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Multicast Troubleshooting

BRKIPM-2264

Denise “Fish” Fishburne

Solutions Architect, CCIE #2639, CCDE 2009:0014

Agenda

- Quick Review
- Multicast Troubleshooting Methodology
- Troubleshooting ASM
- Troubleshooting SSM
- Final Troubleshooting Takeaways

Cisco Webex Teams

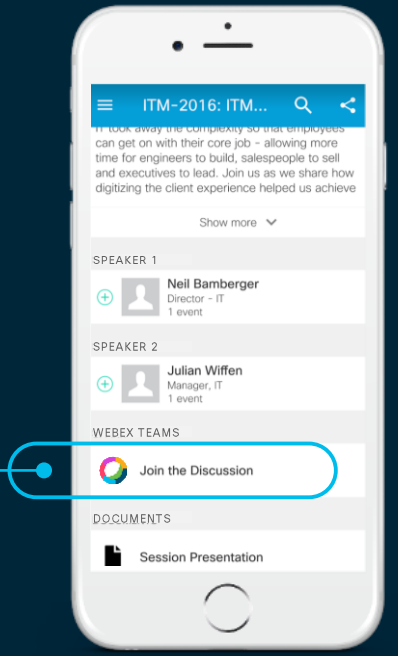
Questions?

Use Cisco Webex Teams to chat with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install Webex Teams or go directly to the team space
4. Enter messages/questions in the team space

Webex Teams will be moderated by the speaker until June 16, 2019.



cs.co/ciscolivebot#BRKIPM-2264

Housekeeping Items

- Cell Phones
- “Intermediate” Class

  Assumes Multicast Operational Experience
- Questions

Quick Review

Quick Review Agenda

- Frequently Used Terms
- Tree Growth
- Sending a (*,G) PIM Join
- Registering a Source
- Designated Routers

Frequently Used Terms

ASM	Any Source Multicast	**FHR**	First Hop Router
SSM	Source Specific Multicast	**LHR**	Last Hop Router
MDT	Multicast Distribution Tree	**IR**	Intermediate Router
RP	Rendezvous Point	**DR**	Designated Router

IGMP	Internet Group Management Protocol
PIM	Protocol Independent Multicast

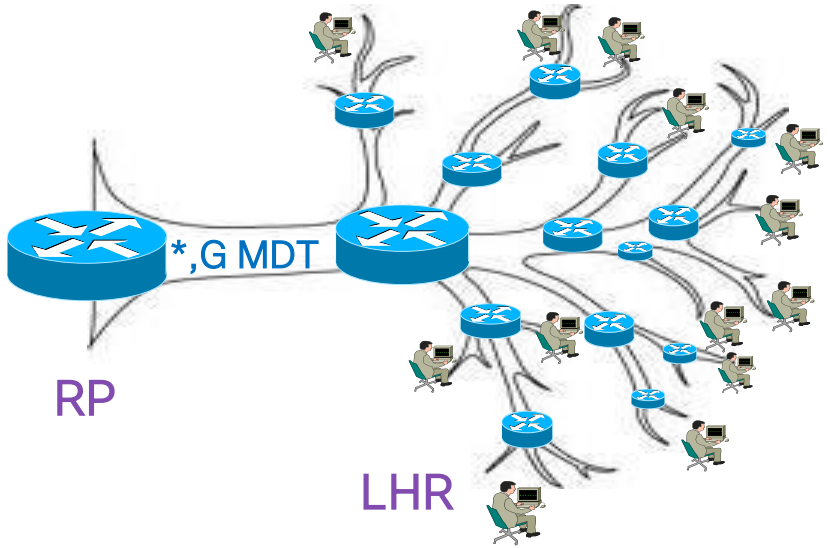
Frequently Used Terms

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

- Source Specific Multicast (**SSM**)
  - a.k.a. Single Source Multicast
  - Supports only Source Trees

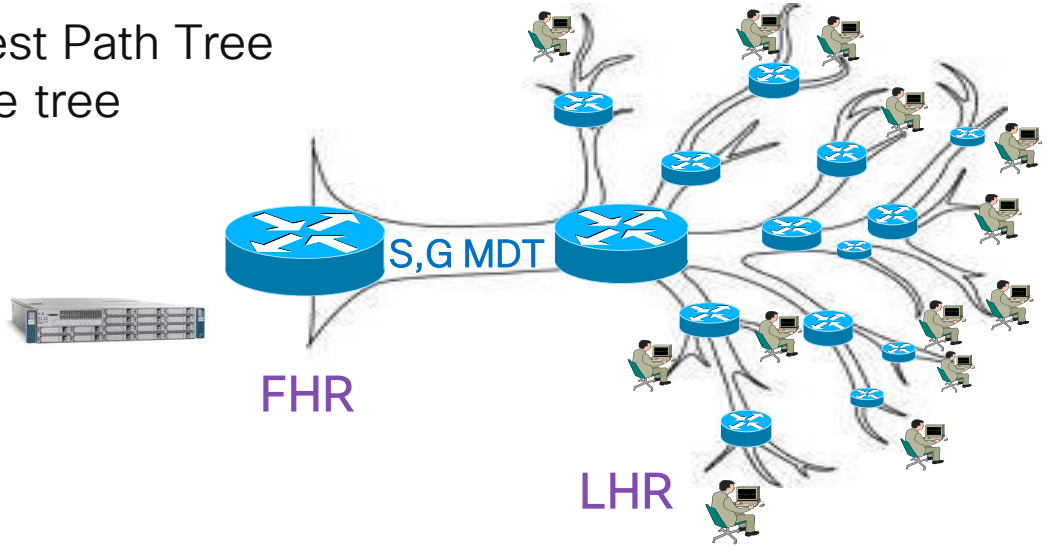
Frequently Used Terms

(*,G) = *,G
= Shared Tree
= RP tree



Frequently Used Terms

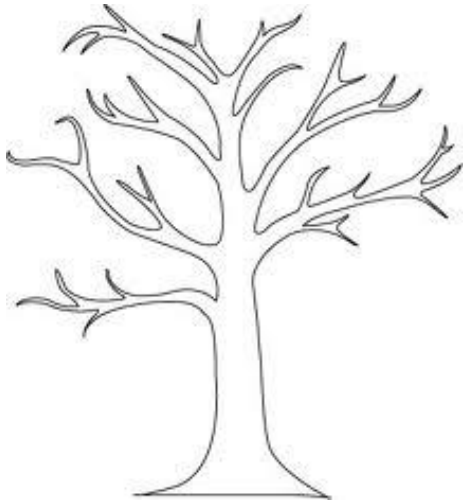
(S,G) = S,G
= Shortest Path Tree
= Source tree



Frequently Used Terms

(*,G) = *,G
= Shared Tree
= RP tree

(S,G) = S,G
= Source Tree
= Shortest Path Tree



Q: What is the Root of the (,G) Tree?*
A: RP

Q: What is the Root of the (S,G) Tree?
A: Source

Frequently Used Terms

IIF Incoming Interface

Interface towards the root of the tree

OIL Outgoing Interface List

Interfaces that have received PIM Joins or IGMP membership requests

Q: What does the IIF of the (*,G) Tree point towards?

A: RP

Q: What does the IIF of the (S,G) Tree point towards?

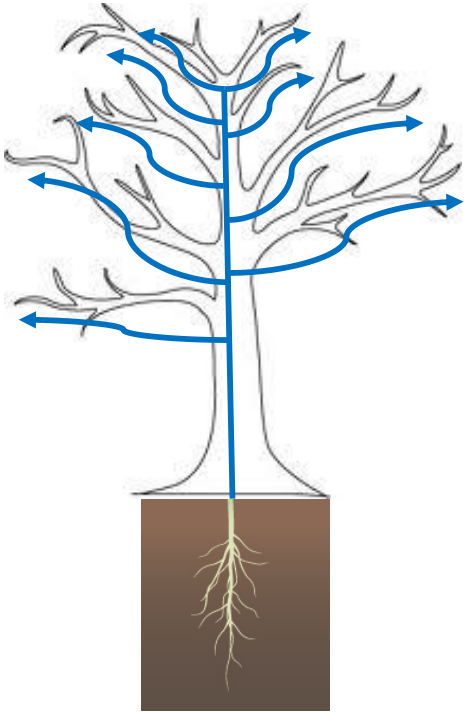
A: Source

Tree Growth Nature's Way

In Nature, trees grow

- UP and
- OUT

from the ROOT



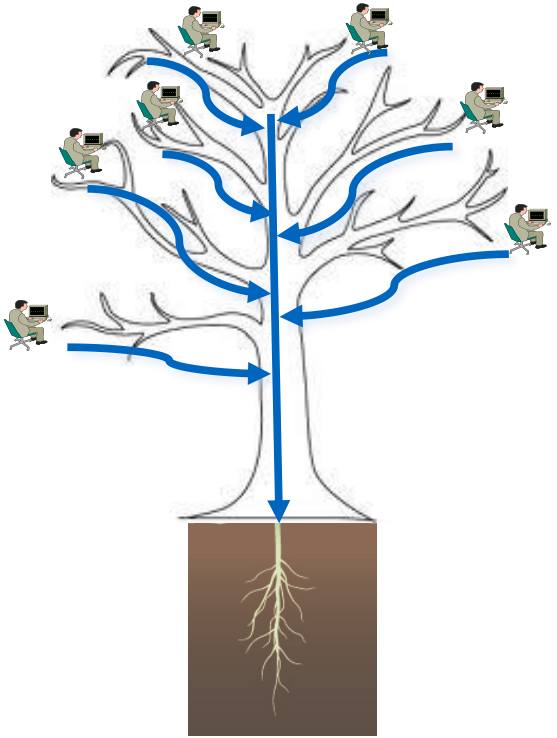
Tree Growth
Multicast Distribution Tree (MDT)

With Multicast, trees grow

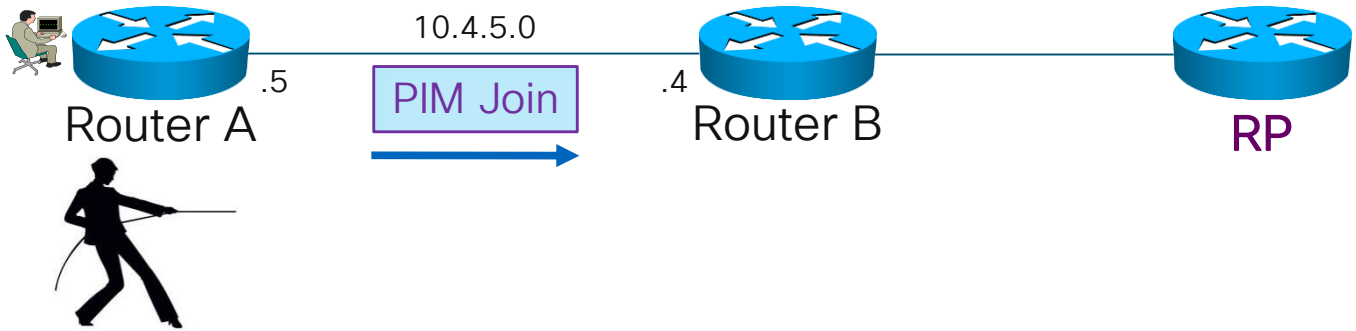
- TOWARD 

the ROOT

Knowledge of the Root Critical



Sending a (*,G) PIM Join



Question:

When Router A sends a PIM (*,G) Join out, what will be the Destination IP?

IP address of the RP?

224.0.0.13?
(All PIM Routers)

IP of Router B?
(10.4.5.4)

**Assume Router A knows the RP, has the RP in its RIB via an IGP with B and has a PIM neighbor with Router B

Sending a (*,G) PIM Join
The PIM Header

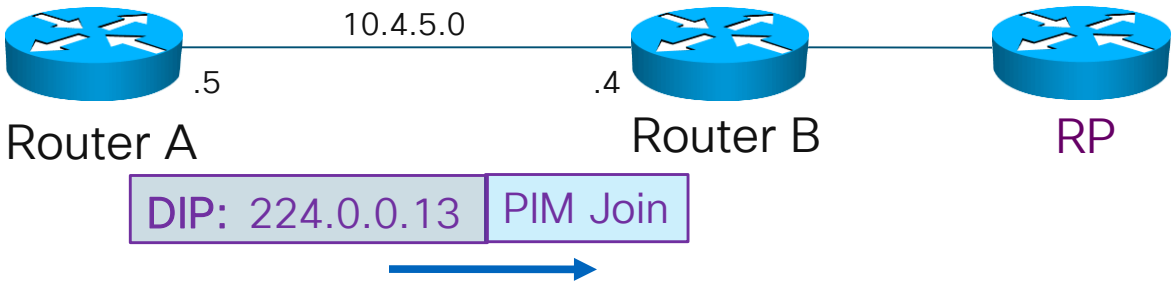
PIM header common to all PIM messages:

Some PIM Types are:

Message Type	Destination
0 = Hello	Multicast to ALL-PIM-ROUTERS
1 = Register	Unicast to RP
2 = Register-Stop	Unicast to source of Register packet
3 = Join/Prune	Multicast to ALL-PIM-ROUTERS
4 = Bootstrap	Multicast to ALL-PIM-ROUTERS
5 = Assert	Multicast to ALL-PIM-ROUTERS

http://www.ietf.org/rfc/rfc4601.txt

Sending a (*,G) PIM Join



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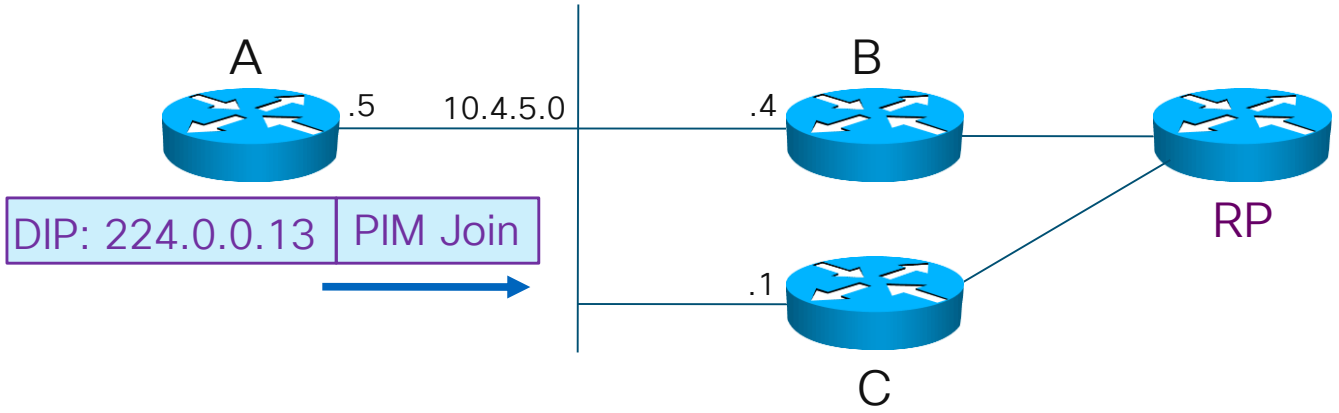
IP of the RP?

224.0.0.13?
(All PIM Routers)

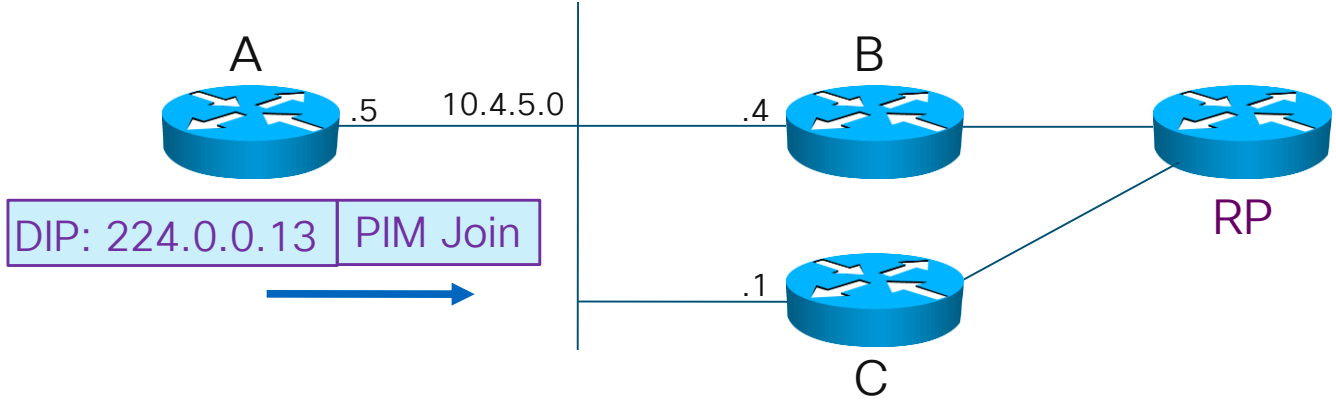
IP of Router B?
(10.4.5.4)

Sending a (*,G) PIM Join

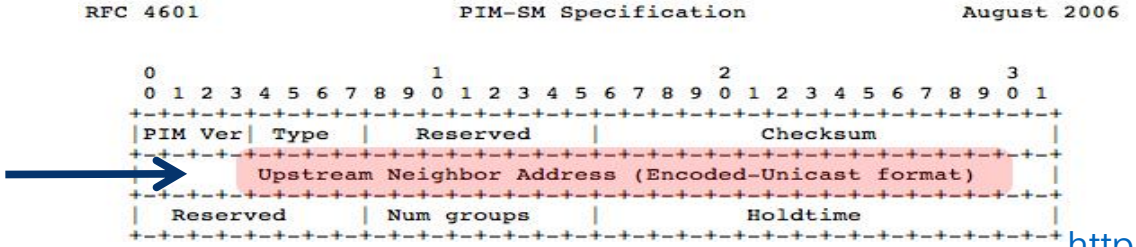


Question:
If the destination IP address of the Join is 224.0.0.13 (all PIM Routers), then how do we keep Router B and Router C from BOTH acting on that join?

Sending a (*,G) Join

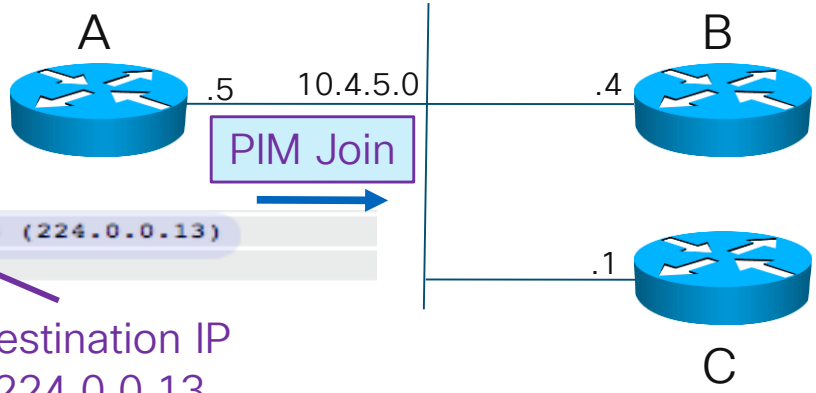


Answer:
The address of the upstream neighbor (B or C) is the target of the message



http://www.ietf.org/rfc/rfc4601.txt

Sending a (*,G) PIM Join



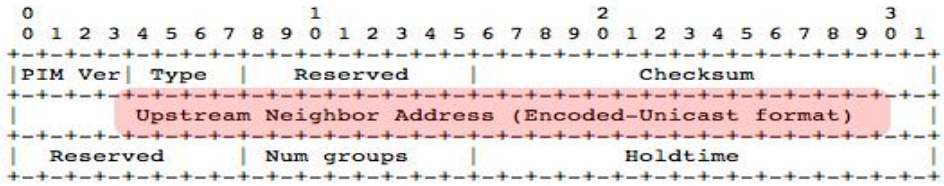

```
▷ Internet Protocol, Src: 10.4.5.5 (10.4.5.5), Dst: 224.0.0.13 (224.0.0.13)
▽ Protocol Independent Multicast
    Version: 2
    Type: Join/Prune (3)
    Checksum: 0xcedc [correct]
  ▽ PIM parameters
      Upstream-neighbor: 10.4.5.4
      Groups: 1
      Holdtime: 210
    ▽ Group 0: 239.1.1.1/32
      ▽ Join: 1
          IP address: 2.2.2.2/32 (SWR)
        Prune: 0
```

Destination IP
224.0.0.13

IP address of B
10.4.5.4

RP
2.2.2.2

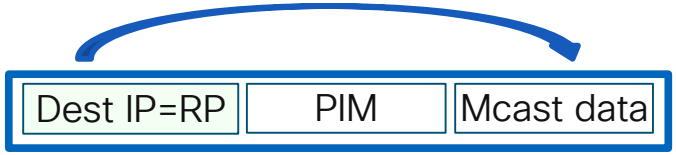
RFC 4601 PIM-SM Specification August 2006



Registering a Source***

***When a shared MDT is already active for that group on the RP

Mcast Data



Mcast packet is encapsulated into unicast PIM packet:
Destination IP is the RP.
PIM header type is Register

gig0 added to the OIL for (S,G)

RP sends PIM (S,G) Join Back Towards Source if there is an active shared tree for that G

Mcast Data

Mcast packets now get sent out twice:
1. With Register
2. Out (S,G)

Mcast Data

Once the RP sees the packets come in on the (S,G),
.... it sends a unicast Register Stop

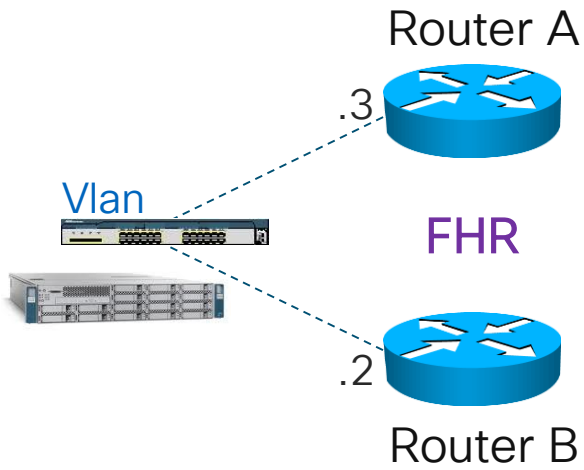
Register Stop to the FHR

Mcast Data

Mcast Data

Mcast packets now only out the (S,G) tree

Designated Routers (DRs)



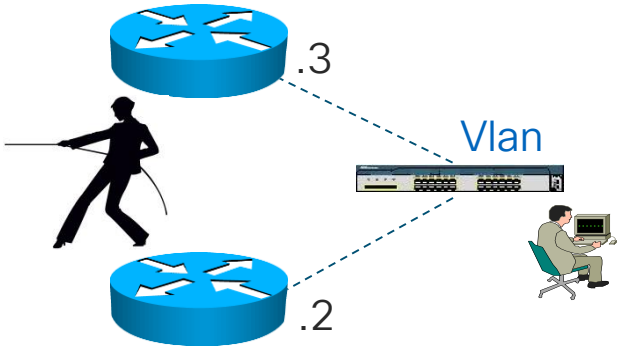
Q: Which router should register the source with the RP?

A: The FHR that is the DR

Designated Routers (DRs)

Q: Which router should send the PIM (*,G) Join?

