Universidad de León
Bachelor Degree on Computer Science and Engineering
Course on Computer Networks

Weekly Homework no. 6 (WH_6)

Exercises and examples about the lectures

1. **Execute these commands in** your Linux system and include their output:

2. **Spanning Tree Protocol. The switches included in Fig. 1 support STP,** consequently, they can collaboratively break any loops that exist in the topology at the time. Respond to the following questions:

   a. Which of the switches will become *root* bridge when executing the ST algorithm?

   B_1. The switches' labels must be fully orderable; the minimum of all the labels becomes root

   b. Do hosts H_n participate in the Spanning Tree Protocol?

   Hosts do not participate in STP, however, they may participate if configured to do so. At the very least, a host can receive and analyze SCMs (Switch Configuration Messages) if that is useful for monitoring the network. An off-the shelf PC running Linux can behave like a switch by configuring Linux's bridge service.

   c. Discuss whether host H_a can receive the BPDUs generated by B_0, in other words, explain what you would do to have B_0 receive and analyze the BPDUs mentioned.

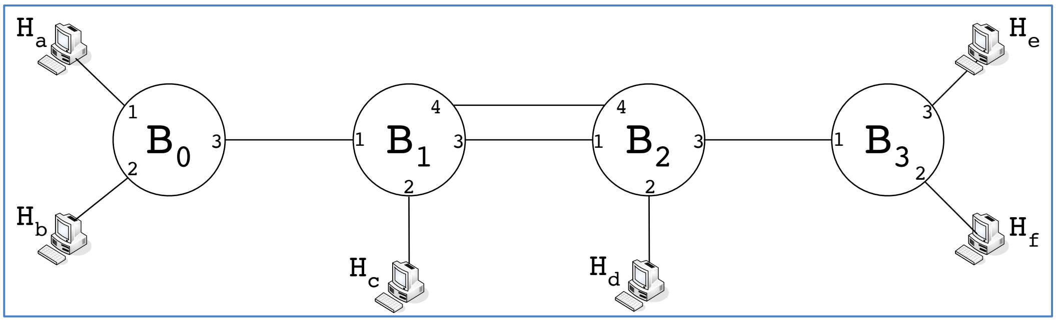

Figure 1. Extended LAN for exercise 2.

Setting H_a's NIC in promiscuous mode will enable B_0 to accept all the frames received by H_a including those sent to a multicast group MAC that is reserved to represent *all the switches in this LAN.* Reading from a datalink raw socket, or with libpcap library or capturing frames with tcpdump or Wireshark and specifying a filter "stp" will allow us to capture the BPDUs.

d. Obtain the spanning tree corresponding to the network graph in Fig. 1 after the execution of the Spanning Tree Algorithm stabilizes. Take the steps that we developed in the lecture about the ST mentioned above.

1. Bridge B_0 will result elected the root bridge
2. Selection of root port at each bridge
    - Root ports marked in melon color
    - The root port selection at B_2 proceeds as follows
        - Distance to root bridge is the same via port 4 and via port 1
        - To break ties, B_2 uses the port number of the *next bridge* on the path to root bridge:
            - Through port 4 of B_2 next port is 4
            - Through port 1 of B_2 next port is 3
            - Since $3 < 4$, port 1 of B_2 results elected root
    - Root port election at the remaining bridges is straightforward
3. Selection of designated bridge port (DBP) at each LAN
    - The graph presents no difficulty regarding DBP calculation

