Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Networked Systems
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Communication Networks

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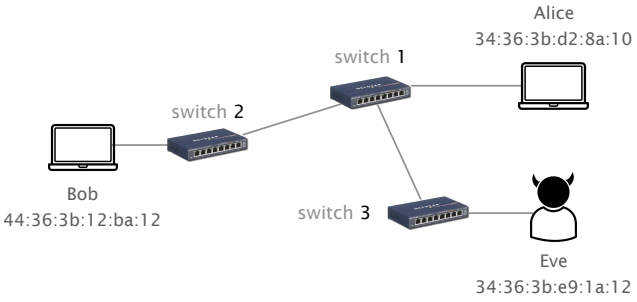
Exercise 4 – Ethernet/Switching and Internet Protocol (IP)

Ethernet & Switching

4.1 Duplicate MAC Address

Consider three hosts Alice, Bob, and Eve connected through the network below composed of 3 Layer 2 (Ethernet) switches.



In the beginning the tables of the learning switches are still empty. Bob starts sending Ethernet frames to Alice. Eve is curious and wants to know what Bob is sending to Alice. Assume that Bob and Alice know the MAC address of each other.

a) What is the source and destination address in the Ethernet header for frames sent from Bob to Alice?

b) What do the switches do when they receive the frames?

c) Due to the flooding, the frames are sent to both Alice and Eve. Does Eve actually receive the frames? (*hint:* promiscuous mode).

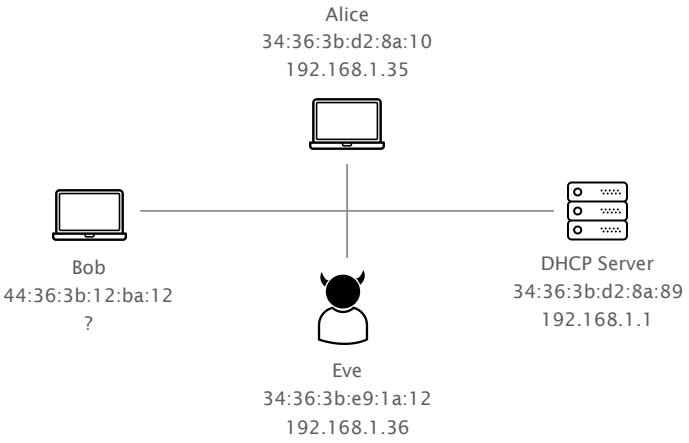
Alice starts acknowledging the received frames by sending frames to Bob.

d) Is Eve able to eavesdrop either on the frames being sent from Alice to Bob or on new frames sent from Bob to Alice? Explain.

e) Can you think of a way for Eve to redirect the frames destined to Alice again to herself?

4.2 Impostor

The three hosts Bob, Alice and Eve are all connected to the same network, which has a DHCP server.



Bob just connected to the network and wants to send important IP packets to Alice. Bob only knows the IP address of Alice (`192.168.1.35`) and his laptop is not yet configured with an IP address.

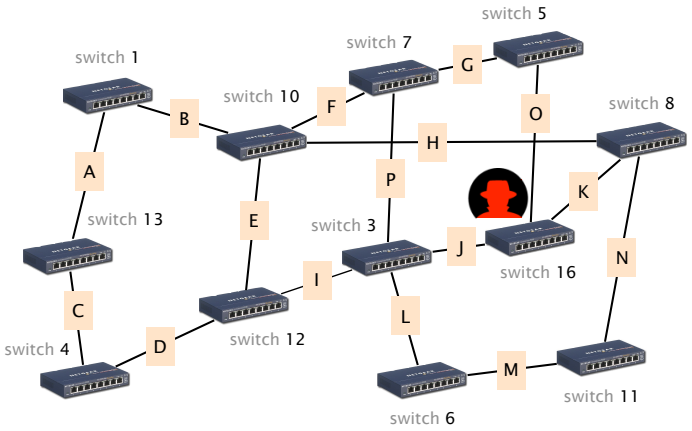
a) Explain all the steps that are necessary such that Bob's computer can finally send packets to Alice.

SRC MAC address	DST MAC address	Message type	Message content

b) Eve is very interested to find out what Bob is sending to Alice. What could she do to intercept Bob's packets?

