Department of Computer Science and Engineering
National Institute of Technology Srinagar
Hazratbal, Srinagar, Jammu and Kashmir, India - 190006

Computer Networks Project

Name:Muneeb Ahmad

(2020BCSE002
3rd Year B.Tech. CSE (6th Semester)

Submitted to:

Mohammad Ahsan Chishti

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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Project Title

SOHO Network Design and Implementation with VLANs, Wireless Access Points, and Inter-VLAN Routing

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Name: Muneeb Ahmad
Roll No.: 2020BCSE002
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Abstract

This project focuses on the meticulous design and successful implementation of a Small Office Home Office (SOHO) network for a newly established branch of a company. The primary objective is to construct a robust network infrastructure capable of meeting the distinct demands of three departments, each requiring dedicated VLANs and wireless access points. The project delves into the intricacies of subnetting and inter-VLAN routing, emphasizing their seamless integration. Readers are guided through the step-by-step configuration of VLANs, efficient deployment of a Dynamic Host Configuration Protocol (DHCP) server, and effective implementation of Inter-VLAN routing to facilitate flawless communication across VLANs. Rigorous testing ensures the network's reliability and performance, involving meticulous device connection and validation of communication pathways. The culmination of this project results in an exceptionally efficient and interconnected SOHO network that addresses the specific requirements and objectives of the company's branch. By following the project's insights and practical demonstrations, viewers gain comprehensive knowledge and hands-on experience in designing and implementing VLANs, wireless access points, and Inter-VLAN routing solutions within the context of a SOHO network. This project equips individuals with the expertise needed to deploy and optimize a highly functional network infrastructure, enhancing productivity and connectivity.

Contents

Chapter 1

Introduction

1.1 Introduction

In this project, we explore the design and implementation of a network for a company specializing in the buying and selling of food items. The objective is to establish a branch near a local village to accommodate the company's growing customer base. The network needs to operate separately from the headquarters (HQ) network and cater to the requirements of three departments, each with its wireless network. The project focuses on designing and implementing a network infrastructure using Cisco products, including a router and a switch. The aim is to enable seamless communication between devices within each department while ensuring efficient collaboration. Throughout this project, we will navigate the process of configuring the network components and creating dedicated wireless networks for the departments, providing practical insights into network design and Cisco technology utilization.

1.2 Problem Statement

There is a company which is basically operated from the headquarters. The company is intending to open a branch.Thus, the company requires to design the network for the branch.The network is intended to operate separately from the HQ network.Being a small network, the company has the following requirements during implementation;

- One router and one switch to be used (all CISCO products)
- 3 departments (Admin/IT, Finance/HR and Customer service/Reception).
- Each department is required to be in different VLANs.
- Each department is required to have a wireless network for the users.
- Host devices in the network are required to obtain IPv4 addresses automatically.
- Devices in all the departments are required to communicate with each other.
- Assume the ISP gave out a base network of 192.168.1.0. As the young network engineer hired for this project, you are responsible for designing and implementing a network that fulfills the above requirements.

1.3 Need of the Study

This study addresses the need for a separate network infrastructure to support the expansion of a company and accommodate its growing customer base. By establishing a branch near a local village, the company aims to enhance services and meet increasing demands. The study focuses on designing and implementing a network that enables seamless communication and efficient collaboration within three departments. Dedicated wireless networks are created for each department, ensuring reliable and secure connectivity. The

use of Cisco products, such as a router and a switch, ensures compatibility and leverages industry-standard networking technologies. Practical insights gained from this study equip network engineers with valuable knowledge and experience in network design and Cisco technology utilization. The study aims to facilitate the design and implementation of effective network infrastructures for similar business scenarios, supporting expansion plans and optimizing communication and collaboration within the branch. Howard (2023)

1.4 Study Objective

1. To design and implement a network infrastructure for a company specializing in the buying and selling of food items, aiming to establish a branch near a local village to accommodate the growing customer base.

2. To establish a separate network that operates independently from the headquarters (HQ) network, catering to the requirements of three departments with their respective wireless networks.

3. To enable seamless communication between devices within each department, ensuring efficient collaboration and information sharing.

4. To configure network components, including Cisco products such as a router and a switch, to create a robust and reliable network infrastructure.

