IP Multicast Technology Overview

IP multicast is a bandwidth-conserving technology that reduces traffic by delivering a single stream of information simultaneously to potentially thousands of businesses and homes. Applications that take advantage of multicast include video conferencing, corporate communications, distance learning, and distribution of software, stock quotes, and news.

This module contains a technical overview of IP multicast. IP multicast is an efficient way to use network resources, especially for bandwidth-intensive services such as audio and video. Before beginning to configure IP multicast, it is important that you understand the information presented in this module.

- Information About IP Multicast Technology, on page 1

Information About IP Multicast Technology

Role of IP Multicast in Information Delivery

IP multicast routing enables a host (source) to send packets to a group of hosts (receivers) anywhere within the IP network by using a special form of IP address called the IP multicast group address. The sending host inserts the multicast group address into the IP destination address field of the packet and IP multicast routers and multilayer switches forward incoming IP multicast packets out all interfaces that lead to the members of the multicast group. Any host, regardless of whether it is a member of a group, can send to a group. However, only the members of a group receive the message.

Multicast Group Transmission Scheme

IP communication consists of hosts that act as senders and receivers of traffic as shown in the first figure. Senders are called sources. Traditional IP communication is accomplished by a single host source sending packets to another single host (unicast transmission) or to all hosts (broadcast transmission). IP multicast provides a third scheme, allowing a host to send packets to a subset of all hosts (multicast transmission). This subset of receiving hosts is called a multicast group. The hosts that belong to a multicast group are called group members.

Multicast is based on this group concept. A multicast group is an arbitrary number of receivers that join a group in order to receive a particular data stream. This multicast group has no physical or geographical boundaries--the hosts can be located anywhere on the Internet or on any private internetwork. Hosts that are interested in receiving data from a source to a particular group must join that group. Joining a group is accomplished by a host receiver by way of the Internet Group Management Protocol (IGMP).

In a multicast environment, any host, regardless of whether it is a member of a group, can send to a group. However, only the members of a group can receive packets sent to that group. Multicast packets are delivered to a group using best-effort reliability, just like IP unicast packets.

In the next figure, the receivers (the designated multicast group) are interested in receiving the video data stream from the source. The receivers indicate their interest by sending an IGMP host report to the routers in the network. The routers are then responsible for delivering the data from the source to the receivers. The routers use Protocol Independent Multicast (PIM) to dynamically create a multicast distribution tree. The video data stream will then be delivered only to the network segments that are in the path between the source and the receivers.

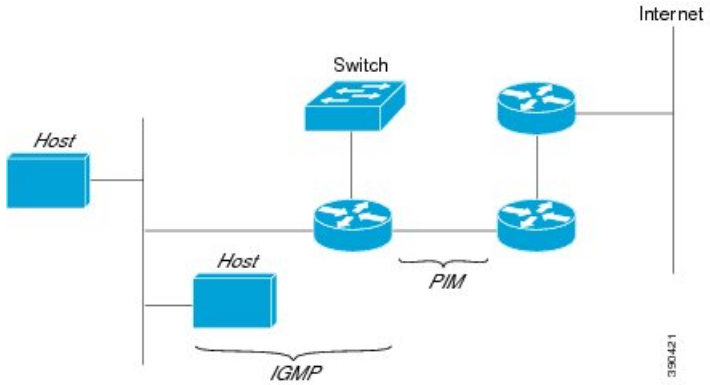
IP Multicast Routing Protocols

The software supports the following protocols to implement IP multicast routing:

- IGMP is used between hosts on a LAN and the routers on that LAN to track the multicast groups of which hosts are members.
- Protocol Independent Multicast (PIM) is used between routers so that they can track which multicast packets to forward to each other and to their directly connected LANs.

The figure shows where these protocols operate within the IP multicast environment.

