南通大學人工智能与计算机学院
School of Artificial Intelligence and Computer Science, Nantong University
（阿里云大数据学院）
（人工智能研究院合署）

计算机网络课程设计

Curriculum Design for Computer Networks

LAB REPORT ON

Static Routing Experiment

Supervisor

Dr. 万杰（Wan Jie）

Associate Professor

School of Artificial Intelligence and Computer Science
Nantong University

Submitted By

Vaskar Chakma

2130130204

Class of 2021

2024 年 12 月 14 日

一、Relate Knowledge

1. Introduction of the Basic Knowledge Required

Static routing is an essential networking concept that involves manually configuring routes on routers to direct data packets between different networks. This approach is commonly used in small to medium-sized networks with stable topologies, where dynamic routing protocols may introduce unnecessary complexity and overhead. To implement static routing effectively, one must have a solid understanding of fundamental networking principles, including IP addressing, subnetting, routing tables, and gateway configurations.

IP addressing is crucial because it uniquely identifies devices on a network, enabling efficient communication. Subnetting divides a larger network into smaller sub-networks, simplifying network management and reducing congestion. Routing tables play a central role in directing traffic, storing information about known networks and the corresponding paths to reach them. These paths can be classified into three types: directly connected routes, static routes, and dynamically learned routes. Directly connected routes are automatically recognized when a router's interface is active, while static routes are manually configured by network administrators. Dynamic routes, on the other hand, are learned through routing protocols such as *RIP, OSPF,* or *EIGRP*.

Another critical concept is administrative distance (AD), which ranks the trustworthiness of routing sources. Lower AD values indicate higher trustworthiness, with directly connected networks having the highest priority (AD of 0), followed by static routes (AD of 1). Additionally, understanding routing metrics such as hop count, bandwidth, and delay helps determine the most efficient path when multiple routes to the same destination exist. These metrics influence the router's decision-making process in selecting the best route.

2. Lab Principle

The principle behind this lab is to understand and apply the concept of static routing in a network environment. Static routing is a method where network routes are manually configured by the network administrator, specifying fixed paths for data packets to travel between networks. Unlike dynamic routing, which automatically adjusts routes based on network changes, static routing requires the administrator to define specific routes to reach different networks, ensuring predictable and stable traffic flow.

In this lab, we will configure static routes on routers to enable communication between different subnets in a network. The process involves configuring IP addresses on routers and hosts, then manually entering static routes that specify the next-hop IP address or the exit interface for packets destined for non-directly connected networks. By doing so, each router will know how to forward packets to remote networks, even if they are not directly connected.

The primary objective is to ensure that the routers have the correct routes in their routing tables to forward data packets to the appropriate destinations. This lab will also demonstrate how routers use administrative distance (AD) to prioritize routes, ensuring the most reliable path is selected for packet forwarding. Additionally, students will gain hands-on experience in troubleshooting static routes, understanding how routing tables are populated, and verifying connectivity across the network. This knowledge is fundamental for managing small to medium-sized networks where the network topology is stable and does not change frequently.

3. Lab Steps

- Select devices and connect cables.
- Clear configuration on routers (`erase startup-config`), then reload.
- Configure basic settings (hostname, disable domain lookup, enable secret).
- Configure interface IP addresses and subnet masks, activate interfaces.
- Configure static IP, subnet mask, and default gateway on PCs.
- Test connectivity by pinging default gateways from each PC.
- Check interface status with `show ip interface brief`.
- Configure static routes on routers.
- Verify routing tables with `show ip route`.
- Configure default route on R1 and R3.
- Final connectivity test across all devices.

二、Lab Report

1. Lab Objective and Requirements

Lab Objectives

The objective of this lab is to provide hands-on experience in configuring static routing on network routers. By the end of this lab, students will understand the concepts of static route configuration, route selection, and the role of the routing table in packet forwarding. They will learn how to configure static routes to ensure that routers can forward data packets between different subnets in a network. Additionally, students will gain a deeper understanding of router interface configuration, IP address assignment, and the process of testing connectivity using commands like ***ping*** and ***show ip route***. This lab aims to reinforce the importance of static routing in small to medium-sized networks, where the network topology remains stable and predictable, making static routes an efficient and reliable routing method.

