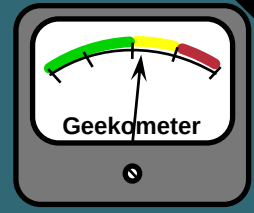
Deploying IP Multicast

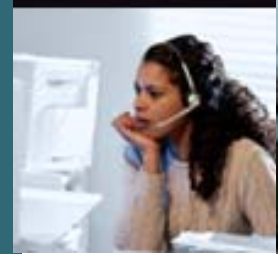
Session RST-2261

Agenda

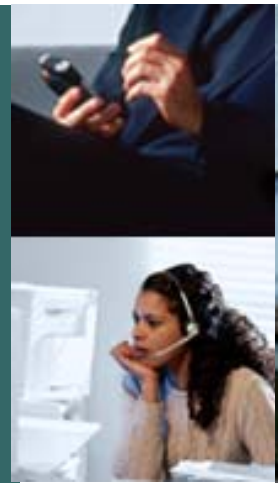


- **Basic Multicast Engineering**
  - **Which Mode: ASM, SSM, Bidir?**
  - **PIM Configuration Steps**
  - **RP Engineering**
  - **QoS Notes**
- **Advanced Multicast Engineering**
  - **Addressing for Admin. Scoped Zones**
  - **Scoping Using Auto-RP, Listener, and Boundaries**
  - **Load Balance via RP**
  - **SSM Mapping**

Basic
Multicast Engineering



Which Mode: ASM, SSM, Bidir?



PIM Sparse Mode Categories

- **Any Source Multicast (ASM)**
  - **Original (Classic) PIM-SM**
  - **Supports both Shared and Source Trees**
- **Single Source Multicast (SSM)**

  aka Source Specific Multicast
  - **Supports only Source Trees**
    - **No need for RP's, RP Failover, etc.**
- **Bidirectional PIM (Bidir)**
  - **Supports only Shared Trees**

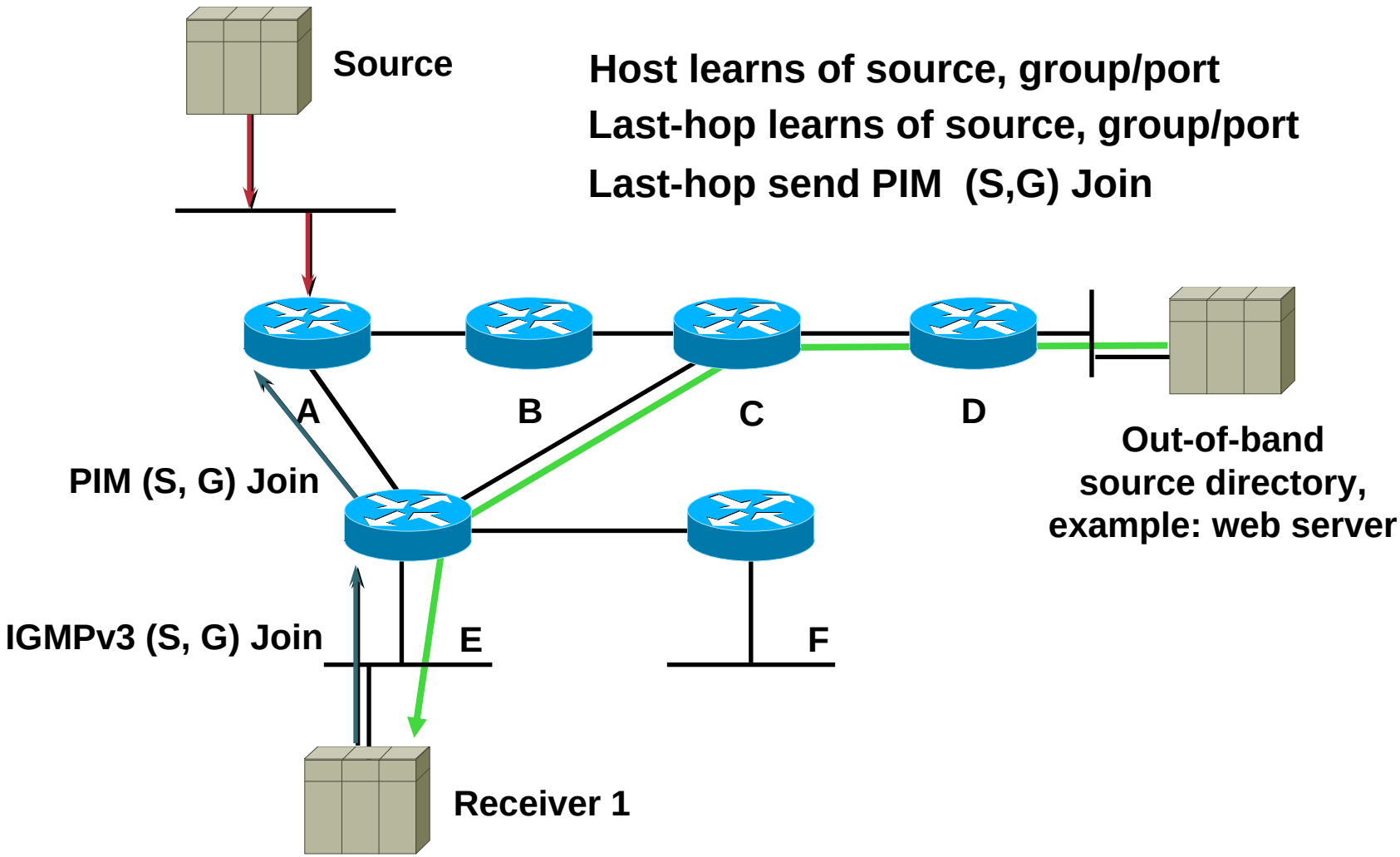
Any Source Multicast (ASM)

- **Classic (original) PIMv2 Sparse Mode**
  - **Defined in RFC 2362**
- **Requires a Rendezvous Point (RP)**
  - **RP and Shared Tree used for Source Discovery**
  - **Need some form of RP Failover mechanism**
  - **Shared to Source Tree switchover complexities**
- **General Purpose Multicast**
  - **Generally works well for most limited multicast applications.**

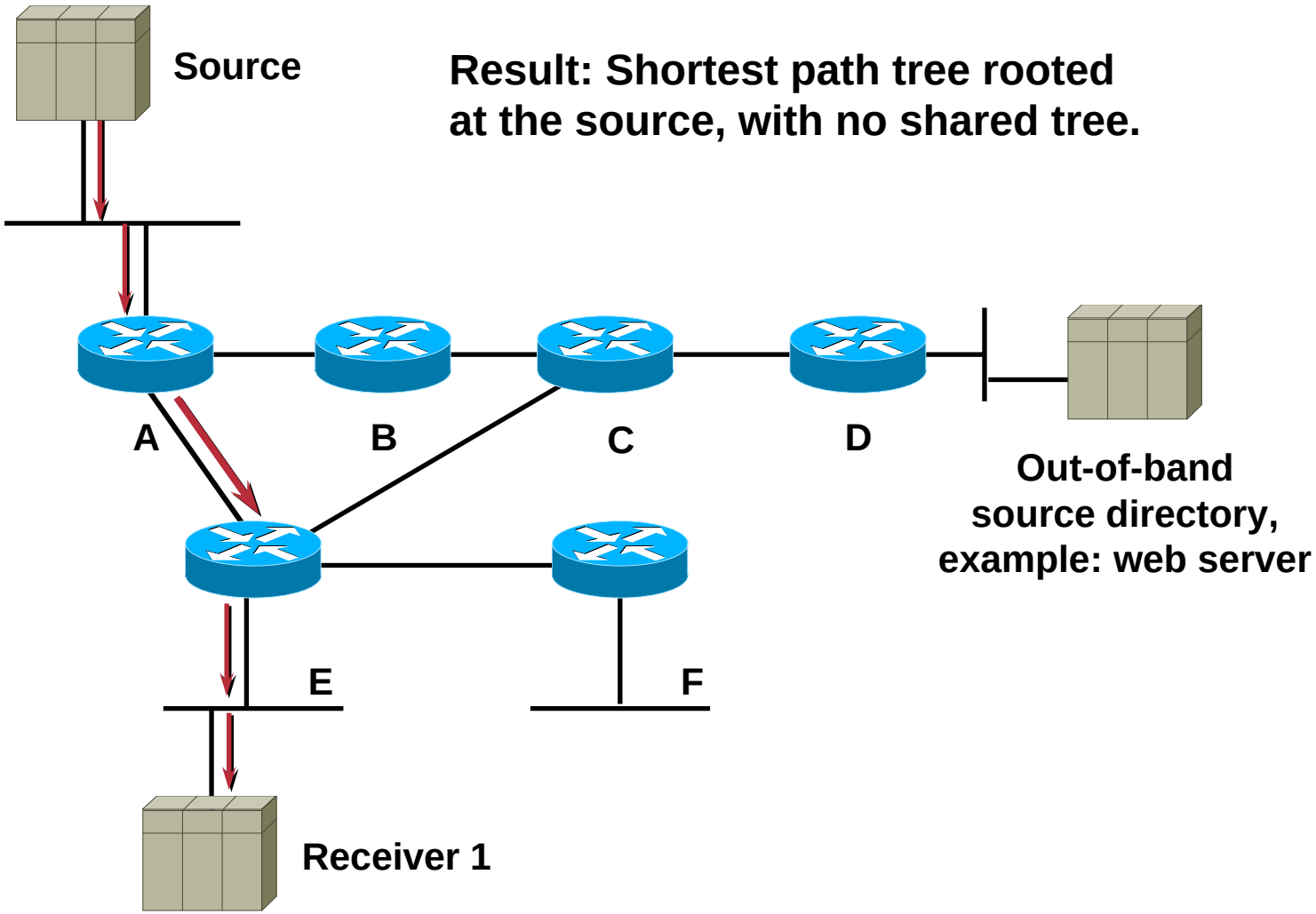
Source-Specific Multicast (SSM)

- **Well suited for One-to-Many Model.**
  - **Examples: IPTV, Stock Tickers**
- **Hosts responsible for learning (S,G) information.**
  - **Host uses IGMPv3 to join specific (S,G) instead of (*,G).**
- **Last-hop router sends (S,G) join toward source**
  - ***No RPs or Shared Trees.***
    - **Eliminates possibility of Capt. Midnight Content Jammers.**
    - **Only specified (S,G) flow is delivered to host.**
    - **Eliminates need for MSDP.**
- **Simplifies address allocation.**
  - **Different content sources can use same group without fear of interfering with each other.**

SSM Example



SSM Example



SSM – Summary

- **Uses Source Trees only.**
  - **Hosts are responsible for source & group discovery.**
  - **Hosts must use IGMPv3 to signal 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.**

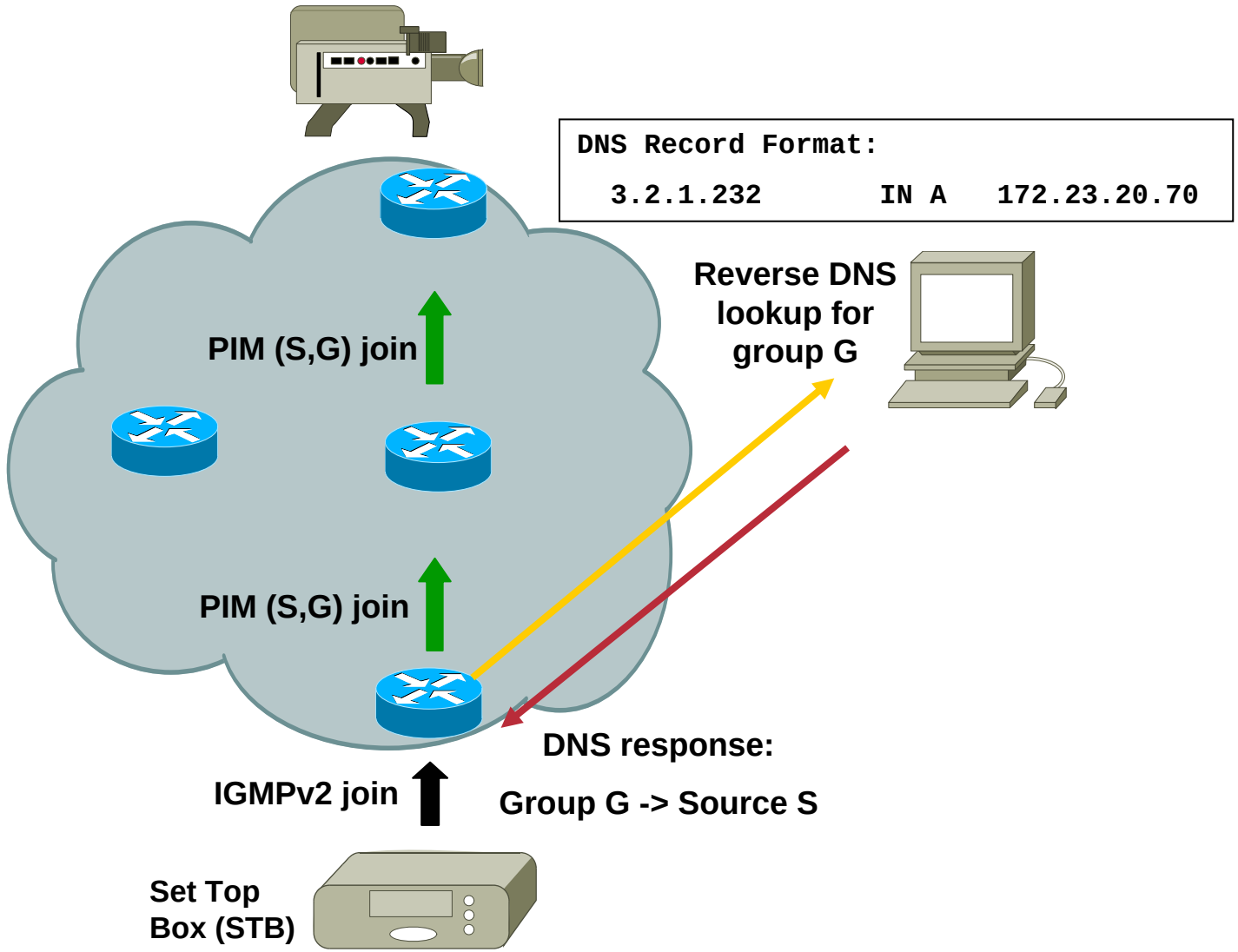
So where is SSM?

- **Dependant on IGMPv3**
  - **Microsoft supports IGMPv3 in Windows XP natively**
  - **Many IPTV STB's are adding support.**
- **Workaround**
  - **Static Source Mapping**
    - **Router maps IGMPv2 Joins in SSM range to well-known sources via DNS or static configuration**

SSM Mapping

- Allows only for one, or more, sources per Group
- Router maps group to source (sources)
  - Uses either DNS or static internal database
    - DNS method allows content providers to provide the mapping
    - DNS Method independent from network operators

SSM Mapping – DNS Example



Bidirectional (Bidir) PIM

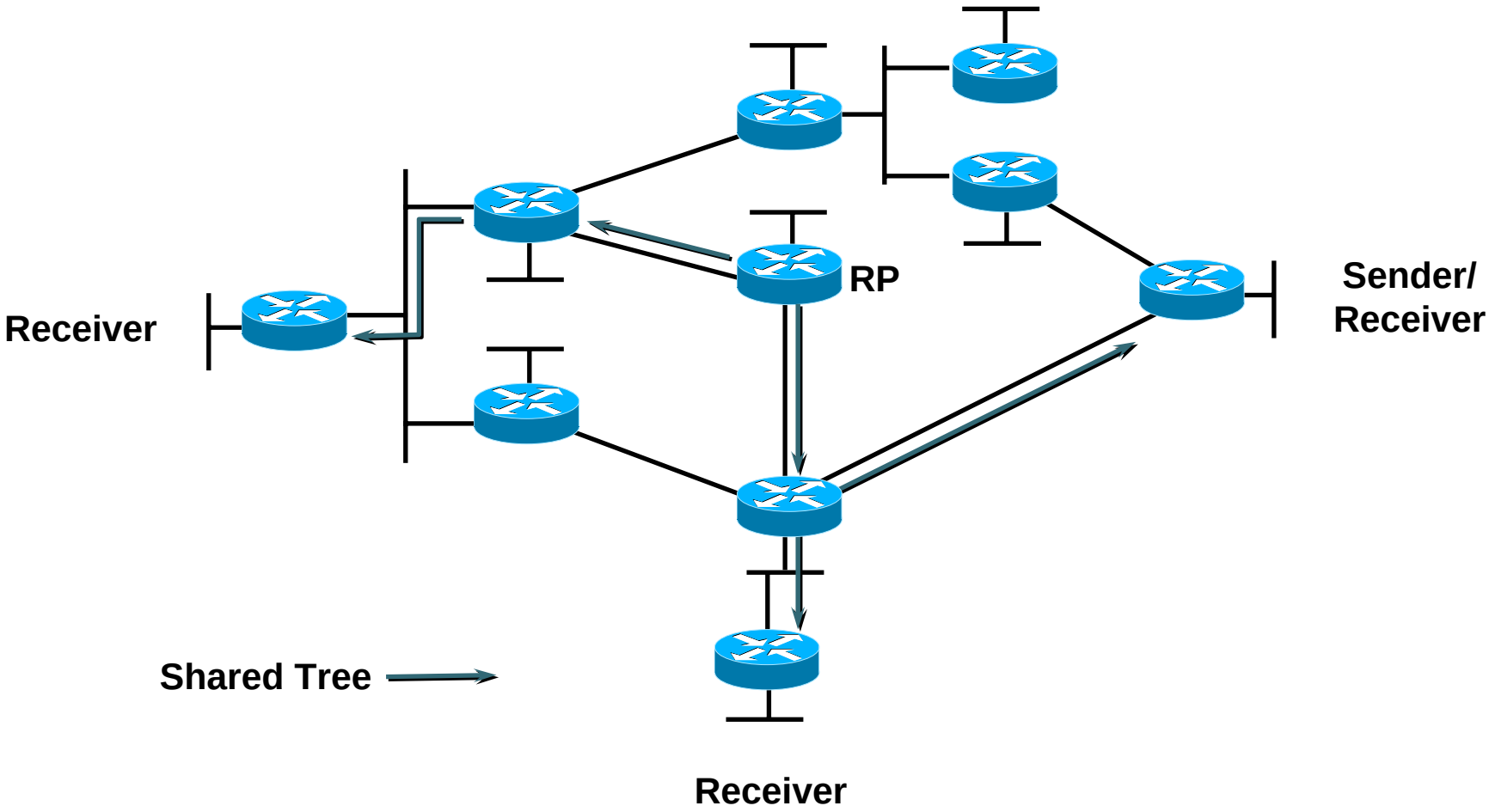
Bidirectional PIM (Bidir)

- **Many-to-Any State problem.**
  - **Large number of sources creates huge (S,G) state problem.**
- **Bidir PIM:**
  - **Use a *bidirectional* Shared Tree to deliver traffic *from* sources to the RP and all other receivers.**
- **Benefits:**
  - **Data and Control Planes decoupled**
  - **Less state in routers**
    - **Only (*, G) state is used. (No Source Trees.)**
    - **Source traffic follows the Shared Tree.**
      - **Flows up the Shared Tree to reach the RP.**
      - **Flows down the Shared Tree to reach all other receivers.**

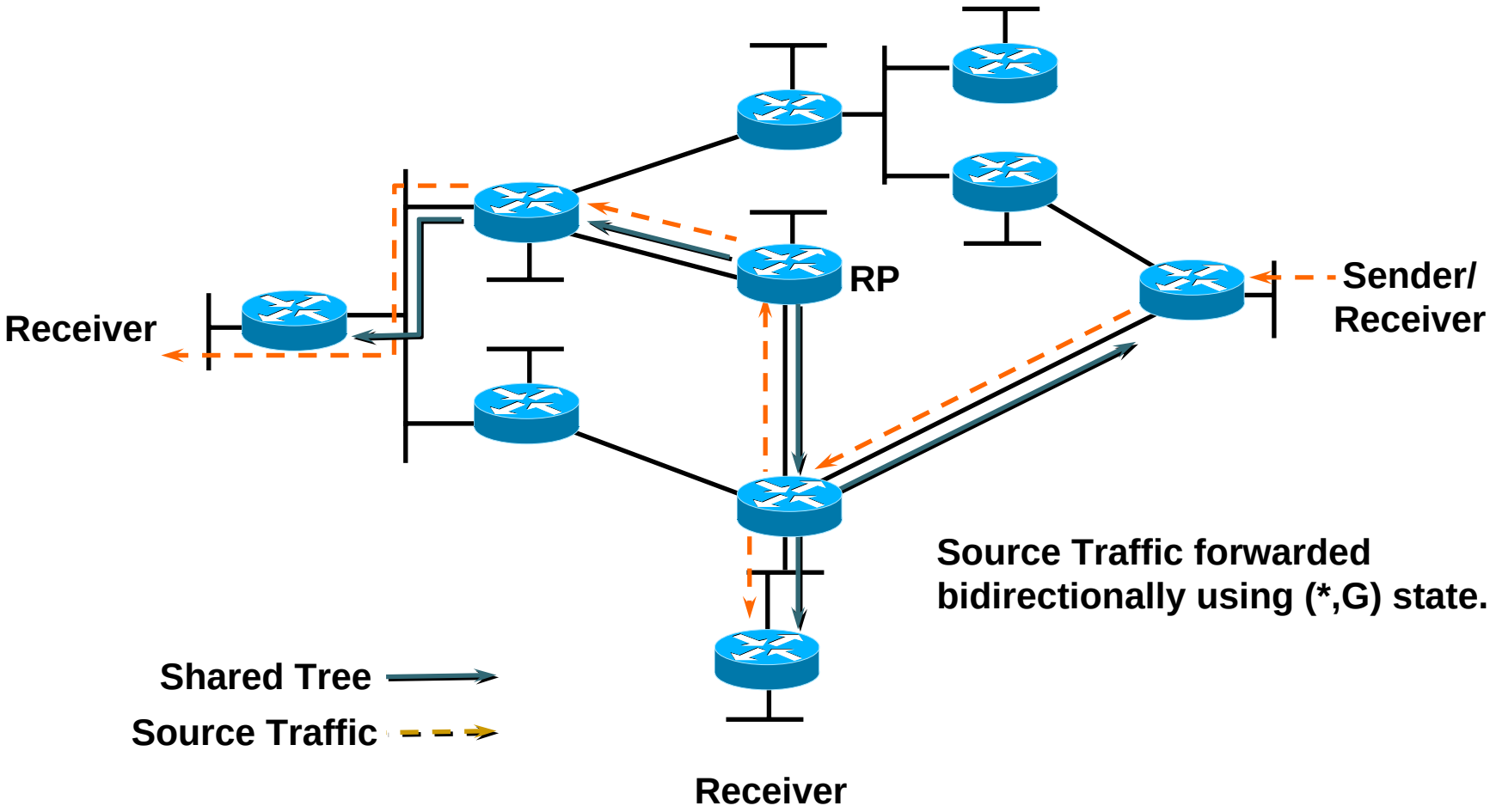
Bidirectional PIM (Bidir)

- **Bidirectional Shared-Trees**
  - **Contrary to SM (*,G) RPF rules**
    - **Traffic often accepted on *outgoing* interfaces.**
    - **Care must be taken to avoid multicast loops**
  - **Requires a Designated Forwarder (DF)**
    - **Election based on the routing metric to the RP**
    - **1 DF per RP per vlan**
    - **Responsible for forwarding traffic up Shared Tree**
      - **DF's will accept data on the interfaces in their OIL.**
      - **Then send it out all other interfaces. (Including the IIF.)**

Bidir PIM – Example



Bidir PIM – Example



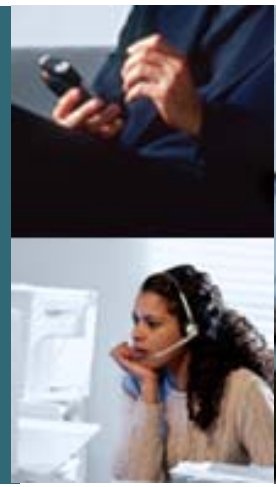
Bidir PIM – Summary

- **Drastically reduces network mroute state**
  - **Eliminates ALL (S,G) state in the network**
    - **SPT's between sources to RP eliminated.**
    - **Source traffic flows both up and down Shared Tree.**
  - **Allows Many-to-Any applications to scale.**
    - **Permits virtually an unlimited number of sources.**
- **Reduces protocol complexity.**
  - **No Source Registration.**
  - **No SPT-Switchover.**

Which Mode – ASM, SSM, Bidir

- **Use SSM**
  - **For One-to-Many applications**
    - **Eliminates need for RP Engineering.**
    - **Greatly simplifies network.**
- **Use Bidir**
  - **For Many-to-Many | Few applications**
    - **Drastically reduces total (S,G) state in network.**
- **Use ASM (Classic PIM-SM)**
  - **For all other general purpose applications**

Some Generic Configuration Notes

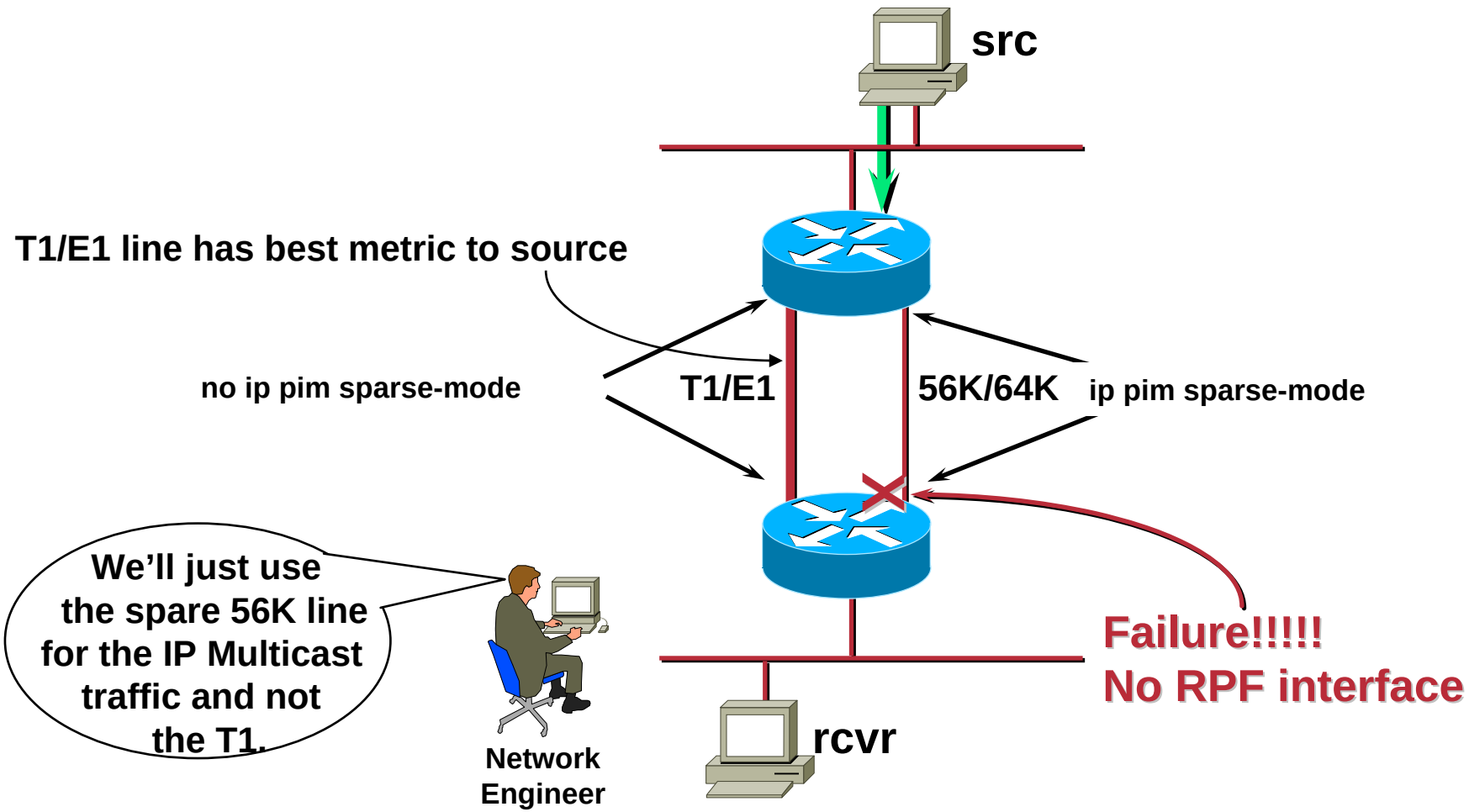


PIM Configuration Steps

- Enable Multicast Routing on every router
- Configure every interface for PIM
- Highly consider Anycast-RP & MSDP
- Configure the RP for ASM/Bidir Groups
  - Using Auto-RP or BSR
    - Configure certain routers as Candidate RP(s)
    - All other routers automatically learn elected RP
  - Static RP addressing
    - RP address must be configured on every router

Configure PIM on Every Interface

Classic Partial Multicast Cloud Mistake #1

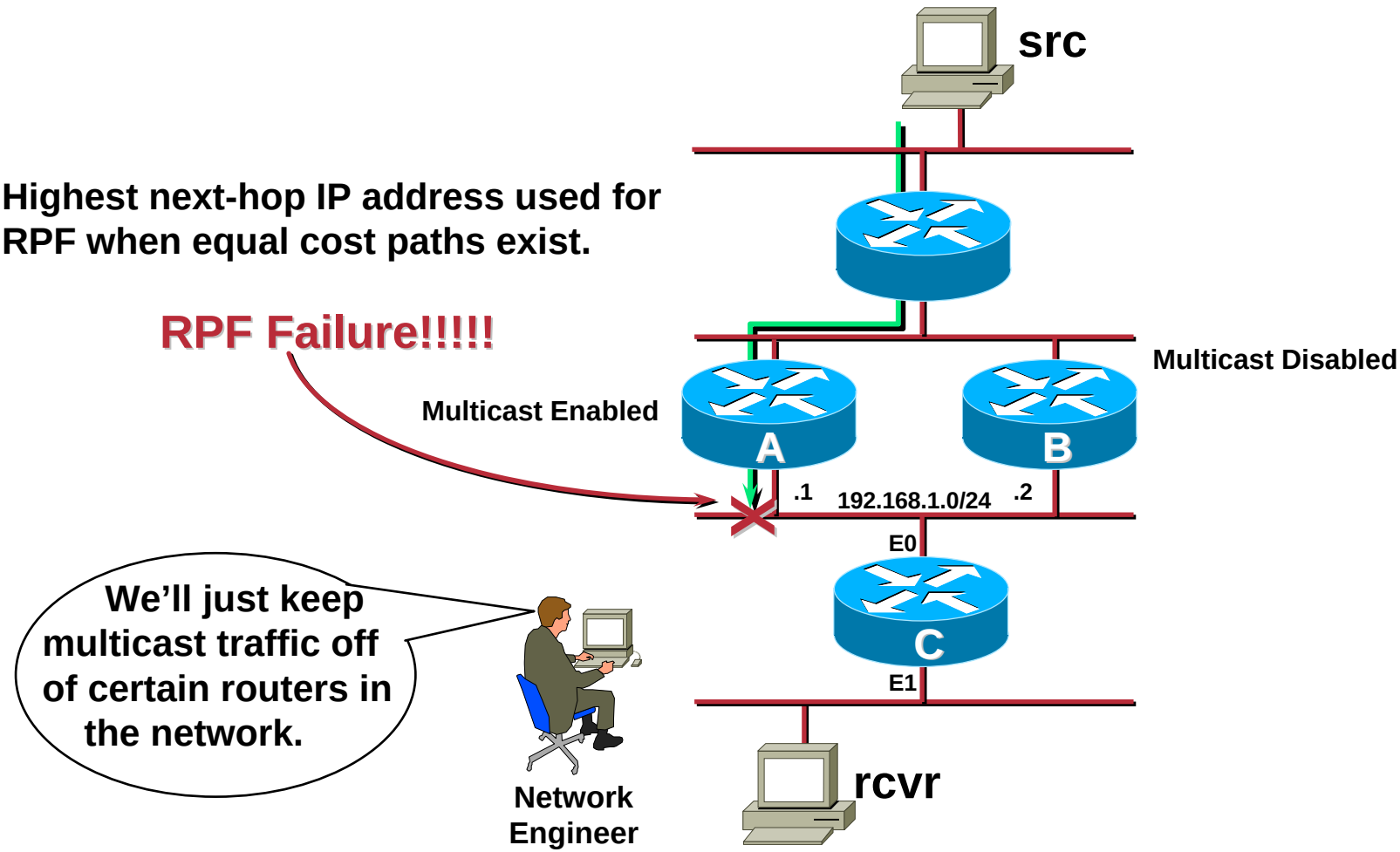


Configure PIM on Every Router

Classic Partial Multicast Cloud Mistake #2

Highest next-hop IP address used for RPF when equal cost paths exist.

