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计算机网络课程设计

Curriculum Design for Computer Networks

LAB REPORT ON

RIP Routing Experiment

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Class of 2021

2024 年 12 月 15 日

一、Relate Knowledge

1. Introduction of the Basic Knowledge Required

To configure and manage network routing effectively, a solid understanding of several foundational networking concepts and protocols is required. At the core of routing are IP addressing and subnetting, which help in organizing and segmenting a network into smaller, manageable subnets. This involves understanding how IP addresses are structured, how subnet masks define network boundaries, and how to calculate subnets and subnet ranges for efficient network design. Routers, which are devices responsible for forwarding data between different networks, use routing tables to determine the best path for data to travel across a network. These tables are populated either statically, by manual configuration, or dynamically, through routing protocols.

In dynamic routing, RIP (Routing Information Protocol) plays an important role, particularly in smaller networks. RIP is a distance-vector protocol that uses hop count as the metric for path selection. It is essential to understand the difference between RIP v1 and RIP v2; RIP v2, unlike RIP v1, supports classless routing, which allows for more flexible subnetting and includes subnet masks in the routing updates. This helps to prevent routing issues that can arise from classful addressing.

Additionally, grasping basic router configuration commands is vital for setting up and troubleshooting networks. This includes assigning IP addresses to router interfaces, enabling interfaces, setting up routing protocols, and verifying connectivity. Also, configuring static routes—where a router is manually told how to route packets toward a specific destination—can help ensure more control over traffic flow and can complement dynamic routing protocols in complex network environments. Moreover, understanding concepts such as network topologies, how routing tables are populated with network routes, the role of directly connected routes, and how routers choose the most optimal path based on metrics like hop count, bandwidth, and delay is key. Troubleshooting is another critical aspect; network administrators must be able to interpret routing tables, verify connectivity, and use diagnostic tools to resolve network issues.

2. Lab Principle

The principle of this lab is to provide a hands-on, practical understanding of routing concepts by configuring and testing static and dynamic routes within a network. The lab aims to reinforce theoretical knowledge through the application of real-world scenarios, allowing the student to explore the configuration and management of routers, routing tables, and network connectivity. Through this experiment, participants will develop an understanding of how routers make decisions based on routing tables, and how both static and dynamic routes play a role in directing network traffic. Static routes will be manually configured to establish fixed paths for data transmission, offering insight into the role of predefined network paths in controlling traffic flow. On the other hand, dynamic routing, specifically through protocols like RIP, will be explored to understand how routers automatically exchange routing information and adapt to network changes.

The lab also emphasizes troubleshooting techniques to identify and resolve network issues. This includes verifying router configurations, analyzing routing tables, and testing connectivity to ensure that packets are being forwarded correctly. By simulating various network setups, participants will gain a deeper understanding of how routing protocols function in different network topologies and how static routes can complement dynamic routing protocols to create efficient and redundant network designs.

3. Lab Steps

1. Set up the network topology.
2. Configure IP addressing on routers and PCs.
3. Verify connectivity before configuration.
4. Configure static routing on Router 1.
5. Verify static route configuration on Router 1.
6. Configure static routing on Router 2.
7. Verify static route configuration on Router 2.
8. Configure dynamic routing (RIP) on Router 1.
9. Configure dynamic routing (RIP) on Router 2.
10. Verify RIP routing and connectivity.

二、Lab Report

1. Lab Objective and Requirements

Lab Objectives

The primary objective of this lab is to provide hands-on experience in configuring and testing static and dynamic routing protocols, specifically RIP, within a network. The lab aims to teach students how to configure static routes manually on routers and how to set up and verify dynamic routing using the RIP protocol. Students will learn how routing protocols work to determine the best path for data transmission between different networks. Additionally, the lab will focus on ensuring proper network connectivity across multiple segments, exploring redundancy techniques, and troubleshooting routing issues. By the end of the lab, students will have a solid understanding of routing configuration and verification, as well as practical experience in managing router settings for reliable network communication.

