

Reto Achermann

SYSTEMS · RESEARCHER

ETH Zurich

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Research Interests

I am interested in building system software for heterogeneous hardware platforms with specialized cores and accelerators, non-uniform memories and storage, and configurable interconnects. My research focus is in the development of useful and accurate operating system abstractions by combining the design and implementation of operating systems, domain specific languages and applications of formal methods to obtain correct-by-construction system software.

Education

Doctor of Science (PhD) in Computer Science, ETH Zurich

- Advisor: Prof. Timothy Roscoe
- Thesis Title: On Memory Addressing [pdf]

November 2014 - February 2020

Zurich, Switzerland

Master of Science (MSc) in Computer Science, ETH Zurich

- Advisor: Prof. Timothy Roscoe
- Specialization: Distributed Systems. Grade: 5.8 / 6.0 (with distinction)
- Thesis Title: Message passing and bulk transport on heterogenous multiprocessors [pdf]

September 2013 - October 2014

Zurich, Switzerland

Bachelor of Science (BSc) in Computer Science, ETH Zurich

- Thesis Title: Barrelfish USB Subsystem

September 2009 - September 2013

Zurich, Switzerland

Officer School Swiss Armed Forces, Swiss Government

- Theoretical and practical leadership education and conflict management.

June 2008 - September 2009

Switzerland

Professional Experience

Research Assistant, ETH Zurich

RESEARCH GROUP OF PROF. TIMOTHY ROSCOE, PHD.

- Dissertation: On Memory Addressing - a more faithful hardware abstractions for modern operating systems.
- Barrelfish: Member of the core OS team working on device drivers, memory management, networking.
- Sockeye: Describing hardware as seen by software using a formal model specified in Isabelle/HOL
- Shoal: memory allocation strategies in a NUMA machine with knowledge of the access patterns.
- Smelt: automatically tuning message passing primitives to the machine hardware topology using measurements.
- Enzian: understanding the coherency protocol for the Enzian research computer.

November 2014 - present

Zurich Switzerland

Intern VMware Research Group, VMware Research

RESEARCH GROUP OF JAYNEEL GANDHI, PHD.

- Project: Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines.

June 2018 - September 2018

Palo Alto (CA), United States

Intern Systems Software, Hewlett-Packard Labs

RESEARCH GROUP OF DEJAN S. MILOJICIC, PHD.

- Project: Consensus protocols and capabilities for the Machine.

September 2015 - December 2015

Palo Alto (CA), United States

Staff Officer (Captain), Swiss Armed Forces

RADIO TRANSMISSION AND IT SERVICES.

- Leadership and management training.
- Planning and deployment of heterogeneous communication systems, IT systems and networks.
- Leading education modules and training exercises with up to 350 people.

June 2009 - present

Switzerland

Peer Reviewed Publications

- Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines** [ASPLOS '20](#)
RETO ACHERMANN, ASHISH PANWAR, ABHISHEK BHATTACHARJEE, TIMOTHY ROSCOE AND JAYNEEL GANDHI 2020
- Memory-Side Protection With a Capability Enforcement Co-Processor** [ACM TACO Vol 16-1](#)
LEONID AZRIEL, LUKAS HUMBEL, RETO ACHERMANN, ALEX RICHARDSON, MORITZ HOFFMANN, AVI MENDELSON, TIMOTHY ROSCOE, ROBERT N. M. WATSON, PAOLO FARABOSCHI AND DEJAN MILOJICIC 2019
- Physical Addressing on Real Hardware in Isabelle/HOL** [ITP'18](#)
RETO ACHERMANN, LUKAS HUMBEL, DAVID COCK AND TIMOTHY ROSCOE 2018
- Formalizing Memory Accesses and Interrupts** [MARS'17](#)
RETO ACHERMANN, LUKAS HUMBEL, DAVID COCK AND TIMOTHY ROSCOE 2017
- Towards Correct-by-Construction Interrupt Routing on Real Hardware** [PLOS'17](#)
LUKAS HUMBEL, RETO ACHERMANN, DAVID COCK AND TIMOTHY ROSCOE 2017
- Separating Translation from Protection in Address Spaces with Dynamic Remapping** [HotOS '17](#)
RETO ACHERMANN, CHRIS DALTON, PAOLO FARABOSCHI, MORITZ HOFFMANN, DEJAN MILOJICIC, GEOFFREY NDU, ALEXANDER RICHARDSON, TIMOTHY ROSCOE, ADRIAN L. SHAW AND ROBERT N. M. WATSON 2017
- Machine-aware Atomic Broadcast Trees for Multicores** [OSDI'16](#)
STEFAN KAESTLE, RETO ACHERMANN, RONI HAECKI, MORITZ HOFFMANN, SABELA RAMOS AND TIMOTHY ROSCOE 2016
- SpaceJMP: Programming with Multiple Virtual Address Spaces** [ASPLOS '16](#)
IZZAT EL HAJJ, ALEXANDER MERRITT, GERD ZELLWEGER, DEJAN MILOJICIC, RETO ACHERMANN, PAOLO FARABOSCHI, WEN-MEI HWU, TIMOTHY ROSCOE AND KARSTEN SCHWAN 2016
- Shoal: Smart Allocation and Replication of Memory for Parallel Programs** [USENIX ATC '15](#)
STEFAN KAESTLE, RETO ACHERMANN, TIMOTHY ROSCOE AND TIM HARRIS 2015
- Not Your Parents' Physical Address Space** [HotOS'15](#)
SIMON GERBER, GERD ZELLWEGER, RETO ACHERMANN, KORNILIOS KOURTIS, TIMOTHY ROSCOE AND DEJAN MILOJICIC 2015

