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SEPP 4.0 - Evaluation of Hands-On IoT-Security Exercises

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Background

- A lot of insecure IoT devices (like Smart Home devices)
- IoT Security Lecture at the Technical University of Regensburg
  - Basics of IoT Security
  - Security analysis of IoT device -> students “hack” their own device
  - Hands-on learning experience
- Problem: every device is different, but they should try all the “hacking” methods

SEPP Platform

SEPP Platform

- Weekly exercise session of 90 minutes that accompanies the IoT Security lecture
- Multiple groups of 2-3 students work on the same exercise sheet
- Evaluation of the exercises through observations and student questionnaires

SEPP Platform: Exemplary Attacks

- Identifying devices on the network using Nmap
- Replay attack
- Address Resolution Protocol (ARP) spoofing based Man-in-the-Middle attack
- Denial of Service / Distributed Denial of Service
- Brute Force attack
- Session Hijacking attack
- Bluetooth Low Energy Sniffing

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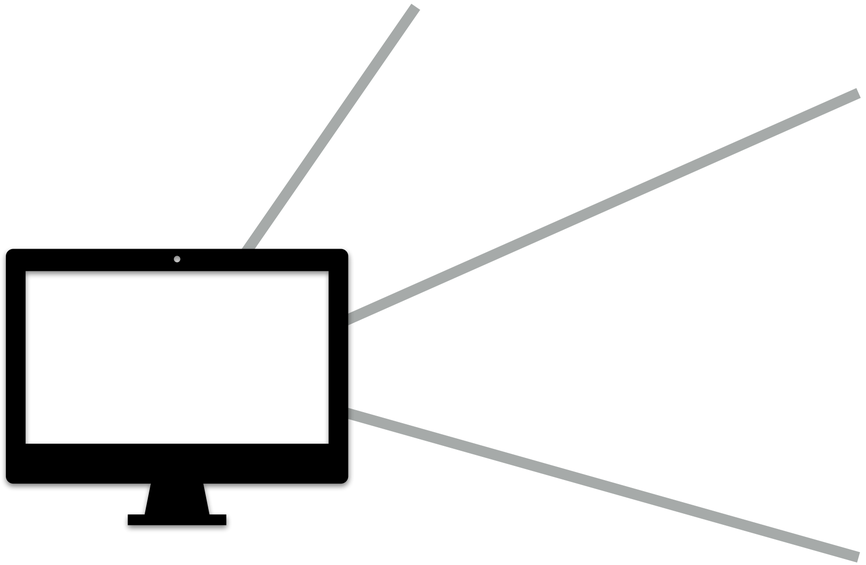
Example Exercise

student



SEPP network

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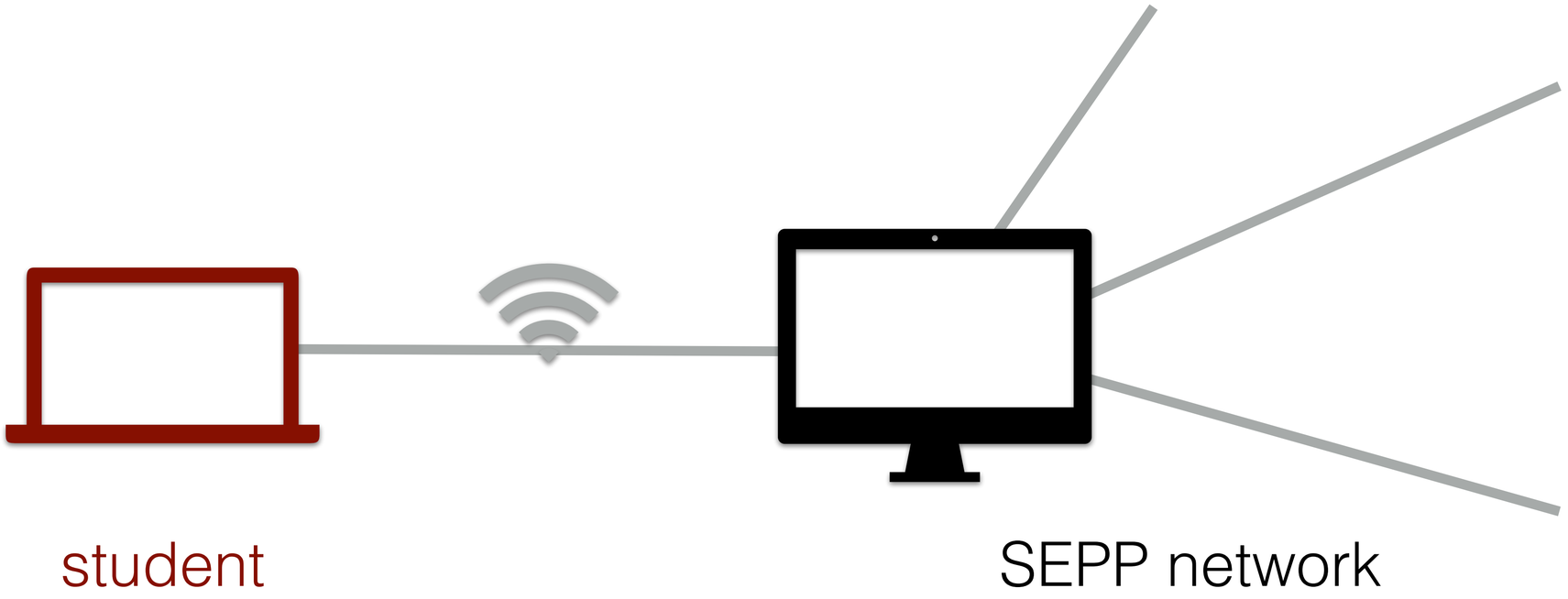
Connect to network



