

STEPHEN D. STROWES, PH.D.

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I am a principal engineer at Fastly, where I lead projects on ingress traffic management and work on network measurement projects. I am a chair for the RIPE Measurements, Analysis, and Tools (MAT) working group.

Previously, I was a senior research scientist at the RIPE NCC. In 2019 while at the RIPE NCC, I took a sabbatical position at CAIDA, the Center for Applied Internet Data Analysis, at the University of California, San Diego. Prior to the NCC, I ran Yahoo's IPv6 program, coordinating multiple teams and projects to expand IPv6 deployment, while also running analyses to understand its impact.

I received my Ph.D. in Computing Science from the University of Glasgow in 2012, and my M.Sci. from the same institution in 2005.

WORK HISTORY

AUG/2021 Principal Engineer, Fastly, USA

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PRESENT

- Leading a project to rearchitect ingress traffic management on the CDN. Design and analysis of new anycast models and automation to remove human intervention from the control loop.
- Implemented and deployed a lightweight form of Verfploeter for Fastly's CDN, to measure anycast cones and assist detection of spoofed traffic for DDOS detection.
- Supervised one summer intern (2024), and two WPI undergraduate major qualifying project teams (2022, 2023).

APR/2019 Sabbatical position: Research Scientist, CAIDA, UCSD, San Diego, CA, USA

-TO-
SEP/2019

- Invested time in Google BigQuery to analyse large measurement datasets collected by the RIPE NCC and CAIDA.
- Led to an ongoing collaboration on the above [44], and another on IPv6 assignment patterns in domestic networks [1].
- Coordinated cross-organisational funding from RIPE NCC to UCSD sustain my work at CAIDA.

DEC/2016 Senior Research Scientist, RIPE NCC, Amsterdam, Netherlands

-TO-
JUL/2021

- Responsible for data analysis, prototyping of measurement strategies, and outreach.
- Product owner for publicly releasing RIPE Atlas data through Google's BigQuery. Released October 2020 [28].
- Collaborated on IPv6 measurement, IPv4 transfers and exhaustion, multipath traceroute behaviour, NTP leap second behaviour, and topological analysis. Output includes papers [1, 2, 3, 4, 5, 6, 7], articles [22, 28, 29, 30, 31, 32, 34, 35, 36], and talks [45, 46].
- Initiated the "NCC Sevens", a recurring lightning talk series to encourage cross-company collaboration. Organised an "IMC at the NCC" mini workshop in 2019.

OCT/2013 Principal Network Engineer and IPv6 Program Manager, Yahoo Inc., Sunnyvale, CA, USA

-TO-
OCT/2016

- Ran the IPv6 program from 2014, enabling IPv6 for millions of users across Yahoo properties. Promoted from Senior to Principal Network Engineer in 2015.
- Highly dynamic cross-organisation role. Included elements of teaching, sharing industry trends, engaging product teams, collaborating with research and engineering teams, data analysis, and supporting deployment work.
- Built IPv6 deployment statistics using access logs from Yahoo's CDN; public results are shared with the Internet Society's World IPv6 Launch project. Ran active measurement of Yahoo's IPv4 inventory to model and conserve space.
- Enabled IPv6 on: Yahoo Search, Finance, Answers, Sports, Local, membership services, global help pages and other static content, redirection servers, geo platforms, advertising platforms, country-specific subdomains for each, Flickr image serving and uploads, Tumblr image serving, Yahoo Messenger, and common mobile endpoints.
- Encouraged testing and monitoring of application code where possible. Crucially, Yahoo now has IPv6 support in internal cloud infrastructure, CI pipelines, mobile lab testing, and an IPv6-only wireless network.
- Output includes a short paper [8], a paper on reverse DNS to AAAA mapping [37], and multiple talks [47, 48, 49, 50, 51].

- MAR/2012 Senior Engineer and Team Lead, Boundary, San Francisco, CA, USA
-TO-
OCT/2013
- Team lead for Boundary’s network monitoring agent. Written in C, responsible for measuring host network traffic, and exporting flow statistics with IPFIX.
 - Managed transition from a legacy agent to a clean implementation, improving performance and stability. Directly engaged customers to debug technical problems.
 - This position resulted in articles describing TCP timestamps in ACM Queue [23] and CACM [24].
- JUL/2008 Research Engineer (Intern), Nokia Research Center, Espoo, Finland
-TO-
OCT/2008
- Built a measurement platform for evaluation of IETF NAT traversal protocols (ICE, TURN, STUN).
 - A paper on this work was published at the ACM Internet Measurement Conference in 2010 [12].
- SEPT/2005 Research Associate, University of Glasgow, UK
-TO-
MAY/2007
- Lead engineer on a collaborative research project with Imperial College London.
 - This project produced various publications [13, 14, 15, 16, 17, 18, 19, 38].

