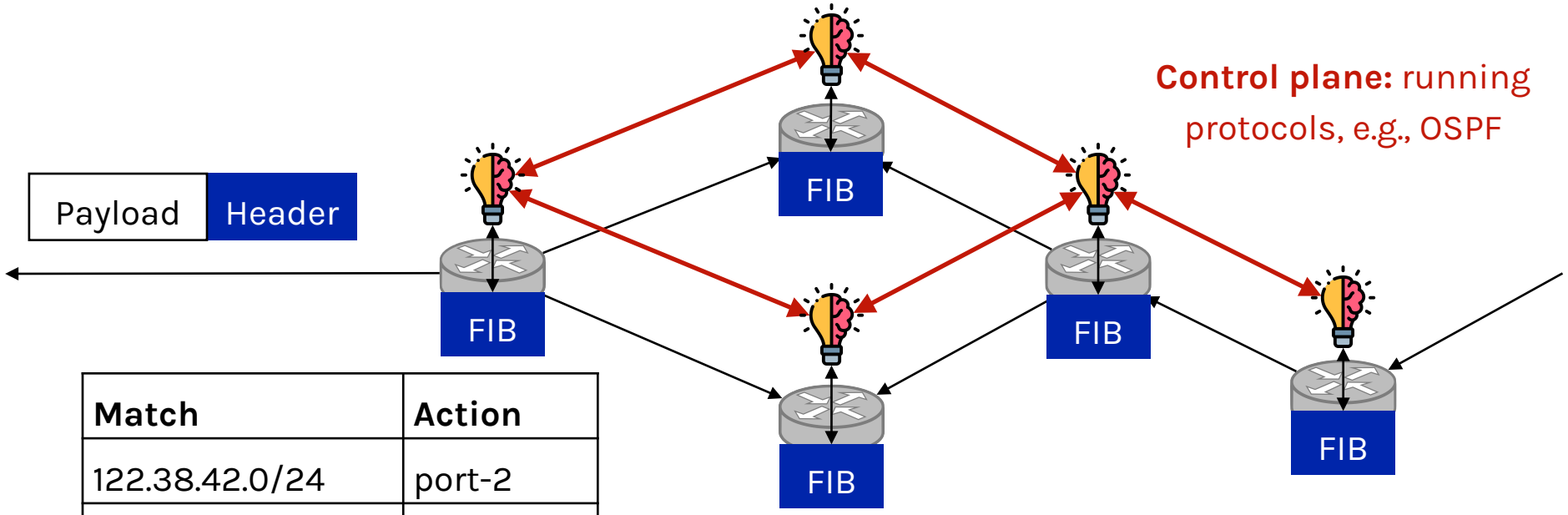
PADERBORN UNIVERSITY

Seminar: Programmable Networks (WS24/25)

Prof. Dr. Lin Wang
Computer Networks Group
Department of Computer Science
Paderborn University

