Lab 5: Final Project. Corporate Network Design

Team number: 17

Members:

Zihao Zhou (u232741) NIA: 285879

Rui Lin (u232208) NIA: 285717

Rúben Silva (u227942) NIA: 280719

DISCLAIMER: It is very important that you carefully read the **entire** document before starting working on the final project.

A. Introduction to the final exercise

You are aimed to design a corporate network that will interconnect three UPF campuses as shown in **Figure 5-1**: Comunicació (COM), Ciutadella (CIU), and Mar (MAR).

Figure 5-1: UPF campuses map.

A packet tracer file (`final_project_students.pkt`) is provided as a starting point (see **Figure 5-2**), and you are expected to provide your **own** solution based on the requirements described below. You will elaborate **a detailed report** explaining such a

solution, thus showing your knowledge and skills learned through the different laboratory sessions on general networks and Packet Tracer.

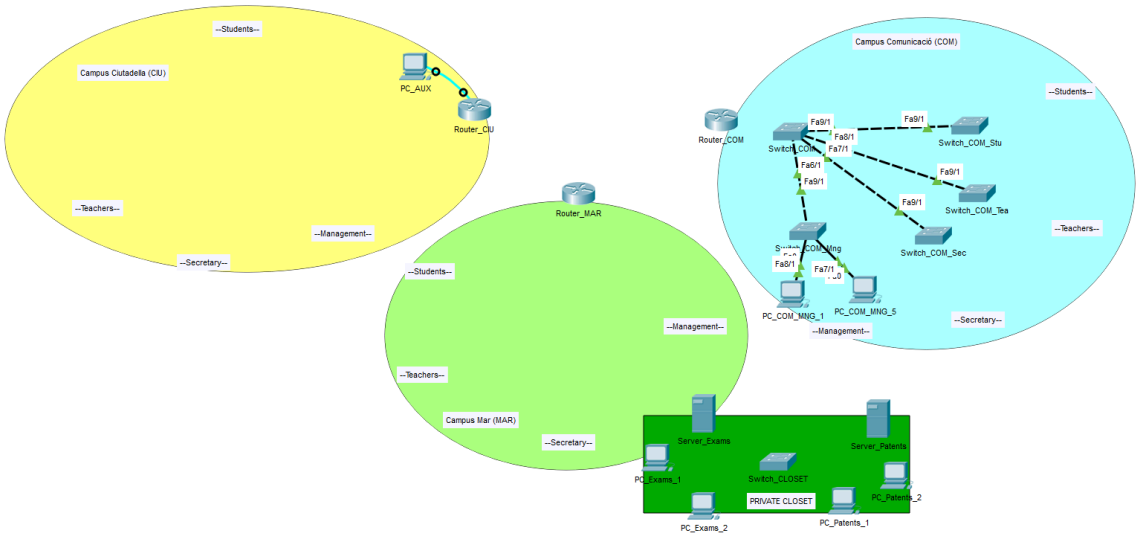


Figure 5-2: Final exercise skeleton.

B. Problem description

You have to design the corporate network for three campuses of the UPF: CIU, COM, and MAR. For that, you must take into account the number of PCs per campus required to be connected to the Internet (see **Table 5-1**).

In addition to the PCs, you should also take into account the servers that are available for any user in the whole network, as defined in **Table 5-2**.

Depart.	CIU	COM	MAR
Students	150	100	20
Teachers	34	27	7
Secretary	28	13	2
Management	12	5	8
TOTAL	**224**	**145**	**37**

Table 5-1: Number of users per campus

Server	CIU	COM	MAR
Web server	0	1	0
FTP server	1	0	0
DNS server	0	0	1
DHCP server (optional)	-	-	-

Table 5-2: Number and type of servers needed in the network

Finally, a separate network should be located in MAR campus, which is expected to be completely independent of the rest of devices (see **Figure 5-3**). As it will be seen later on, this separate network will be used to generate two different private VLANs.

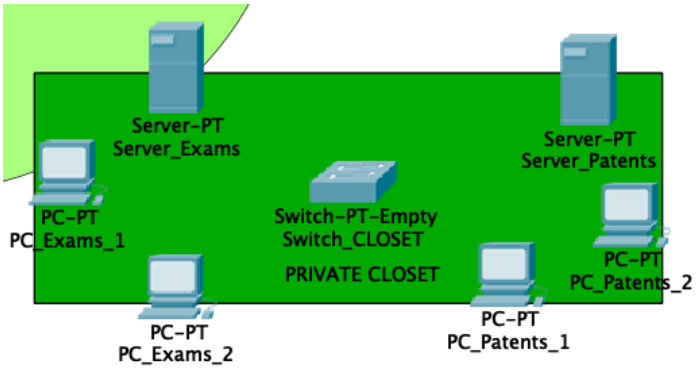


Figure 5-3: Separate network in MAR campus for generating VLANs.

C. Requirements

Next, the specification of what **should be included** in your report is presented. For each of the following subsections, you **should properly write and justify what you have designed**. It is important that you consider each of the requirements described below when designing your solution.

C.1. PHYSICAL LAYER: Network deployment [1.5 p]

1. The network and host devices must be properly placed (physically) in each campus (i.e., city -> building -> closet -> rack).

   We place network and host devices properly, once we place a device in the physical Mode, the host will automatically appear in the logic Mode.

