Practical Lab

Computer Systems Lab

https://github.com/TUM-DSE/sys-lab

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Peter Okelmann
Sebastian Reimers

Course instructors

Chair of Decentralized Systems Engineering

https://dse.in.tum.de/team/

Dr. Atsushi Koshiba

Postdoc

Peter Okelmann

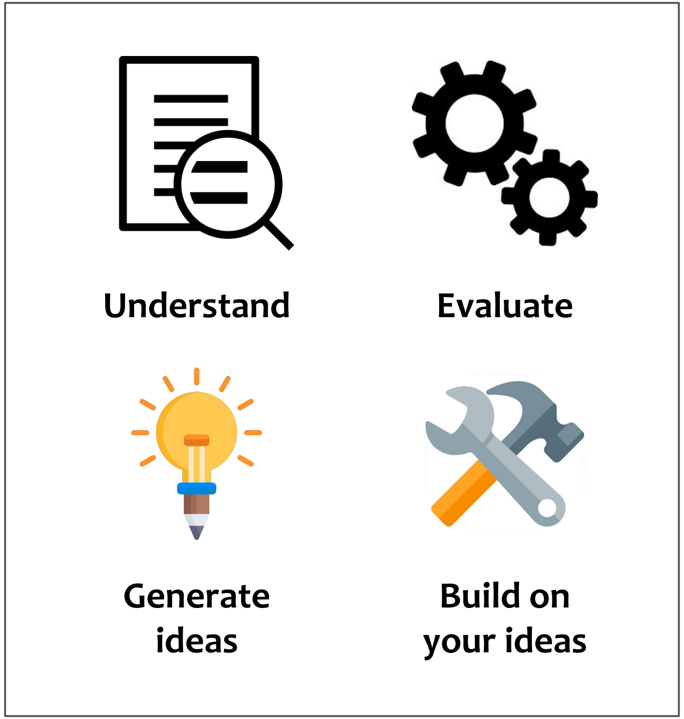
PhD student

Sebastian Reimers

PhD student

Computer systems lab (aka “sys-lab”)

Team
(~4 students per team)



