Chapter 29: PIM

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29.1 PIM Overview

Protocol Independent Multicast-Dense Mode (PIM-DM) is a dense-mode multicast routing protocol, which is applicable to small-sized networks. In a PIM-DM network, members of a multicast group are densely distributed.

29.1.1 Principles of PIM-DM

The operation of PIM-DM can be understood as neighbor discovery, flooding-prune, and graft.

1) Neighbor discovery

Upon save, a PIM-DM router needs to discover neighbors by sending Hello packets. The relationships between PIM-DM capable network nodes are maintained through exchange of Hello packets. In PIM-DM, Hello packets are sent periodically.

2) Flooding & Prune

PIM-DM assumes that all the hosts on a network are ready to receive multicast data. A packet is transmitted from multicast source S to multicast group G. After receiving this multicast packet, the router performs an RPF check based on the unicast routing table and creates an (S,G) entry if the RPF check is successful. Then the router floods the packet to all the downstream PIM-DM nodes in the network. The router discards the packet if the RPF check fails (the multicast packet is from an incorrect interface). In the flooding process, an (S,G) entry will be created in the PIM-DM multicast domain.

If no downstream node is a multicast group member, the router sends a Prune message to notify the upstream node that data should not be sent to downstream nodes any more. After receiving the Prune message, the upstream node removes the interface that sends the multicast packet from the outbound interface list matching the (S,G) entry. Eventually, a Shortest Path Tree (SPT) with S as the root is created. The prune process is initiated by a leaf router. The whole process is called the flooding&prune process. A timeout mechanism is made available on a pruned router so that the router may initiate a flooding&prune process again if the prune process times out. The flooding&prune mechanism of PIM-DM operates periodically over and over again.

In the flooding&prune process, PIM-DM performs RPF check and builds a multicast forwarding tree with the data source as the root based on the current unicast routing tables. When a multicast packet arrives, the router first judges whether the path of the multicast packet is correct. If the interface where the packet

arrives is what specified in theunicast route, the path is considered correct. Otherwise, the multicast packet is discardedas a redundant packet and will not be forwarded in multicast mode. The unicast route maybe discovered by any unicast routing protocol such as RIP and OSPF instead of a specificrouting protocol.

3) Assert

As shown in the following figure, multicast routers A and B are on the same LAN segmentand they have their respective paths to multicast source S. After receiving a multicast

packet from S, both of them will forward the packet on the LAN. As a result, thedownstream multicast router C will receive two identical multicast packets.

An upstream router uses the Assert mechanism to select the only forwarder. The upstream router sends Assert messages to select the best route. If two or more paths have the same priority and metric value, the router with the largest IP address is selected as the upstream neighbor of the (S,G) entry and is responsible for forwarding the (S,G) multicast packet.
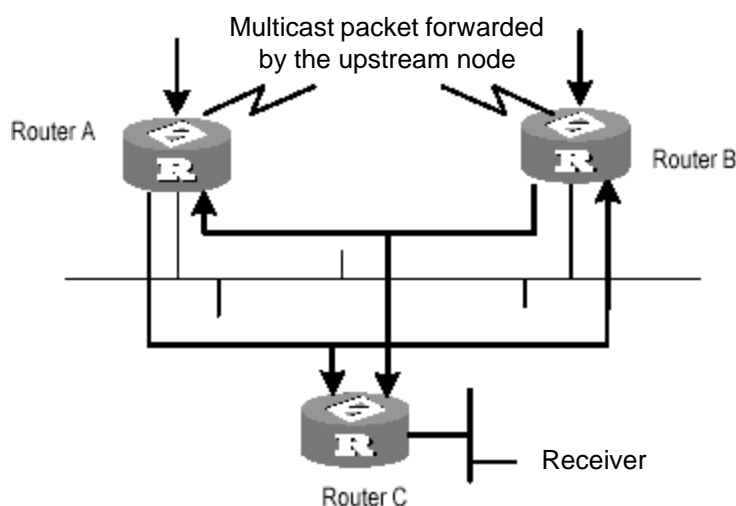
Assert mechanism

4) Graft

When the pruned downstream node needs to enter the forwarding state again, it sends a Graft message to the upstream node. Before Configure the features of IGMP, you must enable the multicast routing function.

5) SRM

To avoid repeated flooding & prune actions, the SRM is added to new protocol standards. Therouter in direct connection with the multicast source sends state update packets periodically. After receiving a state update packet, the PIM-capable router refreshes the prune state.

29.1.2 Principles of PIM-SM

The operation of Protocol Independent Multicast-Sparse Mode (PIM-SM) can be understood asneighbor

discovery, rendezvous point tree (RPT) generation, multicast source registration, andSPT Switch. The neighbor discovery of PIM-SM is the same as that of PIM-DM.

1) RPT generation

When a host joins a multicast group (G), the leaf router which is directly connected with the host if detecting receivers of G by sending IGMP packets, calculates an RP for G andsends a Join message to an upper-level node of the RP for participating in the multicast group. Every router between the leaf router and the RP will generate a (*,G) entry in its forwarding table and therefore they will forward any packets destined for G regardless of where the packets come from. When the RP receives a packet bound for G, the packet will later be sent to the leaf router along the established path and then reach the host. Finally an RPT with the RP as the root is created.

