Understanding the Ping and Traceroute Commands

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Contents

Introduction

This document illustrates the use of the **ping** and **traceroute** commands. With the aid of some **debug** commands, this document captures a more detailed view of how these commands work.

Note: Enabling any **debug** commands on a production router may cause serious problems. We recommend that you carefully read the Use the Debug Command section before you issue **debug** commands.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

This document is not restricted to specific software and hardware versions.

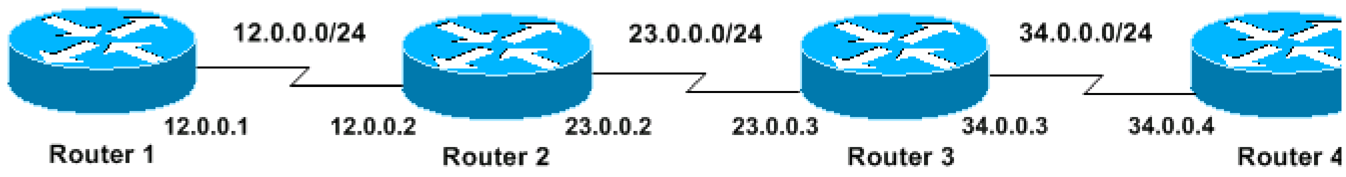
The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to the Cisco Technical Tips Conventions.

Background Information

In this document, we use the basic configuration shown below as a basis for our examples:



The Ping Command

The **ping** command is a very common method for troubleshooting the accessibility of devices. It uses a series of Internet Control Message Protocol (ICMP) Echo messages to determine:

- Whether a remote host is active or inactive.
- The round-trip delay in communicating with the host.
- Packet loss.

The **ping** command first sends an echo request packet to an address, then waits for a reply. The ping is successful only if:

- the echo request gets to the destination, and
- the destination is able to get an echo reply back to the source within a predetermined time called a timeout. The default value of this timeout is two seconds on Cisco routers.

For all the options about this command, see "Ping" under Troubleshooting Commands.

The TTL value of a **ping** packet cannot be changed.

Here is an output example showing the **ping** command after enabling the **debug ip packet detail** command:

Warning: Using the **debug ip packet detail** command on a production router can cause high CPU utilization. This may result in a severe performance degradation or a network outage. We recommend that you carefully read Use the Debug Command before issuing **debug** commands.

```
Router1#debug ip packet detail
IP packet debugging is on (detailed)

Router1#ping 12.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/6/8 ms

Router1#
Jan 20 15:54:47.487: IP: s=12.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
  sending
Jan 20 15:54:47.491: ICMP type=8, code=0

!--- This is the ICMP packet 12.0.0.1 sent to 12.0.0.2.
!--- ICMP type=8 corresponds to the echo message.

Jan 20 15:54:47.523: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 100,
  rcvd 3
Jan 20 15:54:47.527: ICMP type=0, code=0

!--- This is the answer we get from 12.0.0.2.
!--- ICMP type=0 corresponds to the echo reply message.
!--- By default, the repeat count is five times, so there will be five
!--- echo requests, and five echo replies.
```

The table below lists possible ICMP-type values.

ICMP Type	Literal
0	echo-reply
3	destination unreachable code 0 = net unreachable 1 = host unreachable 2 = protocol unreachable 3 = port unreachable 4 = fragmentation needed and DF set

	5 = source route failed
4	source-quench
5	redirect code 0 = redirect datagrams for the network 1 = redirect datagrams for the host 2 = redirect datagrams for the type of service and network 3 = redirect datagrams for the type of service and host
6	alternate-address
8	echo
9	router-advertisement
10	router-solicitation
11	time-exceeded code 0 = time to live exceeded in transit 1 = fragment reassembly time exceeded
12	parameter-problem
13	timestamp-request
14	timestamp-reply
15	information-request
16	information-reply
17	mask-request
18	mask-reply
31	conversion-error
32	mobile-redirect

The table below lists the possible output characters from the ping facility:

Character	**Description**
!	Each exclamation point indicates receipt of a reply.
.	Each period indicates the network server timed out while waiting for a reply.
U	A destination unreachable error PDU was

	received.
Q	Source quench (destination too busy).
M	Could not fragment.
?	Unknown packet type.
&	Packet lifetime exceeded.