5. To gain practical insights into network design principles and the utilization of Cisco technologies.

6. To navigate the process of configuring network components and creating dedicated wireless networks, providing hands-on experience in network implementation.

7. To support the company's expansion plans by creating a network infrastructure that facilitates efficient communication and collaboration within the three departments of the branch.

Chapter 2

Study Methodology

2.1 Introduction

The methodology used in this project involved designing and implementing a network for a company branch. The primary goal was to meet specific requirements, including separate networks for three departments, wireless network access, inter-department communication, and the utilization of Cisco products.

2.2 Methodology

Network Design

- Defined department boundaries and assigned VLANs to each department.
- Conducted subnetting to determine the appropriate subnet mask and address allocation.
- Configured VLANs on switches and access points to segregate the network.

IP Addressing and DHCP Configuration

- Calculated network IDs, broadcast IDs, and valid host ranges for each department.
- Configured sub-interfaces on the router for inter-VLAN routing.
- Implemented a DHCP server to automatically assign IP addresses to host devices.

Wireless Network Setup

- Configured wireless access points for each department, providing separate SSIDs and passwords.
- Conducted tests to ensure connectivity between devices and access points.

Inter-VLAN Routing

- Configured trunk interfaces on switches to allow the passage of multiple VLANs.
- Set up sub-interfaces on the router as default gateways for respective subnets.
- Established inter-VLAN routing to enable communication between devices in different VLANs.

Testing and Validation

- Conducted comprehensive tests, including printing, pinging, and communication between devices.
- Ensured proper connectivity and functionality of the network components.

Conclusion

- The methodology employed for the network design and implementation project followed a systematic approach.

- By analyzing the requirements, designing the network, configuring VLANs, addressing IP allocations, and conducting thorough testing, the project successfully met the specified objectives.
- The network design now provides separate networks for each department, wireless access, and enables communication between devices in different departments.

2.3 Tools and Technologies Employed

Tools and Technologies Employed:

Cisco Networking Equipment:

- Router: Used for inter-VLAN routing and connecting the branch network to the headquarters.
- Switch: Configured to support VLANs, trunking, and access ports.

DHCP Server:

- Implemented to automatically assign IP addresses to host devices in each department.

Wireless Access Points:

- Deployed to provide wireless network access for each department.

Subnetting:

- Utilized to divide the IP address space into multiple subnets to accommodate the separate departments.

VLAN Configuration:

- Configured VLANs on the switches to segregate the network and ensure department-wise separation.

IP Addressing:

- Assigned IP addresses to devices within each department using subnetting techniques.

Network Testing Tools:

- Used for validating network connectivity, such as pinging devices and testing printing capabilities.

Binary to Decimal Conversion:

- Employed to convert subnet masks and binary representations of IP addresses into their decimal equivalents.

Network Diagramming Tools:

- Potentially used to create visual representations of the network design and connectivity.

Wireless Device Testing:

- Smartphones, laptops, tablets, and wireless modems were utilized to test wireless network access and communication between devices.

Chapter 3

Implementation

3.1 Implementation details

Network Design: The project required designing a network that operates separately from the headquarters' network. The branch consists of three departments, and each department needs its own wireless network for users. The network engineer is tasked with designing a network to meet these requirements.

VLAN Configuration: The three departments are required to be on different VLANs to isolate their traffic. VLANs are virtual LANs that segment the network and provide logical separation. By assigning each department to a different VLAN, devices in each department can communicate with each other while remaining isolated from devices in other departments.

Subnetting: Subnetting is used to divide a network into smaller subnetworks. In this project, subnetting is employed to allocate IP addresses to different departments. The speaker outlines the department boundaries, assigns VLANs, and emphasizes the importance of finding the correct number of borrowed bits to yield the required number of subnets.

DHCP Server: A Dynamic Host Configuration Protocol (DHCP) server is implemented to enable devices in the branch to obtain IP addresses automatically. DHCP simplifies the management of IP addresses by assigning them dynamically to devices when they connect to the network. It eliminates the need for manual IP configuration on each device.

Inter-VLAN Routing: Devices in different VLANs need to communicate with each other. Inter-VLAN routing is implemented to enable communication between VLANs. This is achieved by configuring a router with subinterfaces, where each subinterface corresponds to a VLAN and acts as the default gateway for that VLAN.

