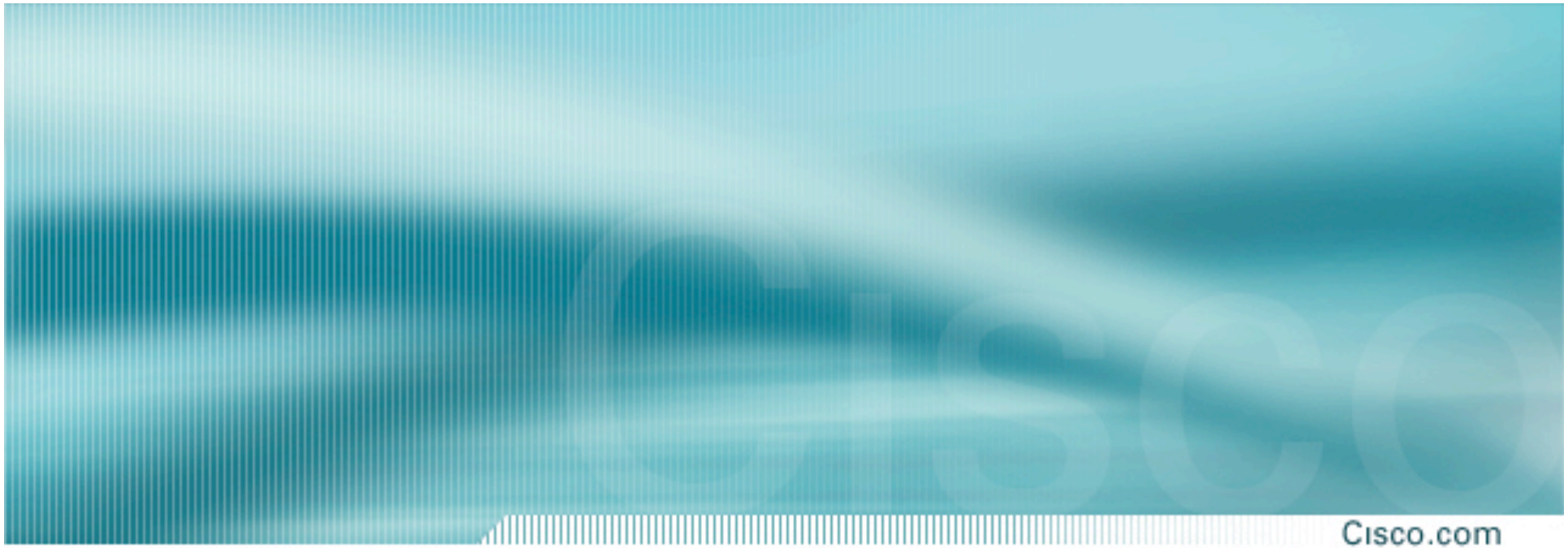


Multicast Source Discovery Protocol (MSDP)

Agenda

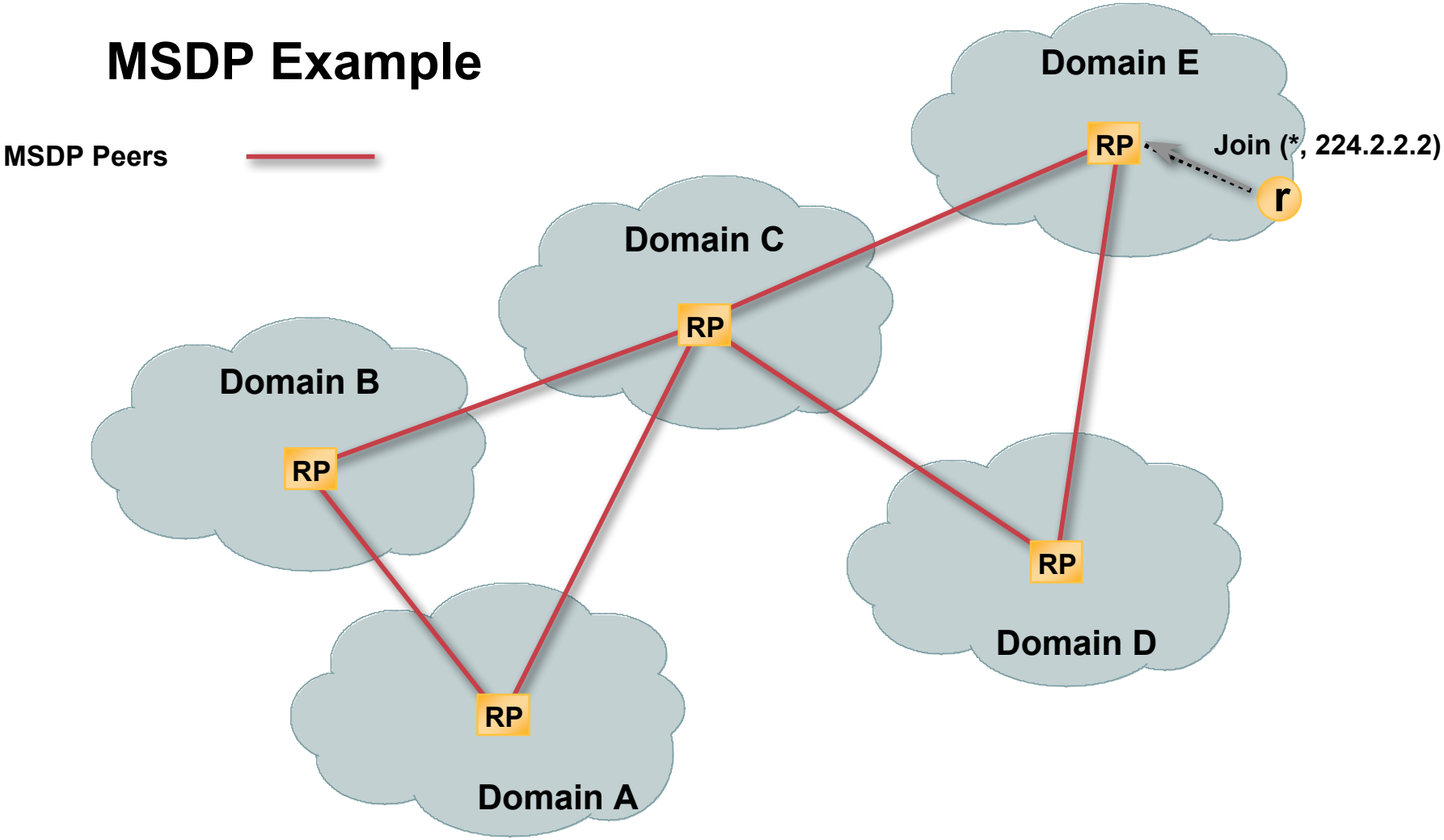
- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
- MSDP State Flags
- MSDP Enhancements

MSDP Overview

- Uses inter-domain source trees only.
  - RP's know about all sources in their domain
    - Sources cause a "PIM Register" to the RP
    - Can tell RP's in other domains of its sources
      - Via MSDP SA (Source Active) messages
  - RP's know about receivers in their domain
    - Receivers cause a "(*, G) Join" to the RP
    - RP can join the source tree in the peer domain
      - Via normal PIM (S, G) joins
      - Only necessary if there are receivers for the group
    - Last-hop routers then join source tree directly.

