DATA COMMUNICATION & NETWORKING

Sir Syed Block, Bahria University

Network Design

Submitted by:

Muhammad Aadil Masaud (01-134231-042)

Muhammad Hassam Cheema (01-134231-056)

Submitted to:

Dr. Moazam Ali

Computer Science Department, Bahria University, Islamabad

Table of Contents

Introduction

Design and implementation of a network infrastructure for Sir Syed Block, encompassing multiple offices, labs, and departments. The project aims to ensure connectivity, resource sharing, and centralized management using routers, switches, and end devices. This project focuses on creating a network capable of supporting multiple departments, allowing file sharing, printer access, and centralized management.

The primary objectives include:

- Seamless communication across all areas.
- Scalable infrastructure for future expansion.
- Secure access to network resources and servers.

Software Used

Cisco Packet Tracer as the design and simulation tool. It is a beginner-friendly network simulator that allows students to easily design and test network configurations. With its user-friendly interface, it supports the setup of network topologies, making it ideal for learning core concepts in Data Communication and Networking.

Advantages of Cisco Packet Tracer:

- **User-Friendly and Beginner-Friendly:** Easy to learn and use, making it ideal for students.
- **Supports Cisco Devices:** Allows simulation of Cisco routers, switches, and firewalls.
- **Real-Time and Simulation Modes:** Offers real-time feedback on network behavior, aiding in troubleshooting and analysis.
- **Free for Educational Use:** Available at no cost to students, making it affordable.

Topologies

1. Mesh Topology:

Line Configuration: Point to Point, each link between switches and devices is a direct, dedicated connection.

Description: Each switch is connected to every other switch, creating a fully interconnected network.

Advantages: Provides high redundancy, if one link fails, data can travel through alternate paths

Disadvantages: High cost and complexity due to numerous connections.

2. Ring Topology:

Line Configuration: Point to Point, each switch is directly connected to its neighboring switches in a unidirectional or bidirectional ring.

Description: Switches are connected in a circular manner. Data travels in one direction around the ring.

Advantages: Simple and inexpensive to implement.

Disadvantages: Failure of a single link or device disrupts the entire network.

3. Star Topology:

Line Configuration: Point to Point, each device (PC) has a dedicated connection to the central switch.

Description: All PCs are connected to a central switch. Communication happens through this central point.

Advantages: Easy to manage and troubleshoot, a failure in one link doesn't affect others.

Disadvantages: Failure of the central switch brings down the entire network.

4. Bus Topology:

Line Configuration: Multipoint, all devices share the same backbone (represented by interconnected switches), so the communication is shared among multiple points.

Description: Devices are connected to a single central backbone link (replicated using switches here).

Advantages: Cost-effective for small networks.

Disadvantages: Backbone failure disrupts the entire network, performance decreases as devices increase.

Network Design Overview

The network is designed using a hybrid topology, combining star and partial mesh structures for efficiency and scalability. Each department is allocated a unique subnet to simplify traffic management and reduce potential network conflicts. Routers enable inter communication, while switches handle local device connections within departments. Centralized servers in the Server Room provide critical services like DNS resolution, FTP, and web hosting, accessible to all departments.

This design ensures seamless communication, efficient resource utilization, and ease of future expansion. The use of structured IP addressing and robust device configurations enhances the network's reliability and security.

IP Addressing Scheme

A structured IP addressing scheme was implemented to ensure efficient communication and avoid IP conflicts. Each department was assigned a unique subnet.

First Floor (192.168.1.0)	
Office 1	192.168.1.2
Office 2	192.168.1.3
Office 3	192.168.1.4
Office 4	192.168.1.5
Office 5	192.168.1.6
Printer	192.168.1.7

OC Labs (192.168.2.0)	
Lab Admin	192.168.2.2
OC LAB 1	192.168.2.3
OC LAB 2	192.168.2.4
OC LAB 3	192.168.2.5
OC LAB 4	192.168.2.6
Printer 7	192.168.2.7

Advisor Office (192.168.3.0)	
OFFICE	192.168.3.2
Printer 2	192.168.3.6
Office PC	192.168.3.3
Printer 3	192.168.3.7
Office PC 1	192.168.3.4
Office PC 2	192.168.3.5
Printer 4	192.168.3.8

HOD Office (128.168.0.0)	
PC2	128.168.0.2
PC3	128.168.0.3
PC4	128.168.0.4
PC5	128.168.0.5
Printer 5	128.168.0.6

SERVER ROOM (1.0.0.0)	
FTP SERVER	1.0.0.4
PC1	1.0.0.5
DNS SERVER	1.0.0.2
WEB SERVER	1.0.0.3

Security Room (192.168.4.0)	
PC 0	192.168.4.2
LAPTOP 0	192.168.4.3

Protocols Used

The network employs several essential protocols to ensure efficient communication, proper routing, and network stability. The following protocols were utilized:

- **STP (Spanning Tree Protocol):**
  Used for routers to switches and switches to end devices to prevent loops in the network. STP ensures a stable topology by blocking redundant paths and avoiding broadcast storms, which are critical for maintaining smooth and reliable data flow.
- **RIPv1 (Routing Information Protocol Version 1):**
  Applied for router-to-router communication, RIPv1 facilitates dynamic routing by sharing routing tables between routers. It ensures efficient packet delivery across subnets by determining the best route using hop count as a metric. Although simple, it is effective for this network's size and structure.
- **IP (Internet Protocol):**
  Serves as the backbone of the network, responsible for addressing and routing data packets. It enables communication across subnets using the assigned IP addresses.
- **TCP (Transmission Control Protocol):**
  Ensures reliable data transmission by verifying packet delivery and maintaining proper sequencing. This is vital for file transfers, web hosting, and other critical services.