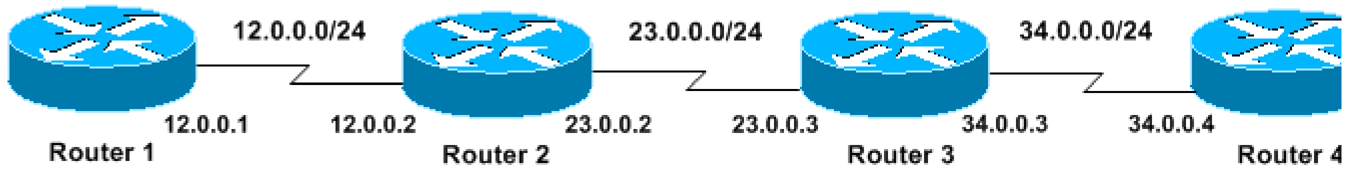
Why Can't I Ping?

If you are not able to successfully ping to an address, consider these causes:

Routing Issue

Here are examples of unsuccessful ping attempts, determining the problem, and what to do to resolve the problem.

This scenario is explained using the network topology diagram below:



```
Router1#
!
!
interface Serial0
ip address 12.0.0.1 255.255.255.0
no fair-queue
clockrate 64000
!
!

Router2#
!
!
interface Serial0
ip address 23.0.0.2 255.255.255.0
no fair-queue
clockrate 64000
!
interface Serial1
ip address 12.0.0.2 255.255.255.0
!
!


Router3#
!
```

```
!
interface Serial0
ip address 34.0.0.3 255.255.255.0
no fair-queue
!
interface Serial1
ip address 23.0.0.3 255.255.255.0
!
!
```

```
Router4#
!
!
interface Serial0
ip address 34.0.0.4 255.255.255.0
no fair-queue
clockrate 64000
!
!
```

Let us try to ping Router4 from Router1:

```
Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

Let us have a closer look at what has happened:

```
Router1#debug ip packet
IP packet debugging is on
```

Warning: Using the **debug ip packet** command on a production router can cause high cpu utilization. This may result in a severe performance degradation or a network outage. We recommend that you carefully read Use the Debug Command before issuing **debug** commands.

```
Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:

Jan 20 16:00:25.603: IP: s=12.0.0.1 (local), d=34.0.0.4, len 100, unroutable.
Jan 20 16:00:27.599: IP: s=12.0.0.1 (local), d=34.0.0.4, len 100, unroutable.
Jan 20 16:00:29.599: IP: s=12.0.0.1 (local), d=34.0.0.4, len 100, unroutable.
Jan 20 16:00:31.599: IP: s=12.0.0.1 (local), d=34.0.0.4, len 100, unroutable.
Jan 20 16:00:33.599: IP: s=12.0.0.1 (local), d=34.0.0.4, len 100, unroutable.
Success rate is 0 percent (0/5)
```

Since no routing protocols are running on Router1, it does not know where to send its packet and we get an "unroutable" message.

Now let us add a static route to Router1:

```
Router1#**configure terminal**
Enter configuration commands, one per line.  End with CNTL/Z.
Router1(config)#**ip route 0.0.0.0 0.0.0.0 Serial0**
```

We now have:

```
Router1#debug ip packet detail
IP packet debugging is on (detailed)

Router1#ping 34.0.0.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
U.U.U
Success rate is 0 percent (0/5)

Jan 20 16:05:30.659: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
  sending
Jan 20 16:05:30.663:     ICMP type=8, code=0
Jan 20 16:05:30.691: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 56,
  rcvd 3
Jan 20 16:05:30.695:     ICMP type=3, code=1
Jan 20 16:05:30.699: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
  sending
Jan 20 16:05:30.703:     ICMP type=8, code=0
Jan 20 16:05:32.699: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
  sending
Jan 20 16:05:32.703:     ICMP type=8, code=0
Jan 20 16:05:32.731: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 56,
  rcvd 3
Jan 20 16:05:32.735:     ICMP type=3, code=1
Jan 20 16:05:32.739: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
  sending
Jan 20 16:05:32.743:     ICMP type=8, code=0
```

Now let us examine what is wrong on Router2:

```
Router2#debug ip packet detail
IP packet debugging is on (detailed)