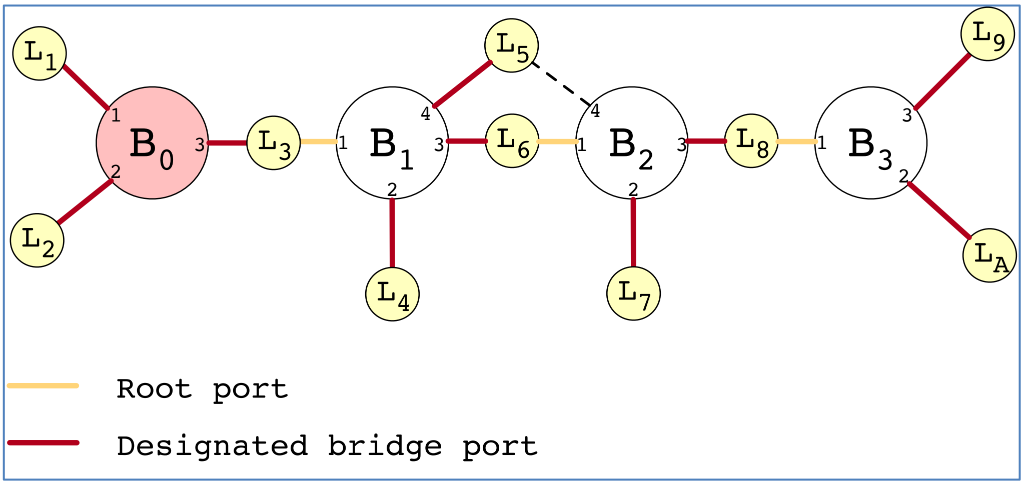

Figure 1. Steps in computing the STP from Ex. 2.d.

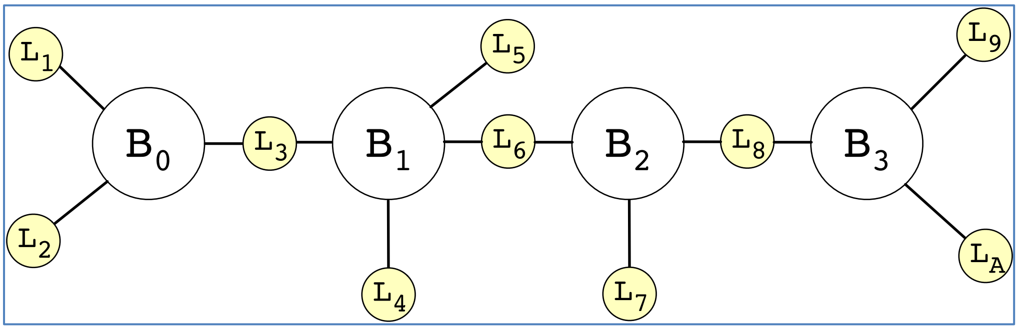

Figure 2. Spanning tree resulting from Ex. 1.d.

3. **Obtain the ST resulting from the following switched LAN.** Each of B_n represents a switch and each L_n is a LAN. Again, you are to apply the ST hand calculation that we explained in the lecture about ST.

