Universidad de León
Ingeniería Informática
Course on Computer Networks

***Notice**: The solutions included in this document are for reference only, consequently they do not represent any endorsed style of exam answer nor any exam rubric whatsoever.*

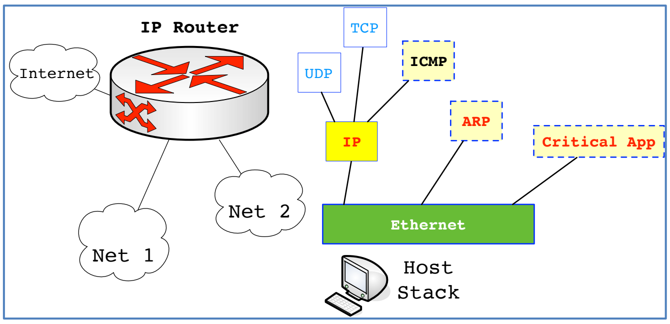
1. In this exercise we wish to explore whether a programmer can send an Ethernet frame which SRC MAC is equal to HEX ff:ff:ff:ff:ff:ff.

   a. What type of socket will allow this in the Linux system?
   `PF_PACKET / SOCK_RAW`

   b. Assume that the sent frame is received by a LAN switch. Discuss here the algorithm executed by the LAN switch to **manage the frame**.

   c. Likewise, we ask you to explore whether a programmer using the same socket can send a frame having DST MAC set to HEX ff:ff:ff:ff:ff:ff `PF_PACKET / SOCK_RAW or PF_PACKET / SOCK_DGRAM`

2. IP networks Net 1 and Net 2 are based on LAN switches. The hosts comprising both networks run *Critical App* which needs full MAC visibility with the hosts from each other network. Hosts, also need access the Internet. Discuss what solutions you suggest that allow *Critical App* from Net 1 to be able to communicate with *Critical App in* hosts from Net 2 and the other way around. *Critical App* can only send and receive over Ethernet and cannot be rewritten.



Have router run Proxy ARP and encap Ethernet in IP

Figure 1. Small internetwork and host's protocol stack

3. Ethernet bridging relies heavily on flooding. For example, broadcast traffic is flooded. List two protocols that generate broadcast traffic, and explain why broadcasting is done: arp, dhcp, explain why

4. Mark the statements that are true from the following list:

   - a. An Ethernet switch stores a mapping of IP addresses to MAC addresses
   - **b. An end host stores a mapping of IP addresses to MAC addresses**
   - c. An Ethernet switch stores a mapping of IP addresses to switch ports
   - **d. An Ethernet switch stores a mapping of MAC addresses to switch ports**

5. Compose a summary about the essential meaning of the following tcpdump trace obtained by a Linux host that is connected to a switch that supports STP.

```
$ tcpdump -i enp3s0 -n -ex -vvv stp

Options used:
-i enp3s0: sniff traffic from nic enp3s0
-ex means print the ethernet header in hex
-n addresses in numeric format
-vvv verbose

stp: limit frames to those carrying a STP packet
        15:36:48.705027 20:4c:9e:6e:55:1e > 01:80:c2:00:00:00, 802.3, length
        39: LLC, dsap STP (0x42) Individual, ssap STP (0x42) Command, ctrl
        0x03: STP 802.1w, Rapid STP, Flags [Learn, Forward, Agreement],
        bridge-id 8000.20:4c:9e:6e:55:0c.8042, length 43
                message-age 0.00s, max-age 20.00s, hello-time 2.00s,
        forwarding-delay 15.00s
                root-id 8000.20:4c:9e:6e:55:0c, root-pathcost 0, port-role
        Designated
                0x0000:  0000 0202 7c80 0020 4c9e 6e55 0c00 0000
                0x0010:  0080 0020 4c9e 6e55 0c80 4200 0014 0002
                0x0020:  000f 0000 0000 0000 0000 00
```

6. [2] Obtain the *Spanning Tree* to the following Switched LAN comprised of STP Switches (B_i) and LANs (L_n).

