Computer Networks Lab

Mini Project Report

Title: **Create an educational institute office n/w of 5 departments. Each department has 500 PCs. The company has an independent DHCP server. DNS service is provided by other service providers. The company has its website address e.g. www.edutechcompany.com**

Contents

1. Introduction:

In the digital age, the infrastructure of an educational institution is pivotal to its operational efficiency, learning experience, and overall success. This report outlines the design and implementation of a robust computer network for an educational institute with five distinct departments. Each department. Establishing a strong, scalable, and secure network infrastructure is the main goal of this project to facilitate effective communication, resource sharing, and easy access to essential educational resources.

2. Problem Statement:

The specific problem addressed in this mini-project is the design and implementation of a computer network infrastructure for an educational institute office consisting of five departments, each equipped with 500 PCs. The project involves setting up a network that can efficiently cater to the needs of the institute, ensuring seamless communication and resource sharing among departments while considering factors like scalability, reliability, and security.

Efficient network infrastructure is crucial for organizational functioning, especially in educational institutes. This project is significant for computer networks as it ensures effective communication, scalability to accommodate growth, reliability to minimize downtime, and security to protect sensitive data. By optimizing these aspects, the network enhances operational efficiency, fosters seamless collaboration, and provides a secure learning and working environment.

3. Objectives:

The primary objectives of this project are:

1. Network Design: To guarantee the best possible traffic flow and device connection, a hierarchical network architecture utilizing core, distribution, and access layer switches will be put into place.

2. DHCP Server Implementation: To simplify network administration, a specialized DHCP server will be set up to automatically assign IP addresses to all institute PCs.

3. DNS Service Integration: To deliver effective domain name resolution (DNS) services, the network will be set up to take advantage of an outside service provider.

4. Website Accessibility: Ensure proper internet connectivity and accessibility of the institute's website.

4. Theoretical Background

1. Computer Networks:

A computer network is a collection of interconnected computing devices that can communicate and share resources. These devices can be physically connected using cables or wirelessly. Networks enable functionalities like:

- Sharing resources such as files, printers, and internet access.
- Facilitating communication and collaboration between users.
- Centralized storage and management of data.
- Remote access to applications and resources.

Networks are categorized based on their:

- **Size:**

1. Local Area Network (LAN): Covers a limited geographical area, typically a building or campus (e.g., the educational institute's network).

2. Wide Area Network (WAN): Spans a large geographical area, connecting networks across cities, states, or even continents (e.g., the internet).

3. Metropolitan Area Network (MAN): Covers a larger area than a LAN but smaller than a WAN, often connecting LANs within a city or town.

- **Purpose:**

1. Client-Server Network: Centralized server(s) provide resources and services to client devices (e.g., the institute's file server).

2. Peer-to-Peer Network: Devices share resources directly with each other without a dedicated server (less common in large-scale networks).

2. Dynamic Host Configuration Protocol (DHCP):

DHCP is a network protocol that automates the process of assigning IP addresses and other network configuration settings to devices on a network. This eliminates the need for manual configuration of each device, saving time and reducing errors in a large network like the educational institute's.

DHCP operates on a client-server model:

- **DHCP Server:** A dedicated server on the network that maintains a pool of available IP addresses and other configuration parameters.
- **DHCP Client:** Any device on the network that requests an IP address and configuration settings from the DHCP server.

The DHCP process typically involves four stages:

1. **Discovery:** The client broadcasts a message seeking a DHCP server.
2. **Offer:** The DHCP server responds with an offer for an IP address and other configuration options.

3. **Request:** The client sends a request message to accept the offered configuration.
4. **Acknowledgement (ACK):** The DHCP server acknowledges the client's request and confirms the assigned IP address and settings.

DHCP leases provide temporary assignments of IP addresses to clients. Leases have a defined duration, after which the client must renew the lease or obtain a new IP address. This dynamic allocation allows for efficient management of IP addresses in a growing network.

3. Domain Name System (DNS):

DNS is a hierarchical naming system that translates human-readable domain names (e.g., www.edutechcompany.com into numerical IP addresses (e.g., 192.168.1.1) used by computers to locate and connect to resources on the internet. DNS operates through a distributed network of DNS servers:

When a user enters a domain name in a web browser:

1. The user's computer contacts its local DNS resolver (often provided by the internet service provider).
2. The local resolver queries various DNS servers based on the hierarchical structure.
3. Eventually, the authoritative nameserver for the domain provides the corresponding IP address.
4. The user's computer uses the IP address to connect to the desired website.

DNS plays a crucial role in making the internet user-friendly by enabling access to websites through easily remembered domain names instead of complex IP addresses.

4. Methodology:

The Cisco Packet Tracer is the software used for the simulation of the network.