Understand

Evaluate

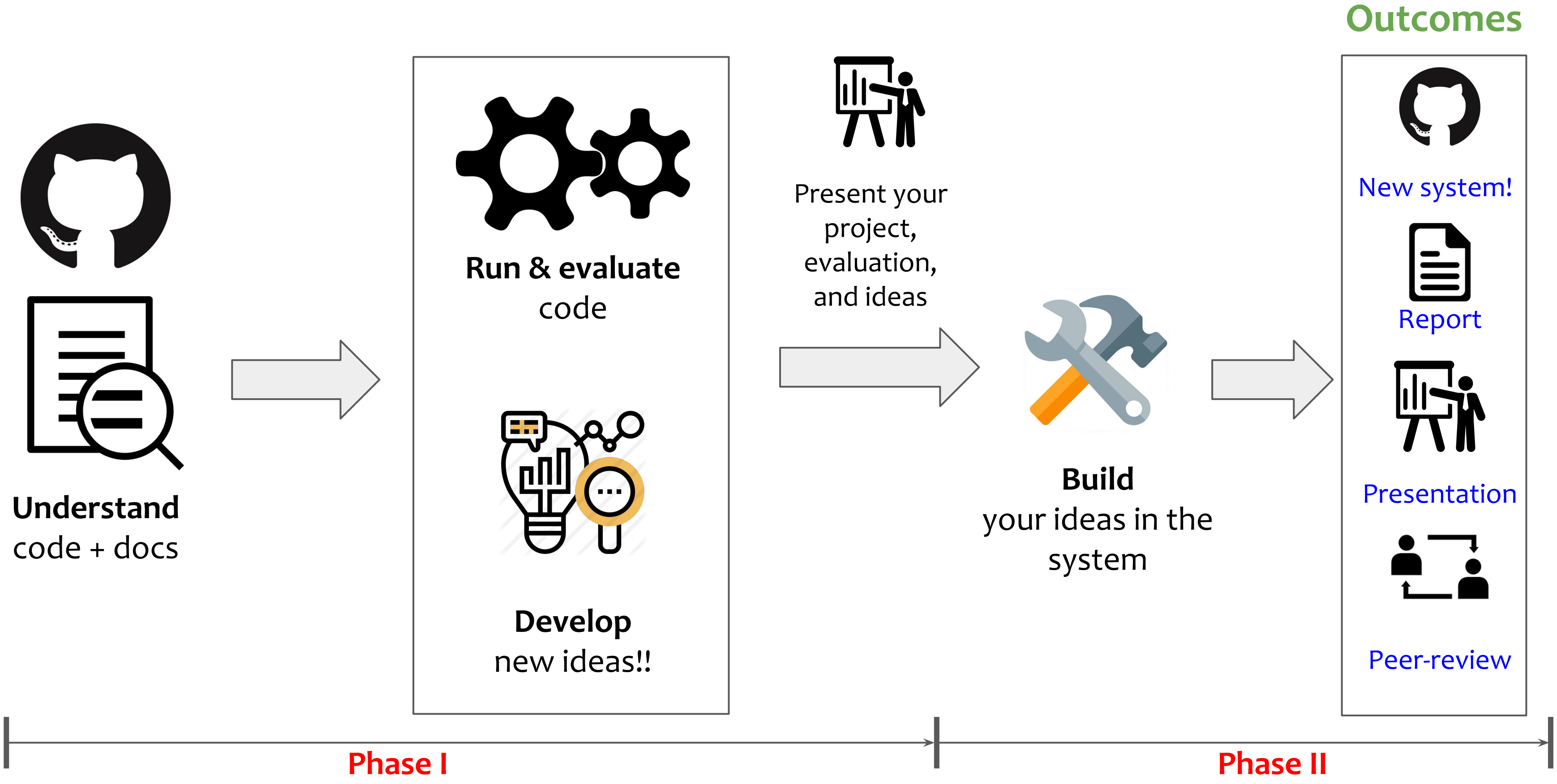
Generate ideas

Build on your ideas

sys-lab

Open source project
(state-of-the-art research topic)

Format



Outcomes

Understand code + docs

Run & evaluate code

Develop new ideas!!

Present your project, evaluation, and ideas

Build your ideas in the system

New system!

Report

Presentation

Peer-review

Phase I

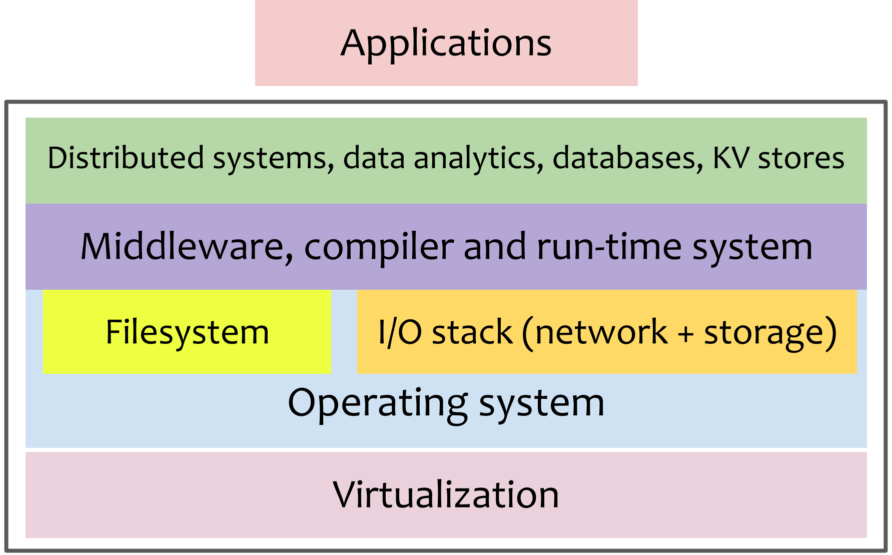
Phase II

Focus of this Lab

- State of the art open-source computer systems projects

- End-to-end system design and development
  - What is it? → Learn by understanding the system
  - How can we use it? → Learn by evaluating the system
  - What can be improved? → Learn by generating new ideas!
  - How to realise our ideas? → Learn by building the system

