Smart Office Network Architecture: A VLAN-Based Design

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1. Introduction

This project demonstrates the implementation of a three-floor network infrastructure using Cisco Packet Tracer, where each floor is managed by its own router and switch. The project is important as it provides segmentation and traffic management between floors, and through proper routing, it ensures reliable inter-floor communication. Additionally, port security and VLAN configuration are implemented to separate user groups on each floor. The network design adheres to industry-standard hierarchical architecture and includes both wired and wireless components to support reliable communication across departments and floors.

1.1 Overview

The organization consists of three floors, each housing multiple departments:

- **First Floor:** Reception, Store, and Logistics
- **Second Floor:** Finance, Human Resources (HR), and Sales
- **Third Floor:** IT and Administration

To enable seamless communication and centralized control, three routers are installed in the IT department's server room. These routers interconnect the floors using serial DCE cables with the IP addressing schemes 10.10.10.0/30, 10.10.10.4/30, and 10.10.10.8/30. Each floor has one access switch and supports wireless access points to accommodate mobile devices such as laptops and phones. Printers are assigned per department for localized access.

1.2 Objective

The objectives of this project are to:

- Implement **Dynamic Host Configuration Protocol (DHCP)** for automatic IP address allocation
- Configure **Open Shortest Path First (OSPF)** for efficient routing between routers
- Enable **Secure Shell (SSH)** for secure remote management of network devices
- Apply **Port Security** to protect the network from unauthorized access
- Set up **Wireless LAN** configuration for mobile client connectivity

Verify network functionality using a test workstation (*Test-PC*) in the IT department to test remote SSH access, inter-VLAN routing, and overall network reachability

"Smart Office Network Architecture: A VLAN-Based Design"

This project demonstrates comprehensive skills in IP addressing, VLAN configuration, DHCP setup, OSPF routing, wireless networking, and secure device management within a simulated enterprise network environment.

2.Process

2.1 Router Setup (Three Routers in IT Server Room)

Each router is responsible for routing data to one floor. All routers are placed centrally in the server room to ensure easier maintenance and control.

Steps to Place Routers:

1) Click on “Router” → Choose Cisco 2911.
2) Drag and drop 3 routers into the server room area.
3) Label them as:

I. R1 → 1st Floor

II. R2 → 2nd Floor

III. R3 → 3rd Floor

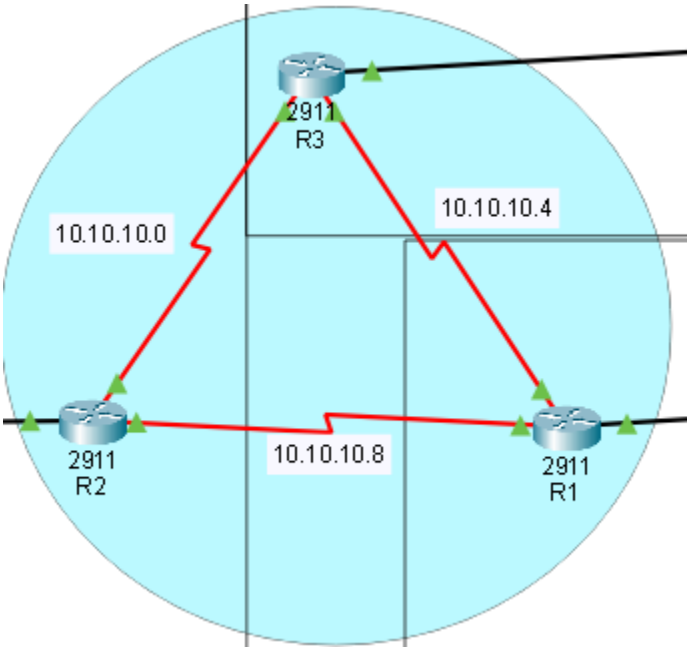


Fig 2.1

2.2 Serial DCE Cable Connections Between Routers

Serial DCE cables are used for WAN (router-to-router) connections. One end is DCE (clock source), the other is DTE.