Router2#
Jan 20 16:10:41.907: IP: s=12.0.0.1 (Serial1), d=34.0.0.4, len 100, unroutable
Jan 20 16:10:41.911:     ICMP type=8, code=0
Jan 20 16:10:41.915: IP: s=12.0.0.2 (local), d=12.0.0.1 (Serial1), len 56, send
Jan 20 16:10:41.919:     ICMP type=3, code=1
Jan 20 16:10:41.947: IP: s=12.0.0.1 (Serial1), d=34.0.0.4, len 100, unroutable
Jan 20 16:10:41.951:     ICMP type=8, code=0
Jan 20 16:10:43.943: IP: s=12.0.0.1 (Serial1), d=34.0.0.4, len 100, unroutable
Jan 20 16:10:43.947:     ICMP type=8, code=0
Jan 20 16:10:43.951: IP: s=12.0.0.2 (local), d=12.0.0.1 (Serial1), len 56, send
Jan 20 16:10:43.955:     ICMP type=3, code=1
Jan 20 16:10:43.983: IP: s=12.0.0.1 (Serial1), d=34.0.0.4, len 100, unroutable
Jan 20 16:10:43.987:     ICMP type=8, code=0
Jan 20 16:10:45.979: IP: s=12.0.0.1 (Serial1), d=34.0.0.4, len 100, unroutable
Jan 20 16:10:45.983:     ICMP type=8, code=0
Jan 20 16:10:45.987: IP: s=12.0.0.2 (local), d=12.0.0.1 (Serial1), len 56, send
Jan 20 16:10:45.991:     ICMP type=3, code=1
```

Router1 is correctly sending its packets to Router2, but Router2 doesn't know how to access address

34.0.0.4. Router2 sends back an "unreachable ICMP" message to Router1.

Now let's enable Routing Information Protocol (RIP) on Router2 and Router3:

```
Router2#
router rip
 network 12.0.0.0
 network 23.0.0.0
Router3#
router rip
 network 23.0.0.0
 network 34.0.0.0
```

Now we have:

```
Router1#debug ip packet
IP packet debugging is on

Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:

Jan 20 16:16:13.367: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending.
Jan 20 16:16:15.363: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending.
Jan 20 16:16:17.363: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending.
Jan 20 16:16:19.363: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending.
Jan 20 16:16:21.363: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending.
Success rate is 0 percent (0/5)
```

This is slightly better. Router1 is sending packets to Router4, but is not getting any answer from Router4.

Let us see what the problem could be on Router4:

```
Router4#debug ip packet
IP packet debugging is on

Router4#
Jan 20 16:18:45.903: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
  rcvd 3
Jan 20 16:18:45.911: IP: s=34.0.0.4 (local), d=12.0.0.1, len 100, unroutable
Jan 20 16:18:47.903: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
  rcvd 3
Jan 20 16:18:47.907: IP: s=34.0.0.4 (local), d=12.0.0.1, len 100, unroutable
Jan 20 16:18:49.903: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
  rcvd 3
Jan 20 16:18:49.907: IP: s=34.0.0.4 (local), d=12.0.0.1, len 100, unroutable
Jan 20 16:18:51.903: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
  rcvd 3
Jan 20 16:18:51.907: IP: s=34.0.0.4 (local), d=12.0.0.1, len 100, unroutable
Jan 20 16:18:53.903: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
  rcvd 3
Jan 20 16:18:53.907: IP: s=34.0.0.4 (local), d=12.0.0.1, len 100, unroutable
```

Router4 receives the ICMP packets, and tries to answer to 12.0.0.1, but because it does not have a route to this network, it simply fails.

Let us add a static route to Router4:

```
Router4(config)#ip route 0.0.0.0 0.0.0.0 Serial0
```

Now it works perfectly, and both sides can access each other:

```
Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/35/36 ms
```

Interface Down

This is a situation where the interface stops working. In the example below, we try to ping Router4 from Router1:

```
Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
U.U.U
Success rate is 0 percent (0/5)
```

Since the routing is fine, we will do the troubleshooting step-by-step. First, let us try to ping Router2:

```
Router1#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

From the above, we see that the problem lies between Router2 and Router3. One possibility is that the serial interface on Router3 has been shut down:

```
Router3#show ip interface brief
Serial0   34.0.0.3    YES manual up                      up
Serial1   23.0.0.3    YES manual administratively down   down
```

This is quite simple to fix:

```
Router3#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router3(config)#interface s1
Router3(config-if)#no shutdown
Router3(config-if)#
```

```
Jan 20 16:20:53.900: %LINK-3-UPDOWN: Interface Serial1, changed state to up
Jan 20 16:20:53.910: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1,
  changed state to up
```

Access-list Command

In this scenario, we want to allow only telnet traffic to enter Router4 through interface Serial0 .

```
Router4(config)# access-list 100 permit tcp any any eq telnet
Router4(config)#interface s0
Router4(config-if)#ip access-group 100 in


Router1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router1(config)#access-list 100 permit ip host 12.0.0.1 host 34.0.0.4
Router1(config)#access-list 100 permit ip host 34.0.0.4 host 12.0.0.1
Router1(config)#end
Router1#debug ip packet 100
IP packet debugging is on
Router1#debug ip icmp
ICMP packet debugging is on
```

Refer to the Use the Debug Command section for using access lists with **debug** commands.

