**IPv4 Addressing and Routing**

Student Version



Huawei Technologies Co., Ltd.

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# IPv4 Addressing and Routing

## Background

Internet Protocol version 4 (IPv4) is a core protocol of the TCP/IP protocol suite and works at the Internet layer in the TCP/IP model or the network layer in the Open System Interconnection (OSI) model. The network layer provides connectionless data transmission. Each IP datagram is transmitted independently, removing the need to establish a connection before IP datagrams are sent.

Routing is the basic element of data communication networks. It is the process of selecting paths on a network along which packets are sent from a source to a destination.

In this lab activity, you will configure IPv4 addresses and static IPv4 routes, and understand basic routing principles in the process.

## Objectives

Upon completion of this task, you will be able to:

Learn how to configure an IPv4 address on an interface

Understand the functions and meanings of loopback interfaces

Understand how direct routes are generated

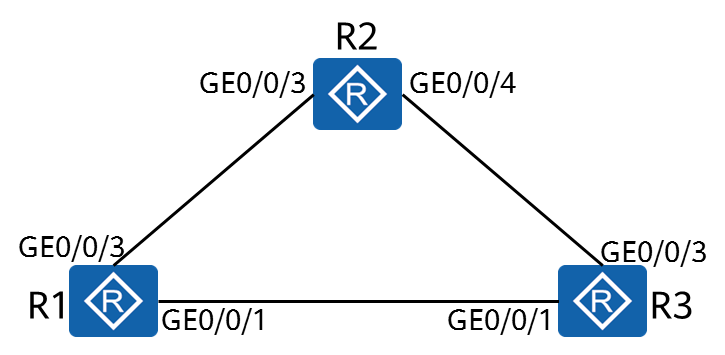
Learn how to configure static routes and understand the conditions for the static routes to take effect

Learn how to test the connectivity of the network layer by using the ping tool

Learn how to configure static routes and understand their application scenarios

## Topology

Lab Topology



## Implementation

### Roadmap

1. Configure IP addresses for the interfaces on the routers.
2. Configure static routes to interconnect the routers.

### Procedure

Complete basic device configuration.

# Name the devices.

The details are not provided here.

Display the IP address of the current interface and the routing table of the router.

# Display the interface status on the router (R1 in this example).

[R1]display ip interface brief

\*down: administratively down

^down: standby

(l): loopback

(s): spoofing

(E): E-Trunk down

The number of interface that is UP in Physical is 3

The number of interface that is DOWN in Physical is 5

The number of interface that is UP in Protocol is 1

The number of interface that is DOWN in Protocol is 10

Interface IP Address/Mask Physical Protocol

GigabitEthernet0/0/1 unassigned up down

GigabitEthernet0/0/2 unassigned up down

GigabitEthernet0/0/3 unassigned up down

The **display ip interface brief** command displays the brief information about interface IP addresses, including the IP addresses, subnet masks, physical status, link-layer protocol status, and number of interfaces in different states.

GigabitEthernet0/0/1 and GigabitEthernet0/0/3 on R1 are not configured with IP addresses. Therefore, the IP Address/Mask field is in the unassigned state, the Protocol field is in the down state, and the Physical field is in the up state.

# Display the routing table on the router (R1 in this example).

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 4 Routes : 4

Destination/Mask Proto Pre Cost Flags NextHop Interface

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

InLoopBack0 is a default loopback interface.

InLoopBack0 uses the fixed loopback address 127.0.0.1/8 to receive data packets destined for the host where InLoopBack0 resides. The IP address of the InLoopBack0 interface cannot be changed or advertised using a routing protocol.

Configure IP addresses for physical interfaces.