Lab Requirements

To successfully complete this lab, students will need access to a network simulator like Cisco Packet Tracer or GNS3, or physical network equipment including at least three routers and three PCs. The routers should support basic configurations and static routing commands. Additionally, students should be familiar with fundamental networking concepts such as IP addressing, subnetting, and the operation of routers. Basic knowledge of Cisco router commands is also essential for this lab. The lab will require an IP addressing scheme for routers and PCs, specifying IP addresses, subnet masks, and default gateways for each device. Students should also be prepared to use various tools, including the ping command for testing connectivity, show ip interface brief for verifying interface status, and show ip route for examining the router's routing table. By completing this lab, students will gain practical skills in configuring and troubleshooting static routes, which is an essential component of network management.

2. Lab Environment

The lab environment consists of three routers and PCs connected via Ethernet and serial interfaces, either using a network simulator like Cisco Packet Tracer. The routers are configured with static IP addresses and routing tables, and the PCs are assigned static IPs with default gateways. The environment allows for configuring static routes, verifying interface statuses, and testing connectivity through commands like `ping` and `show ip route`. This setup simulates a small to medium-sized network where students can practice configuring and troubleshooting static routing.

3. Lab Design

The lab design involves a network topology with three routers and multiple PCs, each connected through both Ethernet and serial links. The routers are interconnected to form a network, with each router having interfaces connected to different subnets. The design is structured to allow the implementation of static routing, where each router must know how to reach remote networks through static routes.

- **Router R1** has interfaces connected to subnets *172.16.3.0/24, 172.16.2.0/24.*
- **Router R2** connects to subnets *172.16.1.0/24, 172.16.2.0/24,* and *192.168.1.0/24*.
- **Router R3** is connected to subnets *192.168.1.0/24, 192.168.2.0/24*.

Each router is configured with static routes to reach the other routers' networks, ensuring complete network connectivity. PCs are placed within the subnets and configured with static IP addresses and appropriate default gateways pointing to the routers' interfaces.

The design ensures that routers must configure static routes to reach non-directly connected networks, and students will practice configuring these static routes and testing the connectivity between devices using ping and routing verification commands.

4. Lab Process and Recording

Device Selection and Connection

The lab process begins with selecting the necessary devices and establishing the connections according to the network topology. This involves choosing three routers and multiple PCs, then connecting them using Ethernet and serial cables. Once the devices are set up, the next step is to clear any previous configurations from the routers by using the erase startup-config command, followed by a router reload with the reload command. This ensures that the routers start with a clean configuration.

