

Exercise for Lecture Software Defined Networking

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Exercise No. 1

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Contact: Please use the Moodle forum to post questions and remarks on the exercise.

Web: <http://www.ps.tu-darmstadt.de/teaching/ws1617/sdn/>

Submission: <https://moodle.tu-darmstadt.de/course/view.php?id=8385>

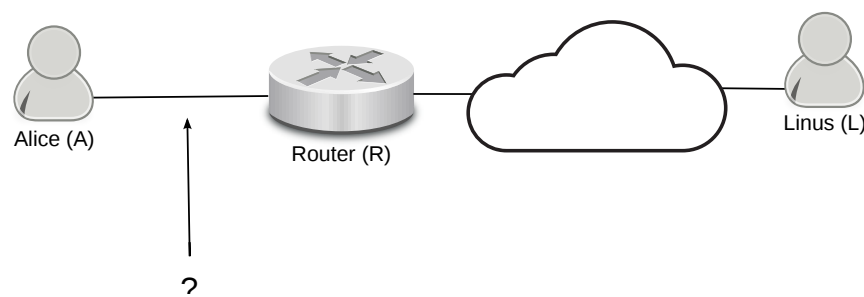
Surname (Nachname):	
First name (Vorname):	
ID# (Matrikelnummer):	

Problem 1.1 - Cross-Layer Networking Basics

Note: This task is not directly related to the content in the slides, however you should be able to solve it with your previous knowledge of communication networks. Depending on your previous skills, it might require some online research. Nevertheless, the understanding of this topic will definitely help you with solving future exercises, labs, and exam questions related to SDN and OpenFlow!

Tip: Recap the following topics: the ISO/OSI layer model, Ethernet, MAC addresses, the Internet Protocol (IP, at least IPv4), ARP, ICMP, TCP (only the basics) and UDP.

Alice has a Linux PC. She connects to the Router via Ethernet, and her first action is to "ping" Linus's PC.



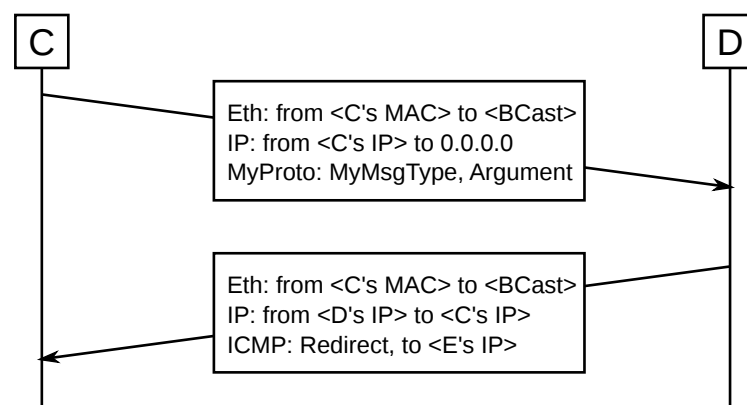
Assume the following:


- Alice uses no domain name, she just enters Linus's IP address for ping
- Linus answers the ping, and the (Internet) connection between Linus and the Router is working as expected.
- Alice does not use DHCP, her IP address and default route was entered manually.
- No Layer 2 information between Alice and the router is known in advance.
- No other communication unrelated to the ping is taking place.

Draw the communication on the Ethernet link between Alice and the Router in a sequence diagram.

- Every message exchanged in your diagram shall contain all protocols of the ISO/OSI layer model that were used, starting with the data link layer.
- For every protocol, specify **data link and network addresses** that are used. As you don't know the actual addresses of anyone, you may write e.g. <IP address of X> or <X's IP> as a placeholder. For broadcast addresses, you also may use <BCast>.
- For the highest protocol used, also write down the message type/opcode that is used, e.g. ICMP **Redirect**.

Below is an **example** diagram, explaining the idea of the format that you shall use (Note: The example diagram makes no sense beyond explaining the *format*). Stop after the first ping answer has been received by Alice.





(Space for your solutionn)

Problem 1.2 - Routing and Basics

Note: If you have fundamental problems in answering these or other basic networking questions from this exercise, we highly recommend to prepare yourself for the later lectures and exercises by refreshing your knowledge in the relevant topics, e.g., using the book by Andrew S. Tanenbaum on “Computer Networks”.

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- a) The lecture briefly summarized a variant of the protocol stack used to describe the functionality required to provide end-to-end communication in computer networks. The stack is organized into layers, where alternative implementations of the same abstract functionality can be realized by alternative mechanisms and protocols. These alternatives can be functionally equivalent or expose specific sets of functions to layers higher up in the stack.

Please name the basic functions that IP(v4), TCP, and UDP provide to higher layers.

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- b) Briefly explain the difference between **routing** and **forwarding**.
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c) Name two examples (each) of **link state** and **distance vector** routing algorithms. State the abbreviation as well as the full names.

d) Briefly name and explain key differences between **link state** and **distance vector** routing approaches.

e) What is the name of the most widely used routing protocol that exchanges routes **between** autonomous systems? Do not abbreviate the name.

f) MPLS - Multiprotocol Label Switching

Although not explicitly in the focus of this lecture, MPLS is mentioned and used throughout the course on various occasions. As a commonly applied mechanism, you are required to be aware of its purpose and high-level principals. Get yourself familiar with the core concepts of MPLS and briefly answer the following questions.

Hint: You may use the main RFC of MPLS as starting point <https://tools.ietf.org/html/rfc3031> or, e.g., the book by Andrew S. Tanenbaum on “Computer Networks”.

I What is an FEC in the context of MPLS?

Forwarding Equivalence Class

II What is the technical motivation of using MPLS inside a network domain instead of normal routing based on the destination IP address?

III To which layer of the IP protocol stack does it belong?

Problem 1.3 - SDN and OpenFlow Basics

a) What steps does SDN take to improve the programmability of networks?

3 Abstractions

b) In the lecture, first example for functionality that can be realized using OpenFlow flow table entries are shown. One example describes a simplified firewall behavior (see slide 38 of lecture 1).

Briefly describe the behavior of an OpenFlow switch that solely uses this entry. Assume that afterwards, packets are passed to the switch's normal Ethernet switching pipeline.

c) Other rules could be specified based on other header fields or their combinations to realize a firewall that completely runs on an OpenFlow switch, without involving the network controller in the packet processing. Which types of firewall rules cannot be realized using the set of functionality introduced so far?
