Swetank Kumar Saha

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Education

2013-2019 **Doctor of Philosophy (Ph.D.)**, Computer Science & Engineering | GPA 3.81/4.0
University at Buffalo (UB), SUNY, NY, US
Advisor: Dr. Dimitrios Koutsonikolas
Thesis (CSE **Best PhD Dissertation** Award):
Improving Client Performance and Energy-Efficiency in Current and Next-Generation Wireless LANs

2009-2013 **Bachelor of Technology**, Computer Science & Engineering (*with Honors*) | GPA 9.01/10.0
IIIT-Delhi, New Delhi, IN
Thesis: *Smartphone-based Anomalous Human Activity Detection and Prediction*

Research Interests & Directions

Wireless Networking

- Next-generation WiFi: Millimeter-wave (60 GHz)/802.11ad based Wireless LANs (WLANs)
  - Characterize 802.11ad PHY/MAC performance using both commercial and SDR testbeds
  - Use Multipath-TCP to combine Leagcy/802.11ac and Gigabit/802.11ad WiFis
  - Related publications: [C11], [C9], [C8], [C5], [C3], [J2], [J1]
- LTE-Unlicensed and WiFi Co-existence in 5 GHz
  - Quantify coexistence issues with LTE-Unlicensed (LTE-U/LAA) and 802.11ac-based Enterprise WLAN
  - Build standard-compliant WiFi-based system to combat LTE inteferece and ensure fair channel usage
  - Related publications: [C10], [P1]

Mobile Systems

- WiFi Power-Performance Tradeoffs in Smartphones
  - Identify the power-performance relationship in the context of 802.11n/ac/ad in mobile devices
  - Build accurate power models that account for both CPU and network component of data transfers
  - Related publications: [C6], [C4], [C2]
- Multipath-TCP in Smartphones
  - Study MPTCP in the context of using LTE+WiFi interfaces together on Smartphones (Android)
  - Characterize the impact of MPTCP on performance, power and CPU utilization for real applications
  - Related publications: [C7]

Technical Skills

Languages	Proficient: C, Python | Intermediate: Java | Familiar: C++
Linux Kernel	Wireless device drivers (`ath9k`, `ath10k`, `wil6210`, `iwlwifi`), TCP and MPTCP Networking subsystem
Simulators	ns2, ns3
Networking	TCP/IP, HTTP, WiFi, LTE, packet sniffer, protocol analyzer, OpenWRT
Smartphone	Android applications (SDK/NDK), Platform (AOSP), Kernel
SDRs	USRP, GNURadio, LabView
Web	Django, PHP, HTML, JavaScript, Jekyll

Work Experience

November 2019–Present
Python Drivers Firmware

Wireless Connectivity Performance Engineer, ***Apple Inc.***, Cupertino, CA, US.
Analyze the connectivity sub-system and identify solutions for improving end-to-end performance

- Devising performance evaluation methodologies on SW/HW prototypes to guide final design
- Responsible for defining the Key Performance Indicators (KPIs)
- Developing tools and techniques for measuring KPIs under different stressors
- In-depth data analysis to identify areas and solutions for connectivity performance enhancement
- Leading cross-functional efforts to ensure targets are being met until commercialization

Summer 2017
C Python OpenWRT

Research Associate (Intern), ***Hewlett Packard Enterprise (HPE) Labs***, Palo Alto, CA, US.
LTE-Unlicensed/WiFi Co-existence in 5 GHz for WiFi Access Points (APs)

- Designed *DeMiLTE*, the first WiFi (802.11ac)-based system for enterprise APs to detect, quantify, and react to LTE-U/LAA interference in real time, without requiring additional AP hardware
- Implemented the system inside the AP firmware making it light-weight and fully 802.11ac-standard compliant
- Improved AP downlink throughput by up to **110%**, without requiring any client modifications
- Published 1 top-tier conference paper [C3] and filed 1 patent [P1]

Summer 2016
C Python Drivers LEDE

Research Intern, ***IMDEA Networks Institute***, Madrid, Spain.
Millimeter-wave Networking

- Analyzed performance bottlenecks in next-generation of WiFi: 60 GHz (802.11ad)-based indoor WLANs
- Modified the Linux 802.11ad wireless device driver (`wil6210`) to export PHY/MAC information to userspace and allow control over PHY parameters, like beam direction
- Undertook an extensive measurement study with the instrumented APs and laptops to study 802.11ad links
- Highlighted novel challenges and practical aspects like coverage and AP deployment, previously unreported
- Published the results of the study in a top-tier conference [C9]

