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Academics

Princeton University Princeton, NJ
Assistant Professor of Computer Science Sept 2007—present

New York University, Courant Institute New York, NY
Ph.D. in Computer Science Sept 2007
Thesis title: *Democratizing Content Distribution*
Visited **Stanford University**, September 2005—May 2007
Advisor: David Mazières ; GPA: 4.0/4.0

M.S. in Computer Science May 2005
Advisor: David Mazières ; GPA: 4.0/4.0

Massachusetts Institute of Technology Cambridge, MA
M.Eng. in Electrical Engineering and Computer Science June 2002
Thesis title: *A Peer-to-Peer Anonymizing Network Layer*
Advisor: Robert Morris ; GPA: 5.0/5.0

S.B. in Computer Science, Minor in Political Science June 2001
Thesis title: *An Anonymous Communications Channel for the Free Haven Project*
Advisor: Ron Rivest ; GPA: 4.9/5.0

Wyoming Valley West High School Plymouth, PA
Graduated Class Valedictorian (1/314), June 1997. National Merit Finalist (PSAT 1550), Advanced Placement Scholar with Distinction, National Honor Society.

Interests

Distributed systems, security, networking, and cryptography

Current Research

2002–present **Content distribution networks and peer-to-peer systems.** Conceived and led the Coral Project. Designed and built an Internet-scale, self-organizing web-content distribution network: CoralCDN [12] uses a network of cooperating DNS redirectors and HTTP proxies, backed by a decentralized indexing infrastructure [21], to allow oblivious clients to transparently download content from nearby servers, while avoiding distant or heavily-loaded ones. CoralCDN has been in production use on 300 servers since March 2004, currently receiving about 25 million HTTP requests from over 1 million clients per day, serving several terabytes of data. <http://coralcdn.org/>

Ongoing research focuses on untrusted peer-assisted CDNs [15] [28] [14], employing *price theory* to study how peer demand can be efficiently matched to available supply. Our work provides both theoretical and practical steps forward. First, we rigorously analyze the efficiency and robustness gains that are enabled by price-based multilateral exchange. We show that multilateral exchanges satisfy several desirable efficiency and robustness properties that bilateral exchanges such as BitTorrent do not, particularly when considering multiple files. Second, our system design, PACE (Price-Assisted Content Exchange), realizes many of the benefits of a price-based multilateral exchange; it encourages sharing of desirable content and network-friendly resource utilization.

2008–present **Federated virtual worlds.** Researching design issues—including naming, addressing, security, and scalability—for building Internet-scale virtual worlds, arising from the federation of loosely-coupled VW service providers.

- 2007–present **Fault-tolerant systems.** Researching general techniques for building robust and scalable services. Investigating the feasibility of using historical information of system output to detect unexpected changes given known inputs. Designing the accompanying system for real-time fault detection—and potentially masking if deployed on-path—in legacy systems of heterogenous components. Also pursuing theoretical problems within the context of scaling more traditional Byzantine fault-tolerant services, by securely partitioning large-scale systems into smaller groups that provide locally reliable service. Earlier work considered a new approach for group membership via link attestations [17].
- 2006–present **Distributed monitoring and debugging.** Developing new techniques for monitoring and analyzing the behavior of large-scale, federated distributed systems. First, helping design end-to-end request tracing to graph the causality of operations across function and network calls, providing the equivalent of a distributed, labeled call graph. Developing graph-based clustering algorithms to analyze millions of such traces—we are currently tracing the production deployments of CoralCDN [12] and OASIS [4]—in order to establish characterizations of system behavior, helping operators to identify normal behavior and isolate exceptional conditions. Second, we are investigating the real-time adaptation of program logging driven by distributed queries, allowing operators to dynamically change the granularity of data collection and to perform distributed monitoring, debugging, and condition verification.
- 2000–present **Privacy-preserving protocols.** Developed cryptographic protocols for private matching (PM), which computes the set intersection between two or more parties’ inputs [10]. PM uses the properties of homomorphic encryption to privately evaluate a polynomial representation of input sets. Subsequent work led to improved constructions for keyword search (KS) based on oblivious pseudorandom functions [8], as well as explicit consideration of detecting graph proximity for social networks [16]. Earlier research included the design and implementation of a prototype system for anonymous cryptographic e-cash, as well as considerations for privacy-enabled digital rights management (DRM) systems [22] [25].

