Raj Joshi

CONTACT INFORMATION

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RESEARCH INTERESTS

Systems and Networking: in particular, programmable dataplanes and their applications/implications for network monitoring, fault tolerance, congestion control and distributed systems.

EDUCATION

PhD Candidate, Computer Science *Aug '15 – Present*
National University of Singapore (NUS)
Advisor: Dr. Ben Leong. Also fortunate to work with Dr. Mun Choon Chan and Dr. Boon Thau Loo.

- Current research interests: Programmable dataplanes and their applications.
- Past: Analyzing dynamic channel width in 802.11ac and its impact on other 802.11 functions.
- Graduate Courses: Advanced Topics in Networking, Distributed Systems, Network Security, Systems Support for Continuous Media, Advanced Topics in Data Mining, The Art of CS Research.
  Cumulative G.P.A.: 4.92 / 5.0

Bachelor of Engineering (Hons.), Computer Science *2009 – 2013*
Birla Institute of Technology and Science (BITS), Pilani, India

- Cumulative G.P.A.: 9.09 / 10.0

Higher Secondary School Certificate Examination (96%) *2009*
Maharashtra State Board of Secondary & Higher Secondary Education, India

- Secured 1st rank amongst more than 100,000 students in the Kolhapur Board in Science stream. Highest marks in Physics, Chemistry and vocational course.

AWARDS AND HONORS

- NUS School of Computing Research Achievement Award 2020.
- Facebook Research Networking Systems Award '19 (USD 50,000) for the proposal 'Record & Replay: Framework for Network-Wide Monitoring and Debugging' with PI Dr. Mun Choon Chan.
- President's Graduate Fellowship 2015-16 awarded to candidates at NUS who show exceptional promise or accomplishment in research.
- Summer Research Fellowship 2012 awarded jointly by the Indian National Science Academy (INSA), National Academy of Sciences India (NASI) and the Indian Academy of Sciences (IAS).
- Merit-cum-Need scholarship at BITS Pilani for all 8 semesters.
- Dhirubhai Ambani Undergraduate Scholarship awarded by the Reliance Foundation to meritorious students at the Higher Secondary School Certificate Examination.
- State Merit Scholarship awarded by Govt. of Maharashtra to top-ranking students at the Higher Secondary School Certificate Examination.

PUBLICATIONS

LinkGuardian: Mitigating the impact of packet corruption loss with link-local retransmission
[ACM APNet '22]
Raj Joshi, Qi Guo, Nishant Budhdev, Ayush Mishra, Mun Choon Chan, Ben Leong

Hop-On Hop-Off Routing
[ACM APNet '22]
Jialong Li, Yiming Lei, Federico De Marchi, Raj Joshi, Balakrishnan Chandrasekaran, Yiting Xia

FSA: fronthaul slicing architecture for 5G using dataplane programmable switches
[ACM MOBICOM '22]
Nishant Budhdev, Raj Joshi, Pravein Govindan Kannan, Mun Choon Chan, Tulika Mitra

Debugging Transient Faults in Data Centers using Synchronized Network-wide Packet Histories
[USENIX NSDI '21]
Pravein Govindan Kannan, Nishant Budhdev, Raj Joshi*, and Mun Choon Chan*
*equal contribution

Conjecture: Existence of Nash Equilibria in Modern Internet Congestion Control
[ACM APNet '21]
Ayush Mishra, Jingzhi Zhang, Melodies Sim, Sean Ng, Raj Joshi, and Ben Leong

Slicing 5G Fronthaul Networks using Programmable Switches
[ACM CoNEXT '20, Posters & Demos]
Nishant Budhdev, Raj Joshi, Pravein Govindan Kannan, and Mun Choon Chan

The Great Internet TCP Congestion Control Census
[ACM SIGMETRICS '20]
Ayush Mishra, Xiangpeng Sun, Atishya Jain, Sameer Pande, Raj Joshi, and Ben Leong

