

Paul Barford

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Research Interests

Measurement and analysis of Internet traffic characteristics and topological structure. Internet security including detection of traffic anomalies and identification of malicious attacks and intrusions. Power-aware networking toward the goal of reducing energy demands and carbon footprint of Internet systems

Education

PhD. Computer Science 2000
Boston University, Boston, MA
Dissertation: Modeling, Measurement and Performance of World Wide Web Transactions
Adviser: Mark Crovella

B.S. Electrical Engineering 1985
University of Illinois, Urbana-Champaign, IL

Professional Experience

Computer Science Department, Univ. of Wisconsin, Madison, WI 2011 - present
Professor, Director of the Wisconsin Advanced Internet Laboratory

Qualys, Inc. Redwood Shores, CA 2010 - 2011
Chief Scientist

Computer Laboratory, University of Cambridge, Cambridge, UK 2010 - 2011
Visiting Professor

Computer Science Department, Univ. of Wisconsin, Madison, WI 2008 - 2011
Associate Professor, Director of the Wisconsin Advanced Internet Laboratory

Nemean Networks, LLC, Madison, WI 2007 - 2010
Founder, Chief Executive Officer - Nemean was acquired by Qualys, Inc. in August, 2010.

Computer Science Department, Univ. of Wisconsin, Madison, WI 2001 - 2007
Assistant Professor, Director of the Wisconsin Advanced Internet Laboratory

Computer Science Department, Boston University, Boston, MA 1995 - 2000
Research Fellow

DeGeorge Financial, Inc., Cheshire, CT 1991 - 1995
Director of Planning and Research

Digital Equipment Corporation, Maynard, MA 1987 - 1991
Senior Engineer

Mathematics Department, University of Illinois Urbana-Champaign, IL 1985 - 1986
Teaching Assistant

Consulting Experience

Technical Advisory Board member - Broadcast Interactive Media	2011 - present
Board of Directors - National LambdaRail, Inc.	2003 - 2010
Technical Advisory Board member - epicRealm, Inc., Richardson, TX	1999 - 2003
Technical Advisory Board member - Netheartbeat, Inc., Austin, TX	2000 - 2001
Infolibria, Inc. Waltham, MA	1998 - 1999

Awards and Honors

UK Engineering and Physical Sciences Research Council, Visiting Fellowship	2010
Wolfson College, University of Cambridge, Visiting Fellowship	2010
IEEE COMSNETS, Best Paper Award	2009
IEEE Symposium on Computers and Communications, selection for fast-track journal publication	2006
National Science Foundation CAREER Award	2004
IEEE Communications Society William R. Bennett Prize in the Field of Communications Circuits and Techniques - Runner up	2002
ACM SIGCOMM, selection for fast-track journal publication	2000
Xerox PARC, University Affairs Committee Award	1999
Hewlett-Packard Research Fellowship, Boston University	1997 - 2000
GAANN Fellowship, Boston University	1995 - 1997
Outstanding Teaching Assistant, University of Illinois, Urbana-Champaign	1986, 1987

Professional Activities

Memberships

ACM SIGCOMM Nominating Committee	2009
NSF/GENI Facility Architecture Working Group	2006 - 2007
NSF/GENI Instrumentation and Measurement Working Group (co-chair)	2009 - present
ACM Internet Measurement Conference Steering Committee	2006 - present
ACM (Senior member), IEEE (Senior member)	

Editorial Boards

Associate Editor, IEEE/ACM Transactions on Networking	2007 - 2010
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Program Chairs

ACM SIGMETRICS	2010
ACM SIGCOMM First Workshop on Green Networking	2010
ACM Internet Measurement Conference	2006

Program Committees

ACM Internet Measurement Conference	2001, 2004, 2005, 2006, 2007, 2009, 2010
ACM SIGMETRICS	2003, 2004, 2007, 2008, 2010, 2012
ACM SIGCOMM	2004, 2007, 2011
ACM SIGCOMM Workshop on Green Networking	2010, 2011
ACM SIGMETRICS Workshop on GreenMetrics	2009, 2010
USENIX Security Symposium	2008, 2009
ACM/USENIX Workshop on Steps to Reduce Unwanted Traffic on the Internet (SRUTI)	2005, 2007
ACM/USENIX Workshop on Hot Topics in Networks (HotNets)	2005
ACM/USENIX Workshop on Hot Topics in BotNets (HotBots)	2007
ACM Computer and Communications Security Conference	2008
ACM Workshop on Rapid Malcode (WORM)	2004
IEEE ICNP	2003
IEEE Workshop on Internet Applications	2003
IEEE 6th International Computer Performance and Dependability Symposium	2002
USENIX 4th International Workshop on Networking Meets Databases (NetDB)	2008
International Conference on Future Energy Systems	2012
Passive and Active Measurement Conference	2012
International Workshop on Green Communications	2011
Asian Internet Engineering Conference (AINTEC)	2008
CoNEXT Conference	2006
Securecomm Conference	2009
Workshop on Performance Evaluation of Next Generation Networks	2009
Workshop on Cyber Security Experimentation and Test	2009
Workshop on Tackling Computer Systems Problems with Machine Learning Techniques (SysML)	2006
Multiresolution Analysis of the Global Internet Workshop	2000
Boston University Workshop on Internet Measurement, Instrumentation and Characterization	1999
World Wide Web Consortium Workshop on Web Characterization	1998