Prior Research

- 2006–2007 **IP analytics.** By instrumenting CoralCDN, used active web content to measure and analyze the characteristics of over 7 million clients with respect to “edge technologies” (NATs, proxies, DNS and DHCP) [2]. Results quantify how Internet services can use IP addresses to identify clients and enforce access-control decisions. Commercialized historical and real-time techniques for proxy detection and IP geolocation with M. Casado; Acquired by Quova, Inc. in Nov. 2006 and currently being tested at large Internet services. <http://illuminati.coralcdn.org/>
- 2006–2007 **Secure enterprise networks.** Design and implementation contributions to Ethane [3] [1], a backwards-compatible protection and management architecture for enterprise networks. Ethane network switches provide connectivity through on-demand virtual circuits, yet they enforce security policies on a per-flow basis through centrally-managed, atomic, auditable name bindings. Multi-month deployment at Stanford served hundreds of both wired and wireless hosts. Technology is now being commercialized by Nicira Networks. <http://yuba.stanford.edu/ethane/>
- 2005–2007 **Anycast.** Designed and built OASIS, a server-selection infrastructure that provides locality- and load-based anycast for replicated Internet services [4] [29]. OASIS tackles the problems of leveraging disparate services to perform (potentially error-prone) network measurement and of scalably managing state information about many services and their participating nodes. OASIS has been in production use since Nov. 2005 and has been adopted by more than a dozen distributed services, handling thousands of replicas. Background measurement studies examines the geographic locality of IP prefixes [6] and the efficacy of virtual coordinate systems [19]. <http://oasis.coralcdn.org/>
- 2005–2007 **Reliable email.** Designed and implemented the security and privacy protections in Re., an email acceptance system that leverages social proximity for automated whitelisting [5], using private matching [10]. Recent analysis of privacy for social networks led to more efficient protocols based only on symmetric-key operations (or achieving stronger properties using bilinear maps) [16].

- 2003–2005 **Secure distributed file systems and file dissemination.** With a focus on settings with mutually-distrustful clients, Shark [7] provides a distributed file system that improves scalability and performance through cooperative reads and semantic chunking, using Coral’s indexing layer to locate files. Yet Shark preserves traditional semantics, manageability, and security. Other research provides integrity guarantees for large files encoded with rateless erasure codes, via a homomorphic hash function that can verify downloaded blocks on-the-fly [11].
- 2000–2002 **Anonymity systems.** Designed and implemented Tarzan [13] [23], a peer-to-peer anonymous IP network layer that is strongly resistant to traffic analysis. Tarzan helped protect against Sybil attacks through the selection of neighbors in a constrained and verifiable manner. Helped design Free Haven, a distributed system for the anonymous publishing, storage, and retrieval of information [26] [27] [31].

Work experience

- 8/07–present **Assistant Professor.** Princeton University, Princeton, NJ.
- 3/06–11/06 **Co-founder.** Illuminics Systems, Mountain View, CA. Acquired by Quova, Inc.
- 9/05–8/07 **Research Staff.** Stanford University (SCS Group), Stanford, CA.
- 5/05–8/05 **Research Assistant.** University of California, Berkeley, Berkeley, CA.
- 9/02–5/05 **Research Assistant.** New York University (SCS Group), New York, NY.
- 5/03–8/03 **Research Associate.** HP Labs (Trusted Systems Lab), Princeton, NJ.
- 9/01–6/02 **Research Assistant.** MIT LCS (PDOS Group), Cambridge, MA.
- 5/01–8/01 **Research Intern.** InterTrust Technologies (STAR Lab), Santa Clara, CA.
- 6/00–8/00 **Research Intern.** Zero-Knowledge Systems Labs, Montreal, Quebec.
- 2/99–5/01 **Undergrad Researcher.** MIT LCS (SLS and CIS Groups), Cambridge, MA.
- 6/99–8/99 **Intern.** Sun Microsystems (HPC Group), Burlington, MA.
- 6/98–8/98 **Intern.** Cognex Corporation, Natick, MA.
- 6/96–2/98 **Undergrad Researcher.** MIT Francis Bitter Magnet Lab, Cambridge, MA.
- 6/95–8/95 **Summer Researcher.** Michigan State University (HPC Group), East Lansing, MI.