Summer 2013
Python Java Android Django

Software Developer, ***Google Summer of Code 2013***, Google.
Funf: Open sensing and data collection framework for Android (acquired by Google)

- Improved Funf-in-a-box (FIAB), a service for users to build custom data collection app with zero programming
- Ported the entire FIAB service from an always-on architecture running on a single EC2 server to on-demand VM instantiation on Google cloud (in <1 month), significantly reducing costs & increasing performance.
- Added support for configuring and deploying custom surveys and capturing additional user input

Summer 2012
Android Ubuntu Juju

Research Intern, ***Airbus India, EADS Innovation Works***, Bangalore, India.
Image based localization techniques

- Built an indoor localization service that uses image features to estimate location of an Android device
- Implemented it as a distributed system that offloads image processing to a remote server
- Packaged and deployed the system as a Juju charm for easy production orchestration

Selected Research Projects

C Python TCP MPTCP tc Kernel

Multipath TCP (MPTCP) for Dual-band WiGig (802.11ad)+WiFi (802.11ac) networks.

- Leveraged MPTCP to engage two network interfaces *simultaneously* achieving throughputs of up to ∼2.2 Gbps
- Instrumented MPTCP (Linux 4.x) using `kernel probes` to monitor over 32 parameters in real-time
- Developed kernel tools to monitor TCP/MPTCP send and recv queues tracking ingress and egress for each byte
- Designed *AMuSe*, a novel MPTCP scheduler to enable dynamic packet assignment based on network conditions
- Implemented it as a Linux kernel module improving overall throughput by up to **2.5x** under diverse scenarios
- Published 1 top-tier conference paper [C11]

Python C Drivers Android

Power-Performance Tradeoffs for Mobile Devices in Next Generation WiFi Networks.

- Developed tools that allow for large-scale automated performance and power measurement of mobile devices
- Enabled data collection & sync across heterogeneous systems: Linux (Wireless AP), Android, and Power monitor
- Modified the Linux wireless drivers (`ath9k`, `ath10k`) to expose userspace control of several PHY/MAC parameters.
- Analyzed the power-performance tradeoff of both the NIC and CPU for uplink/downlink data transfer
- Improved the accuracy of the state-of-the-art power model by up to **40%**
- Published 1 top-tier conference paper [C2]

Labview
Python

X60: A highly Re-configurable Multi-Gigabit Testbed for 60 GHz research.

- Set up the first ever software-defined *X60*, a 60 GHz testbed that offers configurability at PHY/MAC/Network layers, supports phased antenna arrays and 2 GHz baseband bandwidth
- Added several components (e.g., AGC) to existing NI codebase to enable realistic measurements
- Developed set of tools to automate the measurement cycle reducing time from hours to several minutes
- Exposed user controls to enable measurements by external researchers (used by Rice University & UT Austin)
- Related publications: [J2], [W4]

Publications

Conference

C11 **MuSher: An Agile Multipath-TCP Scheduler for Dual-Band 802.11ad/ac Wireless LANs**
Swetank Kumar Saha, Shivang Aggarwal, Rohan Pathak, Dimitrios Koutsonikolas, Joerg Widmer
ACM International Conference on Mobile Computing and Networking (**MobiCom**) *2019*

C10 **DeMiLTE: Detecting and Mitigating LTE Interference for Enterprise Wi-Fi in 5 GHz**
Swetank Kumar Saha, Christina Vlachou, Dimitrios Koutsonikolas, Kyu-Han Kim
ACM International Symposium on Mobile Ad Hoc Networking and Computing (**MobiHoc**) *2019*

C9 **Fast and Infuriating: Performance and Pitfalls of 60 GHz WLANs Based on Consumer-Grade Hardware**
Swetank Kumar Saha, Hany Assasa, Adrian Loch, Naveen Muralidhar Prakash, Roshan Shyamsunder Ananthara-makrishna, Shivang Aggarwal, Daniel Steinmetzer, Dimitrios Koutsonikolas, Joerg Widmer, and Matthias Hollick
IEEE International Conference on Sensing, Communication and Networking (**SECON**) *2018*

C8 **Medium Access and Transport Protocol Aspects in Practical 802.11ad Networks**
Hany Assasa, Swetank Kumar Saha, Adrian Loch, Dimitrios Koutsonikolas, Joerg Widmer
IEEE International Symposium on A World of Wireless, Mobile and Multimedia Networks (**WoWMoM**) *2018*