RPF Failure!!!!!



Group Mode vs. Interface Mode

- **Group & Interface mode are independent.**
  - **Interface Mode**
    - **Determines how the interface operates when sending/receiving multicast traffic.**
  - **Group Mode**
    - **Determines whether the group is Sparse or Dense.**

Group Mode

- Group mode is controlled by local RP info
  - Local RP Information
    - Stored in the Group-to-RP Mapping Cache
    - May be statically configured or learned via Auto-RP or BSR
  - If RP info exists, Group = Sparse
  - If RP info does not exist, Group = Dense
    - Trivia moment; if dm-fallback is enabled there will be a default 0.0.0.0 RP address
  - Mode Changes are automatic.
    - i.e. if RP info is lost, Group falls back to Dense.

Configuring Interface Mode

- **Interface Mode Configuration Commands**
  - **Enables multicast forwarding on the interface.**
  - **Controls the *interface's* mode of operation.**

`ip pim sparse-mode`

- **Interface mode is set to Sparse mode operation.**
  - **Auto-RP groups can be an exception.**

`ip pim sparse-dense-mode`

- **Interface mode is determined by the Group mode.**
  - **If Group is Dense, interface operates in Dense mode.**
  - **If Group is Sparse, interface operates in Sparse mode.**

`ip pim dense-mode`

- **Interface mode is set to Dense mode operation.**

IGMP “static-join” vs. “join-group”

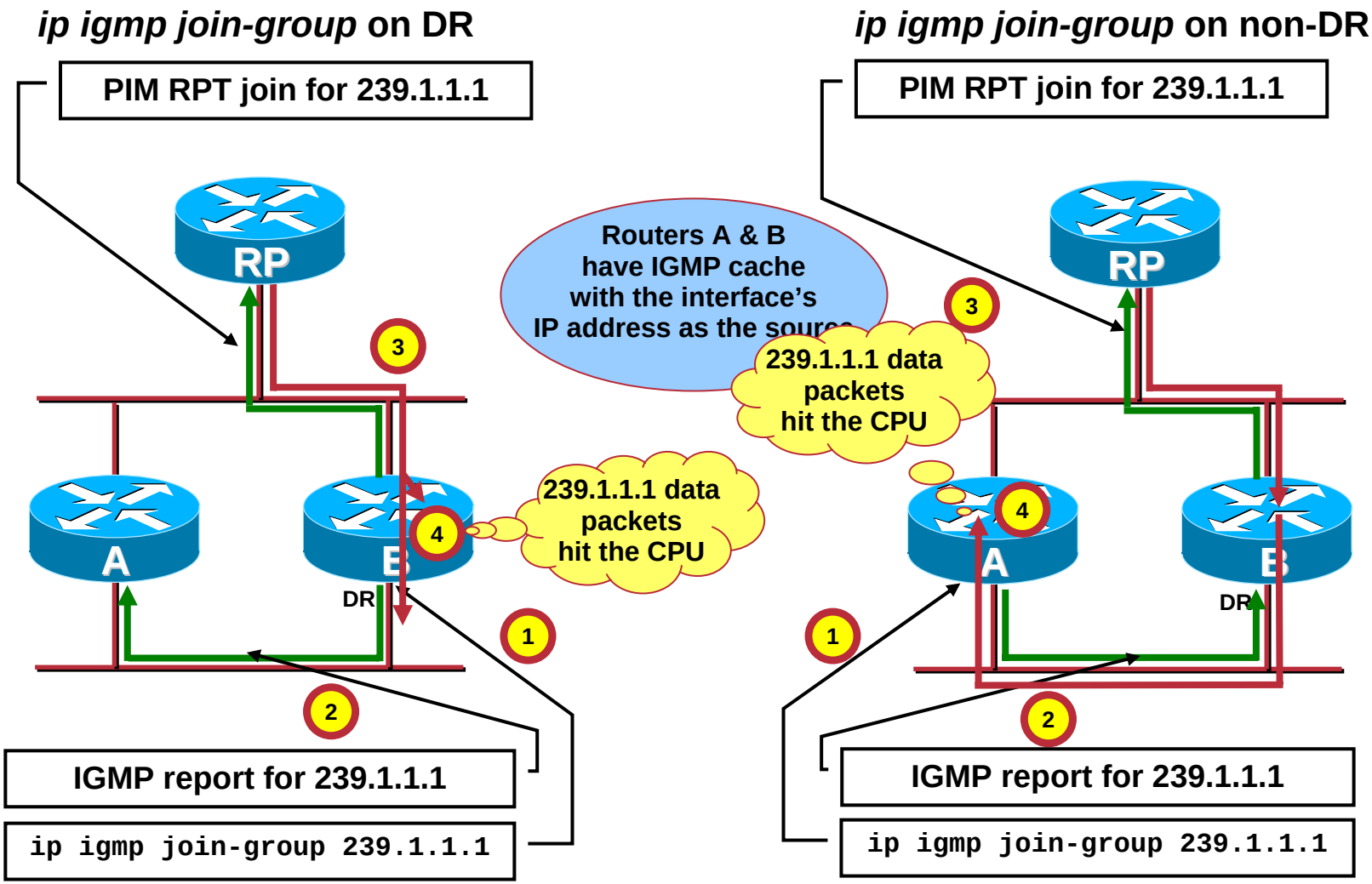
`ip igmp join-group <group-address>`

- Populates IGMP cache
- Sends IGMP report
- Results in
  - PIM RPT join from the DR (may not be this router)
  - CPU receives data, *usually a bad thing*

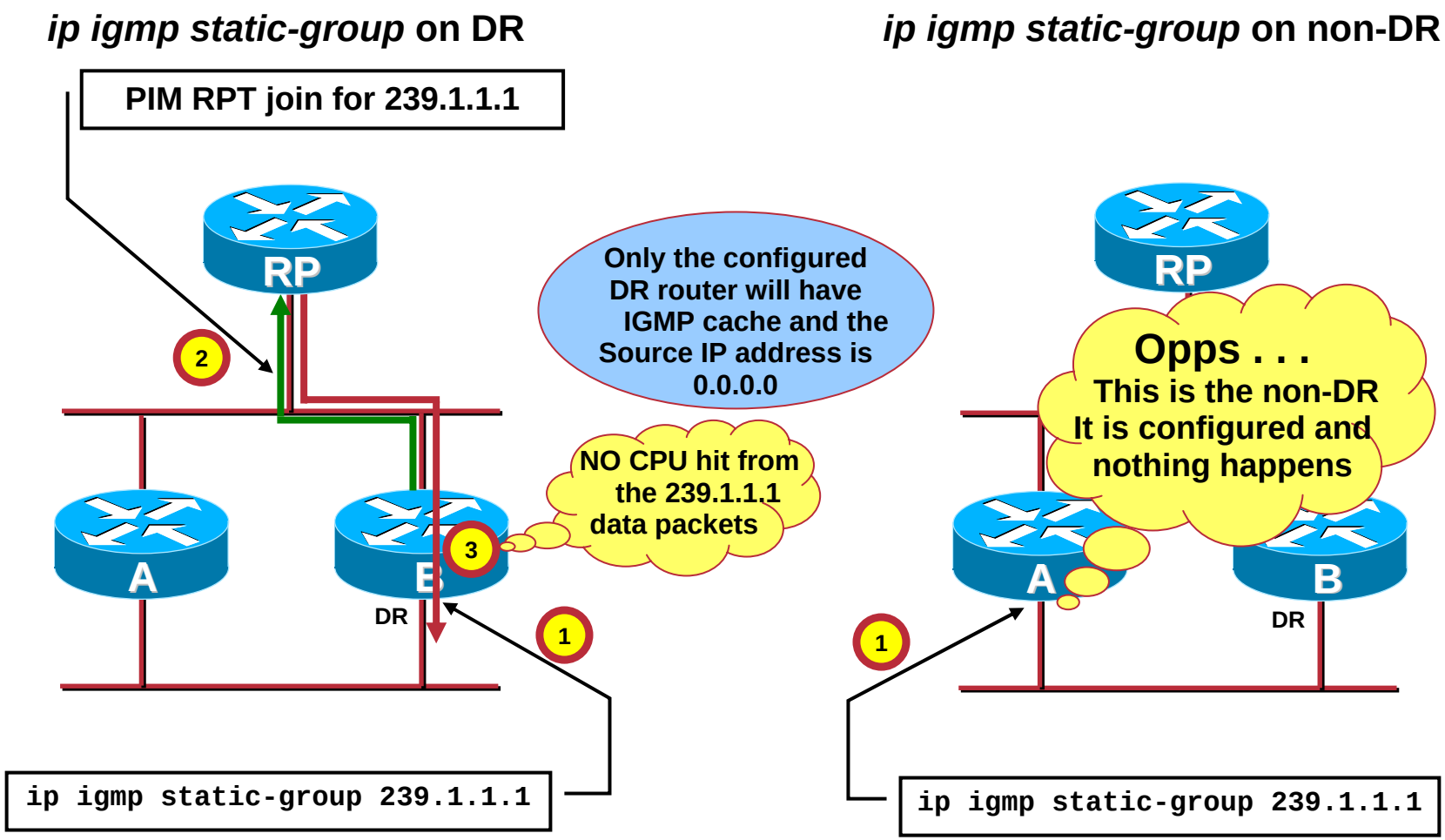
`ip igmp static-group <group-address>`

- Populates IGMP cache
- Results in
  - PIM RPT join ONLY IF configured on the DR
  - No CPU impact, *usually a good thing*

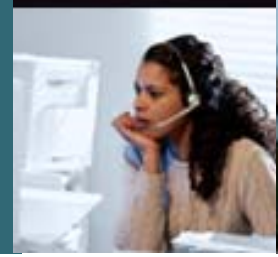
IGMP join-group



IGMP static-group



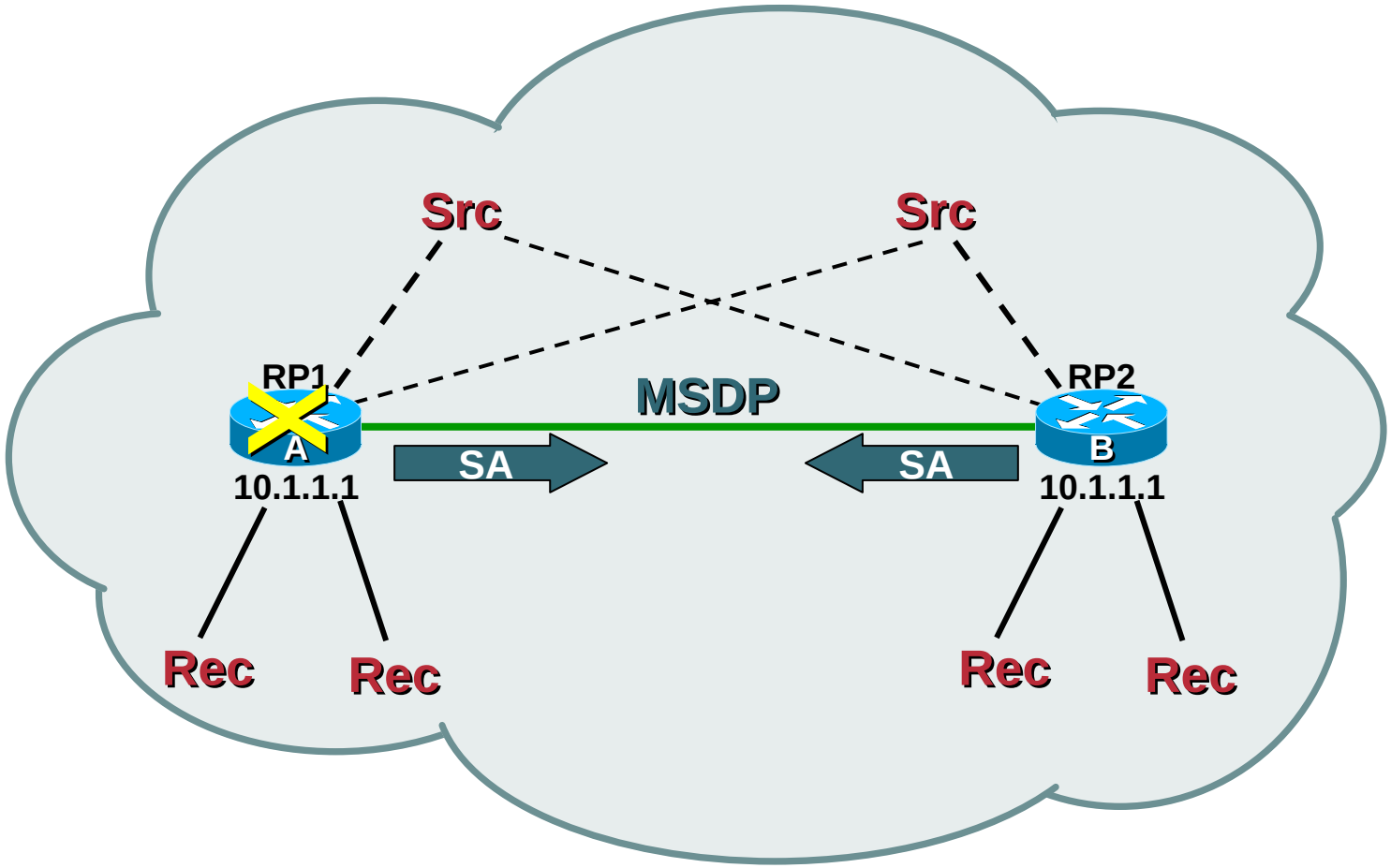
RP Engineering –
RP Configuration Methods



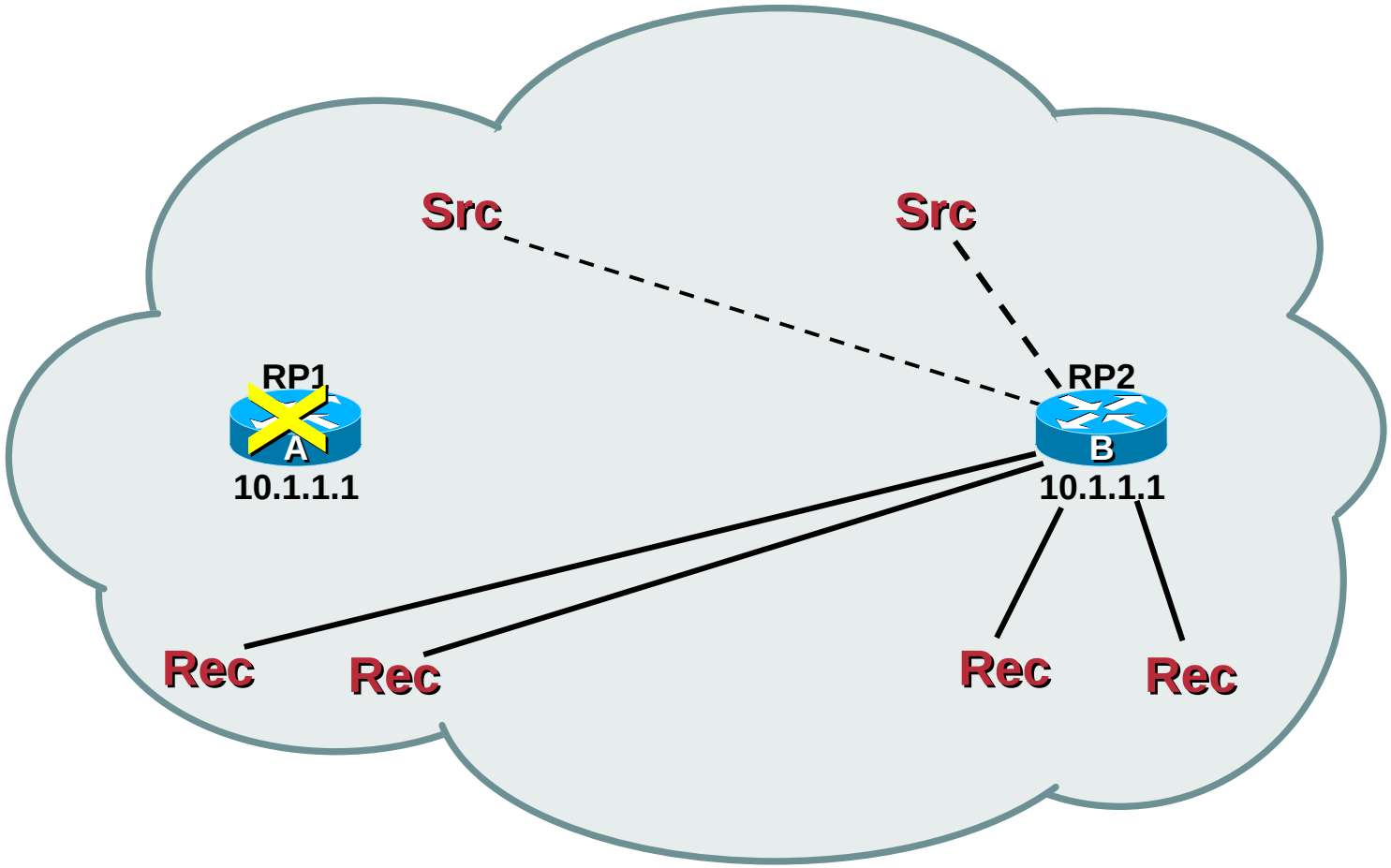
RP Configuration Methods

- **Anycast-RP's**
- **Static**
- **Auto-RP**
- **BSR**

Anycast RP—Overview



Anycast RP—Overview



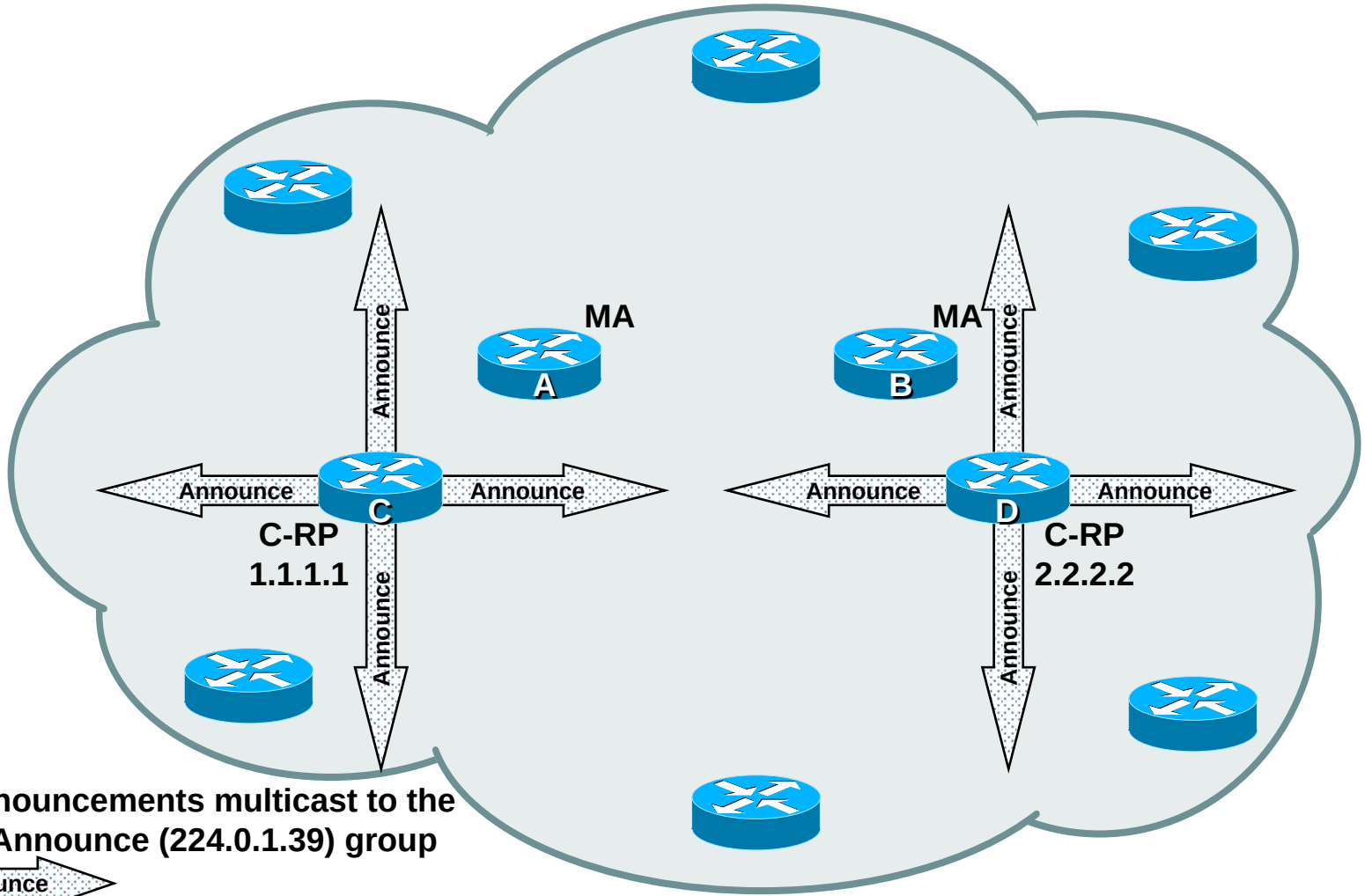
Static RP's

- **Hard-coded RP address**
  - **When used, must be configured on every router**
  - **All routers must have the same RP configuration**
  - **RP fail-over not possible**
    - **Exception: If Anycast RPs are used. Group can never fall back into Dense mode.**

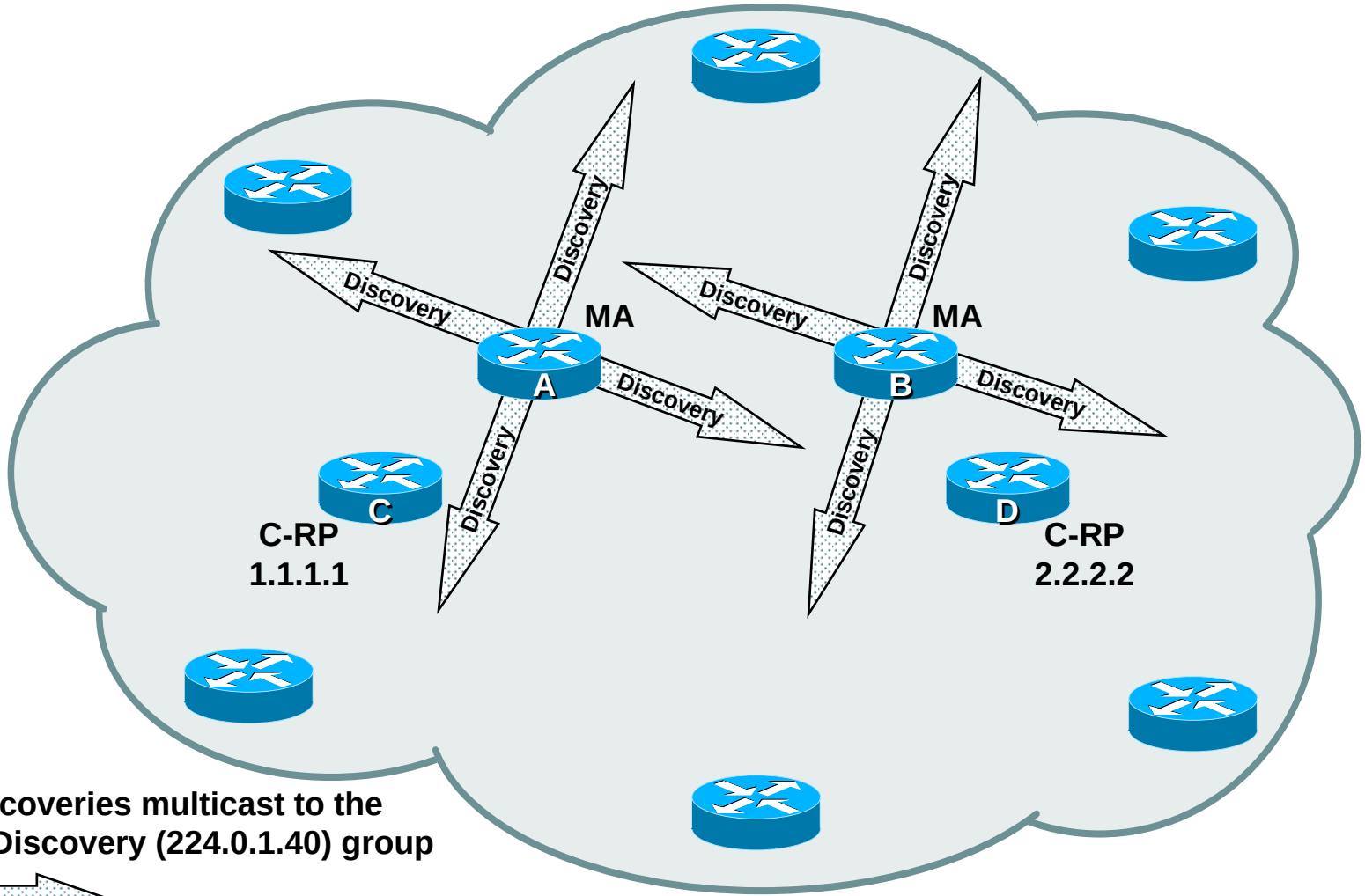
Static RP's

- **RP selection behavior when using static RP**
  - **Static RPs match on the highest IP address, not longest match of the ACL**
  - **If a dynamically learnt Group/RP and a static RP entry match, the dynamically learnt RP will be selected.**
  - **If a dynamically learnt Group/RP and static RP entry(s) with override match, the highest IP addressed static RP will be selected.**
- **Easy to avoid conflicts, do not engineer overlapped Group/RP ranges, exception being Anycast-RPs.**

