

# Muhammad Shahbaz

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## CONTACT INFORMATION

Assistant in Research  
Department of Computer Science  
Princeton University  
Princeton, NJ 08544 USA  
Office: 312 Sherrerd Hall

Spring 2015 — present  
[mshahbaz@cs.princeton.edu](mailto:mshahbaz@cs.princeton.edu)  
+1 (404) 518-2921 (Cell)  
[www.cs.princeton.edu/~mshahbaz](http://www.cs.princeton.edu/~mshahbaz)

## RESEARCH INTERESTS

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

## EDUCATION

**Princeton University**, Princeton, NJ, USA

Ph.D., Computer Science, Spring 2015 — present<sup>1</sup>

- 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 12<sup>th</sup> 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] **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.
- [5] **Muhammad Shahbaz** and Nick Feamster. “The Case for an Intermediate Representation for Programmable Data Planes.” *In Proceedings of the 1<sup>st</sup> ACM SIGCOMM Symposium on SDN Research (SOSR)*, Santa Clara, CA, USA, June 2015. Website: <http://netasm.cs.princeton.edu>.

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<sup>1</sup>Transferred from **Georgia Tech** in Spring’15

- [6] Gianni Antichi, **Muhammad Shahbaz**, Stefano Giordano, and Andrew Moore. “From 1G to 10G: code reuse in action.” *In Proceedings of the 1<sup>st</sup> ACM Workshop on High Performance and Programmable Networking (HPPN)*, NY, USA, June 2013.
- [7] **Muhammad Shahbaz**, Zaheer Ahmed, Habibullah Jamal, Asrar Ashraf, Nadeem Yousaf, and Raania Naeem Khan. “Addition of Virtual Interfaces in NetFlow Probe for the NetFPGA.” *1<sup>st</sup> European NetFPGA Developers Workshop*, Computer Laboratory, University of Cambridge, September 2010.
- [8] 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.
- [9] **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.
- [10] **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.
- [11] **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.
- [12] 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.
- [13] 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.
- [14] Kamran Ali Akhtar, **Muhammad Shahbaz**, and Saad Qaisar. “Efficient Deployment of Network Management Policy using Distributed Database Abstraction.” *In Proceedings of the 11<sup>th</sup> USENIX Symposium on Networked Systems Design and Implementation (NSDI)*, WA, USA, April 2014.
- [15] **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 9<sup>th</sup> ACM/IEEE Symposium on Architectures for Networking and Communications Systems (ANCS)*, CA, USA, October 2013.

- [16] Gianni Antichi\*, **Muhammad Shahbaz\***, Yilong Geng\*, Noa Zilberman, Adam Covington, Marc Bruyere, Nick McKeown, Nick Feamster, Bob Felderman, Michela 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.)

- [17] 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.
- [18] 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.

BOOKS AND BOOK  
CHAPTERS

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

TECHNICAL  
REPORTS

- [20] 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.
- [21] 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.)
- [22] 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.

AWARDS

- 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 Joint Workshop*, October 8, 2013.

*Open Networking Laboratory*, August 15, 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 Instructions*

**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 *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 **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**

*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