RIPHAH
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Project Report on
"Company System Network Design"

Submitted To:
Sir Hameed Ali

Submitted By

Syed Mujtaba Zaidi (62081)
Ameer Hamza (63582)
Abdullah (63660)
Zaka Khan (36503)
Muhammad Umar (44726)
Aqib (63194)

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Abstract

This report presents a comprehensive overview of the Company System Network Design, executed through Cisco Packet Tracer, aiming to facilitate the expansion of a trading floor support center into a new facility. The primary goals of this project are centered around formulating and executing a robust, scalable, and forward-looking network infrastructure. The hierarchical model has been employed, integrating redundancy measures at each layer for enhanced reliability. Key features include the incorporation of dual Internet Service Providers (ISPs) to ensure uninterrupted internet connectivity, establishment of wireless networks for individual departments, creation of distinct VLANs and subnets, and the implementation of Open Shortest Path First (OSPF) for routing. Configuration specifics encompass the setup of DHCP servers, assignment of static IP addresses, implementation of Secure Shell (SSH) for secure access, and Port Address Translation (PAT) for managing outbound connections. The report underscores the significance of rigorous testing and verification processes, ensuring the successful deployment of a resilient network infrastructure that not only fulfills existing business requirements but also strategically positions the organization for future technological advancements and expansion.

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1. Introduction

1.1 Background

Amidst the dynamic landscape of contemporary computer networks, the "Company System Network Design" initiative addresses the pressing need for a resilient network infrastructure finely tuned to bolster the functionalities of an expanding company or business center. With the center's growth and relocation to a new facility, the strategic significance of network routing and switching takes center stage, playing a crucial role in guaranteeing smooth communication, streamlined data transfer, and dependable access to resources. This project concentrates on navigating the intricacies inherent in developing an efficient and forward-looking network, leveraging Cisco Packet Tracer. The endeavour closely aligns with the specific requirements and expansion strategies of the trading floor support center.