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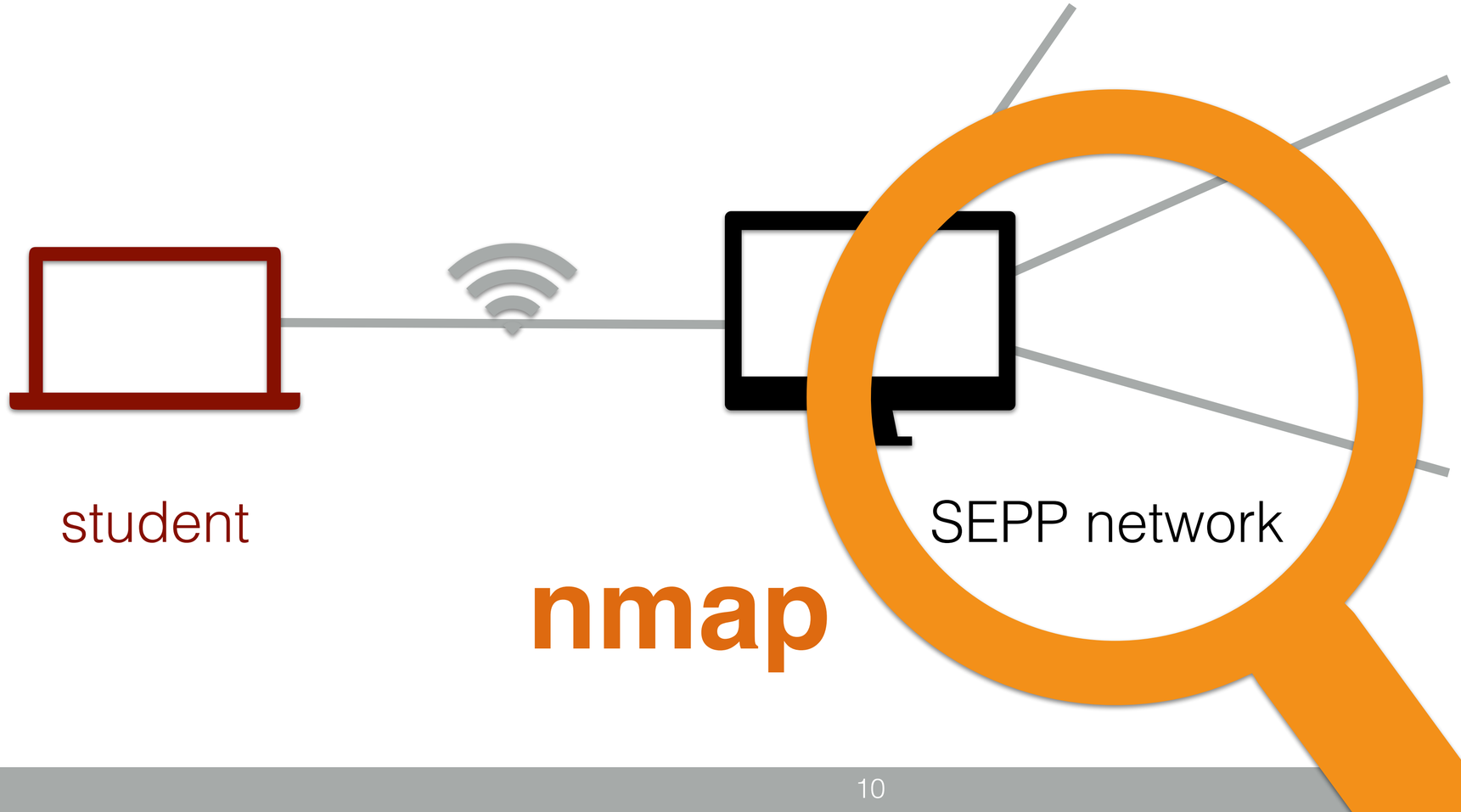
Network scan with nmap

```
nmap -sn <IP adress range>
```



