



ADVANCED IP MULTICAST

SESSION RST-4701

Networkers Multicast Sessions

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- **Breakout Sessions**
 - RST 1701 – Introduction to IP Multicast
 - RST 2701 – Deploying IP Multicast
 - RST 2702 – Deploying IP Multicast VPN's
 - RST 4701 – Advanced IP Multicast
- **Techtorials**
 - RST 2T07 – Enterprise IP Multicast
- **Multicast BoF**

Agenda

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- **MBGP (routing)**
- **MSDP (source discovery)**
- **MBGP/MSDP Examples**
- **SSM (Source Specific Multicast)**
- **MVPN (Multicast VPN)**
- **IPv6 Multicast**
- **Security**
- **Source Redundancy**

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MULTIPROTOCOL BGP (MBGP)



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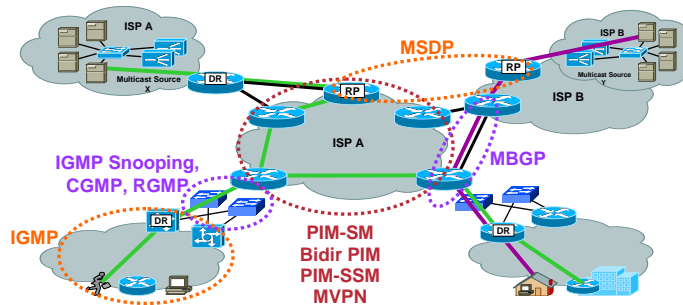
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Multicast Components

Cisco End-to-End Architecture

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Campus Multicast

- End Stations (hosts-to-routers):
 - IGMP
- Switches (Layer 2 Optimization):
 - CGMP, IGMP Snooping or RGMP
- Routers (Multicast Forwarding Protocol):
 - PIM Sparse Mode or Bidirectional PIM

Interdomain Multicast

- Multicast routing across domains
 - MBGP
- Multicast Source Discovery
 - MSDP with PIM-SM
- Source Specific Multicast
 - PIM-SSM

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MBGP Overview

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- **MBGP: Multiprotocol BGP**
 - Defined in RFC 2283 (extensions to BGP)
 - Can carry different types of routes
 - IPv4 Unicast IPv6 Unicast
 - IPv4 Multicast IPv6 Multicast
 - May be carried in same BGP session
 - Does not propagate multicast state info
 - Still need PIM to build Distribution Trees
 - Same path selection and validation rules
 - AS-Path, LocalPref, MED, ...

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MBGP Overview

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- **Separate BGP tables maintained**
 - Unicast BGP Table (U-Table)
 - Multicast BGP Table (M-Table)
 - BGP 'nlri' keyword specifies which BGP Table
 - Allows different unicast/multicast topologies or policies
- **Unicast BGP Table (U-Table)**
 - Contains unicast prefixes for unicast forwarding
 - Populated with BGP unicast NLRI
- **Multicast BGP Table (M-Table)**
 - Contains unicast prefixes for RPF checking
 - Populated with BGP multicast NLRI

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MBGP Update Message

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- **Address Family Information (AFI)**
 - Identifies Address Type (see RFC1700)
 - AFI = 1 (IPv4)
 - AFI = 2 (IPv6)
- **Sub-Address Family Information (Sub-AFI)**
 - Sub category for AFI Field
 - Address Family Information (AFI) = 1 (IPv4)
 - Sub-AFI = 1 (NLRI is used for unicast)
 - Sub-AFI = 2 (NLRI is used for multicast RPF check)

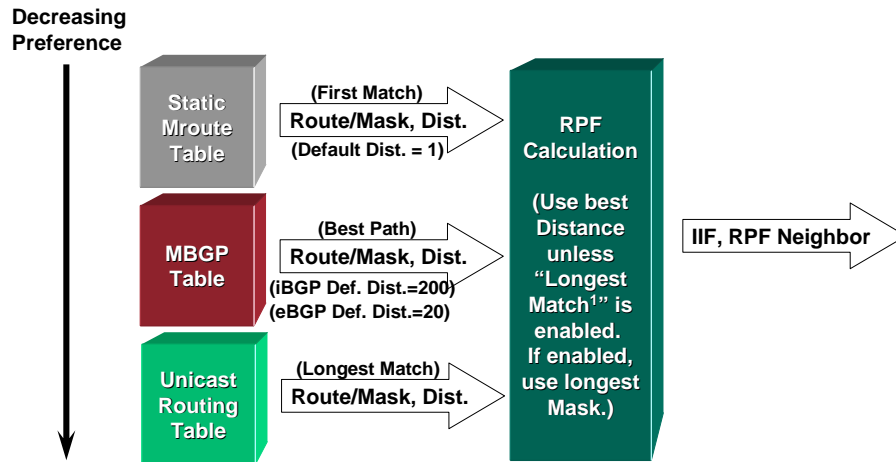
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PIM RPF Calculation Details

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MBGP—Capability Negotiation

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- Keyword on neighbor command

```
neighbor <foo> remote-as <asn> nlri multicast unicast
```

- Configures router to negotiate either or both NLRI
- If neighbor configures both or subset, common NLRI is used in both directions
- If there is no match, notification is sent and peering doesn't come up

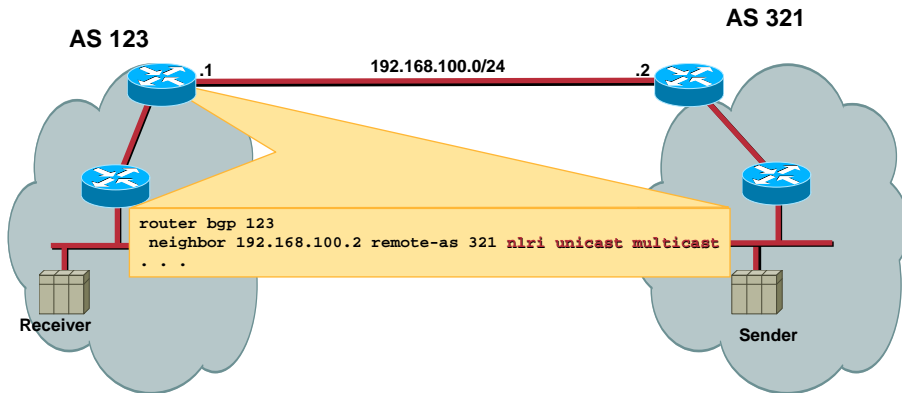
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MBGP — Capability Negotiation

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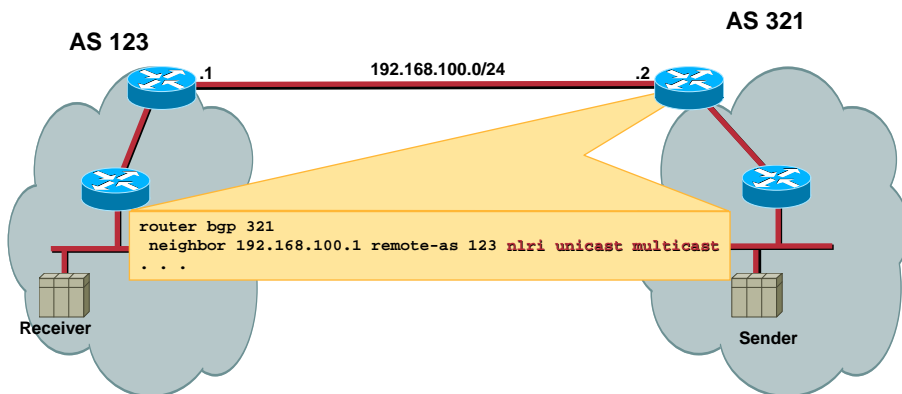
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MBGP — Capability Negotiation

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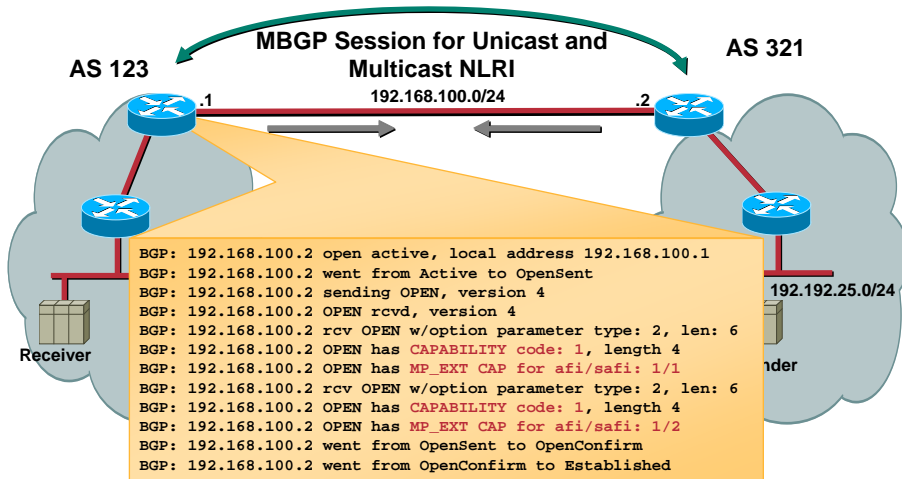
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MBGP — Capability Negotiation

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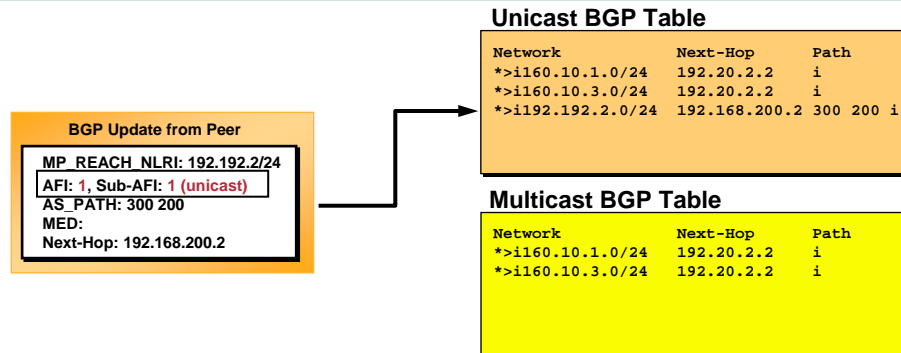
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MBGP—NLRI Information

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- Storage of arriving NLRI information depends on AFI/SAFI fields in the Update message
 - Unicast BGP Table only (AFI=1/SAFI=1 or old style NLRI)

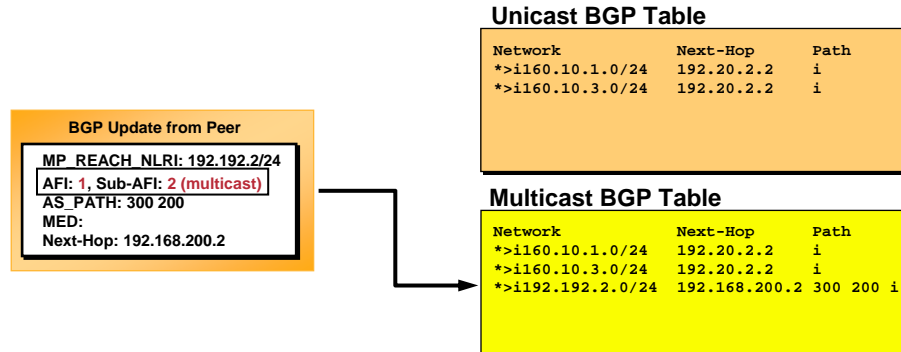
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MBGP—NLRI Information

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- Storage of arriving NLRI information depends on AFI/SAFI fields in the Update message
 - Unicast BGP Table only (AFI=1/SAFI=1 or old style NLRI)
 - Multicast BGP Table only (AFI=1/SAFI=2)**

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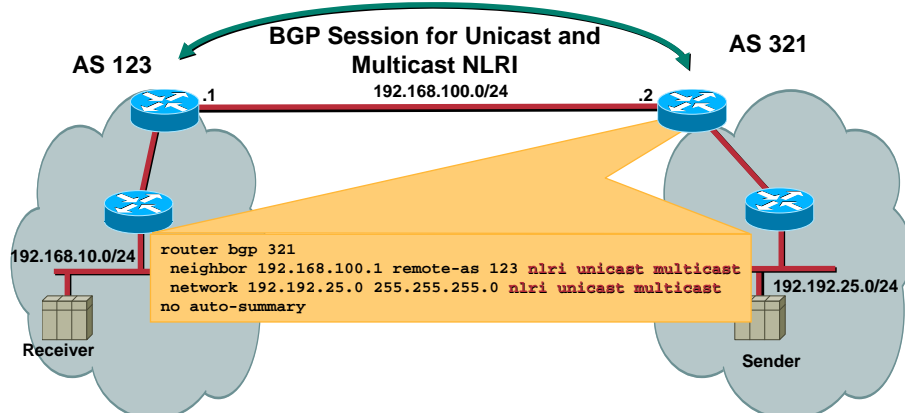
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MBGP—NLRI Information

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Congruent Topologies



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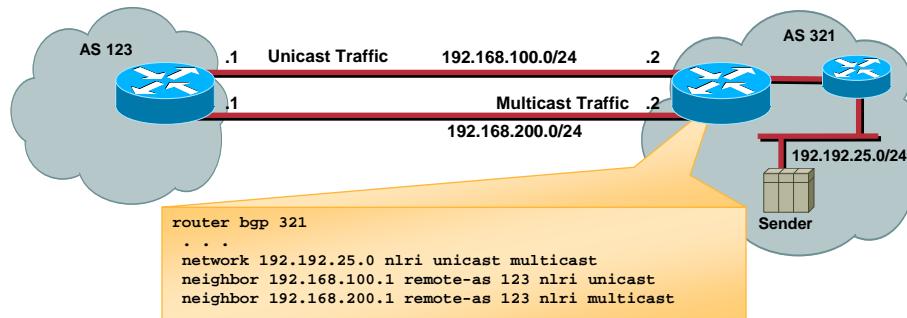
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MBGP—NLRI Information

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Incongruent Topologies



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MBGP Syntax Change

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NLRI Syntax

```
router bgp 5
network 171.69.214.0 mask 255.255.255.0 nlri unicast multicast
neighbor 171.69.214.38 remote-as 2 nlri unicast
neighbor 171.69.214.50 remote-as 2 nlri multicast
```

Address-Family Syntax

```
router bgp 5
no bgp default ipv4-unicast
neighbor 171.69.214.38 remote-as 2
neighbor 171.69.214.50 remote-as 2
!
address-family ipv4 unicast
neighbor 171.69.214.38 activate
network 171.69.214.0 mask 255.255.255.0
exit-address-family
!
address-family ipv4 multicast
neighbor 171.69.214.50 activate
network 171.69.214.0 mask 255.255.255.0
exit-address-family
```

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MBGP—Summary

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- **Solves part of inter-domain problem**
 - Can exchange multicast routing information
 - Uses standard BGP configuration knobs
 - Permits separate unicast and multicast topologies if desired
- **Still must use PIM to:**
 - Build distribution trees
 - Actually forward multicast traffic
 - PIM-SM recommended

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MULTICAST SOURCE DISCOVERY PROTOCOL (MSDP)



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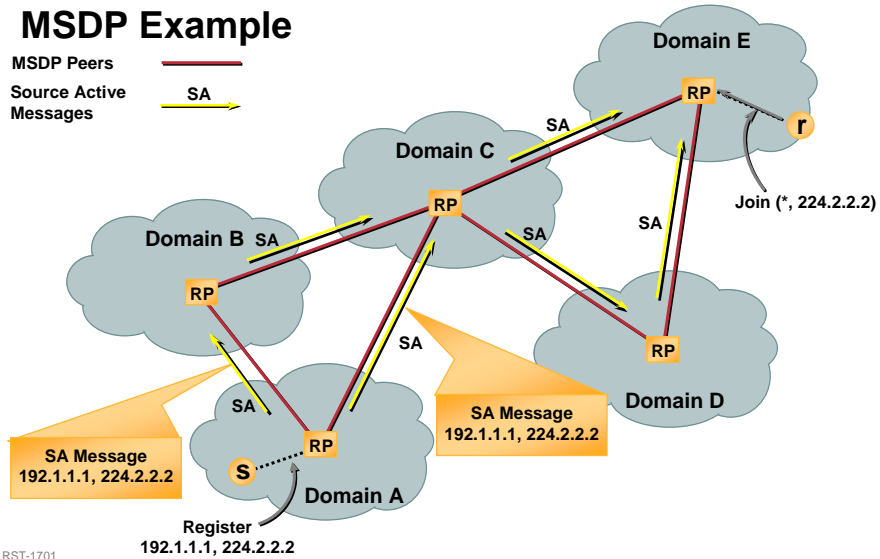
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MSDP Overview