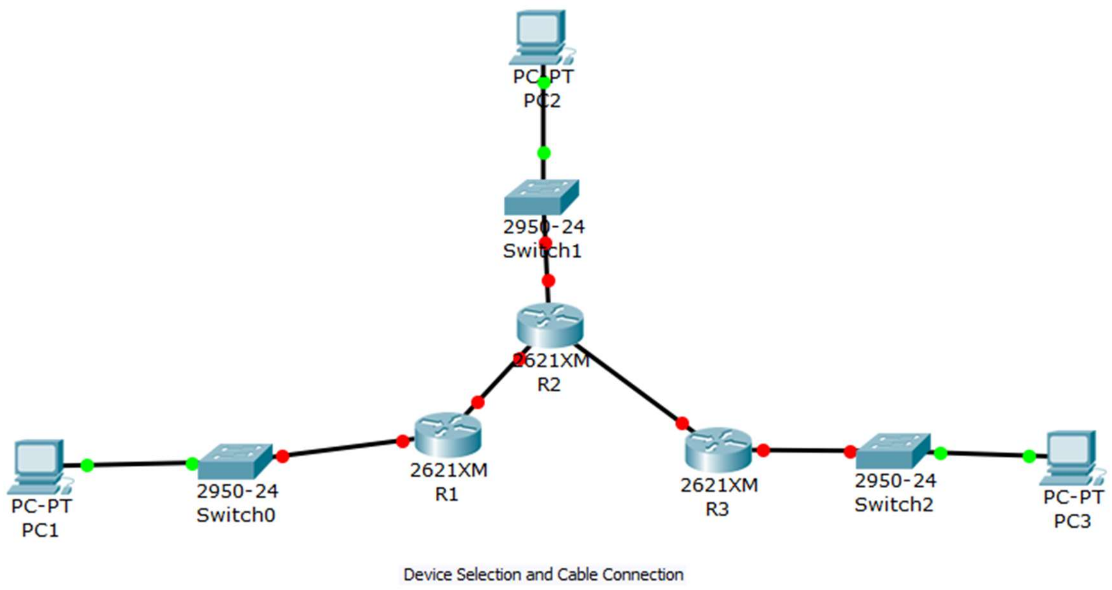


***Fig – 1:** Device Selection and Connection*

Clear Configuration and Reload Routers

Afterward, each router is configured with basic settings. This includes entering global configuration mode, setting the router's hostname (e.g., R1, R2, R3), disabling DNS lookup with the no ip domain-lookup command, and setting an enable secret for security purposes. The next step is to assign IP addresses to the router interfaces according to the provided addressing scheme. The interfaces are activated with the no shutdown command, ensuring they are ready for routing.

Device Name	Interface	IP Address	Subnet Mask	Default Gateway
PC1	Network Card	172.16.3.10	255.255.255.0	172.16.3.1
PC2	Network Card	172.16.1.10	255.255.255.0	172.16.1.10
PC3	Network Card	192.168.2.10	255.255.255.0	192.168.2.1
R1	Fa0/0	172.16.3.1	255.255.255.0	None
	S1/0	172.16.2.1	255.255.255.0	None
R2	Fa0/0	172.16.1.1	255.255.255.0	None
	S1/0	172.16.2.2	255.255.255.0	None
	S1/1	192.168.1.2	255.255.255.0	None
R3	Fa0/0	192.168.2.1	255.255.255.0	None
	S1/1	192.168.1.1	255.255.255.0	None

