

US007114008B2

(12) United States Patent

Jungck et al.

(54) EDGE ADAPTER ARCHITECTURE APPARATUS AND METHOD

(75) Inventors: Peder J. Jungck, San Carlos, CA (US);

Zahid Najam, San Jose, CA (US); Andrew T. Nguyen, San Jose, CA (US); Ramachandra-Rao Penke,

Cupertino, CA (US)

(73) Assignee: Cloudshield Technologies, 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 792 days.

(21) Appl. No.: 09/858,323

(22) Filed: May 15, 2001

(65) **Prior Publication Data**

US 2002/0065938 A1 May 30, 2002

Related U.S. Application Data

- (63) Continuation-in-part of application No. 09/602,129, filed on Jun. 23, 2000, now Pat. No. 6,829,654.
- (51) Int. Cl.

 G06F 15/16 (2006.01)

 G06F 15/00 (2006.01)

 G06F 9/30 (2006.01)

 G06F 9/40 (2006.01)
- (52) **U.S. Cl.** **709/246**; 709/205; 712/201
- (58) **Field of Classification Search** None See application file for complete search history.

(56) References Cited

U.S. PATENT DOCUMENTS

4,692,918	A	9/1987	Elliott et al	370/401
5,179,556	A	1/1993	Turner	
5,195,181	A	3/1993	Bryant et al	709/215
5,566,170	A	10/1996	Bakke et al	370/392
5,784,582	A	7/1998	Hughes	710/117

(10) Patent No.: US 7,114,008 B2

(45) **Date of Patent:** Sep. 26, 2006

5,805,820 A	A 9/1998	Bellovin et al 395/200.55
5,867,704	A 2/1999	Tanaka et al 718/105
5,938,737	A 8/1999	Smallcomb et al 709/247
5,953,503 A	A 9/1999	Mitzenmacher et al.
5,991,713 A	A 11/1999	Unger et al 704/9
6,006,264 A	A 12/1999	Colby et al 709/26

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 865 180 A2 3/1998

(Continued)

OTHER PUBLICATIONS

3com Virtual Lan Tutorial, obtained from http://munshi.sonoma.edu/s97/bus420/vlan.html, Jul. 21, 2003, pp. 1-21.

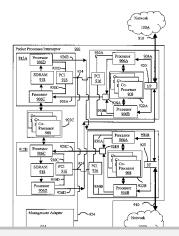
(Continued)

Primary Examiner—Patrice Winder Assistant Examiner—Azizul Choudhury (74) Attorney, Agent, or Firm—Brinks, Hofer Gilson & Lione

(57) ABSTRACT

An architecture for intercepting and processing packets from a network is disclosed. The architecture provides both stateful and stateless processing of packets in the bi-directional network flow. Further, stateless processing is provided by a parallel arrangement of network processors while stateful processing is provided by a serial arrangement of network processors. The architecture permits leveraging existing bi-directional devices to process packets in a uni-directional flow, thereby increasing the throughput of the device. The ability to share state among the stateless processor, among the stateful processors of each packet flow direction and between the stateless and stateful processors provides for dynamic adaptability and analysis of both historical and bi-directional packet activity.