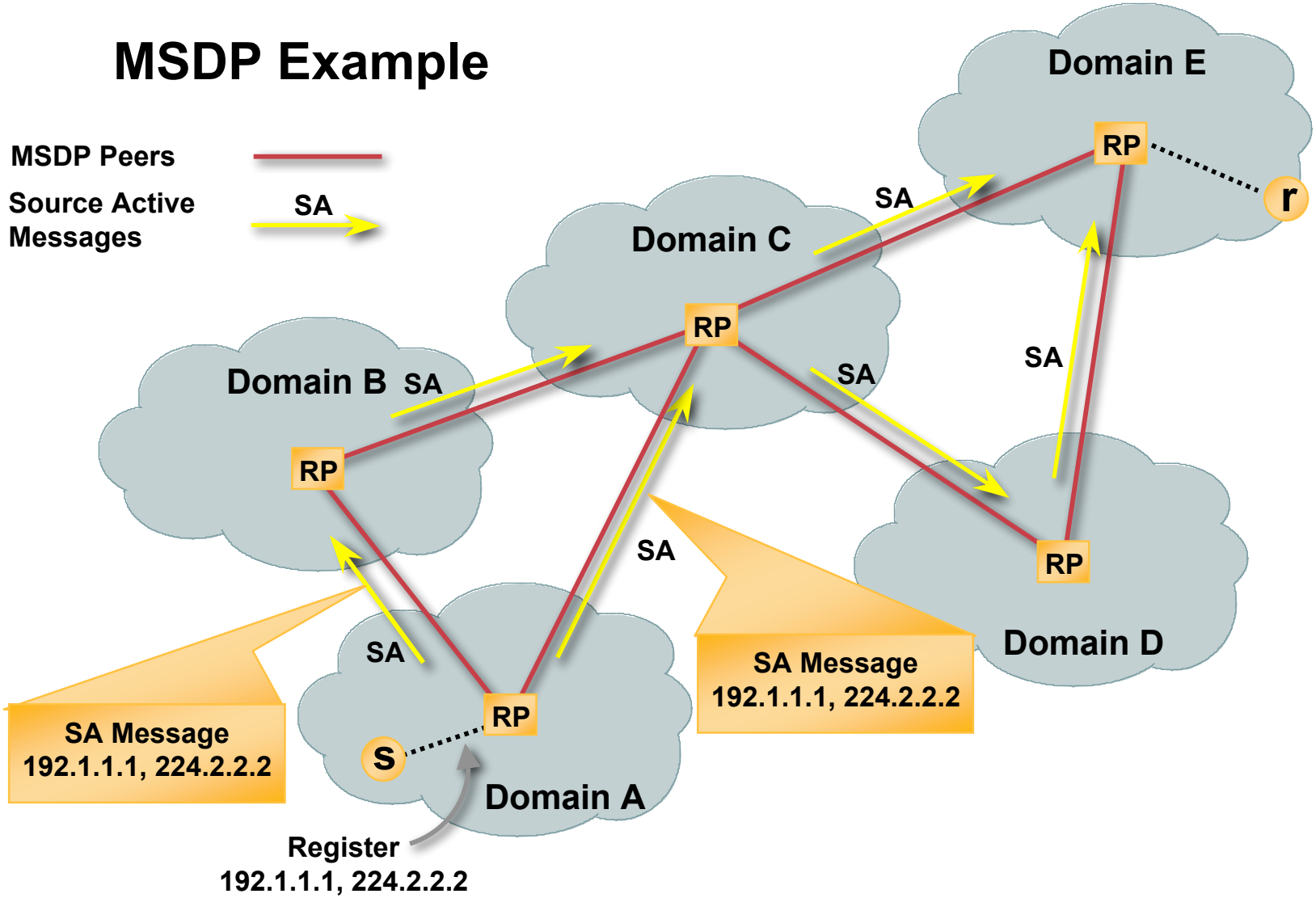
MSDP Overview

MSDP Example



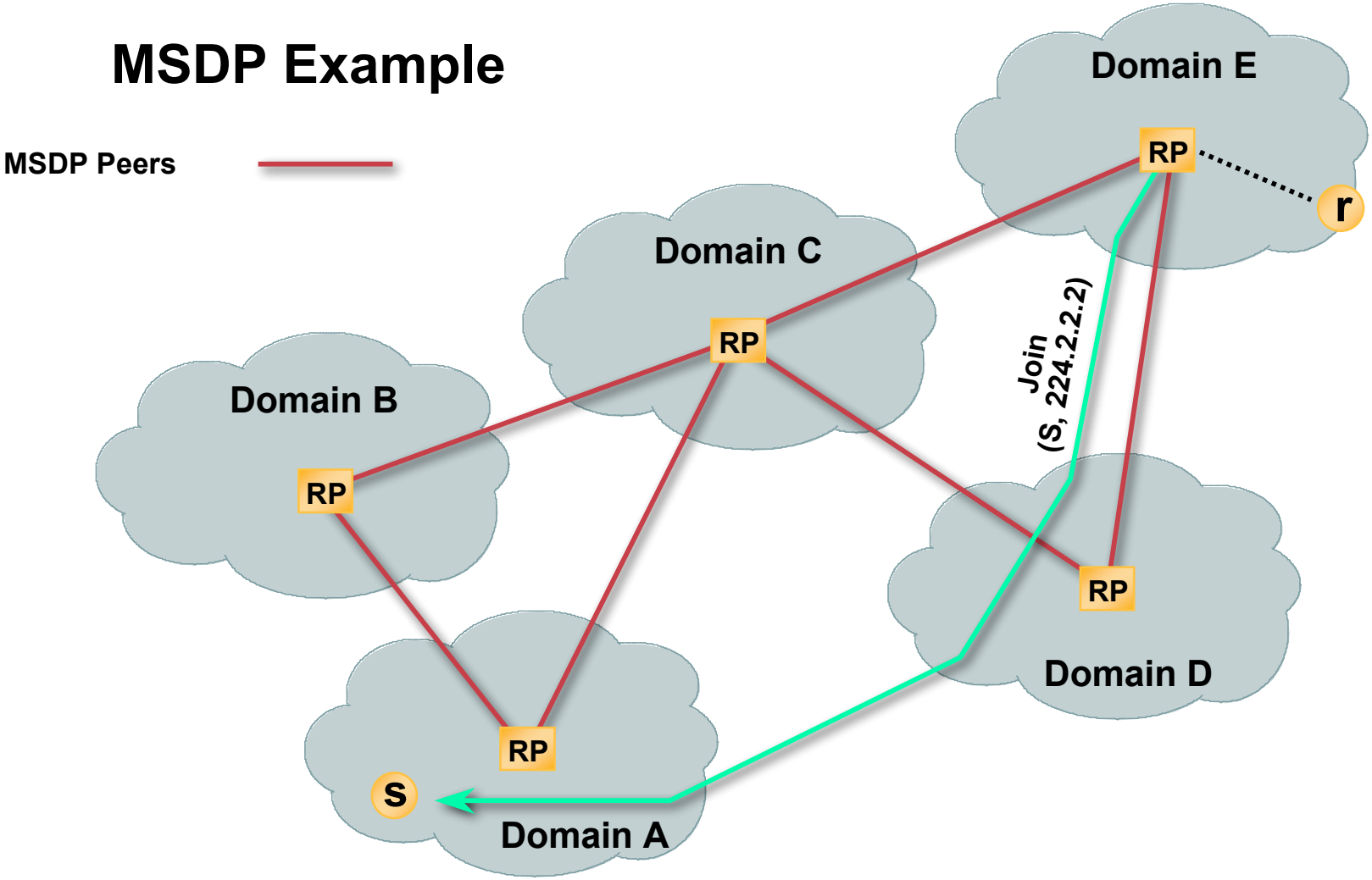
MSDP Overview

MSDP Example



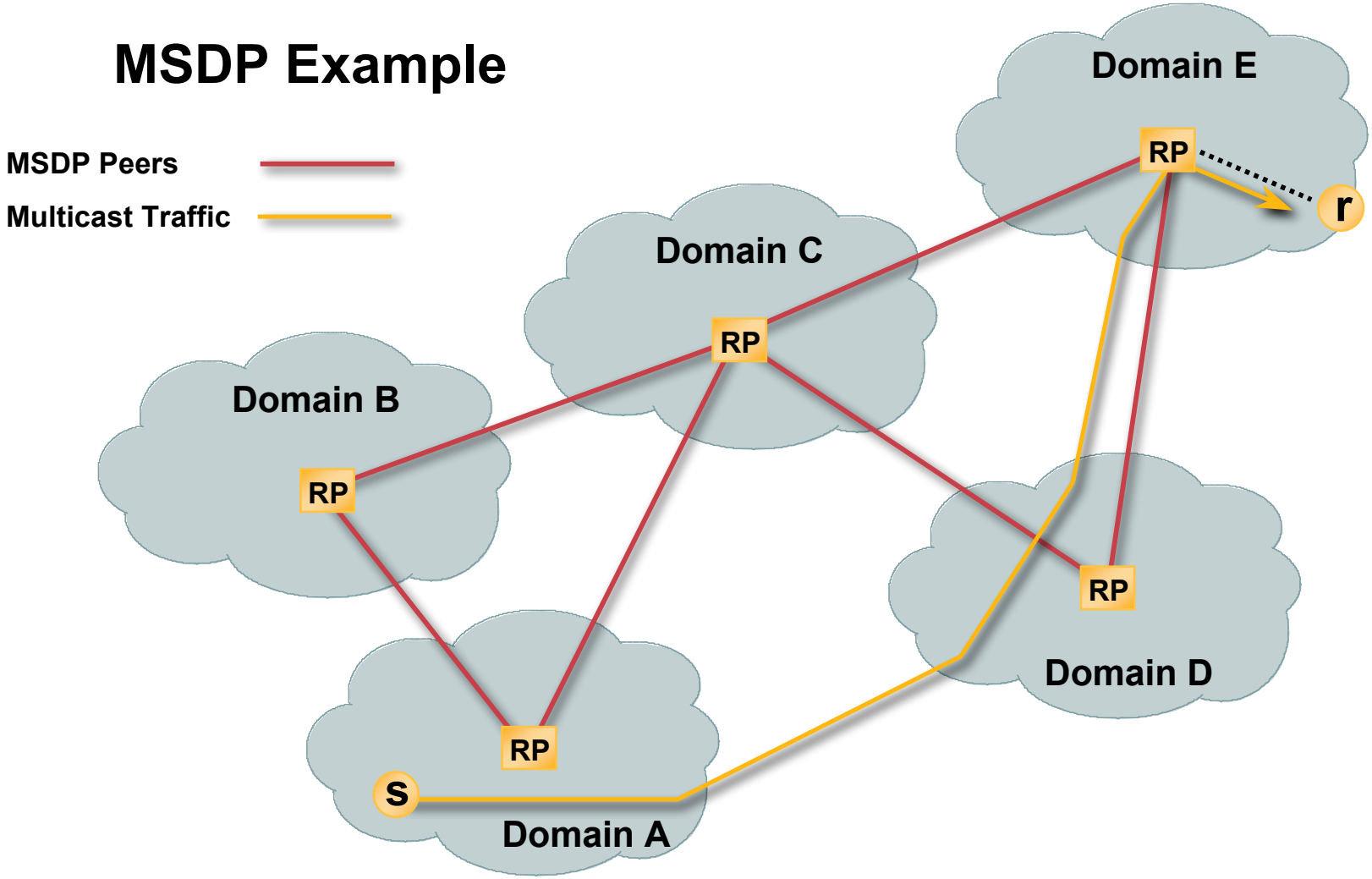
MSDP Overview

MSDP Example



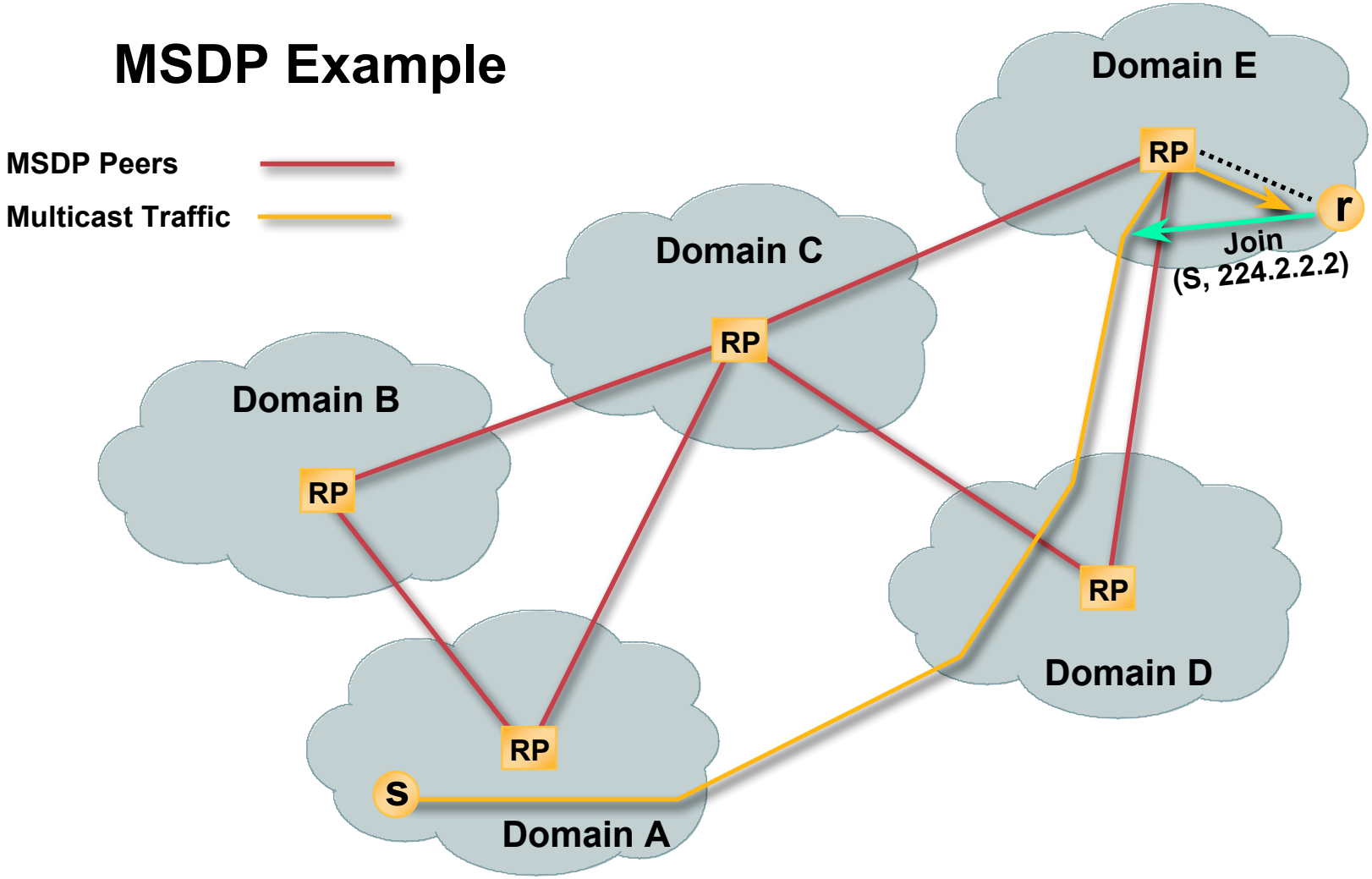
MSDP Overview

MSDP Example



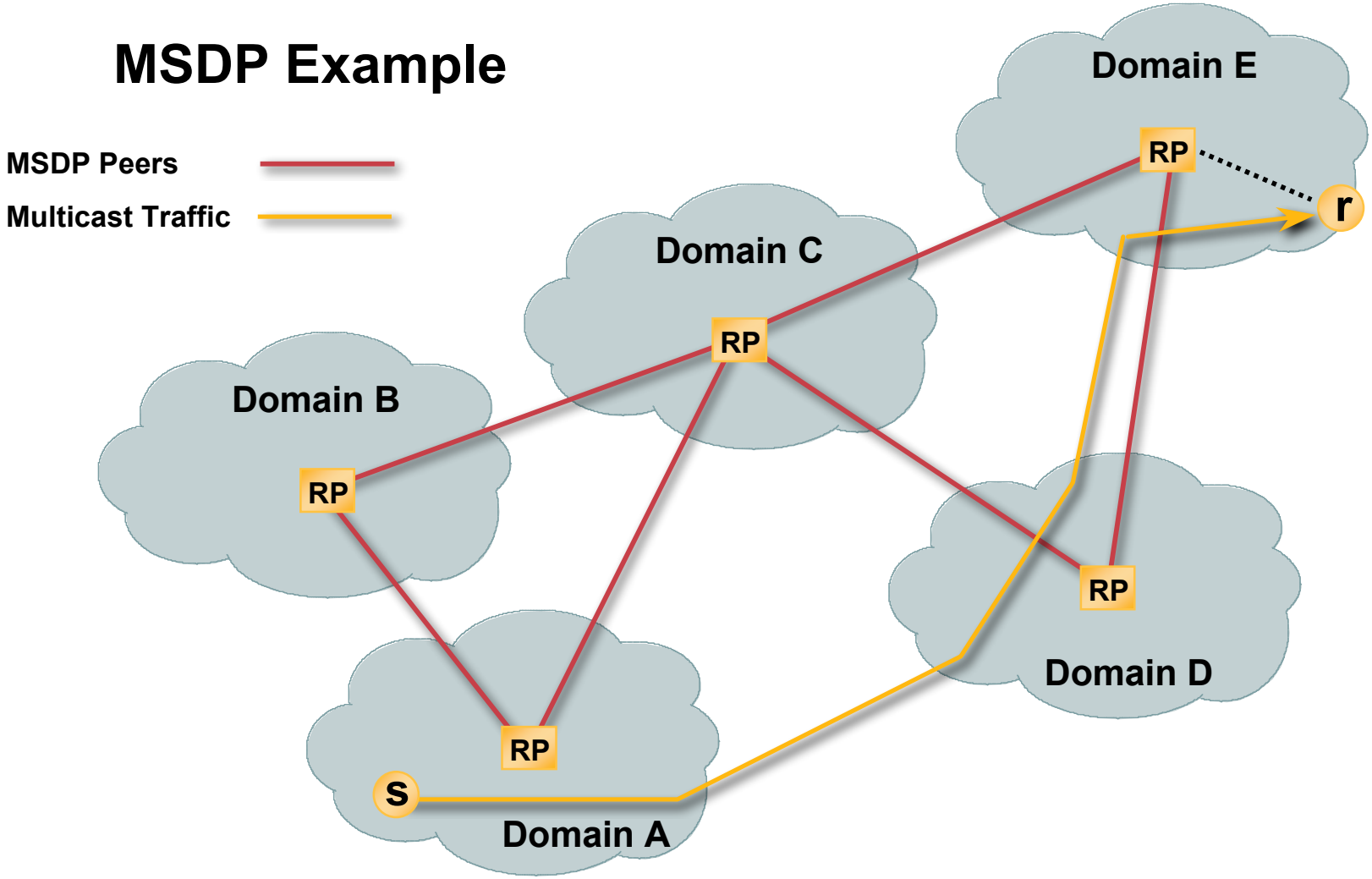
MSDP Overview

MSDP Example



MSDP Overview

MSDP Example



Agenda

- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
- MSDP State Flags
- MSDP Enhancements

MSDP Peers

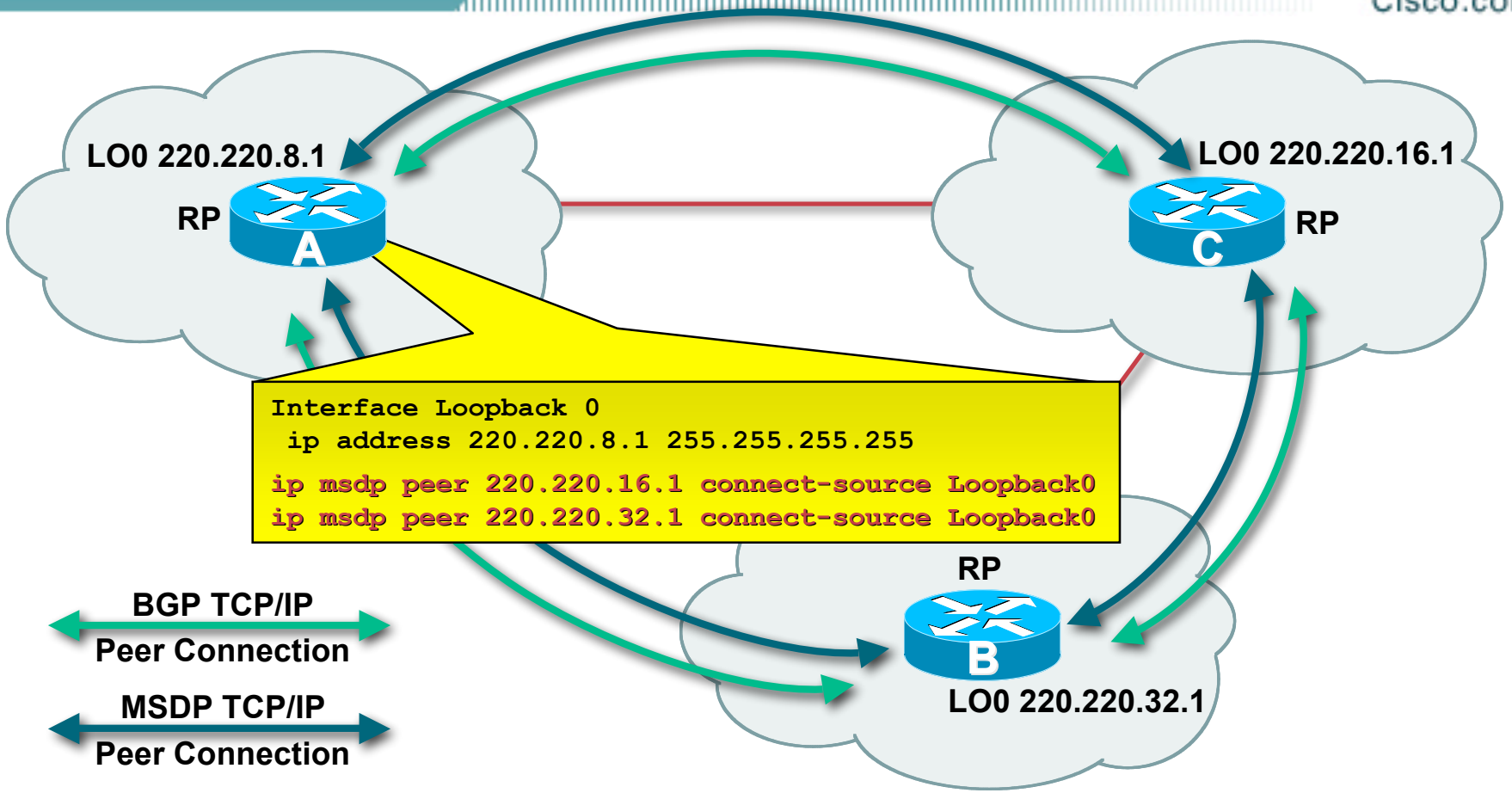
- MSDP Peers configured similar to BGP
- Peers connect using TCP port 639
  - Lower address peer initiates connection
  - Higher address peer waits in LISTEN state
- Peers send keepalives every 60 secs.
- Connection reset after 75 seconds
  - If no MSDP packets or keepalives are received

MSDP Peers

- MSDP peers normally *must* run BGP!
  - BGP NLRI is used to RPF check SA messages.
    - May use NLRI from M-Table, U-Table or both.
  - RPF check prevents SA's from looping.

