



A Master Course on Network Softwarization: Lectures and Practical Assignments

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Frederik Hauser, Mark Schmidt, Michael Menth

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<http://kn.inf.uni-tuebingen.de>



- ▶ bwNET100G+ research project
 - Flexible and intelligent network operation using SDN and NFV
 - Master theses with prototypical implementations
 - 4 concluded
 - 4 running

- ▶ Autodidactic approach to get familiar with SDN
 - Read selected papers from the ONF reading list
 - Start with SDN programming using web tutorials
 - Problems
 - Individual supervision still required
 - Self-familiarization difficult for (some) students



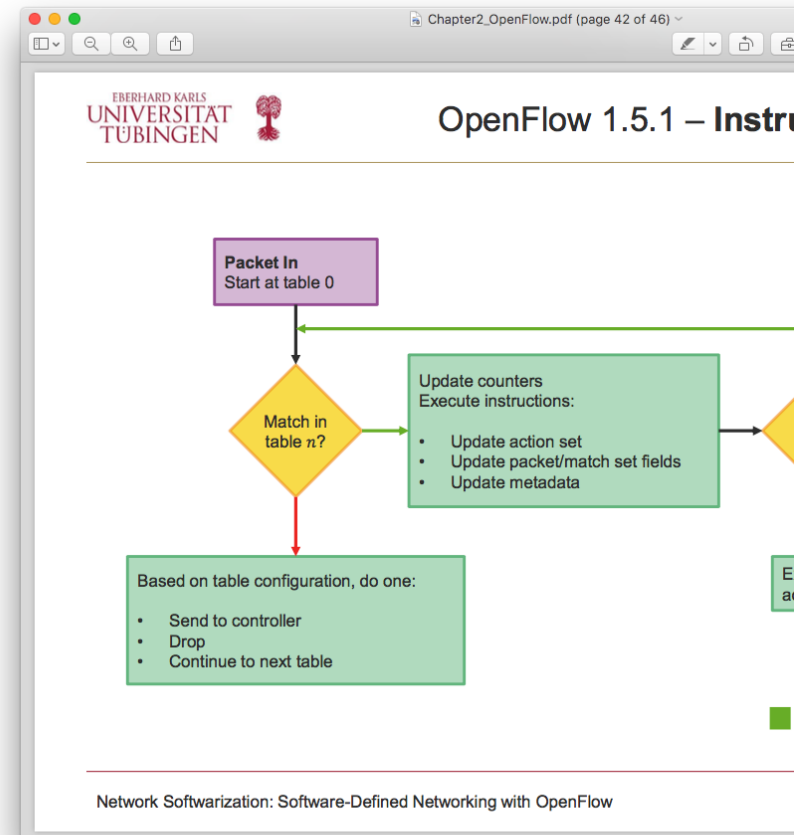


Current Teaching Activities

| | Lectures | | Practical Courses | Seminars |
|----------|---|---------------------------|------------------------------|--|
| Master | <p>Spezielle Kapitel zu Kommunikationsnetzen</p> <p>Pentesting</p> <p>Network Management and Software-Defined Networks</p> <p>Kommunikationsnetze</p> | <p>Leistungsbewertung</p> | <p>Internet-Praktikum II</p> | <p>Advanced Topics in Communications</p> |
| Bachelor | <p>Ausgewählte Themen zu Kommunikationsnetzen</p> <p>Modernes IT Service Management: Die IT Service Factory</p> <p>Grundlagen des Internets</p> <p>Informatik der Systeme</p> | | <p>Internet-Praktikum I</p> | <p>Topics in Communications</p> |



- ▶ Strongly limited workload of 3 ECTS (~ 90 hours)
- ▶ Three parts
 - Seven lecture chapters
 - 90 min per lecture
 - PPT slides and demonstrations
 - Two course projects
 - Interview + programming parts
 - Exam admission with 60% assignment score
 - Exam bonus with up to 10% bonus for scores > 60%
 - Final exam
 - Written exam or oral exam with 25 minutes per student





- ▶ Chapter 1: Introduction to network softwarization
 - Transition from legacy to softwarized networks
 - Legacy management and active networking concepts
 - Software defined networking

- ▶ Chapter 2: OpenFlow
 - OpenFlow architecture and protocol in version 1.0 and 1.5.1
 - Development from the first to the latest feature set

- ▶ Chapter 3: SDN controllers
 - SDN application and control layer
 - Architecture and design principles of SDN controllers
 - Northbound, southbound, east-/westbound interfaces
 - Overview of popular controllers



- ▶ Chapter 4: SDN switches
 - Recap: hardware architecture of legacy routers and switches
 - Hardware and software switches (OF-only, hybrid, whitebox)