Figure 1: IP Multicast Routing Protocols



IP Multicast Group Addressing

A multicast group is identified by its multicast group address. Multicast packets are delivered to that multicast group address. Unlike unicast addresses that uniquely identify a single host, multicast IP addresses do not identify a particular host. To receive the data sent to a multicast address, a host must join the group that address identifies. The data is sent to the multicast address and received by all the hosts that have joined the group indicating that they wish to receive traffic sent to that group. The multicast group address is assigned to a group at the source. Network administrators who assign multicast group addresses must make sure the addresses conform to the multicast address range assignments reserved by the Internet Assigned Numbers Authority (IANA).

IP Class D Addresses

IP multicast addresses have been assigned to the IPv4 Class D address space by IANA. The high-order four bits of a Class D address are 1110. Therefore, host group addresses can be in the range 224.0.0.0 to 239.255.255.255. A multicast address is chosen at the source (sender) for the receivers in a multicast group.

Note The Class D address range is used only for the group address or destination address of IP multicast traffic. The source address for multicast datagrams is always the unicast source address.

IP Multicast Address Scoping

The multicast address range is subdivided to provide predictable behavior for various address ranges and for address reuse within smaller domains. The table provides a summary of the multicast address ranges. A brief summary description of each range follows.

Table 1: Multicast Address Range Assignments

Name	Range	Description
Reserved Link-Local Addresses	224.0.0.0 to 224.0.0.255	Reserved for use by network protocols on a local network segment.
Globally Scoped Addresses	224.0.1.0 to 238.255.255.255	Reserved to send multicast data between organizations and across the Internet.
Source Specific Multicast	232.0.0.0 to 232.255.255.255	Reserved for use with the SSM datagram delivery model where data is forwarded only to receivers that have explicitly joined the group.
GLOP Addresses	233.0.0.0 to 233.255.255.255	Reserved for statically defined addresses by organizations that already have an assigned autonomous system (AS) domain number.
Limited Scope Address	239.0.0.0 to 239.255.255.255	Reserved as administratively or limited scope addresses for use in private multicast domains.

Reserved Link-Local Addresses

The IANA has reserved the range 224.0.0.0 to 224.0.0.255 for use by network protocols on a local network segment. Packets with an address in this range are local in scope and are not forwarded by IP routers. Packets with link local destination addresses are typically sent with a time-to-live (TTL) value of 1 and are not forwarded by a router.

Within this range, reserved link-local addresses provide network protocol functions for which they are reserved. Network protocols use these addresses for automatic router discovery and to communicate important routing information. For example, Open Shortest Path First (OSPF) uses the IP addresses 224.0.0.5 and 224.0.0.6 to exchange link-state information.

IANA assigns single multicast address requests for network protocols or network applications out of the 224.0.1.xxx address range. Multicast routers forward these multicast addresses.

Note All the packets with reserved link-local addresses are punted to CPU by default in the ASR 903 RSP2 Module.

Globally Scoped Addresses

Addresses in the range 224.0.1.0 to 238.255.255.255 are called globally scoped addresses. These addresses are used to send multicast data between organizations across the Internet. Some of these addresses have been reserved by IANA for use by multicast applications. For example, the IP address 224.0.1.1 is reserved for Network Time Protocol (NTP).

Source Specific Multicast Addresses

Addresses in the range 232.0.0.0/8 are reserved for Source Specific Multicast (SSM) by IANA. In Cisco IOS software, you can use the **ip pim ssm**command to configure SSM for arbitrary IP multicast addresses also. SSM is an extension of Protocol Independent Multicast (PIM) that allows for an efficient data delivery mechanism in one-to-many communications. SSM is described in the IP Multicast Delivery Modes, on page 5 section.