    (More on that later.)
- Exceptions:
  - When peering with only a single MSDP peer.
  - When using an MSDP Mesh-Group.

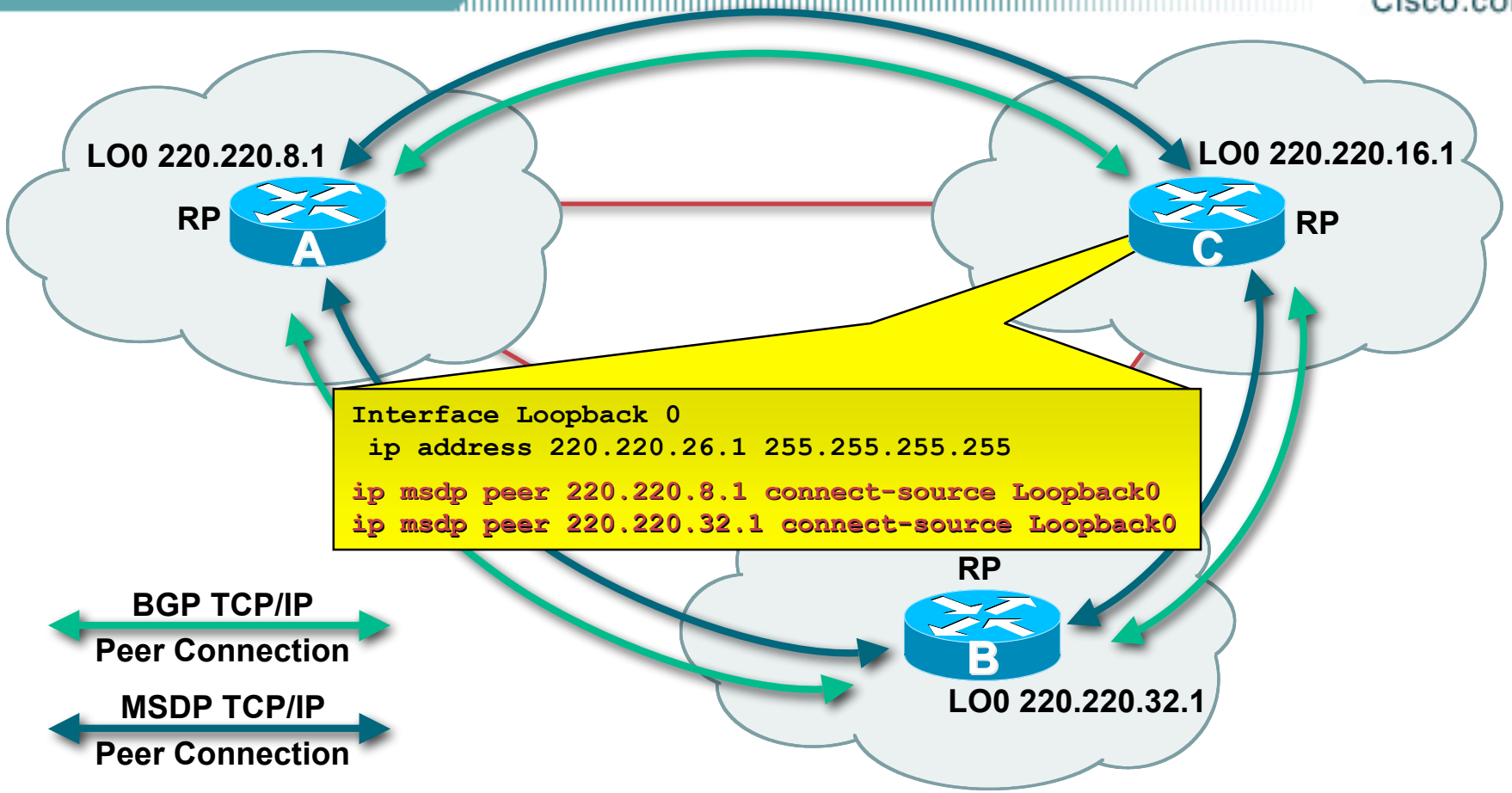
MSDP Peers



- **MSDP peer connections are established using the MSDP "peer" configuration command**

```
ip msdp peer <ip-address> [connect-source <intfc>]
```

MSDP Peers



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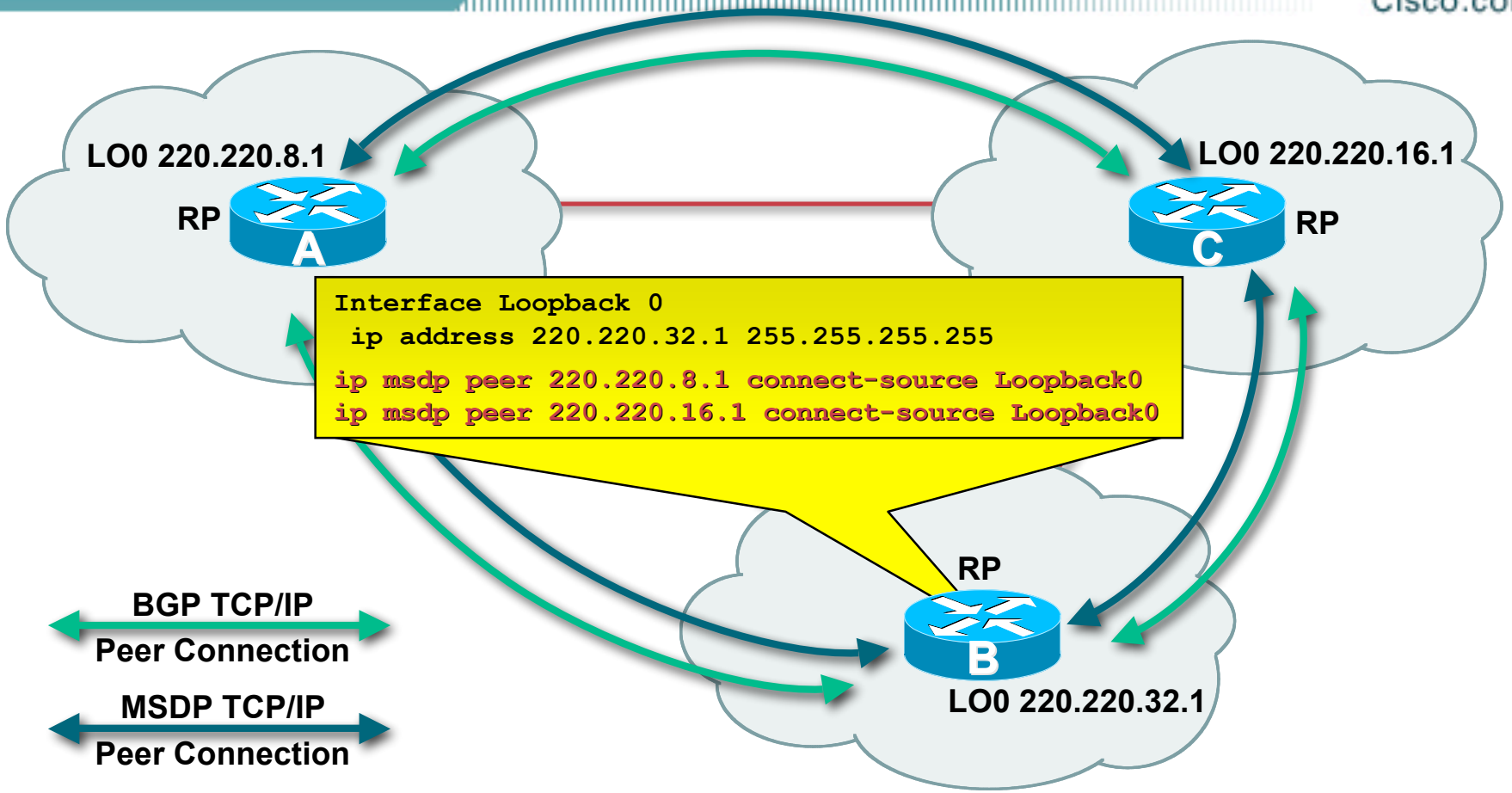
```
ip msdp peer <ip-address> [connect-source <intfc>]
```

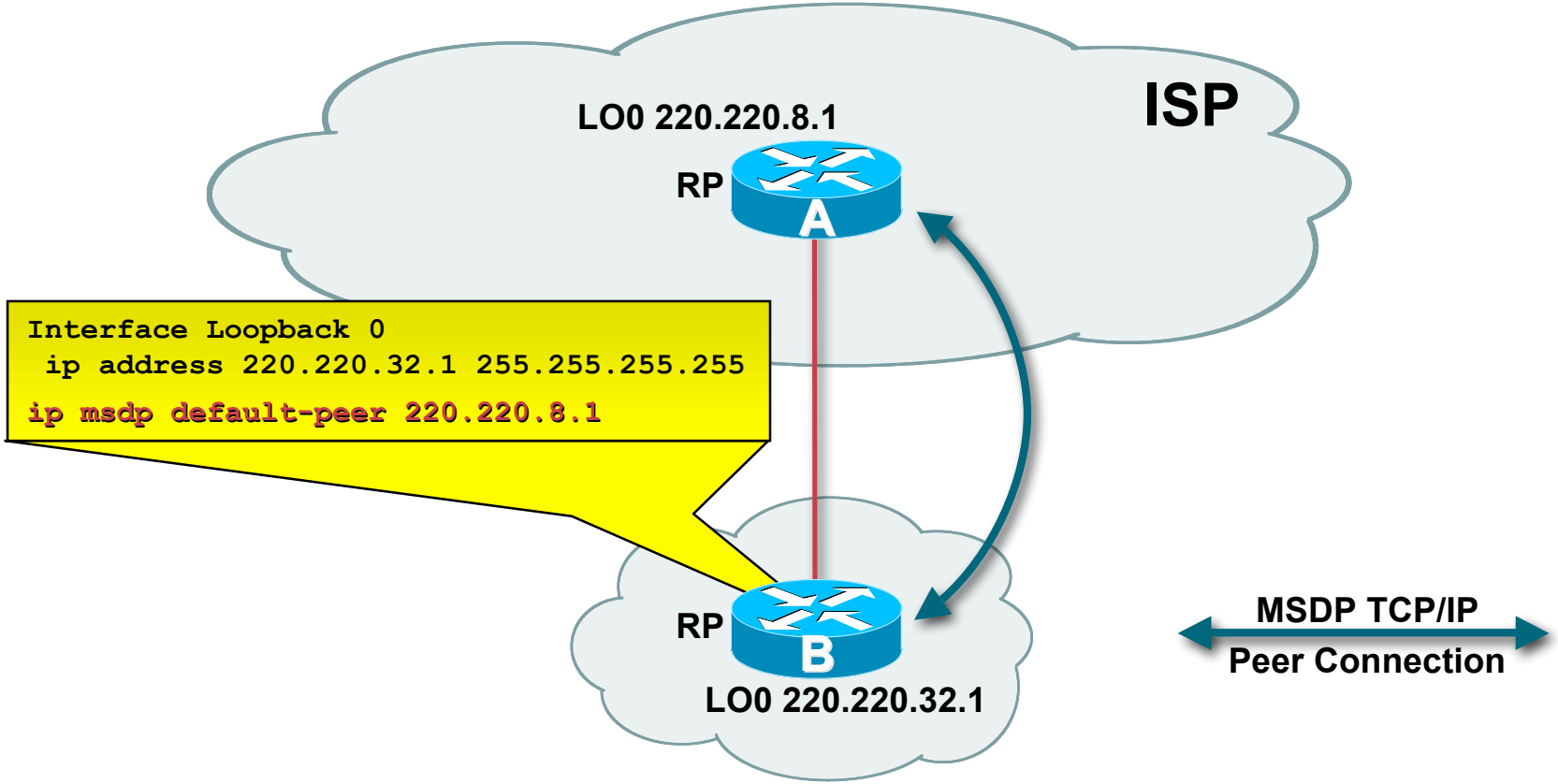
MSDP Peers



- **MSDP peer connections are established using the MSDP "peer" configuration command**

```
ip msdp peer <ip-address> [connect-source <intfc>]
```

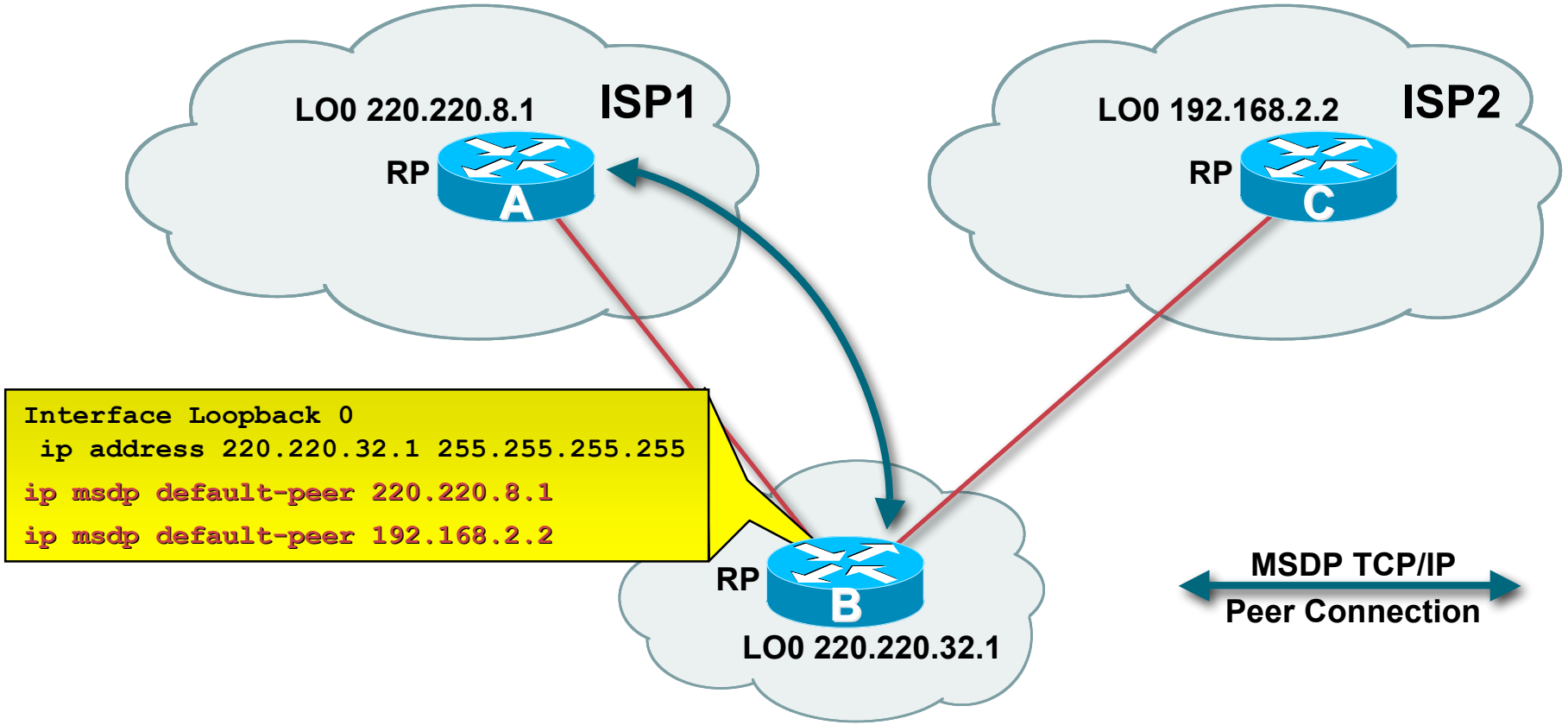
MSDP Peers



- **Stub-networks may use "default" peering without being a BGP peer by using the MSDP "default-peer" configuration command.**