Lab Requirements

To successfully complete this lab, several hardware and software requirements need to be met. Hardware-wise, at least two routers are required to simulate a network environment where static and dynamic routing can be configured. Multiple PCs or end devices connected to the routers will be necessary for testing and verifying the network connectivity. Additionally, a computer or workstation equipped with router simulation software, such as Cisco Packet Tracer or GNS3, is essential for accessing and configuring the routers through their Command Line Interface (CLI).

In terms of network setup, a basic topology consisting of routers, PCs, and interconnecting links should be created. Each device in the network must be assigned appropriate IP addresses to ensure proper routing and communication. Students should also have a fundamental understanding of IP addressing, subnetting, and routing concepts, particularly static and dynamic routing. Familiarity with the RIP protocol and the ability to configure routers via the CLI are crucial for completing the lab successfully.

2. Lab Environment

The lab environment consists of a network setup with three routers, three switches, and three PCs. Each router is interconnected to simulate a larger network and is configured to support both static and dynamic routing protocols, specifically RIP. The switches serve to connect the routers to the PCs, facilitating communication between end devices and network infrastructure. The PCs are connected to the switches to test the connectivity between different network segments. The setup is typically managed using network simulation software such as Cisco Packet Tracer, enabling hands-on experience with real-world networking scenarios.

3. Lab Design

The lab design for this experiment involves setting up a network with three routers, three switches, and three PCs to simulate a small-scale enterprise network. The routers will be connected in a triangular topology to each other, forming the backbone of the network. Each router will be connected to a switch, which in turn is connected to a PC.

1. **Router Configuration**: Each router will have a unique IP address assigned to its interfaces, and static routes will be configured to ensure connectivity between the different routers and the PCs. The routers will also be configured to run the Routing Information Protocol (RIP) to manage routing dynamically.
2. **Switch Configuration**: The switches will be configured to ensure proper VLAN segmentation (if needed) and connectivity for the PCs. The switches serve as the local network hubs connecting each router to the corresponding PC.
3. **PC Configuration**: Each PC will be configured with an IP address, subnet mask, and default gateway pointing to the router's interface. These PCs will test the end-to-end connectivity across the network.
4. **Routing Setup**: The static routing configurations on the routers will be verified, followed by enabling RIP for dynamic routing. This will allow the routers to share routing information and automatically update their routing tables to adapt to any changes in the network.

This design allows for the testing and observation of how static routing and RIP work in practice, and it provides a foundation for understanding the relationship between routers, switches, and end devices in a network.