When we now try to ping Router4, we have the following:

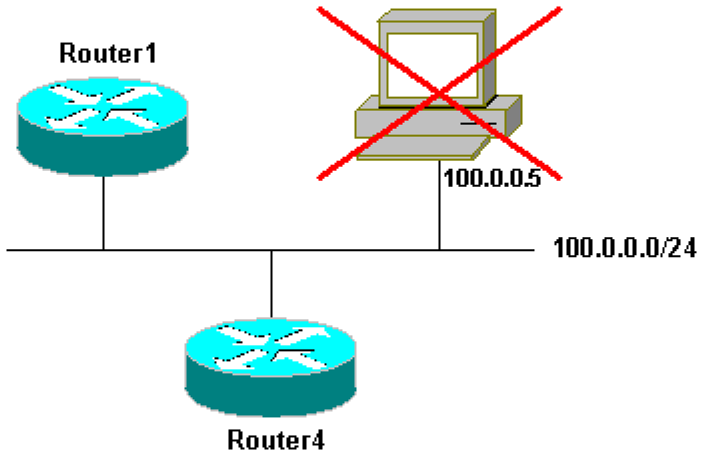
```
Router1#ping 34.0.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 34.0.0.4, timeout is 2 seconds:
U.U.U
Success rate is 0 percent (0/5)

Jan 20 16:34:49.207: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending
Jan 20 16:34:49.287: IP: s=34.0.0.4 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:34:49.291: ICMP: dst (12.0.0.1) administratively prohibited unreachab
 rcv from 34.0.0.4
Jan 20 16:34:49.295: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending
Jan 20 16:34:51.295: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending
Jan 20 16:34:51.367: IP: s=34.0.0.4 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:34:51.371: ICMP: dst (12.0.0.1) administratively prohibited unreachab
 rcv from 34.0.0.4
Jan 20 16:34:51.379: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 100,
 sending
```

At the end of an **access-list** command, we always have an implicit "deny all". This means that the ICMP packets that are entering the Serial 0 interface on Router4 are denied, and Router 4 sends an ICMP "administratively prohibited unreachable" message to the source of the original packet as shown in the **debug** message. The solution is to add the following line in the **access-list** command:

```
Router4(config)#access-list 100 permit icmp any any
```

Address Resolution Protocol (ARP) Issue

Here is a scenario with an Ethernet connection:



```
Router4#ping 100.0.0.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.5, timeout is 2 seconds:

Jan 20 17:04:05.167: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  sending
Jan 20 17:04:05.171: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  encapsulation failed.
Jan 20 17:04:07.167: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  sending
Jan 20 17:04:07.171: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  encapsulation failed.
Jan 20 17:04:09.175: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  sending
Jan 20 17:04:09.183: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  encapsulation failed.
Jan 20 17:04:11.175: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  sending
Jan 20 17:04:11.179: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  encapsulation failed.
Jan 20 17:04:13.175: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  sending
Jan 20 17:04:13.179: IP: s=100.0.0.4 (local), d=100.0.0.5 (Ethernet0), len 100,
  encapsulation failed.
Success rate is 0 percent (0/5)
Router4#
```

In this example, the ping is not working due to "encapsulation failed". This means that the router knows on which interface it has to send the packet, but does not know how to do it. In this case, you need to understand how Address Resolution Protocol (ARP) works. See Configuring Address Resolution Methods for a detailed explanation.

Basically, ARP is a protocol used to map the Layer 2 address (MAC address) to a Layer 3 address (IP address). You can check this mapping using the **show arp** command:

```
Router4#show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  100.0.0.4               -   0000.0c5d.7a0d  ARPA   Ethernet0
Internet  100.0.0.1              10   0060.5cf4.a955  ARPA   Ethernet0
```

