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

# Weekly Homework no. 5 ($WH_5$-Lecture)

## Exercises and examples about the lectures

1. **MAC addressing**

    **a.** Would it be useful to avail a NIC that has no MAC address?

    A NIC that has no MAC address stored in a non-volatile memory would require a source MAC to be included in each sent frame's header, consequently the PF_PACKET/SOCK_DGRAM socket interface wouldn't function as is since it uses the NIC's MAC as the default MAC to be included in each sent frame's header.

    b. Commercial NICs have only one MAC address stored in stable storage. Is that MAC unique?

    The MAC address written in a NIC has been managed by the NIC manufacturer; it canbe assumed to be unique.

    c. Can additional MAC addresses be stored in the NIC, is that technically possible?

    NIC's of today accept MACs additional to the one stored in their non-volatile storage and provided by the manufacturer. Network utilities such as ifconfig, ip and the Netlink socket interface are means to send additional MACs to a NIC. The MAC written to a NIC should be unique, *ie.,* it shouldn't be in use by any other adaptor, save special or experimental applications.

2. **The Destination MAC of an Ethernet frame is ff:ff:ff:ff:ff:ff. This frame** is received by a NIC.

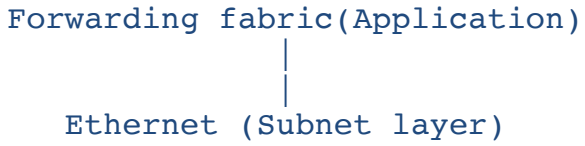
    a. Is the frame accepted by the NIC?

    Yes, every frame sent to the broadcast address must be accepted by any NIC.

    b. If it is in fact accepted, what will the NIC do with that frame if the receiving NIC is installed in a LAN Switch? Justify your answer and include the relevant protocol stack in it.

    The NIC will indicate the *forwarding engine* that the frame should be flooded.

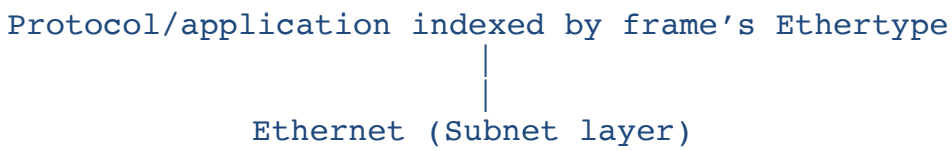
Protocol stack:




c. Again, if the frame is in fact accepted, what will the NIC do with that frame if the receiving NIC is installed in a Linux PC? Justify your answer and include the relevant protocol stack in it.

The frame's Ethertype will indicate which protocol/application should the payload be handed to.

Protocol stack:




d. Regarding the preceding two questions and considering the context for this exercise, can you tell what protocol will be the ultimate destination for the frame's payload?

Oftentimes, the frame will contain an IP packet which Ethertype is 0x0800

Protocol stack:


3. **Modern NICs offer an operation mode that allows the NIC to accept all** the received frames.

   a. **What's the technical name to that mode?**

   Promiscuous mode

   b. **Investigate what mechanisms are available to set the mode** referenced in this exercise.

   Programmatically it can be done with ioctl() syscalls and with Ntelink sockets; uitlities such as ip, ethtool and ifconfig allow setting promiscuous mode on a NIC.

   c. **What is the usefulness of setting a NIC in the mode referenced** above?

Promiscuous mode is essential when capturing traffic (Packet sniffers) and in intrusion detection systems.

4. **In chapter 1, we introduced the Internet Architecture (IA) and explained** that Service Interfaces can be used by programmers when they want to access the services provided by a layer. What's the technical name of the *Service Interface* for accessing the Ethernet Datalink? Since Ethernet Datalink stands at IA Layer 1, in this question, we are referring to the Layer-1 Service Interface. In the conceptual protocol stack in Fig. 1, we are asking about SIF 1 (Service InterFace 1).

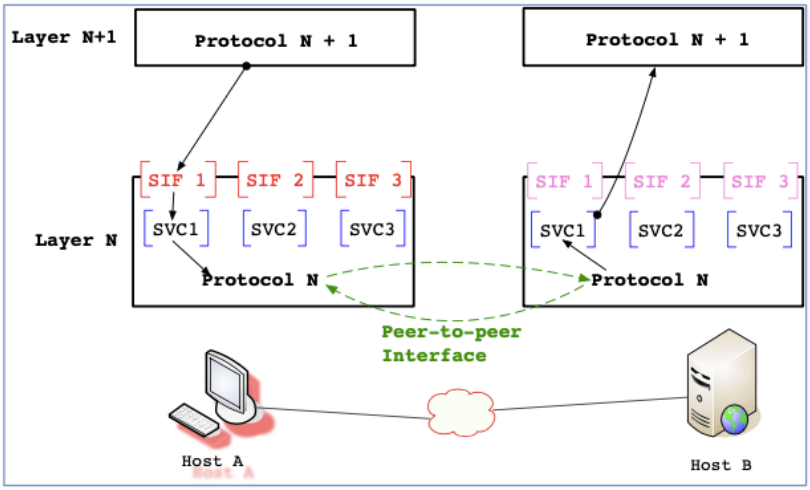



**Figure 1.** From lesson [http://paloalto.unileon.es/cn/lect/CN-Ch1-2018-Section1.pdf](http://paloalto.unileon.es/cn/lect/CN-Ch1-2018-Section1.pdf)

Linux PF_PACKET raw sockets is the datalink interface in Linux.