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MSDP Example

MSDP Peers
Source Active Messages



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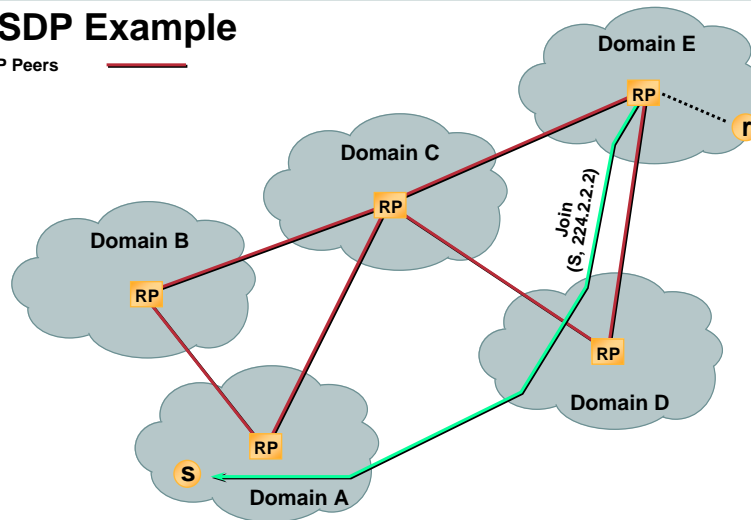
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MSDP Overview

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MSDP Example

MSDP Peers



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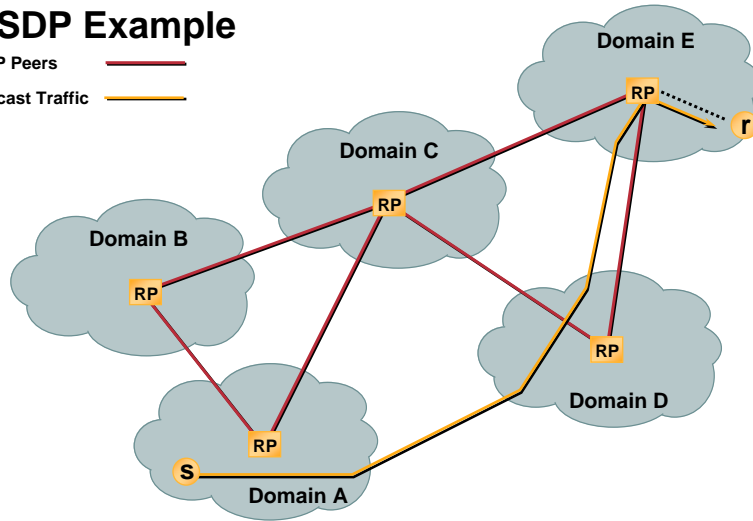
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MSDP Overview

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MSDP Example

MSDP Peers ———
Multicast Traffic ———



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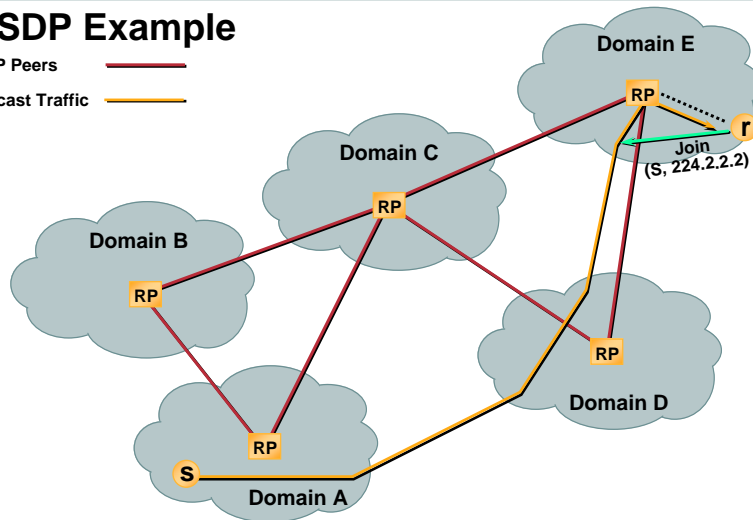
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MSDP Overview

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MSDP Example

MSDP Peers ———
Multicast Traffic ———



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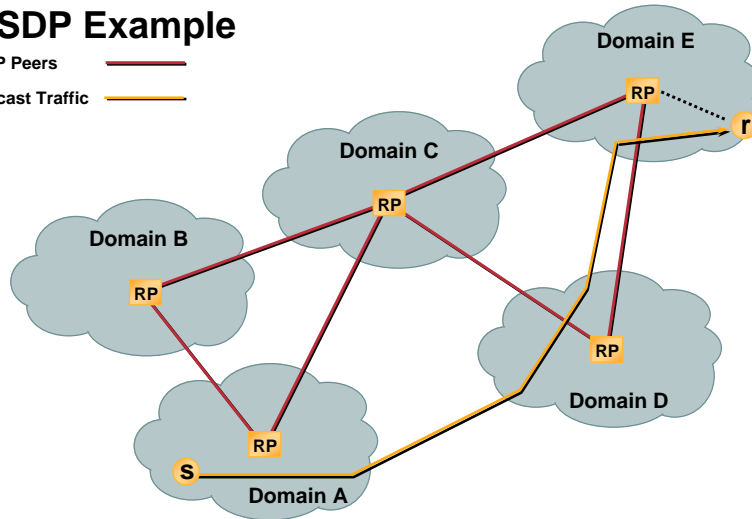
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MSDP Overview

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MSDP Example

MSDP Peers ———
Multicast Traffic ———



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MSDP SA Messages

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- **MSDP Source Active (SA) Messages**
 - Used to advertise active Sources in a domain
 - Carry 1st multicast packet from source
 - Hack for Bursty Sources (ala SDR)
 - **SA Message Contents:**
 - IP Address of Originator (RP address)
 - Number of (S, G)'s pairs being advertised
 - List of active (S, G)'s in the domain
 - Encapsulated Multicast packet

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Receiving SA Messages

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- **RPF Check Rules depend on peering**
 - Rule 1: Sending MSDP peer = i(m)BGP peer
 - Rule 2: Sending MSDP peer = e(m)BGP peer
 - Rule 3: Sending MSDP peer != (m)BGP peer
- **Exceptions:**
 - RPF check is skipped when:
 - Sending MSDP peer = Originating RP
 - Sending MSDP peer = Mesh-Group peer
 - Sending MSDP peer = only MSDP peer
 - (i.e. the 'default-peer' or the only 'msdp-peer' configured.)

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RPF Check Rule 1

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- **When MSDP peer = i(m)BGP peer**
 - Find “Best Path” to RP in BGP Tables
 - Search MRIB first then URIB
 - If no path to Originating RP found, RPF Fails
 - Note “BGP peer” that advertised path
 - (i.e. IP Address of BGP peer that sent us this path)
 - **Warning:**
 - This is not the same as the Next-hop of the path!!!
 - i(m)BGP peers normally do not set Next-hop = Self.
 - This is also not necessarily the same as the Router-ID!
 - Rule 1 Test Condition:
 - MSDP Peer address = BGP peer address?
 - If Yes, RPF Succeeds

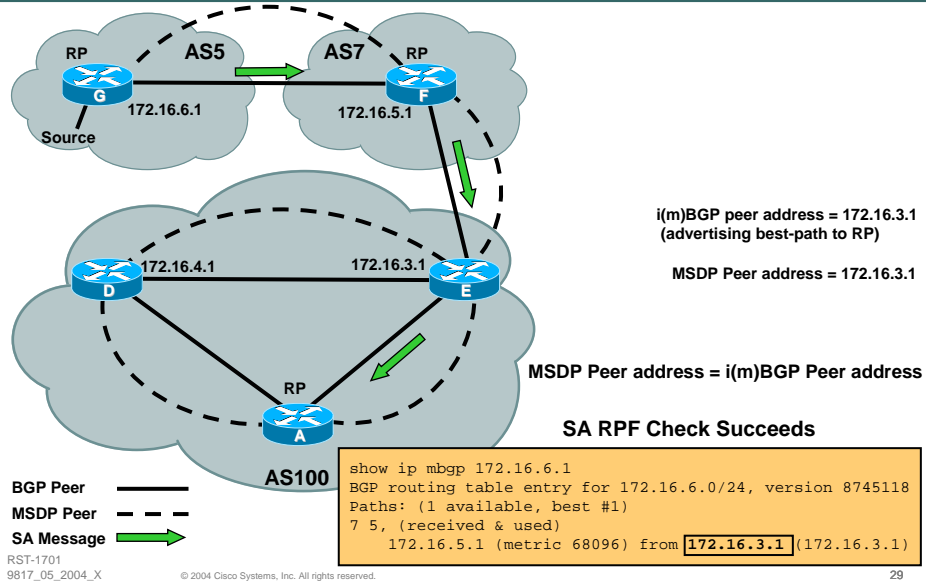
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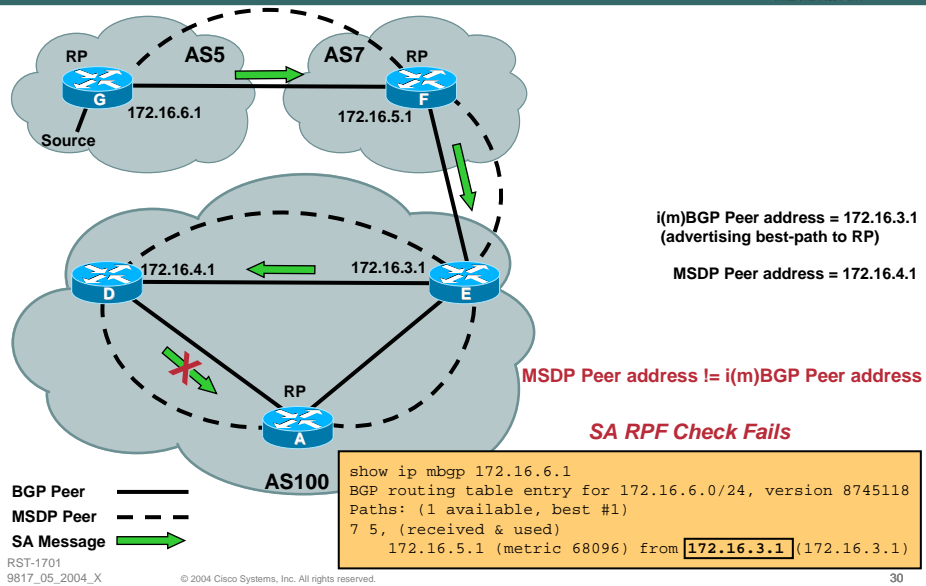
Rule1: MSDP peer = i(m)BGP peer

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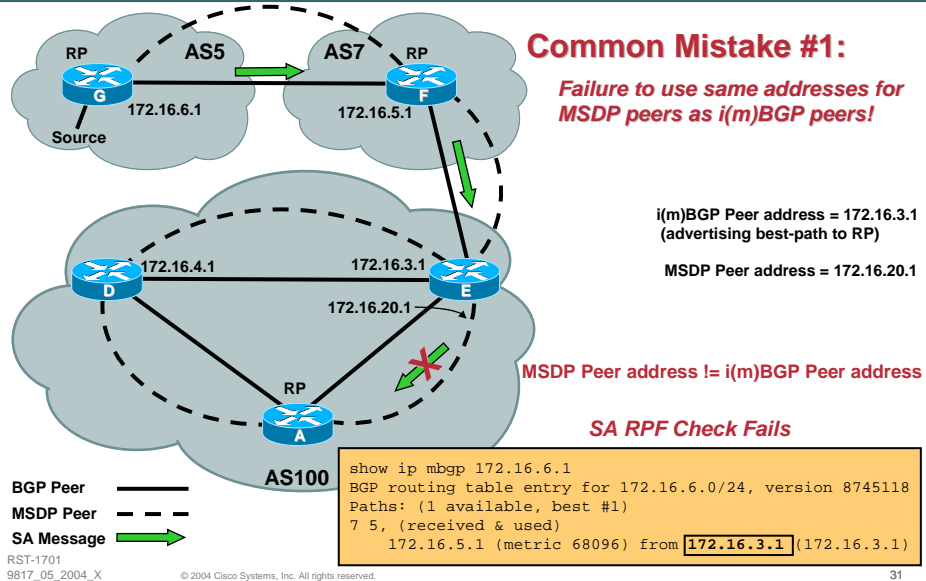
Rule1: MSDP peer = i(m)BGP peer

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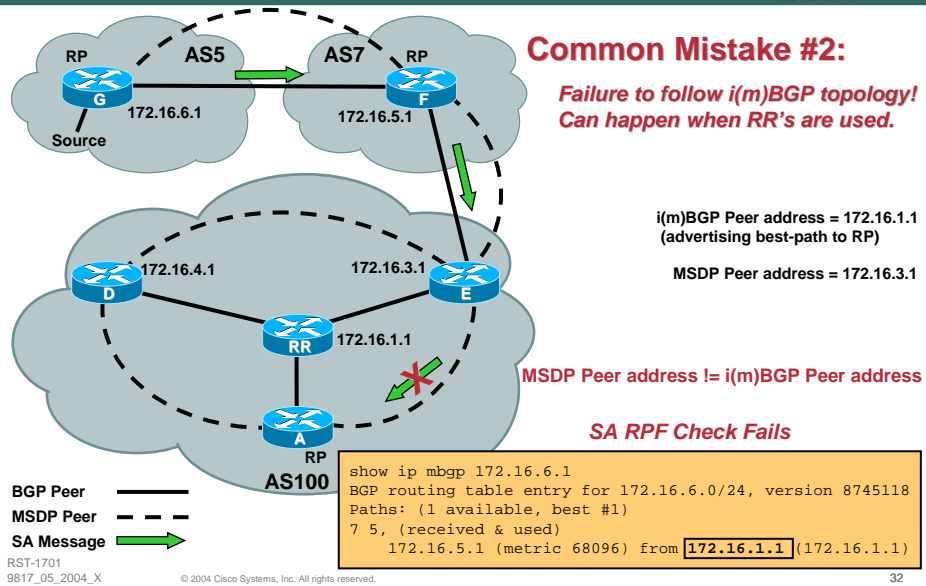
Rule1: MSDP peer = i(m)BGP peer

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Rule1: MSDP peer = i(m)BGP peer

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RPF Check Rule 2

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- When MSDP peer = e(m)BGP peer
 - Find (m)BGP “Best Path” to RP
 - Search MRIB first then URIB
 - If no path to Originating RP found, RPF Fails
 - Rule 2 Test Condition:
 - First AS in path to the RP = MSDP peer?
 - If Yes, RPF Succeeds

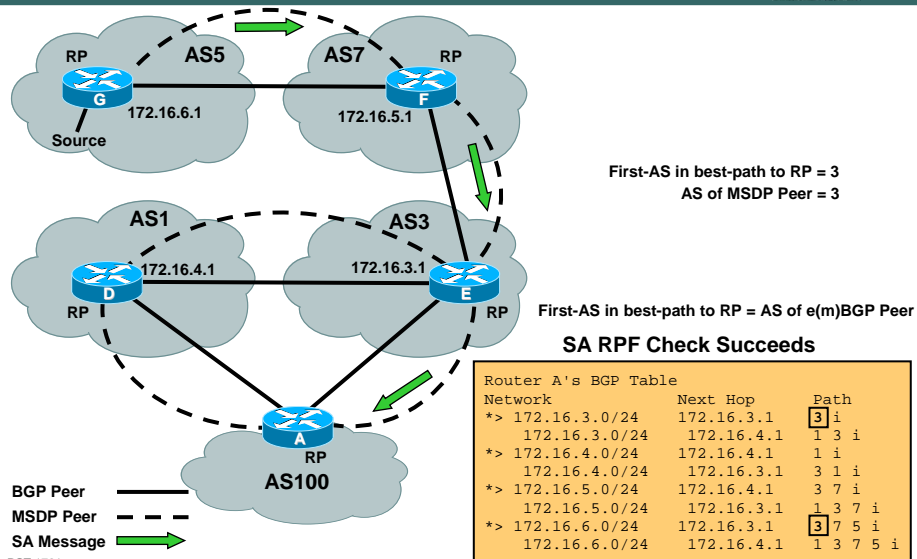
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Rule2: MSDP peer = e(m)BGP peer

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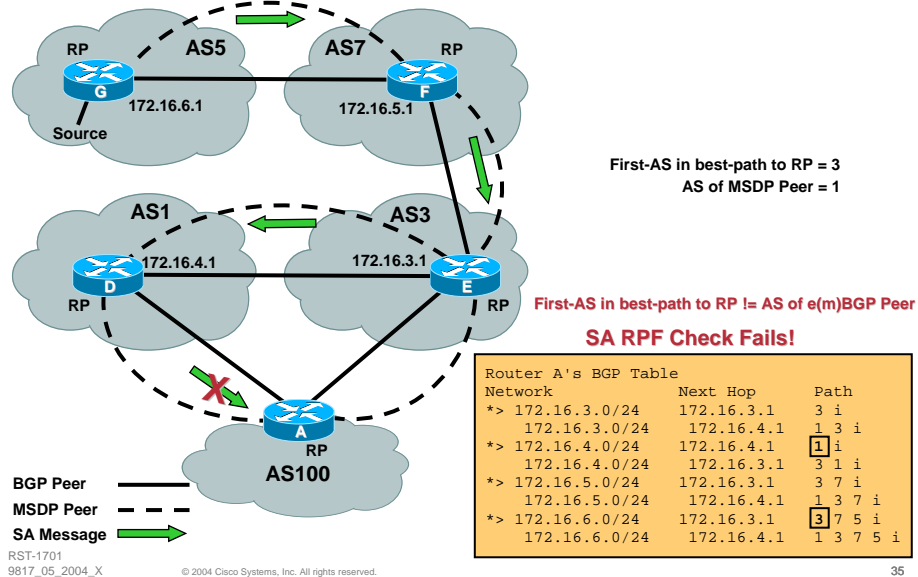
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Rule2: MSDP peer = e(m)BGP peer