Organizing Committees

NSF/DIMACS Workshop on Algorithms in the Field	2011
First NSF/GENI Workshop on Network Measurement	2009
Institute for Pure and Applied Mathematics, Program on “Internet Multiresolution Analysis: Foundations, Applications and Practice”	2008
Workshop on Internet Signal Processing	2004
IEEE Opensig	2003
IEEE ICNP (tutorials co-chair)	2003
Institute for Pure and Applied Mathematics workshop on “Large Scale Communications Networks: Topology, Routing, Traffic and Control”	2002, 2003
Computer Science and Telecommunications Board of the National Research Council study on “Internet Under Crisis Conditions”	2002

Panelist

National Science Foundation

2002, 2003, 2004, 2005, 2007, 2008, 2009, 2010

U.S. Patents

1. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "A Methodology and Apparatus for Providing a Measurement of Performance for a Network", US Patent #8,073,945.
2. Paul Barford, Jonathon Giffin, Somesh Jha and Vinod Yegneswaran. "A Semantically-Aware Network Intrusion Signature Generator", US Patent #8,065,722
3. Vinod Yegneswaran, Paul Barford and David Plonka. "Scalable Monitor for Malicious Network Traffic", US Patent #8,015,605
4. Paul Barford and David Plonka, "Apparatus and Method for Classifying Network Packet Data", US Patent #7,907,543
5. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "Network Performance Anomaly Detection and Localization", Patent pending, 2009.
6. Paul Barford, Jeff Kline, Sangnam Nam, Dave Plonka and Amos Ron. "Multi-resolution Methods for Network Anomaly Detection", Patent pending, 2007.

Refereed Journal Publications and Book Chapters

1. Brian Eriksson, Gautam Dasarathy, Paul Barford and Rob Nowak. "Efficient Network Tomography for Internet Topology Discovery", To appear in *IEEE/ACM Transactions on Networking*.
2. Brian Eriksson, Paul Barford, Joel Sommers and Rob Nowak. "Inferring Unseen Components of the Internet", In *IEEE Journal of Selected Areas of Communications*, November, 2011.
3. Mariyam Mirza, Joel Sommers, Paul Barford and Jerry Zhu. "A Machine Learning Approach to TCP Throughput Prediction", In *IEEE/ACM Transactions on Networking*, Vol. 18(4), pp. 1026-1039, October, 2010.
4. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "Multi-objective Monitoring for SLA Compliance", In *IEEE/ACM Transactions on Networking*, 18(2), pp. 652-665, April, 2010.
5. Jin-Yi Cai, Vinod Yegneswaran, Chris Alfeld and Paul Barford. "Honeynet Games: A Game Theoretic Approach to Defending Network Monitors", In the *Journal of Combinatorial Optimization*, February, 2010.
6. Paul Barford, Yan Chen, Anup Goyal, Zhichun Li, Vern Paxson and Vinod Yegneswaran. "Employing Honeynets For Network Situational Awareness", In *Series: Advances in Information Security*, Springer, 2009.
7. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "A Geometric Method for Active Packet Loss Measurement", In *IEEE/ACM Transactions on Networking*, Vol. 16(2), pp. 307-320, April, 2008.
8. Joel Sommers, Paul Barford, Albert Greenberg and Walter Willinger. "An SLA Perspective on Router Buffer Sizing", In *ACM SIGMETRICS Performance Evaluation Review*, Vol. 35(4), pp.40-51, March, 2008.
9. Joel Sommers, Paul Barford and Walter Willinger. "In Vitro Calibration of Available Bandwidth Estimation Tools", In *Elsevier Microprocessors and Microsystems Journal*, Vol. 31(4), pp. 222-235, June, 2007.

10. Paul Barford and Vinod Yegneswaran. "A Look Inside Botnets", In *Series: Advances in Information Security*, Springer, pp. 171-191, February, 2007. ISBN: 0-387-32720-7.
11. Paul Barford and Joel Sommers. "Comparing Probe- and Router-based Packet Loss Measurement", In *IEEE Internet Computing*, Vol. 8(5), pp. 50-56, September, 2004.
12. James Gast and Paul Barford. "Representing the Internet as A Succinct Forest", In *IEEE Computer Networks*, Vol. 45(1), pp. 35-44, March, 2004.
13. Paul Barford and Larry Landweber. "Bench-style Network Research in an Internet Instance Laboratory", In *ACM SIGCOMM Computer Communications Review*, Vol. 33(3), pp. 21-26, July, 2003.
14. Paul Barford and Mark Crovella. "Critical Path Analysis of TCP Transactions", in *IEEE/ACM Transactions on Networking*, Vol. 9(3), pp. 238-248, June 2001.
15. Mark Crovella, Martin Reiser and Christoph Lindemann: editors, "Internet Performance Modeling," In *Performance Evaluation*, Vol. 42(2-3), pp. 91-108, October, 2000.
16. Paul Barford and Mark Crovella. "Measuring Web Performance in the Wide Area," in *Performance Evaluation Review*, Vol. 27(2), pp. 37-48, September 1999.
17. Paul Barford, Azer Bestavros, Mark Crovella and Adam Bradley. "Changes in Web Client Access Patterns: Characteristics and Caching Implications," in *World Wide Web*, Special Issue on Characterization and Performance Evaluation, Vol. 2, pp. 15-28, December, 1998.