A: The LHR that is the DR

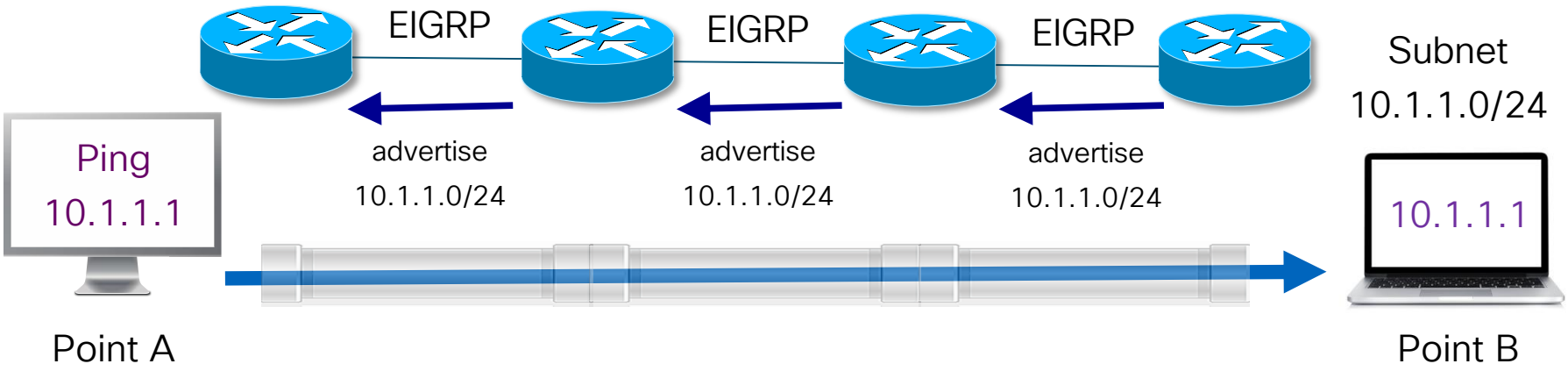


Multicast Troubleshooting Methodology

Multicast Troubleshooting Methodology Agenda

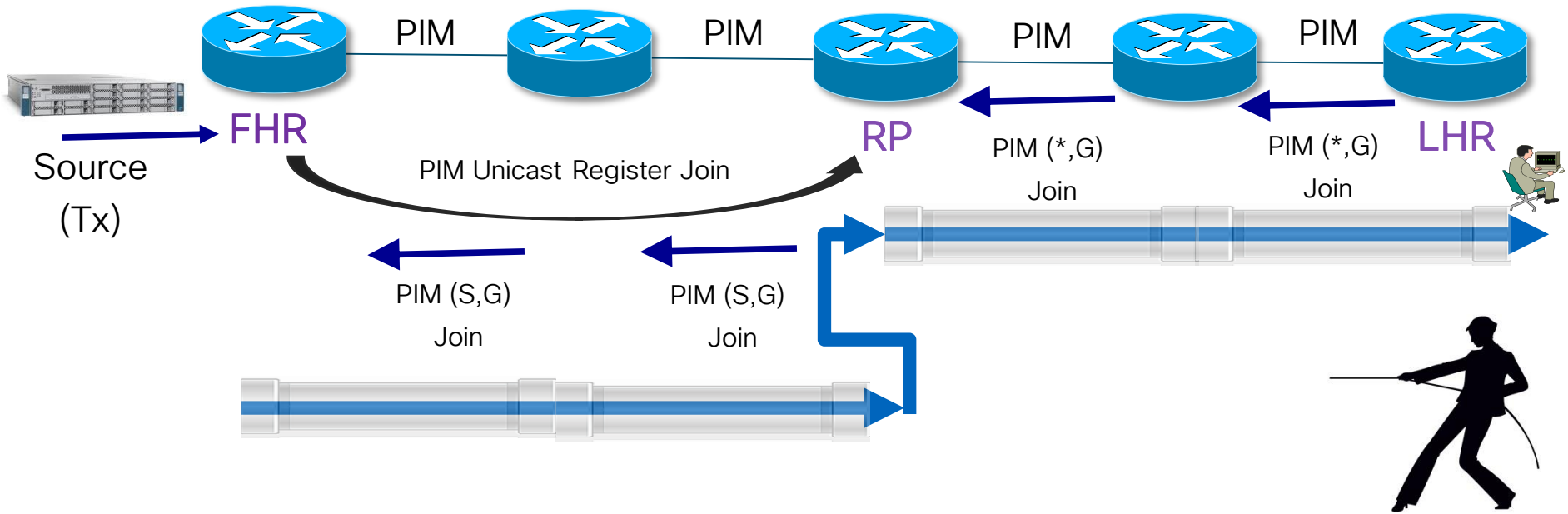
- The Plumbing
- Troubleshooting Toolbox

Building the Plumbing: Unicast



Building the Plumbing Multicast***

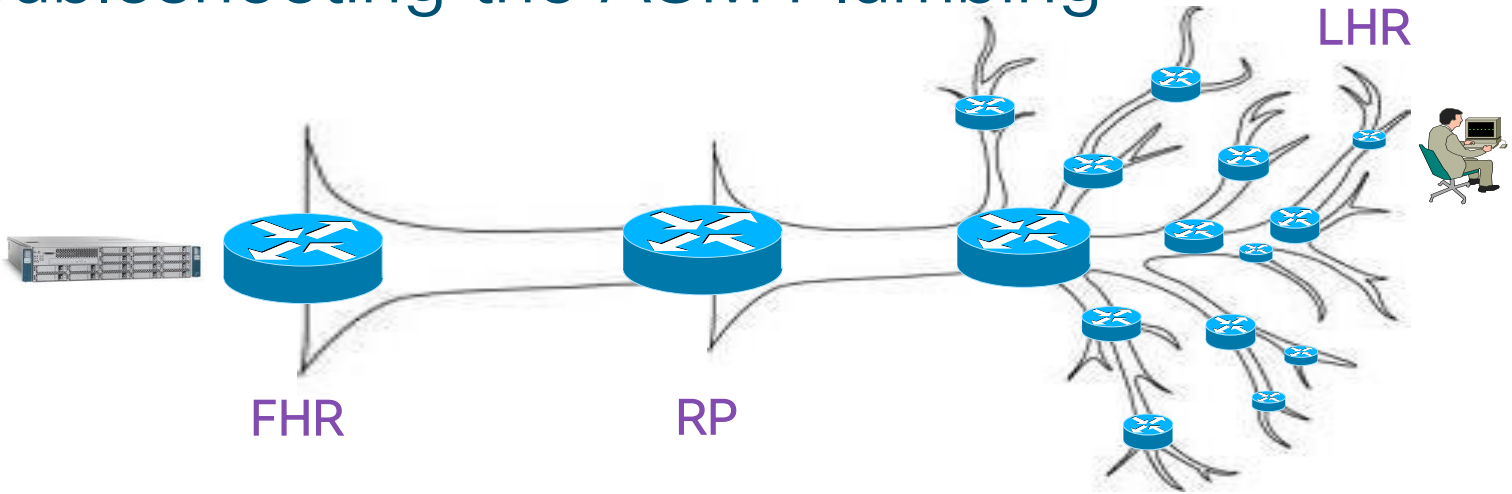
***In this example, LHR is configured to not cut over to the S,G tree.



“In solving a problem of this sort, the grand thing is to be able to reason backward. That is a very useful accomplishment, and a very easy one, but people do not practice it much.”

Sherlock Holmes

Troubleshooting the ASM Plumbing

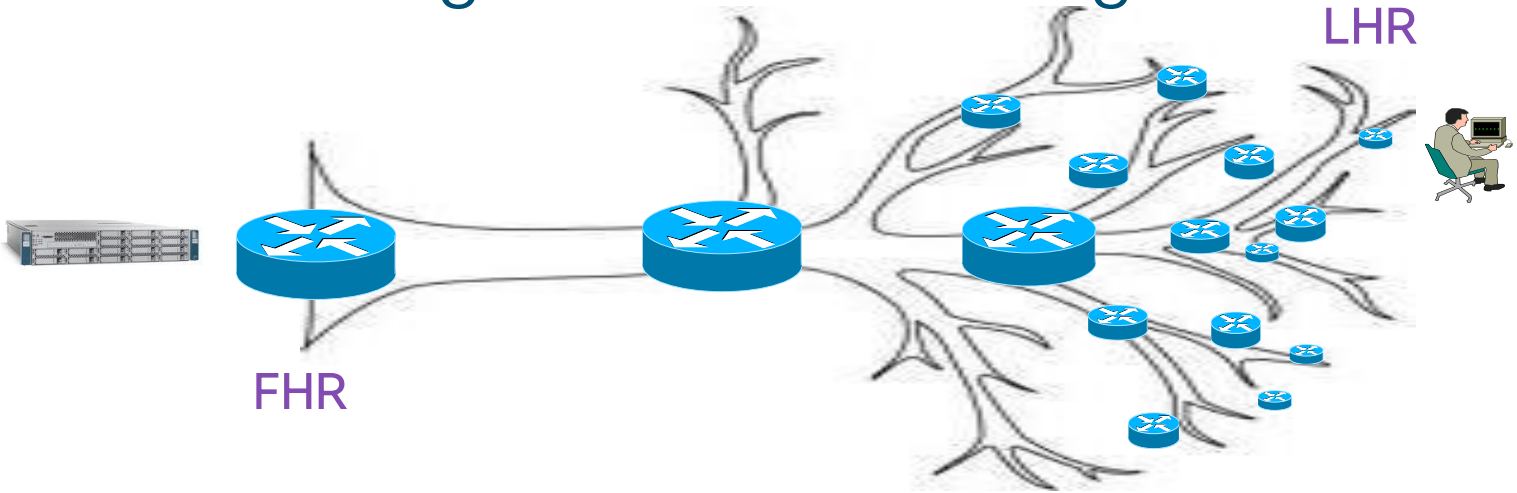


MDTs Built Backwards Towards Root

Traffic

Troubleshooting

Troubleshooting the SSM Plumbing

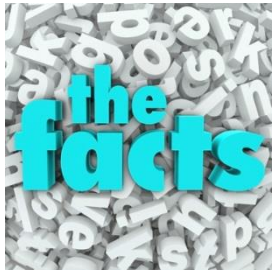


MDTs Built Backwards Towards Root

Traffic

Troubleshooting

Troubleshooting Toolbox
Facts to Remember



- Multicast Routing must be enabled globally
- PIM must be enabled on the interfaces for PIM neighbors to form
- Multicast Trees get built backwards towards the root
- Multicast traffic in ASM and SSM are triggered via a “pull”

- High on the “food chain” dependent on routing working and PIM working

Troubleshooting Toolbox Questions to Remember

- Who is the root?
- Where is the root?
- What is the PIM RPF neighbor towards the root?

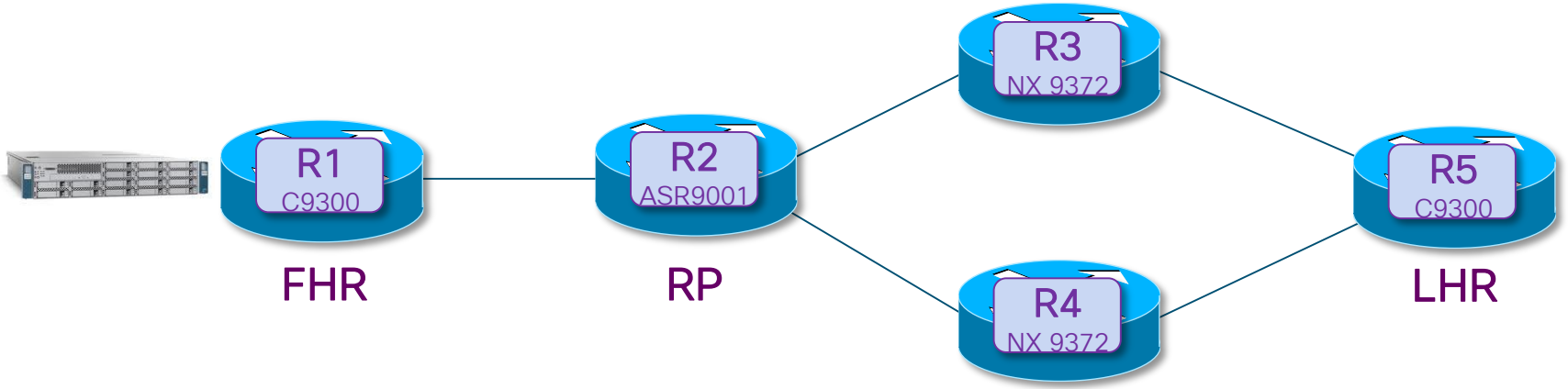
Troubleshooting Toolbox Checklist

- IGMP Membership Report Received by LHR (IPv4)
- MLD Membership Report Received by LHR (IPv6)
- "WHO" is the root?
  - Knowledge of who the RP is for that multicast group
- "WHERE" is the root?
  - Check routing… check routing… check routing
- "WHAT" is the PIM RPF neighbor towards the root?
  - Do you have a PIM neighbor?

Troubleshooting Toolbox "Go To" Commands

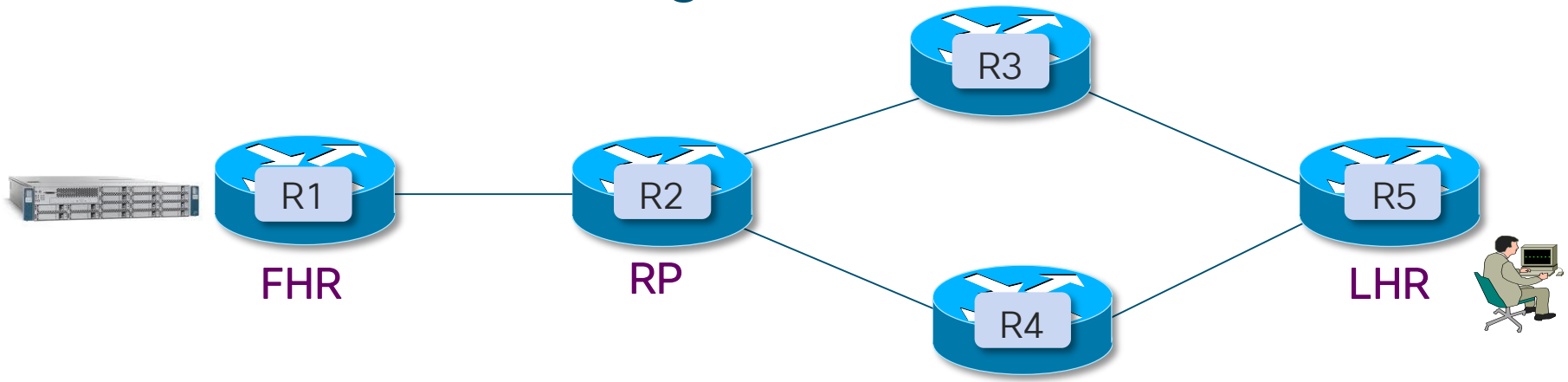

```
show ip mroute
show ip mroute count

show ip pim neighbor
show ip pim interface

show ip igmp group

show ip pim rp [group]
show ip pim rp mapping [group]
show ip rpf [address]
```

Our Environment



ASM Troubleshooting

ASM Troubleshooting



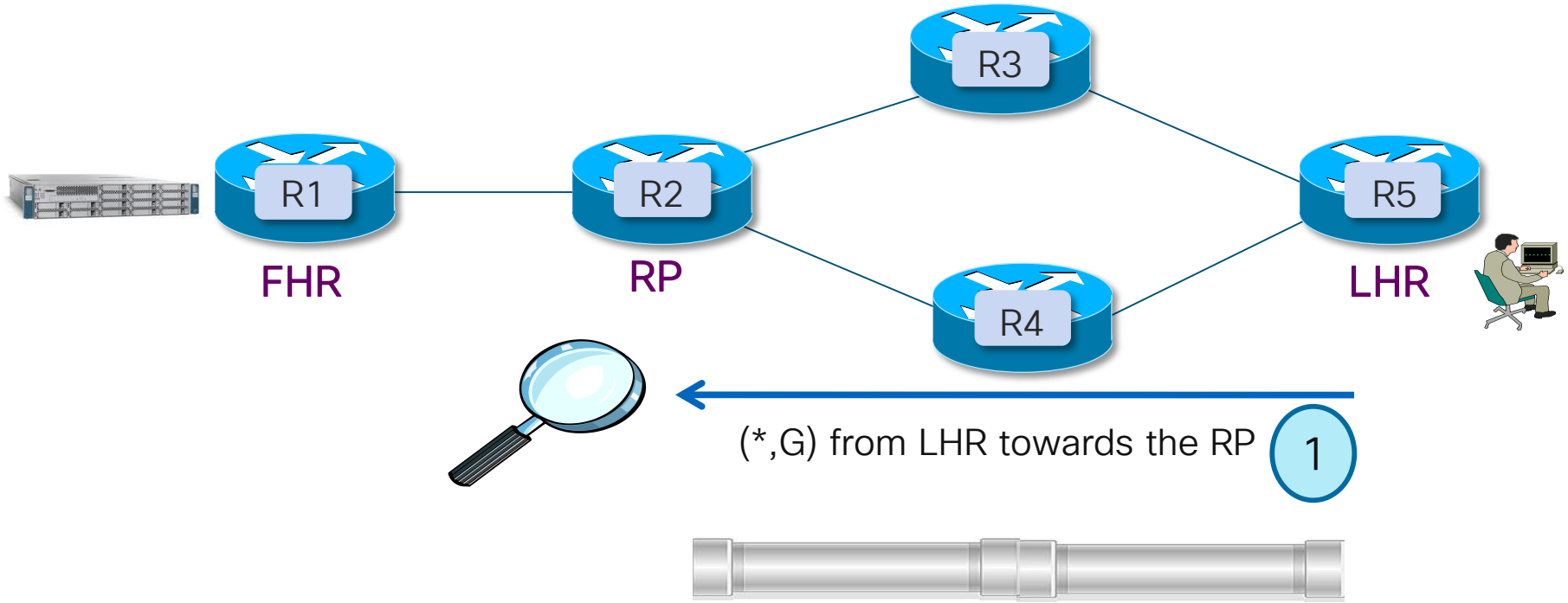
(*,G) from LHR towards the RP 1

2 FHR registers source with RP

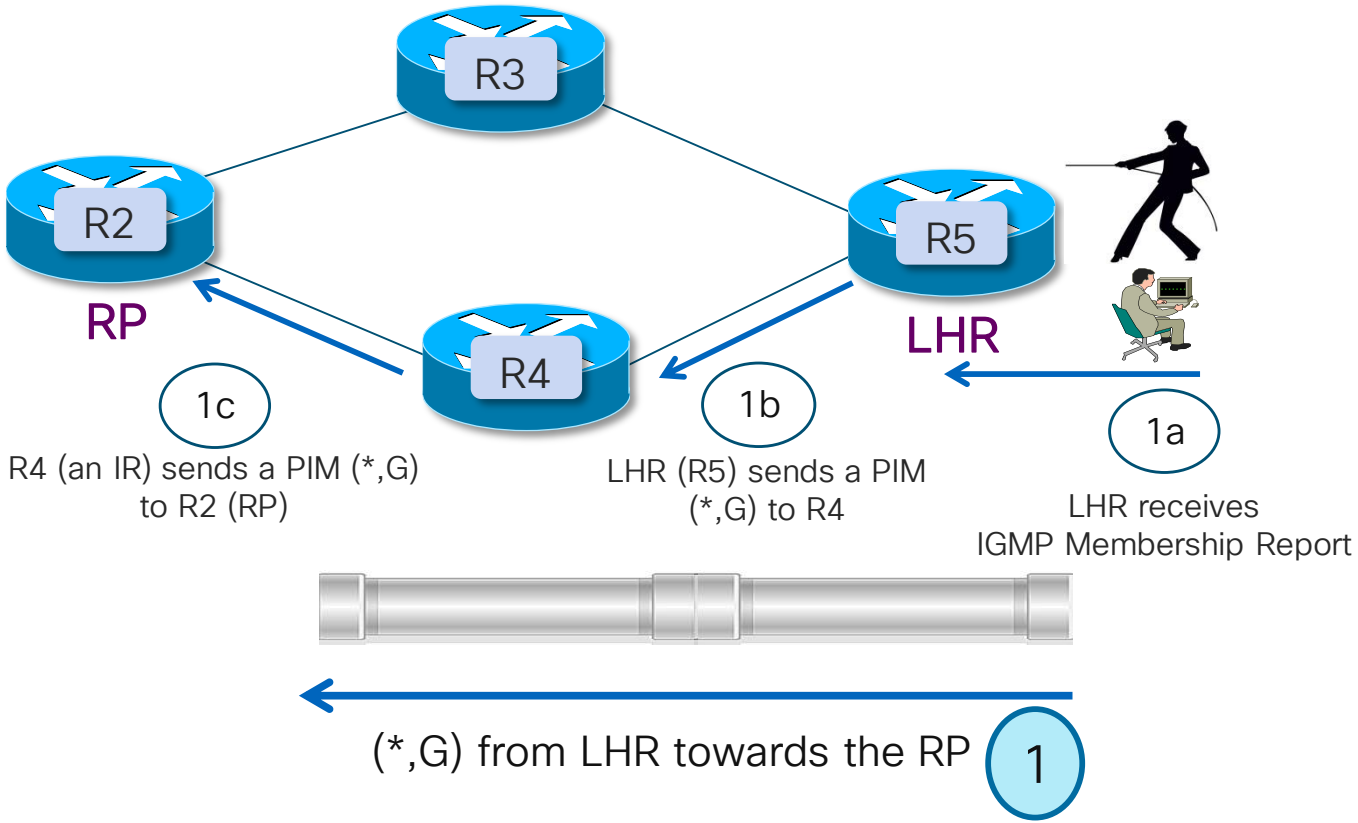
RP sends PIM (S,G) Join Towards Source

LHR Cutting over to SPT (S,G) 3

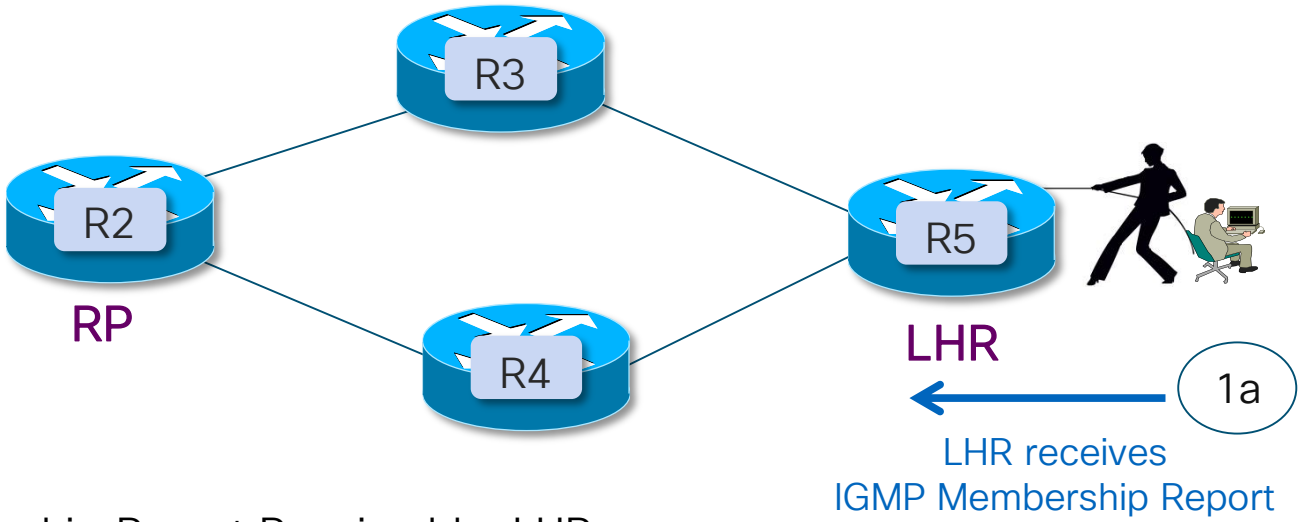
ASM Troubleshooting
Shared Tree



ASM Troubleshooting: Shared Tree



ASM Troubleshooting: Shared Tree

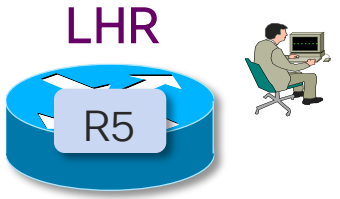


- IGMP Membership Report Received by LHR
- "WHO:" R5 (LHR) knows who the RP is for this group
- "WHERE:" R5 (LHR) knows where (RIB) the RP is
- "WHAT:" R5 (LHR) has a PIM Neighbor to send the PIM (*,G) Join to

ASM Troubleshooting: Shared Tree

1a LHR Receives IGMP Membership Report

- IGMP Membership Report Received by LHR



`R5#show ip mroute` Is completely empty

`R5#show ip igmp group` Is completely empty

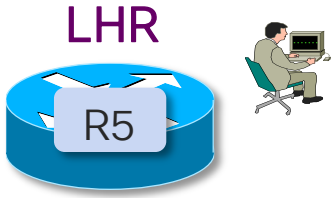
`R5#show ip igmp interface` Is completely empty

ASM Troubleshooting: Shared Tree

1a LHR Receives IGMP Membership Report

- IGMP Membership Report Received by LHR
  - PIM not enable on interface of Receiver

PIM not enabled




```
R5#show run interface gig1/0/5
```

PIM not enabled

```
interface GigabitEthernet1/0/5
    no switchport
 ip address 100.1.1.1 255.255.255.0
    ip pim sparse-mode
```

ASM Troubleshooting: Shared Tree

1a LHR Receives IGMP Membership Report

- IGMP Membership Report Received by LHR


```
R5#show ip mroute
    (*, 224.0.1.40), 00:13:27/00:02:38, RP 0.0.0.0, flags: DCL
        Incoming interface: Null, RPF nbr 0.0.0.0
        Outgoing interface list:
           GigabitEthernet1/0/5, Forward/Sparse, 00:13:25/00:02:38
R5#show ip igmp groups
IGMP Connected Group Membership
Group Address    Interface              Uptime      Expires     Last Reporter
224.0.1.40       GigabitEthernet1/0/5   00:06:13    00:02:31    100.1.1.1
```

ASM Troubleshooting: Shared Tree

1a LHR Receives IGMP Membership Report

- IGMP Membership Report Received by LHR
  - PIM not enable on interface of Receiver
  - Layer 1 issues
  - Layer 2 issues
  - Access-List
  - IGMP membership report not being sent