2.2.1 Steps to Connect with Serial:

1. Click “Connections” → Choose “Serial DCE”.
2. Connect:
    - R1 Serial 0/0/0 <-> R2 Serial 0/0/0
    - R2 Serial 0/0/1 <-> R3 Serial 0/0/0
    - R3 Serial 0/0/1 <-> R1 Serial 0/0/1

2.2.2 Assign IPs for Router Interconnections:

- Between R1 & R2 → 10.10.10.0/30
- Between R2 & R3 → 10.10.10.4/30
- Between R1 & R3 → 10.10.10.8/30

2.2.3 Router Interface Commands:

R1(config)# interface s0/0/0
R1(config-if)# ip address 10.10.10.1 255.255.255.252
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

R1(config)# interface s0/0/1
R1(config-if)# ip address 40.10.10.10 255.255.255.252
R1(config-if)# no shutdown

R3(config)# interface s0/0/0
R3(config-if)# ip address 10.10.10.2 255.255.255.252
R3(config-if)# no shutdown

R3(config)# interface s0/0/1
R3(config-if)# ip address 20.10.10.2 255.255.255.252
R3(config-if)# clock rate 64000
R3(config-if)# no shutdown

R1(config)# interface s0/0/0
R1(config-if)# ip address 10.10.10.4 255.255.255.252
R1(config-if)# no shutdown

R1(config)# interface s0/0/1
R1(config-if)# ip address 30.10.10.10 255.255.255.252
R1(config-if)# clock rate 64000
R1(config-if)# no shutdown

2.3 Switch Per Floor (Placed on Respective Floors)

Switches are used to connect end devices like PCs, printers, and wireless APs within a floor.

1. Click “Switch” → Use 2950-24 switches.
2. Place one switch on each floor.
3. Label them: S1, S2, S3.

2.4 Add Wireless Access Points

WiFi allows mobile users to connect wirelessly.

1. Click on “Wireless Devices” → Choose “Access Point”.
2. Place AP on each floor.
3. Connect to switch via Ethernet (port Fa0/x).

2.5 Add Printers Per Department

1. Click “End Devices” → Choose “Printer”.
2. Add a printer to each department.
3. Connect each to the floor switch.

2.6 VLAN Configuration (Per Department)

VLAN stands for **Virtual Local Area Network**. It is a **logical subgroup** within a physical network that groups together devices from different physical locations as if they are on the same local network.

In traditional networks, all devices connected to the same switch are part of the same broadcast domain. VLANs allow network administrators to break this single broadcast domain into **multiple, isolated broadcast domains**, even if the devices are connected to the same physical switch.

Key Features of VLANs:

- **Segmentation:** VLANs separate departments (e.g., HR, Sales, IT) for better organization and performance.
- **Security:** Devices in one VLAN cannot directly communicate with devices in another VLAN unless routing is configured (e.g., using a router or Layer 3 switch).
- **Efficiency:** Reduces unnecessary broadcast traffic and improves network performance.

VLAN-addresses for each Departments:

- Reception – VLAN 80 – 192.168.8.0/24
- Store – VLAN 70 – 192.168.7.0/24
- Logistics – VLAN 60 – 192.168.6.0/24
- Finance – VLAN 50 – 192.168.5.0/24
- HR – VLAN 40 – 192.168.4.0/24
- Sales – VLAN 30 – 192.168.3.0/24
- Admin – VLAN 20 – 192.168.2.0/24
- IT – VLAN 10 – 192.168.1.0/24

Use trunking for router or multilayer switch connection.

