Software Defined Networking

Lab Work Introduction

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http://www.ps.tu-darmstadt.de/teaching/ws1516/sdn/

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1. Organizational Issues

- Support:
  - Moodle Forum!
  - Lab Work: Jeremias Blendin, Leonhard Nobach, Christian Koch
    - By e-mail [jblendin|lnobach|ckoch|rueckert]@ps.tu-darmstadt.de
    - Room: S3|19 7 or 8 (**only upon appointment!**)

2. Exercise Overview

Oct 20	(JR)	Introduction / Exercise 1 Hand-out
Oct 27	(LN)	Exercise 1 Discussion / Exercise 2 Hand-out
Nov 3	(CK)	Lab Work 1 Introduction
Nov 10	(JB)	Lab Work 1 Discussion / Lab Work 2 Introduction
Nov 17	(JR)	Exercise 2 Discussion / Exercise 3 Hand-out
Nov 24	(JR)	Exercise 3 Discussion / Exercise 4 Hand-out
Dec 1	(CK)	Lab Work 2 Discussion / Lab Work 3 Introduction
Dec 8	(LN)	Exercise 4 Discussion / Exercise 5 Hand-out
Dec 15	(JB)	Lab Work 3 Discussion

Christmas Break

Jan 12	(JR)	Exercise 5 Discussion / Exercise 6 Hand-out
Jan 19	(LN)	Exercise 6 Discussion / Exercise 7 Hand-out
Jan 26	(LN)	Exercise 7 Discussion
Feb 2		Consultation hour for the exam (ALL)
Feb 9		Backup

3. Lab Exercises – Organization

- Goal: Hands on mechanisms presented in the lecture and theoretical exercise
- For lab exercise we use a number of different tools, such as Mininet
- Should be group work! (2-3 persons)
- Submission of solution before next lab
  - Deadline 16:00 before the next lab
  - Individual submissions by each participant to Moodle!
- Code must be runnable and adequately solve task
- Selective code reviewed by supervisors

Our tool to simulate software-defined networks

INTRODUCTION TO MININET

- Lab Requirements
  - Virtualization Software: **VirtualBox**, VMWare, KVM etc...
  - An **SSH Client**
    - e.g. PuTTY for Windows Users or
    - the built-in OpenSSH for Mac/Linux users

Mininet: Installation

- Download Mininet:
  - https://github.com/mininet/mininet/wiki/Mininet-VM-Images (ca. 1 GB)
- ZIP file contains an **.ovf** file:
  - You may open it with VirtualBox, VMWare, KVM etc.
- Change network settings for Mininet to additionally use a **host-only adapter** (VirtualBox):
  - Host-only adapter means: Only your machine can connect to the Mininet VM and vice versa. Do NOT bridge adapters!
  - Select VM >Change... > Network > Adapter 2
    - Check „Active“
    - Select „Connected to Host-Only Adapter“

Mininet: Installation (2)

- Run the Mininet VM
- Login with username **mininet**, password **mininet**
  - Change your password to a *strong* one for additional security (**passwd**)
- Run ifconfig, if no device eth1 is present, enter:

```
sudo –s
nano /etc/network/interfaces
```

