

PIM Version 2

Description

Protocol-Independent Multicast (PIM) Version 2 includes the following improvements over PIM Version 1:

- A single, active rendezvous point (RP) exists per multicast group, with multiple backup RPs. This compares to multiple active RPs for the same group in PIM Version 1.
- A bootstrap router (BSR) provides a fault-tolerant, automated RP discovery and distribution mechanism. Thus, routers dynamically learn the group-to-RP mappings.
- Sparse mode and dense mode are properties of a group, as opposed to an interface. We strongly recommend sparse-dense mode, as opposed to either sparse mode or dense mode only.
- PIM Join and Prune messages have more flexible encodings for multiple address families.
- A more flexible Hello packet format replaces the Query packet to encode current and future capability options.
- Register messages to an RP indicate whether they were sent by a border router or a designated router.
- PIM packets are no longer inside IGMP packets; they are stand-alone packets.

PIM Version 1, together with the Auto-RP feature, can perform the same tasks as the PIM Version 2 BSR. However, Auto-RP is a standalone protocol, separate from PIM Version 1, and is Cisco proprietary. PIM Version 2 is a standards track protocol in the Internet Engineering Task Force (IETF).

Cisco's PIM Version 2 implementation allows good interoperability and transition between Version 1 and Version 2. You can upgrade to PIM Version 2 incrementally. PIM Versions 1 and 2 can be configured on different routers within one network. Internally, all routers on a shared media network must run the same PIM version. Therefore, if a PIM Version 2 router detects a PIM Version 1 router, the Version 2 router downgrades itself to Version 1 until all Version 1 routers have been shutdown or upgraded.

PIM uses the BSR to discover and announce RP-set information for each group prefix to all the routers in a PIM domain. This is the same function accomplished by Auto-RP, but the BSR is part of the PIM Version 2 specification. The BSR mechanism interoperates with Auto-RP on Cisco routers.

To avoid a single point of failure, you can configure several candidate BSRs in a PIM domain. A BSR is elected among the candidate BSRs automatically; they use bootstrap messages to discover which BSR has the highest priority. This router then announces to all PIM routers in the PIM domain that it is the BSR.

Routers that are configured as candidate RPs then unicast to the BSR the group range for which they are responsible. The BSR includes this information in its bootstrap messages and disseminates it to all PIM routers in the domain. Based on this information, all routers will be able to map multicast groups to specific RPs. As long as a router is receiving the bootstrap message, it has a current RP map.

Benefits

PIM Version 2 is a standards track protocol in the IETF.

Platforms

This feature is supported on these platforms:

- Cisco 1003, Cisco 1004, Cisco 1005
- Cisco 1600 series
- Cisco 2500 series
- Cisco 3600 series
- Cisco 3800 series
- Cisco 4000 series (Cisco 4000, 4000-M, 4500, 4500-M, 4700, 4700-M)
- Cisco 5200 series
- Cisco 7200 series
- Cisco 7500 series
- Cisco AS5300

Prerequisites

When PIM Version 2 routers interoperate with PIM Version 1 routers, Auto-RP should have already been deployed. A PIM Version 2 BSR that is also an Auto-RP mapping agent will automatically advertise the RP elected by Auto-RP. That is, Auto-RP prevails in its single RP being imposed on every router in the group. All routers in the domain refrain from trying to use the PIM Version 2 hash function to select multiple RPs.

Because bootstrap messages are sent hop by hop, a PIM Version 1 router will prevent these messages from reaching all routers in your network. Therefore, if your network has a PIM Version 1 router in it, and only Cisco routers, it is best to use Auto-RP rather than the bootstrap mechanism. If you have a network that includes routers from other vendors, configure the Auto-RP mapping agent and the BSR on a Cisco PIM Version 2 router. Also ensure that no PIM Version 1 router is located on the path between the BSR and a non-Cisco PIM Version 2 router.

Configuration Tasks

There are two approaches to using PIM Version 2. You can use Version 2 exclusively in your network, or migrate to Version 2 by employing a mixed PIM version environment.

- If your network is all Cisco routers, you may use either Auto-RP or the bootstrap mechanism (BSR).

- If you have routers other than Cisco in your network, you need to use the bootstrap mechanism.
- If you have PIM Version 1 and PIM Version 2 Cisco routers and routers from other vendors, then you must use both Auto-RP and the bootstrap mechanism.

The tasks to configure PIM Version 2 are described in the sections that follow.