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RPF Check Rule 3

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- **When MSDP peer != (m)BGP peer**
 - Find (m)BGP “Best Path” to RP
 - Search MRIB first then URIB
 - If no path to Originating RP found, RPF Fails
 - Find (m)BGP “Best Path” to MSDP peer
 - Search MRIB first then URIB
 - If no path to sending MSDP Peer found, RPF Fails
 - Note AS of sending MSDP Peer
 - Origin AS (last AS) in AS-PATH to MSDP Peer
 - Rule 3 Test Condition:
 - First AS in path to RP = Sending MSDP Peer AS ?
 - If Yes, RPF Succeeds

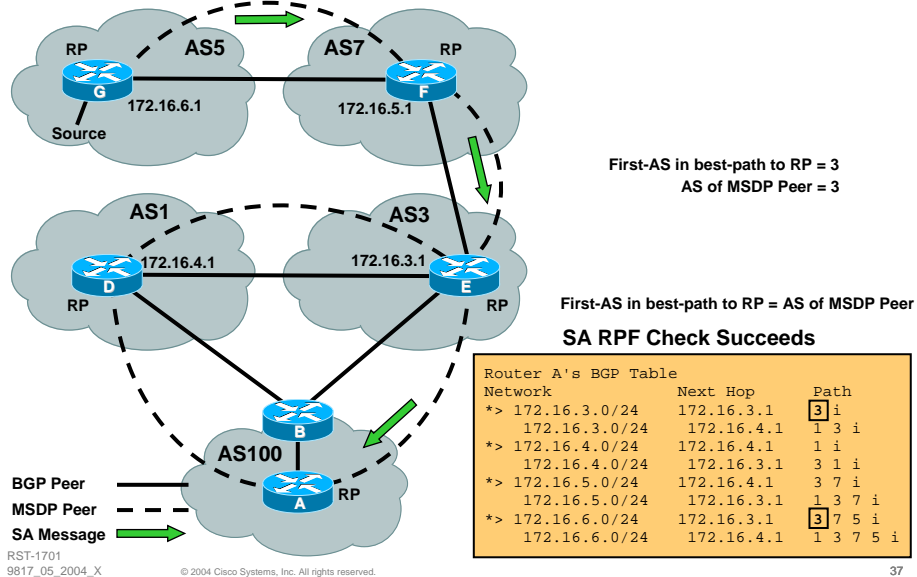
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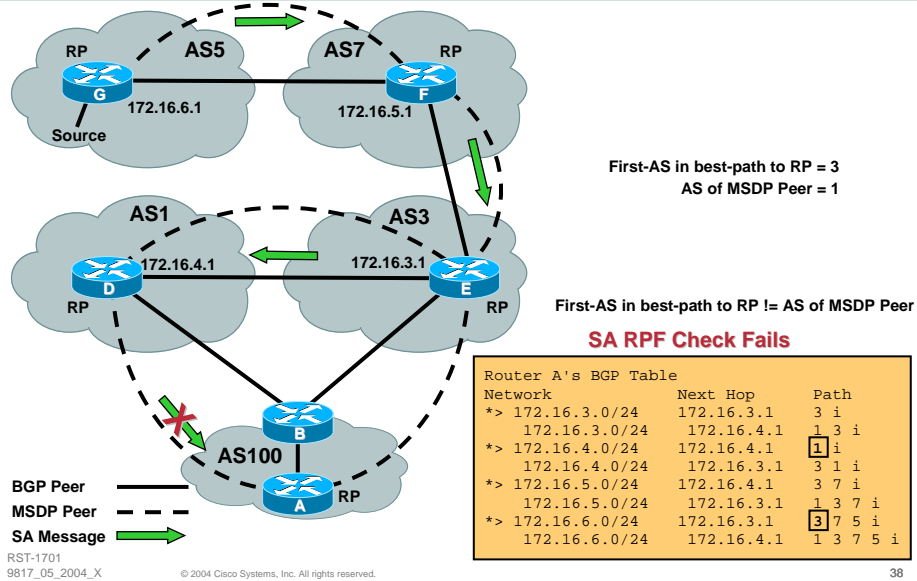
Rule3: MSDP peer != BGP peer

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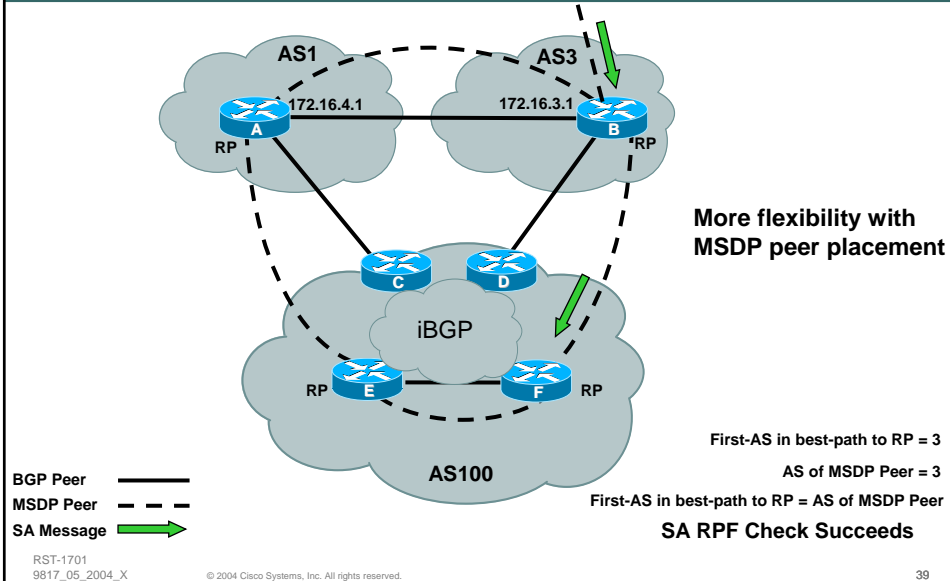
Rule3: MSDP peer != BGP peer

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Rule3: MSDP peer != BGP peer

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MSDP Configuration

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- **Configure peers**

```
ip msdp peer <ip-address> [connect-source <i/f>]
```

- **Configure default peer**

```
ip msdp default-peer <ip-address> [prefix-list acl]
```

- **Mesh groups**

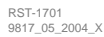
```
ip msdp mesh-group <name> <ip-address>
```

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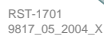
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MSDP Configuration

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- **RFC 3618**
- **Filtering**
 - Can filter SA in/out, groups, with acls or route-maps
- **For configuration commands see:**
 - <ftp://ftpeng.cisco.com/ipmulticast/Multicast-Commands>
- **For MSDP BCP (Best Current Practice) Draft:**
 - [draft-ietf-mboned-msdp-deploy-06.txt](#)

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MSDP Enhancements

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- **New IOS command**

```
ip msdp rpf rfc3618
```

 - **MSDP SA RPF check using IGP**
 - **Accept SA's from BGP NEXT HOP**
 - **Accept SA's from closest peer along the best path to the originating RP**
 - **"show ip msdp rpf"**
 - **12.0(27)S**

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MSDP RPF check using IGP

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- **When MSDP peer = IGP peer (No BGP)**

Find best IGP route to RP

Search URIB

If route to Originating RP found and:

**If IGP next hop (or advertiser) address for RP is the
MSDP peer and in UP state, then that is the RPF
peer.**

If route not found: Fall through to the next rule.

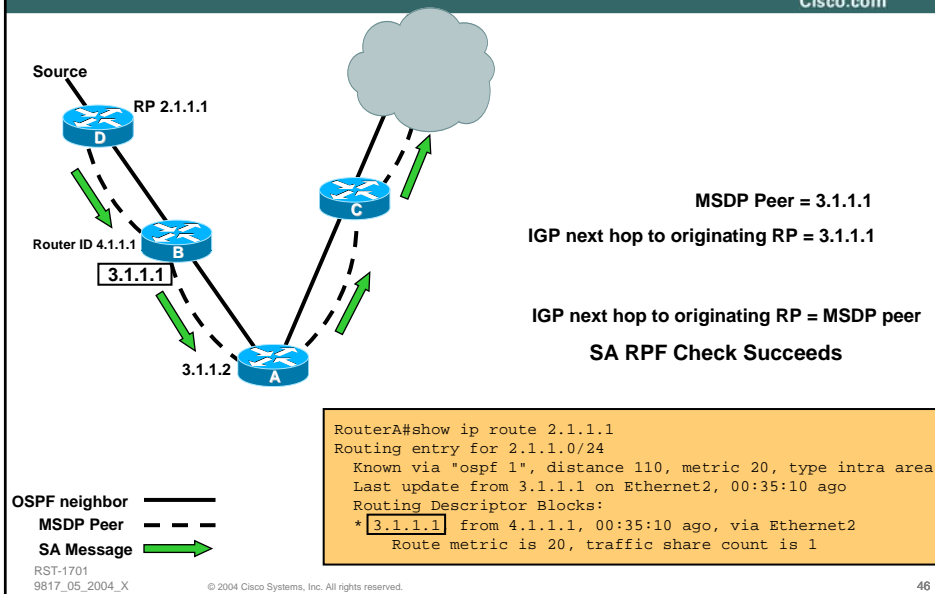
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IGP Rule: MSDP peer = IGP peer (Next hop)

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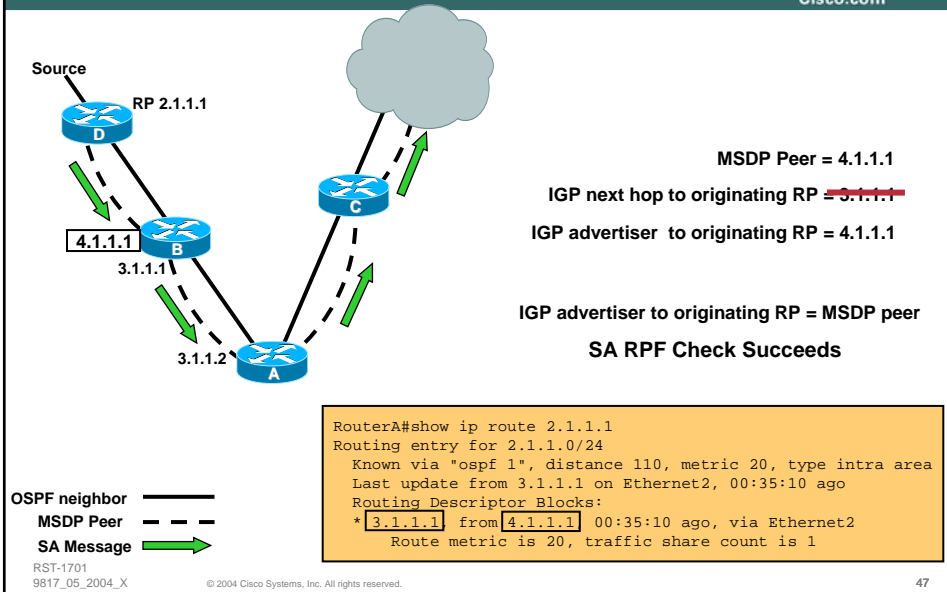
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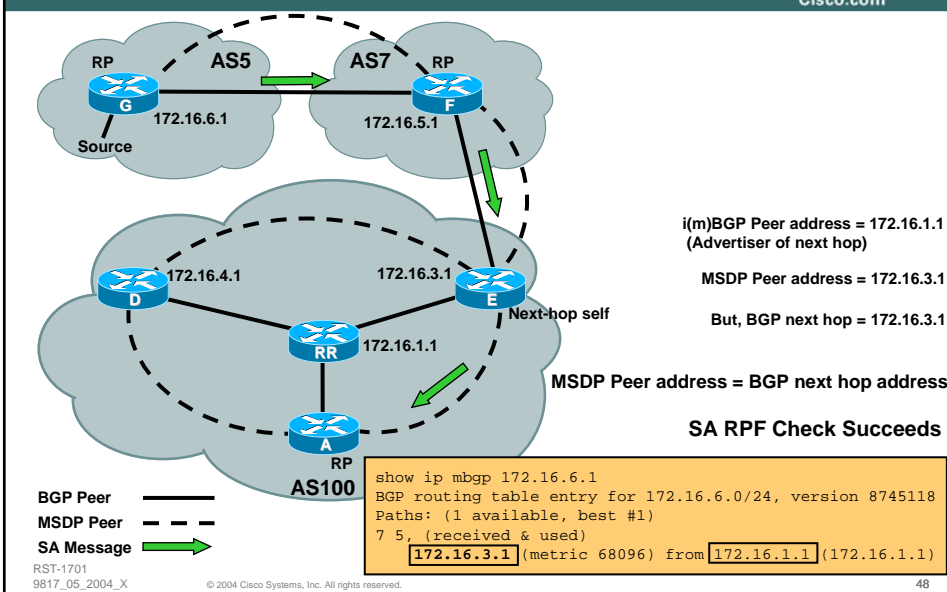
IGP Rule: MSDP peer = IGP peer (Advertiser)

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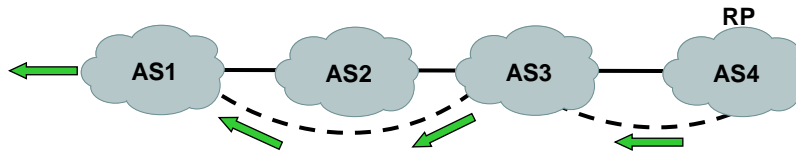
SA's accepted from Next Hop

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Accept SA along RPF path

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Existing Rule: If first AS in best path to the RP != MSDP peer
RPF Fails

New code: Choose peer in CLOSEST AS along best AS path to the RP.
Loosens rule a bit.

RPF Succeeds.

