Mehran University of Engineering and Technology, Khairpur
Department of Software Engineering

Course: SWE-Computer Network Practical			
Instructor	Dr. Asad Raza Malik	Practical/Lab No.	06
Date	04-09-2024	CLOs	03
Student's Roll no:		Point Scored:	
Date of Conduct:		Teacher's Signature:	

LAB PERFORMANCE INDICATOR	Subject Knowledge	Data Analysis and Interpretation	Ability to Conduct Experiment	Presentation	Calculation and Coding	Observation/ Result	Score

Topic	To become familiar with command line interface (CLI) and examine router interfaces, set passwords, and save configuration files of routers.
Objective	• This lab focuses on familiarizing students with the basic configuration of Cisco routers using the CLI. Understanding how to access and configure router interfaces, set passwords, and save configurations are fundamental skills for anyone in network management. By mastering these skills, students will be well-prepared to handle more complex networking tasks and ensure the security and efficiency of the networks they manage.

Lab Discussion: Theoretical concepts and Procedural steps

Theoretical Background:

1. What is a Router?

A router is a networking device that connects multiple networks and directs data traffic between them. It functions as a critical component in both small and large-scale networks, ensuring that data packets find their way from one device or network to another efficiently and securely.

Key Functions of a Router:

1. **Data Routing:**
   - The primary function of a router is to route data packets between different networks. It determines the best path for each data packet to travel to its destination, using information stored in its routing table.
2. **Network Interconnection:**
   - Routers connect various networks. For example, they connect a home network to the internet or link multiple offices in a business environment. This makes them essential for creating wide-area networks (WANs).
3. **Traffic Management:**

- Routers manage network traffic by analyzing incoming and outgoing data packets and deciding where to send them. This helps optimize network performance and reduce congestion.

4. **Network Security:**
    - Routers play a crucial role in network security by controlling data flow. They can be configured with firewalls, access control lists (ACLs), and other security measures to protect the network from unauthorized access and cyber threats.
5. **IP Address Assignment:**
    - Routers often function as a DHCP server, automatically assigning IP addresses to network devices. This ensures each device has a unique IP address, allowing for proper communication.
6. **Protocol Translation:**
    - Routers can also translate protocols between different types of networks. For example, they can convert data from a local area network (LAN) protocol to a wide area network (WAN) protocol.

Types of Routers:

1. **Home/Small Office Routers:**
    - Used in home and small office networks to connect devices to the internet. They often include built-in wireless access points.
2. **Enterprise Routers:**
    - Used in larger networks, such as businesses or data centers. These routers handle higher traffic volumes and offer advanced features like VPN support, extensive security settings, and multiple WAN connections.
3. **Core Routers:**
    - High-capacity routers are used in large networks' backbone, such as the Internet. They are designed to handle vast amounts of data and connect multiple enterprise or service provider networks.
4. **Edge Routers:**
    - Positioned at the edge of a network, these routers connect the internal network to external networks, such as the internet or another WAN.

How Routers Work:

When a data packet arrives at a router, it reads its destination IP address and consults its routing table to determine the best path to forward the packet. The routing table contains information about network paths and metrics, such as the number of hops (intermediate devices) to reach the destination. The router then sends the packet to the following network or device along the path, eventually reaching the destination.

Fig 1: Cisco ISR 4321 Router

2. what is the Command Line Interface (CLI) of a Cisco Router

The CLI is a text-based interface that allows network administrators to configure and manage Cisco devices. Unlike graphical user interfaces (GUIs), the CLI offers direct access to the router's operating system, providing more control and flexibility over the configuration process. Understanding the CLI is crucial for network professionals as it is often the most efficient way to perform tasks such as setting up interfaces, managing security settings, and troubleshooting issues.

3. Understanding Router Interfaces

Routers have multiple network interfaces and connection points, allowing the router to interact with other network devices. These interfaces can be physical ports (like Ethernet ports) or logical interfaces (like subinterfaces). Each interface can be configured with an IP address, which is used to route data to and from the router.

- **Types of Interfaces:**
    - **Ethernet Interfaces:** These are used for wired connections, typically using Ethernet cables.
    - **Serial Interfaces:** Often used for WAN connections, particularly in older or legacy systems.
    - **Loopback Interfaces:** Virtual interfaces are used mainly for testing and network management.