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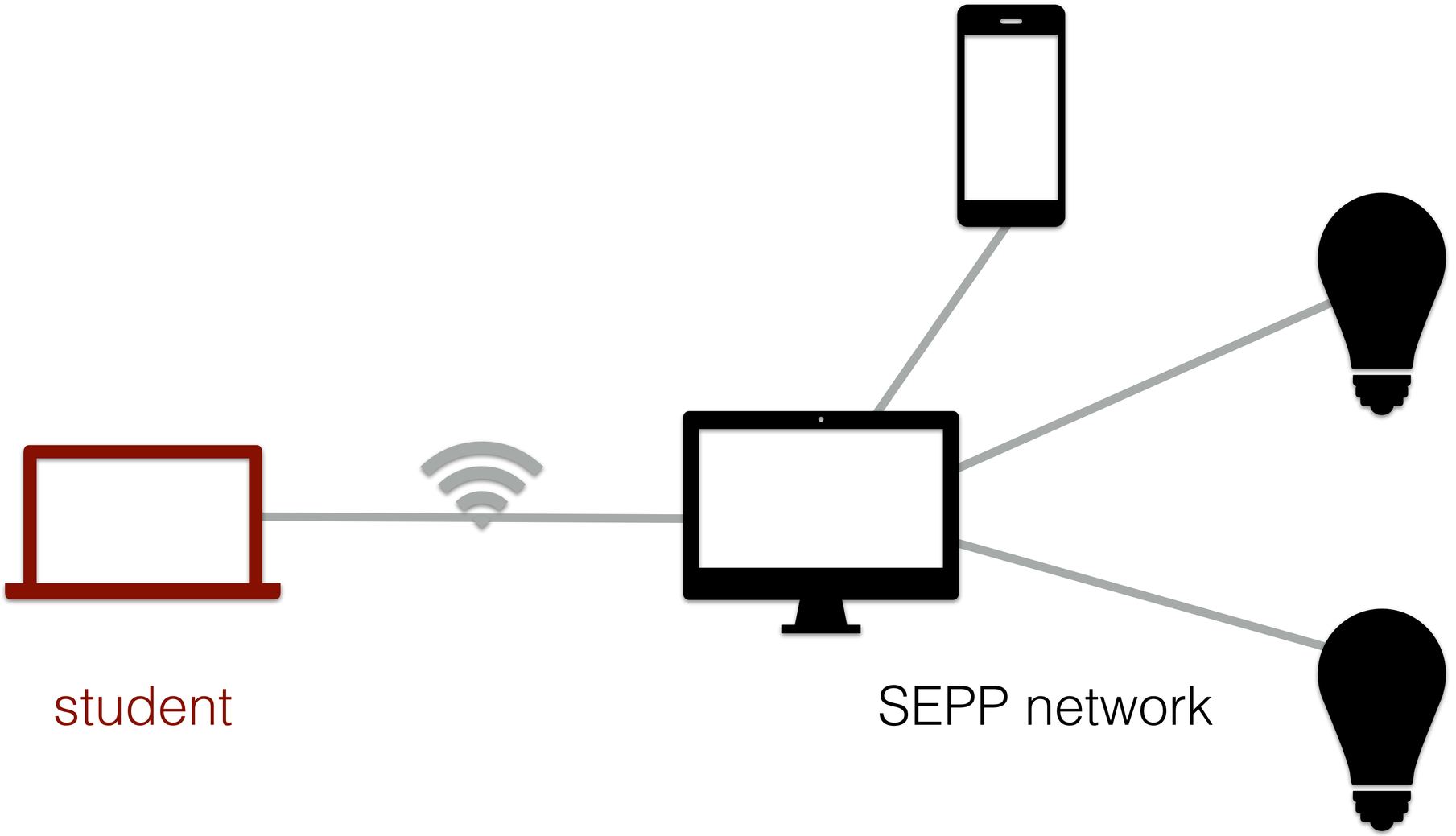
SEPP network



