Lab No.08 - Data Link Layer and Application Layer
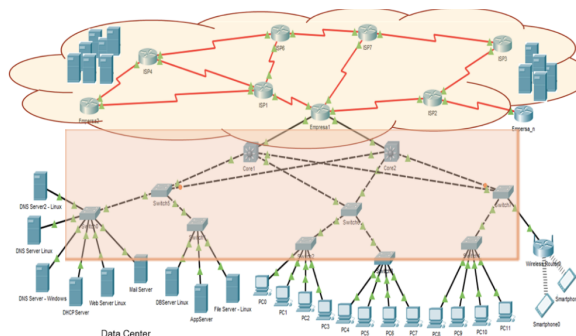
Objective

- Review the operation of Ethernet and WiFi networks.
- Review the operation of interconnection devices.
- Continue installing application layer services.

Tools to be Used

- Computers
- Virtualization software
- Internet access
- Switches
- Packet Tracer
- Wireshark

Introduction

We are still working on the infrastructure of a company, which typically includes several IT infrastructure services. It consists of wired and wireless user workstations and servers (both physical and virtualized), all connected through switches (Layer 2 and Layer 3), wireless devices, and routers that connect it to the Internet. It is also common to have cloud infrastructures where resources are provisioned based on the organization's needs. Among the servers, one can find web services, DNS, email, databases, storage, and applications, among others. Let's recall the baseline configuration we are using:

In this part of the lab, we will focus on the LAN infrastructure and other application layer protocols.

Setup

1. Basic Switch Configuration
[**For groups of 1, 2, and 3 students**]

Perform the following setup in groups. Each pair configures a switch and their 2 PCs.

- Configure the devices as follows:

	PC0	PC1	PC2	PC3
Dirección IP estudiante1	183.24.30.A*	183.24.30.B*	183.24.30.C*	183.24.30.D*
Dirección IP estudiante2	183.24.50.E*	183.24.50.F*	183.24.50.G*	183.24.50.H*
Dirección IP estudiante3	183.24.70.I*	183.24.70.J*	183.24.70.K*	183.24.70.L*
Máscara	255.255.0.0 o /16			

Note: Replace the letter with a number provided by the teacher.

- Verify the connectivity between the computers using the ping command.
- Use Wireshark to capture a packet and examine the Ethernet frame. Verify the frame structure, MAC addresses, error control, etc.
- Interconnect the setups of the entire group and verify that they can communicate with each other using the ping command.
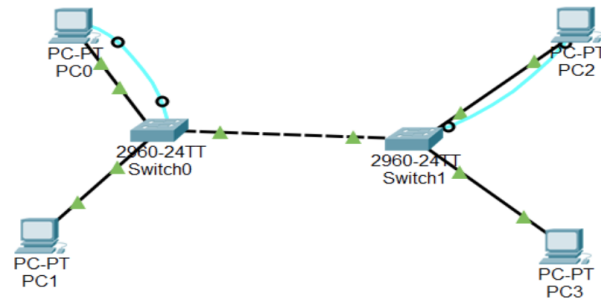
2. Basic Switch Configuration
[**For groups of 1, 2, and 3 students**]

Switches have an operating system specialized in switching tasks. The operating system of Catalyst switches, IOS, has a layered operational structure based on privileges and the configuration activities to be performed.

Based on the setup from the previous point, perform the following configuration:

- Switch name: Student Name.
- Message of the day: "Exclusive use for RECO students"
- Screen synchronization.
- Description of used interfaces.
- Access passwords for the device:
  - Privileged mode: Key_E
  - Console key: Key_C
  - Remote terminal key: Key_T

To carry out this task, the first step is to connect to the switch using console cables and the terminal mode on the PCs.
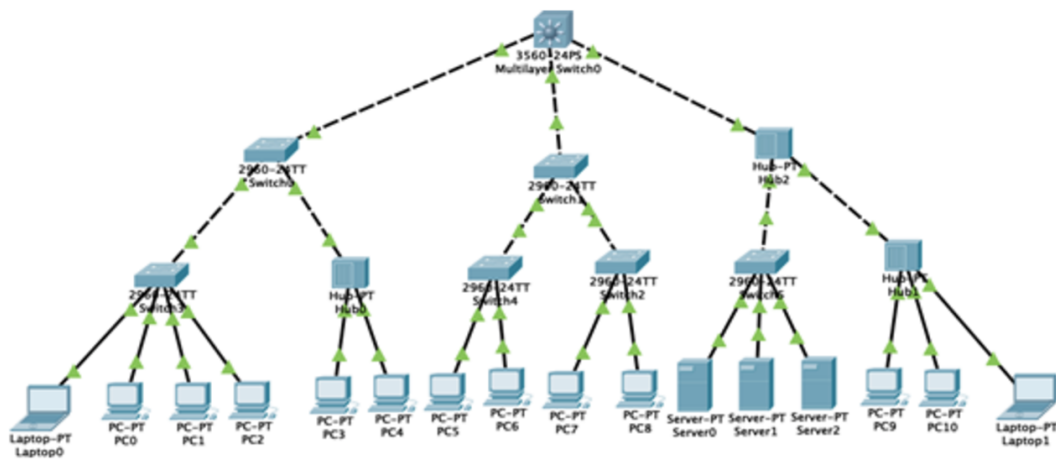