The status and configuration of each interface can be viewed using CLI commands, and understanding this information is vital for network configuration and troubleshooting.

4. Importance of Router Security:

Securing routers is a fundamental aspect of network management. Unsecured routers can be vulnerable to unauthorized access, leading to data breaches, network downtime, and other security incidents. Several layers of security can be implemented on a Cisco router:

- **Console Password:** This restricts access to the router's CLI through the physical console port.

- **VTY (Virtual Terminal Lines) Password:** This secures remote access through protocols like Telnet and SSH.
- **Enable Password:** Controls access to privileged EXEC mode, where critical configurations can be made.
- **Enable Secret:** An encrypted version of the enable password, providing enhanced security.

Setting strong passwords and using encrypted methods (like enabling secret instead of enabling password) are best practices in securing routers.

5. The Role of Configuration Files

Cisco routers use two primary configuration files:

- **Running Configuration:** This file contains the current configuration settings the router uses. Changes made in the CLI are applied immediately to the running configuration.
- **Startup Configuration:** This file is stored in non-volatile memory (NVRAM) and contains the router's configuration upon reboot.

It's essential to save the running configuration to the startup configuration after making changes. If the router is rebooted before saving, any changes made will be lost, and the router will revert to its previous configuration. This is done using the command copy running-config startup-config.

6. Using the CLI for Basic Configuration

The CLI allows for detailed and precise control over router configurations. Some of the basic tasks that can be performed include:

- **Accessing the Router CLI:** Typically, this is done via a console connection, SSH, or Telnet.
- **Entering Privileged EXEC Mode:** Users can access a higher privilege level where most configuration tasks can be performed by typing enable.
- **Viewing Interface Status:** Commands like show IP interface brief provides a quick overview of all interfaces, IP addresses, and operational status.
- **Configuring IP Addresses:** Assigning static IP addresses to interfaces is essential for routing and network communication.
- **Setting Passwords:** Only authorized personnel can access the router's configuration settings.

Lab Tasks:

Task 1: Accessing the Router CLI

1. **Start Cisco Packet Tracer:**
    - Open the Cisco Packet Tracer and add a router (e.g., Cisco 2911) to the workspace.
2. **Access the CLI:**
    - Click on the router and navigate to the CLI tab to access the Command Line Interface.

Task 2: Examining Router Interfaces

1. **Enter Privileged EXEC Mode:**
    - Type `enable` to enter Privileged EXEC mode.
2. **View Router Interfaces:**
    - Use the command show IP interface brief to view all router interfaces' status and IP addresses.
3. **Detailed Interface Information:**
    - Use show running-config or show interfaces to get detailed information about each interface.

Task 3: Setting Router Passwords

1. **Set a Console Password:**
    - Enter global configuration mode with configure terminal.
    - Type line console 0 to access the console line configuration.
    - Set a password with password [YourPassword].
    - Enable password login with login.
2. **Set a VTY (Telnet/SSH) Password:**
    - Still in global configuration mode, type line vty 0 4 to configure VTY lines.
    - Set a password with password [YourPassword].
    - Enable password login with login.
3. **Set an Enable Password:**
    - Use enable password [YourPassword] to set a password for privileged EXEC mode.

4. **Set an Enable Secret:**
    - Set a more secure password using enable secret [YourSecretPassword].

Task 4: Saving the Configuration

1. **Save the Running Configuration:**
    - Use the command copy running-config startup-config to save the current configuration to NVRAM.
2. **Verify the Configuration:**
    - Use show startup-config to verify that the configuration has been saved correctly.

Part 1: Student Worksheet:

Scenario: Small Office Network Setup

Objective:
Configure a small office network using Cisco Packet Tracer. The network will consist of multiple departments, each with its subnet, and will include routers, switches, and end devices such as PCs and printers. The goal is to ensure that all devices within the network can communicate with each other while maintaining proper segmentation between departments.

