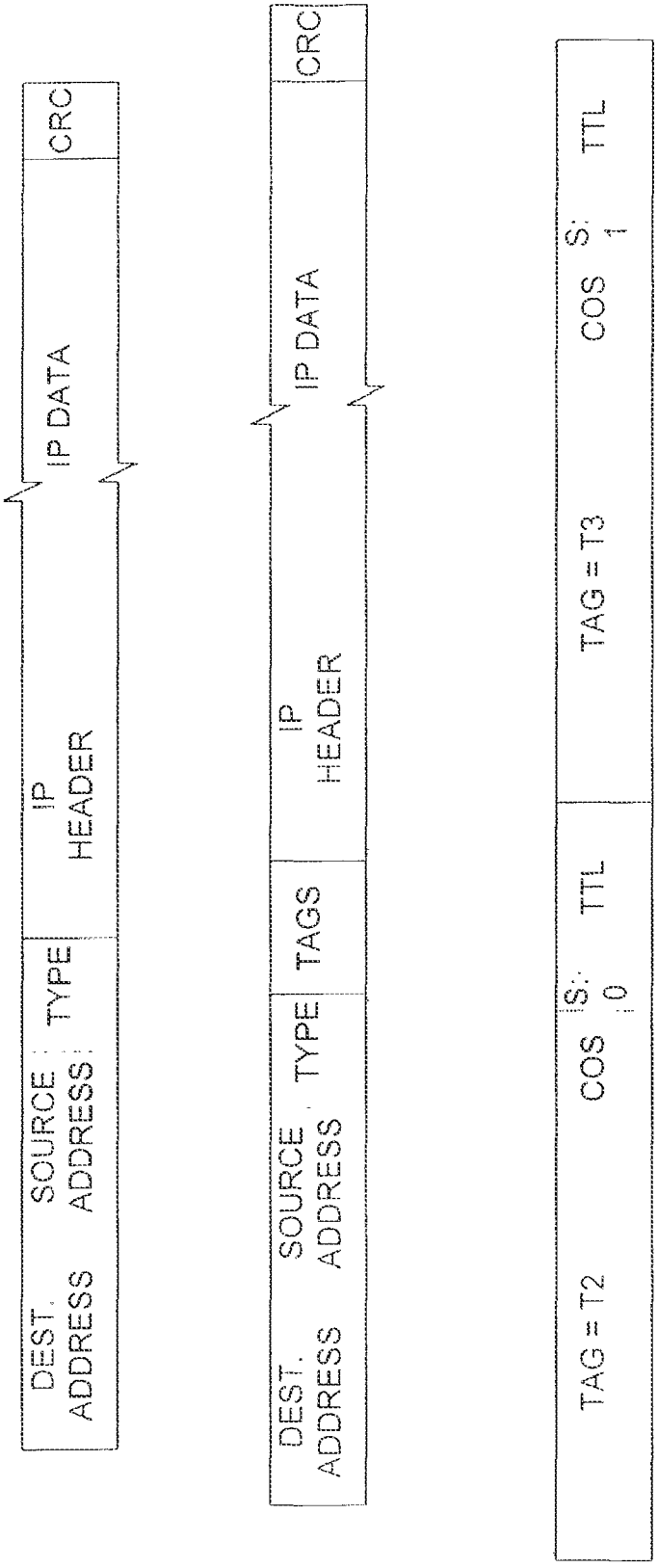

DEST. ADDRESS
SOURCE ADDRESS
TYPE
IP HEADER
IP DATA
CRC
DEST. ADDRESS
SOURCE ADDRESS
TYPE
TAGS
IP HEADER
IP DATA
CRC
TAG = T2
COS
S: 0
TTL
TAG = T3
COS
S: 1
TTL

FIG. 2

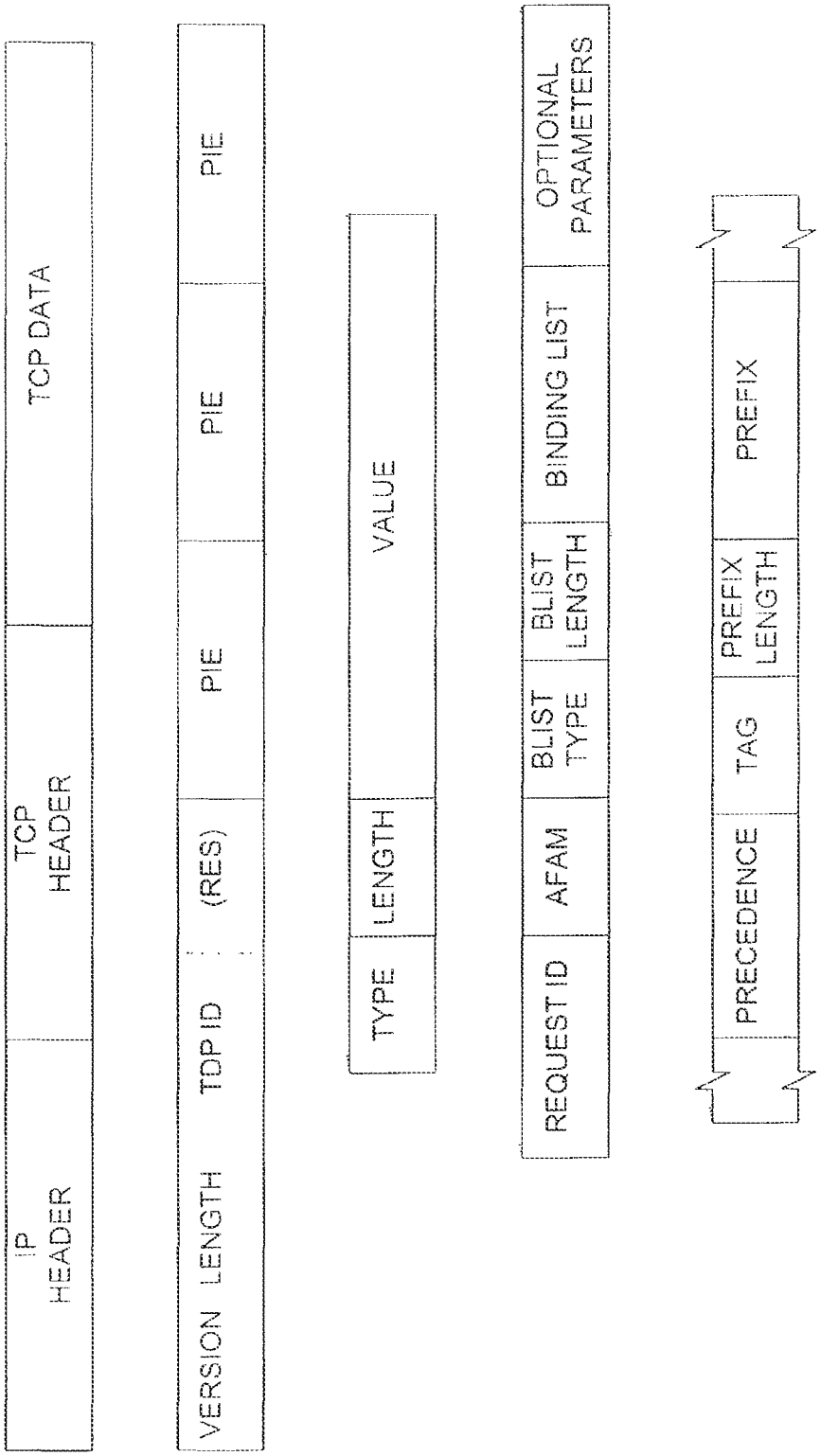

IP HEADER
TCP HEADER
TCP DATA
VERSION
LENGTH
TDP ID
(RES)
PIE
PIE
PIE
TYPE
LENGTH
VALUE
REQUEST ID
AFAM
BLIST TYPE
BLIST LENGTH
BINDING LIST
OPTIONAL PARAMETERS
PRECEDENCE
TAG
PREFIX LENGTH
PREFIX

FIG. 3

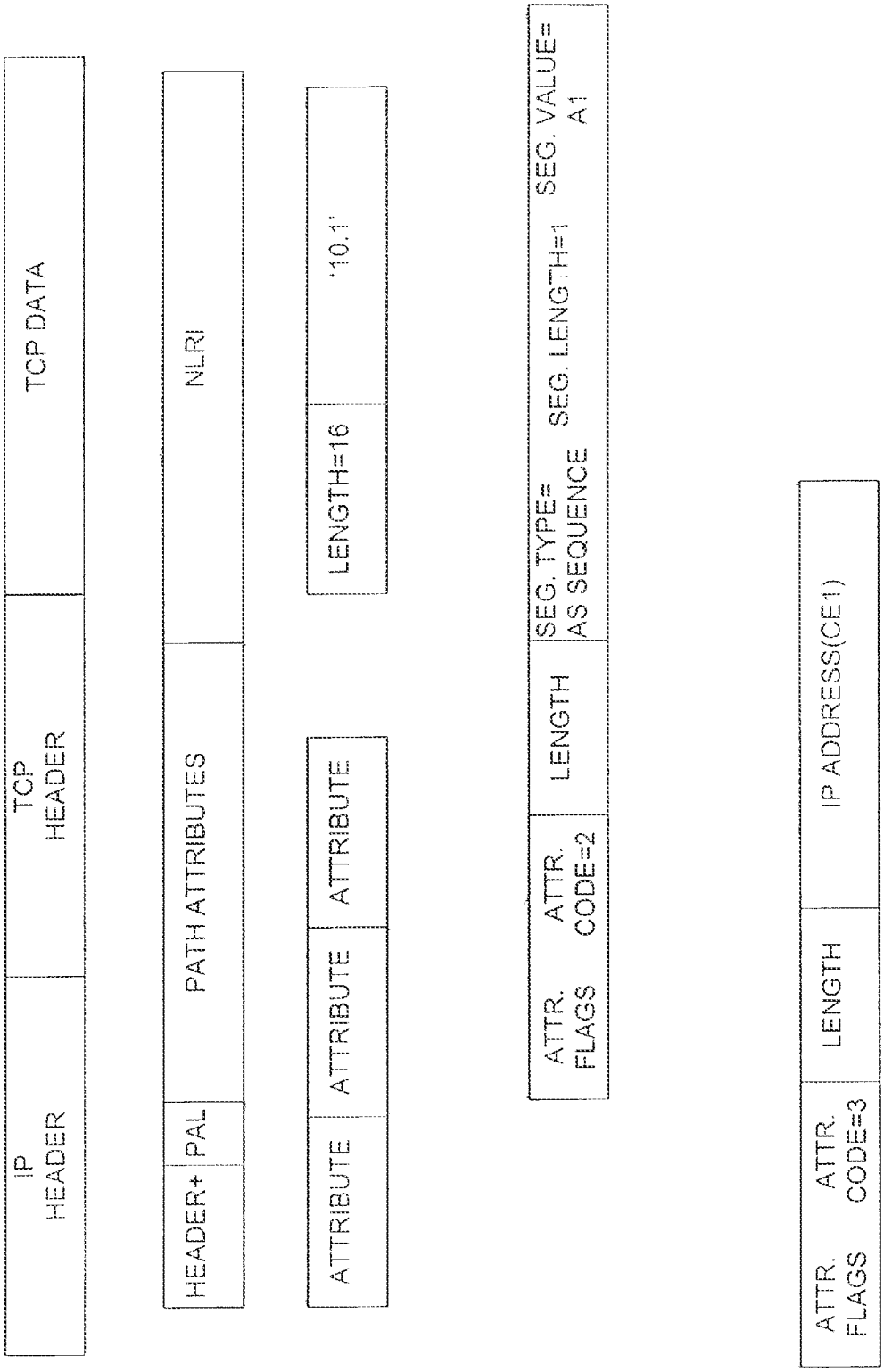

IP HEADER
TCP HEADER
TCP DATA
HEADER+
PAL
PATH ATTRIBUTES
NLRI
ATTRIBUTE
ATTRIBUTE
ATTRIBUTE
LENGTH=16
'10.1'
ATTR. FLAGS
ATTR. CODE=2
LENGTH
SEG. TYPE= AS SEQUENCE
SEG. LENGTH=1
SEG. VALUE= A1
ATTR. FLAGS
ATTR. CODE=3
LENGTH
IP ADDRESS(CE1)

FIG. 4

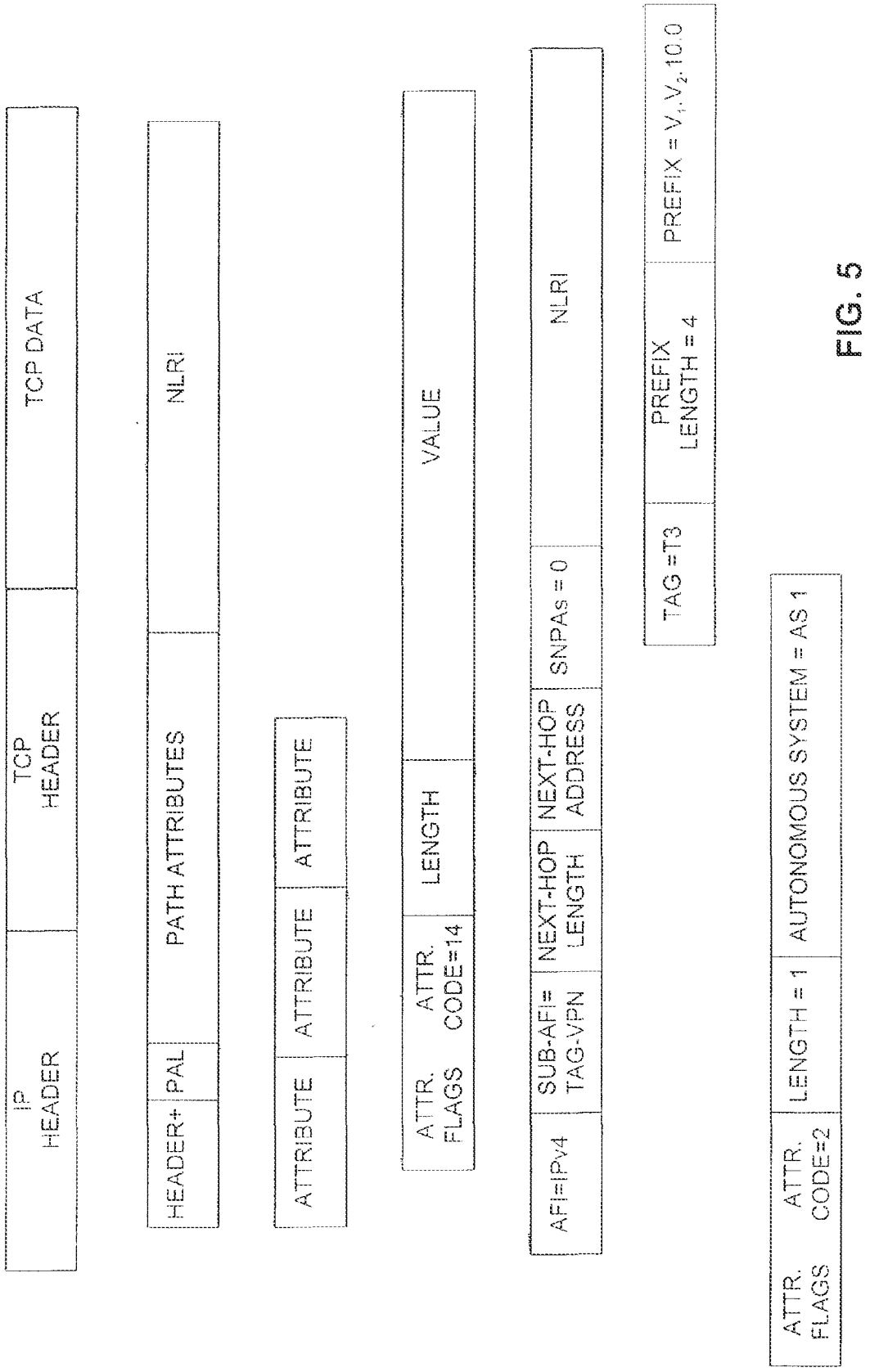

IP HEADER
TCP HEADER
TCP DATA
HEADER+
PAL
PATH ATTRIBUTES
NLRI
ATTRIBUTE
ATTRIBUTE
ATTRIBUTE
ATTR. FLAGS
ATTR. CODE=14
LENGTH
VALUE
AFI=IPv4
SUB-AFI= TAG-VPN
NEXT-HOP LENGTH
NEXT-HOP ADDRESS
SNPAs = 0
NLRI
TAG =T3
PREFIX LENGTH = 4
PREFIX = V1.V2.10.0
ATTR. FLAGS
ATTR. CODE=2
LENGTH = 1
AUTONOMOUS SYSTEM = AS 1

FIG. 5

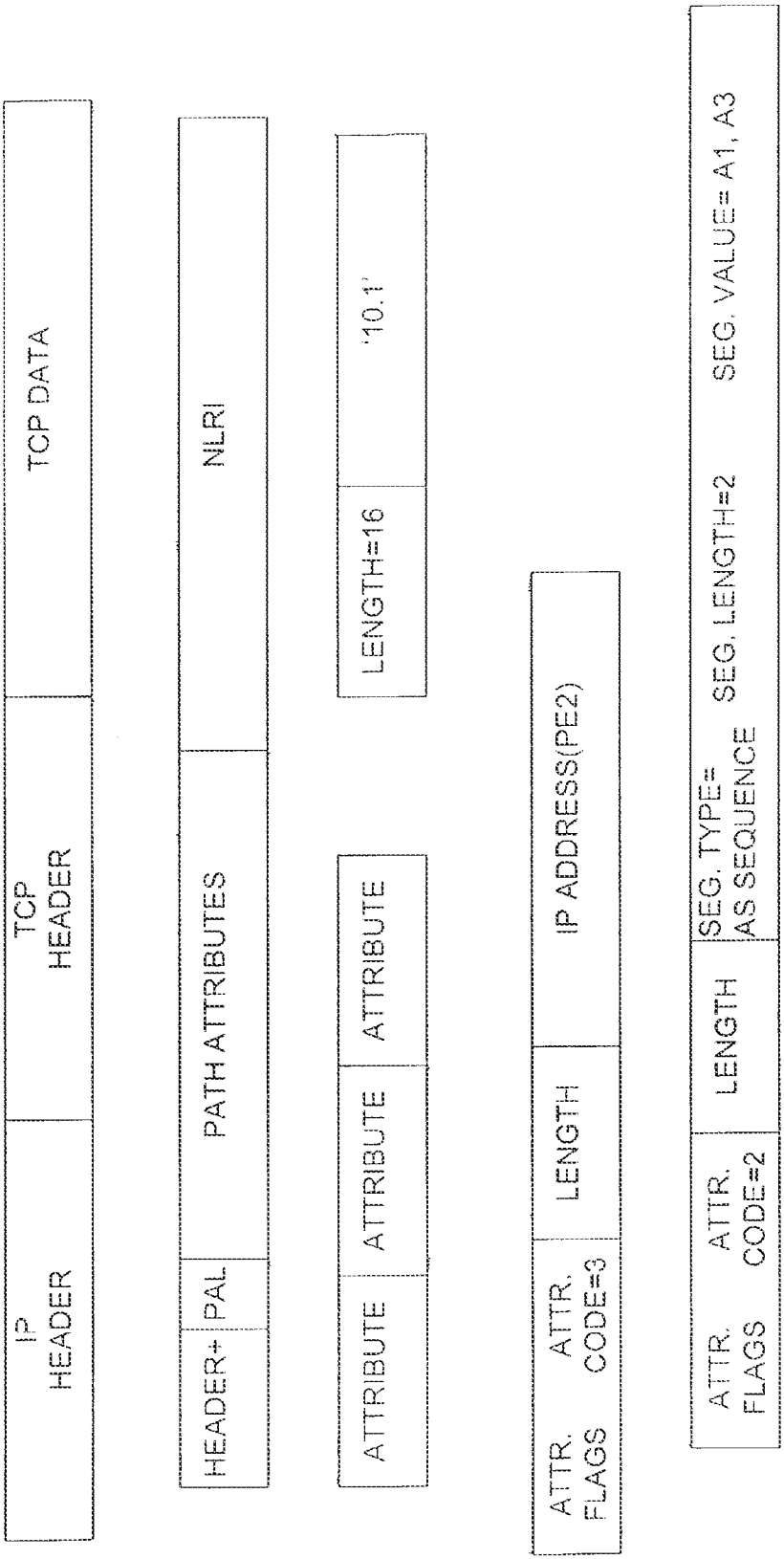

IP HEADER
TCP HEADER
TCP DATA
HEADER+
PAL
PATH ATTRIBUTES
NLRI
ATTRIBUTE
ATTRIBUTE
ATTRIBUTE
LENGTH=16
'10.1'
ATTR. FLAGS
ATTR. CODE=3
LENGTH
IP ADDRESS(PE2)
ATTR. FLAGS
ATTR. CODE=2
LENGTH
SEG. TYPE= AS SEQUENCE
SEG. LENGTH=2
SEG. VALUE= A1, A3

FIG. 6

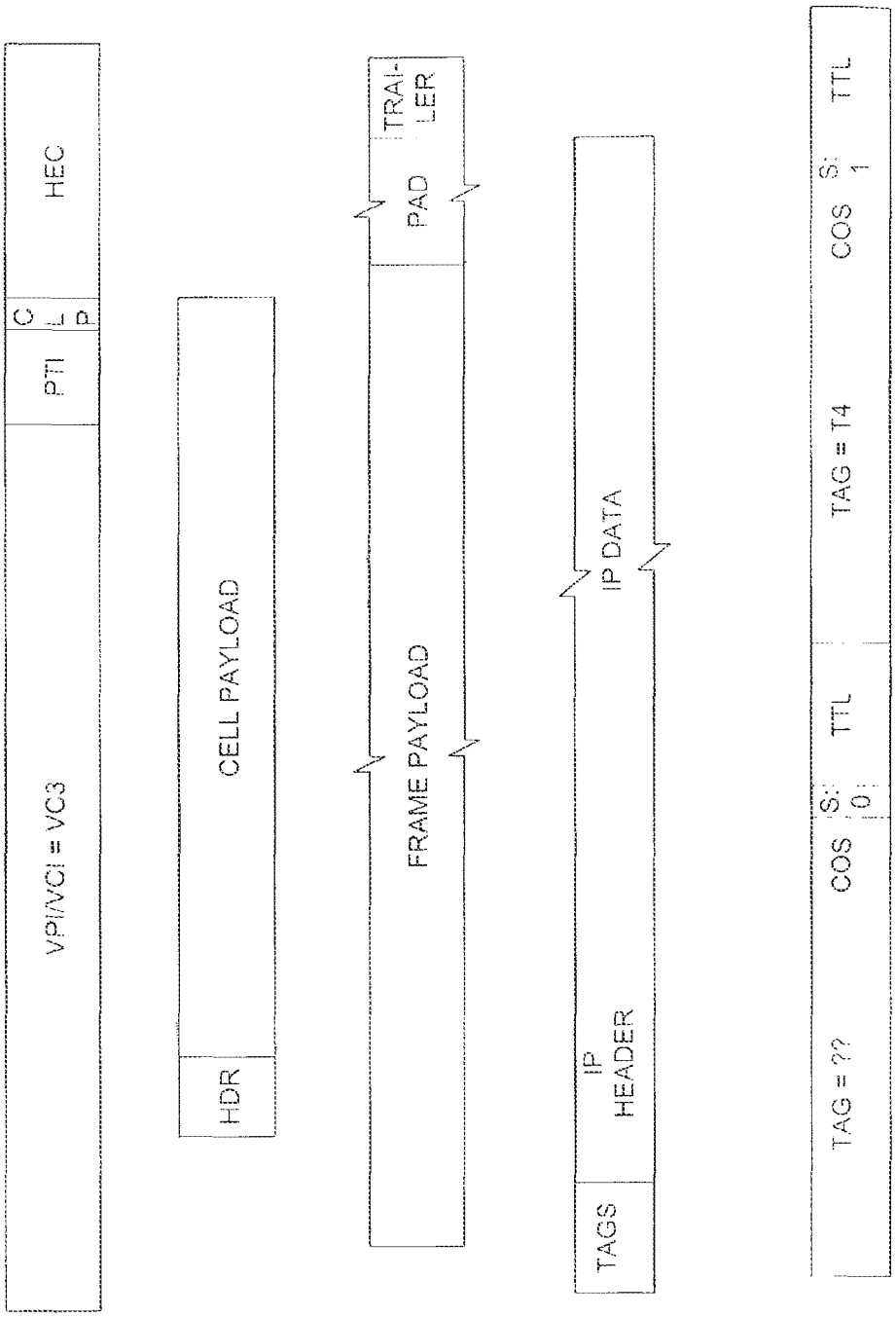

VPI/VCI = VC3
PTI
C L P
HEC
HDR
CELL PAYLOAD
FRAME PAYLOAD
PAD
TRAI-LER
TAGS
IP HEADER
IP DATA
TAG = ??
COS
S: 0
TTL
TAG = T4
COS
S: 1
TTL

FIG. 8

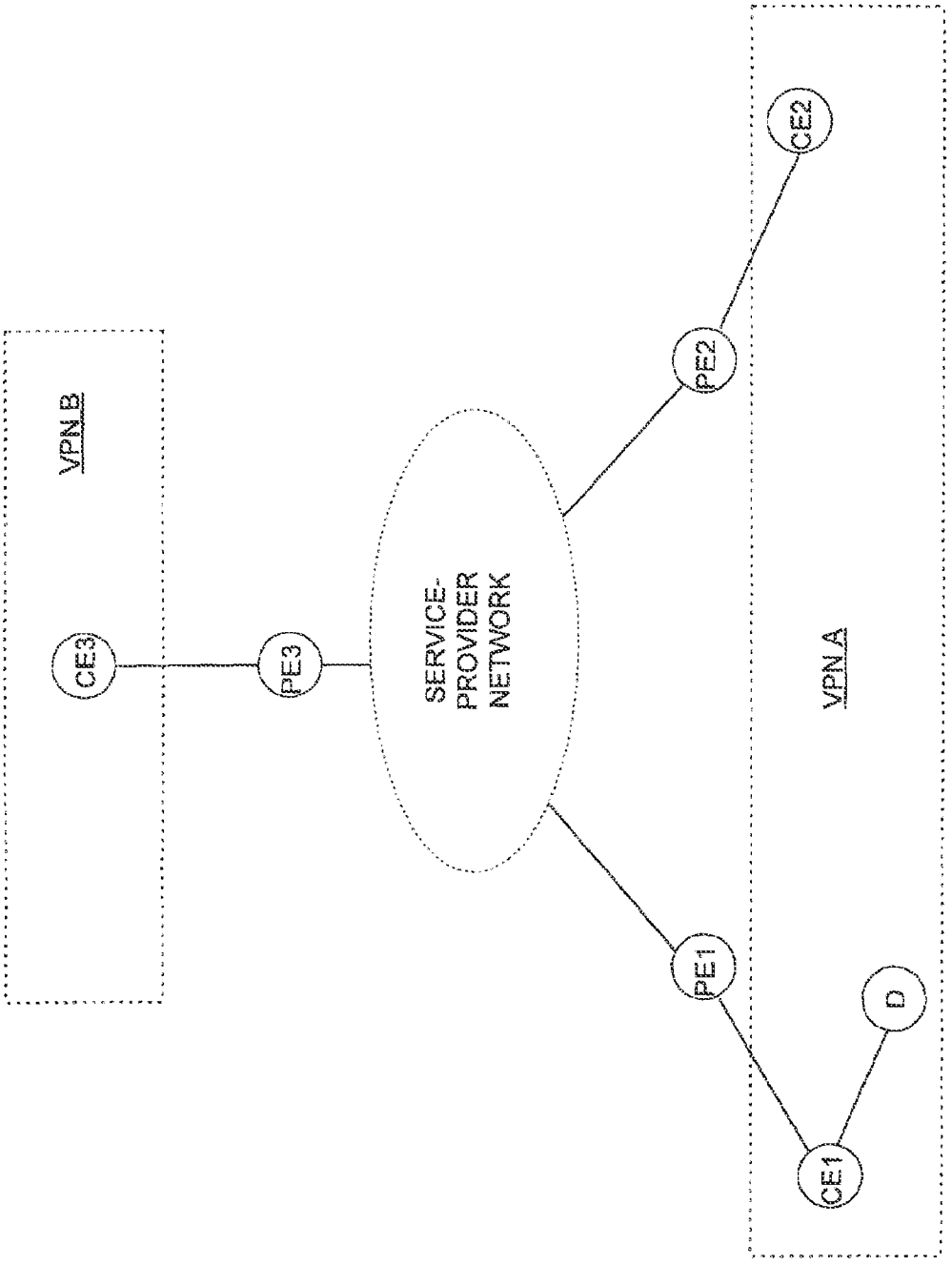


FIG. 9

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Label
Label
CoS
S
TTL
Stack
Entry
Label: Label Value, 20 bits
CoS: Class of Service, 3 bits
S: Bottom of Stack, 1 bit
TTL: Time to Live, 8 bits

FIG. 10

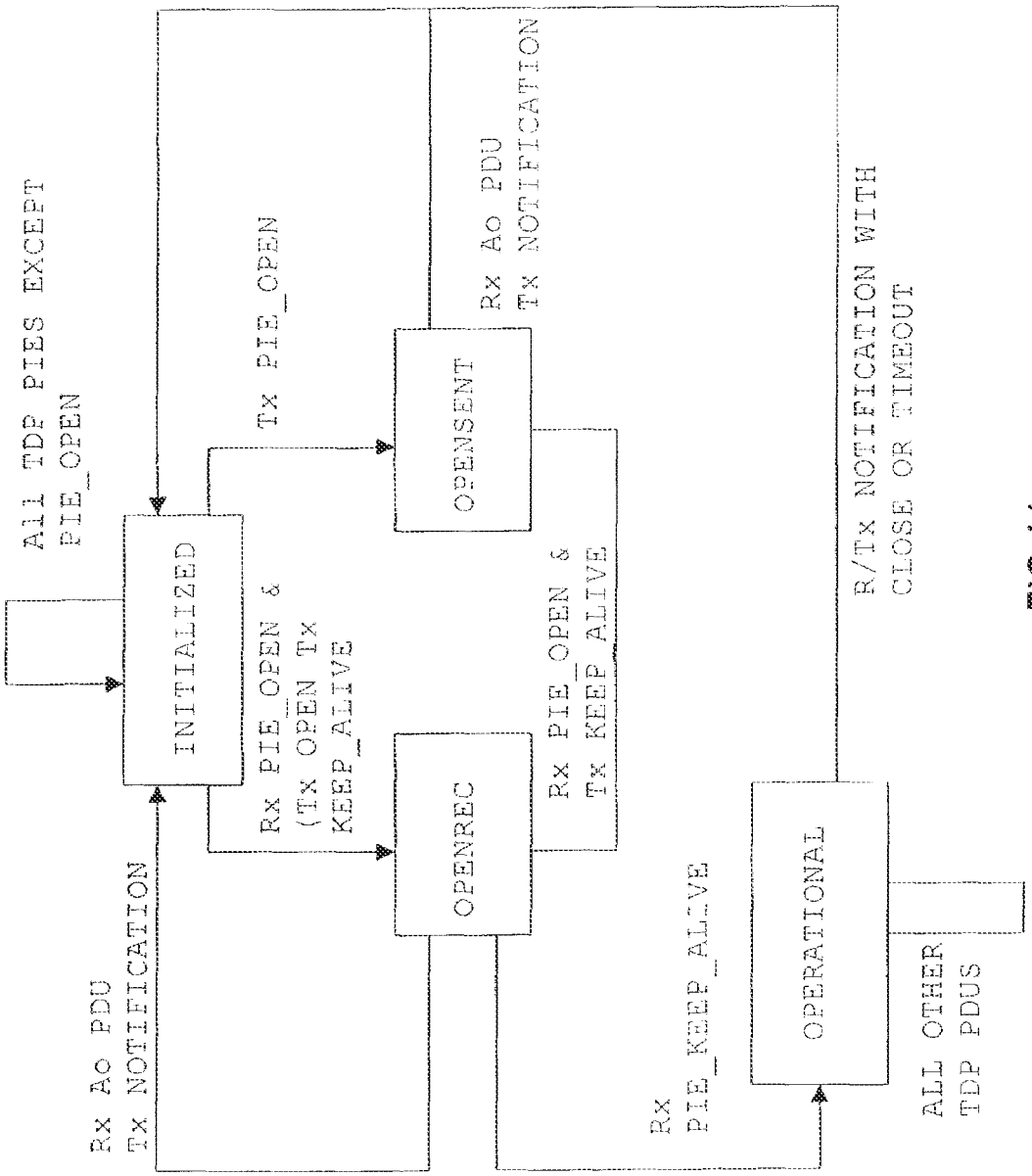

All TDP PIES EXCEPT
PIE_OPEN
INITIALIZED
Tx PIE_OPEN
OPENSENT
Rx Ao PDU
Tx NOTIFICATION
Rx PIE_OPEN &
(Tx OPEN Tx
KEEP_ALIVE
OPENREC
Rx PIE_OPEN &
Tx KEEP_ALIVE
R/Tx NOTIFICATION WITH
CLOSE OR TIMEOUT
OPERATIONAL
Rx Ao PDU
Tx NOTIFICATION
Rx
PIE_KEEP_ALIVE
ALL OTHER
TDP PDUS