***Fig – 2:** Device Configuration with IP Addresses, Subnet Masks, and Default Gateways*

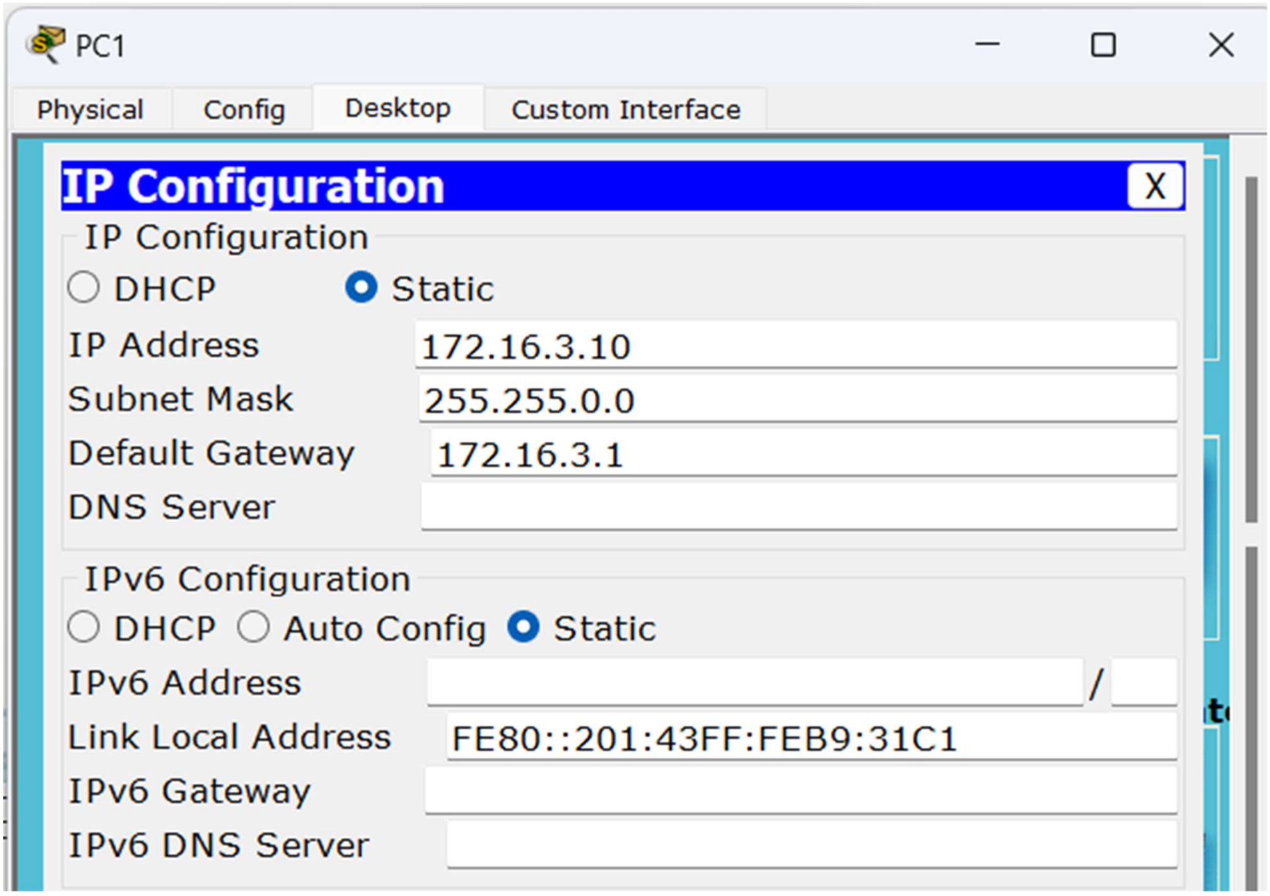


***Fig – 3:** PC1 IP Configuration*

Configure Basic Router Settings

Following the router configuration, each PC is set up with a static IP address, subnet mask, and default gateway as specified in the address table. Once the host PCs are configured, static routes are added to the routers to ensure communication between different networks. On Router R1, static routes are configured to reach the networks 172.16.1.0/24, 192.168.1.0/24, and 192.168.2.0/24 through the appropriate next-hop IP addresses. Similarly, Router R2 is configured with static routes for 172.16.3.0/24 and 192.168.2.0/24, and Router R3 is configured with static routes for 172.16.1.0/24, 172.16.3.0/24, and 172.16.2.0/24.