ASM Troubleshooting: Shared Tree

1a LHR Receives IGMP Membership Report

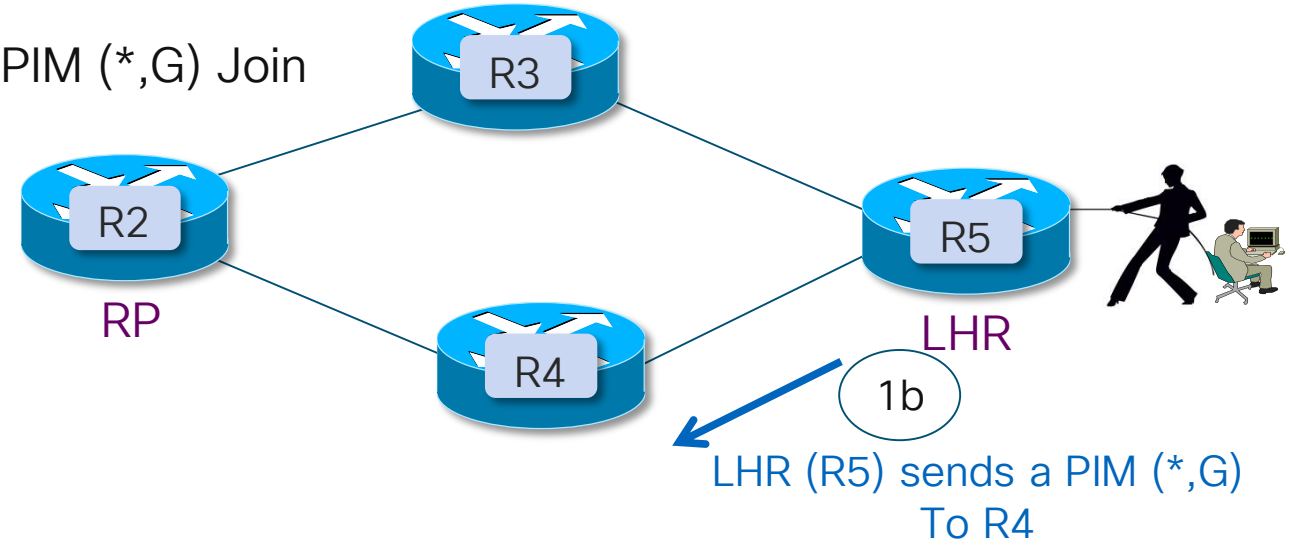
☑ IGMP Membership Report Received by LHR


```
R5#show ip igmp groups
IGMP Connected Group Membership
Group Address  Interface                Uptime    Expires   Last Reporter
239.1.1.1      GigabitEthernet1/0/5     00:19:04 00:02:08  100.1.1.100
224.0.1.40     GigabitEthernet1/0/5     00:38:56 00:02:08  100.1.1.1
```

```
R5#show ip mroute 239.1.1.1
    (*, 239.1.1.1), 00:00:07/00:02:53, RP 0.0.0.0, flags: SJC
      Incoming interface: Null, RPF nbr 0.0.0.0
      Outgoing interface list:
        GigabitEthernet1/0/5, Forward/Sparse, 00:00:07/00:02:53
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

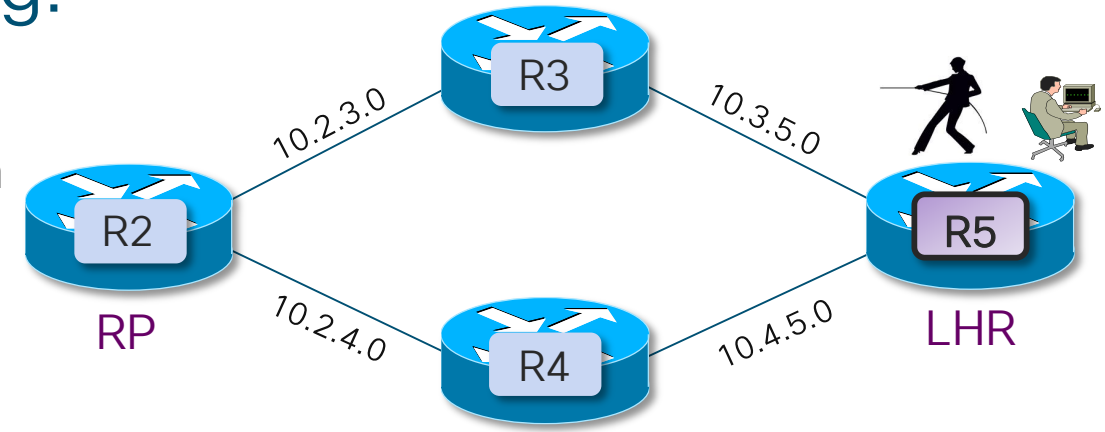


- "WHO:" R5 (LHR) knows who the RP is for this group
- "WHERE:" R5 (LHR) knows where (RIB) the RP is
- "WHAT:" R5 (LHR) has a PIM Neighbor to send the PIM (*,G) Join to

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

?? RP
- ❑Who?
- ❑Where?
- ❑RPF Nbr?



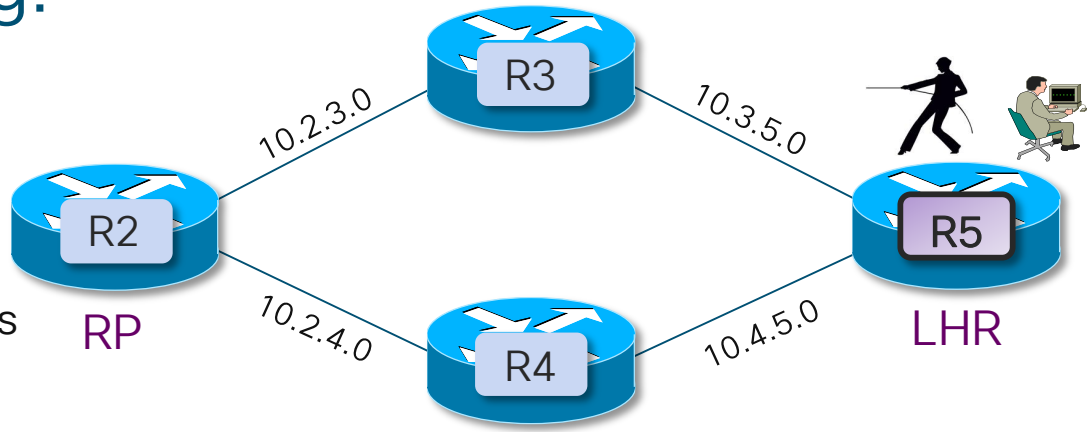

```
R5#show ip mroute 239.1.1.1                                    ?
        (*, 239.1.1.1), 00:00:07/00:02:53, RP 0.0.0.0, flags: SJC
          Incoming interface: Null, RPF nbr 0.0.0.0
          Outgoing interface list:
             GigabitEthernet1/0/5, Forward/Sparse, 00:00:07/00:02:53

R5#show ip pim rp 239.1.1.1                                    ?
            Group: 239.1.1.1, RP: 0.0.0.0
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

Note:
RP information can be shared 3 ways

- Static
- Auto-RP
- BSR



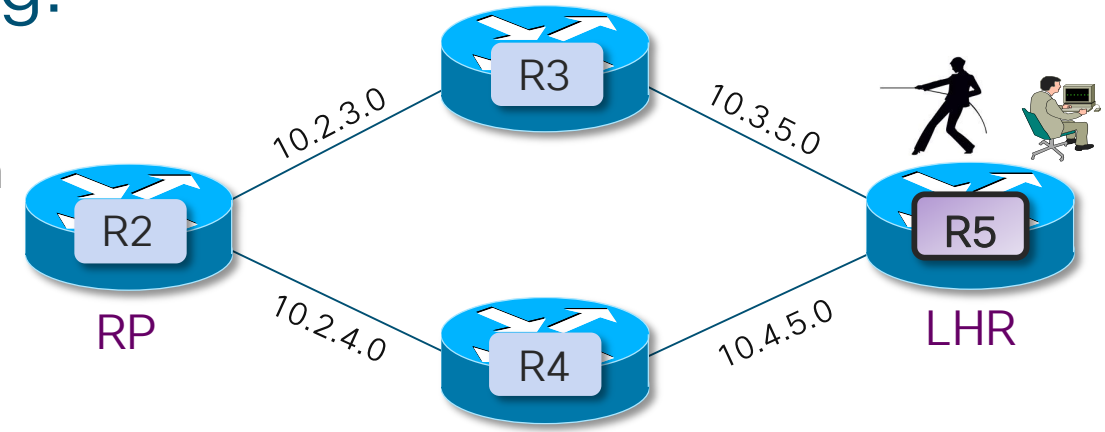

```
R5(config)#ip pim rp-address 2.2.2.2 ?
  <1-99>       Access-list reference for group
  <1300-1999>  Access-list reference for group (expanded range)
  WORD         IP Named Standard Access list
  override     Overrides dynamically learnt RP mappings
 <cr>
```

```
R5(config)#ip pim rp-address 2.2.2.2 override
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

RP
- ✓ Who?
- ❑ Where?
- ❑ RPF Nbr?

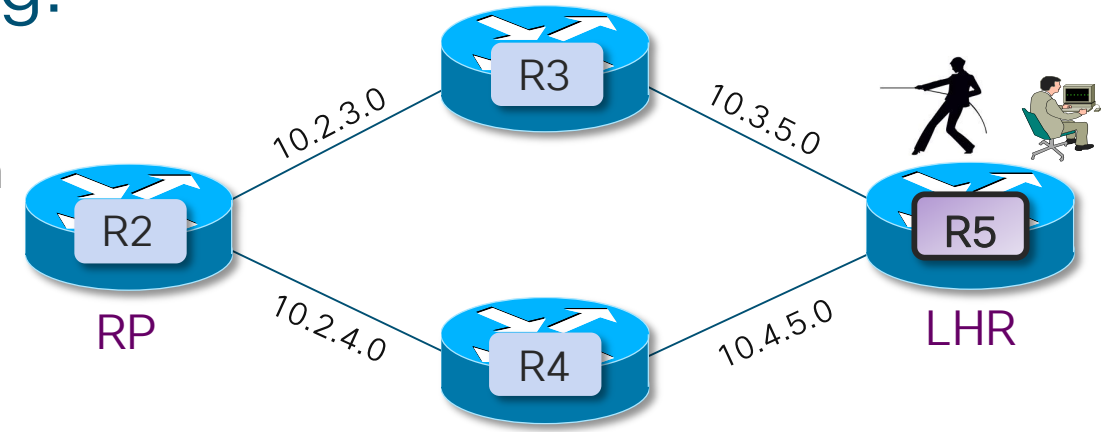



```
R5#sh ip pim rp 239.1.1.1
Group: 239.1.1.1, RP: 2.2.2.2, uptime 00:00:39, expires never

R5#sh ip pim rp mapping 239.1.1.1
PIM Group-to-RP Mappings
Group(s): 224.0.0.0/4, Static-Override
    RP: 2.2.2.2 (?)
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

?? RP ✓
- ❑Who?
- ❑Where?
- ❑RPF Nbr?




```
R5#show ip mroute 239.1.1.1                                          ✓
     (*, 239.1.1.1), 00:08:18/00:02:46, RP 2.2.2.2, flags: SJC
      Incoming interface: Null, RPF nbr 0.0.0.0                      ??
      Outgoing interface list:
        GigabitEthernet1/0/5, Forward/Sparse, 00:08:18/00:02:46
```

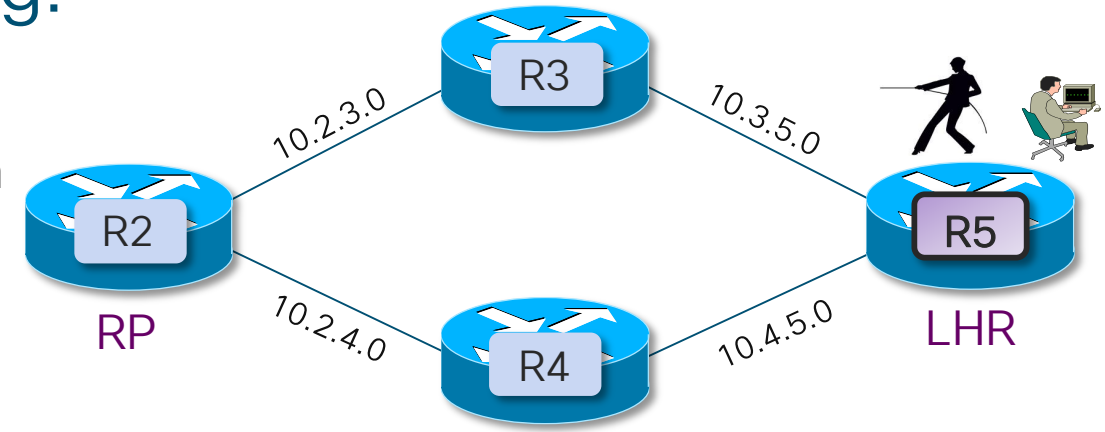
```
R5#show ip rpf 2.2.2.2
   failed, no route exists
```

```
R5#show ip route 2.2.2.2
   % Network not in table
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

RP
- ☑ Who?
- ☑ Where?
- ❑ RPF Nbr?

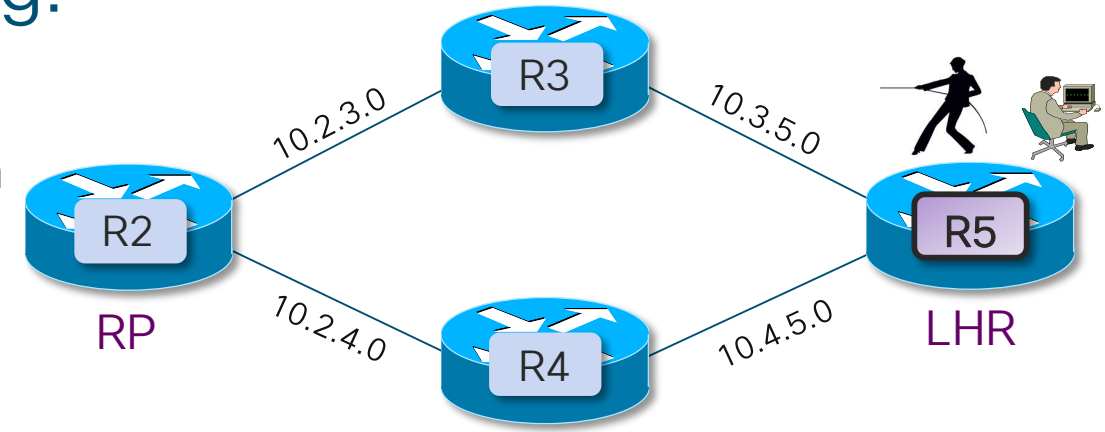



```
R5#show ip route 2.2.2.2
   Routing entry for 2.2.2.2/32
      Known via "ospf 100", distance 110, metric 42, type intra area
      Last update from 10.2.5.3 on GigabitEthernet1/0/1, 00:00:06 ago
      Routing Descriptor Blocks:
         10.4.5.4, from 2.2.2.2, 00:00:09 ago, via GigabitEthernet1/0/2
         10.2.5.3, from 2.2.2.2, 00:00:06 ago, via GigabitEthernet1/0/1
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

RP
- ☑ Who?
- ☑ Where?
- ❑ RPF Nbr?



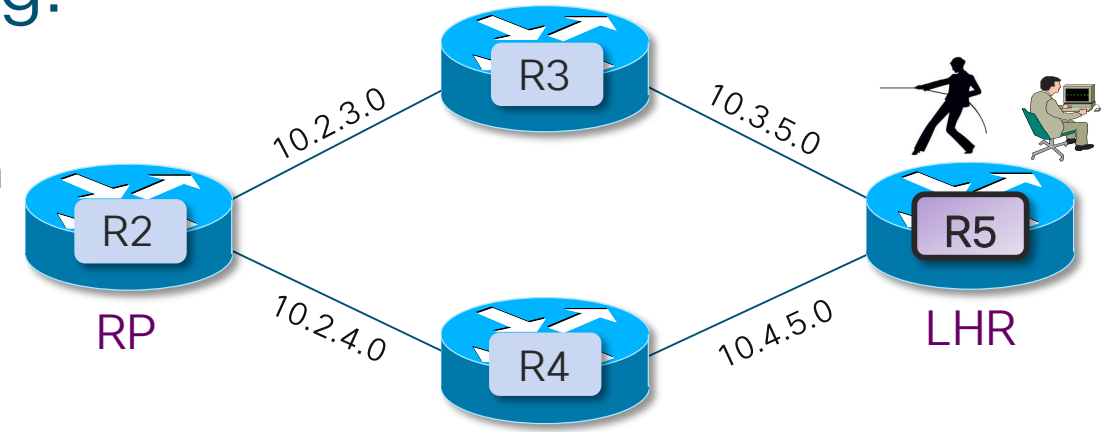

```
R5#show ip mroute 239.1.1.1

    (*, 239.1.1.1), 00:08:18/00:02:46, RP 2.2.2.2, flags: SJC
     Incoming interface: Null, RPF nbr 0.0.0.0
     Outgoing interface list:
       GigabitEthernet1/0/5, Forward/Sparse, 00:08:18/00:02:46
```

??

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

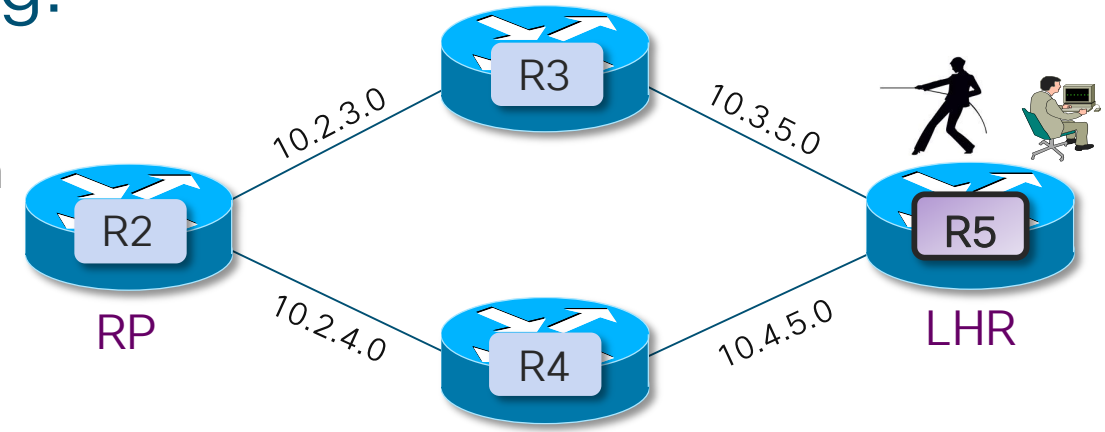
RP
- ☑ Who?
- ☑ Where?
- ?? ❑ RPF Nbr?




```
R5#show ip rpf 2.2.2.2
          failed, no route exists

R5#show ip pim neighbor
          No PIM neighbors listed
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join



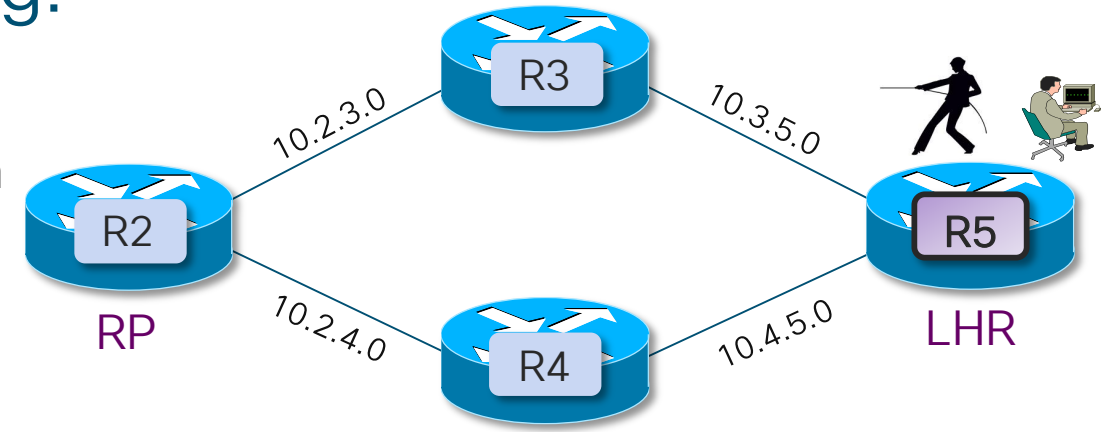

```
R5#show ip pim neighbor
PIM Neighbor Table
Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,
      P - Proxy Capable, S - State Refresh Capable
Neighbor          Interface                Uptime/Expires
10.2.5.3          GigabitEthernet1/0/1     00:00:07/00:01:42
10.4.5.4          GigabitEthernet1/0/2     00:00:07/00:01:39
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

Question:
Why was 10.4.5.4 chosen as the RPF neighbor?

Answer:
If ECMP are available, the RPF for the multicast traffic will be based on highest IP address for the RPF neighbor



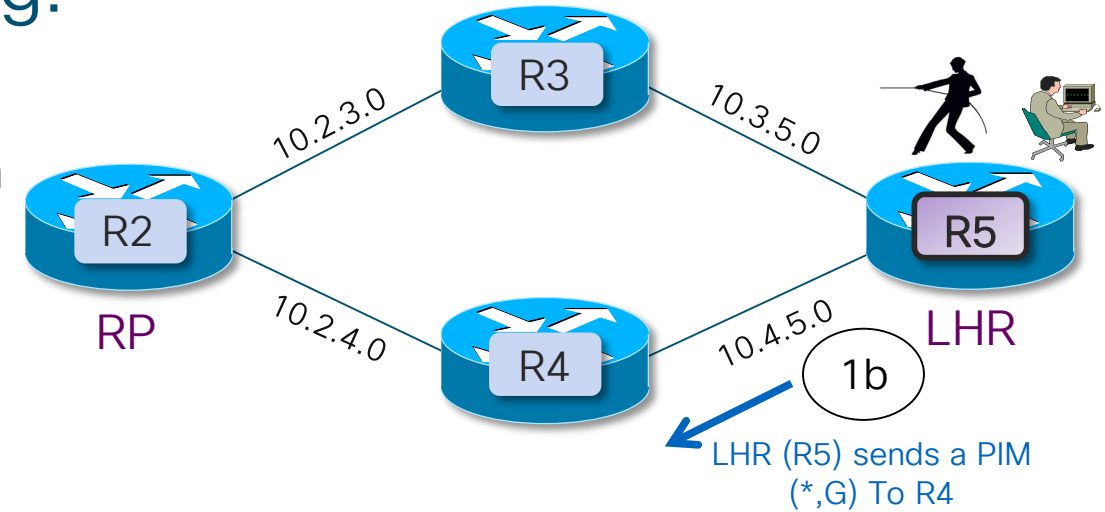

```
R5#show ip rpf 2.2.2.2

    RPF information for ? (2.2.2.2)
       RPF interface: GigabitEthernet1/0/2
       RPF neighbor: ? (10.4.5.4)
       RPF route/mask: 2.2.2.2/32
       RPF type: unicast (ospf 100)
       Doing distance-preferred lookups across tables
       RPF topology: ipv4 multicast base, originated from ipv4 unicast base
```

ASM Troubleshooting: Shared Tree

1b LHR Sends PIM (*,G) Join

Note:
LHR now has all the information it needs to send a PIM (*,G) join to its RPF neighbor.

RP
- ☑ Who?
- ☑ Where?
- ☑ RPF Nbr?