BGP Peer ———
MSDP Peer - - -
SA Message →

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New MSDP RPF command

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```
Router-A# show ip msdp rpf 2.1.1.1
RPF peer information for Router-B (2.1.1.1)
  RPF peer: Router-C (3.1.1.1)
  RPF route/mask: 2.1.1.0/24
  RPF rule: Peer is IGP next hop of best route
  RPF type: unicast (ospf 1)
```

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MBGP/MSDP EXAMPLES



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MSDP Application—Anycast RP

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- **RFC 3446 Anycast RP mechanism using PIM and MSDP**
- **Within a domain, deploy more than one RP for the same group range**
- **Give each RP the same IP address assignment**
- **Sources and receivers use closest RP**
- **Used intra-domain to provide redundancy and RP load sharing**

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MSDP Application—Anycast RP

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- Sources from one RP are made known to other RPs using MSDP
- When an RP goes down, sources and receivers are taken to new RP via unicast routing
 - Fast convergence

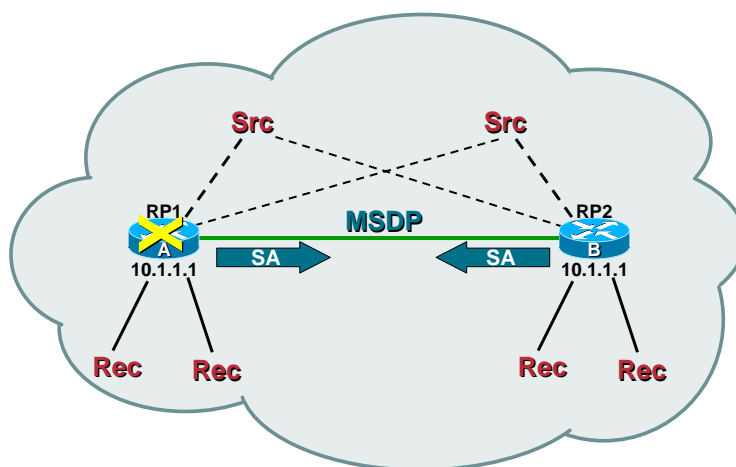
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Anycast RP—Overview

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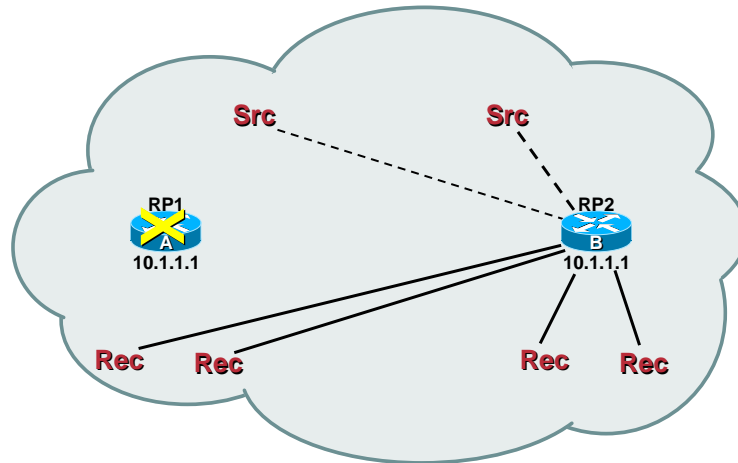
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Anycast RP—Overview

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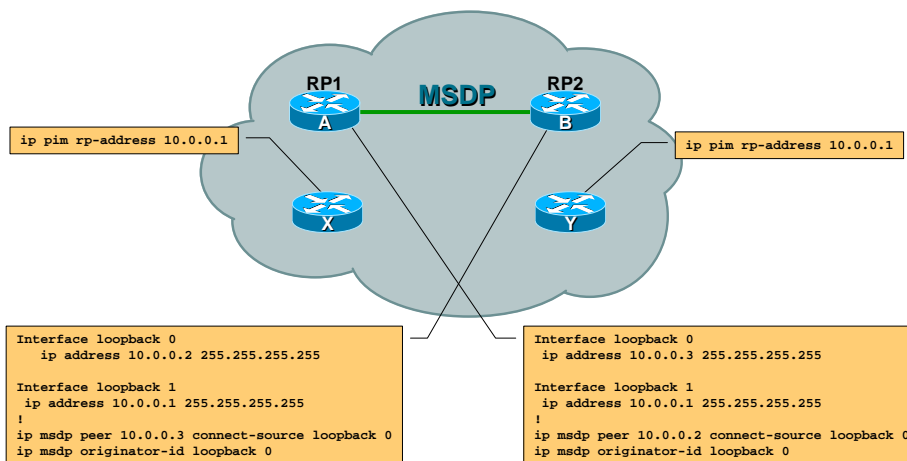
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Anycast RP Configuration

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ISP Requirements at the MIX

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- **Current solution: MBGP + PIM-SM + MSDP**
 - **Environment**
 - ISPs run iMBGP and PIM-SM (internally)
 - ISPs multicast peer at a public interconnect
 - **Deployment**
 - Border routers run eMBGP
 - The interfaces on interconnect run PIM-SM
 - RPs' MSDP peering is fully meshed
 - All peers set a common distance for eMBGP

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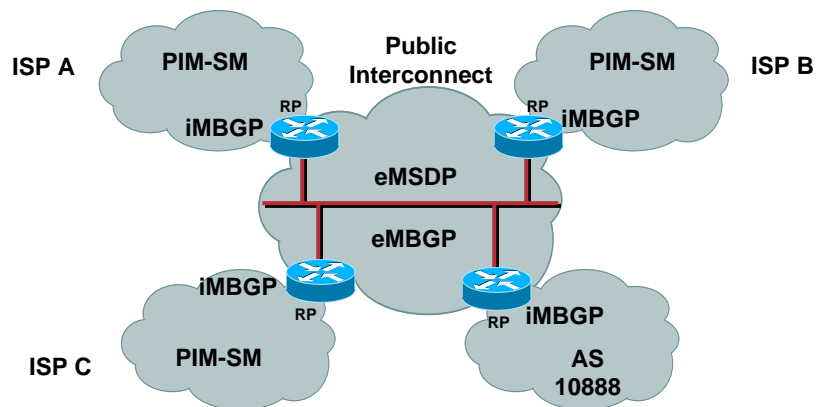
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ISP Requirements at the MIX

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Peering Solution: MBGP + PIM-SM + MSDP



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Recommended MSDP SA Filter

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<ftp://ftpeng.cisco.com/ipmulticast/config-notes/msdp-sa-filter.txt>
<http://www.ietf.org/internet-drafts/draft-ietf-mboned-ipv4-mcast-unusable-01.txt>

```
! domain-local applications
access-list 111 deny ip any host 224.0.2.2 !
access-list 111 deny ip any host 224.0.1.3 ! Rwhod
access-list 111 deny ip any host 224.0.1.24 ! Microsoft-ds
access-list 111 deny ip any host 224.0.1.22 ! SVRLOC
access-list 111 deny ip any host 224.0.1.2 ! SGI-Dogfight
access-list 111 deny ip any host 224.0.1.35 ! SVRLOC-DA
access-list 111 deny ip any host 224.0.1.60 ! hp-device-disc
!-- auto-rp groups
access-list 111 deny ip any host 224.0.1.39
access-list 111 deny ip any host 224.0.1.40
!-- scoped groups
access-list 111 deny ip any 239.0.0.0 0.255.255.255
!-- loopback, private addresses (RFC 1918)
access-list 111 deny ip 10.0.0.0 0.255.255.255 any
access-list 111 deny ip 127.0.0.0 0.255.255.255 any
access-list 111 deny ip 172.16.0.0 0.15.255.255 any
access-list 111 deny ip 192.168.0.0 0.0.255.255 any
access-list 111 permit ip any any
!-- Default SSM-range. Do not do MSDP in this range
access-list 111 deny ip any 232.0.0.0 0.255.255.255
access-list 111 permit ip any any
```

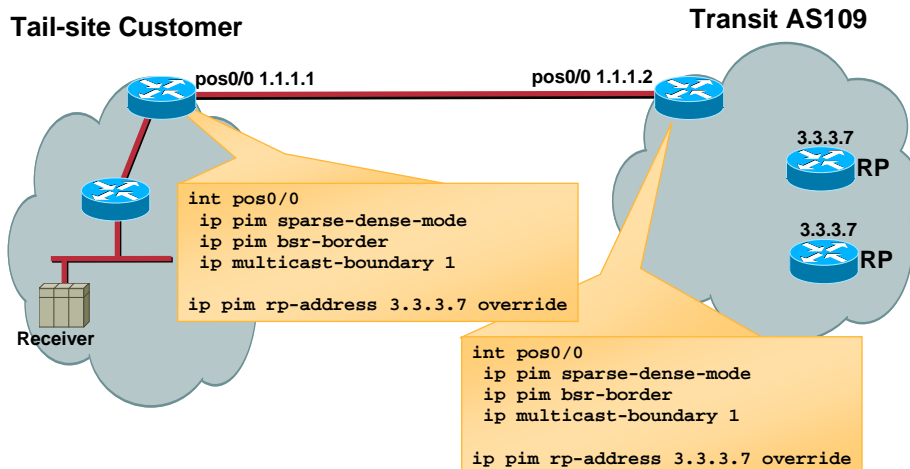
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Single-Homed, ISP RP, Non-MBGP

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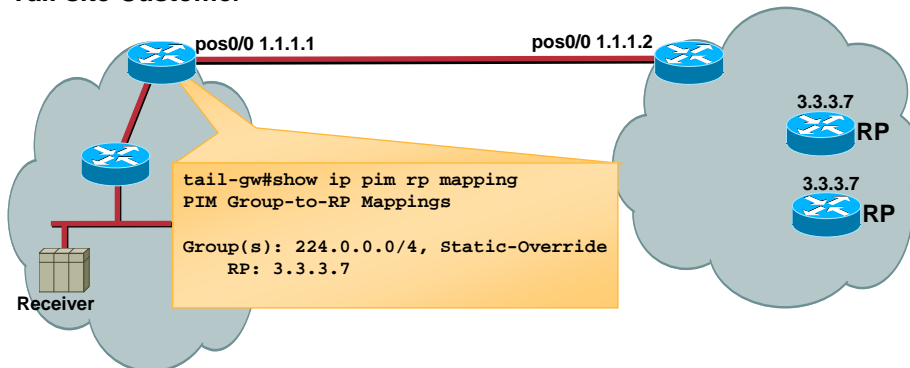
60

Single-Homed, ISP RP, Non-MBGP

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Tail-site Customer

Transit AS109



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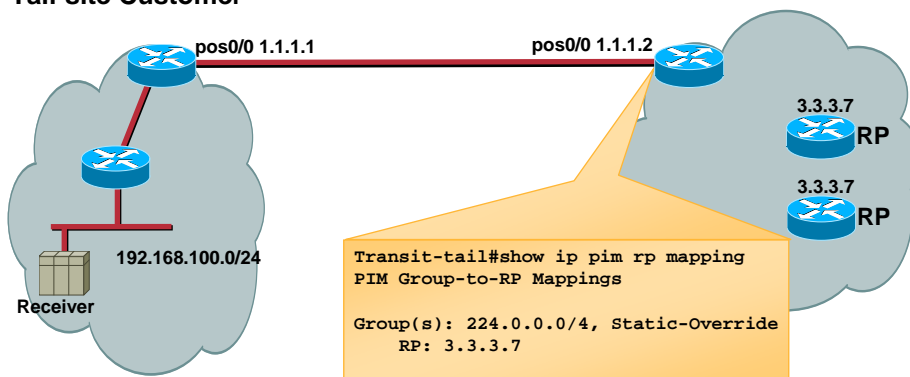
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Single-Homed, ISP RP, Non-MBGP

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Tail-site Customer

Transit AS109



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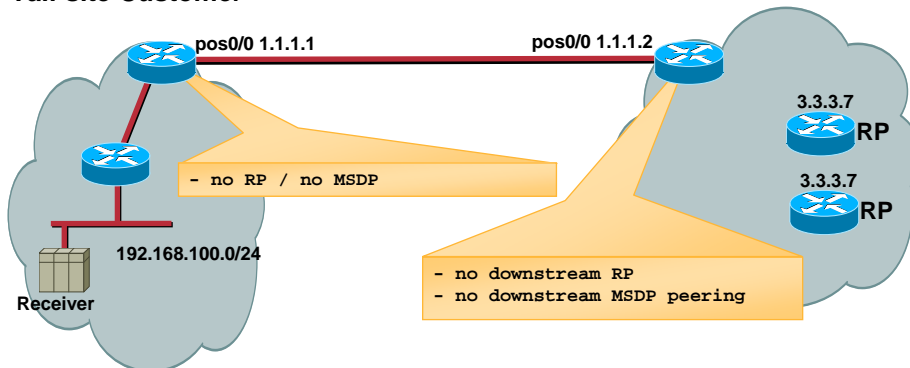
Single-Homed, ISP RP, Non-MBGP

Cisco.com

MSDP RPF Check

Tail-site Customer

Transit AS109



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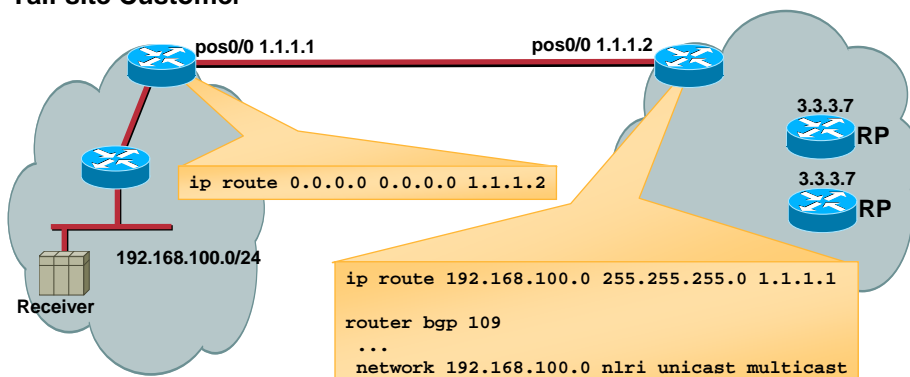
Single-Homed, ISP RP, Non-MBGP

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Multicast RPF Check

Tail-site Customer

Transit AS109



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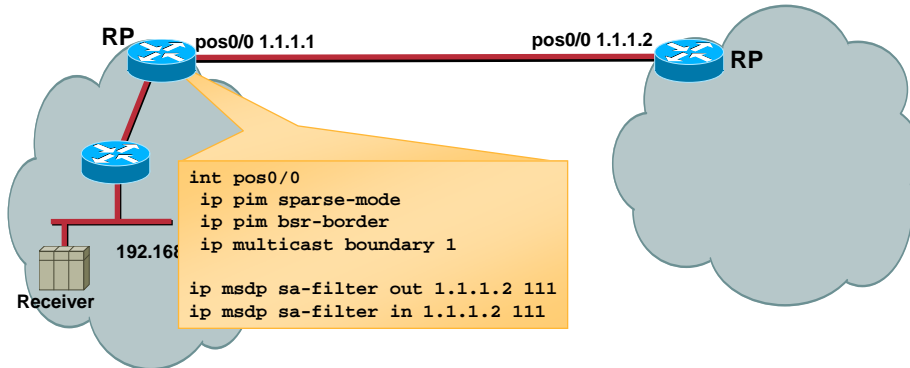
64

Single-Homed, Customer RP, Non-MBGP

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Tail-site Customer

Transit AS109



Note: Access-list 111 = Recommended SA Filter

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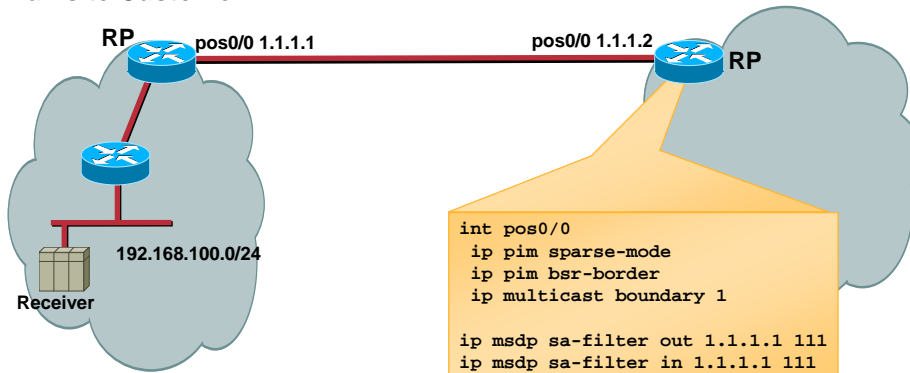
65

Single-Homed, Customer RP, Non-MBGP

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Tail-site Customer

Transit AS109



Note: Access-list 111 = Recommended SA Filter

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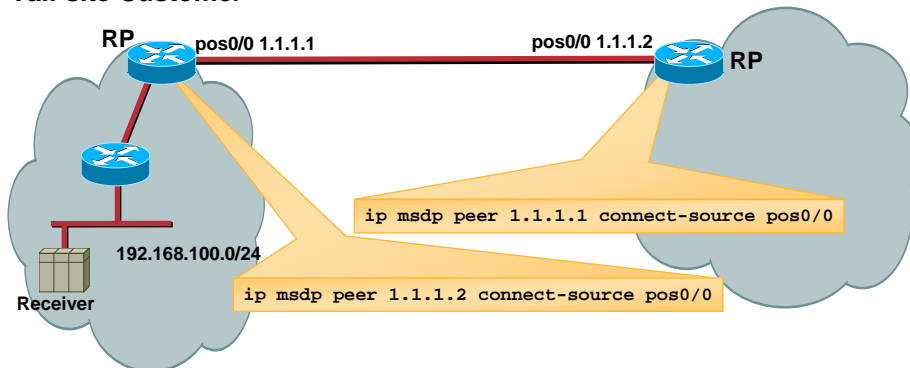
Single-Homed, Customer RP, Non-MBGP

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MSDP RPF Check

Tail-site Customer

Transit AS109



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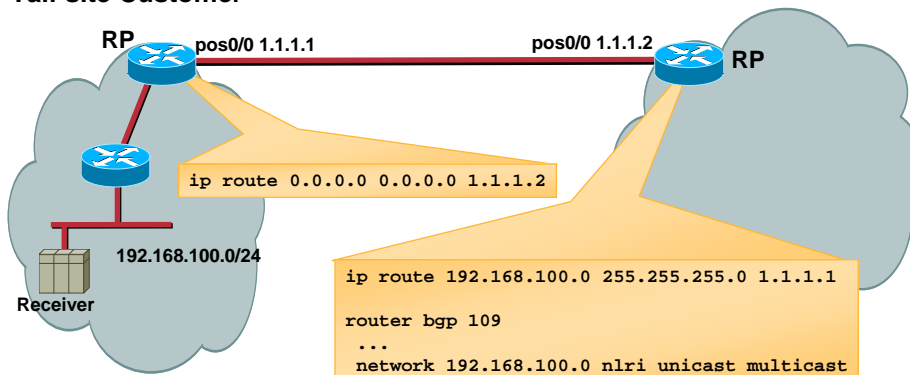
Single-Homed, Customer RP, Non-MBGP

Cisco.com

Multicast RPF Check

Tail-site Customer

Transit AS109



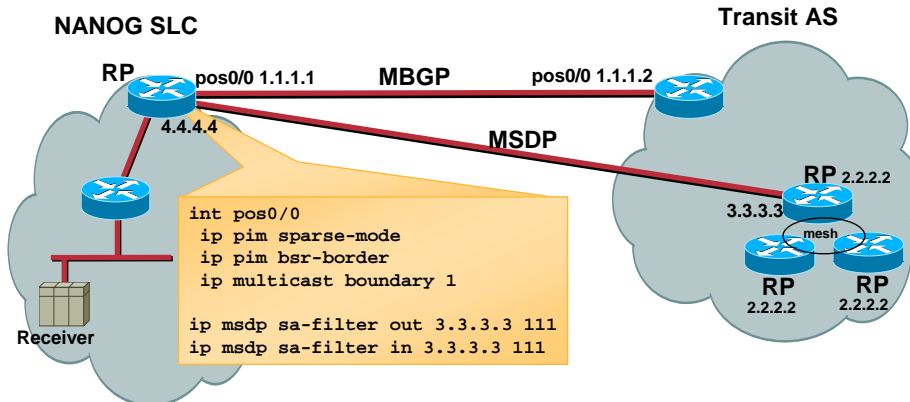
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Single-Homed, Customer RP, MBGP

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Note: Access-list 111 = Recommended SA Filter

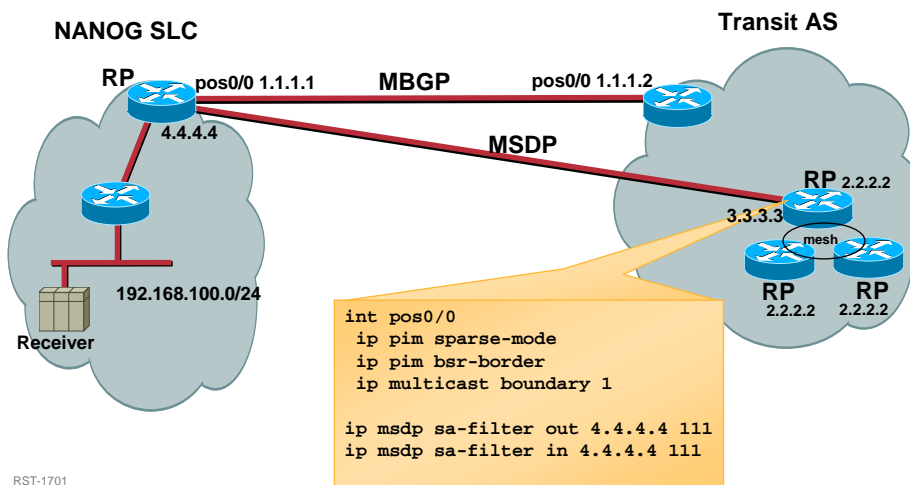
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Single-Homed, Customer RP, MBGP

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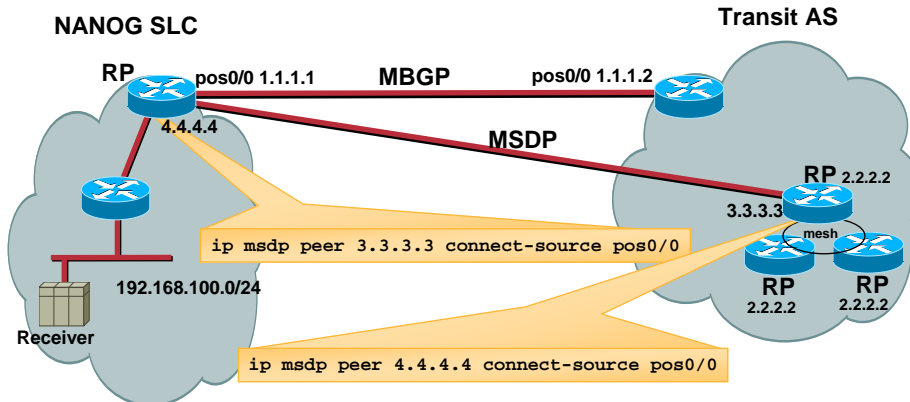
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Single-Homed, Customer RP, MBGP

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MSDP RPF Check



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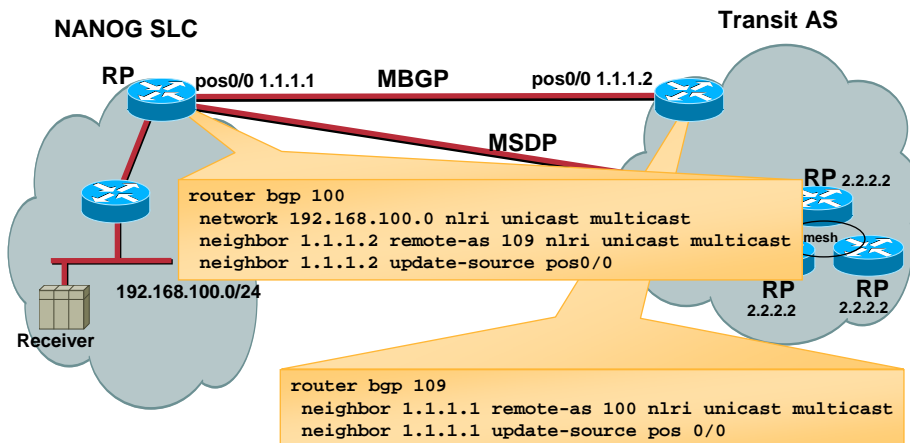
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Single-Homed, Customer RP, MBGP

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Multicast RPF Check



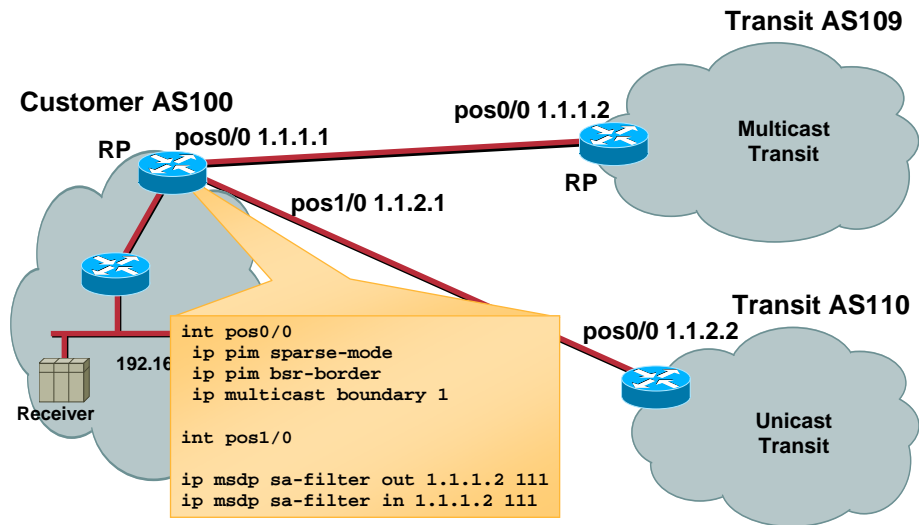
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Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

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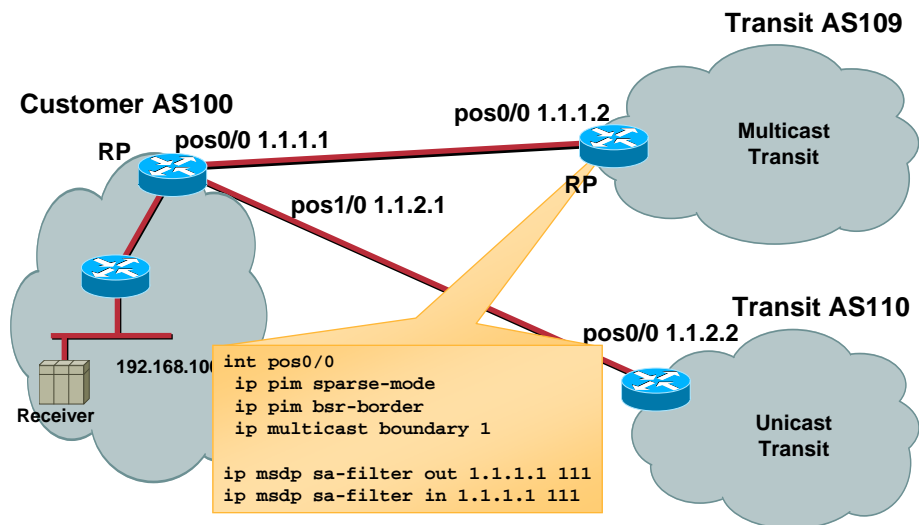
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Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

Cisco.com



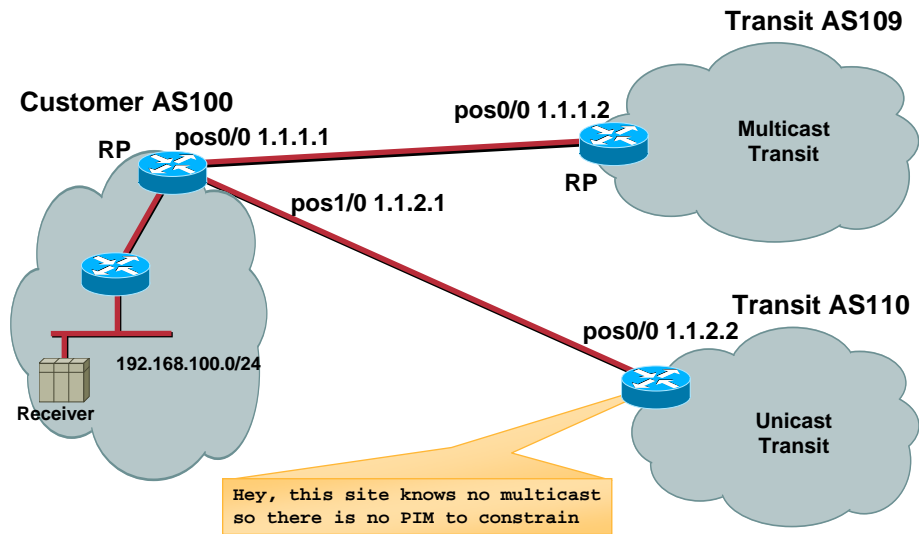
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Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

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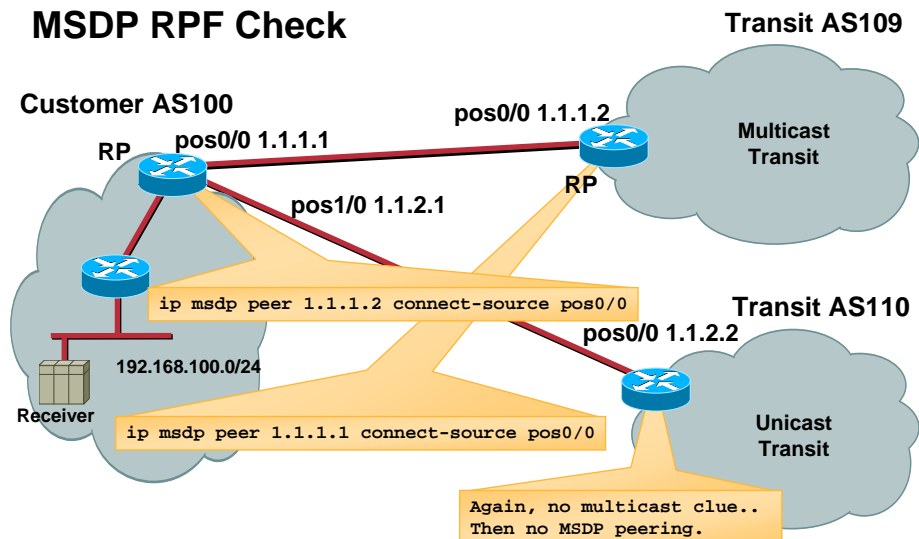
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Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

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MSDP RPF Check



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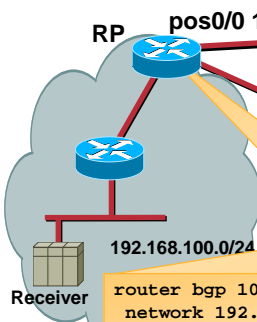
76

Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

Cisco.com

Multicast RPF Check

Customer AS100