FIG.11

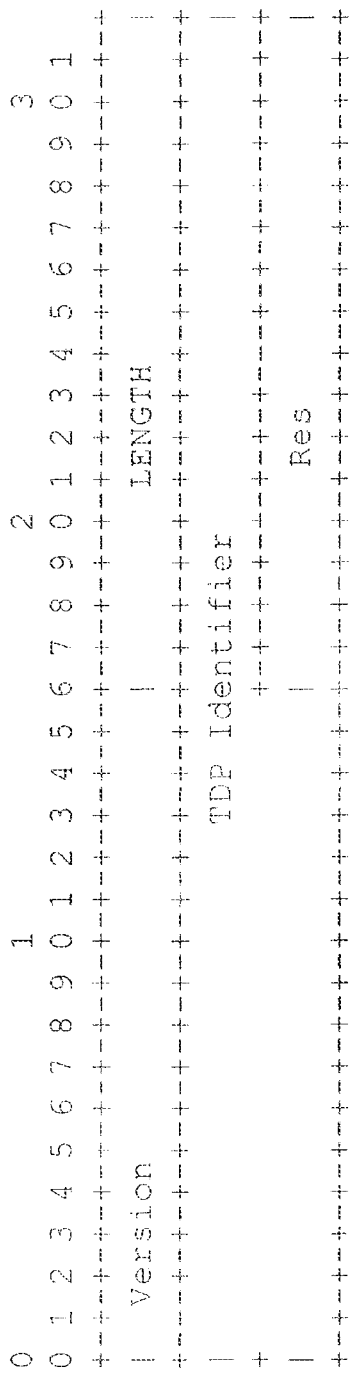

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Version
LENGTH
TDP Identifier
Res

FIG. 12

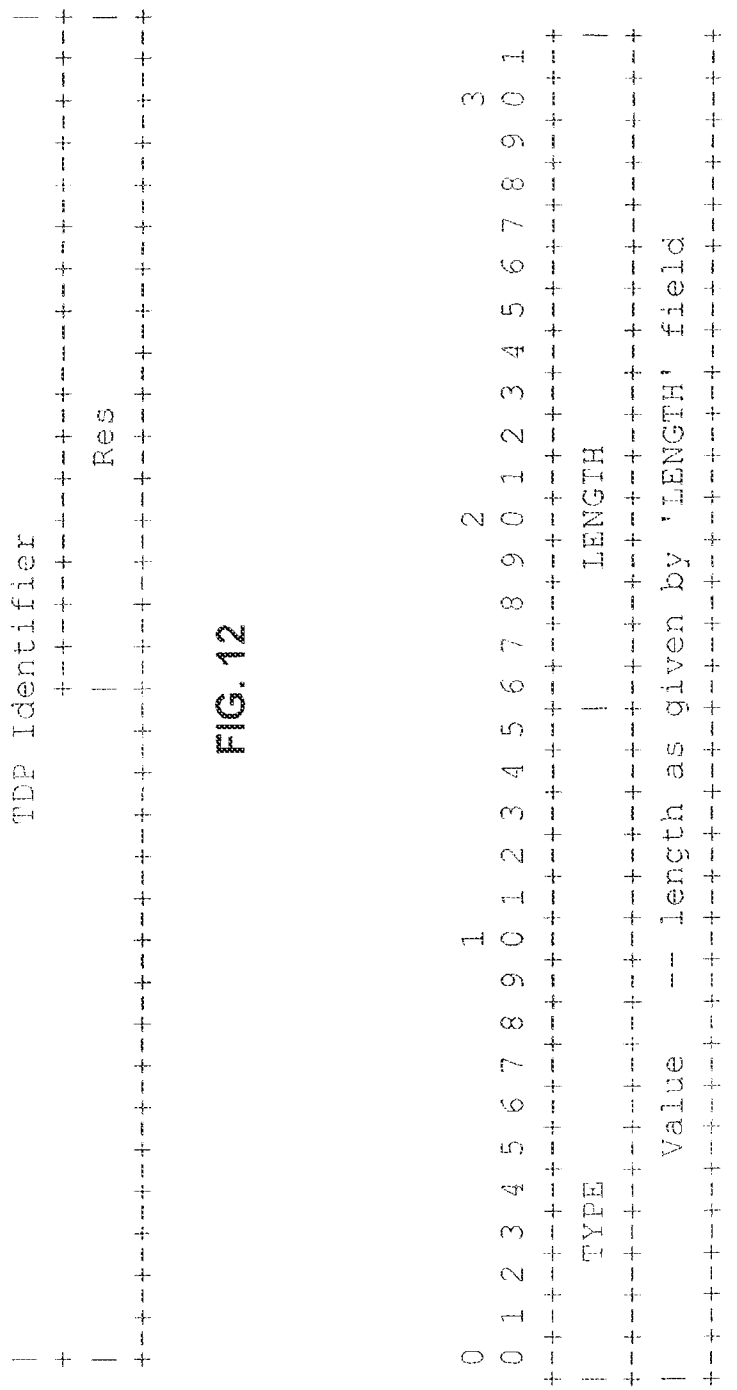

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE
LENGTH
Value -- length as given by 'LENGTH' field

FIG. 13

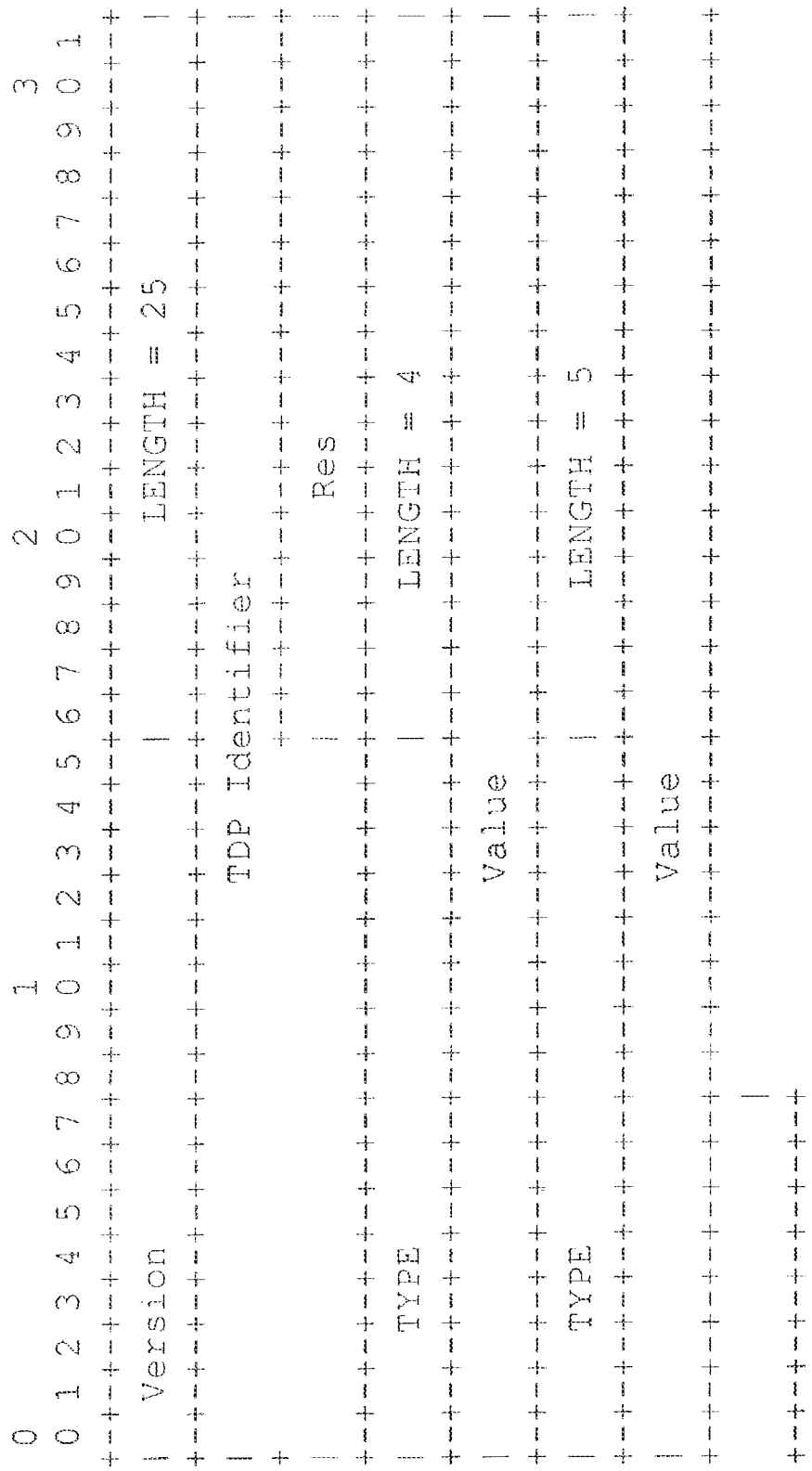

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Version
LENGTH = 25
TDP Identifier
Res
TYPE
LENGTH = 4
Value
Type
LENGTH = 5
Value

FIG. 14

FIG. 15

OPTIONAL PARAMETER	Type	Length	Value
DOWNSTREAM_ON_DEMAND	0x101	0	0
ATM_TAG_RANGE	0x102	Variable	See below
ATM_ENCAPSULATION	0x103	0	0

FIG. 16

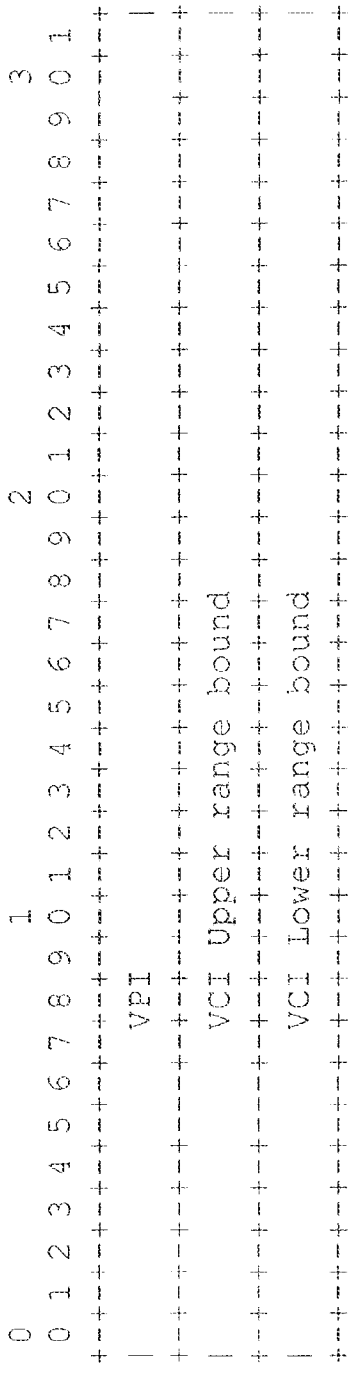

VPI
VCI Upper range bound
VCI Lower range bound

FIG. 17

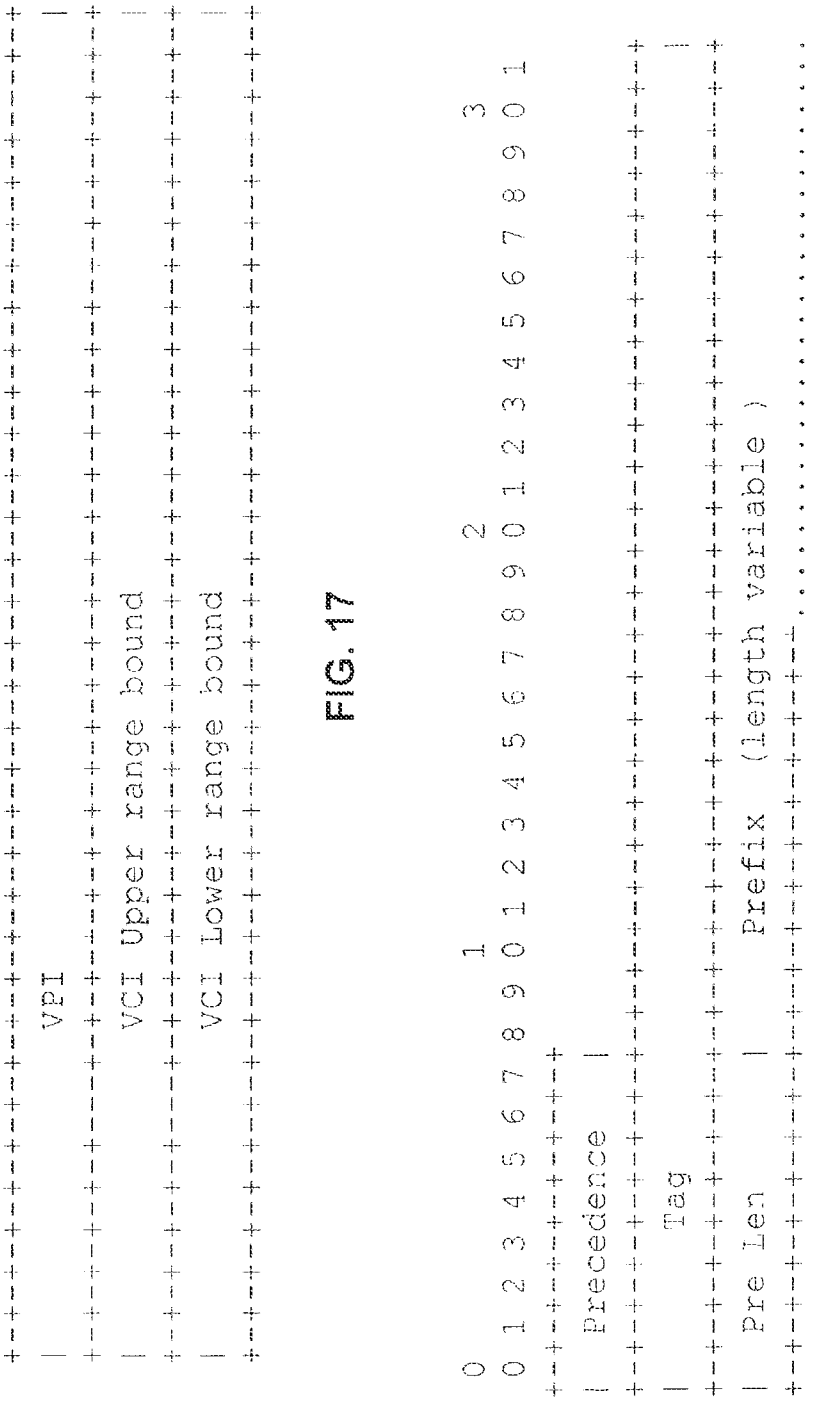

Precedence
Tag
Pre Len
Prefix (length variable)

FIG. 18

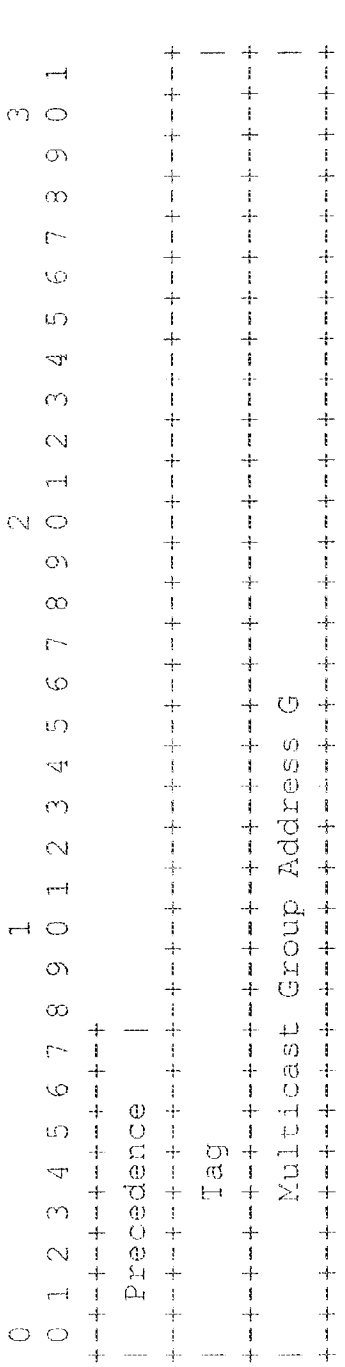

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Precedence
Tag
Multicast Group Address G

FIG. 19

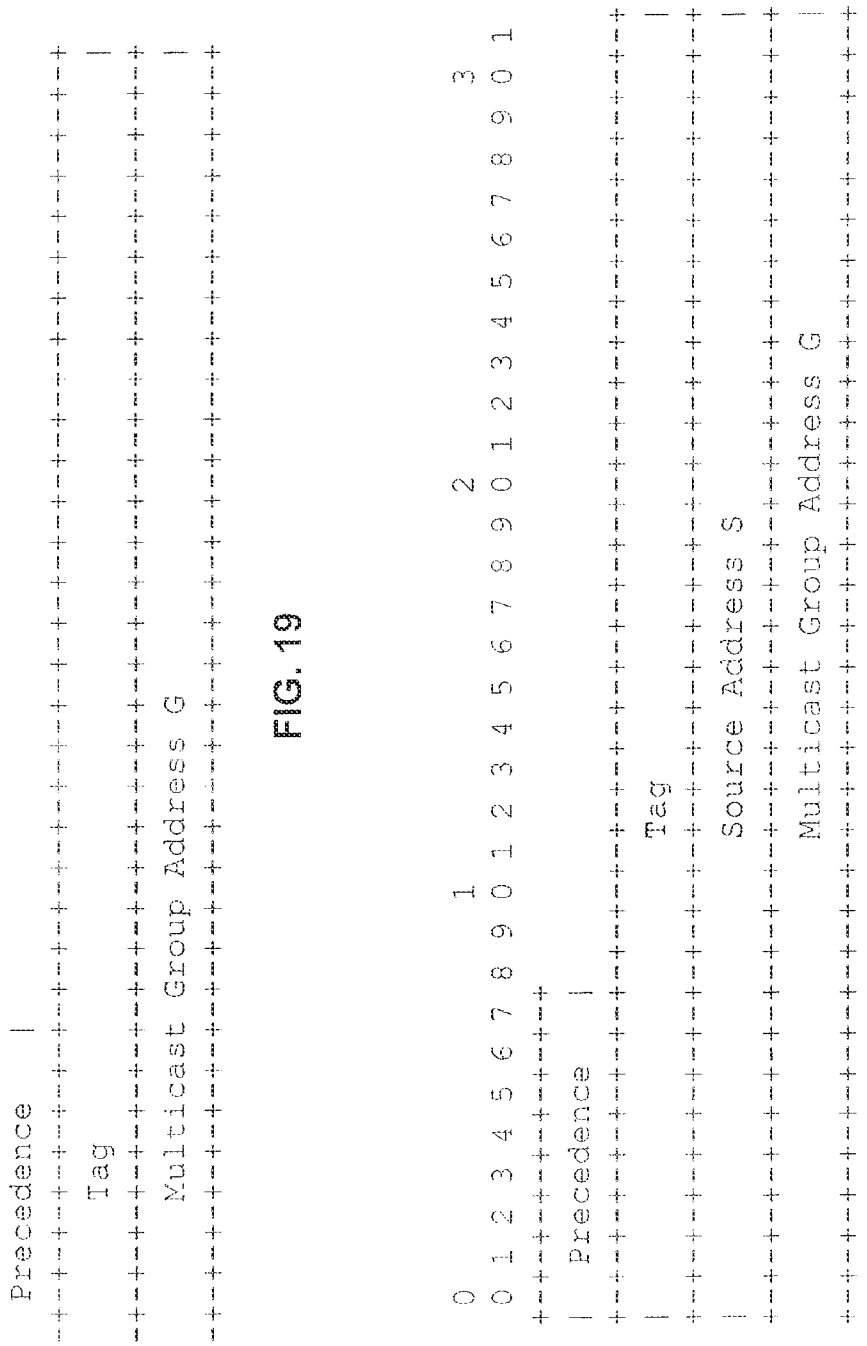

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Precedence
Tag
Source Address S
Multicast Group Address G

FIG.20

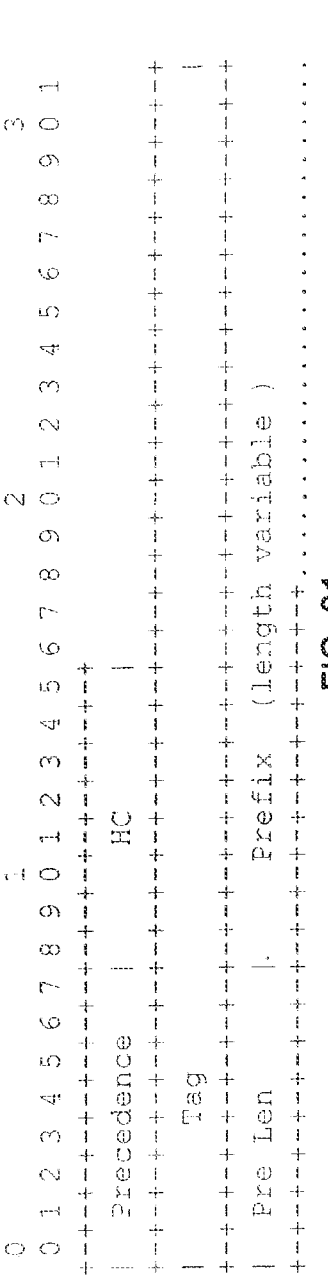

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Precedence
HC
Tag
Pre Len
Prefix (length variable)

FIG. 21

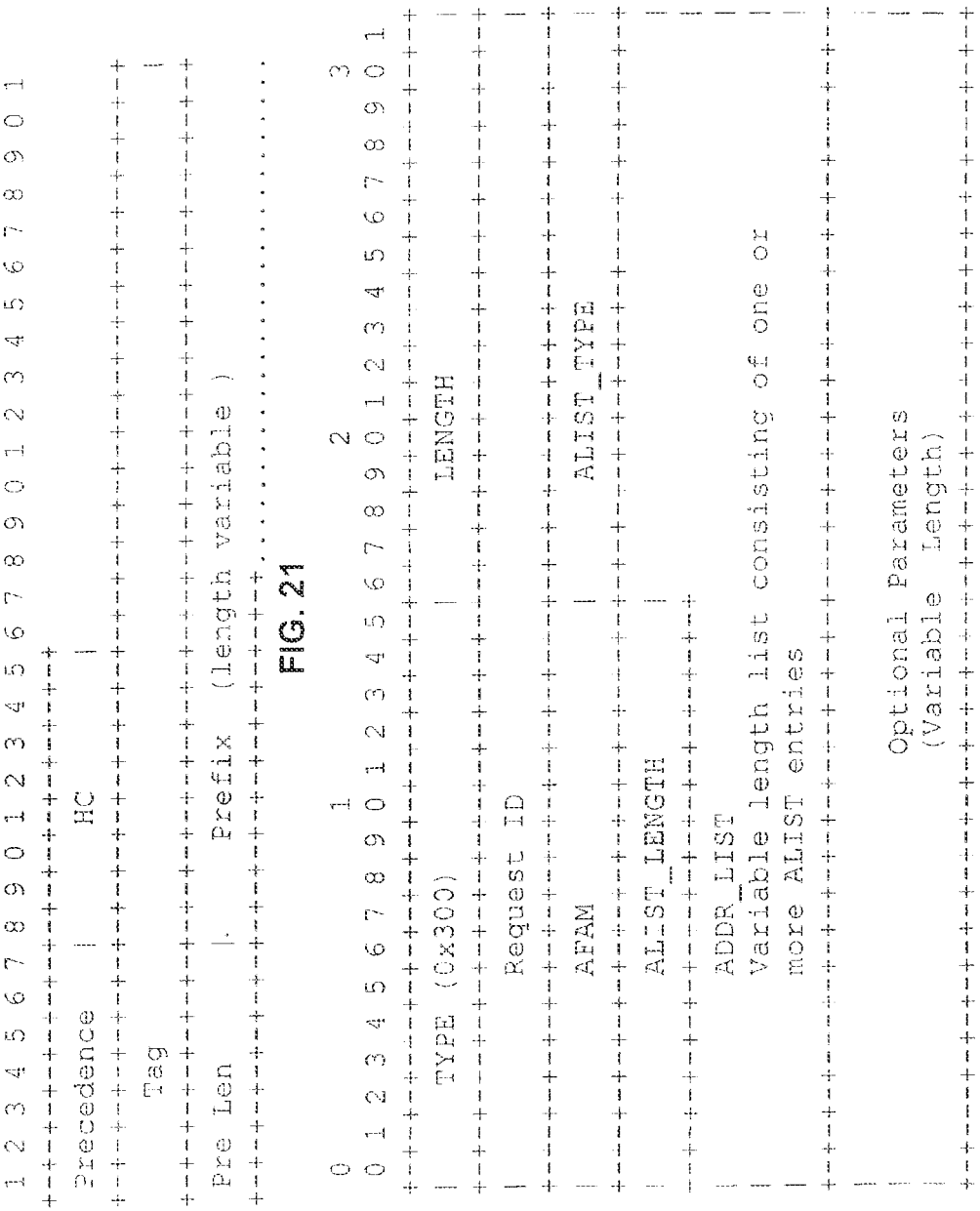

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE (0x300)
LENGTH
Request ID
AFAM
ALIST_TYPE
ALIST_LENGTH
ADDR_LIST
Variable length list consisting of one or
more ALIST entries
Optional Parameters
(Variable Length)

FIG. 22

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Precedence
Pre Len
Prefix (length variable

FIG. 23

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Precedence
HC
Pre Len
Prefix (length variable

FIG. 24

STATUS NOTIFICATION	Type	Length	Value
RESOURCE_LIMIT	0x3F0	4	Request ID
RESOURCES	0x3F1	0	0
HOP_COUNT_EQUALED	0x3F2	Var	See below
NO_ROUTE	0x3F3	Var	See below

FIG. 25

FIG. 26

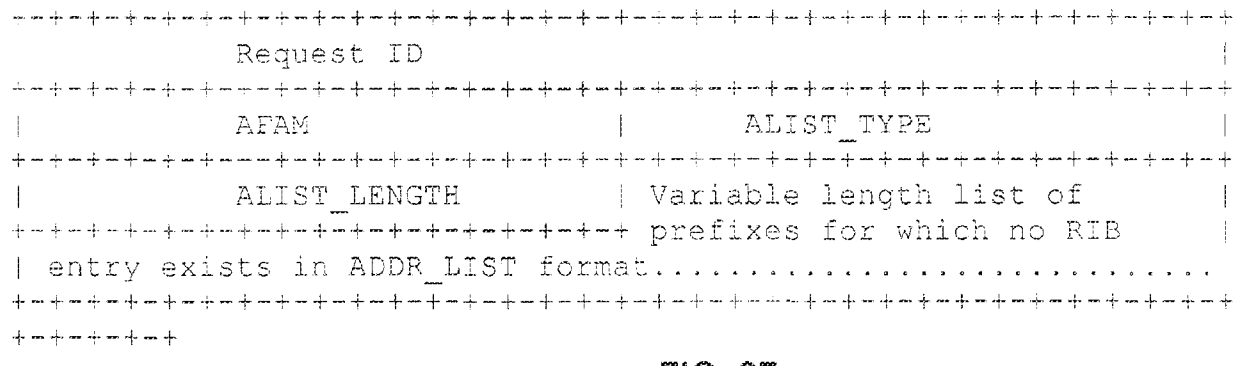

Request ID
AFAM
ALIST_TYPE
ALIST_LENGTH
Variable length list of
prefixes for which no RIB
entry exists in ADDR_LIST format

FIG. 27

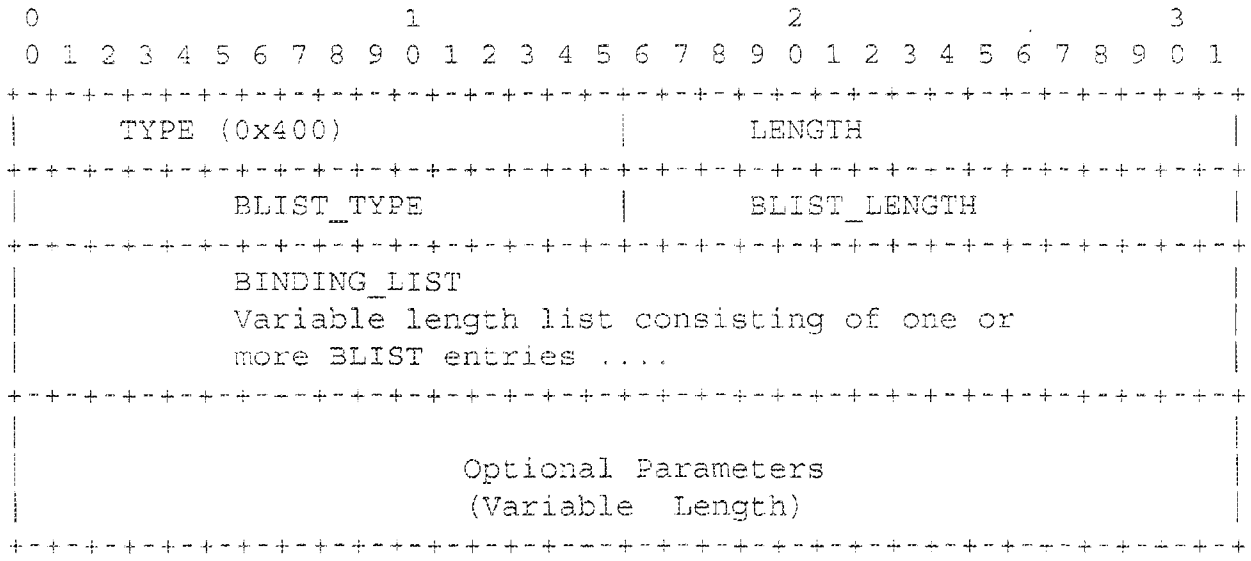

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE (0x400)
LENGTH
BLIST_TYPE
BLIST_LENGTH
BINDING_LIST
Variable length list consisting of one or
more BLIST entries ....
Optional Parameters
(Variable Length)

