[Updated: end of 2015]

Eric R. Keller

http://ecee.colorado.edu/~ekeller/

RESEARCH INTEREST

I design and build secure and reliable networked systems using a cross-layer approach that draws from networking, operating systems, distributed systems, and computer architecture.

EDUCATION

Ph. D., Princeton University, Electrical Engineering, 2011
- Award: Intel PhD Fellowship (2010-2011)
- Advisor: Jennifer Rexford
- Dissertation: Refactoring Router Software to Minimize Disruption

M.S., University of Massachusetts-Amherst, Electrical and Computer Engineering, 2005
- Advisor: Russell Tessier
- Thesis: Programming Model for Network Processing on an FPGA

B.S., Virginia Tech, Computer Engineering, 1999

RESEARCH EXPERIENCE

University of Colorado, Assistant Professor (2012-present)

University of Pennsylvania, Post-doctoral researcher (2011-2012)

Princeton University, Graduate researcher (2006-2011)

Xilinx, Inc, (1999-2006)

Advising

Current (as Advisor):
Matthew Monaco – PhD CS, 4th year
Murad Kaplan – PhD CS, 4th year
Oliver Michel – PhD CS, 3rd year
Michael Coughlin – PhD ECEE, 3rd year
Kelly Kaoudis – PhD CS, 3rd year (1st as PhD)
Azzam Alsaudis – PhD CS 3rd year (1st as PhD)
Dan Hembree – PhD, ITP, 3rd year
Sean Lambert – B.S. ECEE (Discovery Learning Apprenticeship)

Past (as Thesis Advisor):
Ali Ismail – M.S., (5/2015), ECEE, First Job: Embedded System Engineer at Syncroness
Ryan Hand – M.S.(4/2014), CS, First Job: Faculty at United States Military Academy
Matthew Monaco –M.S.(4/2014), CS, continuing as Ph.D. student
Alex Tsankov – B.S., CS, (for Discovery Learning Apprenticeship)
Ji Hoon Kim – B.S., CS, (for Discovery Learning Apprenticeship)
CS Senior Project Team in 2013-14 AY: Brian McWilliams, Scott Pledger, Alexandro Simion, Matthew Peck.
ITP Capstone Team in 2013-14 AY: Srinivas Lakshminarayan, Shankar Shivram, Siddharth Bali, Rohith Vardha

[Updated: end of 2015]

On Committee:
PhD Committee: Bryan Dixson (12/2012)
MS Committee: Matthew Phillips (7/2015), Andy Sayler (12/2013), Amit Gupta (4/2013)
Prelim: as Chair: Mike Coughlin (Apr 2014), Murad Kablan (Dec 2014), committee: Andy Sayler (Apr 2014), Ehab Ababneh (Oct 2014), Ning Gao (Nov, 2014)
Senior Thesis Committee: Peter Klipfel (CS) (4/2014)

Funding

Title: "TWC: Medium: Collaborative: Active Security"
Source of Support: National Science Foundation
Award Amount: $ 746,537. (PI)
Period Covered: 09/01/14-08/31/18

Title: " XPS: SDA: Elasticizing the Linux Operating System for the Cloud"
Source of Support: National Science Foundation (NSF)
Award Amount: $748,399. (co-PI)
Period Covered: 09/01/13-08/31/17

Title: "NeTS: Small: Liquid Networking"
Source of Support: National Science Foundation (NSF)
Award Amount: $500,000. (PI)
Period Covered: 10/01/13-9/30/16

Title: gift from Xilinx
Source of Support: Xilinx
Award Amount: $15,000. (PI)
Period Covered: 09/2012-present

TEACHING

- University of Colorado: ECEN 3350 – Programming Digital Systems (Spring 2016)
- University of Colorado: ECEN 1310 – Intro to Programming for Engineers (Spring 2015)
- University of Colorado: ECEN 5013 / CSCI 7000 - Advanced Computer and Networked System Security (Fall 2013, Fall 2014).
- University of Colorado: ECEN 5023 / CSCI 7000 - Advanced Network Systems (Spring 2013, Spring 2014, Fall 2015).
- University of Colorado: ECEN 5013: Software-defined networking (Fall 2012)
- Teaching assistant for Princeton COS 109, "Computers in our world"
- Guest lecturer in Princeton COS 561 "Advanced computer networks", University of Colorado ECEN5743 Software Engineering of Distributed Systems, University of Colorado CSCI 5023: Network Systems

PUBLICATIONS

2016 **Policy Routing using Process-Level Identifiers**
Oliver Michel, Eric Keller
In Proc. IEEE International Symposium on Software Defined Systems (SDS). April, 2016.

