Oliver Michel

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I am a third-year doctoral student in Computer Science at the University of Colorado at Boulder. Here, I am working in the Next Generation Networks Research Group (NGN) advised by Professor Eric Keller. I received a Bachelor's degree in Computer Science from the University of Vienna, Austria advised by Professor Kurt Tutschku in 2013 and a Master's degree in Computer Science from the University of Colorado Boulder advised by Professor Eric Keller in 2015. During my undergraduate studies, I spent one year at the University of Illinois at Urbana-Champaign working with Professor Brighten Godfrey. My research interests span almost all areas of Computer Networking, and in particular low-latency-networking, multi-path routing, network management abstractions, software-defined networking, intra-application networks, and applications of these topics in healthcare.

Personal Data

Name	<u>Oliver</u> Dominik Michel
Date of Birth	July 21st, 1988.
Citizenship	Germany
Academic Degrees	Master of Science (M.S.), Computer Science, Bachelor of Science (B.Sc.), Computer Science

Education

Aug. 2013 – ongoing	Doctor of Philosophy (Ph.D.), Computer Science University of Colorado Boulder, CO, USA
Aug. 2013 – May 2015	Master of Science (M.S.), Computer Science University of Colorado Boulder, CO, USA – GPA: 3.8/4 – 95%
Mar. 2009 – Jan. 2013	Bachelor of Science (B.Sc.), Computer Science University of Vienna, Austria/Medical University of Vienna, Austria – Specialization: medical informatics – GPA: 3.2/4 – 80% – Thesis: Adaptive Source Routing and Speculative Execution for Multi-homed Wireless Clients in Preclinical Medical Care, grade 4/4 – 100%
Aug. 2011 – Dec. 2011	Austria-Illinois Exchange Program University of Illinois at Urbana Champaign, IL, USA
Jul. 2008 – Feb. 2009	Rettungssanitäter, nationally registered EMT, Germany Academy of the German Red Cross NRW, Düsseldorf, Germany
Aug. 1999 – Jun. 2008	Abitur (high school diploma) Stiftisches Gymnasium Düren, Düren, Germany
Sep. 2006 – Oct. 2006	High School Exchange Program Mount Lebanon High School, Pittsburgh, PA, USA

Publications

Conference Proceedings

Nov. 2013, HotNets-XII	Matthew Monaco, Oliver Michel, and Eric Keller. "Applying Operating System Principles to SDN Controller Design". In *Proceedings of the 12th ACM Workshop on Hot Topics in Networks* (HotNets-XII), College Park, MD, USA, 2013
Oct. 2012, HotNets-XI	Ashish Vulimiri, Oliver Michel, P. Brighten Godfrey, and Scott Shenker. "More is Less: Reducing Latency via Redundancy". In *Proceedings of the 11th ACM Workshop on Hot Topics in Networks* (HotNets-XI), Redmond, WA, USA, 2012

Technical Reports

Aug. 2015	Matthew Monaco, Oliver Michel, Alex Tsankov, and Eric Keller. "Yanc – Yet Another Network Controller". University of Colorado Technical Report, Boulder, CO, USA, 2015

Posters

Aug. 2014, SIGCOMM 2014	Oliver Michel, Michael Coughlin, Eric Keller. "Extending the Software-defined Network Boundary". Poster at the ACM SIGCOMM 2014 Conference, Chicago, IL, USA
Apr. 2014, NSDI 2014	Michael Coughlin, Oliver Michel, Eric Keller, Adam J. Aviv. "Making the Live Network the Honeypot". Poster at the 11th USENIX Symposium on Networked Systems Design and Implementation (NSDI '14), Seattle, WA, USA, 2014
Oct. 2013, GEC18	Oliver Michel, Matthew Monaco, Eric Keller. "Applying Operating System Principles to SDN Controller Design". Poster and Demo at the 18th GENI Engineering Conference (GEC18), New York, NY, USA, 2013
Apr. 2013, NSDI 2013	Oliver Michel, David Stezenbach, Kurt Tutschku. "Multihoming and Adaptive Multipath Transmission using off-the-shelf Components in Preclinical Medical Care". Poster at the 10th USENIX Symposium on Networked Systems Design and Implementation (NSDI '13), Chicago, IL, USA, 2013
Mar. 2012, GEC12	Oliver Michel, Ashish Vulimiri, and P. Brighten Godfrey. "Adaptive Source Routing". Poster at the 13th GENI Engineering Conference (GEC13), Los Angeles, CA, USA, 2012

Presentations

Apr. 2014	Oliver Michel, Matthew Monaco, Eric Keller. "Applying Operating System Principles to SDN Controller Design". Invited Talk, University of Illinois at Urbana-Champaign, Champaign, IL, USA
Apr. 2013	Oliver Michel. "More is Less - Reducing Latency via Redundancy". Invited Talk, University of Colorado Boulder, Boulder, CO, USA