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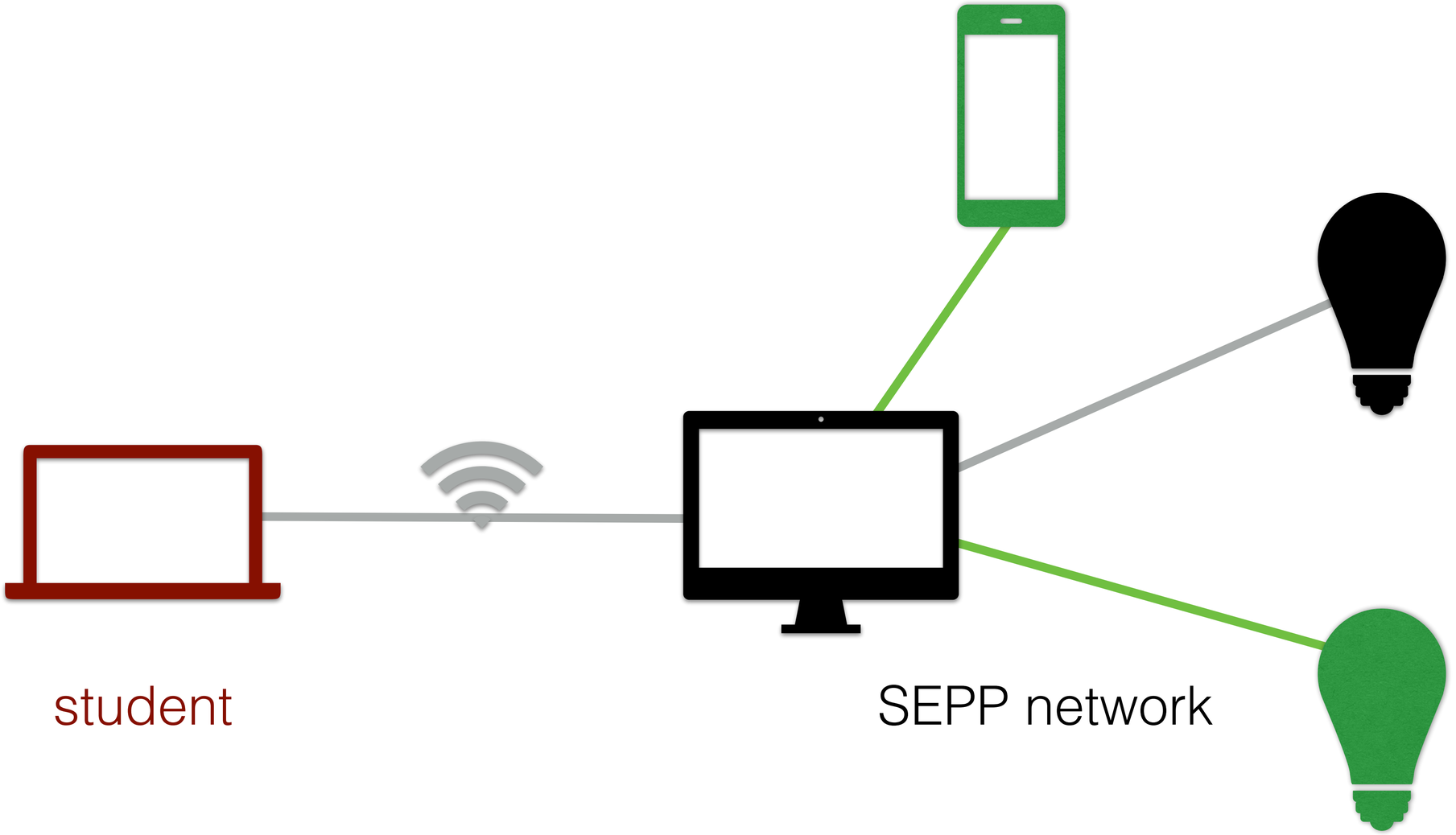
Normal communication with device



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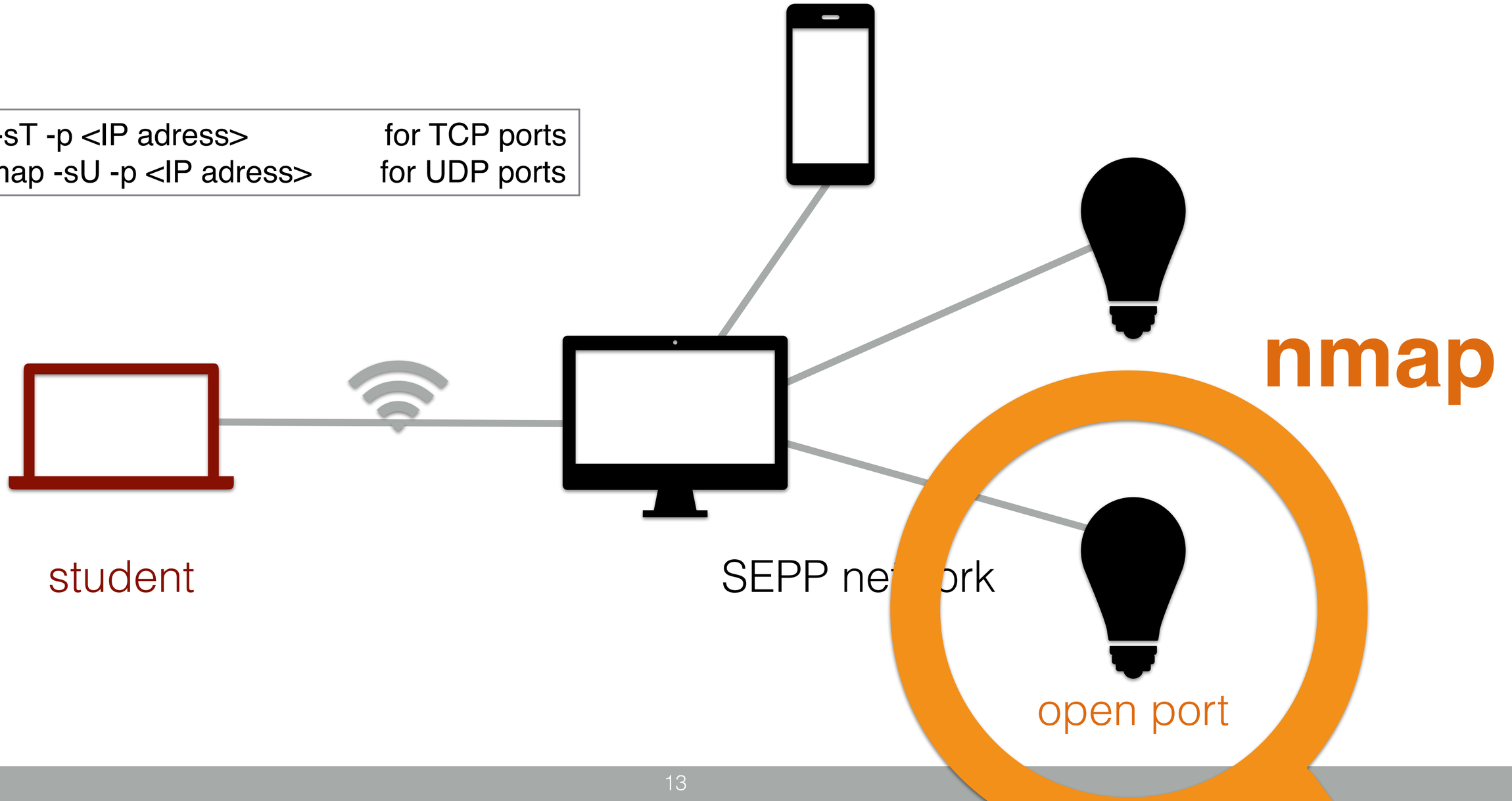
Device scan for open ports (TCP / UPD)