A primer for traditional computer networking

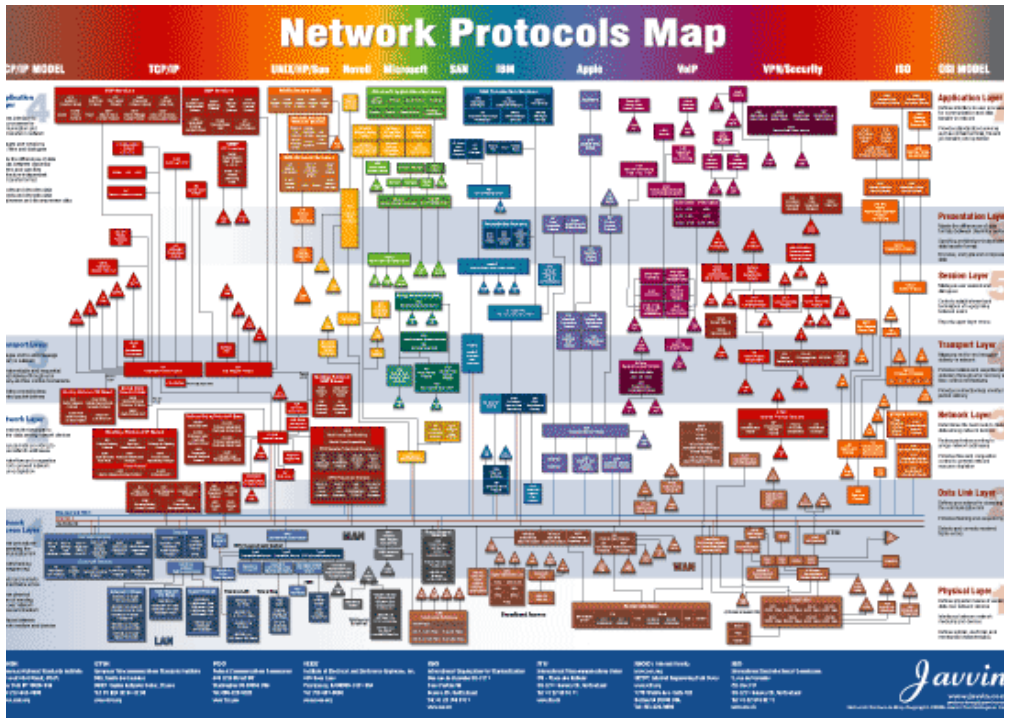


Control plane: running protocols, e.g., OSPF

Match	Action
122.38.42.0/24	port-2
116.16.0.0/16	port-1
139.70.8.0/24	drop

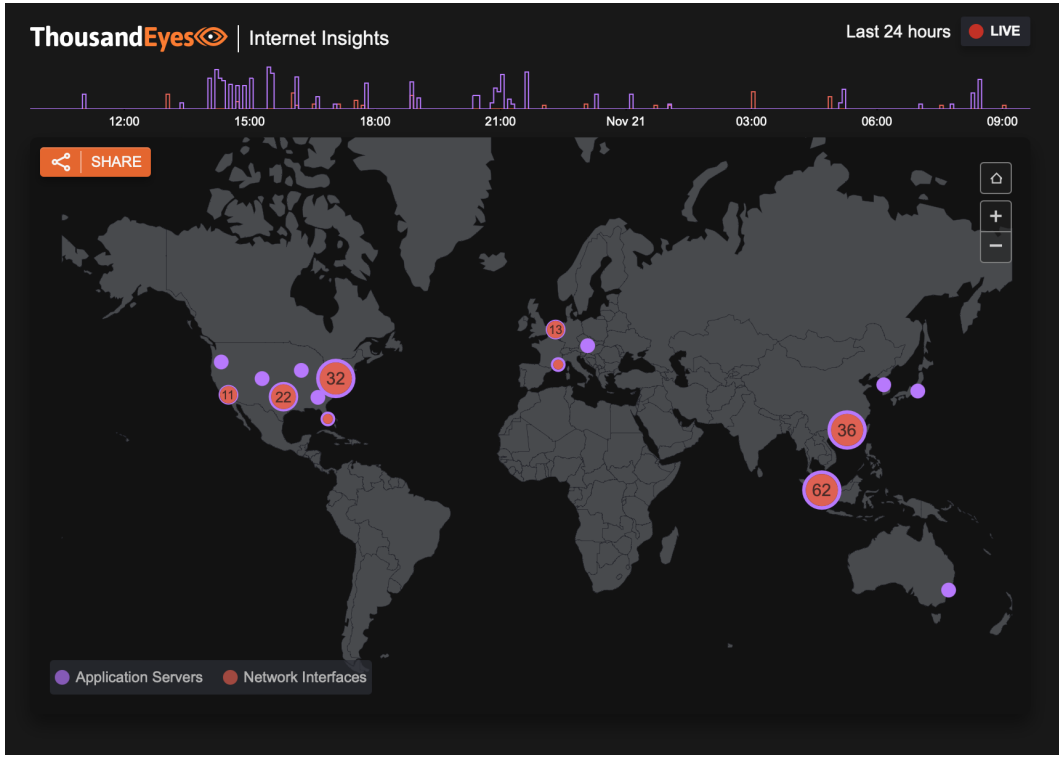
Data plane: packet forwarding with the match-action model

The network is so complex!



The network is built with **a plethora of network protocols**, most of them are **distributed** and **interdependent**!

Internet outages are normal



Optus CEO Kelly Bayer Rosmarin resigns after network outage

Optus parent company Singtel says 'priority is about setting on a path of renewal for the benefit of the community and customers'

- Follow our Australia news live blog for latest updates
- Get our morning and afternoon news emails, free app or daily news podcast

Optus CEO Kelly Bayer Rosmarin resigns following Senate grilling about 14-hour network outage two weeks ago. Photograph: Mike Bowers/The Guardian

https://www.thousandeyes.com/outages/

How to organize these protocols?