- **DNS (Domain Name System):**
  Facilitates the resolution of domain names to IP addresses, enabling user-friendly access to centralized servers like the web and FTP servers.
- **FTP (File Transfer Protocol):**
  Used for file sharing between departments. It allows efficient uploading and downloading of resources from the FTP server.
- **ICMP (Internet Control Message Protocol):**
  Used for testing and troubleshooting connectivity through tools like ping and traceroute. ICMP ensures that devices can communicate effectively across the network.

Why These Protocols Are Used:
The combination of STP and RIPv1 provides a stable and functional network topology. STP prevents network loops and maintains smooth communication between connected devices. RIPv1 simplifies routing configuration and ensures inter-router communication, making it suitable for this network's scale. Application-layer protocols like DNS and FTP support centralized resource access, while TCP and ICMP provide reliability and troubleshooting capabilities.

Departmental Design

The network design is structured to meet the specific requirements of each department while ensuring overall connectivity and efficiency.

- **HOD Office:**
  Includes five PCs and a shared printer, all connected through a switch. Subnet 128.168.0.0/24 ensures efficient management of traffic within the department.
- **OC Labs:**
  Contains PCs for students and lab administrators, along with a shared printer. Devices are connected to Switch1 under the 192.168.2.0/24 subnet, ensuring seamless communication for academic tasks.
- **Server Room:**
  Hosts critical services such as DNS, FTP, and web servers, connected under subnet 1.0.0.0/24. This centralizes resource sharing and simplifies management.
- **Advisor Office:**
  Equipped with four PCs and a printer, connected under the 192.168.3.0/24 subnet to support academic and administrative activities.
- **First Floor and Security Room:**
  First Floor houses office PCs and printers, connected under the 192.168.1.0/24 subnet, while the Security Room uses subnet 192.168.4.0/24 for monitoring systems and related devices.

Testing

Comprehensive testing was conducted to ensure the network operates as intended.

- **Ping Tests:**
  Devices within the same subnet and across subnets were tested for connectivity using ping commands. For example, a ping from the HOD Office PC to the DNS Server in the Server Room was successful, confirming inter-subnet communication.

These results validated the robustness and reliability of the network configuration.

Future Improvements

Although the network is fully functional, there are opportunities for enhancement:

- **Enhanced Security:**
  Implementing firewalls and VLANs to segregate traffic and protect sensitive resources.
- **Wireless Connectivity:**
  Adding wireless access points to extend connectivity for mobile devices and improve flexibility.
- **Protocol Upgrades:**
  Switching to advanced protocols like RIPv2 or OSPF for better routing efficiency and scalability.
- **Performance Monitoring:**
  Using advanced tools to monitor network performance and ensure smooth operation under heavy loads.

Conclusion

The project successfully achieved its goal of creating a reliable and scalable network for Sir Syed Block. Through careful design and protocol implementation, the network provides seamless connectivity, centralized resource sharing, and efficient inter-departmental communication. Testing confirmed the robustness of the configuration, and proposed improvements ensure future growth and adaptability.

