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Research Area

Computer Networks, Overlay and P2P Networks

Education

1975-80 Colorado State University, BSEE
1992-1994 Ph.D., University College London (UCL), Computer Science

Positions

Since 7/03 Associate Professor, Cornell University, Computer Science Dept.
1/03 - 7/03 Instructor, Cornell University Computer Science Dept.
1/01 - 1/03 Chief Scientist, Tahoe Networks
8/00 - 1/01 Chief Scientist, Fast Forward Networks
1/00 - 8/00 Senior Researcher, ACIRI (AT&T Center for Internet Research at ICSI)
1/94 - 1/00 Member Technical Staff, NTT Software Labs, Tokyo
1/90 - 1/94 Member Technical Staff at Bellcore, Morristown NJ
12/82 - 1/90 Member Technical Staff, MITRE Corp., McLean VA
6/80 - 12/82 PBX field repair engineer, AT&T, Denver CO

Publications

Theses

1. Paul Francis, "Addressing in Internetwork Protocols," University College London, Sept. 1994

Journal Publications

2. Paul Francis, S. Jamin, C. Jin, Y. Jin, A. Kurc, D. Raz, Y. Shavitt, L. Zhang "IDMaps: A Global Internet Host Distance Estimation Service," IEEE/ACM Transactions on Networking, Oct. 2001
3. Paul Francis, "Comparison of Geographical and Provider-rooted Internet Addressing," Computer Networks and ISDN Systems 27(3)437-448, 1994 (selected paper from INET 94/JENC 5).
4. Paul Tsuchiya*, Tony Eng, "Extending the IP Internet Through Address Reuse," ACM SIGCOMM Computer Communications Review, 23(1):16-33, Jan. 1993

Refereed Conference Publications

5. Vivek Vishnamurthy, Paul Francis, "A Comparison of Structured and Unstructured P2P Approaches to Heterogeneous Random Peer Selection," USENIX, June 07
6. Vidhyashankar Venkatraman, Kaoru Yoshida, Paul Francis, "Chunkyspread: Heterogeneous Unstructured End System Multicast," The 14th IEEE International Conference on Network Protocols, Nov. 2006
7. Xinyang Zhang, Paul Francis, Jia Wang, Kaoru Yoshida, "Scaling Global IP Routing with the Core Router-Integrated Overlay," The 14th IEEE International Conference on Network Protocols, Nov. 2006
8. Hitesh Ballani, Paul Francis, Sylvia Ratnasamy, "A Measurement-based Deployment Proposal for IP Anycast," Proceedings of Internet Measurement Conference (IMC), Rio de Janeiro, Oct 2006 (Best Paper Award)
9. Vivek Vishnamurthy, Paul Francis, "On Heterogeneous Overlay Construction and Random Node Selection in Unstructured P2P Networks," Infocom 2006, April 2006, Barcelona
10. S. Guha and P. Francis. "Characterization and Measurement of TCP Traversal through NATs and Firewalls," Proceedings of Internet Measurement Conference (IMC), Berkeley, CA, Oct 2005.
11. Hitesh Ballani, Paul Francis, "Towards a Global IP Anycast Service," SIGCOMM 2005, August, 2005, Philadelphia
12. Manpreet Singh, Prashant Pradhan, Paul Francis, "MPAT: Aggregate TCP Congestion Management as a Building Block for Internet QoS" 12th IEEE International Conference on Network Protocols (ICNP 2004), October 2004.
13. Paul Francis, Ramakrishna Gummadi, "IPNL: A NAT-Extended Internet Architecture," SIGCOMM 2001, August, 2001, San Diego
14. Sylvia Ratnasamy, Paul Francis, Mark Handley, Richard Karp, and Scott Shenker, "A Scalable Content-Addressable Network," SIGCOMM 2001, August, 2001, San Diego