Nov. 2012	Oliver Michel. "Adaptive Source Routing and Speculative Execution for Multi-homed Wireless Clients in Preclinical Medical Care". Bachelor Thesis and public presentation at the University of Vienna, Austria
Oct. 2012	Ashish Vulimiri, Oliver Michel, P. Brighten Godfrey, and Scott Shenker. "More is Less - Reducing Latency via Redundancy". Talk at the 15th GENI Engineering Conference (GEC15), Houston, TX, USA

Research Experience

Positions

Jan. 2014 - ongoing	Research Assistant, Next Generation Networks Research Group, Department of Computer Science at the University of Colorado Boulder, Boulder, CO, USA
Oct. 2010 - Feb. 2013	Undergraduate Research Assistant, Institute for Distributed & Multimedia Systems - Chair of Future Communication at the University of Vienna, Austria

Projects

Defragmenting the Cloud Network virtualization is a widely used technique to overcome the ossification of networks. Being commonly applied in both datacenter as well as wide-area settings, network virtualization enhances network flexibility and enables innovation by making it easier to provide network programmability. However, mapping virtual resources (links and nodes) to physical (substrate) resources is a challenging problem and commonly referred to as the provably NP-hard virtual network embedding (VNE) problem. As virtual networks come and go over time, VNE algorithms tend to introduce resource fragmentation in the network leading to request rejection when resources would technically be available but cannot be assigned to the requested topology or other request constraints. In this project we aim at (1) improving VNE algorithms by considering resource fragmentation, (2) design a defragmentation algorithm enabling the online reconfiguration of virtual networks to reduce fragmentation. In a second step, we investigate systems primitives to allow for reconfiguration of virtual networks. This work is based on the work on Live Migration of Ensembles (LIME) as presented by our group at HotNets-XI and SoCC '14.

- Technologies: custom C++ simulation framework, Mixed Integer Programming algorithms, ALEVIN VNE simulation suite

Policy Routing using Process-Level Identifiers Enforcing and routing based on network-wide policies remains a crucial challenge in the operation of large-scale enterprise and datacenter networks. As current dataplane devices solely rely on layer 2 – layer 4 identifiers to make forwarding decisions, there is no notion of the exact origin of a packet in terms of the sending user or process. In this project we ask the question: *Can we go beyond the MAC?* That is, can fine-grained process-level information like user ids, process ids or a cryptographic hash of the sending executable be semantically used to make forwarding decisions within the network? We designed a system architecture and implemented an early prototype leveraging the P4 technology for protocol-independent packet processing and forwarding in conjunction with on-board tools of the Linux operating system. Using this system we are able to make forwarding decisions within the network based on fine-grained process-level identifiers that are traditionally only available within a host's operating system.

- Technologies: Linux systems programming, P4

Network Abstractions in the Application Layer Many of todays applications (in particular data processing applications) use intra-application networks to connect computing elements. By making intra-application networks part of the network itself, we simplify applications by providing an abstraction of the network, freeing applications from the responsibility of maintaining their own internal topology management and forwarding systems. Also, moving the network edge into the applications allows the network management to leverage advances such as software-defined networking, providing a unified management across an entire path. For these networks we are inspecting a new interface to the network based on intra-application channels told to the network rather than addresses.

- Technologies: Apache Storm, DBus, Trema OF Controller, Apache Kafka, Click Modular Router
- Publications:"Extending the Software-defined Network Boundary", Poster, SIGCOMM 2014

SDN Controller Architecture While there is a broad variety of SDN controllers (both proprietary and open source) available, we investigate the commonalities between SDN controllers (often referred to as the network operating system) and traditional operating systems. We believe network application should be developed against an API that is similar to that of existing operating systems. That is that SDN applications should run independently from each other and not in a monolithic design (like todays controllers suggest it). Also applications should be able take advantage of features that operating systems already provide (such as access control and process management). In this area I am particularly interested in how such independent applications are composed and are granted access to the network configuration.

- Technologies: Linux Systems Programming, OpenFlow, libfuse, NFS, OpenVSwitch
- Publications: "Applying Operating System Principles to SDN Controller Design", Paper, HotNets-XII

Low Latency Networking Latency is an extremely important quality metric of computer networks. While network hardware can be designed and provisioned to provide low latency on average, heavy tails are pervasive in latency distributions of almost all classes of networks due to a variety of reasons. We investigate several techniques how to reduce this latency tail and provide networking at the speed of light with a more uniform latency distribution compared to what todays networks are able to achieve. Strategies such as redundant multi- or single-path routing, as well as adaptive source routing across wide-area networks showed extremely satisfactory early results.

