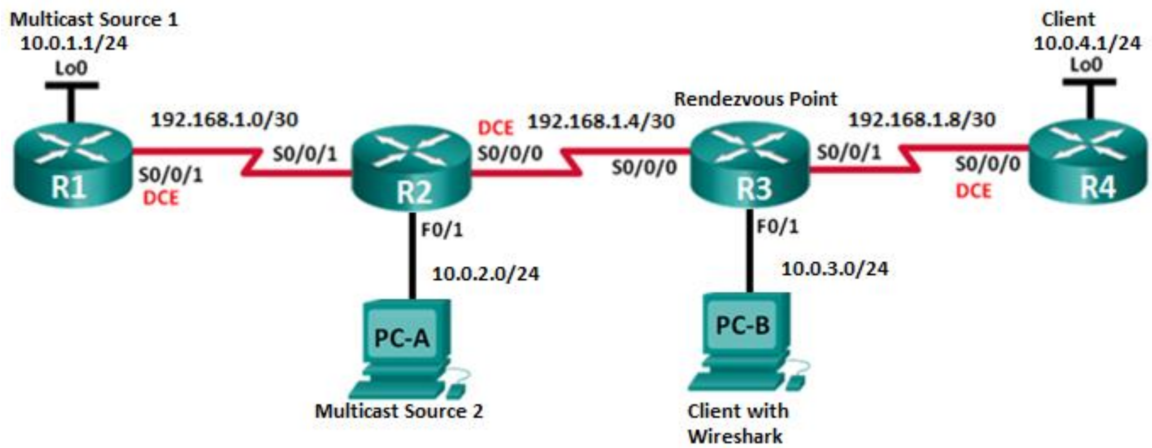
Multicast Routing

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	S0/0/1	192.168.1.1	255.255.255.252	N/A
	Lo0	10.0.1.1	255.255.255.0	N/A
R2	S0/0/0 (DCE)	192.168.1.5	255.255.255.252	N/A
	S0/0/1	192.168.1.2	255.255.255.252	N/A
	F0/1	10.0.2.1	255.255.255.0	N/A
R3	S0/0/0	192.168.1.6	255.255.255.252	N/A
	S0/0/1	192.168.1.9	255.255.255.252	N/A
	F0/1	10.0.3.1	255.255.255.0	N/A
R4	S0/0/0 (DCE)	192.168.1.10	255.255.255.252	N/A
	Lo0	10.0.4.1	255.255.255.0	N/A
PC-A	NIC	10.0.2.2	255.255.255.0	10.0.2.1
PC-B	NIC	10.0.3.2	255.255.255.0	10.0.3.1

Introduction

The Protocol Independent Multicast (PIM) protocol maintains the current IP multicast service mode of receiver-initiated membership. PIM is not dependent on a specific unicast routing protocol; it is IP routing protocol independent and can leverage whichever unicast routing protocols are used to populate the unicast routing table, including Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), and static routes. PIM uses unicast routing information to perform the multicast forwarding function.

Although PIM is called a multicast routing protocol, it actually uses the unicast routing table to perform the reverse path forwarding (RPF) check function instead of building up a completely independent multicast routing table. Unlike other routing protocols, PIM does not send and receive routing updates between routers.

PIM is defined in RFC 4601, Protocol Independent Multicast - Sparse Mode (PIM-SM)

PIM can operate in dense mode or sparse mode. The router can also handle both sparse groups and dense groups at the same time (sparse-dense mode). The mode determines how the router populates its multicast routing table and how the router forwards multicast packets it receives from its directly connected LANs.

PIM Dense Mode

PIM dense mode (PIM-DM) uses a push model to flood multicast traffic to every corner of the network. This push model is a method for delivering data to the receivers without the receivers requesting the data. This method is efficient in certain deployments in which there are active receivers on every subnet in the network.

In dense mode, a router assumes that all other routers want to forward multicast packets for a group. If a router receives a multicast packet and has no directly connected members or PIM neighbors present, a prune message is sent back to the source. Subsequent multicast packets are not flooded to this router on this pruned branch. PIM builds source-based multicast distribution trees.

PIM-DM initially floods multicast traffic throughout the network. Routers that have no downstream neighbors prune back the unwanted traffic. This process repeats every 3 minutes.

Routers accumulate state information by receiving data streams through the flood and prune mechanism. These data streams contain the source and group information so that downstream routers can build up their multicast forwarding table. PIM-DM supports only source trees--that is, (S,G) entries--and cannot be used to build a shared distribution tree.

PIM Sparse Mode

PIM sparse mode (PIM-SM) uses a pull model to deliver multicast traffic. Only network segments with active receivers that have explicitly requested the data will receive the traffic.

Sparse mode interfaces are added to the multicast routing table only when periodic Join messages are received from downstream routers, or when a directly connected member is on the interface. When forwarding from a LAN, sparse mode operation occurs if an RP is known for the group. If so, the packets are encapsulated and sent toward the RP. When no RP is known, the packet is flooded in a dense mode fashion. If the multicast traffic from a specific source is sufficient, the first hop router of the receiver may send Join messages toward the source to build a source-based distribution tree.