SQR: In-network Pkt Loss Recovery from Link Failures for Highly Reliable Datacenter Networks
[IEEE ICNP '19] ***Best Paper Award!***
Ting Qu, Raj Joshi*, Mun Choon Chan, Ben Leong, Deke Guo, Zhong Liu*
*equal contribution

TimerTasks: Towards Time-driven Execution in Programmable Dataplanes
[ACM SIGCOMM '19, Posters & Demos]
Raj Joshi, Ben Leong, Mun Choon Chan

P4TrafficTool: Automated Code Generation for P4 Traffic Generators and Analyzers
[ACM SOSR '19, Posters & Demos]
Deepanshu Jindal, Raj Joshi, Ben Leong

Precise Time-synchronization in the Data-Plane using Programmable Switching ASICs
[ACM SOSR '19] ***Best Paper Award!***
Pravein Govindan Kannan, Raj Joshi, Mun Choon Chan

BurstRadar: Practical Real-time Microburst Monitoring for Datacenter Networks
[ACM APSys '18]
Raj Joshi, Ting Qu, Mun Choon Chan, Ben Leong and Boon Thau Loo

EleTrack: Ultra-Low-Power Retrofitted Monitoring for Elevators
[EWSN '18]
Mobashir Mohammad, Raj Joshi, Mun Choon Chan

HaptiColor: Interpolating Color Information as Haptic Feedback to Assist the Colorblind
[ACM CHI '16]
Marta G. Carcedo, Soon Hau Chua, Simon Perrault, Pawel Wozniak, Raj Joshi, Mohammad Obaid, Morten Fjeld, Shengdong Zhao

Feasibility Study of Mobile Phone WiFi Detection in Aerial Search and Rescue Operations
[ACM APSys '13]
Wei Wang, Raj Joshi, Aditya Kulkarni, Wai Kay Leong and Ben Leong

Contributed Research Grants

- A Buffer-Regulation-Based Approach to Achieving Low-Latency TCP (2020), Singapore Ministry of Education Tier-1, SGD 130k, with Ben Leong.
- Leveraging Data-Plane Programmability for Scalable & Resilient Network Services (2020), Singapore Ministry of Education Tier-2, SGD 489k, with Mun Choon Chan.
- Record & Replay: Framework for Network-Wide Monitoring and Debugging (2019), Facebook Research, USD 50k, with Mun Choon Chan.
- Towards High-Fidelity Datacenter Network Monitoring with Programmable Dataplanes (2018), Singapore Ministry of Education Tier-1, SGD 53k, with Mun Choon Chan and Ben Leong.

Service

- **PC:** NUS Computing Research Week (Fall 2020)
- **Contributed Reviews:** IEEE ICNP (2021, 2022), IEEE INFOCOM (2021, 2022), ACM APNet (2021), ACM HotNets (2017, 2020), ACM Mutimedia (2020), IEEE SECON (2017)
- **Other:** Instructor for P4 Tutorial at SIGCOMM'19

Professional Experience

Member of Technical Staff, Adobe Systems India Pvt. Ltd. *Jul '13 – Jul '15*

I was part of the software engineering team responsible for the Adobe PDF Print Engine, a rendering platform that enables high quality digital printing of Adobe PDF documents. Specifically I worked on the following modules:

- **Color management workflows:** Color management workflows involving Adobe Color Engine, Adobe Graphics Manager and ICM2-based Color Conversion Modules (CMMs). Gained in-depth understanding of PDF's transparent imaging model including transparency composition, blending and overprinting.
- **JPEG2000** and **JDF**: Worked on Adobe's implementation of ISO/IEC 15444 and Job Description Format (JDF). Ensured critical performance and handled security issues.

Received the ***Special Contribution Award*** in recognition of my work.