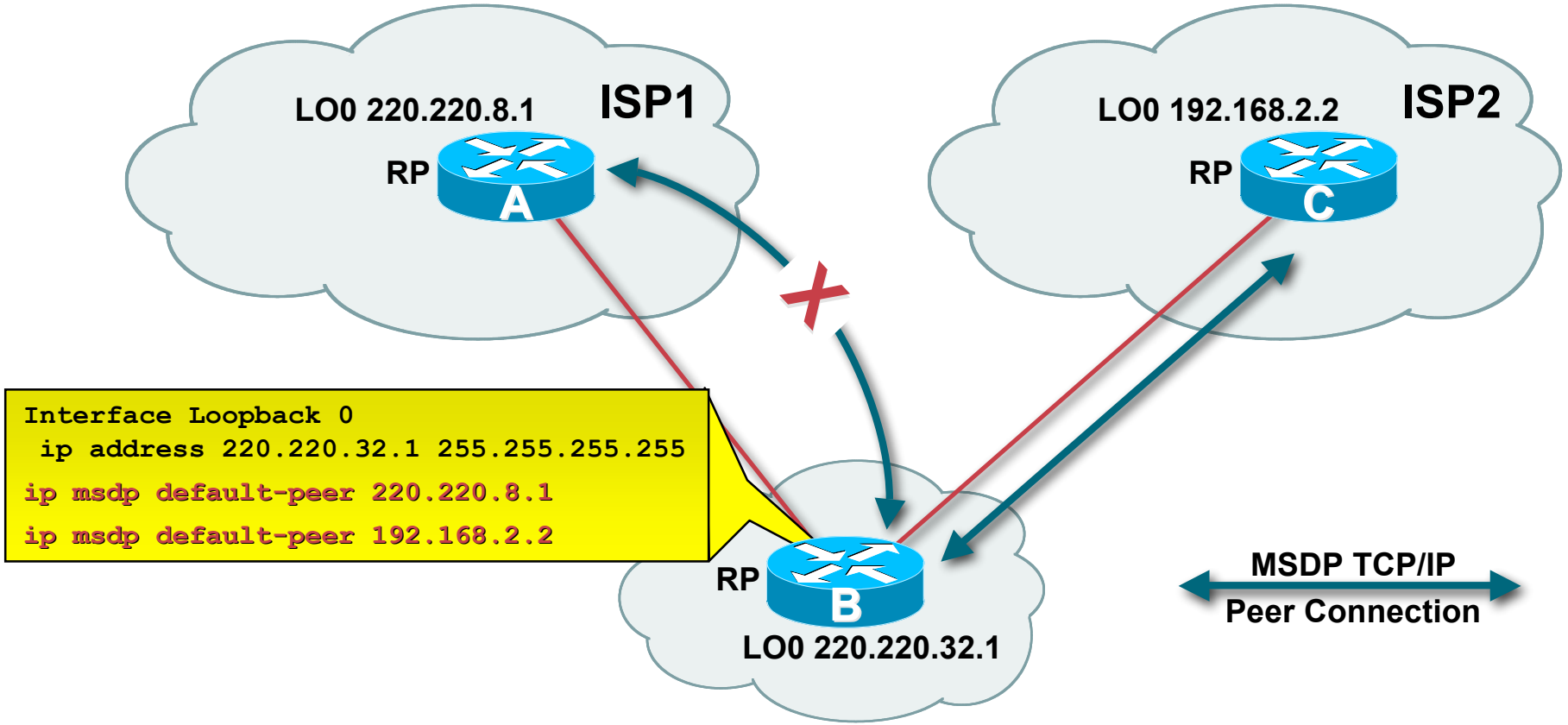
```
ip msdp default-peer <ip-address>
```

MSDP Peers



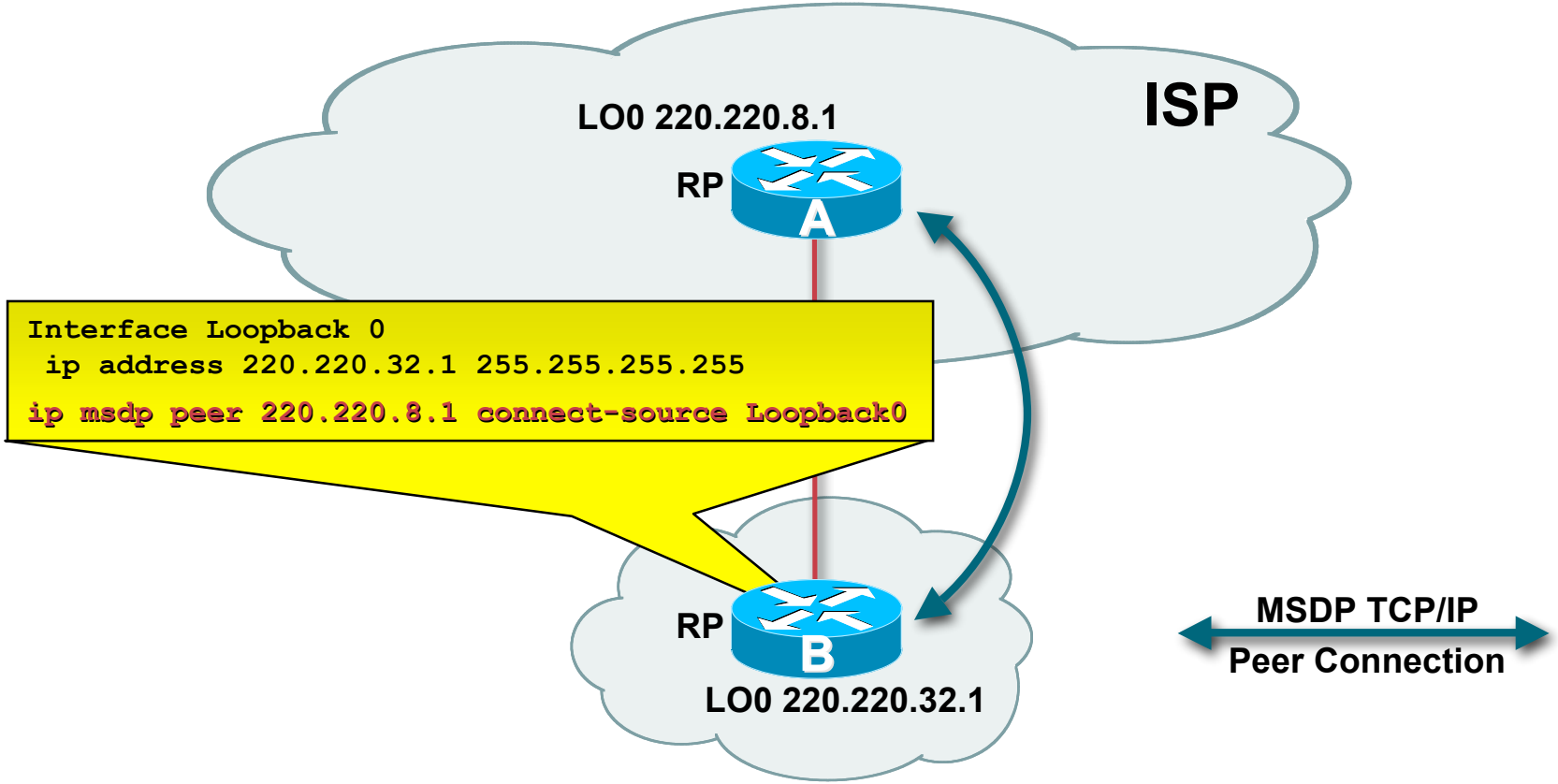
- **Multiple "default-peers" may be configured in case connection to first default-peer goes down.**

MSDP Peers



- When connection to first ‘default-peer’ is lost, the next one in the list is tried.

MSDP Peers



- **Stub-networks configured with only a single MSDP peer are treated in the same manner as when a single "default-peer" is configured. (i.e. BGP is not required.)**

Agenda

- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
- MSDP State Flags
- MSDP Enhancements

SA Message Contents

- MSDP Source Active (SA) Messages
  - Used to advertise active Sources in a domain
  - Can also carry 1st multicast packet from source
    - Hack for Bursty Sources (a'la SDR)
  - SA Message Contents:
    - IP Address of Originating RP
    - Number of (S, G)'s pairs being advertised
    - List of active (S, G)'s in the domain
    - Encapsulated Multicast packet [optional]

SA Messages

- Originating SA Messages
- Receiving SA Messages
- SA Message Caching
- SA Input/Output Filtering
- SA Message RPF Checking

Originating SA Messages

- Local Sources
  - RP's only originate SA's for local sources
    - Denoted by the "A" flag on an (S,G) entry on RP
  - A source is local if:
    - The RP received a "Register" for (S, G), or
    - The source is directly connected to RP

Originating SA Messages

- Use ‘msdp redistribute’ to control what SA’s are originated.
  - Think of this as ‘msdp sa-originate-filter’ function

```
ip msdp redistribute [list <acl>]
                     [asn <aspath-acl>]
                     [route-map <map>]
```

    - Filter by (S,G) pair using ‘list <acl>’
    - Filter by AS-PATH using ‘asn <aspath-acl>’
    - Filter based on route-map ‘<map>’
  - Omitting all acl’s stops all SA origination

```
Example: ip msdp redistribute
```

  - Default: Originate SA’s for all local sources
    - If ‘msdp redistribute’ command is not configured

Originating SA Messages

- SA messages are triggered when any new source in the local domain goes active.
  - Initial multicast packet is encapsulated in an SA message.
    - This is an attempt at solving the bursty-source problem

Originating SA Messages

- **Encapsulating Initial Multicast Packets**
  - **Can bypass TTL-Thresholds**
    - **Original TTL is inside of data portion of SA message**
    - **SA messages sent via Unicast with TTL = 255**
- **Requires special command to control**

```
ip msdp ttl-threshold <peer-address> <ttl>
```

  - **Encapsulated multicast packets with a TTL lower than <ttl> for the specific MSDP peer are not forwarded or originated.**

Originating SA Messages

- **Once a minute**
  - **Router scans mroute table**
  - **If group = sparse AND router = RP for group**
    - **For each (S,G) entry for the group:**
      - **If the '`msdp redistribute`' filters permits**
      - **AND if the source is a local source**
      - **Then originate an SA message for (S,G)**

SA Messages

- Originating SA Messages
- Receiving SA Messages
- SA Message Caching
- SA Input/Output Filtering
- SA Message RPF Checking

Receiving SA Messages

- If SA message RPF checks OK
  - Store in SA Cache
  - If new SA cache entry
    - Immediately flood SA downstream
    - Set entry's SA-expire-timer to 6 minutes.
    - If RP for group and receivers exist
      - » Create (S,G) entry and trigger (S,G) Join
  - If existing entry
    - Reset entry's SA-expire-timer to 6 minutes.
      - » When timer = zero, entry has expired and is deleted.
- Else
  - Discard SA

SA Messages

- Originating SA Messages
- Receiving SA Messages
- SA Message Caching
- SA Input/Output Filtering
- SA Message RPF Checking

SA Message Cache

- **Enabling SA Caching**

```
ip msdp cache-sa-state [list <acl>]
```

  - Caching is now on by default.
    - Beginning with IOS versions 12.1(7), 12.0(14)S1.
      - Cannot be turned off.
  - Router caches all SA messages.
    - Cached (S, G) entries timeout after 6 minutes.
      - If not refreshed by another (S,G) SA message.
  - Once per minute, router scans SA cache.
    - Sends SA downstream for each entry in cache.

SA Message Caching

- **Listing the contents of the SA Cache**

```
show ip msdp sa-cache [<group-or-source>] [<asn>]
```

```
sj-mbone# show ip msdp sa-cache
MSDP Source-Active Cache - 1997 entries
(193.92.8.77, 224.2.232.0), RP 194.177.210.41, MBGP/AS 5408, 00:01:51/00:04:09
(128.119.167.221, 224.77.0.0), RP 128.119.3.241, MBGP/AS 1249, 06:40:59/00:05:12
(147.228.44.30, 233.0.0.1), RP 195.178.64.113, MBGP/AS 2852, 00:04:48/00:01:11
(128.117.16.142, 233.0.0.1), RP 204.147.128.141, MBGP/AS 145, 00:00:41/00:05:18
(132.250.95.60, 224.253.0.1), RP 138.18.100.1, MBGP/AS 668, 01:15:07/00:05:55
(128.119.40.229, 224.2.0.1), RP 128.119.3.241, MBGP/AS 1249, 06:40:59/00:05:12
(130.225.245.71, 227.37.32.1), RP 130.225.245.71, MBGP/AS 1835, 1d00h/00:05:29
(194.177.210.41, 227.37.32.1), RP 194.177.210.41, MBGP/AS 5408, 00:02:53/00:03:07
(206.190.42.106, 236.195.60.2), RP 206.190.40.61, MBGP/AS 5779, 00:07:27/00:04:04
                                .
                                .
                                .
```

- **Clearing the contents of the SA Cache**

```
clear ip msdp sa-cache [<group-address> | group-name]
```

SA Messages

- Originating SA Messages
- Receiving SA Messages
- SA Message Caching
- SA Input/Output Filtering
- SA Message RPF Checking

Filtering Incoming/Outgoing SA Messages

- **SA Filter Command:**

```
ip msdp sa-filter {in|out} <peer-address> [list <acl>]
                                          [route-map
<map>]
```

  - **Filters (S,G) pairs to / from peer based on specified ACL.**
  - **Can filter based on AS-Path by using optional route-map clause with a path-list acl.**
  - **You can filter flooded and originated SA's based on a specific peer, incoming and outgoing.**
- **Caution: Filtering SA messages can break the Flood and Join mechanism!**

Recommended MSDP SA Filter


```
! 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
```

See “ftp://ftp-eng.cisco.com/ipmulticast/msdp-sa-filter.txt” for the latest updates to this list.

SA Messages

- Originating SA Messages
- Receiving SA Messages
- SA Message Caching
- SA Input/Output Filtering
- SA Message RPF Checking

SA Message RPF Checking

- **Purpose**
  - **Accept SA's via a single deterministic path**
    - **Ignore all other arriving SA's**
    - **Necessary to prevent SA's from looping endlessly**
- **Problem**
  - **Need to know MSDP topology of Internet**
    - **But, MSDP does not distribute topology data!**
- **Solution**
  - **Use BGP data to *infer* MSDP topology.**
    - **Impact:**
      - **The MSDP topology must follow BGP topology.**
      - **An MSDP peer must *generally* also be an BGP peer.**

SA Message RPF Checking

- RPF Check Rules depend on peering
  - Rule 1: Sending MSDP peer = iBGP peer
  - Rule 2: Sending MSDP peer = eBGP peer
  - Rule 3: Sending MSDP peer != 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.)