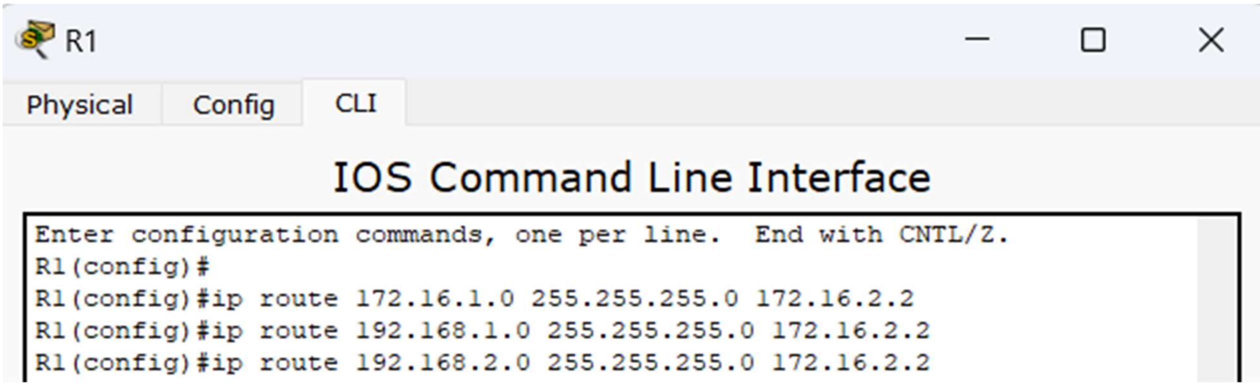


Fig – 4: *R1 Configuration*

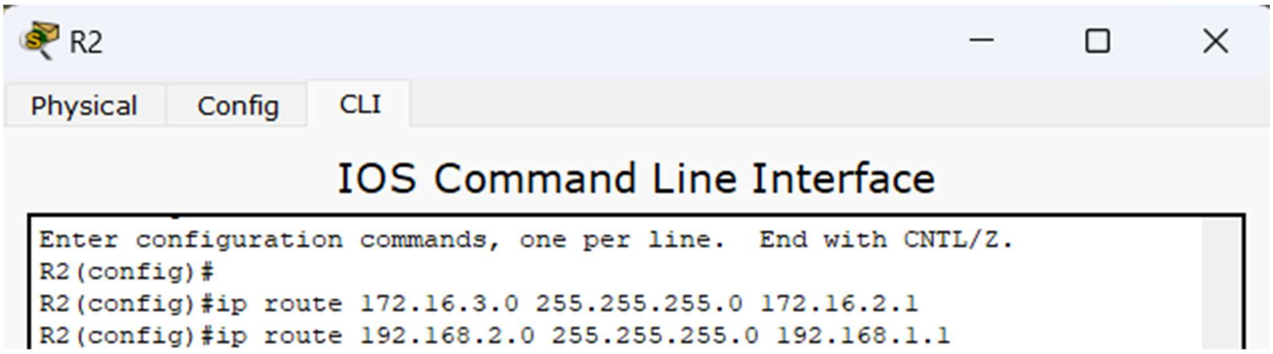


Fig – 5: *R2 Configuration*

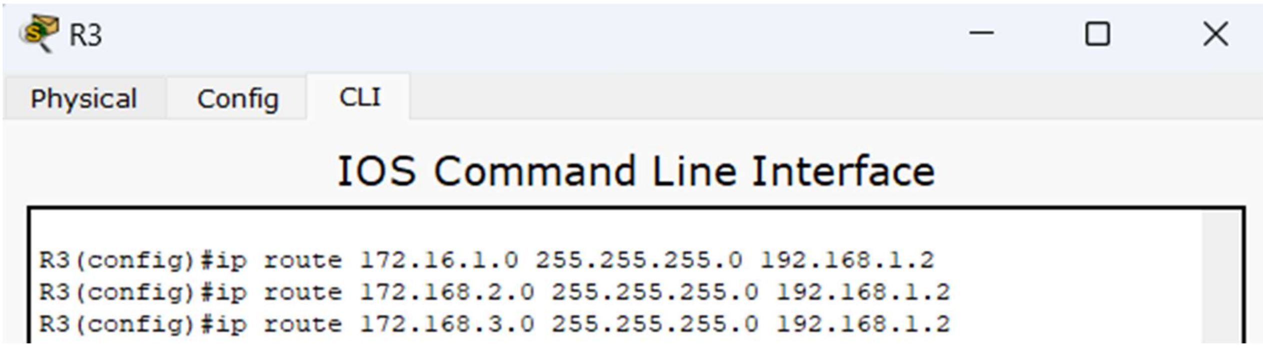


Fig – 6: *R3 Configuration*

The next major step involves configuring static routes on the routers to ensure connectivity between remote networks. For example, on Router R1, static routes are configured to reach networks such as 172.16.1.0/24, 192.168.1.0/24, and 192.168.2.0/24 through the next-hop routers. Similar static route configurations are applied to Routers R2 and R3 to enable communication between their respective connected networks.

Verification and Testing

Once the static routes are configured, the network connectivity is verified. The ping command is used to test communication between PCs and their default gateways to ensure local routing works correctly. Additionally, the show ip interface brief command is executed on each router to confirm that the interfaces are up and running. The show ip route command is also used to view the routing table and verify that all static routes have been properly added.