nmap -sT -p <IP adress>	for TCP ports
and nmap -sU -p <IP adress>	for UDP ports



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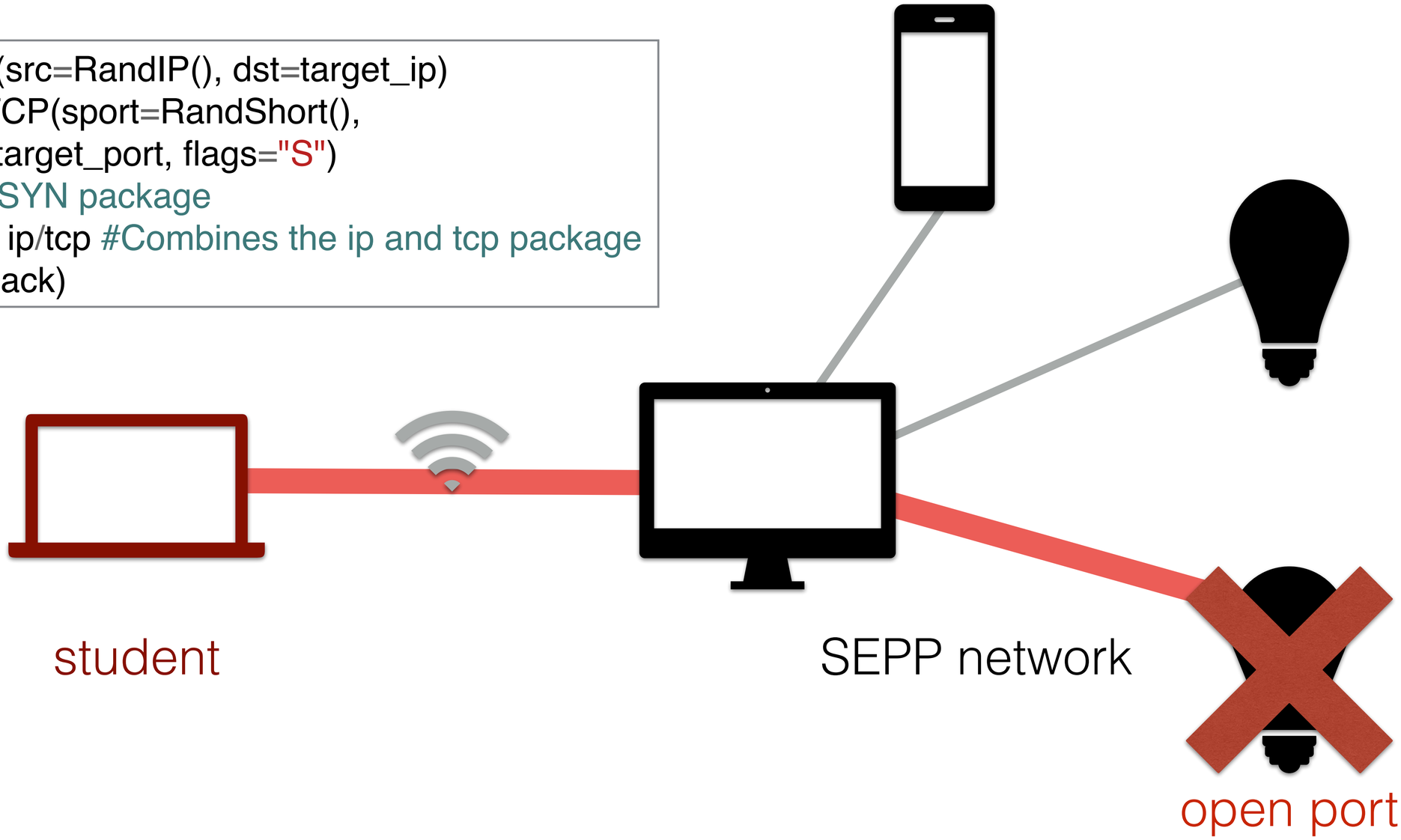
DoS attack with Scapy (Python)

```
ip = IP(src=RandIP(), dst=target_ip)
tcp = TCP(sport=RandShort(),
dport=target_port, flags="S")
#S for SYN package
pack = ip/tcp #Combines the ip and tcp package
send(pack)
```