Consulting

- 8/07–present **Large content provider (\$1B+ revenues).** Helping design content distribution network and data-center architecture to support online distribution of partial and full-length videos.
- 11/06–09/07 **Quova, Inc.** Mountain View, CA. Helped design and build GeoPoint v6.0, an IP geolocation and analytics platform, which incorporated architectural and technical aspects of illuminati research.

Students

Current

Ph.D. Muneeb Ali, Wyatt Lloyd, Siddhartha Sen (co-advised w/ Bob Tarjan), David Shue Jeff Terrace

Previous

Masters Justin Pettit (Stanford), Robert Soule (NYU), Jeff Borden (NYU),

Undergrad Kevin Shanahan (NYU), Ed Kupershlak (NYU), Jeffrey Spehar (Stanford), Hal Laidlaw, Mark Spear

Teaching

- 9/07–1/08 **Instructor.** COS-518—Advanced Operating Systems, Princeton.

1/04–5/04 **Teaching Assistant, Lab Instructor.** V22.0480—Computer Networks, NYU.
 2/02–5/02 **Teaching Assistant.** 6.033—Computer System Engineering, MIT.
 2/01–5/01 **Teaching Assistant.** 6.033—Computer System Engineering, MIT.

Service

9/08–present **Freshman Advisor.** Princeton B.S.E. Majors, Princeton, NJ.
 2/08–05/11 **Academic Advisor.** Princeton Computer Science B.S.E Majors, Class of 2011, Princeton, NJ.
 2/08–present **Faculty Associate.** Princeton Center for Information Technology Policy, Princeton, NJ.
 9/07–present **Faculty Fellow.** Princeton Center for Jewish Life, Princeton, NJ.
 5/03–5/05 **Founder and Organizer.** NYU Systems Reading Group, New York, NY.
 2/04–5/05 **Faculty Representative.** NYU Courant Student Organization, New York, NY.
 9/01–5/02 **Co-organizer.** MIT Applied Security Reading Group, Cambridge, MA.
 9/97–5/02 **President, VP, Winter School Organizer, Member.** MIT Outing Club, Cambridge, MA

Professional activities

Program comm. USENIX Technical '09, IEEE Security and Privacy '09, NSDI '09, IPTPS '09, ROADS '09, CCS '08, CT-RSA '08, IPTPS '08, WORLDS '06, UPGRADE-CDN '06, IRIS Student P2P Workshop '03
 External reviews NSDI '08, NSDI '07, LATIN '06, HotNets '05, EUROCRYPT '05, Usenix Technical '05, ISC '04, CRYPTO '04, IPDPS '04, INFOCOM '04, CCS '03, SOSP '03, ISC '03, PODC '03, EUROCRYPT '03, WPES '02
 Journal reviews Transactions of Networking (ToN), Journal of Computer Security, Transactions on Computer Systems (ToCS), Journal of Parallel and Distributed Computing (JPDC), Handbook of Internet Security - P2P Security (Wiley & Sons), Computer Journal

Honors

Janet Fabri Prize, NYU Computer Science, 2008 (for best Ph.D. dissertation)
 Henning Biermann Award, NYU Computer Science, 2005 (for outstanding education and service)

 NDSEG (DoD) Graduate Fellow, 2002-2005
 NYU McCracken Fellow, 2002-2006

 Highest-ranked paper, SIGCOMM 2007 [1]. Fast-tracked to IEEE/ACM Trans. Networking.
 Best demo, WORLDS 2005 [4].
 Highest-ranked paper, EUROCRYPT 2004 [10].
 Award paper (invited to TISSEC), CCS 2002 [13].

