East West University

Computer Networks

Course Code: CSE 405

Project Title: Design a full-fledged network for an organization with multiple subnets.

Prepared By

Name: **Nishat Vasker**

Id: 2020-2-60-209

Department Of Computer Science and Engineering

East West University

Submitted to

Dr. Anisur Rahman

Assistant Professor, Proctor

Department of Computer Science and Engineering.

East West University

Context:

A plethora of computers form the backbone of a complex network infrastructure in the backdrop of an institution similar to East West University, known as the University of Scholars. This infrastructure not only provides wired internet connectivity to classrooms, labs, staff workstations, the library, and both administrative and academic departments, but it also provides ubiquitous wireless internet access across campus. Furthermore, the institution manages a sophisticated networked system that supports a wide range of vital functions, such as admissions, academic counseling, results management, eTender procedures, library administration, and financial account management.

Content and Features:

Computer Networks encompass multiple interconnected computer systems and hardware devices designed for information sharing. To establish these connections, typical components such as routers, switches, and hubs are commonly utilized.

In the context of this specific project, I have orchestrated an extensive network setup for the University of Scholars, which is comparable to East West University. This network consists of seven distinct routers, each representing a different campus. Additionally, I have integrated 2960 switches to facilitate computer connections, and for wireless accessibility, I have opted for the WRT300N router. For IP address management, a single DHCP server is connected to a switch under Campus 1, configured to handle IP assignments across classes A, B, and C for the PCs. This server is further equipped with a DNS server and a WEB server. I've configured the DNS server to resolve the university's URL, "http://www.scholars.edu.bd," allowing users to access the university's website.

Utilized Tools and Components:

- Cisco Packet Tracer
- DHCP Server
- DNS Server
- WEB Server
- Generic End Devices (for PCs)
- Routers (PT Router)
- WRT300N (Wireless device)
- Switch (2960)
- Laptop
- Wireless Smartphone
- Wireless End Device
- Connectors (Serial DCE with clock, Copper Straight Through)

Complete Diagram:

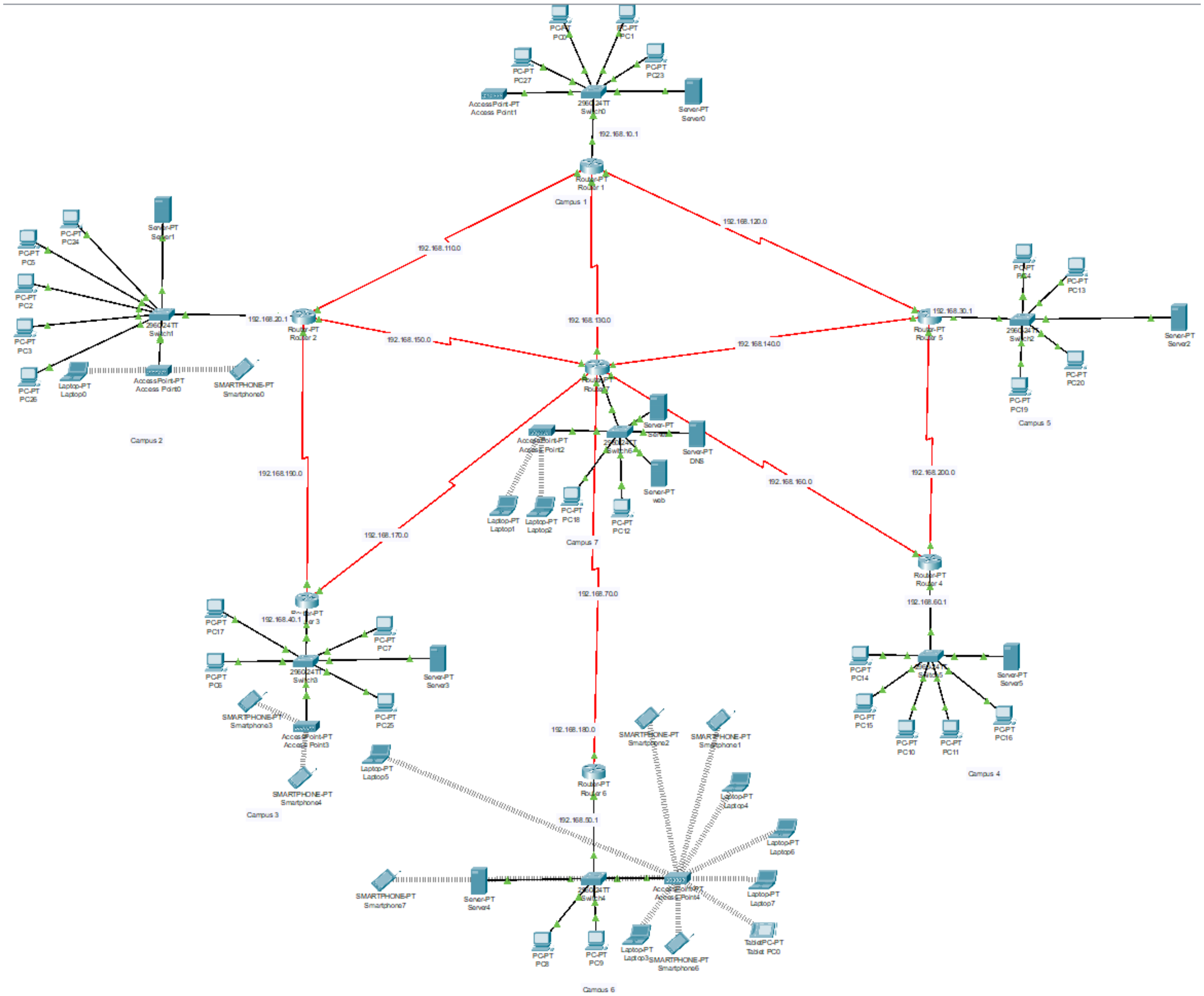


Figure 1: Logical View

Physical View:

Figure 2: Physical View

Interfaces and Diagram of Campus Routers:

Router 1 (Campus 1): Router 1, designated as Campus 1, plays a crucial role in managing the network infrastructure. Within Campus 1, we have established a ServerRoom and a monitoring PC. In this configuration, Campus 1 has been assigned an IP address from the A-Class network, specifically, 192.168.10.1 with a subnet mask of 255.255.255.0. Additionally, Router 1 handles various other networks, including 192.168.130.0, 192.168.110.0, and 192.168.120.0, all within the area 1 of the network.

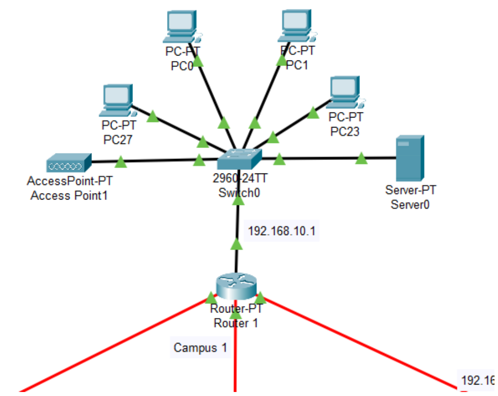


Figure 3: Router 01

Router 2 (Campus 2): Router 2, designated as Campus 2, plays a pivotal role in the network architecture. Within Campus 2, we have set up the necessary components. Campus 2 has been allocated an IP address of 192.168.20.1 with a subnet mask of 255.255.255.0. This router also oversees networks such as 192.168.150.0, 192.168.110.0, and 192.168.190.0, all within area 1.

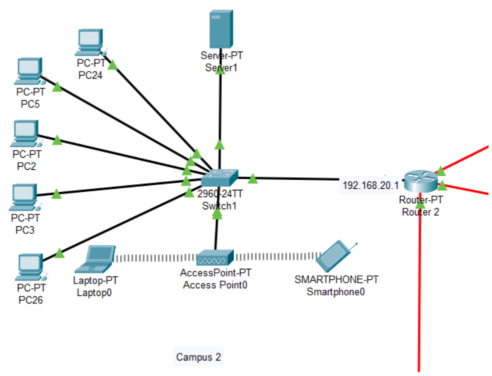


Figure 4: Router 02

Router 3 (Campus 3): Router 3, representing Campus 3, is a fundamental part of the network infrastructure. Within Campus 3, an IP address of 192.168.40.1 with a subnet mask of 255.255.255.0 has been assigned. This router also manages networks including 192.168.190.2, 192.168.170.1, and 192.168.190.2, all within area 1.

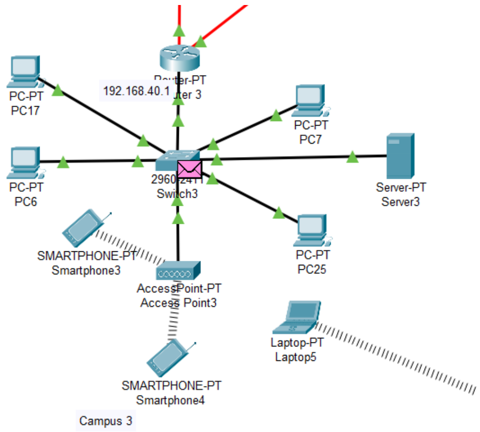


Figure 5: Router 03

Router 4 (Campus 4): Router 4, serving as Campus 4, is integral to the network architecture. Within Campus 4, an IP address of 192.168.60.1 with a subnet mask of 255.255.255.0 has been configured. This router is responsible for networks such as 192.168.200.2, 192.168.160.2, and 192.168.200.1, all within area 1.

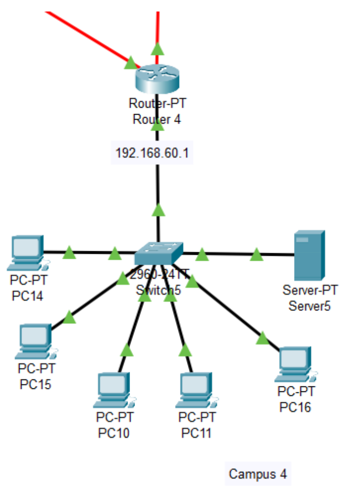


Figure 6: Router 04

Router 5 (Campus 5): Router 5, representing Campus 5, is a vital component of our network setup. Campus 5 has been assigned the IP address 192.168.30.1 with a subnet mask of 255.255.255.0. Router 5 also oversees networks like 192.168.120.2, 192.168.140.1, and 192.168.200.1, all within area 1.