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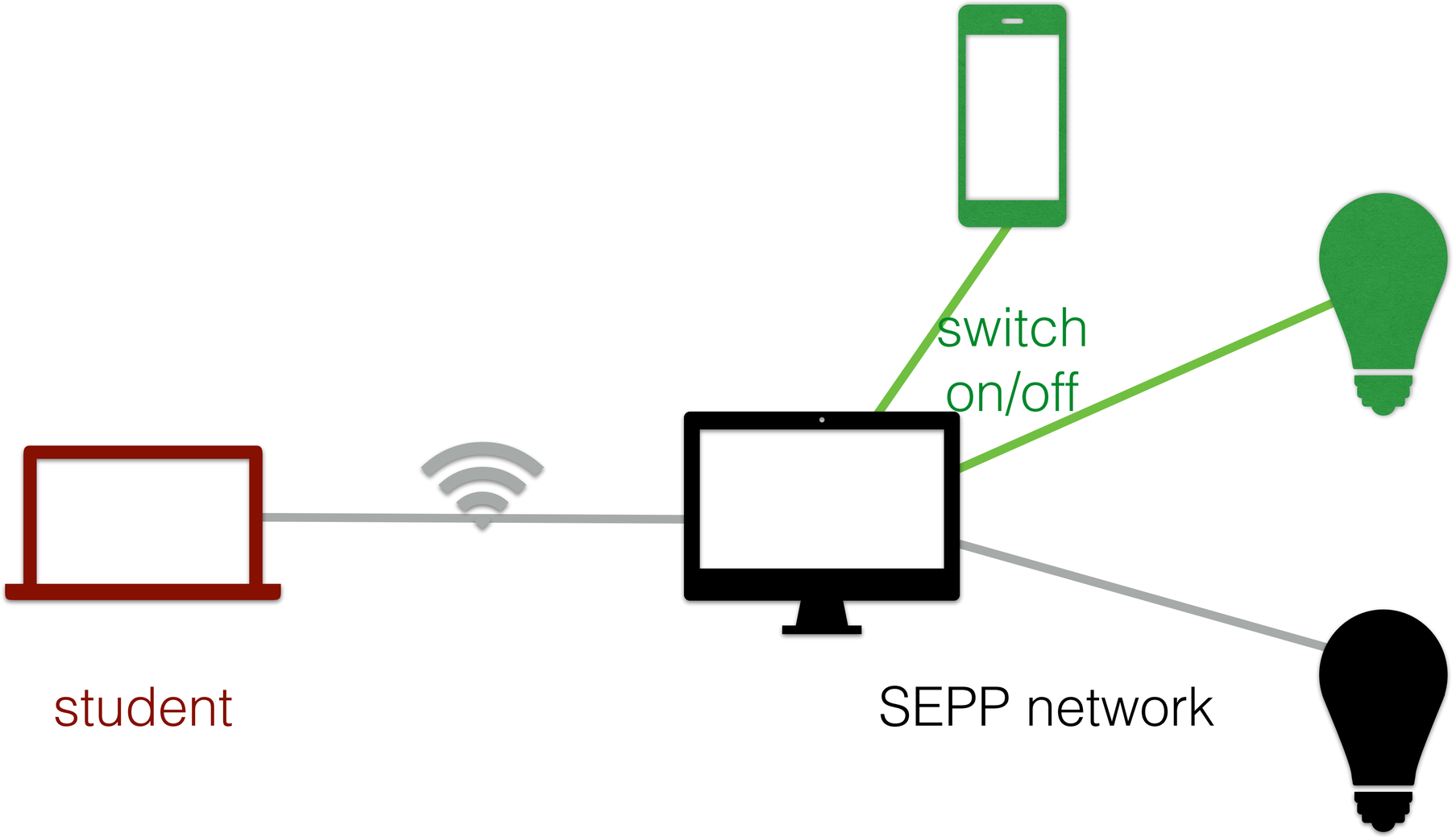
Normal communication with device



