Shih-Hao Tseng

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Professional Summary

- Self-motivated and experienced network research professional specialized in software-defined networking (SDN).
- Published papers on time-aware network scheduling, network stability, and inter-datacenter network coding in prestigious networking conferences/journal.
- Sophisticated system engineer with open-sourced projects on GPU parallel acceleration, multithreaded distributed system, controller synthesis framework in CUDA, C++, and Python.
- Full-stack system working knowledge from low-level hardware architecture to high-level software optimization.

Education

Cornell University (CU), Ithaca, NY, U.S.A. Aug. 2013 - Dec. 2018
PhD in Electrical and Computer Engineering (Advisor: Dr. A. Tang)
- Dissertation: Orchestrating Inter-Datacenter Bulk Transfers with CodedBulk

National Taiwan University (NTU), Taipei, Taiwan Sept. 2008 - June 2012
Bachelor of Science in Engineering (minor in Economics)
- GPA: 92.20/100.00; ranking 2nd in a class of 226

Skills

Programming Languages: Proficient in C, C++, Python and Verilog; working knowledge of Basic, HTML, Java, JavaScript, MySQL, and PHP.
Programming Skills: Working knowledge of Linux based C++ socket, kernel scheduler, GPU parallelization, and multithreaded programming.
Simulation Tools: Proficient in control system (MATLAB) and network simulations (NS-3).
Languages: Fluent in English; native in Mandarin Chinese and Taiwanese Hokkien.

Experience

Meta Platforms, Inc., Menlo Park, CA, U.S.A. Dec. 2021 - Present
Research Scientist

California Institute of Technology, Pasadena, CA, U.S.A. Oct. 2018 - Oct. 2021
Postdoctoral Scholar Research Associate
- Led the project of freshness-driven network control.
- Mentored graduate students on parallel model predictive control and formal test-case generation.
- Derived realization-stability lemma that unifies existing controller synthesis methods.
- Investigated the controller deployment architecture for cyber-physical systems.
- Developed efficient computation technique via dynamic programming and flexible Python framework for system level synthesis.

Cornell University, Ithaca, NY, U.S.A. Aug. 2014 - Aug. 2018
Graduate Research Assistant/Teaching Assistant
- Built CodedBulk to boost the throughput of inter-datacenter bulk transfers using network coding.
- Studied time-aware network management under software-defined networking.
- Helped teach Introduction to Probability and Inference for Random Signals and Systems.

The Chinese University of Hong Kong, Shatin, NT, Hong Kong June 2017 - Aug. 2017
Research Assistant
- Developed efficient scheduling algorithms for hybrid packet/circuit networks.

AT&T, Middletown, NJ, U.S.A. June 2016 - Aug. 2016
Student Intern - Technical II
- Developed routing algorithms to stabilize carrier-grade hybrid software-defined networks.

Awards

Winner of the AT&T SDN Network Design Challenge 2016
- Awarded to the top team providing the most efficient and cost effective routing solution to carrier-grade networks.

Outstanding Project Award 2011
- Awarded to the top 10 teams of Cross-Strait Finals of 2011 Innovate Asia Competition (FPGA design).

Selected Projects and Publications

In-Network Processing

- **S.-H. Tseng**, S. Han, and A. Wierman, "In-Network Freshness Control: Trading Throughput for Freshness," submitted to*IEEE/ACM Trans. Netw.*
- **S.-H. Tseng**, S. Agarwal, R. Agarwal, H. Ballani, and A. Tang, "CodedBulk: Inter-Datacenter Bulk Transfers using Network Coding," in *Proc. USENIX NSDI*, 2021.

With the development of virtualization and programmable technologies, networks have become more capable of performing sophisticated functions than simple forwarding. By processing information within the network, I show that we can improve the freshness and throughput of the flows. In the two projects above, I introduced new scheduling functions to the Linux kernel to perform in-network freshness control and built a distributed system that boosts bulk transfer throughput via network coding at intermediate nodes using multithreaded codecs.

Open-Sourced Controller Synthesis Tools

- **S.-H. Tseng** and J. S. Li, "SLSpy: Python-Based System-Level Controller Synthesis Framework," in submission, [Online] arXiv:2004.12565.
- C. Amo Alonso and **S.-H. Tseng**, "Effective GPU Parallelization of Distributed and Localized Model Predictive Control," submitted to Proc. IEEE CDC.
- **S.-H. Tseng**, "A Generic Solver for Unconstrained Control Problems with Integral Functional Objectives," in *Proc. IEEE ACC*, 2020.

Synthesizing the optimal controller is a non-trivial task both implementation-wise and computationally. To facilitate controller synthesis, I developed and open-sourced a software framework in Python, the SLSpy, that is shipped with state-of-the-art synthesis algorithms. As such, SLSpy allows easier benchmarking and adoption of the latest theoretical advancements in controller synthesis.
On the other hand, it is important to obtain control inputs swiftly to steer the system in a timely fashion. In the two other projects, my colleague and I leverage GPU to parallelize the computation of control inputs. In the projects, we also show that algorithms should be revised according to the computation structures to fully enjoy GPU parallelization benefits.

Network Stability

- **S.-H. Tseng**, "Perseverance-Aware Traffic Engineering in Rate-Adaptive Networks with Reconfiguration Delay," in *Proc. IEEE ICNP*, 2019.
- **S.-H. Tseng**, A. Tang, G. Choudury, and S. Tse, "Routing Stability in Hybrid Software-Defined Networks," in *IEEE/ACM Trans. Netw.*, 2019.

New technologies bring new features into the network. Meanwhile, it is critical for the network operator to ensure stability when adopting them. In the projects above, I investigated the hybrid software-defined networks (SDNs) and rate-adaptive optical networks where we introduce SDN to a legacy router network and operate rate-adaptive links in an optical wide-area network. Both new functions impose new stability challenges, and I design algorithms to guarantee stability and smoothen the transition.

Time-Aware Network Management

- **S.-H. Tseng**, B. Bai, and J. C. S. Lui, "Hybrid Circuit/Packet Network Scheduling with Multiple Composite Paths," in *Proc. IEEE INFOCOM*, 2018.
- A. Gushchin, **S.-H. Tseng**, and A. Tang, "Optimization-Based Network Flow Deadline Scheduling," in *Proc. IEEE ICNP*, 2016.
- **S.-H. Tseng**, C. L. Lim, N. Wu, and A. Tang, "Time-Aware Congestion-Free Routing Reconfiguration," in *Proc. IFIP Networking*, 2016.

With the rise of software-defined networking, networks can be more active in achieving flow-level quality of service. In particular, one can include time as a part of the operational constraints. In these projects, I adopt an optimization-based approach to incorporate timing information and design algorithms to achieve swift routing reconfiguration, short flow completion time, and fast forwarding schedule.