15. Paul Francis, Sugih Jamin, Vern Paxson, Lixia Zhang, Daniel Gryniewicz, Yixin Jin, "An Architecture for a Global Internet Host Distance Estimation Service," Proceedings INFOCOM '99, New York City, March 1999.
16. Paul Francis, Susumu Shimizu, Takashi Kambayashi, and Shin-ya Sato, "A Framework for Multilingual Searching and Meta-information Extraction," Proceedings INET 97, Kuala Lumpur, June 1997.
17. Paul Francis, Shin-ya Sato, "Design of a Database and Cache Management Strategy for a Global Information Infrastructure," Proceedings of the Third International Symposium on Autonomous Decentralized Systems, pp. 283-290, April 1997.
18. Paul Francis, Susumu Shimizu, "De-Centralized Web Searching: An Alternative Paradigm", Proceedings 19th Pacific Telecommunications Conference, Honolulu, Jan. 1997.
19. Paul Francis, Takashi Kambayashi, Shin-ya Sato, Susumu Shimizu, "Ingrid: A Self-Configuring Information Navigation Infrastructure," Proceedings 4th International WWW Conference, Dec. 1995, pp. 519-538.
20. Paul Francis, Ramesh Govindan, "Flexible Routing and Addressing for a Next Generation IP," SIGCOMM 94, September 1994, London.
21. Paul Francis, "Comparison of Geographical and Provider-rooted Internet Addressing," Proceedings INET 94/JENC 5, Prague, June 1994.
22. Tony Ballardie, Paul Tsuchiya*, Jon Crowcroft, "Core Based Trees (CBT): An Architecture for Scalable Inter-Domain Multicast Routing," SIGCOMM 93, San Francisco, Sept. 1993. This paper won the Best Student Paper award.
23. Tony McAuley, Paul Francis, "Fast Routing Table Lookup using Content Addressable Memory (CAM)," INFOCOM 93, March 1993.
24. Paul Tsuchiya*, "Efficient Utilization of Contiguous Two-level Hierarchical Addresses," Proceedings IEEE Globecom 92, Orlando Florida, December 1992.
25. Paul Tsuchiya*, "Internet Routing Over Large Public Data Networks using Shortcuts," Proceedings SIGCOMM 92 Conference, Baltimore Maryland, August 1992.
26. Paul Tsuchiya*, "Efficient and Flexible Hierarchical Address Assignment," Proceedings INET 92, Kobe Japan, June 1992.
27. Paul Tsuchiya*, "Efficient and Robust Policy Routing using Multiple Hierarchical Addresses," proceedings SIGCOMM 91 Conference, Zurich, Switzerland, September 1991.
28. Paul Tsuchiya*, "On the Graceful Degradation of Routing Given Insufficient Resources," Proceedings 14th Conference on Local Computer Networks, Minneapolis Minnesota, October, 1989.

29. Paul Tsuchiya*, "Simulation of a Large Network Distributed Routing Algorithm using OPNET," Proceedings DCA/JDSSC Computer-based Modeling Symposium, September 1988.
30. Paul Tsuchiya*, "The Landmark Hierarchy: A New Hierarchy for Routing in Very Large Networks," Proceedings SIGCOMM 88 Conference, Stanford, California, August, 1988.
31. Paul Tsuchiya*, "Team-of-Gateways: Design and Implementation," Proceedings MILCOM '87, Washington DC, October, 1987.

Refereed Workshop Publications

32. Hitesh Ballani, Paul Francis, "A Simple Approach to DNS DoS Defense", ACM Sigcomm Hotnets Workshop, Nov 1996
33. Hitesh Ballani, Paul Francis, "CONMan: Taking the Complexity out of Network Management," Sigcomm Internet Network Management Workshop, Sept. 2006, Pisa
34. Vidhyashankar Venkatraman, Paul Francis, "Chunkyspread: Multi-tree Unstructured End System Multicast," IPTPS 2006, February 2006
35. Hitesh Ballani, Paul Francis, "Towards a deployable IP Anycast service," First Workshop on Real, Large Distributed Systems (WORLDS '04), Dec 2004
36. Saikat Guha, Paul Francis, Takeda Yutaka, "NUTSS: A SIP-based Approach to UDP and TCP Network Connectivity," Sigcomm Future Directions in Network Architecture (FDNA-04) Workshop, August 2004.
37. Paul Tsuchiya*, "An Architecture for Network-Layer Routing in OSI," SIGCOMM 87 Workshop, Stowe, Vermont, Computer Communication Review, Volume 17, Number 5, August, 1987.

