

Muhammad Shahbaz

CONTACT INFORMATION

Assistant in Research
Department of Computer Science
Princeton University
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Spring 2015 — present
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RESEARCH INTERESTS

Software-Defined Networks — Programmable Data Planes — Language Abstractions
Inter-Domain Routing — Network Management and Performance

EDUCATION

Princeton University, Princeton, NJ, USA

Ph.D., Computer Science, Spring 2015 — present¹

- Advisor: Nick Feamster
- Area of Study: Software-Defined Networks

M.A., Computer Science, Spring 2015 — 2016

- Advisor: Nick Feamster

National University of Sciences & Technology, Islamabad, PK

B.E., Computer Engineering, 2004 — 2008 (Honors)

- Thesis Topic: *Extraction and Evaluation of Cyber Social Structures*
- Advisor: Shoab A. Khan

REFEREED CONFERENCE PUBLICATIONS - FULL PAPERS

- [1] **Muhammad Shahbaz**, Sean Choi, Ben Pfaff, Changhoon Kim, Nick Feamster, Nick McKeown, and Jennifer Rexford. “PISCES: A Programmable, Protocol-Independent Software Switch.” *ACM SIGCOMM*, Florianópolis, Brazil, August 2016. Website: <http://pisc.es.cs.princeton.edu>.
- [2] Hyojoon Kim, Joshua Reich, Arpit Gupta, **Muhammad Shahbaz**, Nick Feamster and Russ Clark. “Kinetic: Verifiable Dynamic Network Control.” *In Proceedings of the 12th USENIX Symposium on Networked Systems Design and Implementation (NSDI)*, WA, USA, May 2015.
- [3] Arpit Gupta, Laurent Vanbever, **Muhammad Shahbaz**, Sean Donovan, Brandon Schinkler, Nick Feamster, Jennifer Rexford, Scott Schenker, Russ Clark, and Ethan Katz-Bassett. “SDX: A Software Defined Internet Exchange.” *ACM SIGCOMM*, Chicago, IL, USA, August 2014.

REFEREED WORKSHOP PUBLICATIONS

- [4] Sean Choi, Xiang Long, **Muhammad Shahbaz**, Skip Booth, Andy Keep, John Marshall, and Changhoon Kim. “The Case for a Flexible Low-Level Backend for Software Data Planes.” *ACM SIGCOMM 1st Asia-Pacific Workshop on Networking (APNet)*, Hong Kong, China, August 2017.
- [5] **Muhammad Shahbaz**, Sean Choi, Ben Pfaff, Chaitanya Kodeboyina, Changhoon Kim, Nick McKeown, Nick Feamster, and Jennifer Rexford. “OvS Datapath Specialization Using P4.” *2nd P4 Workshop*, Palo Alto, CA, USA, November 2015.