Timing SDN Control Planes to Infer Network Configurations
John Sonchack, Adam J. Aviv, Eric Keller
In Proc. ACM International Workshop on Security in Software Defined Networks & Network Function Virtualization (SDN-NFV Security). March, 2016.

[Updated: end of 2015]

Taking the Surprise out of Changes to a Bro Setup
Matthew Monaco, Alexander Tsankov, Eric Keller
In Proc. ACM International Workshop on Security in Software Defined Networks & Network Function Virtualization (SDN-NFV Security). March, 2016.

Enabling Practical Software-defined Networking Security Applications with OFX
John Sonchack, Adam J. Aviv, Eric Keller, Jonathan M. Smith
In Proc. Network and Distributed System Security Symposium (NDSS). February, 2016. **(60 / 390 15%)**

2015 **(Poster) OFX: Enabling OpenFlow Extensions for** Switch-Level Security Applications.
John Soncheck, Adam J. Aviv, Eric Keller, Jonathan M. Smith
In Proc. ACM SIGSAC Conference on Computer and Communications Security (CCS), 2015.

Stateless Network Functions
Murad Kablan, Blake Caldwell, Hani Jamjoon, Eric Keller
In Proc. Workshop on Hot Topics in Middleboxes and Network Function Virtualization (HotMiddlebox), Aug. 2015 (12/32, 37%)

(poster) Stateless Network Functions
Murad Kablan, Blake Caldwell, Hani Jamjoon, Eric Keller
at USENIX Symp. on Networked Systems Design and Implementation (NSDI), May., 2015.

(poster) Mobile Applications with Reconfigurable Hardware
Michael Coughlin, Ali Ismail, Eric Keller.
USENIX Symposium on Operating System Design and Implementation (OSDI), October 2014.

2014 **Transparent, Live Migration of a Software-Defined Network**
Soudeh Ghorbani, Cole Schlesinger, Matthew Monaco, Eric Keller, Matthew Caesar, Jennifer Rexford, David Walker
ACM Symposium on Cloud Computing (SoCC). Nov., 2014 (29/119, 24%)

WASP: A Software-Defined Communication Layer for Hybrid Wireless Networks
Murad Kaplan, Chenyu Zheng, Matthew Monaco, Eric Keller, Douglas Sicker
in ACM/IEEE Symposium on Architectures for Networking and Communications Systems (ANCS). Oct., 2014 (~30-35%)

ClosedFlow: OpenFlow-like Control over Proprietary Devices
Ryan Hand, Eric Keller
in ACM Workshop on Hot topics in SDN (HotSDN), as Full paper. Aug., 2014 (16 full papers out of 116 submissions, 17 accepted as short)

(poster) Extending the Software-defined Network Boundary
Oliver Michel, Michael Coughlin, Eric Keller
at ACM SIGCOMM. Aug., 2014

(poster) Making the Live Network the Honeypot
Michael Coughlin, Oliver Michel, Eric Keller, and Adam J. Aviv.
at USENIX Symp. on Networked Systems Design and Implementation (NSDI), Apr., 2014.

2013 **Applying Operating System Principles to SDN Controller Design**
Matthew Monaco , Oliver Michel , Eric Keller
in ACM Workshop on Hot Topics in Networks (HotNets), Nov., 2013. (26/110, 24%)

[Updated: end of 2015]

Active Security
Ryan Hand , Michael Ton, Eric Keller
in ACM Workshop on Hot Topics in Networks (HotNets), Nov., 2013. (26/110, 24%)

(poster/demo) Applying Operating System Principles to SDN Controller Design
Oliver Michel, Matthew Monaco, Eric Keller.
The 18th GENI Engineering Conference, Oct., 2013.