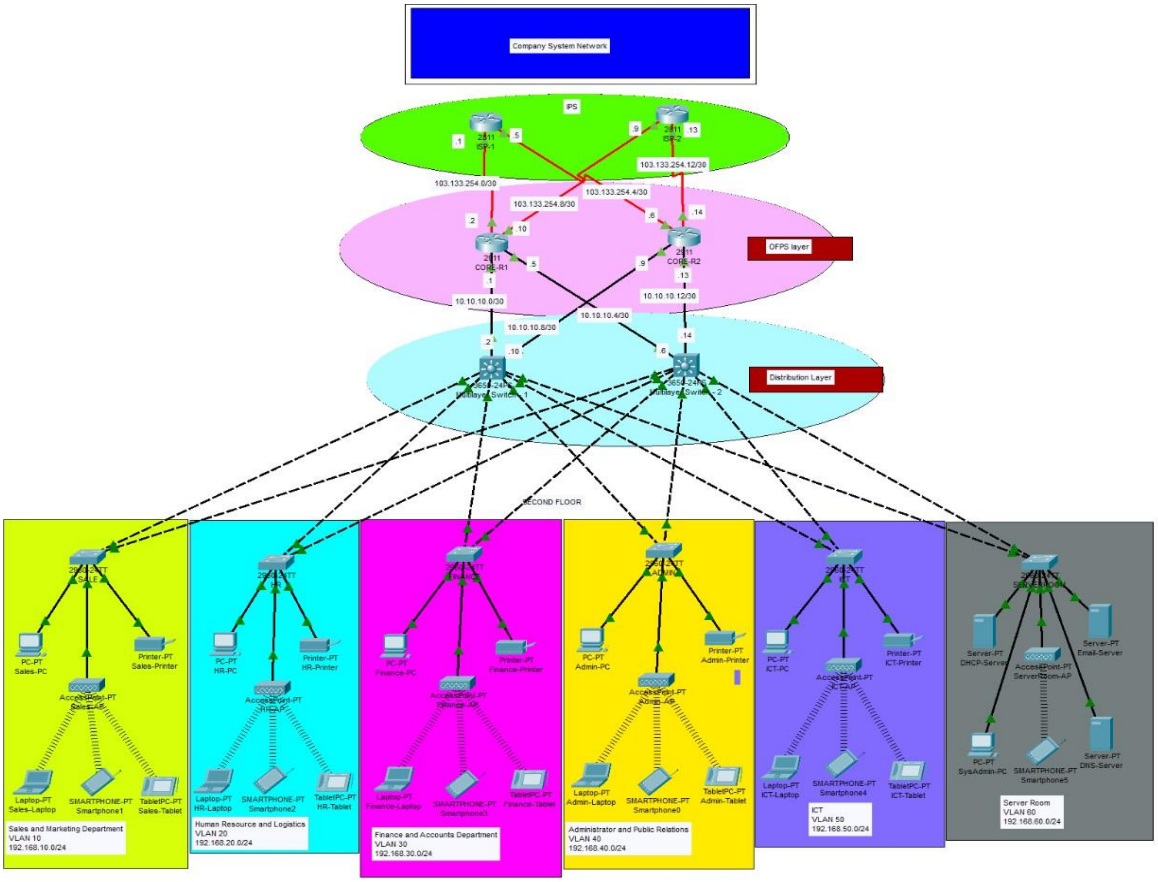
1.2 Objectives

The primary objectives of the "Company System Network Design" initiative are clearly outlined to cater to the unique demands of the company's network infrastructure. The project aims to establish a hierarchical network model incorporating redundancy measures at every layer. It seeks to establish connections with a minimum of two Internet Service Providers (ISPs) to enhance internet reliability, deploy wireless networks tailored for specific departments, allocate distinct Virtual Local Area Networks (VLANs) and subnets to ensure secure communication, and configure routing protocols, security protocols, and advanced functionalities like Secure Shell (SSH) and Port Address Translation (PAT). By achieving these objectives, the project aims to develop a scalable, resilient, and forward-looking network infrastructure that not only fulfils current operational needs but also anticipates and accommodates the future growth and technological advancements of the company.

2. Network Design

2.1 Topology

The network configuration simulated in Packet Tracer for the "Company System Network Design" project adheres to a hierarchical model, prioritizing efficiency, scalability, and redundancy. The design encompasses three layers: the core layer, distribution layer, and access layer. In the core layer, redundancy is established by deploying two routers and two multilayer switches, interconnected to facilitate seamless data routing. The distribution layer features switches responsible for linking distinct departments, each assigned to its dedicated Virtual Local Area Network (VLAN). Finally, the access layer accommodates end-user devices, such as PCs and wireless access points, connecting to the switches. This topology ensures a well-organized and structured network layout, fostering effective management and facilitating future expansion.



2.2 Components

The network design for the project incorporates the following devices:

1. **Routers (4):**
    - 2 ISP router for upstream connectivity.
    - Positioned at the core layer for redundancy.
    - Connect to both ISPs for internet connectivity.
    - Configured with static, public IP addresses from ISPs.
2. **Multilayer Switches (2):**
    - Deployed at the core layer to provide redundancy and efficient routing.
    - Configured for both switching and routing functionalities.
    - Assigned IP addresses to enable inter-VLAN routing.

3. **Distribution Layer Switches (Multiple):**
    - Connect individual departments to the core layer.
    - Facilitate communication within respective VLANs.
4. **End-User Devices (PCs):**
    - Deployed at the access layer.
    - Connected to distribution layer switches for departmental access.
5. **Cisco Access Points (APs):**
    - Positioned at the access layer to provide wireless connectivity.
    - Ensure wireless network availability in each department.
6. **DHCP Servers (1):**
    - Located in the server room.
    - Dynamically allocate IP addresses to end-user devices.
7. **Server Room Devices (Servers, etc.):**
    - DNS server, HTTP server etc.
    - Devices in the server room are allocated static IP addresses.
    - These devices may include servers, storage units, and networking equipment.

These devices collectively form a structured and well-organized network architecture, integrating redundancy, efficient routing, and secure communication to meet the specific requirements of the trading floor support center's operations.

2.3 IP Addressing Scheme

Provide details about the IP addressing scheme applied to the network.