Network Architecture:

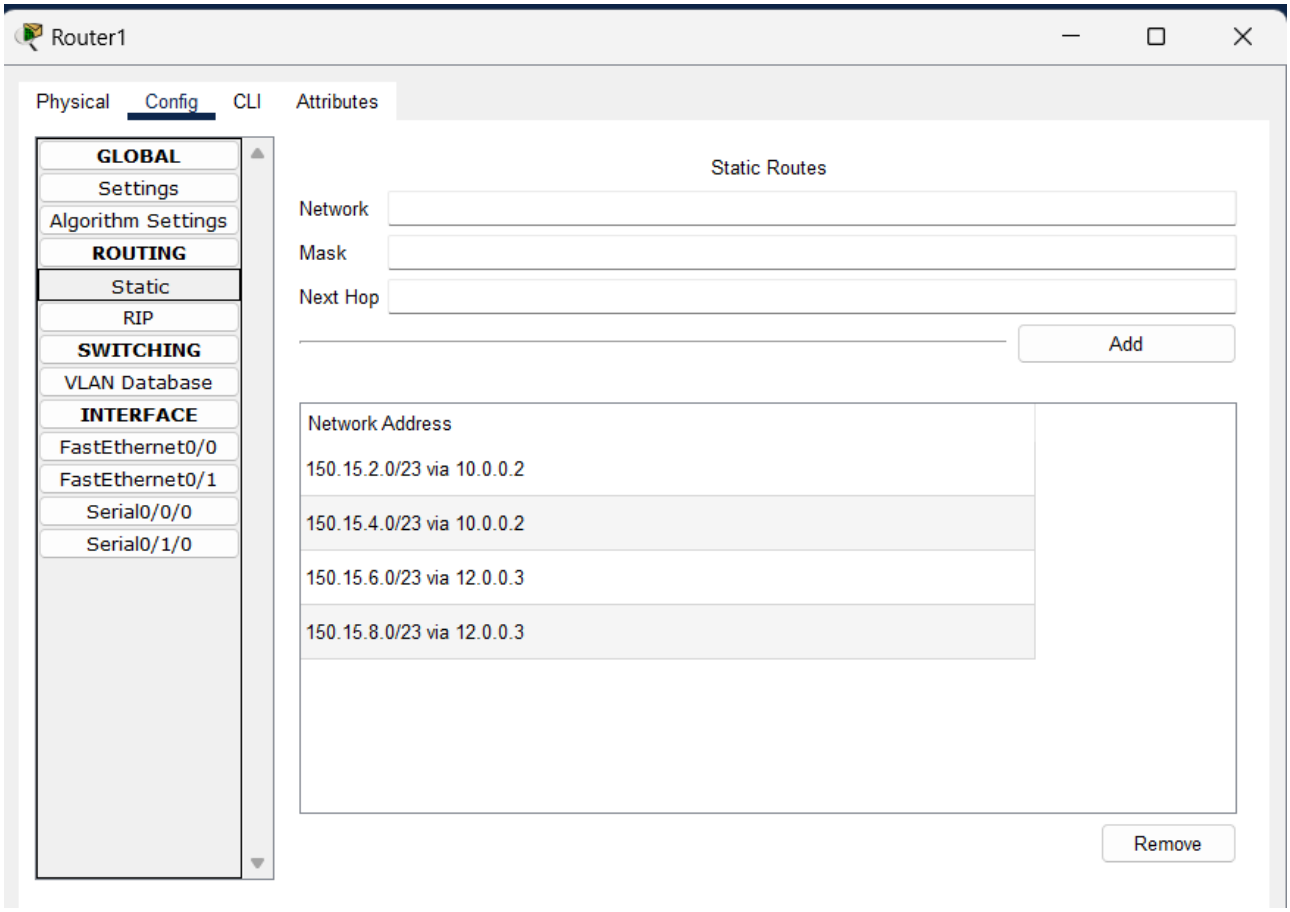
Three tiers of hierarchical architecture will be used by the network:

Core Layer: The backbone of the network will be made up of high-bandwidth core switches, which will enable departmental connections at high speeds.