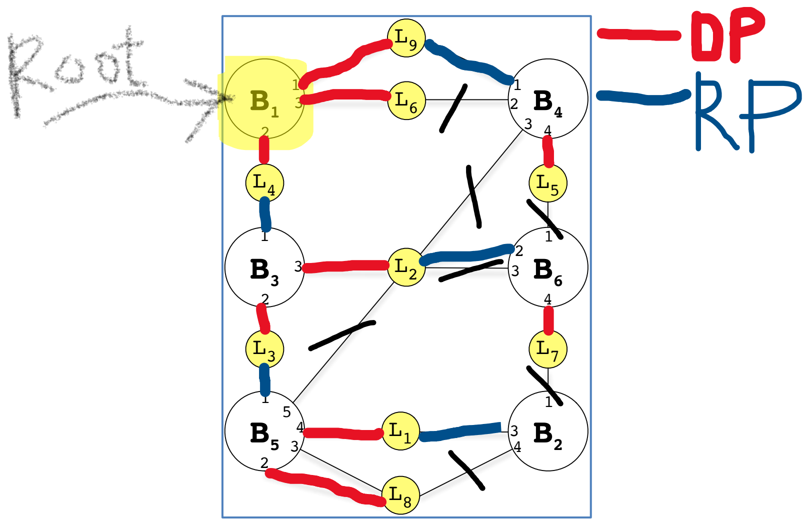


Figure 2. STP Switched LAN

· Obtain the spanning tree!

7. Can STP in the Extended LAN in Fig. 2 **prevent a broadcast** storm caused by the bridges flooding a frame which Dst MAC address is **unknown**?

   STP will prevent any form of flooding storm regardless of whether it is caused by a frame sent to the broadcast address or by a frame which destination mac has not been learned yet

8. Obtain the core parameters of IP block 192.168.0.0/26 and of 192.168.1.0/27. You can copy/paste the results obtained with Linux's ipcalc. **Include a diagram** of each highlighting the network number and the broadcast address.

```
networks@protocol:~$ ipcalc 192.168.0.0/26
Address:   192.168.0.0          11000000.10101000.00000000.00 000000
Netmask:   255.255.255.192 = 26 11111111.11111111.11111111.11 000000
Wildcard:  0.0.0.63             00000000.00000000.00000000.00 111111
=>
Network:   192.168.0.0/26       11000000.10101000.00000000.00 000000
HostMin:   192.168.0.1          11000000.10101000.00000000.00 000001
HostMax:   192.168.0.62         11000000.10101000.00000000.00 111110
Broadcast: 192.168.0.63         11000000.10101000.00000000.00 111111
Hosts/Net: 62                    Class C, Private Internet
```

```
networks@protocol:~$ ipcalc 192.168.1.0/27
Address:   192.168.1.0          11000000.10101000.00000001.000 00000
Netmask:   255.255.255.224 = 27 11111111.11111111.11111111.111 00000
Wildcard:  0.0.0.31             00000000.00000000.00000000.000 11111
=>
Network:   192.168.1.0/27       11000000.10101000.00000001.000 00000
HostMin:   192.168.1.1          11000000.10101000.00000001.000 00001
HostMax:   192.168.1.30         11000000.10101000.00000001.000 11110
Broadcast: 192.168.1.31         11000000.10101000.00000001.000 11111
Hosts/Net: 30                    Class C, Private Internet
```

9. EuroNet Associates needs to partition prefix P_a= 192.168.0.0/23 into 8 equal sized IP blocks for numbering their internal subnetworks.

    a. What's the size of P_a? $2^{32-23} = 2^9 = 512$

    b. Divide size(P_a)/8. The resulting size is the size of each of the 8 resulting subnets. What's the CIDR prefix of each resulting subnet? $2^9 / 8 = 2^9 / 2^3 = 2^6 = 64$

    c. What are the parameters of the first resulting IP block? (The initial IP address in prefix 192.168.0.0/23 is inherited by the first IP block resulting after the breakdown)

    ```
    192.168.0.0/26: 192.168.0.0 -- 192.168.0.63, 62 effective IPs
    ```

    d. [2] Calculate the parameters of all the remaining IP Blocks (#0 - #7)

    ```
    Block #0 = 192.168.0.0 -- 192.168.0.63

    Block #1 = 192.168.0.(63 + 1) -- 192.168.0.127,

    Block #2 = 192.168.0.(127 + 1) -- 192.168.0.191,

    ...

    Block #7 = 192.168.1.192 -- 192.168.1.255
    ```

    e. The network manager at EuroNet observes that instead of using #0 and #1 as they are, they need it be joined so that the resulting size is doubled. Calculate the parameters of the IP Block resulting from joining #0 and #1. `192.168.0.0/25`

10. Can IP blocks 192.168.20.0/24 and 192.168.21.0/25 be joined into a single IP block that encompasses both without adding additional space? Discuss why and do the joining if possible.

    No. Check by applying the mathematical definition of IP block included in the lecture presentation.

11. Can IP blocks 192.168.20.0/24 and 192.168.21.0/24 be joined into a single IP block that encompasses both without adding additional space? Discuss why and do the joining if possible.