# Configure IP addresses for physical interfaces based on the following table.

IP addresses of physical interfaces

|  |  |  |
| --- | --- | --- |
| **Router** | **Interface** | **IP Address/Mask** |
| R1 | GigabitEthernet0/0/1 | 10.0.13.1/24 |
| GigabitEthernet0/0/3 | 10.0.12.1/24 |
| R2 | GigabitEthernet0/0/3 | 10.0.12.2/24 |
| GigabitEthernet0/0/4 | 10.0.23.2/24 |
| R3 | GigabitEthernet0/0/1 | 10.0.13.3/24 |
| GigabitEthernet0/0/3 | 10.0.23.3/24 |

<R1>system-view

<R2>system-view

<R3>system-view

# Use the ping tool to test the connectivity.

[R1]ping 10.0.12.2

PING 10.0.12.2: 56 data bytes, press CTRL\_C to break

Reply from 10.0.12.2: bytes=56 Sequence=1 ttl=255 time=70 ms

Reply from 10.0.12.2: bytes=56 Sequence=2 ttl=255 time=50 ms

Reply from 10.0.12.2: bytes=56 Sequence=3 ttl=255 time=40 ms

Reply from 10.0.12.2: bytes=56 Sequence=4 ttl=255 time=30 ms

Reply from 10.0.12.2: bytes=56 Sequence=5 ttl=255 time=50 ms

--- 10.0.12.2 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 30/48/70 ms

[R1]ping 10.0.13.3

PING 10.0.13.3: 56 data bytes, press CTRL\_C to break

Reply from 10.0.13.3: bytes=56 Sequence=1 ttl=255 time=50 ms

Reply from 10.0.13.3: bytes=56 Sequence=2 ttl=255 time=60 ms

Reply from 10.0.13.3: bytes=56 Sequence=3 ttl=255 time=50 ms

Reply from 10.0.13.3: bytes=56 Sequence=4 ttl=255 time=30 ms

Reply from 10.0.13.3: bytes=56 Sequence=5 ttl=255 time=30 ms

--- 10.0.13.3 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 30/44/60 ms

# Display the routing table of R1.

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 10 Routes : 10

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

The preceding command output shows that three direct routes are automatically generated for each interface after the IP addresses of the interfaces are configured, which are

A route to the network where the interface resides

The host route to the interface

The host route to the broadcast address of the network where the interface resides



A host route is a route with a 32-bit mask.

Create a loopback interface.

# Configure the loopback interface according to the following table.

IP addresses of loopback interfaces

|  |  |  |
| --- | --- | --- |
| **Router** | **Interface** | **IP Address/Mask** |
| R1 | LoopBack0 | 10.0.1.1/32 |
| R2 | LoopBack0 | 10.0.1.2/32 |
| R3 | LoopBack0 | 10.0.1.3/32 |

Loopback interfaces are logical interfaces manually configured and do not exist physically. Logical interfaces can be used to exchange data. A loopback interface is always Up at the physical layer and link layer unless it is manually shut down. Generally, a loopback interface uses a 32-bit mask. Loopback interfaces are used for the following purposes:

Used as the address for identifying and managing the router

Used as the router ID in OSPF

Used for improving network reliability

In this lab activity, the loopback interfaces are used to simulate clients.

# Display the routing table on the router (R1 in this example).

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 11 Routes : 11

Destination/Mask Proto Pre Cost Flags NextHop Interface

**10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0**

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

*Direct routes have been generated.*

# Test the connectivity between the loopback interfaces.

[R1]ping -a 10.0.1.1 10.0.1.2

PING 10.0.1.2: 56 data bytes, press CTRL\_C to break

Request time out

Request time out

Request time out

Request time out

Request time out

--- 10.0.1.2 ping statistics ---

5 packet(s) transmitted

0 packet(s) received

100.00% packet loss

Using the **ping –a** *source-ip-address destination-ip-address* command to specify the source and destination IP addresses of ping packets. At this point, the router does not have a route to the destination IP address. Therefore, the ping operation fails.

Configure static routes.