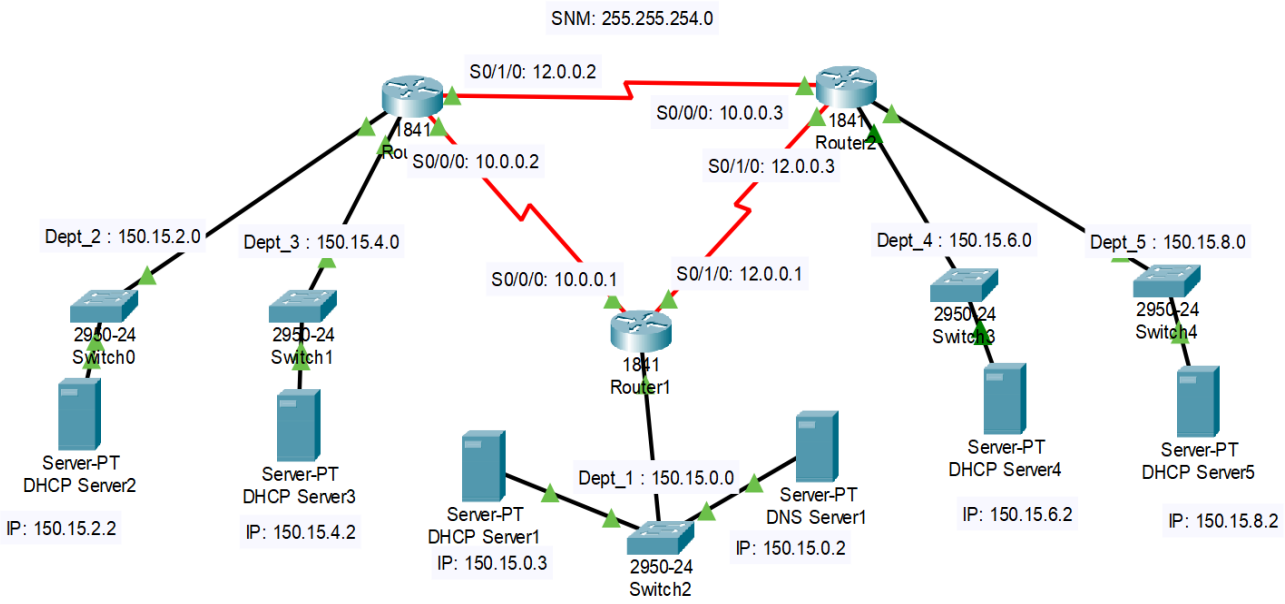
Distribution Layer: Departmental access switches and core switches are connected via distribution switches.

Access Layer: Within each department, individual PCs will be directly connected by access switches.

The Network of an Educational Institute with 5 Departments having 500 PCs each is configured in the Cisco Packet Tracer. In total 3 routers are used to connect the 5 departments. Static routing is used in which the static routes are manually entered in the routing table for directing network traffic



Cisco Packet Tracer GUI for router



Routers, Switches, and Servers configured in the Network

Subnetting of the Network:

The Educational institute network is the bigger network having 5 departments, hence for assigning IP addresses, Subnetting is used. Subnetting in computer networks is the process of dividing a large network into smaller logical subnetworks, also known as subnets. It's a technique used to efficiently manage IP addresses and improve network performance and security.

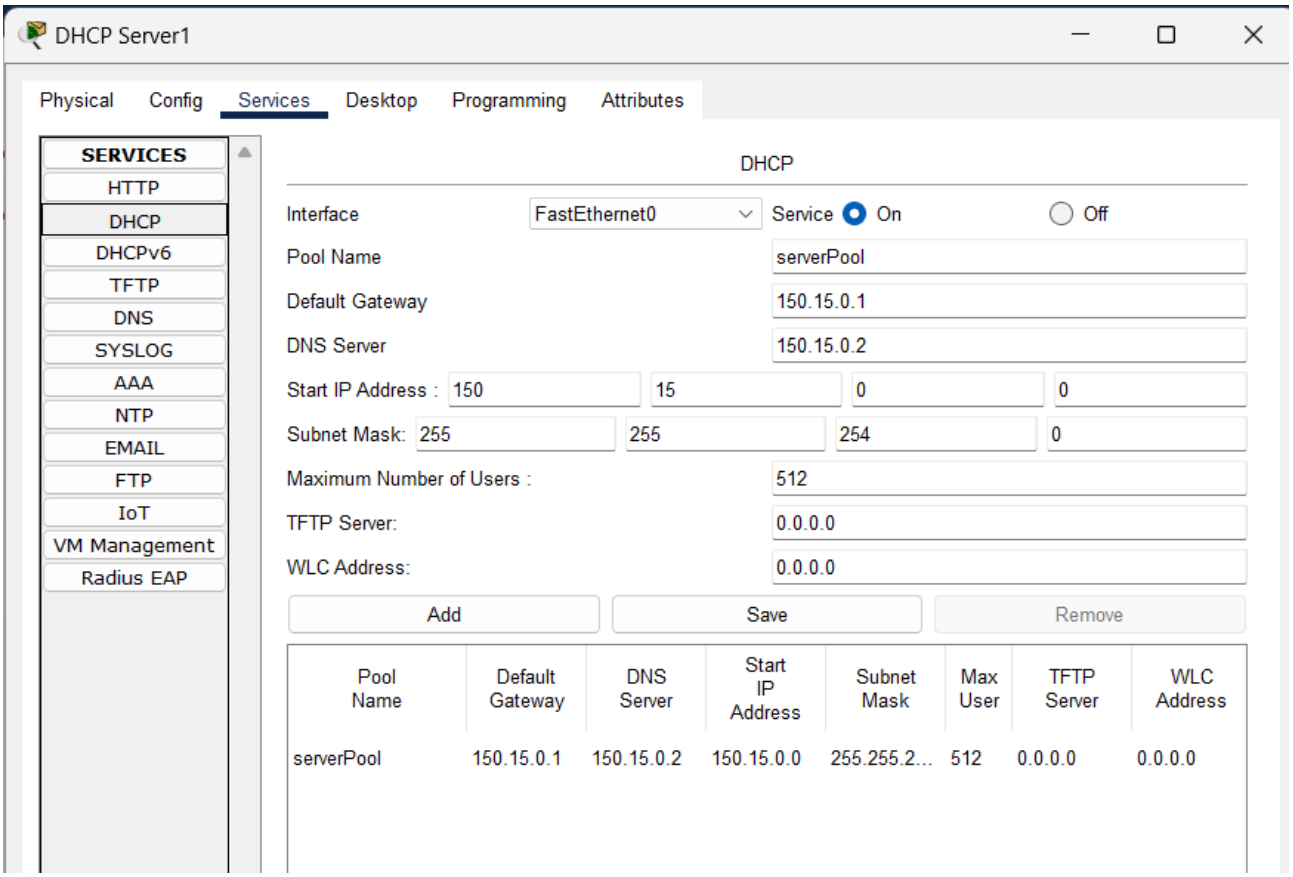
In subnetting, a large network is logically divided into smaller subnetworks for efficient IP address management. A subnet mask defines how much of an IP address identifies the subnet and how much identifies the host device. This optimizes IP allocation, reduces network congestion within a subnet, and enhances security by potentially restricting access between subnets. Subnets essentially create organized network segments within a larger network, improving manageability and performance.