FIG. 28

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE (0x700)
LENGTH
BLIST_TYPE
BLIST_LENGTH
BINDING_LIST
Variable length list consisting of one or
more BLIST entries ...
Optional Parameters
(Variable Length)

FIG. 29

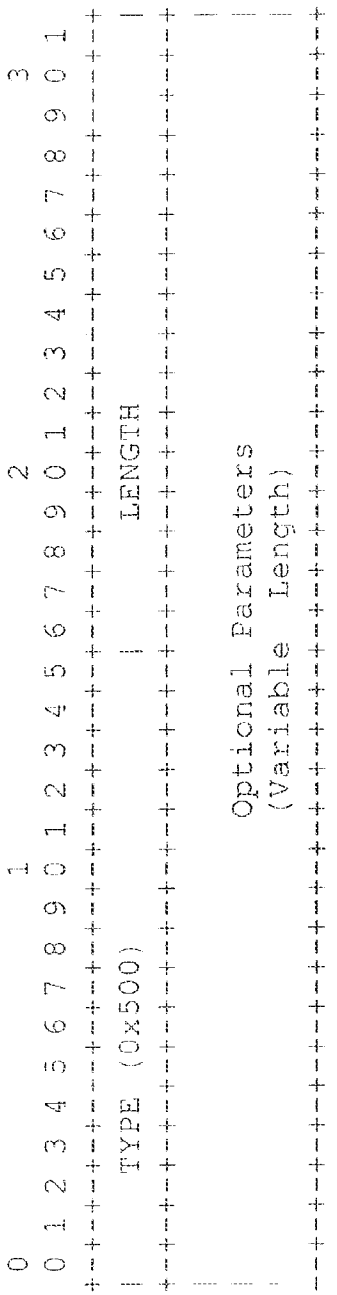

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE (0x500)
LENGTH
Optional Parameters
(Variable Length)

FIG. 30

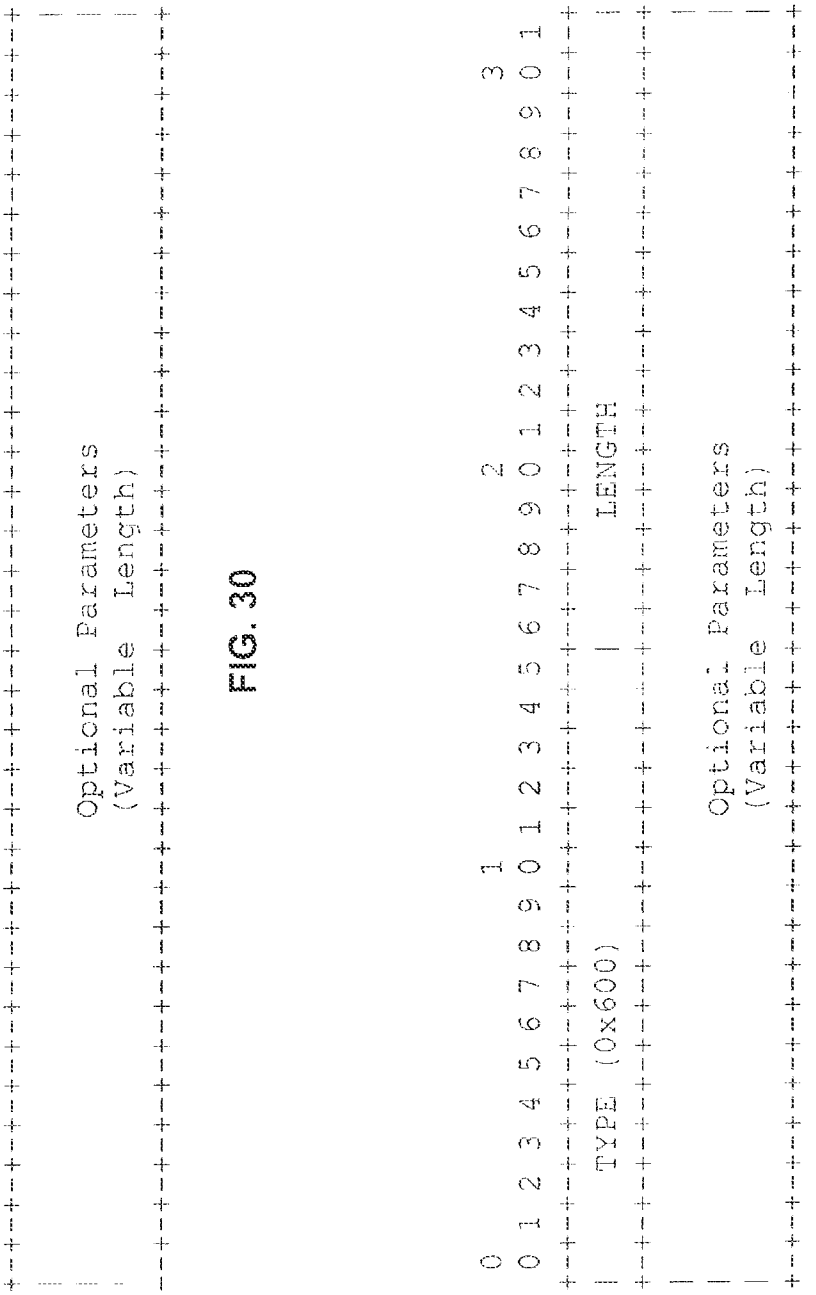
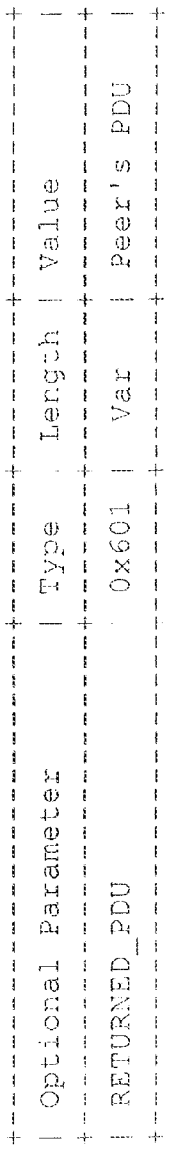

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
TYPE (0x600)
LENGTH
Optional Parameters
(Variable Length)

FIG. 31



Optional Parameter	Type	Length	Value
RETURNED_PDU	0x601	Var	Peer's PDU

FIG. 32

Optional Parameter	Type	Length	Value
CLOSING	0x602	0	0

FIG. 33

Optional Parameter	Type
TDP_OPEN_UNSUPPORTED_VER	0x1F0
TDP_BAD_OPEN	0x1F1
TDP_WRONG_ENCAPS	0x1F2

FIG. 34

Optional Parameter	Type
RESOURCE_LIMIT	0x3F0
RESOURCES	0x3F1
HOP_COUNT_EQUALLED	0x3F2
NO_ROUTE	0x3F3

FIG. 35

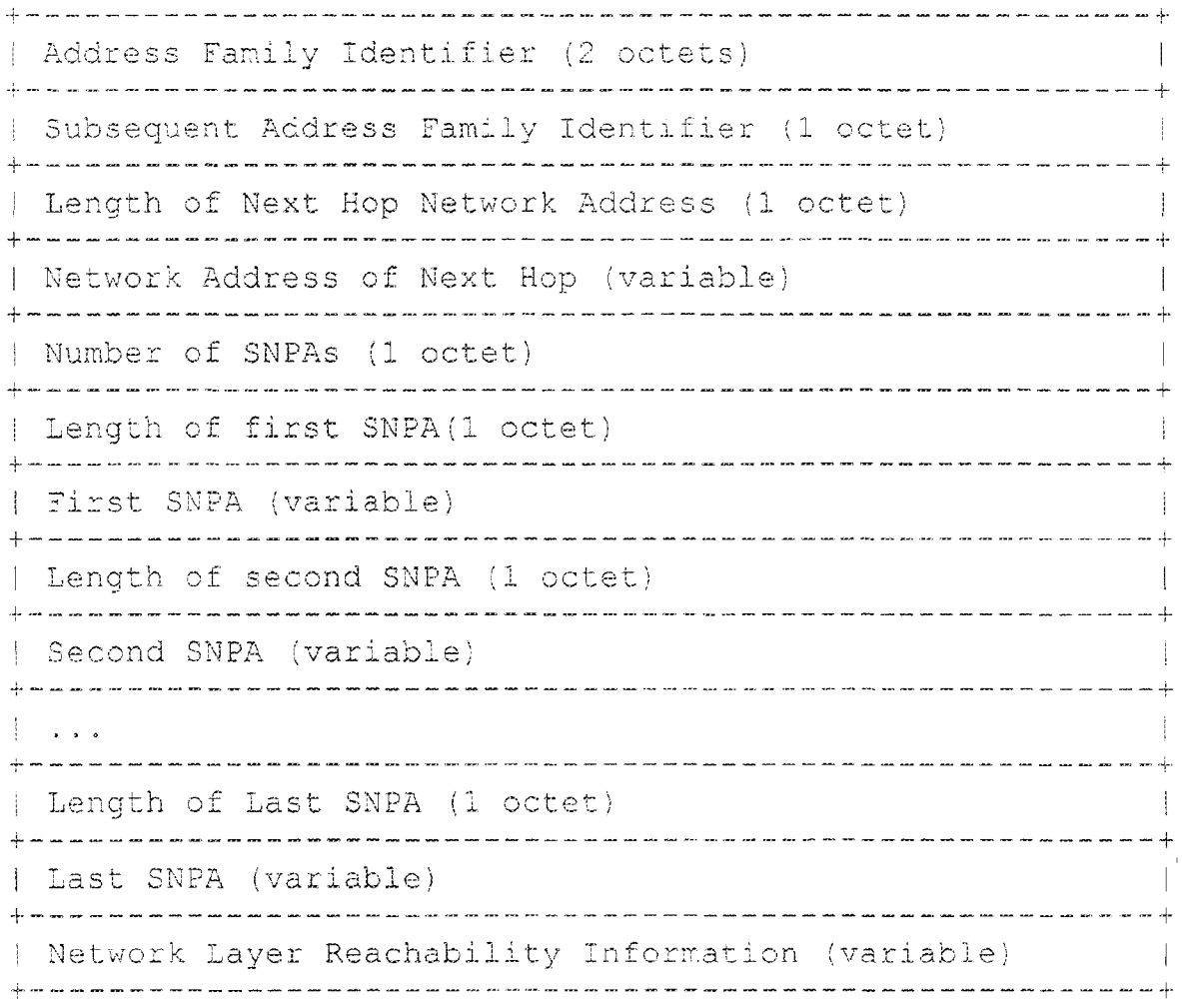

Address Family Identifier (2 octets)
Subsequent Address Family Identifier (1 octet)
Length of Next Hop Network Address (1 octet)
Network Address of Next Hop (variable)
Number of SNPAs (1 octet)
Length of first SNPA(1 octet)
First SNPA (variable)
Length of second SNPA (1 octet)
Second SNPA (variable)
...
Length of Last SNPA (1 octet)
Last SNPA (variable)
Network Layer Reachability Information (variable)

FIG. 36

ROUTER FOR VIRTUAL PRIVATE NETWORK EMPLOYING TAG SWITCHING

CROSS RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 09/217,976 filed on Dec. 21, 1998, now U.S. Pat. No. 6,526,056; which is a continuation of U.S. patent application Ser. No. 08/997,343 filed on Dec. 23, 1997, now issued as U.S. Pat. No. 6,339,595 on Jan. 15, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to communications networking. It is directed particularly to providing routing for private wide-area networks.

2. Background Information

An enterprise that has many sites can build a private wide-area network by placing routers at each site and using leased lines to interconnect them. A router that has a wide-area connection to another router may be called a "backbone router." The "backbone network" is the set of backbone routers and their interconnections.

If every backbone router is connected to every other backbone router, the backbone network is said to be "fully meshed." In a fully meshed backbone network, data that travel from one site to another go through the backbone router at an origin site ("ingress router"), travel over the leased line to the backbone router at the target site ("egress router"), and then enter the target site. More commonly, though, the backbone network is not fully meshed; a router is connected to only a small number of others (three or four). In such a sparse topology, the ingress and egress routers may not be directly connected. In this case, data may have to pass through several additional, "transit" routers on the way from ingress to egress.

In a private network like this, the design and operation of the backbone network is the responsibility of the enterprise. A routing algorithm must run in the backbone routers, enabling them to tell each other the addresses of the destinations to which they can respectively afford access.

It is worth noting that a leased line is not actually a piece of wire going from one site to another. It is really a circuit through some circuit-switching network. But this is of no import to the enterprise network manager, to whom those circuits can be considered simple unstructured pipes. Conversely, although the telephone network itself requires considerable management, the telephone-network managers do not need to know anything about the enterprise backbone network; to them, the telephone network just provides point-to-point connections. They do not need to know what role these connections might be playing in an enterprise data network.

We may say that the enterprise network is "overlaid" on top of the telephone network. The enterprise network can be called the "higher layer" network, the telephone network the "lower layer" network. Both networks exist, but each is transparent to the other. The enterprise's backbone routers exchange routing information with each other, but the telephone switches do not store or process that routing information. That is, backbone routers are "routing peers" of each other, but they are not routing peers of the telephone switches. This way of building a higher-layer network on top of a lower-layer network is called the "overlay model."

2. Virtual Private Networks

Wide-area enterprise networks are now more likely to be built on top of frame-relay and ATM networks than on top of circuit-switched (telephone) networks. Whereas a telephone network really provides circuits between backbone routers, a frame-relay or ATM network provides "virtual circuits" between backbone routers. But this changes nothing as far as the enterprise's routing task is concerned; the overlay model still applies even though the lower-layer network is now a frame-relay or ATM network rather than a circuit-switched one, i.e., even though virtual rather than fixed circuits make the point-to-point connections between backbone routers. The two networks are still transparent to each other. The enterprise network manager still has a wide-area backbone to design and operate. However, because the circuits are "virtual," this is usually called a "virtual private network" (VPN) instead of a "private network."

Since the two networks are transparent to each other in the overlay model, that model is distinguished by the fact that the enterprise's backbone routers do not share with the (service provider's) frame-relay or ATM switches the routing information that they must share with each other. This causes inefficiency when the enterprise's backbone routers are not fully meshed. In such networks, some packets go from the ingress router through one or more transit routers before they reach the egress router. At each one of these "hops," the packet leaves the frame-relay or ATM network and then enters it again. This is sub-optimal—there is little value in having a packet go in and out of the frame-relay or ATM network multiple times.

This problem can be avoided by making the enterprise backbone fully meshed, but that causes problems of its own. The number of virtual circuits the enterprise has to pay the service provider for to make the network fully meshed grows as the square of the number of backbone routers. Apart from the cost, routing algorithms tend to scale poorly as the number of direct connections between routers grows. This causes additional problems.

The overlay model also tends to result in extra traffic when multicast is in use. It is usually impractical or undesirable for the "lower layer" network to do the necessary packet replication, so all packet replication must be done in the "higher layer" network, even if a number of replicated packets must then follow the same "lower layer" path up to a point.

3. The Peer Model

Since these considerations all impose upon the resources of an enterprise for which communications is not necessarily a core competence, a service provider ("SP") can afford its customers greater value if it absorbs the task of designing and operating the backbone. More specifically, the SP should so organize and operate the backbone that, from the point of view of a particular site administrator, every enterprise network address not located at a given site is reachable through the SP's backbone network. How the SP's backbone decides to route the traffic is the SP's concern, not that of the customer enterprise. So the customer enterprise does not really need to maintain a backbone router at each site; it just needs a router that attaches to one of the SP's backbone routers. As will become apparent, providing such an organization involves abandoning the overlay model for a different model. For reasons that will be set forth below, we call the new model the "peer model."

Terminology:

C-network: the enterprise network, consisting of C-routers, which are maintained and operated by the enterprise.

P-network: the SP network, consisting of P-routers, which the SP maintains and operates.

CE-router: an "edge router" in the C-network, i.e., a C-router that attaches directly to a P-router and is a routing peer of the P-router.

PE-router: an "edge router" in the P-network, i.e., a P-router that attaches directly to a C-router and is a routing peer of the C-router.

If a P-router is not a PE-router, i.e., not an edge router, it is a transit router. The concept of edge and transit routers is relative to specific VPNs. If a given one of the SP's routers receives a given VPN's traffic from and forwards it to only others of the SP's routers, the given router is a transit router vis-à-vis the given VPN. Yet that same router may receive another VPN's traffic from and/or forward it to one of that other VPN's edge routers, in which case the given SP router is an edge router from the other VPN's point of view.

In the conventional peer model, where "virtual routers" (i.e., one instance of the routing algorithm per VPN) are used, all C-routers within the same VPN are routing peers of each other. But two C-routers will be routing adjacencies of each other only if they are at the same site. Each site has at least one CE router, each of which is directly attached to at least one PE router, which is its routing peer. Since CE routers do not exchange routing information with each other, there is no virtual backbone for the enterprise to manage, and there is never any need for data to travel through transit CE routers. Data go from the ingress CE router through a sequence of P-routers to the egress CE router. So the resultant routing is optimal. These clear customer benefits have led certain SPs to adopt the peer model.

The conventional peer-model approach also enables the SP to solve certain problems that arise from using a common backbone network for more than one client. One of these is address duplication. Although there is an international assigned-number authority from which unique addresses can be obtained, many enterprise networks simply assign their private-network addresses themselves. So their addresses are unique only within the particular enterprise: they may duplicate addresses that another customer enterprise uses. An SP trying to use, say, an Internet-Protocol ("IP") backbone as the backbone for different enterprise networks having overlapping address spaces needs to provide its P-routers with a way of identifying and selecting a route to the one of potentially many same-address destinations to which it should forward a packet.

So the SP makes use of a "virtual router." When a PE router receives a packet received from a CE router, the PE router "tags" the packet with an indication of the C-network where it originated. It then bases its determination of what router to forward the packet to not only on the packet's destination address but also on the identity of the originating C-network. At each subsequent hop, the router looks up the packet's destination address in the forwarding table specific to the C-network that the tag designates.

This also solves another multiple-customer problem, that of the access control. If an enterprise buys network-backbone service from an Internet SP, it wants some assurance that its network receives only packets that originated in its own network. It also wants to be sure that packets originating in its network do not leave the enterprise network by accident. Of course, two enterprises might want to be able to communicate directly, or to communicate over the Internet. But they want such communication to occur only through "firewalls." By using the virtual router, the SP solves this problem, too.

SUMMARY OF THE INVENTION

We have devised a way for an SP to provide its customers the peer model's advantages at costs considerably lower than those that the conventional virtual-router approach exacts. The way in which we do this enables transit P-routers to base their routing decisions for VPN-destined packets on packet fields that the transit routers interpret without reliance on VPN-specific routing information.

To appreciate the resultant improvement, one must recognize that one of the main problems in large IP backbones is the quantity of resources (memory, processing, bandwidth) needed to maintain the routing information. If an SP now adds parallel routing information for, say, a hundred C-networks, the virtual-router approach requires that each physical P-router act as a hundred "virtual" C-routers. That is, each P-router runs one-hundred routing algorithms (one for each C-network), maintains one-hundred forwarding tables, etc. Clearly, this greatly exacerbates the existing information-maintenance problem.

Indeed, because of poor topological matching, the problem is even worse than it appears at first glance. SPs generally try to assign addresses in a topologically meaningful way. That is, the address a system has should be related to where it attaches to the SP's network. This sort of addressing scheme allows routing information to be aggregated; if addresses of links that are topologically close tend to have the same high-order bits, for instance, a single routing-table entry can be used for a large number of relatively close destinations. Such aggregation reduces the routing load on the P-routers.

But many customer enterprises' networks have addressing schemes that do not map well to the SP's backbone topology. So passing enterprise routing information into the P-network, as a peer-model organization does by definition, exacerbates routing-information overload.

And the virtual-router approach introduces a problem of its own. The C-network's interior-routing algorithm is now running both in C-routers and in P-routers. This blurs the administrative boundaries. If the routing algorithm fails, two different administrations must work together to troubleshoot it. This is in direct contradiction to a lesson of nearly all networking experience: interior-routing algorithms must be confined to a single administrative domain.

We greatly reduce these problems by a judicious use of packet tagging. PE routers in systems that implement the present invention's teachings still use VPN-specific routing information in making their routing decisions, so they still must maintain tables of such VPN-specific information. But they relieve transit routers of the need to do so. When a PE router receives a packet from a customer enterprise, it provides the packet with an internal-routing field, which a transit router can interpret as specifying the egress PE router that will forward the packet into the remotely located part of the customer-enterprise network. For example, the internal-routing field may include a tag that the transit router can interpret as specifying the next router on the way to that egress PE router. Consequently, transit routers need not concern themselves with routes to locations in the customer enterprises' networks. Yet the egress PE router can still determine the particular VPN into which it is to forward the packet, because the first PE router, which can identify the VPN by the CE router from which it received the packet, so

forms the internal-routing field's contents that it additionally specifies the target VPN. For example, the internal-routing field can include a second tag, one that the egress router can interpret as identifying the CE router that affords access to the addressed host in the proper VPN.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention description below refers to the accompanying drawings, of which:

FIG. **1** is a topological diagram of a VPN and a tagging sequence that its routers employ;

FIG. **2** is a diagram that illustrates the format of a tagged packet;

FIG. **3** is a diagram of the environment and format of a tag-distribution-protocol protocol data unit;

FIG. **4** is a diagram that illustrates the format of a conventional Border Gateway Protocol protocol data unit and its environment;

FIG. **5** is a diagram that illustrates the format and environment of a Border Gateway Protocol protocol data unit used to distribute VPN-distinguishing reachability information and tags; and

FIG. **6** is a diagram that illustrates the format of another conventional Border Gateway Protocol protocol data unit and its environment;

FIG. **7** is a topological diagram of a VPN that employs ATM switches in implementing the present invention's teachings;

FIG. **8** is a diagram of an ATM frame used in the FIG. **7** embodiment;

FIG. **9** is a topological diagram used to illustrate inter-VPN communication;

FIG. **10** is diagram that illustrates the format of a label-stack entry that may be used in implementing the present invention's teachings;

FIG. **11** is a state diagram of that describes aspects of the Tag Distribution Protocol;

FIG. **12** is a diagram that depicts the general format of the Tag Distribution Protocol protocol data unit ("a TCP PDU");

FIG. **13** is a diagram that illustrates the format of a time-length-value field;

FIG. **14** is a diagram that illustrates a particular format of a TDP PDU;

FIG. **15** is a diagram that depicts the format of a TDP_PIE_OPEN message;

FIG. **16** is a diagram that depicts the format of protocol information elements that carry optional parameters;

FIG. **17** is a diagram that depicts the format of a message field used to represent virtual-circuit-indicator ranges;

FIG. **18** is a diagram that depicts the format of a message field used to represent tag values;

FIG. **19** is a diagram that depicts the format of a field used to specify a particular type of tag binding;

FIG. **20** is a diagram that depicts a different format used for that purpose;

FIG. **21** is a diagram that depicts yet another format used for that purpose;

FIG. **22** depicts a TDP_PIE_REQUEST_BIND protocol information element ("PIE");

FIG. **23** depicts the format of an ALIST entry for ALIST_TYPE=1;

FIG. **24** depicts the format of an ALIST entry for ALIST_TYPE=2;

FIG. **25** depicts the format of a TDP_PIE_NOTIFICATION PIE used for error reporting;

FIG. **26** depicts the format of an error notification that results from receipt of a binding request containing a hop-count value that exceeds the maximum hop count;

FIG. **27** depicts the format of value field of a NO_ROUTE parameter;

FIG. **28** depicts the format of the TDP_PIE_WITHDRAW_BIND PIE;

FIG. **29** depicts the format of the TDP_PIE_RELEASE_BIND PIE;

FIG. **30** depicts the format of the TDP_PIE_KEEP_ALIVE PIE;

FIG. **31** depicts the format of the TDP_PIE_NOTIFICATION PIE;

FIG. **32** illustrates the use of such a PIE's RETURNED_DU parameter;

FIG. **33** illustrates the use of such a PIE's CLOSING parameter;

FIG. **34** depicts the format of a TDP_PIE_OPEN PIE;

FIG. **35** depicts the format of a TDP_PIE_REQUEST_BIND PIE; and

FIG. **36** illustrates the encoding of the MP_REACH_NLRI attribute.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

Overview

Before we describe an embodiment of the invention in detail, we will employ FIG. **1** to present a brief overview of its operation.

FIG. **1** depicts a very simplified topology for illustrating an SP's connections between two parts of a customer enterprise C's VPN. Two of the enterprise's edge routers CE**1** and CE**2** are located remotely from each other, and the customer enterprise has contracted with the SP to provide connections between the customer's routers such as CE**1** and CE**2** to form a VPN V. Among the SP's resources are edge routers PE**1** and PE**2** and further, transit routers P**1** and P**2** that together form a path between CE**1** and CE**2**.

Consider a packet that a router CE**2** receives from a location (not shown) in VPN V, and suppose that the contents D**1** of the packet's destination-address field is the address of a system in VPN V at CE**1**'s location. We assume that CE**2** has interfaces over which it could potentially have forwarded the packet to routers, not shown in the drawing, to which it is directly linked but that it concludes by consulting stored routing information that it should forward the packet over its interface to edge router PE**2** in the SP.

We also assume that the SP network has another customer for which it uses those same resources to implement a different VPN, W, that also includes a (differently located) host having the same address D**1**. From the fact that PE**2** has received the packet over its link with CE**2**, which is part of V rather than W, PE**2** can tell which D1-addressed system should receive the packet. The VPNs that the SP cooperates with its customers to implement follow the peer model, so PE**2** contains customer-network topological information that the customers have "leaked" to it. It stores this information in a separate routing table for each customer VPN to which PE**2** is directly connected, so it can disambiguate the otherwise ambiguous address D**1**. From this information, PE**2** knows that PE**1** is the SP edge router to which it should direct the packet in order to reach the D1-addressed system in VPN V.

Now, the goal is to have that other edge router, PE**1**, forward the packet to CE**1** so that the packet will reach the

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D1-addressed location in VPN V rather that the one in VPN W, to which PE1 may also be able to forward packets. Therefore, PE2 needs to include in the forwarded packet some indication that the intended D1-addressed host is the one in VPN V. In accordance with the invention, though, this should be done without requiring that transit routers P1 and P2 also maintain the VPN-specific information that the edge routers store.

PE2 achieves this by adding to the packet an internal-routing field that in the illustrated embodiment includes two constituent fields, namely, an egress-router field and an egress-channel field. The egress-router field takes the form of a tag that P2 can map to the next hop in the route to the egress edge router PE1, upon which the transit routers can base their routing decisions without requiring knowledge of the VPN involved. The egress-channel field takes the form of a tag that PE1 can interpret as specifying its interface with CE1 or as otherwise representing the channel that links it to VPN V.

Note that the goal of avoiding VPN-specific forwarding information could be achieved, though to a lesser degree, by having the internal-routing field include only an egress-channel field, not an egress-router field. The transit routers would then be basing their routing decisions on fields that in a sense do designate particular VPNs, but only because a given channel may lead only to nodes in a particular VPN. The transit routers still would not need to store information concerning locations in any of the customer sites.

But we prefer to use both an egress-router field and egress-channel field. Specifically, PE2 "tags" the packet with two tags T2 and T3. As will be explained in detail below, P2 has arranged with its neighbors, including PE2, to tag with T2 any packets sent to P2 for forwarding along a route in which the SP edge router is PE1. T3 is a tag with which PE1 has arranged for the other edge routers to tag packets destined for certain VPN V locations if PE1 is the egress router.

To describe one way to tag a packet, we begin with FIG. 2's first row, which illustrates an exemplary link-level-protocol format. Different link-level protocols may be employed on different links. Examples of such protocols are the IEEE 802 protocol family and the point-to-point protocol (PPP) specified in the Internet community's Requests for Comments ("RFCs") 1331 and 1332. Similar to the former is the Ethernet protocol. If the links connecting CE2 to PE2 and PE2 to P2 are Ethernet links, the link-layer frame that CE2 sends to PE2 takes the form that FIG. 2's top row depicts. Specifically, it consist of a link-level payload encapsulated by an Ethernet header and trailer. The Ethernet trailer consists of a cyclic-redundancy-code (CRC) field used for error detection. The Ethernet header includes destination-address and source-address fields, which respectively contain the link-level ("hardware") addresses of PE2's and CE2's interfaces to that link, and it also includes a type field used for demultiplexing the link packet's contents. In this case, the code represents the Internet Protocol (IP): the receiving router should interpret the contents as an IP "datagram" (as the IP protocol data unit is called), consisting of the IP header and IP data. (Of course, the payload could be a protocol data unit of some other network-level protocol, such as IPX or Appletalk.) Routers generally use network-protocol information to forward packets from one link to another along an internetwork path from the source interface to the ultimate destination interface.

FIG. 2's second row depicts the corresponding link-layer frame after PE2 has added T2 and T3. The Ethernet header and trailer take the same form as before. (For the sake of discussion, we assume that the link-level protocol is the same on the new link, although most embodiments will not exhibit such protocol uniformity.) Since the link-level source and destination are different, of course, the corresponding header fields' contents differ from those in the CE2-to-PE2 frame, and the CRC field contents, having been calculated from different frame contents, are different, too. But the difference most relevant to the present discussion is the type-field difference. Even though the frame does include an IP datagram, the type field does not contain the IP-indicating code. Instead, the code that it contains tells P2's interface that the frame's contents should be interpreted as a tagged packet.

This means that the four bytes immediately following the link-level header should be interpreted as an entry in a "tag stack," whose format FIG. 2's third row illustrates. Specifically, the first twenty bits should be interpreted as the tag, and the twenty-fourth, bottom-of-stack-indicator bit S tells whether the packet contains any more tag-stack entries. (The section below entitled "Internet Draft: Label Stack Encodings" contains a thorough description of the manner in which a tag-switching router can use the various fields, so we will not discuss the other, COS and TTL fields here.) In the example the tag field contains the "top" tag value T2, while the S bit is zero, indicating that this is not the bottom tag-stack entry. Therefore, P2 should interpret the next four bytes as a tag-stack entry, too. In the example, that entry contains a tag value of T3 and an indication that it is the bottom stack entry.

We now return to FIG. 1 and assume that PE2 has just sent P2 a packet thus tagged. Since T2 is a tag that P2 has arranged to have PE2 attach to packets that should follow routes in which PE1 is the egress router, P2 knows to forward that packet to the neighbor, P1, to which it sends PE1-directed traffic. (Again, P2 must make a routing decision because we assume that it additionally has direct links to other routers.) Note that P2 is able to make this decision without having had to maintain separate routing information for the VPN to which the packet is ultimately destined.

When P2 forwards the packet to P1, it replaces tag T2 with a new tag, T1, which P1 has asked its neighbors to attach to any packets that should be sent though PE1-egress routes, and P1 similarly makes its routing decision without having had to maintain separate routing information for the destination VPN. P1's stored routing information tells it to remove a tag rather than replace it, so it does so before forwarding the packet to PE1.