- Specify the PIM Version
- Configure PIM Version 2 Only
- Transition to PIM Version 2
- Monitor the RP Mapping Information

Specify the PIM Version

All systems using Cisco IOS Release 11.3(2)T or later start in PIM Version 2 mode by default. In case you need to reenable PIM Version 2 or specify PIM Version 1 for some reason, you can control the PIM version by performing the following task in interface configuration mode:

Task	Command
Configure the PIM version used.	ip pim version [1 2]

Configure PIM Version 2 Only

To configure PIM Version 2 exclusively, perform the tasks in this section. It is assumed that no PIM Version 1 system exists in the PIM domain.

The first task is recommended, configuring sparse-dense mode. If you configure Auto-RP, none of the other tasks are required to run PIM Version 2. To configure Auto-RP, refer to the “Configuring IP Multicast Routing” chapter in the Cisco IOS Release 11.3 *Network Protocols Configuration Guide, Part 1*.

If you want to configure a BSR, complete the tasks in the sections that follow:

- Configure PIM Sparse-Dense Mode
- Define the PIM Domain Border
- Define the IP Multicast Boundary
- Configure Candidate BSRs
- Configure Candidate RPs

Configure PIM Sparse-Dense Mode

Perform the following tasks on all PIM routers inside the PIM domain, beginning in global configuration mode:

Task	Command
Step 1 Enable IP multicast routing.	ip multicast-routing
Step 2 Configure an interface.	interface <i>type number</i>
Step 3 Enable PIM on the interface. The sparse-dense mode is identical to the implicit interface mode in the PIM Version 2 specification.	ip pim sparse-dense-mode

Task	Command
Step 4 Repeat Steps 2 and 3 for each interface on which you want to run PIM.	

Define the PIM Domain Border

Configure a border for the PIM domain, so that bootstrap messages do not cross this border in either direction. Therefore, different BSRs are elected on the two sides of the PIM border. Perform the following task on the interface of a border router peering with one or more neighbors outside the PIM domain. Perform the task in interface configuration mode:

Task	Command
Configure a PIM domain boundary.	ip pim border

Define the IP Multicast Boundary

To prevent Auto-RP messages from entering the PIM domain, perform the following tasks beginning in global configuration mode. The access list will deny packets destined for 224.0.1.39 and 224.0.1.40, which carry Auto-RP information.

Task	Command
Step 1 Define an administratively scoped boundary.	access-list <i>access-list-number</i> {deny permit} <i>source</i> [<i>source-wildcard</i>]
Step 2 Prevent Auto-RP messages (used in PIM Version 1) from coming into the local PIM domain.	ip multicast boundary <i>access-list-number</i>

Configure Candidate BSRs

Configure one or more candidate BSRs. The routers to serve as candidate BSRs should be well connected and be in the backbone portion of the network, as opposed to the dial-up portion of the network. On the candidate BSRs, perform the following task in global configuration mode:

Task	Command
Configure the router to be a candidate bootstrap router.	ip pim bsr-candidate <i>type number</i> <i>hash-mask-length</i> [<i>priority</i>]

Configure Candidate RPs

Configure one or more candidate RPs. Similar to BSRs, the RPs should also be well connected and in the backbone portion of the network. An RP can serve the entire IP multicast address space or a portion of it. Candidate RPs send candidate RP advertisements to the BSR. Consider the following when deciding which routers should be RPs:

- In a network of Cisco routers where only Auto-RP is used, any router can be configured as an RP.
- In a network of routers that includes only Cisco PIM Version 2 routers and routers from other vendors, any router can be used as an RP.
- In a network of Cisco PIM Version 1 routers, Cisco PIM Version 2 routers, and routers from other vendors, only Cisco PIM Version 2 routers should be configured as RPs.

On the candidate RPs, perform the following task in global configuration mode:

Task	Command
Configure the router to be a candidate RP.	ip pim rp-candidate <i>type number ttl group-list access-list-number</i>

Transition to PIM Version 2

On each LAN, Cisco's implementation of PIM Version 2 automatically enforces the rule that all PIM messages on a shared LAN are in the same PIM version. To accommodate that rule, if a PIM Version 2 router detects a PIM Version 1 router on the same interface, the Version 2 router downgrades itself to Version 1 until all Version 1 routers have been shutdown or upgraded.

Guidelines for When to Configure a BSR

If there are only Cisco routers in your network (no routers from other vendors), there is no need to configure a BSR. Configure Auto-RP in the mixed PIM Version 1/Version 2 environment.