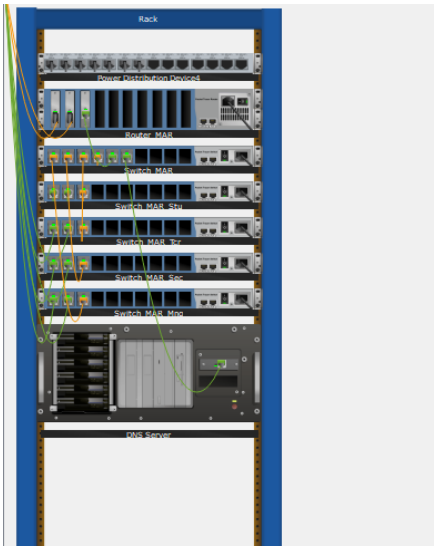
   COM:


Rack
Switch_COM_Mng
Router_COM
Switch_COM
Switch_COM_Stu
Switch_COM_Soc
Switch_COM_Tea
Switch_COM_Mng
Access Point COM
DHCP server
Rack
Power Distribution Device2
Web Server

CIU:


Router_CIU
Switch_CIU
Switch_CIU_Stu
Switch_CIU_Soc
Switch_CIU_Mng
Access Point CIU
FTP Server
PC_AUX

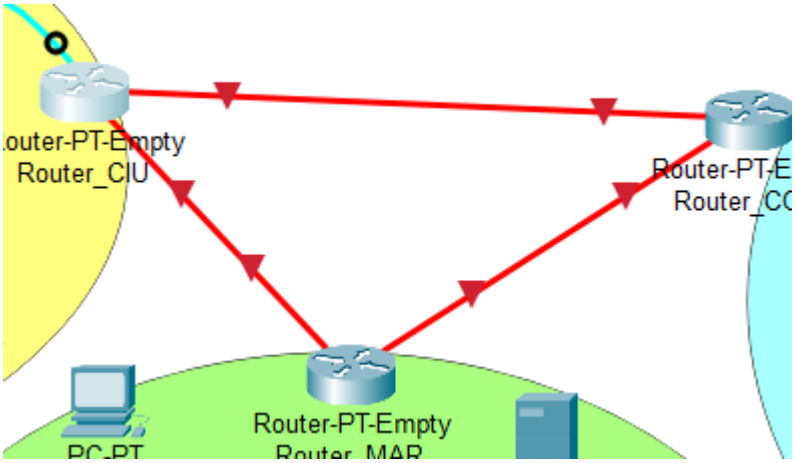
MAR:



We set up the necessary devices in each different campus.

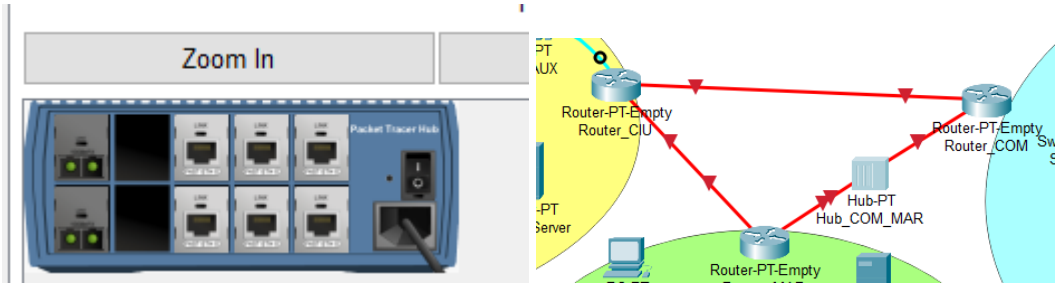
2. The backbone network (i.e., the different subnetworks that interconnect routers) must allow Gigabit rates.

UPDATE TOP PICTURE



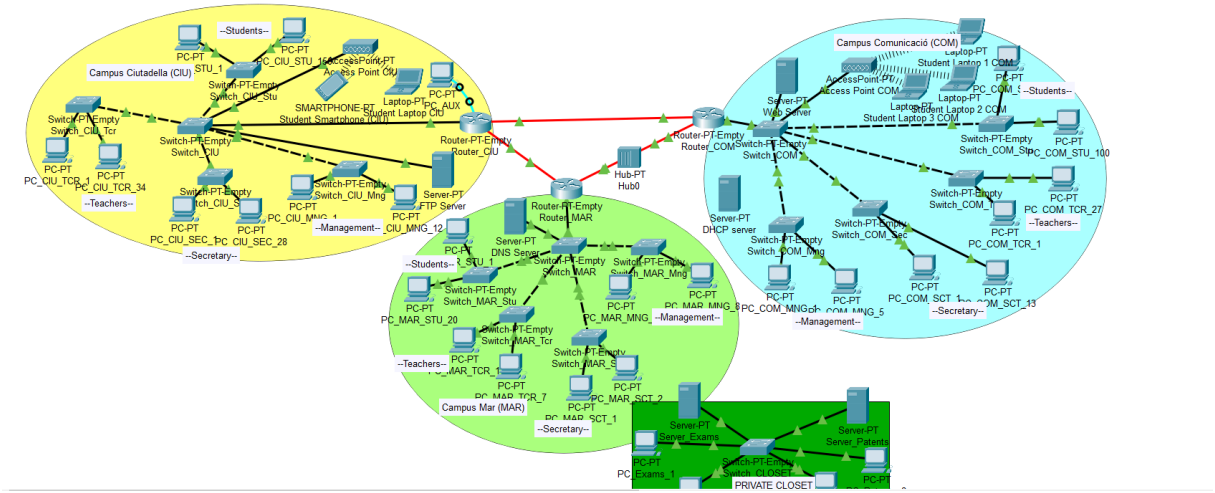
We put PT-ROUTER-NM-1FGE in each router, to let the routers allow a Gigabit rate.

3. You should include a hub between the routers of MAR and COM campus, so that it is ensured that propagation losses are mitigated.



We also put two PT-ROUTER-NM-1FGE here, to let the routers allow a Gigabit rate.

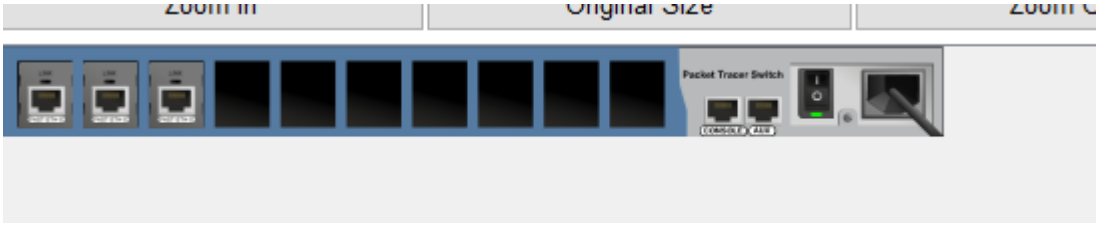
4. In each campus, the PCs of each department are grouped into their corresponding switch. In the `final_project_students.pkt` file, you will see that the COM campus has a separate switch for each department.