Other Publications

- CleanQ: a lightweight, uniform, formally specified interface for intra-machine data transfer** [arXiv:1911.08773](#)
RONI HAECKI, LUKAS HUMBEL, RETO ACHERMANN, DAVID COCK, DANIEL SCHWYN AND TIMOTHY ROSCOE 2019
- Cichlid: Explicit physical memory management for large machines** [arXiv:1911.08367](#)
SIMON GERBER, GERD ZELLWEGER, RETO ACHERMANN, MORITZ HOFFMANN, KORNILIOS KOURTIS, TIMOTHY ROSCOE AND DEJAN MILOJICIC 2019
- A Least-Privilege Memory Protection Model for Modern Hardware** [arXiv:1908.08707](#)
RETO ACHERMANN, NORA HOSSLE, LUKAS HUMBEL, DANIEL SCHWYN, DAVID COCK AND TIMOTHY ROSCOE 2019
- Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines** [arXiv:1910.05398](#)
RETO ACHERMANN, ASHISH PANWAR, ABHISHEK BHATTACHARJEE, TIMOTHY ROSCOE AND JAYNEEL GANDHI 2019
- Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines (Poster)** [OSDI'18:Poster Sessions](#)
RETO ACHERMANN, ASHISH PANWAR, ABHISHEK BHATTACHARJEE, TIMOTHY ROSCOE AND JAYNEEL GANDHI 2018
- Sockeye: Formally Describing Hardware as Seen by Software (Poster)** [OSDI'18:Poster Sessions](#)
RETO ACHERMANN, LUKAS HUMBEL, RONI HAECKI, DAVID COCK AND TIMOTHY ROSCOE 2018
- Enzian: a research computer for datacenter and rackscale computing (Poster)** [OSDI'18:Poster Sessions](#)
DAVID COCK, DAVID SIDLER, MUHSEN OWALDA, RETO ACHERMANN, TOBIAS GROSSER, ZEKE WANG, AMIT KULKARNI, ALAIN DENZLER, ADAM TUROWSKI, ABISHEK RAMDAS, ANASTASIIA RUZHANSKAIA, TIMOTHY ROSCOE AND GUSTAVO ALONSO 2018
- Formalizing Address Space Interactions (Poster)** [OSDI'16:Poster Sessions](#)
RETO ACHERMANN AND TIMOTHY ROSCOE 2016

Patents

Transparent Self-Replicating Page Tables in Computing Systems

RETO ACHERMANN AND JAYNEEL GANDHI

Pending

January 2019

Interoperable capabilities

RETO ACHERMANN, MAURICE BAILLEU, DEJAN S. MILOJICIC AND GABRIEL PARMER

US20170329526A1

January 2016

Memory management with versioning of objects

IZZAT EL HAJJ, ALEXANDER MERRITT, GERD ZELLWEGER, DEJAN S. MILOJICIC AND RETO ACHERMANN

WO2017131789A1

January 2016

Projects

Sockeye - Formally Specifying Hardware as Seen by Software

github.com/BarrelfishOS

Sockeye is a framework for accurately representing hardware configurations. Faithful hardware abstractions used by operating systems to represent memory, interrupt, power and clock domain configurations of heterogeneous computer systems and formally define the semantics there of. With Sockeye, platform specific operating systems code can be generated (e.g. correct-by-construction page-tables). Sockeye is integrated in the Barrelfish OS.

Mitosis - Page-Table Replication for Big Memory Workloads

research.vmware.com/projects/

Big-memory workloads spend a significant fraction of their runtime serving TLB misses. Walking page-tables require up to 24 memory accesses and experiences NUMA effects. Mitosis transparently replicates page-tables across sockets to eliminate cross-socket page-table walks. Implementation of Linux kernel extensions and application runtime.

Enzian - A Research Computer

enzian.systems

Enzian is a research computer combining a big server-class ARM CPU with a large FPGA connected through the Enzian Coherency Interface (ECI). My work targeted the understanding of the processor's native coherence protocol driving the development of ECI.