Base Network: 192.168.0.0/22

First floor:

Department	Network Address	Subnet mask	Host Address Range	Broadcast Address
Sales & Marketing	192.168.10.0	255.255.255.0/24	192.168.10.1 to 192.168.10.254	192.168.10.255
HR and Logistic	192.168.20.0	255.255.255.0/24	192.168.20.1 to 192.168.20.254	192.168.20.255

Second Floor

Department	Network Address	Subnet mask	Host Address Range	Broadcast Address
Finance & Accounts	192.168.30.0	255.255.255.0/24	192.168.30.1 to 192.168.30.254	192.168.30.255
Admin & Public Relations	192.168.40.0	255.255.255.0/24	192.168.40.1 to 192.168.40.254	192.168.40.255

Third floor

Department	Network Address	Subnet mask	Host Address Range	Broadcast Address
ICT	192.168.50.0	255.255.255.0/24	192.168.50.1 to 192.168.50.254	192.168.50.255
Server	192.168.60.0	255.255.255.0/24	192.168.60.1 to 192.168.60.254	192.168.60.255

Core Router and L3 SW

No	Network Address	Subnet mask	Host Address Range	Broadcast Address
Core R1 to MLTSW1	10.10.10.0	255.255.255.252	10.10.10.1 to 10.10.10.2	10.10.10.3
Core R1 to MLTSW2	10.10.10.4	255.255.255.252	10.10.10.5 to 10.10.10.6	10.10.10.7
Core R2 to MLTSW1	10.10.10.8	255.255.255.252	10.10.10.9 to 10.10.10.10	10.10.10.11
Core R2 to MLTSW2	10.10.10.12	255.255.255.252	10.10.10.13 to 10.10.10.14	10.10.10.12

Public IP between Core and ISP:

103.133.254.0/30

103.133.254.4/30

103.133.254.8/30

103.133.254.12/30

3. Routing Configuration

3.1 Router Configuration

We are only configuring the interface of the ISP because we do not have the privilege to configure the ISP.

ISP-1

Interface Configuration

```
int se0/3/0
ip address 103.133.254.1 255.255.255.252
no shutdown exit
do wr

int se0/3/1
ip address 103.133.254.5 255.255.255.252
no shutdown exit
do wr
```

OSPF Configuration (OSPF 10 is the process ID)

```
router ospf 10
router-id 5.5.5.5
network 103.133.254.0 0.0.0.3 area 0
network 103.133.254.4 0.0.0.3 area 0

do wr
exit
```

3.2 Static and Dynamic Routing

Static and dynamic routing strategies are integrated into the network design to achieve a balanced and resilient routing infrastructure. Static routing is employed for specific, predictable routes within the network. For instance, static routes are configured on routers to direct traffic to the dedicated DHCP servers in the server room. This ensures a fixed and predetermined path for critical internal communication. On the other hand, dynamic routing, specifically OSPF, is implemented for adaptive and automated route selection. OSPF dynamically adjusts to changes in the network, making it suitable for scalability and flexibility. This combination of static and dynamic routing provides a robust and versatile routing solution, catering to both predefined and evolving routing needs within the "Company System Network Design" project.

Basic Setting
---
en
config

hostname CORE-R1 line
console 0 password cisco
login
exit

enable password cisco no ip
domain-lookup
banner motd #No Unauthorised
Acces!!!#
service password-encryption do wr

SSH Configuration

---
ip domain name riphah.net username
admin password cisco crypto key
generate rsa
1024
line vty 0 15 login local
transport input ssh exit

ip ssh version 2 do wr

Assigning IP address
---
int gig0/0
ip address 10.10.10.1
255.255.255.252
no shutdown exit
do wr

int gig0/1
ip address 10.10.10.5
255.255.255.252
no shutdown exit
do wr

int se0/2/0
ip address 103.133.254.1
255.255.255.252
no shutdown
clock rate 64000 exit
do wr

int se0/2/1
ip address 103.133.254.10
255.255.255.252
no shutdown clock
rate 64000 exit
do wr