Network Setup Details:

1. **Departments:**
    - **HR Department:** 192.168.10.0/24
    - **IT Department:** 192.168.20.0/24
    - **Finance Department:** 192.168.30.0/24
    - **Admin Department:** 192.168.40.0/24
2. **Network Devices:**
    - **1 Router** (to route traffic between different subnets)
    - **4 Switches** (one for each department)
    - **8 PCs** (2 in each department)
    - **1 Printer** (shared by all departments)
3. **IP Addressing:**
    - HR PCs: 192.168.10.2 - 192.168.10.3
    - IT PCs: 192.168.20.2 - 192.168.20.3

- Finance PCs: 192.168.30.2 - 192.168.30.3
- Admin PCs: 192.168.40.2 - 192.168.40.3
- Printer: 192.168.10.50

4. **Router Configuration:**
   - **Interface G0/0:** 192.168.10.1 (HR Department)
   - **Interface G0/1:** 192.168.20.1 (IT Department)
   - **Interface G0/2:** 192.168.30.1 (Finance Department)
   - **Interface G0/3:** 192.168.40.1 (Admin Department)
5. **Network Requirements:**
   - **Inter-department Communication:** Devices in different subnets should be able to communicate with each other.
   - **Internet Access:** Assume the router is connected to an ISP (you can simulate this with a cloud in Packet Tracer).
   - **Printer Sharing:** All departments should be able to access the shared printer in the HR department.

Tasks:

1. **Step 1: Network Design**
   - Using Cisco Packet Tracer, design the network as described above, placing the appropriate devices and connections.
2. **Step 2: Configure IP Addresses**
   - Assign the correct IP addresses to each device as per the provided subnets.
3. **Step 3: Configure the Router**
   - Set up the router with the IP addresses for each department.
   - Configure routing to ensure that devices from different subnets can communicate.
4. **Step 4: Test Connectivity**
   - Use the ping command from PCs in different departments to ensure they can communicate.
   - Test access to the shared printer by sending a print job from each department.
5. **Step 5: Save the Configuration**
   - Save the configuration files for all devices in Packet Tracer.

6. **Step 6: Documentation**
    - Document the network configuration, including the IP address assignments and any specific routing settings used.

Part 2:

1. **What is a Router?**
    - Define a router in the context of computer networks.
    - Explain the primary functions of a router.
2. **Router Functions:**
    - Describe how a router forwards packets in a network.
    - Explain the concept of routing tables and how they are used in routing decisions.
    - Discuss Network Address Translation (NAT) and how it allows multiple devices on a local network to share a single public IP address.
    - What role does a router play in network security?

Part 3: Introduction to Command Line Interface (CLI)

1. **What is CLI?**
    - Define the Command Line Interface (CLI) and its significance in networking.
    - Compare and contrast the CLI with Graphical User Interfaces (GUIs).
2. **Basic CLI Commands:**
    - List and describe the function of the following CLI commands:
        - enable
        - configure terminal
        - interface
        - IP address
        - no shutdown
        - show running-config
        - copy running-config startup-config
    - Explain the importance of saving configurations using the copy running-config startup-config command.

Part 4: Router Interfaces

1. **Types of Interfaces:**
    - Identify and describe the different types of interfaces available on a router (e.g., Ethernet, Serial).
    - Discuss the typical use cases for each type of interface.
2. **Interface Configuration:**
    - Explain how to assign an IP address to a router interface.
    - What command is used to activate an interface on a router?
    - Describe the purpose of the show interfaces command.

Part 5: Applying the Knowledge (Practical Scenario)

1. **Scenario:**
    - Imagine you are tasked with configuring a new router for a small office network. The network has the following requirements:
        - Two separate LANs, each with its own IP range (e.g., 192.168.1.0/24 and 192.168.2.0/24).
        - The router needs to connect both LANs to the internet via a single WAN interface.
    - Describe the steps you would take to configure the router using the CLI. Include the commands you would use to:
        - Assign IP addresses to the LAN and WAN interfaces.
        - Enable the interfaces.
        - Save the configuration.

Expected Outcome:

- **Functional Network:** The small office network should be fully operational with successful communication across all departments.
- **Shared Resources:** All PCs should be able to print to the shared printer, demonstrating the network's ability to manage shared resources.

Submission Instructions:

- Complete the worksheet and submit your answers by the next class session at Google Classroom.
- Ensure all answers are well-explained and demonstrate a clear understanding of the concepts.

Additional Resources:

- Review your class notes on routers and the CLI.
- Refer to the Cisco Packet Tracer manual for practical examples.
- Use online resources like Cisco's official documentation to explore CLI commands and router configuration more.

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