¹Transferred from **Georgia Tech** in Spring’15

- [6] **Muhammad Shahbaz** and Nick Feamster. “The Case for an Intermediate Representation for Programmable Data Planes.” *In Proceedings of the 1st ACM SIGCOMM Symposium on SDN Research (SOSR)*, Santa Clara, CA, USA, June 2015. Website: <http://netasm.cs.princeton.edu>.
- [7] Gianni Antichi, **Muhammad Shahbaz**, Stefano Giordano, and Andrew Moore. “From 1G to 10G: Code Reuse in Action.” *In Proceedings of the 1st ACM Workshop on High Performance and Programmable Networking (HPPN)*, NY, USA, June 2013.
- [8] **Muhammad Shahbaz**, Zaheer Ahmed, Habibullah Jamal, Asrar Ashraf, Nadeem Yousaf, and Raania Naeem Khan. “Addition of Virtual Interfaces in NetFlow Probe for the NetFPGA.” *1st European NetFPGA Developers Workshop*, Computer Laboratory, University of Cambridge, September 2010.
- [9] Sean Choi, Xiang Long, **Muhammad Shahbaz**, Skip Booth, Andy Keep, John Marshall, and Changhoon Kim. “PVPP: A Programmable Vector Packet Processor.” *ACM SIGCOMM Symposium on SDN Research (SOSR)*, Santa Clara, CA, USA, April 2017.
- [10] **Muhammad Shahbaz**, Sean Choi, Ben Pfaff, Changhoon Kim, Nick Feamster, Nick McKeown, and Jennifer Rexford. “PISCES: A Programmable, Protocol-Independent Software Switch.” *Open Networking User Group (ONUG)*, New York, NY, USA, October 2016.
- [11] **Muhammad Shahbaz**, Sean Choi, Ben Pfaff, Changhoon Kim, Nick Feamster, Nick McKeown, and Jennifer Rexford. “PISCES: A Programmable, Protocol-Independent Software Switch.” *AT&T Research Academic Summit*, Bedminster, NJ, USA, March 2016.
- [12] **Muhammad Shahbaz**, Sean Choi, Ben Pfaff, Chaitanya Kodeboyina, Changhoon Kim, Nick McKeown, Nick Feamster, and Jennifer Rexford. “OvS Datapath Specialization Using P4.” *Open vSwitch Conference*, San Jose, CA, USA, November 2015.
- [13] Arpit Gupta, Laurent Vanbever, **Muhammad Shahbaz**, Sean Donovan, Brandon Schinkler, Nick Feamster, Jennifer Rexford, Scott Schenker, Russ Clark, and Ethan Katz-Bassett. “SDX: A Software Defined Internet Exchange.” *ACM SIGCOMM*, Chicago, IL, USA, August 2014.
- [14] M. Said Seddiki, **Muhammad Shahbaz**, Sean Donovan, Sarthak Grover, Mison Park, Nick Feamster, and Ye-Qiong Song. “FlowQoS: QoS for the Rest of Us.” *ACM SIGCOMM Workshop on Hot Topics in Software Defined Networking*, Chicago, IL, USA, August 2014.
- [15] Kamran Ali Akhtar, **Muhammad Shahbaz**, and Saad Qaisar. “Efficient Deployment of Network Management Policy using Distributed Database Abstraction.” *In Proceedings of the 11th USENIX Symposium on Networked Systems Design and Implementation (NSDI)*, WA, USA, April 2014.
- [16] **Muhammad Shahbaz**, Gianni Antichi, Yilong Geng, Noa Zilberman, Adam Covington, Marc Bruyere, Nick Feamster, Nick McKeown, Bob Felderman, Andrew W. Moore, and Philippe Owezarski. “Architecture for an Open Source Network Tester.” *In Proceedings of the 9th ACM/IEEE Symposium on Architectures for Networking and Communications Systems (ANCS)*, CA, USA, October 2013.

- [17] Gianni Antichi*, **Muhammad Shahbaz***, Yilong Geng*, Noa Zilberman, Adam Covington, Marc Bruyere, Nick McKeown, Nick Feamster, Bob Felderman, Michaela Blott, Andrew W. Moore, and Philippe Owezarski. “OSNT: Open Source Network Tester”. *IEEE Special Issue on Open Source for Networking: Tools and Applications*, pp. 6 — 12, September 2014. (* These authors contributed equally to this work.)
- [18] Zaheer Ahmed, Habibullah Jamal, Rizwana Mehboob, Shoab A. Khan, and **Muhammad Shahbaz**. “Secure Cognitive Mobile Hotspot”. *IEEE Transactions on Consumer Electronics (ISSN 0098-3063)*, Volume 56, Issue 2, pp. 606 — 612, May 2010.
- [19] Rizwana Mehboob, Shoab A. Khan, Zaheer Ahmed, Habibullah Jamal, and **Muhammad Shahbaz**. “Multigig Lossless Data Compression Device”. *IEEE Transactions on Consumer Electronics (ISSN 0098-3063)*, Volume 56, Issue 3, August 2010.

- [20] Editing, Synthesis and Simulation of Verilog codes — Shoab Ahmed Khan. “Digital Design of Signal Processing Systems: A Practical Approach”. *John Wiley & Sons*, 2007.

- [21] M. Said Seddiki, **Muhammad Shahbaz**, Sean Donovan, Sarthak Grover, Mison Park, Nick Feamster, and Ye-Qiong Song. “Per-Flow Quality of Service for Broadband Access Networks”. *Georgia Institute of Technology*, Atlanta, USA, 2015.
- [22] Arpit Gupta*, **Muhammad Shahbaz***, Laurent Vanbever*, Hyojoon Kim, Russ Clark, Nick Feamster, Jennifer Rexford, and Scott Shenker. “SDX: A Software Defined Internet Exchange”. *Georgia Institute of Technology*, Atlanta, USA, 2013. (*These authors contributed equally to this work.)
- [23] Hyojoon Kim, Arpit Gupta, **Muhammad Shahbaz**, Joshua Reich, Nick Feamster, and Russ Clark. “Simpler Network Configuration with State-Based Network Policies”. *Georgia Institute of Technology*, Atlanta, USA, 2013.