 Awarded NSF Graduate Fellowship for 2002-2005
 Awarded Gordon Wu Fellowship (Princeton), 2001 ; Sterling Prize Fellowship (Yale), 2001
 Awarded Graduate Fellowships (U.C.Berkeley, Carnegie-Mellon, UCSD), 2001

 Coca-Cola Scholar, 1997-2001 ; Tylenol Scholar, 1997-1999 ; Big 33 Scholar, 1997-1998
 Tau Beta Pi, 2000 ; Eta Kappa Nu, 2000 ; Sigma Xi, 2000 ; Order of Omega, 1999
 Congressional Award, Silver (1996) and Bronze (1993) medals

Refereed conference publications

- [1] Martin Casado, **Michael J. Freedman**, Justin Pettit, Jianying Luo, Nick McKeown, and Scott Shenker. Ethane: Taking control of the enterprise. In *Proc. ACM SIGCOMM Conference*, pages 1–12, Kyoto, Japan, August 2007.

- [2] Martin Casado and **Michael J. Freedman**. Peering through the shroud: The effect of edge opacity on IP-based client identification. In *Proc. 4th Symposium on Networked Systems Design and Implementation (NSDI 07)*, pages 173–186, Cambridge, MA, April 2007.
- [3] Martin Casado, Tal Garfinkle, Aditya Akella, **Michael J. Freedman**, Dan Boneh, Nick McKeown, and Scott Shenker. SANE: A protection architecture for enterprise networks. In *Proc. 15th USENIX Security Symposium*, pages 137–151, Vancouver, BC, August 2006.
- [4] **Michael J. Freedman**, Karthik Lakshminarayanan, and David Mazières. OASIS: Anycast for any service. In *Proc. 3rd Symposium on Networked Systems Design and Implementation (NSDI 06)*, pages 129–142, San Jose, CA, May 2006.
- [5] Scott Garriss, Michael Kaminsky, **Michael J. Freedman**, Brad Karp, David Mazières, and Haifeng Yu. Re: Reliable email. In *Proc. 3rd Symposium on Networked Systems Design and Implementation (NSDI 06)*, pages 297–310, San Jose, CA, May 2006.
- [6] **Michael J. Freedman**, Mythili Vutukuru, Nick Feamster, and Hari Balakrishnan. Geographic locality of IP prefixes. In *Proc. 5th ACM SIGCOMM Conference on Internet Measurement (IMC 05)*, pages 153–158, Berkeley, CA, October 2005.
- [7] Siddhartha Annapureddy, **Michael J. Freedman**, and David Mazières. Shark: Scaling file servers via cooperative caching. In *Proc. 2nd Symposium on Networked Systems Design and Implementation (NSDI 05)*, pages 129–142, Boston, MA, May 2005.
- [8] **Michael J. Freedman**, Yuval Ishai, Benny Pinkas, and Omer Reingold. Keyword search and oblivious pseudorandom function. In *Proc. 2nd Theory of Cryptography Conference (TCC 05)*, pages 303–324, Cambridge, MA, February 2005.
- [9] Yevgeniy Dodis, **Michael J. Freedman**, Stanislaw Jarecki, and Shabsi Walfish. Versatile padding schemes for joint signature and encryption. In *Proc. 11th ACM Conference on Computer and Communications Security (CCS 04)*, pages 344–353, Washington, D.C., October 2004.
- [10] **Michael J. Freedman**, Kobbi Nissim, and Benny Pinkas. Efficient private matching and set intersection. In *Advances in Cryptology — EUROCRYPT 2004*, pages 1–19, Interlaken, Switzerland, May 2004.
- [11] Maxwell Krohn, **Michael J. Freedman**, and David Mazières. On-the-fly verification of rateless erasure codes for efficient content distribution. In *Proc. IEEE Symposium on Security and Privacy*, pages 226–240, Oakland, CA, May 2004.
- [12] **Michael J. Freedman**, Eric Freudenthal, and David Mazières. Democratizing content publication with Coral. In *Proc. 1st Symposium on Networked Systems Design and Implementation (NSDI 04)*, pages 239–252, San Francisco, CA, March 2004.
- [13] **Michael J. Freedman** and Robert Morris. Tarzan: A peer-to-peer anonymizing network layer. In *Proc. 9th ACM Conference on Computer and Communications Security (CCS 02)*, pages 193–206, Washington, D.C., November 2002.