Auto-RP Overview



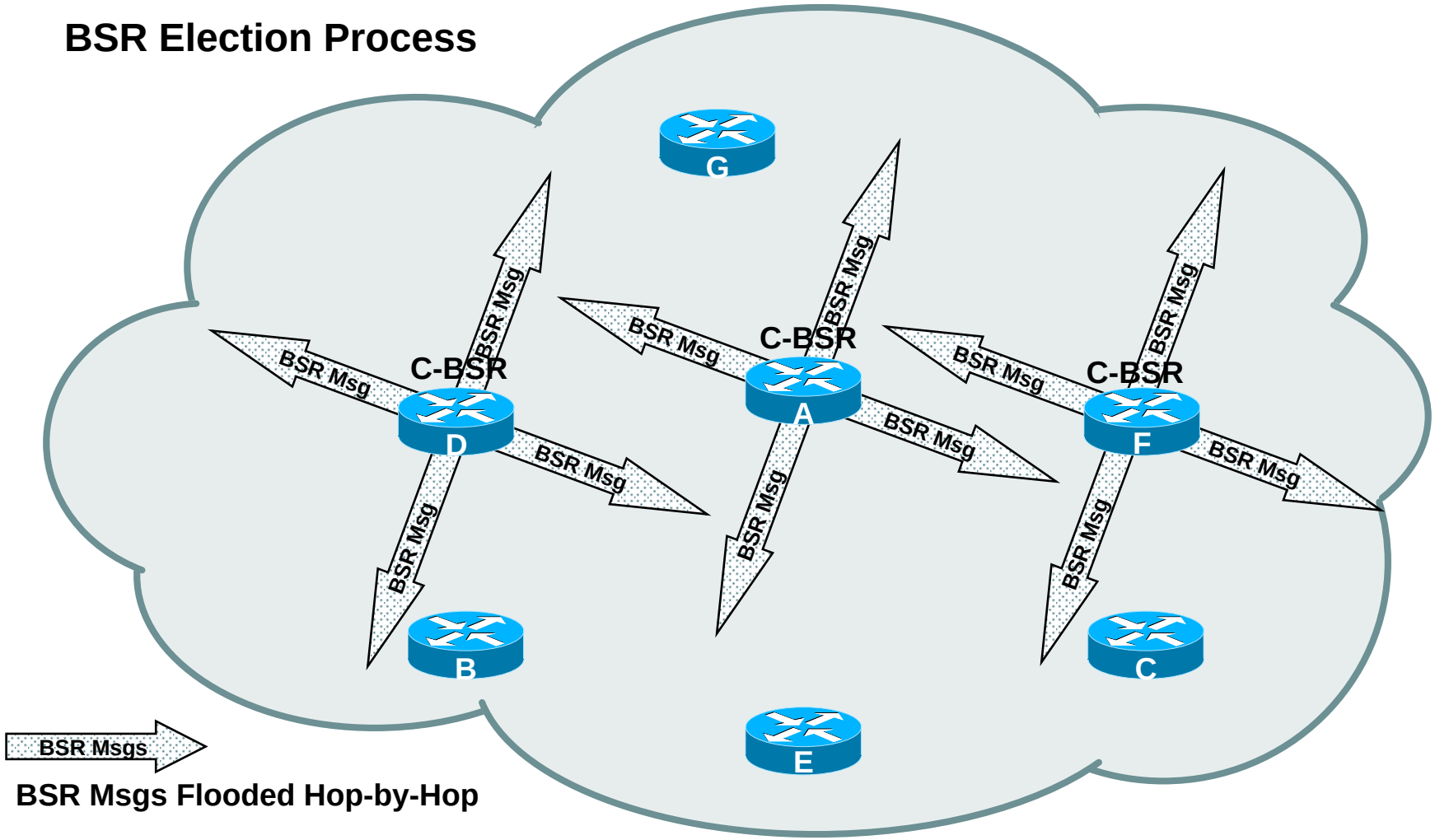
Auto-RP Overview



RP-Discoveries multicast to the Cisco Discovery (224.0.1.40) group

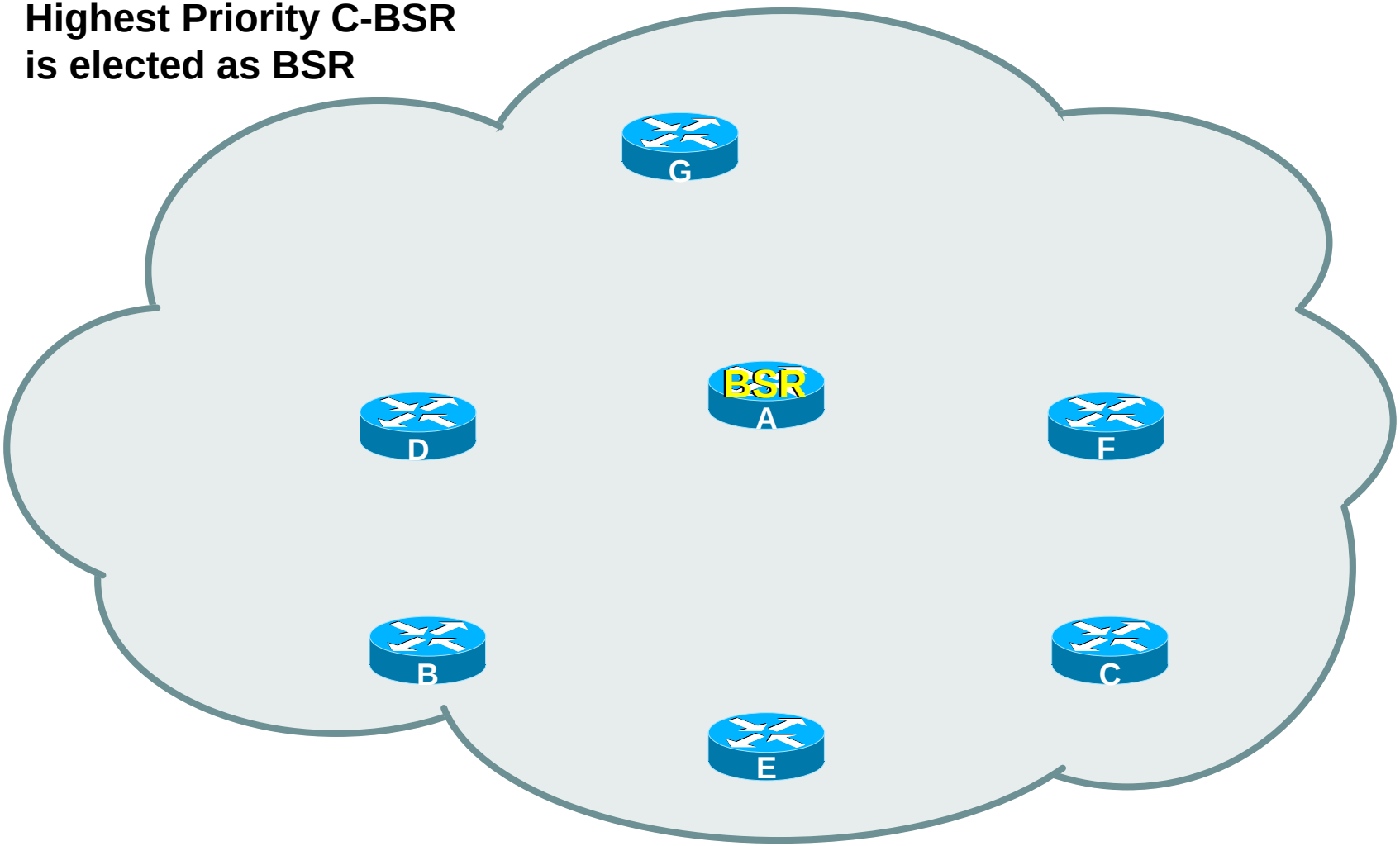
Discovery

BSR Overview

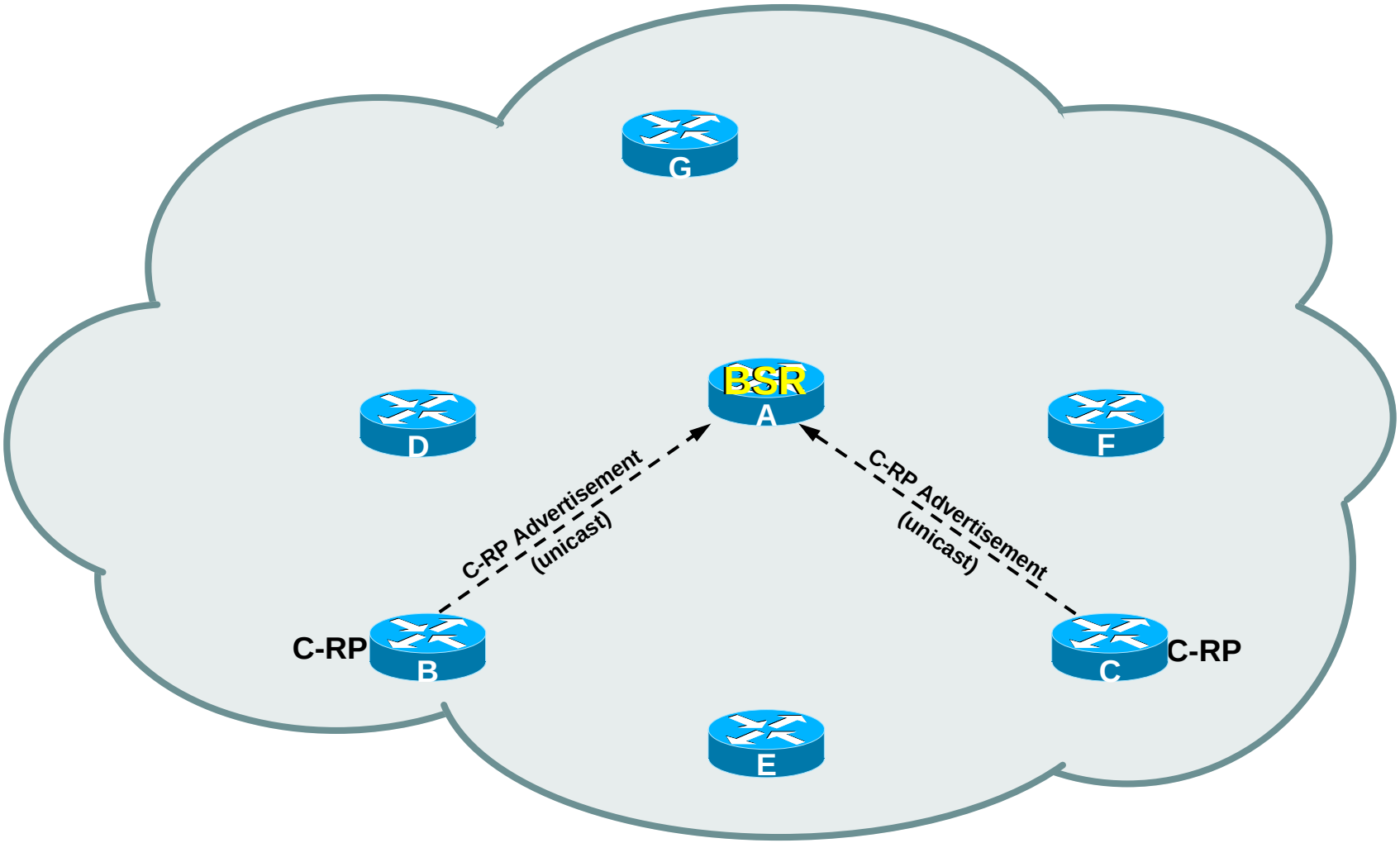


BSR Overview

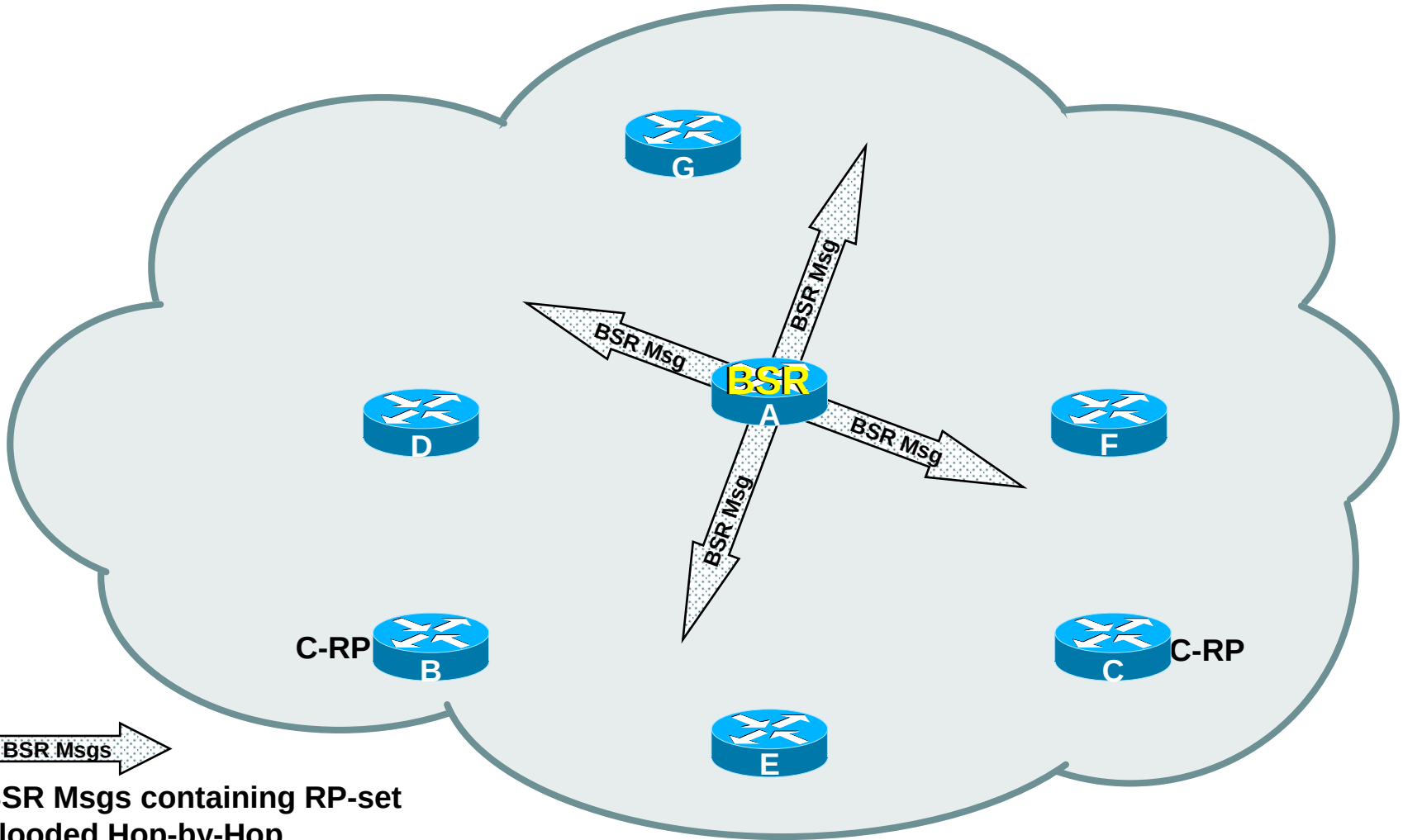
Highest Priority C-BSR is elected as BSR



BSR Overview



BSR Overview



BSR Msgs containing RP-set
Flooded Hop-by-Hop

RP Engineering – Avoiding Dense Mode Fallback

Avoiding DM *Flooding*

- **Use global command**
  - **ip pim autorp listener → Recommended**
  - **Added support for Auto-RP Environments.**
    - **Modifies interface behavior.**
      - **Forces interfaces to *always* use DM for Auto-RP groups.**
      - **Use only if Auto-RP is to be used.**
  - **Available 12.3(4)T, 12.2(28)S, 12.1(26)E**
- **Use with interface command.**
  - **ip pim sparse-mode → Recommended**
    - **Prevents DM Flooding.**
    - **Does not prevent DM *Fallback*!**

Avoiding DM *Flooding*

- **Prior to "listener" in IOS 12.3(4)T, 12.2(28)S, 12.1(26)E**
  - **Must use ip pim sparse-dense mode interface command to support Auto-RP.**
- **Use RP-of-last-resort**
  - **Assign local Loopback as RP-of-last-resort on each router.**
  - **Example***

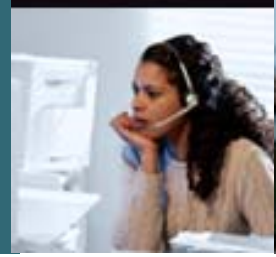
```
ip pim rp-address <local_loopback> 10
access-list 10 deny 224.0.1.39
access-list 10 deny 224.0.1.40
access-list 10 permit any
```

*** see Static RP slides for notes on selection of RP with Static RPs**

Avoiding DM *Fallback*

- **New IOS global command**
  - **no ip pim dm-fallback → Recommended**
- **Totally prevents DM Fallback!!**
  - **No DM Flooding since all state remains in SM**
- **Default RP Address = 0.0.0.0 [nonexistent]**
  - **Used if all RP's fail.**
    - **Results in loss of Shared Tree.**
    - **All SPT's remain active.**
- **Available 12.3(4)T, 12.2(28)S (not available on 6500/7600)**

RP Engineering – General RP Recommendations



General RP Recommendations

- **Use combined Anycast-RP & Auto-RP with autorp listener:**
  - **When rapid RP failover is critical**
  - **When dynamic Group/RP cache required**
  - **When Admin scoping is required**
- **Pros**
  - **Fastest RP Convergence**
  - **Most flexible and easy to maintain**
- **Cons**
  - **No Group/RP cache until a MA packet is received**
  - **Admin scoping can greatly increase complexity**
  - **Requires use of MSDP between RP's**

General RP Recommendations

- **Use combined Anycast-RP with Static:**
  - **When rapid RP failover is critical**
  - **When valid Group/RP cache is critical at all times**
  - **No requirement for dynamic Group/RP cache**
- **Pros**
  - **Fastest RP Convergence method**
  - **With override option, Group/RP cache can not be impacted via Auto-RP or BSR**
  - **Required when connecting to Internet**
- **Cons**
  - **Manual Group/RP configuration change on routers**
  - **Requires use of MSDP between RP's**

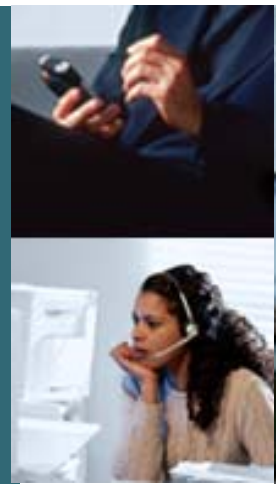
General RP Recommendations

- **Use Auto-RP with autorp listener**
  - **When minimum configuration is desired and/or**
  - **When maximum flexibility is desired**
- **Pros**
  - **Most flexible method**
  - **Easiest to maintain**
- **Cons**
  - **Increased RP Failover times vs Anycast-RP inclusive configurations**
  - **No Group/RP cache until a MA packet is received**

General RP Recommendations

- **Use BSR:**
  - **When dynamic Group/RP cache is required and**
  - **When maximum interoperability is needed**
- **Pros**
  - **Interoperates with all Vendors**
- **Cons**
  - **Some methods greatly increase configuration**
  - **Does not support Admin. Scoping**

QoS Notes

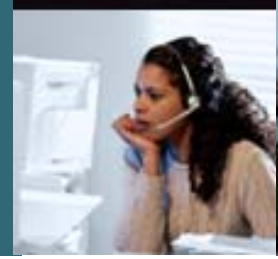


QoS Notes

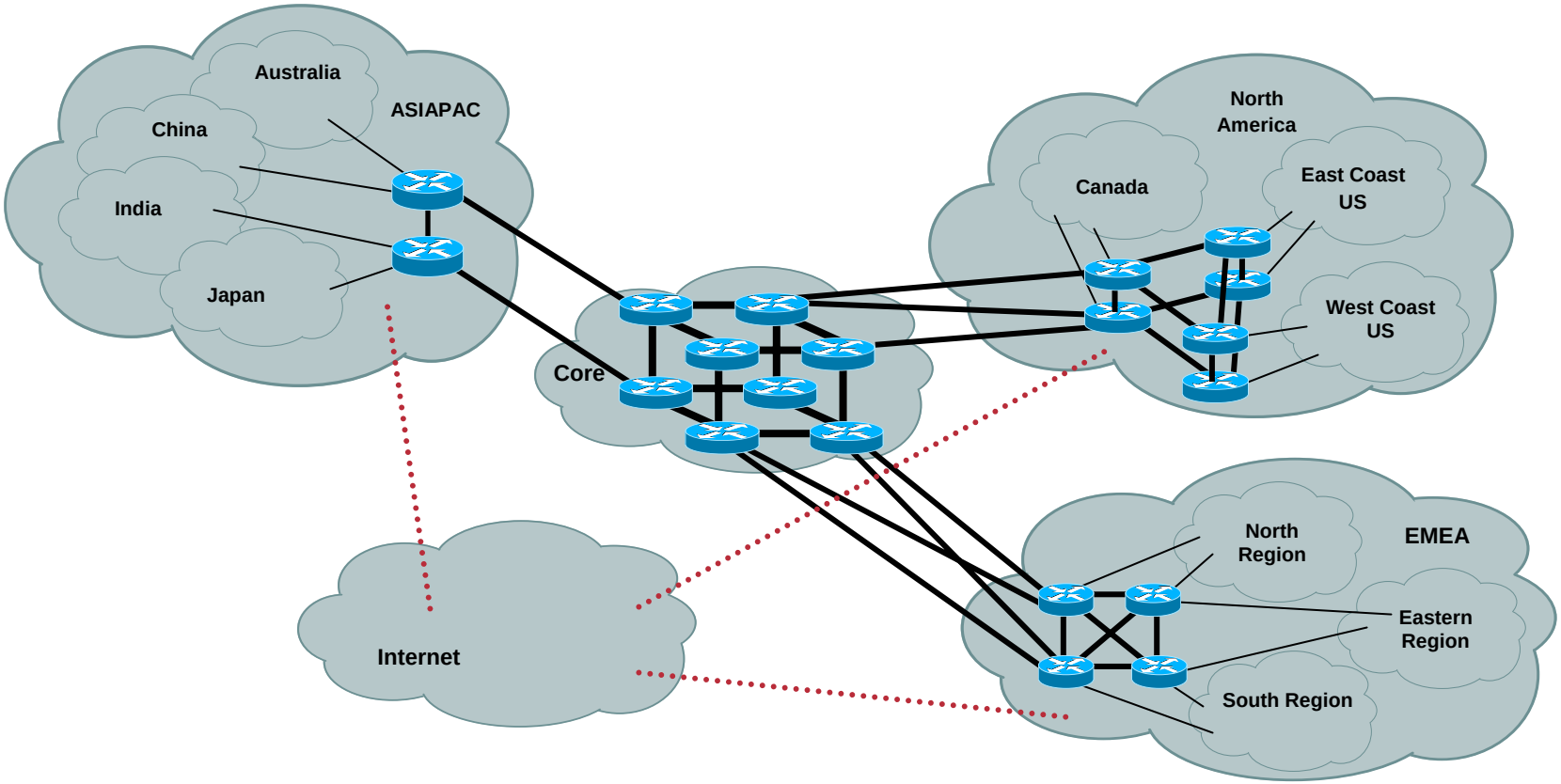
- **IP Multicast is UDP**
  - **Turn off WRED or minimize the window**
    - **no congestion control**
- **Jitter**
  - **Sensitive for real time streams; i.e. audio, video**
- **Financial data**
  - **Data can be retransmitted however it quickly becomes “stale”**
- **Requires knowledge of the traffic**
  - **UDP Multicast needs to be in separate threshold or queue**