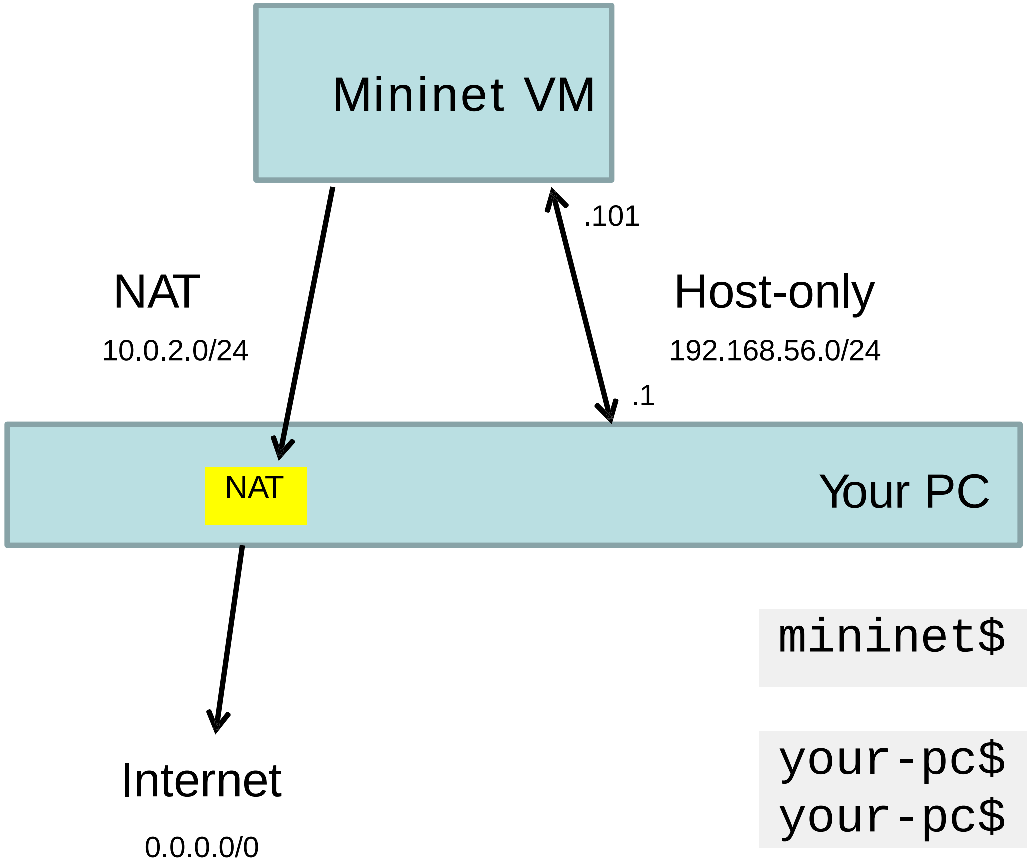
- In the editor nano, then append the lines

```
auto eth1
iface eth1 inet dhcp
```

- Reboot.

Mininet: Installation (3)

- Now, you have the following network configuration:



```
mininet$ ping google.de
```

```
your-pc$ ping 192.168.56.101
your-pc$ ssh mininet@192.168.56.101
```

Mininet: Initial Topology

- Log in to Mininet via ssh (Session 1)
- Create our initial topology

```
$ sudo mn --topo single,3 --mac --arp --switch ovsk \
       --controller=remote,ip=127.0.0.1
```

- Opens a new shell:

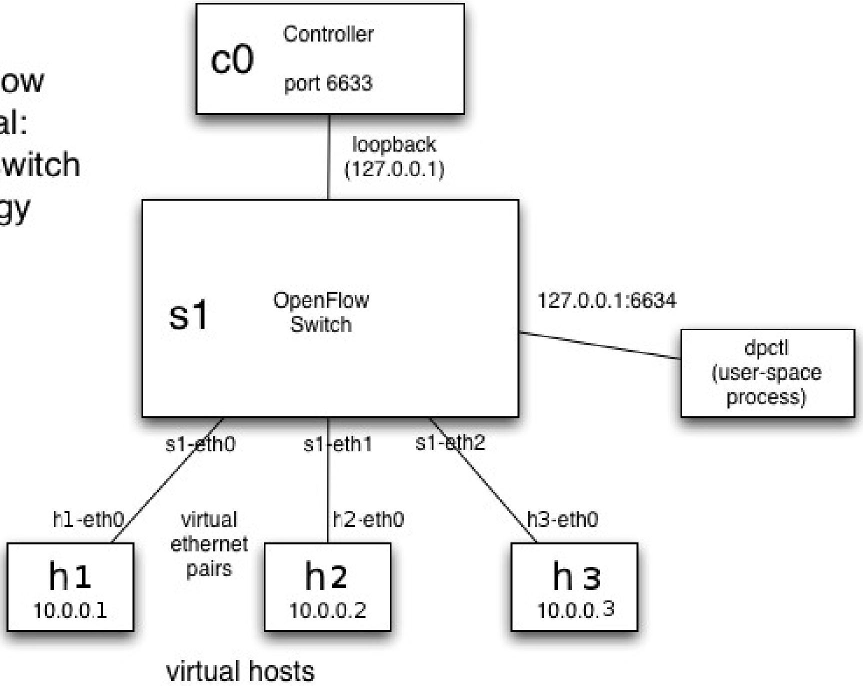
```
mininet>
```

- Trying to ping:

```
mininet> h1 ping 10.0.0.2
```

- Will not succeed.