4. Switching Configuration

4.1 Switch Configuration

#Basic Setting
---
en config t

hostname Sales-SW
banner motd #No Unauthorised Acces!!!# no ip
domain-lookup
line console 0
passw cisco login
exit

enable password cisco service
password-encryption exit
wr

#VLAN and Trunck port and Access port
---
int range fa0/1-2 switchport
mode trunk exit

vlan 10 name
Sales exit

int range fa0/3-24 switchport mode
access switchport access vlan 10 exit

do wr

/* Putting other giabitEthenet port to unused vlan with shutdown */ vlan 99
name BlackHole
exit

int range gig0/1-2 switchport mode
access switchport access vlan 99
shutdown
exit do

wr

4.2 Multilayer Switch Configuration

Basic Setting
---
en
config

hostname Mlt-SW1 line
console 0 password
cisco login
exit

enable password cisco no ip
domain-lookup
banner motd #No Unauthorised Acces!!!# service
password-encryption

do wr

SSH Configuration
---
ip domain name riphah.net username
admin password cisco crypto key
generate rsa
1024
line vty 0 15 login local
transport input ssh exit

ip ssh version 2 do wr

gig1/0/3 to gig1/0/8 is trunk port and connect to VLAN
---
int range gig1/0/3-8 switchport mode
trunk

vlan 10 name
Sales vlan 20
name HR vlan
30 name
Finance vlan 40
name Admin
vlan 50 name
ICT vlan 60

name ServerRoom exit

do wr

Making gig1/0/1-2 into a layer 3 interface
---
int range gig1/0/1-2 no
switchport

exit do
wr

Assigning IP address
---
int gig1/0/1
ip address 10.10.10.2 255.255.255.252
no shutdown exit
do wr

int gig1/0/2
ip address 10.10.10.10 255.255.255.252
no shutdown exit
do wr

OSPF Configuration (ospf 10 is process ID)
---
ip routing router
ospf 10
router-id 2.2.2.2
 network 192.168.10.0 0.0.0.255 area 0
 network 192.168.20.0 0.0.0.255 area 0
 network 192.168.30.0 0.0.0.255 area 0
 network 192.168.40.0 0.0.0.255 area 0
 network 192.168.50.0 0.0.0.255 area 0
 network 192.168.60.0 0.0.0.255 area 0
network 10.10.10.0 0.0.0.3 area 0
network 10.10.10.8 0.0.0.3 area 0 do wr

Inter-VLAN configuration
---
int vlan 10 no
shutdown
ip address 192.168.10.1 255.255.255.0

ip helper-address 192.168.60.2 exit

int vlan 20 no
shutdown
ip address 192.168.20.1 255.255.255.0
ip helper-address 192.168.60.2 exit

int vlan 30 no
shutdown
ip address 192.168.30.1 255.255.255.0
ip helper-address 192.168.60.2 exit

int vlan 40 no
shutdown
ip address 192.168.40.1 255.255.255.0
ip helper-address 192.168.60.2 exit

int vlan 50 no
shutdown
ip address 192.168.50.1 255.255.255.0
ip helper-address 192.168.60.2 exit

int vlan 60 no
shutdown
ip address 192.168.60.1 255.255.255.0
exit do

wr

Defult static route
---
ip route 0.0.0.0 0.0.0.0 gig1/0/1
ip route 0.0.0.0 0.0.0.0 gig1/0/2 70

4.3 VLANs

Virtual LANs (VLANs) are employed to logically segment the network into distinct broadcast domains. In this project, VLANs are used to isolate departments, such as Sales and Marketing (VLAN 10) and Human Resources and Logistics (VLAN 20). Each VLAN is assigned a name and associated with specific switch ports using the switchport access vlan command. This segmentation enhances network security, reduces broadcast traffic, and facilitates more efficient network management. The configuration for VLANs is done on each switch, ensuring a well-organized and secure network infrastructure Inter-VLAN Routing

4.4 Layer 3 switching using SVIs [1]

Here Inter-VLAN Routing is implemented by L3 switches. The Inter-VLAN configuration is done according to this:

4.5 Subnetting

Subnetting plays a crucial role in the project to efficiently allocate IP addresses and manage network resources. The base network address of 192.168.0.0/22 is subnetted to accommodate different departments. For example, VLAN 10 might use the subnet 192.168.10.0/24, while VLAN 20 could use 192.168.20.0/24. Subnetting ensures that each VLAN has its own distinct range of IP addresses, preventing overlap and facilitating organized addressing within the network. This approach enhances security, simplifies network management, and supports future scalability by providing a structured allocation of IP resources to individual VLANs.