GLOP Addresses

GLOP addressing (as proposed by RFC 2770, GLOP Addressing in 233/8) proposes that the 233.0.0.0/8 range be reserved for statically defined addresses by organizations that already have an AS number reserved. This practice is called GLOP addressing. The AS number of the domain is embedded into the second and third octets of the 233.0.0.0/8 address range. For example, AS 62010 is written in hexadecimal format as F23A. Separating the two octets F2 and 3A results in 242 and 58 in decimal format. These values result in a subnet of 233.242.58.0/24 that would be globally reserved for AS 62010 to use.

Limited Scope Addresses

The range 239.0.0.0 to 239.255.255.255 is reserved as administratively or limited scoped addresses for use in private multicast domains. These addresses are constrained to a local group or organization. Companies, universities, and other organizations can use limited scope addresses to have local multicast applications that will not be forwarded outside their domain. Routers typically are configured with filters to prevent multicast traffic in this address range from flowing outside an autonomous system (AS) or any user-defined domain. Within an AS or domain, the limited scope address range can be further subdivided so that local multicast boundaries can be defined.

Note Network administrators may use multicast addresses in this range, inside a domain, without conflicting with others elsewhere in the Internet.

Layer 2 Multicast Addresses

Historically, network interface cards (NICs) on a LAN segment could receive only packets destined for their burned-in MAC address or the broadcast MAC address. In IP multicast, several hosts need to be able to receive a single data stream with a common destination MAC address. Some means had to be devised so that multiple hosts could receive the same packet and still be able to differentiate between several multicast groups. One

method to accomplish this is to map IP multicast Class D addresses directly to a MAC address. Using this method, NICs can receive packets destined to many different MAC address.

IP Multicast Delivery Modes

IP multicast delivery modes differ only for the receiver hosts, not for the source hosts. A source host sends IP multicast packets with its own IP address as the IP source address of the packet and a group address as the IP destination address of the packet.

Any Source Multicast

For the Any Source Multicast (ASM) delivery mode, an IP multicast receiver host can use any version of IGMP to join a multicast group. This group is notated as G in the routing table state notation. By joining this group, the receiver host is indicating that it wants to receive IP multicast traffic sent by any source to group G. The network will deliver IP multicast packets from any source host with the destination address G to all receiver hosts in the network that have joined group G.

ASM requires group address allocation within the network. At any given time, an ASM group should only be used by a single application. When two applications use the same ASM group simultaneously, receiver hosts of both applications will receive traffic from both application sources. This may result in unexpected excess traffic in the network. This situation may cause congestion of network links and malfunction of the application receiver hosts.

Source Specific Multicast

Source Specific Multicast (SSM) is a datagram delivery model that best supports one-to-many applications, also known as broadcast applications. SSM is a core network technology for the Cisco implementation of IP multicast targeted for audio and video broadcast application environments.

For the SSM delivery mode, an IP multicast receiver host must use IGMP Version 3 (IGMPv3) to subscribe to channel (S,G). By subscribing to this channel, the receiver host is indicating that it wants to receive IP multicast traffic sent by source host S to group G. The network will deliver IP multicast packets from source host S to group G to all hosts in the network that have subscribed to the channel (S, G).

SSM does not require group address allocation within the network, only within each source host. Different applications running on the same source host must use different SSM groups. Different applications running on different source hosts can arbitrarily reuse SSM group addresses without causing any excess traffic on the network.

Protocol Independent Multicast

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 can operate in dense mode or sparse mode. The router can also handle both sparse groups and dense groups at the same time. 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.

For information about PIM forwarding (interface) modes, see the following sections:

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.

Note Dense mode is not often used and its use is not recommended. For this reason it is not specified in the configuration tasks in related modules.

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.

Unlike dense mode interfaces, 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 packets are dropped. 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. See the Rendezvous Points, on page 8 section for more information.

In sparse mode, a router assumes that other routers do not want to forward multicast packets for a group, unless there is an explicit request for the traffic. When hosts join a multicast group, the directly connected routers send PIM Join messages toward the RP. The RP keeps track of multicast groups. Hosts that send multicast packets are registered with the RP by the first hop router of that host. At this point, packets are forwarded on a shared distribution tree. If the multicast traffic from a specific source is sufficient, the first hop router of the host may send Join messages toward the source to build a source-based distribution tree.