C7 **Multipath TCP in Smartphones: Impact on Performance, Energy, and CPU Utilization**
Swetank Kumar Saha, Abhishek Kannan, Geunhyung Lee, Nishant Ravichandran, Parag Kamalakar Medhe, Naved Merchant, Dimitrios Koutsonikolas
ACM International Symposium on Mobility Management and Wireless Access (**MobiWac**) *2017*

C6 **A Detailed Look into Power Consumption of Commodity 60 GHz Devices**
Swetank Kumar Saha, Tariq Siddiqui, Dimitrios Koutsonikolas, Adrian Loch, Joerg Widmer, Ramalingam Sridhar
IEEE International Symposium on A World of Wireless, Mobile and Multimedia Networks (**WoWMoM**) *2017*

C5 **A Feasibility Study of 60 GHz Indoor WLANs**
Swetank Kumar Saha, Tariq Siddiqui, Viral Vijay Vira, Anuj Garg, Dimitrios Koutsonikolas
IEEE International Conference on Computer Communication and Networks (**ICCCN**) *2016*

C4 **Revisiting 802.11 Power Consumption Modeling in Smartphones**
Swetank Kumar Saha, Pratham Malik, Selvaganesh Dharmeswaran, Dimitrios Koutsonikolas
IEEE International Symposium on A World of Wireless, Mobile and Multimedia Networks (**WoWMoM**) *2016*

C3 **Multi-Gigabit Indoor WLANs: Looking Beyond 2.4/5 GHz**
Swetank Kumar Saha, Viral Vijay Vira, Anuj Garg, Dimitrios Koutsonikolas
IEEE International Conference on Communications (**ICC**) *2016*

C2 **Power-Throughput Tradeoffs of 802.11n/ac in Smartphones**
Swetank Kumar Saha, Pratik Deshpande, Pranav P Inamdar, Ramanujan K Sheshadri, Dimitrios Koutsonikolas
IEEE Conference on Computer Communications (**INFOCOM**) *2015*

C1 **Take Control of Your SMSes : Designing an Usable Spam SMS Filtering System**
Kuldeep Yadav, Swetank K Saha, Ponnurangam Kumaraguru, Rohit Kumra
IEEE International Conference on Mobile Data Management (**MDM**) 2012

Journal

J2 **X60: A Programmable Testbed for Wideband 60 GHz WLANs with Phased Arrays**
Swetank Kumar Saha, Swetank Kumar Saha, Yasaman Ghasempour, Muhammad Kumail Haider, Tariq Siddiqui, Paulo De Melo, Neerad Somanchi, Luke Zakrajsek, Arjun Singh, Roshan Shyamsunder, Owen Torres, Daniel Uvaydov, Josep Miquel Jornet, Edward Knightly, Dimitrios Koutsonikolas, Dimitris Pados, Zhi Sun, Ngwe Thawdar
Elsevier Computer Communications (**COMCOM**) *2018*

J1 **60 GHz Indoor WLANs: Insights into Performance and Power Consumption**
Swetank Kumar Saha, Darshan Godabanahal Malleshappa, Avinash Palamanda, Viral Vijay Vira, Anuj Garg, Dimitrios Koutsonikolas
Springer Wireless Networks (**WINE**) *2017*

Workshop

W4 **X60: A Programmable Testbed for Wideband 60 GHz WLANs with Phased Arrays**
Swetank Kumar Saha, Yasaman Ghasempour, Muhammad Kumail Haider, Tariq Siddiqui, Paulo De Melo, Neerad Somanchi, Luke Zakrajsek, Arjun Singh, Owen Torres, Daniel Uvaydov, Josep Miquel Jornet, Edward Knightly, Dimitrios Koutsonikolas, Dimitris Pados, Zhi Sun
ACM Workshop on Wireless Network Testbeds, Experimental evaluation & CHaracterization (**WiNTECH**) *2017*

W3 **Improving Connectivity, Coverage, and Capacity in 60 GHz Indoor WLANs Using Relays**
Swetank Kumar Saha, Li Sun, Dimitrios Koutsonikolas
ACM Workshop on Wireless of the Students, by the Students, & for the Students (**S**^{3}) *2015*

W2 **A First Look at TCP Performance in Indoor IEEE 802.11ad WLANs**
Swetank Kumar Saha, Anuj Garg, Dimitrios Koutsonikolas
IEEE Conference on Computer Communications Workshops (**INFOCOM WKSHPS**) *2015*