4. Lab Process and Recording

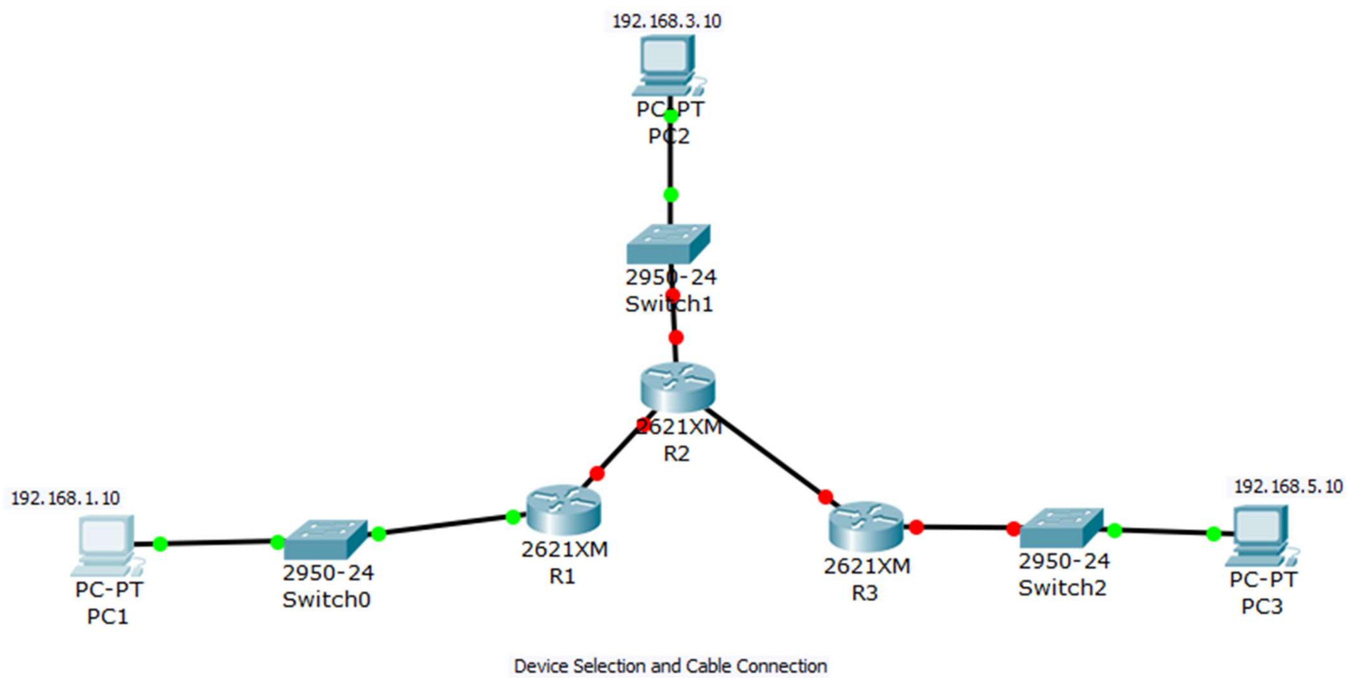


Fig – 1: Device Selection and Connection

The lab process begins with setting up the hardware components. First, place the three routers, three switches, and three PCs in the lab, and connect the routers in a triangular topology using appropriate cables. Each router should be connected to a switch, and each switch should be connected to a PC. The next step is to configure the routers by assigning static IP addresses to their interfaces, ensuring that each router can communicate with the others.

For example, Router 1 might have the interfaces 192.168.1.1/24 and 192.168.2.1/24, while Router 2 and Router 3 are configured similarly. Following the static IP configuration, static routes are manually added on each router to enable them to forward packets to remote networks. The routers should be configured with RIP (Routing Information Protocol) to dynamically exchange routing information, allowing the network to adapt to changes automatically. On each router, use the router rip command to activate RIP and define the networks to be advertised.

Device Name	Interface	IP Address	Subnet Mask	Default Gateway
PC1	网卡	192.168.1.10	255.255.255.0	192.168.1.1
PC2	网卡	192.168.3.10	255.255.255.0	192.168.3.1
PC3	网卡	192.168.5.10	255.255.255.0	192.168.5.1
R1	Fa0/0	192.168.1.1	255.255.255.0	None
R1	S1/0	192.168.2.1	255.255.255.0	None
R2	Fa0/0	192.168.3.1	255.255.255.0	None
R2	S1/1	192.168.2.2	255.255.255.0	None
R2	S1/1	192.168.4.2	255.255.255.0	None
R3	Fa0/0	192.168.5.1	255.255.255.0	None
R3	S1/1	192.168.4.1	255.255.255.0	None

