Eve M. Schooler

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EDUCATION:

Ph.D. Computer Science, California Institute of Technology, Pasadena, CA, USA
M.S. Computer Science, University of California, Los Angeles, CA, USA
B.S. Computer Science, Yale University, New Haven, CT, USA

WORK EXPERIENCE:

6/18-3/23   **Principal Engineer and Director of Emerging IoT Networks, Intel Next Generation & Standards,** Corporate Strategy Office**,** Santa Clara, CA. Focused on evolving the Internet toward a Sustainable edge-cloud infrastructure and Carbon-aware networking. Set technical and strategic direction for Internet of Things (IoT) standards and innovation, bridging upper layer IoT and lower layer networking. Grounded the work in Industrial IoT and Video analytics use cases, and assessed the impact on data stewardship, dynamic IoT Edge architecture, holistic quality of service (QoS) at scale, & interoperable carbon footprint analysis. Influenced broader Internet standards community through co-chairing the IETF Reliable & Available Wireless (RAW) working group to enable L3 network determinism and the Computing-in-the-Network (COIN) research group to explore the convergence of networking-compute-storage. Drove carbon-neutral computing standards, initiatives, strategies into two nascent business units, receiving division recognition from both (see Honors below).

1/15-6/18   **Principal Engineer and Director of Research in Emerging Architectures, Intel Internet of Things Group**, Santa Clara, CA. Led pathfinding on the network, storage and data architecture required to evolve the Cloud toward Edge Computing, while supporting trusted analytics. Led a technical team that worked on real-time visual data support for interactive remote control of devices. Drove R&D on reverse content distribution networks (rCDNs) for aggregation of upstream IoT data flows, Smart Objects for semantic interoperability, data life cycle management including privacy preservation, and bootstrapping IoT trustworthiness in intermittently disconnected (mobile) contexts. Drove multi-year pathfinding that led to investment and launch of $6.5M joint Intel-NSF ICN-WEN program (information-centric networking in wireless edge networks), served on BoA.

1/14-12/14   **Principal Engineer and Senior Architect, Intel Software & Services Group,** IoT Device Services, Santa Clara, CA. Evaluated suitability of data-centric networking and privacy-preserving encryption on energy-constrained mobile devices. Drove development of trusted data management solutions, reputation services, an observation- and measurement-based IoT trust calculus, leading to business unit adoption of an information-centric networking (ICN) publish-subscribe middleware solution.

10/10-12/13   **Principal Engineer and Project Lead, Intel Labs,** Energy & Sustainability Lab, Santa Clara, CA. Led the Trusted Personal Cloud project to architect and to build the trusted communication infrastructure for the Smart home and Smart city. Innovated at the Smart Grid edge by combining information-centric networking (ICN) with attribute-based encryption (ABE) to enable self-securing data with high availability. Led research team that delivered scalable data privacy and visualization solutions, quantified energy savings from presence detection in the Smart home, implemented middleware-agnostic privacy and security library, demonstrated inference-based personal cloud formation and showcased privacy-preservation in neighborhood-coordinated Electric Vehicle Charging use case. Targeted deployment pilot for DoE-funded Pecan Street smart neighborhood trials.

4/08-10/10   **Principal Engineer and Project Lead, Intel Research**
1/05-4/08   **Senior Research Scientist and Project Lead, Intel Research,** Distributed Detection & Inference project, Communication Technology Lab, Corporate Technology Group, Santa Clara, CA. Led research team focused on collaborative anomaly detection in large-scale Enterprise networks, combining machine learning with distributed networking techniques, supporting a fully distributed end-host architecture. Targeted zero-day attacks, where algorithms reduced false positives (1000x), detected two orders of magnitude stealthier malware, with ~95% reduction in the percentage of the network infected at time of detection. Drove the collection of a unique dataset derived from mobile end-host user network traffic traces that led to insights into malware and botnet behavior (Division Recognition Award). Matured system into proof of concept in year-long trial deployment with British Telecom, a major European service provider.

6/04-12/04 **Consultant, Pollere Inc.**, Menlo Park, CA. Performed extensive comparative analysis of network simulation tools to support the Transformation Communications Satellite (TSAT) system. Resultant white paper and recommendations contributed to Lockheed-Martin winning $40M DARPA funding due to superior risk analysis compared to competitors.

9/01-7/03 **Principal Technical Staff Member, AT&T Labs-Research**, Internetworking Research Department, Menlo Park, CA. Designed an aggregation architecture for efficient feedback in large N-to-1 communication systems. Augmented Real-time Transport Control Protocol (RTCP) to improve scaling techniques for operation in constrained topologies, such as source-specific multicast (SSM) and satellite networks. Later applied to wide-area network monitoring and sensor networks contexts. Widely deployed in IPTV distribution systems, the extensions were adopted as an IETF standard (RFC 5760).