Network Name (Department)	Subnet IP	First Host IP	Last Host IP	Broadcast IP
1	150.15.0.0	150.15.0.1	150.15.1.254	150.15.1.255
2	150.15.2.0	150.15.2.1	150.15.3.254	150.15.3.255
3	150.15.4.0	150.15.4.1	150.15.5.254	150.15.5.255
4	150.15.6.0	150.15.6.1	150.15.7.254	150.15.7.255
5	150.15.8.0	150.15.8.1	150.15.9.254	150.15.9.255

Subnetting in the network

Implementation of DHCP Server:

All institute PC IP address allocation will be managed by a dedicated DHCP server in each department. To support the combined requirements of all departments (about 2500 PCs), the server will be configured with an appropriate IP address pool. The start IP address and subnet mask for each department are given to the DHCP server, which will then assign the IP addresses to the PCs in the department dynamically. Also, the default gateway and DNS server IP addresses are entered in the DHCP server. All PCs will get these addresses same as that of the DHCP server when they request the IP address to the server.



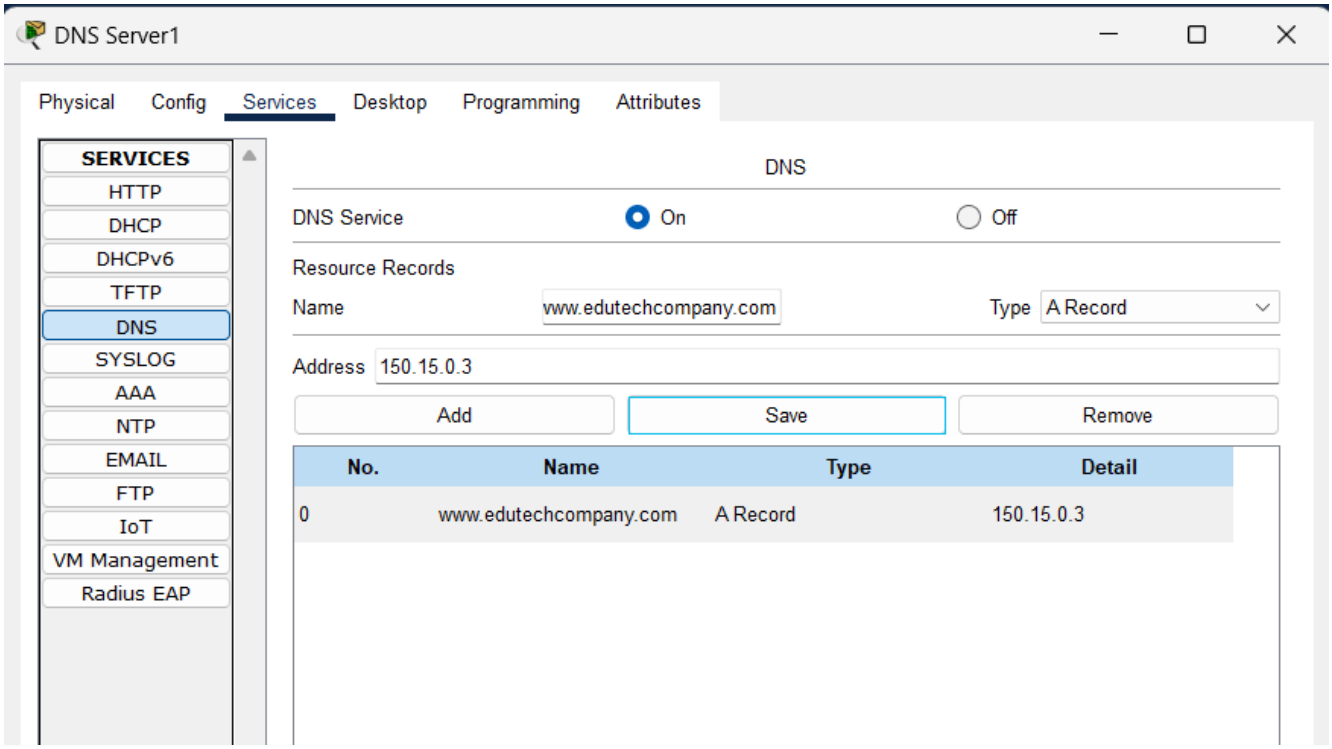
Cisco Packet Tracer GUI of DHCP server

Setting up DNS:

The network will be set up to resolve domain names using the servers of the external DNS service provider. The DNS servers of the provider will be pointed out in the modified router configuration.