EDUCATION

- 2007 Ph.D. in Computing Science, **University of Glasgow**, U.K.
-TO-
2012
- Thesis: “Compact Routing for the Future Internet.” [20].
 - Advisor: Dr. Colin Perkins.
 - A mixture of graph theory, modelling of 14 years of BGP data, and distributed simulations written in Scala to evaluate new routing protocols and their behaviour on historical Internet topologies.
 - This work resulted in two related papers [9, 11], and one unrelated paper [10].
- 2000 Masters in Computing Science, **University of Glasgow**, U.K.
-TO-
2005
- Dissertation: “Peer-to-Peer Audio Conferencing.” [21].
 - In addition to the dissertation, a technical report is available [39].

SKILLS

- **Leadership & Coordination:** I’m a strong communicator, and I dedicate the time to writing coherent talks and, occasionally, lectures. I enjoy cross-organisational work that requires coordination across teams and properties. I co-chair the RIPE MAT Working Group.
- **Networks:** Strong on network protocols and measurement at layer 3 and above; experience with protocol design, and teasing apart concerns isolated in different layers. Knowledgeable of standard network tooling, and familiar with eBPF.
- **Data processing and languages:** Most recently, aspects of eBPF, C, Go, and Google BigQuery. Fluent in common UNIX tools.

SERVICE

- **Program committees:** IMC (2024 – 2025); the IRTF Applied Networking Research Workshop (2022, 2024); TMA (2021, 2024); PAM (2020, 2022 – 2024); the IRTF Applied Networking Research Prize (ANRP) (2019 – 2025); the RIPE NCC Academic Cooperation Initiative (2017 – 2021); Elsevier Computer Networks (2016); ACM CCR (2015); IEEE Global Internet Symposium (2013).
- **Speaking:** I give regular talks [41, 42, 43, 45, 46, 47, 48, 49, 50], and have delivered lectures on IPv6 [51] and measurements in industry [40].
- **Teaching:** Between 2005 and 2012 I co-supervised Honours and Masters students, and was a lab tutor for undergraduate programming and operating systems classes. In 2022 – 2024 I supervised two undergraduate capstone team projects with students at WPI, and one summer intern.
- **PhD Examiner:** Ioana Livadariu, Simula Research Laboratory, Oslo, October, 2019.