9/94-7/01 **Research Assistant, Computer Science Department, Caltech**, Pasadena, CA, Infosphere Project. Focused on scalable distributed control, network performance analysis, resource discovery, multicast and Web-based telecollaboration, agreement protocols, media synchronization (9/94-12/00). Teaching Assistant for CS128 Algorithms, core class on sequential, distributed and parallel algorithms ('95-'96, '98). Supervised visiting undergraduates in the Caltech Summer Research Program in Parallel Computing for Undergraduate Women and Minorities (Summers '95, '98, '99).

5/97- 8/97 **Summer Intern, Microsoft Research**, Telepresence Research Group, Bay Area Research Center, San Francisco, CA. Developed a multicast forward error correction (FEC) protocol for scalable Web file distribution to solve the "Midnight Madness" problem (e.g., a million synchronous requests for the latest software release of the OS, browser, or other popular web-based content) and to support large-scale one-to-many telepresentations. Demonstrated in multicast version of the Powerpoint application.

5/96- 8/96 **Summer Intern, Hewlett-Packard Laboratories**, Broadband Information Systems Lab, Palo Alto, CA. Investigated Quality of Service (QoS) in the Internet and its impact on the design of a hybrid fiber coax (HFC) system to the home. Created an experimental testbed for protocol analysis.

3/88-12/95 **Member Technical Staff, USC/Information Sciences Institute**, Multimedia Conferencing Project, Networking Division, Marina del Rey, CA. Drove the design of a session control protocol for operation over wide area packet networks that supported multiway conference establishment, propagated quality of service info, negotiated heterogeneous site configurations, and resynchronized state as needed. Led to co-authorship of IETF Session Initiation Protocol (SIP), widely used standard for Internet telephony (RFCs 2543 and 3261). Pioneered and implemented evolving protocol in early workstation-based teleconferencing tool over experimental Internet (MBone), combining real-time voice and video with shared computer workspaces. Publicly released software to Internet community. Demonstrated results in (earliest known) Internet-wide distributed music performances, to showcase synchronization algorithms.

9/85-2/88 **Research Assistant**, **Computer Science Department, UCLA**, Advanced Teleprocessing Group, University of California, Los Angeles, CA. Developed the Benevolent Bandit Laboratory, a loosely-coupled testbed for distributed algorithms that took advantage of idle CPUs in a local area network of microcomputers. Thesis work created a distributed debugger/monitor to examine the impact of interprocess communication (1/87-2/88).

8/83-7/85 **Software Engineer, Apollo Computer**, Operating Systems Group, R&D, Chelmsford, MA. Ported and integrated non-kernel Unix functions into Apollo's Aegis distributed operating system. Responsible for portions of the process fault manager and global libraries. Co-composer, "A Long Ray's Journey into Light", SIGGRAPH'05 animation, synthesizing graphics & music using spare cycles across the network.

HONORS
IEEE Fellow (2021)
IEEE Internet Award, Co-recipient (2020)
Intel Division Quality Award, Network & Edge Sustainability Strategy (2023)
Intel Division Recognition Award, Sustainability Software & Open Source Initiatives, SW Adv Tech Group (2022)
Intel "High-5 Award", Intel Patent Group, for 5 or more accepted patents / year (2018, 2019)
Intel Division Recognition Award, Tech Symposium Chair, Womens PE & Fellows Forum (2018)
Intel "Top 3 Inventor" Recognition, Internet of Things (IoT) Group, 16 patents filed (2016)
Intel Division Collaboration Award, IoT Group (2016)
Intel Achievement Award (Intel's highest honor), ROAR program to retain Senior Technical Women (2015)
Intel Division Recognition Award, Intel Labs, Forbidden City Dataset (2007)
Microsoft Graduate Fellowship (1997-1999)

Caltech Earl C. Anthony Scholarship (1994-1995)
American Association of University Women (AAUW), Educational Foundation Fellowship (1994-1995)
Sigma Xi Scientific Research Honors Society (1993)
George Tosic Science Scholarship (1979-1981)

IMPACT SUMMARY: To date, authored over 60 papers, cited over 15K times, with h-index of 29, i-index of 42 (Google Scholar). Elected IEEE Fellow. Innovator on 35+ granted or pending patents. Served on over 40 Technical Program Committees over the last decade, and in more than a dozen cases also served as Industry panel chair, moderator, and/or panelist, to bridge academic & industrial research communities. Reviewer for many IEEE and ACM journals, conferences, workshops, in the areas of networking, distributed systems, Internet, Internet of Things (IoT), edge computing, multimedia, and increasingly in sustainability (delivered 100s of reviews, across 35 publications). Reviewer for US government funding agencies (NSF, DoE, ARPA, NIST) and those in Canada and Germany. Delivered 6 invited keynotes, served on 4 PhD committees (Aalto U., Sorbonne, U. Trento, CMU). Co-recipient of 2020 IEEE Internet award for work on control protocols for Internet telephony and multimedia teleconferencing.