Modularity to the rescue

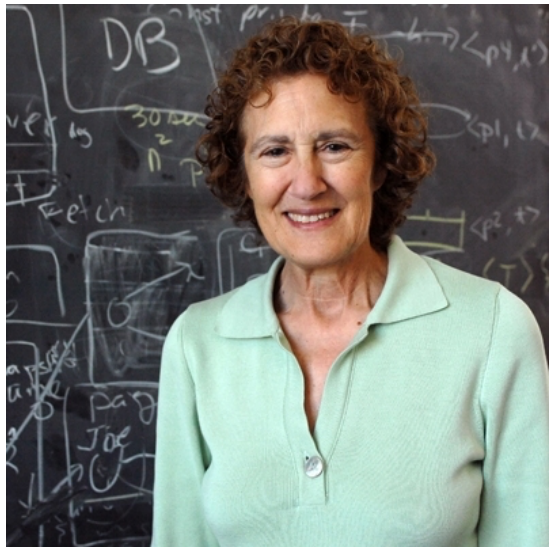


Photo: Donna Coveney

Modularity,
based on abstractions,
is **the** way things get done.

— *Barbara Liskov*, MIT

What abstractions have we learned?

Layered architecture

- Functionalities and protocols are divided into layers based on their responsibilities
- Standard interfaces between different layers to reduce the level of coupling

Software defined networking

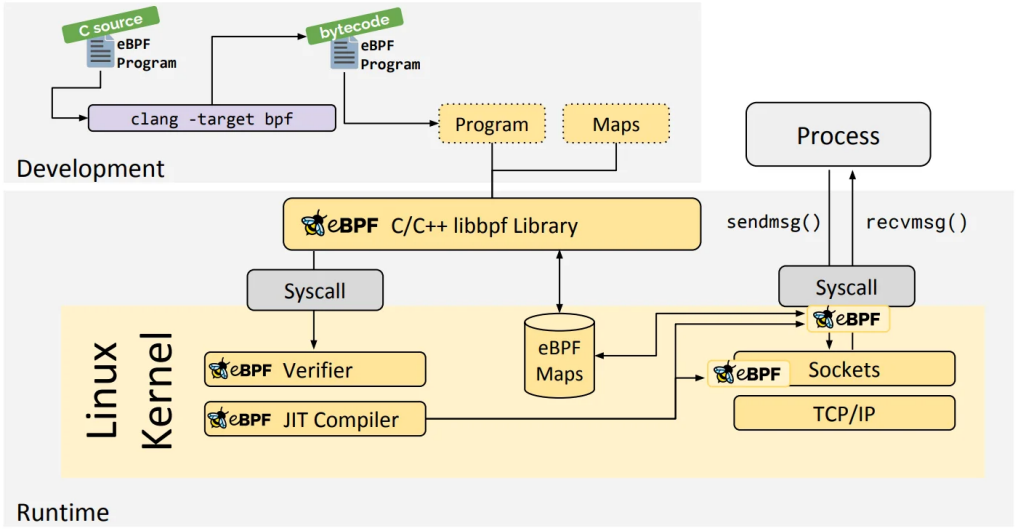
- Decouple control and data planes
- Use centralized software to control the network instead of distributed protocols

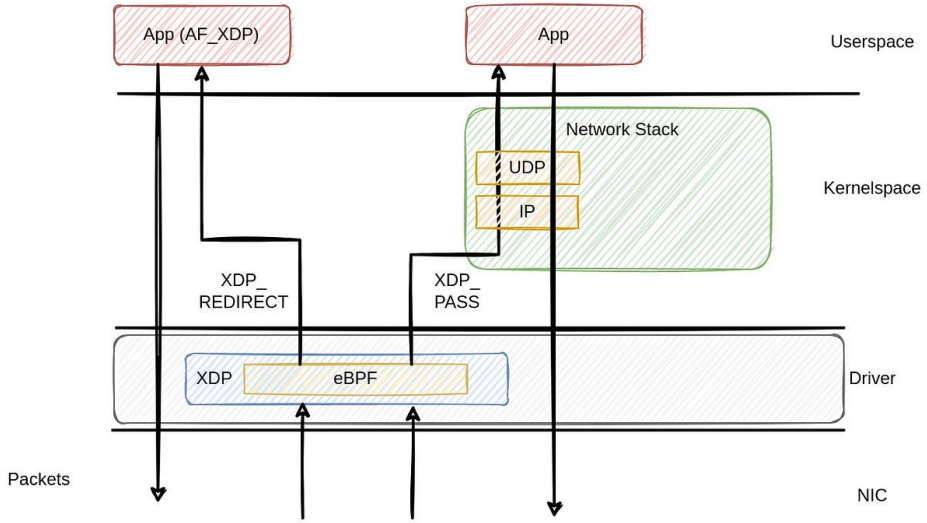
Programmable data plane

- P4 language, programable switches

Can we push it further on programmability?