40 Claims, 9 Drawing Sheets





U.S. PATENT DOCUMENTS

6,014,660	A	1/2000	Lim et al 707/3
6,016,512	A	1/2000	Huitema
6,046,980	A	4/2000	Packer
6,052,718	A	4/2000	Gifford
6,065,055	A	5/2000	Hughes et al
		5/2000	Narendran et al 709/229
6,070,191	A		
6,073,168	A	6/2000	Mighdoll et al 709/217
6,084,878	A	7/2000	Crayford et al 370/389
6,105,027	A	8/2000	Schneider et al.
6,108,703	A	8/2000	Leighton et al
6,167,438	A	12/2000	Yates et al 709/216
6,178,505	B1	1/2001	Schneider et al.
6,226,642	B1	5/2001	Beranek et al.
6,247,059	B1	6/2001	Johnson et al 709/237
6,256,671	B1	7/2001	Strentzsch et al 709/227
6,256,739	B1	7/2001	Skopp et al 713/201
6,285,679	B1 *	9/2001	Dally et al 370/413
6,324,582	B1	11/2001	Sridhar et al.
6,324,585	B1	11/2001	Zhang et al.
6,330,561	B1	12/2001	Cohen et al 707/10
6,389,462	В1	5/2002	Cohen et al 709/218
6,393,026	B1 *	5/2002	Irwin 370/401
6,408,336	B1	6/2002	Schneider et al.
6,424,658	В1	7/2002	Mathur 370/429
6,425,003	В1	7/2002	Herzog et al.
6,480,508	В1	11/2002	Mwikalo et al.
	В1	12/2002	Munger et al 709/225
6,546,423	В1	4/2003	Dutta et al.
6,574,666	В1	6/2003	Dutta et al.
6,578,073	В1	6/2003	Starnes et al 709/219
6,581,090	В1	6/2003	Lindbo et al.
6,587,466	В1	7/2003	Bhattacharya et al 370/395.21
6,598,034	В1	7/2003	Kloth 706/47
6,611,875	B1	8/2003	Chopra et al 709/245
6,662,213	B1	12/2003	Xie et al 709/206
6,772,347	B1	8/2004	Xie et al 713/201
6,785,728	B1	8/2004	Schneider et al.
6,826,694	B1	11/2004	Dutta et al.
6,847,989	B1	1/2005	Chastain et al.
6,850,529	B1	2/2005	Wong
6,854,063	B1	2/2005	Qu et al.
2002/0009079	A1	1/2002	Jungck et al 370/389
2002/0112073	A1	8/2002	MeLampy et al 709/240
2002/0194291	A1	12/2002	Jungck et al 709/213
2003/0009651	A1	1/2003	Najam et al 712/34
2003/0018796	A1	1/2003	Chou et al 709/231

FOREIGN PATENT DOCUMENTS

WO	WO 98/17039	4/1998
WO	WO 99/05584	2/1999
WO	WO 99/09725	2/1999
WO	WO 99/27684	6/1999
WO	WO 99/60459	11/1999
WO	WO 00/14938	3/2000
WO	WO 00/27092	5/2000
WO	WO 00/28713	5/2000

OTHER PUBLICATIONS

Przygienda and Droz, Abstract "Proxy PNNI Augmented Routing (Proxy PAR)", pp. 371-377, © 1998 IEEE.

Stevenson and Julin, Abstract, "Client-Server Interactions in Multi-Server Operating," Sep. 1994, 16 pages.

John Pescatore, Gartner Analyst, "Commentary: Digging into the DNS foundation," obtained at internet address, http://news.cnet. com/news/0-1005-202-2080091.html, Jun. 15, 2000.

Rainbow Technologies Products, "CryptoSwift eCommerce Accelerator," obtained at internet address, http://isg.rainbow.com/products/cs_1.html, Aug. 5, 2000.

FlowWise, "Router Accelerator-RA 7000 from FlowWise," obtained at internet address http://www.flowise.com/products/ ra7000.htm.

Intel® IXP1200 Network Processor, obtained at internet address, http://developer.intel.com/design/network/ixp1200.htm.

Marshall Brain, How Stuff Works, "How Web Servers and the Internet Work," obtained at internet address http://www. howstuffworks.com/web-server.htm.

Marshall Brain, How Stuff Works, "How Domain Name Servers Work," obtained at internet address http://www.howstuffworks. com/dns.htm.

Curt Franklin, How Stuff Works, "How Routers Work," obtained at internet address http://www.howstuffworks.com/router.htm.

Microsoft Corporation, Sep. 1998 "Introduction to TCP/IP," obtained at internet address http://msdn.microsoft.com/library/ backgrnd/html/tepipintro.htm.

Robert Stone, "CenterTrack: An IP Overlay Network for Tracking DoS Floods," Article Oct. 1, 1999, pp. 1-9.

Chapter 1 TCP/IP Fundamentals, obtained at internet address http:// webdocs.sequent.com/docs/tcpoac01/ch_1.htm, pp. 1-28.

Cheng Wu, "Web Switching: A New Generation of Networking," pp. 1-3.

ArrowPoint Communications™ Article, "A Comparative Analysis of Web Switching Architectures," pp. 1-11.

ArrowPoint Communications™, Brochure, "The Top 12 Benefits of Content Intelligence."

L. Peter Deutsch, "DEFLATE Compressed Data Format Specification," May 1996.

Antaeus Feldspar, Article, "An Explanation of the Deflate Algorithm," Sep. 11, 1997.

ArrowPoint CommunicationsTM CDDCenter Vendor Listing, "ArrowPoint CS-50 Highlights" obtained at internet address http:// www.cddcenter.com/arrowpoint.htm, May 21, 2000.

Peter Christy, Analyst Commentary, "When to Distribute Content-The Peters' Principles," obtained at internet address http://www.cddcenter.com/index.html, May 21, 2000

Content Delivery 101: An Introduction to Content Distribution &

CDDCenter, "How Do Caching and Content Delivery Really Differ?" obtained at internet address http://www.cddcenter.com/ cachingvcontent.htm, pp. 1-4, May 21, 2000.