Non-refereed Publications

38. Paul Francis, "Is the Internet Going NUTSS?," IEEE Internet Computing, Nov-Dec 2003
39. Paul Francis, Yukata Ogawa, "Next-Generation Protocol for Internetworking," NTT R&D Journal, 43(9):41-50, 1994, in Japanese.
40. Paul Francis, "A Near-term Architecture for Deploying Pip," IEEE Network Magazine, 7(6):30-37, May 1993.
41. Paul Tsuchiya*, "Inter-domain Routing in the Internet," Connexions Interoperability Report, Volume 5, No. 1, January 1991.
42. Paul Tsuchiya*, "The Landmark Hierarchy: A New Hierarchy for Routing in Very Large Networks," Reprint Collection: Outstanding Papers on Key Topics in Computer Networking, ARTECH House, 1989 (reprinted from SIGCOMM 88).

43. Paul Tsuchiya*, "IS-IS Intra-Domain Routing," Connexions Interoperability Report, Volume 3, No. 8, August 1989.
44. Paul Tsuchiya*, "An Overview of OSI Routing," Connexions Interoperability Report, Volume 3, No. 8, August 1989.
45. Paul Tsuchiya*, "Landmark routing: Architecture, algorithms, and issues", MTR-87W00174, The MITRE Corp., May 1988
46. Paul Tsuchiya*, "The Landmark Hierarchy: Description and Analysis," MTR-87W00152, McLean, VA: The MITRE Corp., June 1987
47. Paul Tsuchiya*, "Assured Destination Binding: A Technique for Dynamic Address Binding," MTR-87W00050, McLean, VA: The MITRE Corporation, March 1987

Poster Sessions and Workshops (without publications)

48. Saikat Guha, Manpreet Singh, "New Transport for High Delay-Bandwidth Product Networks", Poster Session, SIGCOMM05
49. Vidhya Venkatraman, Paul Francis, "ChunkySpread Overlay Multicast," Poster Session, NSDI05
50. Paul Francis, "Self-Configuring Information Discovery Infrastructure, Workshop on Networked Information Retrieval, SIGIR 96, Zurich, Switzerland
51. Paul Tsuchiya*, "On the Generation of Connected General-Topology Networks with Control over Diameter," Poster Session, SIGMETRICS 88, Santa Fe, NM, May 1988.

Standards Publications

52. Saikat Guha, Paul Francis, "Requirements for the End-Middle-End Research Group" IETF Draft draft-guha-emerg-requirements-00.txt, Jan 2007
53. P. Hoffman, S. Guha and P. Francis. "NAT Behavioral Requirements for Unicast TCP," Internet Draft: *draft-hoffman-behave-tcp-04*, July 2006.
54. K. Egevang, Paul Francis, "The IP Network Address Translator (Nat)," RFC 1631, May 1994.
55. Paul Francis, "Pip Header Processing," RFC 1622, May 1994.
56. Paul Francis, "Pip Near-term Architecture," RFC 1621, May 1994.
57. Jon Crowcroft, Paul Tsuchiya*, Tony Ballardie, "Core Based Trees - Scalable Multicast Routing," Internet Draft, July 1992.
58. Paul Tsuchiya*, "Mutual Encapsulation Considered Dangerous," RFC 1326, May 1992.