Academic Internships

School of Computing, National University of Singapore *Jan '13 – Jul '13*
Undergraduate Thesis: *Design and Implementation of Mobile Aerial Nodes*
Advisor: Dr. Ben Leong
Designed and built wireless nodes that could fly autonomously using multi-rotor UAV platform. Interfacing a WiFi-enabled computer with a UAV flight controller was the key contribution. Subsequently conducted a measurement study of signal propagation in aerial WiFi links. Also investigated WiFi scanning patterns and WiFi power consumption in mobile devices.
(This work was supported by the Singapore Ministry of Education tier 1 grant 251RES1204)

Tata Institute of Fundamental Research (TIFR), Mumbai, India *May '12 – Jul '12*
Summer Internship Project: *Evaluation of a Clustered Regression Prediction Setup*
Advisor: Dr. Onkar Dabeer
Using Python numpy-scipy tools, implemented a local regression scheme. Verified the scheme's accuracy and performance in solving a clustered regression prediction setup by using NASDAQ stock and Indian rainfall data.
(The internship was supported by the Summer Research Fellowship 2012)

Indian Space Research Organization (ISRO), Dehradun, India *May '11 – Jul '11*
Summer Internship Project: *GIS Customization for 3D Terrain Visualization*
Advisor: PLN Raju, Scientist G.
Developed a 3D overlay and visualization add-in for ArcGIS Explorer. It allows 3D animation of time-lapse geo-spatial data for policy planning and other studies at the Indian Institute of Remote Sensing (IIRS under the purview of ISRO).

Selected College Projects

Development of a Highly Available Tactical Network (HATNeT) *May '12 – Dec '12*
Project Guide: Dr. Rahul Banerjee
Worked on the design of a tactical mobile ad-hoc network based on specific requirements of the Indian Army to be used for defense as well as emergency mitigation purposes.

Multichannel Routing Algorithms for Mobile Ad-Hoc Networks *Aug '11 – Jul '12*
Project Guide: Dr. Murali P
Conducted literature survey on multichannel routing algorithms for wireless networks. Proposed an AODV-based multichannel routing algorithm and also designed the test environment.

Teaching Experience

Teaching Assistant, CS5229: Advanced Computer Networks *Aug '21 – Dec '21*
Instructor: Dr. Ben Leong
A graduate level course at NUS that covers advanced topics in networking. Includes a hands-on project to reproduce results from a popular research paper.

Teaching Assistant, CS5248: Systems Support for Continuous Media *Aug '17 – Dec '17*
Instructor: Dr. Roger Zimmermann
A graduate level course at NUS that covers major aspects of video and audio streaming systems. Includes a hands-on project to build an end-to-end DASH streaming system from scratch.
- Mean student rating: 4.4 / 5.0

Teaching Assistant, CS1010X: Programming Methodology *Jan '17 – Jun '17*
Instructor: Dr. Ben Leong *Jan '16 – Jun '16*
An undergraduate level course at NUS that introduces freshmen to the fundamental concepts of problem solving by means of computing and programming using the Python programming language.
- Mean student rating: 4.6 / 5.0 *(Jan '17 – Jun '17)*; 4.8 / 5.0 *(Jan '16 – Jun '16)*

Technical Skills

Networking	P4, Intel P4 Studio, DPDK, Scapy, Pcap++, MoonGen, Mininet
Programming	C, C++, Java, Arduino
Scripting	Python, PHP, Bash shell
Mobile and Web Technologies	Android, Django, HTML, CSS, JavaScript

Extracurricular Activities

- Nominated member of the Graduate Student Panel for Student Discipline at the National University of Singapore.
- Steering committee member of the team organizing Alumni Research Talks, a student-industry-research symposium which features research talks and discussions in Computer Science by BITS alumni currently in graduate schools or pursuing industry research. So far, the five successful editions of the event have been generously supported by Microsoft Research, LinkedIn, Google, eBay-PayPal and NetApp.
- Served as President for Embryo, a student driven initiative that organizes video lectures and mini-courses providing students exposure to current research trends in addition to classroom learning.