We divide them into different groups.

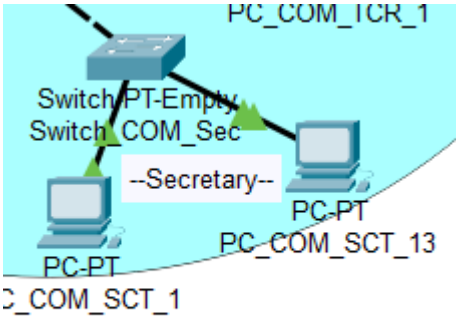
5. When placing a switch, you must use the model “Switch-PT-Empty”, which does not contain any interface by default. Once selected, you should install on it the minimum number of interfaces to fulfill the specified network requirements.

An example of the exercise: Switch_COM_Stu



For those switches that organize a department, we need to install at least 3(Notice that you do not need to include the entire number of PCs per campus), And another switch that connects others 4 switches and routers this switch needs at least 5 if we don't take account extra devices like server, etc.

6. Notice that you do not need to include the entire number of PCs per campus. You have to add, for each department in each campus, at least the **first** and **last** hosts in that department. You will find an example of this in the `final_project_students.pkt` file, where we have only placed two PCs for the Management (Mng) department in COM campus (i.e., PC_COM_MNG_1 and PC_COM_MNG_5). These PCs correspond to the first and the last host of that department.

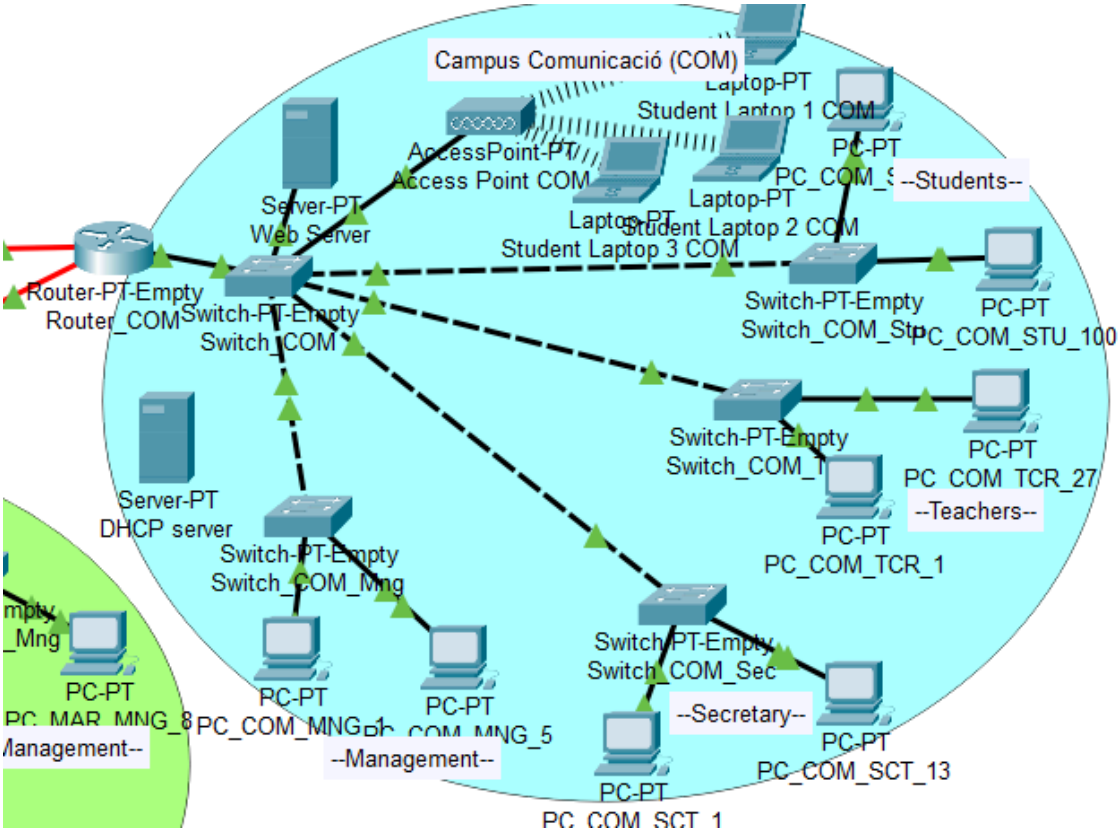


An example of the exercise: The Secretary part in COM campus

For simplicity, we only consider the first and last hosts in that department, we just need to be careful with the name of each last host, which corresponds to the number of the department PCs.

7. You must label the PCs according to the real development as done in the Mng department of the COM campus.

An example of the exercise: COM campus



We use "PDU" to check the connection, and it works well.

8. In addition, **and only as part of your report and not of your final .pkt file**, you have to provide an alternative and theoretical network design detailing the necessary amount of networking devices (switches, access points, etc.) to cope with the requirements of the **real total amount** of PCs per campus.