The IP address of the network device and the domain name are added to the DNS server. The domain name can be directly used instead of an IP address.

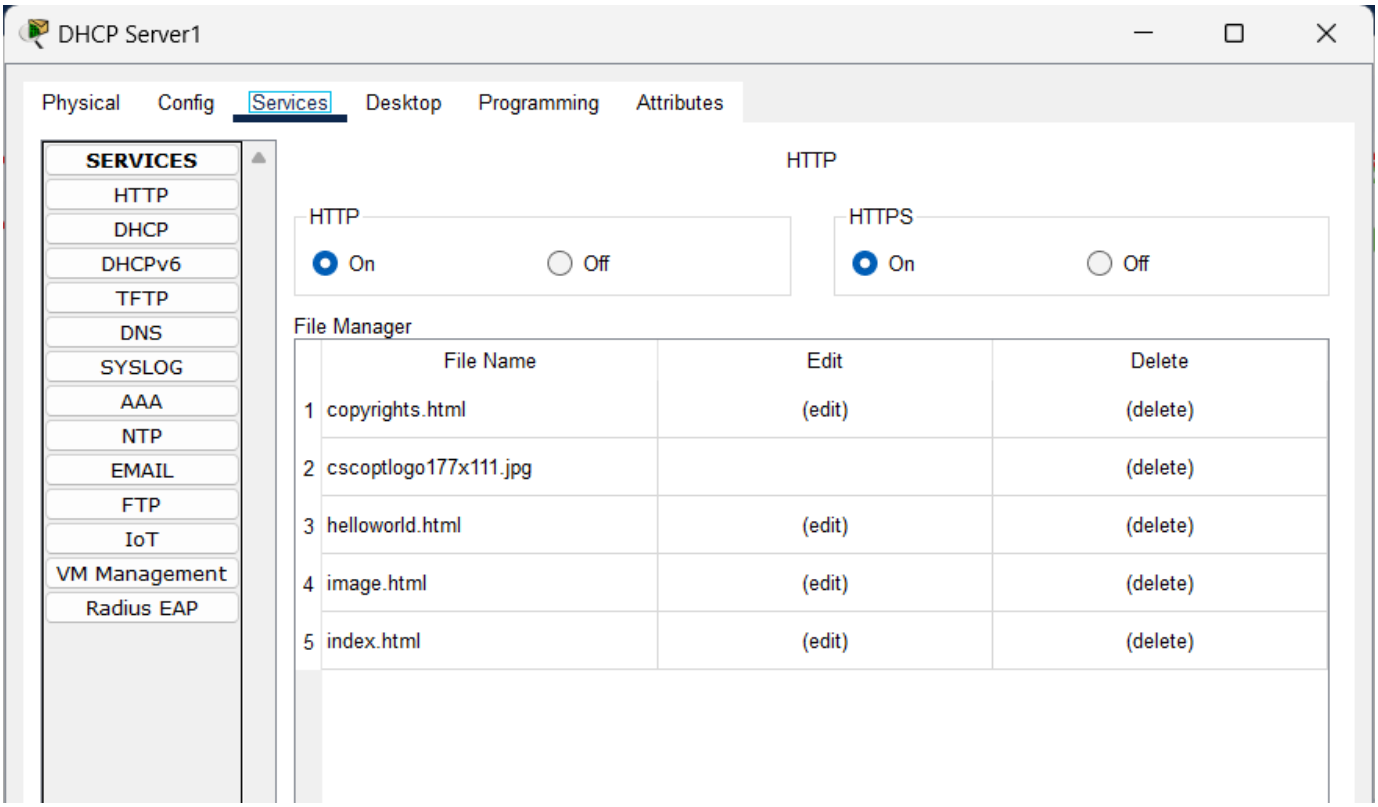
Here, the IP address of the HTTP server - 150.15.0.3 has given the domain name edutechcompany.com. To access the website, one can directly use the domain name instead of searching by the IP address in the web browser.