# On R1, configure a route to the loopback0 interfaces of R2 and R3.

# Display the routing table of R1.

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 13 Routes : 13

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0

**10.0.1.2/32 Static 60 0 RD 10.0.12.2 GigabitEthernet0/0/3**

**10.0.1.3/32 Static 60 0 RD 10.0.13.3 GigabitEthernet0/0/1**

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

*The configured static routes are added to the IP routing table.*

# Test connectivity.

[R1]ping -a 10.0.1.1 10.0.1.2

PING 10.0.1.2: 56 data bytes, press CTRL\_C to break

Request time out

Request time out

Request time out

Request time out

Request time out

--- 10.0.1.2 ping statistics ---

5 packet(s) transmitted

0 packet(s) received

100.00% packet loss

The loopback0 interface of R2 still cannot be pinged because R2 does not have a route to the loopback0 interface of R1.

# On R2, add a route to LoopBack0 of R1.

# Test connectivity.

<R1>ping -a 10.0.1.1 10.0.1.2

PING 10.0.1.2: 56 data bytes, press CTRL\_C to break

Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=255 time=60 ms

Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=255 time=30 ms

Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=255 time=10 ms

Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=255 time=50 ms

Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=255 time=30 ms

--- 10.0.1.2 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 10/36/60 ms

*Loopback0 on R1 can communicate with loopback0 on R2.*

# Configure other necessary routes.

# Test the connectivity between the loopback0 interfaces of the routers by referring to the proceeding description.

Configure a path from R1 to R2 via R3 as the backup path from LoopBack0 of R1 to LoopBack0 of R2.

# Configure static routes on R1 and R2.

# Display the routing tables of R1 and R2.

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 13 Routes : 13

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0

10.0.1.2/32 Static 60 0 RD 10.0.12.2 GigabitEthernet0/0/3

10.0.1.3/32 Static 60 0 RD 10.0.13.3 GigabitEthernet0/0/1

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

[R2]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 13 Routes : 13

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.1.1/32 Static 60 0 RD 10.0.12.1 GigabitEthernet0/0/3

10.0.1.2/32 Direct 0 0 D 127.0.0.1 LoopBack0

10.0.1.3/32 Static 60 0 RD 10.0.23.3 GigabitEthernet0/0/4

10.0.12.0/24 Direct 0 0 D 10.0.12.2 GigabitEthernet0/0/3

10.0.12.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.23.0/24 Direct 0 0 D 10.0.23.2 GigabitEthernet0/0/4

10.0.23.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/4

10.0.23.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/4

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

*The static route with a preference value of 100 is not added to the routing table.*

# Shut down GigabitEthernet0/0/3 interface on R1 and R2 to invalidate the route with the highest priority.

[R1]interface GigabitEthernet0/0/3

[R1-GigabitEthernet0/0/3]shutdown

# Display the routing table on R1 and R2. The command output shows that the routes with a lower priority are activated when the routes with a higher priority are invalidated.

[R1]display IP routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 10 Routes : 10

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0

**10.0.1.2/32 Static 100 0 RD 10.0.13.3 GigabitEthernet0/0/1**

10.0.1.3/32 Static 60 0 RD 10.0.13.3 GigabitEthernet0/0/1

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

[R2]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 10 Routes : 10

Destination/Mask Proto Pre Cost Flags NextHop Interface

**10.0.1.1/32 Static 100 0 RD 10.0.23.3 GigabitEthernet0/0/4**

10.0.1.2/32 Direct 0 0 D 127.0.0.1 LoopBack0

10.0.1.3/32 Static 60 0 RD 10.0.23.3 GigabitEthernet0/0/4

10.0.23.0/24 Direct 0 0 D 10.0.23.2 GigabitEthernet0/0/4

10.0.23.2/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/4

10.0.23.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/4

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

In this case, the original static route becomes invalid and the static route with a lower priority is activated.