Return to the "encapsulation failed" problem. We get a better idea of the problem using this **debug** command:

```
Router4#debug arp
ARP packet debugging is on

Router4#ping 100.0.0.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.5, timeout is 2 seconds:

Jan 20 17:19:43.843: IP ARP: creating incomplete entry for IP address: 100.0.0.
  interface Ethernet0
Jan 20 17:19:43.847: IP ARP: sent req src 100.0.0.4 0000.0c5d.7a0d,
                 dst 100.0.0.5 0000.0000.0000 Ethernet0.
Jan 20 17:19:45.843: IP ARP: sent req src 100.0.0.4 0000.0c5d.7a0d,
                 dst 100.0.0.5 0000.0000.0000 Ethernet0.
Jan 20 17:19:47.843: IP ARP: sent req src 100.0.0.4 0000.0c5d.7a0d,
                 dst 100.0.0.5 0000.0000.0000 Ethernet0.
Jan 20 17:19:49.843: IP ARP: sent req src 100.0.0.4 0000.0c5d.7a0d,
                 dst 100.0.0.5 0000.0000.0000 Ethernet0.
Jan 20 17:19:51.843: IP ARP: sent req src 100.0.0.4 0000.0c5d.7a0d,
                 dst 100.0.0.5 0000.0000.0000 Ethernet0.
Success rate is 0 percent (0/5)
```

The above output shows that Router4 is broadcasting packets by sending them to the Ethernet broadcast address FFFF.FFFF.FFFF. Here, the 0000.0000.0000 means that Router4 is looking for the MAC address of the destination 100.0.0.5. Since it does not know the MAC address during the ARP request in this example, it uses 0000.0000.000 as a placeholder in the broadcast frames sent out of interface Ethernet 0, asking which MAC address corresponds to 100.0.0.5. If we do not get an answer, the corresponding address in the **show arp** output is marked as incomplete:

```
Router4#show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  100.0.0.4               -   0000.0c5d.7a0d  ARPA   Ethernet0
Internet  100.0.0.5               0   Incomplete      ARPA
Internet  100.0.0.1               2   0060.5cf4.a955  ARPA   Ethernet0
```

After a predetermined period, this incomplete entry is purged from the ARP table. As long as the corresponding MAC address is not in the ARP table, the ping fails as a result of "encapsulation failed".

Delay

By default, if you do not receive an answer from the remote end within two seconds, the ping fails:

```
Router1#ping 12.0.0.2
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

On networks with a slow link or a long delay, two seconds are not enough. You can change this default using an extended ping:

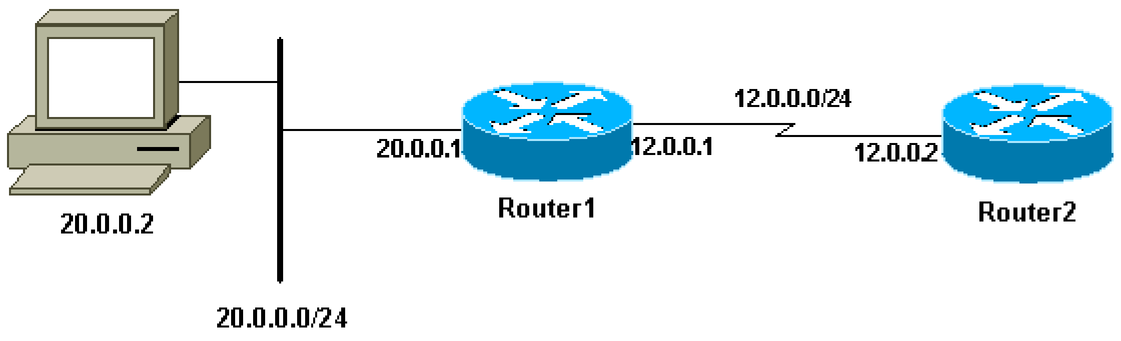
```
Router1#ping
Protocol [ip]:
Target IP address:  12.0.0.2
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]: 30
Extended commands [n]:
Sweep range of sizes [n]:

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 30 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1458/2390/6066 ms
```

In the example above, increasing the timeout has led to a successful ping.

Note: The average round-trip time is more than two seconds.

Correct Source Address

Here is an example of a typical situation:



We add a LAN interface on Router1:

```
Router1(config)#interface e0
Router1(config-if)#ip address
Router1(config-if)#ip address 20.0.0.1 255.255.255.0
```

From a station on the LAN, you can ping Router1. From Router1 you can ping Router2. But from a station on the LAN, you cannot ping Router2.

From Router1, you can ping Router2 because, by default, you use the IP address of the outgoing interface as the source address in your ICMP packet. Router2 has not information about this new LAN.

If it has to reply to a packet coming from this network, it does not know how to handle it.

```
Router1#debug ip packet
IP packet debugging is on
```

Warning: Using the **debug ip packet** command on a production router can cause high cpu utilization. This may result in a severe performance degradation or a network outage. We recommend that you carefully read Use the Debug Command before issuing **debug** commands.