Refereed Conference and Workshop Publications

1. Joel Sommers, Paul Barford and Ben Liblit. "A Router Primitive Approach for Building Diverse Network Services", To appear in *Proceedings of the International Conference on Communication Systems and Networks*, Bangalore, India, January, 2012.
2. Joel Sommers, Brian Eriksson and Paul Barford. "On the Prevalence and Characteristics of MPLS Deployments in the Open Internet", To appear in *Proceedings of the ACM Internet Measurement Conference*, Berlin, Germany, November, 2011.
3. Joe Chabarek and Paul Barford. "Power-Awareness Extensions for Network Testbeds", In *Proceedings of the Fourth ICC Workshop on Green Communications*, Kyoto, Japan, June, 2011.
4. Dave Plonka and Paul Barford. "Flexible Traffic and Host Profiling via DNS Rendezvous", In *Proceedings of the Workshop on Securing and Trusting Internet Names (SATIN '11)*, London, UK, April, 2011.
5. Mariyam Mirza, Paul Barford, Xiaojin Zhu, Suman Banerjee and Mike Blodgett. "Fingerprinting 802.11 Rate Adaptation Algorithms", In *Proceedings of IEEE INFOCOM*, Shanghai, China, April, 2011.
6. Joel Sommers, Rhys Bowden, Brian Eriksson, Paul Barford, Matt Roughan and Nick Duffield. "Efficient Network-wide Flow Record Generation", In *Proceedings of IEEE INFOCOM*, Shanghai, China, April, 2011.
7. Brian Eriksson, Paul Barford, Rob Nowak and Joel Sommers. "Ghost in the Machine: Inferring Unseen Components in the Internet Core", In *Proceedings of IEEE INFOCOM (Mini-Conference)*, Shanghai, China, April, 2011.
8. Brian Eriksson, Paul Barford, Rhys Bowden, Nick Duffield, Joel Sommers and Matt Roughan. "BasisDetect: A Model-based Network Event Detection Framework", In *Proceedings of the ACM Internet Measurement Conference*, Melbourne, Australia, November, 2010.
9. Brian Eriksson, Paul Barford, Joel Sommers and Rob Nowak. "A Learning-based Approach to IP Geolocation", In *Proceedings of the Passive and Active Measurement Conference (PAM '10)*, Zurich, Switzerland, April, 2010.

10. Brian Eriksson, Gautam Dasarathy, Paul Barford and Rob Nowak. "Toward the Practical Use of Network Tomography for Internet Topology Discovery", In *Proceedings of IEEE INFOCOM*, San Diego, CA, March, 2010.
11. Joel Sommers, Paul Barford and Mark Crovella. "Router Primitives for Programmable Active Measurement", In *Proceedings of ACM SIGCOMM PRESTO Workshop*, Barcelona, Spain, August, 2009.
12. Mariyam Mirza, Kevin Springborn, Suman Banerjee, Mike Blodgett and Jerry Zhu. "On the Accuracy of TCP Throughput Prediction for Opportunistic Wireless Networks", In *Proceedings of IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON '09)*, Rome, Italy, June, 2009.
13. Jin-Yi Cai, Vinod Yegneswaran, Chris Alfeld and Paul Barford. "An Attacker-Defender Game for Honeynets", In *Proceedings of the the 15th International Computer and Combinatorics Conference (COCON '09)*, Niagara Falls, NY, June, 2009.
14. Paul Barford, Nick Duffield, Amos Ron and Joel Sommers. "Network Performance Anomaly Detection and Localization", In *Proceedings of IEEE INFOCOM*, Rio de Janeiro, Brazil, April, 2009.
15. Brian Eriksson, Paul Barford and Rob Nowak. "Estimating Hop Distance Between Arbitrary Host Pairs", In *Proceedings of IEEE INFOCOM*, Rio de Janeiro, Brazil, April, 2009.
16. Archit Gupta, Pavan Kuppili, Aditya Akella and Paul Barford. "An Empirical Study of Malware Evolution", In *Proceedings of the Conference on Communications Systems and Networks (COMSNETS '09)*, Bangalore, India, January, 2009.
17. Dave Plonka and Paul Barford. "Context-aware Clustering of DNS Query Traffic", In *Proceedings of ACM Internet Measurement Conference*, Vouliagmeni, Greece, October, 2008.
18. Brian Eriksson, Paul Barford and Rob Nowak. "Network Discovery From Passive Measurements", In *Proceedings of ACM SIGCOMM*, Seattle, WA, August, 2008.
19. Jeff Kline, Sangnam Nam, Paul Barford, Dave Plonka and Amos Ron. "Traffic Anomaly Detection at Fine Time Scales with Bayes Nets", In *Proceedings of the International Conference on Internet Monitoring and Protection (ICIMP '08)*, Bucharest, Romania, June, 2008.
20. Joe Chabarek, Joel Sommers, Paul Barford, Cristian Estan, Steve Wright and David Tsiang. "Power Awareness in Network Design and Routing", In *Proceedings of IEEE INFOCOM*, Phoenix, AZ, April, 2008.
21. Zesheng Chen, Chuanyi Ji and Paul Barford. "Spatial-Temporal Characteristics of Internet Malicious Sources", In *Proceedings of IEEE INFOCOM (Mini-Conference)*, Phoenix, AZ, April 2008.
22. Joel Sommers and Paul Barford. "An Active Measurement System for Shared Environments", In *Proceedings of ACM Internet Measurement Conference*, San Diego, CA, October, 2007.
23. Brian Eriksson, Paul Barford, Robert Nowak and Mark Crovella. "Learning Network Structure from Passive Measurements", In *Proceedings of ACM Internet Measurement Conference*, San Diego, CA, October, 2007.
24. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "Efficient Network-wide SLA Compliance Monitoring", In *Proceedings of ACM SIGCOMM*, Kyoto, Japan, August, 2007.
25. Mariyam Mirza, Joel Sommers, Paul Barford and Jerry Zhu. "A Machine Learning Approach to TCP Throughput Estimation", In *Proceedings of ACM SIGMETRICS*, pp. 97-108, San Diego, CA, June, 2007.
26. Vinod Yegneswaran, Chris Alfeld, Paul Barford and Jin-Yi Cai. "Camouflaging Honeynets", In *Proceedings of IEEE Global Internet Symposium*, Anchorage, AK, May, 2007.

27. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "A Framework for Multi-objective SLA Compliance Monitoring", In *Proceedings of IEEE INFOCOM (Mini-Conference)*, pp. 2436-2440, Anchorage, AK, May, 2007.
28. Paul Barford and Mike Blodgett. "Toward Botnet Mesocosms", In *Proceedings of the USENIX First Workshop on Hot Topics in Understanding Botnets (Hotbots '07)*, Cambridge, MA, April, 2007.
29. Lei Chen, Raghu Ramakrishnan, Paul Barford, Beechung Chen and Vinod Yegneswaran. "Composite Subset Measures", In *Proceedings of the 32nd International Conference on Very Large DataBases (VLDB '06)*, pp. 403-414, Seoul, Korea, September, 2006.
30. Mark Allman, Paul Barford, Balachander Krishnamurthy and Jia Wang. "Tracking the Role of Adversaries in Measuring Unwanted Traffic", In *Proceedings of the USENIX Second Workshop on Steps to Reducing Unwanted Traffic on the Internet (SRUTI '06)*, pp. 37-42, San Jose, CA, July, 2006.
31. Joel Sommers, Paul Barford and Walter Willinger. "A Proposed Framework for Calibration of Available Bandwidth Measurement Tools", In *Proceedings of IEEE Symposium on Computers and Communications (ISCC '06)*, pp. 709-718, Sardinia, Italy, June, 2006.
32. Yolanda Tsang, Mehmet Yildiz, Paul Barford and Robert Nowak. "On the Performance of Round Trip Time Network Tomography", In *Proceedings of IEEE Conference on Communications (ICC '06)*, pp. 483-488, Istanbul, Turkey, June, 2006.
33. Vikas Garg, Vinod Yegneswaran and Paul Barford. "Improving NIDS Performance Through Hardware-based Connection Filtering", In *Proceedings of IEEE Conference on Communications (ICC '06)*, pp. 2183-2188, Istanbul, Turkey, June, 2006.
34. Beechung Chen, Vinod Yegneswaran, Paul Barford, and Raghu Ramakrishnan. "Toward a Query Language for Network Attack Data", In *Proceedings of Second IEEE Workshop on Networks Meets Databases (NetDB '06)*, Atlanta, GA, April, 2006.
35. Joel Sommers, Paul Barford, and Walter Willinger. "SPLAT: A Visualization Tool for Mining Internet Measurements", In *Proceedings of Passive and Active Measurement Conference (PAM '06)*, pp. 31-40, Adelaide, Australia, March, 2006.
36. Paul Barford, Robert Nowak, Rebecca Willett, and Vinod Yegneswaran. "Toward a Model for Sources of Internet Background Radiation" In *Proceedings of Passive and Active Measurement Conference (PAM '06)*, pp. 211-220, Adelaide, Australia, March, 2006.
37. Vinod Yegneswaran, Paul Barford and Vern Paxson. "Using Honeynets for Internet Situational Awareness", In *Proceedings of the Fourth Workshop on Hot Topics in Networks (HotNets IV)*, pp. 17-22, College Park, MD, November, 2005.
38. Shilpi Agarwal, Joel Sommers and Paul Barford. "Scalable Network Path Emulation", In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS '05)*, pp. 219-228, Atlanta, GA, September, 2005.
39. Joel Sommers, Paul Barford, Nick Duffield and Amos Ron. "Improving Accuracy in End-to-end Packet Loss Measurements", In *Proceedings of ACM SIGCOMM*, pp. 157-168, Philadelphia, PA, August, 2005.
40. Vinod Yegneswaran, Jon Giffin, Paul Barford, Somesh Jha. "An Architecture for Generating Semantic-Aware Signatures", In *Proceedings of the USENIX Security Symposium*, pp. 97-112, Baltimore, MD, August, 2005.
41. Rouming Pang, Vinod Yegneswaran, Paul Barford, Vern Paxson and Larry Peterson. "Characteristics of Internet Background Radiation", In *Proceedings of ACM Internet Measurement Conference*, pp. 27-40, Taormina, Italy, October, 2004.