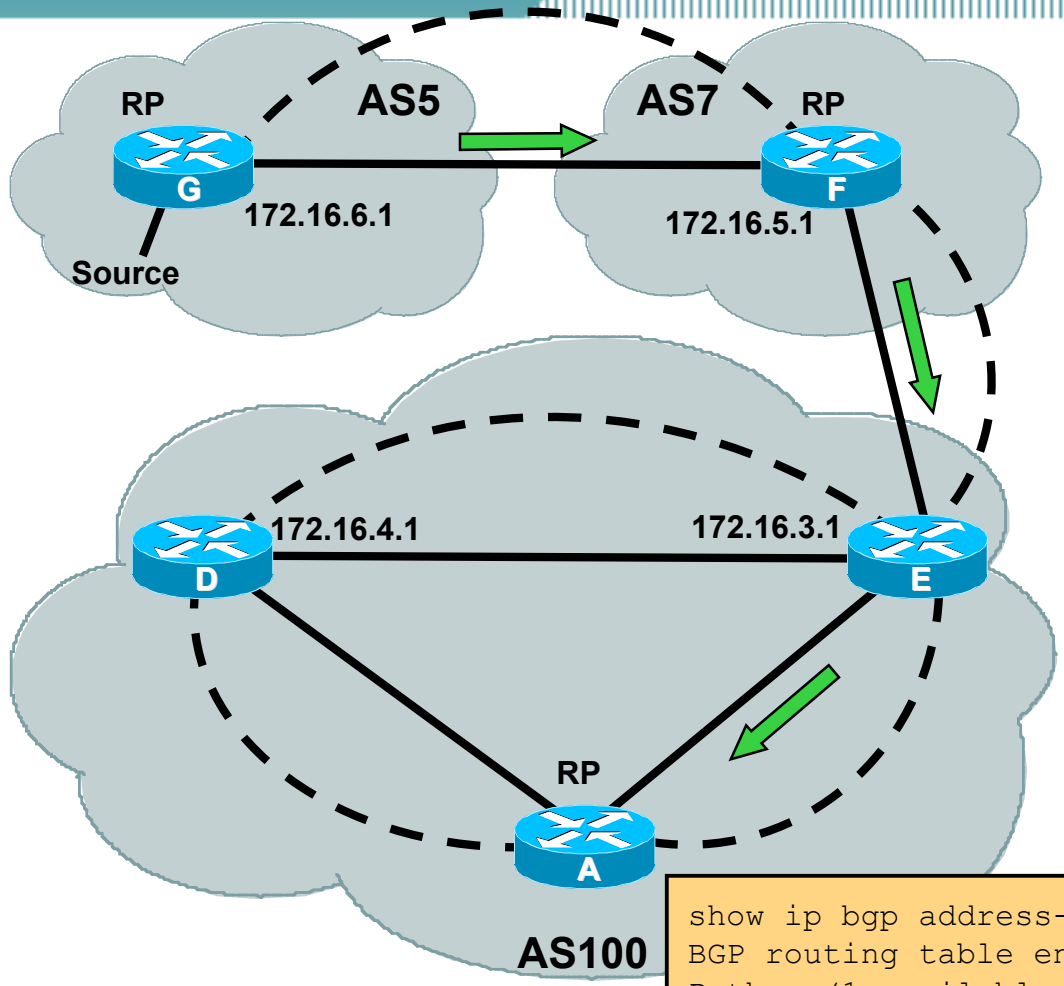
SA Message RPF Checking

- **Determining Applicable RPF Rule**
  - **Use IP address of sending MSDP peer**
    - **Find BGP neighbor w/matching IP address**
    - **IF (no match found)**
      - **Apply Rule 3**
    - **IF (matching neighbor = iBGP peer)**
      - **Apply Rule 1**
    - **ELSE {matching neighbor = eBGP peer}**
      - **Apply Rule 2**
- ***Implication***
  - ***The MSDP peer address must be configured using the same IP address as the BGP peer!***

RPF Check Rule 1

- When MSDP peer = iBGP peer
  - Find "Best Path" to RP in BGP Tables
    - Search M-Table first then U-Table.
    - If no path to Originating RP found, RPF Fails
  - Note "BGP Neighbor" 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!!!*
      - *iBGP 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 Neighbor address?
      - If Yes, RPF Succeeds

Rule1: MSDP peer = iBGP peer



iBGP peer address = 172.16.3.1
(advertising best-path to RP)

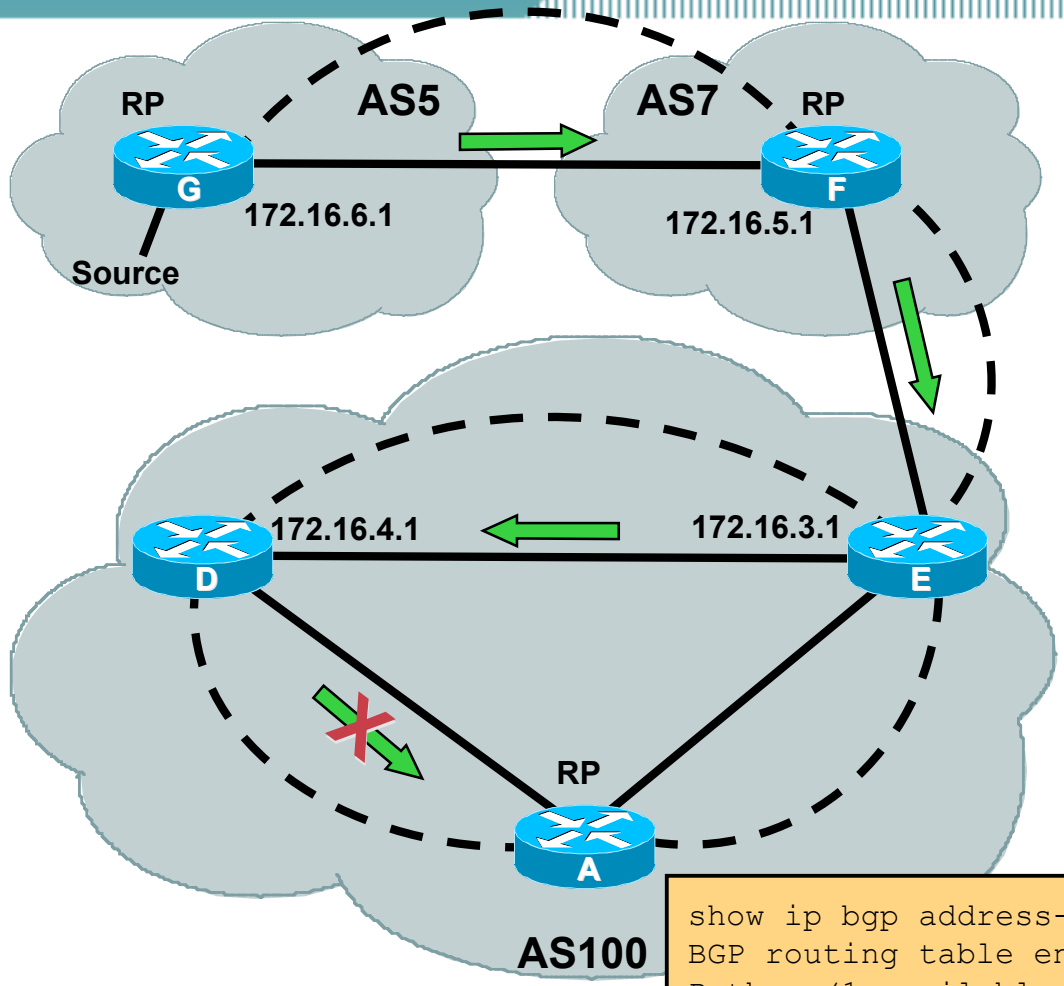
MSDP Peer address = 172.16.3.1

MSDP Peer address = iBGP Peer address

SA RPF Check Succeeds

```
show ip bgp address-family ipv4 multicast 172.16.6.1
BGP routing table entry for 172.16.6.0/24, version 8745118
Paths: (1 available, best #1)
7 5, (received & used)
    172.16.5.1 (metric 68096) from 172.16.3.1 (172.16.3.1)
```

Rule1: MSDP peer = iBGP peer



iBGP Peer address = 172.16.3.1
(advertising best-path to RP)

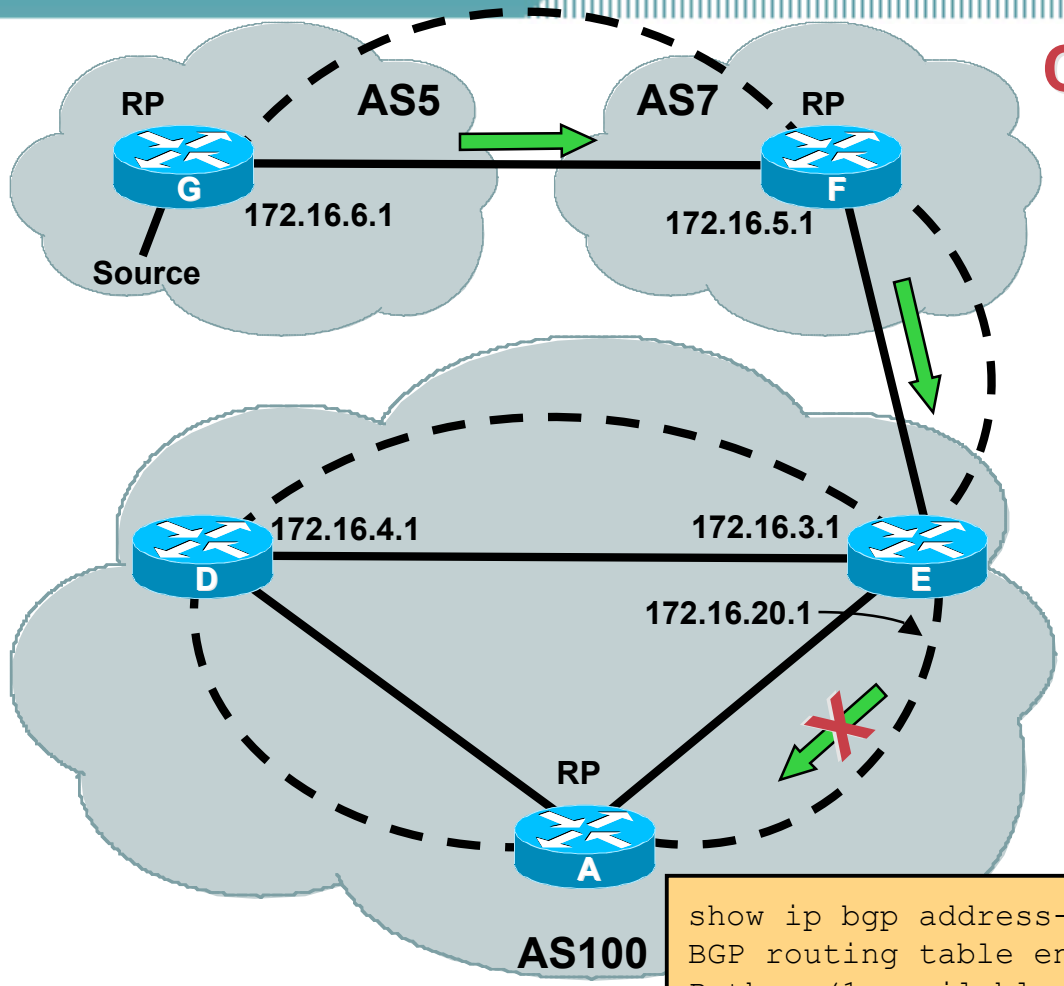
MSDP Peer address = 172.16.4.1

MSDP Peer address != iBGP Peer address

SA RPF Check Fails

```
show ip bgp address-family ipv4 multicast 172.16.6.1
BGP routing table entry for 172.16.6.0/24, version 8745118
Paths: (1 available, best #1)
7 5, (received & used)
    172.16.5.1 (metric 68096) from 172.16.3.1 (172.16.3.1)
```

Rule1: MSDP peer = iBGP peer



Common Mistake #1:

Failure to use same addresses for MSDP peers as iBGP peers!

iBGP Peer address = 172.16.3.1
(advertising best-path to RP)

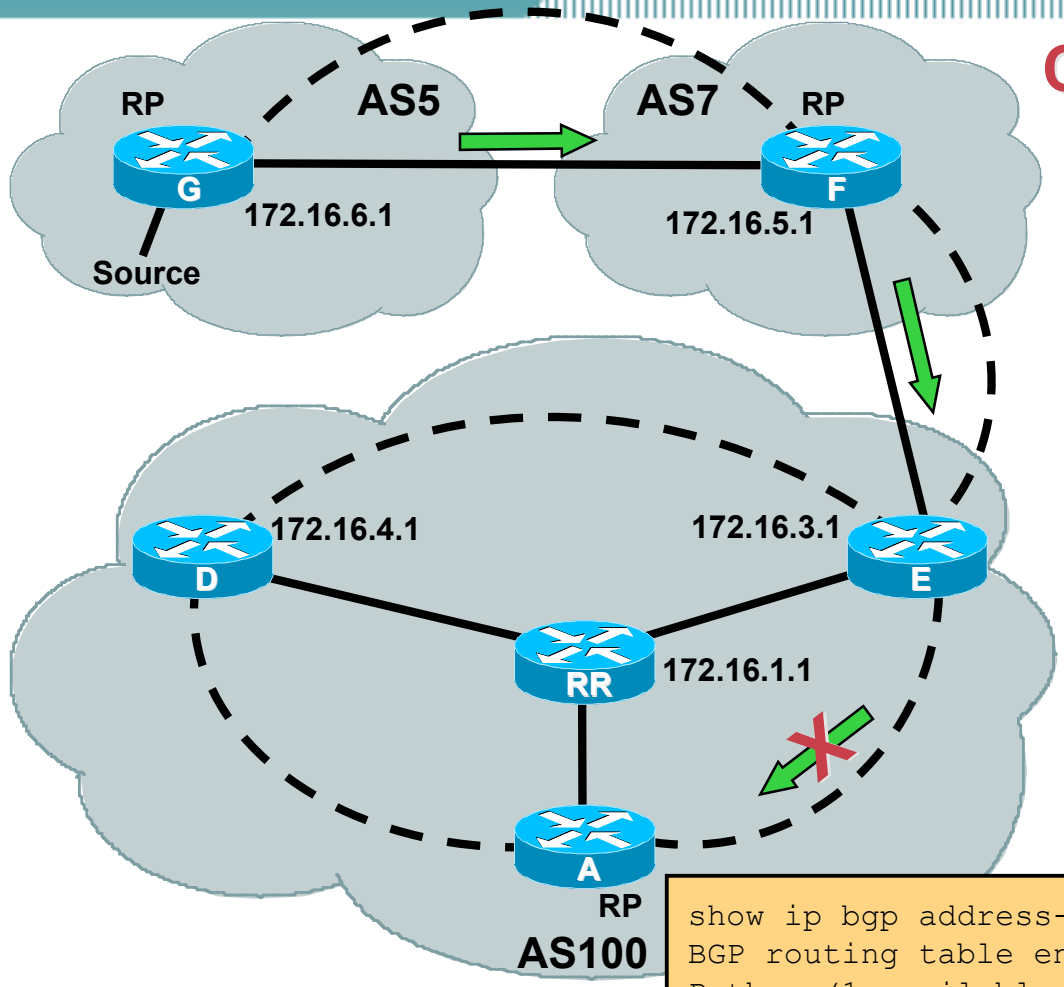
MSDP Peer address = 172.16.20.1

MSDP Peer address != iBGP Peer address

SA RPF Check Fails

```
show ip bgp address-family ipv4 multicast 172.16.6.1
BGP routing table entry for 172.16.6.0/24, version 8745118
Paths: (1 available, best #1)
7 5, (received & used)
    172.16.5.1 (metric 68096) from 172.16.3.1 (172.16.3.1)
```