    Yes. Apply the mathematical definition of IP block included in the lecture presentation.

12. Can IP blocks 192.168.21.0/24 and 192.168.22.0/24 be joined into a single IP block that encompasses both without adding additional space? Discuss why and do the joining if possible.

No. Apply the mathematical definition of IP block included in the lecture presentation.

13. **[3]** Complete the forwarding table of Router R1 so that it can *efficiently* forward traffic to all networks included in the internetwork diagram in Figure 3.

```
192.168.0.0/24   192.168.10.2 eno0
192.168.1.0/24   192.168.11.2 eno1
192.168.3.0/24   192.168.12.2 eno2
192.168.4.0/24   192.168.12.2 eno2
192.168.11.0/24  direct       eno1
192.168.12.0/24  direct       eno2
```

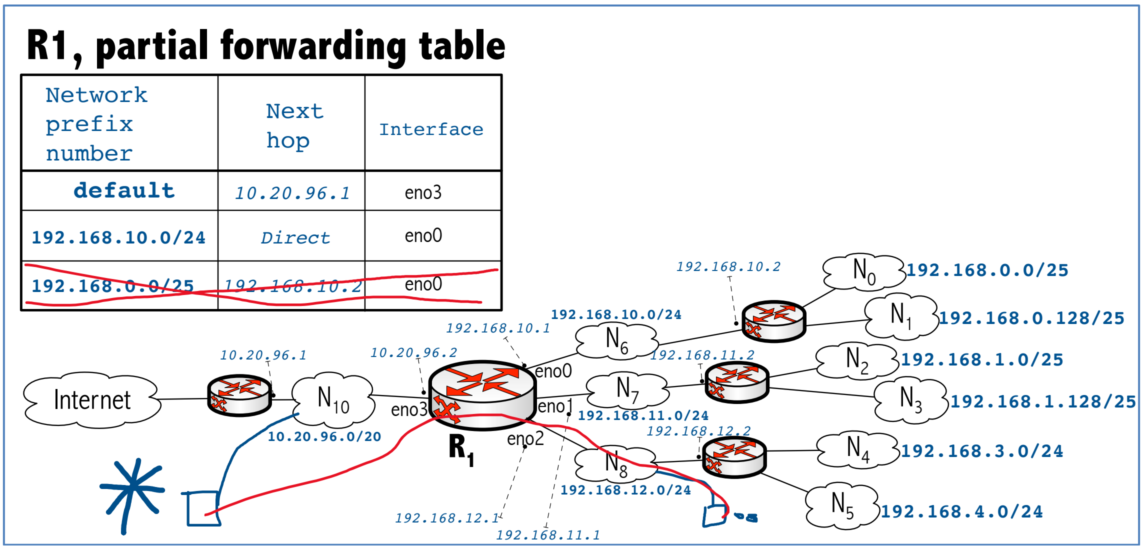


Figure 3. Internetwork

14. [2] Explain the travel of an IP packet that is transmitted from host 10.20.96.10 to host 192.168.12.12. Give meaningful symbolic names to the relevant MAC addresses, which are missing on the diagram, for example the MAC used by the transmitting host can be represented as MAC_{H1}.

Attend the practice that will be given on Thursday 27th-MAY-2021 where we will provide a detailed explanation about the trip of an IP packet over Lab B6 internetwork

15. An IP router has built the following forwarding table and at some instant it receives an IP packet P which destination IP is 10.20.76.100.

   a. [2] Simulate the execution of the *Longest Prefix Matching* when the router is switching P. Clearly indicate the router interface selected for the forwarding/retransmission of P. Assume no ordering whatsoever in the forwarding table entries:

```
enp1s0 10.20.76.0/25
```

b. Now that we know which router's interface will be used for retransmitting P, explain the steps and elements involved in the **encapsulation of P in a new Ethernet** frame alongside its relevant fields. Again, you can represent MAC addresses symbolically.

Dest Network Prefix	Next hop	Interface
192.168.1.0/24	Direct	enp1s0
192.168.2.0/24	Direct	enp2s0
192.168.3.0/24	Direct	enp3s0
10.20.77.0/24	192.168.2.1	enp2s0
LPM — **10.20.76.0/25**	**192.168.1.1**	**enp1s0**
10.20.76.128/25	192.168.1.1	enp1s0
10.20.76.128/25	192.168.3.1	enp2s0
10.20.76.0/24	192.168.1.1	enp1s0
10.20.76.0/23	192.168.1.1	enp1s0

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