Now you must use the appropriate commands to perform the requested configuration.

- Manually configure the switch. When prompted with "Continue with dialog? [yes/no]", respond "no", enter privileged mode, and then global configuration mode.
- Next, configure:
  - Access privileged mode and enter global configuration mode.
  - Switch name.
  - Message of the day.
  - Screen synchronization and password configuration.
  - Disable command lookup on external servers.
  - Description of the interfaces.
  - Password for privileged mode access.
  - Review the device's configuration.
  - Save the configuration.

3. Larger Switch Networks
[For groups of 1, 2, and 3 students]

Using Cisco Packet Tracer, set up the following network. Each student must create their own Packet Tracer project.

1. Perform the basic configuration on ALL switches.

2. Configure the computers and servers with the information provided below:

Student 01	Student 02	
IP: 65.148.77.x (x = sequential number from 100 to 120)	IP: 65.148.77.x (x = sequential number from 130 to 150)	IP:

Estudiante1	Estudiante 2	Estudiante 3
IP: 65.148.77.x (x= número secuencial de 100 a 120) Máscara: 255.255.255.0;/24 Gateway: 65.148.77.1	IP: 65.148.77.x (x= número secuencial de 130 a 150) Máscara: 255.255.255.0;/24 Gateway: 65.148.77.1	IP: 65.148.77.x (x= número secuencial de 160 a 190) Máscara: 255.255.255.0;/24 Gateway: 65.148.77.1

3. Check the connectivity between the devices.

4. Using simulation mode, analyze the network behavior and the format of an Ethernet frame by sending the following frames. Identify the switches' behavior and their forwarding tables.

   a. From PC1 to PC7.

   b. From PC0 to PC9.

   c. From Server0 to Server1.

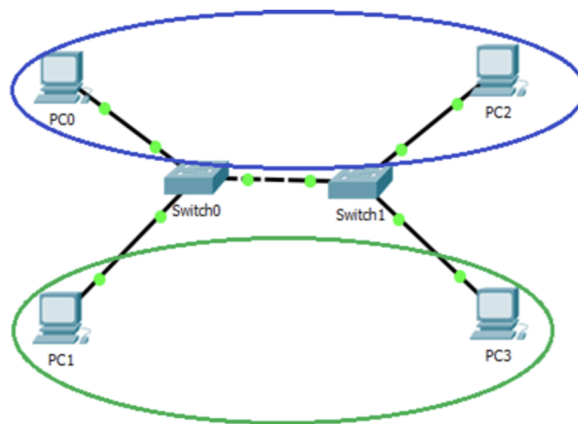   d. From Laptop0 to Laptop1.

   Hint: Observe that at first, the transmission behavior is pure broadcast, and then it starts learning.

5. Examine the operation of the spanning tree algorithm. To do this, interconnect switches 0 and 1 and observe the link behavior.

6. Merge the project files of the team members. For groups with one student, request a project file from a group of classmates, merge their project with yours, and indicate who provided the file.