5. **The learning algorithm executed by a LAN Switch starts by recording** the Source MAC contained in each received frame.

   a. Discuss why that is what must be done

   A LAN station can move from one switch port to another one; the switch must re-record the station's new port number whenever it decides to move ports so that future frames sent to it can be correctly delivered

   b. Linux' Sockets PF_PACKET interface has two modes of operation available for the programmer to choose from (DGRAM and SOCK_RAW). When SOCK_RAW mode is chosen, the programmer can send whatever Ethernet header she wishes, including the Source MAC address. Using this mode, a frame can carry a *fake* Source MAC address. Discuss how this would affect a receiving switch learning algorithm.

   Yes, in principle, that a station sends a fake MAC address as source will cause the receiving switch to update the forwarding table with a fake port/MAC association. Switches of today have various protection degrees against this attack.

c. Discuss the usefulness of having a Learning Switch learn destination MAC addresses along with Source MAC addresses.

Discussion; no answer provided.

**6. Under what two circumstances does a LAN switch flood a frame?**

A switch should flood any frame which destination address is the broadcast address or its switch port is unknown. Some switches having small CAM storage might flood all the frames which destination addresses were not stored into the MAC table due to lack of space.

7. **LAN switching. Apply the LAN Switch learning algorithm explained** in slide no. 11 to the following exercises.

a. The *Extended LAN* in **Fig. 2**. is comprised of bridges $B_0$ through $B_3$ and hosts $H_a$ through $H_f$. When the whole Extended LAN is initialized, all the forwarding tables are empty, then, the following six transmissions are undertaken by the hosts. You are asked to **explain the evolution** of the forwarding tables of each bridge over the time it takes to complete the six transmissions.

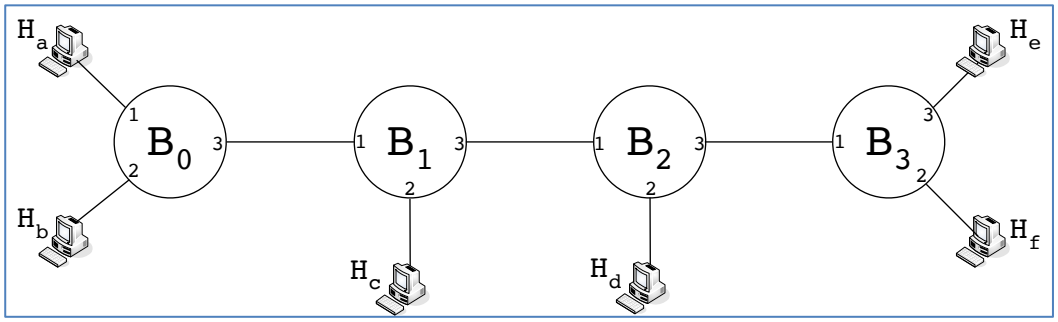



**Figure 2.** Extended LAN for exercise 2.a.

**List of transmissions:**

1. $H_a$ transmits a frame to $H_z$ which is not connected
   All switches learn Ha

2. $H_f$ transmits a frame to $H_e$
   All switches learn Hf

3. $H_e$ transmits a frame to $H_f$
   B3 learns He

4. $H_c$ transmits a frame to $H_b$
   All switches learn Hc

5. $H_a$ transmits a frame to $H_c$
   No change

6. $H_b$ transmits a frame to $H_c$
   B0 and B1 learn $H_b$

b. Consider now the Extended LAN in **Fig. 3** which is the same as that in **Fig. 2** but having a loop between bridges $B_1$ and $B_2$. Do the same calculations that you did in the preceding case. Have you found some instability in the evolution of the forwarding tables?

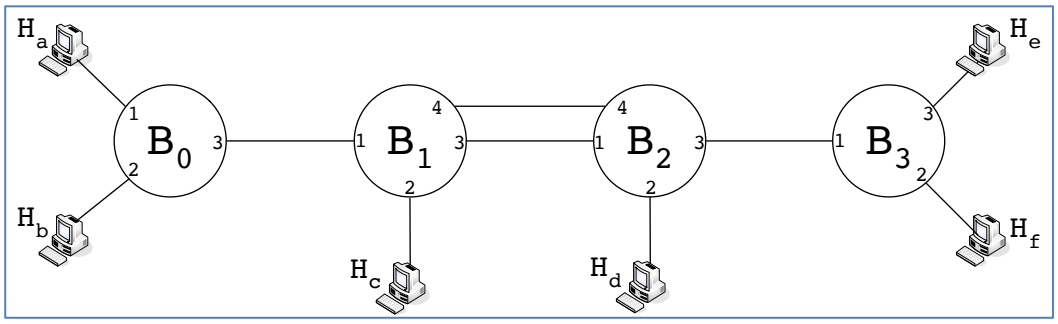



**Figure 3.** Extended LAN for exercise 2.b.

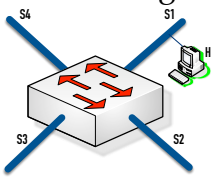
The loop involving B1and B2 will create a broadcast storm whenever the switches flood a frame due to its MAC being unknown

c. According to the results obtained, would you choose the Extended LAN in **Fig. 3** on the basis that it contains a redundant link which would prevent some failures from affecting the connection between $B_1$ and $B_2$. Explain your answer.