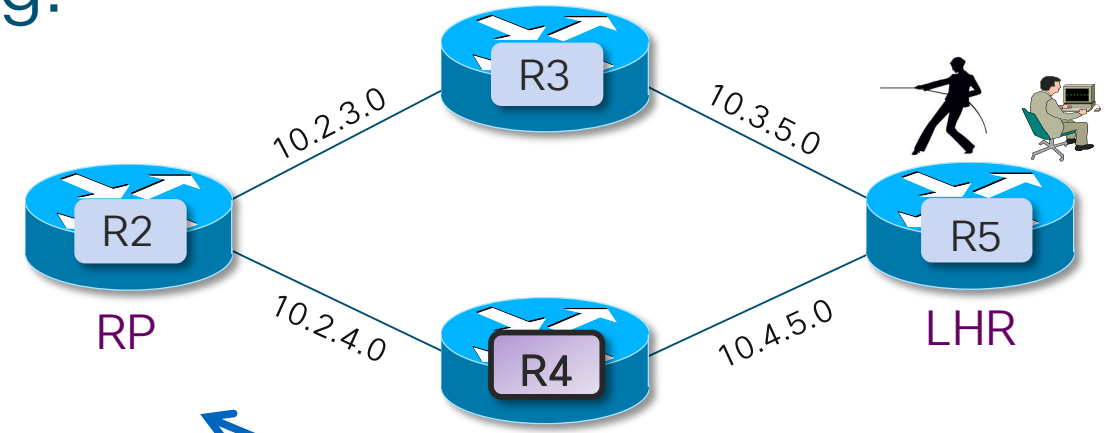



```
R5#show ip mroute 239.1.1.1
(*, 239.1.1.1), 01:33:55/00:02:13, RP 2.2.2.2, flags: SJC
Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.4.5.4
Outgoing interface list:
    GigabitEthernet1/0/5, Forward/Sparse, 01:33:55/00:02:13
```

RP → RP 2.2.2.2
flags → flags: SJC
,G → (, 239.1.1.1)
IIF → Incoming interface: GigabitEthernet1/0/2
RPF nbr → RPF nbr 10.4.5.4
OIL → Outgoing interface list:

ASM Troubleshooting: Shared Tree

1c IR Sends PIM (*,G) Join



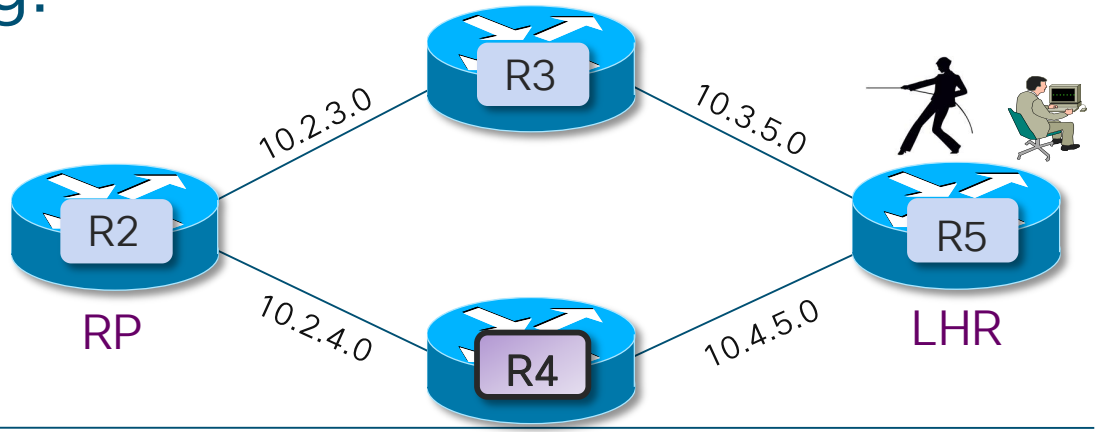
R4 (an IR) sends a PIM (*,G) To R2 (RP) 1c

- "WHO:" R4 (IR) knows who the RP is for this group
- "WHERE:" R4 (IR) knows where (RIB) the RP is
- "WHAT:" R4 (IR) has a PIM Neighbor to send the PIM (*,G) Join to

ASM Troubleshooting: Shared Tree

1c IR Sends PIM (*,G) Join

Note:
Telnetting backwards towards the root is a good way to troubleshoot.




```
R5#show ip mroute 239.1.1.1
  (*, 239.1.1.1), 01:33:55/00:02:13, RP 2.2.2.2, flags: SJC
    Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.4.5.4
    Outgoing interface list:
      GigabitEthernet1/0/5, Forward/Sparse, 01:33:55/00:02:13
R5#telnet 10.4.5.4
Trying 10.4.5.4 ... Open
```

RP
- ☑ Who?
- ☑ Where?
- ☑ RPF Nbr?

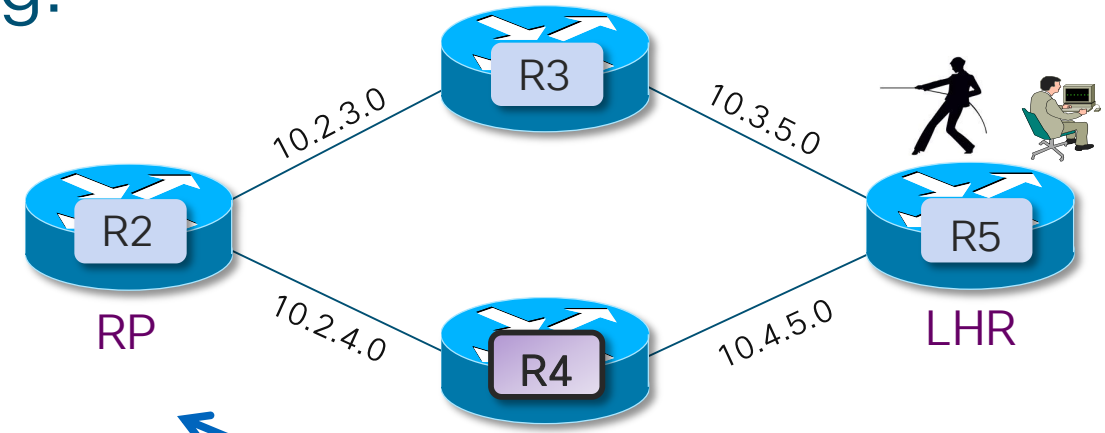
R5

```
R4#show ip mroute 239.1.1.1
(*, 239.1.1.1/32), uptime: 00:00:01, pim ip
  Incoming interface: Ethernet1/1, RPF nbr: 10.2.4.2, uptime: 00:00:01
  Outgoing interface list: (count: 1)
     Ethernet1/2, uptime: 00:00:01, pim
```

ASM Troubleshooting: Shared Tree

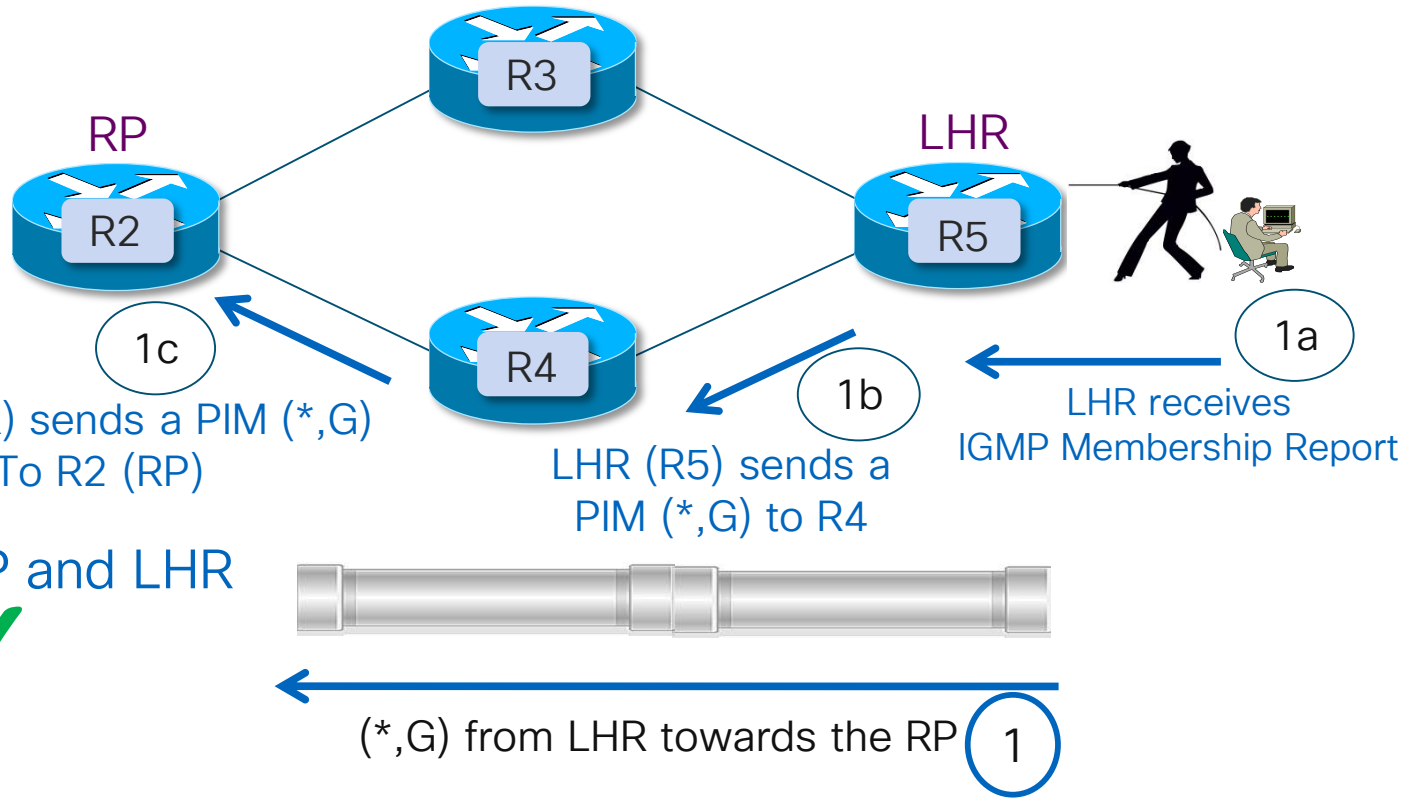
1c IR Sends PIM (*,G) Join

Note:
R4 had all the information it needed to send a PIM (*,G) join its RPF neighbor.



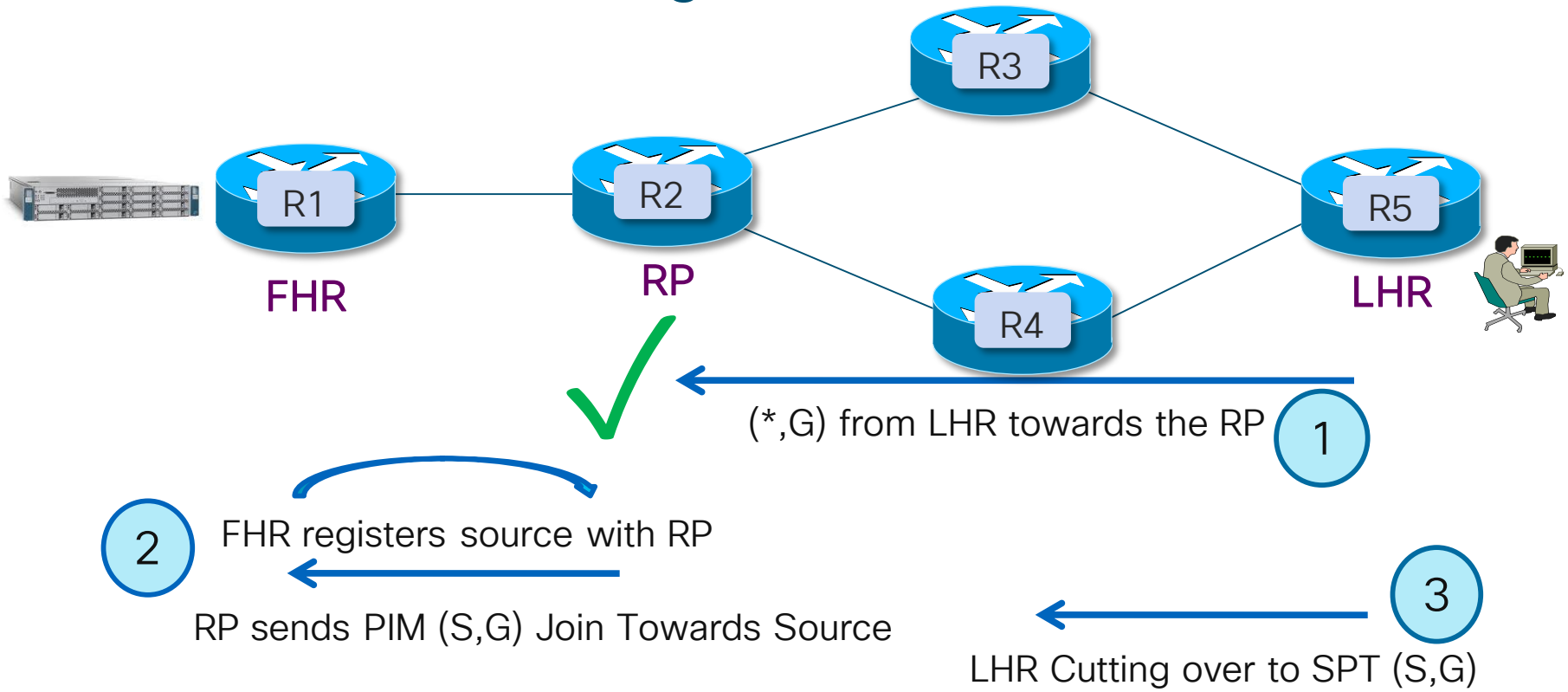

```
R4#telnet 10.2.4.2
Trying 10.2.4.2... Open
R2#show mrib route 239.1.1.1

     (*,239.1.1.1) RPF nbr: 0.0.0.0 Flags: C RPF
        Up: 00:09:19
        Outgoing Interface List
           GigabitEthernet0/0/0/2 Flags: F NS, Up: 00:09:19
```

ASM Troubleshooting: Shared Tree

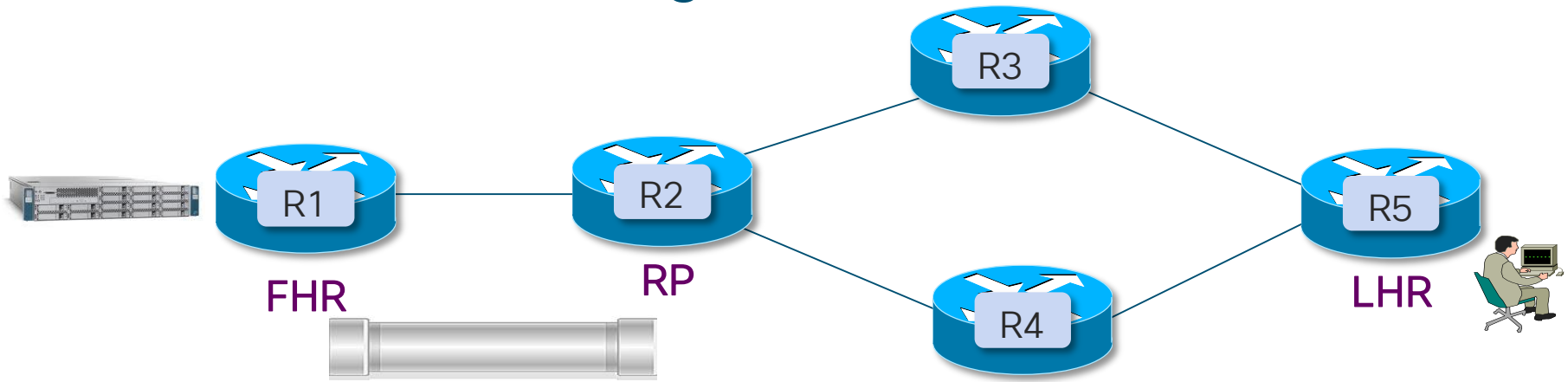


(*,G) Between RP and LHR

ASM Troubleshooting



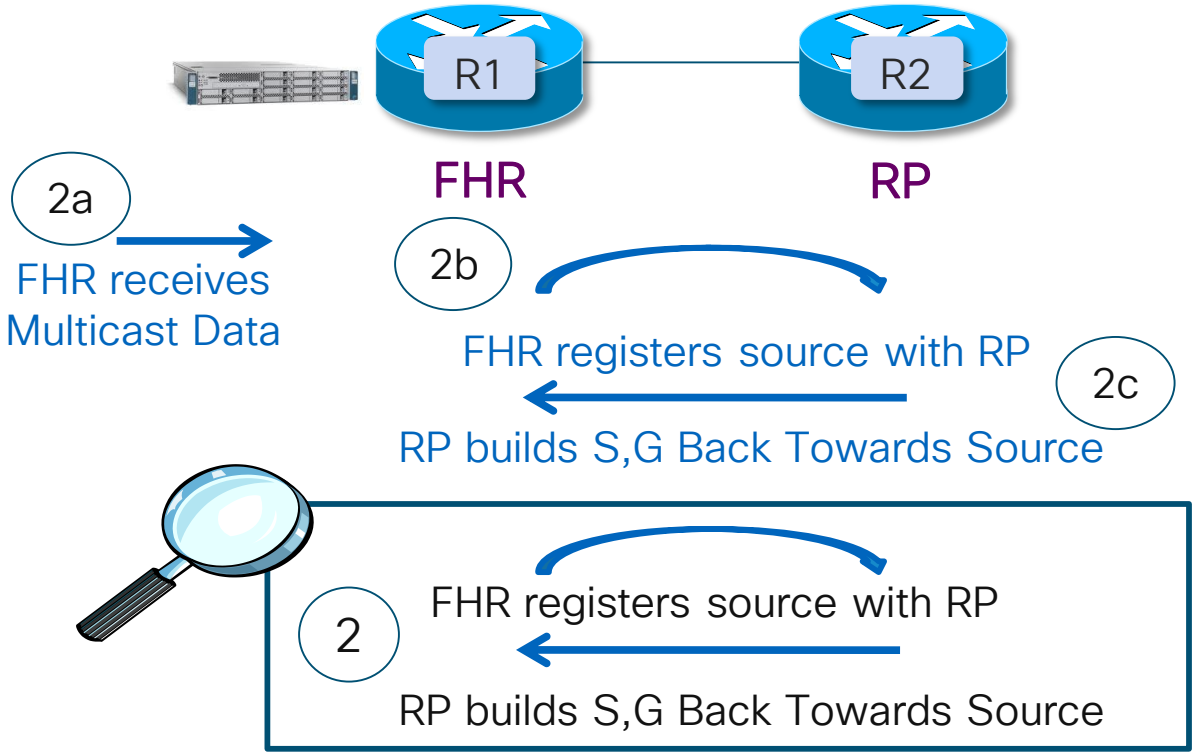
ASM Troubleshooting



2 FHR registers source with RP

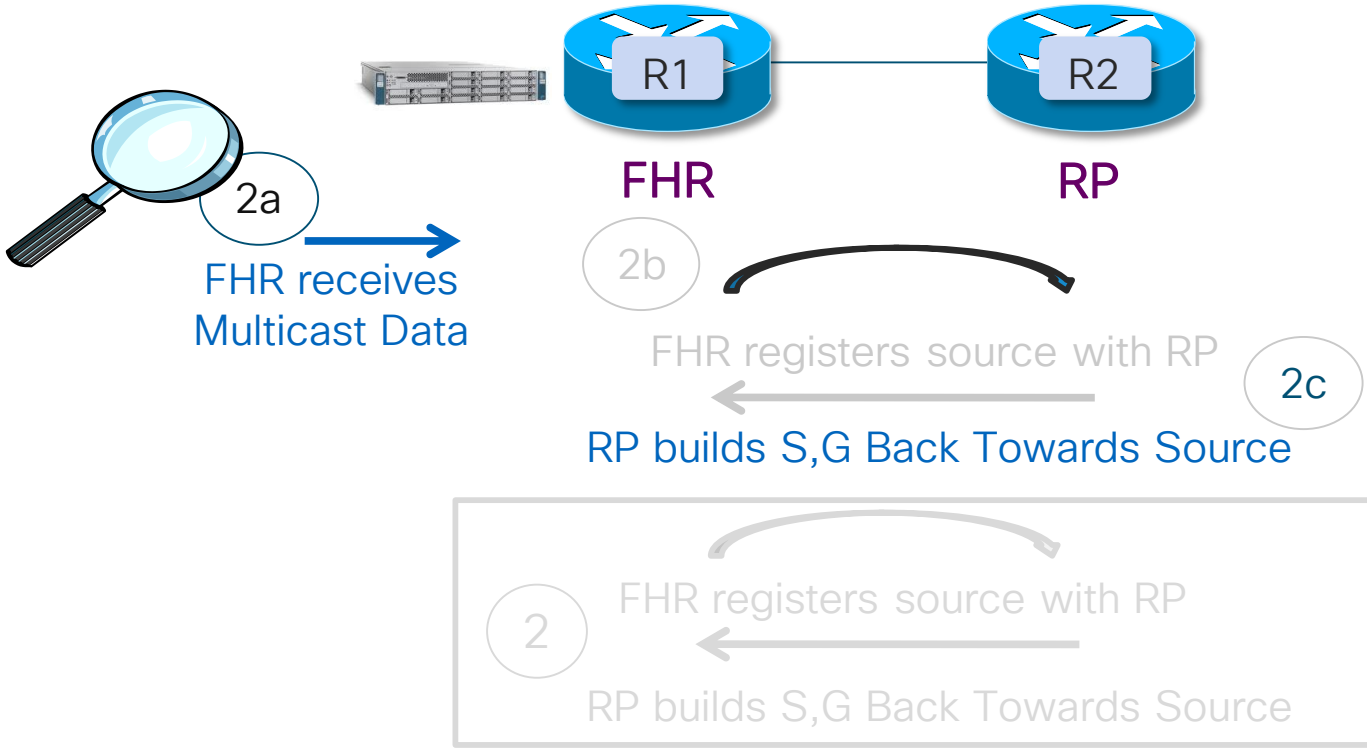
RP sends PIM (S,G) Join Towards Source

ASM Troubleshooting: Source Tree



***When a shared MDT is already active for that group on the RP

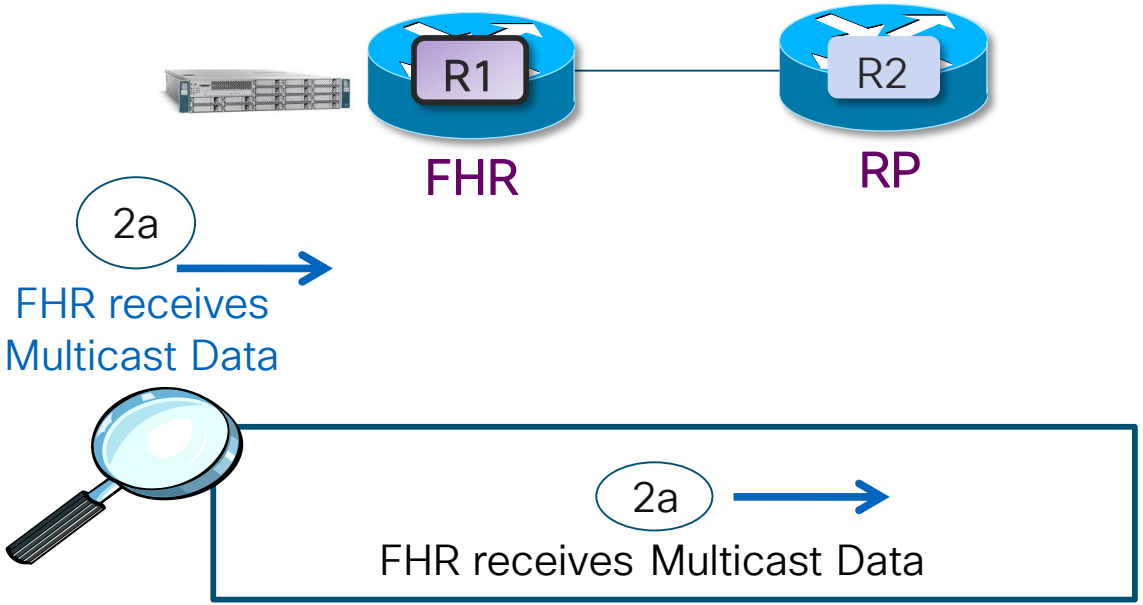
ASM Troubleshooting: Source Tree



***When a shared MDT is already active for that group on the RP

ASM Troubleshooting: Source Tree

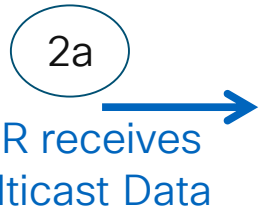
2a FHR Receives Multicast Data



ASM Troubleshooting: Source Tree

2a FHR Receives Multicast Data

- FHR Receives Multicast Data



R1#***show ip mroute*** *Has 224.0.1.40 but not 239.1.1.1*

R1#***sh int gig1/0/5 counters***

Port	InOctets	InUcastPkts	InMcastPkts	InBcastPkts
Gi1/0/5	34006016	0	66418	0

Port	OutOctets	OutUcastPkts	OutMcastPkts	OutBcastPkts
Gi1/0/5	12102	71	49	0

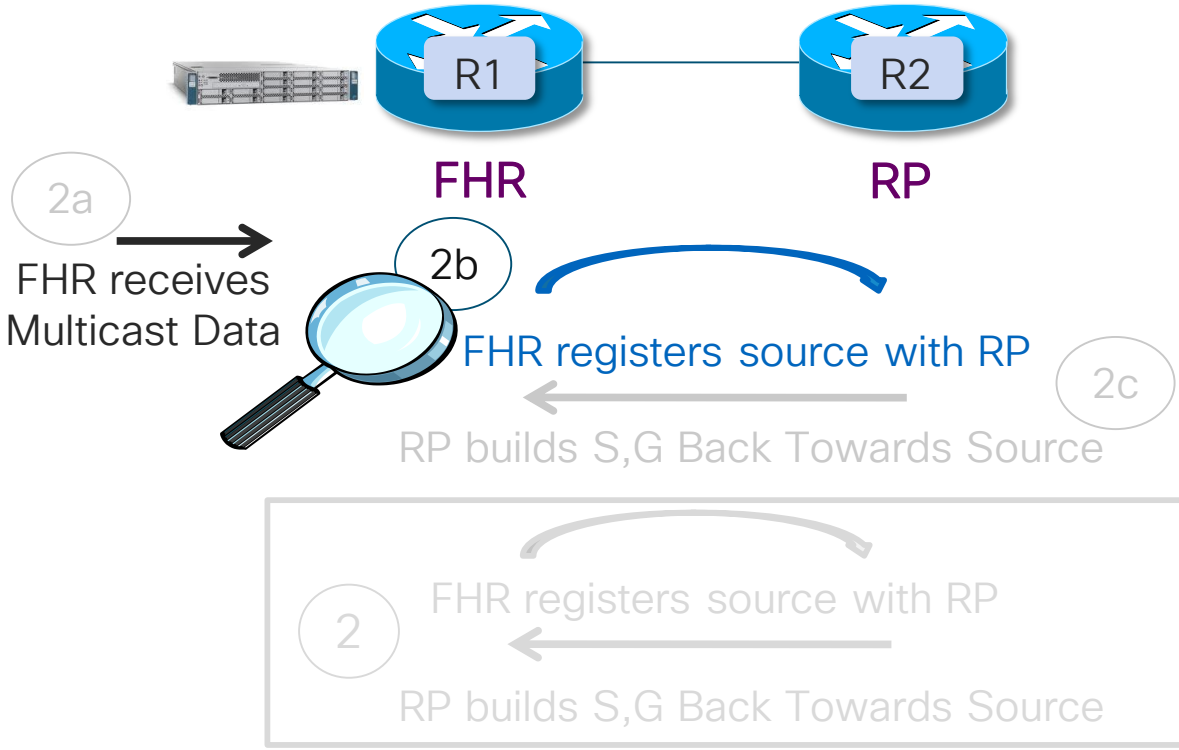
ASM Troubleshooting: Source Tree

2a FHR Receives Multicast Data

- FHR Receives Multicast Data

```
R1# sh run | include access-list
access-list 2239 permit ip any host 239.1.1.1
R1# debug ip packet 2239 detail
IP packet debugging is on (detailed) for access list 2239
May 22 21:17:55.190: FIBipv4-packet-proc: route packet from GigabitEthernet1/0/5
src 200.1.1.100 dst 239.1.1.1
May 22 21:17:55.190: FIBfwd-proc: Default:224.0.0.0/4 multicast entry
May 22 21:17:55.190: FIBipv4-packet-proc: packet routing failed
```