```
router bgp 100
network 192.168.100.0 nlri unicast multicast
neighbor 1.1.1.2 remote-as 109 nlri multicast
neighbor 1.1.1.2 update-source pos 0/0
neighbor 1.1.2.2 remote-as 110 nlri unicast
neighbor 1.1.2.2 update-source pos 1/0
```

Transit AS109

Multicast Transit

Transit AS110

Unicast Transit

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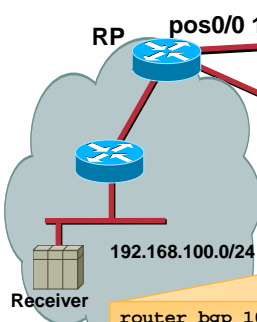
77

Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

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Multicast RPF Check

Customer AS100



```
router bgp 109
neighbor 1.1.1.1 remote-as 100 nlri multicast
neighbor 1.1.1.1 update-source pos 0/0
```

Transit AS109

Multicast Transit

Transit AS110

Unicast Transit

RST-1701
9817_05_2004_X

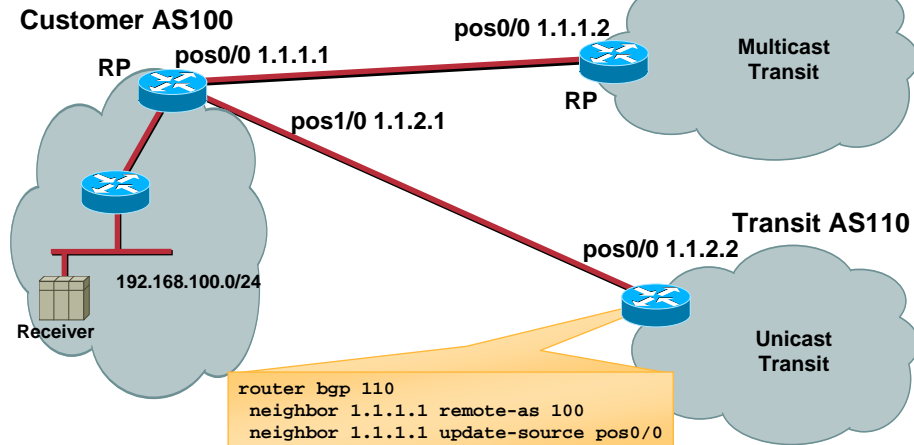
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Dual-Homed, Customer RP, MBGP Incongruent Multicast—Unicast

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Multicast RPF Check



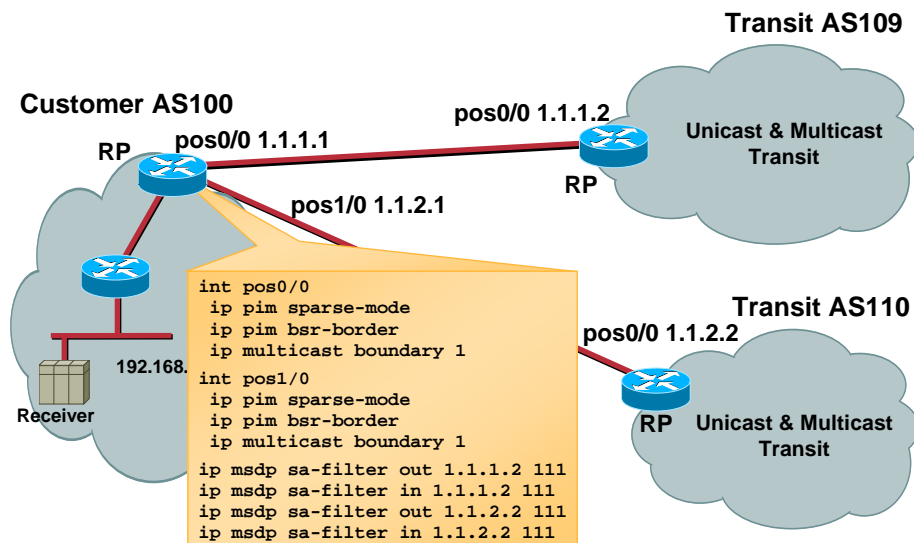
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Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

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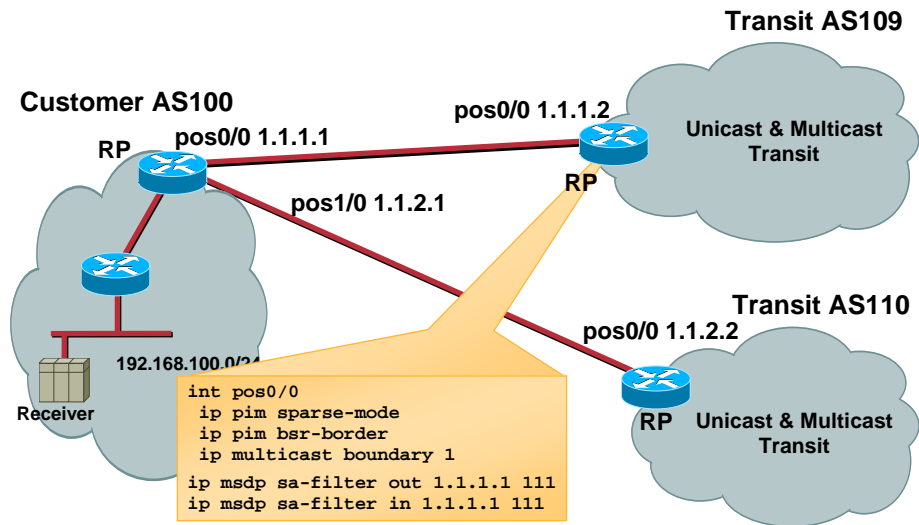
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Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

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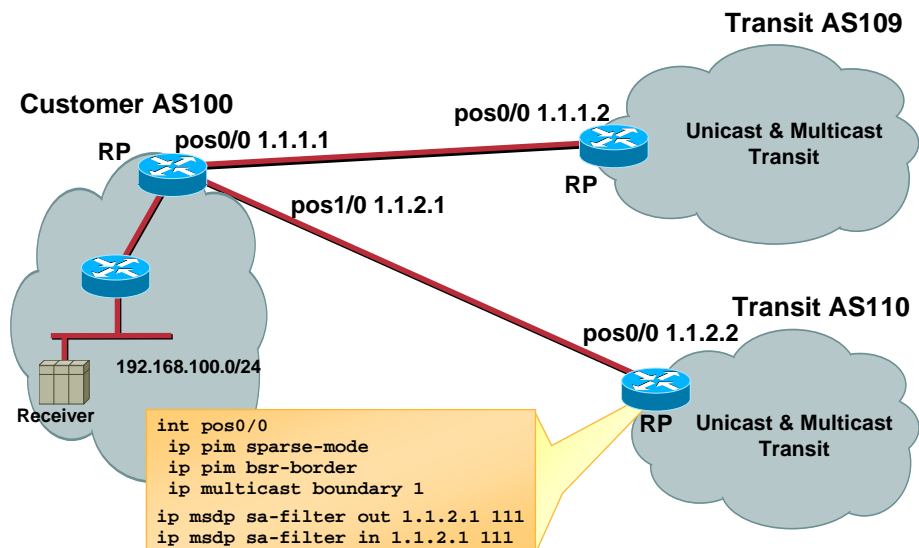
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Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

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9817_05_2004_X

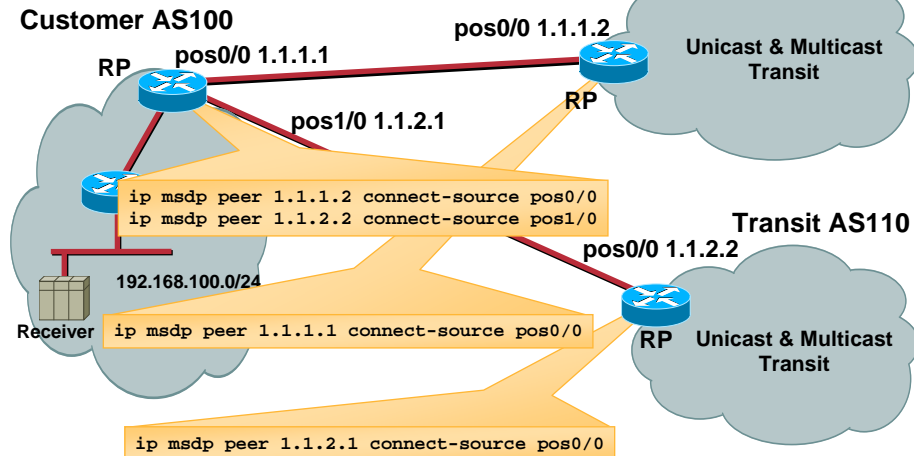
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Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

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MSDP RPF Check



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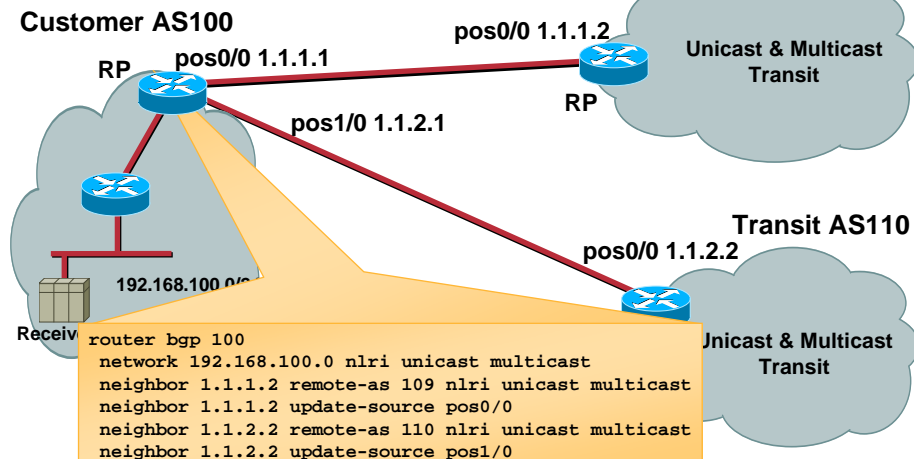
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Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

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Multicast RPF Check



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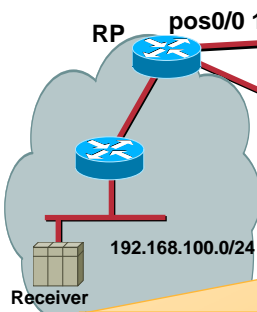
84

Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

Cisco.com

Multicast RPF Check

Customer AS100



Transit AS109

Unicast & Multicast Transit

Transit AS110

Unicast & Multicast Transit