2) Multicast source registration

When multicast source S is sending a multicast packet to multicast group G, the PIM-SM routerwhich is directly connected with S encapsulates the multicast packet into a registration packet and then sends it to an RP in unicast mode. If multiple PIM-SM routers exist on a network

segment, the designated router (DR) sends the multicast packet.

29.1.3 Principles of PIM-SSM

PIM-Source Specific Multicast (PIM-SSM) is dependent on PIM-SM and they may coexist on arouter. Whether PIM-SSM or PIM-SM is used is subject to the multicast address in a data or protocol packet. IANA assigns SSM an address segment (232.0.0.0 to 232.255.255.255). The multicast groups on this address segment will not join an RPT but is processed by SSM. In PIM-SSM, Hello packets are also transmitted periodically between routers for neighbor discovery and DR election.

Usually IGMPv3 is deployed on the host to establish and maintain multicast group memberships. Compared with IGMPv2, IGMPv3 is designed with the source-based filtering function. This function allows a host to receive only the data from a specific group and even from a specific source in this group. Based on a received IS_IN packet of IGMPv3, the SSM-enabled router learns that a host on the network connected with the interface receiving the IS_IN packet wants to receive (S,G) packets. This router unicasts a PIM (S,G) Join message to the next-hop router of the multicast source hop by hop and thereby an SPT can be established between the multicast source and the last-hop router. When the multicast source issending multicast data, the data reaches the receiver along the SPT.

If a host supports only IGMPv1/IGMPv2, you can configure SSM mapping on the router connected with the host to convert the (*,G) Join messages of IGMPv1/IGMPv2 into (S,G) Joinmessages.

29.2 Configure PIM

29.2.1 PIM Configuration List

The operations listed in the tablemust be performed sequentially during PIM configuration. It isrecommended that PIM-DM be enabled on all the interfaces of a non-border router running in PIM-DM domains. In contrast, PIM-SM does not need to be enabled on every interface.

Configuration Task	Description	Detailed Configuration
Basic PIM Configuration	Required	29.2.2
Advanced PIM Configuration	Required	29.2.3

29.2.2 Basic PIM Configuration

Operation	Command	Remarks
Enables PIM-DM on an interface.	**ip pim dense-mode**	
Disables PIM-DM on an interface.	**undo ip pim dense-mode**	
Enables PIM-SM on an interface.	**ip pim sparse-mode**	
Disables PIM-SM on an interface.	**undo ip pim sparse-mode**	

Note:

Enable a multicast protocol before PIM-SM on an interface.

29.2.3 Advanced PIM Configuration

Operation	Command	Remarks
Configures the transmission interval of Hello packets.	**ip pim query-interval** *seconds*	
Restores the default transmission interval.	**undo ip pim query-interval**	
Configures an interface as the border of a BSR.	**ip pim bsr-border**	
Deletes the BSR border configuration of an interface.	**undo ip pim bsr-border**	
Enters the PIM mode.	**pim**	

Quits the PIM mode.	**quit**	
Filters the received multicast packets based on the source.	**source-policy** *acl-number*	
Cancels source-based filtering.	**undo source-policy**	
Filters PIM neighbors.	**ip pim neighbor-policy** *acl-number*	
Cancels PIM neighbor filtering.	**undo ip pim neighbor-policy**	
Configures the maximum of PIM neighbors for an interface.	**ip pim neighbor-limit** *limit*	
Restores the default value.	**undo ip pim neighbor-limit**	
Configures a static RP.	**static-rp** *address*	
Deletes a static RP.	**undo static-rp**	
Configures a C-BSR.	**bsr-candidate** *interface-type interface-number hash-mask-length priority*	
Deletes a C-BSR.	**undo bsr-candidate**	
Configures a C-RP.	**rp-candidate** *interface-type interface-number* **group-list** *acl-number priority*	
Deletes a C-RP.	**rp-candidate** *interface-type interface-number* **group-list** *acl-number*	
Configures a Switching threshold.	**spt-threshold** { *immediately* | *infinity* }	
Restores the default Switching threshold.	**undo spt-threshold**	
Displays the information of PIM interfaces.	**display ip pim interface** [**vlan-interface***vid*]	
Displays the information of PIM neighbors.	**display ip pim neighbor**	
Displays the multicast routing tables learned by PIM, including static and dynamic routing entries.	**display ip mroute** *group-address* [*static* | *dynamic*]	
Displays dynamic and static RPs of PIM.	**display ip pim rp-info** *group-address*	
Displays the information of BSRs, including the elected BSR and local C-BSRs.	**display ip pim bs**	
Displays the range of SSM group	**display ip pim ssm range**	

addresses.		
Configures the range of an SSM multicast group.	**ssm** { **default** | **range** *acl* }	
Deletes the configuration of the range of an SSM multicast group.	**undo ssm** { **default** | **range** *acl* }	

Note: Be sure to enable PIM on an interface before Configure the PIM attributes of the interface. This point must be noted when you use the commands for Configure interface attributes and will not be given again.

Ensure that all the devices in the domain are configured with the same range of SSM multicast group addresses. Otherwise, multicast information cannot be transmitted using the SSM model.

If members of an SSM multicast group send Join messages over IGMPv1 or IGMPv2, (*,G) Join messages will not be triggered.