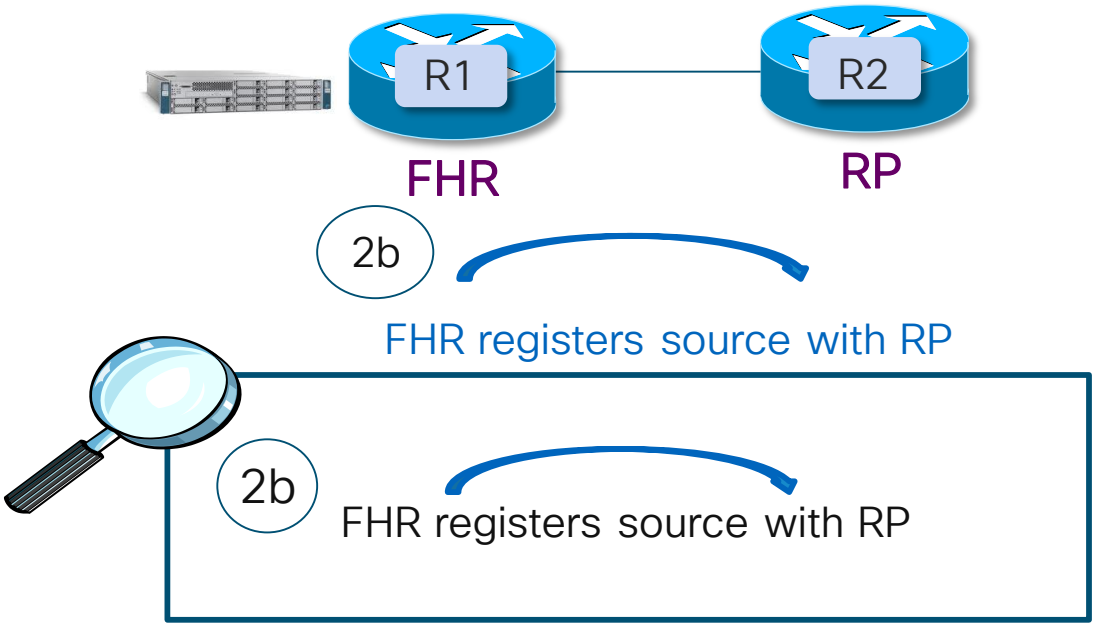
ASM Troubleshooting: Source Tree



***When a shared MDT is already active for that group on the RP

ASM Troubleshooting: Source Tree

2b FHR Receives Source with RP

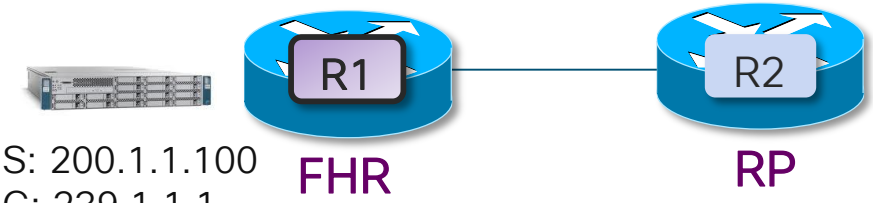


ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP

RP
- ❑Who?
- ❑Where?
- ❑RPF Nbr?

Question:
Why is there no (S,G) or (*,G)?




```
R1#sh ip rpf 200.1.1.100
    RPF information for ? (200.1.1.100)
      RPF interface: GigabitEthernet1/0/5
      RPF neighbor: ? (200.1.1.100) - directly connected
      RPF route/mask: 200.1.1.0/24
      RPF type: multicast (connected)
      Doing distance-preferred lookups across tables
      RPF topology: ipv4 multicast base
```

✓

```
R1#sh ip rpf 2.2.2.2
                failed, no route exists
```

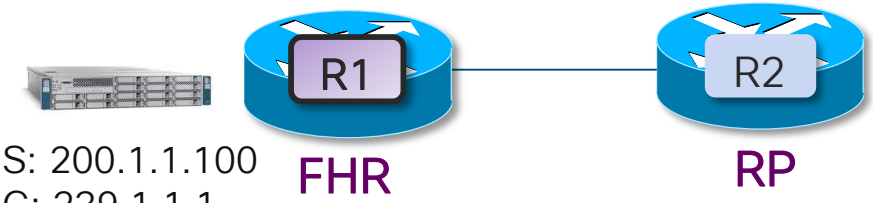
??

ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP

RP
?? ❑Who?
❑Where?
❑RPF Nbr?

Problem:
FHR does not know who the RP is for this group.




```
R1# sh ip pim rp mapping 239.1.1.1
?? PIM Group-to-RP Mappings
R1#
R1#sh ip rpf 2.2.2.2
        failed, no route exists
```

ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP

RP
- ☑ Who?
- ❑ Where?
- ❑ RPF Nbr?

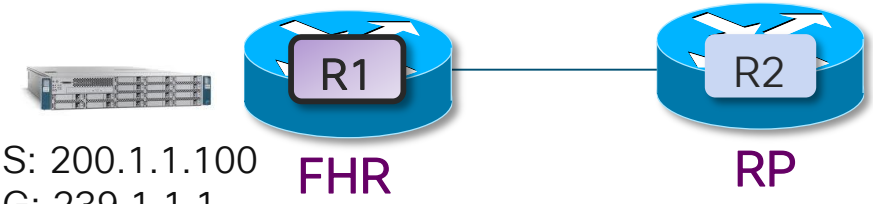
Note:
RP information can be shared 3 ways:
- Static
- Auto-rp
- BSR

→ *"ip pim rp-address 2.2.2.2 override"*

```
R1#sh ip pim rp mapping 239.1.1.1
PIM Group-to-RP Mappings

Group(s): 224.0.0.0/4, Static-Override
    RP: 2.2.2.2 (?)
```

ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP



RP
- ☑ Who?
- ❑ Where?
- ❑ RPF Nbr?

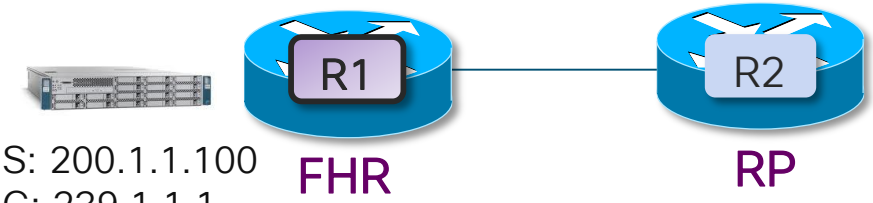
```
R1#show ip mroute 239.1.1.1
(*, 239.1.1.1), 00:11:09/stopped, RP 2.2.2.2, flags: SPF
  Incoming interface: Null, RPF nbr 0.0.0.0 ??
  Outgoing interface list: Null
(200.1.1.100, 239.1.1.1), 00:02:30/00:00:29, flags: PFT
  Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0, Registering
  Outgoing interface list: Null
```

ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP

RP
- ☑ Who?
- ☑ Where?
- ❑ RPF Nbr?

Problem:
FHR doesn't know who the RPF neighbor is for the shared tree for this group.




```
R1#show ip route 2.2.2.2
  2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 10.1.2.2, 01:11:17, Gig1/0/1

R1#show ip rpf 2.2.2.2
RPF information for ? (2.2.2.2) failed, no route exists

R1#show ip pim neighbor
No PIM neighbors
```

??

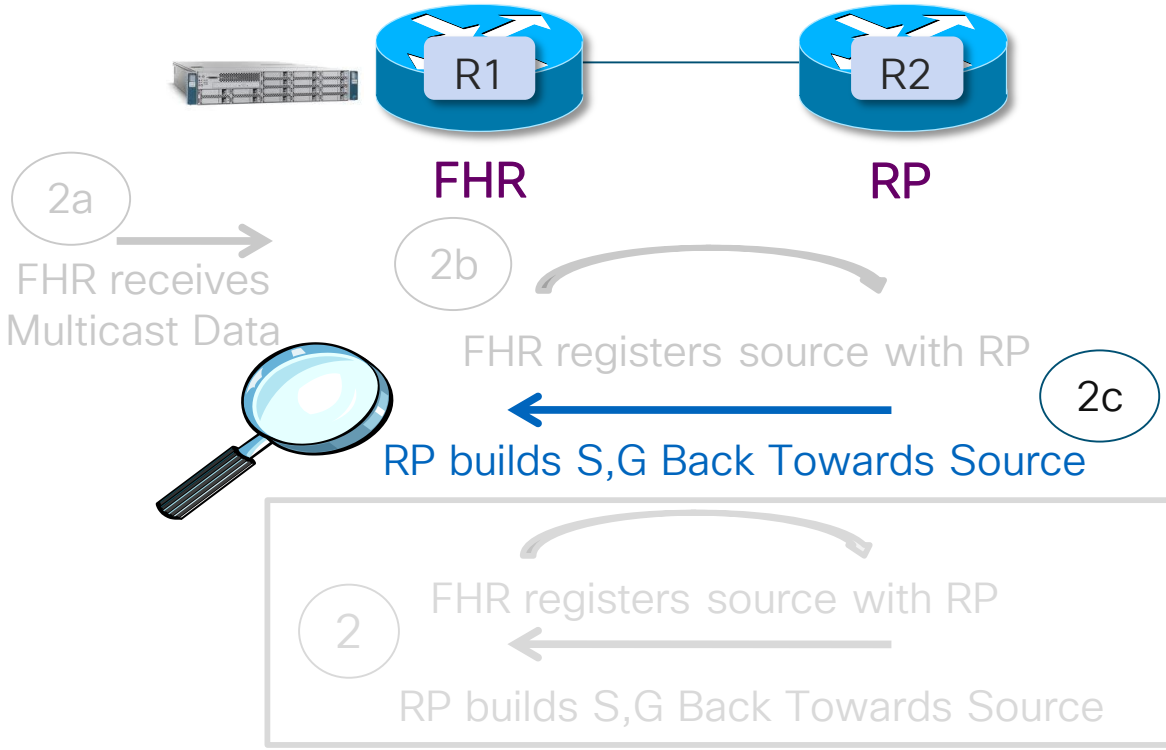
ASM Troubleshooting: Source Tree

2b FHR Registers Source with RP

Note:
"ip pim sparse-mode" added to
Gig 1/0/1 on FHR (R1)

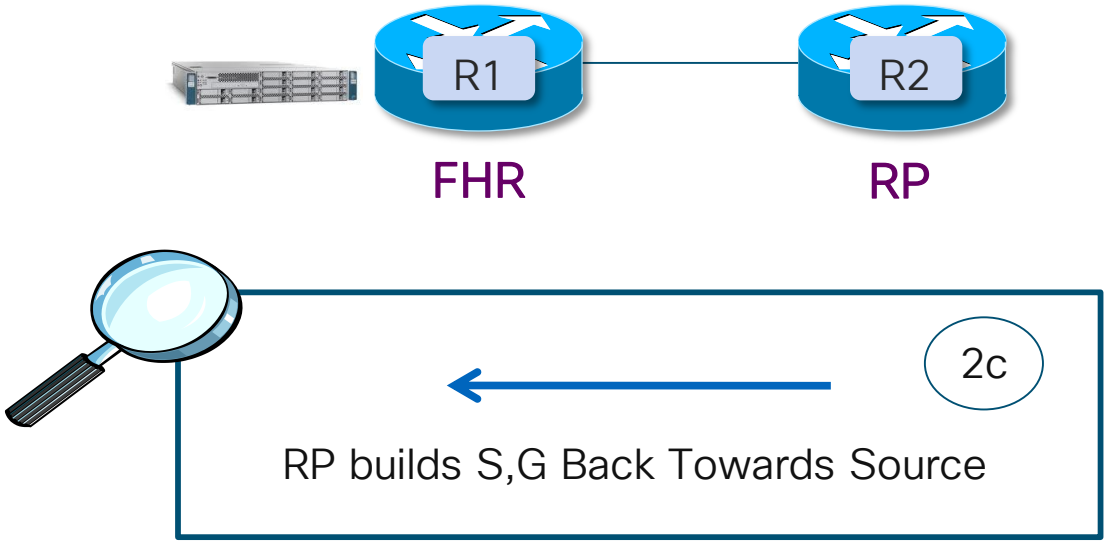

```
R1#show ip mroute 239.1.1.1
(*, 239.1.1.1), 00:02:32/stopped, RP 2.2.2.2, flags: SPF
     Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.1.2.2
     Outgoing interface list: Null
(200.1.1.100, 239.1.1.1), 00:02:32/00:00:27, flags: PFT
     Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0, Registering (data-header)
     Outgoing interface list: Null
```

ASM Troubleshooting: Source Tree



***When a shared MDT is already active for that group on the RP

ASM Troubleshooting: Source Tree



ASM Troubleshooting: Source Tree

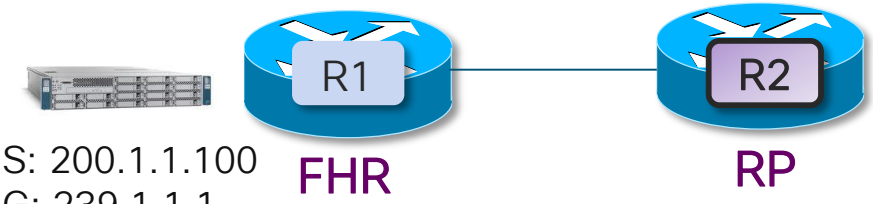
2c RP builds S,G Back Towards Source

Problem:
(S,G) stuck in “registering” on FHR (R1)


```
R1#show ip mroute 239.1.1.1
(*, 239.1.1.1), 00:02:32/stopped, RP 2.2.2.2, flags: SPF
     Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.1.2.2
     Outgoing interface list: Null
(200.1.1.100, 239.1.1.1), 00:02:32/00:00:27, flags: PFT
     Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0, Registering (data-header)
     Outgoing interface list: Null
```

Hmmm... stuck in registering

ASM Troubleshooting: Source Tree



2c RP builds S,G Back Towards Source

Question:
Why is the FHR stuck in “registering”?

Clue:
OIL on FHR for (S,G) is null

Note:
S,G tree will get built backwards from the RP.
So troubleshoot backwards from the RP.

```
R2#show pim rpf 200.1.1.100
     * 200.1.1.100/32
         via Null with rpf neighbor 0.0.0.0

R2#show route 200.1.1.100
     % Network not in table
```

No RPF for the Source

No Route to Source

ASM Troubleshooting: Source Tree

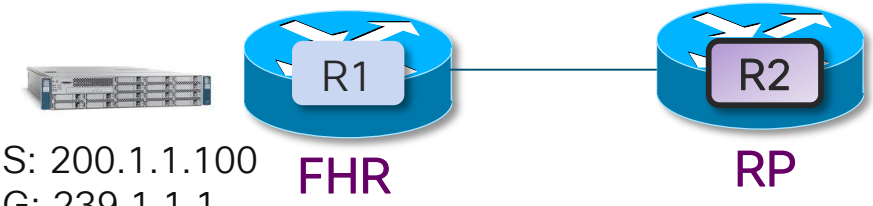
Question:
Why is the FHR stuck in “registering”?

Mcast packet is encapsulated into unicast PIM packet:
Destination IP is the RP.
PIM header type is Register

RP sends PIM (S,G) Join Back Towards Source if there is an active shared tree for that G

Once the RP sees the packets come in on the (S,G), it sends a unicast Register Stop

ASM Troubleshooting: Source Tree



2c RP builds S,G Back Towards Source

Source
- ☑ Who?
- ❑ Where?
- ❑ RPF Nbr?

Problem:
RP doesn't know where the Source is for this group.

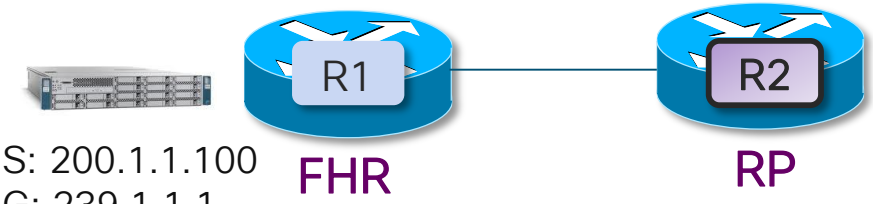
Issue:
Source address not in RIB of RP – routing problem

```
R2#show pim rpf 200.1.1.100
          * 200.1.1.100/32 [-1/-1]
              via Null with rpf neighbor 0.0.0.0
R2#show route 200.1.1.100
          % Network not in table
```

No RPF for the Source

No Route to Source

ASM Troubleshooting: Source Tree

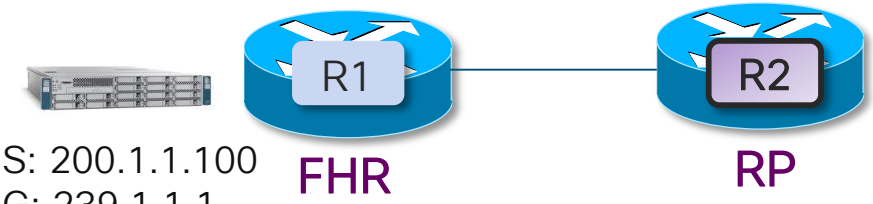


Source
- ☑ Who?
- ☑ Where?
- ☑ RPF Nbr?

Note:
Fix routing problem. RP now has Source in its RIB.

```
R2#show pim rpf 200.1.1.100
          Table: IPv4-Unicast-default
           * 200.1.1.100/32 [110/2]
              via GigabitEthernet0/0/0/0 with rpf neighbor 10.1.2.1
```

ASM Troubleshooting: Source Tree

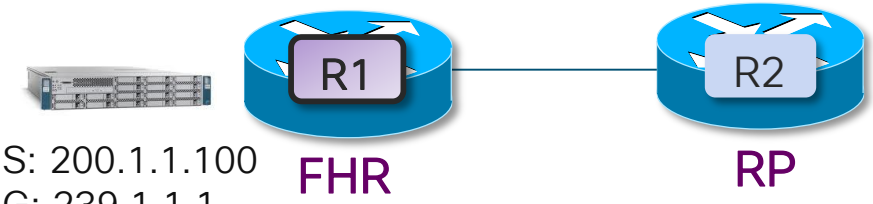


Source
- ☑ Who?
- ☑ Where?
- ☑ RPF Nbr?

Note:
Fix routing problem. RP now has Source in its RIB.

```
R2#show mrib route 239.1.1.1
       (*,239.1.1.1) RPF nbr: 2.2.2.2 Flags: C RPF
          Up: 00:36:30
          Incoming Interface List
            Decapstunnel0 Flags: A, Up: 00:36:30
          Outgoing Interface List
            GigabitEthernet0/0/0/2 Flags: F NS, Up: 00:36:30
       (200.1.1.100,239.1.1.1) RPF nbr: 10.1.2.1 Flags: L RPF
          Up: 00:13:06
          Incoming Interface List
            GigabitEthernet0/0/0/0 Flags: A, Up: 00:02:08
          Outgoing Interface List
            GigabitEthernet0/0/0/2 Flags: F NS, Up: 00:02:08
```

ASM Troubleshooting: Source Tree

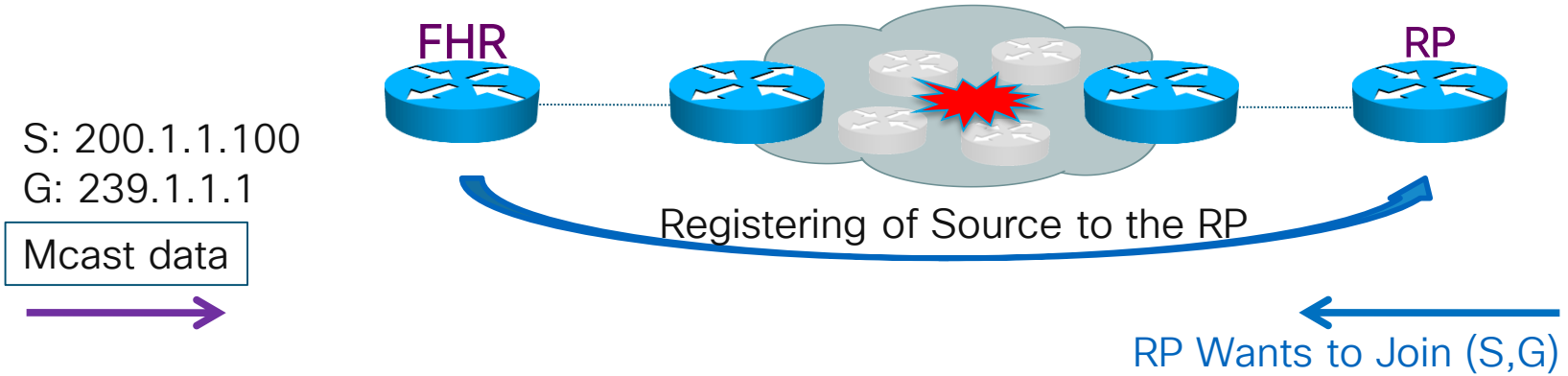


2c RP builds S,G Back Towards Source

Note:
Going back to FHR (R1) with this issue fixed, we now see that the (S,G) is no longer stuck in registering.

```
R1#show ip mroute
(*, 239.1.1.1), 00:16:42/stopped, RP 2.2.2.2, flags: SPF
    Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.1.2.2
    Outgoing interface list: Null
(200.1.1.100, 239.1.1.1), 00:16:42/00:02:41, flags: FT
    Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0
    Outgoing interface list:
        GigabitEthernet1/0/1, Forward/Sparse, 00:05:44/00:02:43
```

ASM Troubleshooting: Source Tree



Potential Reasons for "Black Hole"

1. Source not known in IGP at RP or some IR on the way back to the source (this is the situation we just covered)
2. Usual suspects for any kind of packet loss (physical, firewall, ACL, etc)
3. Missing PIM Neighbor Relationship
4. Multicast Boundary Configured for this Multicast Group