Depart.	CIU	COM	MAR
Students	150	100	20
Teachers	34	27	7
Secretary	28	13	2
Management	12	5	8
TOTAL	**224**	**145**	**37**

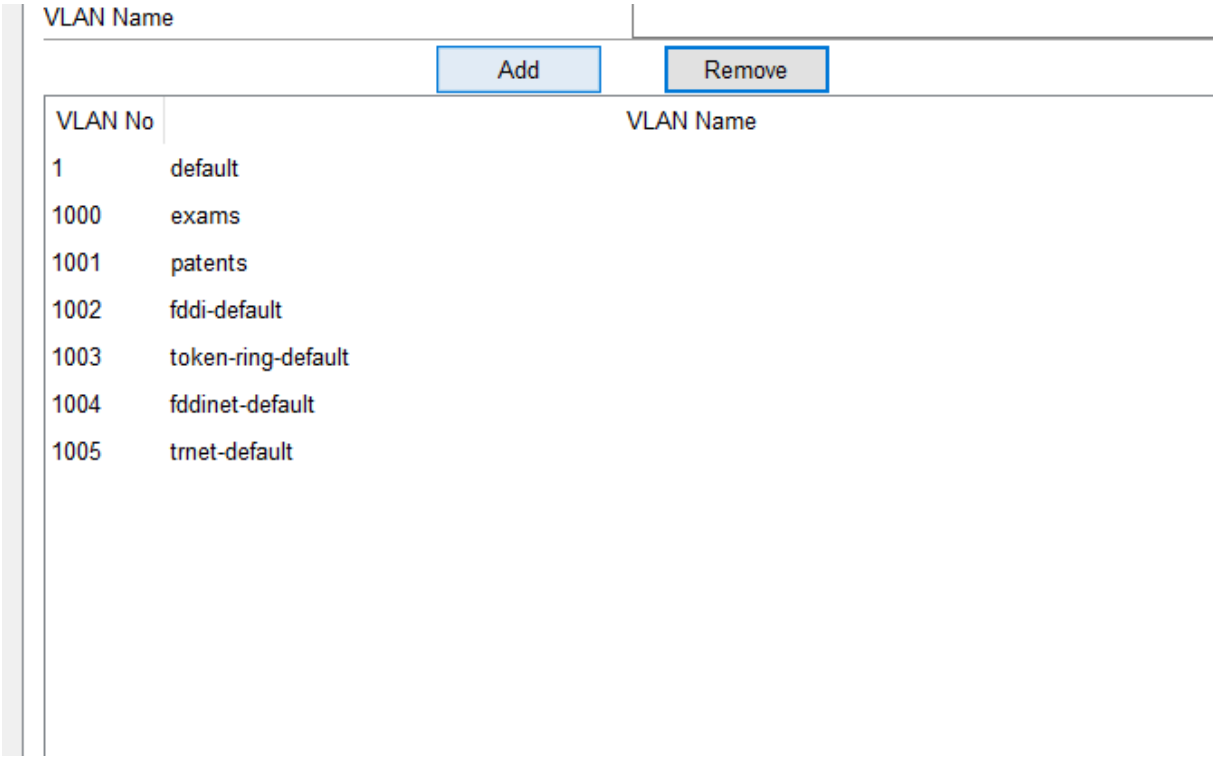
Table 5-1: Number of users per campus

According to the statement, we have 4 department for each campus, so we need at least four switch for each campus, and we need a switch more because we need to connect these four switches. Therefore in each campus we need five switches. Since we have 3 campus, we need 3 * 5 = 15.

In the MAR campus we have a vlan, so one switch more, 16 switches. And the sum of PCs is 224+145+37 = 406 PCs.

C.2. LINK LAYER: VLANs and Wireless Access [2 p]

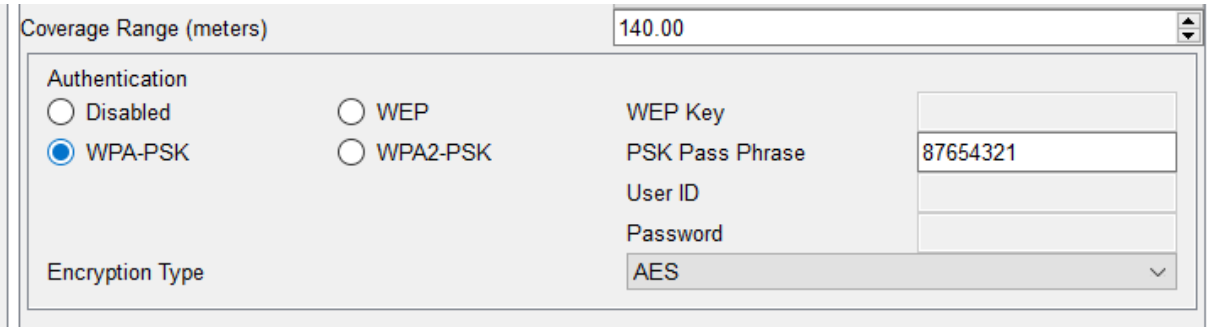
9. [VLAN] You have to configure two VLANs in the independent network located in MAR campus (see **Figure 5-3**). Each VLAN is composed by one server and two computers. The first VLAN is meant for sharing exams, which are stored in the "Server_Exams" server, whereas the second VLAN is for patents (stored in the "Server_Patents" server). For this independent network, you must use the private range 192.168.1.0/29, and then configure the VLANs.



In the switch, FastEthernet 5/1,FastEthernet 9/1 and FastEthernet 8/1, they are Server_exam, PC_exams_1, and PC_exams_2 respectively, these 3 are connected to VLAN 1000 which is "exams".

Other Ethernet cables in the switch are connected to VLAN 1001 which is "patents".

10. [WLAN] You must provide Internet access through WiFi to some students in CIU and COM campuses. You should do that by placing an Access Point (AP) in the most convenient location of those campuses. In particular, you should configure your APs with WPA-PSK authentication.



We put one AP for CIU and one for COM, we don't have to install any interface since it is wireless, we set up Pass 12345678, and 87654321 respectively.

C.3. NETWORK LAYER: Subnetting and routing [4 p]

11. You must define the set of IPs that you need to buy in order to allocate a different IP address to each end device (i.e., computers and servers). Notice that IPs are expensive, hence you need to buy as few as possible. All your IPs should begin with 10.[team number].x.x. For instance, if you are in team number 2, your IPs should look like 10.**2**.x.x.

    As our team number is 17, so we will use 10.17.x.x, since the IPs are very expensive, we need to use the IPs in 10.17.x.x as few as possible.

    For CIU, there are 224 users and one FTP server, and notice that we need two IP addresses for broadcast and network addresses, so it needs 227 IP addresses in total, which needs 8 bits for the hosts.

    For COM, there are 145 users and one WEB server, and notice that we need two IP addresses for broadcast and network addresses, so it needs 148 IP addresses in total, which needs 8 bits for the hosts.