# Test connectivity.

[R1]ping -a 10.0.1.1 10.0.1.2

PING 10.0.1.2: 56 data bytes, press CTRL\_C to break

Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=254 time=80 ms

Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=254 time=60 ms

Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=254 time=60 ms

Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=254 time=110 ms

Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=254 time=80 ms

--- 10.0.1.2 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 60/78/110 ms

# Trace the path of the data packets.

[R1]tracert -a 10.0.1.1 10.0.1.2

traceroute to 10.0.1.2(10.0.1.2), max hops: 30 ,packet length: 40,press CTRL\_C to break

1 10.0.13.3 40 ms 30 ms 50 ms

2 10.0.23.2 80 ms 80 ms 60 ms

The **tracert** command displays the path of packets from the source to the destination.

The command output shows that the data packets pass through GigabitEthernet0/0/1 and GigabitEthernet0/0/3 of R3 and are then forwarded to GigabitEthernet0/0/4 of R2.



In some lab environments, the devices may not respond to ICMP packets for security reasons. Therefore, the results may vary. You can press Ctrl+C to end the tracert operation.

Configure default routes to connect the LoopBack0 interface of R1 and the LoopBack0 interface of R2.

# Restore the interfaces and delete the configured routes.

[R1]

# Display the routing table of R1.

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 12 Routes : 12

Destination/Mask Proto Pre Cost Flags NextHop Interface

10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0

10.0.1.3/32 Static 60 0 RD 10.0.13.3 GigabitEthernet0/0/1

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

*R1 does not have a route to LoopBack0 (10.1.1.2/32) of R2.*

# Configure a default route on R1.

# Display the routing table of R1.

[R1]display ip routing-table

Route Flags: R - relay, D - download to fib

------------------------------------------------------------------------------

Routing Tables: Public

Destinations : 13 Routes : 13

Destination/Mask Proto Pre Cost Flags NextHop Interface

**0.0.0.0/0 Static 60 0 RD 10.0.12.2 GigabitEthernet0/0/3**

10.0.1.1/32 Direct 0 0 D 127.0.0.1 LoopBack0

10.0.1.3/32 Static 60 0 RD 10.0.13.3 GigabitEthernet0/0/1

10.0.12.0/24 Direct 0 0 D 10.0.12.1 GigabitEthernet0/0/3

10.0.12.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.12.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/3

10.0.13.0/24 Direct 0 0 D 10.0.13.1 GigabitEthernet0/0/1

10.0.13.1/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

10.0.13.255/32 Direct 0 0 D 127.0.0.1 GigabitEthernet0/0/1

127.0.0.0/8 Direct 0 0 D 127.0.0.1 InLoopBack0

127.0.0.1/32 Direct 0 0 D 127.0.0.1 InLoopBack0

127.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

255.255.255.255/32 Direct 0 0 D 127.0.0.1 InLoopBack0

*The default route has been activated.*

# Test the connectivity between LoopBack0 of R1 and LoopBack0 of R2.

[R1]ping -a 10.0.1.1 10.0.1.2

PING 10.0.1.2: 56 data bytes, press CTRL\_C to break

Reply from 10.0.1.2: bytes=56 Sequence=1 ttl=255 time=50 ms

Reply from 10.0.1.2: bytes=56 Sequence=2 ttl=255 time=30 ms

Reply from 10.0.1.2: bytes=56 Sequence=3 ttl=255 time=20 ms

Reply from 10.0.1.2: bytes=56 Sequence=4 ttl=255 time=40 ms

Reply from 10.0.1.2: bytes=56 Sequence=5 ttl=255 time=20 ms

--- 10.0.1.2 ping statistics ---

5 packet(s) transmitted

5 packet(s) received

0.00% packet loss

round-trip min/avg/max = 20/32/50 ms

*LoopBack0 of R1 can communicate with LoopBack0 of R2.*

**----End**

## Verification

You can run the ping and tracert commands to test the connectivity between loopback0 interfaces on different devices.