ETH zürich

Networked Systems
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Communication Networks

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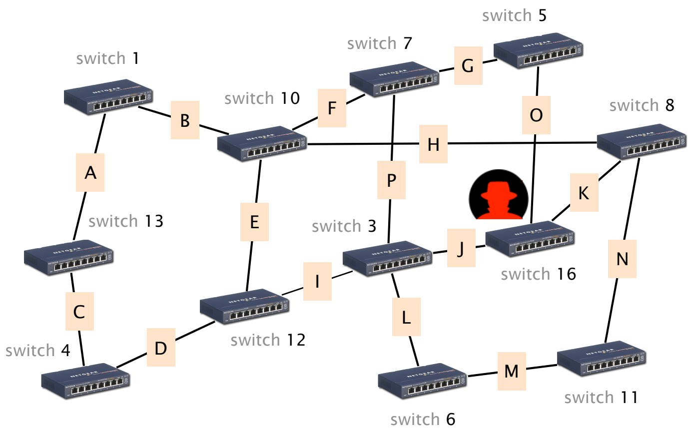
Exercise 4 – Ethernet, Switching & Internet Protocol (IP)

Ethernet & Switching

4.1 Spanning-Tree (Exam Style Question)

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



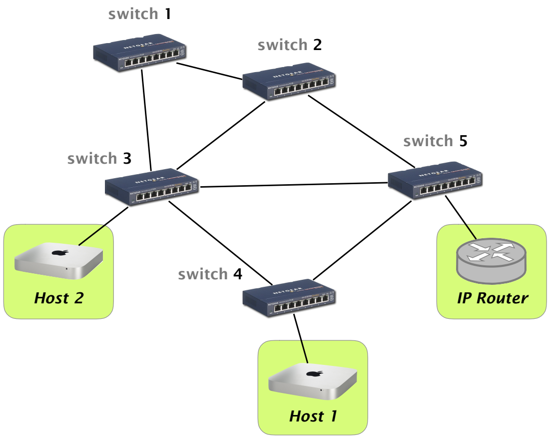
Compute a valid spanning tree, with and without hacker

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?

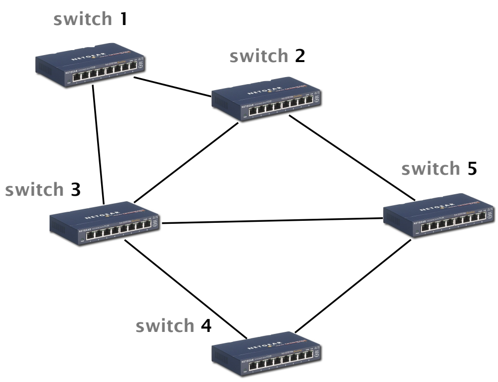
4.2 Moving Target (Exam Style Question)

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.

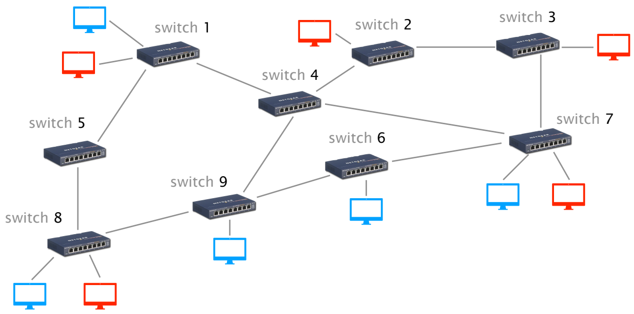
c) Realizing that there is a problem with their configuration, the network operators ask you (a fresh network engineer!) to help them improve their network performance. Briefly explain how you would adapt the configuration of the spanning tree protocol (i.e., the switches identifier and/or the link costs) 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 at the same time *(ii)* the number of hops is minimal considering the given topology.

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

4.3 VLAN

The network below consists of 9 switches and hosts in two different VLANs (blue and red).



L2-network with hosts in two different VLANs (blue and red).

a) Compute a spanning tree in the network using switch 1 as root. When equal-cost paths to the root are encountered, switches break the tie based on the sender ID (lower is better). Clearly indicate the type of each link (trunk, access or deactivated).

b) Using the previously computed spanning tree, which path will the red host connected to switch 7 use to communicate with the red host connected to switch 1?

c) Using the previously computed spanning tree, which path will the red host connected to switch 7 use to communicate with the blue host connected to switch 8?

d) Compute now two per-VLAN spanning-trees (one for each VLAN) such that each link is active in at least one spanning-tree. Hint: you can adapt the switch IDs for each VLAN.

Internet Protocol (IP)

4.4 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

4.5 IPv4 vs. IPv6

a) In the lecture you heard about IPv4 and IPv6. Why was IPv6 introduced? What is the main difference?

b) How many IPv4 and IPv6 addresses exist? Is it possible to use all the addresses for hosts in the Internet?

c) Assuming there are 7.8 billion people in the world, how many IPv4/IPv6 addresses are theoretically available per person? According to Wikipedia[a] an average human body contains around 7×10^{27} atoms. How many IPv6 addresses do we have per atom belonging to all 7.8 billion people?

[a] https://en.wikipedia.org/wiki/Composition_of_the_human_body#Elemental_composition_list

d) Even though a first IPv6 version has been standardized more than 20 years ago, it still has very limited coverage. What are the reasons why the deployment of IPv6 is so slow?

4.6 IPv6 Computations

Answer the following questions to IPv6.

a) Currently, all global unicast IPv6 addresses are inside 2000::/3. Assume that every network in the Internet gets an entire /64 prefix. How many different /64 prefixes can you distribute? How many hosts can be inside one of these /64 prefixes? Compare these numbers with the total amount of IPv4 addresses.

b) Simplify the notation of the following IPv6 addresses:

Full IPv6 address	Simplified IPv6 address
000a:1234:abda:0000:0000:0140:0000:0001	
0000:0000:0000:0000:0000:0003:0000:0010	
000a:0031:003f:0000:0000:0000:0000:0000	
0000:0000:0000:0000:0000:0000:0000:000b	

c) For the following pairs of IPv6 addresses, find the longest prefix that contains both addresses.

Address 1	Address 2	Prefix
2000::a35a	2000::ac3f	
2005::2e90:12fa:1	2005::2eb0:0:1	
200a::789:3	200a:5c::	