GitHub Repository

https://github.com/hassam-cheemaa/SirSyedBlockNetworkDesign.git

Visual Representation

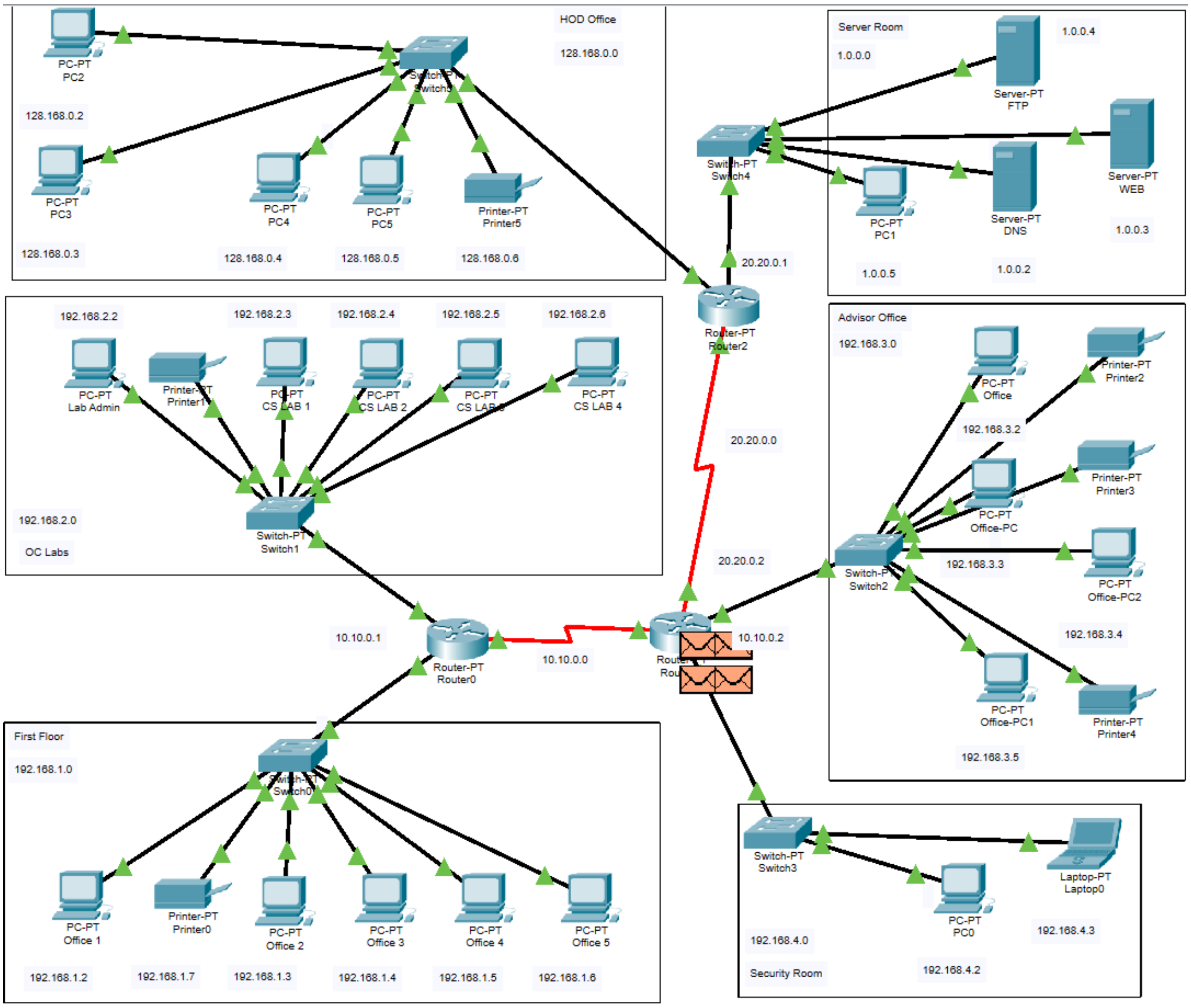
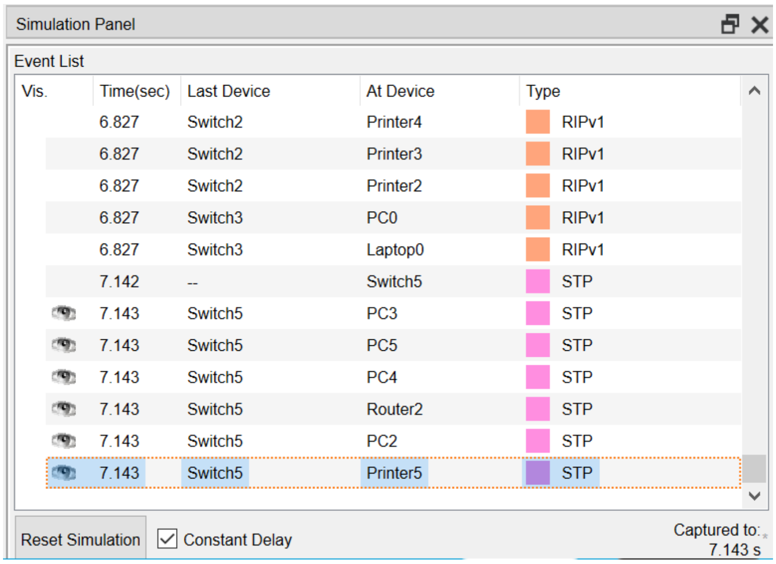


Figure 1: Network Design



Simulation Panel

Event List

Vis.	Time(sec)	Last Device	At Device	Type
	6.827	Switch2	Printer4	RIPv1
	6.827	Switch2	Printer3	RIPv1
	6.827	Switch2	Printer2	RIPv1
	6.827	Switch3	PC0	RIPv1
	6.827	Switch3	Laptop0	RIPv1
	7.142	--	Switch5	STP
	7.143	Switch5	PC3	STP
	7.143	Switch5	PC5	STP
	7.143	Switch5	PC4	STP
	7.143	Switch5	Router2	STP
	7.143	Switch5	PC2	STP
	7.143	Switch5	Printer5	STP

Reset Simulation | Constant Delay | Captured to: 7.143 s

Figure 2: Packet Sniffing