```
router bgp 109
neighbor 1.1.1.1 remote-as 100 nlri unicast multicast
neighbor 1.1.1.1 update-source pos 0/0
```

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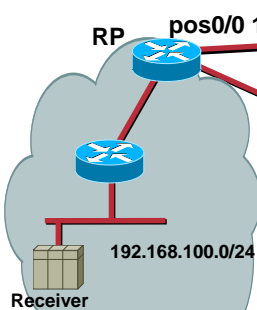
85

Dual-Homed, Customer RP, MBGP Congruent Multicast—Unicast

Cisco.com

Multicast RPF Check

Customer AS100



Transit AS109

Unicast & Multicast Transit

Transit AS110

Unicast & Multicast Transit

```
router bgp 110
neighbor 1.1.2.1 remote-as 100 nlri unicast multicast
neighbor 1.1.2.1 update-source pos0/0
```

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GLOP—Static Allocation of 233/8

Cisco.com

- **Temporary allocation of 233/8**
 - RFC 2770
- **Statically assigned by mapping AS number into middle octets**
 - <http://gigapop.uoregon.edu/glop/index.html>
- **Provides each AS with /24 addresses to use while waiting another solution**

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GLOP—Static Allocation of 233/8

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- **The hexadecimal value of 5662 is 161E. 16 hex equals 22 decimal and 1E hex equals 30 decimal. We get 233.22.30.0/24.**
- **The lazy (smart?) way to calculate your GLOP address space is by entering it here and it will calculate it for you:**
<http://www.ogig.net/glop/>

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SOURCE SPECIFIC MULTICAST (SSM)



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Source Specific Multicast (SSM)

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- **Uses Source Trees only.**
- **Assumes One-to-Many model.**
 - Most Internet multicast fits this model.
 - IP/TV also fits this model.
- **Hosts responsible for source discovery.**
 - Typically via some out-of-band mechanism.
 - Web page, Content Server, etc.
 - Eliminates need for RP and Shared Trees.
 - Eliminates need for MSDP.

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SSM Overview

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- **Hosts join a specific source within a group.**
 - Content identified by specific (S,G) instead of (*,G).
 - Hosts responsible for learning (S,G) information.
- **Last-hop router sends (S,G) join toward source**
 - Shared Tree is never Joined or used.
 - Eliminates possibility of content Jammers.
 - Only specified (S,G) flow is delivered to host.
- **Simplifies address allocation.**
 - Dissimilar content sources can use same group without fear of interfering with each other.

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Host-Router Signaling: IGMP

Cisco.com

- **How hosts tell routers about group membership**
- **Routers solicit group membership from directly connected hosts**
- **RFC 1112 specifies version 1 of IGMP**
 - Supported on Windows 95
- **RFC 2236 specifies version 2 of IGMP**
 - Supported on latest service pack for Windows and most UNIX systems
- **RFC 3376 specifies version 3 of IGMP**
 - Windows XP, FreeBSD, Linux have it.
 - ftpeng.cisco.com/ipmulticast/ssm/index.html#Stacks

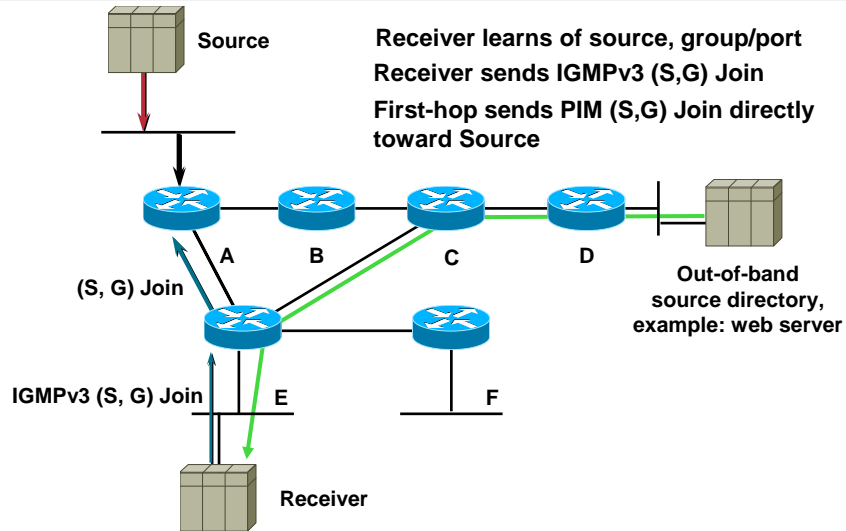
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PIM Source Specific Mode

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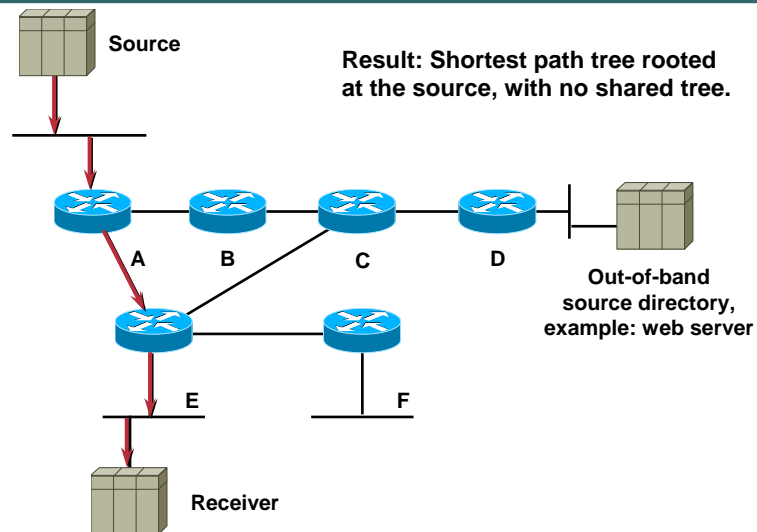
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PIM Source Specific Mode

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SSM Configuration

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- **Global command**
 - `ip pim ssm {default | <acl>}`
 - **Defines SSM address range**
 - Default range = 232.0.0.0/8
 - Use ACL for other ranges
 - **Prevents Shared Tree Creation**
 - (*, G) Joins never sent or processed
 - PIM Registers never sent or processed
 - **Available starting in IOS versions**
 - 12.1(5)T, 12.2, 12.0(15)S, 12.1(8)E

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SSM Mapping

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- **Customers want to deploy SSM**
- **Hosts in network don't support IGMPv3**
- **Host OS is outside of network operators control**
- **Network operators don't control content**
 - **No knowledge about S,G mapping**

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SSM Mapping

Cisco.com

- **Bring Source to Group mapping from host to router**
- **Use an external or internal database for Source to Group mapping**
 - Allows content providers to provide the mapping
 - Independent from network operators
 - Database is chosen to be static or DNS
- **Allows only for one source per Group**

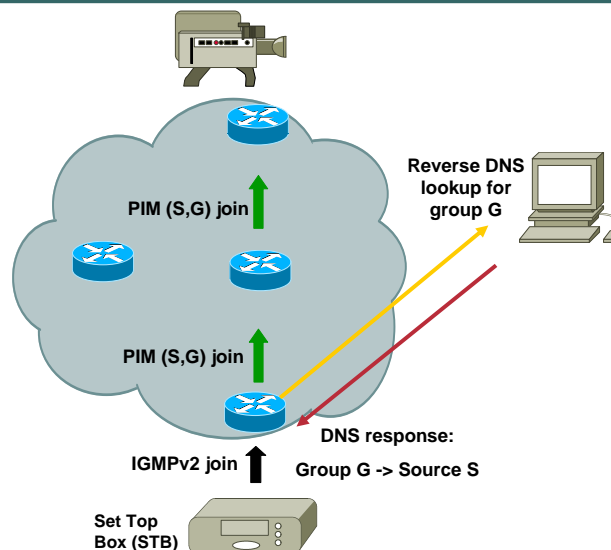
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Example

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Configuration

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Enabling SSM mapping on the router

```
ip igmp ssm-map enable
```

For static mapping:

```
ip igmp ssm-map static <acl-1> <source-1 IP address>
```

```
ip igmp ssm-map static <acl-2> <source-2 IP address>
```

For DNS mapping (existing commands):