On the other hand, if you have non-Cisco, PIM Version 2 routers that need to interoperate with Cisco routers running PIM Version 1, both Auto-RP and a BSR are required. We recommend that a Cisco PIM Version 2 router be both the Auto-RP mapping agent and the BSR.

Dense Mode

Dense mode groups in a mixed Version 1/Version 2 region need no special configuration; they will interoperate automatically.

Sparse Mode

Sparse mode groups in a mixed Version 1/Version 2 region are possible because the Auto-RP feature in Version 1 interoperates with the RP feature of Version 2. Although all PIM Version 2 routers are also capable of using Version 1, we recommend that the RPs be upgraded to Version 2 (or at least upgraded to PIM Version 1 in the Cisco IOS Release 11.3 software).

To ease the transition to PIM Version 2, we also recommend:

- Auto-RP be used throughout the region
- Sparse-dense mode be configured throughout the region

If Auto-RP was not already configured in the PIM Version 1 regions, configure Auto-RP. Refer to the "Configuring IP Multicast Routing" chapter in the Cisco IOS Release 11.3 *Network Protocols Configuration Guide, Part 1*.

Using Auto-RP and a BSR

If you must have one or more BSRs, as discussed in the prior section "Guidelines for When to Configure a BSR," we recommend the following:

- Configure the candidate BSRs as the RP-mapping agents for Auto-RP.

- For group prefixes advertised via Auto-RP, the Version 2 BSR mechanism should not advertise a subrange of these group prefixes served by a different set of RPs. In a mixed Version 1/Version 2 PIM domain, it is preferable to have backup RPs serve the same group prefixes. This prevents the Version 2 designated routers (DRs) from selecting a different RP from those Version 1 DRs, due to longest match lookup in the RP-mapping database.
- Verify the consistency of group-to-RP mappings by performing the following tasks in EXEC mode:

Task	Command
Step 1 On any router, display the available RP mappings.	show ip pim rp <i>[[group-name group-address] mapping]</i>
Step 2 On a PIM Version 2 router, confirm that the same RP appears that a PIM Version 1 system chooses.	show ip pim rp-hash <i>group</i>

Monitor the RP Mapping Information

To monitor the RP mapping information, perform the following tasks in EXEC mode:

Task	Command
Display information about the currently elected BSR.	show ip pim bsr
Display the RP that was selected for the specified group.	show ip pim rp-hash <i>group</i>
Display how the router learns of the RP (via bootstrap or Auto-RP mechanism).	show ip pim rp <i>[[group-name group-address] mapping]</i>

Troubleshooting

When debugging interoperability problems between PIM Version 1 and Version 2, check the following in the order indicated:

- 1 Verify RP mapping with the **show ip pim rp-hash** command, making sure that all systems agree on the same RP for the same group.
- 2 Verify interoperability between different versions of DRs and RPs. Make sure the RPs are interacting with the DRs properly (by responding with register-stops and forwarding decapsulated data packets from registers).

Configuration Examples

This section provides examples in the following sections:

- BSR Configuration Example
- Border Router Configuration Example

BSR Configuration Example

The following example is a configuration for a candidate BSR, which also happens to be a candidate RP:

```

version 11.3
!
ip multicast-routing
!
interface Ethernet0
 ip address 171.69.62.35 255.255.255.240
!
interface Ethernet1
 ip address 172.21.24.18 255.255.255.248
 ip pim sparse-dense-mode
!
interface Ethernet2
 ip address 172.21.24.12 255.255.255.248
 ip pim sparse-dense-mode
!
router ospf 1
 network 172.21.24.8 0.0.0.7 area 1
 network 172.21.24.16 0.0.0.7 area 1
!
ip pim bsr-candidate Ethernet2 30 10
ip pim rp-candidate Ethernet2 group-list 5
access-list 5 permit 239.255.2.0 0.0.0.255

```

Border Router Configuration Example

The following example is a configuration for a PIM border on Ethernet interface 1. Address list 1 prevents Auto-RP packets and data packets in the 239.x.x.x range from going over Ethernet interface 1.

```

version 11.3
!
ip multicast-routing
!
!
interface Ethernet0
 ip address 171.69.62.35 255.255.255.240
!
interface Ethernet1
 ip address 172.21.24.18 255.255.255.248
 ip pim sparse-dense-mode
 ip pim border
 ip multicast boundary 1
!
interface Ethernet2
 ip address 172.21.24.12 255.255.255.248
 ip pim sparse-dense-mode
!
access-list 1 deny 239.0.0.0 0.255.255.255
access-list 1 deny 224.0.1.39 0.255.255.255
access-list 1 deny 224.0.1.40 0.255.255.255
access-list 1 permit 224.0.0.0 15.255.255.255

```

If you remove the RP-related commands and the boundary command, it becomes a configuration for other internal routers.