ASM Troubleshooting
Source Tree

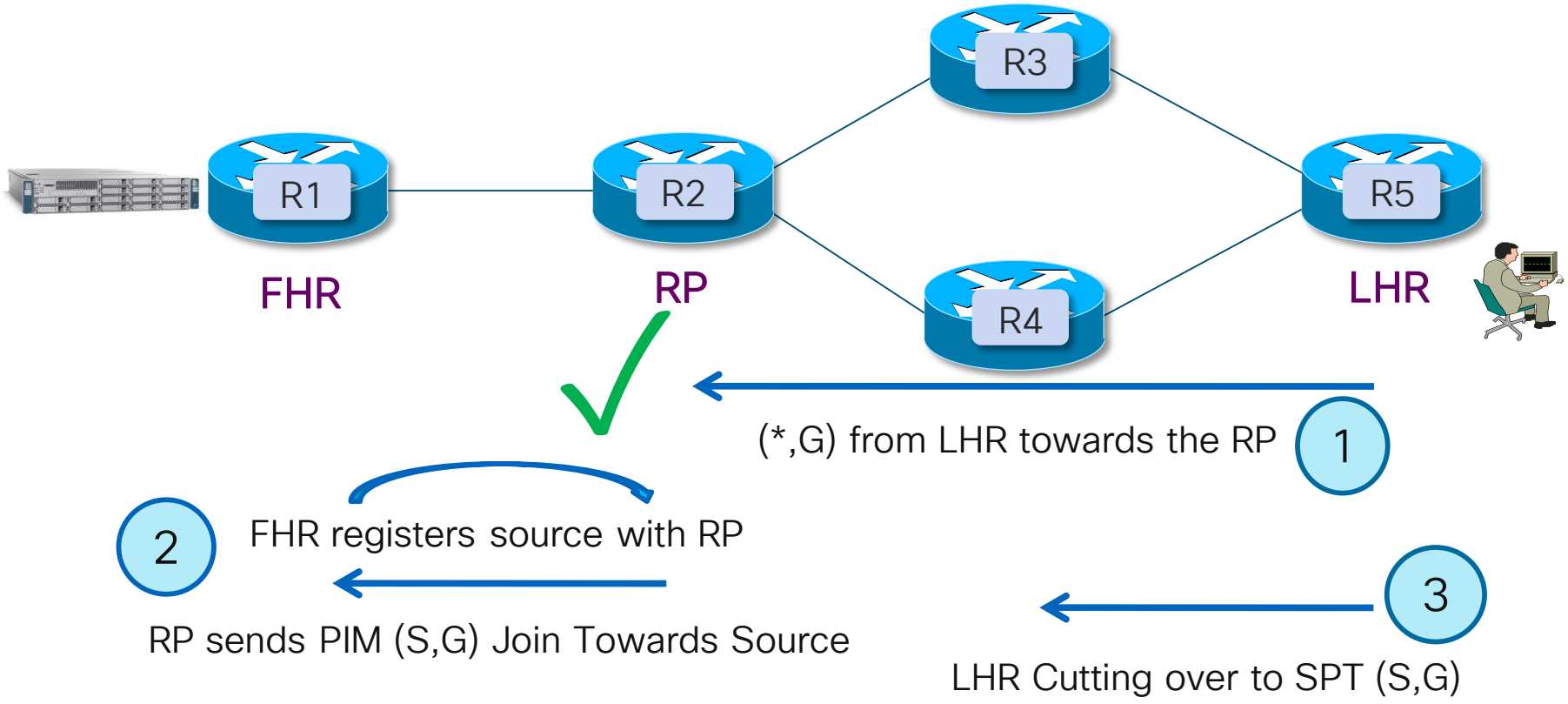
S: 200.1.1.100
G: 239.1.1.1

2 Registering of Source to the RP

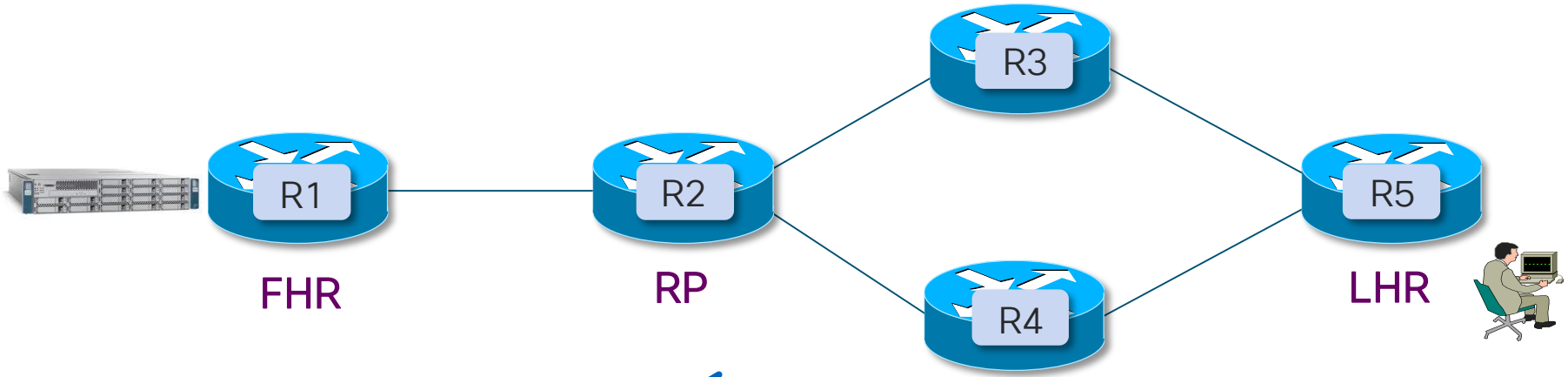
RP building S,G Back Towards Source

(S,G) Between RP and FHR

ASM Troubleshooting



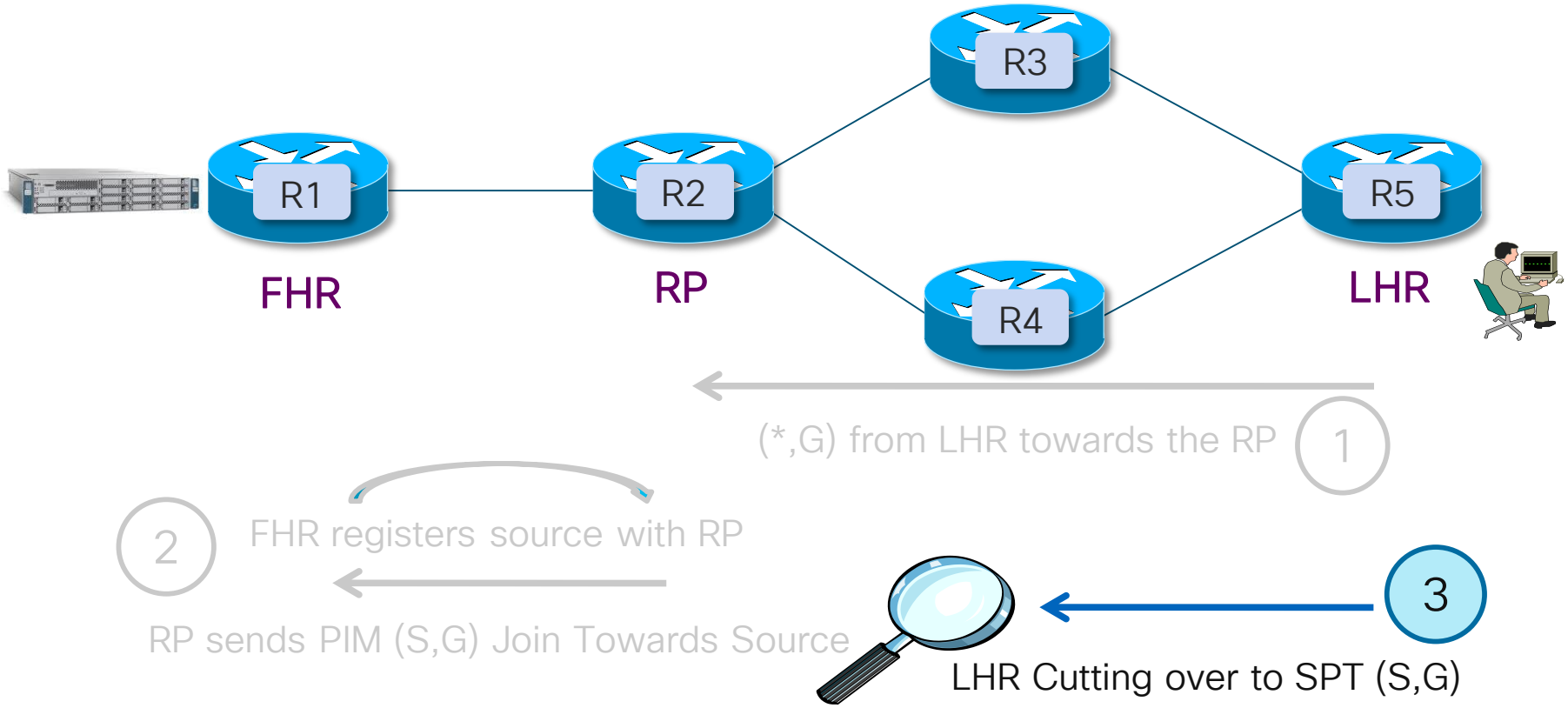
ASM Troubleshooting



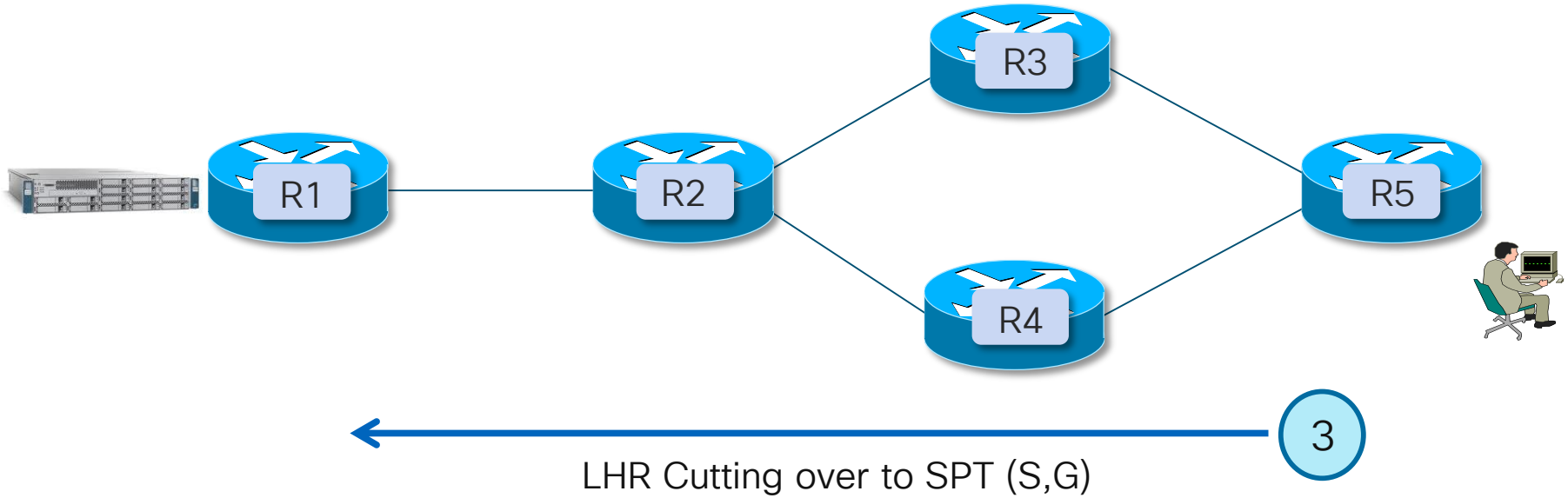
The default behavior of PIM-SM is that routers with directly connected members will join the shortest path tree as soon as they detect a new multicast source.”

PIM-SM Frequently Forgotten Fact

ASM Troubleshooting



ASM Troubleshooting
Joining the SPT

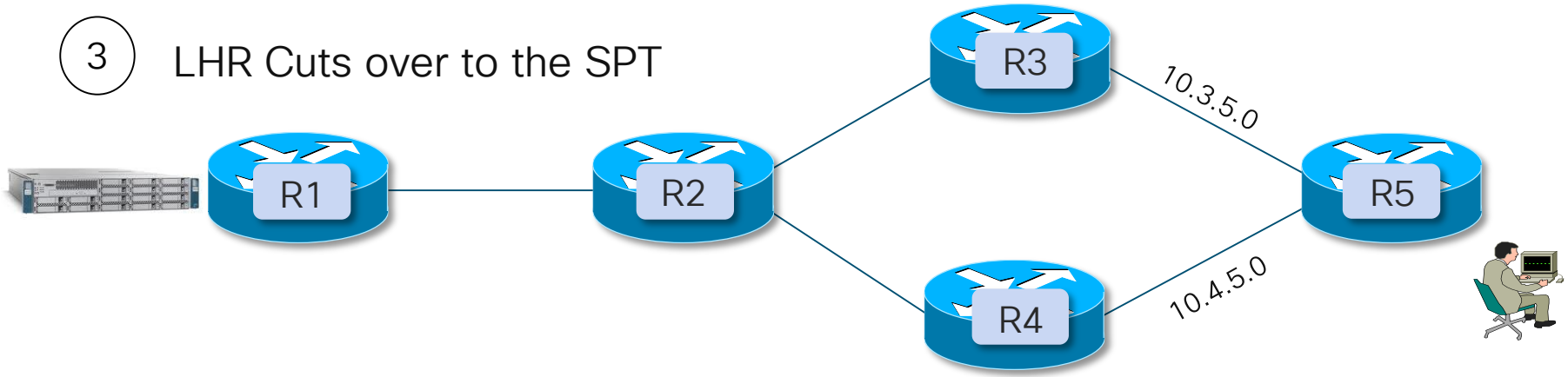


--If SPT Threshold is not infinity (default 0) when the mcast stream comes down the shared tree and into the LHR,

--then the LHR will try to cutover to the shortest path tree

ASM Troubleshooting
Joining the SPT

3 LHR Cuts over to the SPT



3

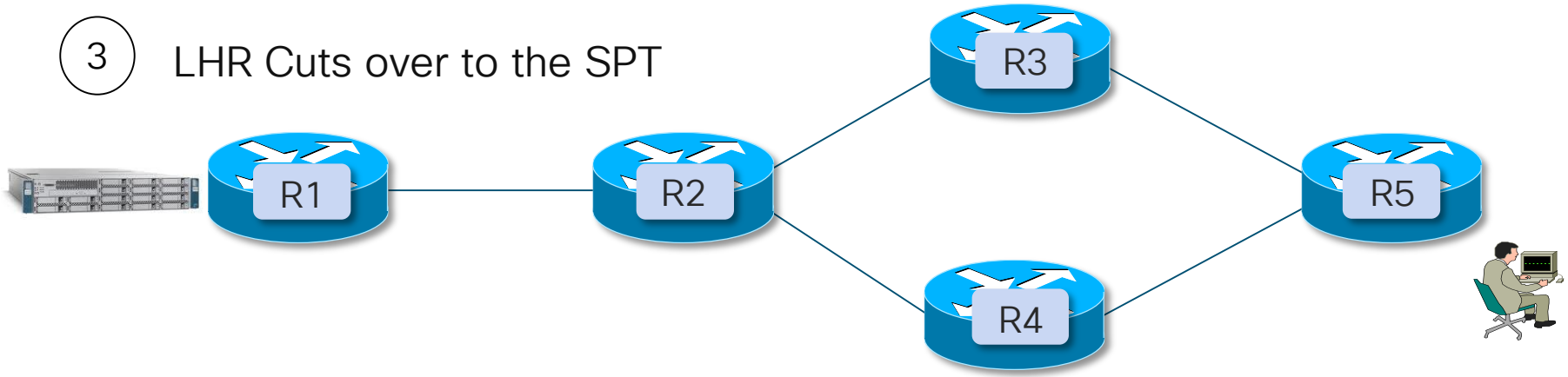
LHR Cutting over to SPT (S,G)

LHR Now must answer 3 questions before sending PIM (S,G) Join

Source
- ❑Who?
- ❑Where?
- ❑RPF Nbr?

ASM Troubleshooting Joining the SPT

3 LHR Cuts over to the SPT



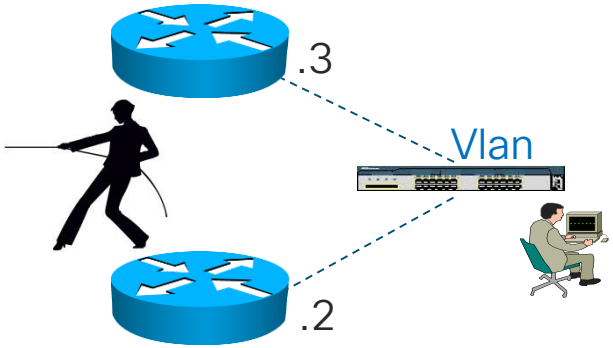
(S,G) Between LHR and FHR

ASM Designated Routers Receivers

Last Hop Designated Router Responsibilities

The LH DR is responsible for sending the PIM (*,G) Join towards the RP

The LH DR will also be responsible for cutting over to the (S,G) tree

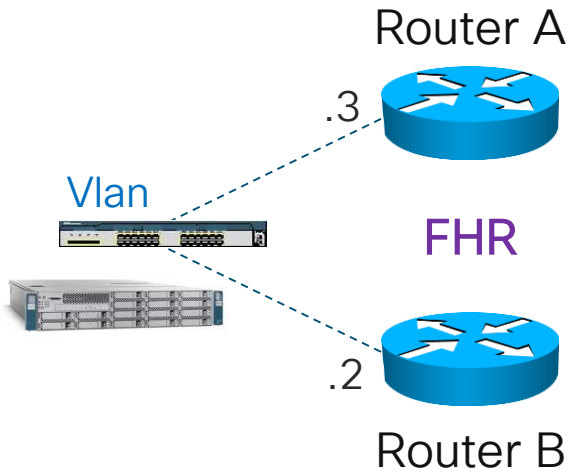


LHR

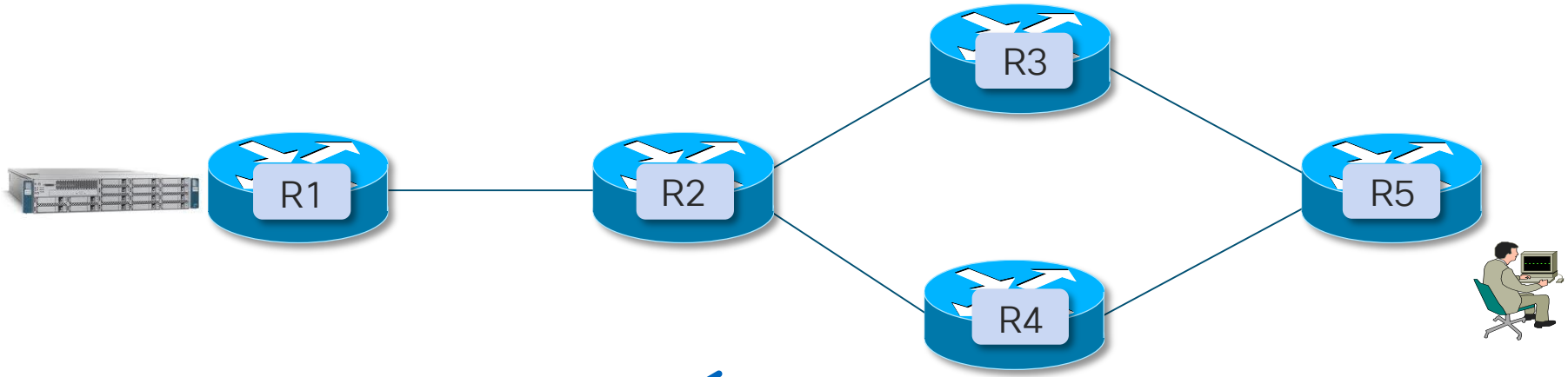
ASM Designated Routers Sources

First Hop Designated Router Responsibilities

The FH DR is responsible for registering the Source/Group with the RP



ASM Troubleshooting



(*,G) from LHR towards the RP 1

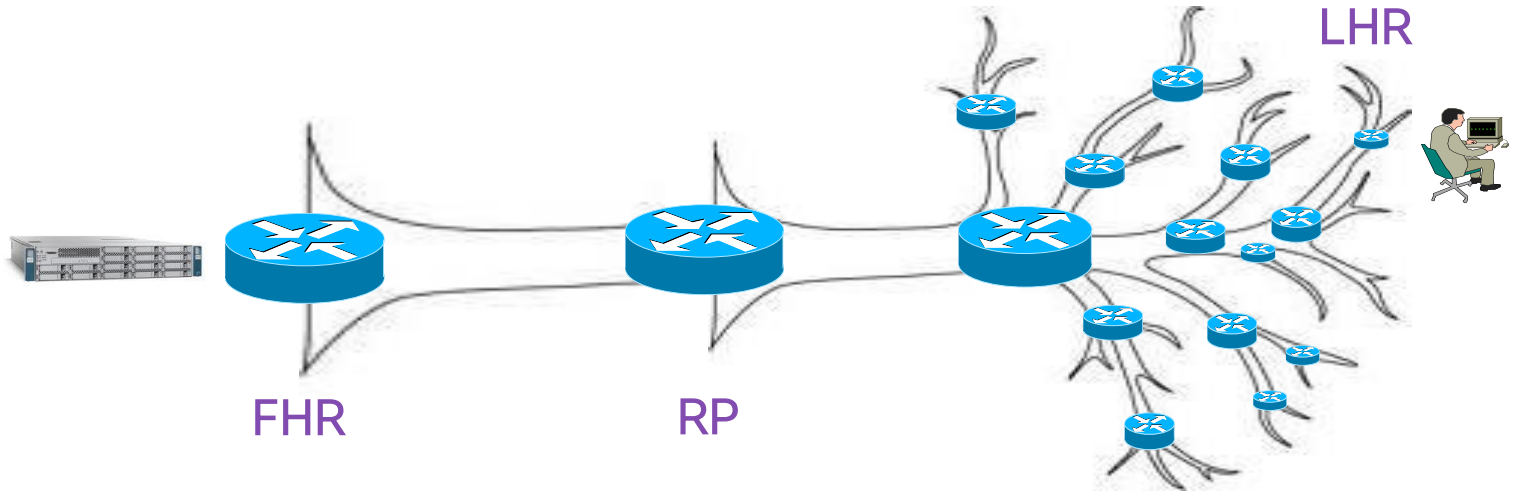
2 Registering of Source to the RP

RP sends PIM (S,G) Join Towards Source

3

LHR Cutting over to SPT (S,G)

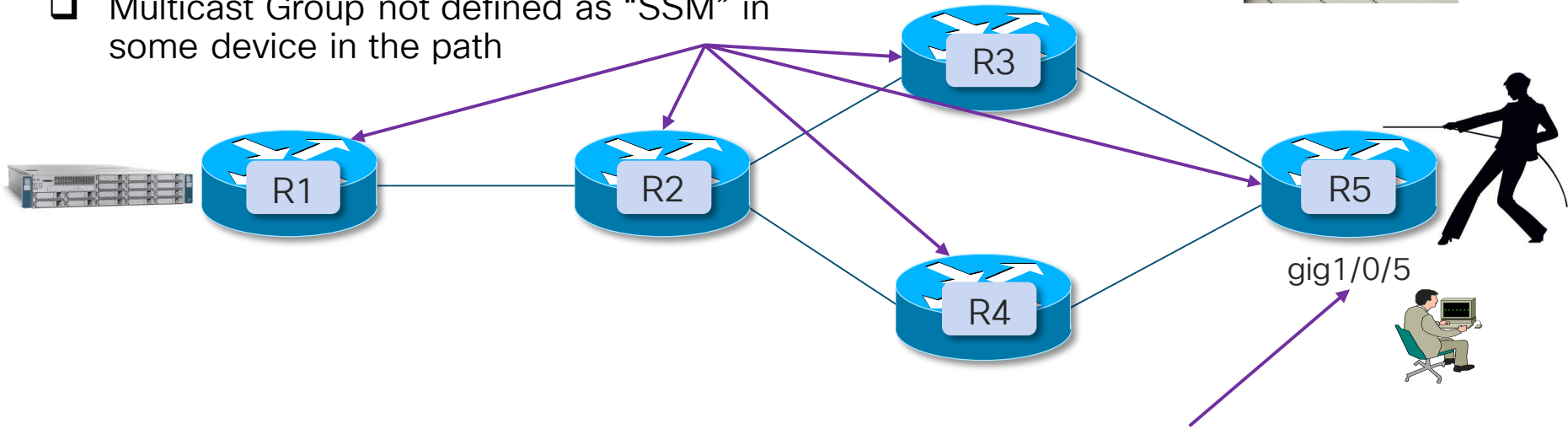
Troubleshooting the ASM Plumbing



SSM Specific Troubleshooting

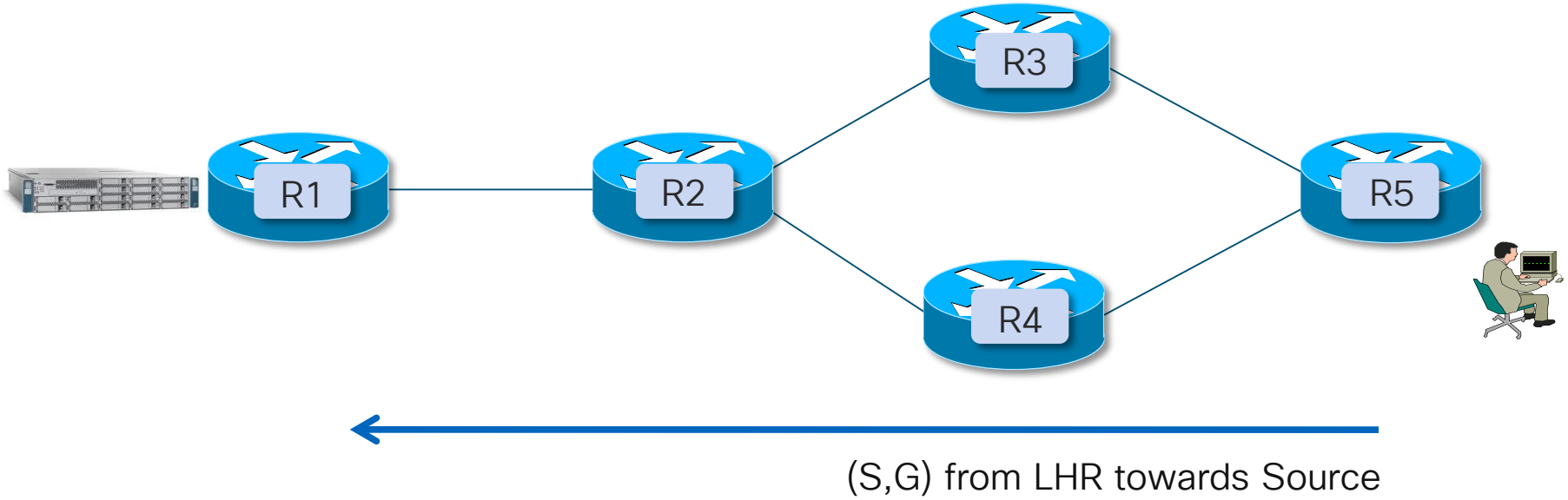
SSM Specific Troubleshooting Checklist

- Multicast Group not defined as “SSM” in some device in the path

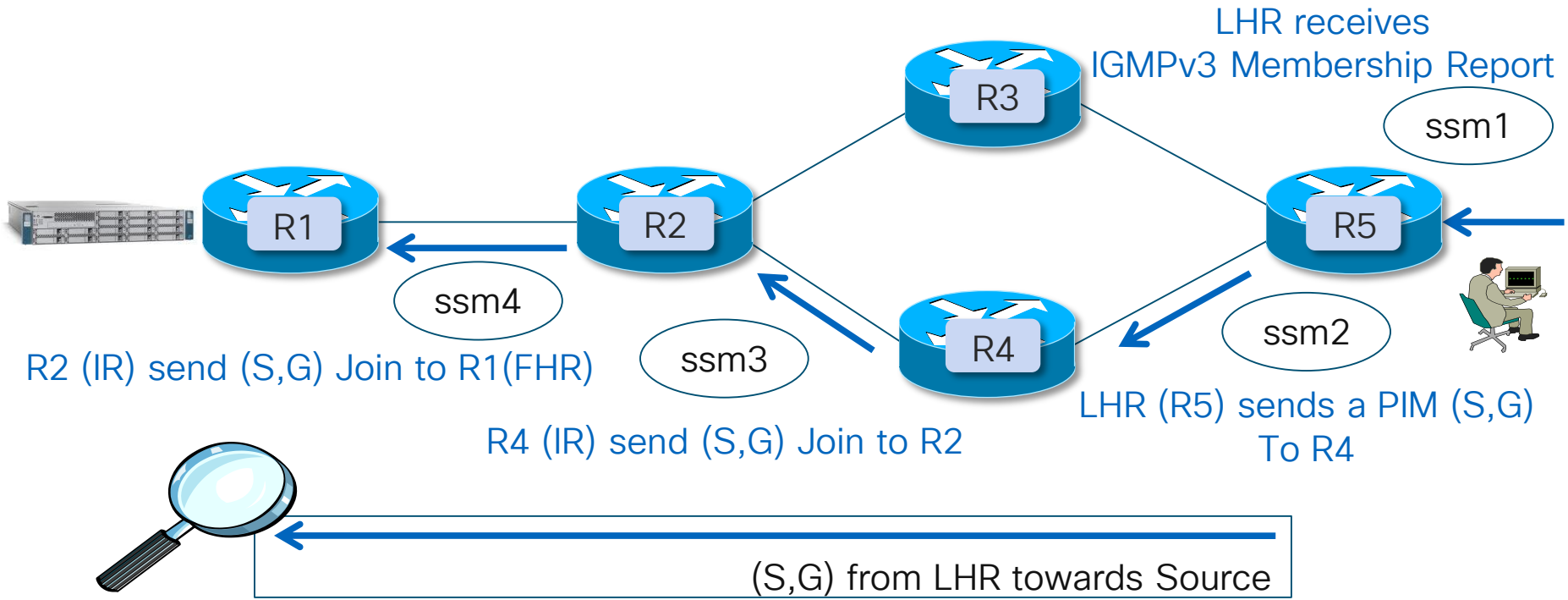


- IGMP Version 3 not enabled (IPv4)
- MLD Version 2 not enabled (IPv6)