Software-Defined Energy Communication Networks: From Substation Automation to Future Smart Grids
Adam Cahn, Juan Hoyos, Matthew Hulse, Eric Keller
in IEEE Conf. on Smart Grid Communications (SmartGridComm), Oct., 2013. (135/334, 40%)

Jobber: Automating Inter-Tenant Trust in The Cloud
Andy Sayler, Eric Keller , Dirk Grunwald
in Workshop on Hot Topics in Cloud Computing (HotCloud), June, 2013. (21/74, 28%)

Towards Elastic Operating Systems
Amit Gupta, Ehab Ababneh, Richard Han, Eric Keller
in Hot Topics in Operating Systems (HotOS), June, 2013. (27/92, 29%)

(poster) WASP: A Centrally Managed Communication Layer for Smart Phone Networks
Murad Kaplan , Chenyu Zheng, Eric Keller
in USENIX Symposium on Networked Systems Design and Implementation (NSDI), May, 2013.

(poster) yanc: Yet Another Network Controller
Matthew Monaco , Eric Keller
in USENIX Symposium on Networked Systems Design and Implementation (NSDI), May, 2013.

(poster) Jobber: Automating Inter-Tenant Trust in The Cloud
Andy Sayler, Eric Keller
in USENIX Symposium on Networked Systems Design and Implementation (NSDI), May, 2013.

Scalable Network Virtualization in Software-Defined Networks
Dmitry Drutskoy, Eric Keller , Jennifer Rexford
in IEEE Internet Computing, March/April 2013.

2012 **Live migration of an entire network (and its hosts)**
Eric Keller, Soudeh Ghorbani, Matt Caesar, Jennifer Rexford
October 2012 In Proc. HotNets. (23/120, 19%)

Virtual switching without a hypervisor for a more secure cloud
Xin Jin, Eric Keller, Jennifer Rexford
April 2012 Proceedings of Hot ICE. (10/20, 50%)

Rehoming edge links for better traffic engineering
Eric Keller, Michael Schapira, Jennifer Rexford. ACM SIGCOMM Computer Communication Review Volume 42 Issue 2, April 2012

2011 **Eliminating the Hypervisor Attack Surface for a More Secure Cloud**
Jakub Szefer, Eric Keller, Jennifer Rexford, and Ruby B. Lee
In Proc. ACM Conference on Computer and Communications Security (CCS). Oct., 2011. (60/429, 14%)

[Updated: end of 2015]

2010 **NoHype: Virtualized cloud infrastructure without the virtualization**
Eric Keller, Jakub Szefer, Jennifer Rexford, and Ruby B. Lee
In Proc. International Symposium on Computer Architecture (ISCA). July, 2010. (44/245, 18%)

Seamless BGP Migration with Router Grafting
Eric Keller, Jennifer Rexford, and Jacobus van der Merwe
In Proc. Networked Systems Design and Implementation (NSDI). Apr., 2010. (29/175, 16%)

The 'Platform as a Service' model for networking
Eric Keller and Jennifer Rexford
In Proc. INM/WREN workshop. Apr., 2010.

2009 **Virtually Eliminating Router Bugs**
Eric Keller, Minlan Yu, Matthew Caesar, and Jennifer Rexford
In Proc. Conference on emerging Networking EXperiments and Technologies (CoNEXT). Dec., 2009. (29/170, 17%)

Better by a HAIR: Hardware-Amenable Internet Routing
Firat Kiyak, Brent Mochizuki, Eric Keller, and Matthew Caesar
In Proc. IEEE International Conference on Network Protocols (ICNP). Oct., 2009. (36/198, 18%)

Accountability in hosted virtual networks
Eric Keller, Ruby Lee, and Jennifer Rexford
In Proc. Workshop on Virtualized Infrastructure Systems and Architectures (VISA). Aug., 2009.

2008 **Virtual Routers on the Move: Live Router Migration as a Network-Management Primitive**
Yi Wang, Eric Keller, Brian Biskeborn, Jacobus van der Merwe, Jennifer Rexford
In Proc. ACM SIGCOMM. Aug., 2008. (35/288, 12%)

Virtualizing the Data Plane Through Source Code Merging
Eric Keller and Evan Green
In Proc. PRESTO workshop. Aug., 2008.