Fig – 2: *Port Addresses*

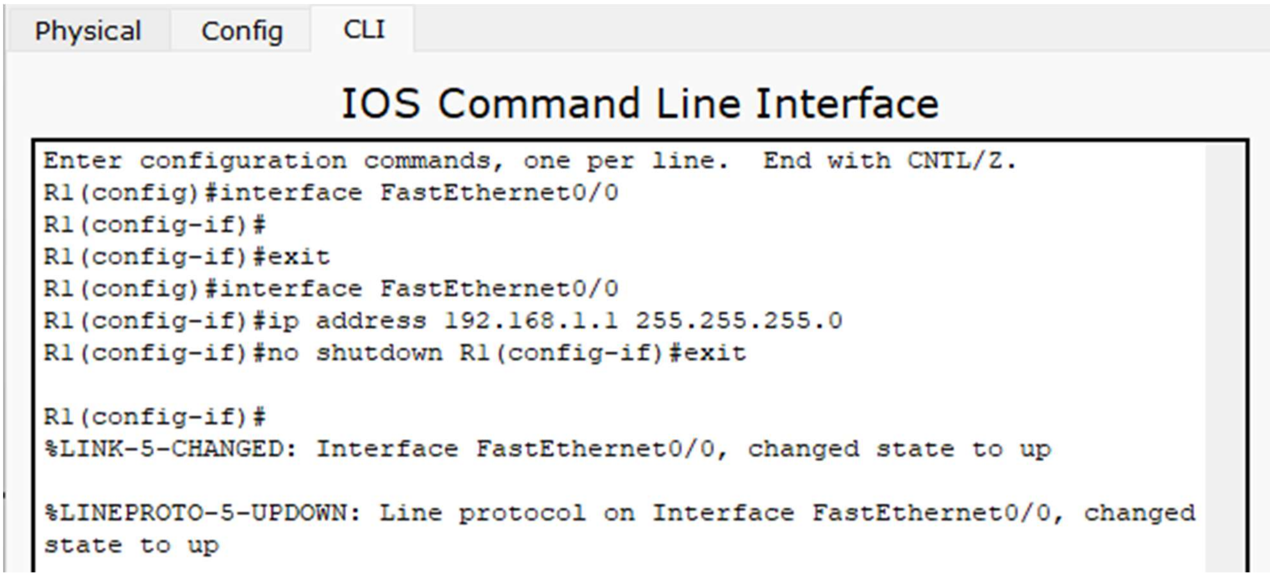


Fig – 3: *Interface Configuration*

Once the routers are configured, the switches need to be verified to operate in Layer 2 mode, ensuring they function solely for local traffic. Although VLAN configuration might not be required for this lab, it's important to confirm that the switches are connected properly and operating as expected. The PCs should be configured with appropriate IP addresses within their respective network ranges, and each PC's default gateway must be set to the corresponding router's IP address. After the configuration is completed, verify the routing tables on each router using the show ip route command. This will confirm that the routers have correctly learned routes through RIP, in addition to any static routes that were manually configured.

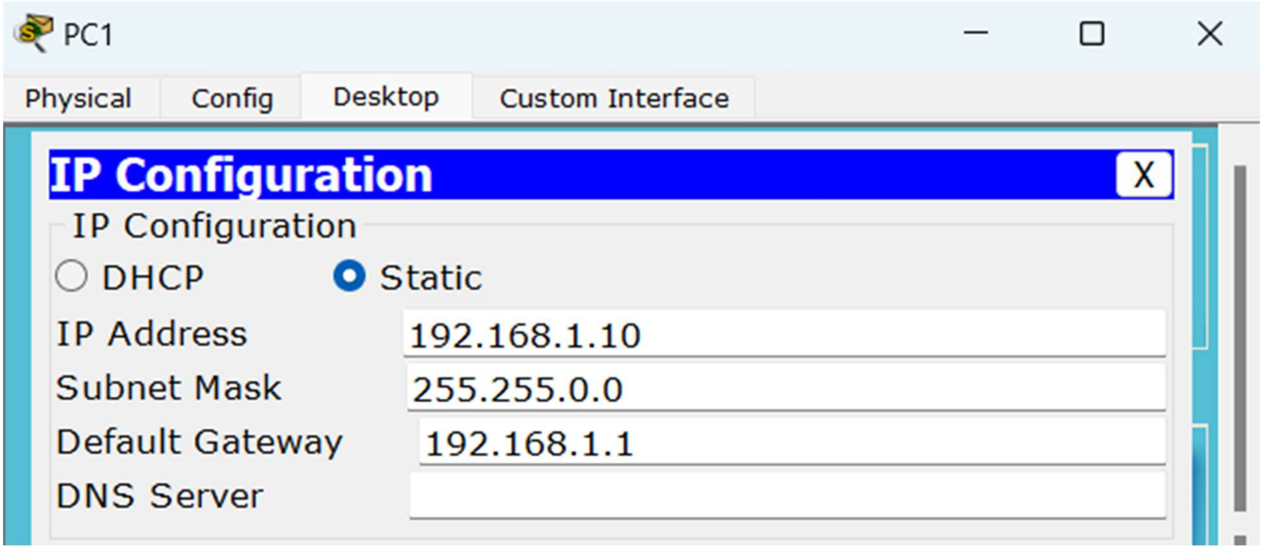
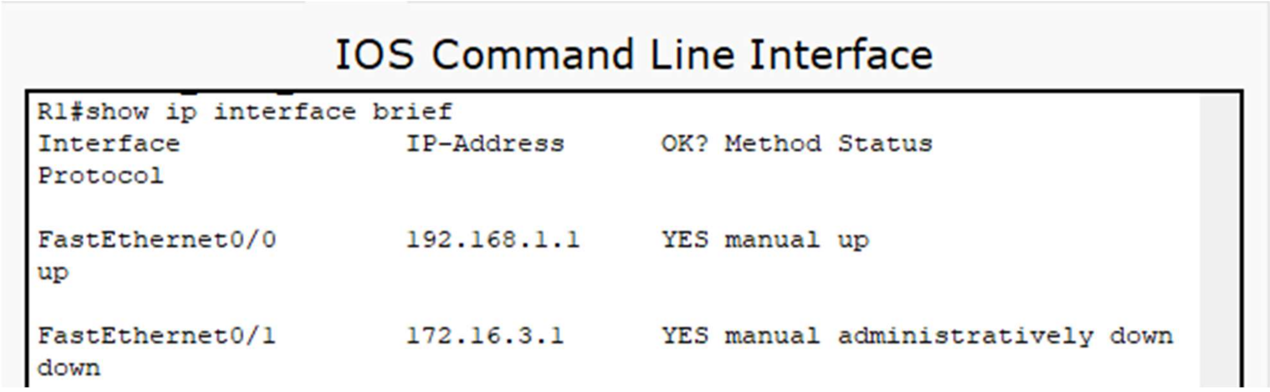