From tag T3, PE1 knows that it should forward the packet to the edge router CE1 that affords access to the D1-addressed location in VPN V. So PE1 forwards the packet to CE1 after removing tag T3. Since CE1 is concerned only with destination addresses in its own VPN, it is able to base its routing decision on D1 alone.

General Routing Features

Having now considered the illustrated embodiment's overall operation, we turn to a review of certain network-operation concepts that will provide a foundation for a more-detailed discussion of the operation described in the above overview. In a typical implementation, router circuitry for performing functions described below will be provided as communications hardware operated by one or more processors software-configured to perform the described operations. Those skilled in the art will recognize that such an approach is usually the most practical, because software configuration of a general-purpose processor enables a relatively small amount of hardware to serve as circuitry for

performing many different functions concurrently. But the present invention can instead be implemented in any circuitry that performs the functions described.

1. The FIB

In conventional IP forwarding, each router maintains a table, sometimes called the "Forwarding Information Base" (FIB), that it uses to map from "address prefixes" to "next hops." A router that receives a packet whose destination address begins with a given address prefix employs the next-hop entry as described below to determine the direction in which to forward the packet.

The manner in which the FIB is constructed is not critical to the present invention. In principle, a system administrator can provide it manually. More typically, routers build such tables automatically by employing routing algorithms to share topological information. But regardless of how the FIB is constructed, a conventional router R executes the following procedure (in principle) to find the next hop for a particular packet:

- It searches the FIB for longest address prefix that matches the IP (or other network-level) address in the packet's network-level destination-address field.
- It fetches the next-hop IP address, N, that corresponds to that address prefix.
- If N is the address of a router to which R is directly connected (i.e., if there are no routers between R and the next hop), then the procedure ends, and R forwards the packet over its link to the router whose address is N.
- If N is not the address of a router to which R is directly connected, then R performs a recursive lookup. That is, it searches the FIB for the longest address pre-fix that matches N, fetches the corresponding next-hop IP address N2, determines whether N2 is directly connected, etc. The recursion ends when R finds a next hop directly connected to it, and it R forwards the packet over its link to the router whose interface has that address.

In practice, as those skilled in the art will recognize, the FIB will have been preprocessed to eliminate the need to perform the recursion during actual packet processing. To avoid complicating the discussion unnecessarily, though, we omit a description of such conventional preprocessing.

A normal Internet router maintains only one FIB table. But routers in a provider of connections for many enterprises' peer-model VPNs need different tables for different VPNs, because a router may need to distinguish between potentially identical prefixes in different VPNs. (Each SP router also needs to maintain a general, i.e., non-VPN-specific, FIB. Unless explicitly stated otherwise, references below to the FIB mean the general FIB.) In accordance with the present invention's teachings, though, transit routers, i.e., routers that are not directly attached to customer's VPN, do not need to maintain VPN-specific FIBs. (We consider a PE router to be "directly attached" to a particular VPN if it is directly attached to a CE router in that VPN.) And an edge router such as PE1 or PE2 needs to maintain, in addition to a general FIB, a separate FIB only for each VPN to which it is connected directly. The reason why this is so will become apparent as the description proceeds.

In the illustrated embodiment, each FIB entry actually differs somewhat from that described above, because the illustrated embodiment uses "tag switching." When data-transmission speeds become high and network sizes become large, searching for longest matches to the packet's ultimate-destination address becomes onerous. So proposals have been made to reduce this burden by "tagging" the packets.

A tag is a field that routers use to make routing decisions. Unlike a network-level address, though, a tag is a true (unique) index to a given router's routing table, whereas the network (e.g., IP) address in the destination field of a packet's header is merely an invitation to a router to find the address prefix that constitutes the best match. By reducing the need for best-match searches, conventional tagging reduces a router's processing burden. And we use tagging in such a way as additionally to reduce routers' storage burdens, as will become apparent after a discussion of further tag-switching and other features.

One way to implement tag switching is to have routers tell their neighbors the tags they want to see in the packets that they receive. Specifically, a given router may decide to associate a particular tag with ("bind a particular tag to") a particular address prefix. If so, it tells its neighbor routers that, when they forward it a packet destined for an address having that prefix, they should attach the specified tag so that the given router can go straight to the right table entry without having to do a best-match search. (Although the illustrated embodiment bases tagging on address prefixes, other embodiments may base it on some other packet attribute that is relevant to routing.)

When tag switching is used, the forwarding table does not merely map an address prefix to a next-hop IP address; it maps the address prefix to an ordered pair whose first element is a next-hop IP address and whose second element is a tag-stack operation. That is, an FIB next-hop entry contains both a next-hop IP address and a tag-stack operation.

Initially, we need to consider only two tag-stack operations:

No op.

Push a specified tag value onto the stack.

The "no op" value is the default tag-stack-operation entry. As will be explained below, neighbors' requests may result in that entry's being modified to contain a push operation.

When router R receives an untagged packet, it finds the longest address-prefix match to R's destination IP address, and it fetches the corresponding next-hop entry. If that next-hop entry's tag operation is "push a specified tag value onto the stack," it pushes the specified tag value onto the tag stack that the packet includes. If it is necessary for R to perform a recursive lookup, it searches for another next-hop entry. If that next-hop entry also has a "push a specified tag value onto the stack" operation in it, that specified value is also pushed. If the recursion ends as a result of the second lookup, then two tag values may have been pushed onto the tag stack.

When the recursion ends (or if there is no recursion), R knows which of its directly connected neighbors is the next hop for the packet. It then transmits the packet to that next hop, using whatever data-link protocol is necessary in order to reach that next hop.

2. The TIB

When a router R uses tag switching, it fetches next-hop information in response to a tag, so it uses a routing table separate from the FIB, from which it fetches next-hop information in response to a destination address. This separate table is sometimes called the Tag Information Base (TIB). The TIB next-hop entries contain a next-hop IP address and a tag-stack operation. For our purposes, we need consider only three tag-stack operations:

remove the tag stack's last-added ("top") value ("pop the stack");

replace the top tag-stack value with a specified value; and

discard the packet.

When router R receives a tagged packet, it uses the packet's top tag as an index into the TIB and fetches the indicated entry. (Those skilled in the art will recognize that security requirements, local-link constraints, or other considerations may in some cases necessitate that the index into the TIB actually consist of both the incoming packet's tag and the interface on which it arrived, but the principle is best explained without complicating the discussion with those details.) In accordance with the fetched TIB entry, it either replaces the tag with a different value or pops the tag stack.

If the TIB entry's next-hop field is the address of one of R's directly connected neighbors, R uses the appropriate data-link protocol to send the tagged packet to that neighbor. If the next hop specified in the TIB entry is not a directly connected neighbor, on the other hand, then R (again, in principle) performs a recursive lookup by finding the FIB entry that corresponds to that address. (The FIB is used since this part of the search is based on an address, not a tag.) Then processing proceeds as described in "The FIB" above.

3. How Interior Routing Algorithms Modify the FIB and the TIB

As was stated above, the present invention does not require any particular mechanism for providing the contents of the FIB and the TIB. But considering one such mechanism, namely, routing protocols, helps one appreciate those contents' purpose. The types of protocols that it uses can be divided into interior gateway protocols (IGPs), exterior gateway protocols (EGPs), and tag-distribution protocols (TDPs). Routers in an internetworking domain under single administration use IGPs to share topological information about that domain. Routers use EGPs to share extra-domain topological information. They use TDPs to distribute tags.

Typically, every router runs an IGP. Examples of such protocols are OSPF, EIGRP, and IS-IS. From time to time, a router sends to its same-domain neighbor routers IGP messages that "advertise" destinations to which it accords direct access. The neighbors in turn forward the messages to their neighbors. In some protocols the forwarding routers modify the messages in such a way that a message tells what route it took to reach the recipient, or at least how long the route was. In any case, the recipient thereby amasses topological information and decides on the basis of that information whether to enter into its FIB as the next hop to the advertised destinations the address of the router that forwarded it the message. So FIB entries that an IGP creates are always non-recursive: the next hop is always a directly connected neighbor.

The customer-enterprise routers may also use an IGP. Although the drawing does not show them, the customer enterprise would typically also have further routers at the same sites as CE1 and CE2, and those routers may use an IGP. But the customer enterprise's nodes that have access to each other only through the provider network do not use an IGP to exchange routing information with each other, so the routers at, for instance, CE1's site use an IGP only for routing-information exchange with other routers at the same site (or other sites to which there is customer-managed access), not for such exchange with routers at CE2's site.

When IGP maps address prefix X to next hop N, it may modify both the FIB and the TIB. The FIB modifications are as follows:

If the FIB already contains an entry that maps X to a next hop, and the next hop is N, then no change is made.

If the FIB does not already contain an entry that maps X to any next hop, or if the FIB already contains an entry that maps X to a next hop other than N, then IGP inserts an entry that maps X to N and removes any entry that maps X to a different router. In a tag-switching routine, the IGP process then determines whether N has sent R a message that binds X to some tag value T. If not, the FIB entry is inserted with the tag-stack operation "no op." Otherwise, the FIB entry is inserted with the tag-stack operation "push T onto the stack."

The TIB modifications are as follows:

If no FIB modification has been made, then no TIB modification is made, either.

If an FIB modification has been made, then R determines whether it has told any of its directly connected neighbors to tag X-destined packets with some tag value T. If not, it makes no TIB modifications. Otherwise, it looks up the TIB entry that corresponds to T.

If there is no corresponding TIB entry, R inserts one for tag T having a next-hop entry of N. If there is a corresponding TIB entry, it replaces the next-hop entry with N.

R then determines whether N has asked it to tag X-destined tags with some tag value T2. If not, the tag-stack operation is "discard the packet." Otherwise:

If N's requested "tag" T2 for X-destined packets is a actually a distinguished tag value that means "pop the tag stack," then N has not really asked that R place a tag on such packets but instead has asked that it merely remove one already in the packet. So TIB entry's tag-stack operation is "pop the tag stack."

Otherwise, the TIB entry's tag-stack operation is "replace the packet's top tag-stack value with T2."

A distinguished value of "next hop" that may exist in both the FIB and the TIB is "me." This means that a packet has reached its final hop, and is delivered to local software rather than forwarded over a data link to a next hop.

4. Edge Routers and the IGP

Now, it was stated above that IGP speakers periodically advertise address ranges to which they afford direct access. If P1 is on a subnet in which all hosts' addresses start with 192.3.45, for instance, it will advertise this prefix, and every IGP speaker in the SP network will have an entry for that prefix in its FIB. Therefore, if PE1 has an interface on the same subnet, say with an address of 192.3.45.12, then those IGP speakers will be able to determine how to reach PE1. But it will become apparent as the description proceeds that, in order to assign certain tags, the illustrated embodiment requires each SP router additionally to have PE1's full address as a prefix in its FIB. And, in general, each SP router should have such a "host route" for every PE-router. (A host route is one whose prefix is the length of a complete IP address and thus corresponds to only one host.) So edge routers in the illustrated embodiment advertise not only the address ranges to which they have access but also their own complete addresses. (Actually, as will shortly be explained, the edge routers are also "BGP speakers," which would conventionally advertise their host routes in IGP anyway.)

5. How BGP Modifies the TIB and the FIB

It was mentioned above that IGPs are used for propagating routing information among routers connected by routes within a commonly administered domain. In such a domain, the assumption is that routers are generally to cooperate in routing any received packets and that they will accumulate

routing information from all sources within that domain. But a domain administered by one entity may additionally be connected to domains administered by others. For such connections, a given domain may choose to be selective about what traffic it will forward and which of its resources it will make available for that purpose. Additionally, it typically is not practical to accumulate routing information from all routers in every other domain, even if the other domains were inclined to supply it, so inter-domain topology-information sharing calls for some selectivity.

This is not something to which IGPs are well suited. For communicating information of that type, therefore, routers involved in communication among such "autonomous systems," as they are called, use external routing protocols, such as External Gateway Protocol (EGP). For the sake of concreteness, we assume here that the external routing protocol used here is the one specified in RFC 1654 and referred to as the Border Gateway Protocol (BGP).

In BGP, the type of message used to advertise a route is called an "update" message. In a conventional, non-tag-switching BGP implementation, an update message contains an address prefix, a "BGP next hop," and an AS Path, which lists the autonomous systems traversed in reaching the advertised destinations. With tag switching, this is modified to add a tag to each address prefix.

When a router R receives a BGP update message for address prefix X from a BGP peer R2, R runs the BGP decision process. Policies that the BGP process implements may or may not result in R's installation of R2's route to X. But if they do, then:

- If the FIB does not already contain an entry that maps X to a next hop, or if it contains an entry that maps X to a next hop other than the one specified in R2's BGP update message, then R adds an entry that maps X to the specified next hop, and it removes any previous entry for X. This next hop will not in general be a directly connected neighbor of R, so the FIB entry may be a recursive one. (In the cases in which we are interested, R2 will specify itself as the BGP next hop, in which case the FIB entry will map X to R2.) If R2's BGP Update message specified tag value T for address prefix X, then the tag-stack operation in the FIB entry is "push T onto the tag stack." Otherwise, the tag-stack operation is "no op."
- If the FIB already contains an entry that maps X to a next hop, and the next hop is the same as the one specified in R2's BGP Update message, then the FIB entry's next-hop field is left unchanged. If R2's BGP Update message specified tag value T for address prefix X, then the FIB entry's tag-stack operation is changed (if necessary) to be "push T onto the tag stack." If R2's BGP Update message specifies no tag value for X, then the tag stack operation in the FIB entry is changed (if necessary) to "no op."

6. The Decision to Distribute a Tag Binding

The preceding discussion concerned what happens when a router has asked another router to associate a tag with a prefix. We now describe the circumstances under which a router makes such a request.

In most tag-switching proposals, a router is allowed to bind a tag to an address prefix if the router's FIB table includes an entry that corresponds to that address prefix. In the illustrated embodiment, if the FIB-entry "prefix" is the complete address ("host route") of a router in the SP's network, then binding a tag to that prefix is not only permitted but required.

If X is the (thirty-two-bit) address of the router R itself, then the tag value that R binds to X is the distinguished value that means "pop the tag stack."

When a tag T is bound to an address prefix X, and the FIB entry for X was inserted as a result of running the IGP, R will distribute the tag binding to its directly connected neighbors by using a tag-distribution protocol that will be described below.

When a tag T is bound to an address prefix X, and the FIB entry for X was inserted as a result of running BGP, R will use BGP to distribute the tag binding, in a manner that will be described below, to any BGP peer to which it distributes the route to X.

If router R binds to an address prefix X a tag T other than the distinguished value that means "pop the tag stack," then R also creates a T-indexed TIB entry in its own TIB table. The TIB entry is created as follows.

- Suppose that R is a PE router, and address prefix X is one for which the next hop is a directly attached CE router. (As will be explained below, the prefix value will have been enhanced to distinguish X in CE's VPN from X in others'.) Then the TIB entry will specify the CE router as the next hop, and its tag-stack-operation entry will be "pop the tag stack."
- Suppose that the FIB entry corresponding to X specifies a next hop of N and a tag-stack operation of "push value T2 onto the stack." Then the TIB entry will give N as the next hop and "replace the value at the top of the stack with T" as the tag-stack operation.
- Suppose that the FIB entry corresponding to X specifies a next hop of N and a tag-stack operation of "no op." Then the TIB entry will specify a next hop of N, and a tag-stack operation of "discard the packet."

Detailed Example

We now have enough background to describe in detail the way in which the illustrated embodiment performs the operations mentioned briefly in connection with FIG. 1 For this purpose, we return to FIG. 1.

All of FIG. 1's P routers (PE1, PE2, P1, and P2) participate in a common IGP. CE1 and CE2 do not participate in this IGP. CE1, PE1, CE2, and PE2 are BGP speakers. CE1 has an External BGP (EBGP) connection to PE1, PE1 has an Internal BGP (IBGP) connection to PE2, and PE2 has an External BGP connection to CE2. (As those skilled in the art are aware, the way in which a BGP speaker reacts to BGP messages originating in its own autonomous system differ from the way in which it responds to BGP messages that originate in a different autonomous system. The BGP session is commonly referred to as "internal" in the former case and "external" in the latter.)

1. FIB Entries that IGP Creates

Since PE1 is an edge router, it exports its own thirty-two-bit address into the P-network's IGP. As a result:

- PE2 has an FIB entry that maps PE1 to a next-hop value of P2. Since P2 is directly connected to PE2, this entry is non-recursive.
- P2 has an FIB entry that maps PE1 to a next-hop value of P1. Since P1 is directly connected to P2, this entry is non-recursive.
- P1 has a FIB entry that maps PE1 to a next hop value of PE1. Since PE1 is directly connected to P1, this entry is non-recursive.
- PE1 has a FIB entry that maps PE1 to a next hop value of "me."

2. TDP Messages; TIB Entries Created as a Result of TDP Processing

As was mentioned above, the illustrated embodiment requires that each of the SP's routers construct a TIB by assigning tags to all of the prefixes for which its FIB has entries and that it ask its neighbors to use those tags in forwarding data packets to it. A mechanism that they can use to make those requests is a tag-distribution protocol (TDP). The section below entitled "Internet Draft: Tag Distribution Protocol" describes that protocol in detail. Here we only digress briefly to mention certain salient features.

TDP is a two-party protocol. It requires a connection-oriented transport layer that provides guaranteed sequential delivery. FIG. **3**'s second row therefore depicts TDP's protocol data units (PDUs) as being carried in a data stream delivered by the well-known Transport Control Protocol (TCP) whose segments are delivered in Internet Protocol (IP) datagrams whose format FIG. **3**'s first row depicts. (That row omits the link-level-protocol header and trailer fields that usually encapsulate the IP datagram for transmission between hosts on the same link.)

The IP datagram begins with a header that includes various types of information such as the datagram's length, the network address of the destination host interface, and a code for the next-higher-level protocol in accordance with which the destination host should interpret the datagram's payload. In the illustrated example, that protocol is TCP, which handles matters such as ensuring that data have been received reliably. As the drawing illustrates, the destination host's TCP process interprets the first part of the IP field as a header used in carrying out these TCP functions. In particular, that header includes a field that specifies the "port" application that is to receive the TCP segment's remainder, payload portion. In the case under consideration, the port field indicates that the host's TDP application is to receive it.

Concatenation of TCP-segment payloads results in a data stream that contains the TDP PDUs.

A TDP PDU begins with a fixed-length four-field header. The header's two-byte version field gives the number of the TDP version that the sender is using. The two-byte length field gives the length in bytes of the remainder of the PDU; i.e., it gives the total PDU length minus four.

As will be explained shortly, TDP communications occur in sessions, of which a given router can be conducting more than one at a time. The first four bytes of the six-byte TDP ID field encode an IP address assigned to the router that started the TDP session, and the TDP ID field's last two bytes identify the particular session.

A two-byte field reserved for further enhancements completes the header, and the remainder of the PDU comprises one or more protocol information elements (PIEs), which take the type-length-value format that FIG. **3**'s third row illustrates.

Each PIE's type field specifies its purpose, while its length field gives the length of its value field. Various PIE types have housekeeping purposes, such as instituting a TDP session between two routers, negotiating protocol versions, providing error notifications, and keeping the session alive. (If a router does not receive a same-session communication within a certain timeout period, it ends the session and discards the tags installed during the session.) But the protocol's main mission, i.e., distributing tag bindings, is carried out by PIEs of the TDP_PIE_BIND type, for which the type field's contents are 0200_{16}.

FIG. **3**'s fourth row depicts this PIE type's value segment. In that segment the request-ID field is zero unless the PIE is being sent in response to a request from the other session participant, in which case that field's request ID matches that of the request. (Such a request would have been sent as another PIE type.) The AFAM (Address Family Numbers) field is set to 1, indicating that the address prefixes contained in the PIE's binding list are intended to be interpreted as IP version 4 (IPv4). If either the sender or the receiver of this PIE is using ATM switching hardware to implement the tag switch forwarding path, the Blist Type field is set to 6 ("32-bit downstream assigned VCI tag") to indicate that, as will be seen below, the tag has a format and location specific to the ATM protocol. Otherwise it is set to 2, which means "32-bit downstream assigned." Downstream assigned means that a tag's meaning is being set by the router that will base its routing decisions on it, as opposed to the router that will tag the packet with it. The next, Blist Length field gives the length in bytes of the Binding-List field, and the optional-parameters field is sometimes included to present related information.

Of these fields, the field of most interest here is the Binding-List field, whose format FIG. **3**'s fifth row depicts. That field contains one or more entries. When the Blist Type is 2, each of the entries includes precedence, tag, prefix-length, and prefix fields, as FIG. **3**'s fifth row indicates. To bind tag T to prefix X, the prefix-length field contains X's length in bits, the prefix field contains X's value right padded with as many bits as needed to make it end on a byte boundary, and the precedence field is an eight-bit field that specifies the precedence with which the router that issued the PDU will service traffic that bears T as a tag.

So to request that a neighbor router use a given tag value when it forwards packets destined for a given prefix, a router sends a TDP message containing a TDP_PIE_BIND type PIE whose binding-list portion's tag and prefix fields respectively contain that tag and prefix.

Now, PE1 uses this mechanism to ask that P1 bind to PE1's own address a distinguished tag value that means "pop the tag stack." (It makes a similar request to any other of the SP's transit routers to which it is directly connected.) The purpose of this request is to establish PE1, an edge router, as one that should see the lower, ultimate-destination-designating tag (T3 in FIG. **1**) hidden from the transit routers. As a result of PE1's having advertised its host route, P1 already has an FIB entry that maps PE1's address to a next hop of PE1 and a tag-stack operation of "no op." As was stated above, the SP's routers are required to create TIB entries for all prefixes that they have FIB entries for, so P1 assigns a tag T1 to PE1 by creating a TIB entry that maps T1 to the destination PE1. And, in accordance with PE1's bind request, that entry's tag-stack operation is "pop the stack."

P1 must also distribute the new tag, so it uses TDP to ask that P2 use the T1 tag whenever it sends P1 a packet destined for PE1.

PE1's advertisement of its host route has resulted in P2's already having a FIB entry that maps PE1's address to a next hop of P1 and a tag-stack operation of "no op." P2 now modifies this FIB entry so that the tag-stack operation is "push T1."

Since PE1 is a destination in P2's FIB, P2 must bind a tag value to PE1's address. That is, it creates a TIB entry that maps T2 to a next hop of P1—i.e., to its FIB's next-hop entry for PE1—and to a tag-stack operation of "replace the top tag value with T1." P2 then uses TDP to ask that PE2 use tag value T2 whenever it sends P2 a packet destined for PE1.

PE2 already has a FIB entry that maps PE1's address to a next hop of P2 and a tag-stack operation of "no op." In

response to P2's TDP message, PE2 now modifies this FIB entry so that the tag-stack operation is "push T2."

3. EBGP Messages from CE Routers to PE Routers

So far we have described only the tag binding that results from the routing information that the SP's routers have used an IGP to share with each other. But the present invention is intended to be used to implement a peer-model VPN, so the client enterprise, too, shares routing information with some of the SP's routers.

The CE1 router is a routing adjacency of the PE1 router. That is, when CE1 forwards a packet destined for a remote system that can be reached through PE1, CE1 explicitly directs that packet to PE1. In the illustrated example as it will be elaborated on in connection with FIG. 2, it performs the explicit direction by encapsulating the packet in a link-level header containing PE1's hardware address on a common multinode network. In other configurations, it may do so by, for instance, placing that packet on a point-to-point link with or by sending the packet in transmission cells whose headers include a code that represents a channel between CE1 and PE1. Yet another way of providing the explicit direction is to use, e.g., encapsulated IP, whereby the packet includes an IP datagram whose destination address is PE1's network address but whose payload is another IP datagram, this one having the destination address of the remote destination. In this way, an internetwork route between CE1 and PE1 acts as a "link" in a higher-level internetwork route.

In contrast, CE1 is not in general a routing adjacency of CE2. That is, even when CE1 forwards a packet destined for a remote system reachable through CE2, it never explicitly specifies CE2 as a router through which the packet should pass on the way. True, the fact that CE2 is in the route may have been included in the reachability information that CE1 amassed in the course of filling its forwarding-information database. But in the course of actually forwarding a packet, CE1 simply notes that PE1 is the next hop to the ultimate destination.

In the FIG. 1 topology, suppose that CE1 is to tell PE1 which hosts are reachable at its site. For this purpose, it must use an external routing protocol, and we have assumed for the sake of example that it uses BGP. Together with RFC 1655, RFC 1654 and its predecessors describe that protocol's operation exhaustively, and we will not repeat that description here. For present purposes, we mention only a few features of most interest to the illustrated embodiment's operation.

As FIG. 4's first row indicates, BGP uses the TCP transport protocol. Concatenation of TCP-segment payloads results in a data stream in which the BGP application looks for a predetermined marker sequence. It interprets the marker and subsequent fields as a BGP message header that contains information such as the message's length and type. To share routing information, the type of message that CE1 uses is the BGP "Update" message, whose format FIG. 4's second row depicts.

The drawing uses a section labeled "header+" to represent the header and a number of fields not of particular interest to the present discussion. The message ends with a list of interface address prefixes referred to as Network-Level Reachability Information (NLRI), and a Path Attributes field describes a path to hosts whose IP addresses begin with those prefixes. A Path Attribute Length field ("PAL" in the drawing) tells how long the Path Attributes field.

In the present example, let us suppose that CE1 is at a site where all the hosts have IP addresses whose first byte is 10 ($0A_{16}$) and whose second byte is 1 (01_{10}). That is, they can be represented by the two-byte prefix $0A01_{16}$ (which the literature conventionally represents as "10.1.") To communicate this, CE1 places in an NLRI-field length segment an indication that the prefix to follow is two bytes in length, and it puts $0A01_{16}$ in the following, prefix field, as FIG. 4's third row indicates.

FIG. 4's third row depicts the message's path-attributes portion as having three attribute fields, of which FIG. 4's fourth row illustrates one in detail. Attribute fields take the <type, length, value> form. The type field's second, "attribute code" half is shown as containing the code value of 2, which indicates that the value field is to be interpreted as describing a path to the hosts that the message advertises as being reachable. Specifically, it is to be interpreted as listing the "autonomous systems" that have to be traversed to reach those hosts.

Now, whenever a system has a BGP connection of any sort, it must use an Autonomous System Number (ASN). This is a number that the assigned number authority issues so that independently administered systems can identify each other when they use an external routing protocol. An "autonomous system" (AS) is a system under administration separate from others, and connection among an AS's hosts, whether direct or indirect, must be possible by way of the AS's resources only. Since CE1 cannot communicate with CE2 without using the SP's resources, the customer-enterprise-administered resources comprise at least two ASs. So we will assume that CE1's ASN is A1, CE2's ASN is A2, and the PE routers' ASN is A3.

From PE1, only AS A1 is involved in reaching the hosts represented by prefix 10.1. To indicate this, the AS-path attribute's value includes a first field that identifies it a sequence of ASs, a second field that gives the number of ASNs in the list as one, and a third field that contains the list's sole ASN, A1.

FIG. 4's fifth row depicts another of that message's attribute fields, one whose attribute-code byte identifies it as specifying the "next hop" to be used in reaching the advertised host-address range. The value field contains CE1's address, thereby indicating that CE1 can forward traffic to those reachable destinations.

So CE1 has told PE1 that it undertakes to forward traffic to hosts whose IP address prefixes are 10.1. In response, PE1 assigns a tag, T3, to that address prefix in CE1's VPN, VPN V. (Actually, PE1 may use the same tag value for every address prefix mentioned by CE1.) In its TIB, PE1 creates an entry, indexed by this tag value, that specifies CE1 as the next hop. The entry specifies a tag-stack operation of "pop the tag stack" so that the tag used will be discarded to reveal the network-layer header to CE1.

4. IBGP Messages from PE1 to PE2

Additionally, PE1 sends BGP update messages to certain other of the SP's routers to tell them that they can forward to PE1 any packets destined for hosts whose addresses are in the 10.1 range. But PE1's SP network provides service to other customer enterprises that may also have 10.1-prefix hosts: those hosts' addresses may not be unique. So the SP assigns a different VPN identifier to each of its customers' VPNs. In the case of CE1's enterprise, let us assume that the code is a 16-bit identifier V. PE1 prepends the VPN identifier V to the IPv4 address prefix (10.1 in the example) and uses it in the BGP message to the other provider routers.

Indeed, the SP may assign VPN V more than one VPN identifier. A reason for doing so could arise if VPN V uses the SP not only as its backbone but also as its connection to

outside systems, such as the SP's other customers or the public internet. In addition to the above-described reachability advertisement, which VPN V does not intend the SP to share with systems outside the VPN, CE1 or another of VPN V's edge routers could also send PE1 information regarding routes over which VPN V would permit outside-origin traffic. For example, one route to a given node may be shorter and thus preferred for traffic from within the VPN, but a different route to the same node may include a firewall and therefore be preferred for traffic from outside the VPN. CE1 could specify the permitted scope of dissemination by using, say, the BGP communities attribute (RFC 1997) in the update message, or it could distinguish between different dissemination scopes by using separate channels between it and PE1 (e.g., by using different ones of PE1's IP addresses) for the different scopes.

PE1 must make this distinction in BGP messages that it sends to others of the SP's routers, because the roles of various SP routers as edge and transit routers is not in general the same for intra-VPN traffic as they are for inter-VPN traffic. To distinguish between different routes to the same destination, PE1 may prepend a first VPN identifier, say, V_I, to prefixes in routes intended only for intra-VPN advertisement and a second identifier, say, V_E, to prefixes in routes whose extra-VPN advertisement is permitted. Further identifiers may be used for further dissemination scopes. For the sake of discussion, though, we will assume that VPN V uses the SP as its internal backbone only and that the SP has accordingly assigned VPN V only one VPN identifier.

In accordance with the present invention, transit routers do not need the reachability information that CE1 has shared with PE1. So PE1 does not send the BGP message to the transit routers, and it may not send it to all edge routers. But FIG. 1 depicts only one other edge router, router PE2, and PE1 does send the BGP message to PE2, because that router is connected directly to VPN V. Those skilled in the art will recognize, though, that the message does not have to be sent as part of an actual BGP session between PE1 and PE2. In some large service providers, it is not considered practical for each BGP speaker to maintain BGP sessions with all other BGP speakers. So "route reflectors" act as intermediaries, maintaining sessions either directly or through other route reflectors with each of the BGP speakers and thereby propagating the necessary routing information. In that way, the number of IBGP sessions increases only linearly with the number of BGP speakers. But the diagram shows only two PE routers, so it includes no route reflectors.

Regardless of how PE1 sends the message, FIG. 5 illustrates that message's format. Since it is a BGP update message, its format is similar to the one that CE1 sent to PE1. Instead of using the conventional NLRI field to contain reachability information, though, PE1 obtains the greater format flexibility needed for the VPN-IPv4 address by using a "multiprotocol reachability information" type of attribute field, which has its own NLRI subfield. As FIG. 5's fourth row indicates, this type of attribute's code is 14. The first three octets of this type of field specify the address family that the attribute value will use to represent the reachability information in the NLRI field, and FIG. 5's fifth row shows that PE1 assigns these bytes a value representing the Tagged VPN-IPv4 format.

As FIG. 5's sixth row illustrates, the Tagged VPN-IPv4 format starts with a four-byte tag, whose value is T3 in the example. This is followed by a field representing the prefix-field length, which is four bytes in the example. The prefix field's first two bytes encode the value V, which identifies the VPN, and the second two bytes have the value $0A01_{16}$, i.e., the sixteen-bit address prefix 10.1.