SELECTED LEADERSHIP AND SERVICE:

NSF (National Science Foundation): Board of Advisors, Intel-NSF joint program on Information-Centric Networking in Wireless Edge Networks (ICN-WEN) (2017-2020); Industry panelist, Role of Information Sciences and Engineering in Sustainability (RISES) workshop (2011); Technical Advisor, Wireless Nano-Bio-Info Sensors and Systems Program (2008-2009), part of the EPSCoR program for diversity in funding across the US; Reviewer, Aware Networking (ANET) program area (2008); Member, Committee of Visitors, CISE/ANIR (2003).

Editorial Boards: Associate Editor, ACM Transactions on Internet Technology (ToIT) (2017-2020); Guest Editor, IEEE Network Magazine, Special issue on "In-Network Computing: Emerging Trends for the Edge-Cloud Continuum" (2021); Guest Editor, ACM ToIT, Special issue on "Evolution of IoT Networking", 20(3) (Oct 2020); Guest Editor, IEEE Pervasive Computing, Special issue on "Smart Energy Systems", 10(1) (2011).

Board of Advisors: Computing Research Association ([CRA](#)), Board of Directors (7/21-), Socially Responsible Computing Committee (7/22-), Computing, Climate and Sustainability working group (1/23-); EU H2020 SPATIAL project (Security & Privacy Accountable Technology Innovations, Algorithms and ML), Board of Advisors (2020-); Advisory Council, Computing & Information Sciences, College of Engineering, University of Delaware (10/22-).

IETF/IRTF (Internet Engineering Task Force/Internet Research Task Force) Standards Organization: Co-chair, Reliable & Available Wireless (RAW) working group (2/20-); Co-chair, Compute in the Network (COIN) research group (2/19-); Member, Internet of Things (IoT) Directorate (2017-); Co-founder and Co-chair, Multiparty, Multimedia Session Control (MMusic) working group (3/93-10/99); Co-founder and Co-chair, Conference Control (ConfCtrl) research group (1992); Member, Transport Area Directorate (1994-1997).

Intel: Intel RISE 2030 Technology Initiative (IRTI), Sustainability Committee (2021-2023) to fund customer proof-of-concepts demonstrating environmental footprint reductions and innovation; Patent Review committees (2017-2023) to decide which IP to submit externally; Corporate Research Council (CRC) committees to award funding to university research (2005-2023).

Diversity, Equity & Inclusion (DEI) Champion: Anita Borg Institute, Intel BRAID liaison, CS diversity longitudinal study (2020); Grace Hopper Conference ([GHC](#)): Career Panel, Girl-serving Organizations (GHC'20); Technical Panels (GHC'16, GHC'17, GHC'19); New Investigators (GHC'08); Co-Chair, Invited Tech Talks (GHC'07); Publications Chair (GHC'05), Web Designer and Host for resume database (GHC'02): Intel Women's Principal Engineer & Fellows Forum, Tech Symposium leadership (2018-2022); Mentor, UPWARD U.N.I.T.E.S., Intel-University Santa Clara partnership (2020-2022); Mentor, MentorNet ('02-'04); Workshop Instructor, "Music and Computer Networks: Friends or Foes?", Sally Ride Science Festival for Middle School Girls, Stanford, CA (2002); Many other DEI volunteer activities, too numerous to list.

SELECTED PUBLICATIONS: See [google scholar](#), [dblp](#) or [researchgate](#) for further details.

Schooler, E.M., Taylor, R., Zilberman, N., Soule, R., Nafus, D., Manohar, R., "A Perspective on Carbon-Aware Networking", IAB *Workshop on Environmental Impact of Internet Apps & Systems,* E-Impact'22 (Dec 2022).

Zilberman, N., Schooler, E.M., Cummings, U., Manohar, E., Nafus, D., Soule, R., Taylor, R., "Toward Carbon-Aware Networking", *Workshop on Sustainable Computer Systems Design and Implementation*, HotCarbon'22 (July 2022).

D. Nafus, E.M. Schooler, K.A. Burch, "Carbon-Responsive Computing: Changing the Nexus between Energy and Computing", *Energies,* Vol.14, No.21 (Oct 2021).

M. Mirshekari, S. Pan, J. Pagert, E.M. Schooler, P. Zhang, H.Y. Noh, "Occupant Localization Using Footstep-Induced Structural Vibration", *Mechanical Systems and Signal Processing*, Vol.112, pp.77-97 (2018).

Hassnaa Moustafa, Eve M. Schooler, Jessica McCarthy, "rCDN for Fog Computing: The Data Lifecycle of Video in Connected and Autonomous Vehicles", *Fog World Congress,* FWC'17 (Oct 2017).