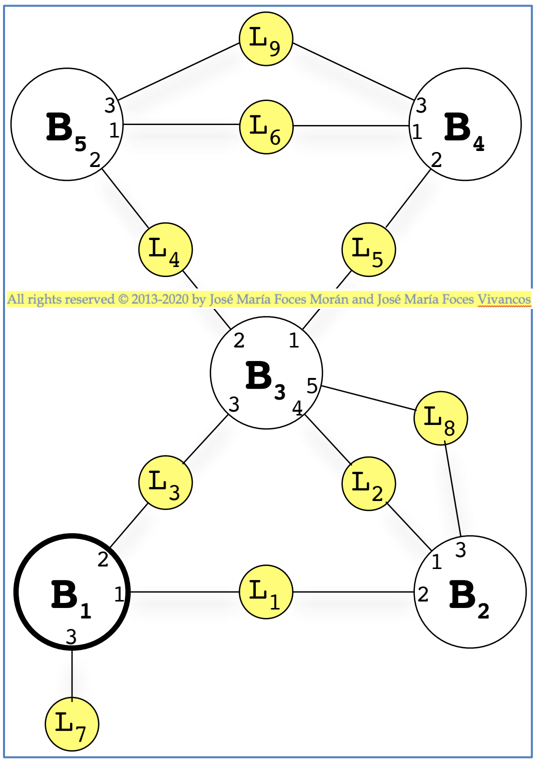

Figure 2. Switched LAN for ST hand calculation

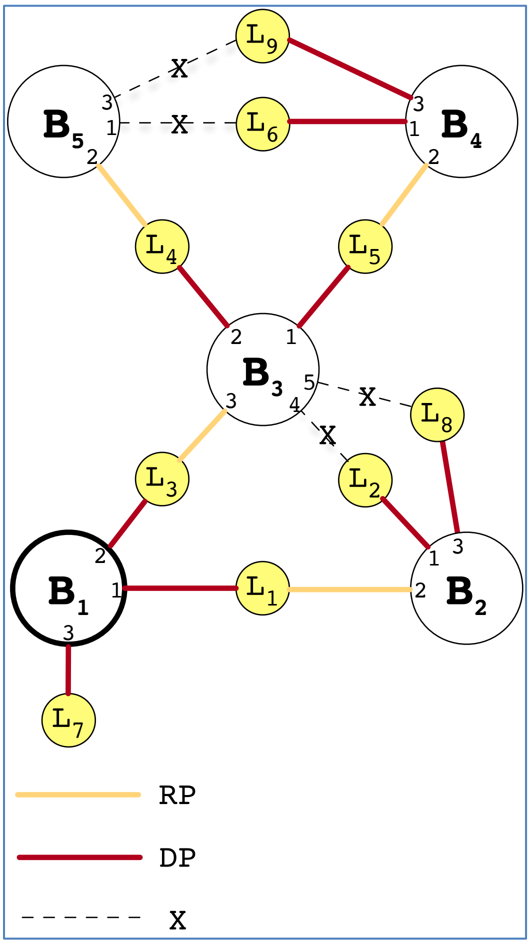

Figure 3. Spanning tree calculation for Ex. 3

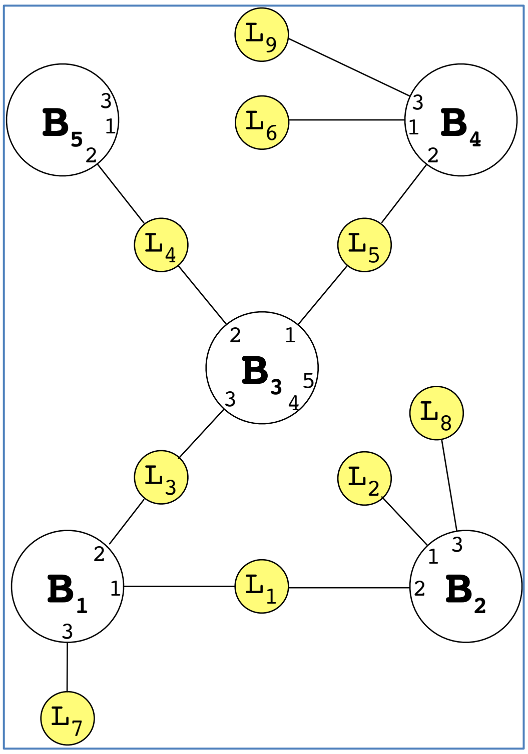

Figure 4. Spanning tree for Ex. 3

4. **Consider anew the topology from Fig. 2. In this case, L_3 has a** redundant connection from B_1 via new port 4 of B_1. Do you think that this loop could be detected and broken by STP? Search past exams and questionnaires in paloalto.unileon.es/cn for similar exercises to justify your answer.

That loop is detected and broken by STP by exchanging the protocol's Stored Configuration Messages of each switch. In this case, the resulting designated bridge port to LAN L_3 is port 2 of B_1 since it has the lowest transmitting port number out of 2 and 4.

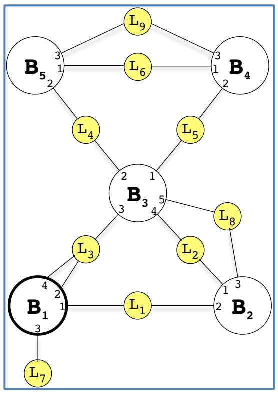

Figure 4. Extended LAN for Ex. 4.

5. **Respond to the following questions about the internetwork in Fig. 3**

   a. **Host B boots a custom Linux kernel that does not include a full** TCP/IP stack but it does have a network driver for its Ethernet NIC. The driver provides a full implementation of the Ethernet datalink; the system includes a standard Linux datalink service interface. What's the technical name to the latter service interface?