eBPF/XDP

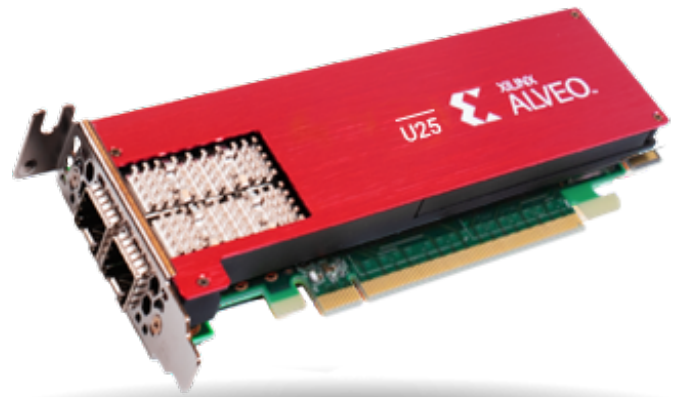


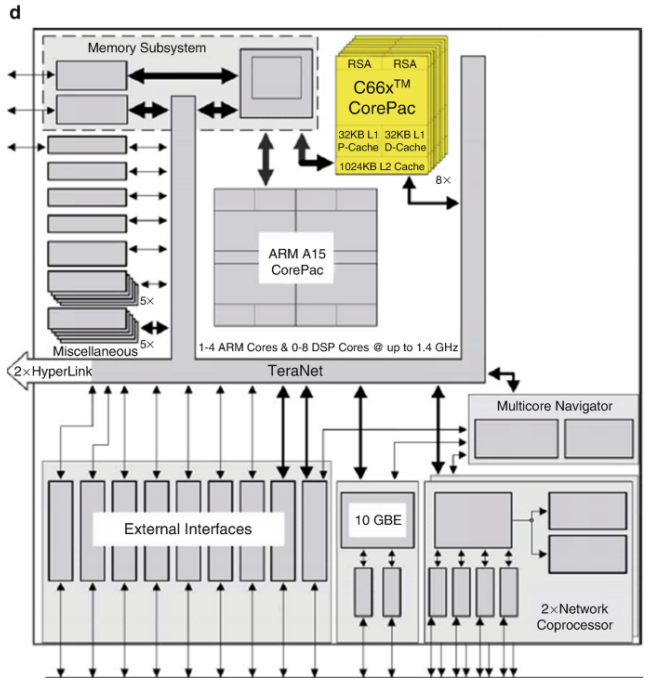


How to leverage eBPF/XDP to do something useful? How to accelerate eBPF execution with hardware?