The other fields that FIG. 5's fifth row depicts include a next-hop field and a field that tells how long the next-hop field is. The next-hop field contains a six-byte VPN-IPv4 address whose first two bytes are zero—the next hop is not one of the customers' routers—and whose remaining four bytes are PE1's IP address. the section below entitled "Internet Draft: Multiprotocol Extensions for BGP-4" describes messages of this general type in more detail.

In response to this message, PE2 extracts the NLRI field's VPN-IPv4 value and decodes it into a VPN identifier and an IPv4 address prefix. In its FIB for that VPN, it creates an FIB entry that maps the IPv4 prefix to a next hop and a tag-stack operation. The next-hop value is PE1's address (since PE1's address appeared in the message's next-hop field). The tag-stack operation is "push tag value T3 onto the tag stack." Since PE1 is not a direct neighbor of PE2, this is a recursive FIB entry.

Note also that BGP Update messages concerning VPN-IPv4 address prefixes cause modification only of the VPN-specific FIB, not of the general FIB. However, if the original BGP message from CE1 had indicated that the reachability information could be disseminated beyond VPN V (or a broader dissemination scope could be inferred from, e.g., the channel by which it came, then PE2 would additionally install that IPv4 prefix, next hop, and tag-stack operation in the FIBs for all the VPNs to which that information's dissemination.

Although the illustrated embodiment employs only a single service provider to provide the VPN's backbone, there is no reason why more than one SP, whose facilities constitute more than one autonomous system, cannot cooperate to implement the present invention's teachings. In that case, the tag-binding and reachability information would further flow from one SP to the next by EBGP in the FIG. 5 format.

Specifically, the egress PE router in one of the SP networks could use BGP to distribute a tag binding for a particular VPN-IPv4 address to the BGP border router between the two SP networks. That BGP border router would then distribute a tag binding for that address to the ingress PE router.

5. EBGP Message from PE2 to CE2

PE2 then relays this information to CE2 by sending it an EBGP message similar to the one that CE1 sent to PE1. As FIG. 6 shows, this message's NLRI field indicates that hosts whose addresses begin with prefix 10.1 are reachable, its next-hop attribute field indicates that the next hop in the route to those hosts is PE2, and the AS-path attribute field indicates that the path to that prefix traverses autonomous systems A1 and A3.

When CE2 receives this message, it creates an FIB entry that maps prefix 10.1 to a next hop of PE2. Note that CE2 need not support tag switching. CE2 must also use its own IGP to inform other routers (not shown) at its site that it has a route to hosts whose addresses begin with prefix 10.1.

6. Tracing a Data Packet

As a result of these operations, the various routers have the routing information that they need when CE2 sends to PE2 a data packet P whose destination address is 10.1.0.1, which FIG. 1 depicts as "D1"

To send P, CE2 looks up address 10.1.0.1 in its FIB and finds that the longest matching address prefix is the sixteen-bit prefix 10.1. The corresponding next hop is PE2. CE2 is

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directly attached to PE2, so it forwards P to PE2 over the data link connecting the two routers.

PE2 receives packet P and notes that it received that packet from a particular VPN, VPN V. For the sake of simplicity, we assume that PE2 concludes this from the fact that it receives the packet over a point-to-point interface dedicated to communication with CE2. But edge routers can base that determination on other factors instead. For example, suppose that the interface the interface is a local-area-network interface over which packets from different VPNs could arrive. In that case, CE2 might rely on the data-link source address and base the determination on its knowledge of the VPN's constituent systems. Other implementations may base the source determination on cryptographic authentication data that the packet contains. In a similar vein, the log-in procedure performed by a customer contacting the PE router by way of a dial-in link may result in the PE router's obtaining information from an authentication server, and it may base its identification of the source VPN on this further information.

In any event, the PE router identifies the source VPN, and the source VPN in this case is VPN V. So PE2 looks up P's destination address in its FIB that is specific to VPN V. It finds that the longest matching address prefix is the sixteen-bit prefix 10.1. (In this example, which focuses on intra-VPN communication, we assume that PE2 further infers from the source determination that the packet is not to be permitted outside VPN V, so PE2 would not look further if it failed to find a match. In other circumstances, though, PE2 might look in the FIBs of other VPNs, which may have indicated their availability to forward packets to that address.) The corresponding next hop is PE1, and the tag-stack operation is "push T3 on the tag stack." So PE2 creates a tag stack for P and pushes T3 onto it. Since PE2 is not directly connected to PE1, P2 performs a recursive lookup in its general FIB.

We know from the preceding discussion that PE2 has an FIB entry corresponding to PE1's thirty-two-bit address, that the next hop in that FIB entry is P2, and that the tag-stack operation in that FIB entry is "push T2 onto the tag stack." So PE2 pushes T2 onto P's tag stack. The stack now has two tags; the top tag T2, and the bottom tag is T3. PE2 tags P with this stack and sends P over the data link to P2, as FIG. 1 shows diagrammatically.

When P2 receives packet P, it attempts to forward it by looking up T2 in its TIB. From the tag-distribution discussion, we know that T2 maps to a TIB entry whose next hop is P1 and whose tag-stack operation is "replace the top tag value with T1." So P2 performs the tag-stack operation and sends the packet over the data link to P1. (At this point, packet P's top tag is T1, and its bottom tag is T3.)

When P1 receives packet P, it attempts to forward it by looking up T1 in its TIB. We know from the tag-distribution discussion that T1 maps to a TIB entry whose next hop is PE1 and whose tag-stack operation is "pop the tag stack." So P1 performs the tag-stack operation and sends the packet over the data link to PE1. (At this point, packet P is carrying only one tag, T3.)

When PE1 receives packet P, it attempts to forward it by looking T3 up (which is now at the top of the stack) in its TIB. We know from the tag-distribution discussion that T3 maps to a TIB entry whose next hop is CE1 and whose tag-stack operation is "pop the tag stack." So PE1 performs the tag-stack operation and sends the packet over the data link to CE1. Note that PE1 has popped the last tag off the tag stack before sending the packet to CE1. So CE1 receives an untagged packet, which it forwards in the conventional way.

Now, although we introduced the foregoing example with FIG. 2's illustration of Ethernet as the link-level protocol, those skilled in the art will recognize that other protocols can readily be substituted. The adaptations required for that purpose are largely straightforward and do not in general require separate discussion. But there may be some value in briefly discussing an Asynchronous Transfer Mode (ATM) example, because such an adaptation moves part of the tag stack to the ATM header.

To that end, we consider FIG. 7, whose topology is identical to that of FIG. 1, but we assume that P1 and P2 are ATM switches and that PE1 and PE2 are routers that attach to P1 and P2, respectively, over ATM interfaces. FIG. 8 depicts the typical data message that, say, PE2 would send to P2 in such an arrangement. FIG. 8 is best understood by comparison with the second row of FIG. 2's Ethernet example. In that diagram, the Ethernet header (DEST. ADDRESS, SOURCE ADDRESS, and TYPE) and trailer (CRC) encapsulate a payload in the form of tag fields and an IP datagram. FIG. 8's third row depicts an ATM frame, and that drawing's fourth and fifth rows show that the frame's payload is similar to that of FIG. 2's Ethernet frame. The only difference in the payloads is that FIG. 8's fifth row represents the left (top) tag by question marks, which indicate that the top tag's contents do not matter.

The reason why they do not is that the routing decisions made by FIG. 1's P2 on the basis of those contents are made by FIG. 7's (ATM) router P2 on the basis of an ATM VPI/VCI field in the header of an ATM "cell." From the point of view of an ATM client, the frame of FIG. 8's third row is the basic unit of transmission, and it can vary in length to as much as 64 Kbytes of payload. (Those skilled in the art will recognize that there are also other possible ATM frame formats, but FIG. 8's third row depicts one, known as "AAL5," that would typically be employed for user data.) For communication between ATM switches, however, ATM actually breaks such frames into fixed-size cells.

Each cell consists of a header and a payload, as FIG. 8's second row illustrates. Among the purposes of the header's PTI field, depicted in FIG. 8's first row, is to indicate whether the cell is the last one in a frame. If it is, its last eight bytes form the frame trailer field that FIG. 8's third row depicts. Among other things, the trailer indicates how much of the preceding cell contents are actual payload, as opposed to padding used to complete fixed-size cell.

The only other header field of interest to the present discussion is the VPI/VCI field of FIG. 8's first row. As is well known to those skilled in the art, ATM systems organize their routes into "virtual channels," which may from time to time be grouped into "virtual paths." Each switch associates a local virtual path/virtual channel indicator (VPI/VCI) with a channel or path that runs through it. When an ATM switch receives a cell, it consults the cell's VPI/VCI field to identify by table lookup the interface by which to forward it, replaces that field's contents with a value indicated by the table as being the next switch's code for that path or channel, and sends the resultant cell to the next switch. In other words, the function performed by the VPI/VCI field enables it to serve as the stack's top tag.

So PE1 will bind a VPI/VCI tag, call it VC1, to the address of PE1 and distribute that binding to P1. P1 will bind a VPI/VCI tag, call it VC2, to the address of PE1 and distribute that binding to P2. P2 will bind a VPI/VCI tag, call it VC3, to the address of PE1 and distribute that binding to PE2.

Now, when PE2 receives from CE2 a packet destined for a site that is in CE2's VPN and is reachable via CE1, it does the following.

First, it looks up the destination address of that packet in its VPN-specific forwarding table. It finds a recursive entry whose tag operation is "push on T3". On performing the recursive lookup, it finds that the next hop is an ATM switch and that the tag value is the VPI/VCI value VC3. It accordingly forms the frame depicted in FIG. 8's bottom three rows. It then breaks the frame into cells of the type that FIG. 8's top two rows depict, placing the VC3 value in the VPI/VCI field, and sends them in sequence to P2.

P2, on a cell-by-cell basis, replaces VC3 with VC2 and forwards the resultant cells to P1. Similarly, P1 replaces VC2 with VC1 on a cell-by-cell basis and forwards the resultant cells to PE1. PE1 eventually collects all the frame's cells and reassembles them. PE1 then extracts the resultant frame's user data, pops the tag stack, and forwards the resultant frame in accordance with the resultant tag stack (which now contains a single tag, T3). Note that in this scenario it is PE1, not P1, that pops the stack to get to the tag, T3, that indicates the extra-SP route. This is because P1 in this scenario is an ATM switch, and ATM switches do not have the capability of popping the stack themselves.

In the foregoing ATM example, the top tag in the tag-stack field never has any meaning. But now suppose that only P1 is an ATM switch: P2 and PE1 are routers attached to P1 via ATM interfaces. Then the PE2-P2 link would contain FIG. 2-*style* packets, P2 would base its decision on the top tag-field tag, and it would forward ATM cells in response.

Considerations for Extension to Inter-VPN Use

To avoid obscuring the present invention's basic principles, the foregoing discussion focused mainly on their use for intra-VPN communication. We now turn to suggestions for ways in which systems that employ those teachings could perform inter-VPN communication.

1. Internal vs. External VPN-IPv4 Addresses

As was explained above, it may be necessary to maintain two routes to a particular IPv4 address exported from one VPN to another. One route is used for intra-VPN traffic, and the other is used for inter-VPN traffic. When a particular IPv4 address is exported from one VPN to another. For example, suppose that the system bearing a particular address is in site S1. Intra-VPN traffic to that system should certainly go directly to S1. However, there may be a firewall located at site S2, and it may be desired to pass all inter-VPN traffic through that firewall. In this case, inter-VPN traffic to the system in question should travel via S2.

In order to be sure that BGP can simultaneously install an intra-VPN and an inter-VPN route to the same address, it is necessary to use a different VPN-IPv4 address for intra-VPN connectivity than for inter-VPN connectivity.

Therefore, each VPN will have two VPN IDs. One will be the "Internal VPN ID," and one will be the "External VPN ID."

Each PE router will translate the IPv4 addresses from its attached VPNs to one or the other or to both of these VPN-IPv4 addresses. The rules for doing so will be discussed later.

A VPN-IPv4 address whose VPN ID is the Internal VPN ID of its VPN must not be distributed by any PE router to any CE router, unless that CE router is in that VPN. To prevent any unintended redistribution, a PE router that distributes an IPv4 address to another PE router must assign it the NO_EXPORT Community Attribute. According to RFC 1997, "BGP Communities Attribute," this attribute means:

> All routes received carrying a communities attribute containing this value MUST NOT be advertised outside a BGP confederation boundary (a stand-alone autonomous system that is not part of a confederation should be considered a confederation itself).

As we shall see below, this will prevent the corresponding address from being advertised outside the VPN. (One could instead define a new Community Attribute value, e.g., NO_EXPORT_OUTSIDE_VPN, for this purpose, but NO_EXPORT seems adequate and makes it easy to accommodate the case where the CE router itself specifies a NO_EXPORT attribute.

(An alternative would be to install filters that prevent VPN-IPv4 addresses with Internal VPN IDs from being transmitted outside a BGP confederation. This could be done if one could tell by inspection that a particular VPN ID is Internal, rather than External.)

2. Autonomous System Numbers

a. ASN Used by PE Routers on IBGP Connections

Since the PE routers (in the same P-network) are to use IBGP to distribute routes among themselves, it follows that there must be some Autonomous System Number (ASN), known to all the PE routers, which they use when setting up these connections. (A BGP connection is not treated as an IBGP connection unless both BGP speakers have used the same ASN.)

If the P-network is already in use as an internet transit network, it will likely already have a globally unique ASN, and this can be used on these IBGP connections.

b. ASN Used by CE Routers on EBGP Connections

When a particular site is a "stub site," it is not necessary for the CE router to talk BGP to the PE router, though under certain circumstances it may be desirable for it to do so. However, whenever a particular site has a C router that is talking BGP to another C router, then the CE router will need to talk BGP to the PE router. This is true whether the C routers talking BGP are talking to other C routers at the site, to other C routers at different sites of the same VPN, to other C routers of different VPNs, or even to routers in the public internet.

When a CE router distributes routing information to a PE router, the intention is that the information ultimately be distributed to one or more other CE routers. One PE router uses IBGP to distribute the information to another, and the latter redistributes it to another CE router.

Since routes learned over IBGP are in general not redistributed over IBGP, and since PE routers have IBGP connections to each other, it follows that the CE routers must talk EBGP to the PE routers. Each site where a CE router talks EBGP to a PE router must have an ASN. Call this a "Site ASN."

The number of globally unique ASNs is limited, and it is not feasible to assign one to each individual VPN site. There is however a "private ASN" numbering space containing 1023 ASNs, which a service provider can administer as he sees fit. So the Site ASNs must be taken from the private ASN space. Since the size of the private ASN space is limited, it is desirable to use the same ASN numbers in different VPNs.

This can be done by modeling each VPN as a "BGP Confederation." This means that the CE router and the PE router do not run "regular" EBGP between them: they run

"Confederation EBGP (CEBGP)." CEBGP uses some of the procedures of regular EBGP, some of the procedures of IBGP, and some procedures of its own. However, these procedures are all well-defined and implemented.

3. Using BGP-Confederation Techniques for AS-Path Manipulation

A BGP confederation is a set of Autonomous Systems (ASs) that appear as a single AS to all ASs not in the Confederation. Only within the Confederation are the component ASs visible. That is, externally to the Confederation, the Confederation has a single ASN. Within the Confederation, each "Member AS" of the Confederation has its own ASN, which is distinct from the Confederation's ASN. The distinction shows up primarily in BGP Confederation procedures for AS-path manipulation, which we recommend for inter-VPN communication. (This does not imply that BGP Confederation procedures affecting other attributes should also be used.)

BGP maintains loop freedom by associating an AS-path with each route. Roughly, this is a list of the ASs through which a packet must travel to reach the destination. When a router distributes a route via EBGP, it adds its own ASN to the AS-path. When a router receives a route via EBGP, it checks to see if its own ASN is already in the AS-path. If so, it discards the route, in order to prevent the loop.

With Confederations, this procedure is slightly changed. When a router distributes a route on a CEBGP connection, it adds its own AS to the AS-path, but it marks that AS as being within the Confederation. When a router that is within a Confederation distributes a route on an EBGP connection, it first removes from the AS-path all ASs that are marked as being within the Confederation. Then it adds the Confederation's ASN to the AS-path.

When a router that is in a Confederation receives a route over an EBGP connection, it will discard the route if the AS-path contains the Confederation's ASN. When a router receives a route over a CEBGP connection, it will discard that route if the AS-path contains the Member ASN of that router, and that Member ASN is marked as being within the Confederation.

Since the Member ASNs of a Confederation are never seen outside the Confederation, they can be assigned from the Private ASN space.

In a VPN, each site containing a CE router that talks BGP to a PE router would have a Site ASN taken from the Private ASN space. Then these Site ASNs need be unique only within a single VPN: they can be reused in other VPNs. The P network is part of each such Confederation and needs to have a Member ASN that can be used within each Confederation. The P network can have a single ASN that it uses as its Member ASN in all Confederations. If it has a globally unique ASN, this can be used.

If a VPN spans multiple service providers, then its Site ASNs must be unique across all the providers, and each P network must use a globally unique ASN.

When a router receives a route whose AS-path contains its site number, it conventionally rejects the route if the site number is not marked as being part of the confederation, and it is preferable for CE routers to follow this policy. Otherwise, since a VPN is modeled as a Confederation, care must be taken to ensure that whenever two C routers in the same VPN have a direct BGP connection with each other (i.e., a "backdoor" connection between routers in the same VPN, at the same or different sites), they talk either IBGP or CEBGP, never regular EBGP. When talking CEBGP, each router would use its Site ASN as its ASN, for the purpose of (a) filling in the "My Autonomous System Number" field in the BGP Open message, and (b) adding its ASN to the AS-path.

When a PE router receives from a CE router over a CEBGP connection, routes to IPv4 addresses, the PE router will immediately translate those addresses to VPN-IPv4 addresses, using the Internal VPN ID of the CE's VPN. ("Immediate translation" means that the addresses appear in BGP's "adj-rib-in" table as VPN-IPv4 addresses.) When a PE router distributes VPN-IPv4 addresses to a CE router over a CEBGP connection, it first converts them to IPv4 addresses by stripping off the VPN ID.

The External VPN ID of a particular VPN can have the same value as the VPN ASN. The Internal VPN ID must have a different value. It may be convenient for these values to be algorithmically related, but this is not required.

If a VPN spans multiple service providers, its Internal VPN ID and its External VPN ID must be globally unique. Otherwise, they must be unique only within the scope of a single service provider. Note also that any quantity that is used as an External VPN ID of one VPN may not be used as an Internal VPN ID of any other VPN, and vice versa.

4. Inter-VPN Communication as Communication Between Two Confederations

Since each VPN is modeled as a BGP Confederation, each VPN appears as an AS to each other VPN. Communication between two VPNs is modeled as communication between two ASs, using the P network as the transit AS. Therefore if a CE router uses BGP to export routes, via a PE router, to another VPN, it must do so via a regular EBGP connection to the PE router. Of course, on the EBGP connection it uses the VPN ASN, not the Site ASN.

If the P-network has a globally unique ASN, it can be used both within a Confederation and between Confederations.

Whenever two C routers in different VPNs have a direct BGP connection with each other (i.e., a "backdoor" connection between routers in different VPNs), care must be taken to ensure that they talk EBGP with each other. When talking (nonconfederation) EBGP, each router would use its Confederation ASN as its ASN for the purposes of (a) filling in the "My Autonomous System Number" field in the BGP Open message, and (b) adding its ASN to the AS-path.

So in the most general case, a CE router may need to have two BGP connections to a PE router, an EBGP connection (for inter-VPN connectivity) and a CEBGP connection (for intra-VPN connectivity). There may be only one BGP connection between a given pair of IP addresses. So if a given pair of routers need to have two BGP connections between them, each router must use a distinct address on each connection.

When a PE router receives, from a CE router over an EBGP connection, routes to IPv4 addresses, the PE router will immediately translate those addresses to VPN-IPv4 addresses, using the External VPN ID of the CE's VPN. When a PE router distributes VPN-IPv4 addresses to a CE router over an EBGP connection, it will first convert them to IPv4 addresses by stripping off the VPN ID.

A site in a VPN may maintain a backdoor connection to the public internet, via an EBGP connection. If this EBGP connection is not via the same service provider that is providing the VPN, the VPN ASN must be from the public AS numbering space. Otherwise, it may be from the private AS numbering space, and the C router maintaining the EBGP connection to the internet should be configured to strip all private ASNs from the AS-path.

In general, P routers with EBGP connections to routers outside the P network will not accept routes to VPN-IPv4

addresses over those connections. To do so would allow routers outside the Service Provider's control to spoof routes to the VPN, thereby compromising the security that the customer expects. If it is necessary to make any exceptions to this rule (to support, say, multi-provider VPNs), the security effects of those exceptions would need to be carefully considered.

5. How to Determine When a CE Router Needs Zero, One, or Two BGP Connections to a PE Router

If the CE router's site does not have any backdoor connections, neither a CEBGP nor an EBGP connection is necessary. In this case, all the information that would be passed via BGP can be statically configured in the PE router. The site will not have a Site ASN. IBGP between PE routers is still used to pass routing information about one site to the others.

By a "backdoor connection," we mean a BGP connection between a C router at the site and any router other than a PE router. If two sites in a particular VPN are interconnected via static routing and/or IGP, then we model them as a single site, rather than as two sites with a backdoor connection.

Even in the absence of backdoor connections, it can be desirable to use BGP between the CE and the PE router, if the site has a significant number of address prefixes that are sometimes up and sometimes down, or if there are address prefixes that move from one site to another. This can also be desirable simply as a way to avoid the configuration task associated with static routing.

If the CE router's site does not have any backdoor connections to other VPNs (or to the public internet), but it is desired to have a BGP connection to the PE router (either for the reason given in the prior paragraph, or because there are backdoor connections to other sites in the VPN), it is necessary to have a CEBGP connection between CE router and PE router. As we will see below, routes distributed over CEBGP will not thereby be distributed to any other VPN. However, distribution of routes to other VPNs can still be achieved via configuration of the PE router.

If the CE router's site has backdoor connections to other VPNs (or to the public internet), and if it serves as a transit network for traffic from other VPNs (or the public internet), then the CE router must run EBGP with the PE router, in order to properly distribute the routes for which it is a transit network.

If a VPN has multiple sites that have EBGP connections to PE routers, then there must also be a CEBGP connection from each of those sites to a PE router.

6. Using Community Attributes to Control the Exporting of Addresses from One VPN to Another

As stated previously, whenever a PE router uses IBGP to distribute to another PE router (or route reflector) a route to a VPN-IPv4 address, the NO_EXPORT Community Attribute will be included as an attribute of that route if the VPN ID of that address is an Internal VPN ID.

When a PE router uses IBGP to distribute a route to a VPN-IPv4 address to another PE router (or route reflector), and the VPN ID of that address is an External VPN ID, Community Attributes must be included that specify the set of VPNs to which the address in question is to be exported.

This requires a distinguished class of Community Attributes that are used only for this purpose. In general, when such attributes are received by P routers over EBGP connections, they should be removed (via inbound filtering), unless there is explicit configuration of the P router that allows them to be passed on unchanged.

The Community Attribute that is used to indicate that an address is to be exported to a particular VPN should be algorithmically derivable from that VPN's ASN, and vice versa.

If a CE router talks EBGP to a PE router, the CE router may, with each address it distributes, include a set of Community Attributes, indicating the set of other VPNs (possibly including the public internet) to which the address is to be exported. If so, the PE router may be configured with a set of addresses from the C network that the CE router is authorized to export to a set of other VPNs. In that case, the PE router will remove (via inbound filtering) any unauthorized Community Attributes sent by the CE router. The PE router may be configured with a set of addresses from the C network that are to be exported to a set of other VPNs, even if the CE router does not include the necessary Community Attributes. In this case, the PE router must add (via inbound filtering) the missing Community Attributes.

When a PE router receives a route to an external VPN-IPv4 address and that route is associated with a Community Attribute that identifies the VPN of a CE router to which that PE router is attached, then the route is a candidate for redistribution to the CE router. (Of course, a VPN-IPv4 address is translated into an IPv4 address, by having its VPN ID stripped off, before being distributed to a CE router.)

The PE router may be configured to allow only particular VPN-IPv4 addresses to be distributed to a particular CE router, regardless of the Community Attribute. Or it may be configured to prevent the distribution of particular VPN-IPv4 addresses to a particular CE router, regardless of the Community Attribute. In such cases, outbound filtering should be used to prevent distribution of such addresses to the CE router.

7. A Slightly Different Way to Use Community Attributes: Closed User Groups

The Community Attribute can be used in a similar though somewhat different way to represent "Closed User Groups" (CUGs) of VPNs, rather than target VPNs.

A CUG is a set of VPNs. A CE router could associate a route to a particular address with one or more CUGs. The PE router would strip any CUGs that the CE router is not authorized to use. The PE router could also add additional CUGs, or could add CUGs when the CE router has not specified any. The PE router would need to know which VPNs are members of which CUGs, so it could determine which other PE routers it needs to distribute the routes to.

When a route with a CUG is received, it will be distributed over an EBGP connection to a CE router only if the PE router is configured with the knowledge that the CE router is a member of that CUG.

The use of CUGs may simplify the configuration of the PE routers.

8. IBGP Between PE Routers

In conventional uses of BGP, the set of EBGP/CEBGP speakers in a given AS is supposed to be "fully meshed" (or "fully reflected" through route reflectors). Otherwise, there is no way to ensure that communication between any two points is possible. For VPNs, we do not want to require that communication between every pair of points be possible, so the PE routers need not in general be fully meshed. A PE router A needs to talk IBGP to a PE router B only if A and B both attach to CE routers in the same VPN, or if A attaches to a CE router in VPN 1 that is exporting addresses to a VPN 2, and B attaches to a CE router in VPN 2.

For each PE router that is to be an IBGP peer of a given PE router, the given PE router will know which VPNs the

peer is interested in. If a PE router A has an IBGP peer B, and B is interested in VPN 1, then A shall distribute a route to B if and only if one of the following two conditions holds:

the address corresponding to the route is a VPN-IPv4 address in VPN 1, or

one of the following conditions holds:

the VPN ID of the VPN-IPv4 address is the Internal VPN ID for VPN 1, or

the VPN ID of the VPN-IPv4 address is the External VPN ID for VPN 1, and the route has a Community Attribute that indicates that it should be distributed into VPN 1.

Each PE router, before distributing a route, will also assign a tag for that route. This will be encoded, in a way to be defined, as an attribute of that route.

When a PE router redistributes over IBGP a route received from a CE router (whether it is received over EBGP or CEBGP), it should always put itself in as the next hop. This ensures that the next hop is always reachable in the P network's IGP (i.e., it does not require routes to all the CE routers to be injected into the P-networks' IGP). It also ensures proper interpretation of the tag that the PE router assigns to the distributed address prefix; the tag associated with an address prefix should be a tag assigned by the "next hop" for that prefix.

For the purpose of supporting VPNs, PE routers need to support the following capabilities:

Tag distribution via BGP

VPN-IPv4 Address Family

VPN "edge capabilities," i.e., whatever special procedures are needed in order to interact with the CE routers—e.g., translation between VPN-IPv4 and IPv4 addresses, per-VPN lookup tables, etc.

BGP Capability Negotiation, as described in the section below entitled "Internet Draft: Capabilities Neogation", should be used to determine whether an IBGP peer has the appropriate capabilities.

9. IBGP Between a PE Router and a P Router that is not a PE Router

PE routers may have "ordinary" EBGP and IBGP connections that have nothing to do with VPNs. On such ordinary connections, IPv4 NLRI rather than VPN-IPv4 NLRI is used; routes learned from CE routers will not be sent on such connections, unless the PE router is configured to export those routes to the public internet.

Any router with a BGP connection to the internet must ensure, through proper filtering, that it does not leak any routes to the internet that are not part of the P network's AS, or of the AS of some client network of the P network. When routes are leaked to the internet, all private AS numbers must be removed (via outbound filtering) from the AS-path.

10. Configuration of the Pe Routers

Each PE router must be configured with the following information:

A. Per CE Router that Attaches to the PE Router

i. The address of the CE router to use when participating in a CEBGP connection.

The PE router may maintain a static route to this address and need not redistribute this address into the IGP of the P network (as long as the PE router always sets itself as the next hop before redistributing routes received from the CE router). In this case, the same address may be reused for other CE routers, subject to the constraint that all the CE routers attaching to a given PE router have distinct addresses. If the PE router distributes this address into the P network's IGP, though, the address should be a unique address in the P network's address space.

This parameter can be omitted if no CEBGP connection is to be formed.

ii. The address of the CE router to use when participating with it in an EBGP connection.

This parameter can be omitted if no EBGP connection is to be formed.

iii. The address of the PE router to use when participating in a CEBGP connection with the above-specified CE router.

iv. The address of the PE router to use when participating in an EBGP connection with the above-specified CE router.

(Can be omitted if no EBGP connection is to be formed.)

v. The CE router's Site ASN.

This parameter can be omitted if no CEBGP connection is to be formed.

vi. The CE router's Internal VPN ID.

vii. The CE router's External VPN ID

This doubles as its VPN ASN if an EBGP connection is to be formed.

viii. A list of VPNs or CUGs to which the CE router can export addresses, and, for each such VPN, the set of addresses that are authorized to be exported to it.

The set of addresses may be "all." For each such set of addresses, there needs to be an indication as to whether the PE router should allow the addresses to be exported if the CE router attempts to export them, or whether the PE router should initiate the export of the addresses independently of any action on the part of the CE router. (The latter would be the only way to get export if there is no EBGP connection to the CE router.)

ix. A list of VPNs or CUGs that can export addresses to the VPN of the CE router, and, for each such VPN, a set of addresses that are authorized for export into the VPN of the CE router.

This set may be "all." For distribution of an address between the public internet and a VPN, the public internet shall be represented as VPN 0.

B. Per VPN or CUG, for Each VPN to Which the PE Router Attaches Via a CE Router, And for Each VPN or CUG to which One of the Attached VPNs can Export Addresses: the Set of PE Routers Interested in that VPN or CUG.

IBGP connections will be opened to all such PE routers. If these are provided by only a few route reflectors, manual configuration is acceptable, but auto-discovery will be required as a practical matter if they are provided by a large number of other PE routers.

If the PE router has a CEBGP connection to the CE router, the addresses to be distributed intra-VPN will be those addresses distributed by the CE router over the CEBGP connection. Otherwise, the PE router needs to be configured with those addresses, or it needs to obtain them in some other way (such as ODR or RIP).

If the PE router has an EBGP connection to the CE router, the addresses to be distributed inter-VPN will be those addresses distributed by the CE router over the EBGP connection. Otherwise, the PE router needs to be configured with those addresses.

11. Configuration of the CE Routers

If the CE router is talking BGP to a PE router, the CE router will need to be configured to set up a CEBGP connection, or both a CEBGP and an EBGP connection, to

a PE router. It must then be configured with an address of the PE router for each such connection. This address will be from the address space of the P network.

The CE router should have a static route to the PE router address. This route need not be redistributed into the C-network's IGP (though it should be safe to do so, because we are not trying to handle the case where there is addressing conflict between the C network and the P network).

The CE router does not use VPN-IPv4 addressing, and does not assign tags to the addresses it distributes to the PE router.

If the CE router is at a stub site, then:

- if it uses the same PE router(s) for intra-VPN as for inter-VPN traffic, it should be configured to have a default route pointing to the PE router(s), and should inject "default" into its IGP.
- if it uses a different PE router for inter-VPN traffic than for intra-VPN traffic, then it must be configured with appropriate static routes, and must inject them into its IGP.