- ▶ Chapter 5: SDN use cases
 - Datacenter, enterprise, WAN network use cases

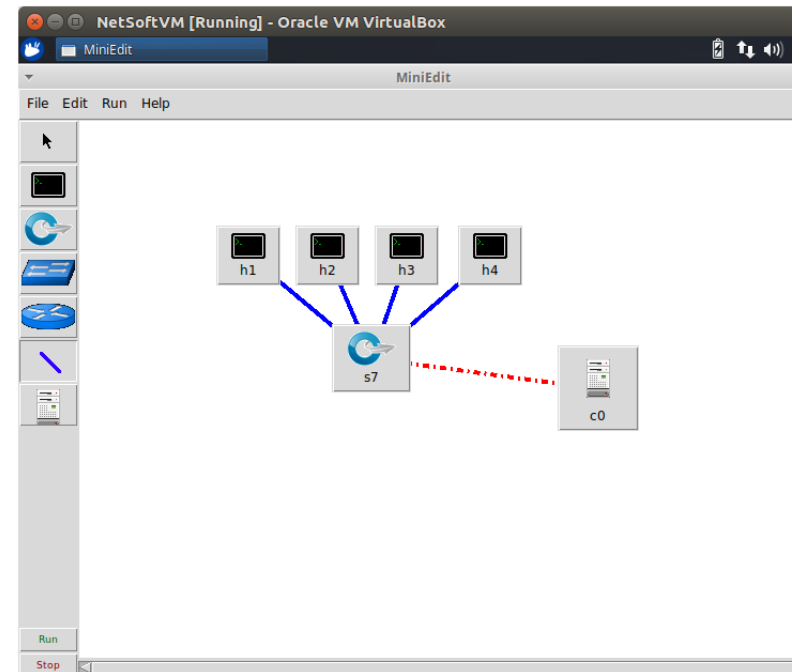
- ▶ Chapter 6: Virtualization techniques
 - Hypervisor-based and OS-level virtualization technologies
 - Orchestration

- ▶ Chapter 7: Network function virtualization
 - ETSI NFV architecture
 - ETSI NFV use cases



- ▶ Two course projects
 - Work in groups of two students

- ▶ Project structure
 - Interview questions
 - Pool of 15 to 20 questions on the assignment's topic
 - Oral test: 5 answers as requirement for assignment grading
 - Programming assignment
 - Infrastructure: Netsoft-VM for VirtualBox
 - Software: Mininet, Miniedit, Ryu





► Method

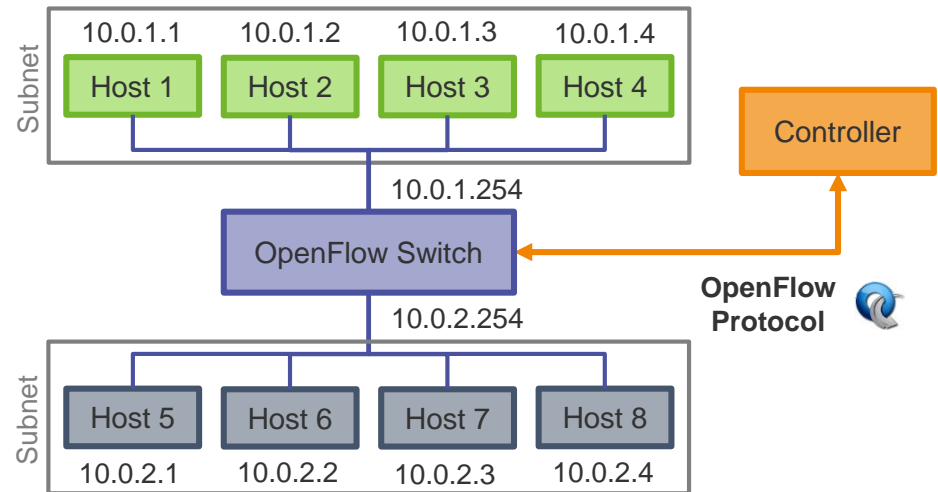
- Define the network topology in Miniedit
- Implement network logic for Ryu

► Project I

- L2 switching
- Port-based ACLs
- Simple IPv4 routing

► Project II

- LP IPv4 / IPv6 routing
- Packet- and flow-based IP Anycast





- ▶ Master course "Network Softwarization" (3 ECTS)
 - Prerequisites: good knowledge of Internet basics and programming skills
 - Introduction of SDN and NFV concepts
 - Overview of related work and research activities
 - Practical programming experiences

- ▶ Experience from summer term 2017
 - Well feasible for advanced students
 - Too demanding for students missing prerequisites
 - Highly specialized – great preparation for Master theses