Advanced Multicast Engineering

Admin. Scoped Zones

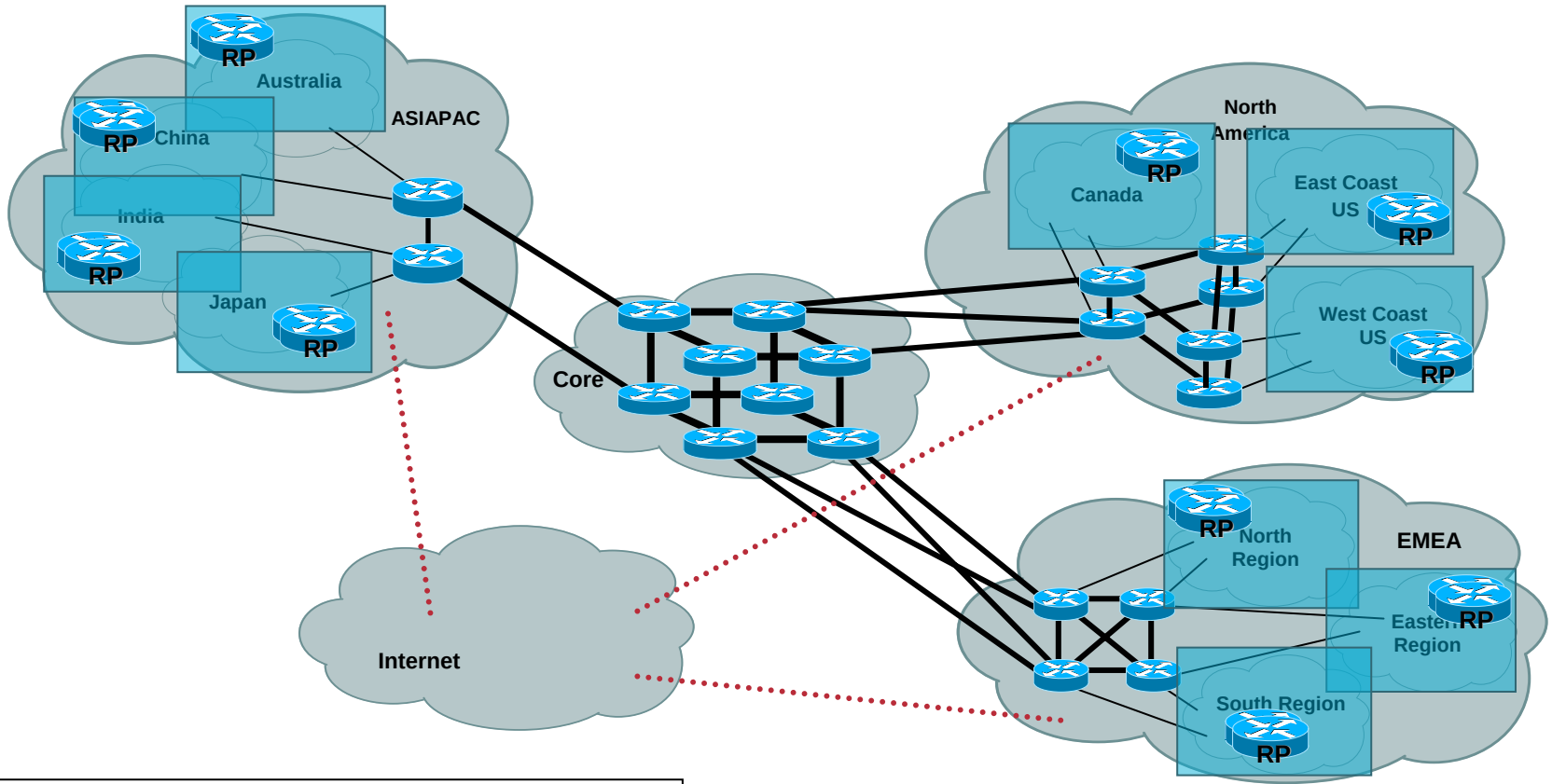


Administratively-Scoped Zones Example



Administratively-Scoped Zones Example

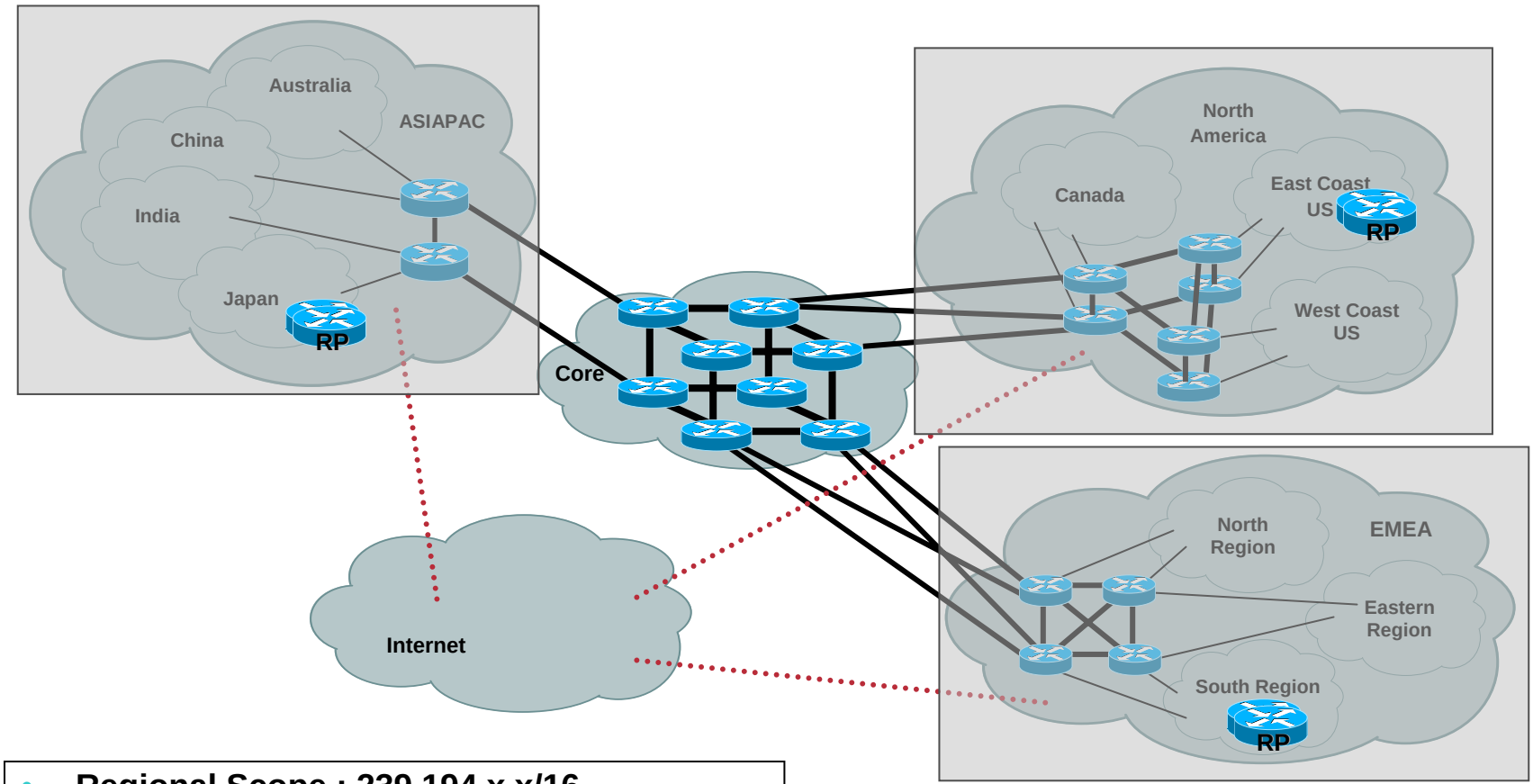
Level1: Campus Scope



- **Campus Scope: 239.193.x.x/16**
- **RP per Campus**

Administratively-Scoped Zones Example

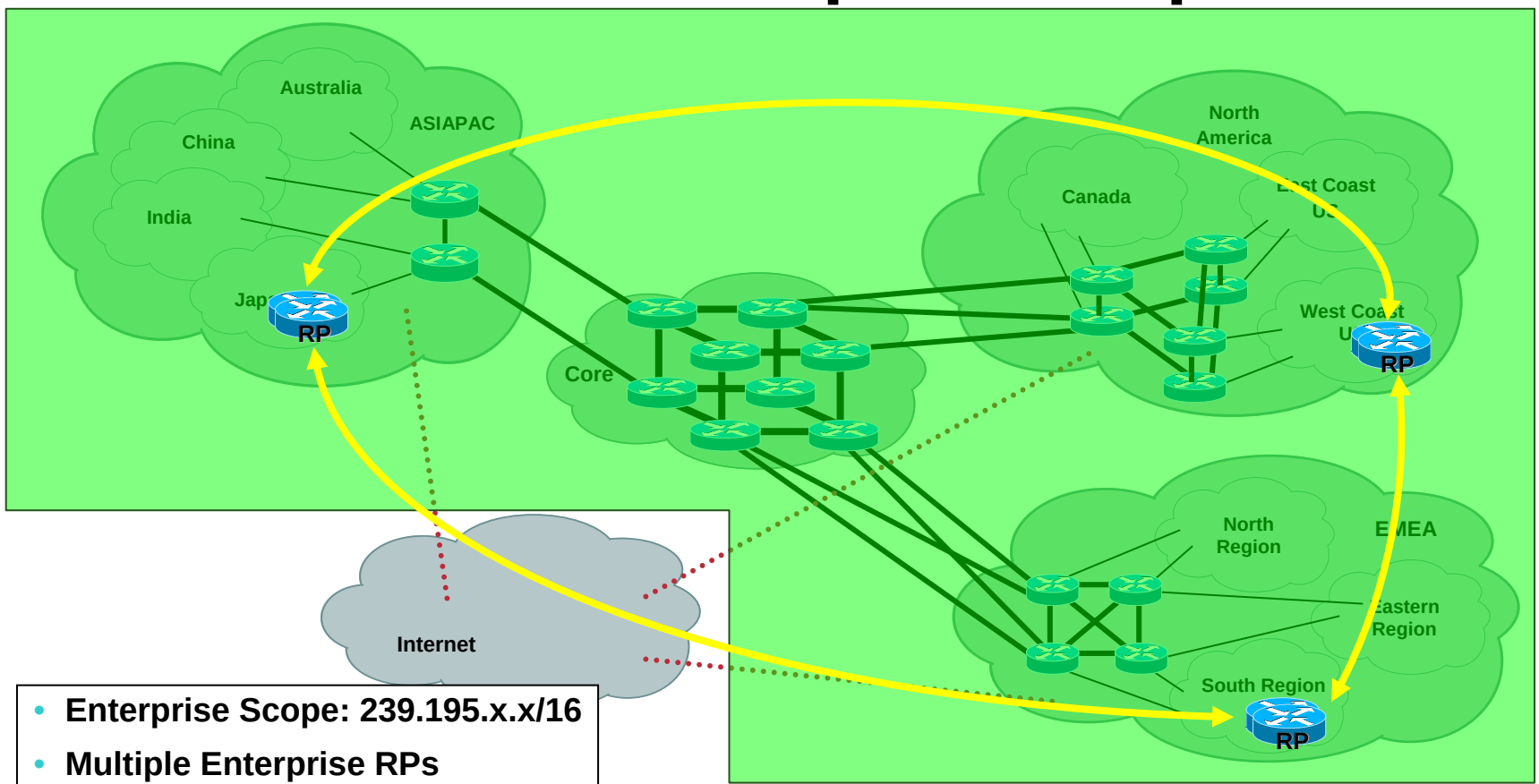
Level2: Regional Scope



- **Regional Scope : 239.194.x.x/16**
- **RP per Region**

Administratively-Scoped Zones Example

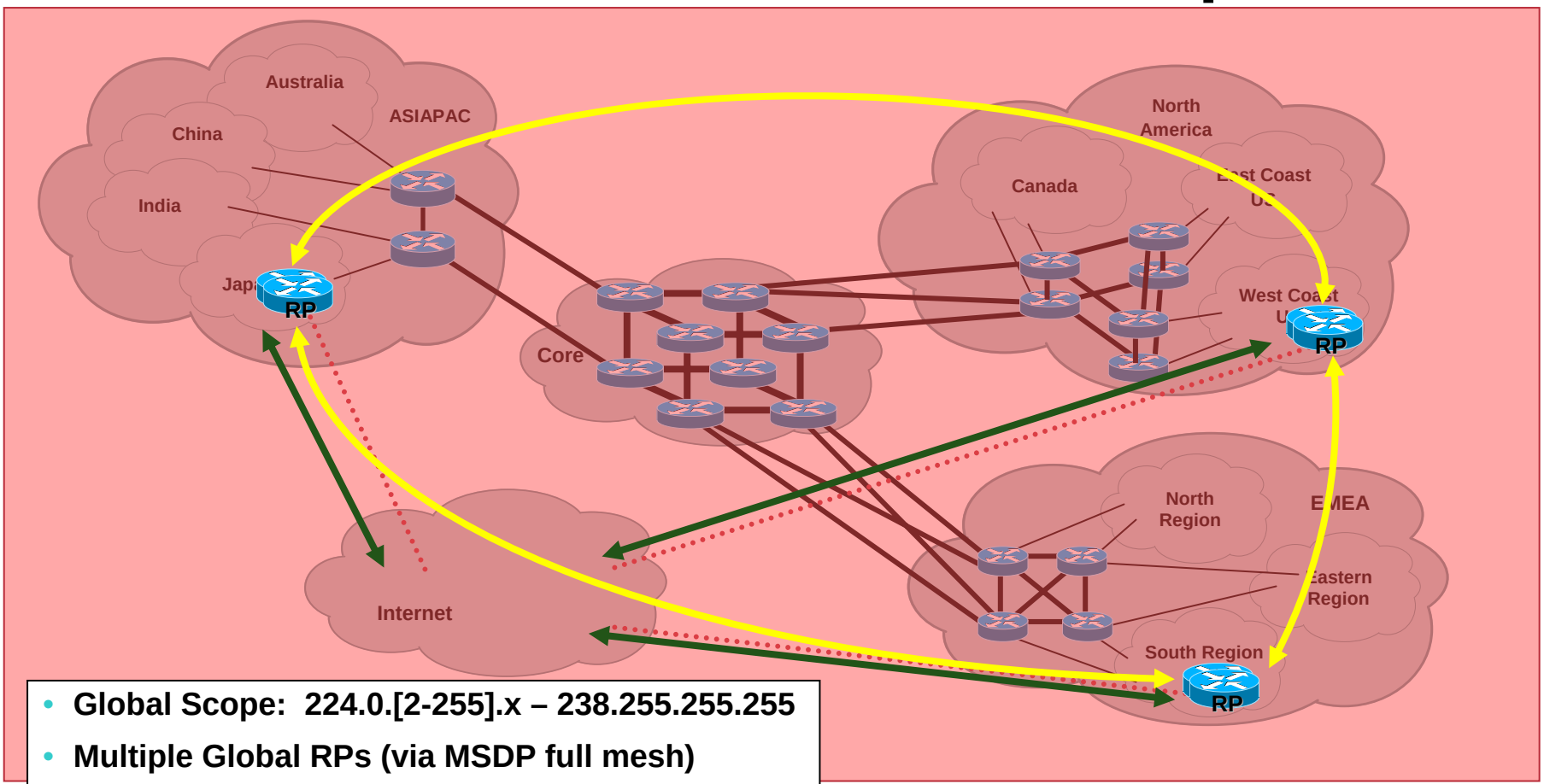
Level3: Enterprise Scope



- **Enterprise Scope: 239.195.x.x/16**
- **Multiple Enterprise RPs (via MSDP full mesh)**

Administratively-Scoped Zones Example

Level 4: Internet Global Scope

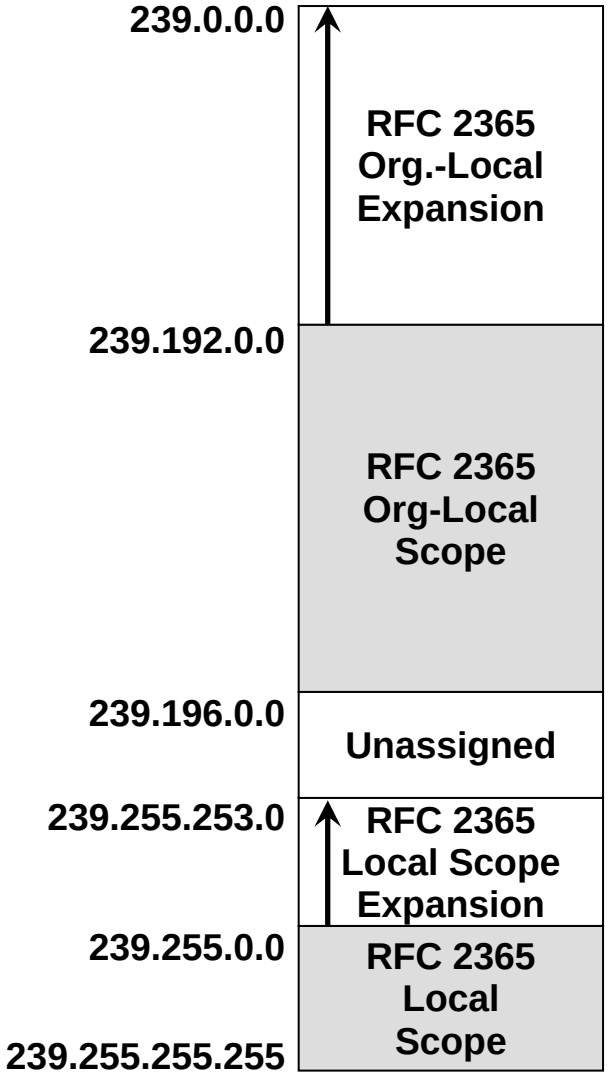


- **Global Scope: 224.0.[2-255].x – 238.255.255.255**
- **Multiple Global RPs (via MSDP full mesh)**
- **MSDP connectivity to SP network**

Administratively-Scoped Zones

- **Used to limit:**
  - **High-BW sources to local site**
  - **Control sensitive multicast traffic**
- **Simple scoped zone example:**
  - **239.193.0.0/16 = Campus Scope**
  - **239.194.0.0/16 = Region Scope**
  - **239.195.0.0/16 = Organization-Local (Enterprise) Scope**
  - **224.1.0.0 - 238.255.255.255 = Global scope (Internet) zone**
    - **High-BW sources use Site-Local scope**
    - **Low-Med. BW sources use Org.-Local scope**
    - **Internet-wide sources use Global scope**

Administratively Scoped Address Range



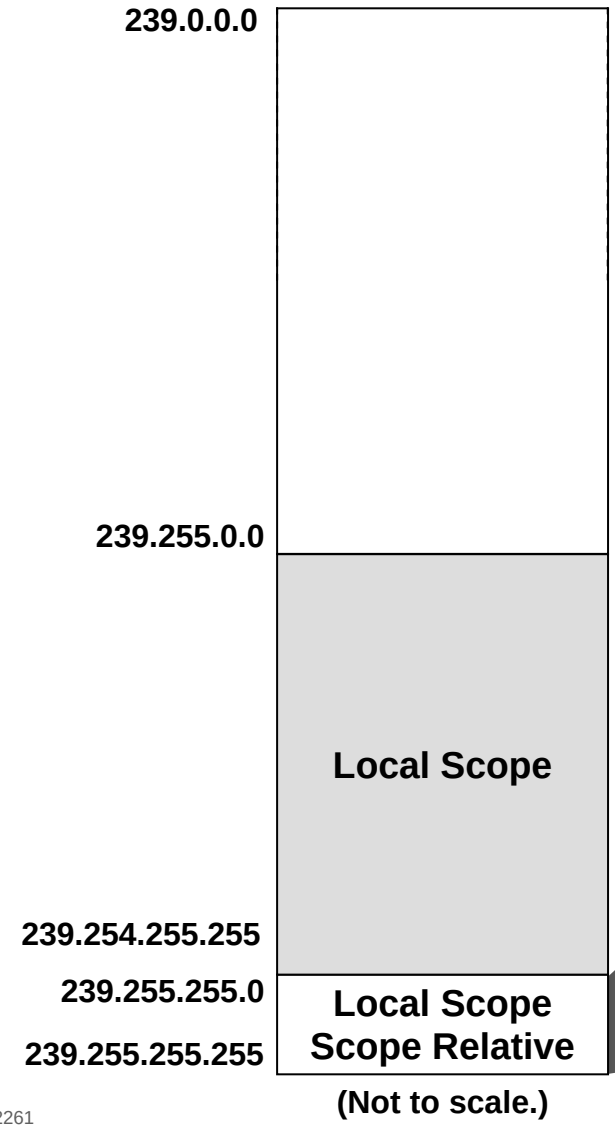
- Address Range: 239.0.0.0/8
  - Private multicast address space.
  - Similar to RFC1918 private unicast address space.
- RFC 2365 Administratively Scoped Zones.
  - Organization-Local Scope (239.192/14)
    - Largest scope within the Enterprise network (i.e. Enterprise-wide).
    - Expands downward in address range.
  - Local Scope (239.255/16)
    - Expands downward in address range.
    - Smallest possible scope within the Enterprise network.
    - Other scopes may be equal but not smaller.

Scope Relative Addresses – RFC 2365

Top 256 Addresses of every Admin. Scope Range.

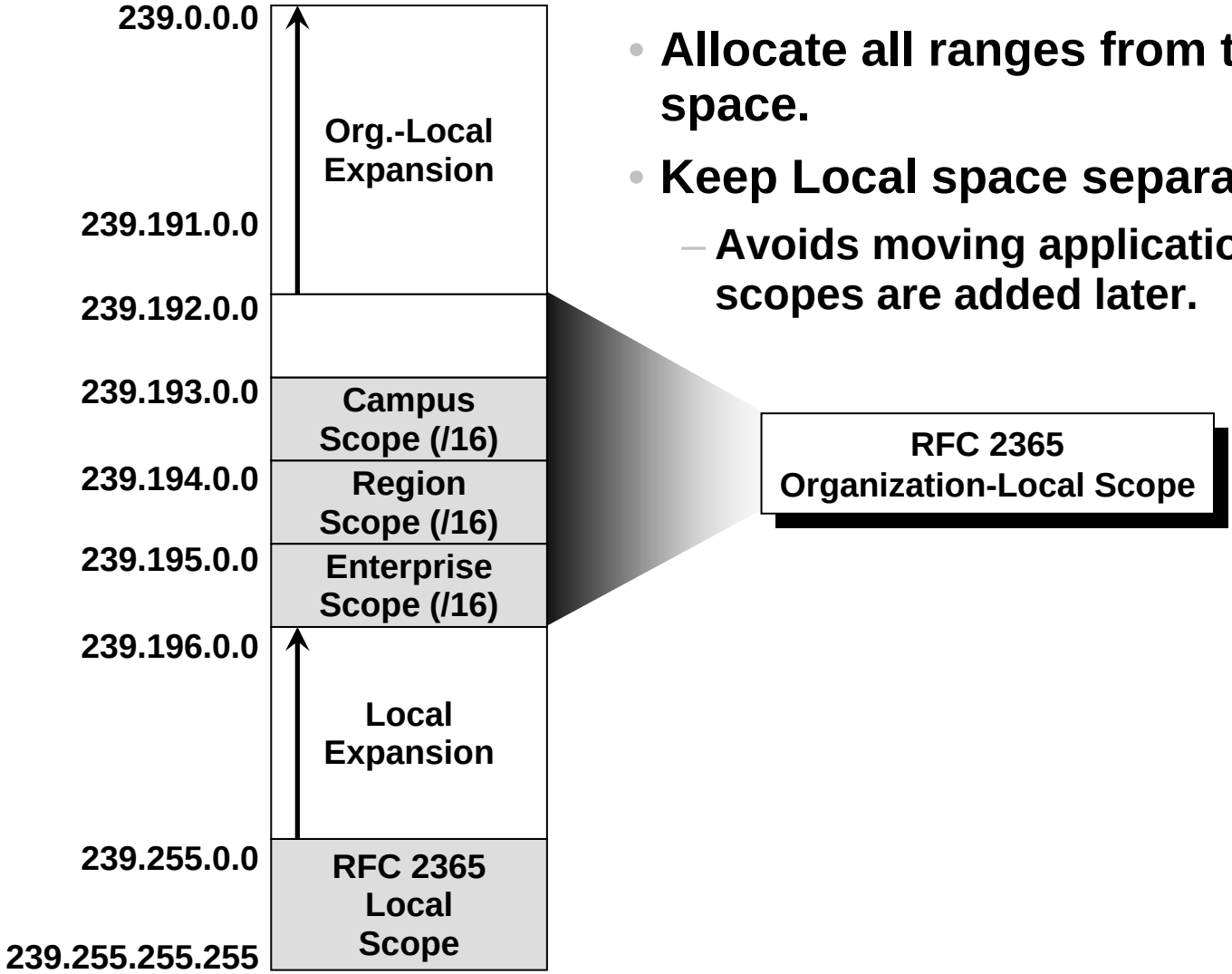
Last Octet	Offset	Description
.255	0	SAP Session Announcement Protocol (SDR)
.254	1	MADCAP Protocol
.253	2	SLPv2 Protocol
.252	3	MZAP Protocol
.251	4	Multicast Discovery of DNS Services
.250	5	SSDP
.249	6	DHCPv4
.248	7	AAP
.247	8	MBUS
	9 - 255	Unassigned

Scope Relative Example – Local Scope



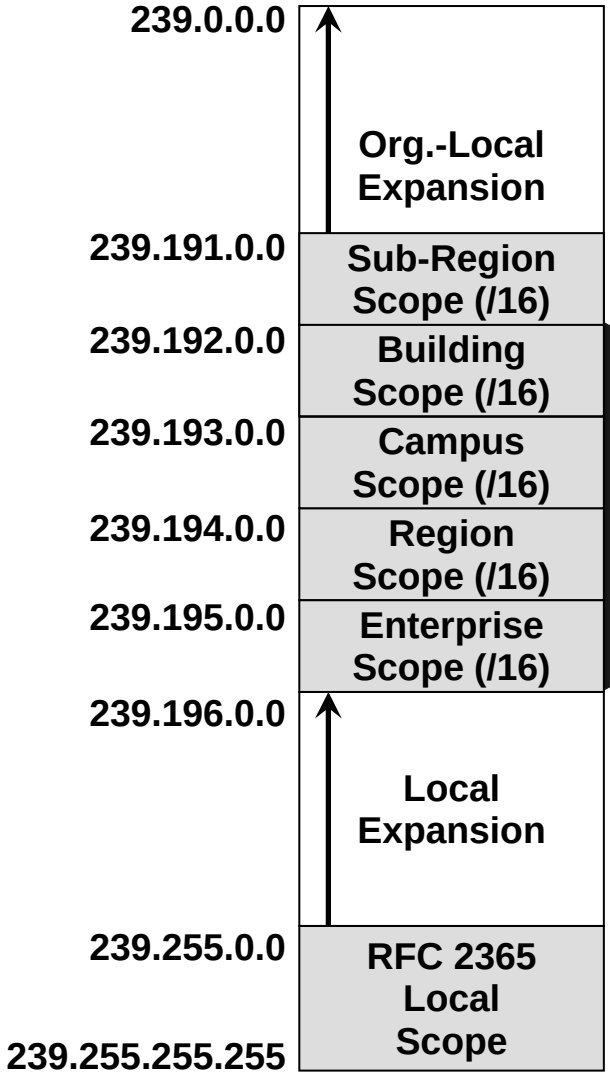
Address	Description
239.255.255.255	SAP Session Announcement Protocol (SDR)
239.255.255.254	MADCAP Protocol
239.255.255.253	SLPv2 Protocol
239.255.255.252	MZAP Protocol
239.255.255.251	Multicast Discovery of DNS Services
239.255.255.250	SSDP
239.255.255.249	DHCPv4
239.255.255.248	AAP
239.255.255.247	MBUS

Example Scope Address Assignments



- **Allocate all ranges from the Org-Local space.**
- **Keep Local space separate.**
  - **Avoids moving applications when smaller scopes are added later.**

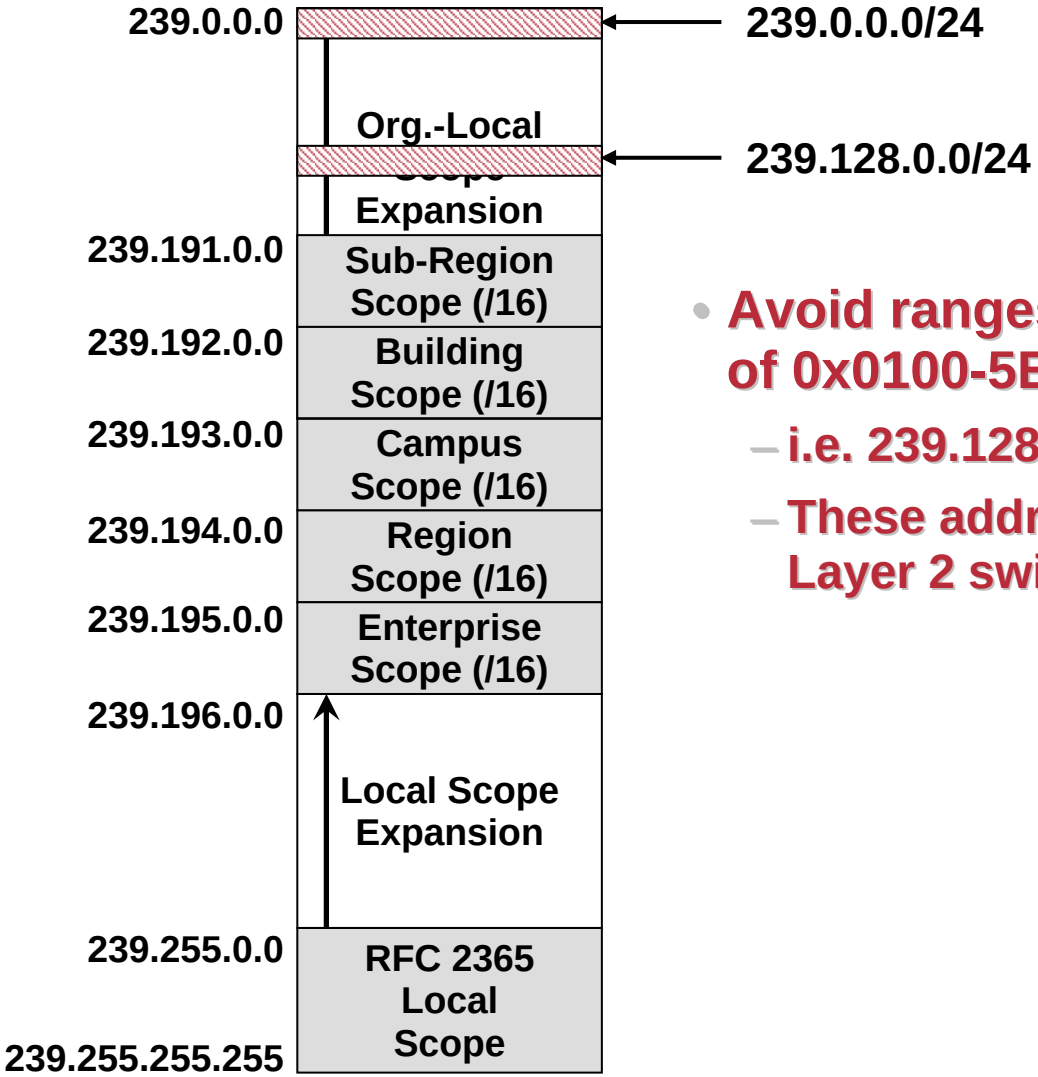
Adding a Additional Scopes



- **Additional scope ranges are allocated downward into Org-Local Expansion.**
  - **Not necessary to keep ranges in scope size order.**
  - **(i.e. "Sub-Region" scope is a larger physical scope than the "Building" and "Campus" scopes).**

