Hospital Network Design

using Cisco Packet Tracer

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C.Net. Project Report

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Objective:

The primary goal of this project is to design and implement a robust network infrastructure for a hospital using Cisco Packet Tracer. This network will ensure seamless connectivity, enhanced security, and efficient management of hospital resources. By integrating VLAN, ACL, NAT, and DHCP technologies, the network will facilitate secure communication, minimize broadcast domains, manage IP addressing efficiently, and control access to critical network resources.

Technologies Used:

Cisco Packet Tracer: A powerful network simulation tool used for designing, configuring, and troubleshooting network setups.
VLAN (Virtual Local Area Network): Used to segment network traffic into different broadcast domains, improving security and reducing congestion.
ACL (Access Control List): Implemented to control the flow of traffic and restrict access based on IP addresses or subnets.
NAT (Network Address Translation): Utilized to map internal IP addresses to a single public IP address, enhancing network security and efficient IP address management.
DHCP (Dynamic Host Configuration Protocol): Used to automatically assign IP addresses to devices within the network, simplifying network management.

Implementation Details:

The Network includes departments like Medical Lead Operation & Consultancy Services (MLOCS), Medical Emergency and Reporting (MER), Medical Records Management (MRM), Information Technology (IT), and Customer Service (CS), Nurses & Surgery Operations (NSO), Hospital Labs (HL), Human Resource (HR), Marketing (MK), and Finance (FIN) and also a Guest/Waiting area (GWA) for patients or visitors.

Explanation of how Cisco or socket programming was applied in your project.
Code snippets or configuration screenshots to support the key functionality or the concept used

Key Elements:

1. **MASTER Router**:
    - Acts as the central hub connecting all sub-networks.
2. **Sub-Routers:**
    - 2 Sub Routers (Sub_router1 and Sub_router2) that further divide into Sub-Networks
    - A third DHCP_router managing the DHCP-Network which contains a single DHCP Server responsible for assigning IP addresses throughout the network.
3. **Sub-Networks**:
   The Sub Networks are as follows
    - **DHCP Network** (for IP address allocation)
    - **NAT Network** (Connected to Main Router only for NAT)
    - **GWA Network** (Guest Waiting Area)
    - **CS Network** (Customer Service)
    - **IT Network** (Information Technology)
    - **MER Network** (Medical Emergency & Reporting)
    - **MLOCS Network** (Medical Lead Operation & Consultancy Services)
    - **MRM Network** (Medical Records Management)
    - **NSO Network** (Nurse & Surgery Operations)
    - **MK Network** (Marketing)
    - **HR Network** (Human Resources)
    - **FIN Network** (Finance)

You can view the Topology in the figure below.

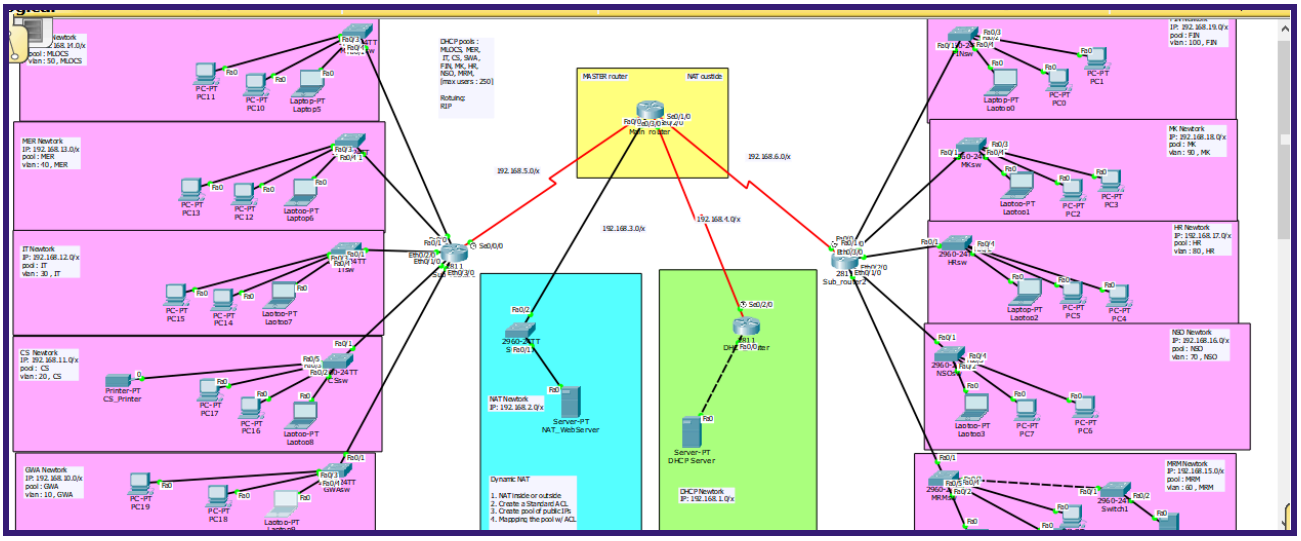


Fig 1: Screenshot of final topology from Cisco Packet Tracer

4. **Devices**:
    - Various network devices including PCs, laptops, printers, and servers within the sub-networks.
5. **IP Addressing**:
    - Each sub-network has a specific IP address range (e.g., 192.168.5.0/x, 192.168.3.0/x, 192.168.4.0/x).
6. **Routing Configurations:**
    - This Network uses RIP, NAT and VLAN as routing Protocols

You can see the RIP and VLAN Tables of the routers in the figures below.