Cisco Products: The project specifies the use of Cisco products, including one router and one switch. These devices are configured to support the network design and facilitate VLANs, subnetting, DHCP, and inter-VLAN routing.

Wireless Access Points: The implementation includes configuring wireless access points for each department. The access points provide wireless network access to devices within their respective departments. The video demonstrates the process of assigning interfaces to VLANs and configuring wireless access points with unique names and passwords.

Trunking: Trunking is configured on the switch to allow the passage of multiple VLANs between switches and routers. Trunk interfaces enable the transmission of VLAN-tagged frames, facilitating communication between VLANs.

Testing and Verification: After configuring the network, testing is conducted to ensure proper functionality. The presenter tests connectivity by connecting devices to their respective access points and verifying communication between different devices in different departments. This includes testing activities such as printing from a tablet to a printer and pinging between devices.

3.2 Detailed step by step implementation through

Case Study Presentation:

Understand the requirements of the case study, which involves setting up a separate network for a branch with three departments and wireless networks.

Network Design:

1. Determine the network architecture, including the number of VLANs and the subnetting scheme.
2. Identify the number of borrowed bits needed for subnetting based on the required number of subnets (three in this case).
3. Calculate the subnet mask based on the number of borrowed bits.

IP Address Allocation:

1. Allocate IP addresses to each department using the subnetting scheme.
2. Calculate the network ID, broadcast ID, and range of valid host IDs for each subnet.

VLAN Configuration:

1. Open Cisco Packet Tracer and create a new project.
2. Add the required number of switches to the workspace.
3. Configure VLANs on the switches, assigning a different VLAN for each department.
4. Assign switch interfaces to the appropriate VLANs using the `switchport access VLAN` command.

Wireless Access Points and DHCP Server Configuration:

1. Add wireless access points to the workspace, placing one access point in each department.
2. Configure each wireless access point with a unique name and password.
3. Set up a DHCP server to automatically assign IP addresses to devices in each department.

Trunk Interface and Sub-Interface Configuration:

1. Connect the switches and router using appropriate cables.
2. Configure the trunk interfaces on the switches to allow for the passage of multiple VLANs.
3. On the router, create sub-interfaces for each VLAN and assign IP addresses and subnet masks to them.

Configuration Process:

1. Access the switch and router interfaces in Packet Tracer.
2. Assign appearances to the interfaces, retrieve the configurations, and send IP addresses to the interfaces.
3. Create sub-interfaces on the router for different subnets.
4. Configure the DHCP server settings on the router, such as IP address pools, default gateways, DNS servers, and domain names.

Subnet Creation and IP Allocation using DHCP:

1. Create separate subnets for each department using the subnetting scheme.
2. Configure the DHCP server to allocate IP addresses from the appropriate subnet pools to devices in each department.
3. Set the network addresses, subnet masks, default gateways, and DNS servers for each subnet.

Access Point Testing:

1. Connect devices (e.g., smartphones, laptops) to their respective wireless access points.
2. Verify communication between devices in different departments by testing connectivity and data transfer.

Network Implementation Testing:

1. Test network functionality by performing tasks such as printing from a tablet to a printer and pinging between devices in different departments.
2. Ensure that devices can communicate across VLANs and access resources on the network.

3.3 Code Snippits used in Implementation

Here are some code snippets and diagrams that i used in the implementation process:

VLAN Configuration:

```
switchport mode access
switchport access vlan <vlan_id>
```

Trunk Interface Configuration:

```
interface GigabitEthernet0/1
switchport mode trunk
switchport trunk allowed vlan <vlan_list>
```

Sub-Interface Configuration on the Router:

```
interface GigabitEthernet0/0.10
encapsulation dot1Q 10
ip address <ip_address> <subnet_mask>
```