(Even if the CE router talks BGP to the PE router, there is no reason to redistribute the BGP routes into the IGP.)

If the CE router is not at a stub site, then proper administration must be done to ensure that BGP routes and/or default routes are injected into the IGP in a proper manner.

12. Distribution of Routes from CE Routers to PE Routers on CEBGP Connections

a. CE Router Procedures

A CE router will distribute all routes to all destinations on its site over its CEBGP connection to a PE router. Routes to destinations on other sites (through backdoor routes) may also be distributed to the PE router on the CEBGP connection; this is a matter of policy of the C network.

b. PE Router Procedures

When a PE router receives routes on the CEBGP connection, it will of course translate the IPv4 addresses to VPN-IPv4 addresses. It will also remove from each route any VPN Community attributes that may be present. It will add the NO_EXPORT community attribute, to prevent the route from being distributed out of the Confederation.

The PE router should check the AS-path of each route it receives from the CE outer to ensure that the appropriate Site ASN appears at the beginning.

13. Distribution of Routes from CE Routers to PE Routers on EBGP Connections

a. CE Router Procedures

A CE router may distribute any routes to a PE router on an EBGP connection. However, it should avoid distributing any route on such a connection unless it intends to export that route to another VPN, or to the public internet.

b. PE Router Procedures

The PE router will ignore routes to any destinations that, according to the PE router's configuration, are not to be exported to other VPNs (including the public internet).

If a route from the CE router does not have a Community Attribute associated with it, the PE router will, before further distributing it, add the VPN community for each other VPN to which the route may be exported, according to the PE router's configuration.

If a route from the CE router does have one or more Community Attributes associated with it, the PE router will remove any Community Attributes that do not correspond to VPNs to which the route may be exported, according to the PE router's configuration.

If the PE router allows a particular route to be exported to a number of VPNs, this procedure allows the CE router to specify a subset of those VPNs to which it should be exported. If this is allowed, then the PE router must be able to detect when an EBGP update removes a Community Attribute that used to be there, so the route can be withdrawn from the corresponding VPN.

The PE router should check the AS-path of each route it receives from the CE router to ensure that the correct value of the VPN ASN appears at the beginning. If not, the PE router may replace it with the correct value.

The PE router will convert all IPv4 addresses from the CE router to VPN-IPv4 addresses, using the External VPN ID of the CE router's VPN, before redistributing them. There is one exception: if a route is to be distributed to VPN **0**, it should be distributed as an IPv4 address, without any Community Attribute. (This allows for distribution to the public internet via a BGP speaker that is not VPN-aware.)

14. Distribution of Routes from PE Routers to CE Routers on CEBGP Connections

A PE router will distribute to a CE router, over a CEBGP connection, routes to all VPN-IPv4 addresses whose VPN ID is the Internal VPN ID of the CE router's VPN. No other routes shall be distributed on this connection. The VPN-IPv4 addresses will be translated to IPv4 addresses before distribution.

The AS-path should be modified by prepending the P network's ASN.

15. Distribution of Routes from PE Routers to CE Routers on EBGP Connections

A PE router will distribute a route with VPN-IPv4 NLRI to a CE router on an EBGP connection only if both the following conditions hold:

- the PE router is configured to allow the particular VPN-IPv4 address to be exported to the CE router, and
- the PE router received the router with a Community Attribute that corresponds to the VPN of the CE router, or to a CUG that is associated with that CE router.

This ensures that the route came from a proper place, and is going to a proper place.

Community Attributes that represent target VPNs or CUGs should be stripped before the route is distributed to the CE router.

VPN-IPv4 addresses should be translated into IPv4 addresses.

The AS-path should be modified by prepending the P network's ASN.

A PE router will distribute a route with IPv4 NLRI to a CE router on an EBGP connection only if the PE router is explicitly configured to allow that address to be exported to the CE router's VPN. This allows the VPN to import addresses from the public internet.

Inter-VPN-Routing Example

To illustrate the use of internal and external VPN IDs, FIG. **9** depicts a service-provider network simply as an oval, omitting all individual routers except PE**1**, PE**2**, and PE**3**. PE**1** and PE**2** are edge routers with respect to customer nodes in a first VPN, VPN A, and PE**3** is an edge router with respect to a second VPN, VPN B. A target destination D in one VPN A is reached most directly through a customer edge router CE**1** at the same site. But VPN A has a firewall in CE**2**, and the policy is that any packets from outside VPN A must go through CE**2** before they go to any VPN A destination.

In this situation, CE1 uses EBGP to advertise to PE1 its access to D. In some manner determined by local configuration, PE1 recognizes that advertisement as being only for VPN A consumption. For example, PE1 may be configured to recognize the interface used by CE1 as one that advertises only intra-VPN reachability, or CE1 may employ a NO_EXPORT value of the BGP community attribute in its advertisement. In any case, PE1 reports itself by IBGP as the next hop to destination Int(D) (where "Int(D)" represents the concatenation of VPN A's internal VPN ID with D's network address or prefix). Preferably, it knows which routers are edge routers with respect to VPN A and makes this advertisement only to them. Alternatively, it is not so discriminating, but it is only such routers that adjust their FIBs in accordance with that information.

In either case, PE2 thereby learns this information and uses it to construct an FIB entry in its per-VPN FIB corresponding to VPN A. (If, as the drawing does not show, PE3 attaches to a CE router that is in VPN A, then it, too, uses that information to construct an FIB entry in its per-VPN FIB corresponding to VPN A.)

Since CE2 is to operate as the firewall, it must advertise itself as according access to all systems that the enterprise is willing to accord extra-VPN visibility, so it also uses EBGP to advertise node D's reachability. In some manner determined by local configuration, PE2 recognizes that advertisement as being for extra-VPN A consumption, and it reports itself as the next hop to destination Ext(D) (where "Ext(D)" represents the concatenation of VPN A's external VPN ID with D's network address). PE3 thereby learns this information and uses it to construct an FIB entry in its per-VPN FIB corresponding to VPN A. (If, as the drawing does not show, PE2 attaches to a CE router that is in VPN B, then it, too, would use that information to construct an FIB entry in its per-VPN FIB corresponding to VPN B.)

Now, when a packet addressed to D arrives at PE2 from CE2, the packet is identified by, for instance, its incoming interface as coming from VPN A. PE2 looks in its per-VPN FIB for VPN A and sees that the next hop is PE1. This is the intra-VPN case.

When a packet addressed to D arrives at PE3 from CE3, the packet is identified, again possibly by virtue of its incoming interface, as coming from VPN B. PE3 looks in its per-VPN FIB for VPN B and sees that the next hop is PE2. The packet then gets sent to PE2, which sends it on to CE2. CE2 runs the packet through the firewall, and CE2 attempts to forward the packet if the firewall does not reject it. Since the destination is not on-site, the packet gets sent to PE2. This time PE2 identifies the packet as coming from VPN A. PE2 looks up D in its per-VPN FIB for VPN A, and sees that PE1 is the next hop. The packet is then sent to PE1.

In short, when PE router receives a packet from a CE router, it can always identify the CE router from which the packet was just transmitted, so it can identify the VPN from which it just came. This enables the PE router to select the proper per-VPN FIB.

Although CE2 ran the packet that it received in the above scenario through the firewall, it would ordinarily be preferred that only packets from outside VPN A receive this treatment, in which case CE2 will need to know whether a packet that it receives is from a different VPN. The way in which this is accomplished is in general a localconfiguration matter, but the most-common approach would likely be for CE2 to have two channels to PE2. Suppose, for instance, that CE2 has two different CE2 interfaces for such communication. It would run BGP on both interfaces. On one of the interfaces, it would advertise reachability to some set of addresses in VPN A (including D) and possibly specify appropriate community attributes to ensure that this information is exported to VPN B. PE2 would use VPN A's external VPN ID for information received over this BGP connection. On the other interface, it would advertise reachability to its on-site addresses, and PE2 would use VPN A's internal VPN ID for information received over this BGP connection.

Although the use of different interfaces would be the most-typical way to provide the different channels by which the achieve the internal- and external-route information and traffic are distinguished, internal routes and external routes could be mapped to the same interface, too, with the demultiplexing provided by, say, the presence or absence of cryptographic information in the packet header.

Alternatives

The foregoing discussion describes an advantageous approach to implementing the present invention's teachings, one whose advantages extend not only to situations in which the customer VPNs' address spaces overlap. But the particular approach there described is far from the only one that can implement the present invention's teachings. For example, some of the routing could be set statically rather than in response to routing protocols such as BGP. Also, although we have described VPN-specific information as being stored in separate tables because that approach seems most convenient, there is no reason in principle why a common table containing VPN-identifying entries could not be used instead.

And our focus on tag switching should not be interpreted to mean that the present invention's teachings are so limited. For instance, although we use tags to contain both the egress-router routing information and the egress-channel routing information, one could instead use, say, encapsulated IP to hide the inner, egress-channel (and thereby VPN-distinguishing) routing information from the transit routers, this is by no means a requirement. We prefer tag switching because it tends to be more efficient, to use less overhead, and to lend itself to uses where the network administration controls the routes to a greater degree than dynamic IP routing ordinarily allows. Also, unlike encapsulated IP, tag switching supports arrangements in which different VPN sites are attached to the networks of different autononmous service-providers that use BGP to exchange routing information and together form the back-bone-providing service-provider network. And tag switching lends itself to applications in which part of the backbone is an ATM link: tags can be put in the ATM header's VCI field.

But even when tags are used, they can represent the exterior-routing information in a way different from the one that the illustrated embodiment employs. For example, although the illustrated embodiment interprets the exterior-routing tag exemplified by T3 to specify a next hop, it could instead simply contain, say, a VPN identifier that the egress router uses to disambiguate the regular IP address.

Although we prefer to use tags for both the egress-router and egress-channel fields, moreover, the applicability of the present invention's teachings is not so limited. In an architecture in which every PE router always uses different interfaces for links to different VPNs' nodes, for example, the internal-routing field could be provided simply as a tag associated with such an interface. That is, there would be no separate tag for the egress router's interface with the previous P router. In such an arrangement, edge routers could use IGP to install host routes to all of their interfaces with client edge routers. To advertise external reachability, PE2, for

instance, would use BGP to specify the IP address of the interface between PE2 and CE2 as the next-hop address for VPN-IPv4 addresses reachable through CE2. And PE2, P2, and P1 would all use TDP to bind tags to the host route to that interface; PE2 would not use the distinguished tag value meaning "pop the tag stack."

In short, the present invention's advantages can be obtained from a wide variety of embodiments. It therefore constitutes a significant advance in the art.

The following four sections, referred to above, set forth the contents of respective Internet drafts in which techniques that embodiments of the present invention may employ are described.

Internet Draft: Label Stack Encodings

Network Working Group
Internet Draft
Expiration Date: January 1998

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Label Switching Label Stack Encodings

draft-rosen-tag-stack-03.txt

Status of this Memo

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Abstract

"Multi-Protocol Label Switching (MPLS)" [1,2,9] requires a set of procedures for augmenting network layer packets with "label stacks" (sometimes called "tag stacks"), thereby turning them into "labeled packets". Routers which support MPLS are known as "Label Switching Routers", or "LSRs". In order to transmit a labeled packet on a particular data link, an LSR must support an encoding technique which, given a label stack and a network layer packet, produces a labeled packet. This document specifies the encoding to be used by an LSR in order to transmit labeled packets on PPP data links and on LAN data links. This document also specifies rules and procedures for processing the various fields of the label stack encoding.

1. Introduction

"Multi-Protocol Label Switching (MPLS)" [1,2,9] requires a set of procedures for augmenting network layer packets with "label stacks" (sometimes called "tag stacks"), thereby turning them into "labeled packets". Routers which support MPLS are known as "Label Switching Routers", or "LSRs". In order to transmit a labeled packet on a particular data link, an LSR must support an encoding technique which, given a label stack and a network layer packet, produces a labeled packet.

This document specifies the encoding to be used by an LSR in order to transmit labeled packets on PPP data links and on LAN data links.

This document also specifies rules and procedures for processing the various fields of the label stack encoding. Since MPLS is independent of any particular network layer protocol, the majority of such procedures are also protocol-independent. A few, however, do differ for different protocols. In this document, we specify the protocol-independent procedures, and we specify the protocol-dependent procedures for IPv4.

LSRs that are implemented on certain switching devices (such as ATM switches) may use different encoding techniques for encoding the top one or two entries of the label stack. When the label stack has additional entries, however, the encoding technique described in this document may be used for the additional label stack entries.

1.1. Specification of Requirements

In this document, several words are used to signify the requirements of the specification. These words are often capitalized.

MUST

This word, or the adjective "required", means that the definition is an absolute requirement of the specification.

MUST NOT

This phrase means that the definition is an absolute prohibition of the specification.

SHOULD

This word, or the adjective "recommended", means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications must be understood and carefully weighed before choosing a different course.

MAY

This word, or the adjective "optional", means that this item is one of an allowed set of alternatives. An implementation which does not include this option MUST be prepared to interoperate with another implementation which does include the option.

2. The Label Stack

2.1. Encoding the Label Stack

On both PPP and LAN data links, the label stack is represented as a sequence of "label stack entries". Each label stack entry is represented by 4 octets. This is shown in FIG. **10**.

The label stack entries appear AFTER the data link layer headers, but BEFORE any network layer headers. The top of the label stack appears earliest in the packet, and the bottom appears latest. The network layer packet immediately follows the label stack entry which has the S bit set.

Each label stack entry is broken down into the following fields:

1. Bottom of Stack (S)

This bit is set to one for the last entry in the label stack (i.e., for the bottom of the stack), and zero for all other label stack entries.

2. Time to Live (TTL)

This eight-bit field is used to encode a time-to-live value. The processing of this field is described in section 2.3.

3. Class of Service (CoS)

This three-bit field is used to identify a "Class of Service". The setting of this field is intended to affect the scheduling and/or discard algorithms which are applied to the packet as it is transmitted through the network.

When an unlabeled packet is initially labeled, the value assigned to the CoS field in the label stack entry is determined by policy. Some possible policies are:

the CoS value is a function of the IP ToS value

the CoS value is a function of the packet's input interface

the CoS value is a function of the "flow type"

Of course, many other policies are also possible.

When an additional label is pushed onto the stack of a packet that is already labeled:

in general, the value of the CoS field in the new top stack entry should be equal to the value of the CoS field of the old top stack entry;

however, in some cases, most likely at boundaries between network service providers, the value of the CoS field in the new top stack entry may be determined by policy.

4. Label Value

This 20-bit field carries the actual value of the Label.

When a labeled packet is received, the label value at the top of the stack is looked up. As a result of a successful lookup one learns:

(a) information needed to forward the packet, such as the next hop and the outgoing data link encapsulation; however, the precise queue to put the packet on, or information as to how to schedule the packet, may be a function of both the label value AND the CoS field value;

(b) the operation to be performed on the label stack before forwarding; this operation may be to replace the top label stack entry with another, or to pop an entry off the label stack, or to replace the top label stack entry and then to push one or more additional entries on the label stack.

There are several reserved label values:

i. A value of 0 represents the "IPv4 Explicit NULL Label". This label value is only legal when it is the sole label stack entry. It indicates that the label stack must be popped, and the forwarding of the packet must then be based on the IPv4 header.

ii. A value of 1 represents the "Router Alert Label". This label value is legal anywhere in the label stack except at the bottom. When a received packet contains this label value at the top of the label stack, it is delivered to a local software module for processing. The actual forwarding of the packet is determined by the label beneath it in the stack. However, if the packet is forwarded further, the Router Alert Label should be pushed back onto the label stack before forwarding. The use of this label is analogous to the use of the "Router Alert Option" in IP packets [6]. Since this label cannot occur at the bottom of the stack, it is not associated with a particular network layer protocol.

iii. A value of 2 represents the "JPv6 Explicit NULL Label". This label value is only legal when it is the sole label stack entry. It indicates that the label stack must be popped, and the forwarding of the packet must then be based on the IPv6 header.

iv. A value of 3 represents the "Implicit NULL Label". This is a label that an LSR may assign and distribute, but which never actually appears in the encapsulation. When an LSR would otherwise replace the label at the top of the stack with a new label, but the new label is "Implicit NULL", the LSR will pop the stack instead of doing the replacement. Although this value may never appear in the encapsulation, it needs to be specified in the Label Distribution Protocol, so a value is reserved.

v. Values 4-16 are reserved.

2.2. Determining the Network Layer Protocol

When the last label is popped from the label stack, it is necessary to determine the particular network layer protocol which is being carried. Note that the label stack entries carry no explicit field to identify the network layer header. Rather, this must be inferable from the value of the label which is popped from the bottom of the stack. This means that when the first label is pushed onto a network layer packet, the label must be one which is used ONLY for packets of a particular network layer. Furthermore, whenever that label is replaced by another label value during a packet's transit, the new value must also be one which is used only for packets of that network layer.

2.3. Processing the Time to Live Field

2.3.1. Definitions

The "incoming TTL" of a labeled packet is defined to be the value of the TTL field of the top label stack entry when the packet is received.

The "outgoing TTL" of a labeled packet is defined to be the larger of:

(a) one less than the incoming TTL,

(b) zero.

2.3.2. Protocol-Independent Rules

If the outgoing TTL of a labeled packet is 0, then the labeled packet MUST NOT be further forwarded; the packet's lifetime in the network is considered to have expired.

Depending on the label value in the label stack entry, the packet MAY be silently discarded, or the packet MAY have its label stack stripped off, and passed as an unlabeled packet to the ordinary processing for network layer packets which have exceeded their maximum lifetime in the network. However, even if the label stack is stripped, the packet MUST NOT be further forwarded.

When a labeled packet is forwarded, the TTL field of the label stack entry at the top of the label stack must be set to the outgoing TTL value.

Note that the outgoing TTL value is a function solely of the incoming TTL value, and is independent of whether any labels are pushed or popped before forwarding. There is no significance to the value of the TTL field in any label stack entry which is not at the top of the stack.

2.3.3. IP-Dependent Rules

We define the "IP TTL" field to be the value of the IPv4 TTL field, or the value of the IPv6 Hop Limit field, whichever is applicable.

When an IP packet is first labeled, the TTL field of the label stack entry MUST BE set to the value of the IP TTL field. (If the IP TTL field needs to be decremented, as part of the IP processing, it is assumed that this has already been done.)

When a label is popped, and the resulting label stack is empty, then the value of the IP TTL field MUST BE replaced with the outgoing TTL value, as defined above. In IPv4 this also requires modification of the IP header checksum.

3. Fragmentation and Path MTU Discovery

Just as it is possible to receive an unlabeled IP datagram which is too large to be transmitted on its output link, it is possible to receive a labeled packet which is too large to be transmitted on its output link.

It is also possible that a received packet (labeled or unlabeled) which was originally small enough to be transmitted on that link becomes too large by virtue of having one or more additional labels pushed onto its label stack. In label switching, a packet may grow in size if additional labels get pushed on. Thus if one receives a labeled packet with a 1500-byte frame payload, and pushes on an additional label, one needs to forward it as frame with a 1504-byte payload.

This section specifies the rules for processing labeled packets which are "too large". In particular, it provides rules which ensure that hosts implementing RFC 1191 Path MTU Discovery, and hosts using IPv6, will be able to generate IP datagrams that do not need fragmentation, even if they get labeled as the traverse the network.

In general, hosts which do not implement RFC 1191 Path MTU Discovery send IP datagrams which contain no more than 576 bytes. Since the MTUs in use on most data links today are 1500 bytes or more, the probability that such datagrams will need to get fragmented, even if they get labeled, is very small.

Some hosts that do not implement RFC 1191 Path MTU Discovery will generate IP datagrams containing 1500 bytes, as long as the IP Source and Destination addresses are on the same subnet. These datagrams will not pass through routers, and hence will not get fragmented.

Unfortunately, some hosts will generate IP datagrams containing 1500 bytes, as long the IP Source and Destination addresses do not have the same classful network number. This is the one case in which there is any risk of fragmentation when such datagrams get labeled. (Even so, fragmentation is not likely unless the packet must traverse an ethernet of some sort between the time it first gets labeled and the time it gets unlabeled.)

This document specifies procedures which allow one to configure the network so that large datagrams from hosts which do not implement Path MTU Discovery get fragmented just once, when they are first labeled. These procedures make it possible (assuming suitable configuration) to avoid any need to fragment packets which have already been labeled.

3.1. Terminology

With respect to a particular data link, we can use the following terms:

Frame Payload:

The contents of a data link frame, excluding any data link layer headers or trailers (e.g., MAC headers, LLC headers, 802.1Q or 802.1p headers, PPP header, frame check sequences, etc.).

When a frame is carrying an unlabeled IP datagram, the Frame Payload is just the IP datagram itself. When a frame is carrying a labeled IP datagram, the Frame Payload consists of the label stack entries and the IP datagram.

Conventional Maximum Frame Payload Size:

The maximum Frame Payload size allowed by data link standards. For example, the Conventional Maximum Frame Payload Size for ethernet is 1500 bytes.

True Maximum Frame Payload Size:

The maximum size frame payload which can be sent and received properly by the interface hardware attached to the data link.

On ethernet and 802.3 networks, it is believed that the True Maximum Frame Payload Size is 4-8 bytes larger than the Conventional Maximum Frame Payload Size (as long neither an 802.1Q header nor an 802.1p header is present, and as long as neither can be added by a switch or bridge while a packet is in transit to its next hop). For example, it is believed that most ethernet equipment could correctly send and receive packets carrying a payload of 1504 or perhaps even 1508 bytes, at least, as long as the ethernet header does not have an 802.1Q or 802.1p field.

On PPP links, the True Maximum Frame Payload Size may be virtually unbounded.

Effective Maximum Frame Payload Size for Labeled Packets:

This is either be the Conventional Maximum Frame Payload Size or the True Maximum Frame Payload Size, depending on the capabilities of the equipment on the data link and the size of the ethernet header being used.

Initially Labeled IP Datagram

Suppose that an unlabeled IP datagram is received at a particular LSR, and that the LSR pushes on a label before forwarding the datagram. Such a datagram will be called an Initially Labeled IP Datagram at that LSR.

Previously Labeled IP Datagram

An IP datagram which had already been labeled before it was received by a particular LSR.

3.2. Maximum Initially Labeled IP Datagram Size

Every LSR which is capable of

(a) receiving an unlabeled IP datagram,

(b) adding a label stack to the datagram, and

(c) forwarding the resulting labeled packet, MUST support a configuration parameter known as the "Maximum IP Datagram Size for Labeling", which can be set to a non-negative value.

If this configuration parameter is set to zero, it has no effect.

If it is set to a positive value, it is used in the following way. If:

(a) an unlabeled IP datagram is received, and

(b) that datagram does not have the DF bit set in its IP header, and

(c) that datagram needs to be labeled before being forwarded, and

(d) the size of the datagram (before labeling) exceeds the value of the parameter, then

(a) the datagram must be broken into fragments, each of whose size is no greater than the value of the parameter, and

(b) each fragment must be labeled and then forwarded.

If this configuration parameter is set to a value of 1488, for example, then any unlabeled IP datagram containing more than 1488 bytes will be fragmented before being labeled. Each fragment will be capable of being carried on a 1500-byte data link, without further fragmentation, even if as many as three labels are pushed onto its label stack.

In other words, setting this parameter to a non-zero value allows one to eliminate all fragmentation of Previously Labeled IP Datagrams, but it may cause some unnecessary fragmentation of Initially Labeled IP Datagrams.

Note that the parameter has no effect on IP Datagrams that have the DF bit set, which means that it has no effect on Path MTU Discovery.

3.3. When are Labeled IP Datagrams Too Big?

A labeled IP datagram whose size exceeds the Conventional Maximum Frame Payload Size of the data link over which it is to be forwarded MAY be considered to be "too big".

A labeled IP datagram whose size exceeds the True Maximum Frame Payload Size of the data link over which it is to be forwarded MUST be considered to be "too big".

A labeled IP datagram which is not "too big" MUST be transmitted without fragmentation.

3.4. Processing Labeled IPv4 Datagrams which are Too Big

If a labeled IPv4 datagram is "too big", and the DF bit is not set in its IP header, then the LSR MAY discard the datagram.

Note that discarding such datagrams is a sensible procedure only if the "Maximum Initially Labeled IP Datagram Size" is set to a non-zero value in every LSR in the network which is capable of adding a label stack to an unlabeled IP datagram.

If the LSR chooses not to discard a labeled IPv4 datagram which is too big, or if the DF bit is set in that datagram, then it MUST execute the following algorithm:

1. Strip off the label stack entries to obtain the IP datagram.
2. Let N be the number of bytes in the label stack (i.e, 4 times the number of label stack entries).
3. If the IP datagram does NOT have the "Don't Fragment" bit set in its IP header:
   a. convert it into fragments, each of which MUST be at least N bytes less than the Effective Maximum Frame Payload Size.
   b. Prepend each fragment with the same label header that would have been on the original datagram had fragmentation not been necessary.
   c. Forward the fragments
4. If the IP datagram has the "Don't Fragment" bit set in its IP header:
   a. the datagram MUST NOT be forwarded
   b. Create an ICMP Destination Unreachable Message:
      i. set its Code field (RFC792) to "Fragmentation Required and DF Set",
      ii. set its Next-Hop MTU field (RFC 1191to the difference between the Effective Maximum Frame Payload Size abd the value of N
   c. If possible, transmit the ICMP Destination Unreachable Message to the source of the of the discarded datagram.

3.5. Processing Labeled IPv6 Datagrams which are Too Big

To process a labeled IPv6 datagram which is too big, an LSR MUST execute the following algorithm:

1. Strip off the label stack entries to obtain the IP datagram.
2. Let N be the number of bytes in the label stack (i.e, 4 times the number of label stack entries).
3. If the IP datagram contains more than 576 bytes (not counting the label stack entries), then:
   a. Create an ICMP Packet Too Big Message, and set its Next-Hop MTU field to the difference between the Effective Maximum Frame Payload Size and the value of N
   b. If possible, transmit the ICMP Packet Too Big Message to the source of the datagram.
   c. discard the labeled IPv6 datagram.
4. If the IP datagram is not larger than 576 octets, then
   a. Convert it into fragments, each of which MUST be at least N bytes less than the Effective Maximum Frame Payload Size.
   b. Prepend each fragment with the same label header that would have been on the original datagram had fragmentation not been necessary.
   c. Forward the fragments.

   Reassembly of the fragments will be done at the destination host.

3.6. Implications with Respect to Path MTU Discovery

The procedures described above for handling datagrams which have the DF bit set, but which are "too large", have an impact on the Path MTU Discovery procedures of RFC 1191. Hosts which implement these procedures will discover an MTU which is small enough to allow n labels to be pushed on the datagrams, without need for fragmentation, where n is the number of labels that actually get pushed on along the path currently in use.

In other words, datagrams from hosts that use Path MTU Discovery will never need to be fragmented due to the need to put on a label header, or to add new labels to an existing label header. (Also, datagrams from hosts that use Path MTU Discovery generally have the DF bit set, and so will never get fragmented anyway.)

However, note that Path MTU Discovery will only work properly if, at the point where a labeled IP Datagram's fragmentation needs to occur, it is possible to route to the packet's source address. If this is not possible, then the ICMP Destination Unreachable message cannot be sent to the source.

3.6.1. Tunneling Through a Transit Routing Domain

Suppose one is using MPLS to "tunnel" through a transit routing domain, where the external routes are not leaked into the domain's interior routers. If a packet needs fragmentation at some router within the domain, and the packet's DF bit is set, it is necessary to be able to originate an ICMP message at that router and have it routed correctly to the source of the fragmented packet. If the packet's source address is an external address, this poses a problem.

Therefore, in order for Path MTU Discovery to work, any routing domain in which external routes are not leaked into the interior routers MUST have a default route which causes all packets carrying external destination addresses to be sent to a border router. For example, one of the border routers may inject "default" into the IGP.

3.6.2. Tunneling Private Addresses Through a Public Backbone

In other cases where MPLS is used to tunnel through a routing domain, it may not be possible to route to the source address of a fragmented packet at all. This would be the case, for example, if the IP addresses carried in the packet were private addresses, and MPLS were being used to tunnel those packets through a public backbone.

In such cases, the LSR at the transmitting end of the tunnel MUST be able to determine the MTU of the tunnel as a whole. It SHOULD do this by sending packets through the tunnel to the tunnel's receiving endpoint, and performing Path MTU Discovery with those packets. Then any time the transmitting endpoint of the tunnel needs to send a packet into the tunnel, and that packet has the DF bit set, and it exceeds the tunnel MTU, the transmitting endpoint of the tunnel MUST send the ICMP Destination Unreachable mes-

sage to the source, with code "Fragmentation Required and DF Set", and the Next-Hop MTU Field set as described above.

4. Transporting Labeled Packets Over PPP

The Point-to-Point Protocol (PPP) [7] provides a standard method for transporting multi-protocol datagrams over point-to-point links. PPP defines an extensible Link Control Protocol, and proposes a family of Network Control Protocols for establishing and configuring different network-layer protocols.

This section defines the Network Control Protocol for establishing and configuring label Switching over PPP.

4.1. Introduction

PPP has three main components:

1. A method for encapsulating multi-protocol datagrams.
2. A Link Control Protocol (LCP) for establishing, configuring, and testing the data-link connection.
3. A family of Network Control Protocols for establishing and configuring different network-layer protocols.

In order to establish communications over a point-to-point link, each end of the PPP link must first send LCP packets to configure and test the data link. After the link has been established and optional facilities have been negotiated as needed by the LCP, PPP must send "MPLS Control Protocol" packets to enable the transmission of labeled packets. Once the "MPLS Control Protocol" has reached the Opened state, labeled packets can be sent over the link.

The link will remain configured for communications until explicit LCP or MPLS Control Protocol packets close the link down, or until some external event occurs (an inactivity timer expires or network administrator intervention).

4.2. A PPP Network Control Protocol for MPLS

The MPLS Control Protocol (MPLSCP) is responsible for enabling and disabling the use of label switching on a PPP link. It uses the same packet exchange mechanism as the Link Control Protocol (LCP). MPLSCP packets may not be exchanged until PPP has reached the Network-Layer Protocol phase. MPLSCP packets received before this phase is reached should be silently discarded.

The MPLS Control Protocol is exactly the same as the Link Control Protocol [7] with the following exceptions:

1. Frame Modifications

   The packet may utilize any modifications to the basic frame format which have been negotiated during the Link Establishment phase.

2. Data Link Layer Protocol Field

   Exactly one MPLSCP packet is encapsulated in the PPP Information field, where the PPP Protocol field indicates type hex 8081 (MPLS).

3. Code field

   Only Codes 1 through 7 (Configure-Request, Configure-Ack, Configure-Nak, Configure-Reject, Terminate-Request, Terminate-Ack and Code-Reject) are used. Other Codes should be treated as unrecognized and should result in Code-Rejects.

4. Timeouts

   MPLSCP packets may not be exchanged until PPP has reached the Network-Layer Protocol phase. An implementation should be prepared to wait for Authentication and Link Quality Determination to finish before timing out waiting for a Configure-Ack or other response. It is suggested that an implementation give up only after user intervention or a configurable amount of time.

5. Configuration Option Types

   None.

4.3. Sending Labeled Packets

Before any labeled packets may be communicated, PPP must reach the Network-Layer Protocol phase, and the MPLS Control Protocol must reach the Opened state.