42. Yolanda Tsang, Mehmet Yildiz, Paul Barford and Robert Nowak. "Network Radar: Tomography from Round Trip Time Measurements", In *Proceedings of ACM Internet Measurement Conference*, pp. 175-180, Taormina, Italy, October, 2004.
43. Joel Sommers and Paul Barford. "Self-Configuring Network Traffic Generation", In *Proceedings of ACM Internet Measurement Conference*, pp. 68-81, Taormina, Italy, October, 2004.
44. Joel Sommers, Vinod Yegneswaran and Paul Barford. "A Framework for Malicious Workload Generation", In *Proceedings of ACM Internet Measurement Conference*, pp. 82-87, Taormina, Italy, October, 2004.
45. Vinod Yegneswaran, Paul Barford and David Plonka. "On the Design and Use of Internet Sinks for Network Abuse Monitoring", In *Proceedings of the Symposium on Recent Advances in Intrusion Detection (RAID '04)*, pp. 146-165, Sophia Antipolis, France, September, 2004.
46. Joel Sommers, Hyungsuk Kim and Paul Barford. "Harpoon: A Flow-Level Traffic Generator for Router and Network Tests", In *Proceedings of ACM SIGMETRICS*, pp. 392-393, New York, NY, June, 2004.
47. Vinod Yegneswaran, Paul Barford and Somesh Jha. "Global Intrusion Detection in the DOMINO Overlay System", In *Proceedings of Network and Distributed Systems Security Symposium (NDSS '04)*, pp. 79-95, San Diego, CA, February, 2004.
48. Jim Gast and Paul Barford. "Evaluating and Modeling Window Synchronization in Highly Multiplexed Flows", In *Proceedings of IEEE the 6th Workshop on Workload Characterization*, pp. 51-61, Austin, TX, October, 2003.
49. Vinod Yegneswaran, Paul Barford and Johannas Ullrich. "Internet Intrusions: Global Characteristics and Prevalence", In *Proceedings of ACM SIGMETRICS*, pp. 138-147, San Diego, CA, June, 2003.
50. Paul Barford, Jeff Kline, David Plonka, Amos Ron. "A Signal Analysis of Network Traffic Anomalies", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop*, pp. 71-82, Marseilles, France, November, 2002.
51. Jim Gast and Paul Barford. "Resource Deployment based on Autonomous System Clustering", In *Proceedings of IEEE Global Telecommunications Conference (Globcom '02)*, pp. 2240-2244, Taipei, Taiwan, October, 2002.
52. Paul Barford, Azer Bestavros, John Byers and Mark Crovella. "On the Marginal Utility of Network Topology Measurements", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop*, pp. 5-17, San Francisco, CA, November, 2001.
53. Paul Barford and David Plonka. "Characteristics of Network Traffic Flow Anomalies", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop*, pp. 69-73, San Francisco, CA, November, 2001.
54. Paul Barford and Mark Crovella. "Critical Path Analysis of TCP Transactions", In *Proceedings of ACM SIGCOMM*, pp. 127-138, Stockholm, Sweden, August, 2000.
55. Paul Barford and Mark Crovella. "A Performance Evaluation of Hyper Text Transfer Protocols," in *Proceedings of the ACM SIGMETRICS*, pp. 188-197, Atlanta, GA, May, 1999.
56. Paul Barford and Mark Crovella. "Generating Representative Web Workloads for Network and Server Performance Evaluation," in *Proceedings of the ACM SIGMETRICS*, pp. 151-160, Madison, WI, June 1998.
57. Mark Crovella and Paul Barford. "The Network Effects of Prefetching," in *Proceedings of the IEEE INFOCOM*, pp. 1232-1239, San Francisco, CA, April 1998.
58. Quinn Canfield, Paul Barford, Paul Kinzelman and Cary Trlica. "A System Simulation Environment," in *Proceedings of Computer Design: VLSI in Computers and Processors (ICCD '89)*, pp. 555-560, Cambridge, MA, 1989.

National Reports

1. Paul Barford (Ed.). “GENI Measurement and Instrumentation Specification”, Global Environment for Network Innovations Technical Document GDD-06-12, September, 2006.
2. Computer Science and Telecommunications Board, National Research Council. “The Internet Under Crisis Conditions: Learning from September 11,” *National Academy Press*, November, 2002. ISBN: 0-309-08702-3.

Invited Papers

1. Dave Plonka and Paul Barford. “Network Anomaly Confirmation, Diagnosis and Remediation”, In *Proceedings of the Allerton Conference on Communication, Control and Computing*, Monticello, IL, October, 2009.
2. Joel Sommers, Vinod Yegneswaran and Paul Barford. “Recent Advances in Network Intrusion Detection System Tuning”. In *Proceedings of the 40th IEEE Conference on Information Science Systems*, pp. 1490-1495, Princeton, NJ, March, 2006.
3. Paul Barford, Somesh Jha and Vinod Yegneswaran. “Fusion and Filtering in Network Intrusion Detection”, In *Proceedings of the Allerton Conference on Communication, Control and Computing*, pp. 1546-1556, Monticello, IL, October, 2004.
4. Guido Appenzeller, Nick McKeown, Joel Sommers and Paul Barford. “Recent Results on Sizing Router Buffers”, In *Proceedings of the Network Systems Design Conference*, San Jose, CA, October, 2004.
5. Paul Barford and Larry Landweber. “Bench-style Network Research in an Internet Instance Laboratory”, In *Proceedings of SPIE ITCOM*, pp. 175-183, Boston, MA, August, 2002.
6. Paul Barford and Mark Crovella. “Critical Path Analysis of TCP Transactions”, In *Proceedings of ACM SIGCOMM Latin America*, San Jose, Costa Rica, April 2001.

Other Publications

Technical Reports

1. Paul Barford, Craig Partridge and Walter Willinger. “Internet Multi-Resolution Analysis: A Vision and Framework in Support of Representing, Analyzing and Visualizing Internet Measurements”, UW Technical Report #1646, September, 2008.
2. Jin-Yi Cai, Vinod Yegneswaran, Chris Alfeld, and Paul Barford. “Honeygames: A Game Theoretic Approach to Defending Network Monitors”, UW Technical Report #1577, December, 2006.
3. Joel Sommers, Paul Barford, Albert Greenberg and Walter Willinger. “An SLA Perspective on the Router Buffer Sizing Problem”, UW Technical Report #1569, July, 2006.
4. Joel Sommers, Vinod Yegneswaran and Paul Barford. “Toward Comprehensive Traffic Generation for Online IDS Evaluation”, UW Technical Report #1525, May, 2005.
5. Paul Barford and Joel Sommers. “On the Precision of Active Probes for Packet Loss”, UW Technical Report #1442, September, 2002.
6. Paul Barford, David Donoho, Georgina Flesia and Vinod Yegneswaran, “Characteristics of Network Delays in Wide Area File Transfers,” UW Technical Report #1443, July, 2002.
7. Paul Barford, Jin-Yi Cai and Jim Gast. “Cache Placement Methods Based on Client Demand Clustering,” UW Technical Report #1437, June, 2001.