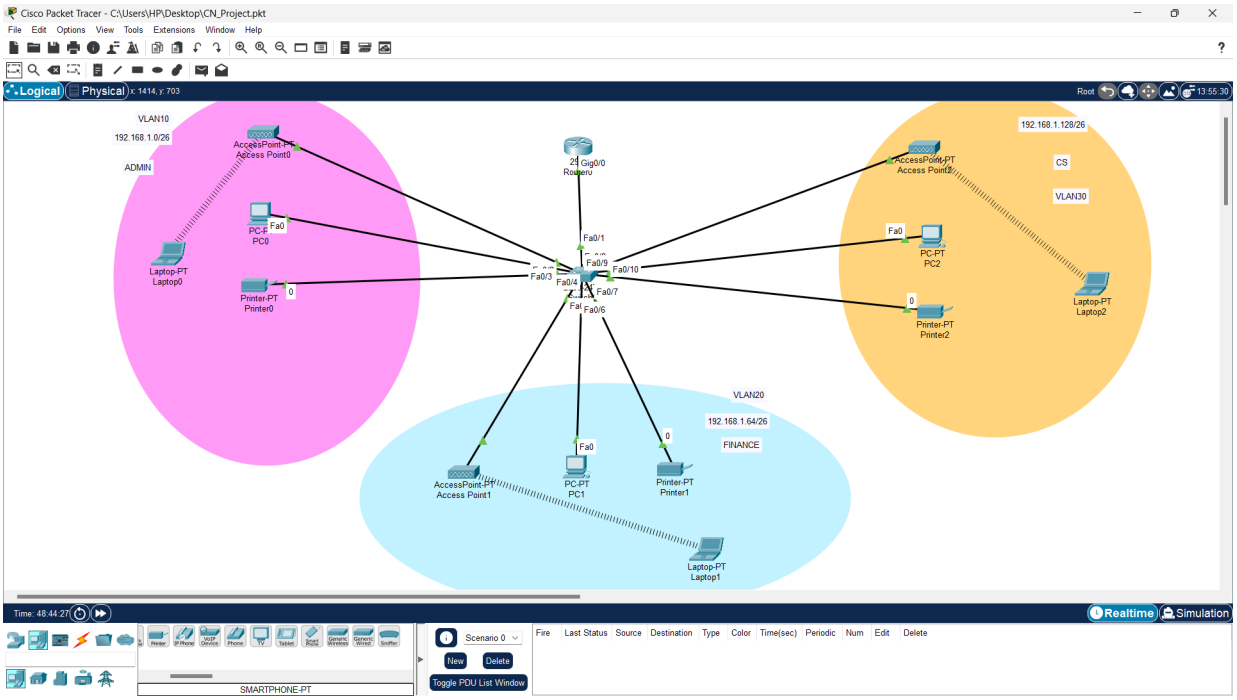
DHCP Server Configuration:

```
ip dhcp pool <pool_name>
network <network_address> <subnet_mask>
default-router <default_gateway>
dns-server <dns_server>
```