59. Paul Tsuchiya*, "On the Assignment of Subnet Numbers," RFC 1219, April 1991.

* My name was changed from Tsuchiya to Francis in 1993

Patents

1. "Electronic Dual Programmable Metronome," USA Patent 4,442,752, (1982)
2. "Landmark Hierarchy," USA Patent 4,823,111 (1988)
3. "Dynamic Address Binding," USA Patent 5,025,491 (1988)
4. "Alternate-path distance-vector routing ," USA patent 5,115,495 (1989)
5. "Multicast Routing using Core Base Trees," USA Patent 5,331,637 (1994)
6. "General internet method for routing packets in a communications network," USA Patent 5,353,283 (1994)
7. "Fast multilevel hierarchical routing table lookup using content addressable memory," USA Patent 5,386,413 (1994)
8. "Method and system for shortcut routing over public data networks," USA Patent 5,583,996 (1994)
9. "Method for Distributed Information Searching," Japanese Patent 8-6091, in Japanese (1998)
10. "Information Navigation System using Clusterised Information Resource Topology," British Patent GB 2,297,179 (1998)
11. "Information Navigation System using Clusterised Information Resource Topology," USA Patent application 8/587,511 (1998)
12. "Method for Distributed Creation of Multicast Trees", Japanese patent, number currently unknown. (1999)

Lectures and Talks

Invited Talks (2003 – Present*)

1. "Small Routing Tables," Cisco Routing Summit, Aug. 2006
2. "Trees versus meshes: Is the debate really over?," P2P Streaming and IPTV Workshop, Pisa, Sept. 2006
3. "Network Issues in P2P," First Keynote, IEEE Tenth International Workshop on Web Content Caching and Distribution, September, 2005
4. "Deep-4D: A New Architecture for Network Management", Microsoft Summit on Self-Managing Networks, June 2005

- 3-8 "Firebreak: A DDoS Guard Deployment Architecture," presented at: IBM Research, AT&T Research, Sprint Research, NTT Research (Tokyo), Google, and the IAI@Rome Summer Seminar Series, Summer of 2004
9. "NAT and IPv6, We Meet at Last". North American Network Operators Group 30, Miami (February 2004).
10. "NUTSS: the DeFacto Next-generation Internet Architecture". IAI@Rome Summer Seminar Series (August 2003).

* Note: I didn't catalogue invited talks before arriving at Cornell in 2003.

Invited Panels (2003 – Present)

11. "The Impact of P2P in Content Distribution," Panelist, IEEE Tenth International Workshop on Web Content Caching and Distribution, September, 2005
12. IPv6 Workshop, U.S. Dept. of Commerce, July, 2004

Funding

Funded Research Proposals

Concerto CBMANET, DARPA, Subcontract to BAE Systems, (Cornell portion, \$250,000)

NSF NeTS-FIND: Collaborative Research: Towards Complexity-Oblivious Network Management, with Jay Lepreau (Co-PI) (Cornell portion, \$300,000)

RapidTrace: Rapid Traceback of Cyber Attacks, ARDA/NSA, Subcontract to Telcordia (PI), 2005 (Cornell portion: \$190,166)

QuickSilver: Middleware for Scalable Self-regenerative Systems, DARPA/AFRL, Co-PI, with *Ken Birman* (PI) and Johannes Gehrke. 2004 (\$1,098,321)

Very Fine-grained Proximity Addressing, NSF. 2004 (\$496,421)

Yoid End-System Multicast, DARPA, Co-PI, with Ramesh Govindan (PI), ISI, 2000 (Not sure of amount. I was at ACIRI at the time, and received no funds for this project)

PIP Next Generation IP, DARPA, with Ramesh Govindan (co-PI), 1994 (Don't recall the amount)

Corporate Gifts

End-Middle-End Internet Connection Establishment, from Cisco CRP, (\$92,246)

Proxy IP Anycast Measurement and Deployment, from Cisco FIRST, 2006, (\$206,465)

IP Anycast Deployment, from Sylvia Ratnasamy at Intel, 2005, (\$20,000)