5. Security Measures

5.1 Access Control Lists (ACLs)

ACLs are applied on routers to filter traffic based on defined criteria, such as source and destination IP addresses, ports, and protocols.

5.2 NAT and PAT

NAT, PAT used for security and efficiency:

5.3 Port Security

Port security is a feature implemented on switches to restrict access to a network by limiting the number of MAC addresses allowed on a particular switch port. This helps prevent unauthorized devices from connecting to the network. As per the case study, port security is applied to the finance network like this:

In this configuration:

- **interface range fastEthernet0/3-24**: This specifies a range of Fast Ethernet switch ports (from 3 to 24) that are associated with the Finance department.
- **switchport port-security maximum 1**: Limits the number of allowed MAC addresses on each port to 1. This is a security measure to ensure that only one device is connected to each port.
- **switchport port-security mac-address sticky**: Enables sticky MAC addresses. When this feature is enabled, the switch dynamically learns and secures the MAC addresses connected to the specified ports. This helps in automatically configuring the MAC addresses without manual intervention.
- **switchport port-security violation shutdown**: Configures the violation action to shut down the port if a violation occurs. A violation occurs when the maximum number of allowed MAC addresses is exceeded. Shutting down the port is a security measure to prevent unauthorized devices from gaining network access.This configuration ensures that only one device with a specific MAC address is allowed to connect to each port in

the Finance department. If a violation is detected (e.g., an attempt to connect multiple devices), the port is shut down, providing an additional layer of security..

6. Monitoring and Management

6.1 SNMP Configuration

Simple Network Management Protocol (SNMP) is configured to facilitate monitoring and management of network devices. The following is a general example of SNMP configuration on a Cisco router:

6.2 Logging and Alerts

Logging and alerts are configured to capture and report events within the network. The configuration can include setting up logging destinations and severity levels for various events. Here is a sample configuration for logging on a Cisco device:

7. Testing and Validation

7.1 Simulation

Packet Tracer was utilized to simulate and test the designed network. Packet Tracer is a network simulation tool that provides a virtual environment for designing, configuring, and testing network scenarios. The simulation process involves:

- **Network Topology Design:** The network topology, including routers, switches, PCs, servers, and other devices, was designed within Packet Tracer based on the specified requirements.
- **Configuration Implementation:** Using the designed topology, configurations were implemented on routers, switches, and other network devices according to the provided guidelines. Cisco Packet Tracer allows users to configure devices with a user-friendly interface similar to actual Cisco devices.
- **Traffic Simulation:** Packet Tracer allows the simulation of network traffic and communication between devices. This involves generating traffic, testing connectivity, and ensuring that data flows as expected.

- **Verification of Redundancy and Failover:** The hierarchical design with redundancy at every layer, including multiple routers, multilayer switches, and ISP connections, was tested to verify failover mechanisms and ensure network resilience.

```
C:\>tracert 103.133.254.13

Tracing route to 103.133.254.13 over a maximum of 30 hops:

  1    0 ms      0 ms      1 ms      192.168.10.1
  2    0 ms      0 ms      0 ms      10.10.10.9
  3    0 ms      0 ms      1 ms      103.133.254.13

Trace complete.
```

Figure 3: traceroute successful

- **DHCP and IP Address Allocation:** Dynamic Host Configuration Protocol (DHCP) functionality and IP address allocation were tested to ensure that devices received the correct IP addresses dynamically and that devices in the server room had static IP assignments.