Research topics



Applications

Distributed systems, data analytics, databases, KV stores

Middleware, compiler and run-time system

Filesystem

I/O stack (network + storage)

Operating system

Virtualization

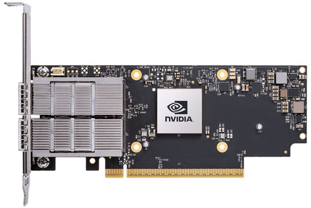
100s-1000s of machines

Data center systems

Key topics: WS 2022/23

- List of projects: https://docs.google.com/spreadsheets/d/17VQ0uc3D0sDqZKhEIgkyOWl-5LmcLCpryMVhSq020JE/edit?usp=sharing

FPGA + Operating systems



SmartNICs +
network & distributed systems

eBPF + storage systems

Project #1: FPGA OS

Project lead: Atsushi Koshiba

Project

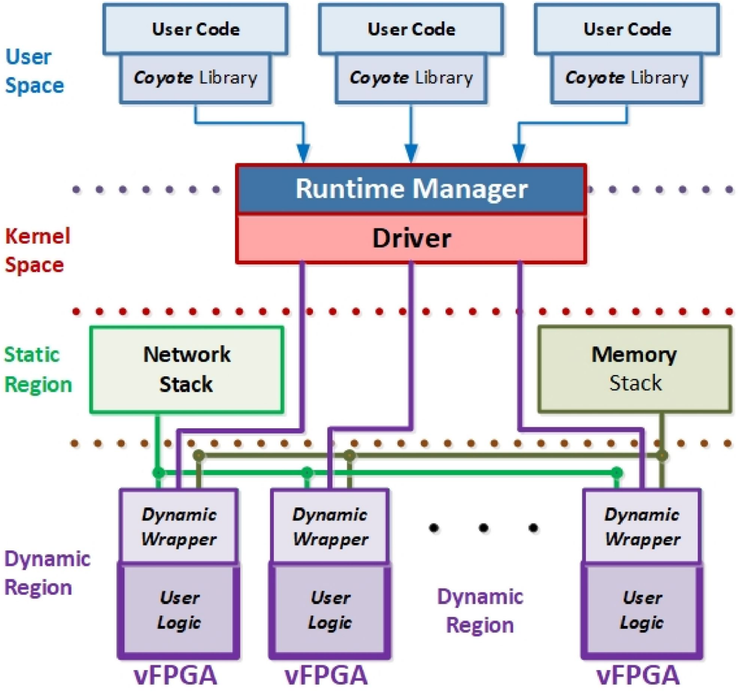
- Coyote [OSDI’20]
- https://github.com/fpgasystems/Coyote

Motivation

- FPGAs popular in cloud computing (e.g., AWS F1)
- Lack OS-level abstraction (multi-tasking, isolation)

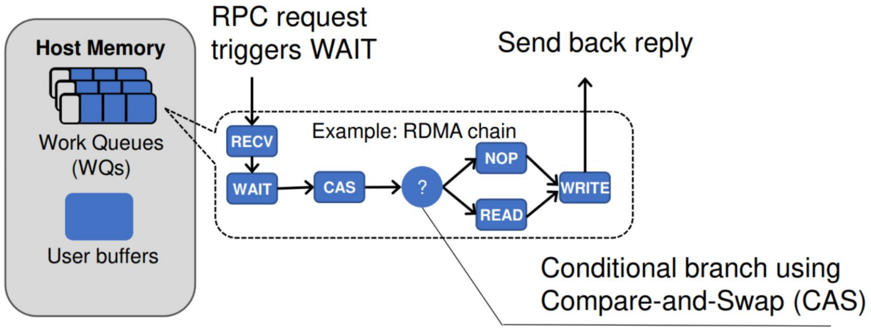
Approach

- Configurable “Shell” offers OS features to user logics



Project #2: SmartNICs

Project lead: Peter Okelmann



Project

- RedN [NSDI'22]
- https://github.com/redn-io/RedN

Motivation

- Commodity NICs[1] have accelerators: RDMA[2], ACLs[3], Regex…
- Does that make them as versatile as SmartNICs?