Eve M. Schooler, David Zage, Jeff Sedayao, Hassnaa Moustafa, Andrew Brown, Moreno Ambrosin, "An Architectural Vision for a Data-Centric IoT: Rethinking Things, Trust and Clouds", *37th IEEE International Conference on Distributed Computing Systems,* ICDCS'17, pp.1717-1728 (June 2017).

Wang, X., Zhang, J., Schooler, E.M., Ion, M., "Performance Evaluation of Attribute-based Encryption: Toward Privacy in the IoT", *IEEE International Conference on Communications,* ICC'14, pp. 725-730 (Aug 2014).

J. Zhang, Q. Li, E.M. Schooler, "iHEMS: An Information-Centric Approach to Secure Home Energy Management", *IEEE International Conference on Smart Grid Communications*, SmartGridComm'12, pp.217-222 (Nov 2012).

Ott, J., Chesterfield, J., Schooler, E., "RTCP Extensions for Single-Source Multicast Sessions with Unicast Feedback", **RFC 5760,** IETF Standard, Audio Video Transport (AVT) Working Group (Feb 2010).

Giroire, F., Chandrashekar, J., Taft, N., Schooler, E.M., Papagiannaki, D., "Exploiting Temporal Persistence to Detect Covert Botnet Channels", *Recent Advances in Intrusion Detection,* RAID'09, pp.326-345 (Sept 2009).

Dash, D., Kveton, B., Agosta, J.M., Schooler, E., Chandrashekar, J., Bachrach, A., Newman, A., "When Gossip is Good: Distributed Probabilistic Inference for Detection of Slow Network Intrusions", *21st National Conference on Artificial Intelligence,* AAAI'06, pp. 1115-1122 (July 2006).

Gemmell, J., Schooler, E., and Kermode, R., "An Architecture for Multicast Telepresentations", *Journal of Computing and Information Technology*, Vol. 6, No. 3, pp. 255-272 (July 1998).

Gemmell, J., Schooler, E., Gray, J., "Fcast Multicast File Distribution", *IEEE Network,* 14(1), pp.58-68 (Jan 2000).

Handley, M., Schulzrinne, H., Schooler, E., Rosenberg, J., "Session Initiation Protocol (SIP)", **RFC 2543**, IETF Standard, Multiparty Multimedia Session Control (MMusic) Working Group (Mar 1999).

Schooler, E.M., "Conferencing & Collaborative Computing", *Multimedia Systems J.*, 4(5), pp.210-225 (Oct 1996).

Felderman, R.E., Schooler, E.M., Kleinrock, L., "The Benevolent Bandit Laboratory: A Testbed for Distributed Algorithms", *IEEE Journal on Selected Areas in Communications*, Vol. 7, No. 2, pp. 303-311 (Feb 1989).

SELECTED US PATENTS: See Justia for latest status.

10559202 - "Ubiquitous visual computing witness" (Feb 2020).
10356197 - "Data management in an information-centric network" (July 2019).
7953852 - "Method and System for Detecting and Reducing Botnet Activity" (May 2011).

SELECTED PRESENTATIONS:

"Carbon-responsive computing: How to get there from here?", *invited keynote,* 25th Conference on Innovation in Clouds, Internet and Networks, ICIN'22, Paris, France (Mar 2022).

"Carbon Awareness: A Lightning Talk on the Greening of ICT Algorithms", *invited talk,* BSc Labs, Zurich University of Applied Sciences, Switzerland (Dec 2022).

"Carbon-aware networking: An environmental impact use case for Time Variant Routing (TVR)", IETF (Nov 2022).

"Connecting the Dots: From Sustainability Standards to Edge Computing", Intel Sustainability Summit (Dec 2021).

"Why Those in the Arts can be Great Role Models for Those in STEM: How a Computer Scientist Found Inspiration from Her Opera Singer Mother", *invited keynote*, Girls in STEM, Menlo School, Menlo Park, CA (Mar 2014).

Empowering CSE-driven Sustainability", Industry panel, NSF Role of Information Sciences and Engineering in Sustainability (RISES) workshop, Washington, DC (Feb 2011).

SELECTED PANELS:

"Next Generation Resilient and Sustainable Networks", Distinguished Experts Panel, IEEE NOMS (May 2023).

"Green Networks", Environmental Variables Podcast, Episode 10, Green Software Foundation (Nov 2022).

"Sustainable Energy: A Boost from NextGen Wireless & Edge Computing?", Senza Fili (June 2021).

"Yale Computer Science: Broadening Perspectives", Panel on Diversity in CS, Yale University (April 2021).

"The Evolving Edge: Challenges, Gaps, Opportunities?", ACM/IEEE Symposium on Edge Computing (Nov 2020).