- Technologies: Linux Systems Programming, Linux Tunneling, GENI Mesoscale Infrastructure
- Publications: "More is Less – Reducing Latency by Redundancy", Paper, HotNets-XI

Work Experience

Jun. 2009 – Jun. 2011	iPhone-Software-Developer, Tupalo.com Internet-Services GmbH, Vienna, Austria
Jan. 2003 – ongoing	Founder, Owner, editum internet solutions, Hürtgenwald, Germany

Voluntary Work

Aug. 2014 - ongoing	Emergency Medical Technician, University of Colorado Emergency Medical Services, Boulder, CO, USA
Feb. 2009 - ongoing	Emergency Medical Technician, Fire Department, emergency medical services, ICU transfers, City of Düren, Germany

Internships

Jun. 2013 – Jul. 2013	Visiting Researcher, Department of Computer Science, University of Colorado at Boulder, CO, USA
Jul. 2012 – Aug. 2012	Undergraduate Research Intern (NSF REU), Information Trust Institute, University of Illinois at Urbana-Champaign, IL, USA
Jan. 2012 – Mar. 2012	Visiting Researcher, Department of Computer Science, University of Illinois at Urbana-Champaign, IL, USA
Sep. 2009	Medical Center of the Albert-Ludwig University Freiburg, Department for heart and vascular surgery, transplant center, Freiburg, Germany
Jan. 2009	St. Marien-Hospital Düren, Department of Anesthesiology and surgical intensive-care medicine, Düren, Germany
Oct. 2008 – Dec. 2008	Fire Department, emergency medical services, ICU transfers, City of Düren, Germany
Aug. 2008	Medical Center of the RWTH Aachen University, Department of plastic-, hand- and burn-surgery, burn/trauma center, Aachen, Germany
Sep. 2005	Spymac Network Germany GmbH, Düsseldorf, Germany
Apr. 2004	Clanotopia IT-Service Ltd., Essen, Germany

Awards and Fellowships

Aug. 2013	Dean's Outstanding Merit Fellowship, University of Colorado Boulder, CO, USA
Jun. 2011	Joint Study Scholarship of the Rector of the University of Vienna, Austria

Teaching Experience

Oct. 2015	Guest Lecturer, Advanced Networking, (ECEN5013), Prof. Eric Keller, University of Colorado at Boulder, CO, USA
Aug. 2013 - Dec. 2013	Teaching Assistant, Introduction to Computer Systems (CSCI2400), Prof. Richard Han, University of Colorado at Boulder, CO, USA
Mar. 2012 - Jun. 2012	Teaching Assistant, Undergraduate Networking (VO Network Technologies), Prof. Kurt Tutschku, University of Vienna, Austria

Technical Skills

Programming Languages	C, C++, Objective-C, Ruby, Wolfram Language, Python, Bash, Java, Java Script, PHP
Technologies/Tools	UNIX Systems Development, OpenFlow, P4, LaTeX, Apple Cocoa & iOS, Mathematica, Click Modular Router, Ruby on Rails, OpenGL, CMake, Git, Subversion, dbus, systemd, UML, libvirt

Graduate Coursework

2015	Design and Analysis of Algorithms (CSCI5454) Natural Language Processing (CSC5832)
2014	Advanced Networking (CSCI7000/05) Advanced Database Systems (CSCI5817) Computer Graphics (CSCI5229) Network Analysis (CSCI5352)
2013	Advanced Computer and Networked System Security (CSCI7000/12) Research Topics in Datacenter Scale Computing (CSCI7000/14)
2011	Advanced Computer Networks (CS538 – University of Illinois)

Et cetera

Conference Attendances	SIGCOMM 2011 (2011, Toronto, Canada), GEC 13 (2012, Los Angeles, CA), SIGCOMM 2012 (2012, Helsinki, Finland), HotNets-XI (2012, Seattle, WA), NSDI 2013 (2013, Chicago, IL), HotNets-XII (2013, College Park, MD), NSDI 2014 (2014, Seattle, WA), SIGCOMM 2014 (2014, Chicago, IL), 2nd P4 Workshop (2015, Palo Alto, CA), 1st P4 Developer Bootcamp (2015, Palo Alto, CA)
Travel Grants	GEC18, NSDI '14
Associations	ACM, USENIX
Languages	German (native language), English (fluent), Latin (Latinum)

References

- Eric Keller, Professor, University of Colorado Boulder, CO, USA – eric.keller@colorado.edu

- Richard Han, Professor, University of Colorado Boulder, CO, USA – rhan@colorado.edu

- Kurt Tutschku, Professor, Blekinge Institute of Technology, Sweden – kurt.tutschku@bth.se

- Philip Brighten Godfrey, Professor, University of Illinois at Urbana-Champaign, IL, USA – pbg@illinois.edu

- Ernst Schuster, Professor emeritus, Medical University of Vienna, Austria – ernst.schuster@meduniwien.ac.at