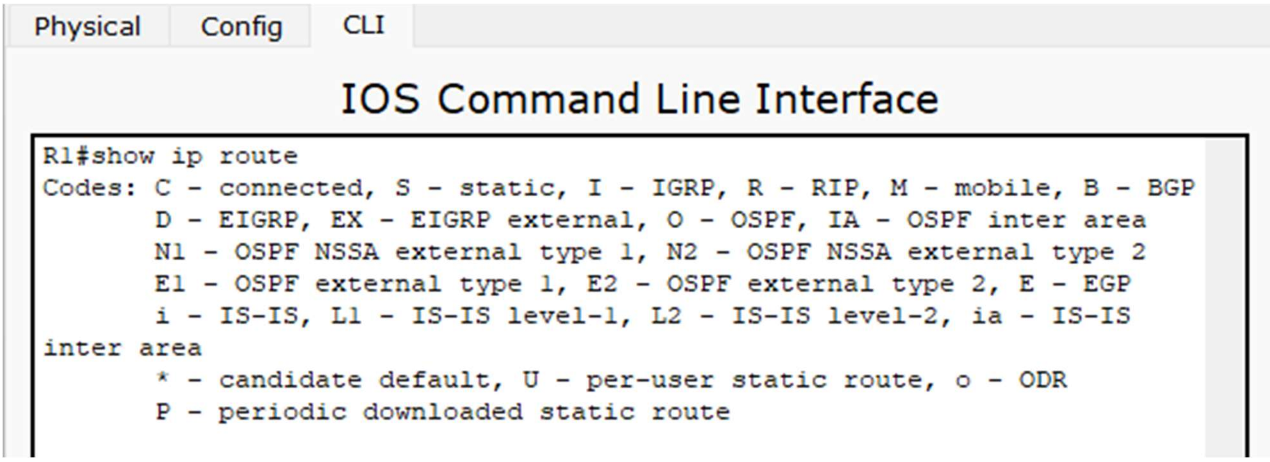


***Fig – 7:** Show ip route*

5. Lab Results and Analysis

In this lab, the static routing configuration and connectivity testing were successfully performed. All devices, including PCs and routers, were assigned the correct IP addresses, subnet masks, and default gateways based on the predefined table. Static routes were manually configured on the routers (R1, R2, and R3) to ensure that each network could communicate with others across different segments. The connectivity between devices was verified using the ping command. Each PC was able to communicate with its respective gateway and other devices within the network. Additionally, the routers were able to forward packets to the correct destinations, as the static routes ensured proper path selection.

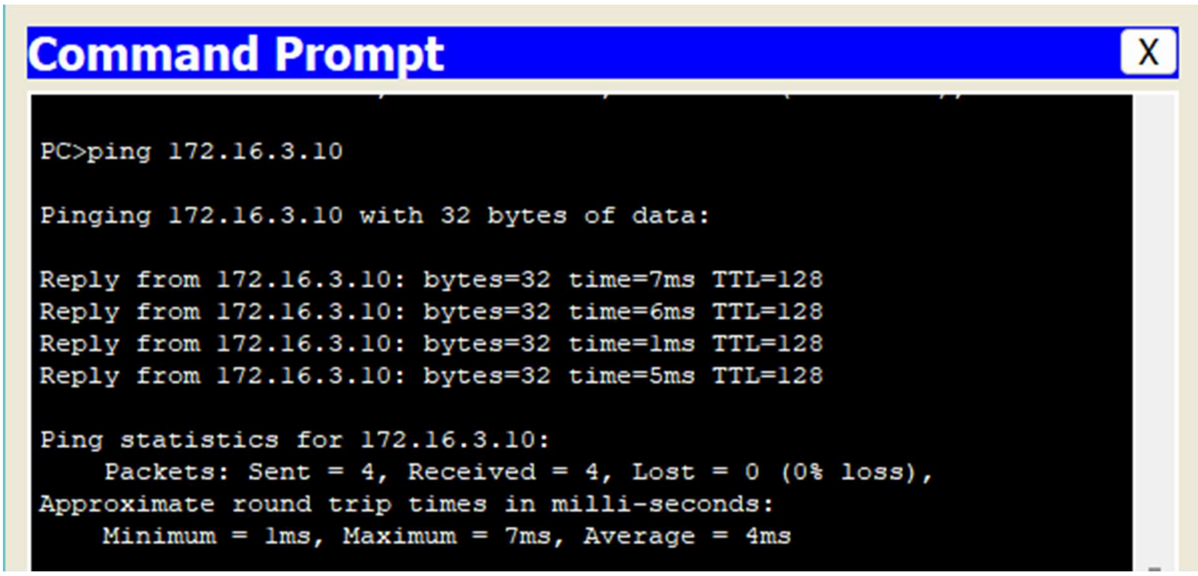
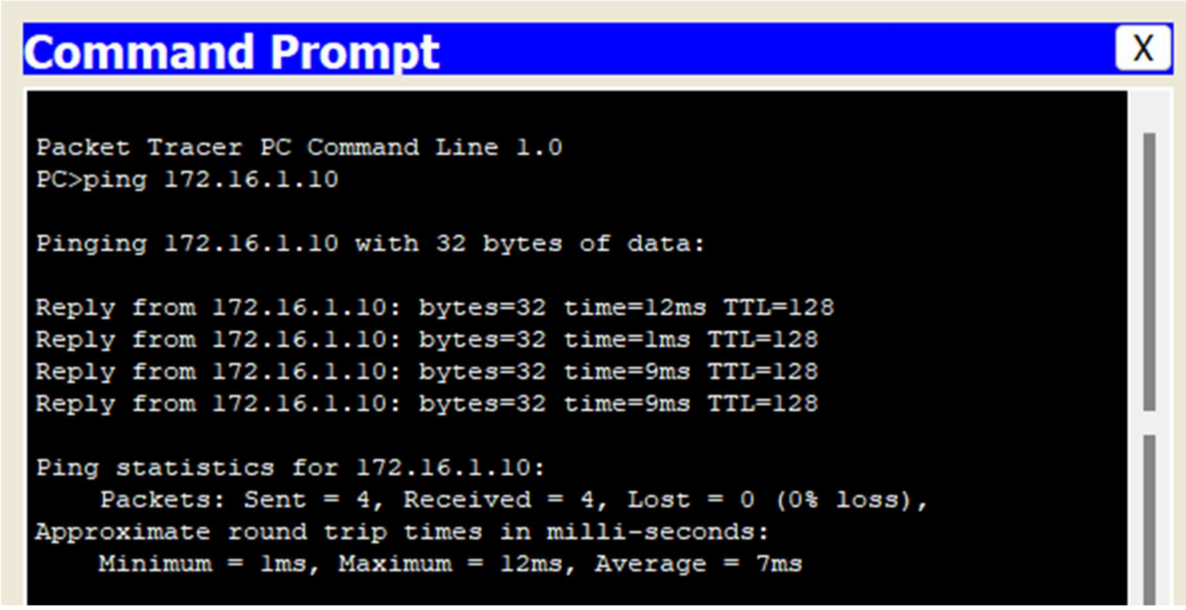