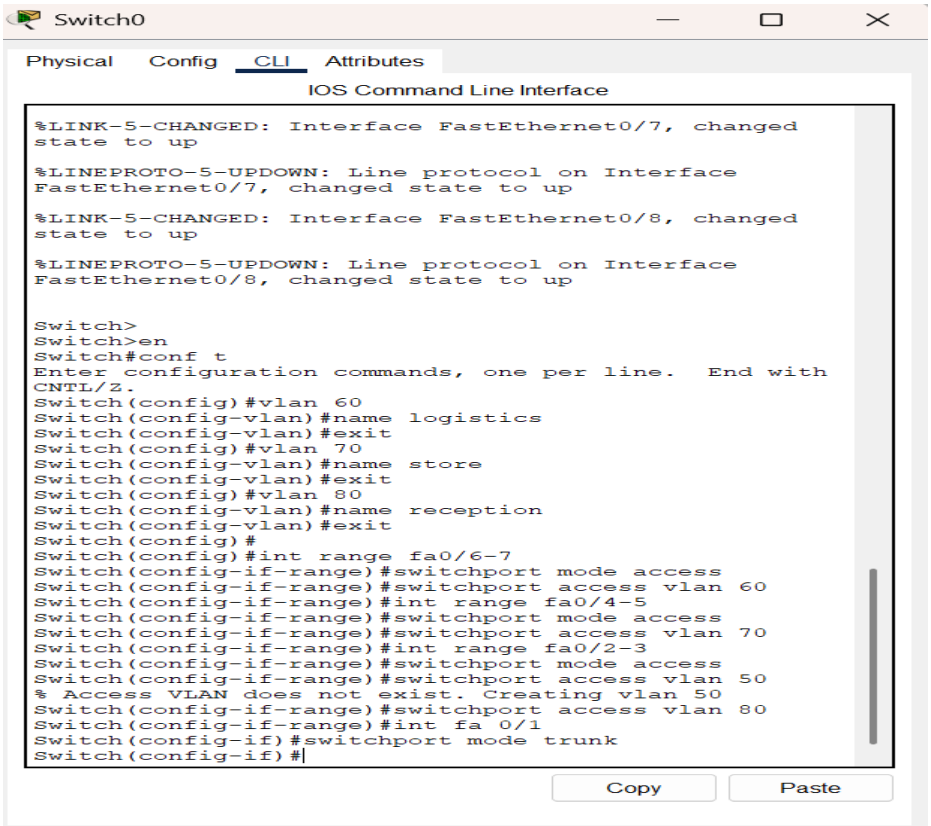


Fig 2.6 VLAN configuration on a switch

2.7 OSPF Configuration for Routing

OSPF is a dynamic routing protocol that efficiently routes between routers.

OSPF stands for **Open Shortest Path First**. It is a **dynamic routing protocol** used in **IP networks** to find the best path for data packets. OSPF is a **link-state protocol** and works within an **Autonomous System (AS)**, meaning it operates inside a single organization's network.

It uses the **Dijkstra (Shortest Path First) algorithm** to calculate the most efficient path between routers. OSPF quickly adapts to network changes and is one of the most commonly used routing protocols in enterprise networks.

Commands for Router 1:

R1 (config)# router ospf 1

R1 (config-router) # network 10.10.10.4 0.0.0.3 area 0

R1 (config-router) #network 30.10.10.10 0.0.0.3 area 0

R1 (config-router) # network 192.168.6.0 0.0.0.255 area 0

R1 (config-router) # network 192.168.7.0 0.0.0.255 area 0

R1 (config-router) # network 192.168.8.0 0.0.0.255 area 0

Commands for Router 2:

R2 (config)# router ospf 1

R2 (config-router) # network 10.10.10.1 0.0.0.3 area 0

R2 (config-router) # network 40.10.10.10 0.0.0.3 area 0

R2 (config-router) # network 192.168.3.0 0.0.0.255 area 0

R2 (config-router) # network 192.168.4.0 0.0.0.255 area 0

R2 (config-router) # network 192.168.5.0 0.0.0.255 area 0

Commands for Router 3:

R3 (config)# router ospf 1

R3 (config-router) # network 10.10.10.2 0.0.0.3 area 0

R3 (config-router) # network 20.10.10.2 0.0.0.3 area 0

R3 (config-router) # network 192.168.1.0 0.0.0.255 area 0

R3 (config-router) # network 192.168.2.0 0.0.0.255 area 0

2.8 DHCP Configuration on Routers

DHCP (Dynamic Host Configuration Protocol) is used to **automatically assign IP addresses** and other network settings (like subnet mask, gateway, DNS) to hosts in a network. This eliminates the need to manually configure IPs on every device.

Commands for Router 1:

R1 (config)# ip dhcp pool VLAN60

R1 (dhcp-config) # network 192.168.6.0 255.255.255.0

R1 (dhcp-config) # default-router 192.168.6.1

R1 (dhcp-config) # dns-server 8.8.8.8

R1 (config)# ip dhcp pool VLAN70

R1 (dhcp-config) # network 192.168.7.0 255.255.255.0

R1 (dhcp-config) # default-router 192.168.7.1

R1 (dhcp-config) # dns-server 8.8.8.8

R1 (config)# ip dhcp pool VLAN80

R1 (dhcp-config) # network 192.168.8.0 255.255.255.0

R1 (dhcp-config) # default-router 192.168.8.1

R1 (dhcp-config) # dns-server 8.8.8.8

Router(config)# ip dhcp excluded-address 192.168.6.1

Router(config)# ip dhcp excluded-address 192.168.7.1

Router(config)# ip dhcp excluded-address 192.168.8.1

Commands for Router 2:

R2 (config)# ip dhcp pool VLAN30

R2 (dhcp-config) # network 192.168.3.0 255.255.255.0

R2 (dhcp-config) # default-router 192.168.3.1

R2 (dhcp-config) # dns-server 4.4.4.4

R2 (config)# ip dhcp pool VLAN40

R2 (dhcp-config) # network 192.168.4.0 255.255.255.0

R2 (dhcp-config) # default-router 192.168.4.1

R2 (dhcp-config) # dns-server 4.4.4.4

R2 (config)# ip dhcp pool VLAN50

R2 (dhcp-config) # network 192.168.5.0 255.255.255.0

R2 (dhcp-config) # default-router 192.168.5.1

R2 (dhcp-config) # dns-server 4.4.4.4

Router(config)# ip dhcp excluded-address 192.168.3.1

Router(config)# ip dhcp excluded-address 192.168.4.1

Router(config)# ip dhcp excluded-address 192.168.5.1

Commands for Router 3:

R3 (config)# ip dhcp pool VLAN10

R3 (dhcp-config) # network 192.168.1.0 255.255.255.0

R3 (dhcp-config) # default-router 192.168.1.1

R3 (dhcp-config) # dns-server 6.6.6.6

R3 (config)# ip dhcp pool VLAN20

R3 (dhcp-config) # network 192.168.2.0 255.255.255.0

R3 (dhcp-config) # default-router 192.168.2.1

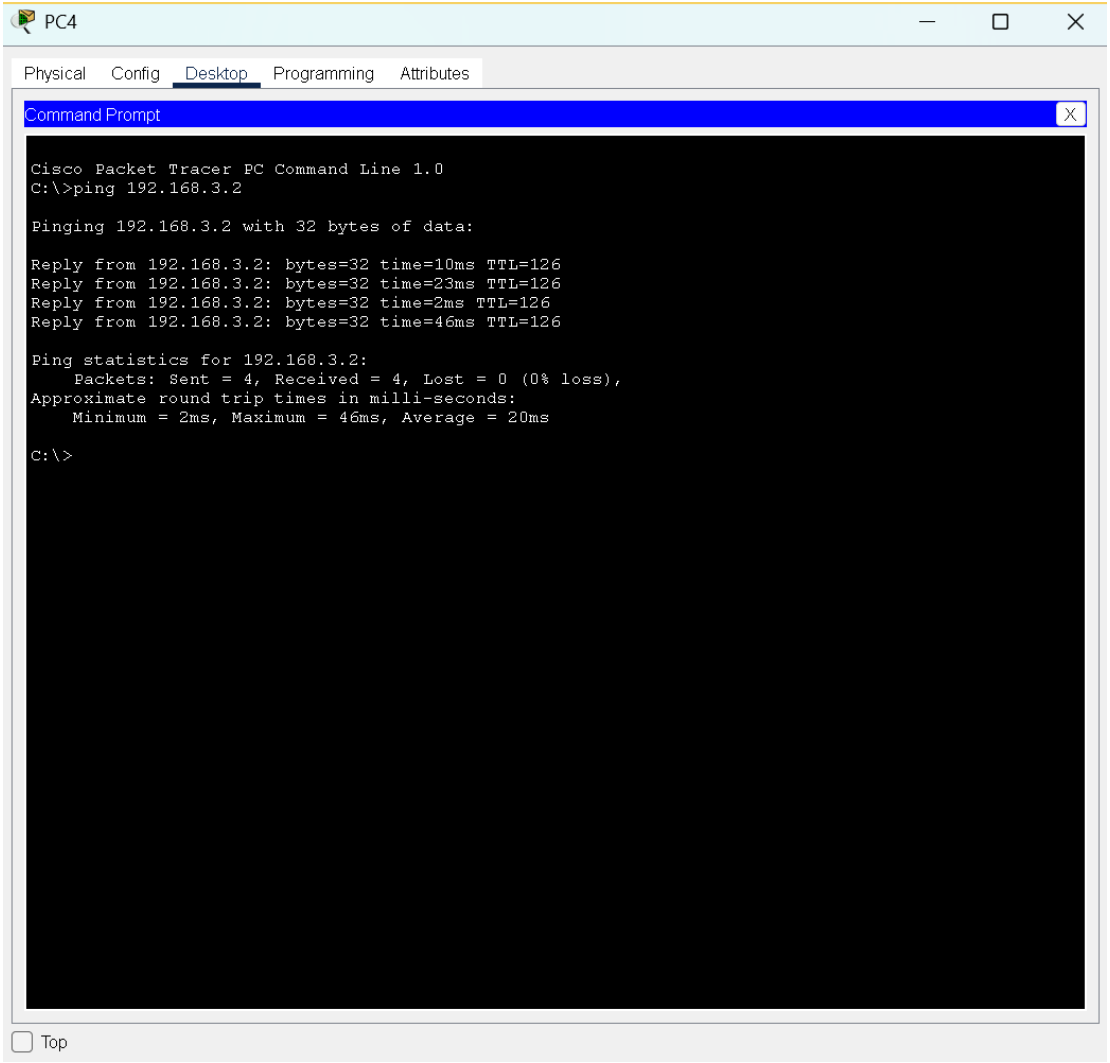
R3 (dhcp-config) # dns-server 6.6.6.6

Router(config)# ip dhcp excluded-address 192.168.1.1

Router(config)# ip dhcp excluded-address 192.168.2.1

2.9 Full Device Communication (End-to-End Ping)

1. Assign all IPs via DHCP.
2. From PC → open Command Prompt → ping 192.168.X.X
3. Ensure cross-VLAN and cross-floor ping works.



2.10 Configure SSH on Routers

SSH (Secure Shell) is a **network protocol** used to securely access and manage devices (like routers, switches, and servers) **remotely over a network**.

It encrypts the communication between the client and the device, making it secure from eavesdropping, hijacking, or man-in-the-middle attacks.