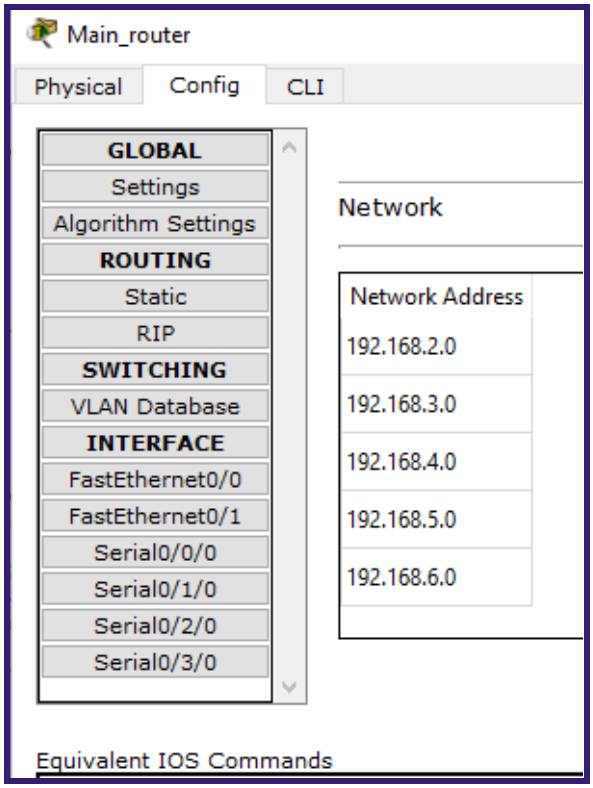


Fig 2 : MainRouter RIP configuration

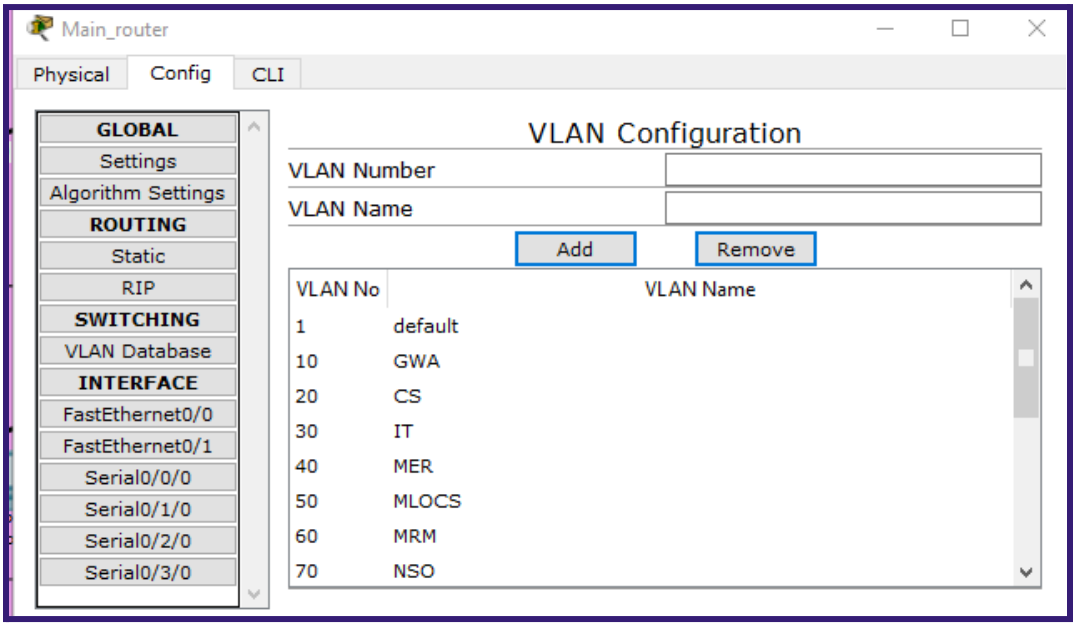


Fig 3 : MainRouter VLAN Database configuration

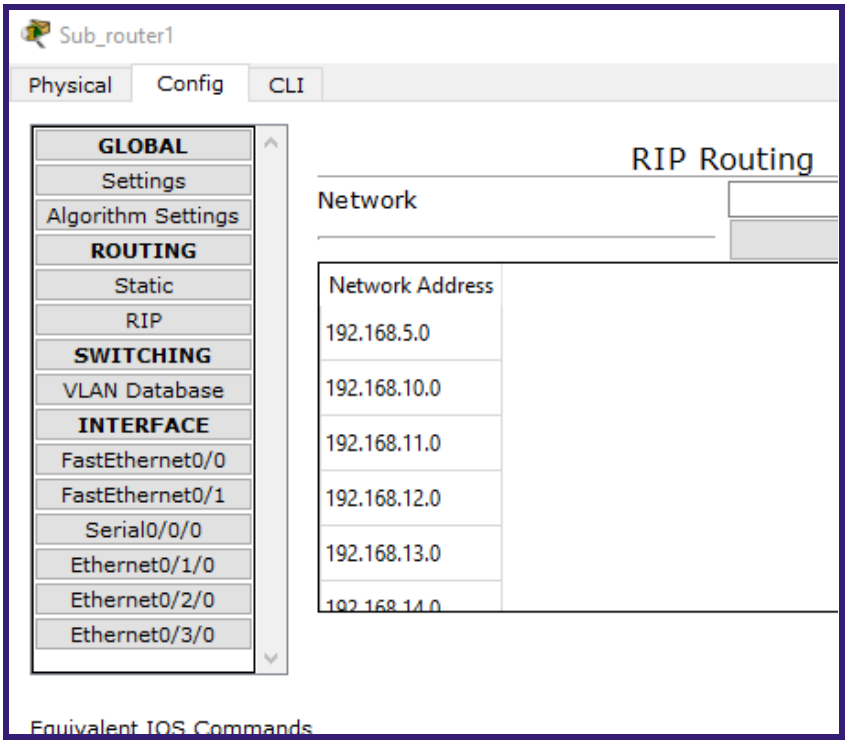


Fig 4 : Sub_router 1 RIP Configuration

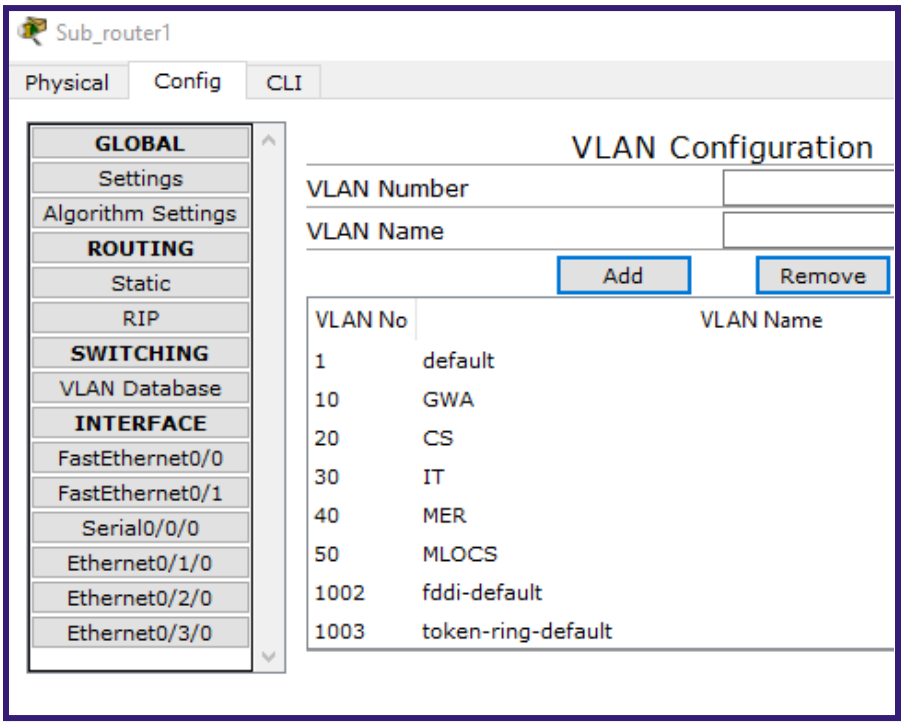


Fig 5 : Sub_router 1 VLAN Database Configuration