PIM-SM distributes information about active sources by forwarding data packets on the shared tree. Because PIM-SM uses shared trees (at least, initially), it requires the use of a rendezvous point (RP). The RP must be administratively configured in the network.

In this lab, you will implement PIM dense and sparse modes for multicasting. You will enable multicast routing on all routers in the topology. First you will enable and test PIM dense mode. Second you will PIM Sparse mode, configure the RP router both static and using cisco proprietary autoRP , and finally test the multicast operation using two different sources and destinations.

Required Resources

- 4 Routers.
- 2 PCs.
- Console cables to configure the Cisco IOS devices via the console ports.
- Ethernet and serial cables as shown in the topology.

Part 1: Build the Network and Verify Connectivity

In Part 1, you will set up the network topology and configure basic settings, such as the interface IP addresses, routing, device access, and passwords.

Step 1: Cable the network as shown in the topology.

Step 2: Configure basic settings for each router.

a. Console into the router and enter global configuration mode.

b. Do the following basic configuration on each router.

```
no ip domain-lookup
service password-encryption
enable secret pass
banner motd #
Unauthorized access is strictly prohibited. #
Line con 0
password pass
login
logging synchronous
line vty 0 4
password pass
login
end
```

c. Configure the host name as shown in the topology.

d. Configure and activate all interfaces on all routers.

Step 3: Configure OSPF routing.

a. Configure OSPF on all routers with process ID 1.

b. Add all connected interfaces to Area 0.

c. Use the **show ip route** command on all routers to view the routing table (all routing tables on all routers should contain seven networks including connected and remote).

Step 4: Verify network connectivity.

a. Verify that you can ping across the serial links when you are finished. Use the following Tcl scripts to check full and partial connectivity.

```
R1# tclsh
```

```
foreach address {
192.168.1.2
192.168.1.5
192.168.1.6
192.168.1.9
192.168.1.10
10.0.2.1
10.0.3.1
10.0.4.1
10.0.3.2
10.0.2.2

} { ping $address }
```

```
R4# tclsh

foreach address {
192.168.1.2
192.168.1.5
192.168.1.6
192.168.1.9
10.0.2.1
10.0.3.1
10.0.3.2
10.0.2.2

} { ping $address }
```

b. Troubleshoot if the pings are unsuccessful.

Part 2: Configure PIM Dense Mode

Step 1: Enable multicast routing

To enable multicast routing on all routers do the following:

```
(config)# ip multicast-routing
```

Step 2: Enable PIM dense mode

To enable PIM dense mode do the following on all interfaces on all routers:

```
(config-if)# ip pim dense-mode
```

Step 3: Verify PIM configuration

Use the following commands to verify PIM operation:

a. **show ip pim neighbor :** what is shown on R2?

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b. **show ip mroute**: To verify that the mroute table is being populated properly.

Step 4: Join the multicast group.

On router R4, interface loopback 0 will join the multicast group 239.1.2.3.

```
R4(config)#interface lo0
R4(config-if)# ip igmp join-group 239.1.2.3
```

To verify the join use the command **show ip igmp groups**.

Step 5: Create a multicast stream from R1

On R1 use the ping command to send traffic to the multicast address 239.1.2.3:

```
R1# ping 239.1.2.3 source lo0
```

What happened?

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Step 6: Verify the mroutes.

On R2 and R3 view the mroute table. What is new in the tables?

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Part 3: Configure PIM Sparse Mode

In Part 3, you will configure all routers to support PIM sparse mode on all interfaces, and set R3 to be the Rendezvous point statically.

Step 1: Disable PIM Dense mode and enable PIM sparse mode

To enable PIM sparse mode do the following on all interfaces on all routers:

```
(config-if)# no ip pim dense-mode
(config-if)# ip pim sparse-mode
```

Step 2: Test the multicast address 239.1.2.3

On R1 use the ping command to send traffic to the multicast address 239.1.2.3:

```
R1# ping 239.1.2.3 source lo0
```

What happened? Explain.

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Step 3: Set R3 to be the RP.

To set the RP, on all routers (R1, R2, R3, and R4):

```
(config)# ip pim rp-address 192.168.1.6
```

Step 4: Verify PIM configuration

Use the following commands to verify PIM operation:

a. **show ip pim rp mapping:** To confirm that the group-to-RP mappings are being populated correctly on the last hop router.

b. **show ip mroute**: To verify that the mroute table is being populated properly.

Step 5: Create a multicast stream from R1

On R1 use the ping command to send traffic to the multicast address 239.1.2.3:

```
R1# ping 239.1.2.3 source lo0
```

What happened?

Step 6: Verify the mroutes.

On R2 and R3 view the mroute table. What is new in the tables?

Step 7: Add a second source.

From PC-A use the command ping 239.1.2.3 –t to send a continuous stream of traffic.