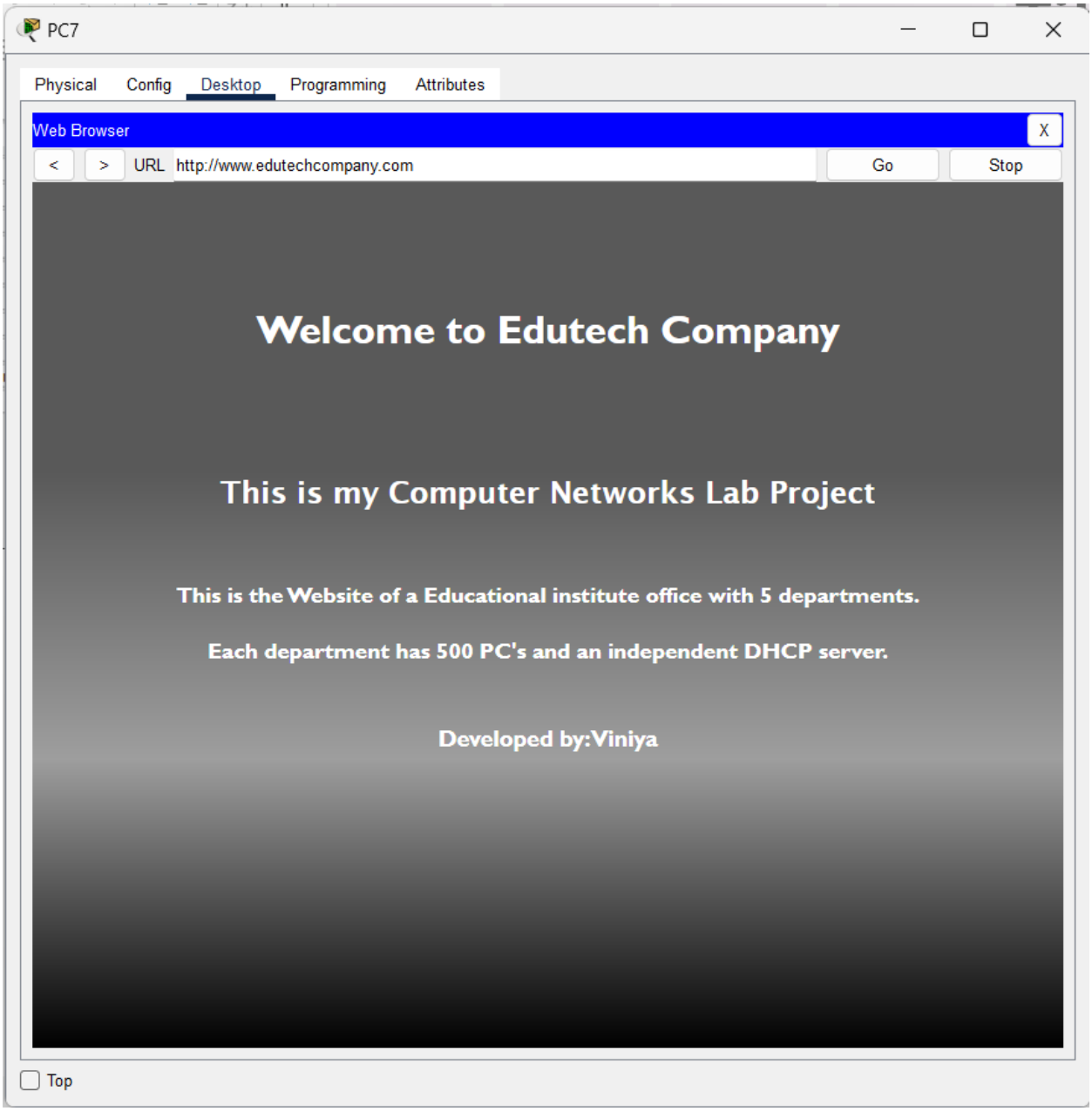
Cisco Packet Tracer GUI of DNS server

Website Accessibility:

A different web server will house the institute's website. The web server will be able to be accessed from the internet. www.edutechcompany.com is the official website of the Educational Institute. The basic webpage is created using HTML and an HTTP server.