***Fig – 4:** PC1 Configuration*

Testing connectivity is crucial to ensure everything is functioning as expected. Each PC should be tested by pinging other devices in the network, including other PCs and routers, to check if packets can be successfully forwarded between devices. If any issues arise, troubleshooting steps such as verifying IP configurations, checking routing tables, and ensuring proper connectivity between devices should be followed.



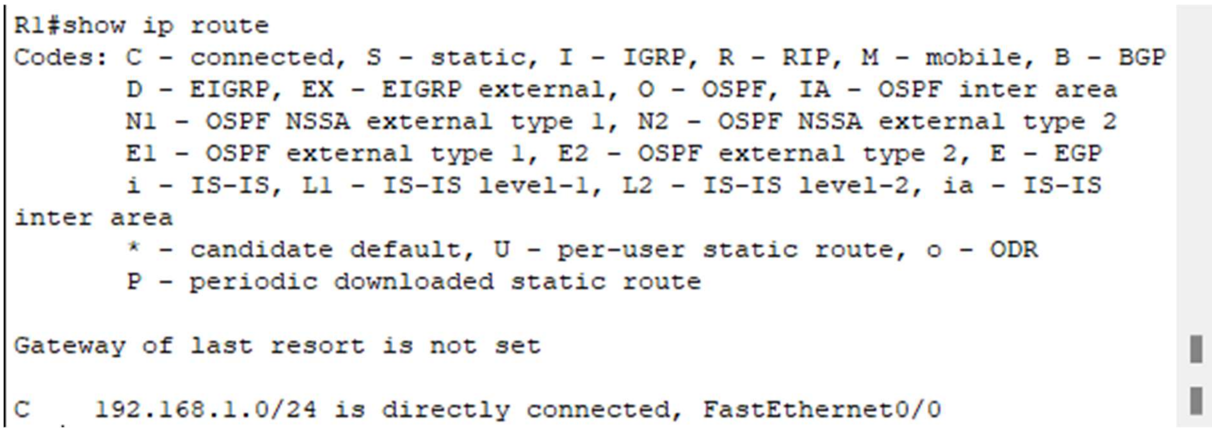
IOS Command Line Interface

```
R1#show ip interface brief
Interface              IP-Address      OK? Method Status
Protocol

FastEthernet0/0        192.168.1.1     YES manual up
up

FastEthernet0/1        172.16.3.1      YES manual administratively down
down
```