2.10.1 SSH CONFIGURATION IN ROUTERS:

Router(config)# hostname R1

R1(config)# ip domain-name project.com

R1(config)# crypto key generate rsa

How many bits in the modulus [512]: 1024

R1(config)# username admin password cisco

R1(config)# line vty 0 4

R1(config-line) # login local

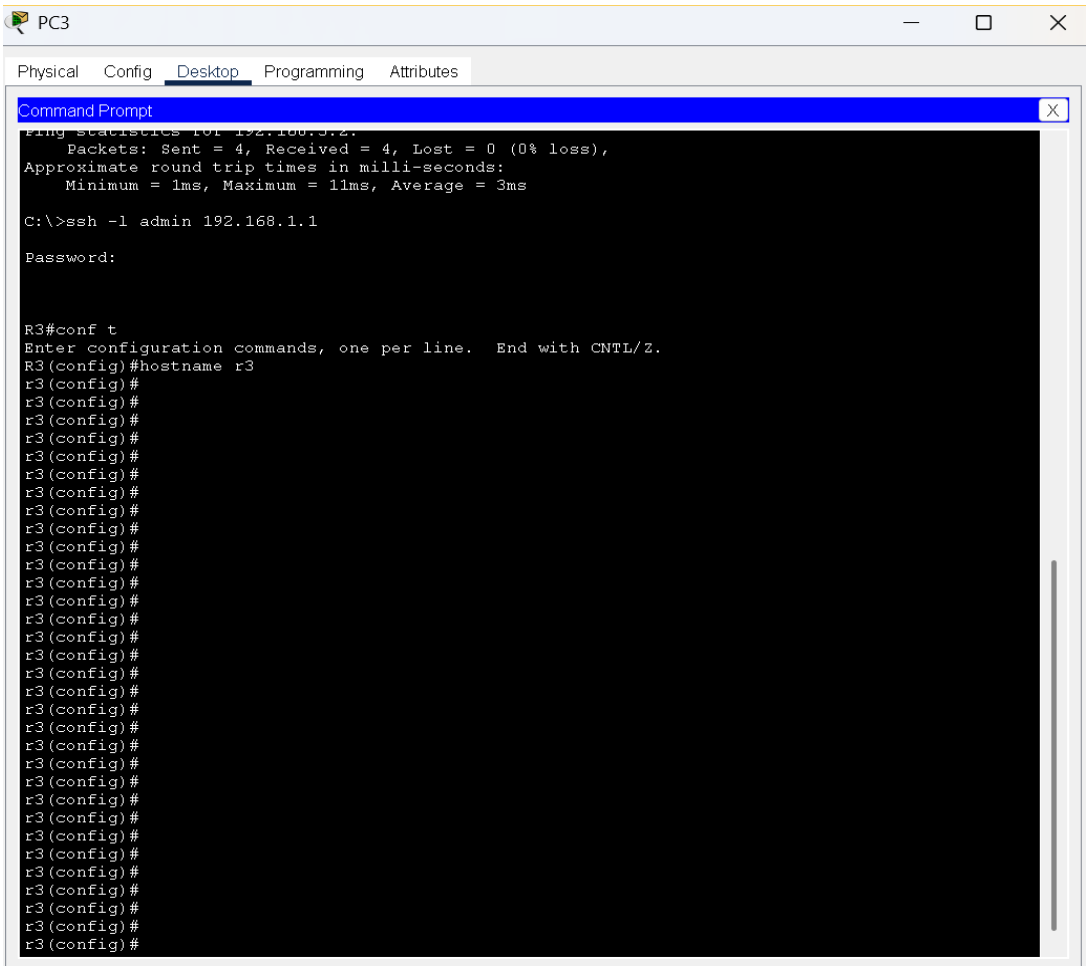
R1(config-line) # transport input ssh

2.10.2 From a PC – Test SSH Login

1. Click on a **PC** (e.g., Test-PC in IT department).
2. Go to **Desktop > Terminal or Command Prompt**.
3. Type: ssh -l admin 192.168.X.X

2.11 Test-PC in IT Department for SSH

- Connect Test-PC to IT switch (port Fa0/1)
- Assign IP from VLAN 10 or via DHCP.
- Use Command Prompt: ssh -l admin 192.168.1.1


PC3
Physical