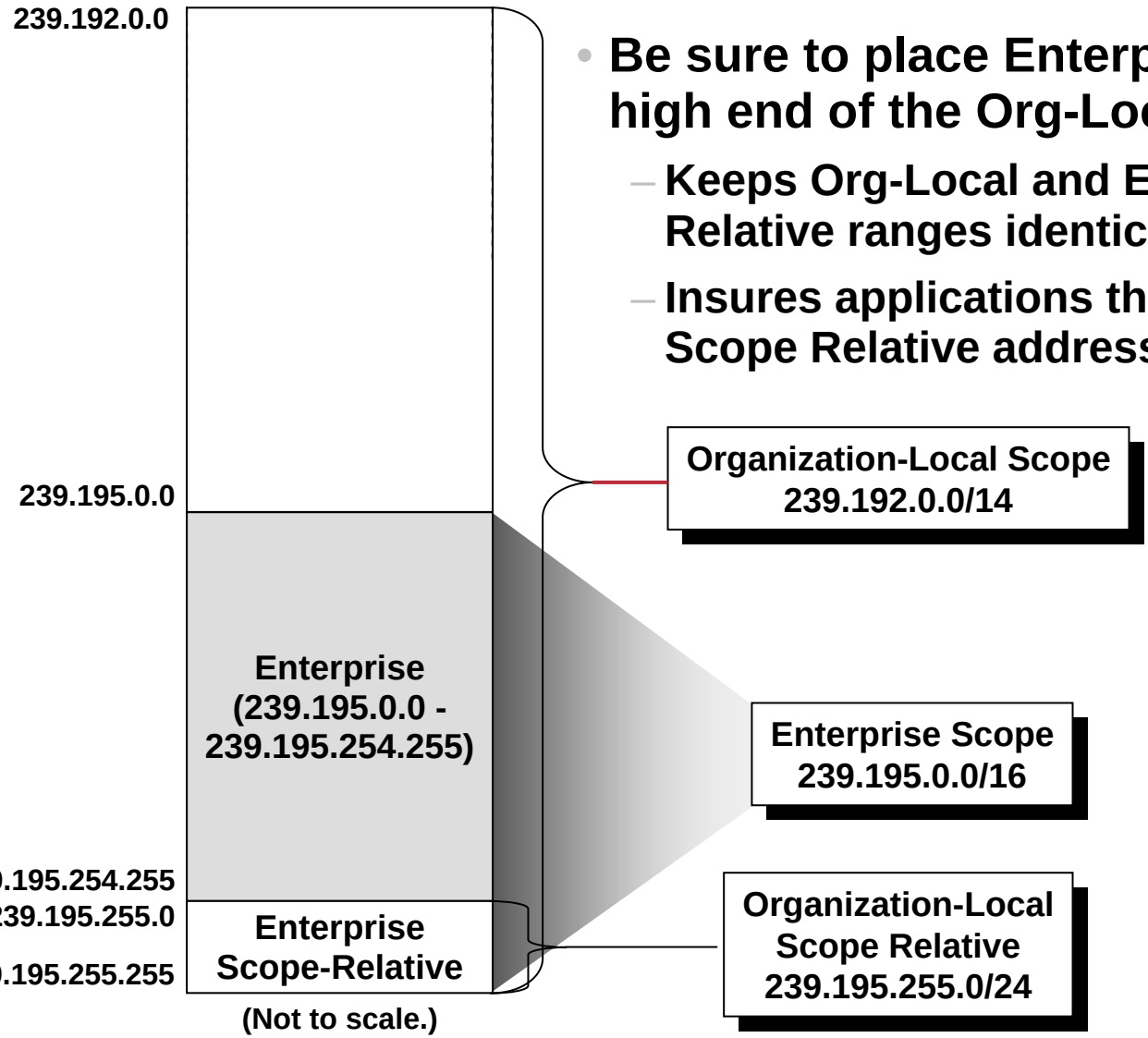
RFC 2365 Organization-Local Scope

Address Ranges to Avoid



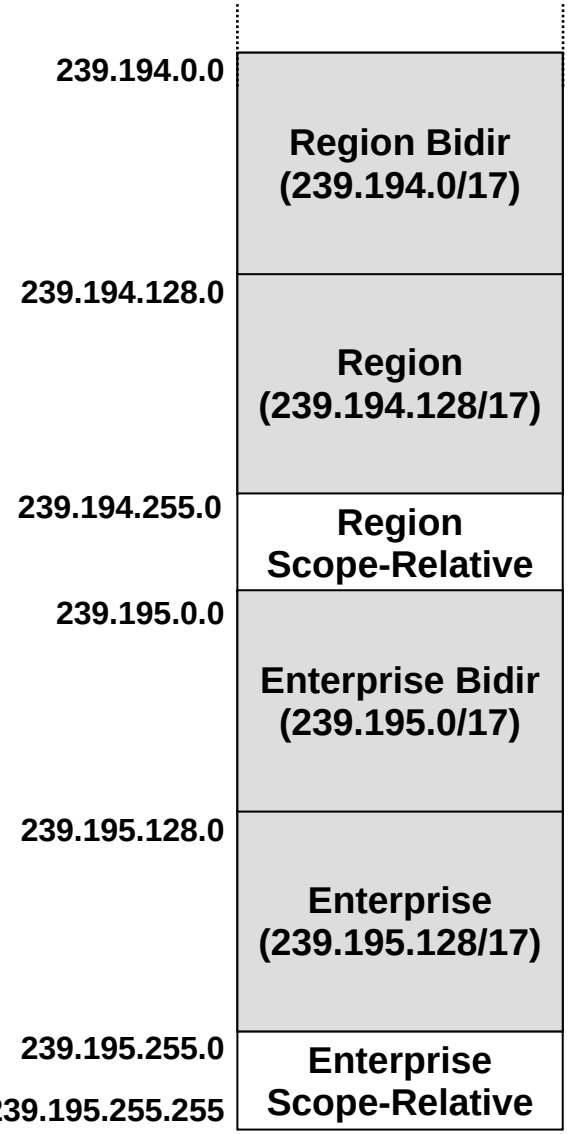
- Avoid ranges that map to a MAC address of 0x0100-5E00-00xx!
  - i.e. 239.128.0/24 & 239.0.0/24
  - These addresses are always flooded by Layer 2 switches!

Enterprise Scope Relative Range



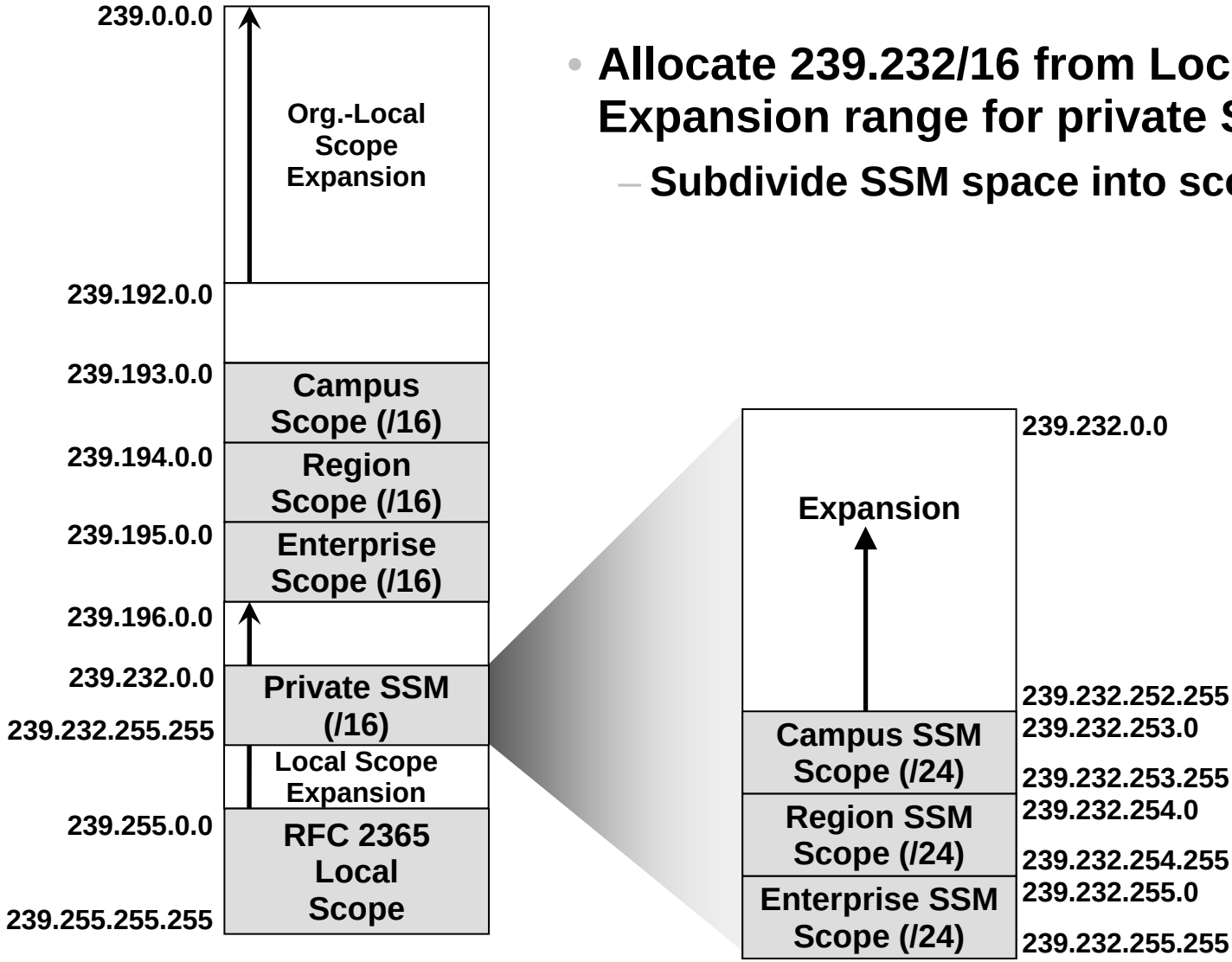
- **Be sure to place Enterprise Scope at the high end of the Org-Local range.**
  - **Keeps Org-Local and Enterprise Scope Relative ranges identical.**
  - **Insures applications that use Org-Local Scope Relative addresses work correctly.**

Adding Bidir Ranges to each Scope



- **Subdivide each scope's address range into Bidir and ASM ranges.**
  - **Keep ASM range at the upper end of the address range.**
  - **Keeps Scope-Relative multicast in ASM mode.**

Adding Private SSM Space



- **Allocate 239.232/16 from Local Scope Expansion range for private SSM space.**
  - **Subdivide SSM space into scoped zones.**

Avoid Overlapping Group Ranges

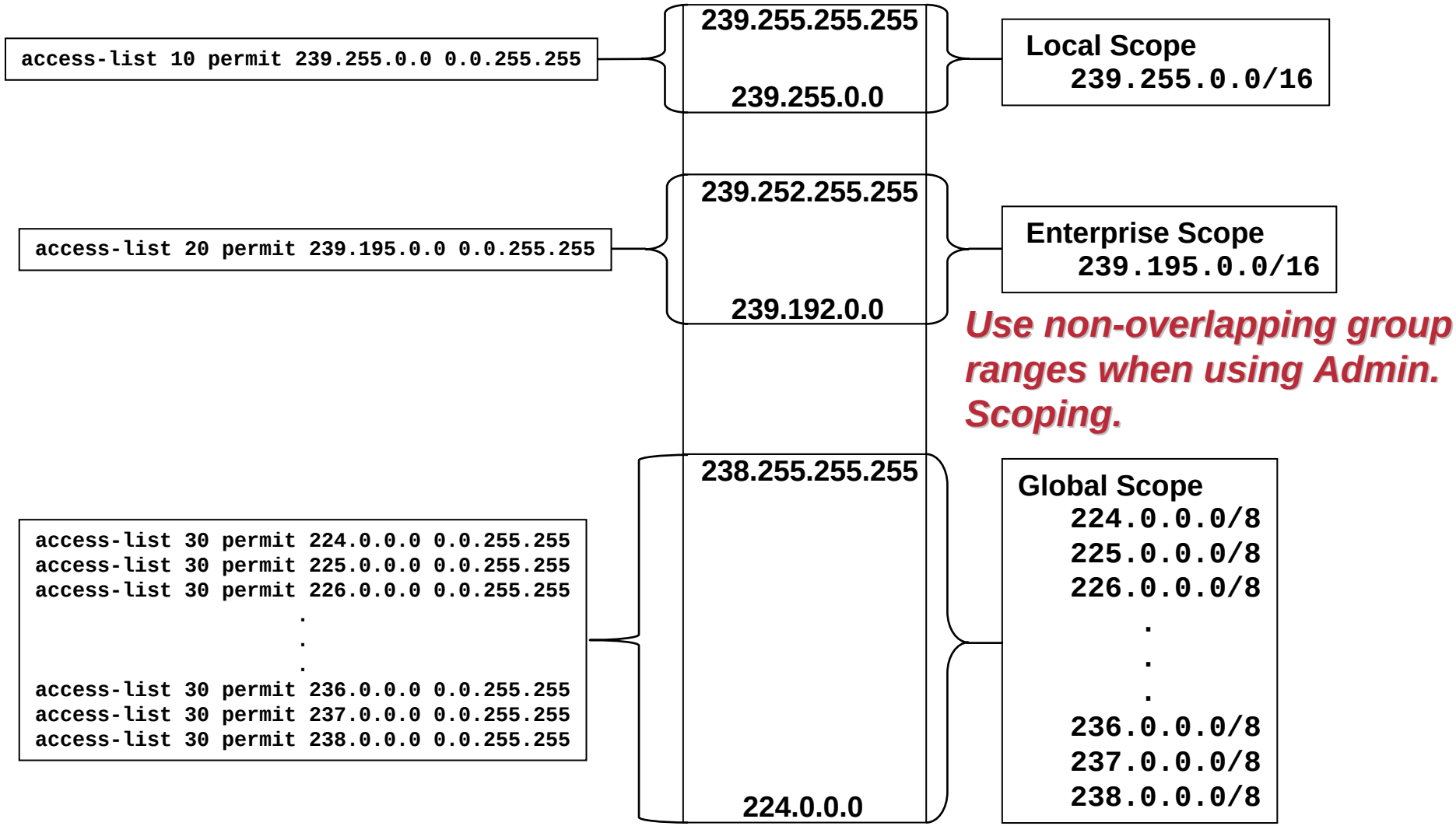
- **Avoiding Overlapping Group Ranges**
  - **Can't use "deny" clause in C-RP ACL's**
    - **Implies "Dense-mode Override"**

```
ip pim send-rp-announce loopback0 scope 16 group-list 10
access-list 10 deny 239.0.0.0 0.255.255.255
access-list 10 permit 224.0.0.0 15.255.255.255
```

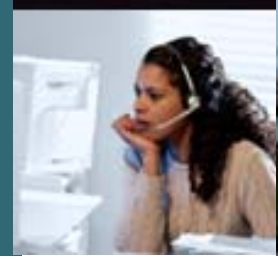
  - **Must only use "permit" clauses**

```
ip pim send-rp-announce loopback0 scope 16 group-list 10
access-list 10 permit 224.0.0.0 0.255.255.255
access-list 10 permit 225.0.0.0 0.255.255.255
                       .
                       .
                       .
access-list 10 permit 238.0.0.0 0.255.255.255
```

Avoid Overlapping Group Ranges



Admin Scoping using Anycast-RP with Static RP Configuration



Anycast-RP with Static RPs

- **Concept:**
  - **One set of Anycast RP's per physical zone.**
  - **MSDP peer only between a zone's RP's**
  - **Static RP to populate Group/RP cache**
- **Advantages:**
  - **Fast RP failure over**
  - **Never lose Group/RP cache**
  - **No need for special C-RP filters at boundaries**
- **Disadvantages:**
  - **Changing address range allocation is a configuration change on all routers within the zone**

Anycast-RP with Static RPs

- These Zones typically are defined as:
  - Enterprise
  - Region
  - Campus

Zones

- **Enterprise**
  - **IP Multicast streams needed to be sourced at any Enterprise Site for receivers located across the enterprise.**
    - **Enterprise traffic does not exit the Enterprise boundary**
    - **Regions and Campuses receive Enterprise traffic**

Anycast-RP with Static RPs

- **Region**
  - **IP Multicast streams that have sources/receivers only within *that* region.**
    - **Region traffic does not exit the Region boundary**
    - **Campuses within *this* Region receives *this* Region's traffic**

Anycast-RP with Static RPs

- **Campus**
  - **Local source/receivers only**
    - **Campus traffic does not exit *this* Campus boundary**

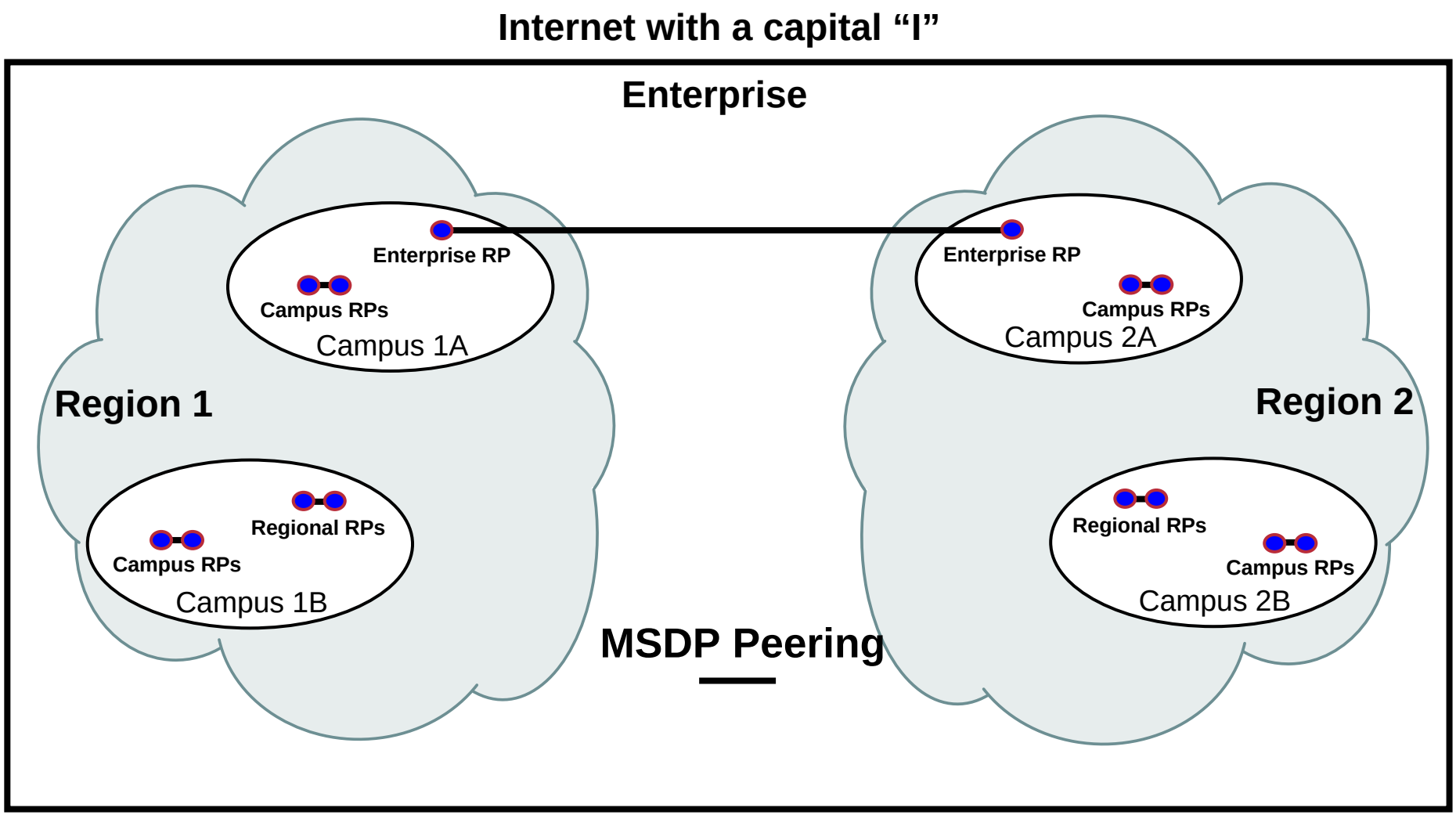
The role of Group/RP cache

- **Why is control of Group/RP cache so Important?**
  - **Group mode is determined by Group/RP cache**
    - **Did we have a hit for the Group in Group/RP cache?**
    - **Is the Group Dense or Sparse?**
    - **Given the group Mode**
      - **What operations are supported by the interfaces?**

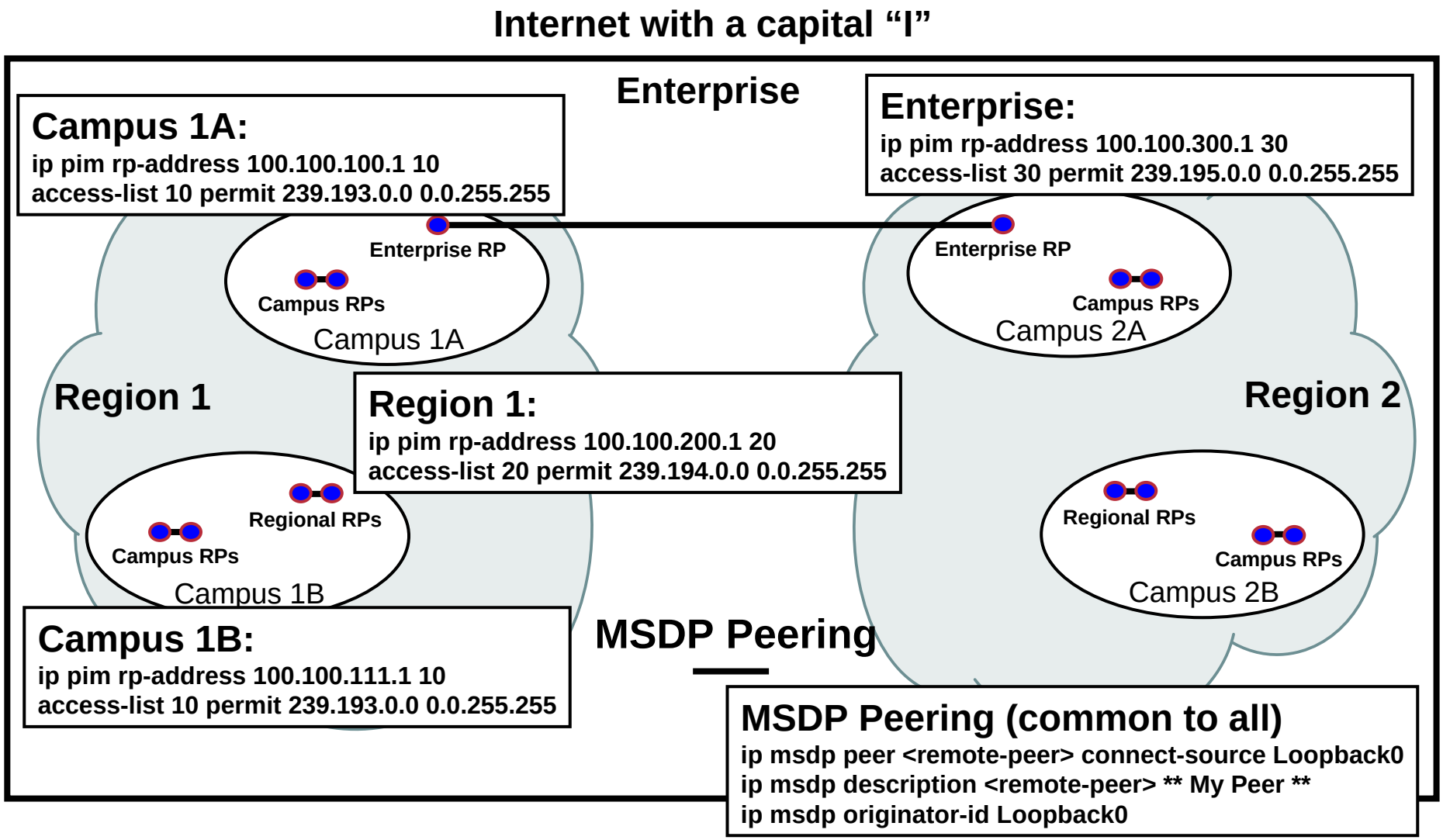
The role of Group/RP cache

- If the interfaces are Sparse operation . . .
  - Dense mode groups' traffic have no way out of the router
    - Exception – IGMP report will populate the OIL
- In PIM-SM, control of IP Multicast traffic flows depends on Group/RP cache hits.
  - If no Group/RP cache hit, then group mode is Dense. Thus no PIM joins/registers and no flow outside of the router.
  - "no Group/RP cache hit" . . . you can not use what you don't know!

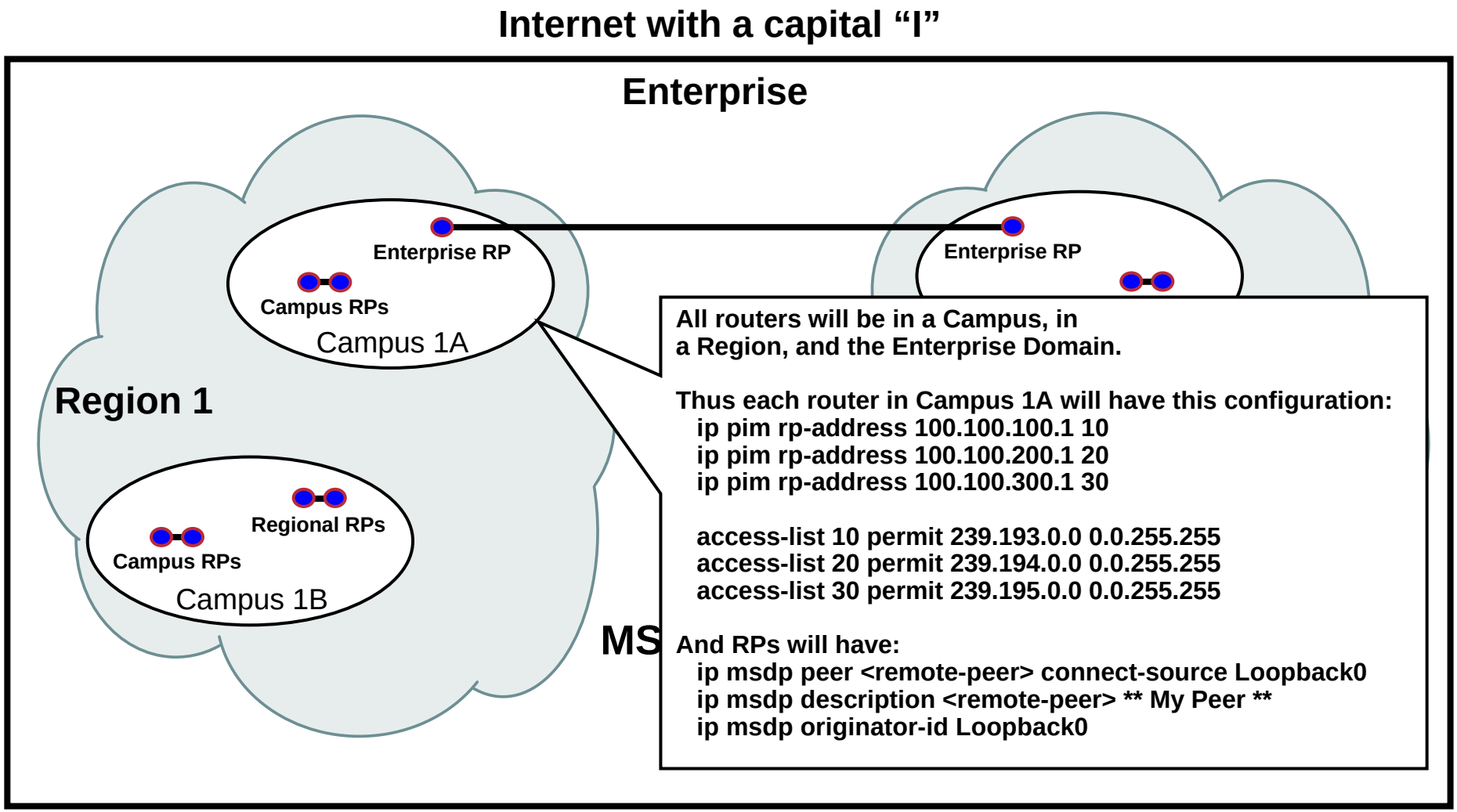
Anycast-RP with Static RPs



Anycast-RP with Static RPs



Anycast-RP with Static RPs



Anycast-RP with Static RPs

- **Summary configuration points**
  - **Boundary statements**
    - **In a perfect world, not needed**
    - **However, use boundary commands for catching mis-configurations**
  - **MSDP filters**
    - **Must use MSDP filters when the router is the RP for more than one scope.**
    - **In a perfect world of separate RPs (routers) for each different scope, not needed**
  - **No special Dense mode group handling**
    - **Interfaces are in Sparse mode operation**

Implementing Scoping using Auto-RP, Autorp listener, and Boundary Configuration

Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

- **Concept:**
  - **One set of Anycast RP's per physical zone.**
  - **MSDP peer only between a zone's RP's**
  - **Auto-RP to populate Group/RP cache**
  - **Control Auto-RP packets to control Group/RP cache**

    ip multicast boundary access-list [filter-autorp | in | out]

    - **Match access-list ACEs to C-RP ACEs**
    - **Interface command**

Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

- **Advantages:**
  - **Fast RP failure over**
  - **Less configuration to modify the group range**
    - **Change ACL on C-RP routers**
    - **Change ACL on Boundary routers**
- **Disadvantages:**
  - **Can lose Group/RP cache, must wait for MA packet**
    - **Mitigated by using the "interval" option in the rp-send-discovery command**
  - **Need for special boundary filtering at scope boundaries**

Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

- **By using:**
  - **Auto-RP/autorp listener**
  - **Anycast-RP (including MSDP)**
  - **Sparse Mode interface configuration**
- **We can achieve a relatively fast convergence.**

Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

- **Multicast Boundary Command**

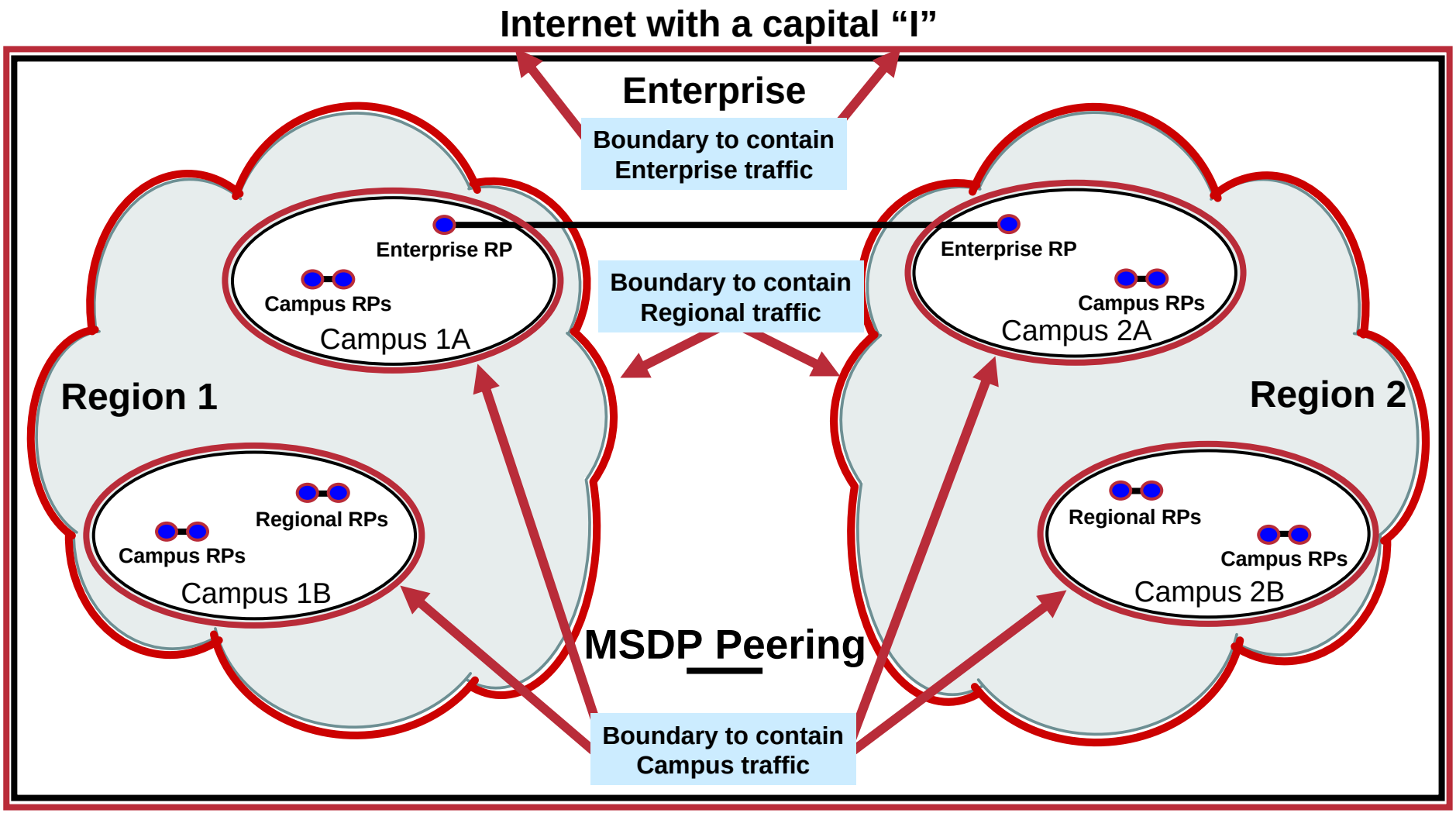
  ip multicast boundary <acl> [filter-autorp]

  - **New ‘filter-autorp’ option**
    - **Filters contents of Auto-RP packets**
      - » **Filters both Announcement and Discovery messages**
      - » **C-RP/MA entries that match “deny” ACE are removed from packet**
    - **Prevents C-RP/MA information from crossing the edge of a scoped zone.**
    - **Greatly simplifies Administratively-Scoped Zone support using Auto-RP.**
    - **Available in 12.0(22)S, 12.1(26)E, 12.2(18)SXD 12.2(12).**

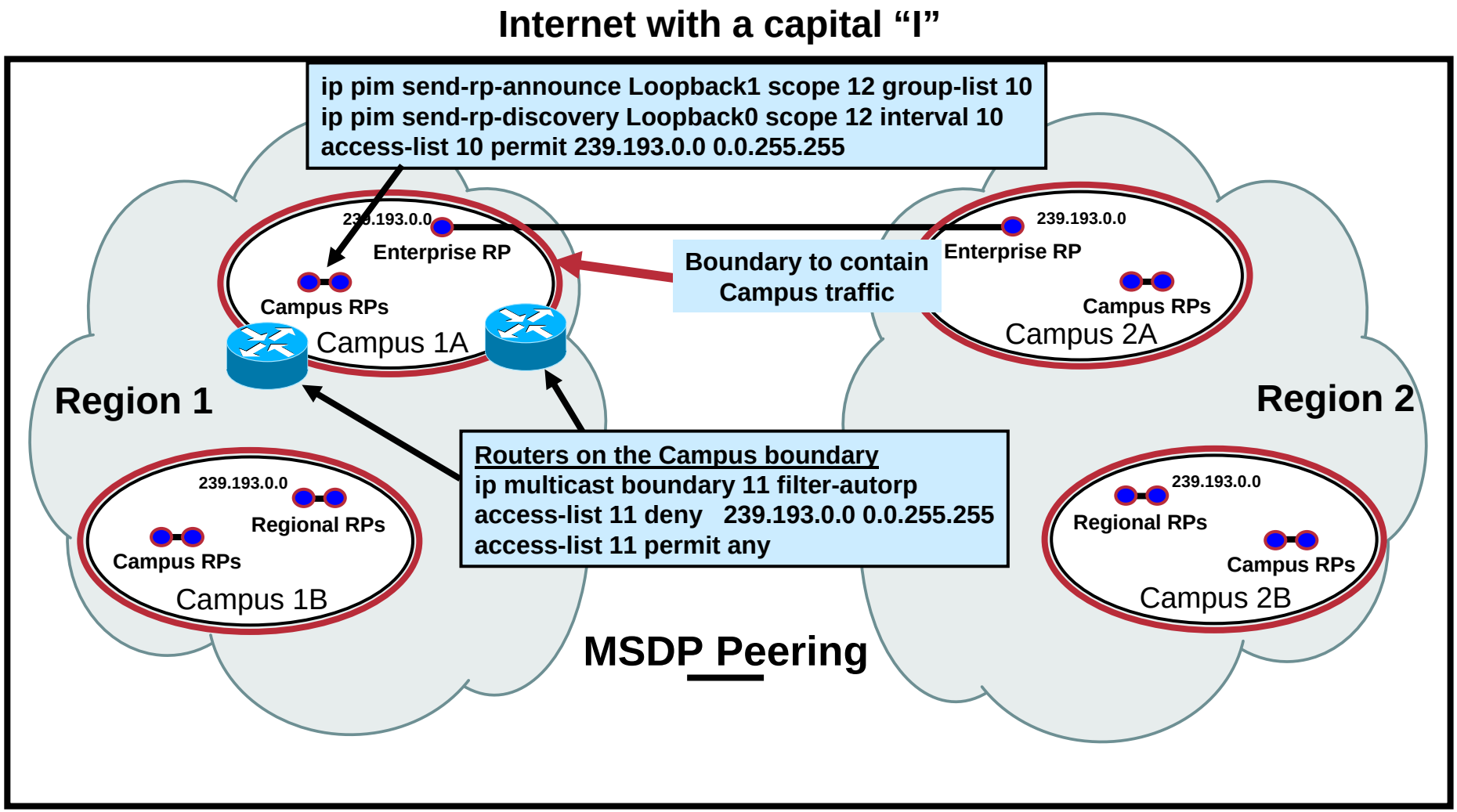
Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

- How ‘filter-autorp’ option works:
  - For each RP Entry in Auto-RP packet:
    - If group-range in RP-Entry ‘*intersects*’ any ‘denied’ group-range in the Multicast Boundary ACL,
    - Delete the RP Entry from Auto-RP packet.
  - If resulting Auto-RP packet is non-empty,
    - Forward across multicast boundary.
    - Usually the MA packet is non-empty
- Simple method to ensure success
  - Always match Auto-RP Group-Range ACLs to Multicast Boundary ACLs.
  - Never use overlapping Auto-RP group ranges.

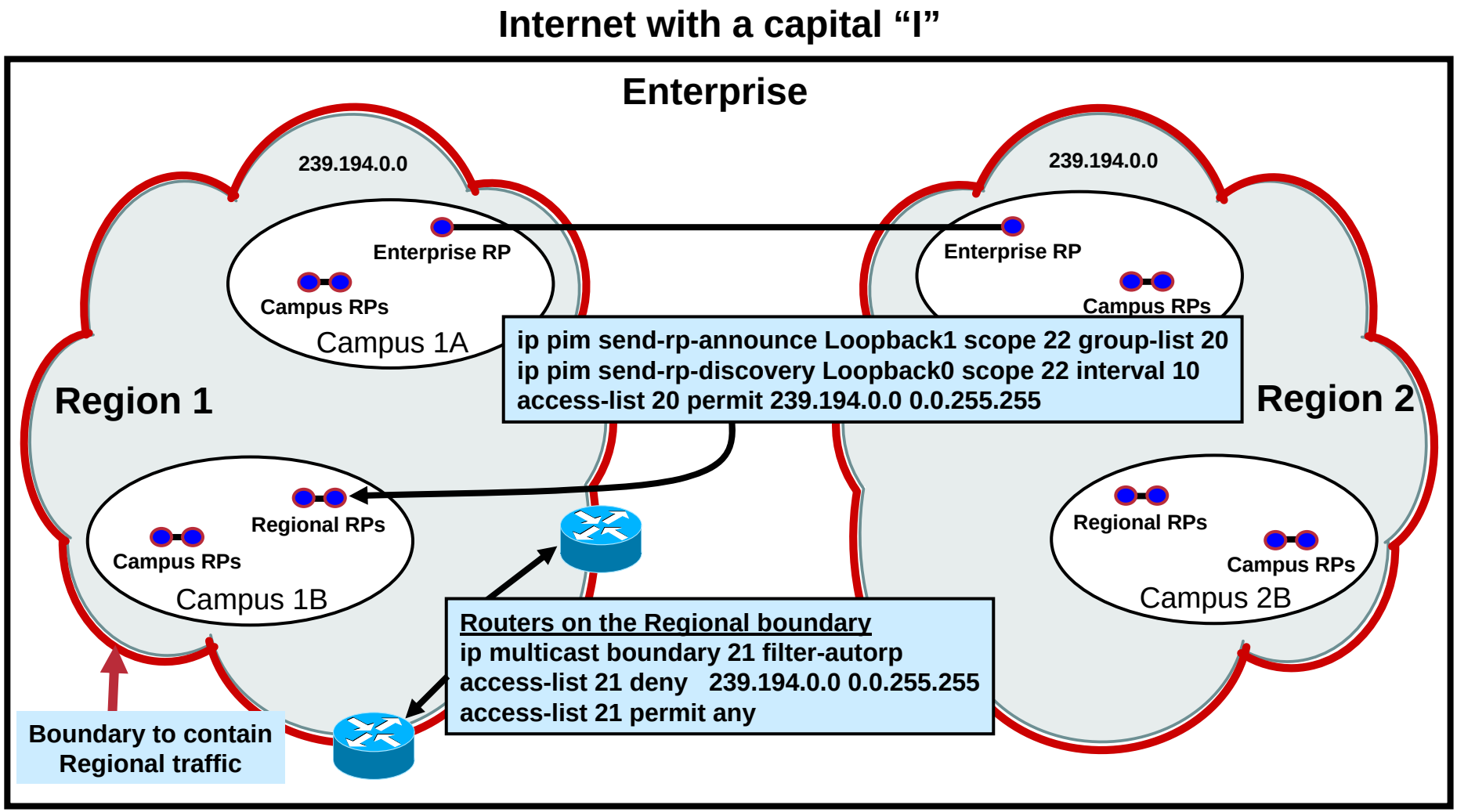
Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP



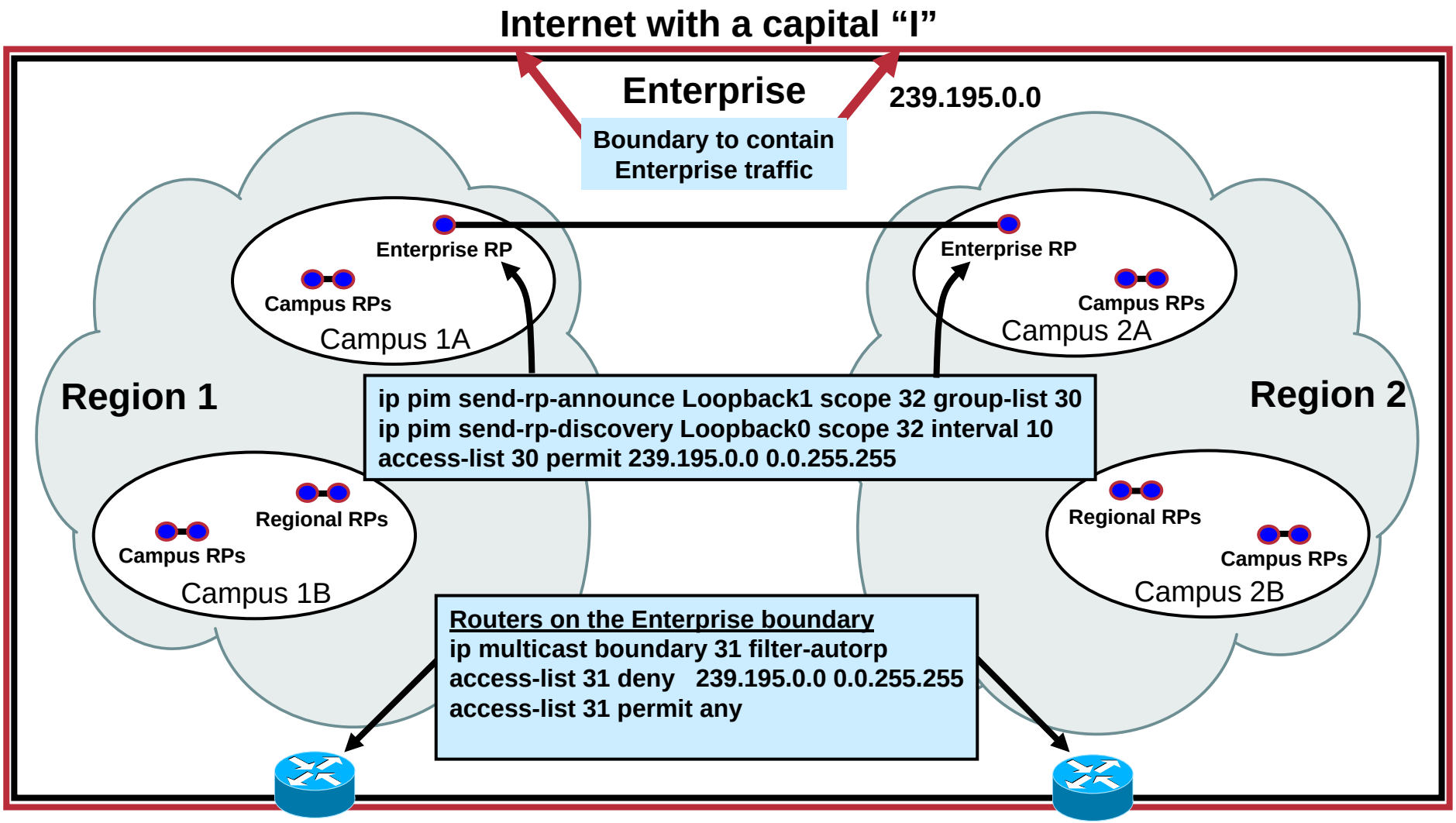
Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP



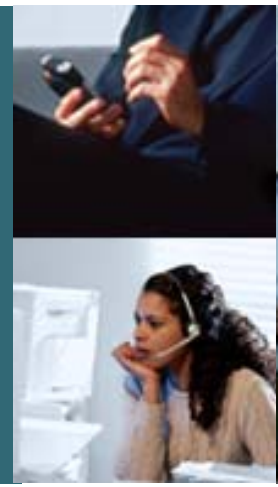
Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP



Implementing Administratively-Scoped Zones Anycast-RP with Auto-RP

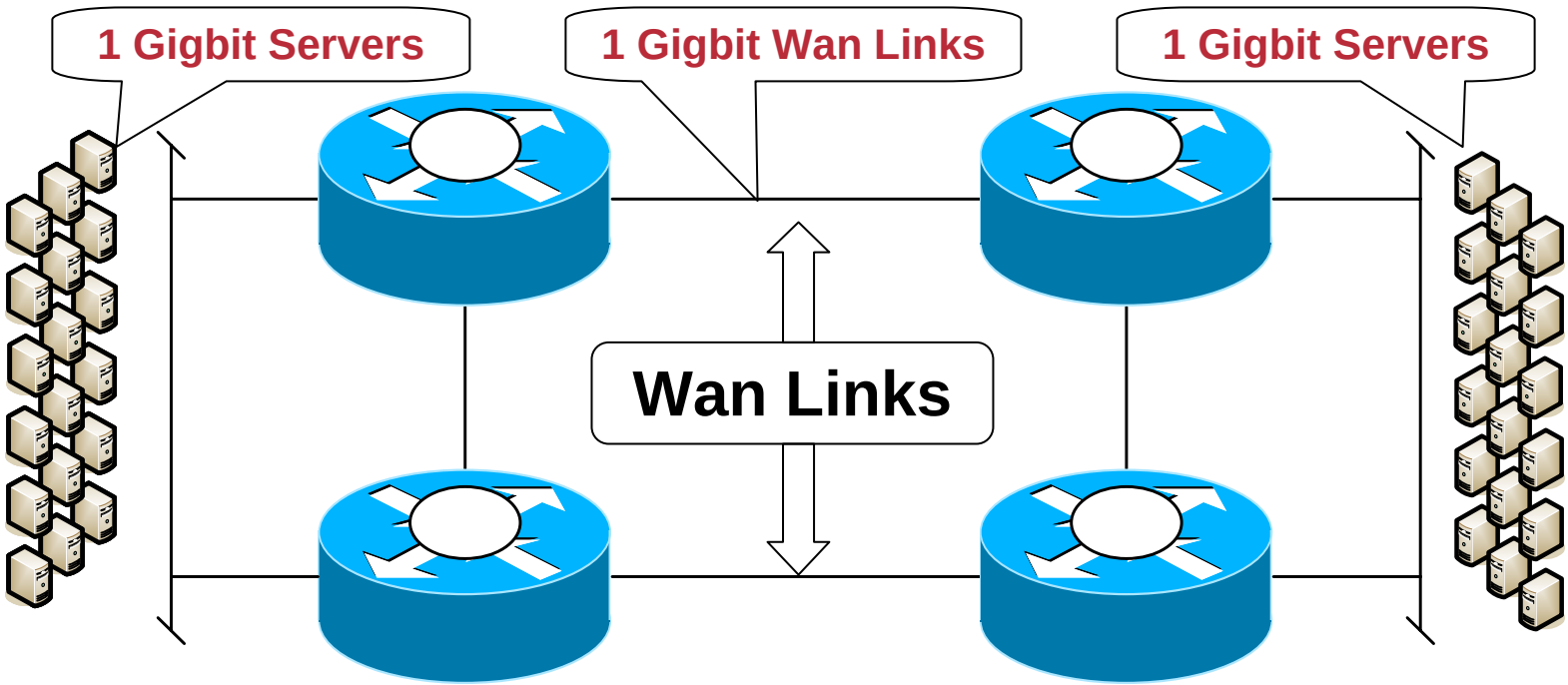


Load Splitting via Group Range



Load Splitting via BiDir RPs

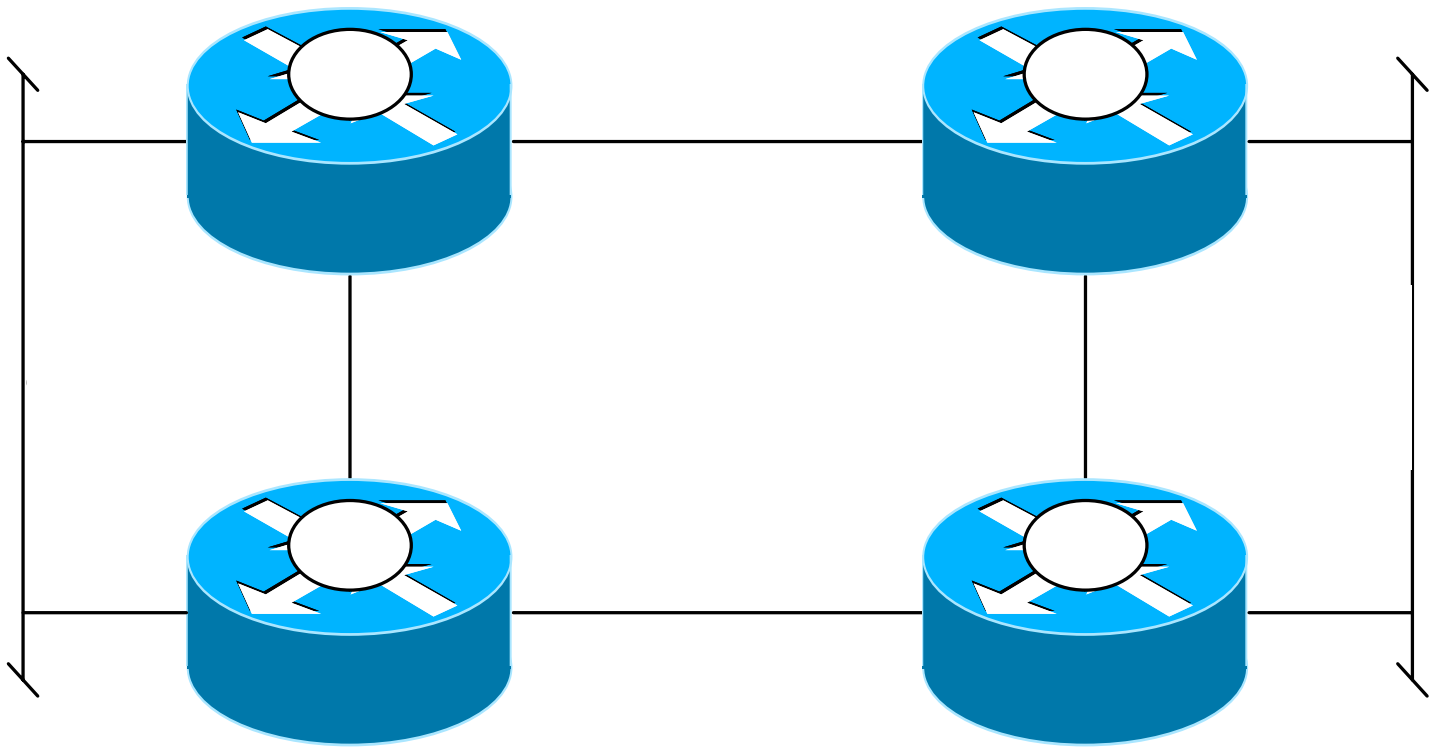
Utilize bandwidth on both Wan links



Load Splitting via BiDir RPs

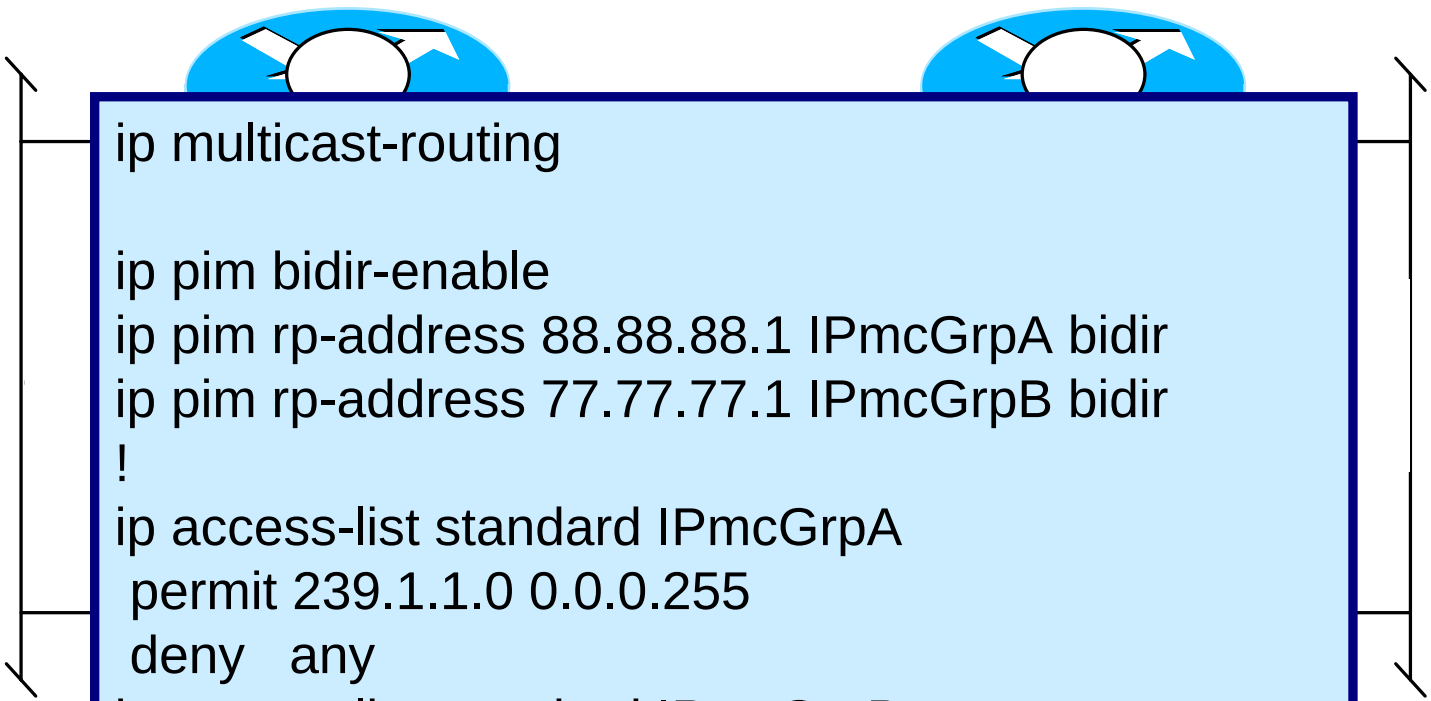
- **A Solution**
  - **Configure Bidir PIM**
  - **Use 2 RP sets, one set for each Data Center**
  - **Use Phantom RP**
  - **Engineer LAN's DF and "best metric" RP on same router**
- **A simple configuration**
  - **Easy to support**
  - **Easy to troubleshoot**

Load Splitting via BiDir RPs



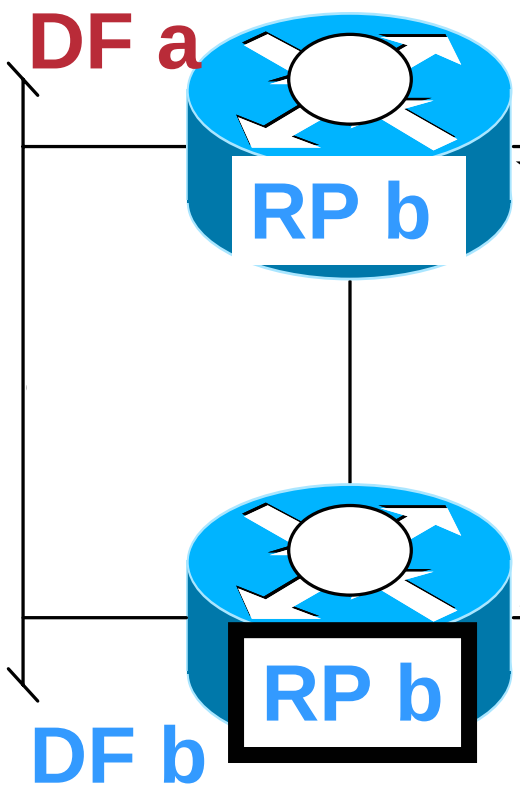
Load Splitting via BiDir RPs

Common configuration to all routers



```
ip multicast-routing

ip pim bidir-enable
ip pim rp-address 88.88.88.1 IPmcGrpA bidir
ip pim rp-address 77.77.77.1 IPmcGrpB bidir
!
ip access-list standard IPmcGrpA
 permit 239.1.1.0 0.0.0.255
 deny   any
ip access-list standard IPmcGrpB
 permit 239.1.2.0 0.0.0.255
 deny   any
```