Command Reference

This section documents new or modified commands. All other commands used with this feature are documented in the Cisco IOS Release 11.3 command references.

- **ip pim border**
- **ip pim bsr-candidate**
- **ip pim rp-candidate**
- **ip pim version**
- **show ip pim bsr**
- **show ip pim rp-hash**

ip pim border

To configure the interface to be the PIM domain border, use the **ip pim border** interface configuration command. To remove the border, use the **no** form of this command.

ip pim border
no ip pim border

Syntax Description

This command has no arguments or keywords.

Default

Disabled

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

When this command is configured on an interface, no bootstrap message can pass through this border in either direction. This command effectively partitions the network into regions using different bootstrap routers. Other PIM messages can pass the domain border.

Note This command does not set up multicast boundaries. It only sets up a PIM bootstrap message boundary.

Example

The following example configures the interface to be the PIM domain border:

```
interface ethernet 1
 ip pim border
```

Related Commands

ip pim bsr-candidate

ip pim bsr-candidate

To configure the router to announce its candidacy as a bootstrap router (BSR), use the **ip pim bsr-candidate** global configuration command. To remove this router as a candidate for being a bootstrap router, use the **no** form of this command.

```
ip pim bsr-candidate type number hash-mask-length [priority]  
no ip pim bsr-candidate
```

Syntax Description

<i>type number</i>	Interface type and number on this router from which the bootstrap router address is derived, to make it a candidate. This interface must be enabled with PIM.
<i>hash-mask-length</i>	Length of a mask (32 bits maximum) that is to be ANDed with the group address before the hash function is called. All groups with the same seed hash (correspond) to the same RP. For example, if this value is 24, only the first 24 bits of the group addresses matter. This fact allows you to get one RP for multiple groups.
<i>priority</i>	(Optional) Integer from 0 to 255. The bootstrap router with the larger priority is preferred. If the priority values are the same, the router with the larger IP address is the bootstrap router. The default value is 0.

Default

Disabled

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

This command causes the router to send bootstrap messages to all its PIM neighbors, with the designated interface's address as the BSR address. Each neighbor compares the BSR address with the address it had from previous bootstrap messages (not necessarily received on the same interface). If the current address is the same address or better, it caches the current address and forwards the bootstrap message. Otherwise, it drops the bootstrap message.

This router continues to be the BSR until it receives another candidate BSR's message saying it has a higher priority (or if the same priority, a higher IP address).

Use this command only in backbone routers that have good connectivity to all parts of the PIM domain. That is, a stub router that relies on an on-demand dialup link to connect to the rest of the PIM domain is not a good candidate BSR.

Example

The following example configures the router's IP address on Ethernet interface 0 to be a candidate bootstrap router with priority of 10:

```
ip pim bsr-candidate ethernet 0 10
```

Related Commands

ip pim border

ip pim rp-candidate

ip pim send-rp-discovery

show ip pim bsr

show ip pim rp

ip pim rp-candidate

To configure the router to advertise itself as a PIM Version 2 candidate Rendezvous Point (RP) to the bootstrap router, use the **ip pim rp-candidate** global configuration command. To remove this router as a candidate for being an RP, use the **no** form of this command.

```
ip pim rp-candidate type number [group-list access-list-number]  
no ip pim rp-candidate
```

Syntax Description

<i>type number</i>	IP address associated with this interface type and number on this router is advertised as a candidate RP address.
group-list <i>access-list-number</i>	(Optional) Standard IP access list number that defines the group prefixes that are advertised in association with the RP address.

Default

Disabled

Command Mode

Global configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

This command causes the router to send a PIM Version 2 message advertising itself as a candidate RP to the bootstrap router. The addresses allowed by the access list, together with the router identified by the type and number, constitute the RP and its range of addresses it is responsible for.

Use this command only in backbone routers that have good connectivity to all parts of the PIM domain. That is, a stub router that relies on an on-demand dialup link to connect to the rest of the PIM domain is not a good candidate RP.