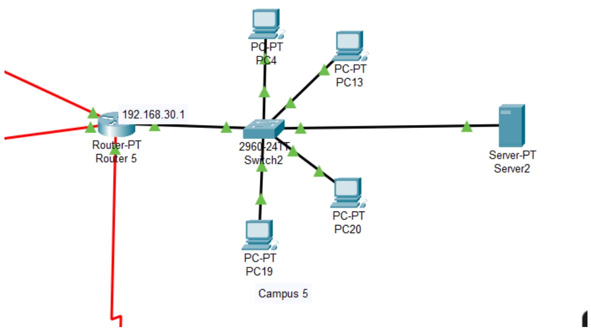


Figure 7:Router 05

Router 6 (Campus 6): Router 6, designated for Campus 6, plays a critical role in our network infrastructure. Campus 6 has been configured with an IP address of 192.168.50.1 and a subnet mask of 255.255.255.0. Additionally, Router 6 is responsible for networks within area 1.

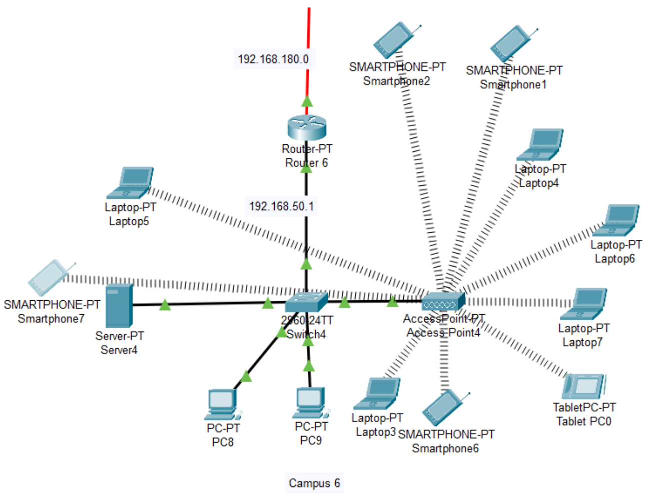


Figure 8: Router 06

Router 7 (Campus 7): Router 7, serving Campus 7, is a pivotal element in our network architecture. Campus 7 has been allocated the IP address 192.168.70.1 with a subnet mask of 255.255.255.0. This router also manages various other networks within area 1, ensuring seamless connectivity and data exchange.

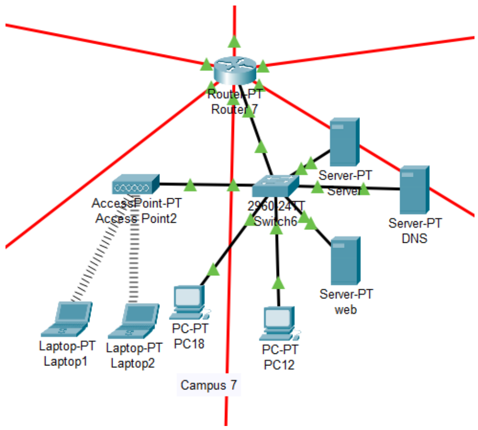


Figure 9: Router 07

Sequence:

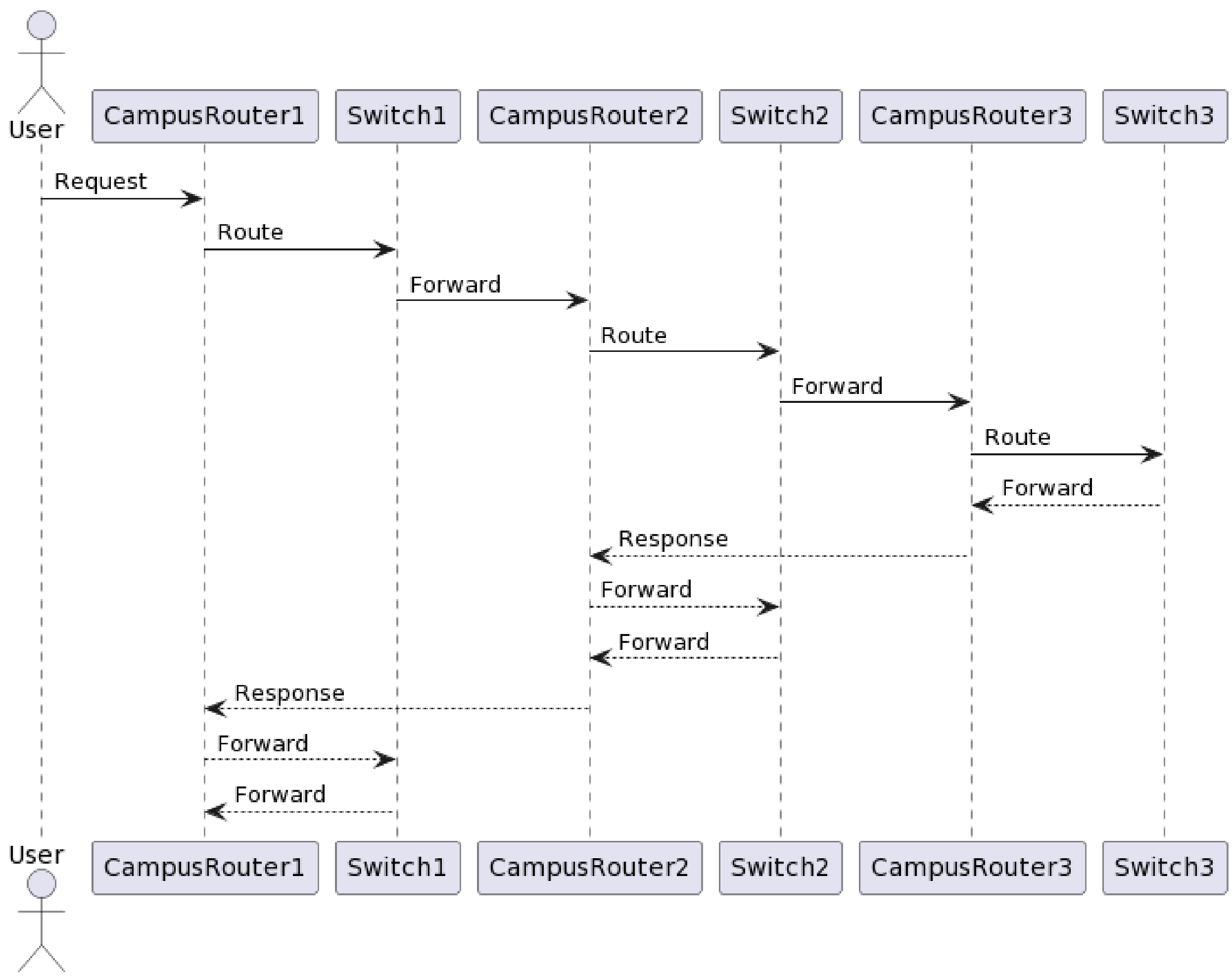


Figure 10: Sequence visualization with diagram

In Sequence Diagrams, we can apply mathematical concepts to analyze network latency and performance. We use metrics such as round-trip time (RTT), which represents the time taken for a message to travel from the sender to the receiver and back. By measuring RTT for specific message exchanges, we can calculate average latency and assess network responsiveness using the formula:

Average Latency (ms)=∑RTT measurementsNumber of measurementsAverage Latency (ms)=Number of measurements∑RTT measurements

Analyzing the variance in RTT measurements can also help us identify network jitter and assess its impact on real-time applications.

Router Activity:

Router configurations often involve specifying IP addresses and subnet masks. We can use CIDR (Classless Inter-Domain Routing) notation and subnetting mathematics to calculate the number of available subnets and hosts within each subnet.

For example, given an IP address range with a subnet mask, we can determine the number of subnets $(2^n)$and the number of hosts per subnet $(2^{32-n} - 2$, where *n* is the subnet mask length). This mathematical approach allows us to efficiently allocate IP addresses to subnets and optimize address utilization.