Position Papers and Notes

1. Paul Barford. “Measurement as a First Class Network Citizen,” Position paper for NSF Workshop on the Next Generation Secure Internet, July, 2005.
2. Vijayan Prabhakaran, Joseph Stanley and Paul Barford. “High Throughput Data Transfers using the Tornado Transport Protocol,” November, 2002.
3. Paul Barford and David Plonka. “Inferring Client Experience from Flow-based Measurements,” July, 2001.
4. Paul Barford. “Global Internet Measurement Infrastructure,” Position paper for NSF Large Scale Networking Workshop, March, 2001.

Tutorials

1. Paul Barford and Vishal Misra “Measurement, Modeling and Analysis of the Internet,” Presented at:
 - *IMA Workshop on Internet Measurement and Modeling* , Minneapolis, MN, January, 2004.
2. Paul Barford. “Internet-wide Measurement Infrastructures,” Presented at:
 - *IPAM Workshop on Large Scale Communications Networks* , Los Angeles, CA, March, 2002.
3. Paul Barford. “Web Server Performance Analysis,” Presented at:
 - *ACM SIGMETRICS '99*, Atlanta, GA, April, 1999.
 - *IEEE Local Area Networks '99*, Lowell, MA, October, 1999.

Selected Invited Talks, Panels and Workshops

1. Invited talk, Security Innovations Network Summit, Cambridge, MA, October, 2011.
2. Invited talk, Computer Laboratory, University of Cambridge, Cambridge, UK, November, 2010.
3. Invited panelist, ”From Turing to Google: What Makes Good Research?”, IEEE INFOCOM, San Diego, CA, March, 2010.
4. Distinguished lecture, Computer Science Department, University of California - Irvine, Irvine, CA, February, 2010.
5. Distinguished lecture, Computer Science Department, University of Utah, Salt Lake City, UT, August, 2009.
6. Invited talk, Deutsche Telekom Labs, Berlin, Germany, July, 2009.
7. Invited talk, Fifth Computer Network Defense Research & Technology Workshop, Annapolis Junction, MD, June, 2009.
8. Invited talk, Center for Information and Systems Engineering, Boston University, Boston, MA, March, 2009.
9. Invited talk, DHS/SRI Infosec Technology Transition Council Workshop, Menlo Park, CA, February, 2009.
10. Invited talk, American Mathematical Society, Special Session on The Mathematics of Information and Knowledge, Washington, DC, January, 2009.
11. Invited talk, IPAM Workshop on Multiscale Representation, Analysis and Modeling of Internet Data Measurements, University of California, Los Angeles, CA, September, 2008.

12. Invited talk, DIMACS Workshop on Internet Tomography, Rutgers University, New Brunswick, NJ, May, 2008.
13. Invited talk, EU-US Cyber Trust Summit, Monticello, IL, April, 2007.
14. Invited talk, NSF FIND Information Meeting, Washington D.C., December, 2006.
15. Invited talk, National Academy of Engineering, Japan-America Frontiers of Engineering Symposium, Tsukuba, Japan, November, 2006.
16. Invited talk, University of Wisconsin CEO Summit, October, 2006.
17. Invited talk, Cisco Systems Nerd Lunch, San Jose, CA, June, 2006.
18. Invited talk, Computer Science Department, Northwestern University, Evanston, IL, May, 2006.
19. Invited talk, Cisco Network Management Research Summit, Santa Clara, CA, January, 2006.
20. Invited talk, Computer Science Department, Massachusetts Institute of Technology, Cambridge, MA, October, 2005.
21. Invited talk, Computer Science Department, Boston University, Boston, MA, October, 2005.
22. Invited talk, Computer Science Department, California Institute of Technology, Pasadena, CA, September, 2005.
23. Invited talk, ARO/DHS Workshop on Malware Detection, Arlington, VA, August, 2005.
24. Invited participant, NSF Workshop on the Next Generation Secure Internet, Pittsburgh, PA, July, 2005.
25. Invited talk, Microsoft Research Self-Managing Networks Summit, Kirkland, WA, June, 2005.
26. Invited talk, Workshop on Internet Signal Processing, San Diego, CA, November, 2004.
27. Invited talk, InfoSec Research Council, Arlington, VA, September, 2004.
28. Invited talk, EMC Corporation, Hopkinton, MA, June, 2004.
29. Invited talk, Intel Research, Berkeley, CA, June, 2004.
30. Invited talk, Computer Science Department, University of Michigan, Ann Arbor, MI, March, 2004.
31. Invited talk, Laboratoire d'Informatique de Paris (LIP6), Paris, France, February, 2004.
32. Invited panelist, Worm Monitoring Infrastructures, ACM Workshop on Rapid Malcode, Washington, D.C., October, 2003.
33. Invited talk, Computer Science Department, University of Maryland, College Park, MD, June, 2003.
34. Invited talk, Army Research Lab, Adelphi, MD, September, 2003.
35. Invited talk, IPAM workshop on Large Scale Communications Networks, Lake Arrowhead, CA, September, 2003.
36. Invited talk, AT&T Research Labs, Florham Park, NJ, December, 2002.
37. Invited talk, Microsoft Research Labs, Redmond, WA, December, 2002.
38. Invited talk, Computer Science Department, University of Washington, Seattle, WA, December, 2002.
39. Invited talk, Intel Research Labs, Hillsboro, OR, December, 2002.
40. Invited talk, Computer Science Department, University of Illinois, Urbana, IL, October, 2002.