Refereed workshop publications

- [14] Christina Aperjis, **Michael J. Freedman**, and Ramesh Johari. A comparison of bilateral and multilateral exchanges for peer-assisted content distribution. In *Proc. 2nd Workshop on Network Control and Optimization (NetCoop 08)*, Paris, France, September 2008.
- [15] **Michael J. Freedman**, Christina Aperjis, and Ramesh Johari. Prices are right: Managing resources and incentives in peer-assisted content distribution. In *Proc. 6th International Workshop on Peer-to-Peer Systems (IPTPS 08)*, Tampa Bay, FL, February 2007.
- [16] **Michael J. Freedman** and Antonio Nicolosi. Efficient private techniques for verifying social proximity. In *Proc. 7th International Workshop on Peer-to-Peer Systems (IPTPS 07)*, Bellevue, WA, February 2007.
- [17] **Michael J. Freedman**, Ion Stoica, David Mazières, and Scott Shenker. Group therapy for systems: Using link-attestations to manage failures. In *Proc. 5th International Workshop on Peer-to-Peer Systems (IPTPS 06)*, Santa Barbara, CA, February 2006.

- [18] **Michael J. Freedman**, Karthik Lakshminarayanan, Sean Rhea, and Ion Stoica. Non-transitive connectivity and DHTs. In *Proc. 2nd Workshop on Real, Large, Distributed Systems (WORLDS 05)*, pages 55–60, San Francisco, CA, December 2005.
- [19] Kevin Shanahan and **Michael J. Freedman**. Locality prediction for oblivious clients. In *Proc. 4th International Workshop on Peer-to-Peer Systems (IPTPS 05)*, pages 252–263, Ithaca, NY, February 2005.
- [20] Max Krohn and **Michael J. Freedman**. On-the-fly verification of erasure-encoded file transfers (extended abstract). In *Proc. 1st IRIS Student Workshop on Peer-to-Peer Systems*, Cambridge, MA, August 2003.
- [21] **Michael J. Freedman** and David Mazières. Sloppy hashing and self-organizing clusters. In *Proc. 2nd International Workshop on Peer-to-Peer Systems (IPTPS 03)*, pages 45–55, Berkeley, CA, February 2003.
- [22] Joan Feigenbaum, **Michael J. Freedman**, Tomas Sander, and Adam Shostack. Economic barriers with existing privacy technologies in e-commerce systems. In *Proc. Workshop on Economics and Information Security*, Berkeley, CA, May 2002.
- [23] **Michael J. Freedman**, Emil Sit, Josh Cates, and Robert Morris. Introducing Tarzan, a peer-to-peer anonymizing network layer. In *Proc. 1st International Workshop on Peer-to-Peer Systems (IPTPS 02)*, pages 121–129, Cambridge, MA, March 2002.
- [24] **Michael J. Freedman** and Radek Vingralek. Efficient peer-to-peer lookup based on a distributed trie. In *Proc. 1st International Workshop on Peer-to-Peer Systems (IPTPS 02)*, pages 66–75, Cambridge, MA, March 2002.
- [25] Joan Feigenbaum, **Michael J. Freedman**, Tomas Sander, and Adam Shostack. Privacy engineering in digital rights management systems. In *Proc. ACM Workshop in Security and Privacy in Digital Rights Management (DRM 01)*, pages 76–105, Philadelphia, PA, November 2001.
- [26] Roger Dingledine, **Michael J. Freedman**, David Hopwood, and David Molnar. A reputation system to increase MIX-net reliability. In *Proc. Information Hiding Workshop (LNCS 2137)*, pages 126–141, Pittsburgh, PA, March 2001.
- [27] Roger Dingledine, **Michael J. Freedman**, and David Molnar. The Free Haven Project: Distributed anonymous storage service. In *Proc. Workshop on Design Issues in Anonymity and Unobservability (LNCS 2009)*, pages 67–95, Berkeley, CA, July 2000.