Exactly one labeled packet is encapsulated in the PPP Information field, where the PPP Protocol field indicates either type hex 0081 (MPLS Unicast) or type hex 0083 (MPLS Multicast). The maximum length of a labeled packet transmitted over a PPP link is the same as the maximum length of the Information field of a PPP encapsulated packet.

The format of the Information field itself is as defined in section 2.

Note that two code-points are defined for labeled packets; one for multicast and one for unicast. Once the MPLSCP has reached the Opened state, both label Switched multicasts and label Switched unicasts can be sent over the PPP link.

4.4. Label Switching Control Protocol Configuration Options

There are no configuration options.

5. Transporting Labeled Packets Over LAN Media

Exactly one labeled packet is carried in each frame.

The label stack entries immediately precede the network layer header, and follow any data link layer headers, including any VLAN headers, 802.1p headers, and/or 802.1Q headers that may exist.

The ethertype value 8847 hex is used to indicate that a frame is carrying an MPLS unicast packet.

The ethertype value 8848 hex is used to indicate that a frame is carrying an MPLS multicast packet.

These ethertype values can be used with either the ethernet encapsulation or the 802.3 SNAP/SAP encapsulation to carry labeled packets.

6. Security Considerations

Security considerations are not discussed in this document.

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1. Abstract

An overview of a tag switching architecture is provided in [Rekhter]. This document defines the Tag Distribution Protocol (TDP) referred to in [Rekhter].

TDP is a two party protocol that runs over a connection oriented transport layer with guaranteed sequential delivery. Tag Switching Routers use TDP to communicate tag binding information to their peers. TDP supports multiple network layer protocols including but not limited to IPv4, IPv6, IPX and AppleTalk.

We define here the PDUs and operational procedures for this TDP and specify its transport requirements. We also define aspects of the protocol that are specific to the case where it is run over an ATM data-link.

2. Protocol Overview

A tag switching architecture is described in [Rekhter]. As explained in that document Tag Switching Routers (TSRs) create tag bindings, and then distribute the tag binding information among other TSRS.

TDP provides the means for TSRs to distribute, request, and release tag binding information for multiple network layer protocols. TDP also provides means to open, monitor and close TDP sessions and to indicate errors that occur during those sessions.

TDP is a two party protocol that requires a connection oriented transport layer with guaranteed sequential delivery. We use TCP as the transport for TDP.

A TSR that wishes to exchange tag bindings with another opens a TCP connection to the TDP port (TBD) on that other TSR. Once the TCP connection has been established then the TSRs exchange TDP PDUs that encode tag binding information. TDP is symmetrical in that once the TCP connection has been opened the peer TSRs may each send and receive TDP PDUs at will.

A single TSR may have TDP sessions with multiple other TSRs. Each of these sessions is completely independent of the others. Multiple TDP sessions may exist between any given pair of TSRs. Each of these sessions is completely independent of the others. TDP sessions are identified by the 'TDP Identifier' field in the TDP header (see below).

TDP does not require any keepalive notification from the transport, but implements its own keepalive timer. The usage is straightforward: peers must communicate within the period specified by the timer. Each time a TDP peer receives a TDP PDU it resets the timer. If the timer expires some number of times without reception of a TDP PDU from the remote system the TDP closes the session with its peer.

When a TSR determines that it lost a TDP session with another TSR, if the TSR has any tag bindings that were created as a result of receiving tag binding requests from the peer, the TSR may destroy these bindings (and deallocate tags associated with these binding).

When a TSR determines that it lost a TDP session with another TSR, the TSR shall no longer use the binding information it received from the other TSR.

The procedures that govern when other components in a TSR invoke services from TDP and how a TSR maintains its TIBs are beyond the scope of this document.

The use of TDP does not preclude the use of other mechanisms to distribute tag binding information.

2.1. TDP and Tagswitching Over ATM

The tagswitching architecture [Rekhter] describes application of tag switching to ATM, [Davie] provides more details and describes a number of features of TDP required specifically to support this ATM case. We describe control circuit useage and encapsulation here. The sections on TDP_PIE_BIND and TDP_PIE_REQUEST_BIND describe how 'Hop Count' referred to in [Davie] is carried.

2.1.1. Default VPI/VCI

By default the TDP connection between two ATM-TSRs uses VPI/VCI 0/32. The default TDP connection uses the LLC/SNAP encapsulation defined in RFC1483 [Heinanen]. This TDP VC may be used to exchange other LLC/SNAP encapsulated traffic. In particular the TDP VC might be used to carry Network Layer routing information. There are circumstances (see ATM_TAG_RANGE) when this VC is also used to carry data traffic.

TDP provides means to advertise the range of, and negotiate the encapsulation used on, the data VCs. See the section on TDP_PIE_OPEN for further details.

Cooperating TSRs may agree to use VPI/VCI other than 0/32 as the TDP VC, how they do this (management) is outside the scope of this document.

3. State Machines

We describe the TDP's behavior in terms of a state machine. We define the TDP state machine to have four possible states and present the behavior as a state transition table and diagram.

3.1. TDP State Transition Table

STATE	EVENT	NEW STATE
	Initialization	INITIALIZED
INITIALIZED	Sent TDP_PIE_OPEN	OPENSENT
	Received TDP_PIE_OPEN	OPENREC
OPENREC	Received TDP_PIE_KEEP_ALIVE	OPERATIONAL
	Received Any other TDP PDU	INITIALIZED
OPENSENT	Received TDP_PIE_OPEN & Transmit TDP_PIE_KEEP_ALIVE	OPENREC
	Received Any other TDP PDU	INITIALIZED
	Sent TDP_PIE_NOTIFICATION	INITIALIZED
OPERATIONAL	Rx/Tx TDP_PIE_NOTIFICATION with CLOSING parameter	INITIALIZED
	Other TDP PDUs	OPERATIONAL
	Timeout	INITIALIZED

3.2. TDP State Transition Diagram

See FIG. **11**.

3.3. Transport Connections

A TSR that implements TDP opens a TCP connection to a peer TSR. Once open, and regardless of which TSR opened it, the TCP connection is used bidirectionally. That is there is only one TCP 'connection' used for a TDP session between two TSRs. TDP uses TCP port (TBD).

3.4. Timeout

Timeout in the state transition table and diagram indicates that the keep alive timer set to HOLD_TIME has expired. See TDP_PIE_OPEN for a discussion of this mechanism.

4. Protocol Data Units (PDUs)

TDP PDUs are variable length and consist of a fixed header and one or more Protocol Information Elements (PIE) each with a Type Length Value (TLV) structure. Within a single PIE TLVs may be nested to an arbitrary depth.

A single TDP PDU may contain multiple PIEs. The maximum TDP PDU size is 4096 octets.

4.1. TDP Fixed Header

The fixed header of the TDP PDU is shown in FIG. **12**.

Version:

This two octet unsigned integer contains the version number of the protocol. A TDP version number must lie in the range 0x01<=Version <=0xFF. This version of the TDP specification specifies protocol Version=1.

LENGTH:

This two octet integer specifies the length in octets of the data portion of the PDU. LENGTH is set to the length of the PDU in octets minus four.

TDP Identifier:

Six octet unsigned integer containing a unique identifier for the TSR that generated the PDU. The value of this Identifier is determined on startup. The first four octets encode an IP address assigned to the TSR. The last two octets represent the 'instance' of TDP on the TSR. A TSR with only one active TDP session would supply the value zero in this field.

Res:

This field is reserved. It must be set to zero on transmission and must be ignored on receipt.

4.2. TDP TLVs

The TDP fixed header frames Protocol Information Elements (PIEs) that have a Type Length Value (TLV) structure.

In this protocol TYPE is a 16 bit integer value that encodes how the VALUE field is to be interpreted. Within a single PIE TLVs may be nested to an arbitrary depth. A TDP must silently discard TLVs that it does not recognize.

LENGTH is an unsigned 16 bit integer value that encodes the length of the VALUE field in octets. LENGTH is set to the length of the whole TLV in octets minus four. A LENGTH of zero indicates that there is no value field present.

VALUE is an octet string of length LENGTH octets that encodes information the semantics of which are indicated by the TYPE field.

A single TLV has the following format that FIG. **13** shows.

4.3. Example TDP PDU

A complete TDP PDU containing two PIEs having 4 and octets of Value field respectively would have the following structure that FIG. **14** depicts:

4.4. PIEs Defined in V1 of TDP

The following PIEs are defined for this version of the protocol. They are described in the sections that follow

Type 0x100 TDP_PIE_OPEN
Type 0x200 TDP_PIE_BIND
Type 0x300 TDP_PIE_REQUEST_BIND
Type 0x400 TDP_PIE_WITHDRAW_BIND
Type 0x500 TDP_PIE_KEEP_ALIVE
Type 0x600 TDP_PIE_NOTIFICATION
Type 0x700 TDP_PIE_RELEASE_BIND
Type 0x800 Unassigned
. . . . . .
Type 0xFF00

Each of these PIEs may have optional TLV encoded parameters.

4.5. TDP_PIE_OPEN

TDP_PIE_OPEN is the first PIE sent by a TSR initiating a TDP session to its peer. It is sent immediately after the TCP connection has been opened. The TSR receiving a TDP_PIE_OPEN responds either with a TDP_PIE_KEEPALIVE or with a TDP_PIE NOTIFICATION.

4.5.1. Initiating a TDP Session

A TSR initiating a TDP session sets the TDP_OPEN_PIE's fields as described below, issues a PDU containing it to the target peer, the TDP state machine transitions to the OPENSENT state.

While in the OPENSENT state a TSR takes the following actions:

If it receives an 'acceptable' TDP_PIE_OPEN then TSR sends a TDP_PIE_KEEPALIVE and the TDP state machine transitions to the OPEN_REC state.

Receipt of any other PDU is an error and results in sending a TDP_PIE_NOTIFICATION indicating a bad open and transition to the INITIALIZED state.

4.5.2. Passive OPEN

A TSR in the INITIALIZED state that receives a TDP_PIE_OPEN behaves as follows:

If it can support the version of the protocol proposed by the TSR that issued the TDP_PIE_OPEN then it sets Version in all its subsequent communication with that

TSR to the value proposed in Prop Ver and obeys the rules specified for that version of the protocol.

TSR sends a PDU containing a TDP_PIE_OPEN PIE to the TSR that initiated the TDP session.

TSR sends a PDU containing a TDP_PIE_KEEPALIVE PIE to the TSR that initiated the TDP session.

The TDP state machine transitions to the OPEN_REC state

If the TSR cannot support the version of the protocol proposed in the TDP_PIE_OPEN then it sends a TDP_PIE_NOTIFICATION PDU that informs the TSR which generated the PIE_OPEN of the version(s) it can support. The TDP state machine transitions to the INITIALIZED state. See below under errors for more details.

4.5.3. OPENREC State

When in the OPENREC state a TSR takes the following actions:

If a TDP_PIE_KEEPALIVE is received then it transitions to the OPERATIONAL state.

Receipt of any other PDU causes the generation of a TDP_PIE_NOTIFICATION and transition to the INITIALIZED state.

The TDP_PIE_OPEN has the format that FIG. **15** depicts.

TYPE:

Type field as described above. Set to 0x100 for TDP_PIE OPEN.

LENGTH:

Length in octets of the value field of this PIE. LENGTH is set to the length of the whole PIE in octets minus four.

Prop Ver:

The Version of the TDP that the TSR that generated this PDU proposes be used for this TDP session once it is established. Note that the session is not established until the TSR that issues a TDP_PIE_OPEN receives a TDP_PIE_OPEN in response.

Hold Time:

Two octet unsigned non zero integer that indicates the number of seconds that the peer initiating the connection proposes for the value of the Hold Timer. Upon receipt of a PDU with PIE TDP_PIE_OPEN, a TDP peer MUST calculate the value of the Hold Timer by using the smaller of its configured HOLD_TIME and the HOLD_TIME received in the PDU. The value chosen for HOLD_TIME indicates the maximum number of seconds that may elapse between the receipt of successive PDUs from the TDP peer. The Hold Timer is reset each time a TDP_PDU arrives. If the timer expires without the arrival of a TDP_PDU then a TDP_NOTIFICATION with the optional parameter CLOSING is sent.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

See FIG. **16**.

DOWNSTREAM_ON_DEMAND:

A TSR may supply this optional parameter to indicate that it wishes to use downstream tag allocation on demand. When either of the peers in a TDP session indicates that it requires downstream allocation on demand then both shall use that mechanism. TSRs operating in downstream on demand provide bindings only in response to TDP_PIE_REQUEST BINDs.

ATM_TAG RANGE:

An ATM-TSR supplies this parameter to indicate to its ATM peer the range of VCIs that it can use as tags (on this VP). An ATM TSR, when satisfying a TDP_PIE_BIND_REQUEST, may only generate VCI/prefix bindings, ie bindings of BLIST_TYPE 6, containing VCI values from the range communicated to it using this optional parameter.

If an ATM-TSR is unable to generate a BLIST_TYPE 6 binding within the constraints imposed by ATM_TAG_RANGE it may generate a binding of BLIST_TYPE 2.[In that case the TSR receiving the binding sends data traffic on the default TDP VCI but tagged with the BLIST_TYPE 2 tag]

The value for this optional parameter is a list of entries of the form that FIG. **17** depicts

VPI:

32 bit unsigned integer encoding the VPI to the which the following VCI range bounds apply.

VCI Upper range bound:

32 bit unsigned integer encoding the upper bound of a block of VCIs that the ATM_TSR originating the TDP_PIE_OPEN is making available as tags. VCI values between and including Upper and Lower range bound may be used as tags.

VCI Lower range bound:

32 bit unsigned integer encoding the lower bound of a block of VCIs that the ATM_TSR originating the TDP_PIE_OPEN is making available as tags. VCI values between and including Upper and Lower range bound may be used as tags.

The number of entries may be deduced from the value in the Length field. VCI tags may be allocated from the range indicated by the upper/lower values inclusive of those values. There must be at least one entry. There may be more than one. There may be more than one entry with the same VPI value.

ATM_NULL_ENCAPSULATION:

An ATM-TSR supplies this parameter to indicate that it supports the null encapsulation of RFC1483 [Heinanen] for its data VCs. In this case IP packets are carried directly inside AAL5 frames. This option is only used by an ATM-TSR that it is configured to support a single level of tagging. See [Davie] for more details.

An ATM-TSR that cannot support this option will generate the error TDP_WRONG_ENCAPS.

4.5.4. Errors

All Errors generated by the receipt of a TDP_PIE_OPEN are reported by issuing a TDP_PIE_NOTIFICATION. The value field of the PIE contains one or more TLVs describing individual errors with more precision.

Error	Type	Length	Value
TDP_OPEN_UNSUPPORTED_VER	0x1F0	Var	See below
TDP_BAD_OPEN	0x1F1	0	0
TDP_WRONG_ENCAPS	0x1F2	0	0

4.5.4.1. TDP_OPEN_UNSUPPORTED_VER:

This error is issued to indicate to the TSR that generated the TDP_PIE_OPEN that this TSR does not support the version of TDP proposed in 'Prop Ver' in the PIE_OPEN. TDP_OPEN UNSUPPORTED_VER reports the version(s) of the protocol that this TSR does support.

A TSR that receives this error may choose to reissue the TDP_PIE_OPEN specifying a version of the protocol that the target systems has indicated it can support.

If a TSR is to take this action it should not close (and reopen) the TCP connection before so doing but should leave the connection 'up' during the negotitation process.

A TSR that generates this error should anticipate that the other system may reissue the TDP_PIE_OPEN and should wait at least TRANSPORT_HOLDDOWN seconds (default 30) before it closes the TCP connection. The TRANSPORT_HOLDDOWN timer is started when a TDP_PIE_NOTIFICATION containing TDP_OPEN_UNSUPPORTED_VER is sent and is reset on reception of a TDP_PIE_OPEN. These measure are designed to stop the version negotiation mechanism 'thrashing' the transport setup mechanism.

TYPE:

TDP_OPEN_UNSUPPORTED_VER=0x1F0

LENGTH:

Length in octets of the value field of this PIE.

LENGTH is set to the length of the whole PIE in α-tets minus four.

VALUE:

One or more 2 octet integers that encode the Version(s) of the protocol that this TSR supports.

The format of an NOTIFICATION PIE containing TDP_OPEN_UNSUPPORTED_VER is:

4.5.4.2. TDP_BAD_OPEN

This error is issued to indicate failure during the open phase.

4.5.4.3. TDP_WRONG_ENCAPS

This error is used to indicate that an ATM-TSR will not support the null encapsulation proposed in the TDP_PIE_OPEN (by the inclusion of the option ATM_NULL_ENCAPSULATION).

4.6. TDP_PIE_BIND

TDP_PIE_BIND is sent from one TSR to another to distribute tag bindings. Transmission of a TDP_PIE_BIND may occur as a result of some local decision or it may be in response to the reception of a TDP_REQUEST_BIND.

This PIE has the following format

TYPE:

Type field as described above. Set to 0x200 for TDP_PIE_BIND.

LENGTH:

Length in octets of the value field of this PIE.

LENGTH is set to the length of the whole PIE in octets minus four.

Request ID:

If this TDP_PIE_BIND is generated in response to a TDP_PIE_REQUEST_BIND then TSR places the value of the Request ID from that request PIE in this field. For all other TDP_PIE_BINDS this field must be set to zero.

AFAM:

This 16 bit integer contains a value from ADDRESS FAMILY NUMBERS in Assigned Numbers [Reynolds] that encodes the address family that the network layer address in the tag bindings in the BINDING_LIST is from. This protocol provides support for multiple network address families.

BLIST_TYPE:

This 16 bit integer contains a value from the table below that encodes the format and semantics of the BLIST entries in the BINDING_LIST field.

BLIST_TYPE	BLIST entry format
0	Null list (see TDP_PIE_WITHDRAW_BIND)
1	32 bit Upstream assigned
2	32 bit Downstream assigned
3	32 bit Multicast Upstream assigned (*,G)
4	32 bit Multicast Upstream assigned (S,G)
5	32 bit Upstream assigned VCI tag
6	32 bit Downstream assigned VCI tag

The formats are defined below.

BLIST_LENGTH:

Two octet unsigned integer that encodes the length of the BINDING_LIST

BINDING_LIST:

Variable length field consisting of one or more BLIST entries of the type indicated by BLIST_TYPE.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

4.6.1. BLIST_TYPE 0

BLIST_TYPE=0 indicates that there are no BLIST entries. See TDP_PIE_WITHDRAW_BIND for further details.

4.6.2. BLIST_TYPE 1 and 2

A BLIST_TYPE 1 contains Upstream assigned tags. A TDP must only include tag values in a BLIST_TYPE 1 tag entry that lie between the values, inclusive of those values, that the TSR to whom the TDP_PIE_BIND is being sent indicated it could support during the OPEN phase.

BLIST entries of type 1 and 2 have the format given in FIG. **18**.

Precedence

8 bit unsigned integer containing the precedence with which traffic bearing this tag will be serviced by the TSR that issued the TDP_PIE_BIND. [Note that the precedence is likely to be restricted to perhaps three bits of the space reserved here.]

Tag:

Tag is a 32 bit unsigned integer encoding the value of the tag.

Pre Len:

This one octet unsigned integer contains the length in bits of the address prefix that follows.

Prefix:

A variable length field containing an address prefix whose length, in bits, was specified in the previous (Pre Len) field. A Prefix is padded with sufficient trailing zero bits to cause the end of the field to fall on an octet boundary.

4.6.3. BLIST_TYPE 3

This binding allows the association of a tag with the (*,G) shared tree. See [Deering] for a discussion of (*,G) shared trees.

The (*,G) binding has the format that FIG. **19** illustrates.

Precedence

8 bit unsigned integer containing the precedence with which traffic bearing this tag will be serviced by the TSR that issued the TDP_PIE_BIND. [Note that the precedence is likely to be restricted to perhaps three bits of the space reserved here.]

Tag:

Tag is a 32 bit unsigned integer encoding the value of the tag.

Multicast Group Address G:

Multicast Group Address. The length of this address is network layer specific and can be deduced from the value of AFAM. The diagram above illustrates a four octet IPv4 address format.

4.6.4. BLIST_TYPE 4

This binding type allows association of a tag with a (S,G) source rooted tree. See [Deering] for a discussion of (S,G) trees.

The (S,G) binding has the format that FIG. **20** depicts.

Precedence

8 bit unsigned integer containing the precedence with which traffic bearing this tag will be serviced by the TSR that issued the TDP_PIE_BIND. [Note that the precedence is likely to be restricted to perhaps three bits of the space reserved here.]

Tag:

Tag is a 32 bit unsigned integer encoding the value of the tag.

Source Address S:

Network Layer address of the source sending to the G tree. The length of this address is network layer specific and can be deduced from the value of AFAM. The diagram above illustrates a four octet IPv4 address format.

Multicast Group Address G:

Network Layer Multicast group address. The length of this address is network layer specific and can be deduced from the value of AFAM. The diagram above illustrates a four octet IPv4 address format.

4.6.5. BLIST_TYPE 5 and 6

BLIST entries of type 5 and 6 have the following format that FIG. **21** depicts.

Precedence:

8 bit unsigned integer containing the precedence with which traffic bearing this tag will be serviced by the TSR that issued the TDP_PIE_BIND. [Note that the precedence is likely to be restricted to perhaps three bits of the space reserved here.]

HC:

Hop count. See [Davie] for a detailed description.

Tag:

Tag is a 32 bit signed integer encoding the value of the tag. (See section 2.1).

Pre Len:

This one octet unsigned integer contains the length in bits of the address prefix that follows.

Prefix:

A variable length field containing an address prefix whose length, in bits, was specified in the previous (Pre Len) field. A Prefix is padded with sufficient trailing zero bits to cause the end of the field to fall on an octet boundary.

4.7. TDP_PIE_REQUEST_BIND

TDP_PIE_REQUEST_BIND is sent from a TSR to a peer to request a binding for one or more specific NLRIs, or to request all the bindings that its peer has.

A TSR receiving a TDP_PIE_REQUEST_BIND must respond with a TDP_PIE_BIND or with a TDP_PIE_NOTIFICATION. A TSR that issues a TDP_PIE_BIND in response to a TDP_PIE_REQUEST_BIND places the Request ID from TDP_PIE_REQUEST_BIND in the Request ID field in the TDP_PIE_BIND that it issues.

When a TSR receiving a TDP_PIE_REQUEST_BIND is unable to satisfy it because of resource limitations it issues a TDP_PIE_NOTIFICATION for RESOURCE_LIMIT containing the Request ID from the TDP_PIE_REQUEST_BIND.

A TSR that issues TDP_PIE_NOTIFICATION with RESOURCE_LIMIT set must send a subsequent TDP_PIE_NOTIFICATION, containing the status notification RESOURCES, to the peer to whom it previously sent that TDP_PIE_NOTIFICATION when it has resources available to satisfy further TDP_PIE_BIND_REQUESTs from that peer.

If a TDP_PIE_NOTIFICATION is received containing RESOURCE_LIMIT the TSR may not issue further TDP_PIE_REQUEST_BINDs until it receives a TDP_PIE_NOTIFICATION with the Optional parameter RESOURCES.

A TSR may receive a TDP_PIE_REQUEST_BIND for a pre-fix for which there is no entry in its router information base (RIB). If this occurs the TSR issues a TDP_PIE_NOTIFICATION containing the Optional parameter NO_ROUTE. The value field of the NO_ROUTE parameter contains the prefix(es) for which no entry was found in the RIB.

The procedures to be employed by a TSR that receives a TDP_PIE_NOTIFICATION with the optional parameter NO_ROUTE are outside the scope of this specification.

A TSR may issue TDP_PIE_BIND and TDP_PIE_NOTIFICATION containing RESOURCE_LIMIT or NO_ROUTE in response to a single TDP_PIE_REQUEST_BIND.

A TSR must satisfy as much of a TDP_PIE_REQUEST_BIND as it can. A TSR may not ignore other prefixes in a TDP_PIE_REQUEST_BIND on encountering an error with one prefix.

This PIE has the format that FIG. **22** depicts.

TYPE:

Type field as described above. Set to 0x300 for TDP_PIE_REQUEST_BIND.

LENGTH:

Length in octets of the value field of this PIE. LENGTH is set to the length of the whole PIE in octets minus four.

Request ID:

This four octet unsigned integer contains a locally significant non zero value that a TSR uses to identify TDP_PIE_BINDs or TDP_PIE_NOTIFICATIONs that are generated in response to this request.

AFAM:

This 16 bit integer contains a value from ADDRESS FAMILY NUMBERS in Assigned Numbers [Reynolds] that encodes the address family that the network layer address in the tag bindings in the BINDING_LIST is from. This version of TDP supports IPv4 and IPv6.

ALIST_TYPE:

This 16 bit integer contains a value from the table below that encodes the format of the ALIST entries in the ADDR_LIST field. Currently there are 3 values defined by this specification.

ALIST_TYPE	ALIST entry format
0	Null list
1	Precedence followed by variable length NLRI
2	Precedence, Hop Count followed by variable length NLRI

The format for these entries is defined below.

ALIST_LENGTH:

Two octet unsigned integer that encodes the length in octets of the ADDR_LIST field.

ADDR_LIST:

A variable length list consisting of one or more entries of type ALIST_TYPE.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

4.7.1. ALIST formats

ALIST_TYPE=0 indicates a null list ie there are no ALIST entries. A TDP receiving a TDP_PIE_REQUEST_BIND with ALIST_TYPE set to 0 interprets this as an implicit request for all the bindings that it currently has.

For ALIST_TYPE=1 ALIST entries have the form that FIG. **23** illustrates.

For ALIST_TYPE=2 ALIST entries have the form that FIG. **24** illustrates:

HC:

Hop count.

Precedence:

This one octet unsigned integer encodes the precedence with which the requester wants traffic to this prefix handled.

Pre Len:

This one octet unsigned integer contains the length in bits of the address prefix that follows.

Prefix:

A variable length field containing an address prefix whose length, in bits, was specified in the previous (Pre Len) field. A Prefix is padded with sufficient trailing zero bits to cause the end of the field to fall on an octet boundary.

4.7.2. Errors

Errors are reported using TDP_PIE_NOTIFICATION. See FIG. **25**.

RESOURCE_LIMIT:

If the TSR is unable to provide a TDP_PIE_BIND in response to a request the TSR indicates this by supplying the RESOURCE_LIMIT status notification as a parameter in the TDP_PIE_NOTIFICATION. The Request ID from the TPD_ PIE_REQUEST bind is supplied in the Value field of this status notification

RESOURCES:

A TSR that has sent RESOURCE_LIMIT to a peer sends RESOURCES when that resource limit clears.

HOP_COUNT_EQUALLED:

An ATM_TSR that receives a TDP_PIE_BIND_REQUEST containing a HOP_COUNT that equals MAX_HOP_COUNT does not generate a binding but instead sends this error notification. The length is variable and the value returns the Request ID and the ALIST entry (ies) that caused the error in the format that FIG. **26** illustrates.

NO_ROUTE:

A TSR that has no RIB entry for a prefix that it receives in a TDP_PIE_REQUEST_BIND issues a notification containing this parameter for that prefix(es). The value field of this parameter contains the Request_ID, AFAM, ALIST_TYPE from the TDP_PIE_REQUEST_BIND and a suitably modified ALIST_LENGTH and ADDR_LIST in the format that FIG. **27** illustrates.

See section 4.7 for descriptions of the Request_ID, AFAM, ALIST_TYPE, ALIST_LENGTH and ADDR_LIST elements.

4.8. TDP_PIE_WITHDRAW_BIND

TDP_PIE_WITHDRAW_BIND is issued by a TSR that originally provided a binding-containing the tag in question and is an absolute instruction to the TSR that receives it that it may not continue to use that tag to forward traffic to the TSR issuing the TDP_PIE_WITHDRAW_BIND.

This PIE has the following format that FIG. **28** illustrates.

TYPE:

Type field as described above. Set to 0x400 for TDP_PIE WITHDRAW_BIND.

LENGTH:

Length in octets of the value field of this PIE. LENGTH is set to the length of the whole PIE in octets minus four.

BLIST_TYPE

This 16 bit integer encodes the format of the BLIST entries in the BINDING_LIST field. Possible values are defined in Section 4.6. A TDP receiving this PIE with the BLIST_TYPE set to Null interprets it (based on the semantics) as either (a) an implicit instruction to WITHDRAW all bindings belonging to the peer that issued the PIE, or (b) as an indication that all the bindings requested by the peer are no longer needed by the peer that issued the PIE.

BLIST_LENGTH:

This 16 bit unsigned integer encodes the length in octets of the BINDING_LIST.

BINDING_LIST:

Variable length field consisting of one or more BLIST entries of the type indicated by BLIST_TYPE. The format of these entries is defined in Section 4.6.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

4.9. TDP_PIE_RELEASE_BIND

TDP_PIE_RELEASE_BIND is issued by a TSR that received a tag as a consequence of an Upstream Request/downstream assignment sequence. It is an indication to the TSR that receives it that the TSR that requested the binding no longer needs that binding.

This PIE has, with the exception of a different type value exactly the same syntax as TDP_PIE_WITHDRAW_BIND.

See FIG. **29**.

See the discussion of TDP_PIE_WITHDRAW_BIND for details of the syntax.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

4.10. TDP_PIE_KEEP_ALIVE

The Hold Timer mechanism described earlier in Sections 3 and 4 is reset every time a TDP_PDU is received. TDP_PIE_KEEP_ALIVE is provided to allow reset of the Hold Timer in circumstances where a TDP has no other information to communicate to its peer.

A TDP must arrange that its peer sees a TDP_PDU from it at least every HOLD_TIME period. That PDU may be any other from the protocol or, in circumstances where there is no need to send one of them, it must be TDP_PIE_KEEP_ALIVE.

This PIE has the format that FIG. **30** depicts.

TYPE:

Type field as described above. Set to 0x500 for TDP_PIE_KEEP_ALIVE.

LENGTH:

Length in octets of the value field of this PIE. LENGTH is set to the length of the whole PIE in octets minus four.

Optional Parameters:

This variable length field contains zero or more optional PIEs supplied in TLV structures.

4.11. TDP_PIE_NOTIFICATION

TDP_PIE_NOTIFICATION is issued by TDP to inform its peer of a significant event. 'Significant events' include errors and changes in TSR capabilities or operational state.

All notification information is encoded as TLVs in the optional parameters field.

This PIE has the format that FIG. **31** depicts.

TYPE:

Type field as described above. Set to 0x600 for TDP_PIE_NOTIFICATION

LENGTH:

Length in octets of the value field of this PIE. LENGTH is set to the length of the whole PIE in octets minus four.

Optional Parameters:

This variable length field contains zero or more optional parameters supplied in TLV structures. The optional parameter types and their uses are:

RETURNED_PDU:

A TSR uses this parameter to return a PDU to the TSR that issued it.

See FIG. **32**.

As much as possible of the complete PDU, including the header, that is to be returned is inserted into the value field. The Length is set to the number of octets of the PDU that is being returned that have been inserted into the Value field of this optional parameter. Implementations parsing RETURNED_PDU must be careful to recognize that the returned PDU may have been truncated.

CLOSING: A TSR uses this parameter to indicate that it is terminating the TDP session.

See FIG. **33**.

TDP may send a TDP_PIE_NOTIFICATION with CLOSING set in response to a protocol error or to administrative intervention.

A TDP receiving or issuing this notification transitions to the INITIALIZED state.

The following optional parameters are defined for returning errors from individual PIEs. See the description of the relevant PIEs for a complete description of the errors.

TDP_PIE_OPEN: See FIG. **34**.

TDP_PIE_REQUEST_BIND: See FIG. **35**.