41. Invited talk, Network Modeling and Simulation Workshop, Hanover, NH, July, 2002.
42. Invited talk, IPAM Workshop on Internet Measurement, University of California - Los Angeles, CA, March, 2002.
43. Invited talk, Sprint Labs, Burlingame, CA, November, 2001.
44. Invited talk, 16th Annual IEEE Computer Communications Workshop, Charlottesville, VA, October, 2001.
45. Invited talk, HP Labs, Palo Alto, CA, October, 2001.
46. Invited talk, Cisco Systems, San Jose, CA, October, 2001.
47. Invited talk, Multiresolution Analysis of Global Internet Measurements Workshop, Leiden, Holland, September, 2001.
48. Invited talk, IDR-IMA Workshop on Ideal Data Representation, Minneapolis, Mn, April, 2001.
49. Invited talk, ACM SIGCOMM Latin America, San Jose, Costa Rica, April, 2001.
50. Invited talk, Princeton University PACM Colloquium, Princeton, NJ, February, 2001.
51. Invited talk, Multiresolution Analysis of the Global Internet Workshop, Palo Alto, CA, October, 2000.
52. Invited talk, 15th IEEE Computer Communications Workshop, Captiva, FL, October, 2000.
53. Invited talk, The Global Internet: Measurement, Modeling and Analysis Workshop, Leiden, Holland, September, 2000.
54. Invited talk, Internet2 Network Research Workshop, Chicago, IL, June, 2000.
55. Invited talk, Work in Progress Session, *ACM SIGCOMM*, Cambridge, MA, September, 1999.
56. Invited participant, Institute for Mathematics and Its Applications Workshop: Scaling Phenomena in Communication Networks, Minneapolis, MN, October, 1999.
57. Invited participant, Workshop on Internet Performance Modeling, Dagstuhl Castle, Germany, September, 1999.

Grants and Gifts

1. "Spatio-temporal Analysis of Current Power Generation and Potential Bioenergy Substitution in the GLBRC Region", UW-Madison BACTER Institute for Computational Biology, P. Barford co-PI, \$50K, 2011 - 2012.
2. "Information and Software Assurance: A Coordinated Approach to Cyber-Situation Awareness Based on Traffic Anomaly Detection", Army Research Office, P. Barford co-PI, \$800K, 2011 - 2015.
3. "Toward Strategies for Power Aware Networking", Engineering and Physical Sciences Research Council, UK, P. Barford PI, £100K, 2010 - 2011.
4. "TC: Medium: Collaborative Research: Wide-Aperture Traffic Analysis for Internet Security", National Science Foundation, P. Barford co-PI, \$1M, 2009 - 2013.
5. "CT-M: Meta-Environments for Experiments on Diverse Topics in Network Security", National Science Foundation, P. Barford PI, \$850K, 2008 - 2012.
6. "Instrumentation and Measurement for GENI", BBN, P. Barford PI, \$499K, 2008 - 2011.
7. "Collaborative Research: CT-T: Logic and Data Flow Extraction for Live and Informed Malware Execution", National Science Foundation, P. Barford PI, \$1.1M, 2007 - 2010.

8. "Virtual Center for Network and Security Data", Department of Homeland Security, P. Barford PI, \$336K, 2007 - 2012.
9. "Collaborative Research: CRI: CRD Synthetic Traffic Generation Tools and Resources: A Community Resource for Experimental Networking Research", P. Barford co-PI, \$60K, 2007 - 2008.
10. "Collaborative HoneyStream Analytics Exploitation System (CHAES)", Department of Homeland Security, P. Barford PI, \$30K, 2006 - 2007.
11. "Requirements Driven Resource Allocation in Next Generation Routers", Cisco Systems donation, P. Barford PI, \$175K, 2006.
12. "GENI Instrumentation and Measurement Systems (GIMS)", National Science Foundation, P. Barford PI, \$150K, 2006 - 2008.
13. "Cyber Threat Analytics", Army Research Office, P. Barford PI, \$100K, 2006 - 2007.
14. "NeTS-FIND: Design for Manageability in the Next Generation Internet", National Science Foundation, P. Barford PI, \$650K, 2006 - 2008.
15. "Infrastructure to Support Cyberforensics", Army Research Office, P. Barford PI, \$350K, 2005 - 2006.
16. "Self Directed Intrusion Detection", Army Research Office, P. Barford PI, \$30K, 2004 - 2005.
17. "Datasets for Network Security", Department of Homeland Security, P. Barford PI, \$274K, 2004 - 2007.
18. "Student Travel Grant Support for the First Workshop on Internet Signal Processing", National Science Foundation, P. Barford PI, \$10.5K, 2004.
19. "CAREER: A Multiresolution Approach to Network Anomaly and Intrusion Detection", National Science Foundation, \$501K, P. Barford PI, 2004 - 2009.
20. "An Integrated Program for Content Addressable Storage Research", EMC Corporation, \$590K, P. Barford PI, December, 2003 - 2004.
21. "Evaluating Buffer Behavior in High Performance Routers", Cisco Systems University Research Program, \$92K, P. Barford PI, 2003 - 2004.
22. "MRI: Acquisition of the GLOW Distributed Computing System at the University of Wisconsin - Madison", National Science Foundation, \$2M, P. Barford co-PI, 2003 - 2004.
23. "NMI: An Integrative Testing Framework for Grid Middleware and Grid Environments", National Science Foundation, \$1.8M, P. Barford co-PI, 2003 - 2005.
24. "Collaborative ITR: Modular Strategies for Internetwork Monitoring", National Science Foundation, \$1M, P. Barford co-PI, August, 2003-2007.
25. "NRT: Collaborative Research: A Unified Experimental Environment for Diverse Networks", National Science Foundation, \$4.4M, P. Barford co-PI, 2003 - 2007.
26. "Data Center Traffic Monitoring and Control". Intel Corporation. \$145K. P. Barford PI. 2003 - 2005.
27. "Distributed Storage Research in the Wisconsin Advanced Internet Lab," EMC Corporation, PI, \$1M, 2002.
28. "Distributed Anomaly Characterization and Detection," Army Research Office, P. Barford PI, \$320K, 2002-2005.
29. "The Wisconsin Advanced Internet Laboratory," Cisco Systems/TOSA Foundation, P. Barford PI, \$3.2M, 2002.
30. "The Wisconsin Advanced Internet Laboratory," Sun Microsystems, P. Barford PI, \$135k, 2002.