2004 **Programming a Hyper-Programmable Architectures for Networked Systems**
Eric Keller and Gordon Brebner
In Proc. International Conference on Field-Programmable Technology (FPT). Dec., 2004. (34/122, 27%)

Hyper-Programmable Architectures for Adaptable Networked Systems
Gordon Brebner, Phil James-Roxby, Eric Keller, Chidamber Kulkarni
In Proc. IEEE Conf. on Application-specific Systems, Architectures and Processors (ASAP). Sept., 2004.

2003 **Software Decelerators**
Eric Keller, Gordon Brebner, Phil James-Roxby
In Proc. 13th International Field Programmable Logic and Applications Conference (FPL). Sept., 2003. (~30%)

A Self-Reconfiguring Platform
Brandon Blodget, Philip James-Roxby, Eric Keller, Scott McMillan, Prasanna Sundararajaran
In Proc. 13th International Field Programmable Logic and Applications Conference (FPL). Sept., 2003. (~30%)

2002 **Gene Matching Using JBits**
Steven A. Guccione and Eric Keller
In Proc. 12th International Field-Programmable Logic and Applications Conference (FPL). Sept., 2002.

(~30%)

An FPGA Wire Data-Base for Run-Time Routers
Eric Keller and Scott McMillan
In Proc. Military and Aerospace Applications of Programmable Logic Devices (MAPLD). Sept., 2002.

2001 **Building Asynchronous Circuits With JBits**
Eric Keller
In Proc. 11th International Field-Programmable Logic and Applications Conference (FPL). Aug., 2001.
(~30%)

Run-Time Reconfigurable 2D Discrete Wavelet Transform Using JBits
Jonathan Ballagh, Peter Athanas, and Eric Keller
In Proc. Reconfigurable Technology: FPGAs for Computing and Applications II. Aug., 2001.

Java Debug Hardware Models using JBits
Jonathan Ballagh, Peter Athanas, and Eric Keller
In Proc. 8th Reconfigurable Architectures Workshop (RAW 2001). May, 2001.

2000 **Dynamic Circuit Specialization of a CORDIC Processor**
Eric Keller
In Proc. Reconfigurable Technology: FPGAs for Computing and Applications II. Nov., 2000.

JRoute: A Run-Time Routing API for FPGA Hardware
Eric Keller
In Proc. 7th Reconfigurable Architectures Workshop (RAW 2000). May, 2000.

SERVICE

Department:
- 2015-16 AY: Executive Committe (ExComm)
- 2014-15 AY: Faculty Search Committee
- Spring 2014: Strategic Vision Committee

Organizing Committee:
- 2015: co-Chair CoNEXT Student Workshop, ANCS Publicity Chair

Technical Program Committee:
- 2016: SDN-NFV Security, NOMS, HotMiddleBox
- 2015: ICNP, ANCS, EWSDN, PLVNET, NFV-SDN
- 2014: CNERT, ANCS, HotSDN, HotCloud, ICCCN (SDN Track), EWSDN, SDN-NGA, SIGCOMM Poster/Demo, Infocomm Poster/Demo, SDN-AA,
- 2013: ANCS, HotSDN, EWSDN, SIGCOMM Poster/Demo
- 2010: NetFPGA Developers Workshop
- 2009: NetFPGA Developers Workshop

Reviewer:

2016: CCR
2015: ToN, COSE, Sensors, CCR
2014: Internet Computing, TRETS, ToN, TNSM, CCR
2013: Internet Computing, TRETS, TNMS, ToN
2012: COMNET, ToN, CCR
2011: ToN

Panelist:

2015: NSF in person, NSF virtual
2014: NSFi n person, NSF ad-hoc

Other:

Member of Shadow Program Committee for International Conference on emerging Networking EXperiments and Technologies (CoNEXT) 2011. External reviewer for NSDI 2010, HPCA 2010, SIGCOMM 2009, USENIX ATC 2009, IEEE CCNC 2009. Scribe for NSDI 2009, PRESTO 2007

Internet Computing = IEEE Internet Computing
ToN = IEEE Transactions on Networking
TRETS = ACM Transactions on Reconfigurable Technology and Systems
TNSM = IEEE Transactions on Network and Service Management
CCR = ACM SIGCOMM Computer Communication Review
COSE = Elseviewer Computers & Security Journal
Sensors = MDPI Sensors Journal