Example

The following example configures the router to advertise itself as a candidate RP to the bootstrap router in its PIM domain. Standard access list number 4 specifies the group prefix associated with the RP that has the address identified by Ethernet interface 2. That RP is responsible for the groups with the prefix 239.

```
ip pim rp-candidate ethernet 2 group-list 4  
access-list 4 permit 239.0.0.0 0.255.255.255
```

Related Commands

ip pim rp-announce-filter
ip pim bsr-candidate

ip pim version

To configure the PIM version of the interface, use the **ip pim version** interface configuration command. To restore the default value, use the **no** form of this command.

```
ip pim version [1 | 2]  
no ip pim version
```

Syntax Description

1 (Optional) Configures PIM Version 1.

2 (Optional) Configures PIM Version 2.

Default

Version 2

Command Mode

Interface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

An interface in Version 2 mode automatically downgrades to Version 1 mode if that interface has a PIM Version 1 neighbor. The interface returns to Version 2 mode after all Version 1 neighbors disappear (that is, they are shut down or upgraded).

Example

The following example configures the interface to operate in PIM Version 1 mode:

```
interface ethernet 0  
  ip address 1.1.1.1 255.0.0.0  
  ip pim sparse-dense-mode  
  ip pim version 1
```

show ip pim bsr

To display the bootstrap router (BSR) information, use the **show ip pim bsr** EXEC command.

```
show ip pim bsr
```

Syntax Description

This command has no arguments or keywords.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

The output includes elected BSR information and information about the locally configured candidate RP advertisement.

Sample Display

The following is sample output from the **show ip pim bsr** command:

```
Router# show ip pim bsr
PIMv2 Bootstrap information
This system is the Bootstrap Router (BSR)
  BSR address: 171.69.143.28
  Uptime: 04:37:59, BSR Priority: 4, Hash mask length: 30
  Next bootstrap message in 00:00:03 seconds

Next Cand_RP_advertisement in 00:00:03 seconds.
  RP: 171.69.143.28(Ethernet0), Group acl: 6
```

Table 1 describes the fields in the display.

Table 1 Show IP PIM BSR Field Descriptions

Field	Description
BSR address	IP address of the bootstrap router.
Uptime	Length of time that this router has been up, in hours:minutes:seconds.
BSR Priority	Priority as configured in the ip pim bsr-candidate command.
Hash mask length	Length of a mask (32 bits maximum) that is to be ANDed with the group address before the hash function is called. This value is configured in the ip pim bsr-candidate command.
Next bootstrap message in	Time (in hours:minutes:seconds) in which the next bootstrap message is due from this BSR.
Next Cand_RP_advertisement in	Time (in hours:minutes:seconds) in which the next candidate RP advertisement will be sent.
RP	List of IP addresses of RPs.

Table 1 Show IP PIM BSR Field Descriptions (Continued)

Field	Description
Group acl	Standard IP access list number that defines the group prefixes that are advertised in association with the RP address. This value is configured in the ip pim rp-candidate command.

Related Commands**ip pim bsr-candidate****ip pim rp-candidate****show ip pim rp****show ip pim rp-hash**

show ip pim rp-hash

To display which RP is being selected for a specified group, use the **show ip pim rp-hash EXEC** command.

```
show ip pim rp-hash group
```

Syntax Description

group Group for which to display RP information.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 11.3 T.

This command displays which RP was selected for the group specified. It also shows whether this RP was selected by Auto-RP or the PIM Version 2 bootstrap mechanism.

Sample Display

The following is sample output from the **show ip pim rp-hash** command with the group address 239.1.1.1 specified:

```
Router# show ip pim rp-hash 239.1.1.1
RP 172.21.24.12 (mt1-47a.cisco.com), v2
  Info source: 172.21.24.12 (mt1-47a.cisco.com), via bootstrap
  Uptime: 05:15:33, expires: 00:02:01
```

Table 2 describes the fields in the display.

Table 2 Show IP PIM RP-Hash Field Descriptions

Field	Description
RP 172.21.24.12 (mt1-47a.cisco.com), v2	Address of the RP for the group specified (239.1.1.1). Within parentheses is the DNS name of the RP. If the RP's address is not registered in the DNS, a question mark (?) is displayed. PIM Version 2 configured.
Info source: 172.21.24.12 (mt1-47a.cisco.com), via bootstrap	Indicates from which system the router learned this RP information, along with the source's DNS name. RP was selected by the bootstrap mechanism. In this case, the BSR is also the RP.
Uptime	Length of time (in hours:minutes:seconds) that the router has known about this RP.
expires	Time (in hours:minutes:seconds) after which the information about this RP expires. If the router does not receive any refresh messages in this time, it will discard information about this RP.