Load Splitting via BiDir RPs



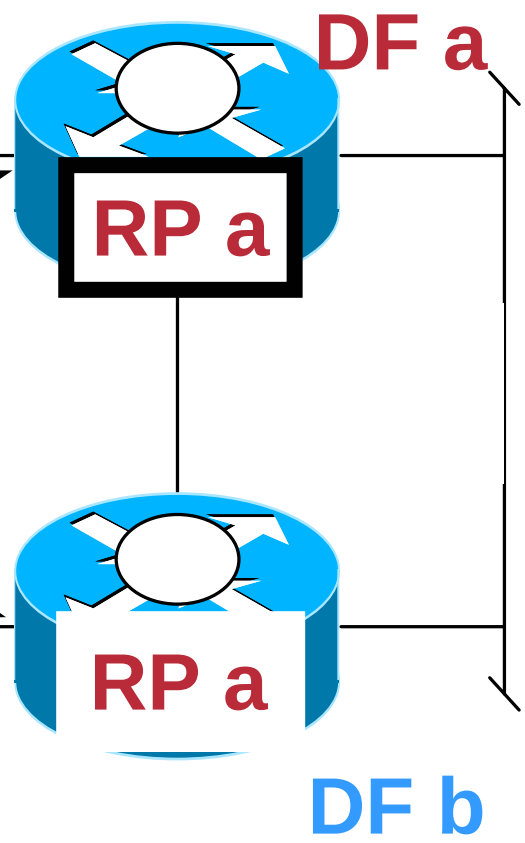

```
interface Loopback1
 description *** Anycast-RP Grp B ***
 ip address 77.77.77.1 255.255.255.248
 ip pim sparse-mode
 ip ospf network point-to-point

interface Ethernet0/0
 ip address 8.8.8.1 255.255.255.0
 ip pim query-interval 1
 ip pim sparse-mode
```

```
interface Loopback1
 description *** Anycast-RP Grp B ***
 ip address 77.77.77.1 255.255.255.252
 ip pim sparse-mode
 ip ospf network point-to-point
!
interface Ethernet0/0
 ip address 8.8.8.2 255.255.255.0
 ip pim query-interval 1
 ip pim sparse-mode
```

Load Splitting via BiDir RPs

```
interface Loopback1
 description *** Anycast-RP Grp A ***
 ip address 88.88.88.1 255.255.255.252
 ip pim sparse-mode
 ip ospf network point-to-point
!
interface Ethernet0/0
 ip address 9.9.9.1 255.255.255.0
 ip pim query-interval 1
 ip pim sparse-mode
```

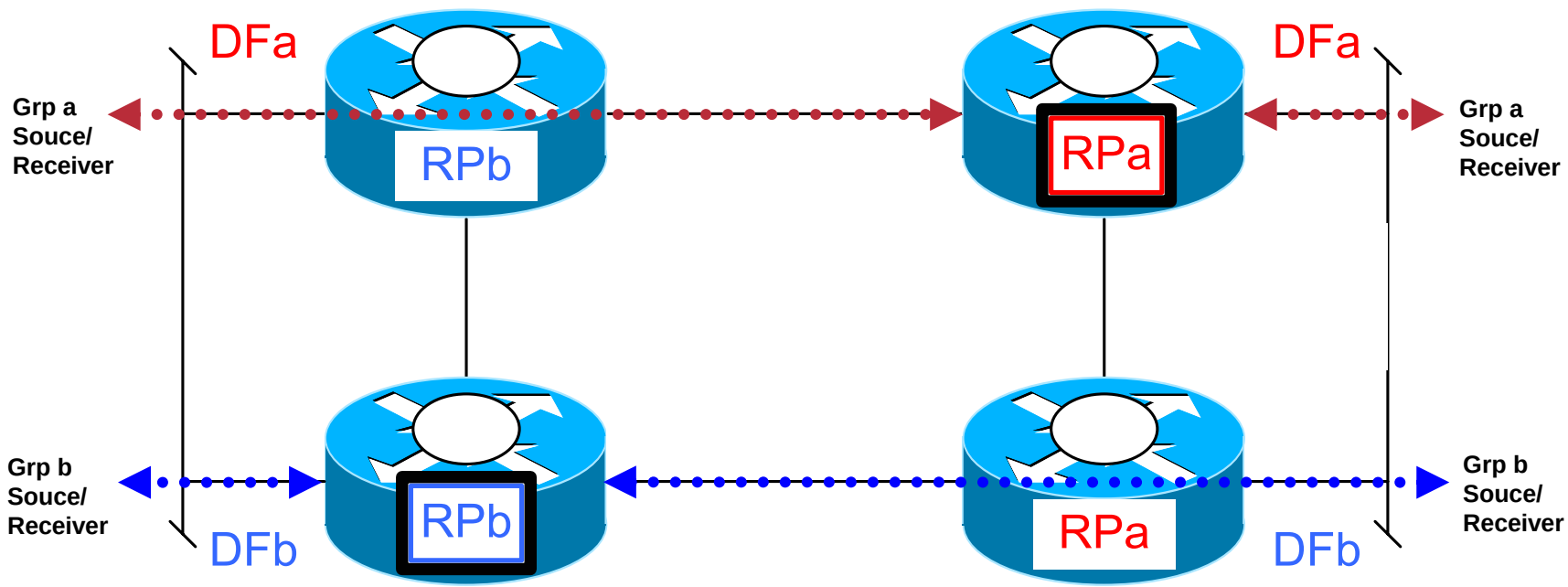
```
interface Loopback1
 description *** Anycast-RP Grp A ***
 ip address 88.88.88.1 255.255.255.248
 ip pim sparse-mode
 ip ospf network point-to-point
!
interface Ethernet0/0
 ip address 9.9.9.2 255.255.255.0
 ip pim query-interval 1
 ip pim sparse-mode
```



Load Splitting via BiDir RPs

Interface	RP	DF Winner
Ethernet0/0	88.88.88.1	8.8.8.1

Interface	RP	DF Winner
Ethernet0/0	88.88.88.1	9.9.9.1



Interface	RP	DF Winner
Ethernet0/0	77.77.77.1	8.8.8.2

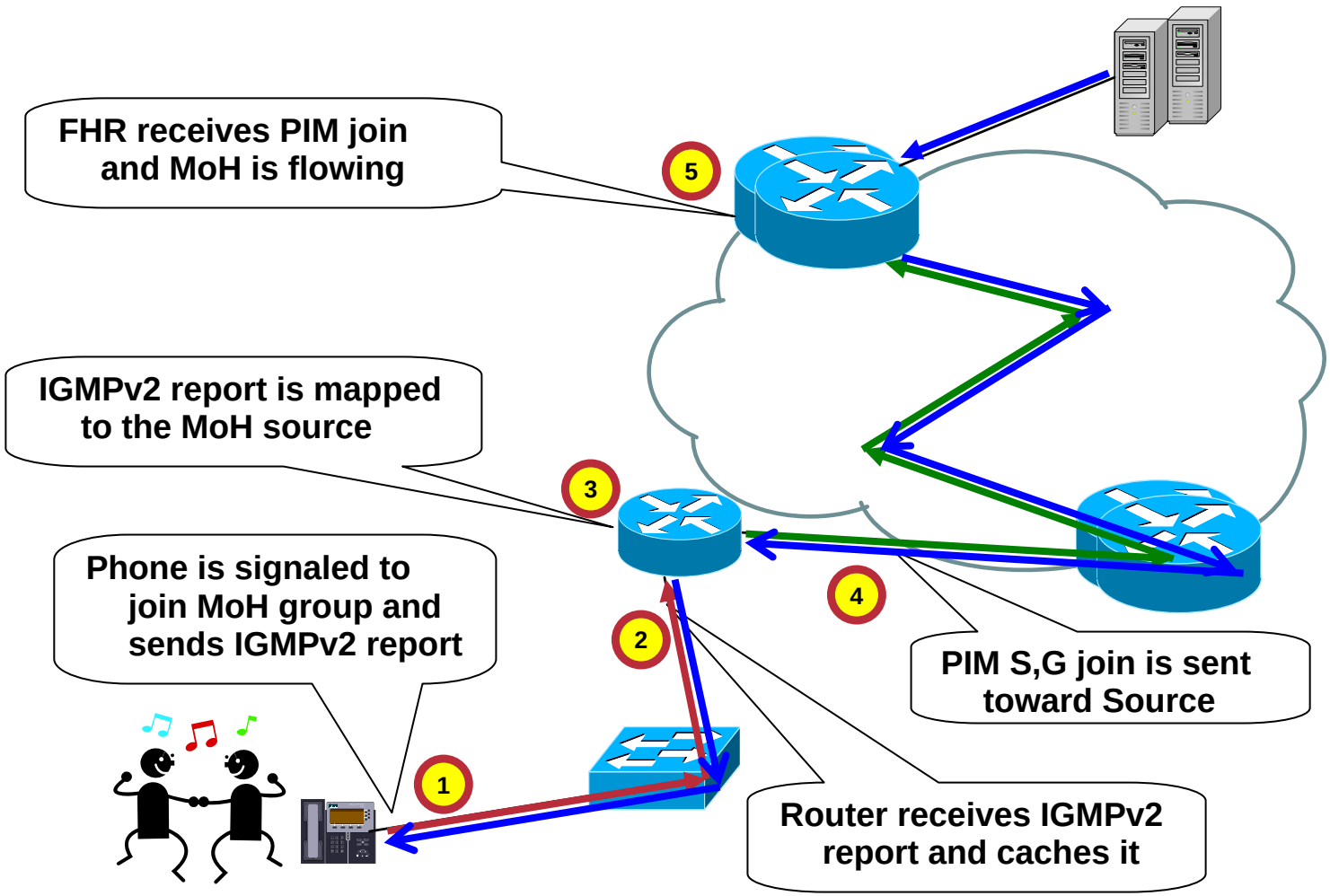
Interface	RP	DF Winner
Ethernet0/0	77.77.77.1	9.9.9.2

SSM mapping for MoH

SSM mapping for MoH

- **Used when the Corporate Standard is SSM globally**
  - **Provides interim configuration for non-IGMPv3 hosts**
- **No RPs to configure**
  - **Simplifies control plane across routers**
- **Simple configuration on LHRs**
  - **SSM mapping is configured only on the LHRs**
  - **Same configurations on all LHRs**
- **SSM mapping was first introduced in 12.3(2)T**

SSM mapping for MoH



SSM mapping for MoH

- Enable SSM range

  ip pim [vrf *vrf-name*] ssm {default | range *access-list*}

- Enable SSM mapping

  ip igmp [**vrf** *vrf-name*] **ssm-map enable**

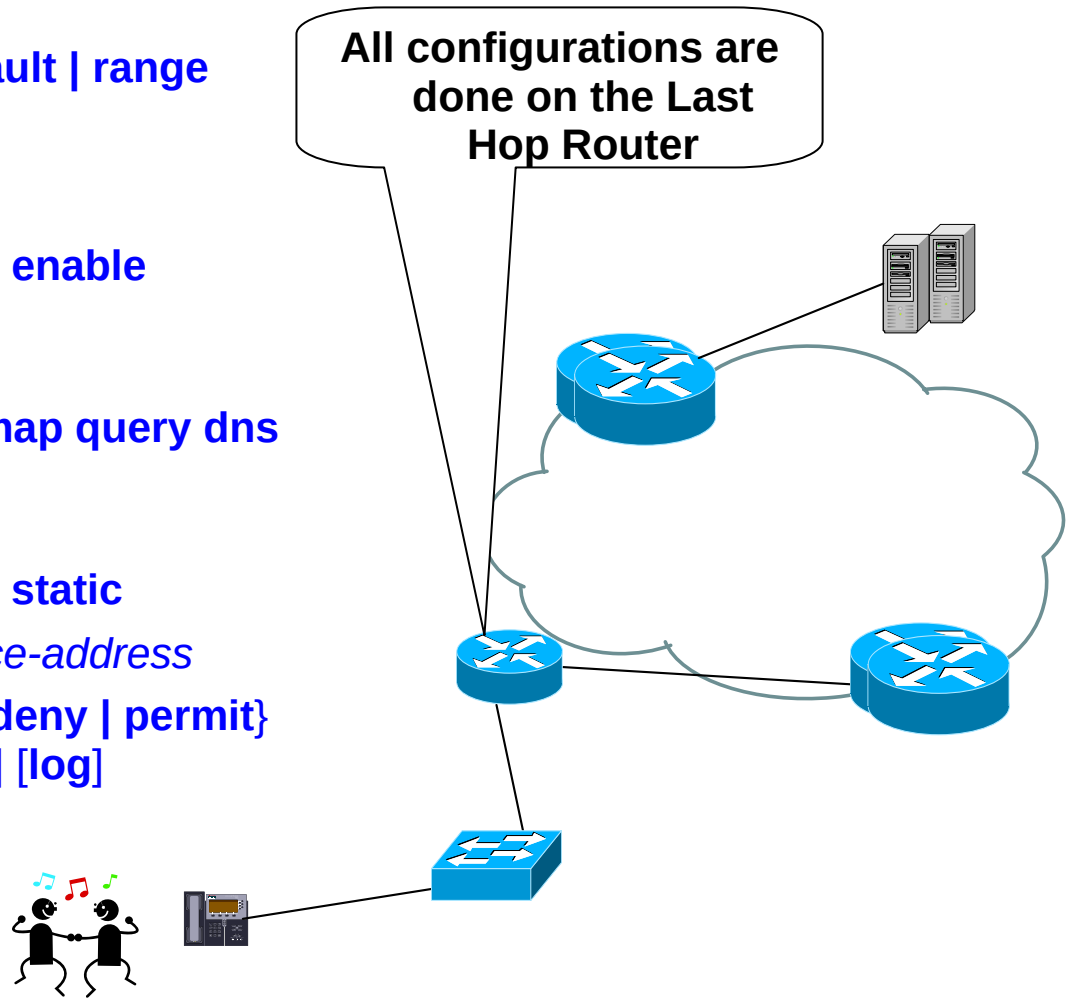
- Disable DNS option:

  no ip igmp [**vrf** *vrf-name*] **ssm-map query dns**

- Create map and ACL

  ip igmp ssm-map [**vrf** *vrf-name*] **static** *access-control-list source-address*

  access-list *access-list-number* {**deny | permit**} *source* [*source-wildcard*] [**log**]



SSM mapping for MoH

Configuration on all routers

ip pim ssm range 64

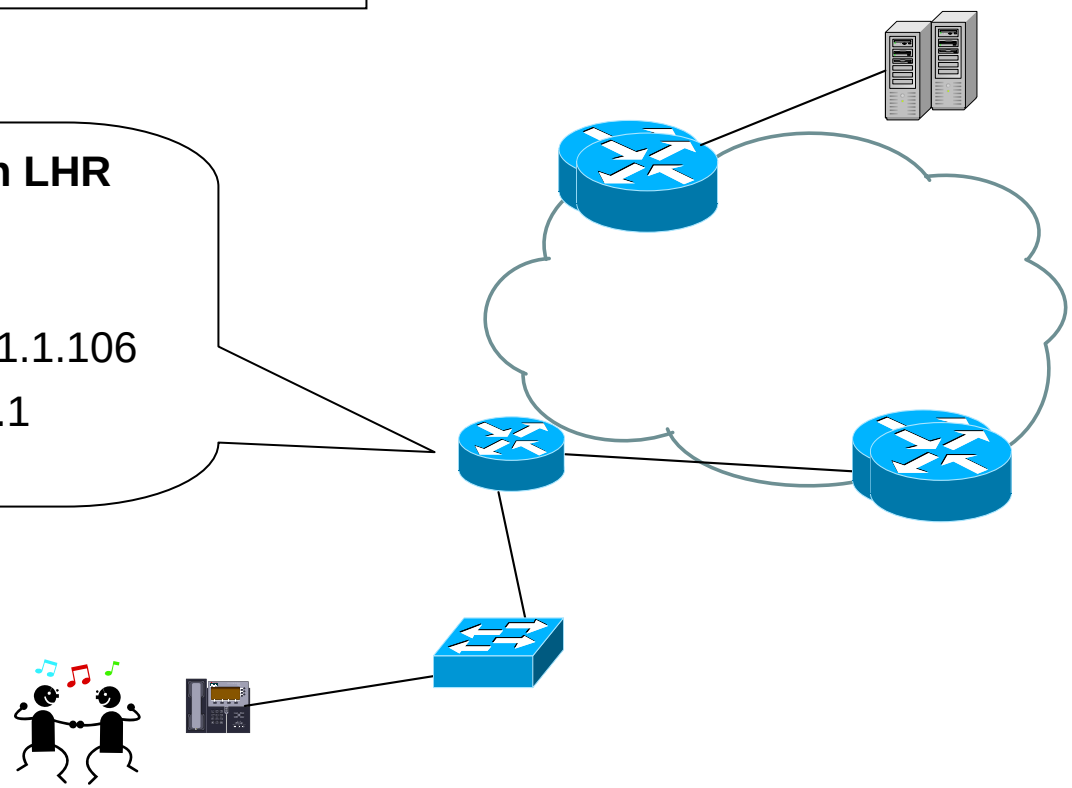
access-list 64 permit 239.232.0.0 0.0.255.255

SSM mapping configurations on LHR

ip igmp ssm-map enable

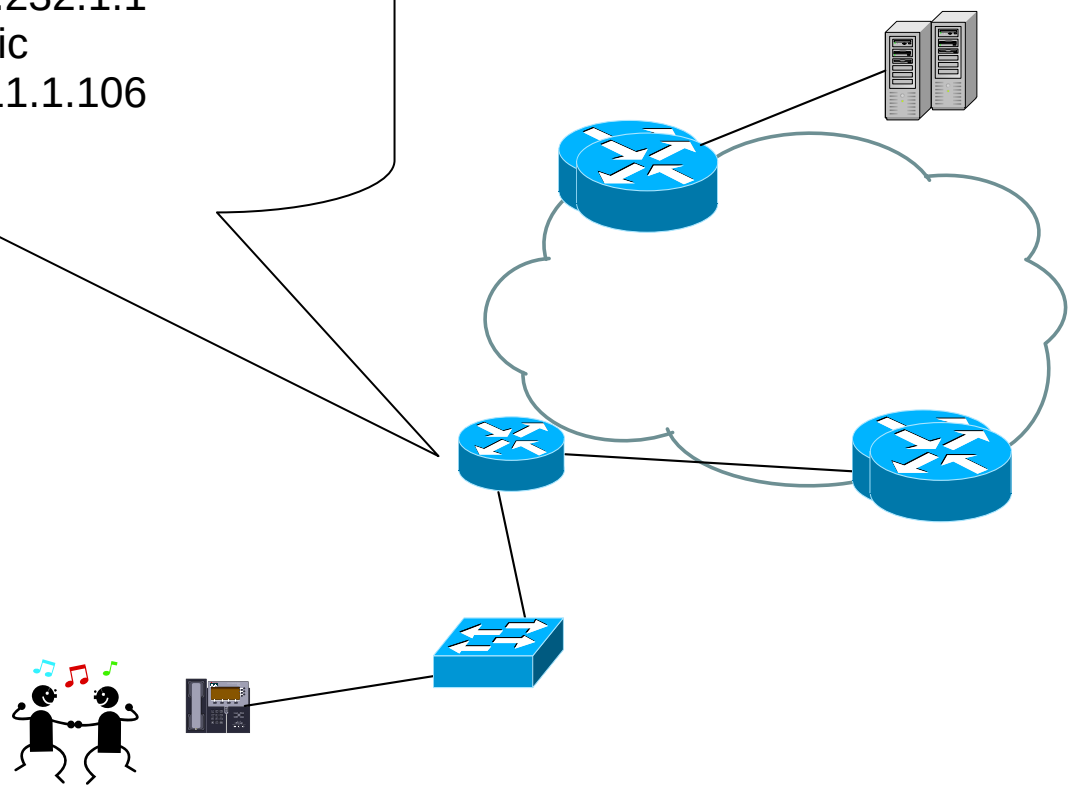
no ip igmp ssm-map query dns
ip igmp ssm-map static 12 33.11.1.106

access-list 12 permit 239.232.1.1



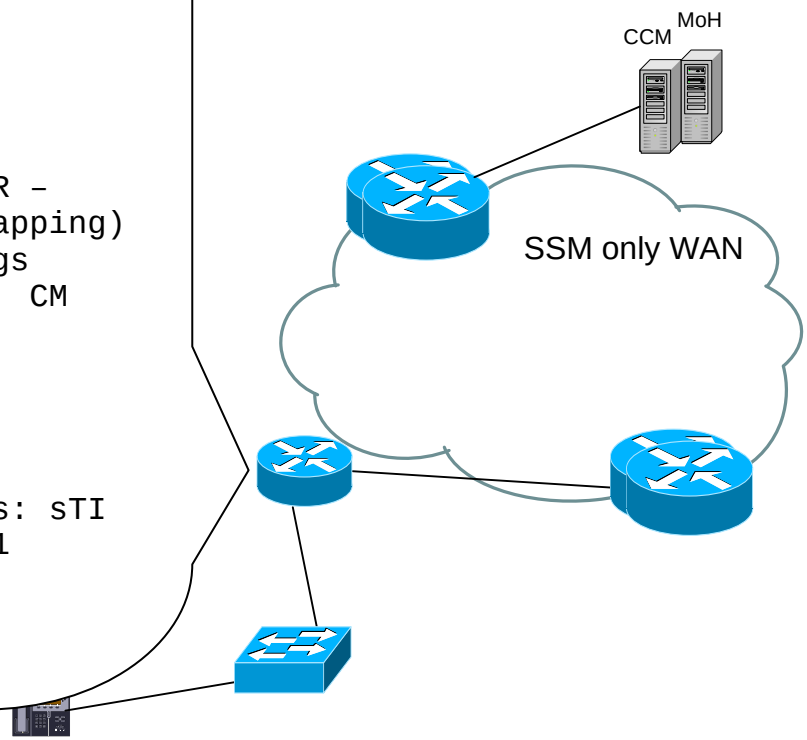
SSM mapping for MoH

```
Router# sh ip igmp ssm-mapping 239.232.1.1
        Group address      : 239.232.1.1
        Database           : Static
        Source list        : 33.11.1.106
```



SSM mapping for MoH

```
Router# show ip igmp group 239.232.1.1 detail
Interface:                Vlan20
Group:                    239.232.1.1
Flags:                    SSM
Uptime:                   00:25:52
Group mode:               INCLUDE
Last reporter:            0.0.0.0
CSR Grp Exp:              00:02:56
Group source list: (C - Cisco Src Report, U - URD, R –
         Remote, S - Static, V - Virtual, M - SSM Mapping)
Source Address  Uptime   v3 Exp   CSR Exp  Fwd  Flags
  33.11.1.106    00:25:52  stopped   00:02:56   Yes  CM



Router# show ip mroute 239.232.1.1

(33.11.1.106, 239.232.1.1), 00:07:37/00:02:34, flags: sTI
  Incoming interface: Ethernet0/0, RPF nbr 11.11.2.1
  Outgoing interface list:
    Ethernet1/0, Forward/Sparse, 00:07:37/00:02:34
```



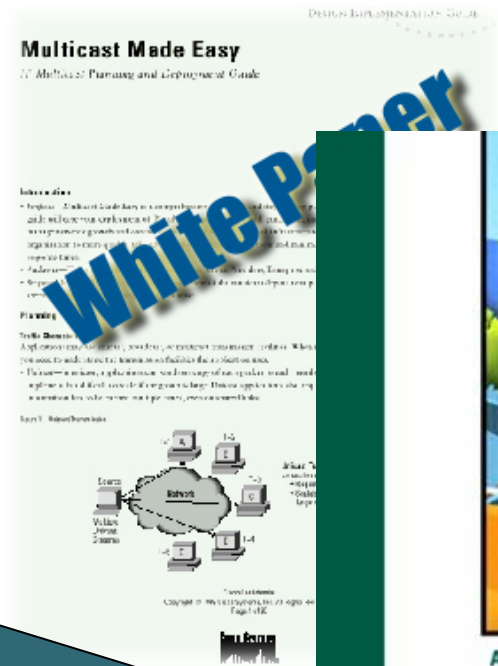
Summary - SSM mapping for MoH

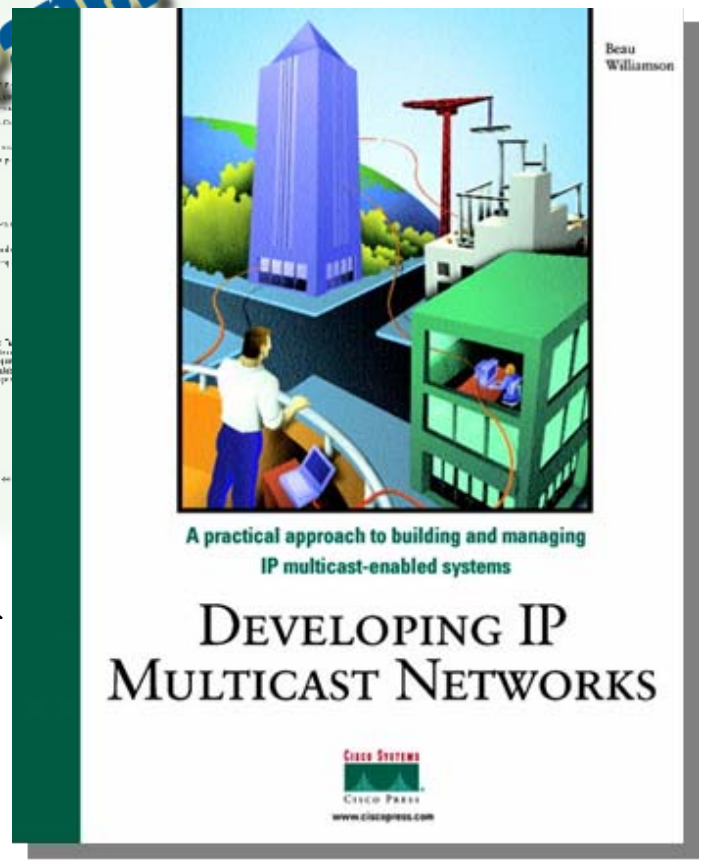
- **Advantages**
  - **SSM Mapping provides compliance for IGMPv2 hosts in a SSM environment**
  - **SSM Mapping avoids more complex solutions for IP Multicast, i.e. GRE tunnels, RP configurations, etc.**
- **Disadvantages**
  - **SSM Mapping is static**
  - **Configuration on the LHRs**

More Information

- White Papers
- Web and Mailers
- Cisco Press

RTFB

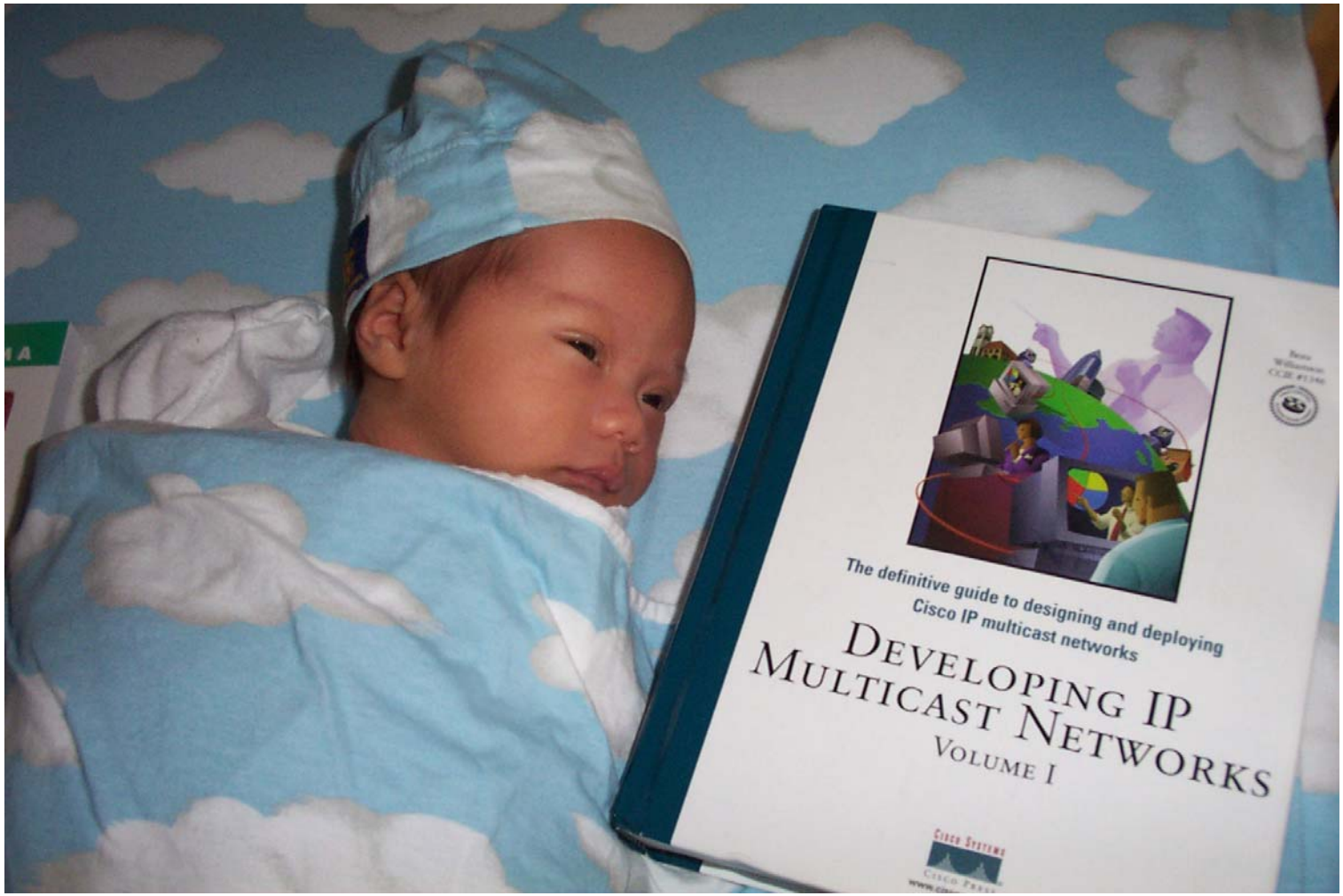




CCO Multicast page:
http://www.cisco.com/go/ipmulticast
Questions:
cs-ipmulticast@cisco.com
Customer Support Mailing List:
tac@cisco.com

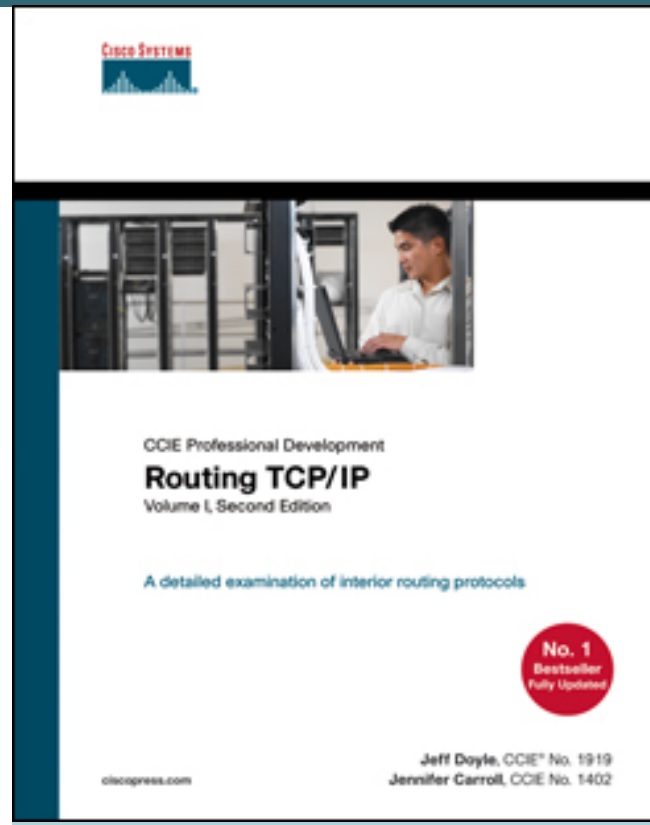
RTFB = "Read the Fine Book"

Multicast Bedtime Stories



Recommended Reading

- **Continue your Cisco Networkers learning experience with further reading from Cisco Press**
- **Check the Recommended Reading flyer for suggested books**



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  - Thursday, June 22 at 12:15 p.m. and 2:00 p.m.