PUBLICATIONS

CONFERENCE AND WORKSHOP PAPERS

- [1] R. Padmanabhan, J. P. Rula, P. Richter, S. D. Strowes, and A. Dainotti, "DynamIPs: Analyzing address assignment practices in IPv4 and IPv6," in *Proceedings of the 16th International Conference on Emerging Networking Experiments And Technologies (CoNEXT)*, Dec. 2020.
- [2] S. D. Strowes, R. Wilhelm, and E. Aben, "Withdrawal Symptoms: Filtering of Announcements from a Route Collector System," in *ANRW '20: Applied Networking Research Workshop*, July 2020.
- [3] S. D. Strowes, R. Wilhelm, F. Obser, R. Stagni, A. Formoso, and E. Aben, "Debogonising 2a10::/12: Analysis of one week's visibility of a new /12," in *Network Traffic Measurement and Analysis Conference (TMA) 2020*, June 2020.
- [4] Q. Scheitle, O. Hohlfeld, J. Gamba, J. Jelten, T. Zimmermann, S. D. Strowes, and N. Vallina-Rodriguez, "A Long Way to the Top: Significance, Structure, and Stability of Internet Top Lists," in *Proceedings of the 2018 Internet Measurement Conference (IMC)*, Nov. 2018, **winner: Community Contribution Award**.
- [5] O. Gasser, Q. Scheitle, P. Pawel Foremski, Q. Lone, M. Korczynski, S. D. Strowes, L. Hendriks, and G. Georg Carle, "Clusters in the Expanse: Understanding and Unbiasing IPv6 Hitlists," in *Proceedings of the 2018 Internet Measurement Conference (IMC)*, Nov. 2018.
- [6] K. Kevin Vermeulen, S. D. Strowes, O. Fourmaux, and T. Friedman, "Multilevel MDA-Lite Paris Traceroute," in *Proceedings of the 2018 Internet Measurement Conference (IMC)*, Nov. 2018.
- [7] P. Gigis, V. Kotronis, E. Aben, S. D. Strowes, and X. Dimitropoulos, "Characterizing User-to-User Connectivity with RIPE Atlas," in *Proceedings of the Applied Networking Research Workshop*, ser. ANRW '17, 2017.
- [8] S. D. Strowes, "Diurnal and Weekly Cycles in IPv6 Traffic," in *Proceedings of the Applied Networking Research Workshop*, July 2016.
- [9] S. D. Strowes and C. Perkins, "Harnessing Internet Topological Stability in Thorup-Zwicky Compact Routing," in *Proceedings of IEEE INFOCOM 2012 Mini Conference*, Mar. 2012.
- [10] M. Ellis, S. D. Strowes, and C. Perkins, "An Experimental Study of Client-Side Spotify Peering Behaviour," in *Proceedings of the 36th IEEE Conference on Local Computer Networks*, Oct. 2011.
- [11] S. D. Strowes, G. Mooney, and C. Perkins, "Compact Routing on the Internet AS-Graph," in *Proceedings of the 14th IEEE Global Internet Symposium 2011*, Apr. 2011.
- [12] S. Hätönen, A. Nyrhinen, L. Eggert, S. Strowes, P. Sarolahti, and M. Kojo, "An Experimental Study of Home Gateway Characteristics," in *Proceedings of the 10th ACM SIGCOMM Internet Measurement Conference (IMC)*, Nov. 2010.
- [13] S. Heeps, J. Sventek, N. Dulay, A. E. Schaeffer-Filho, E. Lupu, M. Sloman, and S. D. Strowes, "Dynamic Ontology Mapping for Interacting Autonomous Systems," in *Proceedings of the 2nd International Workshop on Self-Organizing Systems*, Sept. 2007.
- [14] S. L. Keoh, N. Dulay, E. Lupu, K. Twidle, A. E. Schaeffer-Filho, M. Sloman, S. Heeps, S. D. Strowes, and J. Sventek, "Self-Managed Cell: A Middleware for Managing Body-Sensor Networks," in *Proceedings of the 4th International Conference on Mobile and Ubiquitous Systems (MobiQuitous)*, Aug. 2007.
- [15] A. E. Schaeffer-Filho, E. Lupu, N. Dulay, S. L. Keoh, K. Twidle, M. Sloman, S. Heeps, S. D. Strowes, and J. Sventek, "Towards Supporting Interactions between Self-Managed Cells," in *Proceedings of the 1st International Conference on Self-Adaptive and Self-Organizing Systems (SASO)*, July 2007.
- [16] S. L. Keoh, K. Twidle, N. Pryce, A. E. Schaeffer-Filho, E. Lupu, N. Dulay, M. Sloman, S. Heeps, S. D. Strowes, J. Sventek, and E. Katsiri, "Policy-based Management for Body-Sensor Networks," in *Proceedings of the 4th International Workshop on Wearable and Implantable Body Sensor Networks (BSN)*, May 2007.
- [17] S. Heeps, N. Dulay, A. E. Schaeffer-Filho, E. Lupu, M. Sloman, S. D. Strowes, and J. Sventek, "The Autonomic

Management of Ubiquitous Systems Meets The Semantic Web,” in *Proceedings of the 2nd International Workshop on Semantic Web Technology For Ubiquitous and Mobile Applications (SWUMA)*, Aug. 2006.

- [18] S. D. Strowes, N. Badr, N. Dulay, S. Heeps, E. Lupu, M. Sloman, and J. Sventek, “An Event Service Supporting Autonomic Management of Ubiquitous Systems for e-Health,” in *Proceedings of the 26th International Conference on Distributed Computing Systems Workshops (ICDCSW)*, July 2006.

JOURNAL PAPERS

- [19] E. Lupu, N. Dulay, M. Sloman, J. Sventek, S. Heeps, S. D. Strowes, K. Twidle, S. L. Keoh, and A. E. Schaeffer-Filho, “AMUSE: Autonomic Management of Ubiquitous e-Health Systems,” *Concurrency and Computation: Practice and Experience*, vol. 20, no. 3, pp. 277 – 295, May 2007.

THESES

- [20] “Compact Routing for the Future Internet,” Ph.D. Thesis, University of Glasgow, Feb. 2012.
- [21] “Peer-to-Peer Audio Conferencing,” Masters Thesis, University of Glasgow, May 2005.

MAGAZINE ARTICLES

- [22] S. D. Strowes, “No Shortcuts to Long Prefixes,” *GÉANT CONNECT*, no. 26, Sept. 2017.
- [23] S. D. Strowes, “Passively Measuring TCP Round-trip Times,” *ACM Queue*, vol. 11, no. 8, p. 50, 2013.
- [24] S. D. Strowes, “Passively Measuring TCP Round-Trip Times,” *Communications of the ACM*, vol. 56, no. 10, pp. 57–64, 2013.