Approach

- Read/Write arbitrary memory + Conditional branching = RDMA NIC is Turing Complete

1) NIC: Network Interface Card
2) RDMA: Remote Direct Memory Access
3) ACL: Access Control List (for firewalls)

Project #3: eBPF for Storage

Project lead: Sebastian Reimers

Project:

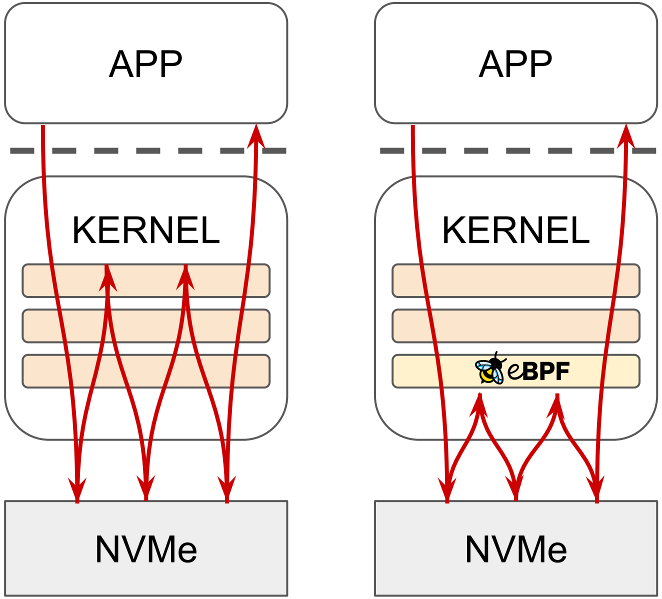
- XRP [OSDI'22]
- https://github.com/xrp-project/XRP

Motivation:

- Convoluted & expensive kernel storage stack
- Kernel bypass solutions lack protection

Approach:

- eBPF enhanced driver to avoid context switches

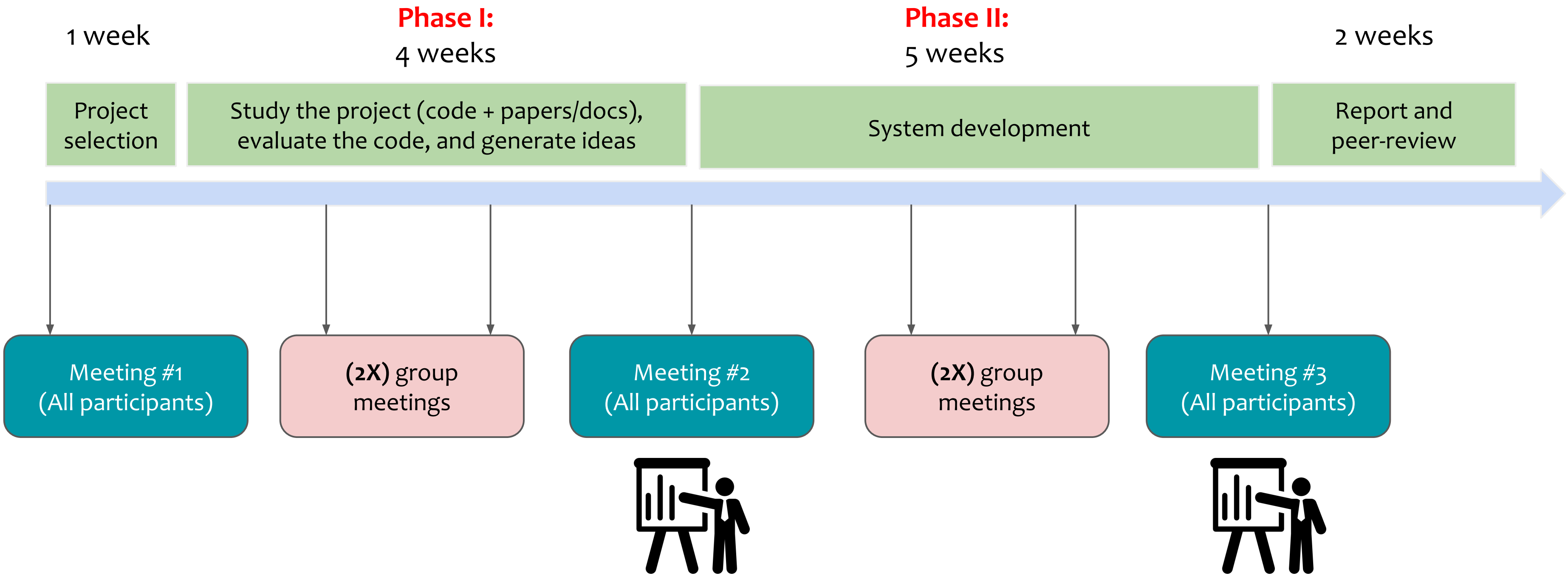


*eBPF: verified userland policies, running in kernel space; https://ebpf.io/

Project selection

#1 FPGA OS	#2 SmartNICs	#3 eBPF for storage
Justus Simon von der Beek	Batuhan Erden	Hanwen Liu
Zixuan Li	Lan Ouyang	Yi He
Rohan Francis Fernandez	Akash Yadav	Wonbang Seo
		Yiwen Liu

Timeline



1 week

Project selection

Phase I:
4 weeks

Study the project (code + papers/docs), evaluate the code, and generate ideas

Phase II:
5 weeks

System development

2 weeks

Report and peer-review

Meeting #1
(All participants)

(2X) group meetings

Meeting #2
(All participants)

(2X) group meetings

Meeting #3
(All participants)

Important Dates

All participant meetings – **IN PERSON**	Dates
Kick-off	20 October 2022, 1:00 PM
Phase I	21 November 2022, 1:30 PM
Phase II	16 January 2023, 1:30 PM

Group meetings – **VIRTUAL**	Dates
(2x) phase I meetings	Directly organized with the team mentor
(2x) Phase II meetings	Directly organized with the team mentor

Grading

Category	Details	Grade
System building	Extending the system with additional features	40%
Running and evaluating code	Reproduce the results described by the authors	20%
Presentation	Two presentations are due after each phase, audience participation is also graded	20%
Report and peer-reviewing	One report covering all aspects and reviewing reports of your peers	20%

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Pull-requests	**Successful pull requests to the project**	**20% (BONUS)**

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peer-reviewing	reports of your peers	
Pull-requests	**Successful pull requests to the project**	**20% (BONUS)**

The top students will be nominated/encouraged to participate in the artifact evaluation committee for the major systems conferences

Organization

- Meetings:
  - Project-based course (~4 students / group)
  - 3 all participant meetings
  - 4 group meetings (with the team mentor)
- Communication:
  - Slack: course channel for announcements and group channel for the team work
  - Hotcrp for report submission and peer-reviewing
- Format:
  - **Meeting #1: Kick-off --** project selection, team formation, and next steps
  - **Meeting #2: Intermediate presentation** covering overview, evaluation, and new ideas!
  - **Meeting #3: Final presentation** covering your final contributions (demo, code, & report)

Learning goals

- Our goal is to have fun breaking and hacking computer systems
- Learn about cutting-edge research in computer systems
- Cultivate an environment for innovation and collaboration
  - Pushes the boundaries of the state of the art
  - Contributing to ongoing open-source projects
- Communication: presenting your work to your peers
- Peer-reviewing: giving constructive feedback to improve other’s work
- Reproducibility: delivering your work such that others can build on it

Code of conduct

- University plagiarism policy
  - https://www.in.tum.de/en/current-students/administrative-matters/student-code-of-conduct/
- Decorum
  - Promote freedom of thoughts and open exchange of ideas
  - Cultivate dignity, understanding and mutual respect, and embrace diversity
  - Racism and bullying will not be tolerated

Contacts

- Dr. Atsushi Koshiba
  - atsushi.koshiba@tum.de
  - **All course information:** https://github.com/TUM-DSE/sys-lab

slack

Workspace: http://ls1-courses-tum.slack.com/

Channel: #ws-22-sys-lab

Join us with TUM email address (@tum.de)