Sources register with the RP and then data is forwarded down the shared tree to the receivers. The edge router sends PIM (S,G) Join messages toward that source. Each router along the reverse path compares the unicast routing metric of the RP address to the metric of the source address. If the metric for the source address is better, it will forward a PIM (S,G) Join message toward the source. If the metric for the RP is the same or better, then the PIM (S,G) Join message will be sent in the same direction as the RP. In this case, the shared tree and the source tree would be considered congruent.

If the shared tree is not an optimal path between the source and the receiver, the routers dynamically create a source tree and stop traffic from flowing down the shared tree. This behavior is the default behavior in software. Network administrators can force traffic to stay on the shared tree by using the **ip pim spt-threshold infinity** command. The default value of **ip pim spt-threshold infinity** command is 0.

PIM-SM scales well to a network of any size, including those with WAN links. The explicit join mechanism prevents unwanted traffic from flooding the WAN links.

Sparse-Dense Mode

If you configure either sparse mode or dense mode on an interface, then sparseness or denseness is applied to the interface as a whole. However, some environments might require PIM to run in a single region in sparse mode for some groups and in dense mode for other groups.

An alternative to enabling only dense mode or only sparse mode is to enable sparse-dense mode. In this case, the interface is treated as dense mode if the group is in dense mode; the interface is treated in sparse mode if the group is in sparse mode. You must have an RP if the interface is in sparse-dense mode and you want to treat the group as a sparse group.

If you configure sparse-dense mode, the idea of sparseness or denseness is applied to the groups for which the router is a member.

Another benefit of sparse-dense mode is that Auto-RP information can be distributed in a dense mode; yet, multicast groups for user groups can be used in a sparse mode manner. Therefore there is no need to configure a default RP at the leaf routers.

When an interface is treated in dense mode, it is populated in the outgoing interface list of a multicast routing table when either of the following conditions is true:

- Members are on the interface.
- There are PIM neighbors and the group has not been pruned.

When an interface is treated in sparse mode, it is populated in the outgoing interface list of a multicast routing table when either of the following conditions is true:

- Members are on the interface.
- An explicit Join message has been received by a PIM neighbor on the interface.

Bidirectional PIM

Bidirectional PIM or bidirectional multicast (RFC-5015) is an operating mode that enhances PIM by creating bidirectional multicast distribution trees. It helps deploy emerging communication and financial applications that rely on a many-to-many applications model.

Multicast Group Modes

In PIM, packet traffic for a multicast group is routed according to the rules of the mode configured for that multicast group. The Cisco implementation of PIM supports three modes for a multicast group:

- PIM Sparse mode
- PIM Dense mode
- PIM Source Specific Multicast (SSM) mode

A router can simultaneously support all three modes or any combination of them for different multicast groups.

Sparse Mode

Sparse mode operation centers around a single unidirectional shared tree whose root node is called the rendezvous point (RP). Sources must register with the RP to get their multicast traffic to flow down the shared tree by way of the RP. This registration process actually triggers a shortest path tree (SPT) Join by the RP toward the source when there are active receivers for the group in the network.

A sparse mode group uses the explicit join model of interaction. Receiver hosts join a group at a rendezvous point (RP). Different groups can have different RPs.

Multicast traffic packets flow down the shared tree to only those receivers that have explicitly asked to receive the traffic.

Dense Mode

Dense mode operates using the broadcast (flood) and prune model.

In populating the multicast routing table, dense mode interfaces are always added to the table. Multicast traffic is forwarded out all interfaces in the outgoing interface list to all receivers. Interfaces are removed from the outgoing interface list in a process called pruning. In dense mode, interfaces are pruned for various reasons including that there are no directly connected receivers.