***Fig – 8:** PC1 ping result*



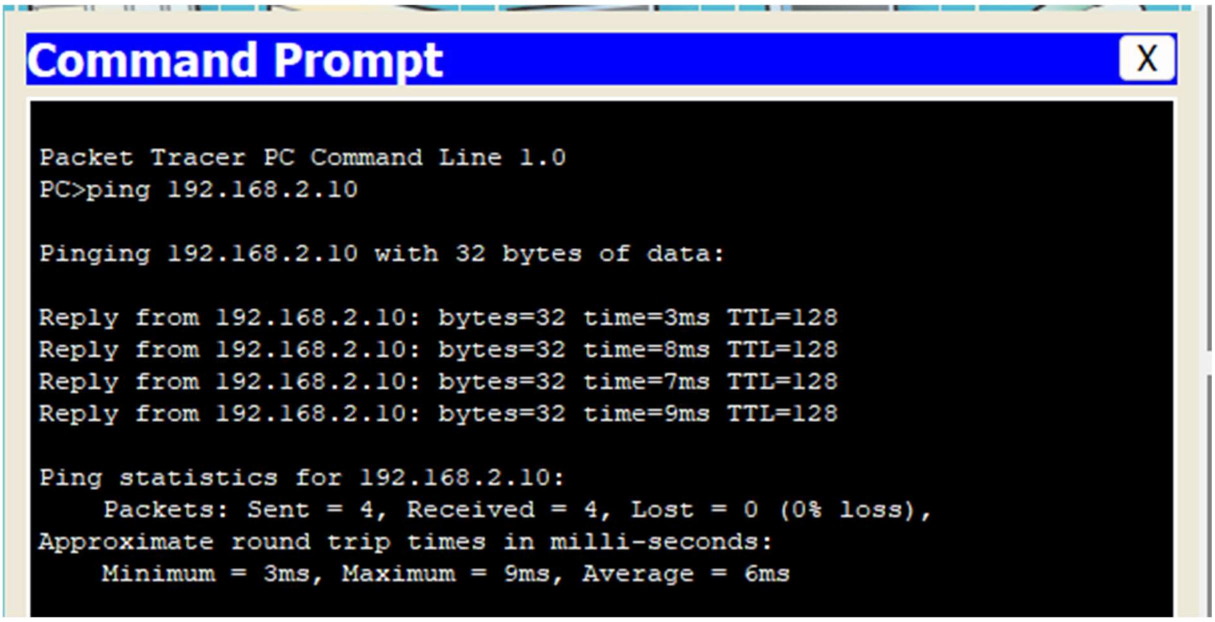
```
Command Prompt
Packet Tracer PC Command Line 1.0
PC>ping 172.16.1.10

Pinging 172.16.1.10 with 32 bytes of data:

Reply from 172.16.1.10: bytes=32 time=12ms TTL=128
Reply from 172.16.1.10: bytes=32 time=1ms TTL=128
Reply from 172.16.1.10: bytes=32 time=9ms TTL=128
Reply from 172.16.1.10: bytes=32 time=9ms TTL=128

Ping statistics for 172.16.1.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 12ms, Average = 7ms
```