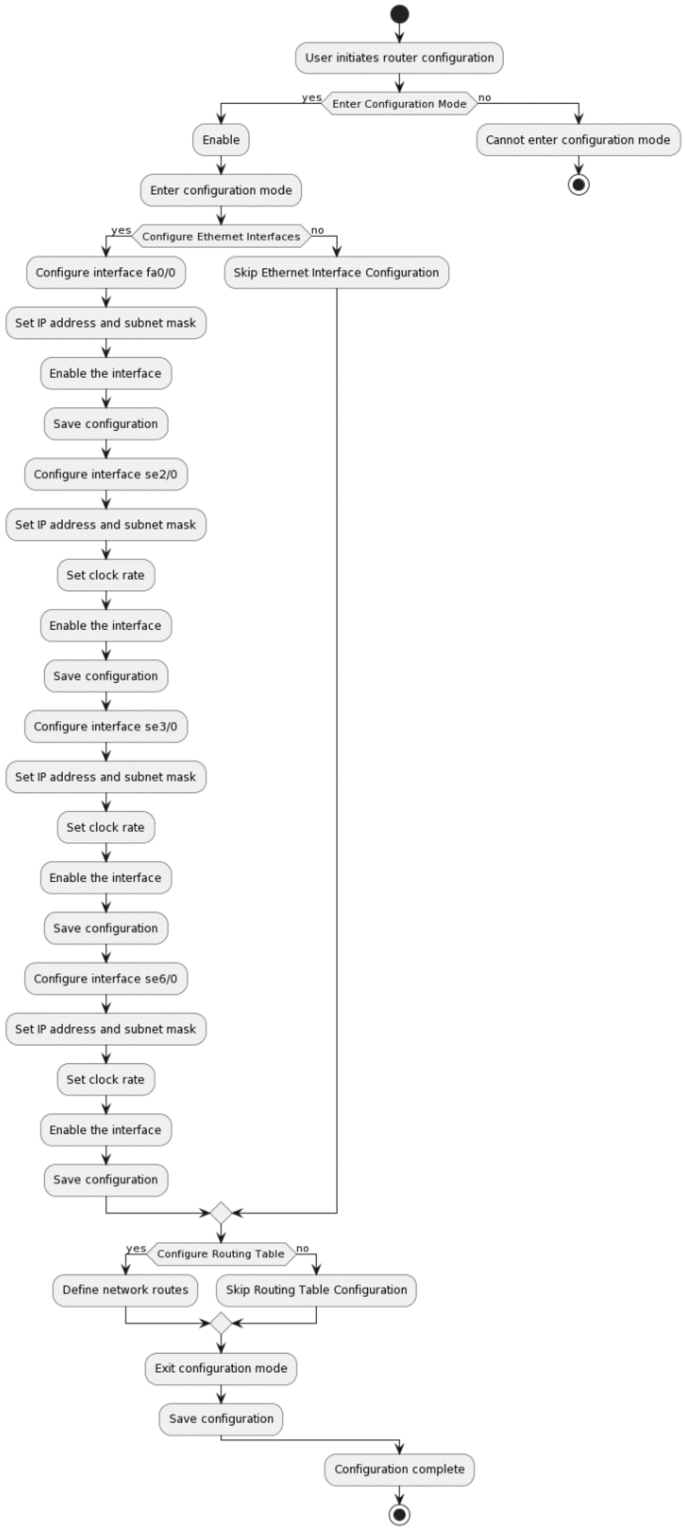


Figure 11: Router Configuration

Routing Table Diagram:

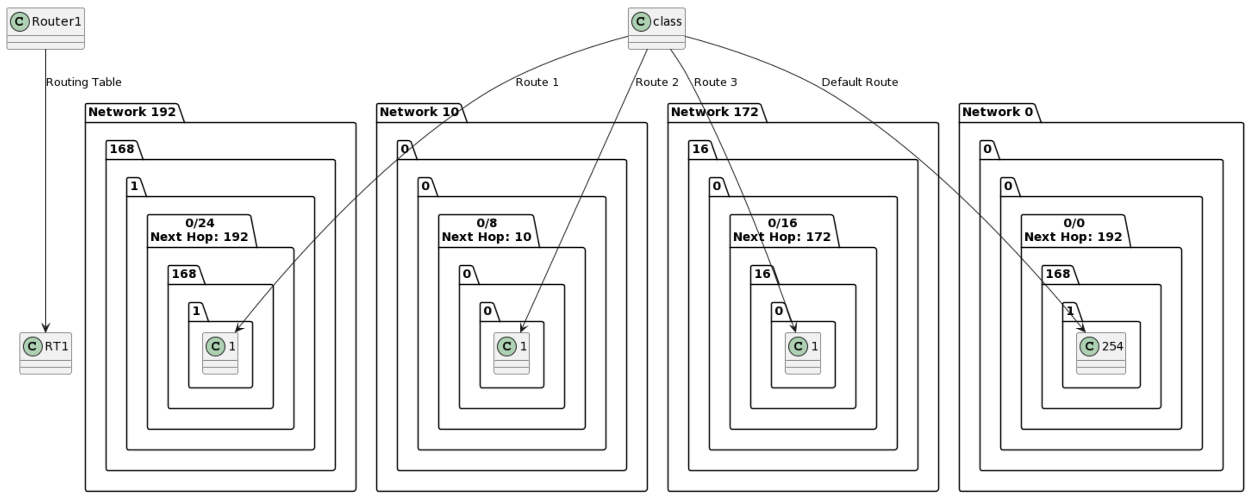


Figure 12: Routing Table Diagram

Routing tables involve the application of routing algorithms, such as the Shortest Path First (SPF) algorithm in OSPF (Open Shortest Path First) routing. We can use graph theory and Dijkstra's algorithm to calculate the shortest path between routers and assess the efficiency of routing decisions.

Mathematically, Dijkstra's algorithm calculates the shortest path cost $(D(v))$from a source router to all other routers in the network. It uses the formula:

$$D(v) = \min(D(u) + c(u, v))$$

Where *u* and *v* are routers, *c*(*u*,*v*) is the cost of the link between *u* and *v*, and *D*(*v*) is the cost to reach router *v*.

Subnetting Diagram:

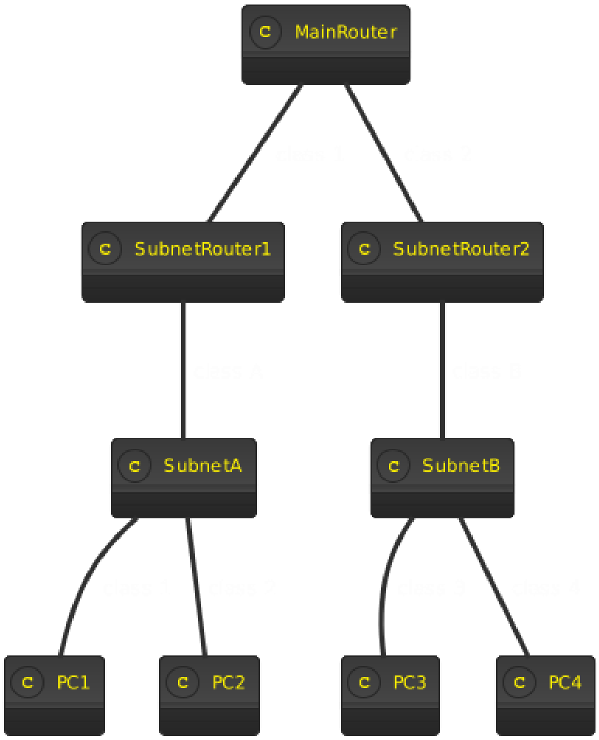


Figure 13: Subnetting Diagram

Subnetting involves dividing IP address ranges into smaller subnets. We can use subnetting math to calculate the number of subnets and hosts within each subnet. The number of subnets is 2^n (where *n* is the number of subnet bits), and the number of hosts per subnet is $2^{32-n}-2$.