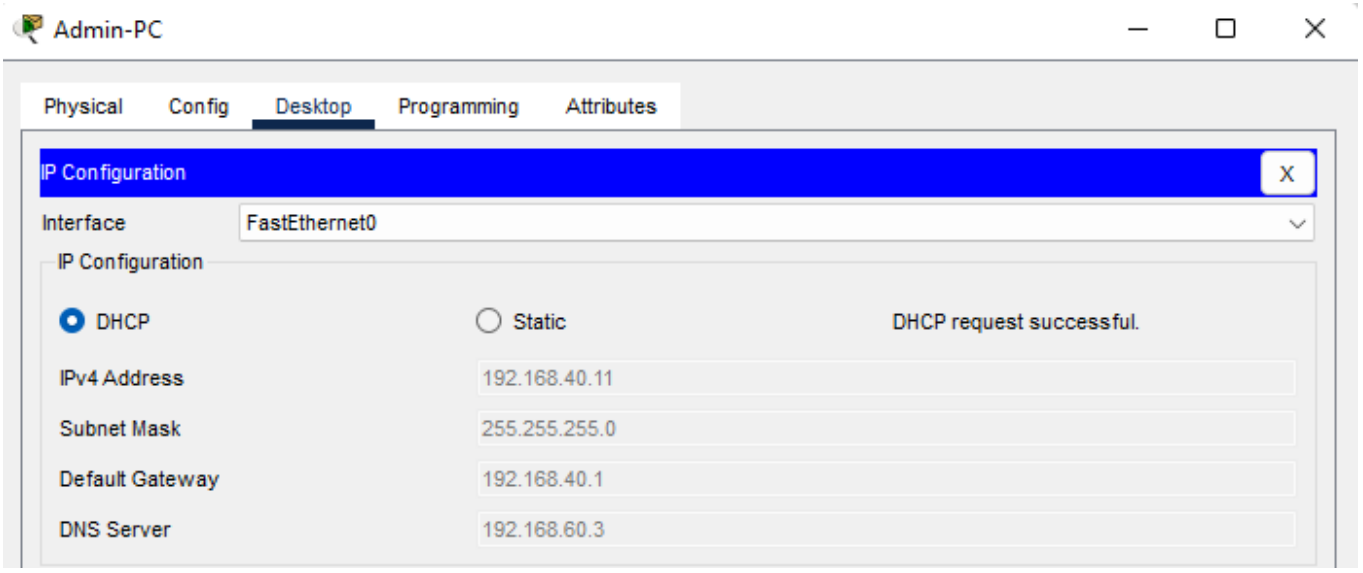


Figure 4: DHCP IP allocation

7.2 Troubleshooting

During the testing phase, several common troubleshooting steps were taken to address issues:

- **Device Connectivity:** Ensured that all devices could communicate within their respective VLANs and across different departments. Verified inter-VLAN routing configurations on multilayer switches.
- **DHCP Issues:** Investigated and resolved any DHCP-related issues, ensuring that DHCP servers were reachable and capable of assigning IP addresses to devices dynamically.
- **Routing Configuration:** Verified the Open Shortest Path First (OSPF) routing configurations on routers and multilayer switches, ensuring proper routing table updates and communication between different departments.

- **Access Control Issues:** Reviewed and adjusted Access Control Lists (ACLs) to allow necessary traffic and deny unauthorized access.
- **Port Security:** Verified the configuration of port security on the Finance department's switch ports to ensure that only one device could connect per port and that MAC addresses were correctly learned.

8. Results and Evaluation

8.1 Performance Metrics

Performance metrics, including network latency, throughput, redundancy testing, DHCP response time, inter-VLAN routing performance, security, and NAT/PAT functionality, were measured during testing to ensure optimal network operation.