A pruned interface can be reestablished, that is, grafted back so that restarting the flow of multicast traffic can be accomplished with minimal delay.

Rendezvous Points

A rendezvous point (RP) is a role that a device performs when operating in Protocol Independent Multicast (PIM) Sparse Mode (SM). An RP is required only in networks running PIM SM. In the PIM-SM model, only network segments with active receivers that have explicitly requested multicast data will be forwarded the traffic.

This method of delivering multicast data is in contrast to PIM Dense Mode (PIM DM). In PIM DM, multicast traffic is initially flooded to all segments of the network. Routers that have no downstream neighbors or directly connected receivers prune back the unwanted traffic.

An RP acts as the meeting place for sources and receivers of multicast data. In a PIM-SM network, sources must send their traffic to the RP. This traffic is then forwarded to receivers down a shared distribution tree. By default, when the first hop device of the receiver learns about the source, it will send a Join message directly to the source, creating a source-based distribution tree from the source to the receiver. This source tree does not include the RP unless the RP is located within the shortest path between the source and receiver.

In most cases, the placement of the RP in the network is not a complex decision. By default, the RP is needed only to start new sessions with sources and receivers. Consequently, the RP experiences little overhead from traffic flow or processing. In PIM version 2, the RP performs less processing than in PIM version 1 because sources must only periodically register with the RP to create state.

Auto-RP

In the first version of PIM-SM, all leaf routers (routers directly connected to sources or receivers) were required to be manually configured with the IP address of the RP. This type of configuration is also known as static RP configuration. Configuring static RPs is relatively easy in a small network, but it can be laborious in a large, complex network.

Following the introduction of PIM-SM version 1, Cisco implemented a version of PIM-SM with the Auto-RP feature. 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.

Multiple RPs can be used to serve different group ranges or serve as backups to each other. 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.

Note If you configure PIM in sparse mode or sparse-dense mode and do not configure Auto-RP, you must statically configure an RP.

Note If router interfaces are configured in sparse mode, Auto-RP can still be used if all routers are configured with a static RP address for the Auto-RP groups.

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.

Each method for configuring an RP has its own strengths, weaknesses, and level of complexity. In conventional IP multicast network scenarios, we recommend using Auto-RP to configure RPs because it is easy to configure, well-tested, and stable. The alternative ways to configure an RP are static RP, Auto-RP, and bootstrap router.

Sparse-Dense Mode for Auto-RP

A prerequisite of Auto-RP is that all interfaces must be configured in sparse-dense mode using the **ip pim sparse-dense-mode** interface configuration command. An interface configured in sparse-dense mode is treated in either sparse mode or dense mode of operation, depending on which mode the multicast group operates. If a multicast group has a known RP, the interface is treated in sparse mode. If a group has no known RP, by default the interface is treated in dense mode and data will be flooded over this interface. (You can prevent dense-mode fallback; see the module "Configuring Basic IP Multicast.")

To successfully implement Auto-RP and prevent any groups other than 224.0.1.39 and 224.0.1.40 from operating in dense mode, we recommend configuring a "sink RP" (also known as "RP of last resort"). A sink RP is a statically configured RP that may or may not actually exist in the network. Configuring a sink RP does not interfere with Auto-RP operation because, by default, Auto-RP messages supersede static RP configurations. We recommend configuring a sink RP for all possible multicast groups in your network, because it is possible for an unknown or unexpected source to become active. If no RP is configured to limit source registration, the group may revert to dense mode operation and be flooded with data.

Multicast Forwarding

Forwarding of multicast traffic is accomplished by multicast-capable routers. These routers create distribution trees that control the path that IP multicast traffic takes through the network in order to deliver traffic to all receivers.

Multicast traffic flows from the source to the multicast group over a distribution tree that connects all of the sources to all of the receivers in the group. This tree may be shared by all sources (a shared tree) or a separate distribution tree can be built for each source (a source tree). The shared tree may be one-way or bidirectional.