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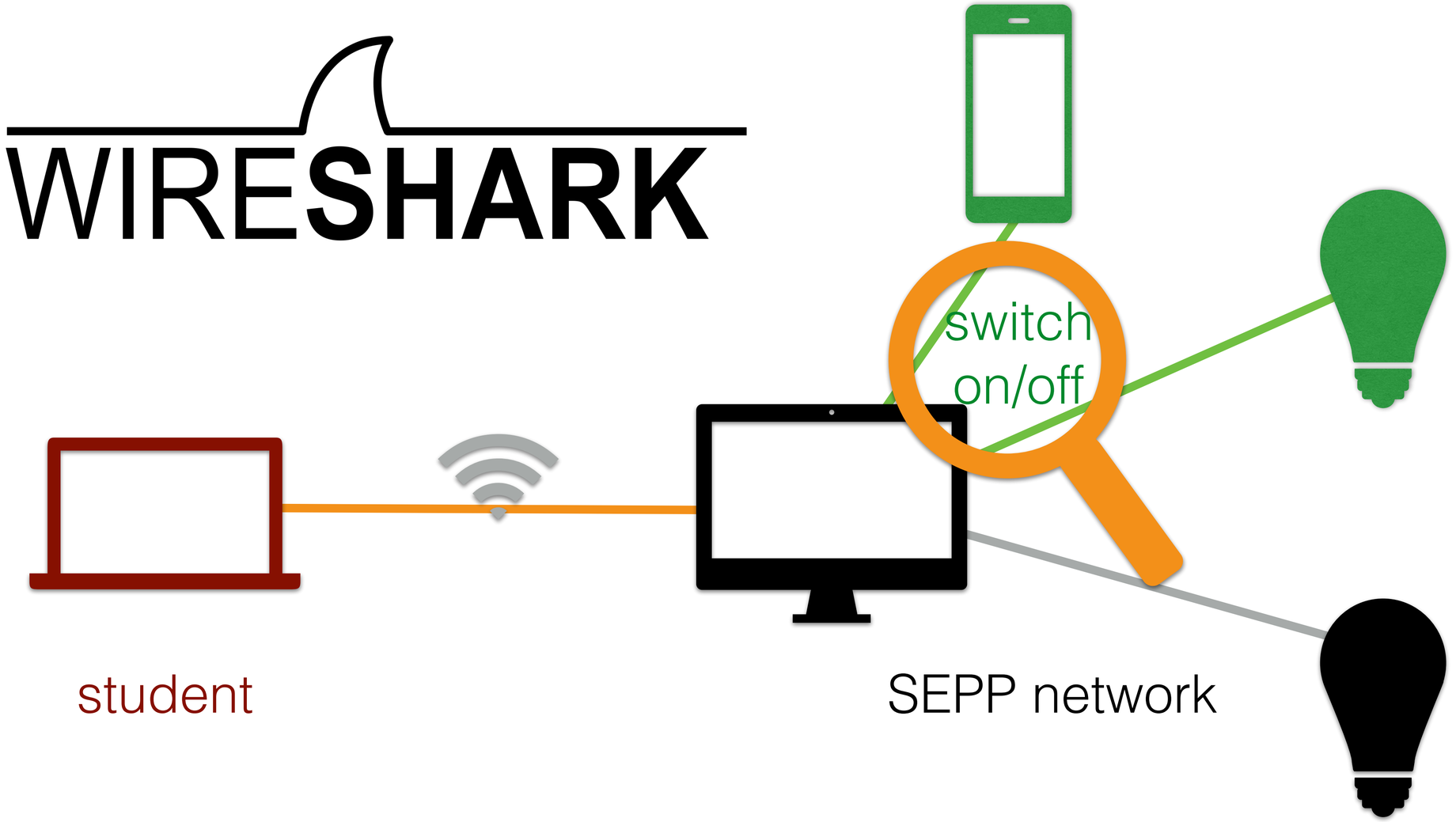
Capture communication with Wireshark