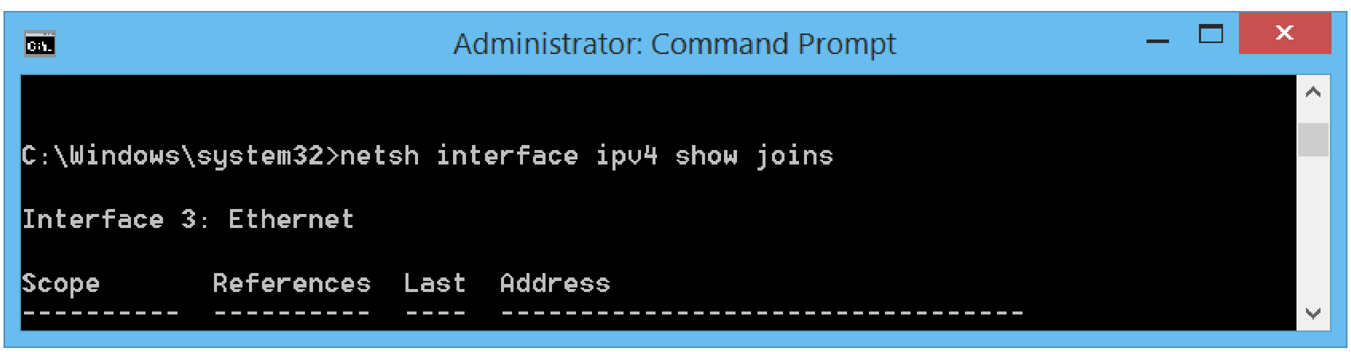
Step 8: Verify the mroute table on R2 and R3.

Is the new source in the mroute table? And how is it listed?

Step 9: Add a second receiver.

a. On PC-B start a WireShark capture using the Ethernet interface with a filter of ip.addr == 239.1.2.3.

b. Open the command line CMD as an administrator and run the following command to find the interface index (in this example the index is 3):
netsh interface ipv4 show joins



c. Run the command **netsh interface ipv4 add ROUTE 239.1.2.3/32 interface=3** to join the multicast group:

```
Administrator: Command Prompt
^C
C:\Windows\system32>netsh interface ipv4 add ROUTE 239.1.2.3/32 interface=3
Ok.

C:\Windows\system32>
```

d. Now your wireshark window should start showing the multicast traffic being received from the continuous ping from PC-A.

Part 4: Configuring autoRP

In Part 4, you will configure all routers to support Auto-RP for choosing the Rendezvous point.

Auto-RP automates the distribution of group-to-RP mappings in a PIM network. Auto-RP has the following benefits:

- Configuring the use of multiple RPs within a network to serve different groups is easy.
- Auto-RP allows load splitting among different RPs and arrangement of RPs according to the location of group participants.
- Auto-RP avoids inconsistent, manual RP configurations that can cause connectivity problems.

For Auto-RP to work, a router must be designated as an RP-mapping agent, which receives the RP-announcement messages from the RPs and arbitrates conflicts. The RP-mapping agent then sends the consistent group-to-RP mappings to all other routers. Thus, all routers automatically discover which RP to use for the groups they support.

To make Auto-RP work, a router must be designated as an RP mapping agent, which receives the RP announcement messages from the RPs and arbitrates conflicts. The RP mapping agent then sends the consistent group-to-RP mappings to all other routers by dense mode flooding. Thus, all routers automatically discover which RP to use for the groups they support. The Internet Assigned Numbers Authority (IANA) has assigned two group addresses, 224.0.1.39 and 224.0.1.40, for Auto-RP. One advantage of Auto-RP is that any change to the RP designation must be configured only on the routers that are RPs and not on the leaf routers. Another advantage of Auto-RP is that it offers the ability to scope the RP address within a domain. Scoping can be achieved by defining the time-to-live (TTL) value allowed for the Auto-RP advertisements.

Step 1: Remove the static RP

To remove the static RP do the following on all routers:

(config)# **no ip pim rp-address 192.168.1.6**

Step 2: Configure Listener on all routers

On all routers (R1, R2, R3, and R4), run the following command:

(config)#**ip pim autorp listener**

Step 3: Configure R3 to be the RP

On R3, run the following command:

R3(config)#**ip pim send-rp-announce serial 0/0/0 scope 2**

Step 4: Configure R2 as a mapping agent

On R2, run the following command:

R2(config)#**ip pim send-rp-discovery serial 0/0/0 scope 5**

Step 5: Create a multicast stream from R1

On R1 use the ping command to send traffic to the multicast address 239.1.2.3:

`R1#` **`ping 239.1.2.3 source lo0`**

What happened?

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Step 6: Verify PIM configuration

Use the following commands on R1 to verify PIM operation:

a. **show ip pim rp mapping:** To confirm that the group-to-RP mappings are being populated correctly on the last hop router.

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b. **show ip mroute**: To verify that the mroute table is being populated properly.

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c. **show ip pim interface count**: confirm that multicast traffic is being forwarded.

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For more information on PIM:

https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3750x_3560x/software/release/15-2_2_e/multicast/configuration_guide/b_mc_1522e_3750x_3560x_cg/b_mc_3750x_3560x_chapter_010.html