SSM Specific Troubleshooting



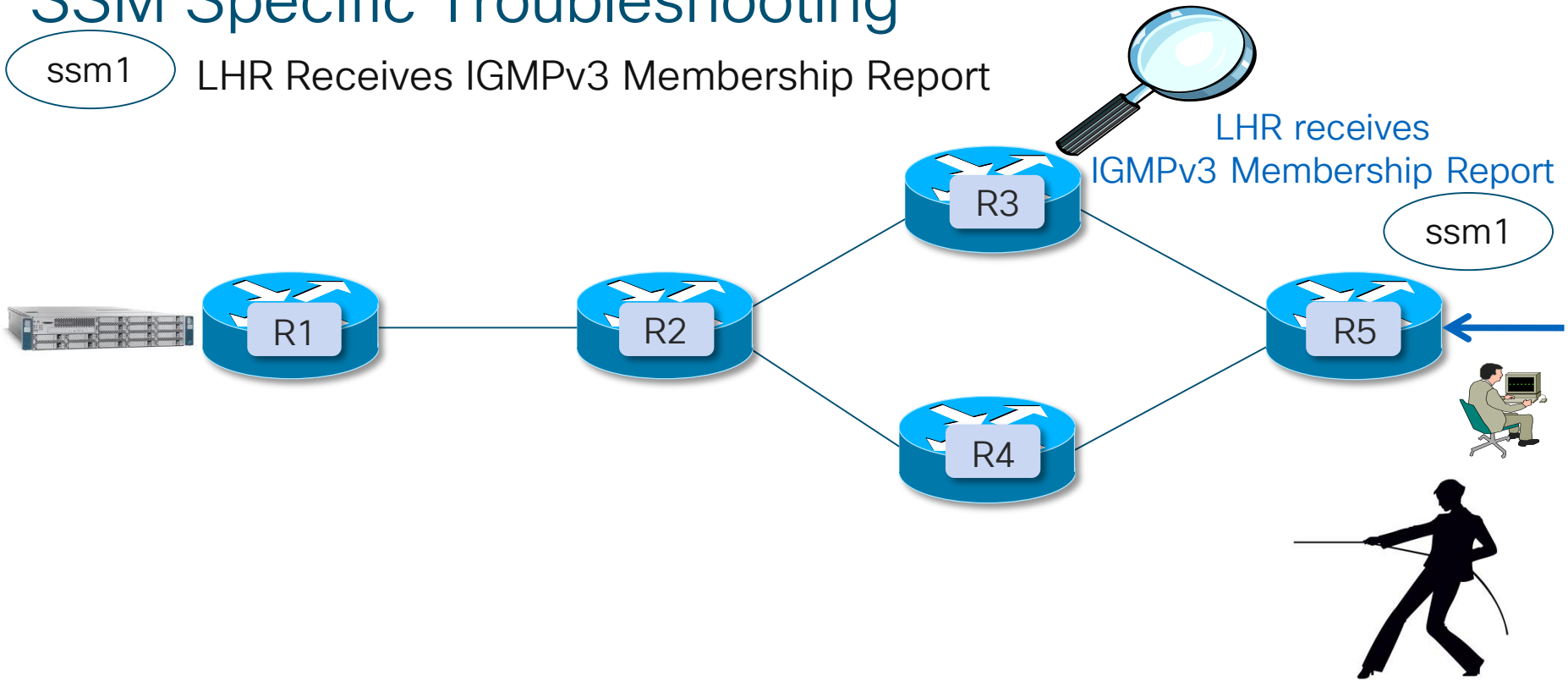
SSM Specific Troubleshooting



SSM Specific Troubleshooting

ssm1

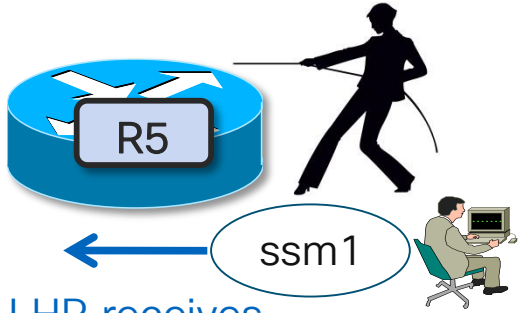
LHR Receives IGMPv3 Membership Report



SSM Specific Troubleshooting

ssm1 LHR Receives IGMPv3 Membership Report

- PIM Enabled
- IGMP Version 3 enabled



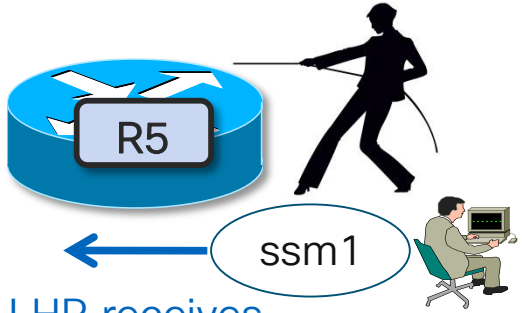
LHR receives
IGMPv3 Membership Report

```
R5#show run int gig1/0/5

     interface GigabitEthernet1/0/5
          no switchport
          ip address 100.1.1.1 255.255.255.0
          ip pim sparse-mode
          ip igmp version 3
```

SSM Specific Troubleshooting

ssm1 LHR Receives IGMPv3 Membership Report

- ❑ PIM Enabled
- ❑ IGMP Version 3 enabled



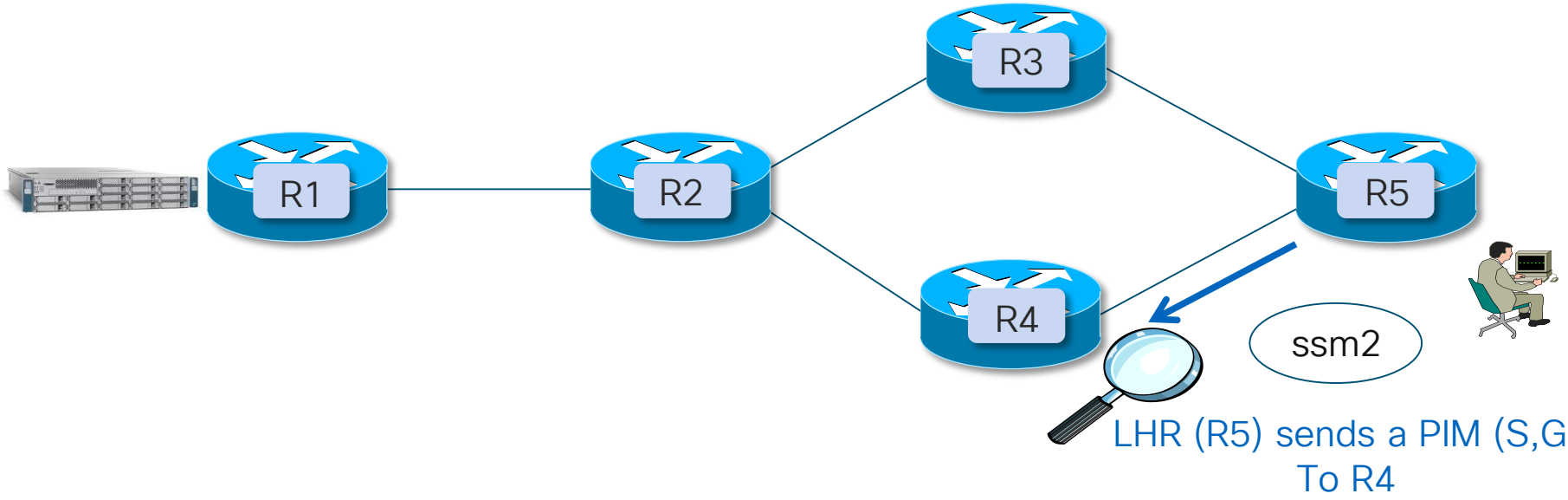
LHR receives
IGMPv3 Membership Report

```
R5#show ip mroute 232.1.1.1

     (*, 232.1.1.1), 00:01:11/00:01:59, RP 2.2.2.2, flags: SJC
        Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.4.5.4
        Outgoing interface list:
          GigabitEthernet1/0/5, Forward/Sparse, 00:01:11/00:01:59
```

SSM Specific Troubleshooting

ssm2

LHR Send (S,G) Join



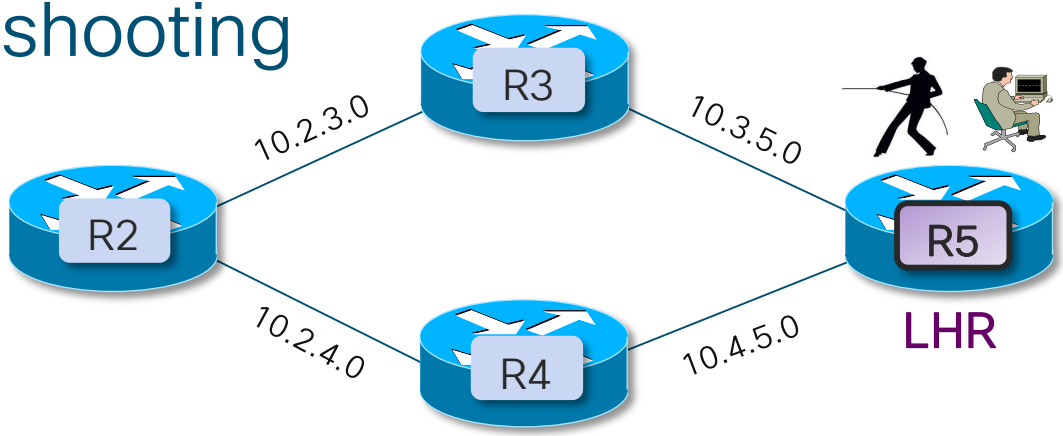
SSM Specific Troubleshooting

ssm2

LHR Send (S,G) Join

Problem:
LHR is configured for this group to be an ASM group, not an SSM group.

[Mode of Group]
- ASM
- SSM



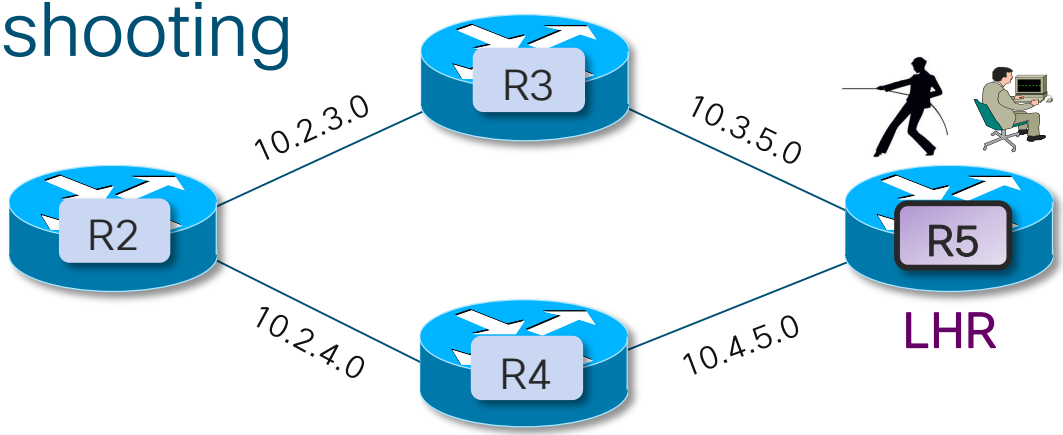

```
R5#show ip mroute ssm          Is completely empty

R5#show ip mroute
     (*, 232.1.1.1), 00:01:11/00:01:59, RP 2.2.2.2, flags: SJC
        Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.4.5.4
        Outgoing interface list:
          GigabitEthernet1/0/5, Forward/Sparse, 00:01:11/00:01:59
```

??

Flags:
D - Dense
S - Sparse
B - Bidir Group
s - SSM Group

SSM Specific Troubleshooting

ssm2 LHR Send (S,G) Join



Note:
Some platforms (XR) have the 232/8 group as SSM by default.
In IOS it must be configured.

Mode of Group
- ASM
- SSM

If SSM Source
- Who?
- Where?
- RPF Nbr?

```
R5(config)#ip pim ssm ?
  default  Use 232/8 group range for SSM
  range    ACL for group range to be used for SSM
R5(config)#ip pim ssm default
```

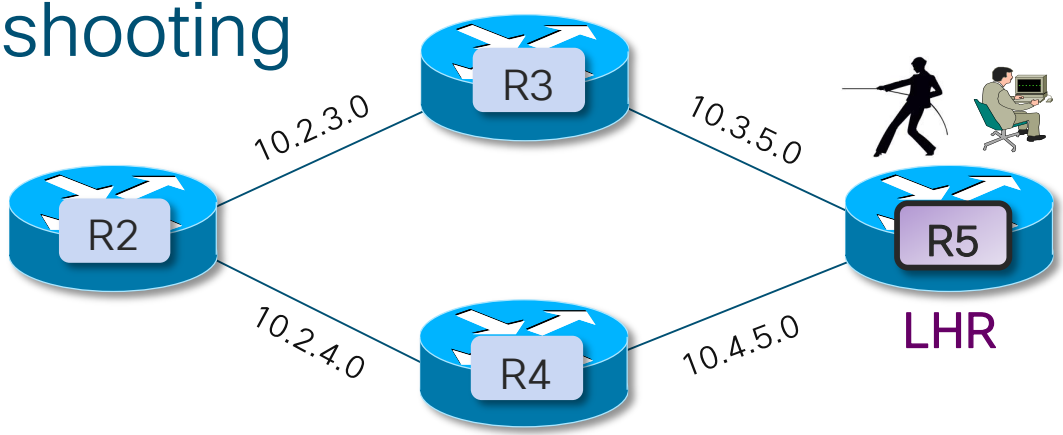
"232.0.0.0-232.255.255.255 (232/8) Source-Specific Multicast Block"

-- http://www.iana.org/assignments/multicast-addresses/

SSM Specific Troubleshooting

ssm2

LHR Send (S,G) Join



Question:
Assuming equal cost paths to the source from the LHR through R3 and R4, which router will the LHR use as its RPF neighbor?

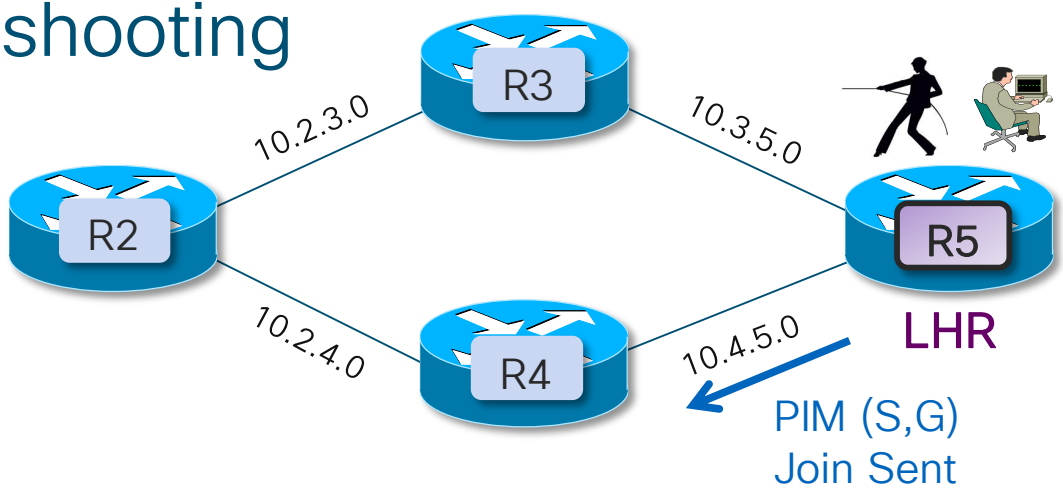
SSM Specific Troubleshooting

ssm2

LHR Send (S,G) Join

Note:
With this group now an SSM group, the LHR asks itself where is the Source and who is the RPF nbr for this source? Then it sends the (S,G) Join.

Mode of Group	If SSM Source
❑ ASM	☑ Where?
☑ SSM	☑ RPF Nbr?

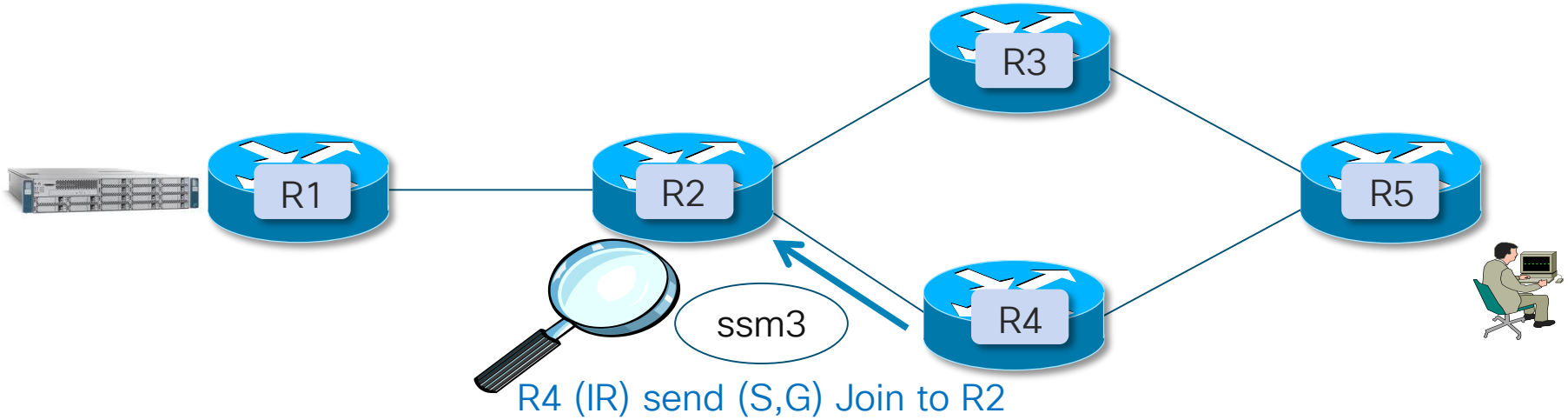



```
R5#show ip mroute 232.1.1.1

(200.1.1.100, 232.1.1.1), 00:04:44/00:02:19, flags: sTI
  Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.4.5.4
  Outgoing interface list:
    GigabitEthernet1/0/5, Forward/Sparse, 00:04:44/00:02:19
```

S - SSM Group
T - SPT-bit set
I - Received Source Specific Host Report

SSM Specific Troubleshooting

ssm3 IR (R4) Sends (S,G) Join



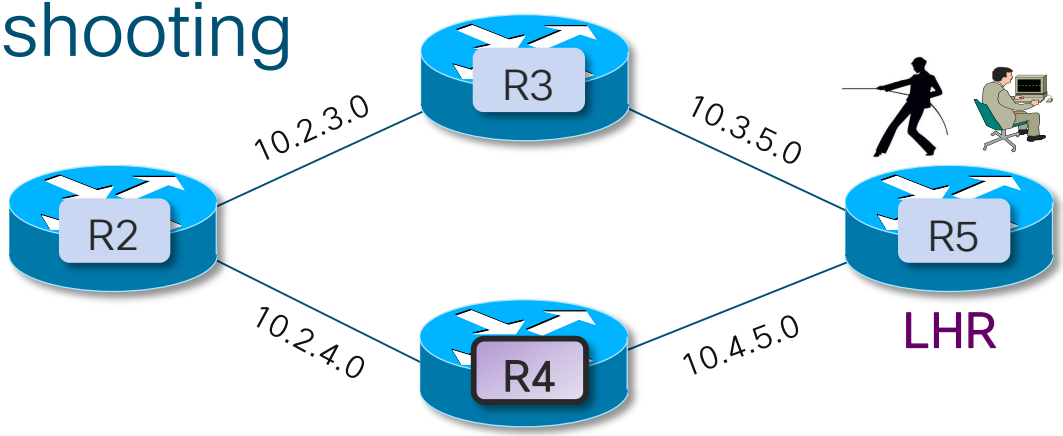
SSM Specific Troubleshooting

ssm3

IR (R4) Sends (S,G) Join

Problem:
IR is configured for this group to be an ASM group, not an SSM group.

Mode of Group
- ASM
- SSM




```
R4#show ip mroute
     (200.1.1.100/32, 232.1.1.1/32), uptime: 00:15:59, pim ip
        Incoming interface: Ethernet1/1, RPF nbr: 10.2.4.2, uptime: 00:15:59
        Outgoing interface list: (count: 1)
            Ethernet1/2, uptime: 00:15:59, pim
R4#sh run | include ssm
     ip pim ssm range 232.0.0.0/8
R4#
```

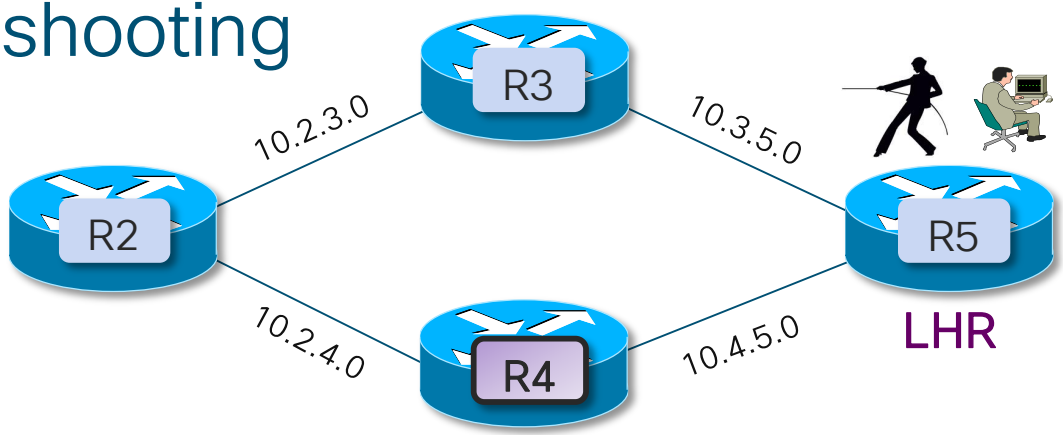
SSM Specific Troubleshooting

ssm3

IR (R4) Sends (S,G) Join

Note:
With this group now an SSM group, the IR (R4) asks itself where is the Source and who is the RPF nbr for this source. Then it sends the (S,G) Join.