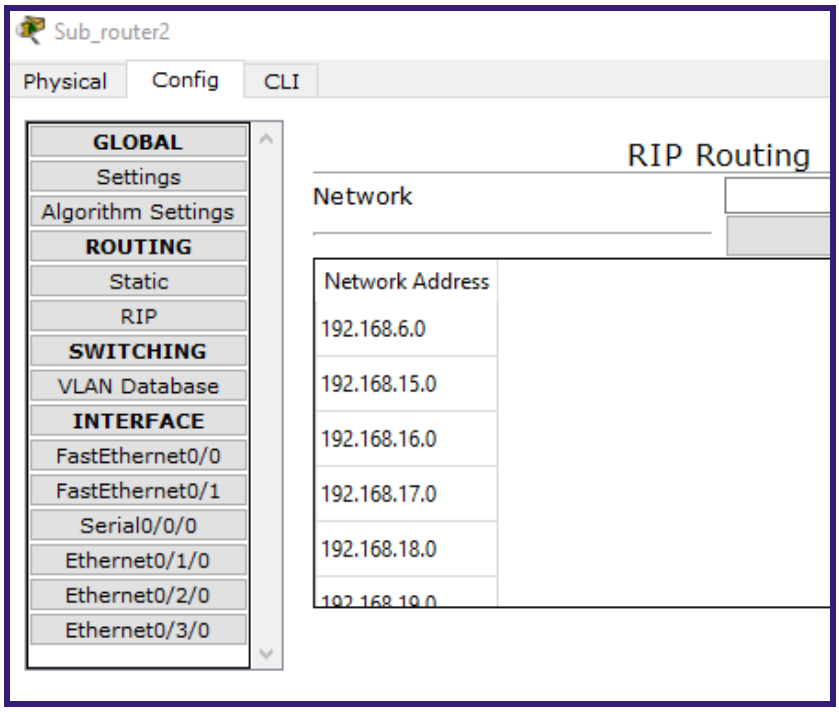


Fig 6 : Sub_router 2 RIP Configuration

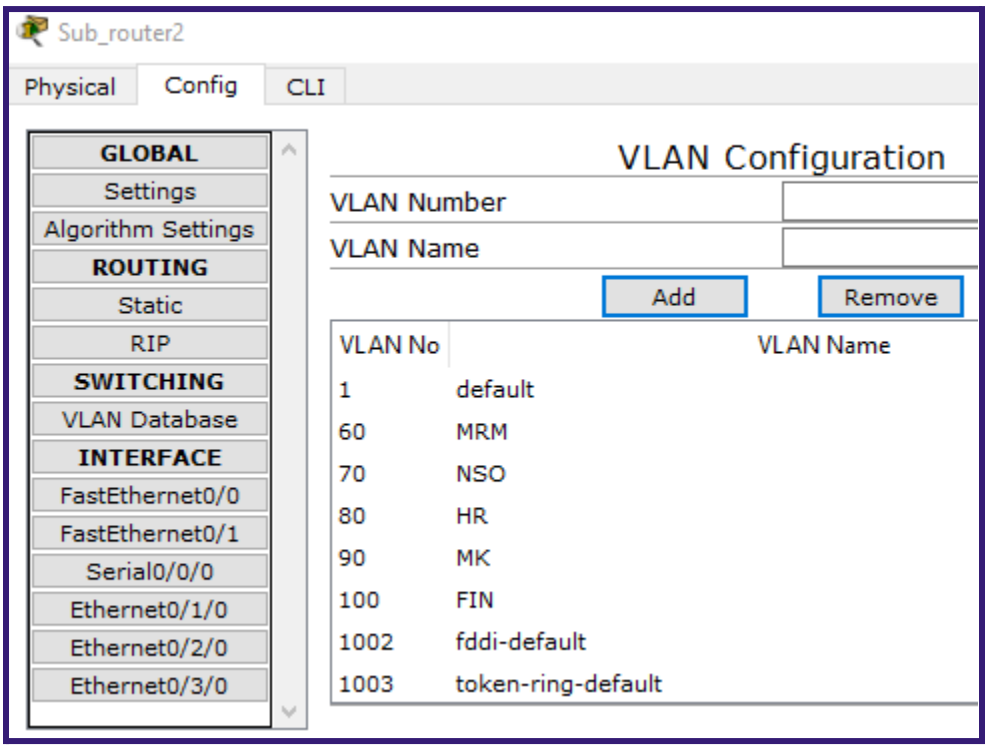


Fig 7 : Sub_router 2 VLAN Database Configuration

7. **DHCP Pools & VLANS**:
    - All 10 Sub-Networks , besides DHCP and NAT Networks are DHCP Pools
    - All 10 Sub-Networks , besides DHCP and NAT Networks are also VLANS