5. Intellectual Property Considerations

Cisco Systems may seek patent or other intellectual property protection for some or all of the technologies disclosed in this document. If any standards arising from this document are or become protected by one or more patents assigned to Cisco Systems, Cisco intends to disclose those patents and license them on reasonable and non-discriminatory terms.

6. Acknowledgments

Jim Gibson, Keith McCloghrie, Alex Raj, Dan Tappan and Bob Thomas pointed out omissions and errors in the previous version of this document and provided guidance on the definition of new capabilities.

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Internet Draft: Multiprotocol Extensions for BGP-4

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Internet Draft
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Multiprotocol Extensions for BGP-4

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1. Status of this Memo

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2. Abstract

Currently BGP-4 [BGP-4] is capable of carrying routing information only for IPv4 [IPv4]. This document defines extensions to BGP-4 to enable it to carry routing information for multiple Network Layer protocols (e.g., IPv6, IPX, etc . . .). The extensions are backward compatible—a router that supports the extensions can interoperate with a router that doesn't support the extensions.

3. Overview

The only three pieces of information carried by BGP-4 that are IPv4 specific are (a) the NEXT_HOP attribute (expressed as an IPv4 address), (b) AGGREGATOR (contains an IPv4 address), and (c) NLRI (expressed as IPv4 address prefixes). This document assumes that any BGP speaker (including the one that supports multiprotocol capabilities defined in this document) has to have an IPv4 address (which will be used, among other things, in the AGGREGATOR attribute). Therefore, to enable BGP-4 to support routing for multiple Network Layer protocols the only two things that have to be added to BGP-4 are (a) the ability to associate a particular Network Layer protocol with the next hop information, and (b) the ability to associated a particular Network Layer protocol with NLRI. To identify individual Network Layer protocols this document uses Address Family, as defined in [RFC1700].

One could further observe that the next hop information (the information provided by the NEXT_HOP attribute) is meaningful (and necessary) only in conjunction with the advertisements of reachable destinations_in conjunction with the advertisements of unreachable destinations (withdrawing routes from service) the next hop information is meaningless. This suggests that the advertisement of reachable destinations should be grouped with the advertisement of the next hop to be used for these destinations, and that the advertisement of reachable destinations should be segregated from the advertisement of unreachable destinations.

To provide backward compatibility, as well as to simplify introduction of the multiprotocol capabilities into BGP-4 this document uses two new attributes, Multiprotocol Reachable NLRI (MP_REACH_NLRI), and Multiprotocol Unreachable NLRI (MP_UNREACH_NLRI). The first one (MP_REACH_NLRI) is used to carry the set of reachable destinations together with the next hop information to be used for forwarding to these destinations. The second one (MP_UNREACH_NLRI) is used to carry the set of unreachable destinations. Both of these attributes are optional and non-transitive. This way a BGP speaker that doesn't support the multiprotocol capabilities will just ignore the information carried in these attributes, and will not pass it to other BGP speakers.

4. Multiprotocol Reachable NLRI—MP_REACH_NLRI (Type Code 14):

This is an optional non-transitive attribute that can be used for the following purposes:

(a) to advertise a feasible route to a peer

(b) to permit a router to advertise the Network Layer address of the router that should be used as the next hop to the destinations listed in the Network Layer Reachability Information field of the MP_NLRI attribute.

(c) to allow a given router to report some or all of the Subnetwork Points of Attachment (SNPAs) that exist within the local system

The attribute contains one or more triples <Address Family Information, Next Hop Information, Network Layer Reachability Information>, where each triple is encoded as shown in FIG. **36**.

The use and meaning of these fields are as follows:

Address Family Identifier:

This field carries the identity of the Network Layer protocol associated with the Network Address that follows. Presently defined values for this field are specified in RFC1700 (see the Address Family Numbers section).

Subsequent Address Family Identifier:

This field provides additional information about the type of the Network Layer Reachability Information carried in the attribute.

Length of Next Hop Network Address:

A 1 octet field whose value expresses the length of the "Network Address of Next Hop" field as measured in octets

Network Address of Next Hop:

A variable length field that contains the Network Address of the next router on the path to the destination system

Number of SNPAs:

A 1 octet field which contains the number of distinct SNPAs to be listed in the following fields. The value 0 may be used to indicate that no SNPAs are listed in this attribute.

Length of Nth SNPA:

A 1 octet field whose value expresses the length of the "Nth SNPA of Next Hop" field as measured in semi-octets

Nth SNPA of Next Hop:

A variable length field that contains an SNPA of the router whose Network Address is contained in the "Network Address of Next Hop" field. The field length is an integral number of octets in length, namely the rounded-up integer value of one half the SNPA length expressed in semi-octets; if the SNPA contains an odd number of semi-octets, a value in this field will be padded with a trailing all-zero semi-octet.

Network Layer Reachability Information:

A variable length field that lists NLRI for the feasible routes that are being advertised in this attribute. When the Subsequent Address Family Identifier field is set to one of the values defined in this document, each NLRI is encoded as specified in the "NLRI encoding" section of this document.

The next hop information carried in the MP_REACH_NLRI path attribute defines the Network Layer address of the border router that should be used as the next hop to the destinations listed in the MP_NLRI attribute in the UPDATE message. When advertising a MP_REACH_NLRI attribute to an external peer, a router may use one of its own interface addresses in the next hop component of the attribute, provided the external peer to which the route is being advertised shares a common subnet with the next hop address. This is known as a "first party" next hop. A BGP speaker can advertise to an external peer an interface of any internal peer router in the next hop component, provided the external peer to which the route is being advertised shares a common subnet with the next hop address. This is known as a "third party" next hop information. A BGP speaker can advertise any external peer router in the next hop component, provided that the Network Layer address of this border router was learned from an external peer, and the external peer to which the route is being advertised shares a common subnet with the next hop address. This is a second form of "third party" next hop information.

Normally the next hop information is chosen such that the shortest available path will be taken. A BGP speaker must be able to support disabling advertisement of third party next hop information to handle imperfectly bridged media or for reasons of policy.

A BGP speaker must never advertise an address of a peer to that peer as a next hop, for a route that the speaker is originating. A BGP speaker must never install a route with itself as the next hop.

When a BGP speaker advertises the route to an internal peer, the advertising speaker should not modify the next hop information associated with the route.

When a BGP speaker receives the route via an internal link, it may forward packets to the next hop address if the address contained in the attribute is on a common subnet with the local and remote BGP speakers.

An UPDATE message that carries the MP_REACH_NLRI must also carry the ORIGIN and the AS_PATH attributes (both in EBGP and in IBGP exchanges). Moreover, in IBGP exchanges such a message must also carry the LOCAL_PREF attribute. If such a message is received from an external peer, the local system shall check whether the leftmost AS in the AS_PATH attribute is equal to the autonomous system number of the peer than sent the message. If that is not the case, the local system shall send the NOTIFICATION message with Error Code UPDATE Message Error, and the Error Subcode set to Malformed AS_PATH.

5. Multiprotocol Unreachable NLRI— MP_UNREACH_NLRI (Type Code 15):

This is an optional non-transitive attribute that can be used for the purpose of withdrawing multiple unfeasible routes from service.

The attribute contains one or more triples <Address Family Information, Unfeasible Routes Length, Withdrawn Routes>, where each triple is encoded as shown below:

Address Family Identifier (2 octets)
Subsequent Addres`s Family Identifier (1 octet)
Withdrawn Routes (variable)

The use and the meaning of these fields are as follows:

Address Family Identifier:

This field carries the identity of the Network Layer protocol associated with the NLRI that follows. Presently defined values for this field are specified in RFC1700 (see the Address Family Numbers section).

Subsequent Address Family Identifier:

This field provides additional information about the type of the Network Layer Reachability Information carried in the attribute.

Withdrawn Routes:

A variable length field that lists NLRI for the routes that are being withdrawn from service. When the Subsequent Address Family Identifier field is set to one of the values defined in this document, each NLRI is encoded as specified in the "NLRI encoding" section of this document.

An UPDATE message that contains the MP_UNREACH_NLRI is not required to carry any other path attributes.

6. NLRI Encoding

The Network Layer Reachability information is encoded as one or more 2-tuples of the form <length, prefix>, whose fields are described below:

Length (1 octet)
Prefix (variable)

The use and the meaning of these fields are as follows:

a) Length:

The Length field indicates the length in bits of the address prefix. A length of zero indicates a prefix that matches all (as specified by the address family) addresses (with prefix, itself, of zero octets).

b) Prefix:

The Prefix field contains address prefixes followed by enough trailing bits to make the end of the field fall on an octet boundary. Note that the value of trailing bits is irrelevant.

7. Subsequent Address Family Identifier

This document defines the following values for the Subsequent Address Family Identifier field carried in the $MP\_REACH\_NLR_1$ and $MP\_UNREACH\_NLR_1$ attributes:

1—Network Layer Reachability Information used for unicast forwarding

2—Network Layer Reachability Information used for multicast forwarding

3—Network Layer Reachability Information used for both unicast and multicast forwarding

This document reserves values 128-255 for vendor-specific applications.

This document reserves value 0.

8. Security Considerations

Security issues are not discussed in this document.

9. Acknowledgements

To be supplied.

10. References

[BGP-4]

[IPv4]

[IPv6]

[RFC1700]

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Internet Draft: Capabilities Negotiation

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Capabilities Negotiation with BGP-4

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2. Abstract

Currently BGP-4 [BGP-4] requires that when a BGP speaker receives an OPEN message with one or more unrecognized Optional Parameters, the speaker must terminate BGP peering. This complicates introduction of new capabilities in BGP.

This document defines new Optional Parameter, called Capabilities, that is expected to facilitate introduction of new capabilities in BGP by providing graceful capability negotiation.

The proposed parameter is backward compatible—a router that supports the parameter can maintain BGP peering with a router that doesn't support the parameter.

3. Overview of Operations

When a BGP speaker that supports capabilities negotiation sends an OPEN message to its BGP peer, the message includes an Optional Parameter, called Capabilities. The parameter lists the capabilities supported by the speaker. The speaker can mark a listed capability as "Required", which means that if the peer doesn't recognize/support the capability, the BGP peering shall be terminated.

When the peer receives the OPEN message, if the message contains the Capabilities Optional Parameter, the peer checks whether it supports all of the listed α-pabilities marked as R, and if not, sends a NOTIFICATION message, and terminates peering. The Error Subcode in the message is set to Unsupported Capability. The message should contain all the capabilities marked as R that are not supported by the peer.

If the peer doesn't support a capability that is not marked as R, the peer should not use this as a reason to terminate peering.

A BGP speaker may use a particular capability when peering with another speaker if both speakers support that capability. A BGP speaker determines the capabilities supported by its peer by examining the list of capabilities present in the Capabilities Optional Parameter carried by the OPEN message that the peer sends to the speaker.

A BGP speaker determines that its peer doesn't support capabilities negotiation, if in response to an OPEN message that carries the Capabilities Optional Parameter, the speaker receives a NOTIFICATION message with the Error Subcode set to Unsupported Optional Parameter.

4. Capabilities Optional Parameter (Parameter Type 2):

This is an Optional Parameter that is used by a BGP speaker to convey to its BGP peer the list of capabilities supported by the speaker.

The parameter contains one or more triples <Capability Code, Capability Length, Capability Value>, where each triple is encoded as shown below:

Capability Code (1 octet)
Capability Length (1 octet)
Capability Value (variable)

The use and meaning of these fields are as follows:

Capability Code:

Capability Code is a one octet field that unambiguously identifies individual capabilities.

The high-order bit of this field is used to mark the capability as "Required" (if the bit is set to 1).

Capability Length:

Capability Length is a one octet field that contains the length of the Capability Value field in octets.

Capability Value:

Capability Value is a variable length field that is interpreted according to the value of the Capability Code field.

5. Extensions to Error Handling

This document defines new Error Subcode_Unsupported Capability. The value of this Subcode is 7. The Data field in the NOTIFICATION message lists the set of capabilities that are marked as Required, but are either unsupported or unrecognized by the BGP speaker that sends the message. Each such capability is encoded the same way as it was encoded in the received OPEN message.

6. Security Considerations

Security issues are not discussed in this document.

7. Acknowledgements

To be supplied.

8. References

[BGP-4]

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What is claimed is:

1. A method for operating a provider edge router, comprising:

receiving a data packet by the provider edge router from a first customer edge router of a customer network, the data packet associated with a particular virtual private network (VPN) of the customer network;

creating a header for forwarding the data packet, the header containing a first tag and a second tag, the first tag to be read by a provider transit router, the first tag indicating a next-hop on a path through a provider network to a second provider edge router, and the second tag to be read by the second provider edge router, the second tag indicating an egress channel of

the second provider edge router providing access to a second customer edge router that is part of the VPN; and

forwarding the data packet with the header to the provider transit router so that the provider transit router can forward the data packet toward the second provider edge router in response to the first tag, and the second provider edge router can forward the data packet to the second customer edge router in response to the second tag.

2. The method as in claim 1, further comprising:

forming a router adjacency between the provider edge router and the first customer edge router.

3. The method as in claim 1, further comprising:

forming a router adjacency between the second provider edge router and the second customer edge router.

4. The method as in claim 1, further comprising:

maintaining an information base by the provider edge router, the information base holding forwarding data accessible in response to fields in the data packet received from the first customer edge router, the forwarding data associating the second provider edge router with an address read from the data packet, and the forwarding data base also associating the provider transit router with a route to the second provider edge router;

placing the first tag and the second tag into the header in response to the second provider edge router and the provider transit router as determined from the information base in association with the address read from the data packet.

5. A method for operating a system of routers, comprising:

receiving at a first provider edge router a data packet from a first customer edge router of a customer network, the data packet associated with a particular virtual private network (VPN) of the customer network;

creating a header by the first provider edge router for forwarding the data packet, the header containing a first tag and a second tag, the first tag to be read by a provider transit router, the first tag indicating a next-hop on a route through the provider network to a second provider edge router, and the second tag to be read by a second provider edge router, the second tag indicating a particular egress channel of the second provider edge router providing access to a second customer edge router that is part of the VPN;

forwarding the data packet with the header to the provider transit router;

reading the first tag by the provider transit router, and forwarding the data packet in response to the first tag, on the route to the second provider edge router; and

reading the second tag by the second provider edge router, and forwarding the data packet by the second provider edge router in response to the second tag to a second customer edge router.

6. The method as in claim 5, further comprising:

forming a router adjacency between the first provider edge router and the first customer edge router.

7. The method as in claim 5, further comprising:

forming a router adjacency between the second provider edge router and the second customer edge router.

8. The method as in claim 5, further comprising:

maintaining an information base by the first provider edge router, the information base holding forwarding data accessible in response to fields in the data packet received from the customer edge router, the forwarding data associating the second provider edge router with an address read from the data packet, and the forwarding data base also associating the provider transit router with a route to the second provider edge router;

placing the first tag and the second tag into the header in response to the second provider edge router and the provider transit router as determined from the information base in association with the address read from the data packet.

9. The method as in claim 5, further comprising:

maintaining an information base by the provider transit router, the information base associating the first tag with a route to the second provider edge router.

10. The method as in claim 5, further comprising:

removing the first tag from the data packet by the provider transit router before forwarding the data packet along the route to the second provider edge router.

11. The method as in claim 5, further comprising:

forwarding the data packet to a second provider transit router in response to the second tag when the route to the second provider edge router requires a hop through the second provider transit router;

removing the first tag from the header before forwarding the data packet to the second provider transit router; and

writing a third tag into the header for the second provider transit router to use in forwarding the data packet on a further route toward the second provider edge router.

12. The method as in claim 1, wherein the data packet received by the provider edge router includes a destination address that specifies a customer node accessible through the second customer edge router, and the step of creating a header is performed in response to determining the data packet should traverse one or more provider routers to reach the second customer edge router.

13. The method as in claim 1, further comprising:

maintaining the VPN through the provider edge router for transmission of the data packet.

14. The method as in claim 13, wherein the VPN extends at least between the first customer edge router and the second customer edge router.

15. A method for operating a router, comprising:

receiving a data packet from a provider router, the data packet having a header, the data packet associated with a particular virtual private network (VPN) of a customer network;

reading a first tag and a second tag from the header;

deciding, in response to the first tag and the second tag, whether the router is a provider transit router or a provider edge router;

routing the data packet, in the event that the decision is that the router is a provider transit router, to a downstream provider router in response to the first tag; and

routing the data packet, in the event that the decision is that the router is a provider edge router, to a particular egress channel that leads to a downstream customer edge router that is part of the VPN in response to the second tag.

16. The method as in claim 15, further comprising:

deciding that the router is a provider transit router, in response to the first tag specifying a route to another provider router.

17. The method as in claim 15, further comprising:

deciding that the router is a provider edge router, in response to the first tag not specifying a route to another provider router.

18. The method as in claim 15, further comprising:

reading, in response to the first tag, forwarding data from a tag information database, and in response to the forwarding data, deciding that the router is a provider transit router.

19. The method as in claim 15, further comprising:

reading, in response to the first tag, forwarding data from a tag information database, and in response to the forwarding data, deciding that the router is a provider edge router.

20. A method for operating an edge router of a provider network comprising:

receiving a data packet from a router of a customer network associated with a virtual private network (VPN), the data packet including a destination address field that specifies an address of a node in another portion of the customer network also associated with the VPN, the other portion of the customer network accessible through the provider network;

making a routing decision based on the contents of the data packet's destination address field and the router of the customer network the data packet is received from, the routing decision determining a path through the provider network to an egress edge router that provides access to the other portion of the customer network;

adding to the data packet an internal-routing field that includes a first tag and a second tag, the first tag to indicate a next hop along the path to the egress edge router, and the second tag to indicate a particular egress channel of the egress edge router that leads to the node in another portion of the customer network also associated with the VPN;

indicating in the data packet that any routers along the path through the provider network to the egress edge router are to make routing decisions based on the internal-routing field without reference to the destination address field; and

forwarding the data packet.

21. The method of claim 20 further comprising:

forming a routing adjacency between the edge router and at least one node of the customer network.

22. The method as in claim 20 wherein the internal-routing field further comprises a field that identifies a virtual channel for the data packet.

23. A system comprising:

an edge router of a provider network configured to receive a data packet from a router of a customer network associated with a virtual private network (VPN), the data packet including a destination address field that specifies an address of a node in another portion of the customer network that is also associated with the VPN, the other portion of the customer network accessible through the provider network, the edge router configured to determine a path through the provider network to an egress edge router that provides access to the other portion of the customer network, the path determined based upon the data packet's destination address field and the router of the customer network the data packet is received from, the edge router to add to the data packet an internal-routing field that includes a first tag and a second tag that describe the path;

a transit router of the provider network configured to receive the data packet and to make a next-hop routing decision based on the first tag of the internal-routing field, without reference to the destination address field, the transit router further configured to generate a new value for the first tag and to update the first tag with this new value before forwarding the data packet; and

an egress edge router of the provider network configured to receive the data packet and to select a particular egress channel based on the second tag, the egress channel to lead to the node in another portion of the customer network also associated with the VPN.

24. The system of claim 23 wherein the edge router of the provider network is further configured to form an adjacency with at least one node of the customer network.

25. The system of claim 24 wherein the transit router of the provider network is configured to not have an adjacency with any nodes of the customer network.

26. The system of claim 23 wherein the transit router of the provider network is configured to not maintain VPN-specific routing information.

27. The system of claim 23, wherein the internal-routing field further comprises a field that identifies a virtual channel for the data packet.

* * * * *

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	U.S. Patent No. 8,130,775 .
Filer:	Theodore Foster/Theresa Lowe
Attorney Docket Number:	43614.399

Filed as Large Entity

Filing Fees for ex parte reexam

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
EX PARTE REEXAMINATION (1.510(A)) NON-STREAMLINED	1812	1	12600	12600
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**12600**

Electronic Acknowledgement Receipt

EFS ID:	42168654
Application Number:	90014701
International Application Number:	
Confirmation Number:	4147
Title of Invention:	Mechanism For Protecting a Pseudo-wire
First Named Inventor/Applicant Name:	U.S. Patent No. 8,130,775 .
Customer Number:	27683
Filer:	Theodore Foster/Theresa Lowe
Filer Authorized By:	Theodore Foster
Attorney Docket Number:	43614.399
Receipt Date:	12-MAR-2021
Filing Date:	
Time Stamp:	16:02:50
Application Type:	Reexam (Third Party)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$12600
RAM confirmation Number	E20213BG03212234
Deposit Account	081394
Authorized User	Theresa Lowe

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Request_for_Ex_Parte_Reexamination_Transmitta_Form.pdf	140334 aa802d740012f39086b14e06b10bdd7b25256fe9	no	3
Warnings:					
Information:					
2	Reexam - Info Disclosure Statement Filed by 3rd Party	PTO_1449_modified_form_Ex_Parte_Reexam.pdf	27763 36d11342d9f350798fb9c0f23aff8be1790fc5c8	no	1
Warnings:					
Information:					
3	Power of Attorney	Cisco_Power_of_Attorney.pdf	150904 31aa9919e2ada6b554d6a4785d9e3fb7c8aef0b5	no	1
Warnings:					
Information:					
4		8130775_Patent_Ex_Parte_Reexam_Request.pdf	1511860 83f898c86cffa1432f827cedac5fdab049f74e26	yes	58

Multipart Description/PDF files in .zip description

Document Description	Start	End
Receipt of Orig. Ex Parte Request by Third Party	1	57
Reexam Certificate of Service	58	58

Warnings:					
Information:					
5	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1001_US8130775.pdf	1855310 a7f37d020962543d77e820e4722ddd325c8bd4d8	no	15
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Information:					

6	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1002_FH_US8130775.pdf	15757499 8edaa29b8a32a2a2a51a49c1d4119a6d6a57bac1	no	302
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7	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1003_Expert_Declaration_Henry_Houh.pdf	1408750 d37481a10f652055b802dd3b9ae84822d98337a6	no	74
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Information:					
8	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1004_Houh_CV.pdf	239131 288fdaa87b976a2a47de91cd483719643ffccea9	no	12
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9	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1005_US7602702_Aggarwal.pdf	2385167 3ad32f0284a488191a831de708827c9263dc0664	no	19
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11	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1010_Bryant.pdf	134015 9aae370c0081ff3fbb24cda1359c8ff62c12302c	no	43
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12	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1012_Tanenbaum.pdf	14275238 6493fa38d0f1101b6ad0507d9b259b959702b1de	no	118
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13	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1013_Minei.pdf	7771147 0459c89b87503b139657a15d3b22284423a6289c	no	48
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14	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1014_Ingrid_Declaration.pdf	1959811 bf4b4b6e2d3c2e77fd07c600deceff64c88fc89f	no	53
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Information:					
16	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1016_Zhang.pdf	90807 07cded182769a132b52766237b0c3aad79cd9dda	no	14
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Information:					
17	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1017_Complaint.pdf	9491397 33d30b21bdfd728c1ed88b87a02facc6cd0a2564	no	56
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18	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1018_Docket_Control_Order.pdf	277825 c3f1a267dc9d725b39d29c0f048c3353394393a3	no	8
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Information:					
19	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1019_RFC2026.pdf	138560 625a0a4934d12f48ac5692ac214b1528a3b0b27f	no	37
Warnings:					
Information:					

20	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1020_Internet_Drafts_Database_Interface.pdf	187109 7559216313a7188d72b6352b366da0be26693c7b	no	2
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Information:					
21	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1023_PCTFR0850324_Written_Opinion_ISA.pdf	989411 feb66bfa519616cd0607051390b33ff45ead7997	no	10
Warnings:					
Information:					
22	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1024_IPR2020_01226_Decision_on_Institution.pdf	295657 cdadf15c5996b2b4b4d6a41568713f62900abfc6	no	19
Warnings:					
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23	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1025_EDTX_2_20_cv_00015_128_Claim_Construction_Order.pdf	754376 3b8e361461288fed834e0adf475ff326f6def72d	no	95
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Information:					
24	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1026_Pseudo_Wire_Protection_IETF_Draft.pdf	105447 71a50969b1522e09076d971a3265aeeb3ea534a9	no	21
Warnings:					
Information:					
25	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1027_An_Architecture_for_MSPW_Emulation.pdf	105843 50039d61ff4ad77f6c2395418799cdae0eb84906	no	21
Warnings:					
Information:					
26	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1028_Recovery_Terminology_for_GMPLS_IETF_Draft.pdf	106970 92ee96adacae59a15ccd7811ad63e23ab335cf64	no	21
Warnings:					
Information:					

27	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1029_Dynamic_Placement_of_MSPW_IETF_Draft.pdf	105661 0254013845a7813cf1e98ba89e7c428f53f69fad	no	21
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28	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1030_IPR2020_01226_POPR.pdf	1109380 da2349326ac813427465f9f7a4c257788806c327	no	58
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29	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1034_US7369556_Rekhter.pdf	9497113 4f4fb11c169113039e9583ebc02f42c468722bcb	no	61
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30	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1035_RFC2105.pdf	93107 a1b2bb0549ed17f351fd53c6bc3a232087cb49a1	no	14
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Information:					
31	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1036_RFC3031.pdf	187252 04225017143b9868779d51e9ca1edcf32c8c8e90	no	62
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32	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1037_draft_ietf_pwe3_vccv_02.pdf	98324 10c2d5b3e5abd69a0fd5e85965c7e93576496f36	no	17
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33	Reexam - Affidavit/Decl/Exhibit Filed by 3rd Party	Ex_1038_draft_ietf_pwe3_arch_06.pdf	156028 052cbe10776dd39427ddf2c0e52ffa0478680eab	no	47
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Information:					

34	Fee Worksheet (SB06)	fee-info.pdf	30121 d450821e174e193be95c5aa7e575b9a23f059709	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	83670393

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

PTO/SB/57 (01-18)
Approved for use through 11/30/2021. OMB 0651-0064
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

(Also referred to as FORM PTO-1465)

REQUEST FOR *EX PARTE* REEXAMINATION TRANSMITTAL FORM

Address to:
Mail Stop *Ex Parte* Reexam
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Attorney Docket No.: 43614.399

Date: March 12, 2021

1. ☒ This is a request for *ex parte* reexamination pursuant to 37 CFR 1.510 of patent number 8,130,775 issued March 6, 2012. The request is made by:
   ☐ patent owner. ☒ third party requester.

2. ☒ The name and address of the person requesting reexamination is:
   Theodore M. Foster, HAYNES AND BOONE, LLP
   2323 Victory Avenue, Suite 700
   Dallas, Texas 75219

3. Requester ☐ asserts small entity status (37 CFR 1.27) or ☐ certifies micro entity status (37 CFR 1.29). Only a patent owner requester can certify micro entity status. Form PTO/SB/15A or B must be attached to certify micro entity status.

4. This request is accompanied by payment of the reexamination fee as set forth in:
   ☒ 37 CFR 1.20(c)(2); or
   ☐ 37 CFR 1.20(c)(1). **In checking this box for payment of the fee set forth in 37 CFR 1.20(c)(1), requester asserts that this request has forty (40) or fewer pages and complies with all other requirements of 37 CFR 1.20(c)(1).**

   Payment of the reexamination fee is made by the method set forth below.
   a. ☐ A check in the amount of $_____ is enclosed to cover the reexamination fee;
   b. ☐ The Director is hereby authorized to charge the reexamination fee to Deposit Account No. _____;
   c. ☐ Payment by credit card. Form PTO-2038 is attached, or
   d. ☒ Payment made via EFS-Web.

   ☒ In addition, the Director is hereby authorized to charge any fee deficiencies to Deposit Account No. 08-1394.

5. ☒ Any refund should be made by ☐ check or ☒ credit to Deposit Account No. 08-1394. 37 CFR 1.26(c). If payment is made by credit card, refund must be to credit card account.

6. ☒ A copy of the patent to be reexamined having a double column format on one side of a separate paper is enclosed. 37 CFR 1.510(b)(4).

7. ☐ CD-ROM or CD-R in duplicate, Computer Program (Appendix) or large table
   ☐ Landscape Table on CD

This collection of information is required by 37 CFR 1.510. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) a request for reexamination. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop *Ex Parte* Reexam, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

8. ☐ Nucleotide and/or Amino Acid Sequence Submission
If applicable, items a. -- c. are required.
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. ☐ CD-ROM (2 copies) or CD-R (2 copies) **or**
      ii. ☐ paper
   c. ☐ Statements verifying identity of above copies.

9. ☒ A copy of any disclaimer, certificate of correction or reexamination certificate issued in the patent is included.

10. ☒ Reexamination of claim(s) 1 and 6 is requested.

11. ☒ A copy of every patent or printed publication relied upon is submitted herewith including a listing thereof on Form PTO/SB/08, PTO-1449, or equivalent.

12. ☐ An English language translation of all necessary and pertinent non-English language patents and/or printed publications is attached.

13. ☒ The attached detailed request includes at least the following items:
   a. A statement identifying each substantial new question of patentability based on prior patents and printed publications. 37 CFR 1.510(b)(1).
   b. An identification of every claim for which reexamination is requested, and a detailed explanation of the pertinency and manner of applying the cited art to every claim for which reexamination is requested. 37 CFR1.510(b)(2).

14. ☐ A proposed amendment is included (only where the patent owner is the requester). 37 CFR 1.510(e).

15. ☒ It is certified that the statutory estoppel provisions of 35 U.S.C. 315(e)(1) or 35 U.S.C. 325(e)(1) do not prohibit requester from filing this *ex parte* reexamination request. 37 CFR 1.510(b)(6).

16. Service
   a. ☒ It is certified that a copy of this request (if filed by other than the patent owner) has been served in its entirety on the patent owner as provided in 37 CFR 1.33(c).

      The name and address of the party served are:

      Westman Champlin & Koehler, P.A.

      121 South Eighth Street, Suite 1110

      Minneapolis MN 55402

      Date of Service: March 12, 2021

   OR

   b. ☐ A duplicate copy is enclosed since service on patent owner was not possible. An explanation of the efforts made to serve patent owner **is attached**. See MPEP 2220.

Juniper Exhibit 1008, page 641

17. Correspondence Address: Direct all communication about the reexamination to:

☒ The address associated with Customer Number: 27683

OR

☐ Firm or Individual Name _____
(at the address identified below)

Address

City	State	Zip

Country

Telephone	Email
214-651-5000	IPDOCKETING@HAYNESBOONE.COM

18. ☒ The patent is currently the subject of the following concurrent proceeding(s):

a. ☐ Copending reissue Application No. _____

b. ☐ Copending reexamination Control No. _____

c. ☐ Copending Interference No. _____

d. ☒ Copending litigation styled:

Monarch Networking Solutions LLC v. Cisco Systems, Inc. and Charter Communications, Inc.,

No. 2-20-cv-00015 (E.D. Tex., filed Jan 21, 2020)

WARNING : Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

/Theodore M. Foster/ — Authorized Signature

March 12, 2021 — Date

Theodore M. Foster — Typed/Printed Name

57,456 — Registration No.

☐ For Patent Owner Requester ☒ For Third Party Requester

In place of PTO-1449 Form	U. S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE			*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(use as many sheets as necessary)*				Application Number	In Ex Parte Reexamination of 8,130,775
				Filing Date	Herewith
				First Inventor Name	Frederic Jounay
				Art Unit	TBD
				Examiner Name	TBD
SHEET	1	OF	1	Attorney Docket Number	43614.399

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NON-PATENT LITERATURE DOCUMENTS		
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	Ex. 1006	IFTEKHAR HUSSAIN, "Fault-tolerant IP and MPLS Networks" (1st ed. 2004)

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