Barrelfish Operating System

barrelfish.org

Barrelfish is a Multikernel based research operating system developed at ETH Zurich. Part of this project, my work consists of architectural support (Xeon Phi, ARMv8), device drivers (Xeon Phi co-processor, USB, DMA drivers), runtimes (bulk-transport subsystem, OpenMP, multiple-virtual address spaces, Shoal runtime).

Smelt - Machine Aware Message-Passing Primitives

github.com/libsmelt

Machine-optimized construction of broadcast and reduction trees as message-passing primitives. Smelt targets multi-core systems. The project work consisted of design and implementation of the Smelt runtime library including message passing abstractions.

Shaal - Smart Memory Allocation for NUMA Machines

github.com/libshaal

Automatic optimization of memory allocation for parallel programs (Graph processing in Green-Marl) based on access patterns. Project work consisted of the design and implementation of the memory abstractions, Barrelfish runtime support and support for DMA engines of the runtime.

Awards

HiPEAC Paper Award SpaceJMP: Programming with Multiple Virtual Address Spaces (ASPLOS'16)

2016

Scientific Presentations

Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines

March 19, 2020

25TH INTERNATIONAL CONFERENCE ON ARCHITECTURAL SUPPORT FOR PROGRAMMING LANGUAGES AND OPERATING SYSTEMS

Memory Topology Models and Their Application in Operating Systems

February 25, 2020

TRUSTWORTHY SYSTEMS, DATA 61, CSIRO, AUSTRALIA.

Faithful Hardware Representation and Least-Privilege Memory Management in Operating Systems

December 06, 2019

LAB FOR ADVANCED SYSTEMS RESEARCH (LASR), UNIVERSITY OF TEXAS AT AUSTIN, USA

Realistic Hardware Abstractions and Least-Privilege Memory Management in Operating Systems

NETWORKS, SYSTEMS, AND SECURITY (NSS) LAB, UNIVERSITY OF BRITISH COLUMBIA, CANADA

November 01, 2019

Mitosis: Transparently Self-Replicating Page-Tables for Large-Memory Machines

SYSTEMS GROUP, ETH ZURICH, SWITZERLAND.

November 30, 2018

Model based system configuration and tasteful hardware

SYSTEMS RESEARCH GROUP, UNIVERSITY OF CAMBRIDGE, CAMBRIDGE, UK

July 06, 2017

Provable Correct Memory Management

11TH EUROSYS DOCTORAL WORKSHOP

April 23, 2017

Smelt: Machine-aware Atomic Broadcast Trees for Multicores

12TH USENIX SYMPOSIUM ON OPERATING SYSTEMS DESIGN AND IMPLEMENTATION

November 2, 2016

Teaching Experience

Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2019, ETH Zurich
Teaching Assistant	Application-Oriented Programming (252-0840-02L)	Spring 2019, ETH Zurich
Teaching Assistant	Advanced Operating Systems (263-3800-00L)	Spring 2019, ETH Zurich
Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2018, ETH Zurich
Teaching Assistant	Application-Oriented Programming (252-0840-02L)	Spring 2018, ETH Zurich
Teaching Assistant	Advanced Operating Systems (263-3800-00L)	Autumn 2017, ETH Zurich
Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2017, ETH Zurich
Teaching Assistant	Introductory Programming in MATLAB (252-0840-01L)	Spring 2017, ETH Zurich
Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2016, ETH Zurich
Teaching Assistant	Introductory Programming in MATLAB (252-0840-01L)	Spring 2016, ETH Zurich
Teaching Assistant	Parallel Programming (252-0024-00L)	Spring 2015, ETH Zurich
Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2014, ETH Zurich
Teaching Assistant	Data Modelling and Databases (252-0063-00L)	Spring 2014, ETH Zurich
Teaching Assistant	Systems Programming and Computer Architecture (252-0061-00L)	Autumn 2013, ETH Zurich
Teaching Assistant	Operating Systems and Networks (252-0062-00L)	Spring 2013, ETH Zurich

Student Mentoring Experience

Nora Hossle	Master's Thesis: Multiple Address Spaces in a Distributed Capability System	September 2019, ETH Zurich
Leo Horne	Bachelor's Thesis: Using NetBSD Kernel Components on Barrelfish Through Rump Kernels	August 2019, ETH Zurich
Giuseppe Arcuti	Bachelor's Thesis: Formally modelling hardware standards	August 2019, ETH Zurich
Sven Knobloch	Bachelor's Thesis: System Modeling Co-Design	September 2018, ETH Zurich
Joel Busch	Bachelor's Thesis: Device Queues for USB	May 2018, ETH Zurich
Daniel Schwyn	Master's Thesis: Hardware Configuration With Dynamically-Queried Formal Models	October 2017, ETH Zurich
Andrei Poenaru	Master's Thesis: Explicit OS support for hardware threads	March 2017, ETH Zurich
David Keller	Bachelor's Thesis: Dynamic Linking and Loading in Barrelfish	August 2015, ETH Zurich