```
ip domain-server <ip address>
```

```
ip domain-name <domain.com>
```

To disable DNS mapping

```
no ip igmp ssm-map query dns
```

DNS Record Format:	3.2.1.232	IN A	172.23.20.70
--------------------	-----------	------	--------------

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Where Is SSM?

Cisco.com

- **Framework**
 - draft-holbrook-idmr-igmpv3-ssm-06.txt
 - draft-ietf-ssm-arch-04.txt
- **BCP proposal**
 - draft-ietf-mboned-ssm232-08.txt
 - RFC 3569 Overview of SSM
- **Supported in:**
 - IOS 12.X
 - Windows XP, FreeBSD, Linux
 - <ftp://ftpeng.cisco.com/ipmulticast/ssm/index.html#Stacks>

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SSM – Summary

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- **Uses Source Trees only.**
 - Hosts are responsible for source & group discovery.
 - Hosts must signal router which (S,G) to join.
- **Solves multicast address allocation problems.**
 - Flows differentiated by both source and group.
 - Content providers can use same group ranges.
 - Since each (S,G) flow is unique.
- **Helps prevent certain DoS attacks**
 - “Bogus” source traffic:
 - Can’t consume network bandwidth.
 - Not received by host application.

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MULTICAST VPN (MVPN)



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Why Multicast VPNs

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- **Until now only unicast has been supported in MPLS/BGP VPN**
- **VPN customers need multicast connectivity**
 - Applications that require multicast
 - Internet multicast connectivity
- **Service Providers want to offer additional services**
 - e.g. Video streaming to its VPN customers

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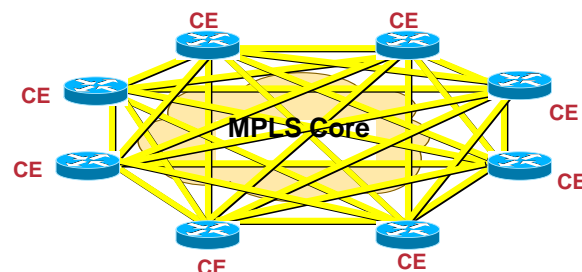
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Multicast VPN – Challenges

Cisco.com

- **Workaround has been point-to-point GRE tunnels from CE to CE**
- **Not scalable with many CE routers**
 - Traffic overhead
 - Administration overhead



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Multicast VPN – Requirements

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- Service provider may have a preferred PIM operating mode in the core.
- VPN customer may have a preferred PIM operating mode in his/her network.
- PIM mode used in the core and VPN should be independent.
- Implementation must support any PIM operating mode in customer and provider networks.
 - PIM Bidirectional (PIM-BIDIR)
 - PIM Source Specific Multicast (PIM-SSM)
 - PIM Sparse-Mode (PIM-SM)

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Cisco's Implementation

Cisco.com

- Based on Multicast Domains in draft-rosen-vpn-mcast-07.txt
 - Provider builds independent multicast network in the core.
 - All arriving customer multicast traffic is encapsulated and multicast across Provider Network.
 - A separate multicast group is used inside of Provider Network for each customer VPN.
 - Provider's multicast address space is independent of all customer address space.
 - Avoids VPN overlap of customers' multicast addresses.
- MVPN in 12.2(13)T and 12.0(23)S on 3600, 7200 and 7500. 10k in 12.0(25)S. 12K in 12.0(26)S. 7600 in 12.2S.

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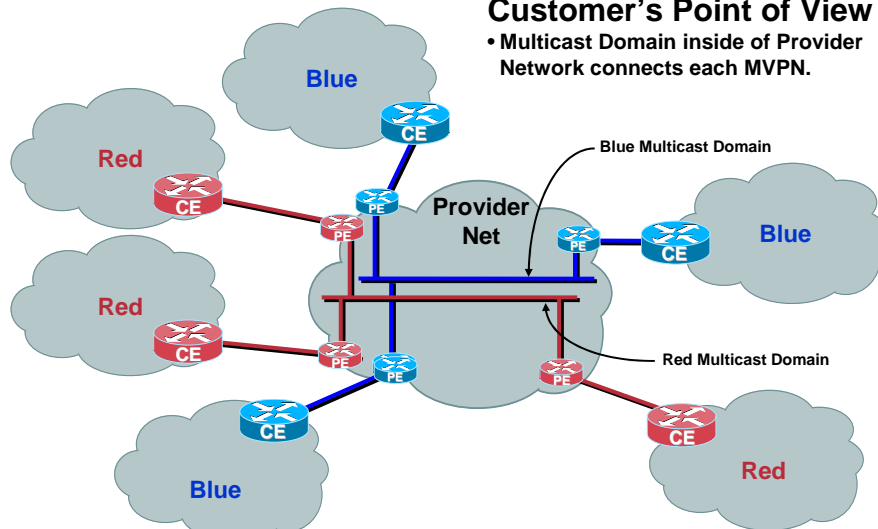
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Multicast VPN – Overview

Cisco.com

Customer's Point of View

- Multicast Domain inside of Provider Network connects each MVPN.



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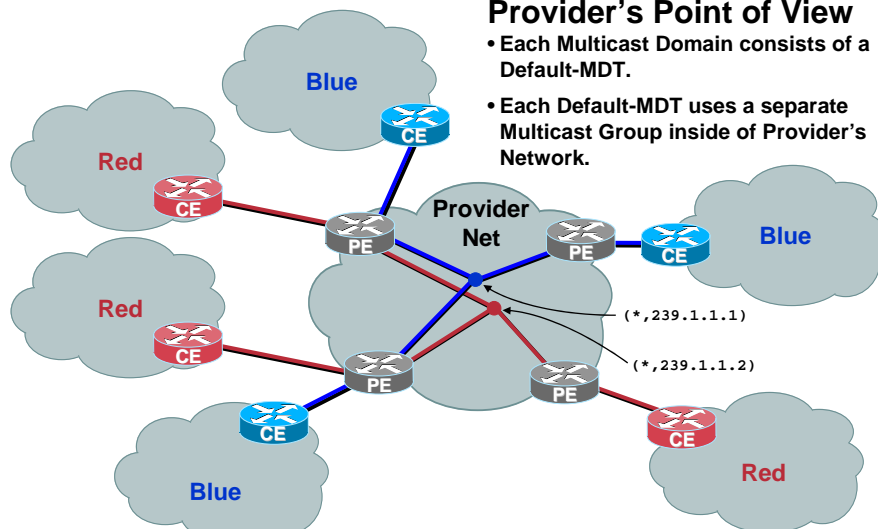
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Multicast VPN – Overview

Cisco.com

Provider's Point of View

- Each Multicast Domain consists of a Default-MDT.
- Each Default-MDT uses a separate Multicast Group inside of Provider's Network.



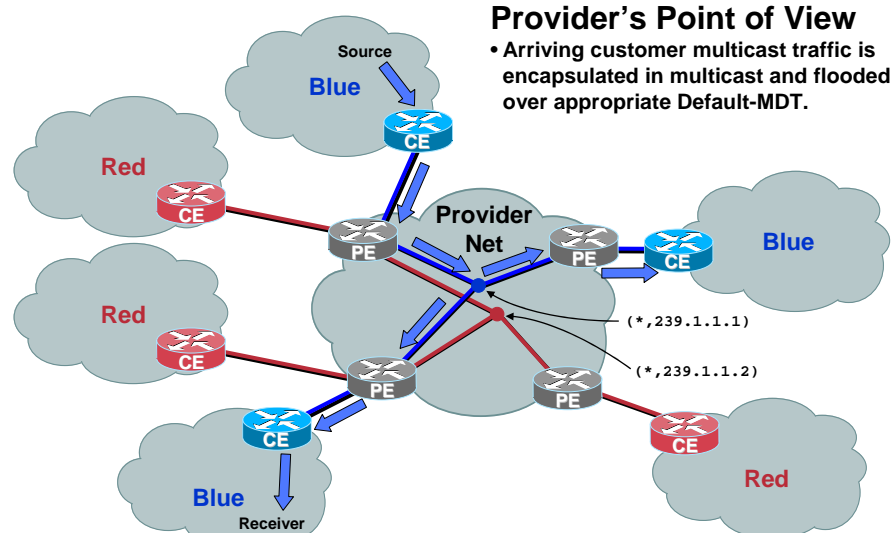
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Multicast VPN – Overview

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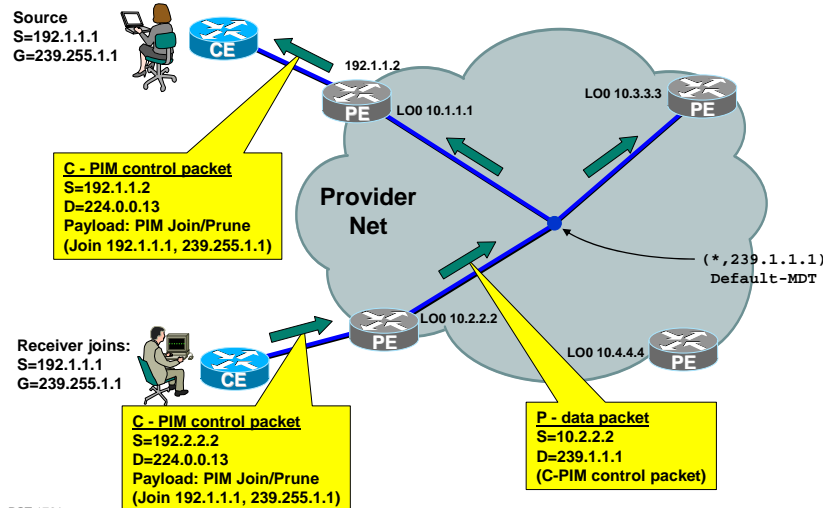


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Default MDT – A Closer Look

Cisco.com

PIM Control Traffic Flow

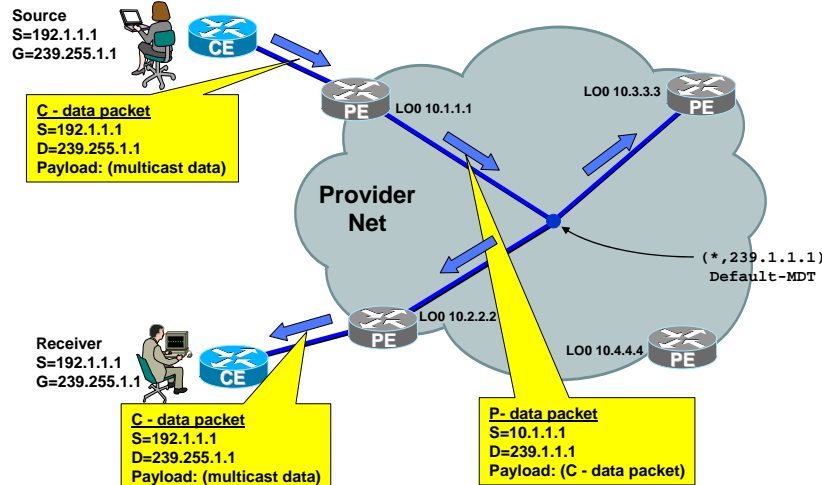


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Default MDT – A Closer Look

Cisco.com

Multicast Data Traffic Flow



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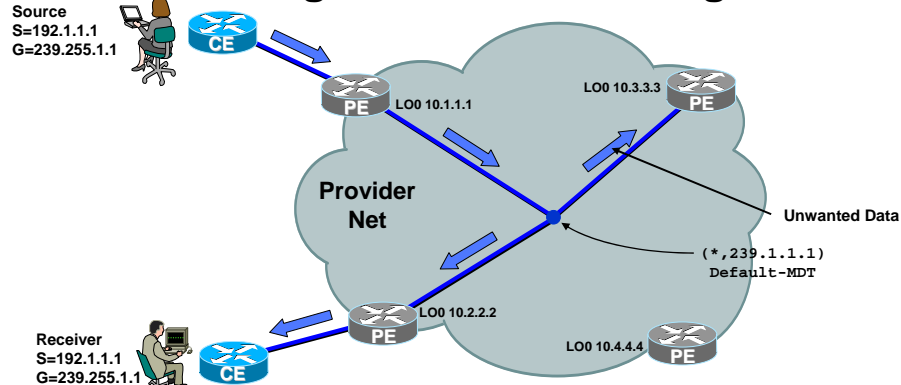
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Default MDT – A Closer Look

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Advantages and Disadvantages



Advantage : Reduces multicast state in the P routers in the core.

Disadvantage : Can result in wasted bandwidth.

Solution : Use separate Data-MDTs for high rate sources.

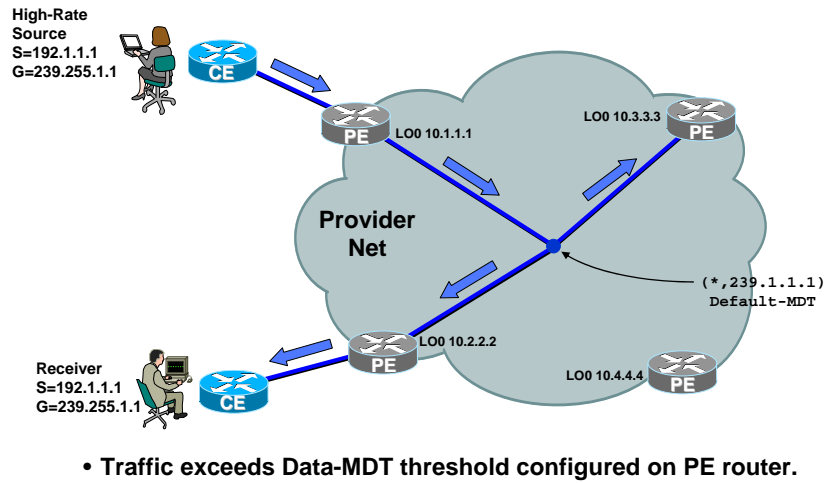
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Data MDTs – Concepts

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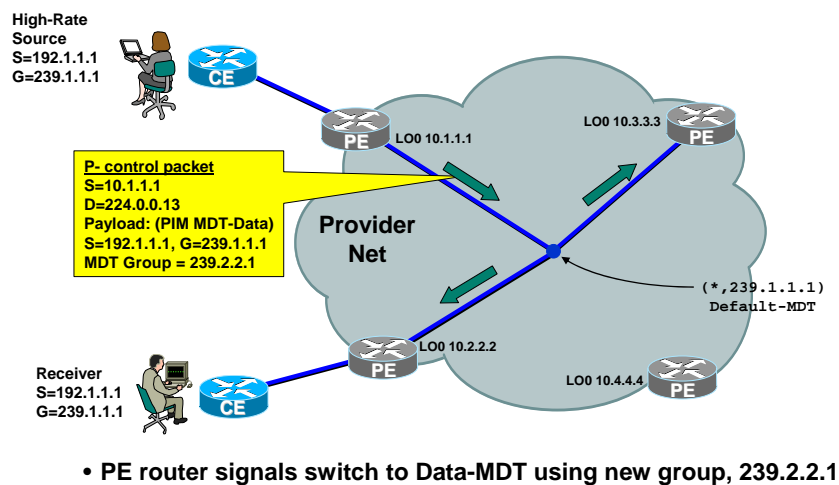
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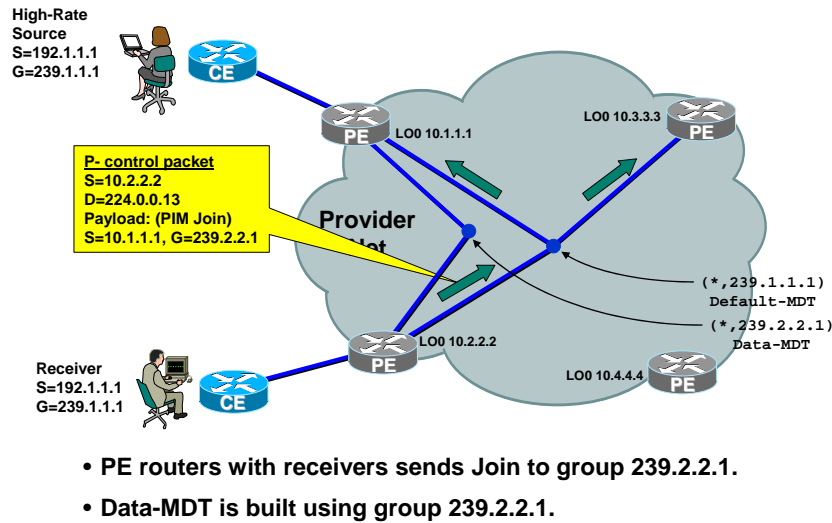
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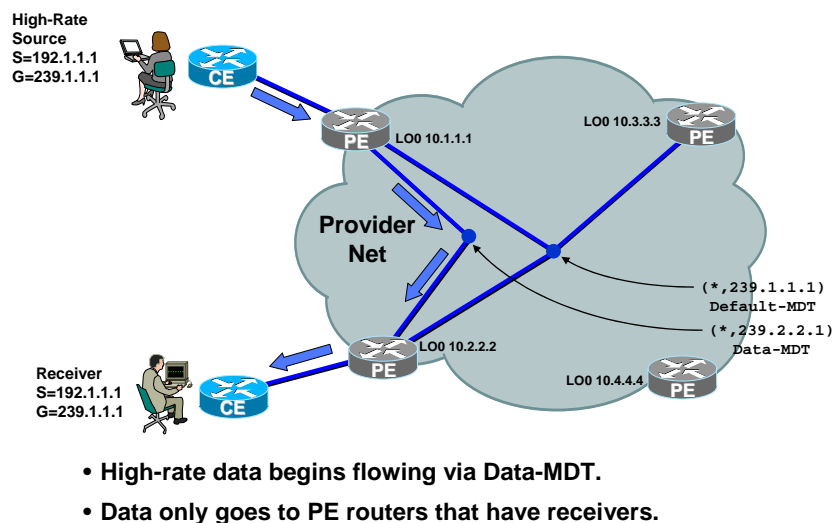
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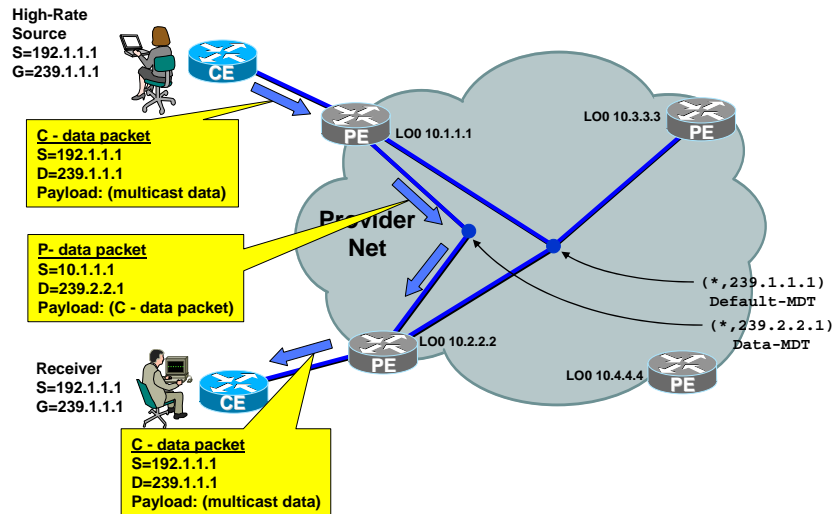
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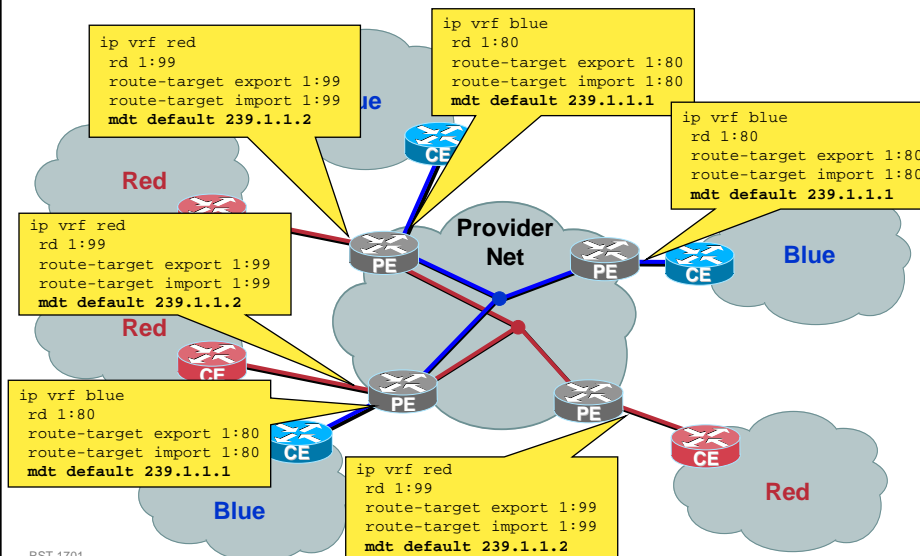
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Default-MDT Group Address Example

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IPv6 MULTICAST



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IPv6 Multicast Addressing

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- **Multicast Addresses (RFC 2373)**
 - **ff::/8** is the ipv6 equivalent of 224/4
 - **ff02::1** is the ipv6 equivalent of the link local address 224.0.0.1
 - **SSM address range** is ff3X::/32, where X represents the scope bits.

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IPv6 Multicast – O.S. & Application Support

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- **Stacks**
 - KAME host stack
 - Microsoft Windows XP
 - Mac OS 10.2
 - Linux
 - HP OpenVMS and True64
- **Applications**
 - Microsoft Media Player & Server 9
 - Many emerging commercial applications
 - DVTS, Videolan, etc
 - Standard MBONE Tools (vic, rat, ...) support IPv6

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IOS CLI: Configure like v4, but easier

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Group mode determines how to forward, compared to interface mode in v4.

By default all interfaces are PIM enabled unless explicitly disabled.

Config for PIM-SSM:

```
!  
ipv6 multicast-routing  
!
```

Config for PIM-SM:

```
!  
ipv6 multicast-routing  
ipv6 pim rp-address <v6_address>  
!
```

Config for PIM-bidir:

```
!  
ipv6 multicast-routing  
ipv6 pim rp-address <v6-address> bidir  
!
```

Disable PIM on an interface

```
!  
interface ethernet 0  
no ipv6 pim  
!
```

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IPv4 versus IPv6 Multicast

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IP Service	IPv4 Solution	IPv6 Solution
Address Range	32-bit, class D	128-bit
Routing	Protocol Independent All IGPs, and BGP4+	Protocol Independent All IGPs, and BGP4+ with v6 mcast SAFI
Forwarding	PIM-DM, PIM-SM, PIM-SSM, PIM-bidir	PIM-SM, PIM-SSM, PIM-bidir
Group Management	IGMPv1, v2, v3	MLDv1, v2
Domain Control	Boundary/Border	Scope Identifier
Interdomain Solutions	MSDP across Independent PIM Domains	Single RP within Globally Shared Domains

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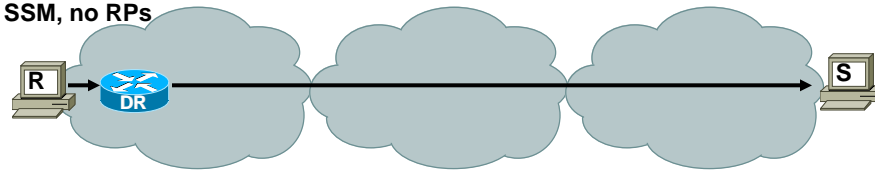
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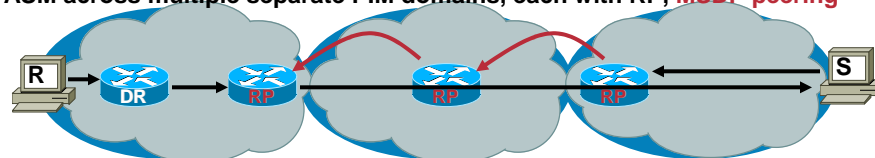
Interdomain v6 Multicast Options

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SSM, no RPs



ASM across multiple separate PIM domains, each with RP, MSDP peering



ASM across single shared PIM domain, one RP



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Embedded-RP Addressing Overview

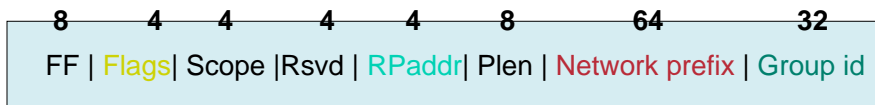
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- draft-savola-mboned-mcast-rpaddr-00.txt
- Relies on a subset of RFC3306 IPv6 unicast-prefix multicast group addresses with special encoding rules:

Group address carries the RP address for the group!

For each Unicast prefix you own, you now also own:

16 RPs for each of the 16 Multicast Scopes (256 total) with 2^{32} multicast groups assigned to each RP (2^{40} total)



New Address format defined :

Flags = 0RPT, R = 1, P = 1, T = 1 => RP address embedded

Example Group: FF76:0130:1234:5678:9ab0::01020304

Embedded RP: 1234:5678:9ab0::1

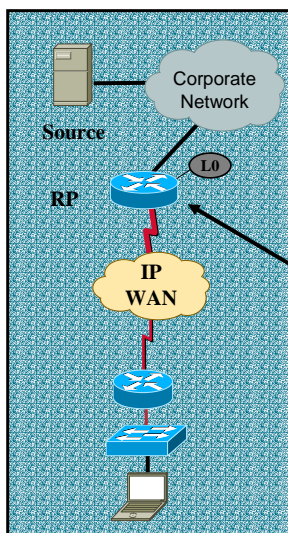
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Embedded-RP Configuration Example

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•RP, used as an Embedded-RP, to be configured with address/ group range

•All other non-RP routers have no special configuration

```
ipv6 pim rp-address 2001:DB8:C003:111D::1 ERP
!
ipv6 access-list ERP
permit ipv6 any FF7E:140:2001:DB8:C003:111D::/96
```

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Embedded RP

Does it work?

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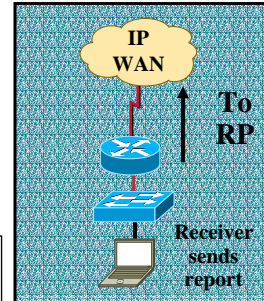
```
branch#show ipv6 pim group
FF7E:140:2001:DB8:C003:111D::/96*
  RP      : 2001:DB8:C003:111D::1
  Protocol: SM
  Client   : Embedded
  Groups   : 1
  Info     : RPF: Se0/0.1,FE80::210:7FF:FEDD:40
```

```
branch#show ipv6 mroute active

Active IPv6 Multicast Sources - sending >= 4 kbps
Group: FF75:140:2001:DB8:C003:111D:0:1112
Source: 2001:DB8:C003:1109::2
Rate: 21 pps/122 kbps(1sec), 124 kbps(last 100 sec)
```

```
branch#show ipv6 pim range | include Embedded

Embedded SM RP: 2001:DB8:C003:111D::1 Exp: never Learnt from : ::
FF7E:140:2001:DB8:C003:111D::/96 Up: 00:00:24
```



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Conclusion

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- Cisco IOS IPv6 Multicast in initial deployment now
- Multicast Applications can be developed and tested over an infrastructure running Cisco IOS IPv6 Multicast
- IPv6 Multicast is an IPv6 service fully integrated with other Cisco IPv6 solutions

v6 Mcast Questions?:

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SECURITY



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Controlling Source Registration

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- **Global command**
 - `ip pim accept-register [list <acl>] | [route-map <map>]`
 - Used on RP to filter incoming Register messages
 - Filter on Source address alone (Simple ACL)
 - Filter on (S, G) pair (Extended ACL)
 - May use route-map to specify what to filter
 - Filter by AS-PATH if (m)BGP is in use.
- **Helps prevents unwanted sources from sending**
 - First hop router blocks traffic from reaching net

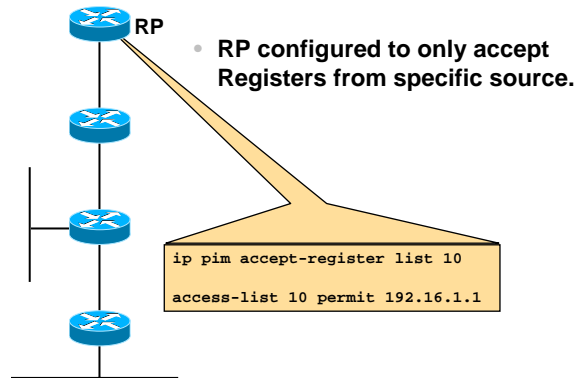
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Controlling Source Registration

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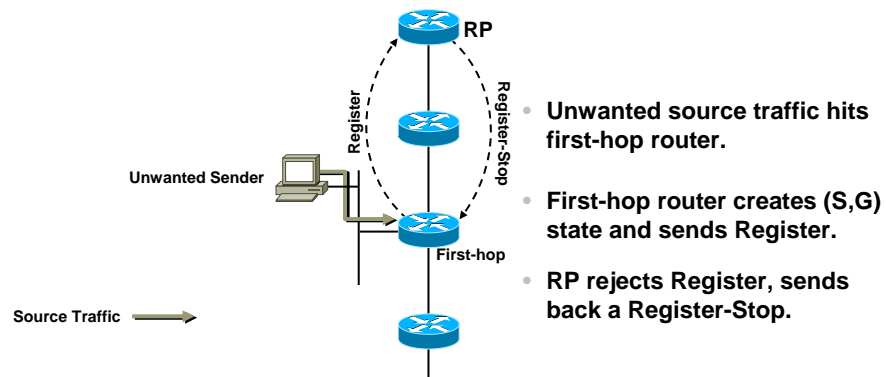
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Controlling Source Registration

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Worms

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- To propagate, the Sasser worm sent a packet to TCP port 445 of random IP addresses, including multicast. Filter TCP destined to all multicast addresses:

```
access-list 115 deny tcp any 224.0.0.0 15.255.255.255
```

- Pings (ICMP) used to scan for hosts to infect. Filter ICMP packets towards 224/4:

```
access-list 115 deny icmp any 224.0.0.0 15.255.255.255
```

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Commands used to Protect

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- **ip multicast route-limit** <routes>
Use this command to limit the impact of Denial of Service attacks based on creating useless IP multicast routing state.
- **ip pim rp-address** <ip-address> [<group-access-list>] [override]
A single RP will be used only for certain defined groups.
- **ip pim accept-rp** {<address> | auto-rp} [<acl>]
To configure a router to accept Joins or Prunes destined for a specified RP and for a specific list of groups.
- **ip msdp sa-filter** in|out <ip-address-or-name> [list <acl>]
Filters incoming/outgoing SA messages to/from a peer.
- **ip msdp sa-limit** <peer-address-or-name> <limit>
Introduced as a mean of protection against (distributed) denial of service attacks. Limits the overall number of SA messages the router will accept from a peer.

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Commands used to Protect

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- **ip pim neighbor-filter** <acl>

Used to administratively deny a misconfigured PIM neighbor from participating in PIM

- **ip pim bsr-border**

Bootstrap messages will not be able to pass through this border in either direction.

- **ip multicast boundary** <acl>

No multicast data packets, defined in acl, will be allowed to flow across the boundary from either direction. For example, to configure a boundary for all administratively scoped addresses, do:

```
access-list 1 deny 239.0.0.0 0.255.255.255
access-list 1 permit 224.0.0.0 15.255.255.255
interface ethernet 0
ip multicast boundary 1
```

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SOURCE REDUNDANCY



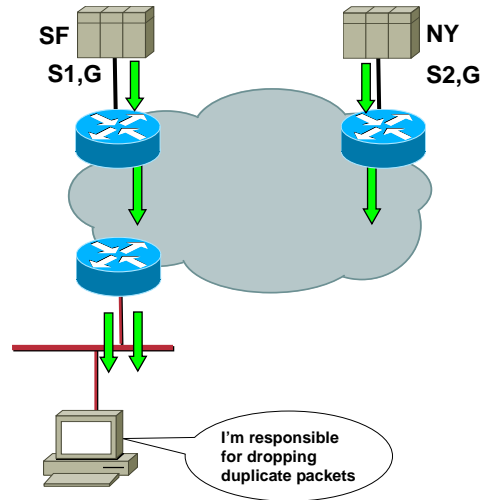
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Source Redundancy (Duplicate Streams)

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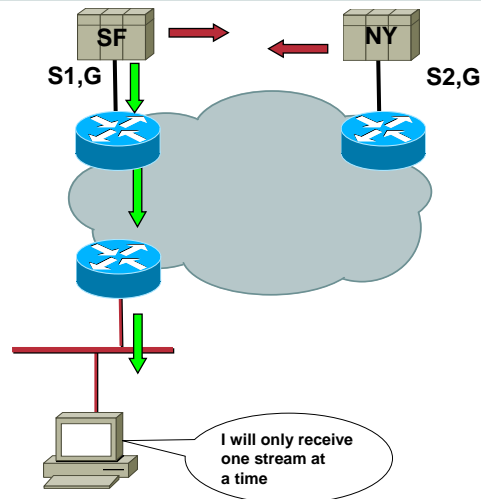
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Source Redundancy (Server Heartbeat)

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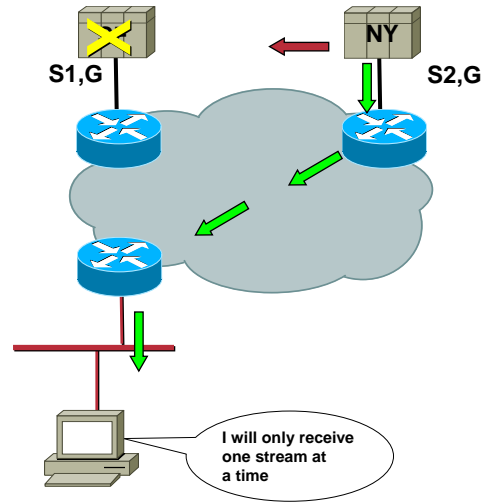
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Source Redundancy (Server Heartbeat)

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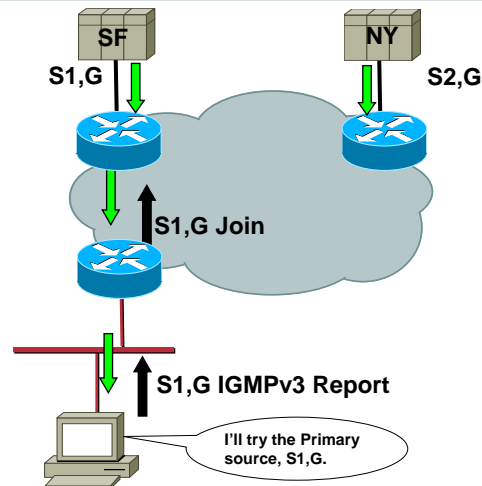
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Source Redundancy (SSM)

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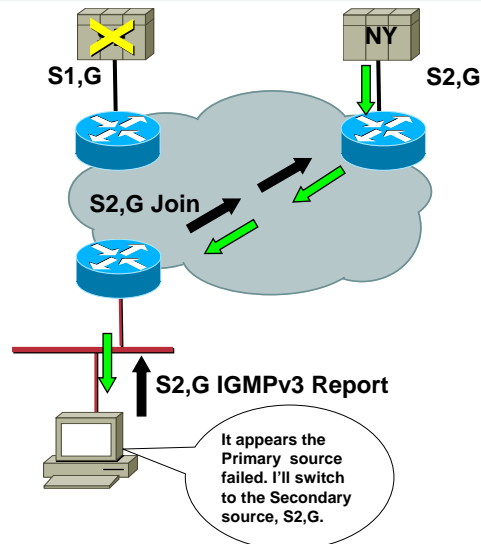
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Source Redundancy (SSM)

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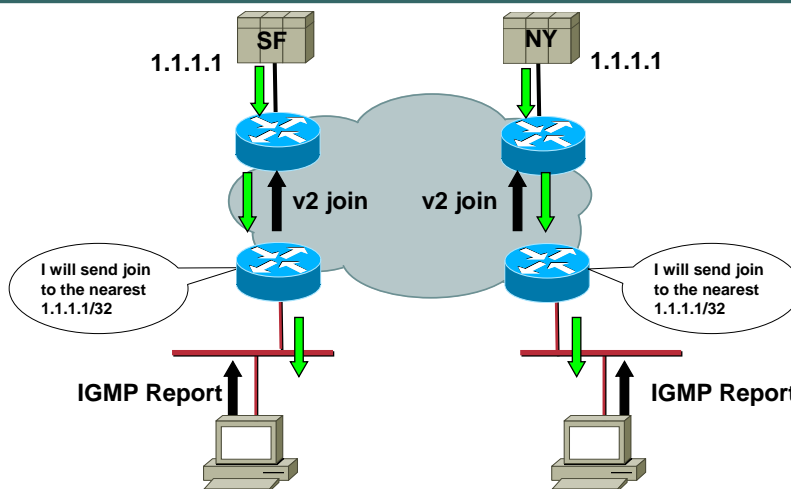
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Anycast Sources

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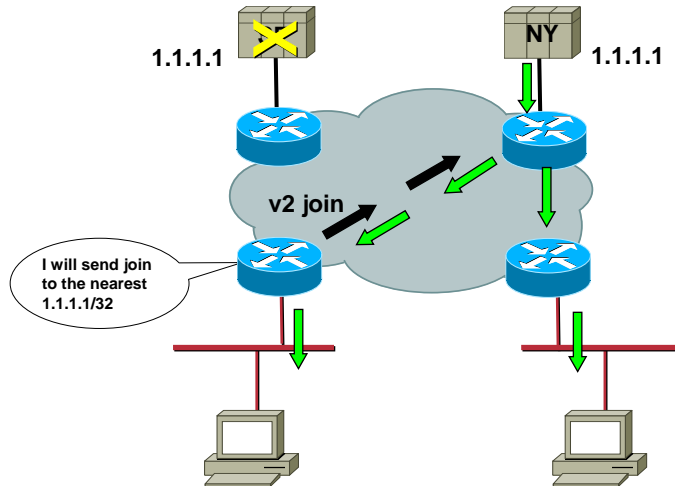
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- Web and Mailers
- Cisco Press

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<http://www.cisco.com/go/ipmulticast>

Questions:

cs-ipmulticast@cisco.com

Customer Support Mailing List:

tac@cisco.com



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- WHY:** Win fabulous prizes! Give us your feedback!
- WHERE:** Go to the Internet stations located throughout the Convention Center
- HOW:** Winners will be posted on the onsite Networkers Website; four winners per day

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