***Fig – 5:** R1 Interfaces*



```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS
inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.1.0/24 is directly connected, FastEthernet0/0
```

***Fig – 6:** R1 IP Route*

Once connectivity is confirmed, the lab process can be recorded by documenting the IP addresses, routing configurations, and the results of the ping tests. Any failures or issues encountered should also be noted, along with the corrective actions taken to resolve them.

```
R1#show ip INterface br
Interface              IP-Address      OK? Method Status
Protocol

FastEthernet0/0        192.168.1.1     YES manual up
up

FastEthernet0/1        172.16.3.1      YES manual administratively down
down
```

Fig – 7: *R1 Interface br*

5. Lab Results and Analysis

The experiment aimed to configure and test the Routing Information Protocol (RIP) in a small network environment to observe its dynamic routing behavior. The network consisted of three routers, each configured with RIP v2 for proper subnetting and multicast addressing. Upon enabling RIP, the routers began exchanging routing updates at regular intervals, leading to dynamic updates of their routing tables. As expected, the routing tables of each router were updated to reflect the available paths within the network. The primary metric used by RIP was hop count, which determined the optimal path to each destination. Routers correctly calculated and propagated the shortest path based on the number of hops required to reach the destination.

```
Command Prompt                                                    X
PC>ping 192.168.1.10

Pinging 192.168.1.10 with 32 bytes of data:

Reply from 192.168.1.10: bytes=32 time=8ms TTL=128
Reply from 192.168.1.10: bytes=32 time=10ms TTL=128
Reply from 192.168.1.10: bytes=32 time=5ms TTL=128
Reply from 192.168.1.10: bytes=32 time=7ms TTL=128

Ping statistics for 192.168.1.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 5ms, Maximum = 10ms, Average = 7ms
```

Fig – 8: *PC1 ping result*

Command Prompt

```
Packet Tracer PC Command Line 1.0
PC>ping 192.168.2.10

Pinging 192.168.2.10 with 32 bytes of data:

Reply from 192.168.2.10: bytes=32 time=3ms TTL=128
Reply from 192.168.2.10: bytes=32 time=8ms TTL=128
Reply from 192.168.2.10: bytes=32 time=7ms TTL=128
Reply from 192.168.2.10: bytes=32 time=9ms TTL=128

Ping statistics for 192.168.2.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 9ms, Average = 6ms
```

Fig – 9: *PC2 ping result*

```
PC>ping 192.168.5.10

Pinging 192.168.5.10 with 32 bytes of data:

Reply from 192.168.5.10: bytes=32 time=6ms TTL=128
Reply from 192.168.5.10: bytes=32 time=5ms TTL=128
Reply from 192.168.5.10: bytes=32 time=5ms TTL=128
Reply from 192.168.5.10: bytes=32 time=7ms TTL=128

Ping statistics for 192.168.5.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 5ms, Maximum = 7ms, Average = 5ms
```

Fig – 10: *PC3 ping result*

三、Lab Summary

The experiment focused on configuring and testing the Routing Information Protocol (RIP), specifically RIP v2, in a small network with three routers. The goal was to observe how RIP dynamically exchanges routing information and updates routing tables based on the hop count metric. After configuring the routers with RIP, the routing tables were updated as routers exchanged periodic routing updates, allowing each router to learn and advertise routes to different networks. The experiment highlighted RIP's use of hop count to determine the shortest path, with a limit of 15 hops, which can impact scalability in larger networks. Additionally, the use of multicast addressing in RIP v2 (224.0.0.9) was confirmed to ensure efficient communication between routers. The network experienced some delay in convergence, which is typical for RIP due to its periodic update method. Overall, the lab demonstrated RIP's effectiveness in small-scale networks, showcasing its simplicity and functionality while also revealing limitations related to scalability and convergence speed.