4.3 Spanning-Tree (Exam Style Question)

Consider this network composed of 12 Layer 2 (Ethernet) switches.



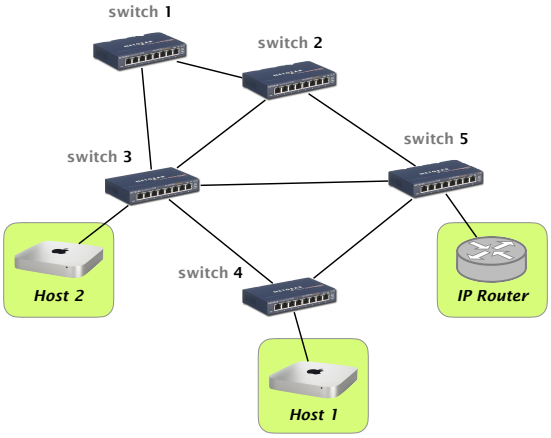
Compute a valid spanning tree, with and without hacker

a) Use the Spanning-Tree Protocol (STP) described in the lecture to compute a spanning tree. The numbers next to each switch indicate the switches identifier (switch 1 has ID "1"). Each link is labeled with a letter. Indicate the set of links (the letters, in alphabetical order) that are not part of the STP after the protocol has converged.

b) As described in the course, STP is not the most secure protocol. Assume now that a hacker managed to take over switch 16 and starts pretending that the switch ID is "1". Concretely, there are now two switches with ID "1" in the network. Indicate the set of links that will now be part of the attacker's spanning tree, once the protocol has converged. Is the network still connected?

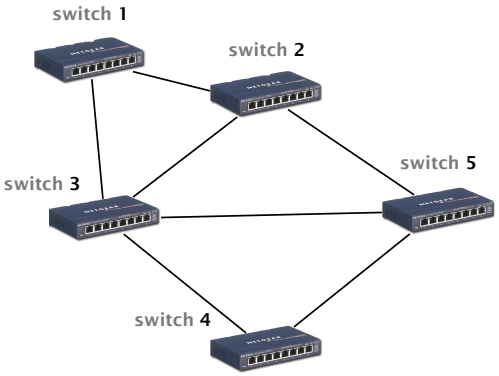
4.4 Moving Target (Exam Style Question)

Consider the switched network depicted in the figure below. It is composed of 5 Ethernet switches, two hosts (connected to switch 3 and 4, respectively) and one IP router acting as default gateway for the hosts. For redundancy reasons, the network exhibits cycles and each switch therefore runs the Spanning Tree Protocol (STP). All links have a unary cost. When equal-cost paths to the root are encountered, switches break the tie based on the sender ID (lower is better).



An Ethernet network running the spanning tree protocol.

a) In the figure below, indicate all the links that end up being **deactivated** in the final state, once all the switches have converged towards the final spanning tree.



b) Perhaps unsurprisingly, a *lot* of traffic is exchanged between Host 1 (resp. Host 2) and Internet destinations. Briefly explain **two distinct reasons** why this configuration is not optimal in terms of network utilization/throughput.

c) Realizing that there is a problem with their configuration, the network operators ask you (a fresh network engineer!) to help them improve their network performance. Briefly explain how you would adapt the configuration of the spanning tree protocol (i.e., the switches identifier and/or the link costs) so as to maximize the throughput between Host 1 (resp. Host 2) and Internet destinations.

d) The network operators are happy with your changes. But they now realize that Host 1 and Host 2, in addition to exchanging a lot of Internet traffic, also exchange a lot of traffic between themselves. The network operators ask for your help again! They ask you to find a spanning tree configuration such that: *(i)* the number of hops between any of these three hosts (Host 1 and 2, and the router) is equivalent; and *(ii)* the number of hops is minimum.

Briefly explain how you would configure the spanning tree protocol to achieve these requirements, or why these requirements are impossible to achieve.

Internet Protocol (IP) - Part 1

4.5 IPv4 Calculations

Each row in the following table describes an IP network. Fill in the missing values.

Slash–notation	Netmask–notation	First usable address	Last usable address	Broadcast address
10.0.0.0/24				
126.127.128.0/17				
	12.34.32.0/255.255.224.0			
		222.208.0.1	222.223.255.254	
		123.45.67.225		123.45.67.255