Appendix

- Configuring SSM
- Configuring SSM Mapping
- Configuring Bidir
- Configuring Combined Auto-RP & Anycast-RP
- Administrative Scoping Example
- Configuring Admin. Scoping with Auto-RP
- Configuring Admin. Scoping with Anycast-RP

Configuring SSM

- **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 in IOS versions**
    - **12.1(5)T, 12.2, 12.0(15)S, 12.1(8)E**

SSM Mapping Configuration

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
```

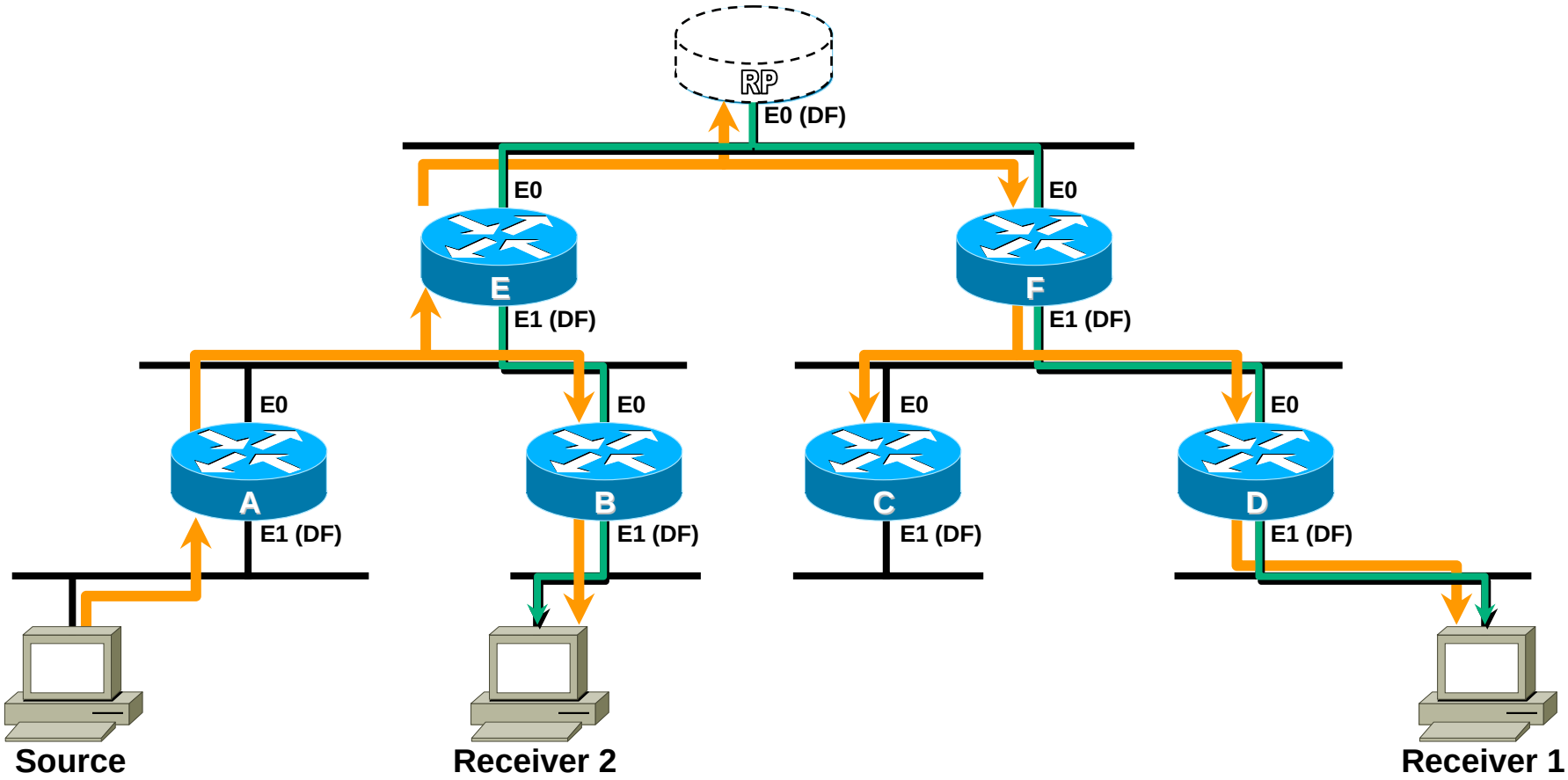
```
DNS Record Format:   3.2.1.232        IN A   172.23.20.70
```

Configuring Bidir PIM
(Auto-RP Example)

- **Define Candidate RP and groups / modes it is willing to serve**

```
ip pim send-rp-announce Loopback0 scope 10 group-list 45 bidir
ip pim send-rp-announce Loopback1 scope 10 group-list 46
! Two loopbacks needed due to a nature of ACLs (permit, deny)
ip pim send-rp-discovery scope 10

access-list 45 permit 224.0.0.0 0.255.255.255
access-list 45 permit 227.0.0.0 0.255.255.255
! 224/8 and 227/8 will be PIM Bidir groups
access-list 45 deny 225.0.0.0 0.255.255.255
! 225/8 will be a PIM Dense Mode group

access-list 46 permit 226.0.0.0 0.255.255.255
! 226/8 will be a PIM Sparse Mode group
```

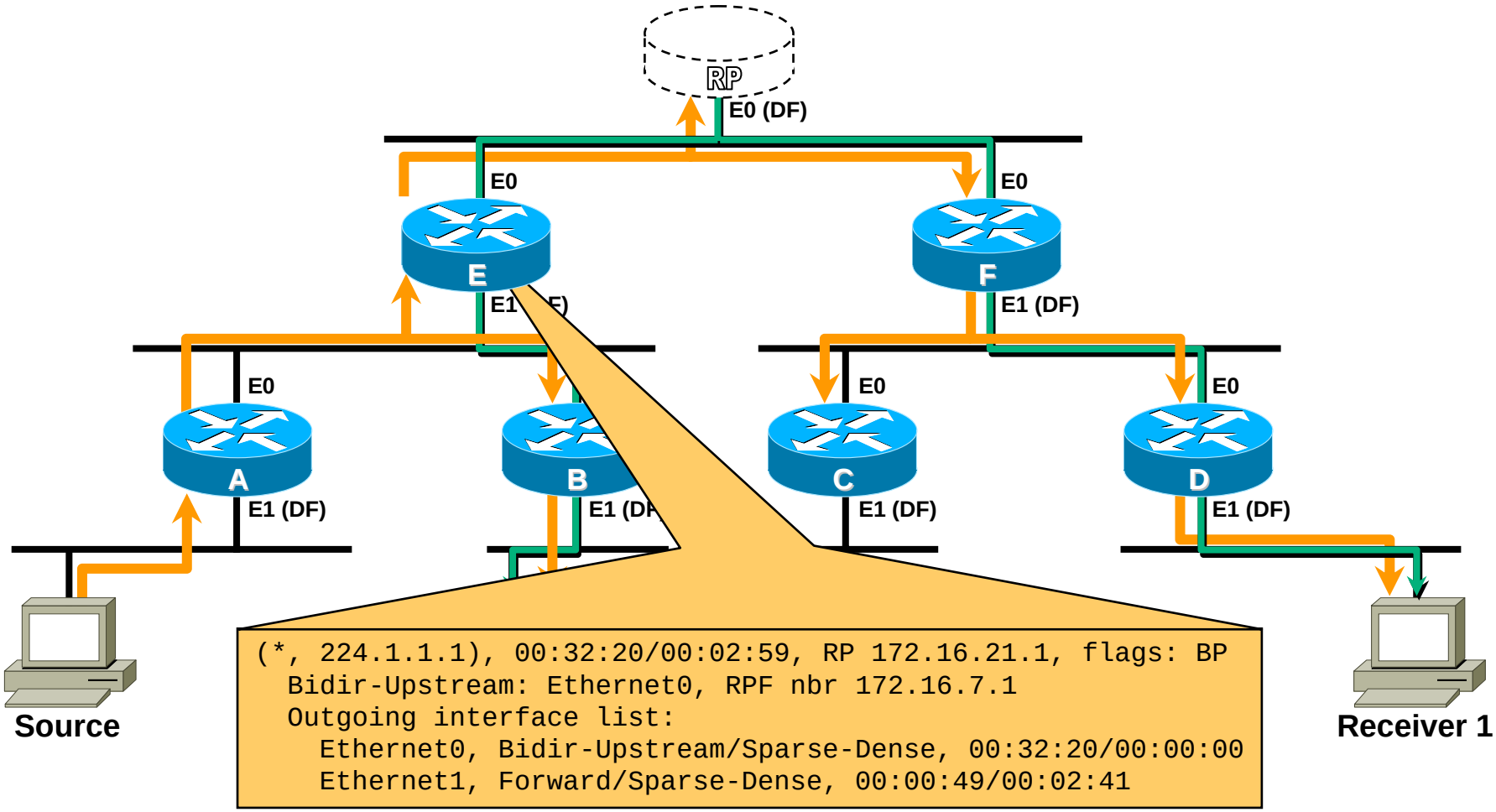
Bidir PIM – Phantom RP



Question: Does a Bidir RP even have to physically exist?

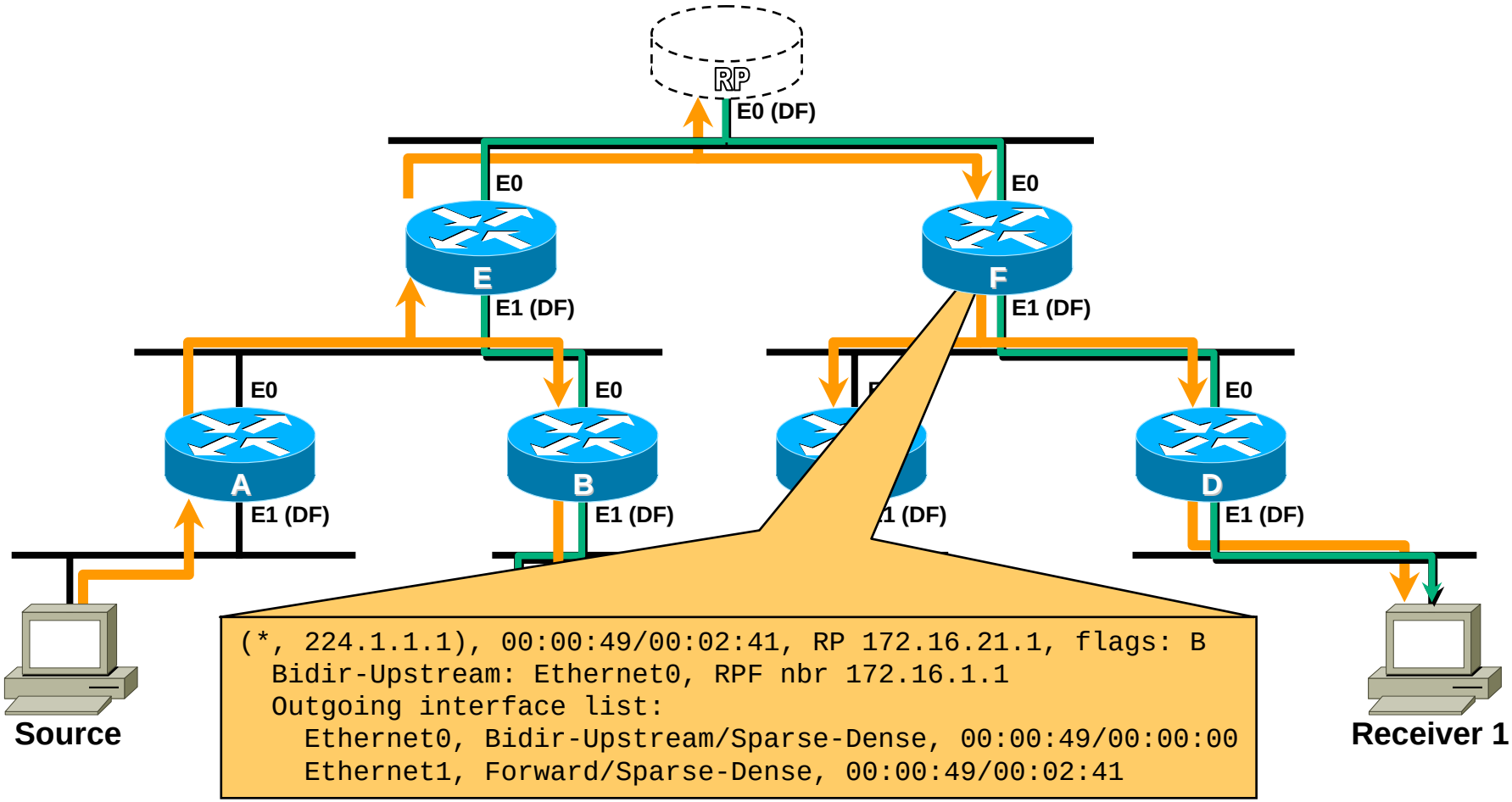
Answer: No. It can just be a phantom address.

Bidir PIM – Phantom RP



Router “E” forwards traffic onto core LAN segment.

Bidir PIM – Phantom RP

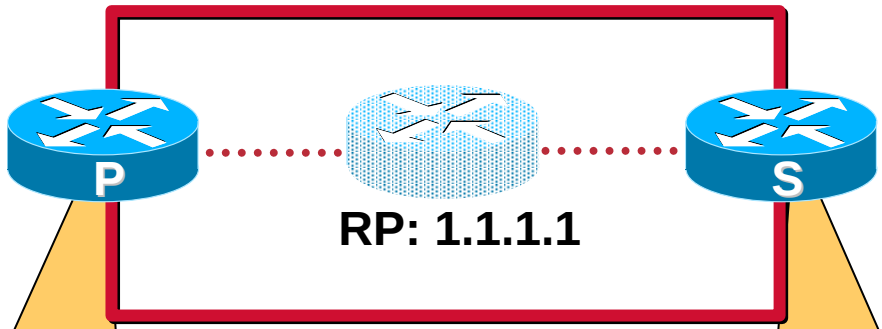


Router “F” forwards traffic on down the Shared Tree ala normal PIM-SM.

RP doesn’t even have to physically exist.

Phantom RP on Point-to-Point Core

Static Route Method

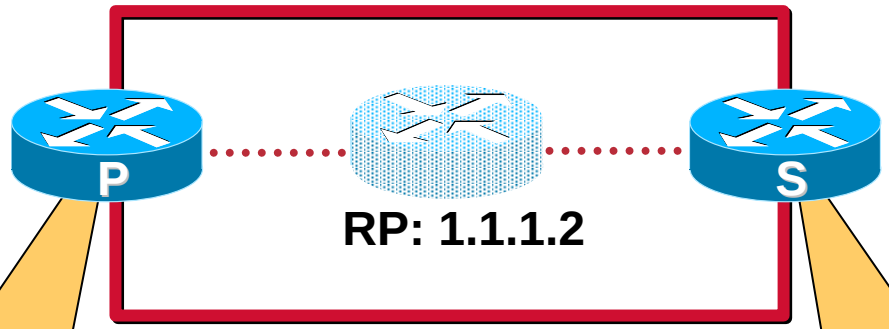



```
ip multicast-routing

interface Loopback0
 ip address 11.0.0.1 255.255.255.255
 ip pim sparse-mode

router ospf 11
 redistribute static subnets

ip route 1.1.1.1 255.255.255.255 Loopback0

ip pim bidir-enable
ip pim rp-address 1.1.1.1 bidir
```

```
ip multicast-routing

interface Loopback0
 ip address 11.0.0.2 255.255.255.255
 ip pim sparse-mode

router ospf 11
 redistribute static subnets

ip route 1.1.1.0 255.255.255.254 Loopback0

ip pim bidir-enable
ip pim rp-address 1.1.1.1 bidir
```

Phantom RP on Point-to-Point Core

Netmask Method




```
ip multicast-routing
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.252
 ip pim sparse-mode
 ip ospf network point-to-point
!
router ospf 11
 network 1.1.1.0 0.0.0.3 area 0
 network 10.1.1.0 0.0.0.255 area 0
 network 10.1.2.0 0.0.0.255 area 0
!
ip pim bidir-enable
ip pim rp-address 1.1.1.1
ip pim rp-address 1.1.1.2 bidir
```

```
ip multicast-routing
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.248
 ip pim sparse-mode
 ip ospf network point-to-point
!
router ospf 11
 network 1.1.1.0 0.0.0.7 area 0
 network 10.1.1.0 0.0.0.255 area 0
 network 10.1.2.0 0.0.0.255 area 0
!
ip pim bidir-enable
ip pim rp-address 1.1.1.1
ip pim rp-address 1.1.1.2 bidir
```

Combining Auto-RP and Anycast-RP

Configuration Steps

1. **Enable Auto-RP**
   - **Newer IOS images**
     - » **Use ip pim autorp listener global command and configure ip pim sparse-mode on all interfaces.**
   - **Older IOS images**
     - » **Configure ip pim sparse-dense-mode on all interfaces.**
2. **Configure Auto-RP Mapping Agents**

```
ip pim send-rp-discovery interface Loopback0 scope 32
```

Combining Auto-RP and Anycast-RP

Configuration Steps

3. Block DM Fallback
   - Newer IOS images
     - » Use no ip pim dm-fallback
   - Older IOS images
     - » Configure RP-of-last-Resort

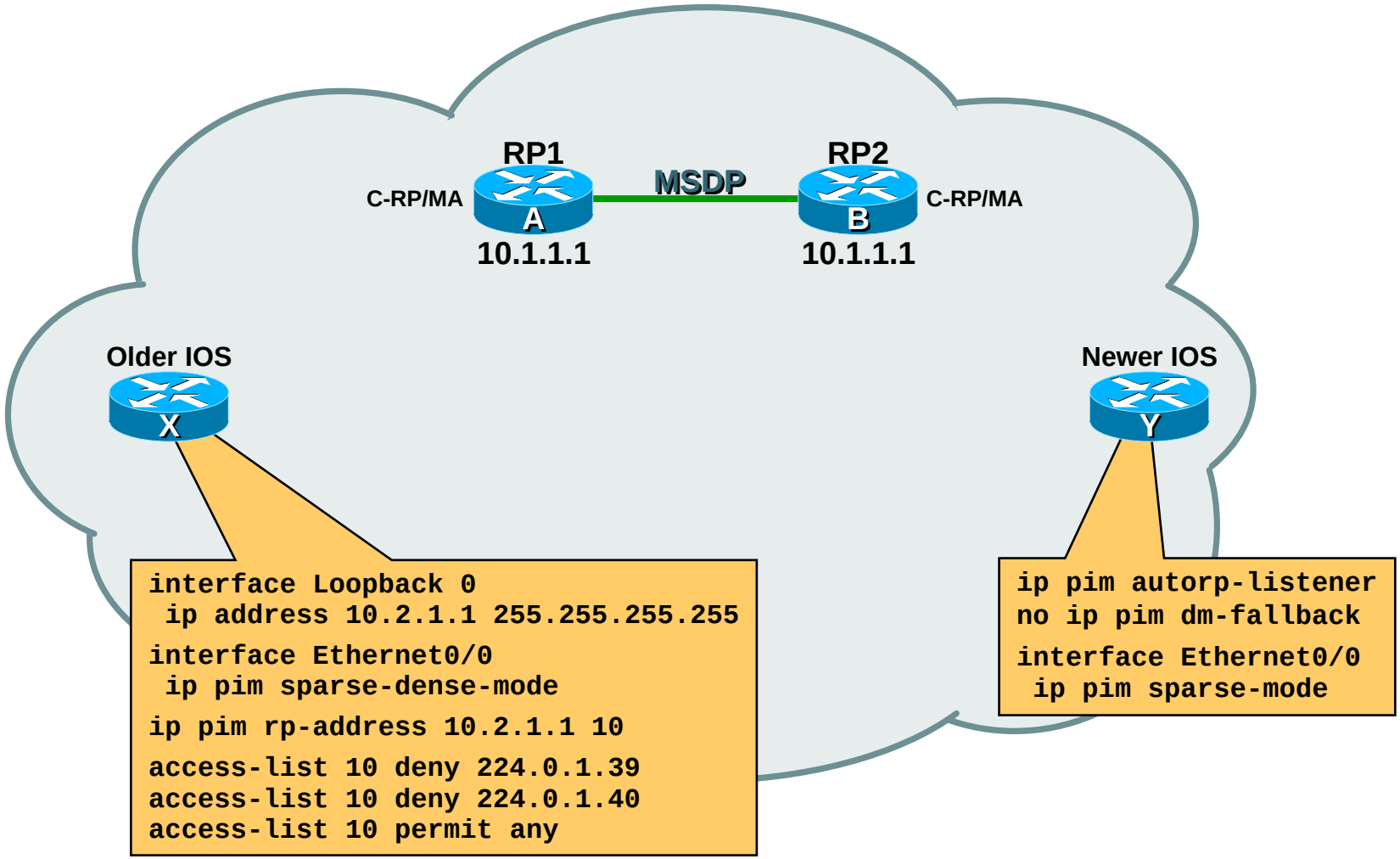
```
ip pim rp-address <local_loopback> 10
access-list 10 deny 224.0.1.39
access-list 10 deny 224.0.1.40
access-list 10 permit any
```

4. Configure Anycast RP's for desired group range.
5. Configure Anycast RP's as Auto-RP C-RP's

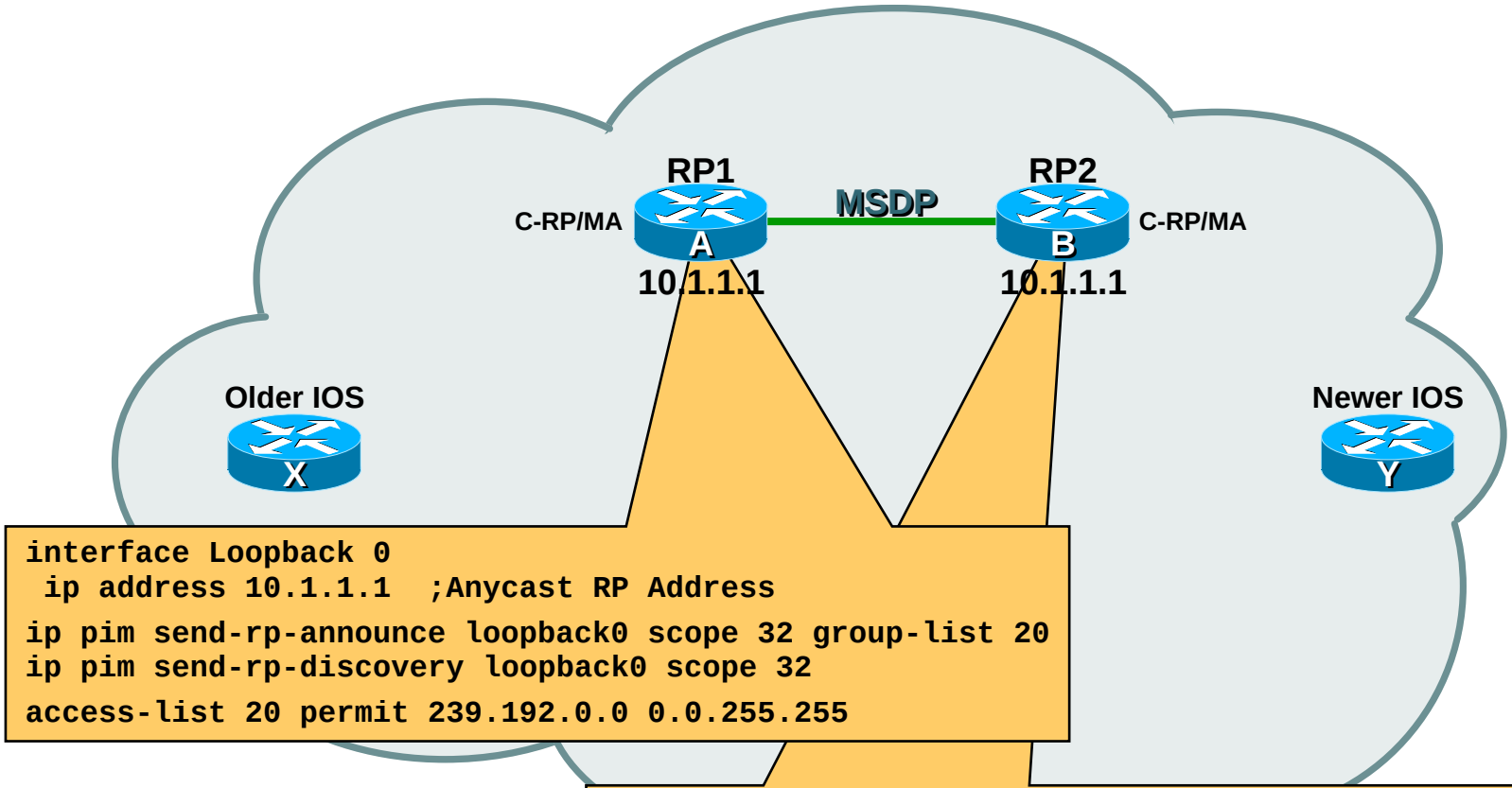
```
ip pim send-rp-discovery Loopback0 scope 32 group-list 10
```

   - Loopback0 = Anycast RP Address
     - » Anycast-RP's will announce Anycast-RP address via Auto-RP

Example Auto-RP and Anycast-RP



Example Auto-RP and Anycast-RP




```
interface Loopback 0
 ip address 10.1.1.1  ;Anycast RP Address
ip pim send-rp-announce loopback0 scope 32 group-list 20
ip pim send-rp-discovery loopback0 scope 32
access-list 20 permit 239.192.0.0 0.0.255.255
```

```
interface Loopback 0
 ip address 10.1.1.1  ; Anycast RP Address
ip pim send-rp-announce loopback0 scope 32 group-list 20
ip pim send-rp-discovery loopback0 scope 32
access-list 20 permit 239.192.0.0 0.0.255.255
```