Rule1: MSDP peer = iBGP peer



Common Mistake #2:

Failure to follow iBGP topology!
Can happen when RR's are used.

iBGP Peer address = 172.16.1.1
(advertising best-path to RP)

MSDP Peer address = 172.16.3.1

MSDP Peer address != iBGP Peer address

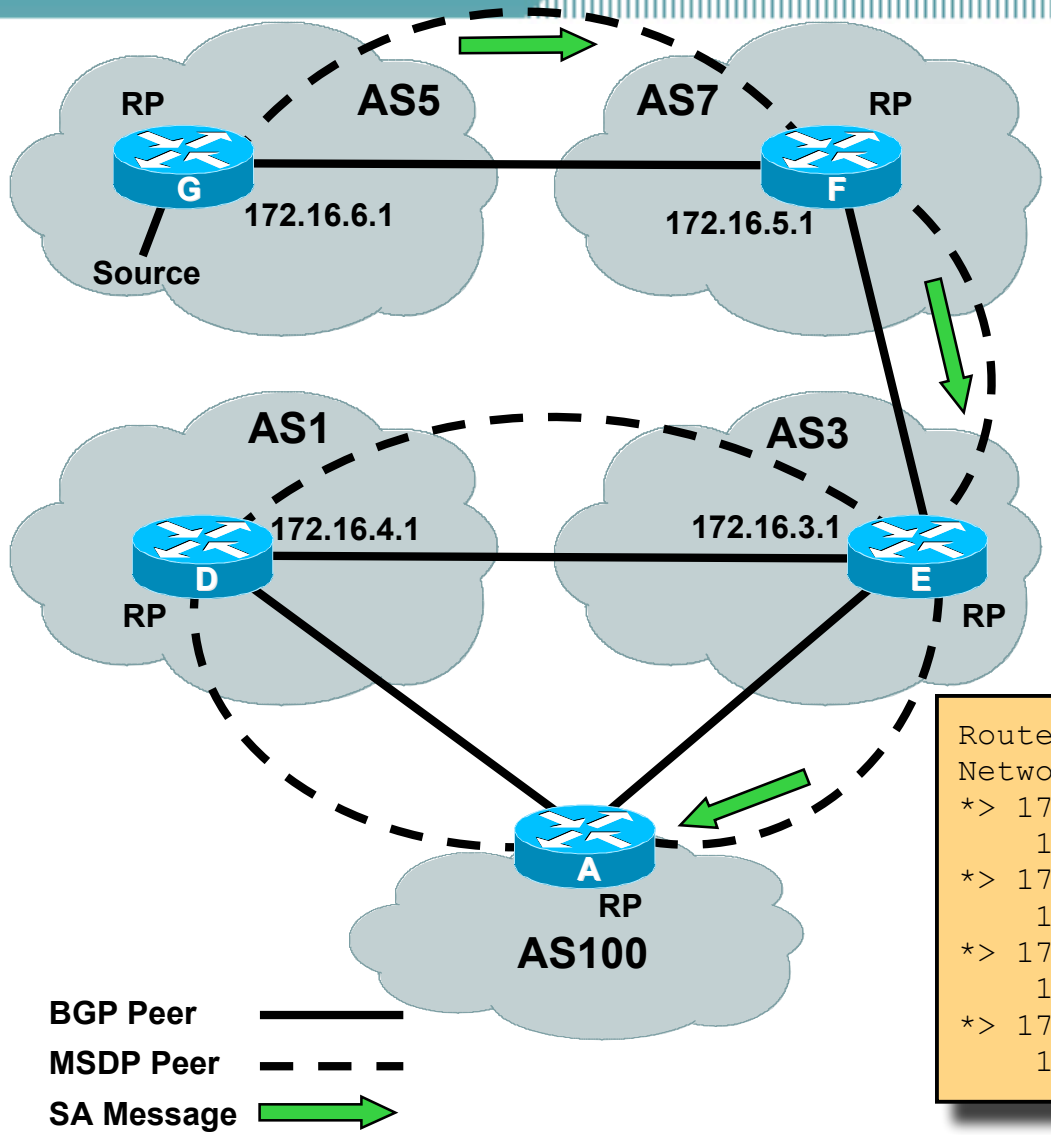
SA RPF Check Fails

```
show ip bgp address-family ipv4 multicast 172.16.6.1
BGP routing table entry for 172.16.6.0/24, version 8745118
Paths: (1 available, best #1)
7 5, (received & used)
    172.16.5.1 (metric 68096) from 172.16.1.1 (172.16.1.1)
```

RPF Check Rule 2

- When MSDP peer = eBGP peer
  - Find BGP "Best Path" to RP
    - Search M-Table first then U-Table.
      - If no path to Originating RP found, RPF Fails
  - Rule 2 Test Condition:
    - First AS in path to the RP = AS of eBGP peer?
      - If Yes, RPF Succeeds

Rule2: MSDP peer = eBGP peer



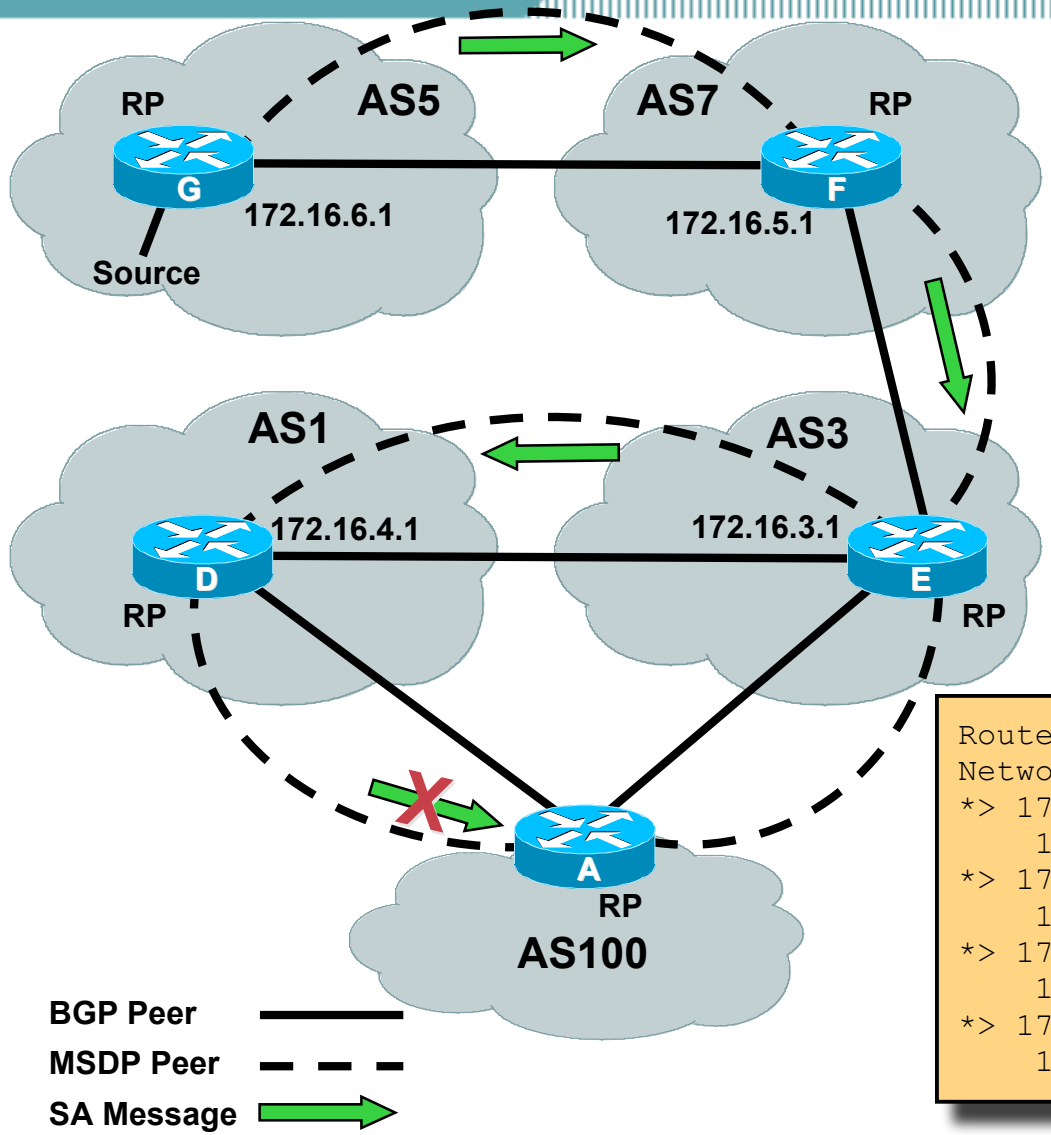
First-AS in best-path to RP = 3
AS of MSDP Peer = 3

First-AS in best-path to RP = AS of eBGP Peer

SA RPF Check Succeeds

```
Router A's ipv4 multicast BGP Table
Network             Next Hop        Path
*> 172.16.3.0/24    172.16.3.1      3 i
    172.16.3.0/24    172.16.4.1     1 3 i
*> 172.16.4.0/24    172.16.4.1      1 i
    172.16.4.0/24    172.16.3.1     3 1 i
*> 172.16.5.0/24    172.16.3.1      3 7 i
    172.16.5.0/24    172.16.4.1     1 3 7 i
*> 172.16.6.0/24    172.16.3.1      3 7 5 i
    172.16.6.0/24    172.16.4.1     1 3 7 5 i
```

Rule2: MSDP peer = eBGP peer



First-AS in best-path to RP = 3
AS of eBGP Peer = 1

First-AS in best-path to RP != AS of eBGP Peer

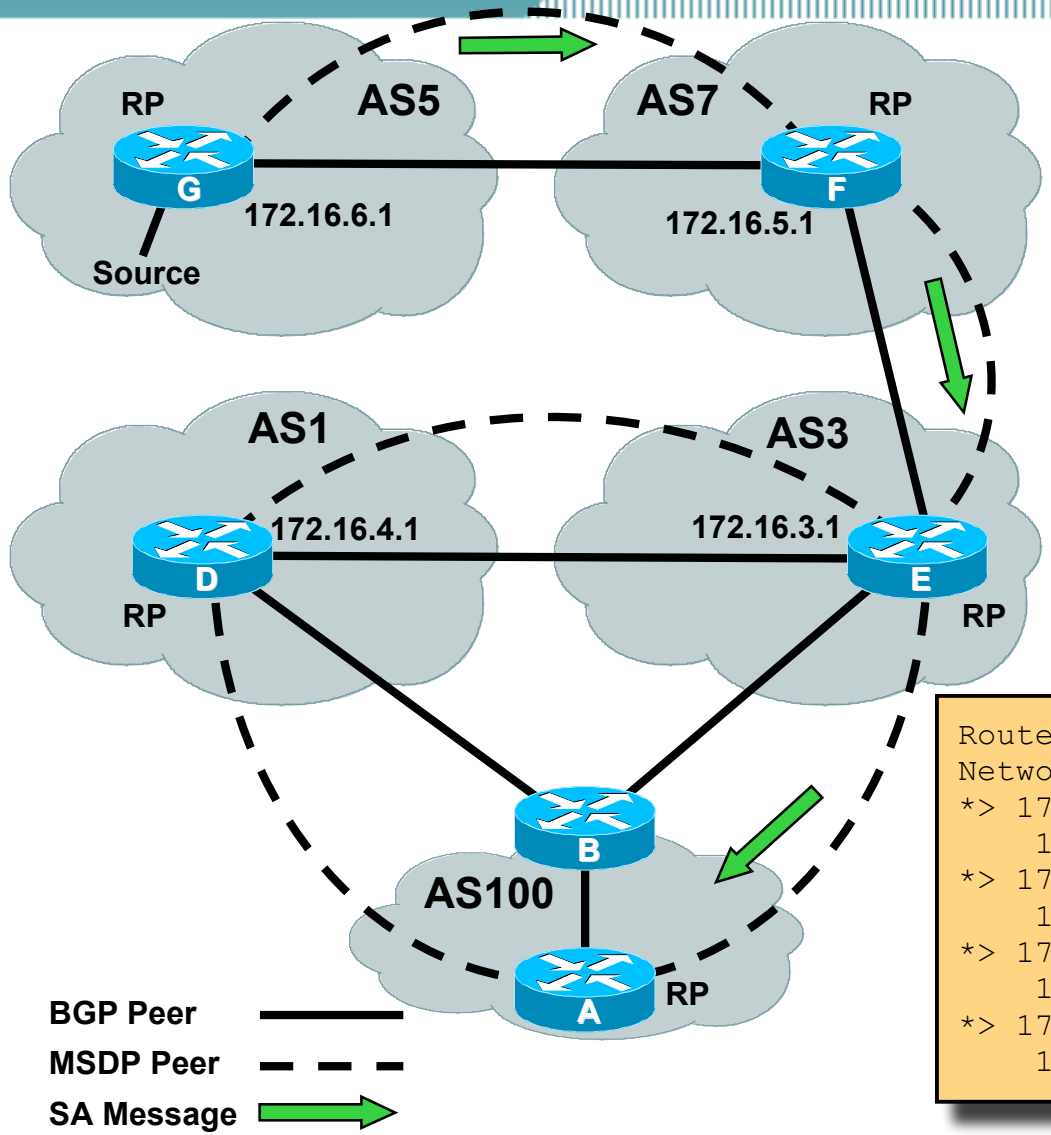
SA RPF Check Fails!

```
Router A's ipv4 multicast BGP Table
Network              Next Hop       Path
*> 172.16.3.0/24     172.16.3.1     3 i
    172.16.3.0/24     172.16.4.1     1 3 i
*> 172.16.4.0/24     172.16.4.1     1 i
    172.16.4.0/24     172.16.3.1     3 1 i
*> 172.16.5.0/24     172.16.3.1     3 7 i
    172.16.5.0/24     172.16.4.1     1 3 7 i
*> 172.16.6.0/24     172.16.3.1     3 7 5 i
    172.16.6.0/24     172.16.4.1     1 3 7 5 i
```

RPF Check Rule 3

- When MSDP peer != BGP peer
  - Find BGP "Best Path" to RP
    - Search M-Table first then U-Table.
      - If no path to Originating RP found, RPF Fails
  - Find BGP "Best Path" to MSDP peer
    - Search M-Table first then U-Table.
      - 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