Before describing the structure of source and shared trees, it is helpful to explain the notations that are used in multicast routing tables. These notations include the following:

- (S,G) = (unicast source for the multicast group G, multicast group G)
- (*,G) = (any source for the multicast group G, multicast group G)

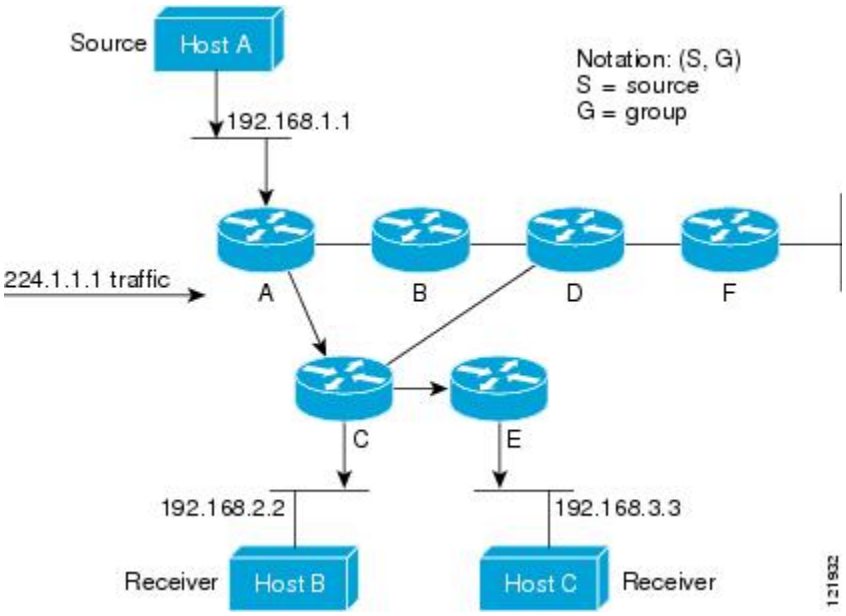
The notation of (S,G), pronounced "S comma G," enumerates a shortest path tree where S is the IP address of the source and G is the multicast group address.

Shared trees are (*,G) and the source trees are (S,G) and always routed at the sources.

Multicast Distribution Source Tree

The simplest form of a multicast distribution tree is a source tree. A source tree has its root at the source host and has branches forming a spanning tree through the network to the receivers. Because this tree uses the shortest path through the network, it is also referred to as a shortest path tree (SPT).

The figure shows an example of an SPT for group 224.1.1.1 rooted at the source, Host A, and connecting two receivers, Hosts B and C.



Using standard notation, the SPT for the example shown in the figure would be (192.168.1.1, 224.1.1.1).

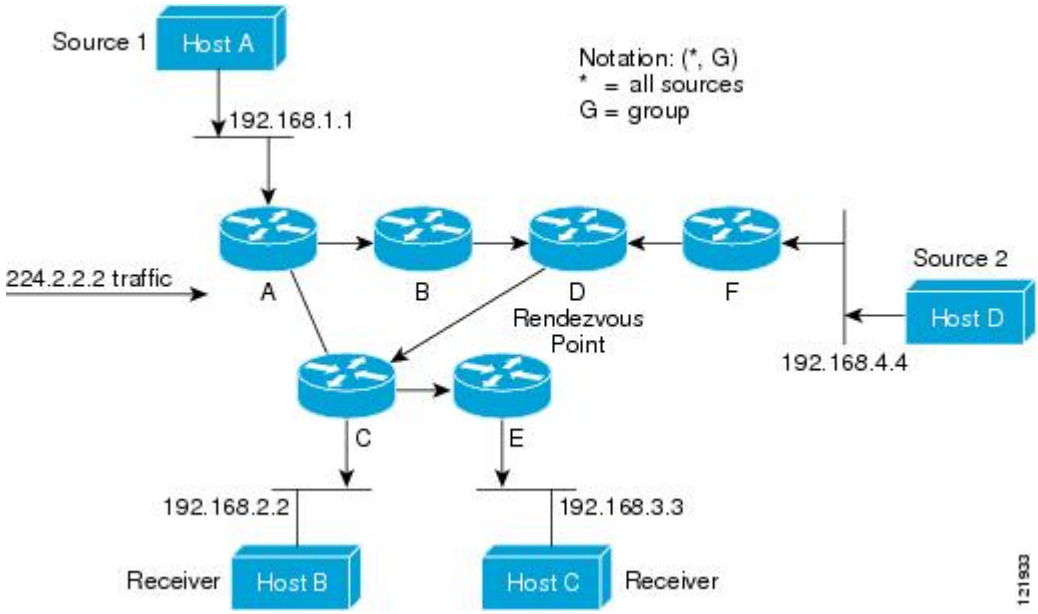
The (S,G) notation implies that a separate SPT exists for each individual source sending to each group--which is correct.