Details of these configurations can be found in the the table below

Network Name	DHCP Pool / VLAN name	VLAN Number	IP Range
GWA Network	GWA	10	192.168.10.0 …
CS Network	CS	20	192.168.11.0 …
IT Network	IT	30	192.168.12.0 …
MER Network	MER	40	192.168.13.0 …
MLOCS Network	MLOCS	50	192.168.14.0 …
MRM Network	MRM	60	192.168.15.0 …
NSO Network	NSO	70	192.168.16.0 …
HR Network	HR	80	192.168.17.0 …
MK Network	MK	90	192.168.18.0 …
FIN Network	FIN	100	192.168.19.0 …

Table 1: DHCP and VLAN Configuration Data

Sub_Router 1	***Sub_Router 2***
Router>enable Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface FastEthernet0/0 Router(config-if)#ip address 192.168.14.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown Router(config-if)#end Router#copy run start %SYS-5-CONFIG_I: Configured from console by console Destination filename [startup-config]?	Router>enable Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface FastEthernet0/0 Router(config-if)# Router(config-if)#exit Router(config)#interface FastEthernet0/0 Router(config-if)# Router(config-if)#exit Router(config)#interface FastEthernet0/0 Router(config-if)# Router(config-if)#ip address 192.168.19.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown

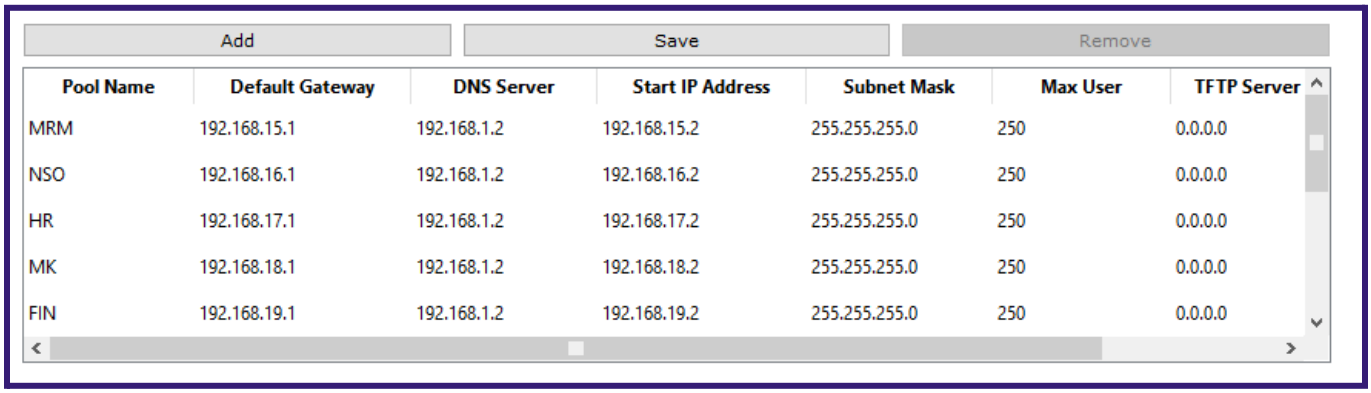
```
Building configuration...
[OK]
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#ip address 192.168.13.1
255.255.255.0
Router(config-if)#ip helper-address 192.168.1.2
Router(config-if)#no shutdown
Router(config-if)#end
Router#copy run start
%SYS-5-CONFIG_I: Configured from console by
console

Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/1/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/3/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/2/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/1/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/2/0
Router(config-if)#ip address 192.168.12.1
255.255.255.0
Router(config-if)#ip helper-address 192.168.1.2
Router(config-if)#no shutdown
Router(config-if)#end
Router#copy run start
%SYS-5-CONFIG_I: Configured from console by
console

Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface Ethernet0/2/0
Router(config-if)#
Router(config-if)#exit
```

```
Router(config-if)#end
Router#copy run start
%SYS-5-CONFIG_I: Configured from console by
console

Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#ip address 192.168.18.1 255.255.255.0
Router(config-if)#ip helper-address 192.168.1.2
Router(config-if)#no shutdown
Router(config-if)#end
Router#copy run start
%SYS-5-CONFIG_I: Configured from console by
console

Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface FastEthernet0/1
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/1/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/3/0
Router(config-if)#
Router(config-if)#ip address 192.168.17.1 255.255.255.0
Router(config-if)#ip helper-address 192.168.1.2
Router(config-if)#no shutdown
Router(config-if)#end
Router#copy run start
%SYS-5-CONFIG_I: Configured from console by
console

Destination filename [startup-config]?
Building configuration...
[OK]
Router#
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#interface Ethernet0/3/0
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Ethernet0/2/0
```

Router(config)#interface Ethernet0/1/0 Router(config-if)#ip address 192.168.11.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown Router(config-if)#end Router#copy run start %SYS-5-CONFIG_I: Configured from console by console Destination filename [startup-config]? Building configuration... [OK] Router# Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface Ethernet0/1/0 Router(config-if)# Router(config-if)#exit Router(config)#interface Ethernet0/3/0 Router(config-if)#ip address 192.168.10.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown Router(config-if)#end Router#copy run start %SYS-5-CONFIG_I: Configured from console by console Destination filename [startup-config]? Building configuration... [OK] Router# Router#	Router(config-if)#ip address 192.168.16.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown Router(config-if)#end Router#copy run start %SYS-5-CONFIG_I: Configured from console by console Destination filename [startup-config]? Building configuration... [OK] Router# Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface Ethernet0/2/0 Router(config-if)# Router(config-if)#exit Router(config)#interface Ethernet0/1/0 Router(config-if)#ip address 192.168.15.1 255.255.255.0 Router(config-if)#ip helper-address 192.168.1.2 Router(config-if)#no shutdown Router(config-if)#end Router#copy run start %SYS-5-CONFIG_I: Configured from console by console Destination filename [startup-config]? Building configuration... [OK] Router# Router#configure terminal Enter configuration commands, one per line. End with CNTL/Z. Router(config)#interface Ethernet0/1/0 Router(config-if)# Router(config-if)#exit Router(config)#interface Ethernet0/1/0 Router(config-if)# Router(config-if)#exit Router(config)# Router(config)#router rip Router(config-router)# Router# %SYS-5-CONFIG_I: Configured from console by console