Rule3: MSDP peer != BGP peer



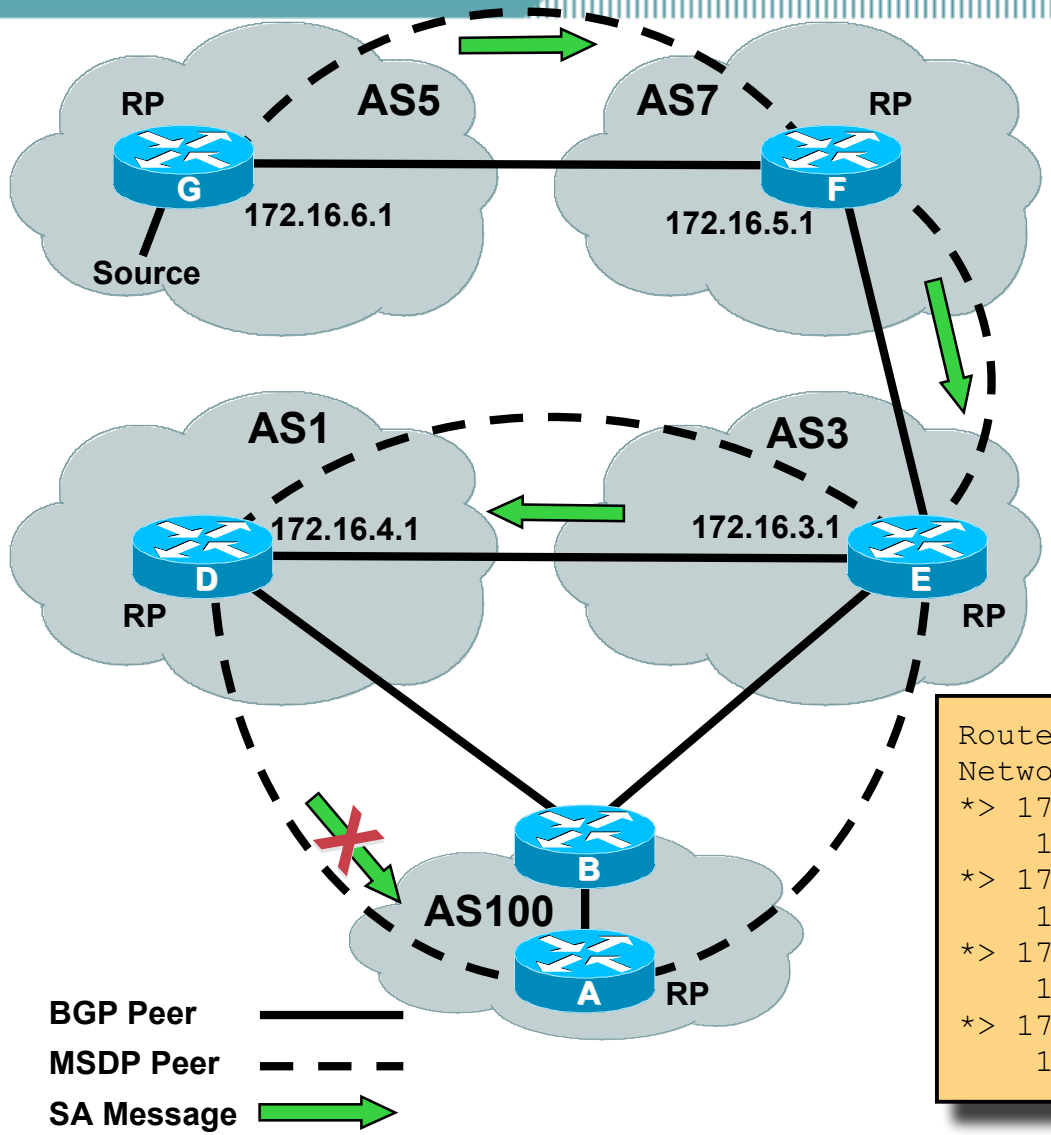
First-AS in best-path to RP = 3
AS of MSDP Peer = 3

First-AS in best-path to RP = AS of MSDP Peer

SA RPF Check Succeeds

```
Router A's ipv4 multicast BGP Table
Network             Next Hop        Path
*> 172.16.3.0/24    172.16.3.1      3 i
    172.16.3.0/24    172.16.4.1     1 3 i
*> 172.16.4.0/24    172.16.4.1      1 i
    172.16.4.0/24    172.16.3.1     3 1 i
*> 172.16.5.0/24    172.16.3.1      3 7 i
    172.16.5.0/24    172.16.4.1     1 3 7 i
*> 172.16.6.0/24    172.16.3.1      3 7 5 i
    172.16.6.0/24    172.16.4.1     1 3 7 5 i
```

Rule3: MSDP peer != BGP peer



First-AS in best-path to RP = 3
AS of MSDP Peer = 1

First-AS in best-path to RP != AS of MSDP Peer

SA RPF Check Fails

```
Router A's ipv4 multicast BGP Table
Network             Next Hop       Path
*> 172.16.3.0/24    172.16.3.1     3 i
    172.16.3.0/24    172.16.4.1     1 3 i
*> 172.16.4.0/24    172.16.4.1     1 i
    172.16.4.0/24    172.16.3.1     3 1 i
*> 172.16.5.0/24    172.16.3.1     3 7 i
    172.16.5.0/24    172.16.4.1     1 3 7 i
*> 172.16.6.0/24    172.16.3.1     3 7 5 i
    172.16.6.0/24    172.16.4.1     1 3 7 5 i
```

Agenda

- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
- MSDP State Flags
- MSDP Enhancements

MSDP Mesh-Groups

- Optimises SA flooding.
  - Useful when 2 or more peers are in a group.
  - Requires full mesh of mesh group peers.
- Reduces amount of SA traffic in the net.
  - SA's not flooded to other mesh-group peers.
- Suspends RPF check of SA messages.
  - When received from a mesh-group peer.
  - SA's always accepted from mesh-group peers.
  - Eliminates need for BGP.

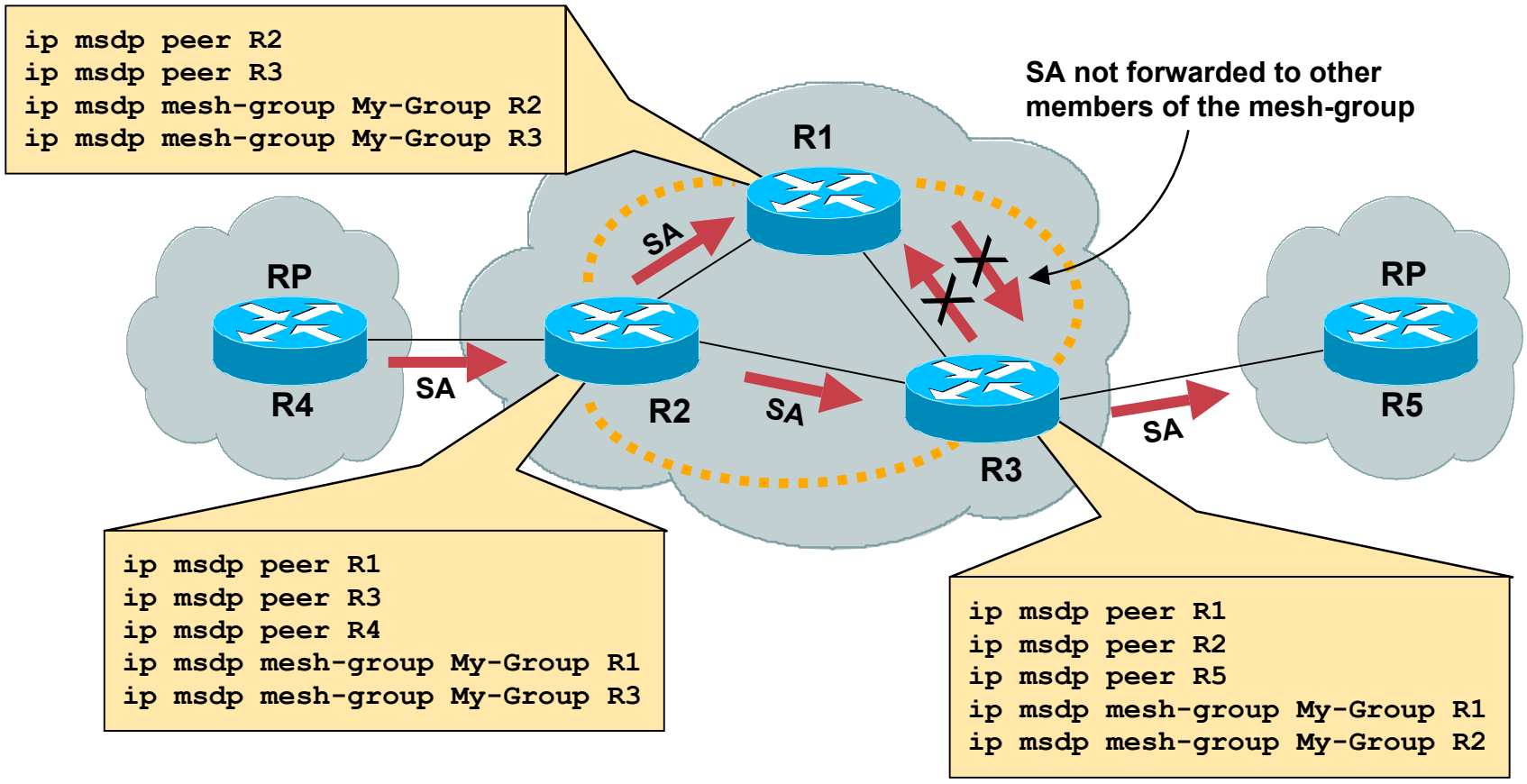
MSDP Mesh-Groups

- **Configured with:**

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

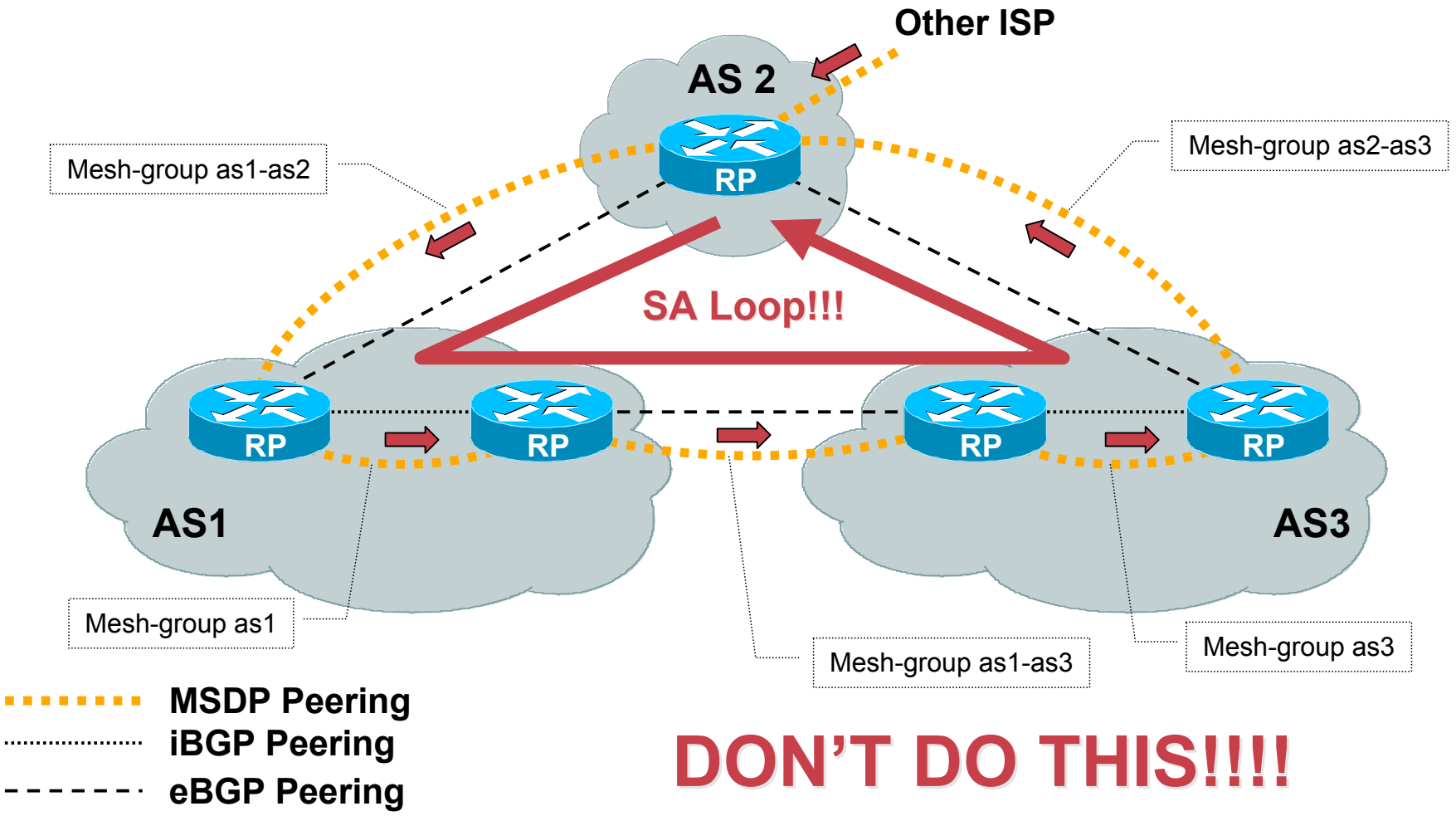
- **Peers in the mesh-group must be fully meshed.**
- **Multiple mesh-groups per router are supported.**

MSDP Mesh-Group Example



Avoid Mesh-Group Loops!!!

WARNING: There is no RPF check between Mesh-groups!!!



DON'T DO THIS!!!!