Multicast Distribution Shared Tree

Unlike source trees that have their root at the source, shared trees use a single common root placed at some chosen point in the network. This shared root is called a rendezvous point (RP).

The following figure shows a shared tree for the group 224.2.2.2 with the root located at Router D. This shared tree is unidirectional. Source traffic is sent towards the RP on a source tree. The traffic is then forwarded down the shared tree from the RP to reach all of the receivers (unless the receiver is located between the source and the RP, in which case it will be serviced directly).

Figure 2: Shared Tree



In this example, multicast traffic from the sources, Hosts A and D, travels to the root (Router D) and then down the shared tree to the two receivers, Hosts B and C. Because all sources in the multicast group use a common shared tree, a wildcard notation written as (*, G), pronounced "star comma G", represents the tree. In this case, * means all sources, and G represents the multicast group. Therefore, the shared tree shown in the figure would be written as (*, 224.2.2.2).

Both source trees and shared trees are loop-free. Messages are replicated only where the tree branches. Members of multicast groups can join or leave at any time; therefore the distribution trees must be dynamically updated. When all the active receivers on a particular branch stop requesting the traffic for a particular multicast group, the routers prune that branch from the distribution tree and stop forwarding traffic down that branch. If one receiver on that branch becomes active and requests the multicast traffic, the router will dynamically modify the distribution tree and start forwarding traffic again.

Source Tree Advantage

Source trees have the advantage of creating the optimal path between the source and the receivers. This advantage guarantees the minimum amount of network latency for forwarding multicast traffic. However, this optimization comes at a cost. The routers must maintain path information for each source. In a network that has thousands of sources and thousands of groups, this overhead can quickly become a resource issue on the routers. Memory consumption from the size of the multicast routing table is a factor that network designers must take into consideration.

Shared Tree Advantage

Shared trees have the advantage of requiring the minimum amount of state in each router. This advantage lowers the overall memory requirements for a network that only allows shared trees. The disadvantage of shared trees is that under certain circumstances the paths between the source and receivers might not be the optimal paths, which might introduce some latency in packet delivery. For example, in the figure above the shortest path between Host A (source 1) and Host B (a receiver) would be Router A and Router C. Because we are using Router D as the root for a shared tree, the traffic must traverse Routers A, B, D and then C.

Network designers must carefully consider the placement of the rendezvous point (RP) when implementing a shared tree-only environment.

In unicast routing, traffic is routed through the network along a single path from the source to the destination host. A unicast router does not consider the source address; it considers only the destination address and how to forward the traffic toward that destination. The router scans through its routing table for the destination address and then forwards a single copy of the unicast packet out the correct interface in the direction of the destination.

