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I am a senior research scientist at the RIPE NCC, where I work on Internet measurement projects and outreach. In 2019, I took a sabbatical position at CAIDA, the Center for Applied Internet Data Analysis, at the University of California, San Diego.

Previously, I ran Yahoo's IPv6 program. This required complex project coordination to achieve IPv6 deployment, and network measurement to understand its effects. Formerly, I was a team lead at Boundary Inc., leading development of software agents to monitor network flows on hosts for upstream aggregation.

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 -to- present

Principal Engineer, Office of the CTO, Fastly, USA
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Apr/2019 -to- Sep/2019

Sabbatical position: Research Scientist, CAIDA, UCSD, San Diego, CA, USA
- 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 [40], 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 -to- Jul/2021

Senior Research Scientist, RIPE NCC, Amsterdam, Netherlands
- 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 [27].
- Research studies include IPv6 measurement, IPv4 transfers and exhaustion, multipath traceroute behaviour, NTP leap second behaviour, topological analysis.
- Output includes papers [1, 2, 3, 4, 5, 6, 7], articles [22, 27, 28, 29, 30, 31, 33, 34, 35], and talks [41, 42].
- 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 -to- Oct/2016

Principal Network Engineer and IPv6 Program Manager, Yahoo Inc., Sunnyvale, CA, USA
- Ran the IPv6 program from 2014, enabled 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 [36], and multiple talks [43, 44, 45, 46, 47].

Mar/2012 -to- Oct/2013	**Senior Engineer and Team Lead, Boundary, San Francisco, CA, USA** • 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. • Implemented new protocol-level metrics: TCP RTT monitoring, loss/retransmit counters, fragmentation detection, NTP time correction, and STUN reflection to determine public IP addresses per-agent. • Tens of thousands of agents deployed on customer hosts. Directly engaged customers to debug technical problems. • This position resulted in articles describing TCP timestamps in ACM Queue [23] and CACM [24].
Jul/2008 -to- Oct/2008	**Research Engineer (Intern), Nokia Research Center, Espoo, Finland** • 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 -to- May/2007	**Research Associate, University of Glasgow, UK** • Lead engineer on a collaborative research project with Imperial College London. • Built a publish/subscribe event bus and discovery services for battery-powered hardware in Java and C, interfaced via JNI. I integrated these with the policy management software developed by Imperial College London. • This project produced various publications [13, 14, 15, 16, 17, 18, 19, 37].

Education

2007 -to- 2012	**Ph.D. in Computing Science, University of Glasgow, U.K.** • 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 -to- 2005	**Masters in Computing Science, University of Glasgow, U.K.** • Dissertation: "Peer-to-Peer Audio Conferencing." [21]. • In addition to the dissertation, a technical report is available [38].

Skills

- **Leadership & Coordination**: I'm a strong communicator. I enjoy cross-organisational work that requires coordination across teams and properties.

- **Outreach**: Authored and co-authored various articles and peer-reviewed papers. I am experienced at giving talks, lecturing, and tutoring.

- **Networks**: strong on network protocols and measurement at layer 3 and above; experience with protocol design, and teasing apart concerns isolated in different layers. Very knowledgable of standard network tooling, including ping(6), traceroute(6), ip(6)tables, tcpdump, telnet, nc, zmap, and so forth.

- **Programming languages**: most familar with C, Python, Rust, and Perl. I'm familiar with standard APIs for building distributed systems, such as sockets libraries, and libraries such as libevent.

- **Data processing**: Google BigQuery, Apache Spark and Pig. Fluent in common UNIX tools. Some high-level statistical analysis using R.

Service

- **Peer review**: Served on program committees for the IEEE Global Internet Symposium 2013, TinyTOCs (vols. 3 and 4), ACM CCR, Elsevier Computer Networks, PAM 2020 & 2022, and TMA 2021. Reviewer for the RIPE NCC Academic Cooperation Initiative (RACI) between 2017 and 2021, and the IRTF Applied Networking Research Prize (ANRP) since 2019.

- **Speaking**: I give regular talks [39, 41, 42, 43, 44, 45, 46], and have lectured on IPv6 [47].
- **Chairing**: I was session chair for the Glasgow Networks and Distributed Systems research seminar series from 2007 to 2008. Between 2017 and 2021 I co-chaired the "NCC Sevens", an internal lightning talks series at the RIPE NCC.
- **Teaching**: Between 2005 and 2012 I co-supervised Honours and Masters students, and was a lab tutor for undergraduate programming and operating systems classes.
- **PhD Examiner**: Ioana Livadariu, Simula Research Laboratory, Oslo, October, 2019.

I attend key conferences in the field: typically, the ACM Internet Measurement Conference (IMC) and related research conferences, Internet Engineering Task Force (IETF) meetings, and RIPE meetings.

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-Zwick 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] S. D. Strowes, A. Formoso, and E. Dominguez, "Announcing RIPE Atlas Data on Google BigQuery," *RIPE Labs*, Oct. 2020.

[28] S. D. Strowes, "Reviewing RIPE Atlas Software Probes," *RIPE Labs*, Oct. 2020.

[29] S. D. Strowes, "Visibility of IPv4 and IPv6 Prefix Lengths in 2019," *RIPE Labs*, Apr. 2019.

[30] S. D. Strowes, "Comparing Virtual and Metal RIPE Atlas Anchors," *RIPE Labs*, July 2018.

[31] S. D. Strowes, "IPv6 Launchiversary: the View from RIPE Atlas and K-root," *RIPE Labs*, June 2018.

[32] S. D. Strowes, "Here to Stay: RIPE Atlas Daily Archives," *RIPE Labs*, Feb. 2018.

[33] S. D. Strowes, "Current Network Connectivity from Puerto Rico," *RIPE Labs*, Oct. 2017.

[34] S. D. Strowes and C. Petrie, "BGP Even-More Specifics in 2017," *RIPE Labs*, July 2017.

[35] S. D. Strowes and E. Aben, "Reviewing the 2016 Leap Second," *RIPE Labs*, Jan. 2017.

[36] S. D. Strowes, "Bootstrapping Active IPv6 Measurement with IPv4 and Public DNS," *CoRR*, vol. abs/1710.08536.

[37] 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.

[38] 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.

Recent Talks

[39] "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.

[40] "Atlas and Ark Data in BigQuery," presented at MAT-WG, RIPE79. [ripe.net], Oct. 2019.

[41] "Monitoring What You Don't Own," Monitorama EU. [vimeo], Sept. 2018.

[42] "Time, NTP, & Leap Seconds," invited to the Netnod Spring meeting 2017. [youtube], Apr. 2017.

[43] "IPv6 at Yahoo: growth and disparity," presented at the *IRTF & ISOC Workshop on Research and Applications of Internet Measurements (RAIM)*, Oct. 2015.

[44] "IPv6 Transition at Yahoo," invited to the School of Computing Science, University of Glasgow, Aug. 2015.

[45] "IPv6 Transition at Yahoo," invited to the International Computer Science Institute (ICSI), Berkeley, July 2015.

[46] "Who do you think you're talking to?" invited to E8 Security, Redwood City, June 2015.

[47] "IPv6," invited industry lecture, University of California, Berkeley, undergraduate class CS 168, Nov. 2014.