   Linux PF_PACKET raw sockets.

   b. **Describe what you would have to do to have host B send a** message 'Hello, world!' to Host A.

   Since both hosts are connected to the same Ethernet, host B would have to send a frame with appropriate src and dst MACs. Sending the frame is done with system call sendto() over a PF_PACKET socket.

   c. **Describe the contents of all the fields of the Ethernet frame** resulting from the send operation from the preceding question.

   DST MAC = 0x112233445540
   SRC MAC = 0x112233445530
   Ethertype = 0x07ff; Any non-reserved Ethertype number would suffice
   Payload = 'Hello, world!'

d. **What would you have to do to have the same 'Hello, world!'** sent to R_0? What will R_0 do with the received Ethernet frame.

Technically, sending to R_0 involves building and sending an ethernet frame equivalent to the one sent in the preceding section, however, Host A can be expected to be running an application that expects the encapsulated message 'Hello, world!' whereas R_0 cannot. That R_0 is running such application is not reasonable, consequently, R_0 will drop the frame altogether when it discovers that the ethertype value does not correspond to a running upper layer protocol.

e. **Now, we wish to send the same message to Host X, which** belongs in Network 2. Assume that Host X implements a full TCP/IP stack. Describe with detail, step by step, what would do in this case.

Sending messages across networks entails sending IP packets.

Host B is supposed to know the IP address of Host X and also has a default router configured in its forwarding table.

1. Builds IP packet
    - Dest IP = 192.168.86.80
    - Src IP = 192.168.1.30
    - ...

2. Host B sends arp for its configured *default router:* R_0

3. Encapsulates IP packet in new Ethernet frame:
    - DST MAC = Result from step 2.: 0xAABBCCDDEE10
    - SRC MAC = 0X112233445530
    - Ethertype = 0x0800

f. **Describe the Ethernet frames involved in the communication** from Host B to Host X.

1. Host B -> R_0
    MAC of default router R_0 discovered via arp
2. R_0 sends arp for Host X and builds new Ethernet frame R_0 -> Host X

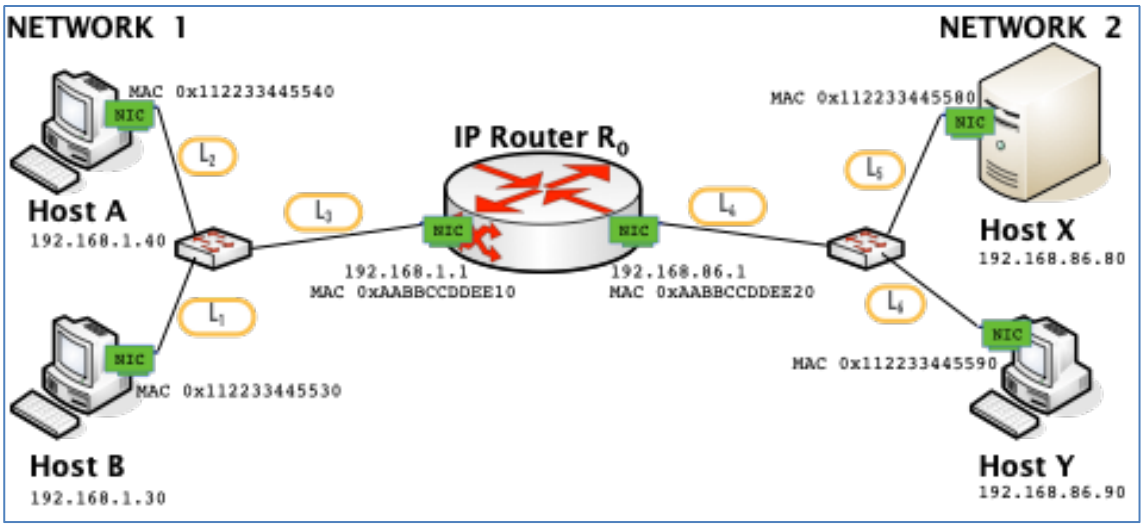

Figure 3. Internetwork for exercise 5.