    For MAR, there are 37 users and one DNS server, and notice that we need two IP addresses for broadcast and network addresses, so it needs 40 IP addresses in total, which only needs 6 bits for the hosts; the two remaining bits can be for the connections between the campuses, in order to minimize the amount of networks we buy and make our implementation much more efficient, instead of buying the network 10.17.4.0 for these connections.

12. You must provide and justify your subnetting solution for the three campuses and the backbone. You must include your own version of **Table 5-3** in your report, specifying the IP addresses allocated to each subnetwork.
    WE remain a ip address for DHCP server in COM campus so its last host is 10.17.2.148/24
    Three subnets for 3 campuses, CIU, COM, MAR.
    To build the connection between routers, we need 3 networks.
    CIU-COM, A network between COM campus and CIU campus

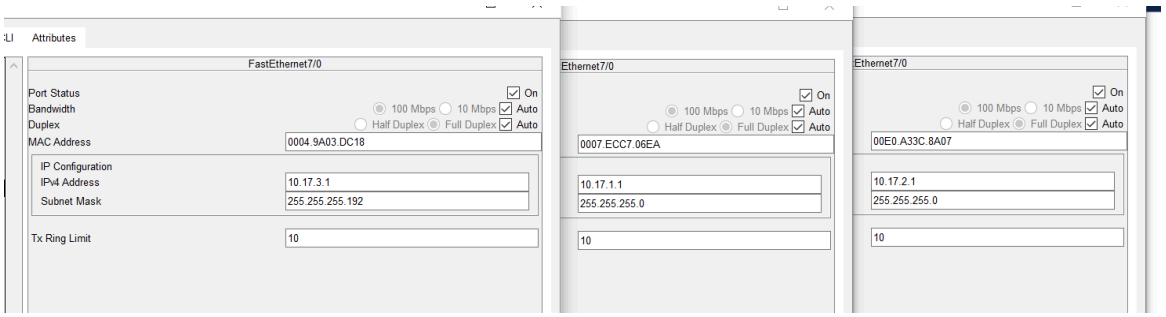
CIU-MAR, A network between CIU campus and MAR campus
COM-MAR, A network between COM campus and MAR campus

Net	Name	@Network	@Broadcast	@First host	@Last host
1	CIU	10.17.1.0/24	10.17.1.255/24	10.17.1.1/24	10.17.1.226/24
2	COM	10.17.2.0/24	10.17.2.255/24	10.17.2.1/24	10.17.2.148/24
3	MAR	10.17.3.0/26	10.17.3.63/26	10.17.3.1/26	10.17.3.39/26
4	CIU-COM	10.17.3.64/30	10.17.3.67/30	10.17.3.65/30	10.17.3.66/30
5	CIU-MAR	10.17.3.68/30	10.17.3.71/30	10.17.3.69/30	10.17.3.70/30
6	COM-MAR	10.17.3.72/30	10.17.3.75/30	10.17.3.73/30	10.17.3.74/30

Table 5-3: Subnetting solution

13. The default gateway of each subnetwork must be the first available host IP of the corresponding range. For instance, if a given subnetwork has the range 192.168.1.0/24, the default gateway must be configured with IP 192.168.1.1.

    Default gateway for each subnet. The default gateway will be the first host in each Campus subnet.



Since the CIU campus subnet address is 10.17.1.0/24, default gateway will be 10.17.1.1/24

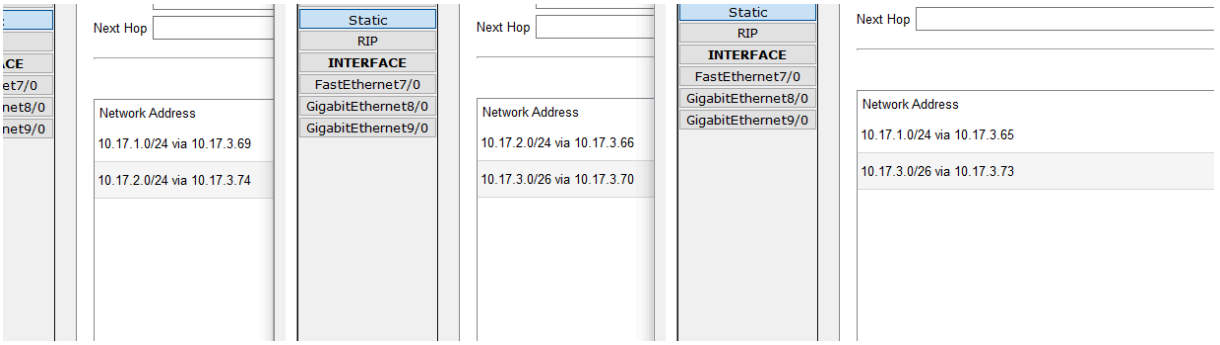
Since the COM campus subnet address is 10.17.2.0/24, default gateway will be 10.17.2.1/24

Since the MAR campus subnet address is 10.17.3.0/26, default gateway will be 10.17.3.1/26

14. You must configure the routing tables of each router, so that there is full connectivity among all campuses.

    Static Routes:

    In the network and subnet bracket, we put the IP address of subnet, in the next hop bracket, we put the corresponding IP address of the <interface name>.



15. You must configure the CIU router through Cisco commands and provide the corresponding screenshots. Instead of using the CLI of the router, you must use PC_AUX, which is connected to CIU router via "console". PC_AUX is already included in the `final_project_students.pkt` file, so you only need to introduce the commands from the "Terminal" application, which is equivalent to using the CLI of the router.

    We use command interface <interface name> and IP address to configure the IP of the interface through the terminal.