OpenFlow Tutorial: 3hosts-1switch topology



Source of Initial Topology:
http://pages.cs.wisc.edu/~agember/sdn/session1
with a correction of a mistake.

Mininet: dpctl

- Tool for manipulating flow rules on a particular OpenFlow switch, preinstalled on the Mininet VM
- View current rules on our switch s1 with:

```
$ dpctl dump-flows tcp:127.0.0.1:6634
```

- Enter:

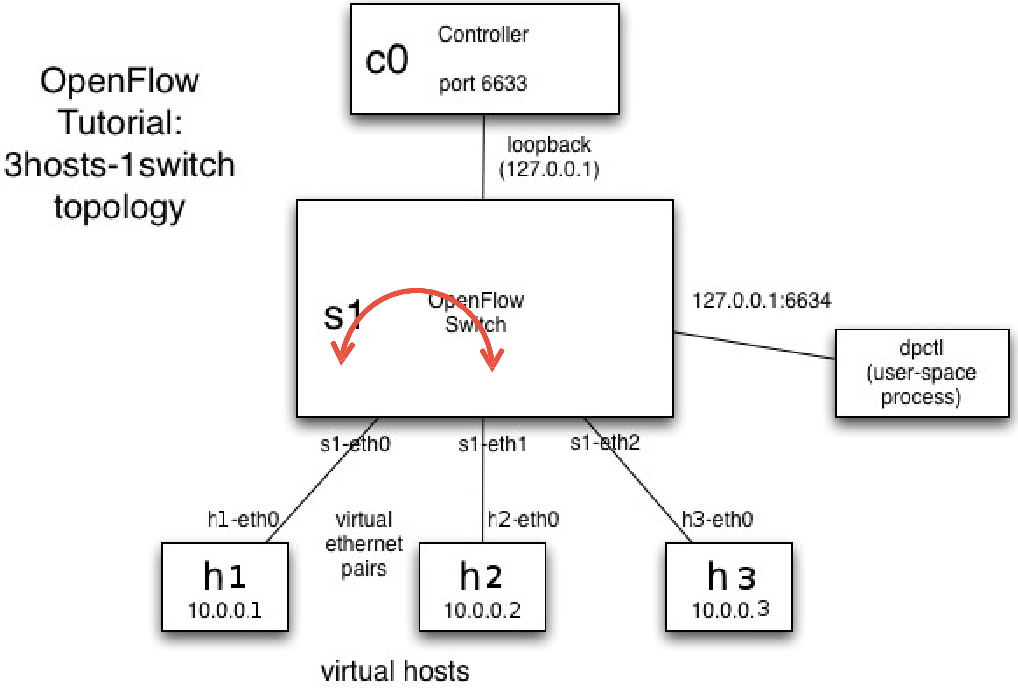
```
$ dpctl --help
```

for a list of commands, or enter „man dpctl“ into Google.

- **Advice:** Get yourself familiar with the commands.

Mininet Example Task: Passthrough

- The OpenFlow switch shall pass every packet from h1 to h2, and vice versa.
  - No matching necessary



Mininet: Passthrough - Solution

- Log in via another SSH session (Session 2)
  - E.g. open a new PuTTY window (Alternative: use **screen**)
- On the switch s1, create two flows:
  - Whatever enters Port 1 (h1) should leave Port 2 (h2)
  - Whatever enters Port 2 (h2) should leave Port 1 (h1)
- For that, use dpctl:

```
$ s1 dpctl add-flow tcp:127.0.0.1:6634 \
in_port=1,idle_timeout=0,actions=output:2
```

```
$ s1 dpctl add-flow tcp:127.0.0.1:6634 \
in_port=2,idle_timeout=0,actions=output:1
```

```
$ s1 dpctl dump-flows tcp:127.0.0.1:6634
```