Unrefereed publications, book chapters

- [28] Christina Aperjis, **Michael J. Freedman**, and Ramesh Johari. The role of prices in peer-assisted content distribution. Technical Report TR-814-08, Princeton University, Department of Computer Science, February 2008.
- [29] **Michael J. Freedman**. Automating server selection with OASIS. In *;login: The USENIX Magazine*, pages 46–52, October 2006.
- [30] Roger Dingledine, **Michael J. Freedman**, David Molnar, and David Parkes. Reputation. In *Digital Government Civic Scenario Workshop*, Cambridge, MA, April 2003.
- [31] Roger Dingledine, **Michael J. Freedman**, and David Molnar. *Peer-to-Peer: Harnessing the Power of Disruptive Technology*, chapter Accountability, pages 271–340. O’Reilly, 2001.
- [32] Roger Dingledine, **Michael J. Freedman**, and David Molnar. *Peer-to-Peer: Harnessing the Power of Disruptive Technology*, chapter Free Haven, pages 159–190. O’Reilly, 2001.

Posters and demos

- [33] **Michael J. Freedman** and Martin Casado. Measuring the Internet’s edge with Illuminati (poster and demo). In *7th USENIX Symposium on Operating Systems Design and Implementation (OSDI 06)*, *3rd Workshop on Real, Large, Distributed Systems (WORLDS 06)*, Seattle, WA, November 2006.

- [34] **Michael J. Freedman**, Karthik Lakshminarayanan, and David Mazières. Building a practical anycast service (demo). In *2nd Workshop on Real, Large, Distributed Systems (WORLDS 05)*, San Francisco, CA, December 2005.
- [35] Kevin Shanahan and **Michael J. Freedman**. Saccades: Locality prediction for oblivious clients (poster). In *2nd IRIS Student Workshop on Peer-to-Peer Systems*, Cambridge, MA, November 2004.
- [36] Siddhartha Annapureddy, **Michael J. Freedman**, and David Mazières. Shark: A scalable and secure cooperative-caching file system (poster). In *1st Symposium on Networked Systems Design and Implementation (NSDI 04)*, San Francisco, CA, March 2004.
- [37] **Michael J. Freedman**, Eric Freudenthal, and David Mazières. Democratizing content publication with Coral (demo). In *1st Symposium on Networked Systems Design and Implementation (NSDI 04)*, San Francisco, CA, March 2004.

Refereed conference presentations

- [38] Prices are Right: Managing resources and incentives in peer-assisted content distribution. 7th International Workshop on Peer-to-Peer Systems (IPTPS 08), February 26 2008.
- [39] OASIS: Anycast for any service. 3rd Symposium on Networked Systems Design and Implementation (NSDI 06), May 9 2006.
- [40] Group therapy for systems: Using link attestations to manage failures. 5th International Workshop on Peer-to-Peer Systems (IPTPS 06), February 28 2006.
- [41] OASIS: Anycast for any service. CodeCon, February 10 2006.
- [42] Non-transitive connectivity and DHTs. 2nd Workshop on Real, Large, Distributed Systems (WORLDS 05), December 14 2005.
- [43] Keyword search and oblivious pseudorandom functions. 2nd Theory of Cryptography Conference (TCC 05), February 11 2005.
- [44] Efficient private matching and set intersection. Advances in Cryptology — EUROCRYPT 2004, May 3 2004.
- [45] Democratizing content distribution with Coral. 1st Symposium on Networked Systems Design and Implementation (NSDI 04), March 30 2004.
- [46] Efficient set intersection for privacy-preserving data mining. DIMACS Privacy-Preserving Data Mining, March 15 2004.
- [47] Sloppy hashing and self-organizing clusters. 2nd International Workshop on Peer-to-Peer Systems (IPTPS 03), February 20 2003.
- [48] Tarzan: A peer-to-peer anonymizing network layer. 9th ACM Conference on Computer and Communications Security (CCS 02), November 20 2002.
- [49] The case for network-layer, peer-to-peer anonymization. 1st International Workshop on Peer-to-Peer Systems (IPTPS 02), March 7 2002.
- [50] Privacy engineering in digital rights management systems. ACM Workshop in Security and Privacy in Digital Rights Management (DRM 01), November 5 2001.