For example, if we allocate 3 bits for subnetting, we get $2^3=8$ subnets with 2^{32-3}−2=254 hosts per subnet. This mathematical approach ensures efficient IP address allocation and subnet design.

Interfaces:

Campus 1

enable

config t

interface fa0/0

ip address 192.168.10.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.110.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.130.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se6/0

ip address 192.168.120.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 2

enable

config t

interface fa0/0

ip address 192.168.20.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.110.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.150.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se6/0

ip address 192.168.190.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 3

enable

config t

interface fa0/0

ip address 192.168.40.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.170.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.190.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 4

enable

config t

interface fa0/0

ip address 192.168.60.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.200.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.160.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 5

enable

config t

interface fa0/0

ip address 192.168.30.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.120.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.140.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se6/0

ip address 192.168.200.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 6

enable

config t

interface fa0/0

ip address 192.168.50.1 255.255.255.0

no shut

do wr

exit

interface se3/0

ip address 192.168.180.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

Campus 7

enable

config t

interface fa0/0

ip address 192.168.70.1 255.255.255.0

no shut

do wr

exit

interface se2/0

ip address 192.168.150.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se3/0

ip address 192.168.130.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se6/0

ip address 192.168.140.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se7/0

ip address 192.168.170.2 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se9/0

ip address 192.168.180.1 255.255.255.0

clock rate 64000

no shut

do wr

exit

interface se8/0

ip address 192.168.160.1 255.255.255.0

clock rate 64000

no shut

do wr

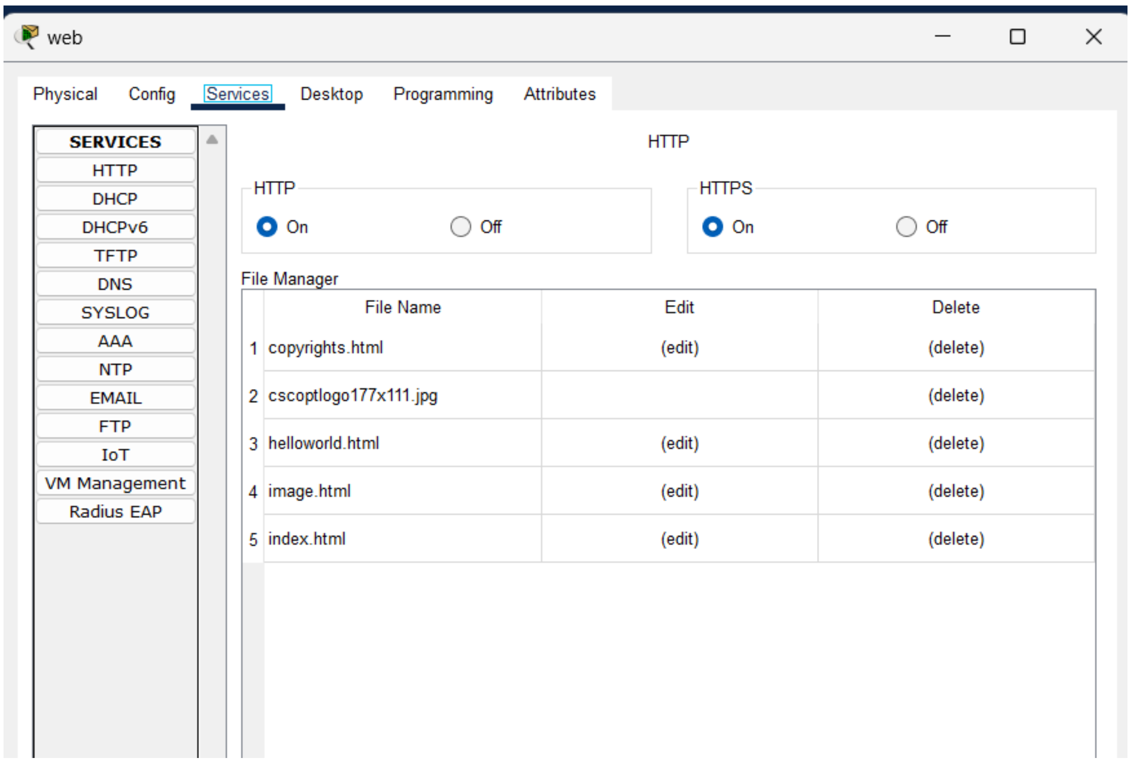
exit

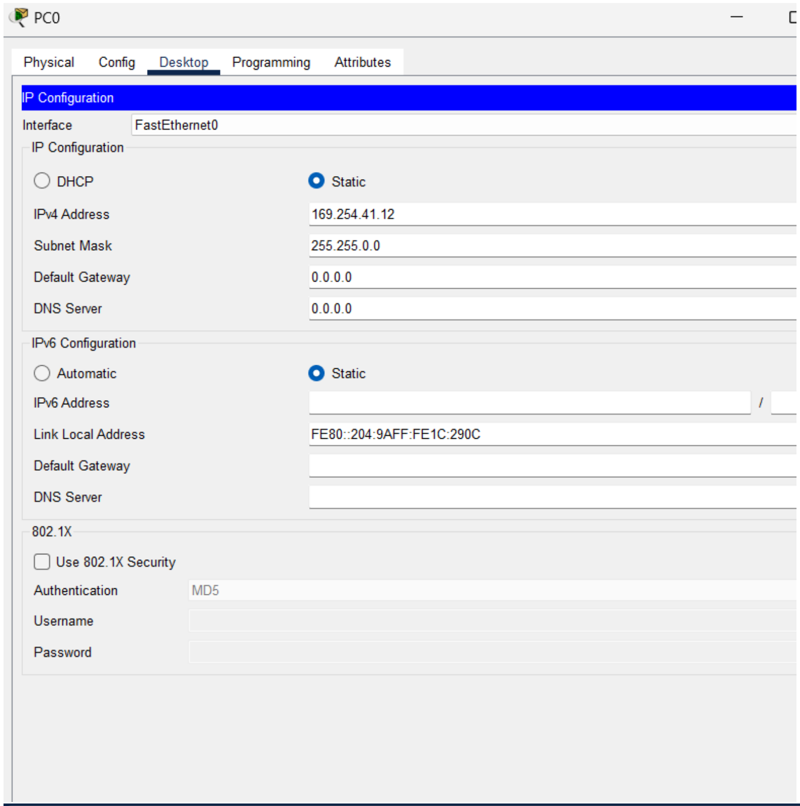
Routing Table:

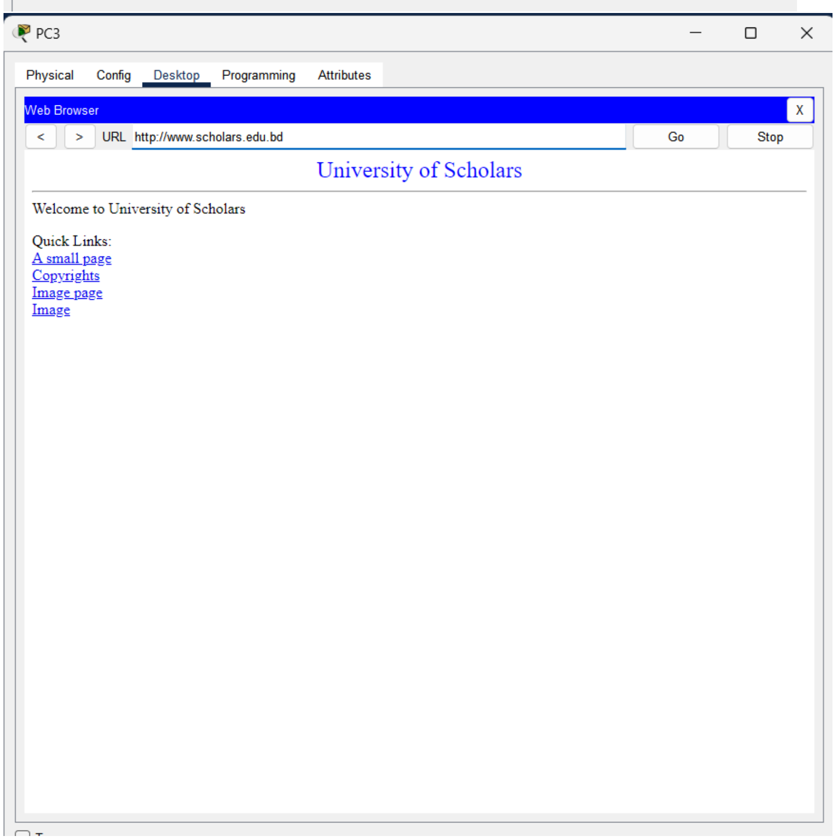
Router	Network	Area
Router 1	192.168.130.0/24	1
	192.168.10.0/24	1
	192.168.110.0/24	1
	192.168.120.0/24	1
Router 2	192.168.150.0/24	1
	192.168.20.0/24	1
	192.168.110.0/24	1
	192.168.190.0/24	1
Router 3	192.168.190.0/24	1
	192.168.40.0/24	1
	192.168.170.0/24	1
Router 4	192.168.160.0/24	1
	192.168.60.0/24	1
	192.168.200.0/24	1
Router 5	192.168.120.0/24	1
	192.168.30.0/24	1
	192.168.140.0/24	1
	192.168.200.0/24	1
Router 6	192.168.180.0/24	1
	192.168.50.0/24	1
Router 7	192.168.130.0/24	1
	192.168.70.0/24	1
	192.168.140.0/24	1