Config
Desktop
Programming
Attributes
Command Prompt
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 11ms, Average = 3ms
C:\>ssh -l admin 192.168.1.1
Password:
R3#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R3(config)#hostname r3
r3(config)#

3.0 Analysis of the Topic

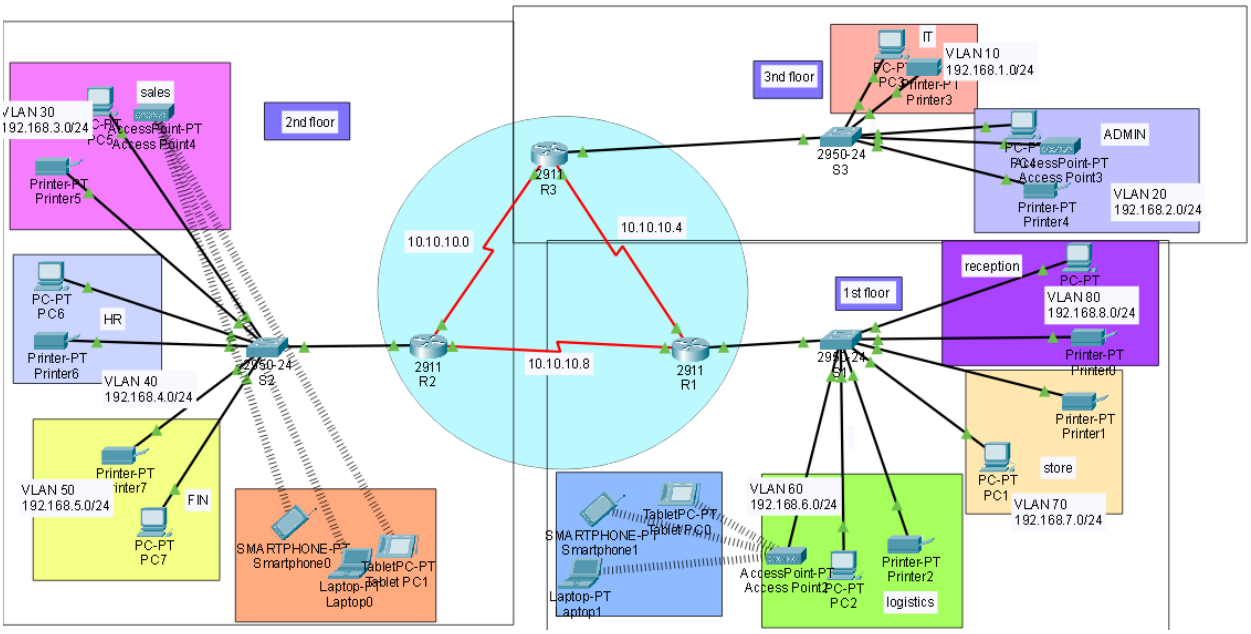


Fig.4.0 Final view of the Network

Device	Interface	IP Address	Subnet Mask
Router	GigabitEthernet0/0, Serial0/0/0	10.10.10.X	255.255.255.0
Switch	2690-24	192.168.X.X	255.255.255.0
PC-P0	NIC	192.168.X.X	255.255.255.0
Printer	FastEthernet0	192.168.X.X	255.255.255.0
Access Points	Wireless0	192.168.X.X	255.255.255.0
Laptop-PT	NIC	192.168.X.X	255.255.255.0

4.0 REFERENCE

i. https://chatgpt.com/

ii.