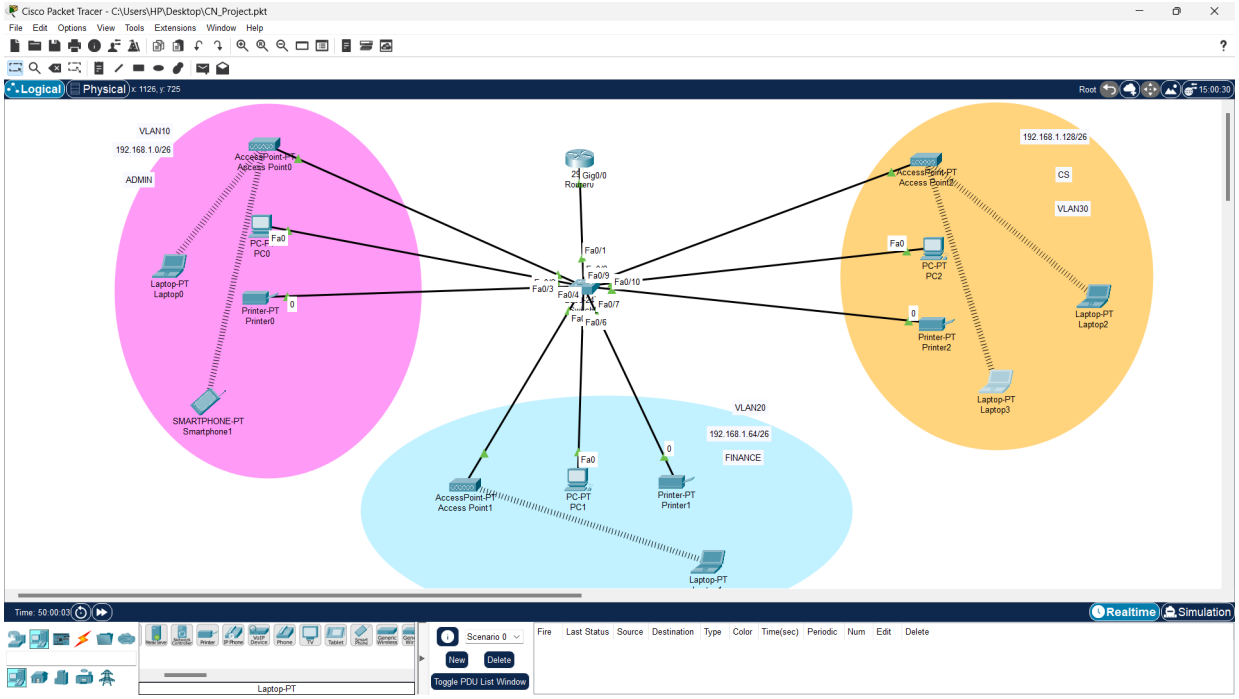
Chapter 4

Result and Analysis

4.1 Results and Findings: Project



We can add more devices and configure them



OUTPUT:

Ping Results: Provide the results of the ping tests conducted between devices in different departments. Include details such as the IP addresses of the source and destination devices, the number of packets sent, received, and lost, as well as the average round-trip time (RTT) for each ping.

Ping Test between Laptop 3 (Department CS) and Laptop 0 (Department Admin):

TABLE 4.1: Ping Test Laptop 3(CS) to Laptop 0(Admin)

Pinging **Data Size**	192.168.1.5 32 bytes
Reply	
Request timed out	
Reply from 192.168.1.5	bytes=32 time=70ms TTL=127
Reply from 192.168.1.5	bytes=32 time=44ms TTL=127
Reply from 192.168.1.5	bytes=32 time=79ms TTL=127
Ping Statistics	
Packets: Sent Packets: Received Packets: Lost	4 3 1 (25% loss)
Approximate round trip times	
Minimum Maximum Average	44ms 79ms 64ms