7. Present the interconnected setup to your professor.
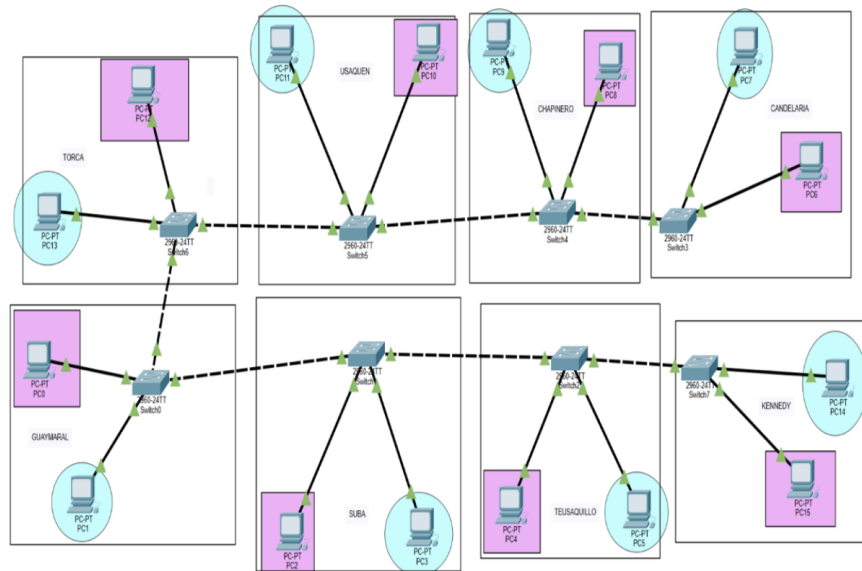
4. VLAN Configuration
[**For groups of 1, 2 and 3 students**]

Using the configuration from points 1 and 2 as a base, in the small groups (disconnect the connections between the entire lab group and only keep the connections for the small groups), create two VLANs as shown in the diagram.

- Enter configuration mode.
- Configure two VLANs.

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a. systems → VLAN_ID 50 (blue circular frame).

b. others → VLAN_ID 55 (green circular frame).

- Assign computers PC1 and PC3 to the "systems" VLAN. Assign computers PC2 and PC0 to the "others" VLAN.

- Configure the link between the switches to allow VLAN connections.
  Hint: What are trunk links? What are they used for?

- Verify connectivity.

- Now, interconnect all setups from the entire group and verify their operation. It should look something like this:

- Show the operation to your professor.

- Disconnect the devices, leave the computers connected to the D ports of the structured cabling, and remove the configuration made on the switches.

5. Basic WiFi Configuration
[**For groups of 1, 2 and 3 students**]

Perform the following setup in Cisco Packet Tracer. Each student must complete it individually.
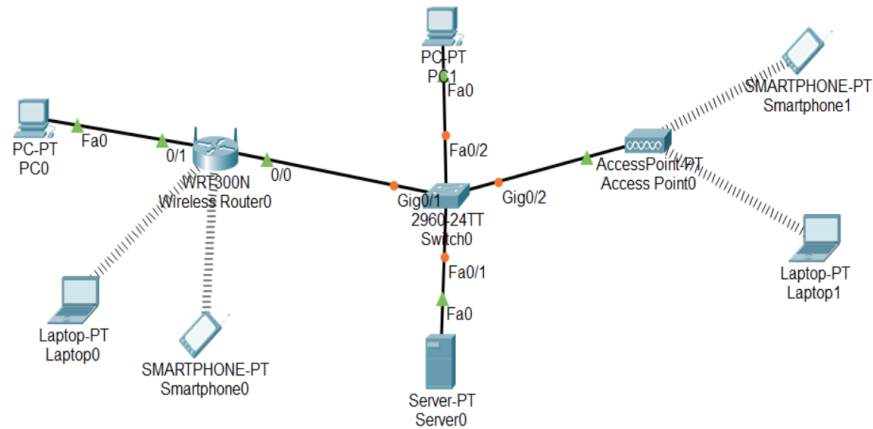
The wired LAN portion (Server0, PC1, and the router's Internet interfaces) belongs to the range 65.148.77.1 to 65.148.77.20 with a subnet mask of 255.255.255.0. This range will also include Smartphone1 and Laptop1.

Use a laptop to configure the wireless router. Username and password: admin/admin. (The router is configured via a web interface. For more information, consult the router manual online.)

The IP address of the wireless router towards the wired LAN should be 65.148.77.200 with a subnet mask of 255.255.255.0.

For the wireless network, use the following information:

- Wireless network identifier - SSID: student_name

- Wireless network IP: 192.168.0.0/24
- Wireless router IP address (wireless interface): 192.168.0.1
- IP address range for mobile devices (DHCP): 192.168.0.X to 192.168.0.Y, where X and Y correspond to an IP range:
  - Student_1: 10 to 50
  - Student_2: 60 to 100
  - Student_3: 110 to 150
- Access mechanism for wireless clients: WPA2-PSK with AES
- Router access password for mobile devices: SECURITY_R
- Configure a specific channel. What channel options can be configured on each wireless router?
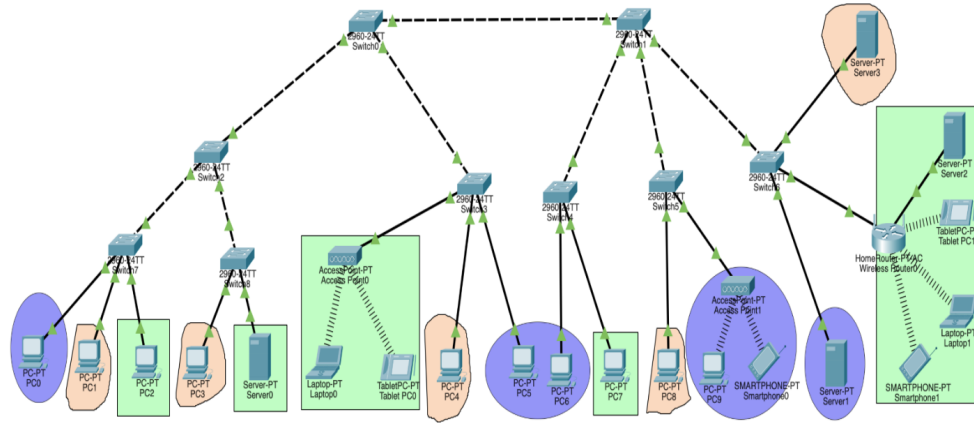
For the Access Point, review the available configurations. The SSID will be Lastname_Student, and the password will be SECURITY_AP.

- Configure the devices to connect to the wireless router and the AP as shown in the diagram.
- For wireless devices connected to the AP, assign IP addresses in the range 65.148.77.100 to 65.148.77.120 with a subnet mask of 255.255.255.0.
- Verify connectivity between the devices. Which devices can ping each other, and why?

6. Configuration of Wired and Wireless LAN
[For groups of 1, 2 and 3 students]

Create a setup in Packet Tracer as shown in the diagram (include the frames and colors presented in the diagram). Initially, VLANs are not configured. Each student must complete the setup individually.
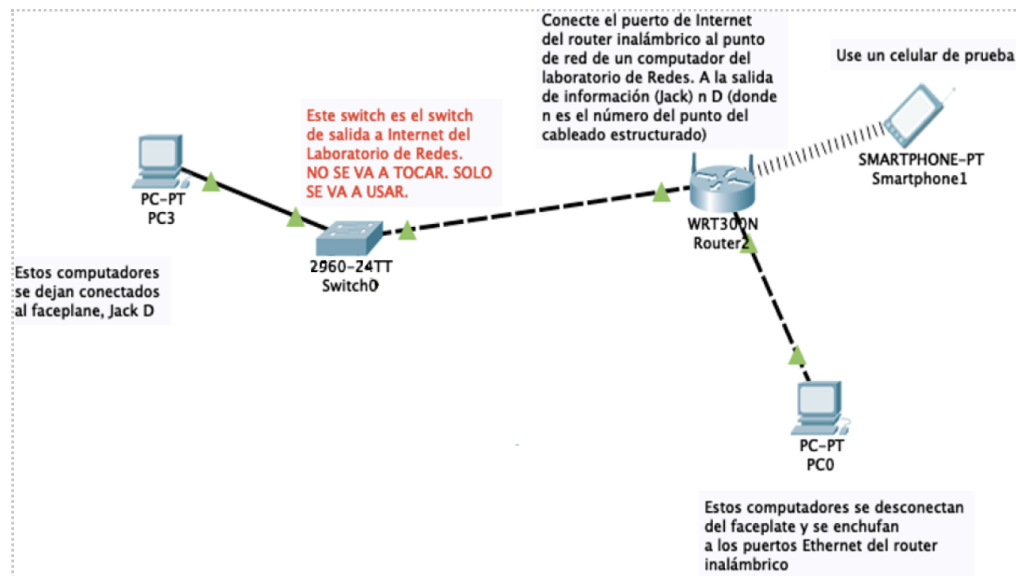