Invited conference presentations and panels

- [51] Make CDNs work for you: Measuring the Internet's edge with Illuminati (talk and panel). NY Systems/Networking Summit, November 17 2006.
- [52] Lessons from PlanetLab (panel). WORLDS, November 5 2006.
- [53] Accountability and resource management in peer-to-peer systems. O'Reilly Peer-to-Peer Conference, February 16 2001.

Other presentations

- [54] The role of prices in peer-assisted content distribution. Princeton/Supelec/Alcatel-Lucent Workshop on Wireless Communications and Networks, February 4 2008.
- [55] P2P-CDNs: Content distribution via access links. PRISM Center for Networks, Science, and Applications Workshop, December 6 2007.
- [56] Towards peer-assisted content distribution. NEC Labs, November 28 2007.
- [57] Democratizing content distribution. Brown, Carnegie Mellon, Columbia, Cornell, Duke, Intel Research-Berkeley, MIT, Microsoft Research-SVC, NYU, PARC, Princeton, Stanford, UCLA, UCSD, UT Austin, U. Washington, Yale, Spring 2007.
- [58] RE: Fighting spam with reliability and privacy. Princeton University, Systems Seminar, November 20 2006.
- [59] RE: Fighting spam with reliability and privacy. Cornell University, Security Seminar, November 15 2006.
- [60] RE: Reliable Email. Georgia Tech, Network Research Seminar, October 11 2006.
- [61] RE: Reliable Email. Microsoft Research, Silicon Valley Center, July 19 2006.
- [62] Illuminating the shadows of the Internet. Quova, Inc., June 28 2006.
- [63] OASIS: Anycast for any service. Xerox PARC, February 22 2006.
- [64] Privacy-preserving protocols through polynomial encodings. U.C. Berkeley, Theory Seminar, February 13 2006.
- [65] Privacy-preserving protocols through polynomial encodings. UCLA, Seminar Series, January 24 2006.
- [66] Shark: Scaling file servers via cooperative caching. ICSI Seminar, June 15 2005.
- [67] The design and deployment of Coral, an open peer-to-peer content distribution network. U.C. Berkeley, Systems Seminar, September 13 2004.
- [68] Democratizing content distribution with Coral. O'Reilly Foo Camp, September 11 2004.
- [69] Supporting clients 24/7: On service deployment and development. PlanetLab Workshop, April 1 2004.
- [70] Democratizing content distributing with Coral. Columbia University, Systems Seminar, March 25 2004.
- [71] Private matching. CRYPTO '03 (rump session), August 18 2003.
- [72] Anonymous communication and the design of Tarzan. Virginia Tech, NOVA, November 20 2002.
- [73] Building a peer-to-peer anonymizing network layer. Public Design Workshop, September 13 2002.
- [74] Digital rights management and cryptographic privacy. MIT Network and Computer Security class, November 1 2001.
- [75] Accountability and resource management in P2P systems. Lotus Research, P2P Speaker's Series, May 2 2001.

Support

Michael J. Freedman (PI) and Tom Funkhouser, linked with Phil Levis (PI), Pat Hanrahan, and Vladlen Koltun. A Network Architecture for Federated Virtual/Physical Worlds. NSF NeTS-ANET. \$509K to Princeton (0831374), \$950K to Stanford (0831163). 2008–2011.

References

Available upon request.

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