```
Router1#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/7/9 ms
Router1#

Jan 20 16:35:54.227: IP: s=12.0.0.1 (local), d=12.0.0.2 (Serial0), len 100, sen
Jan 20 16:35:54.259: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 100, r
```

The output example above works because the source address of the packet we are sending is s=12.0.0.1. If we want to simulate a packet coming from the LAN, we have to use an extended ping:

```
Router1#ping
Protocol [ip]:
Target IP address: 12.0.0.2
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 20.0.0.1
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:

Jan 20 16:40:18.303: IP: s=20.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
 sending.
Jan 20 16:40:20.303: IP: s=20.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
 sending.
Jan 20 16:40:22.303: IP: s=20.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
 sending.
Jan 20 16:40:24.303: IP: s=20.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
 sending
Jan 20 16:40:26.303: IP: s=20.0.0.1 (local), d=12.0.0.2 (Serial0), len 100,
 sending.
Success rate is 0 percent (0/5)
```

This time, the source address is 20.0.0.1, and it is not working! We are sending our packets, but we are not receiving anything. To fix this issue, we simply have to add a route to 20.0.0.0 in Router2.

The basic rule is that the pinged device should also know how to send the reply to the source of the ping.

High Input Queue Drops

When a packet enters the router, the router attempts to forward it at interrupt level. If a match cannot be found in an appropriate cache table, the packet is queued in the input queue of the incoming interface to be processed. Some packets are always processed, but with the appropriate configuration and in stable networks, the rate of processed packets must never congest the input queue. If the input queue is full, the packet is dropped.

Though the interface is up and you may not ping the device due to high input queue drops. You can check the the input drops with the **show interface** command.

```
Router1#show interface Serial0/0/0

Serial0/0/0 is up, line protocol is up

  MTU 1500 bytes, BW 1984 Kbit, DLY 20000 usec,
     reliability 255/255, txload 69/255, rxload 43/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:02, output 00:00:00, output hang never
  Last clearing of "show interface" counters 01:28:49
  Input queue: 76/75/5553/0 (size/max/drops/flushes);
     Total output drops: 1760
  Queueing strategy: Class-based queueing
  Output queue: 29/1000/64/1760 (size/max total/threshold/drops)
     Conversations  7/129/256 (active/max active/max total)
     Reserved Conversations 4/4 (allocated/max allocated)
     Available Bandwidth 1289 kilobits/sec


!--- Output supressed
```

As seen from the output, Input Queue Drop is high. Refer to Troubleshooting Input Queue Drops and Output Queue Drops in order to troubleshoot Input/Output queue drops.

The Traceroute Command

The **traceroute** command is used to discover the routes that packets actually take when traveling to their destination. The device (for example, a router or a PC) sends out a sequence of User Datagram Protocol (UDP) datagrams to an invalid port address at the remote host.

Three datagrams are sent, each with a Time-To-Live (TTL) field value set to one. The TTL value of 1 causes the datagram to "timeout" as soon as it hits the first router in the path; this router then responds with an ICMP Time Exceeded Message (TEM) indicating that the datagram has expired.

Another three UDP messages are now sent, each with the TTL value set to 2, which causes the second router to return ICMP TEMs. This process continues until the packets actually reach the other destination. Since these datagrams are trying to access an invalid port at the destination host, ICMP Port Unreachable Messages are returned, indicating an unreachable port; this event signals the Traceroute program that it is finished.

The purpose behind this is to record the source of each ICMP Time Exceeded Message to provide a trace of the path the packet took to reach the destination. For all the options about this command, see **Trace (privileged)**.

```
Router1#traceroute 34.0.0.4

Type escape sequence to abort.
Tracing the route to 34.0.0.4

  1 12.0.0.2 4 msec 4 msec 4 msec
  2 23.0.0.3 20 msec 16 msec 16 msec
  3 34.0.0.4 16 msec *  16 msec

Jan 20 16:42:48.611: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.615:     UDP src=39911, dst=33434
Jan 20 16:42:48.635: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:42:48.639:     ICMP type=11, code=0

!--- ICMP Time Exceeded Message from Router2.