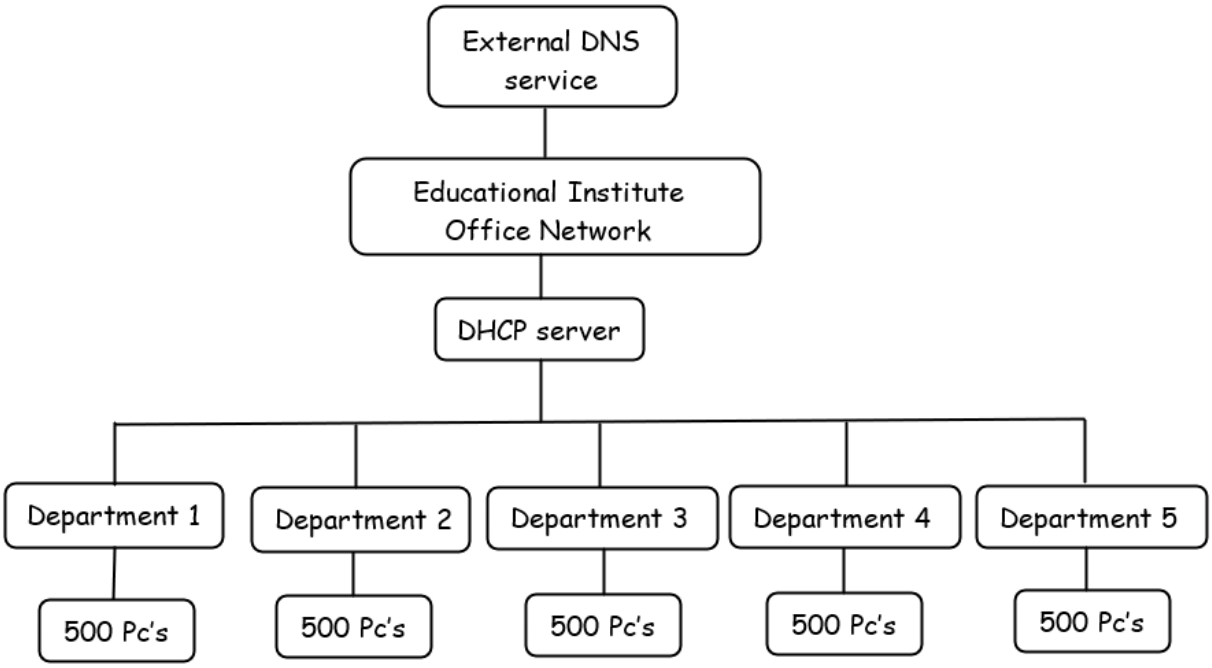


Cisco Packet Tracer GUI of HTTP server



This website is visible when the www.edutechcompany.com is accessed. The code for this is written in the index.html file on the HTTP server having IP address 150.15.0.3 and the domain assigned to it is edutechcomoany.com. Any PC on the network can access this through the web browser.

5. Block Diagram:



1. Educational Institute Office Network:

The network comprises five departments, each with 500 PCs, connected via Ethernet switches. The PCs are used by staff and students for various academic and administrative tasks. It facilitates communication and resource sharing among departments, supporting academic and administrative activities within the institute.

2. DHCP Server:

The educational institute office operates an independent DHCP (Dynamic Host Configuration Protocol) server. The DHCP server dynamically assigns IP addresses to the PCs within each department, simplifying network configuration and management. It automates the assignment of IP addresses to PCs, ensuring efficient network configuration and connectivity for all devices within the network. It serves as a digital platform for the educational institute, providing information to users about the institute's offerings, events, and announcements, enhancing its online presence and accessibility.

3. External DNS Service:

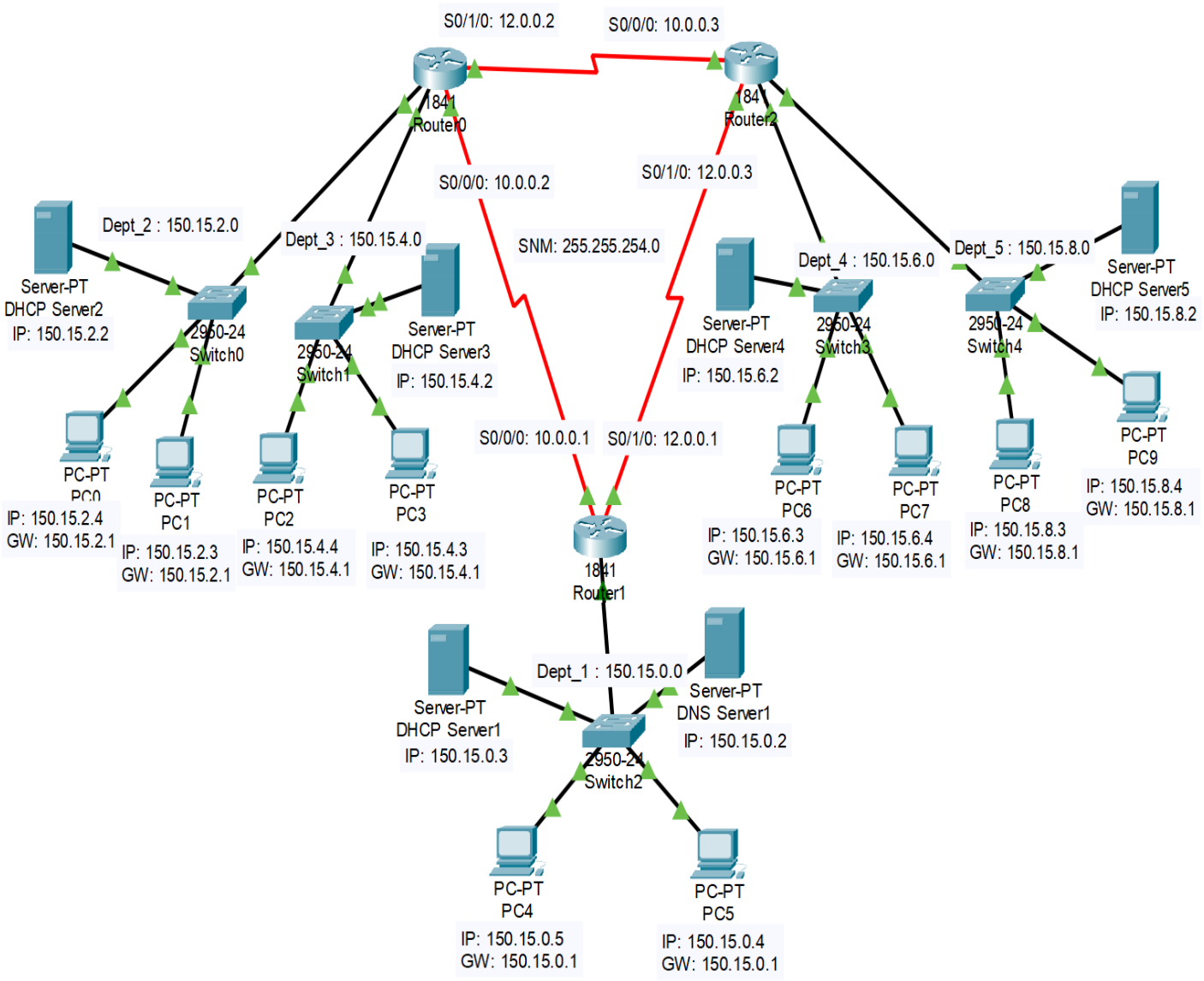
The DNS (Domain Name System) service is provided by an external service provider. It resolves domain names, including the company's website address (e.g., www.edutechcompany.com), to corresponding IP addresses, enabling users to access websites