Internet Research Group "Infrastructure Application Service Providers," Feb. 2000, pp. 1-7.

Peter Christy, Internet Research Group, "Content Delivery Architectures: Why Doesn't One Size Fit All?" pp. 1-12.

Steven Vonder Haar, Inter@ctive Week, Feb. 14, 2000, "Content Delivery Shifts To Edge of Net," obtained at internet address http://www.zdnet.com/intweek/stories/news/0,4164,2436865,00. html, Dated May 22, 2000.

David Willis, Network Computing, "The Content-Delivery Edge," obtained at internet address http://www.networkcomputing.com/ 1103/1103colwillis.html, Dated May 22, 2000.

Phrack Magazine, "IP-spoofing Demystified (Trust-Relationship Exploitation)" vol. Seven, Issue Forty-Eight, File 14 of 18. pp. 1-9, obtained at internet address http://www.fc.net/phrack/files/p48/p48-14.html, Dated Jun. 5, 2000.

Eddie Mission, "What is Eddie?", obtained at internet address http://www.eddieware.org/what.html, Dated Apr. 21, 2000.

Cisco Enterprise Solutions, "Quality of Service," obtained at internet address http://www.cisco.com/warp/public/779/largeent/ learn/technologies/qos/.

Cisco White Paper, "Delivering End-to-End Security in Policy-Based Networks," obtained at internet address, http://www.cisco. com/warp/public/cc/pd/nemnsw/cap/tech/deesp_wp.htm.

Technology Packeteer, obtained at internet address, http://www. packeteer.com/technology/index.cfm.

Overview Cisco Content Networking, obtained at internet address http://www.cisco.com/warp/public/cc/so/neso/ienesv/cxne/ cenov ov.htm.

Overview Cisco Secure Policy Manager 2.0, obtained at internet



Alteon Web Systems, White Paper "Optimizing ISP Networks and Services with DNS Redirection," Aug. 1999.

Alteon Web Systems, White Paper "Virtual Matrix Architecture Scaling Web Services for Performance and Capacity," Apr. 2000. Alteon Web Systems, White Paper, Questions and Answers, pp. 1-3. 3Com Technical Papers, Layer 3 Switching, May 1998.

Web Cache Communication Protocol Version 2, pp. C-1 to C-54. RFC2267 Working Group—Denial of Service Counter Measures, Tele-conference Meeting Aug. 25, 2000, Moderator, Henry Teng of eBay.

Track-back Architecture General Requirements Version 0.1, Initial Draft submitted to Counter-DoS Solutions Working Group, Jul. 31, 2000, Edited by Bob Geiger, Recourse Technologies.

SwitchOn Networks, Inc., ClassiPITM At-a-Glance.

C-PortTM A Motorola Company, C-5TM Digital Communications Processor, Product Brief, pp. 1-8, May 4, 2000.

Peder Jungck, "Building a Faster Cache Server" A Theoretical Whitepaper, Silicon Valley Internet Capital, pp. 1-19.

IXF1002 Dual Port Gigabit Ethernet MAC, Product Brief, Level One^{TM} an Intel Company.

NetLogic Microsystems Product Overview.

Agere, Inc. "The Challenge for Next Generation Network Processors", Sep. 10, 1999.

Philips Semiconductors' VMS747 Security Processor Overview. Cisco Systems, Cisco 12000 Series GSR, "Performing Internet Routing and Switching at Gigabit Speeds," obtained at internet address, http://www.cisco.com/warp/public/cc/pd/rt/12000/.

Cisco Systems, "Cisco 10000 Edge Service Router," obtained at internet address, http://www.cisco.com/warp/public/cc/pd/rt/10000/.

Nortel NetworksTM "Passport 8600 Routing Switch," obtained at internet address, http://www.nortelnetworks.com/products/01/passport/8600/index.html.

Lucent Technologies, "InterNetworking Systems," obtained at internet address, http://www.lucent.com/ins/products/grf/.

Lucent Technologies, "InterNetworking Systems," obtained at internet address, http://www.lucent.com/ins/products/grf/grf1600. html.

Juniper Networks, "M20 Internet Backbone Router," Datasheet, obtained at internet address, http://www.juniper.net/products/dsheet/100009.html.

Juniper Networks, "M40 Internet Backgbone Router," Datasheet, obtained at internet address, http://www.juniper.net/products/dsheet/100001.html.