Next Generation NAT and Firewall Traversal, from Cisco CRP, 2005, (\$99,930)

External Committees

Standards Committees

Co-chair, IETF Inter-domain Multicast Working Group (IDMR), 1994-1995

Chair, IETF PIP Next Generation IP Working Group, 1993

Initiator, IRTF End-Middle-End Research Group, 2006

Program Committees and Editorships

SIGCOMM 95, Program Committee

SIGCOMM 96, Program Committee

SIGCOMM 97, Program Committee

SIGCOMM FDNA Workshop 04, Program Committee

IEEE CCW 04, P2P session organizer

IEICE Transactions on Communications, Special Issue: Internet Technology V,
Associate Editor

NSDI 05, Program Committee

WCW 05, Program Committee

SIGCOMM Internet Network Management (INM) Workshop 06, Program Committee,
Panel Organizer

SIGCOMM '07, Workshops and Tutorials Co-chair

GI'07 Program Committee

ICDCS'07 Program Committee

Journal Reviewer

Elsevier Computer Networks Journal

World Enformatika Society International Journal of Computer Science

ACM Transactions on Computer Systems (TOCS)

Other

Member, NLR (National Lambda Rail) Network Research Board, 2005 - 2006

Member, NSF FIND Planning Committee, 2006

Member, NSF GENI Research Coordination Committee, 2006

University Activities

Teaching

- CS414: Systems Programming and Operating Systems, Fall 2005
- CS419/519: Computer Networks, Spring 2004, Spring 2005, Spring 2006
- CS514: Intermediate Computer Systems, Spring 2003, Fall 2003
- CS619: Advanced Computer Networks, Fall 2004, Fall 2006

Have guest lectured on computer networking for CS212 (Java Programming) and ORIE480 (Information Technology)

Service

BOOM Coordinator, (2006/2007 academic year) (BOOM is an undergraduate project showcase event)

Systems Q Exam Coordinator, (2005/2006 academic year)

Graduate Student Admissions Committee, (2004/2005, 2005/2006 and 2006/2007 academic years)

Current PhD Students

- Xinyang Zhang (Admission Control in Internets)
- Vivek Vishnumurthy (Random Selecting and Proximity Addressing in P2P Networks)
- Vidhyashankar Venkatraman (Using Priority Queuing to Improve TCP for High Bandwidth-Delay Product Networks)
- Hitesh Ballani (Complexity Oblivious Network Management)
- Saikat Guha (Name-based Signaling-Based Approach to Network Connection Establishment)

Completed PhD Students

- Manpreet Singh, “End-to-End Techniques for Network Resource Management” (Summer 2006, Google)

Doctoral Dissertation Committees

- Douglas Chan (ECE)
- Benjamin Atkin

CS790 (MEng) and CS490 (UGrad) Projects Supervised

2003: Andrew Chi, Cho-Min Chou, Heng-Scheng Chuang, Chaitanya Desai, Visar Gashi, Kiran Kannancheri, Hamid Schricker, Neal Sidhwaney, Elizabeth Wilgus

2004: Atitkumar Patel, Andrew Ch, Brian Kent, Chika Ekeji, Charles Dietrich, David Park, Gudlaugur Gudmundsson, Jason Hills, Jonathan Margulies, Jignesh Parmar, Pei-hsuan Tsai, Shareef Mostafa, Visar Gashi, Yah chun Chen

2005: Manu Manianchira, Swati Agarwal, Mike Jennings, Adam Berlinsky-Schine, Matthew Decker, Grant Goodale, Amar Phanishayee, Vadim Vassiliev, Charles Salada, Hong Tat Tong, Gei-Tai Lin

2006: Swati Agarwal, Kashif Javed, David Lifson, Manu Manianchira, Saket Navlakha, Ryan Pijai, Amer Shahnawaz, Vikram Singh, Michael Sullivan, Kainan Yin,

Cornell Presidential Research Scholars Supervised

Current: Sheng Rao