Table 2: DHCP Configuration on CLIs with IP helper

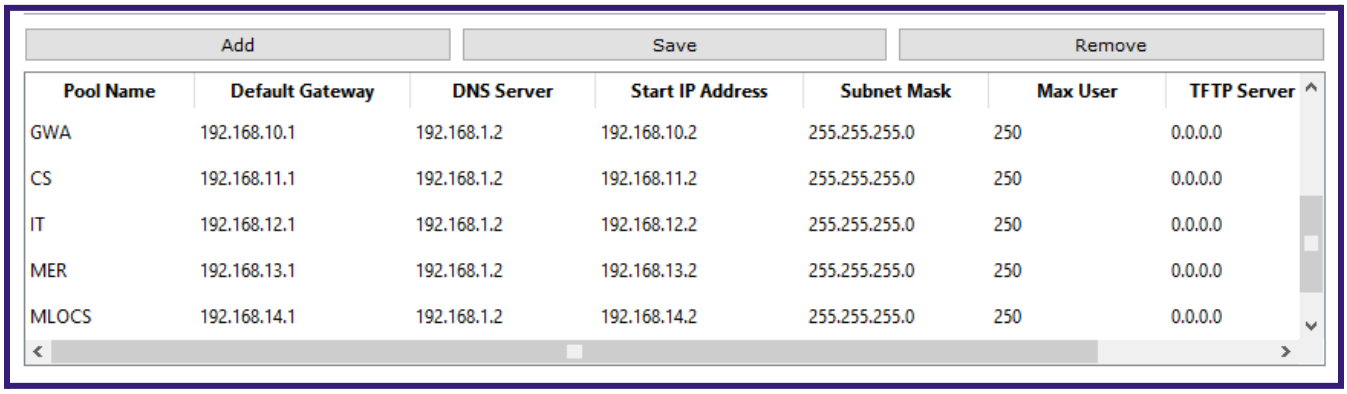
Here are a few Screenshots of the configured DHCP pools.



Add | Save | Remove

Pool Name	Default Gateway	DNS Server	Start IP Address	Subnet Mask	Max User	TFTP Server
MRM	192.168.15.1	192.168.1.2	192.168.15.2	255.255.255.0	250	0.0.0.0
NSO	192.168.16.1	192.168.1.2	192.168.16.2	255.255.255.0	250	0.0.0.0
HR	192.168.17.1	192.168.1.2	192.168.17.2	255.255.255.0	250	0.0.0.0
MK	192.168.18.1	192.168.1.2	192.168.18.2	255.255.255.0	250	0.0.0.0
FIN	192.168.19.1	192.168.1.2	192.168.19.2	255.255.255.0	250	0.0.0.0

Fig 8: DHCP pool configuration pt-1



Add | Save | Remove

Pool Name	Default Gateway	DNS Server	Start IP Address	Subnet Mask	Max User	TFTP Server
GWA	192.168.10.1	192.168.1.2	192.168.10.2	255.255.255.0	250	0.0.0.0
CS	192.168.11.1	192.168.1.2	192.168.11.2	255.255.255.0	250	0.0.0.0
IT	192.168.12.1	192.168.1.2	192.168.12.2	255.255.255.0	250	0.0.0.0
MER	192.168.13.1	192.168.1.2	192.168.13.2	255.255.255.0	250	0.0.0.0
MLOCS	192.168.14.1	192.168.1.2	192.168.14.2	255.255.255.0	250	0.0.0.0

Fig 9: DHCP pool configuration pt-2

8. **NAT Configuration**:
    - Network Address Translation is set up for external access.

Some Screenshots of the process of Implementing NAT are shown below.