31. "The Wisconsin Advanced Internet Laboratory," Intel, P. Barford PI, \$50k, 2002.
32. "Network Measurement and Management," Fujitsu Labs America, P. Barford PI, \$25K, 2002.
33. "iSWORD: Instrumented Streaming Research and Testbed," National Science Foundation, P. Barford co-PI, \$800K, 2001 - 2004
34. "Particle Physics Data Grid Collaboratory Pilot," Department of Energy, P. Barford co-PI, \$1.5M, 2001 - 2004.

Student Supervision

Current Students

Joe Chabarek - 6th year PhD., UW Computer Science Department
 Mariyam Mirza - 7th year PhD., UW Computer Science Department
 David Plonka - 6th year PhD., UW Computer Science Department
 Scott Alfeld - 1st year PhD., UW Computer Science Department

Former Students

Brian Eriksson (PhD. '10) - Post Doctoral Researcher, Boston University
 Joel Sommers (PhD. '07) - Assistant Professor, Colgate University
 Chris Alfeld (PhD. '07) - Director of Research, Qualys, Inc.
 Vinod Yegneswaran (PhD. '06) - Research Scientist, SRI International
 James Gast (PhD. '03) - Senior Specialist, TDS Telecom
 Sanjay Bharadwaj (MS. '10) - Engineer, Oracle
 Charles Xie (MS. '09) - Engineer, Oracle
 Kevin Springborn - (MS. '07) - Senior Engineer, Qualys, Inc.
 Ramanathan Palaniappan (MS. '06) - Engineer, Amazon
 Shilpi Agrawal (MS. '04) - Engineer, VMWare
 Janani Thanigachalam (MS. '04) - Engineer, Oracle
 Badhri Varanasi (MS. '04) - Engineer, Oracle

Examining Committee Member

Joe Chabarek, Prelim '10 *Toward a Power-Aware Internet*, UW Computer Science Department, First reader/advisor.
 Brian Eriksson, PhD. '10 *Internet Network Discovery Using a Passive Measurement Framework*, UW ECE Department, 2nd reader/co-advisor.
 Vivek Shrivastava, PhD. '10 *Optimizing Enterprise Wireless Networks using Centralization*, UW Computer Science Department, Second reader.
 David Plonka, Prelim '10 *Scalable and Robust Classification of Internet Traffic*, UW Computer Science Department, First reader/advisor.

Mariyam Mirza, Prelim '09 *On the Utility of Single Vantage Point Monitoring in Wireless Networks*, UW Computer Science Department, First reader/advisor.

Bee Chung Chen, PhD. '07 *Cube-Space Data Mining*, UW Computer Science Department, Fourth reader.

Joel Sommers, PhD. '07 *Calibrated Network Measurement*, UW Computer Science Department, First reader/advisor.

Mihai Christodorescu, PhD. '07 *Behavior-based Malicious Code Understanding and Detection*, UW Computer Science Department, Second reader.

Qunfeng Dong, PhD. '07 *Efficient Schemes for Stateless Packet Classification*, UW Computer Science Department, Second reader.

Manish Bhardwaj, PhD. '07 *An Analytic Approach to the Design of Survivable Optical Mesh Networks*, UW ECE Department, Outside reader.

Vinod Yegneswaran, PhD. '06 *Measurement, Detection and Analysis of Internet Intrusions*, UW Computer Science Department, First reader/advisor.

Sechang Son, PhD. '06 *Recovering Internet Symmetry in Distributed Computing*, UW Computer Science Department, Second reader.

Shai Rubin, PhD. '06 *Toward Trustworthy NIDS*, UW Computer Science Department, Second reader.

Leonidas Galanis, PhD. '04 *Towards A Data-Centric Internet*, UW Computer Science Department, Fourth reader.

Victor Zandy, PhD. '04, *Application Mobility*, UW Computer Science Department, Third reader.

Jim Gast, PhD. '03, *Topology Aware Estimation Methods for Internet Traffic Characteristics*, UW Computer Science Department, First reader/advisor.

Jim Basney, PhD. '01, *Network and CPU Co-Allocation in High Throughput Computing Environments*, UW Computer Science Department, Third reader.

Ariel Tamshes, PhD. '01, *Fine-Grained Dynamic Instrumentation of Commodity Operating System Kernels*, UW Computer Science Department, Fourth reader.