- Configure all wired devices with the following IP addresses:
    - Student 1: 171.18.100.50 to 171.18.100.80. Subnet mask 255.0.0.0
    - Student 2: 171.18.110.50 to 171.18.110.80. Subnet mask 255.0.0.0
    - Student 3: 171.18.120.50 to 171.18.120.80. Subnet mask 255.0.0.0
- For the wireless network configuration, consider the following:
    - Green Wireless Network (Rectangles)
        * Wireless network identifier - SSID: Rectangle
        * Wireless network IP: 192.168.0.0/24
        * Wireless router IP address (wireless interface): 192.168.0.1
        * IP address range for mobile devices: 192.168.0.x to 192.168.0.y. Use the same ranges from the previous setup
        * Access mechanism for wireless clients: WPA2-PSK with AES
    - Purple Wireless Network (Circles)
        * Wireless network identifier - SSID: Circle
        * Access mechanism for wireless clients: WPA2-PSK with AES
        * Access Point password for mobile devices: Circle
        * Assign IP addresses to computers connected to this network based on the range used in the wired network.
    - Orange Wireless Network (Irregular)
        * Wireless network identifier - SSID: Irregular
        * Access mechanism for wireless clients: WPA2-PSK with AES
        * Access Point password for mobile devices: Irregular
        * Assign IP addresses to computers connected to this network based on the range used in the wired network.
- Verify connectivity between all devices. What can and cannot be done?
- Configure the VLANs based on the colors in the diagram.
- Verify that the network operates as expected according to the configured VLANs.

- Merge the project files from team members. For groups of 1 student, request a project file from another group member (e.g., Student2 or Student3) and interconnect their setup with yours. Indicate who provided the project file.

7. WiFi
[For groups of 1, 2 and 3 students]

In the same groups, complete the following setup.

Each group must configure a wireless router using the computers that were disconnected. The routers will be configured via web; refer to the router manual online for instructions on how to connect and configure it.

Use the IP configuration of the computer you disconnected to configure the Internet port of each wireless router. This will allow all devices connected to the wireless routers to have internet access.

Configure the wireless network as follows:

- Wireless network identifier - SSID: Lab8_ape (where ape is the last name of one of the group members).
- Wireless router IP address (wireless interface): 192.168.0.1.
- IP address range for mobile devices (DHCP): 192.168.0.20 to 192.168.0.30.
- Towards the wired LAN: Use the IP address of the computer you disconnected to connect the wireless router.
- Access mechanism for wireless clients: WPA2-PSK with AES.
- Router access password for mobile devices: WiFi_Seg.
- Change the default channel and assign a different one. Ensure that both devices do not use the same channel.
- What channel options can be configured on each wireless router?
- Perform the following test using a smartphone:
  - Disable your mobile data plan and enable WiFi.
  - Connect the smartphone to the wireless router you just configured.

– Browse the internet using the smartphone.
– Install an app that allows you to execute the ping command and perform operation tests.

- Test the connection between devices in the diagram and devices on the internet. Use the ping command between devices.

- Report which pings are successful and which are not.

- If not all pings are successful, explain why. (Hint: What is NAT?)

- Using the smartphone, review active networks nearby using an app to monitor wireless traffic, such as WiFi Analyzer for Android. Discover wireless networks in the lab area, including your own and your classmates' networks. Also, check the channels they are using.

- Present the results to your professor.

- Test disabling the beacon frame and connecting to the network without accessing it via your smartphone.

- Use WiFi Analyzer again to see if your network is still visible.

- Present the results to your professor.

8. Reviewing WiFi Networks Near Your Home
[For groups of 1, 2, and 3 students]

Using a wireless traffic monitoring app, such as WiFi Analyzer for Android, discover wireless networks near your home, including your own. Document the networks found, the bands, and the channels they operate on.

Are there networks operating on the 2.4 GHz, 5.7 GHz, and 60 GHz bands?

Base Software Installation

As we have seen, part of the foundational platform of an organization is the web server. This server can be static, as we have defined it so far, or dynamic, which allows pages to be built at the moment they are needed. This functionality is useful for applications that, for example, query data stored in databases or the file system directly, perform calculations based on user-provided data, among other tasks.

1. Dynamic Web Service
[For groups of 1, 2, and 3 students]

Using the cloud lab on the AWS platform as a base, write a web application to be deployed on Apache. This application should display a webpage that functions as a basic grade calculator for courses in the School. It must request the student's name and the final grades for each third of the semester and calculate the final semester grade (30%, 30%, and 40%). Configure it dynamically to interpret PHP code. Additionally, it must save these records in a relational database (e.g., PostgreSQL).

2. Other Useful Commands
[For groups of 1, 2, and 3 students]

Study the functionality of network information commands, such as ifconfig, netstat, vnstat, route, and ethtool (or similar) for Slackware, NetBSD, and Windows Server systems. Examine the various parameters that can be used and create a Shell program that utilizes them (create a menu with at least 5 options to show different executions of these commands). Students must be able to understand the output of the commands and present it in a user-friendly manner.