Jan 20 16:42:48.643: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.647:     UDP src=34237, dst=33435
Jan 20 16:42:48.667: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:42:48.671:     ICMP type=11, code=0
Jan 20 16:42:48.675: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.679:     UDP src=33420, dst=33436
Jan 20 16:42:48.699: IP: s=12.0.0.2 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:42:48.703:     ICMP type=11, code=0
```

This is the first sequence of packets we send with a TTL=1. The first router, in this case Router2 (12.0.0.2), drops the packet, and sends back to the source (12.0.0.1) a type=11 ICMP message. This corresponds to the Time Exceeded Message.

```
Jan 20 16:42:48.707: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.711:     UDP src=35734, dst=33437
Jan 20 16:42:48.743: IP: s=23.0.0.3 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:42:48.747:     ICMP type=11, code=0

!--- ICMP Time Exceeded Message from Router3.

Jan 20 16:42:48.751: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.755:     UDP src=36753, dst=33438
Jan 20 16:42:48.787: IP: s=23.0.0.3 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
Jan 20 16:42:48.791:     ICMP type=11, code=0
Jan 20 16:42:48.795: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
 sending
Jan 20 16:42:48.799:     UDP src=36561, dst=33439
Jan 20 16:42:48.827: IP: s=23.0.0.3 (Serial0), d=12.0.0.1 (Serial0), len 56,
 rcvd 3
```

```
     Jan 20 16:42:48.831:     ICMP type=11, code=0
```

The same process occurs for Router3 (23.0.0.3) with a TTL=2:

```
     Jan 20 16:42:48.839: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
      sending
     Jan 20 16:42:48.843:     UDP src=34327, dst=33440
     Jan 20 16:42:48.887: IP: s=34.0.0.4 (Serial0), d=12.0.0.1 (Serial0), len 56,
      rcvd 3
     Jan 20 16:42:48.891:     ICMP type=3, code=3

     !--- Port Unreachable message from Router4.

     Jan 20 16:42:48.895: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
      sending
     Jan 20 16:42:48.899:     UDP src=37534, dst=33441
     Jan 20 16:42:51.895: IP: s=12.0.0.1 (local), d=34.0.0.4 (Serial0), len 28,
      sending
     Jan 20 16:42:51.899:     UDP src=37181, dst=33442
     Jan 20 16:42:51.943: IP: s=34.0.0.4 (Serial0), d=12.0.0.1 (Serial0), len 56,
      rcvd 3
     Jan 20 16:42:51.947:     ICMP type=3, code=3
```

With a TTL=3, we finally reach Router4. This time, since the port is not valid, Router4 sends back to Router1 an ICMP message with type=3, a Destination Unreachable Message, and code=3 meaning port unreachable.

The table below lists the characters that can appear in the **traceroute** command output.

IP Traceroute Text Characters

Character	Description
nn msec	For each node, the round-trip time in milliseconds for the specified number of probes
*	The probe timed out
A	Administratively prohibited (example, access-list)
Q	Source quench (destination too busy)
I	User interrupted test
U	Port unreachable
H	Host unreachable
N	Network unreachable
P	Protocol Unreachable
T	Timeout
?	Unknown packet type

Performance

Using the **ping** and **traceroute** commands, we obtain the round-trip time (RTT). This is the time required to send an echo packet, and get an answer back. This can be useful to have a rough idea of the delay on the link. However, these figures are not precise enough to be used for performance evaluation.

When a packet destination is the router itself, this packet has to be process-switched. The processor has to handle the information from this packet, and send an answer back. This is not the main goal of a router. By definition, a router is built to route packets. Answering a ping is offered as a best-effort service.

To illustrate this, here is an example of a ping from Router1 to Router2:

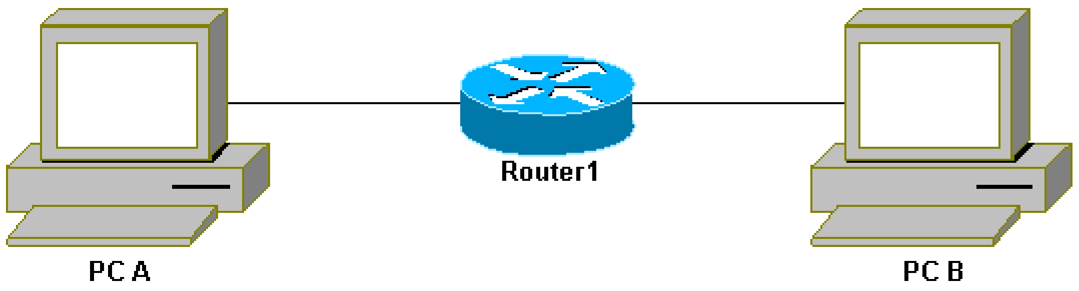
```
Router1#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

The RTT is approximately four milliseconds. After you enable some process-intensive features on Router2, try to ping Router2 from Router1.