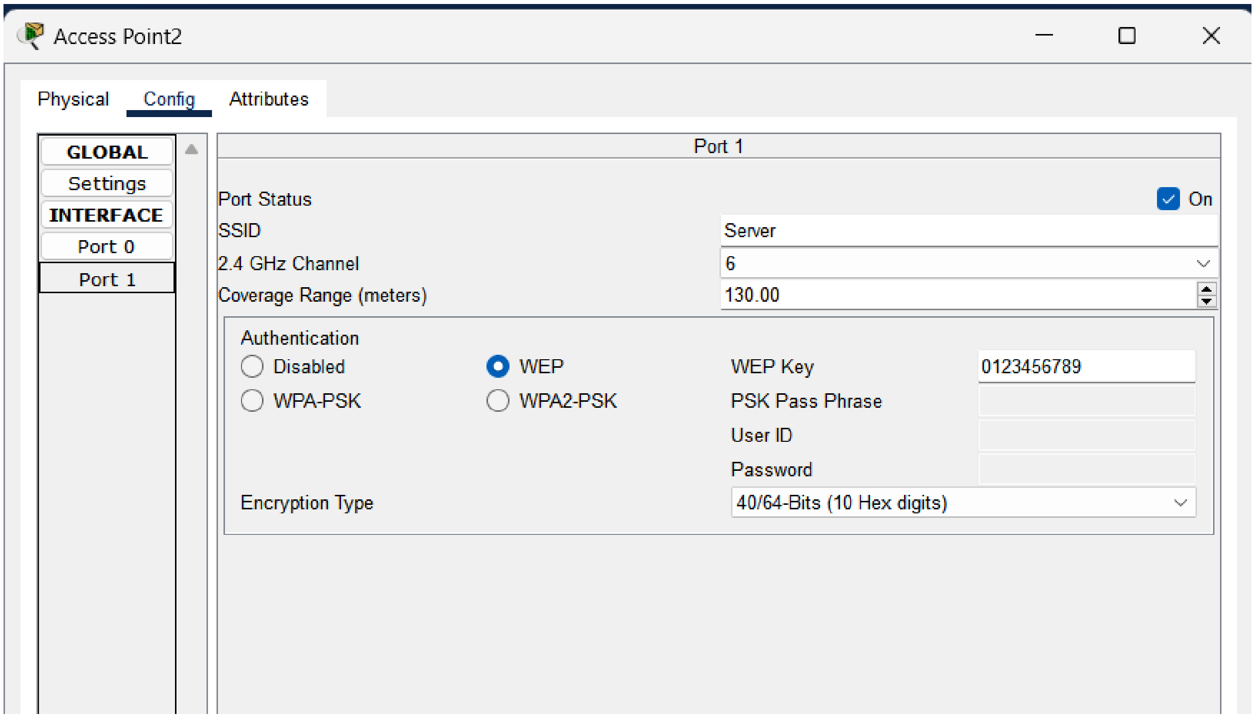
Router	Network	Area
	192.168.160.0/24	1
	192.168.180.0/24	1
	192.168.170.0/24	1
	192.168.150.0/24	1

Setup:




PC0
Physical
Config
Desktop
Programming
Attributes
IP Configuration
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
169.254.41.12
Subnet Mask
255.255.0.0
Default Gateway
0.0.0.0
DNS Server
0.0.0.0
IPv6 Configuration
Automatic
Static
IPv6 Address
Link Local Address
FE80::204:9AFF:FE1C:290C
Default Gateway
DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Username
Password


PC3
Physical
Config
Desktop
Programming
Attributes
Web Browser
X
URL
http://www.scholars.edu.bd
Go
Stop
University of Scholars
Welcome to University of Scholars
Quick Links:
A small page
Copyrights
Image page
Image



Future Work:

As our network infrastructure continues to evolve, there are several areas of potential future work and improvement that we can consider:

1. **Network Monitoring Enhancements:** Implement advanced network monitoring tools and solutions to gain deeper insights into network performance, security, and traffic patterns. This includes the integration of AI-based anomaly detection and predictive analytics for proactive issue resolution.

2. **Security Enhancements:** Strengthen network security by implementing next-generation firewalls, intrusion detection and prevention systems, and regular security audits. Explore the adoption of zero-trust network access (ZTNA) principles to enhance security posture.

3. **Scalability and Redundancy:** Plan for network scalability by adding redundant links and devices to ensure high availability. Evaluate the potential for network expansion to accommodate the growing needs of our institution.

4. **IPv6 Transition:** Prepare for the gradual transition to IPv6 to address the growing scarcity of IPv4 addresses. Develop an IPv6 migration plan to ensure seamless coexistence of both protocols during the transition phase.

5. **Automation and Orchestration:** Invest in network automation and orchestration solutions to streamline routine network management tasks, such as provisioning and configuration changes. This will improve operational efficiency and reduce human error.

6. **Disaster Recovery Planning:** Develop a comprehensive disaster recovery and business continuity plan to ensure network resilience in the face of unexpected events. Regularly test and update the plan to adapt to changing circumstances.
7. **Training and Skill Development:** Invest in continuous training and skill development for network administrators and IT staff to keep them updated with the latest networking technologies and best practices.
8. **Green Networking:** Explore energy-efficient networking technologies and practices to reduce the environmental impact of our network infrastructure. This includes optimizing power usage and adopting eco-friendly hardware where possible.

Conclusion:

In conclusion, our network infrastructure, as depicted in this documentation, forms the backbone of our educational institution, University of Scholars. Through meticulous planning and configuration, we have established a robust and efficient network that caters to the diverse needs of students, faculty, and administrative staff.

Our network design incorporates multiple campuses, each with its set of routers, switches, and subnets, ensuring seamless connectivity and access to digital resources. The use of advanced routing protocols, subnetting strategies, and network management tools underscores our commitment to providing a reliable and high-performance network environment.

While we have achieved a strong foundation, we acknowledge that the world of networking is dynamic and ever-evolving. Therefore, we remain dedicated to continuous improvement and readiness for future challenges. The outlined future work highlights our commitment to staying at the forefront of networking technologies, security, and scalability.

In conclusion, our network infrastructure is not just a technical asset but a strategic enabler of academic excellence and administrative efficiency at University of Scholars. We look forward to an exciting future of innovation and growth in the realm of networking to better serve our academic community.