- Nominated to attend Google Networking Research Summit**, Sunnyvale, CA, USA, February 2017.
- 2nd place in ONUG SDN Hackathon** for *demonstrating excellence in the area of code development for open programmable networks*, New York, NY, USA, 2014.
- Graduate Teaching Assistant Award** for *outstanding work on the Coursera SDN MOOC*, Georgia Tech, 2014.
- Student Travel Grant** for *Networked Systems Design and Implementation (NSDI) Conference*, Seattle, WA, USA, 2014.
- Student Travel Grant** for *Architectures for Networking and Communications Systems (ANCS) Conference*, San Jose, CA, USA, 2013.
- NSF Travel Award** for *US Ignite ONF Joint Workshop*, Juniper Networks, Sunnyvale, CA, USA, 2013.
- Internet2 Innovative Applications Award** for *Software Defined Networking (SDN) for Internet Exchange Points*, USA, 2013.
- Google Travel Grant** for *Open Networking Summit*, San Jose, CA, USA, 2013.

Star Laureate Award in recognition of credentials par excellence on national level, South Asia Publications, 2008.

Excellence Award and **Honorable Mention** in the *Galaxies of Who's who in Pakistan*, South Asia Publications, 2007.

Gold Medal for the best final year project at *National University of Sciences and Technology* (NUST), Islamabad, PK, 2008.

Excellence Award for exceptional performance in the *Digital Systems Design* course at NUST, Islamabad, PK, 2005.

Fellowship for *Undergraduate Studies* at NUST by Federal Board of Intermediate and Secondary Education (FBISE), PK, 2004 — 2008.

Silver Medal in the field of *Intermediate Computer Sciences* (ICS) at FBISE, Islamabad, PK, 2004.

Certificate of Excellence at the *VISIOPARK* software competition, Islamabad, PK, 2008.

Certificate of Excellence at the *COMPEC* IT competition, Islamabad, PK, 2007.

Certificate of Excellence in the *Intra-School Debates* at Garrison Boys High School, Lahore, PK, 2001.

PROFESSIONAL
MEMBERSHIPS

Association for Computing Machinery (ACM)
Student Member, 2013 — present

USENIX Association
Student Member, 2013 — present

INVITED TALKS

PISCES: A Programmable, Protocol-Independent Software Switch
Barefoot Networks, November 10, 2016.
P4 Developer Day, November 9, 2016.
Open vSwitch Conference, November 2, 2016.
VMware, July, 2016.
Microsoft Research (Redmond), July 15, 2016.
P4 Workshop, May 24, 2016.
AT&T Research Academic Summit, March 31, 2016.
Open vSwitch Conference, November, 2015.

NetASM: A Network Assembly Language
ONF Workday Event: PIF Session, September 10, 2015.
ACM SOSR, Santa Clara, CA, USA. June 18, 2015.

SDX: Software Defined Internet Exchange
Internet2 Global Summit, April 9, 2014.
US Ignite ONF Join Workshop, October 8, 2013.
Open Networking Laboratory, August 15, 2013.

From 1G to 10G: Code Reuse in Action
HPPN, New York, NY, USA. June 18, 2013.

PANELIST

Juniper Software Defined Networking Event
Georgia Institute of Technology, September 24, 2013.

TEACHING
EXPERIENCE

Princeton University — Computer Science Undergraduate/Graduate Program

Assistant in Instruction **February to May 2015**
(sample graded material and student evaluations available upon request)

- Instructor for on-campus class, COS 461: Computer Networks
 - Responsible for creating and grading *programming assignments*, *quizzes*, and supervision of *discussion forums*.

Udacity — Georgia Tech Online Masters in Compute Science

Teaching Assistant **May to August 2014**
(sample graded material and student evaluations available upon request)

- Instructor for online class, **Computer Networks**
 - Responsible for creating and grading *programming assignments*, *quizzes*, and supervision of *discussion forums*.