Fig – 9: *PC2 ping result*



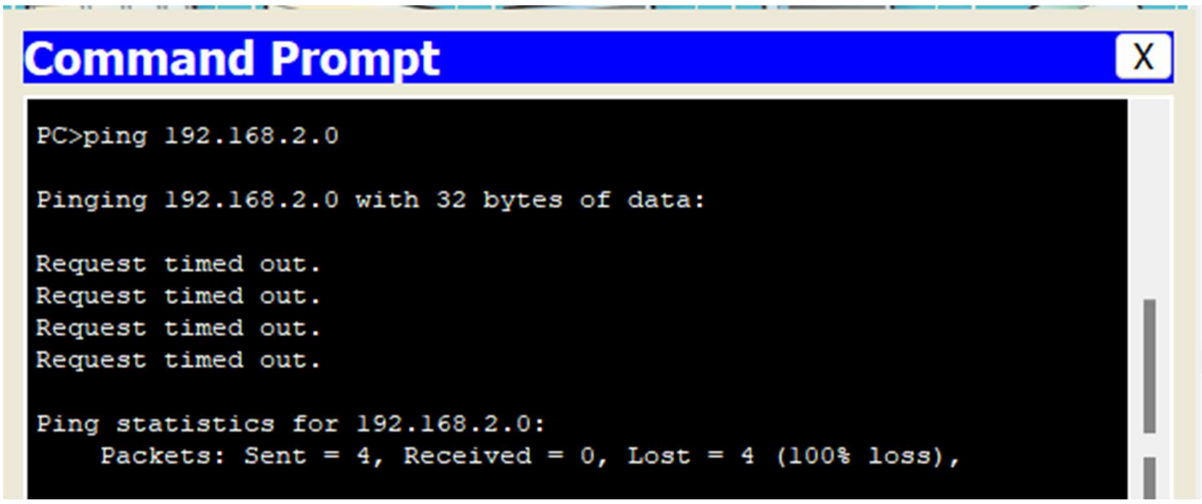
```
Command Prompt
Packet Tracer PC Command Line 1.0
PC>ping 192.168.2.10

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 – 10: *PC3 ping result*



```
Command Prompt
PC>ping 192.168.2.0

Pinging 192.168.2.0 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.2.0:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig – 11: *Incorrect ping result*

The results confirmed that static routing works as expected when routes are correctly configured on all routers. However, any misconfiguration, such as incorrect IP addresses, subnet masks, or missing routes, would result in connectivity failure. This highlights the importance of precise configuration and verification steps in networking.

三、Lab Summary

In this lab, we focused on understanding and implementing static routing within a network environment. The primary objective was to configure static routes on multiple routers to establish and maintain communication between different networks. Each device, including PCs and routers, was assigned a specific IP address, subnet mask, and, where necessary, a default gateway to enable proper network connectivity. Static routes were manually added on the routers, specifying either the next-hop IP addresses or the exit interfaces to ensure data packets could traverse the correct path to their destination. Connectivity between devices was tested and verified using the ping command, which allowed us to confirm successful routing configuration and troubleshoot any issues related to misconfigurations.

This lab also provided an opportunity to analyze the behavior of static routing and understand its importance in network design. By manually configuring routes, we were able to observe how data is forwarded across interconnected networks without relying on dynamic routing protocols. The process highlighted the advantages of static routing, such as simplicity and control over routing paths, particularly in small, stable networks. However, it also demonstrated the limitations, including the need for manual updates when network topology changes, which can become impractical in larger or more dynamic networks.