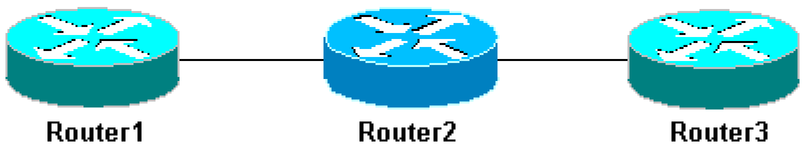
```
Router1#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/25/28 ms
```

The RTT has dramatically increased here. Router2 is quite busy, and answering the ping is not its main priority.

A better way to test router performance is with traffic going **through** the router:



The traffic is then fast-switched, and is handled by the router with the highest priority. To illustrate this, let us go back to our basic network:



Let us ping Router3 from Router1:

```
Router1#ping 23.0.0.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.0.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/32 ms
```

The traffic is going through Router2, and is now fast-switched.

Now let us enable the process-intensive feature on Router2:

```
Router1#ping 23.0.0.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 23.0.0.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 32/32/36 ms
```

There is almost no difference. This is because, on Router2, the packets are now handled at interrupt level.

Use the Debug Command

Before issuing **debug** commands, please see Important Information on Debug Commands.

The different **debug** commands we have used so far gives us an insight into what happens when we use a **ping** or **traceroute** command. They can also be useful for troubleshooting. However, in a production environment, debugs should be used with caution. If your CPU is not powerful, or if you have a lot of process-switched packets, they can easily stall your device. There are a couple of ways to minimize the impact of the **debug** command on the router. One way is to use access lists to narrow down the specific traffic that you want to monitor. Here is an example:

```
Router4#debug ip packet ?
  <1-199>      Access list
  <1300-2699>  Access list (expanded range)
  detail       Print more debugging detail

Router4#configure terminal
Router4(config)#access-list 150 permit ip host 12.0.0.1 host 34.0.0.4
Router4(config)#^Z

Router4#debug ip packet 150
IP packet debugging is on for access list 150
```

```
Router4#show debug
Generic IP:
  IP packet debugging is on for access list 150

Router4#show access-list
Extended IP access list 150
    permit ip host 12.0.0.1 host 34.0.0.4 (5 matches)
```

With this configuration, Router4 only prints the debug message that matches the access-list 150. A ping coming from Router1 causes the following message to be displayed:

```
Router4#
Jan 20 16:51:16.911: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:51:17.003: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:51:17.095: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:51:17.187: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:51:17.279: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
```

We no longer see the answer from Router4 because, these packets do not match the access-list. To see them, we should add the following:

```
Router4(config)#access-list 150 permit ip host 12.0.0.1 host 34.0.0.4
Router4(config)#access-list 150 permit ip host 34.0.0.4 host 12.0.0.1
```

We then have:

```
Jan 20 16:53:16.527: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:53:16.531: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
Jan 20 16:53:16.627: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:53:16.635: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
Jan 20 16:53:16.727: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:53:16.731: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
Jan 20 16:53:16.823: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:53:16.827: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
Jan 20 16:53:16.919: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
Jan 20 16:53:16.923: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
```

Another way of minimizing the impact of the **debug** command is to buffer the debug messages and show them using the **show log** command once the debug has been turned off:

```
Router4#configure terminal
Router4(config)#no logging console
```

```
Router4(config)#logging buffered 5000
Router4(config)#^Z

Router4#debug ip packet
IP packet debugging is on
Router4#ping 12.0.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/36/37 ms

Router4#undebug all
All possible debugging has been turned off

Router4#show log
Syslog logging: enabled (0 messages dropped, 0 flushes, 0 overruns)
    Console logging: disabled
    Monitor logging: level debugging, 0 messages logged
    Buffer logging: level debugging, 61 messages logged
    Trap logging: level informational, 59 message lines logged

Log Buffer (5000 bytes):

Jan 20 16:55:46.587: IP: s=34.0.0.4 (local), d=12.0.0.1 (Serial0), len 100,
 sending
Jan 20 16:55:46.679: IP: s=12.0.0.1 (Serial0), d=34.0.0.4 (Serial0), len 100,
 rcvd 3
```

As you can see, the **ping** and **traceroute** commands are very helpful utilities that you can use to troubleshoot network access problems. They are also very easy to use. As these two commands are the most widely used commands by network engineers, understanding them is very crucial for troubleshooting network connectivity.

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