https://ebpf.io/what-is-ebpf/

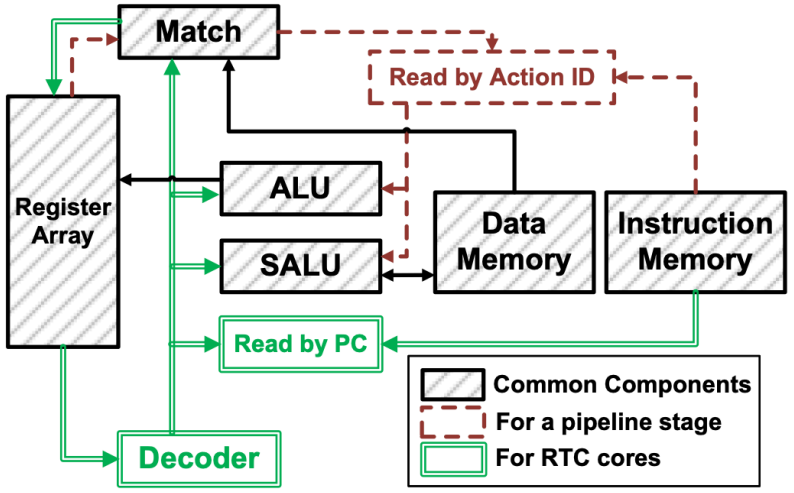
SmartNIC/DPUs: FPGA- or SoC-based

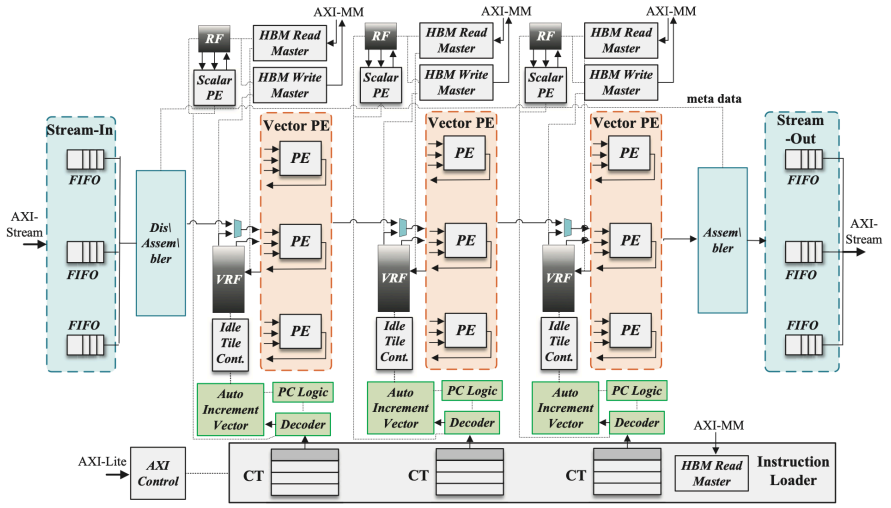




How to achieve high performance, high flexibility, and easy management?

Programmable switches





Customized high-performance switch architectures and switch-application co-design

Seminar Organization

Learning goals

Read scientific papers and perform some basic **literature study**

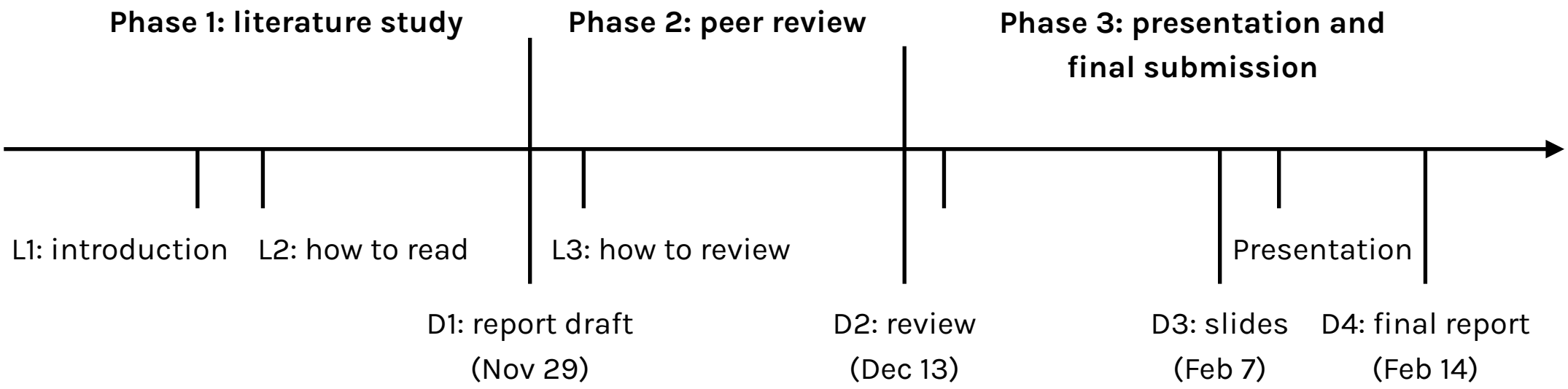
Write a scientific report based on the findings in the literature study

Present your scientific report to a wide audience

Provide feedback to the reports of others in a constructive manner

Timeline

Dates are tentative and subject to changes; always check PANDA



Phase 1: literature study

Select a paper to start with

- We will provide a list of papers
- Go through them briefly and choose one that fits your interest

Find two or more highly relevant papers

- Similar problems but using different approaches, not necessily from the list
- Read all selected papers in-depth

Draft a report for the literature study

- We will provide a latex template, which must be followed strictly

Phase 2: peer review

Logistics

- Submit your draft report **before the deadline**
- Each of you will be assigned with two other reports from your peers

Review comments

- Read the reports assigned to you carefully and write a review for each report
- Submit your review comments on PANDA **before the deadline**
- You will receive comments from two peer students, plus mine

Phase 3: presentation and final submission

Presentation

- Prepare slides for the presentation of your report
- Submit your slides **before the deadline**
- **Attend all the presentations in-person**
- Presentation length: 20 mins of talk + 5 mins of Q&A

Final submission

- Submit your final report **before the deadline**

Grading

Three components

- **Report quality (60%):** understanding, structure, logic, and writing quality
- **Presentation quality (30%):** storyline, flow, slides quality, and question answering
- **Review feedback (10%):** understanding, precision of the comments, and constructiveness of the feedback

PASS criteria

- If you obtain more than 0% for every component AND,
- If you obtain no less than 50% in total

Sub-topics to select papers from

eBPF/XDP

SmartNIC

Switch

Please register your paper preference at https://panda.uni-paderborn.de/mod/choice/view.php?id=2950061

Questions?