W1 **On the Feasibility of Indoor IEEE 802.11ad WLANs**
Swetank Kumar Saha, Viral Vijay Vira, Anuj Garg, Andrew Tennenbaum, Dimitrios Koutsonikolas
IEEE Conference on Computer Communications Workshops (**INFOCOM WKSHPS**) *2015*

Patent

P1 **LTE Interference Detection and Mitigation for Wi-Fi Links**
Swetank Kumar Saha, US Patent
Record ID: 90547646 (**Application #: 15/962,722**)

Poster

Po5 **Poster: Can Mobile Hardware Keep Up with Today's Gigabit Wireless Technologies?**
Shivang Aggarwal, Swetank Kumar Saha, Pranab Dash, Jiayi Meng, Arvind Thirumurugan, Dimitrios Koutsonikolas, Y. Charlie Hu
ACM International Conference on Mobile Computing and Networking (**MobiCom**) *2019*

Po4 **Poster: AMuSe: An Agile Multipath TCP Scheduler for Dual-Band 802.11ad/ac Wireless LANs**
Swetank Kumar Saha, Shivang Aggarwal, Dimitrios Koutsonikolas, Joerg Widmer
ACM International Conference on Mobile Computing and Networking (**MobiCom**) *2018*

Po3 **Poster: Can MPTCP Improve Performance for Dual-Band 60 GHz/5 GHz Clients?**
Swetank Kumar Saha, Roshan Shyamsunder, Naveen Muralidhar Prakash, Hany Assasa, Adrian Loch, Dimitrios Koutsonikolas, Joerg Widmer
ACM International Conference on Mobile Computing and Networking (**MobiCom**) *2017*

Po2 **Poster: X60: A Programmable Testbed for Wideband 60 GHz WLANs with Phased Arrays**
Swetank Kumar Saha, Yasaman Ghasempour, Muhammad Kumail Haider, Tariq Siddiqui, Paulo De Melo, Neerad Somanchi, Luke Zakrajsek, Arjun Singh, Owen Torres, Daniel Uvaydov, Josep Miquel Jornet, Edward Knightly, Dimitrios Koutsonikolas, Dimitris Pados, Zhi Sun
ACM International Conference on Mobile Computing and Networking (**MobiCom**) *2017*

Po1 **LTE/WiFi Coexistence in 5 GHz: Bringing LTE-Awareness to Enterprise WiFi**
Swetank Kumar Saha, Christina Vlachou, Kyu-Han Kim
Hewlett Packard Enterprise (**Technical Conference**) *2017*

Technical Report

T1 **60 GHz Multi-Gigabit Indoor WLANs: Dream or Reality?**
Swetank Kumar Saha, Viral Vijay Vira, Anuj Garg, Dimitrios Koutsonikolas
arXiv:1509.04274 (**arXiv**) *2015*

Awards

- **CSE Best PhD Dissertation Award** UB Computer Science & Engineering department 2019
- **Faculty Choice Graduate Award** UB Computer Science & Engineering Department 2019
- **2**nd **Runner Up** ACM Student Research Competition (SRC) 2017 [Po3]
- **Best Paper Runner Up** ACM WiNTECH 2017 [W4]
- **1**st prize at the UB School of Engineering & Applied Sciences (SEAS) Lightning Talk Competition
- **Winner** of the *Tally Innovation Award* at the All-India Jedi Project Challenge 2012, IISc., Bangalore.
- Travel Grants: IEEE SECON, ACM SRC (2018) | ACM MobiCom, SRC (2017) | ACM MobiCom, IEEE ICCC (2016) | ACM IMC, IEEE ICNP (2015)

Professional Service

Chair
- ACM Wireless of the Students, by the Students, and for the Students (S^3) Workshop 2018

Web Chair
- International Conference on Embedded Wireless Systems and Networks (EWSN) 2018
- ACM Workshop on Wireless Network Testbeds, Experimental evaluation & CHaracterization (WiNTECH) 2016

Invited Journal Reviews
- IEEE Transactions on Wireless Communications (TWC) 2019, 2017
- IEEE/ACM Transactions on Networking 2019
- IEEE Vehicular Technology Magazine 2019
- IEEE Transactions on Communications 2018
- IEEE Transactions on Mobile Computing (TMC) 2017
- MDPI Applied Sciences 2017
- IEEE Symposium on Computers and Communications (ISCC) 2017
- MDPI Sensors 2015