Georgia Tech — Computer Science Graduate Program

Teaching Assistant **January to May 2014**
(sample graded material and student evaluations available upon request)

- Instructor for on-campus class, CS 6250: Advanced Computer Networks
 - Responsible for creating and grading *programming assignments*, *quizzes*, and supervision of *discussion forums*.

Coursera — Massive Open Online Courses (MOOCs)

Teaching Assistant **May to August 2013**
(sample graded material and student evaluations available upon request)

- Instructor for online class, **Software Defined Networking (SDN)**
 - Responsible for creating and grading *programming assignments*, and supervision of *discussion forums*.

NetFPGA Summer Camp — (Week-long)

Instructor for the Hands-on Workshop at *Stanford University*. **August 2013**

NetFPGA Tutorial — (Day-long)

Instructor for the Hands-on Workshop at *SIGMETRICS*. **June 2012**

Xilinx EDA Tutorial — (Day-long)

Instructor for the Hands-on Workshop at *NUST*. **October 2010**

PROFESSIONAL
EXPERIENCE

Princeton University, Princeton, NJ, USA

Assistant in Research **February 2015 to present**

- Supervisor: Nick Feamster
- PISCES: A Programmable, Protocol-Independent Software Switch.
- NetASM: A Network Assembly Language for Programmable Data Planes.

Visiting Student Research Collaborator **January 2015**

- Supervisor: Nick Feamster

Visiting Student **June 2014**

- Host: Jennifer Rexford
- NetCore to NetFPGA: Research Collaboration on Compiling NetCore to NetFPGAs.

VMware

Data Plane xCloud Intern

June to September 2017

VMware

Software Engineering Intern

June 2016 to January 2017

Barefoot Networks

Software Engineering Intern

May to September 2015

Stanford University, Stanford, CA, USA

Visiting Student

December 2014

- Host: Nick McKeown
- NetASM: Collaborating on building an Intermediate Representation for Programmable Data Planes.

Visiting Student

June to August 2013

- Host: Nick McKeown
- Open Source Network Tester (OSNT): Design and Development of an Open Source Network Tester for Academia and Research Community.

Georgia Institute of Technology, Atlanta, GA, USA

Graduate Research Assistant

January 2013 to January 2015

- Supervisor: Nick Feamster
- NetASM: A Network Assembly Language for Programmable Data Planes.
- Past Projects:
 - Software-Defined Exchange (SDX): Novel applications for Internet Exchange Points using Software-Defined Networks.
 - Resonance: Event-Driven Control for Software-Defined Networks.
 - Open Source Network Tester (OSNT): Design and Development of an Open Source Network Tester for Academia and Research Community.
 - NetFPGA: A flexible and open platform for research and class room experimentation.

University of Cambridge, Computer Laboratory, Cambridge, UK

Research Assistant

August 2011 to October 2012

- Supervisor: Andrew W. Moore
- NetFPGA: A flexible and open platform for research and class room experimentation.
- CTSRD: Rethinking the hardware-software interface for Security.

Xilinx, Research Laboratory, Dublin, IE

Visiting Research Scholar

October 2011

- Host: Michaela Blott
- NetFPGA: A flexible and open platform for research and class room experimentation.

Center for Advanced Research in Engineering, Islamabad, PK

Senior Design Engineer

April 2010 to July 2011

- Manager: Shoab A. Khan
- NGN-VoIP Monitoring: A Hardware/Software co-design VoIP monitoring solution to prevent rapid proliferation of Internet and VoIP based communication. The project got the best in Security Applications award at APICTA, Malaysia, 2010.
- CARE Voice Recognition System.
- Bulk Encryption System.

Design Engineer

April 2008 to March 2010

- Manager: Shoab A. Khan

Research Intern

February 2007 to March 2008

- Manager: Shoab A. Khan

REFERENCES

Dr. Nick Feamster (e-mail: feamster@cs.princeton.edu; phone: +1-609-258-2203)

- Professor, Department of Computer Science, Princeton University

★ *Dr. Feamster is my current PhD supervisor.*

Dr. Jennifer Rexford (e-mail: jrex@cs.princeton.edu; phone: +1-609-258-5182)

- Professor, Department of Computer Science, Princeton University

Dr. Nick McKeown (e-mail: nickm@stanford.edu; phone: +1-650-725-3641)

- Professor, Department of Computer Science, Stanford University