and services on the internet. It resolves domain names to IP addresses, enabling users to access websites and services on the internet, including the company's website (www.edutechcompany.com).

4. Company Website (www.edutechcompany.com):

The educational institute company hosts its website (www.edutechcompany.com) on a web server. Users, both within and outside the network, can access the website to obtain information about the institute, courses offered, announcements, etc.

6. Simulation Diagram:



PDU List Window

Fire	Last Status	Source	Destination	Type	Color	Time(sec)	Periodic	Num	Edit	Delete
	Successful	PC1	PC6	ICMP		0.000	N	0	(edit)	
	Successful	PC0	PC8	ICMP		0.000	N	1	(edit)	
	Successful	PC2	PC4	ICMP		0.000	N	2	(edit)	
	Successful	PC5	PC9	ICMP		0.000	N	3	(edit)	
	Successful	PC4	PC3	ICMP		0.000	N	4	(edit)	
	Successful	DHCP ...	PC6	ICMP		0.000	N	5	(edit)	
	Successful	DNS S...	PC9	ICMP		0.000	N	6	(edit)	
	Successful	DHCP ...	PC9	ICMP		0.000	N	7	(edit)	

Data packets are successfully transferred between the PCs and servers

Description of Simulation Parameters and Settings:

1. Network Topology:

- The network topology is designed using Cisco Packet Tracer to represent an educational institute office with five departments, each containing 500 PCs.

- Departments are connected via switches and routers to ensure seamless communication and resource sharing.

2. DHCP Server Configuration:

- An independent DHCP server is configured within the network to automate the assignment of IP addresses to the PCs in each department.

- DHCP server settings include IP address range allocation, lease duration, DNS server addresses, and gateway configuration to ensure efficient network connectivity.

3. DNS Service Configuration:

- DNS service is provided by an external service provider.

- Domain name resolution is tested to ensure proper mapping of domain names, including the company's website address (www.edutechcompany.com), to corresponding IP addresses.

4. Website Hosting:

- The company's website (www.edutechcompany.com) is hosted on a web server within the network.

- Web server settings include domain name configuration, web page content, and accessibility settings to allow users to access the website both within and outside the network.

5. Traffic Monitoring and Analysis:

- Packet Tracer's simulation features are utilized to monitor network traffic, analyze data transmission, and troubleshoot connectivity issues.

- Traffic patterns, network utilization, and performance metrics are observed to ensure optimal network operation and identify any potential bottlenecks or security concerns.

By simulating these parameters and settings in Cisco Packet Tracer, the network design and configuration can be thoroughly tested and validated to ensure its effectiveness, reliability, and scalability in meeting the requirements of the educational institute office.

7. Results:

The following advantages will arise from this network design's successful implementation:

Scalability: The addition of new departments or devices is possible in the future thanks to the hierarchical structure.

Efficiency: By automating IP address administration, DHCP lowers the amount of administrative work.

Centralized Control: By centralizing the control of DNS and DHCP, network administration can be expedited.

Better Resource Sharing: Departments may share files, printers, and programs more effectively thanks to the network.

Improved Internet Access: The institute's website and online resources are accessible with dependable internet connectivity.

8. References:

1. https://www.techtarget.com/searchnetworking/definition/domain-name-system

2. https://www.infoblox.com/glossary/dhcp-server/#:~:text=A%20DHCP%20Server%20is%20a,to%20broadcast%20queries%20by%20clients.

3. https://www.britannica.com/technology/local-area-network

4.https://www.cisco.com/c/en/us/td/docs/routers/access/800M/software/800MSCG/routconf.html