SIGCOMM = The flagship annual conference of the ACM Special Interest Group on Data Communication (SIGCOMM) on the applications, technologies, architectures, and protocols for computer communication
ICNP = IEEE International Conference on Network Protocols
ANCS = ACM/IEEE Symposium on Architectures for Networking and Communications Systems
NFV-SDN = IEEE Conference on Network Functions Virtualization and Software-defined Networking
EWSDN = European Workshop on Software Defined Networks
HotSDN = ACM SIGCOMM Workshop on Hot Topics in Software Defined Networking
HotCloud = USENIX Workshop on Hot Topics in Cloud Computing
ICCCN = IEEE International Conference on Computer Communication and Networks
CNERT = International Workshop on Computer and Networking Experimental Research using Testbeds
SDN-NGA = International Workshop on Software Defined Networks for a New Generation of Applications and Services
SDN-AA = IEEE Workshop on SDN Architecture and Applications 2014 (SDN-AA
PVLNET = workshop on PL and verification for networking
NOMS = IEEE/IFIP Network Operations and Management Symposium

INVITED TALKS

Software-Defined: The Power of Centralized Control

- Xilinx (2013)

CloudBase: Enabling a dynamically deployable wireless infrastructure

- Microsoft Research (2012)

Secure Virtualization for Dependable Cloud Services

- Georgetown University, University of Maryland, Boston University, University of Colorado, Indiana University, Battelle (2012)

NoHype: Virtualized Cloud Infrastructure without the Virtualization
- University of Pennsylvania (2011), IBM, (2010).

Dynamic Infrastructure for Dependable Cloud Services
- University of Maryland, Northeastern University, Bell Labs,University of Delaware (2011), Rutgers (2010)

Refactoring Router Software to Minimize Disruption
(Earlier title: Migrating and Grafting Routers to Accommodate Change)
- Georgetown University (2011), University of North Carolina, Rutgers University, University of Pennsylvania, North Carolina State University, Duke University, Bell Labs (2010)

Accountability in Hosted Virtual Networks
- Microsoft Research, AT&T Research (2009).

PATENTS

- *8,032,874* – "Generation of executable threads having source code specs. that describe network packets"
- *7,990,867* – "Pipeline for processing network packets"
- *7,823,162* – "Thread circuits and a broadcast channel in programmable logic"
- *7,792,117* – "Method for simulating a processor of network packets"
- *7,788,402* – "Circuit for modification of a network packet by insertion or removal of a data segment"
- *7,784,014* – "Generation of a specification of a network packet processor"
- *7,770,179* – "Method and apparatus for multithreading on a programmable logic device"
- *7,698,449* – "Method and apparatus for configuring a processor embedded in an integrated circuit for use as a logic element"
- 7,689,726 – "Bootable integrated circuit device for readback encoding of configuration data"
- *7,653,895* – "Memory arrangement for message processing by a plurality of threads"
- *7,574,680* – "Method and apparatus for application-specific programmable memory architecture and interconnection network on a chip"
- *7,552,042* – "Method for message processing on a programmable logic device"
- *7,386,826* – "Using redundant routing to reduce susceptibility to single event upsets in PLD designs"
- *7,328,335* – "Bootable programmable logic device for internal decoding of encoded configuration data"
- *7,228,520* – "Method and apparatus for a programmable interface of a soft platform on a programmable logic device"
- *7,227,378* – "Reconfiguration of a programmable logic device using internal control"
- *7,185,309* – "Method and apparatus for application-specific programmable memory architecture and interconnection network on a chip"
- *7,131,077* – "Using an embedded processor to implement a finite state machine"
- *7,111,215* – "Methods of reducing the susceptibility of PLD designs to single event upsets"
- *7,076,596* – "Method of and apparatus for enabling a hardware module to interact with a data structure"
- *7,028,283* – "Method of using a hardware library in a programmable logic device"
- *7,010,664* – "Configurable address generator and circuit using same"
- *6,920,627* – "Reconfiguration of a programmable logic device using internal control"
- *6,883,147* – "Method and system for generating a circuit design including a peripheral component connected to a bus"
- *6,725,441* – "Method and apparatus for defining and modifying connections between logic cores implemented on programmable logic devices"
- *6,487,709* – "Run-Time Routing for Programmable Logic Devices"