(Idle_timeout=0 prevents flows from being deleted after 60 seconds)

Mininet: Passthrough - Solution

- In the first SSH session (with the mininet prompt), try to ping between both hosts again:

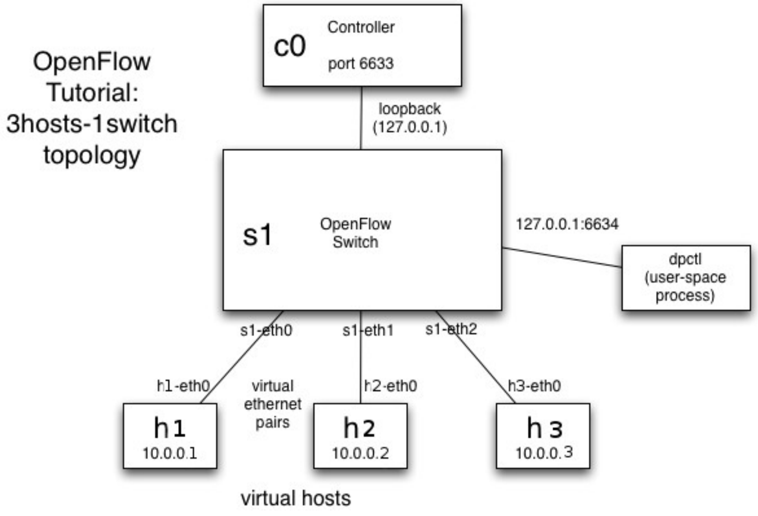
```
mininet> h1 ping 10.0.0.2
```

```
mininet> h2 ping 10.0.0.1
```

- It should work now.
- **Congratulations,** you software-defined your first network!

Lab 1 Task 1: Layer 2 Bridge

- Define Layer 2 OpenFlow rules, so that all three hosts are able to ping each other.
- Use MAC address matching
  - You can „hard code“ the MAC addresses
- Broadcast broadcast frames, and unicast unicast frames. For performance reasons, do not broadcast everything!



Lab 1 Task 2: „Spam Filter“

- Spam is a serious problem today. If a client is part of a botnet, it may send tons of spam out via SMTP
  - The three hosts should **not be able** to exchange **SMTP traffic**. For that, explicitly filter SMTP traffic.
  - Building on Task 1, define appropriate rules to match and drop SMTP traffic, while not harming other traffic.

Lab 1 Tips (1): Scripting

- After restarting Mininet, your entered OpenFlow rules will be lost. So create a shell script:

```
$ nano create-lab1-rules.sh
```

  - This opens the editor **nano**, editing the shell script with the filename above (feel free to use another editor).
  - Enter your Unix shell commands (e.g. dpctl), each in a new line.
  - Save with **Ctrl+X**, confirm saving with **Y**
  - Run with:

```
$ sh create-lab1-rules.sh
```

  - This will execute all commands in the script.

Lab 1 Tips (2)

- dpctl Example: Forward packets matching a destination MAC address:

```
$ s1 dpctl add-flow tcp:127.0.0.1:6634 \
dl_dst=11:22:33:44:55:66,idle_timeout=0,\
actions=output:2
```

- Get yourself familiar with Layer 2 bridging/broadcast and the behavior of the **ARP** protocol, which precedes L3 communication.

Lab 1 Tips (3): Tools

- tcpdump will output all frames entering or leaving a host. Google „man tcpdump“ for more advanced usage.

```
mininet> h1 tcpdump
```

- Get yourself familiar with Layer 2 bridging/broadcast and the behavior of the **ARP** protocol, which precedes Layer 3 IP communication.

Submission

- The Layer 2 rules you have defined should be submitted as a **shell script** to Moodle.
  - It should contain the appropriate rule definitions (e.g. via dpctl) to program the switch s1 with the desired behavior.
- After creating the initial topology **and** running the shell script you have submitted, the setup should show the desired behavior.
- It is sufficient if you submit an all-in-one shell script containing the behavior of both Task 1 and Task 2.

Good Luck!