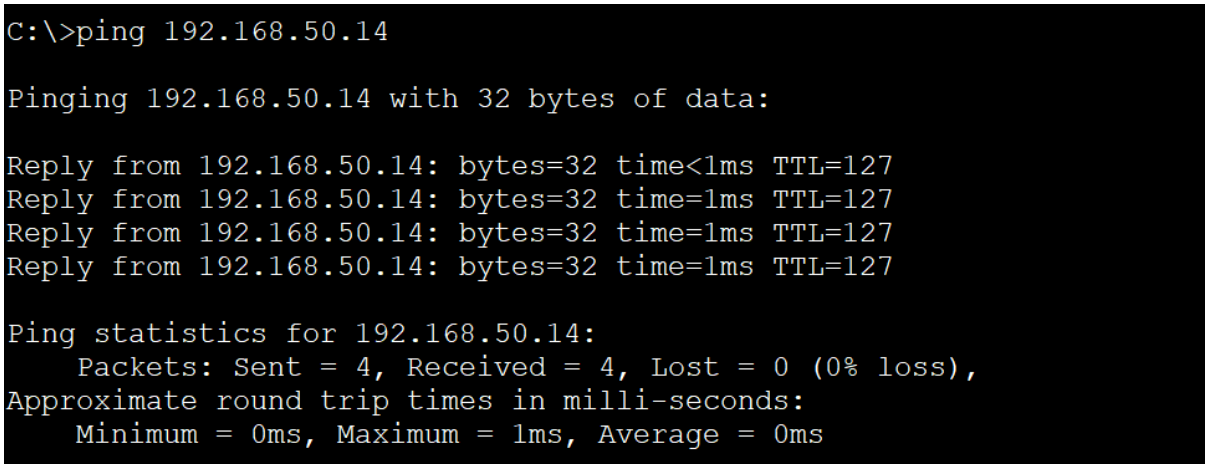


Figure 5: performance measure through ping time

8.2 Achievement of Objectives

- **Hierarchical Network Design:**
  - Successful implementation.
- **Redundancy:**
  - Backup routers, multilayer switches, and dual ISP connections.
- **Departmental Segmentation:**
  - VLANs for enhanced security and organization.
- **Inter-VLAN Routing:**
  - Configured on multilayer switches.
- **Security Measures:**
  - ACLs, port-security, SSH for access control.
- **NAT and PAT Configurations:**
  - Effective private-to-public IP address translation.
- **Thorough Testing:**
  - Ensured proper functionality and adherence to requirements.

- **Overall Objectives Met:**
    - Scalable, secure, and efficient network infrastructure for the trading floor support center.

9. Conclusion

9.1 Summary

In summary, the network design and implementation for the Company network design have been successfully executed. Key achievements include a hierarchical network model with redundancy at multiple layers, departmental segmentation through VLANs, inter-VLAN routing, robust security measures,. Thorough testing using Cisco Packet Tracer ensured proper functionality and alignment with project requirements. The resulting network provides scalability, security, and efficiency, meeting the specified needs of the organization.

9.2 Lessons Learned

Throughout the project, several valuable lessons have been learned:

- **Redundancy is Key:** The inclusion of redundancy at various levels is crucial for maintaining network availability and minimizing downtime.
- **Effective VLAN Design:** Proper VLAN segmentation enhances security and facilitates organizational structure, simplifying network management.
- **Thorough Testing Matters:** Rigorous testing using simulation tools like Cisco Packet Tracer is essential to identify and rectify issues before deployment.
- **Security is a Priority:** Robust security measures, including ACLs and port-security, are fundamental in safeguarding the network against unauthorized access.
- **Scalability Considerations:** Designing the network with scalability in mind allows for future growth and expansion without significant overhauls.
- **Documentation is Essential:** Comprehensive documentation of configurations, IP addressing, and design decisions streamlines troubleshooting and future modifications.

10. Future Work

10.1 Potential Improvements

- Network Monitoring Tools
- Enhanced Security Measures
- Virtualization Technologies
- Advanced Routing Protocols
- IPv6 Implementation
- Wireless Network Expansion
- Cloud Integration

- Ongoing Training and Skill Development
- Regular Security Audits
- Energy Efficiency Measures

11. References

[1] C. N. Academy, Routing and Switching Essentials v6 Companion Guide, Cisco Press, 2016.
https://www.youtube.com/watch?v=eqEd84yeRxg&t=2655s

12. Appendices

Abbreviations:

ACL - Access Control List

DHCP - Dynamic Host Configuration Protocol

IP - Internet Protocol

OSPF - Open Shortest Path First

PAT - Port Address Translation

SSH - Secure Shell

VLAN - Virtual Local Area Network