Juniper Networks, Inc., "M160 Internet Backbone Router" Datasheet, obtained at internet address, http://www.juniper.net/products/dsheet/10012.

Rajeev Kumar, Intel Confidential, "IXP1200 Overview"

Intel "IXP1200 Network Processor," Datasheet, pp. 1-109 (out of 146 pages), May, 2000.

Cisco 7500 Series Routers, pp. 1-2, obtained at internet address http://www.cisco.com/warp/public/cc/pd/rt/7500/.

Philips Semiconductors—I2C-bus, News and Events, obtained at internet address, http://www.semiconductors.philips.comi2c/, Jul. 28, 2001.

Comnet Booth #4421 "VHB Technologies Introduces Breakthrough Appliance for High-Bandwidth Networks at Comnet" News Release, Jan. 29, 2001, VHB Technologies, Inc., Richardson, Texas. VHB Technologies, Inc. presents "The VIPRE™ NPU.".

VHB Technologies News & Views, "Pioneering Gigabit-Speed Content-Intelligent Appliances".

VHB Technologies, A Security Technology Paper, Defending Against Denial-of-Service Attacks with the . . . VHB-2000 Network Security Appliance.

Netlogic Microsystems™ Product Brief, obtained at internet address, http://www.netlogicmicro.com/html/datasheets/nse3128. html, pp. 1-2, May 11, 2001.

Switch On Networks, Inc. "ClassiPI" Content Co-Processor, general content and features brochure, pp. 1-5.

C-Port, "C-5TM Digital Communications Processor" Product Brief, pp. 1-8, © 1999-2000 C-Port Corporation, May 4, 2000.

NetLogic Microsystems $^{\text{TM}}$ "Policy Co-Processor $^{\text{TM}}$ " applications and features sheet, p. 1.

NetLogic Microsystems TM "CIDR Co-Processor" applications and features sheet, p. 1.

NetLogic MicrosystemsTM "IPCAM® Ternary CAM" application and features sheets, pp. 1-2.

NetLogic MicrosystemsTM "SynCAM® Binary CAM" application and features sheet, p. 1.

NetLogic Microsystems $^{\text{TM}}$ "NCAM Binary CAM" application and features sheet, p. 1.

NetLogic Microsystems[™] product overview, pp. 1-2.

Level One™ an Intel Company "IXF1002 Dual Port Gigabit Ethernet MAC," product brief, pp. 1-2, Copyright © 2000 Level One Communications, Inc.

Agere, Inc., Agere White Paper, "Building Next Generation Network Processors," Sep. 10, 1999, pp. 1-8.

Eric J. Rothfus, Agere, Inc., Agere White Paper, "The Case for A Classification Language," Sep. 10, 1999, pp. 1-7.

Philips "VMS747 Security Processor," Overview and Features, pp. 1-3, date of release Jan. 2000, © Philips Electronics N.V. 1999.

Web Cache Communication Protocol Version 2, Appendix C, Cisco Cache Engine User Guide, Version 2.0.0, pp. C1-C54.

CloudShield Technologies, Inc., White Paper, "Security at Optical Speed," pp. 1-10, Jan. 21, 2001.

NetLogic MicrosystemsTM Product Brief "NSE3128 Network Search Engine," obtained at internet address http://209.10.226.214/html/datasheets/nse3128.html pp. 1-2, May 11, 2001.

Listing of Well Known Port Numbers assigned by the Internet Assigned Numbers Authority, obtained at the internet address, http://www.iana.org/assignments/port-numbers pp. 1-55, Aug. 5, 2000

PM2329 PMC-Sierra, "ClassiPITM Network Classification Processor," Overview and Features sheet pp. 1-2, 2001 Copyright PMC-Sierra, Inc. Jan. 2001.

JISC JTAP Report "Network Delivery of High Quality MPEG-2 Digital Video," Oct. 1998, 58 pages.

Steven D. Gribbler. "System Design Issues for Internet Middleware Services: Deductions from a Large Client Trace." 1997. http.cs. berkeley.edu/~gribble/papers/msc_thesis.ps.gz.

Gene H. Kim, Hilarie Orman, Sean O'Malley. "Implementing a Secure rlogin Environment: A Case Study of Using a Secure Network Layer Protocol." 1995. ftp.cs.arizona.edu/xkernel/Papers/rlogin.ps.

Claude Castelluccia. "A Hierarchical Mobility Management Scheme for IPv6." ballesta.inrialpes.fr/Infos/Personnes/Claude. Castelluccia/iscc98.ps.gz.