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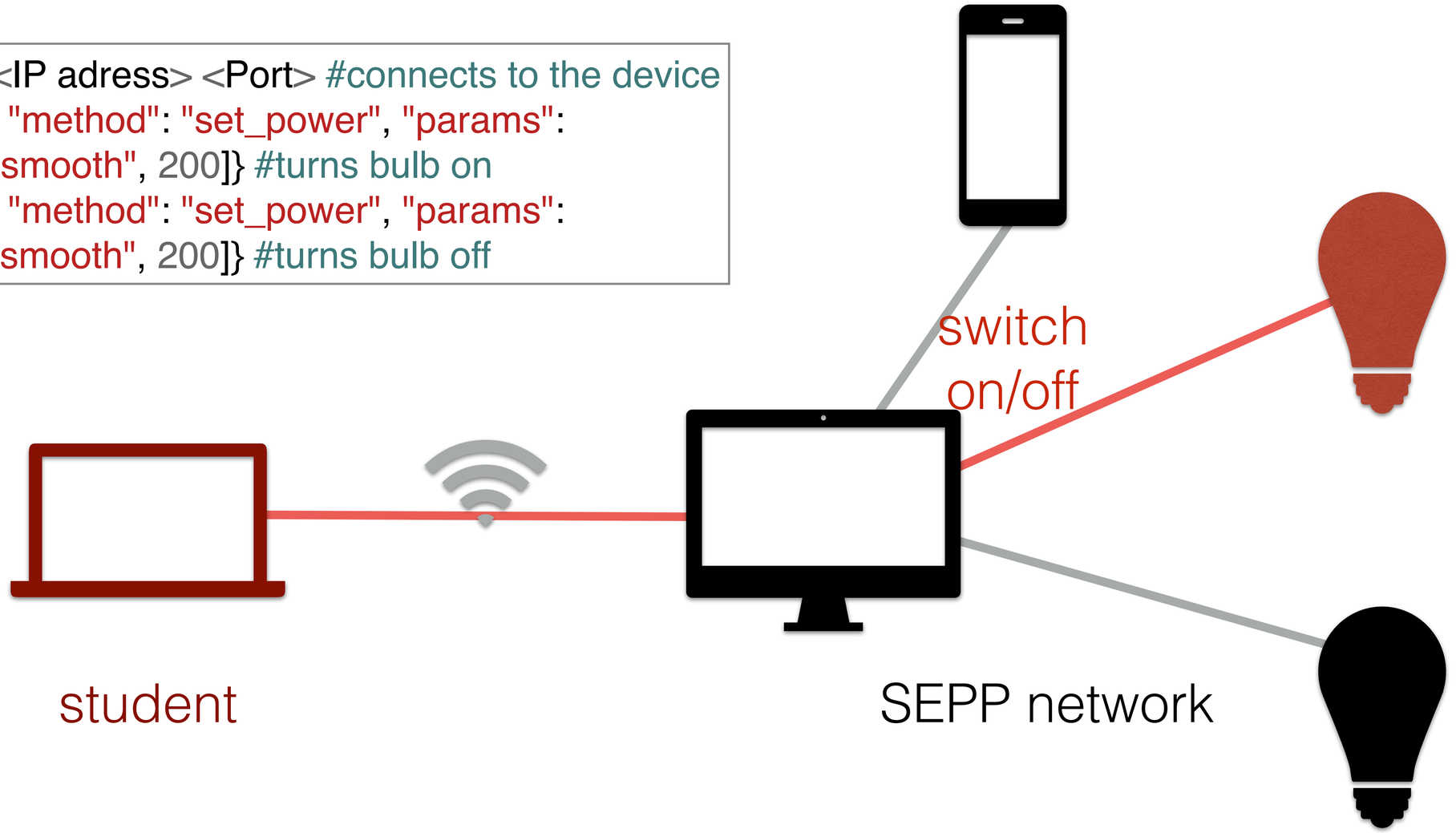
Send command via telnet

```
telnet <IP adress> <Port> #connects to the device
{"id":0, "method": "set_power", "params":
["on", "smooth", 200]} #turns bulb on
{"id":0, "method": "set_power", "params":
["off", "smooth", 200]} #turns bulb off
```



Evaluation Results

Generally positive feedback

+ High student engagement
+ Clear benefits from working with real IoT devices in a Hands-On approach
+ Ability to apply the knowledge learned in the lecture
+ Surprised by the simplicity of certain attacks (e.g. DoS, Man-in-the-Middle)
+ … and tools used to collect the necessary information (e.g. Nmap, Wireshark)

Evaluation Results: Areas of Concern

1) Device Choice:

   - Not all devices provided clear feedback if an attack was successful

   - Unintentional DoS scenario on some devices due to multiple groups sending commands at the same time

2) Repetition of attacks:

   - Performing a DoS attack was part of four of the ten exercises

3) Arrangement within the semester:

   - Tools and vulnerabilities were included on exercise sheets before they were introduced in the lecture

Evaluation Results: Areas of Concern

4) Instructions and guidance:

   - Errors / Incompleteness of the instructions on some exercise sheets
   - Often no guidance or examples for tools that were not introduced in the lecture

5) Understanding:

   - The security relevancy of all steps was not always apparent

6) Preparation of the exercise sessions:

   - Provide clear instructions on how the exercise needs to be prepared

Evaluation Results: Areas of Concern

7) Wi-Fi issues:

- Raspberry Pi is not suitable as router, as it can not handle the desired number of clients

8) Timely constraints:

- Students should be provided with ready-to-go laptops and phones that have all necessary tools installed
- Files like Python scripts should be distributed efficiently (e.g. via Git)
- Students should not waste time on unnecessary steps (e.g. full Nmap UDP port scan)

Conclusion and Outlook

The SEPP platform is a promising and well-received tool

- Eliminate areas of concern
- Ongoing evaluation and improvements
- More platforms needed for more parallel groups
    - we are trying to get a founding Add another setup

Contact

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