EXTENDED ABSTRACTS

- [25] S. D. Strowes and C. Perkins, “Randomness for Reduced-State Inter-Domain Forwarding,” in *Trilogy Future Internet Summerschool*, Université catholique de Louvain, Louvain-la-Neuve, Aug. 2009.
- [26] S. D. Strowes and C. Perkins, “Deterministic, Reduced-Visibility Inter-Domain Forwarding,” in *CoNEXT 2009 Student Workshop*, Dec. 2009.

TECHNICAL REPORTS

- [27] E. Boswell, S. McQuistin, C. Perkins, and S. Strowes, “Measuring NAT64 Usage in the Wild,” Feb. 2024. [Online]. Available: <https://arxiv.org/abs/2402.14632>
- [28] S. D. Strowes, A. Formoso, and E. Dominguez, “Announcing RIPE Atlas Data on Google BigQuery,” *RIPE Labs*, Oct. 2020.
- [29] S. D. Strowes, “Reviewing RIPE Atlas Software Probes,” *RIPE Labs*, Oct. 2020.
- [30] S. D. Strowes, “Visibility of IPv4 and IPv6 Prefix Lengths in 2019,” *RIPE Labs*, Apr. 2019.
- [31] S. D. Strowes, “Comparing Virtual and Metal RIPE Atlas Anchors,” *RIPE Labs*, July 2018.
- [32] S. D. Strowes, “IPv6 Launchiversary: the View from RIPE Atlas and K-root,” *RIPE Labs*, June 2018.
- [33] S. D. Strowes, “Here to Stay: RIPE Atlas Daily Archives,” *RIPE Labs*, Feb. 2018.
- [34] S. D. Strowes, “Current Network Connectivity from Puerto Rico,” *RIPE Labs*, Oct. 2017.
- [35] S. D. Strowes and C. Petrie, “BGP Even-More Specifics in 2017,” *RIPE Labs*, July 2017.
- [36] S. D. Strowes and E. Aben, “Reviewing the 2016 Leap Second,” *RIPE Labs*, Jan. 2017.
- [37] S. D. Strowes, “Bootstrapping Active IPv6 Measurement with IPv4 and Public DNS,” *CoRR*, vol. abs/1710.08536.
- [38] S. D. Strowes, N. Dulay, S. Heeps, E. Lupu, A. E. Schaeffer-Filho, M. Sloman, and J. Sventek, “Wide-Area SMC

Interaction, Implementation and Emulation,” University of Glasgow Department of Computing Science, Tech. Rep. TR-2007-324, 2007.

- [39] S. D. Strowes and C. Perkins, “Orta – an Overlay for Real Time Applications,” University of Glasgow Department of Computing Science, Tech. Rep. TR-2005-323, 2005.

TALKS

- [40] “Measurement in industry,” invited lecture, University of Twente, Internet Measurements course., June 2024.
- [41] “IPv6 Address Assignment Practices in Domestic ISPs,” presented at the GAIA Workshop hosted by Simula, Norway, Oct. 2021.
- [42] “IPv6,” presented at the RIPE NCC Roundtable Meeting for Governments (Europe), Jan. 2021.
- [43] “Debogonising 2a10::/12: Analysis of one week’s visibility of a new /12,” presented at the *Network Traffic Measurement and Analysis Conference (TMA) 2020*. [youtube], June 2020.
- [44] “Atlas and Ark Data in BigQuery,” presented at MAT-WG, RIPE79. [ripe.net], Oct. 2019.
- [45] “Monitoring What You Don’t Own,” Monitorama EU. [vimeo], Sept. 2018.
- [46] “Time, NTP, & Leap Seconds,” invited to the Netnod Spring meeting 2017. [youtube], Apr. 2017.
- [47] “IPv6 at Yahoo: growth and disparity,” presented at the *IRTF & ISOC Workshop on Research and Applications of Internet Measurements (RAIM)*, Oct. 2015.
- [48] “IPv6 Transition at Yahoo,” invited to the School of Computing Science, University of Glasgow, Aug. 2015.
- [49] “IPv6 Transition at Yahoo,” invited to the International Computer Science Institute (ICSI), Berkeley, July 2015.
- [50] “Who do you think you’re talking to?” invited to E8 Security, Redwood City, June 2015.
- [51] “IPv6,” invited industry lecture, University of California, Berkeley, undergraduate class CS 168, Nov. 2014.