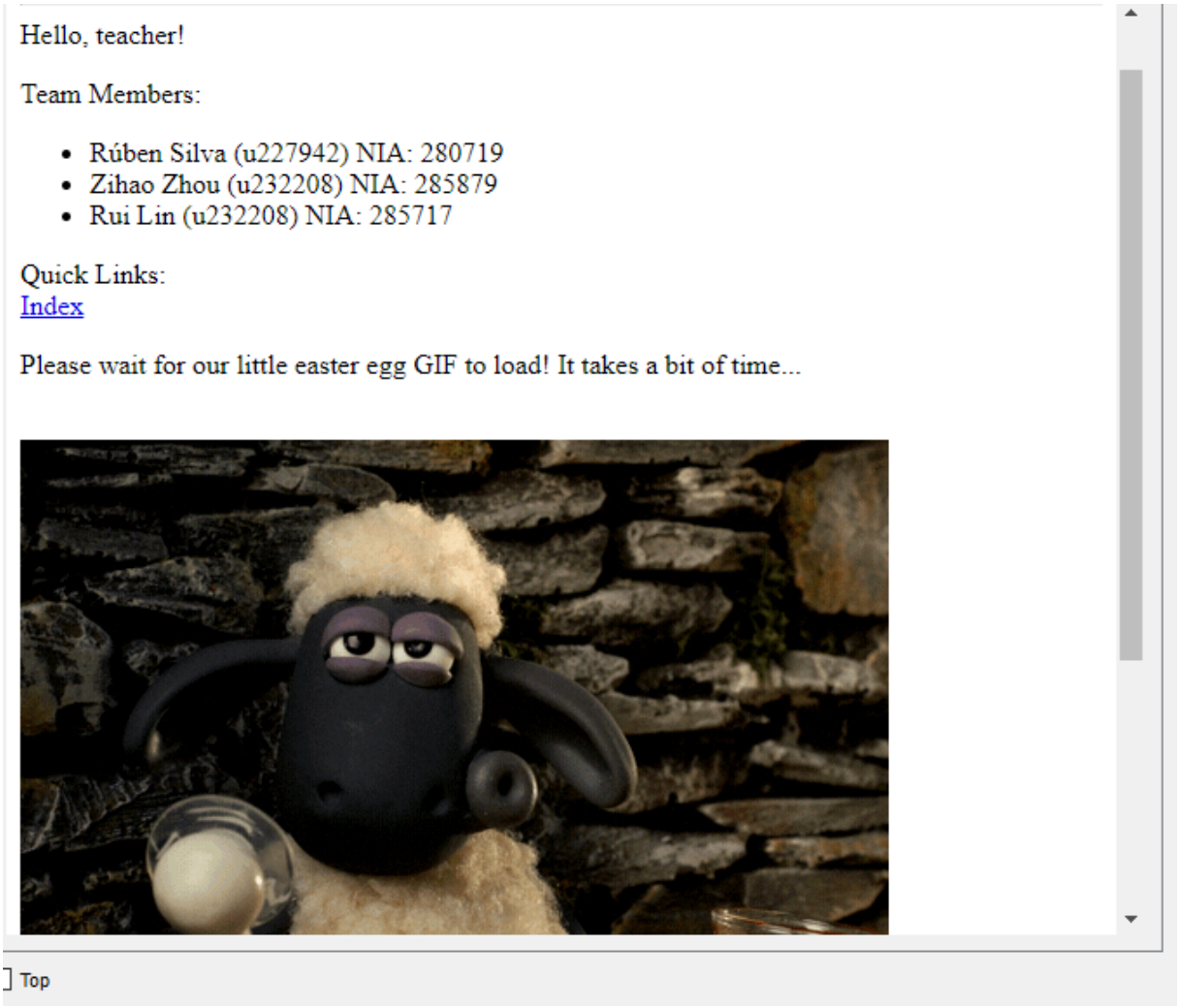
    Use the IP route command to configure the static routes.

```
Router(config)#interface FastEthernet7/0
Router(config-if)#ip address 10.17.1.1 255.255.255.0
Router(config-if)#exit
Router(config)#ip route
% Incomplete command.
Router(config)#
Router(config)#ip route 10.17.2.0 255.255.255.0 10.17.3.66
Router(config)#ip route 10.17.3.0 255.255.255.192 10.17.3.70
Router(config)#
```

16. You must ensure that there is communication among all the PCs in the network (department-to-department included). ***NOTE:*** *You do not need to provide any answer nor screenshot here. Teachers will validate this in the packet tracer file that you will deliver.*

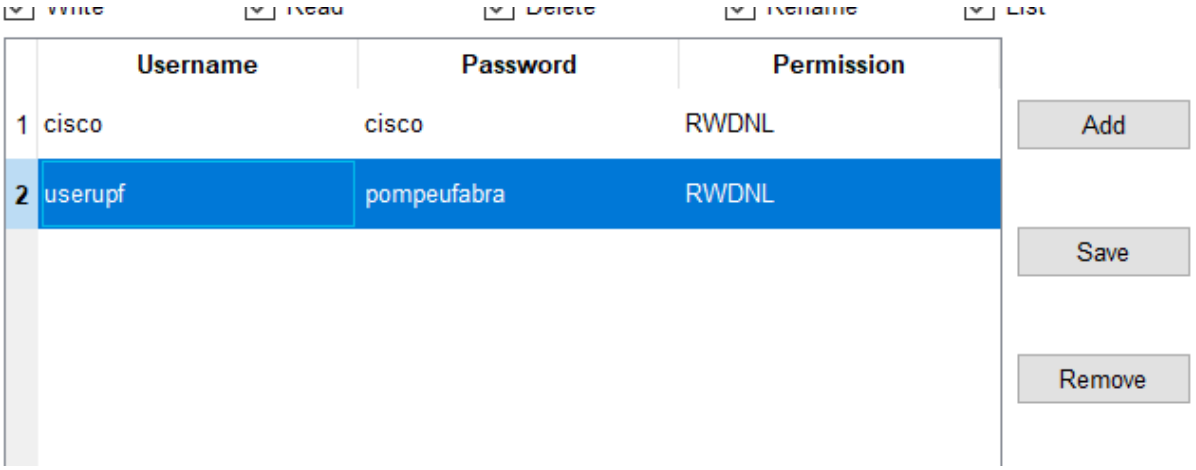
C.4. TRANSPORT & APPLICATION LAYER [2.5 p]

17. The COM campus must have a **web server**. Any PC in the whole network must be able to access a very simple website designed by you. Such a website must contain at least your names and a link back to *index.html*. Your website must be named *www.final_project_<team number>.edu*.