In multicast forwarding, the source is sending traffic to an arbitrary group of hosts that are represented by a multicast group address. The multicast router must determine which direction is the upstream direction (toward the source) and which one is the downstream direction (or directions) toward the receivers. If there are multiple downstream paths, the router replicates the packet and forwards it down the appropriate downstream paths (best unicast route metric)--which is not necessarily all paths. Forwarding multicast traffic away from the source, rather than to the receiver, is called Reverse Path Forwarding (RPF). RPF is described in the following section.

Reverse Path Forwarding

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Protocol Independent Multicast (PIM) uses the unicast routing information to create a distribution tree along the reverse path from the receivers towards the source. The multicast routers then forward packets along the distribution tree from the source to the receivers. RPF is a key concept in multicast forwarding. It enables routers to correctly forward multicast traffic down the distribution tree. RPF makes use of the existing unicast routing table to determine the upstream and downstream neighbors. A router will forward a multicast packet only if it is received on the upstream interface. This RPF check helps to guarantee that the distribution tree will be loop-free.

RPF Check

When a multicast packet arrives at a router, the router performs an RPF check on the packet. If the RPF check succeeds, the packet is forwarded. Otherwise, it is dropped.

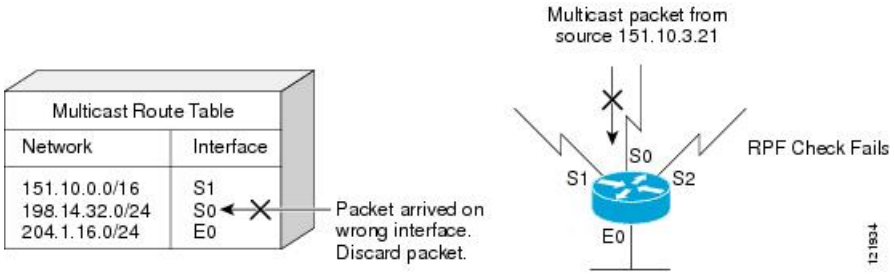
For traffic flowing down a source tree, the RPF check procedure works as follows:

1. The router looks up the source address in the unicast routing table to determine if the packet has arrived on the interface that is on the reverse path back to the source.
2. If the packet has arrived on the interface leading back to the source, the RPF check succeeds and the packet is forwarded out the interfaces present in the outgoing interface list of a multicast routing table entry.

3. If the RPF check in Step 2 fails, the packet is dropped.

The figure shows an example of an unsuccessful RPF check.

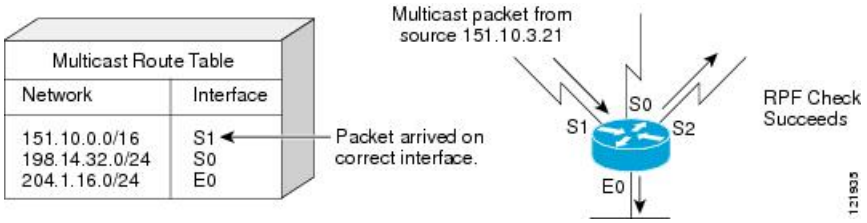
Figure 3: RPF Check Fails



As the figure illustrates, a multicast packet from source 151.10.3.21 is received on serial interface 0 (S0). A check of the unicast route table shows that S1 is the interface this router would use to forward unicast data to 151.10.3.21. Because the packet has arrived on interface S0, the packet is discarded.

The figure shows an example of a successful RPF check.

Figure 4: RPF Check Succeeds



In this example, the multicast packet has arrived on interface S1. The router refers to the unicast routing table and finds that S1 is the correct interface. The RPF check passes, and the packet is forwarded.

Guidelines for Choosing a PIM Mode

Before beginning the configuration process, you must decide which PIM mode needs to be used. This determination is based on the applications you intend to support on your network.

Basic guidelines include the following:

- In general, if the application is one-to-many or many-to-many in nature, then PIM-SM can be used successfully.
- For optimal one-to-many application performance, SSM is appropriate but requires IGMP version 3 support.