Redundant links can be incorporated in an extended LAN if the switches run STP

8. **A network is comprised of shared medium Ethernet segments $S_1$-$S_4$, each** connected to one port of a 4-port switch. Respond to the following questions:

a. Draw a diagram of the resulting Extended LAN




b. Host H in segment $S_1$ sends a frame which destination MAC is that of broadcast, explain which hosts will receive that frame

All the hosts in the whole extended LAN will receive that frame (The whole broadcast domain)

c. How many broadcast domains there exist in the network?

One broadcast domain comprised of all the stations connected to the shared Ethernets

d. How many collision domains there exist in the network?

There exist as many collision domains as there are switch ports

9. **What is a broadcast storm?**

a. Why are broadcast storms to be avoided, altogether?

The traffic offered by a broadcast storm will become a switch bandwidth hog; station traffic competing with the storm's will be in a clear disadvantage with the consequent low service level perceived by station's users

b. What protocol/algorithm is used to prevent that broadcast storms occur?

STP (IEEE 802.1D)

10. **Thoroughly review the bridge learning/switching algorithm in slide** no. 11 of the lesson presentation above, then, solve the following textbook exercises (From P&D 5th edition -*not from the 6th edition*):

a. P&D 5th edition, Chapter 3, Exercise 17. **Find this exercise, solved in Spanish, in this URL in page number 8, exercise number 4 (Compose your solution in English):**

http://paloalto.unileon.es/cn/notes/CN-ExRefSol2013.pdf

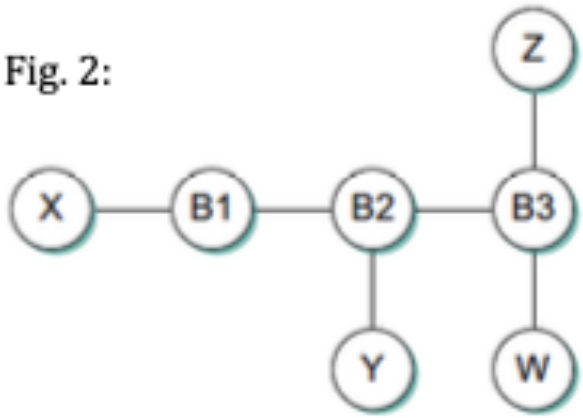



**Figure 4.** Extended LAN for exercise 10.a. © 2012 Larry Peterson and Bruce Davie, Morgan-Kaufmann Pub. Co, From textbook "Computer Networks"

b. P&D 5th edition, Chapter 3, Exercise 15. **Develop** the evolution of the Forwarding Tables of each switch (B1, B2, B3 and B4) in the Extended LAN in **Fig. 4** as the ensuing frame transmissions take place (A, C and D are hosts):

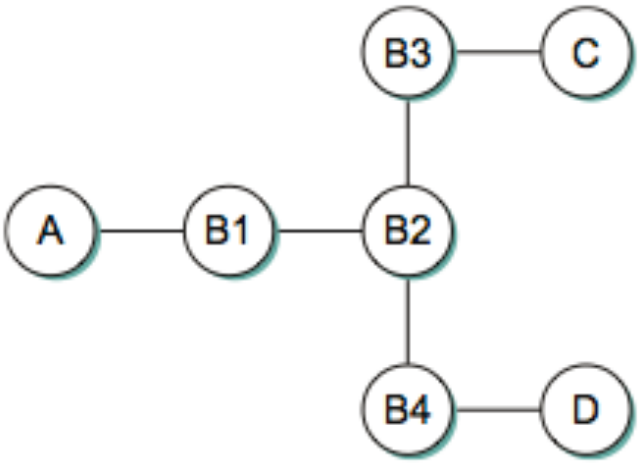



**Figure 5.** Extended LAN for exercise 10.b.


**Transmission at $t_0$: A sends a correct frame to C.** *Since the forwarding tables are empty now, B1 will flood the frame sent by A, therefore all switches learn A.*

**Transmission at $t_1$: C sends a correct frame to A:** *B3 learns C and, since it knows A, it will forward the frame to B2, which will forward it to B1, from which will be eventually delivered to A. Switches B3, B2 and B1 learn C.*

**Transmission at $t_2$: D sends to C a correct frame:** *B4 learns D, and since B4 has not learned C so far, B4 will flood this frame, thereby causing B2 to learn D. B2 will forward the frame to B3 which will learn D, and finally, the frame will be delivered to C.*