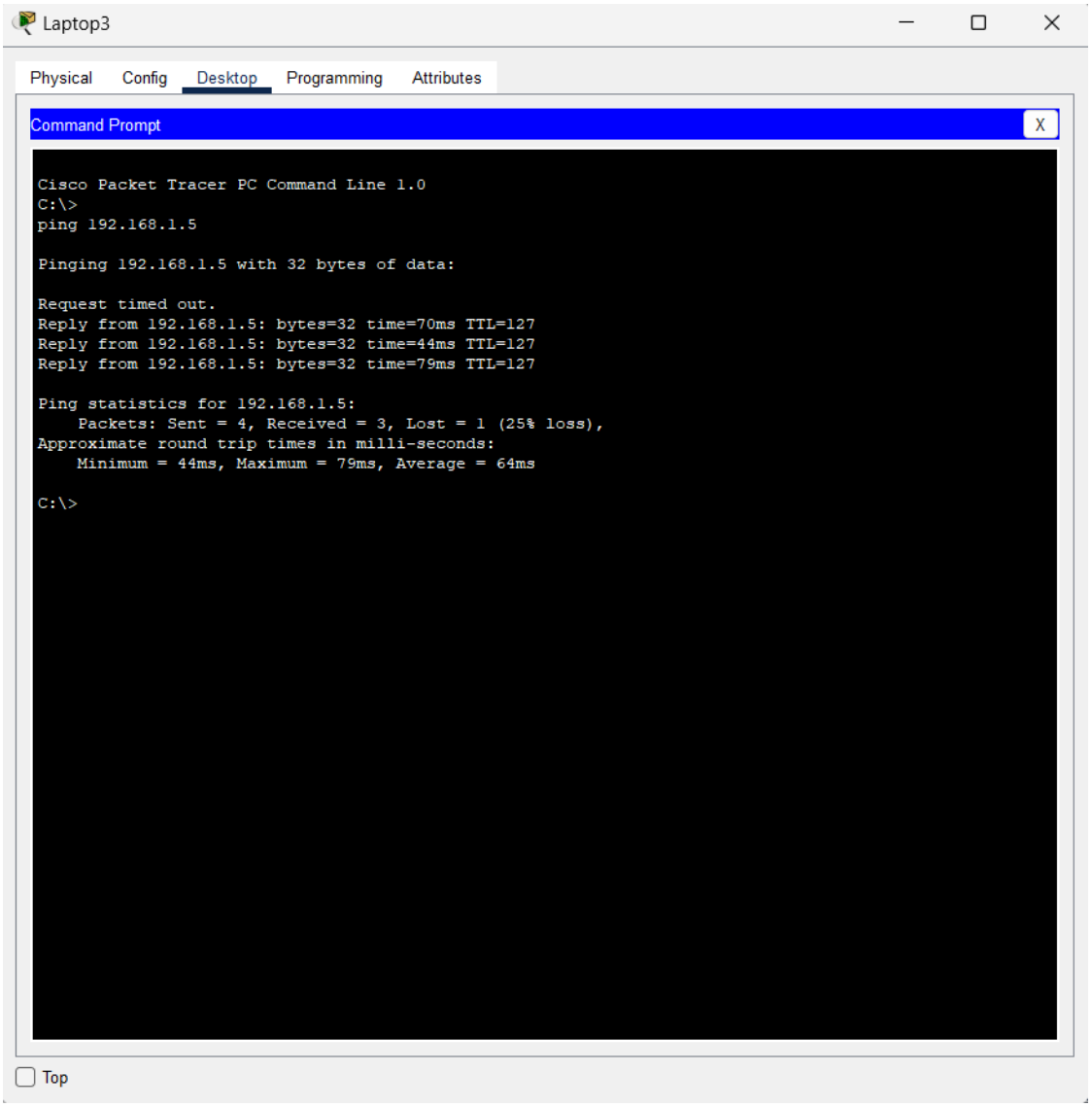
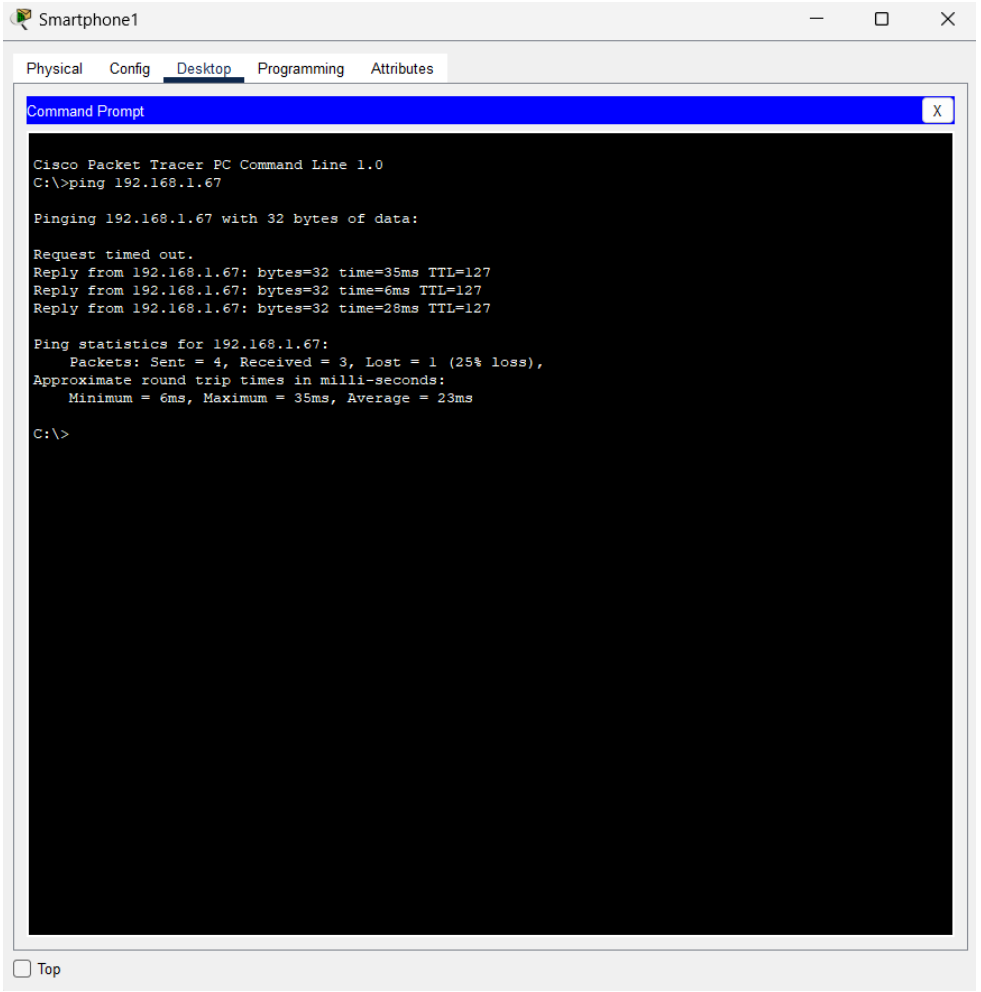