Agenda

- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
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MSDP Mroute Flags

New ‘mroute’ Flags for MSDP

```
sj-mbone#show ip mroute summary
IP Multicast Routing Table
Flags: D - Dense, S - Sparse, C - Connected, L - Local, P - Pruned
       R - RP-bit set, F - Register flag, T - SPT-bit set, J - Join SPT
       M - MSDP created entry, X - Proxy Join Timer Running
       A - Advertised via MSDP
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 224.2.246.13), 5d17h/00:02:59, RP 171.69.10.13, flags: S
  (171.69.185.51, 224.2.246.13), 3d17h/00:03:29,   flags: TA
  (128.63.58.45, 224.2.246.13), 00:02:16/00:00:43, flags: M
  (128.63.58.54, 224.2.246.13), 00:01:16/00:01:43, flags: M
```

“M” flag indicates source was learned via MSDP

“A” flag indicates source is a *candidate* for advertisement by MSDP

Agenda

- MSDP Overview
- MSDP Peers
- MSDP SA Messages
- MSDP Mesh Groups
- MSDP State Flags
- MSDP Enhancements

MSDP Enhancements

- **New IOS command**

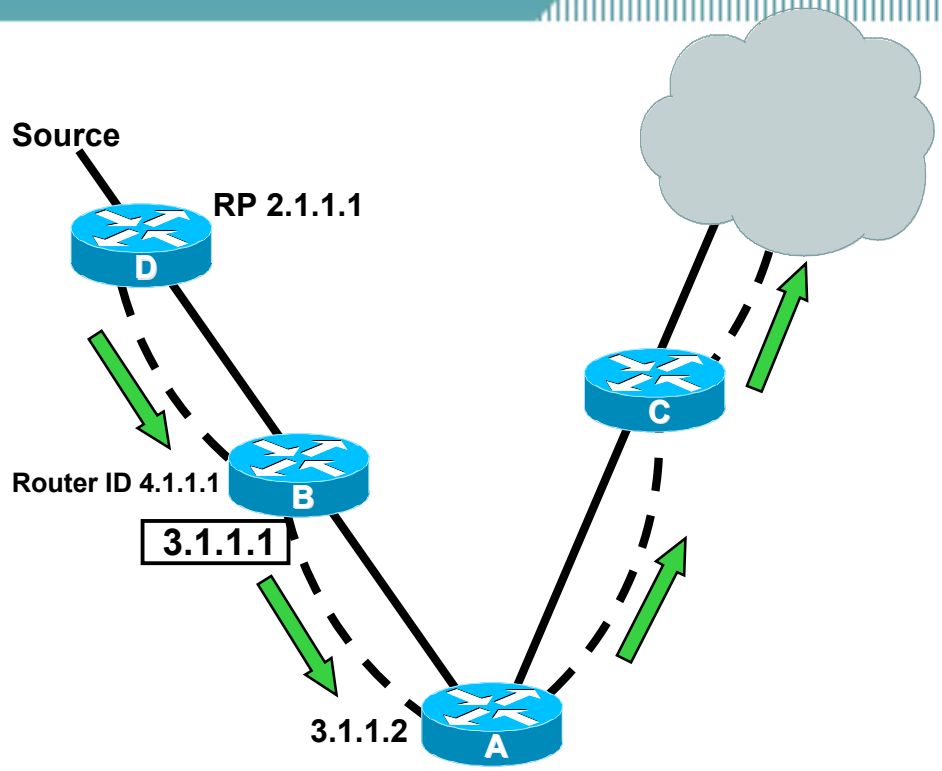
```
ip msdp new-rpf-rules
```

  - **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"**

MSDP RPF check using IGP

- **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.**

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



MSDP Peer = 3.1.1.1

IGP next hop to originating RP = 3.1.1.1

IGP next hop to originating RP = MSDP peer

SA RPF Check Succeeds

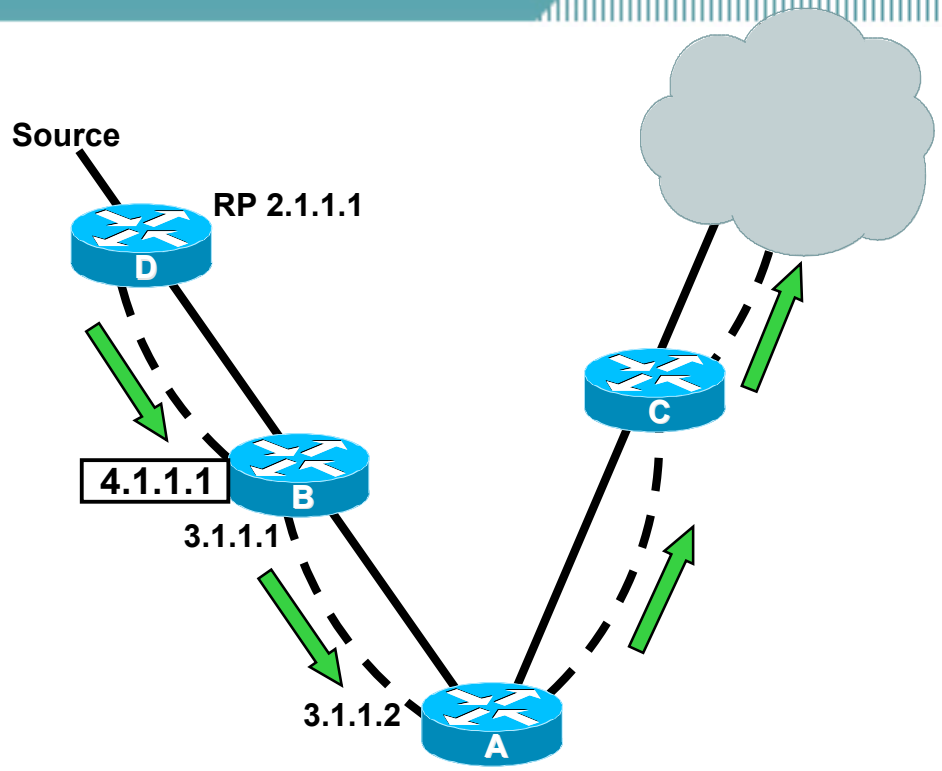
OSPF neighbor

MSDP Peer

SA Message

```
RouterA#show ip route 2.1.1.1
Routing entry for 2.1.1.0/24
  Known via "ospf 1", distance 110, metric 20, type intra area
  Last update from 3.1.1.1 on Ethernet2, 00:35:10 ago
  Routing Descriptor Blocks:
  * 3.1.1.1, from 4.1.1.1, 00:35:10 ago, via Ethernet2
      Route metric is 20, traffic share count is 1
```

IGP Rule: MSDP peer = IGP peer (Advertiser)



MSDP Peer = 4.1.1.1

IGP next hop to originating RP = ~~3.1.1.1~~

IGP advertiser to originating RP = 4.1.1.1

IGP advertiser to originating RP = MSDP peer

SA RPF Check Succeeds

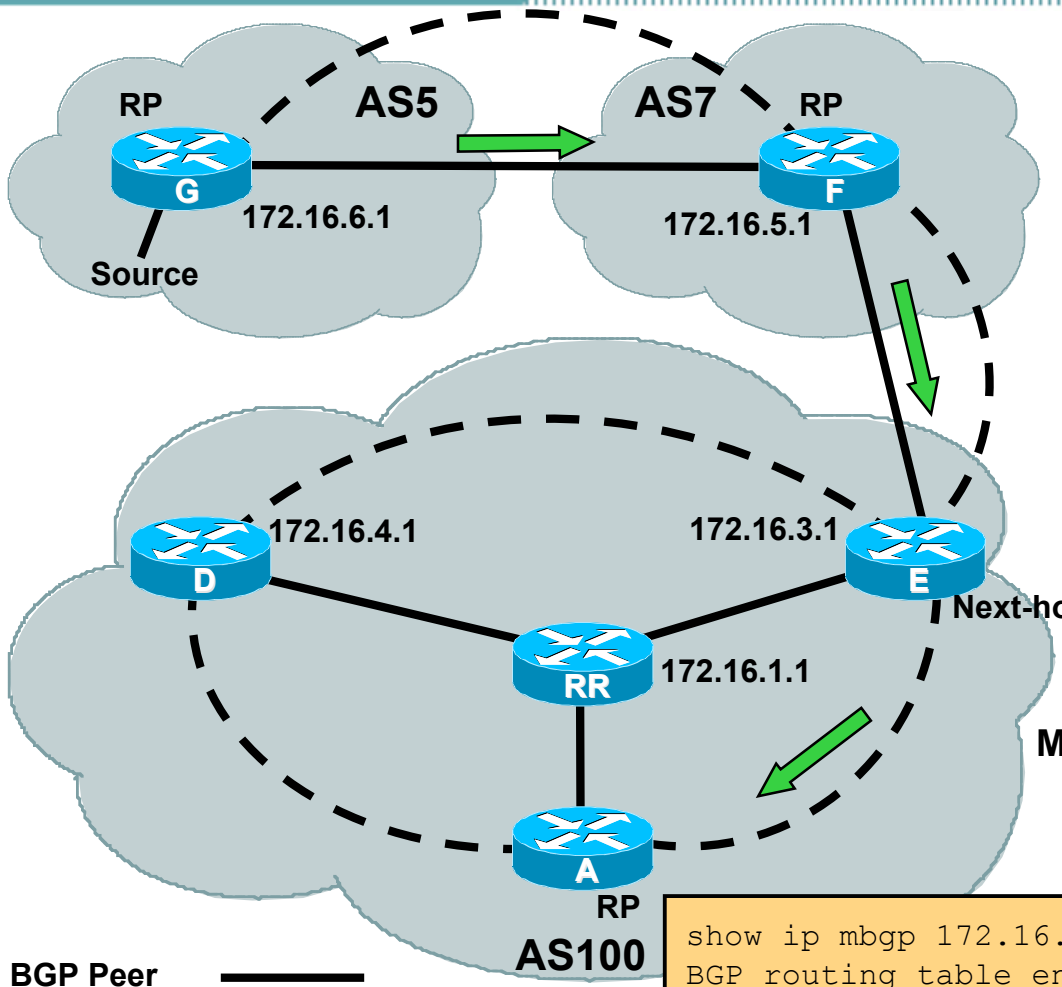
OSPF neighbor

MSDP Peer

SA Message

```
RouterA#show ip route 2.1.1.1
Routing entry for 2.1.1.0/24
  Known via "ospf 1", distance 110, metric 20, type intra area
  Last update from 3.1.1.1 on Ethernet2, 00:35:10 ago
  Routing Descriptor Blocks:
  * 3.1.1.1, from 4.1.1.1, 00:35:10 ago, via Ethernet2
      Route metric is 20, traffic share count is 1
```

SA's accepted from Next Hop



i(m)BGP Peer address = 172.16.1.1
(Advertiser of next hop)

MSDP Peer address = 172.16.3.1

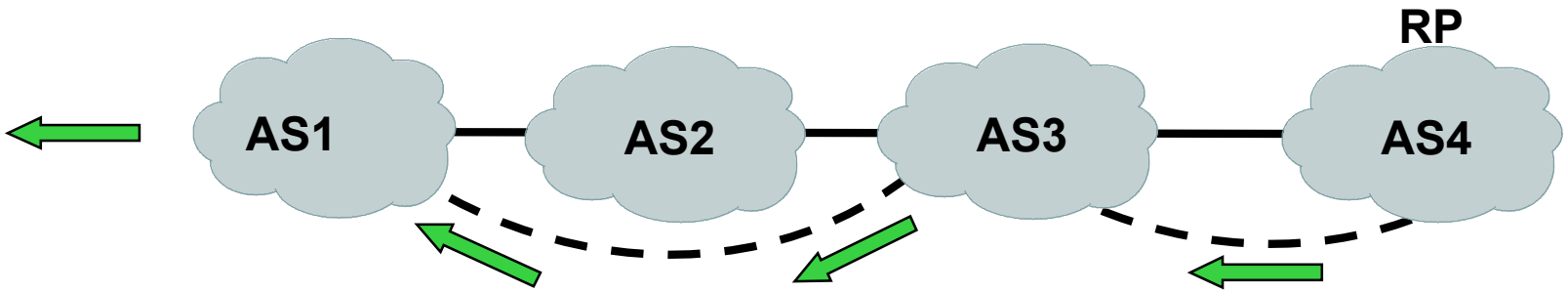
But, BGP next hop = 172.16.3.1

MSDP Peer address = BGP next hop address

SA RPF Check Succeeds

```
show ip mbgp 172.16.6.1
BGP routing table entry for 172.16.6.0/24, version 8745118
Paths: (1 available, best #1)
7 5, (received & used)
    172.16.3.1 (metric 68096) from 172.16.1.1 (172.16.1.1)
```

Accept SA along RPF path



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

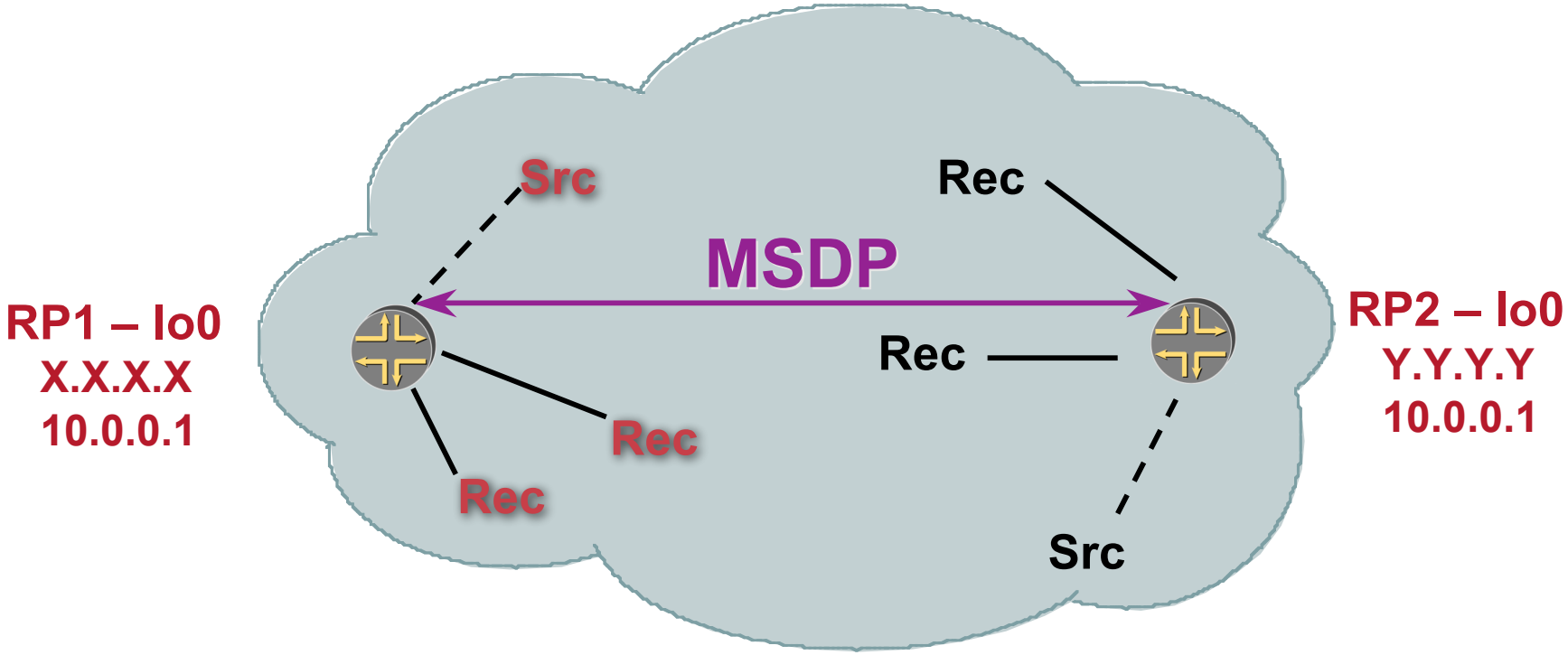
New MSDP RPF command


```
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)
```

Anycast-RP

- draft-ietf-mboned-anycast-rp-08.txt
- Within a domain, deploy more than one RP for the same group range
- Sources from one RP are known to other RPs using MSDP
- Give each RP the same /32 IP address
- Sources and receivers use closest RP, as determined by the IGP
- Used intra-domain to provide redundancy and RP load sharing, when an RP goes down, sources and receivers are taken to new RP via unicast routing
  - Fast convergence!

Anycast-RP



Anycast-RP