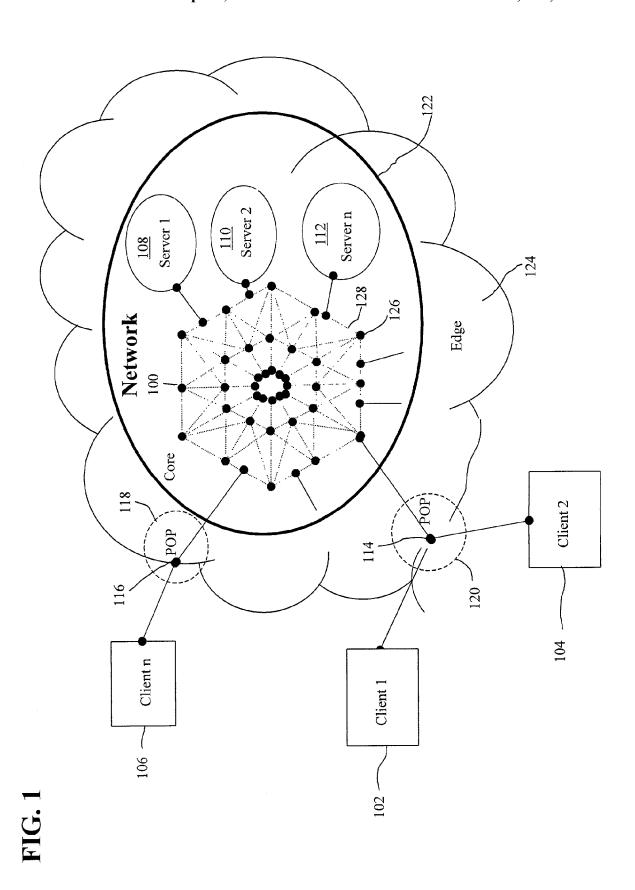
Corpus-Based Learning of Compound Noun Indexing—Ung-Kwan Jee Hyub (2000) www.ai.mit.edu/people/jimmylin/papers/Kwak00.pdf.

The Role of Test Cases in Automated Knowledge Refinement—Palmer, Craw (1996) www.scms.rgu.ac.uk/publications/96/96_4.ps.gz.

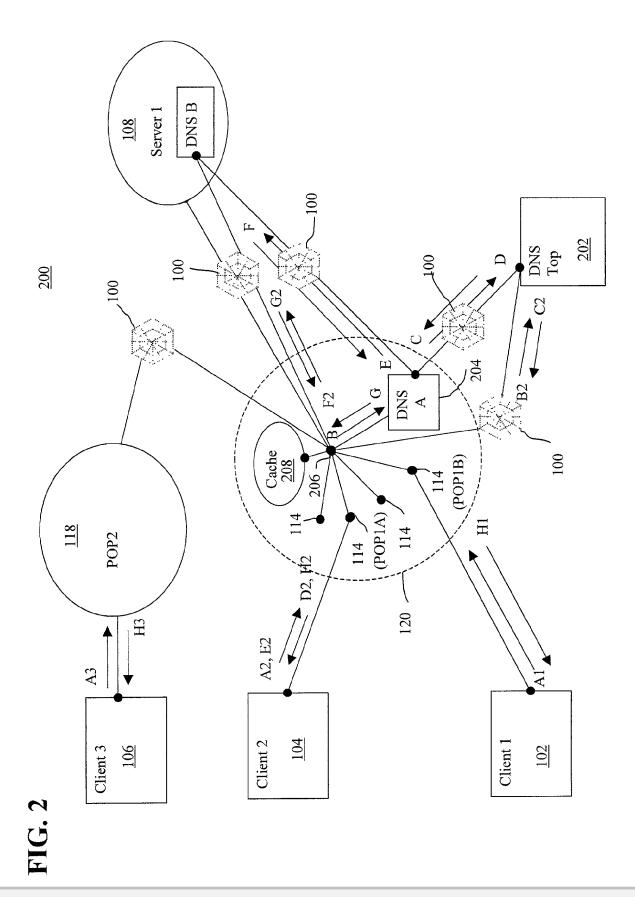
The Policy Obstacle Course: The Realisation of Low-Level . . . —Schema York July www.cs.york.ac.uk/~jdm/pubs/polobstc.ps.Z. Data Filter Architecture Pattern Robert Flanders and Eduardo . . . —Dept of Computer jerry.cs.uiuc.edu/~plop/plop99/proceedings/Fernandez5/Flanders3.PDF.

* cited by examiner





Sep. 26, 2006



DOCKET

Explore Litigation Insights



Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time** alerts and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