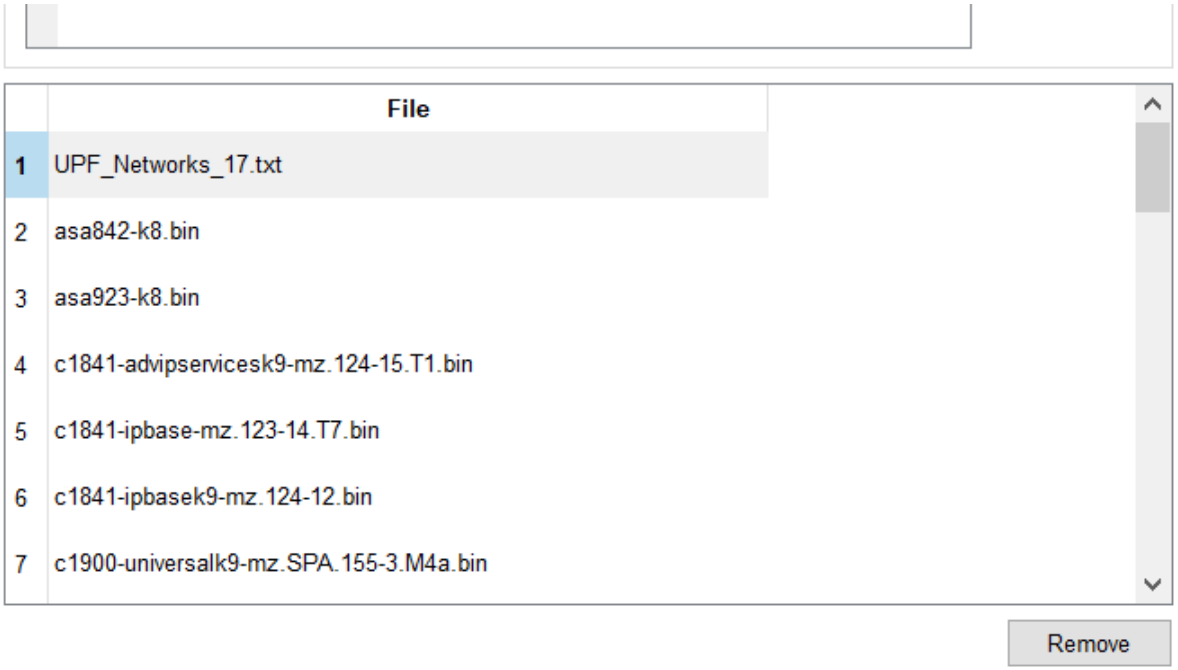
Since our team number is 17, and our web name is *www.final_project_17.edu*, *we put the corresponding file in the web, so that PCs can access these files.*

18. The CIU campus must have an **FTP server** accessible through the URL *www.ftp-upf.edu*. The server contains documents that can only be accessed by users introducing the specified user/password combination, which is *userupf/pompeufabra*.



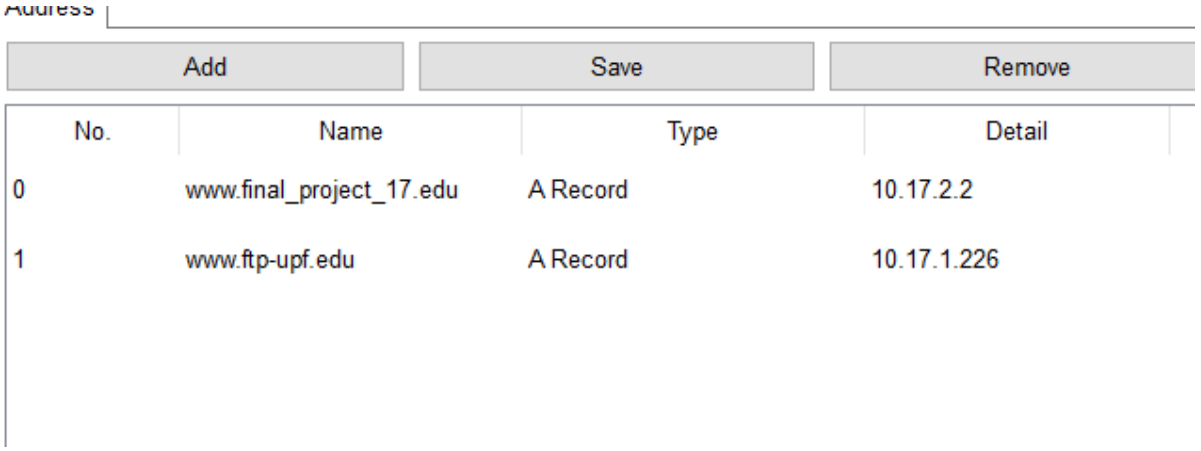
We add the corresponding Username and Password in the FTP server.

19. You have to create and edit a file named “UPF_Networks_<team number>.txt”. This file should be stored in the FTP server.



We put the corresponding file into the FTP server.

20. You must implement a **DNS server** in MAR campus in order to allow any end device in the whole network to access the aforementioned web and FTP servers by typing their corresponding URL.



The IP address of the web server is 10.17.2.2 and the IP address of the FTP server is 10.17.1.226. We put this information in the DNS server correctly.

C.5. EXTRA POINTS [1.5 p]

21. [+0.5 p] Include a .gif image to be displayed when accessing your website in the web server located in COM campus.