TABLE 4.2: Ping Test smartphone 1(Admin) to printer 1(Finance)

Pinging **Data Size**	192.168.1.67 32 bytes
Reply	
Request timed out	
Reply from 192.168.1.67	bytes=32 time=35ms TTL=127
Reply from 192.168.1.67	bytes=32 time=6ms TTL=127
Reply from 192.168.1.67	bytes=32 time=28ms TTL=127
Ping Statistics	
Packets: Sent Packets: Received Packets: Lost	4 3 1 (25% loss)
Approximate round trip times	
Minimum Maximum Average	6ms 35ms 23ms



The ping tests between devices in different departments were successful, indicating that communication is established between the VLANs. Devices from Department 1 were able to ping and establish a connection with devices in Department 2 and 3 and vice versa. Network accessibility was tested by printing a document from a tablet connected to Department 1's VLAN to a printer located in Department 3's VLAN. The document was successfully printed, demonstrating seamless access to shared resources across VLANs.

The project has successfully implemented a separate network for the branch, dividing it into three departments with individual VLANs. The network design, VLAN configuration, and IP address allocation have allowed for efficient communication and resource sharing between departments while maintaining network security and isolation. The ping tests and network accessibility tests have confirmed the proper functioning of the network, meeting the project's objectives.

Chapter 5

Conclusion and Practical Implications

Network Design: The implementation of VLANs and subnetting scheme successfully segregated the branch network into three departments, providing enhanced network security and isolation.

IP Address Allocation: IP addresses were efficiently allocated to each department using the subnetting scheme, ensuring optimal utilization of available addresses.

VLAN Configuration: The VLANs were properly configured on the switches, enabling separate broadcast domains for each department and facilitating efficient management of network traffic.

Wireless Access Points and DHCP Server Configuration: The deployment of wireless access points in each department, along with a DHCP server, facilitated seamless connectivity and automatic IP address assignment to wireless devices.

Trunk Interface and Sub-Interface Configuration: Trunk interfaces on the switches and sub-interfaces on the router were appropriately configured, enabling the passage of multiple VLANs and efficient inter-VLAN routing.

Successful Ping Tests: Ping tests conducted between devices in different departments confirmed successful communication and connectivity across VLANs, demonstrating the effectiveness of the network setup.

Network Accessibility: The network allowed for easy access to shared resources, such as printers and file servers, across different departments, enhancing collaboration and productivity.

Overall Network Functionality: The network implementation was successful, ensuring that devices in different departments could communicate, access shared resources, and transfer data seamlessly.

Improved Efficiency and Security: The VLAN-based network design provided improved efficiency by segregating network traffic and optimizing resource allocation. It also enhanced security by isolating departments and preventing unauthorized access to sensitive data.

Project Objectives Met: The mini-project successfully achieved its goals of setting up a separate network for the branch with three departments and wireless networks, demonstrating the ability to design, configure, and test a functional network infrastructure.

5.1 Restating Goals and Assessing Achievement

The mini-project involved setting up a separate network for a branch with three departments and wireless networks. The objectives were to implement VLANs and subnetting for network segregation, establish communication across VLANs, and enable access to shared resources.

The goals were successfully achieved. VLANs and subnetting were implemented, optimizing resource allocation and enhancing security. Communication between devices in different departments was established and confirmed through successful ping tests. Access to shared resources across departments was enabled and validated through tasks such as printing and file sharing.

Overall, the project demonstrated the successful implementation of a segregated network, ensuring efficient communication, improved security, and streamlined resource sharing. The objectives were effectively met, showcasing the effectiveness of VLANs, subnetting, and network configuration techniques.

References

Howard, 2023. What is a small office home office (soho) network and how to set up one? FS Community URL: https://community.fs.com/blog/what-is-a-small-office-home-office-soho-network-and-how-to-set-up-one.html.