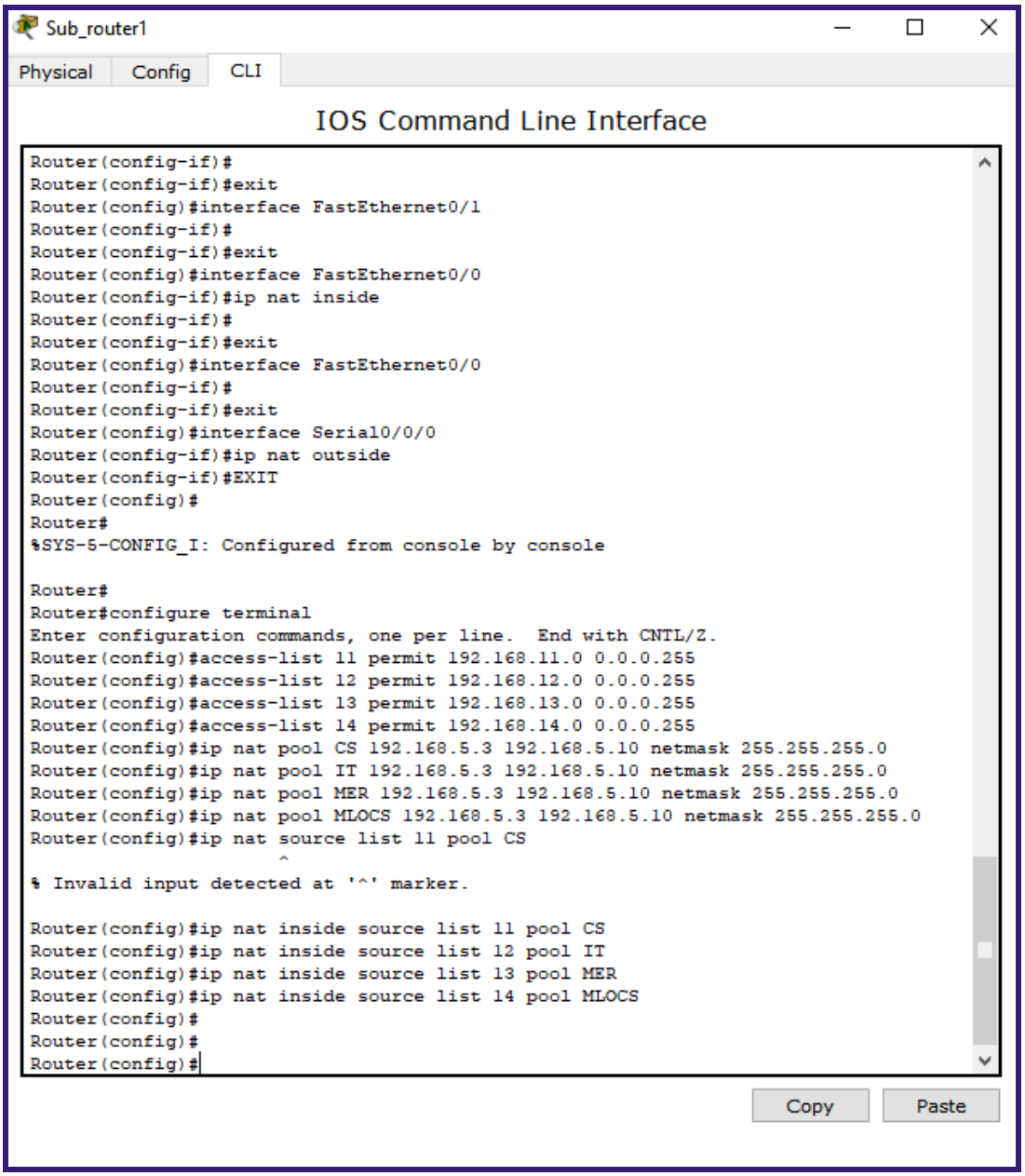


Fig 10: Implementation of NAT on Main Router

Understanding the Sub-Networks:

- **MER Network**: Handles specific devices and services related to the MER team.
- **IT Network**: Dedicated to IT-related devices and resources.
- **CS Network**: Supports Customer Service devices.
- **GWA Network**: Specific to the GWA team or department.
- **FN Network**: Managed for financial devices and systems.
- **MK Network**: Associated with marketing team devices.

- **HR Network**: Supports Human Resources devices.
- **NSO Network**: Configured for the Nurse and Surgery Operations
- **MRM Network**: Dedicated to the Medical Records Management team or services.
- **MLOCS Network:** Dedicated to the Medical Lead Operation & Consultancy Services
- **DHCP Network:** Dedicated Network with a server to handle all DHCP protocols
- **NAT Network:** Dedicated Network stemming from the main router for all NAT protocols , simulating routing similar to that of an ISP.

Key Configurations:

- **Dynamic NAT**: Allows internal devices to access external networks using a pool of public IPs.
- **RIP (Routing Information Protocol)**: Used to exchange routing information between routers.
- **ACL (Access List) :** Used to allow access to all

Results and Testing:

We can See the results in the Figures Below

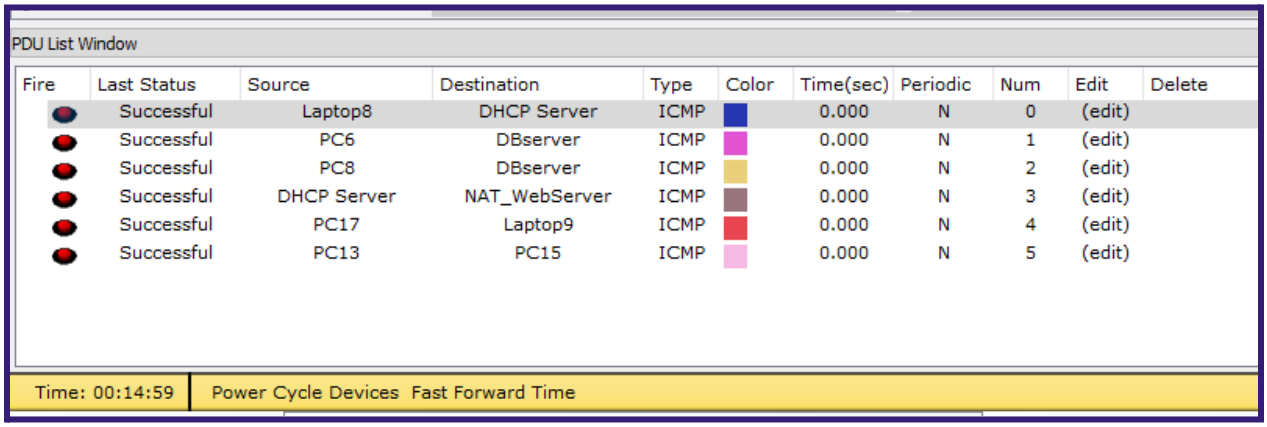


Fig 11: Message Passing between Networks , all are successful

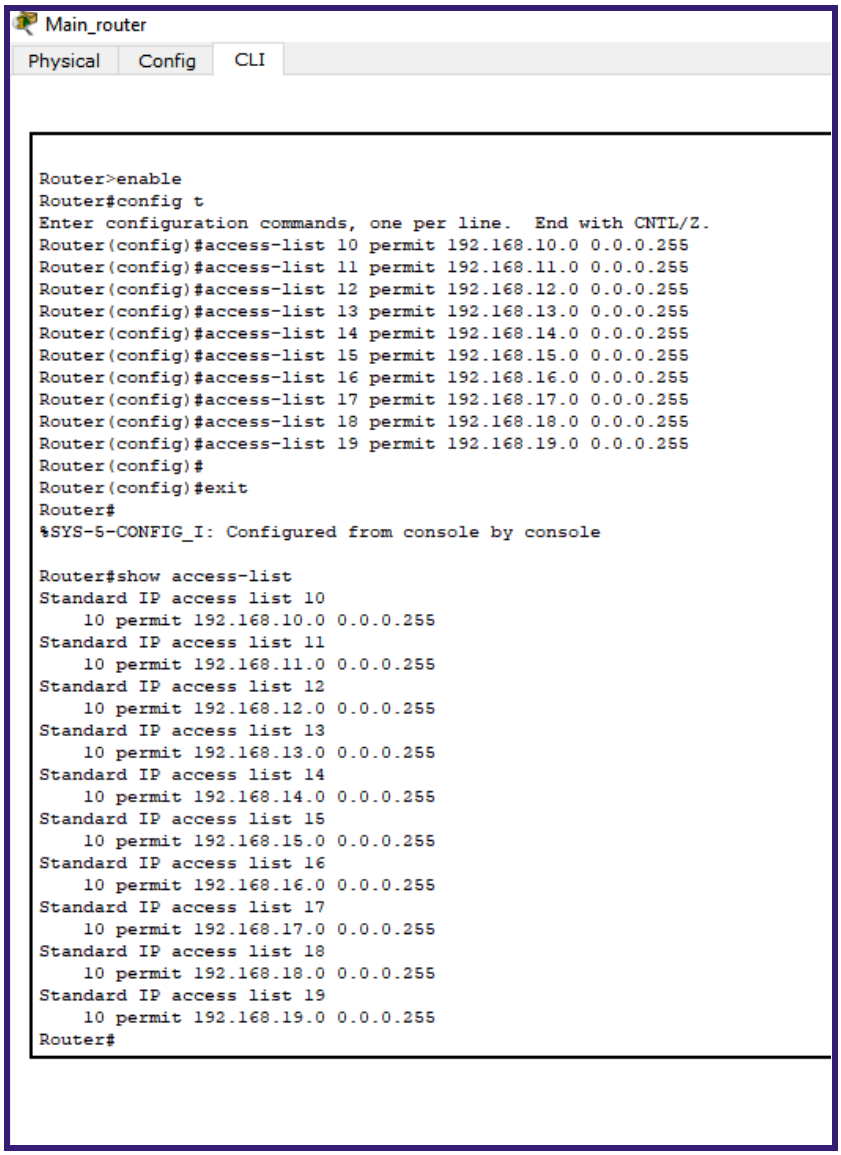


Fig 12: viewing ACL configurations on CLI of Main Router

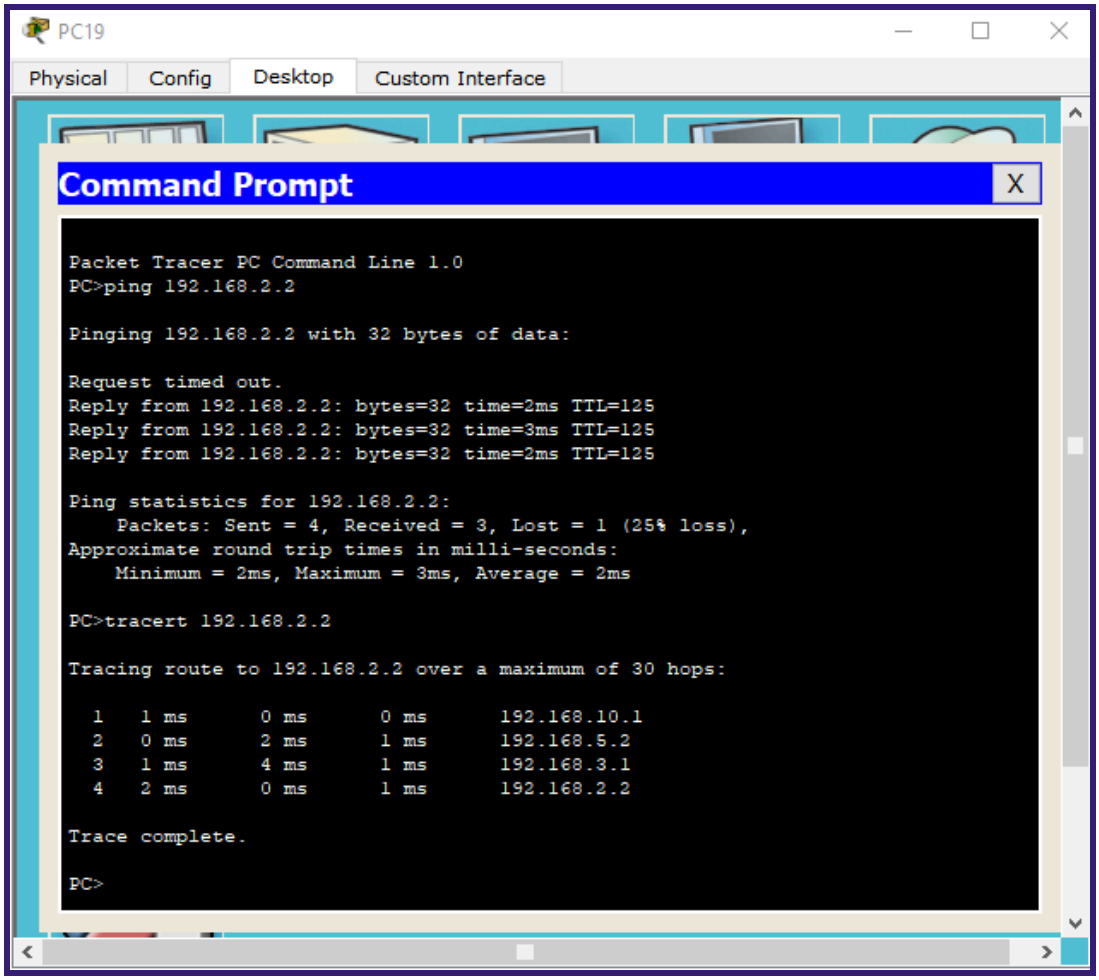


Fig 13: Pinging NAT_Server IP (192.168.2.2) on a PC

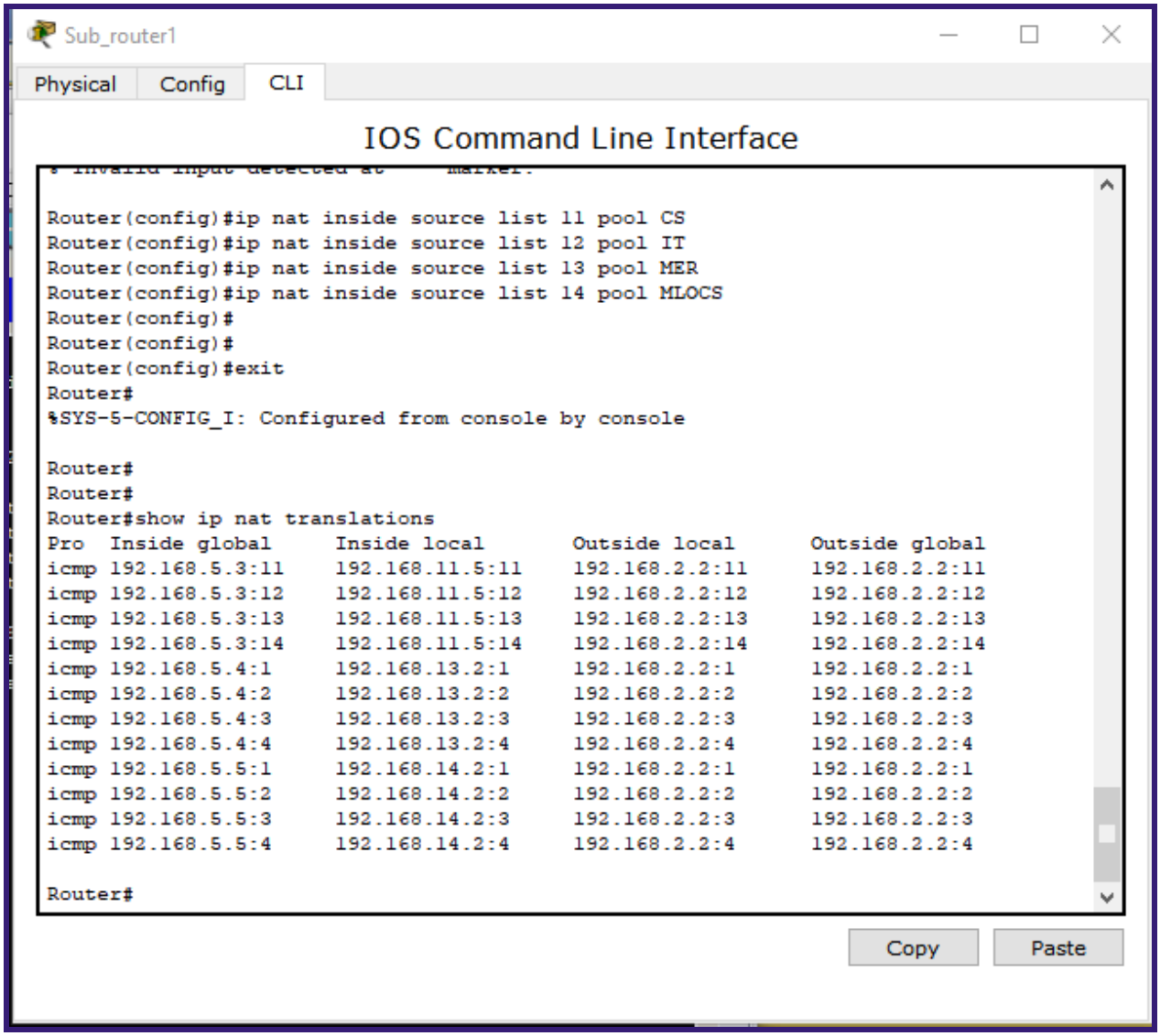


Fig 14: NAT Results seen through a CLI

Challenges and Learnings:

During this project, we encountered several challenges and learned valuable lessons. One of the main difficulties was setting up Network Address Translation (NAT). Ensuring seamless external access while maintaining internal network security was intricate. Debugging and testing the NAT rules to avoid service disruptions required meticulous attention.

Another challenge was configuring Virtual Local Area Networks (VLANs) on a complex topology. This involved segmenting the network into different VLANs, ensuring proper communication between them, and avoiding broadcast storms. Making sure that all devices were correctly assigned to their respective VLANs and managing inter-VLAN routing presented unique challenges.

From these experiences, we gained a deeper understanding of NAT. The process underscored the importance of thorough testing and validation to ensure network services function correctly. Setting up VLANs highlighted best practices in network segmentation and traffic management, emphasizing the need for clear planning and documentation to avoid misconfigurations. This project also taught us the importance of using VLANs to enhance network performance and security.

Both the NAT and VLAN configurations significantly improved our problem-solving and troubleshooting skills. Encountering and resolving unexpected issues sharpened our ability to diagnose and fix network-related problems efficiently. Additionally, effective collaboration and comprehensive documentation throughout the project were crucial. They ensured that the team was aligned and that any future modifications or troubleshooting could be handled smoothly.

These challenges and learnings not only improved our technical skills but also enhanced our overall approach to managing and implementing complex network topologies.

Conclusion:

The project successfully designed a secure and efficient network for the hospital using Cisco Packet Tracer. By integrating VLAN, ACL, NAT, and DHCP technologies, the network now ensures enhanced security, efficient IP management, optimized traffic, and seamless external access. To maintain and improve this network, it is recommended to regularly update network configurations for scalability, continuously monitor and update security policies, use performance monitoring tools to identify and resolve issues, and provide ongoing training for IT staff on network management. These steps will help the hospital maintain a reliable, secure, and scalable network infrastructure that supports its operational needs and future growth.