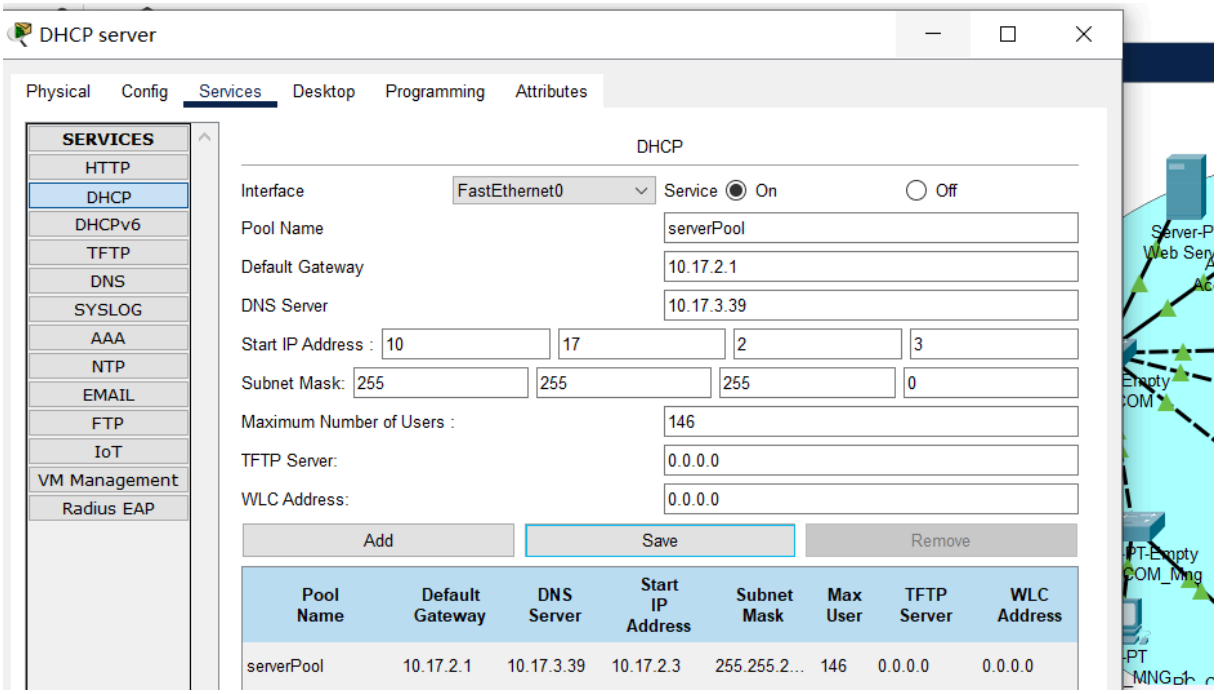
Please wait for our little easter egg GIF to load! It takes a bit of time...

22. [+1 p] Place a **DHCP server** in one of the 3 campus, which should be only reachable by the computers of its own subnetwork, and create a new DHCP addressing pool that explicitly excludes the IP address of any existing server located in the same subnetwork. Set DHCP as the default method to obtain an IP address for the computers of that subnetwork.

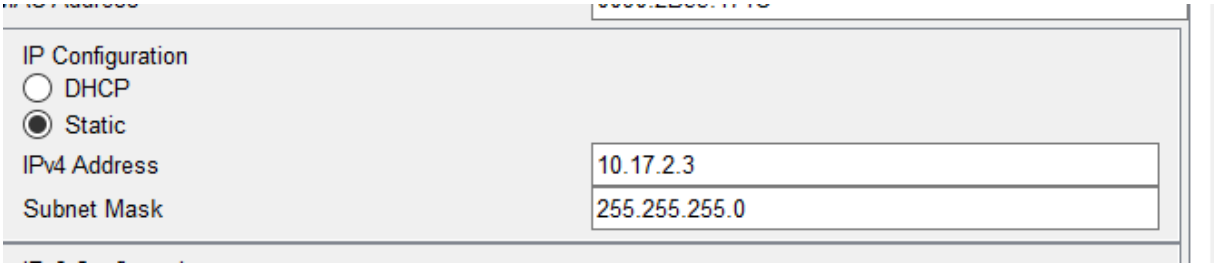
DHCP server will assign the IP address for the hosts automatically, and for stable purposes, we set up a static IP for the DHCP server which is 10.17.2.3.

Since the default gateway can't be changed, we assign a static IP address to it that is 10.17.2.1.

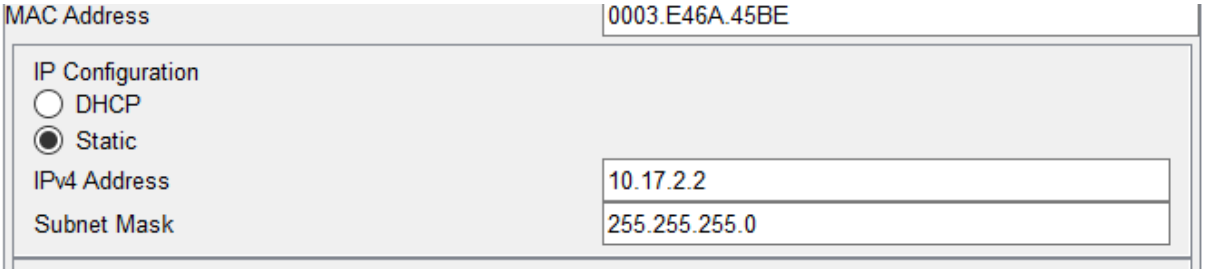
Finally, the IP address of the web server can't be changed, otherwise DNS can't find the corresponding IP address. So we put 10.17.2.2 as a fixed IP.



Static IP addresses for DHCP server



Static IP addresses for Web server



Note: all the simulations of sending packets work perfectly, but we have noticed that sometimes if someone is opening the project for the first time they need to switch to the Simulation mode when sending a PDU, at least one time. Any subsequent packet can be sent in Realtime mode. We don't know why this bug occurs, but we think it's because of Cisco, and not our project.

D. Evaluation criteria

Teachers will consider several things when grading this final part. Some of them are mentioned in the list below:

- The design of your network must be clearly detailed and justified in your report.
- Different solutions regarding the IP ranges may be OK depending on your explanation.
- Use of resources (do not use bazookas for killing flies).
- The elegance of the Packet Tracer file (must be understandable and nice).
    - The proper order of components and logical topology.
    - Devices and ports' IPs must be labeled.
- **IMPORTANT (anti-plagiarism): plagiarism will be strongly penalized.**