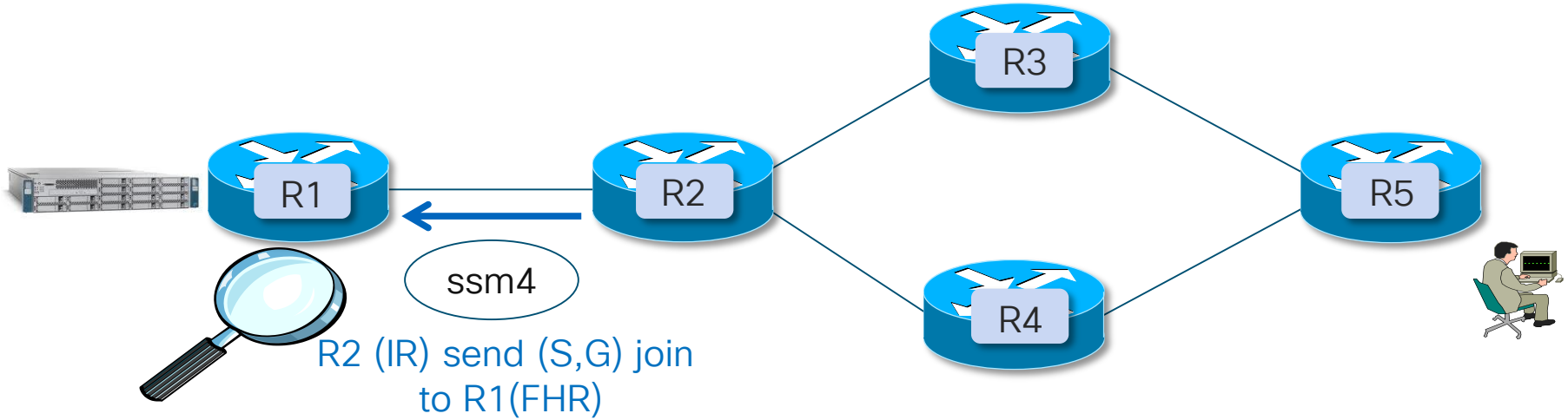
Mode of Group	If SSM Source
❑ASM	☑Where?
☑SSM	☑RPF Nbr?




```
R4#show ip mroute

(200.1.1.100/32, 232.1.1.1/32), uptime: 00:15:59, pim ip
   Incoming interface: Ethernet1/1, RPF nbr: 10.2.4.2, uptime: 00:15:59
   Outgoing interface list: (count: 1)
       Ethernet1/2, uptime: 00:15:59, pim
```

SSM Specific Troubleshooting

ssm4 IR (R2) Sends (S,G) Join



SSM S

SS

y useful
show pim
”

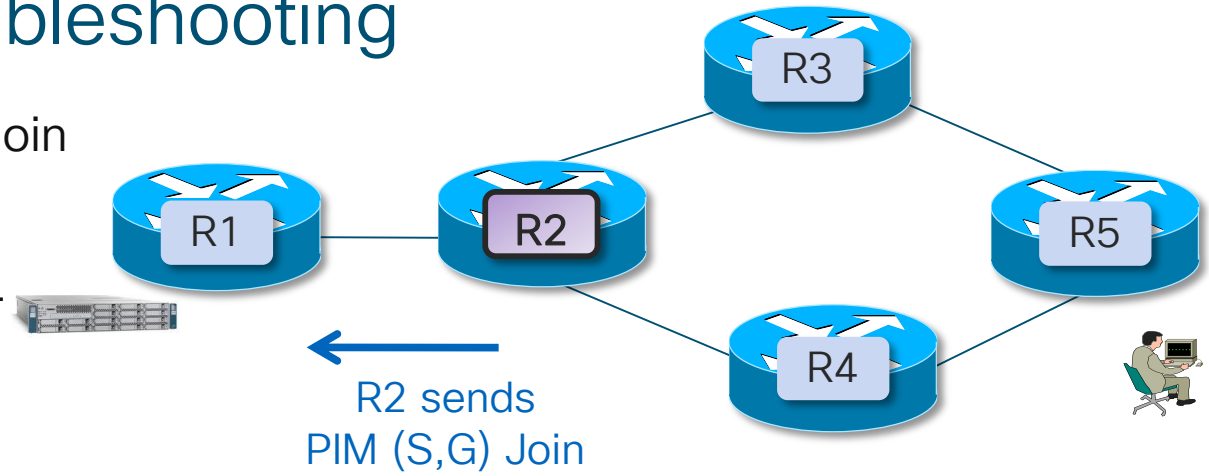
```
im group-map
roup Mapping Table
 group mappings being used)
 group mappings active in MRIB)
to Client   Groups    RP address
22
232.0.
224.0.0.0/
224.0.0.0/4
                                  .2.2.2 (us)
                                  Null,0.0.0.0
```

SSM Specific Troubleshooting

ssm4 IR (R2) Sends (S,G) Join

Note:
IR (R2) asks itself where is the Source and who is the RPF nbr for this source. Then it sends the (S,G) Join.

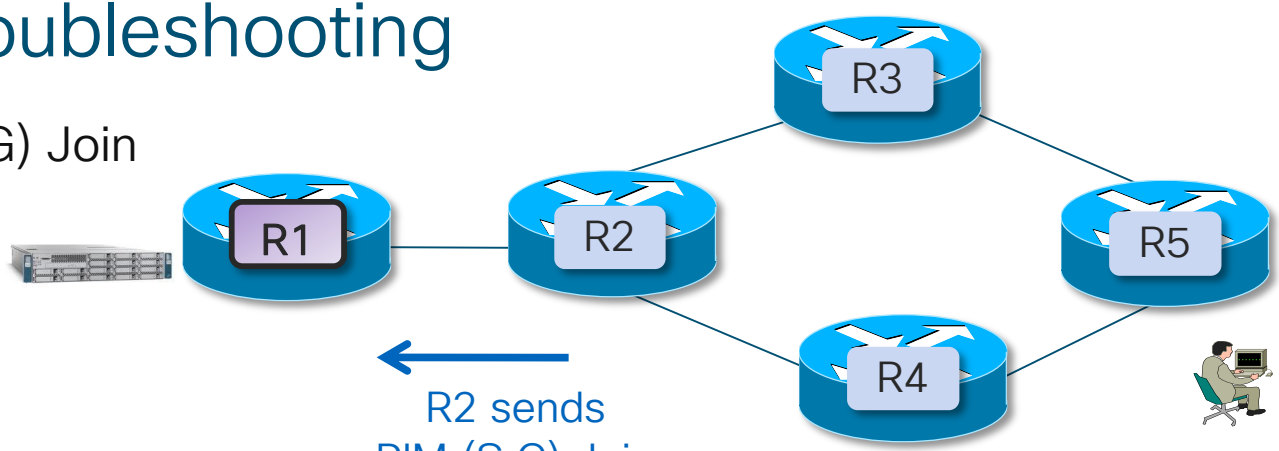
Mode of Group	If SSM Source
❑ASM	☑Where?
☑SSM	☑RPF Nbr?




```
R2#show mrib ipv4 route 232.1.1.1

      (200.1.1.100,232.1.1.1) RPF nbr: 10.1.2.1 Flags: RPF
        Up: 00:17:34
        Incoming Interface List
           GigabitEthernet0/0/0/0 Flags: A, Up: 00:17:34
        Outgoing Interface List
           GigabitEthernet0/0/0/2 Flags: F NS, Up: 00:17:34
```

SSM Specific Troubleshooting

ssm4 IR (R2) Sends (S,G) Join



Mode of Group
- ASM
- SSM

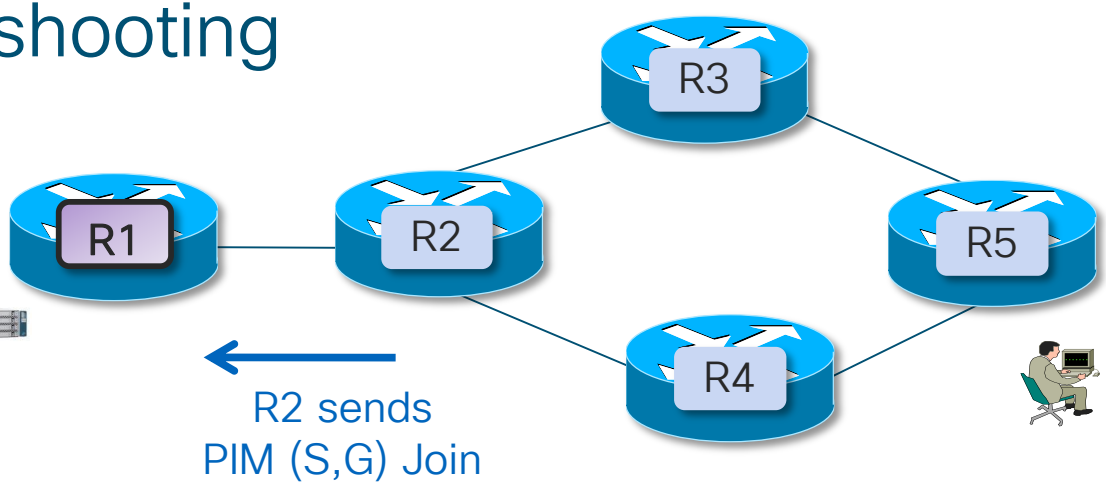
If SSM Source
- Where?
- RPF Nbr?

```
R1#show ip mroute 232.1.1.1
  (*, 232.1.1.1), 00:22:18/stopped, RP 2.2.2.2, flags: SPF
     Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.1.2.2
     Outgoing interface list: Null

  (200.1.1.100, 232.1.1.1), 00:01:17/00:01:42, flags: FT
     Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0, Registering
     Outgoing interface list:
         GigabitEthernet1/0/1, Forward/Sparse, 00:01:17/00:03:12
```

SSM Specific Troubleshooting

ssm4 IR (R2) Sends (S,G) Join

Note:
(S,G) MDT built all the way from the LHR to the FHR. But note how no traffic has yet been sent from the source.

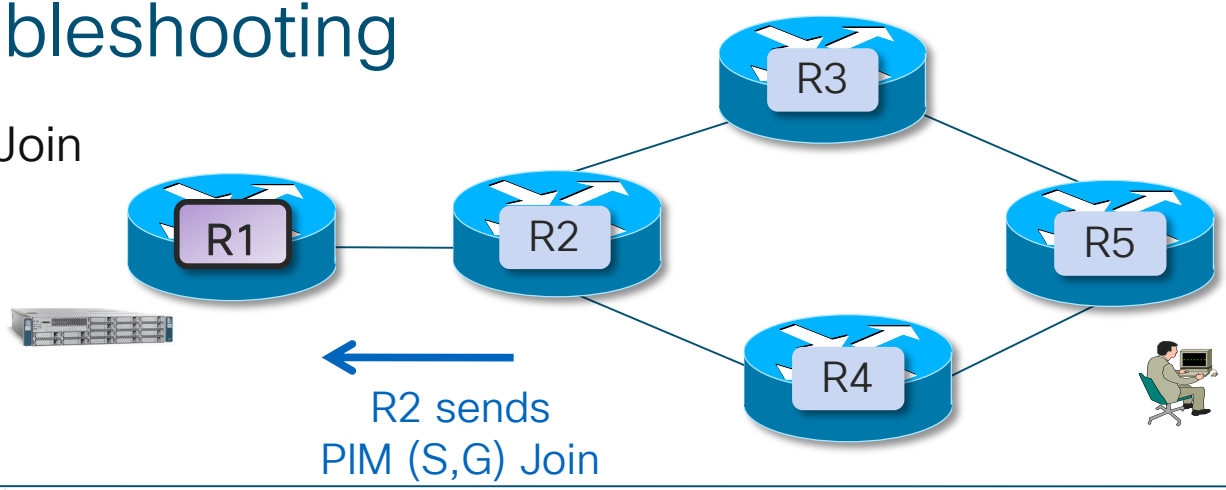



```
R1#show ip mroute 232.1.1.1

(200.1.1.100, 232.1.1.1), 00:01:23/00:03:06, flags: sT
   Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0
   Outgoing interface list:
     GigabitEthernet1/0/1, Forward/Sparse, 00:01:23/00:03:06
```

SSM Specific Troubleshooting

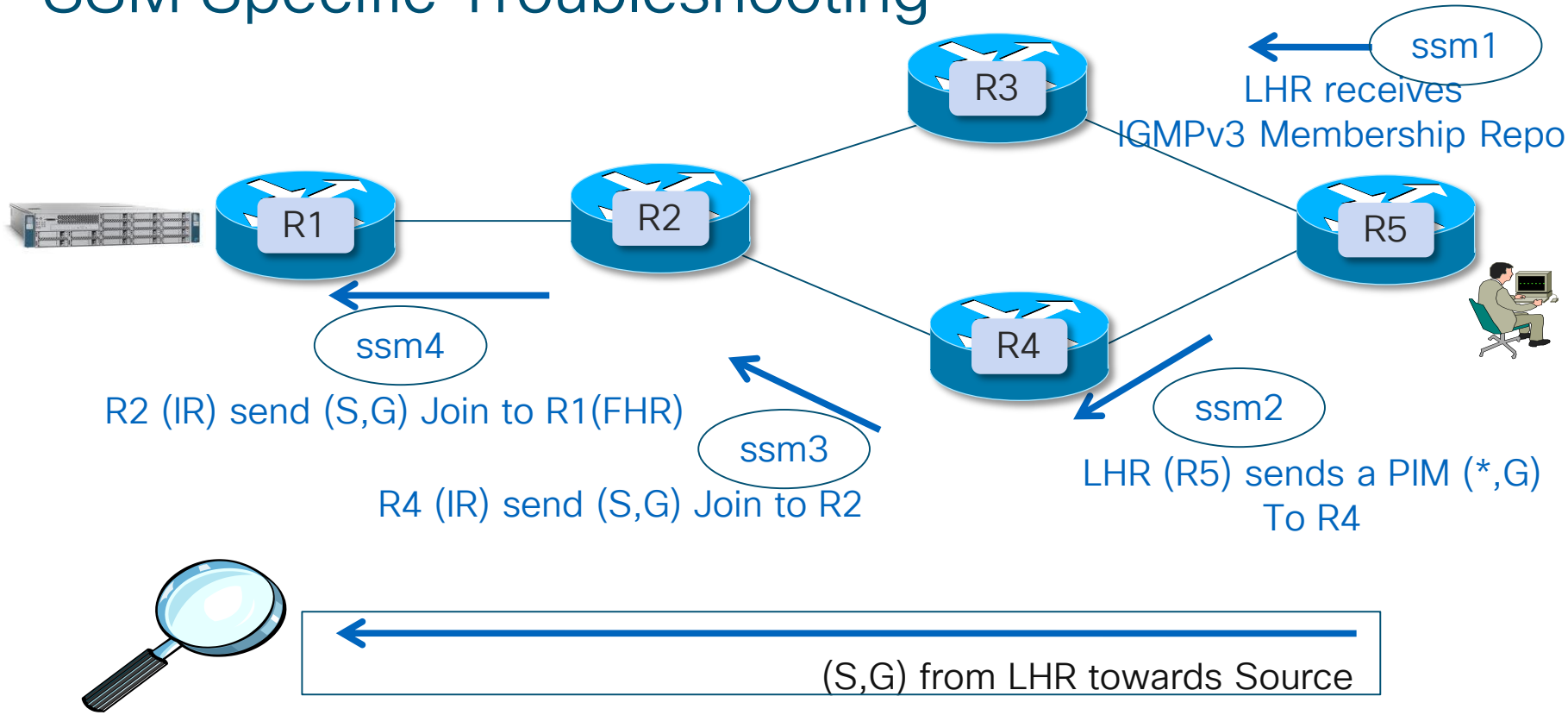
ssm4 IR (R2) Sends (S,G) Join

Note:
(S,G) MDT built all the way from the LHR to the FHR. But note how no traffic has yet been sent from the source.



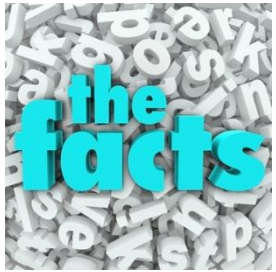

```
R1#show ip mroute 232.1.1.1

  (200.1.1.100, 232.1.1.1), 00:01:23/00:03:06, flags: sT
     Incoming interface: GigabitEthernet1/0/5, RPF nbr 0.0.0.0
     Outgoing interface list:
        GigabitEthernet1/0/1, Forward/Sparse, 00:01:23/00:03:06

R1#show ip mroute 232.1.1.1 count

   Group: 232.1.1.1, Source count: 1, Packets forwarded: 0, Packets received: 0
   Source: 200.1.1.100/32, Forwarding: 0/0/0/0, Other: 0/0/0
```

SSM Specific Troubleshooting



Final Troubleshooting Takeaways

Troubleshooting Toolbox
Facts to Remember



- Multicast Trees get built backwards towards the root
- Multicast traffic in ASM and SSM are triggered via a “pull”
- High on the “food chain” dependent on routing working and PIM working

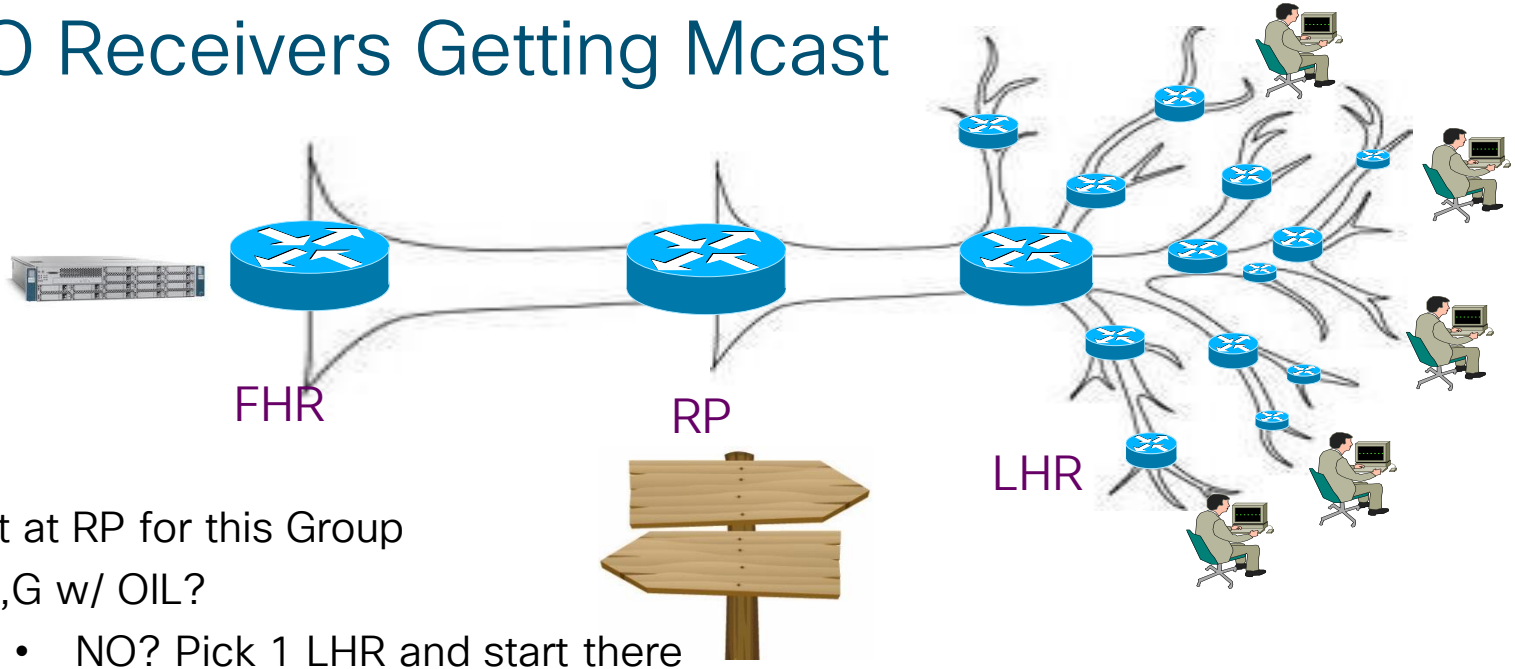
Troubleshooting Toolbox Questions to Remember

- Who is the root?
- Where is the root?
- What is the PIM RPF neighbor towards the root?

Troubleshooting Toolbox Checklist

- ❑ IGMP Membership Report Received by LHR
- ❑ “WHO:” is the root?
- ❑ “WHERE” is the root?
- ❑ “WHAT” is the PIM RPF neighbor towards the root?

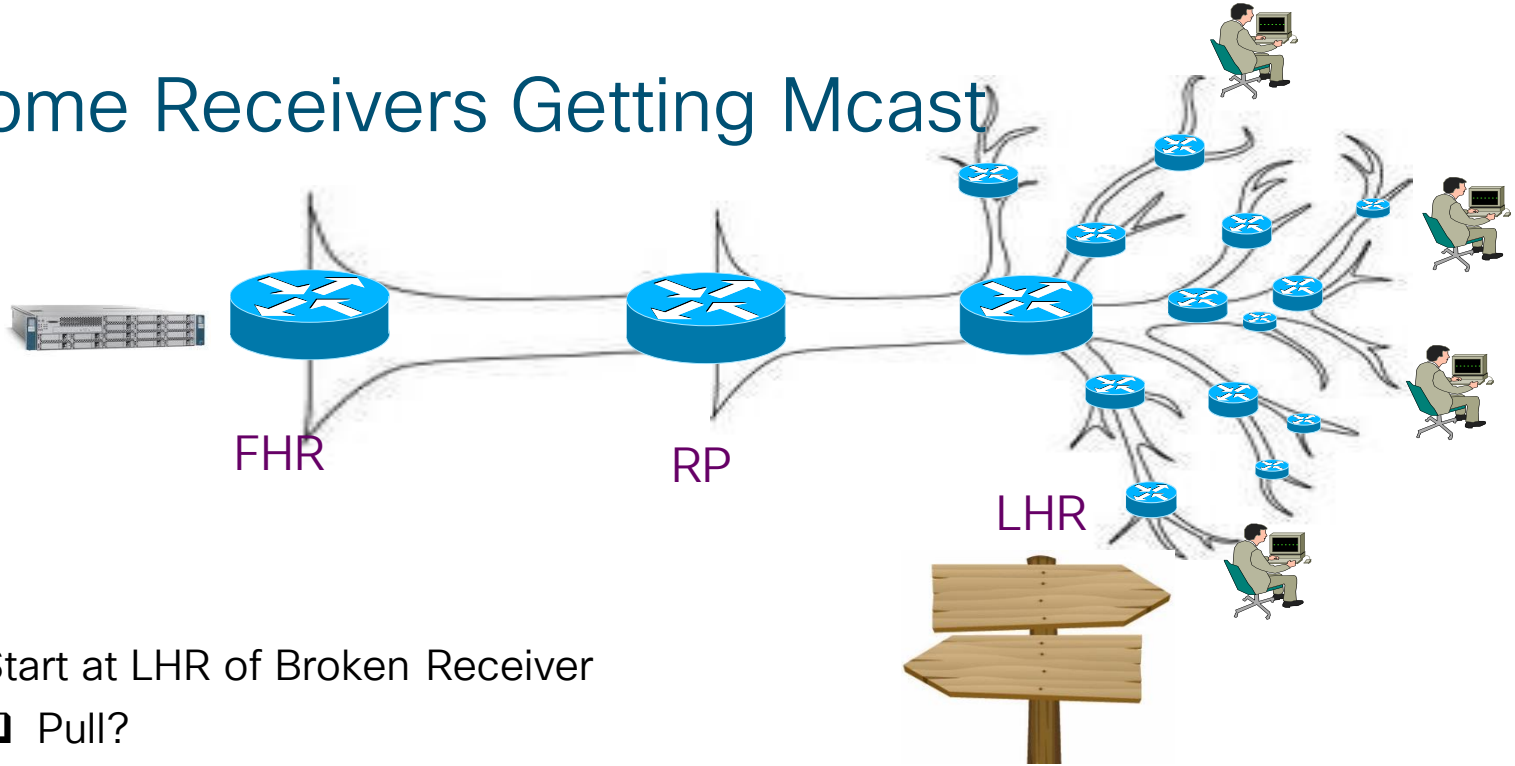
NO Receivers Getting Mcast



Start at RP for this Group

- ❑ *,G w/ OIL?
  - NO? Pick 1 LHR and start there
- ❑ S,G
  - NO? Go to FHR

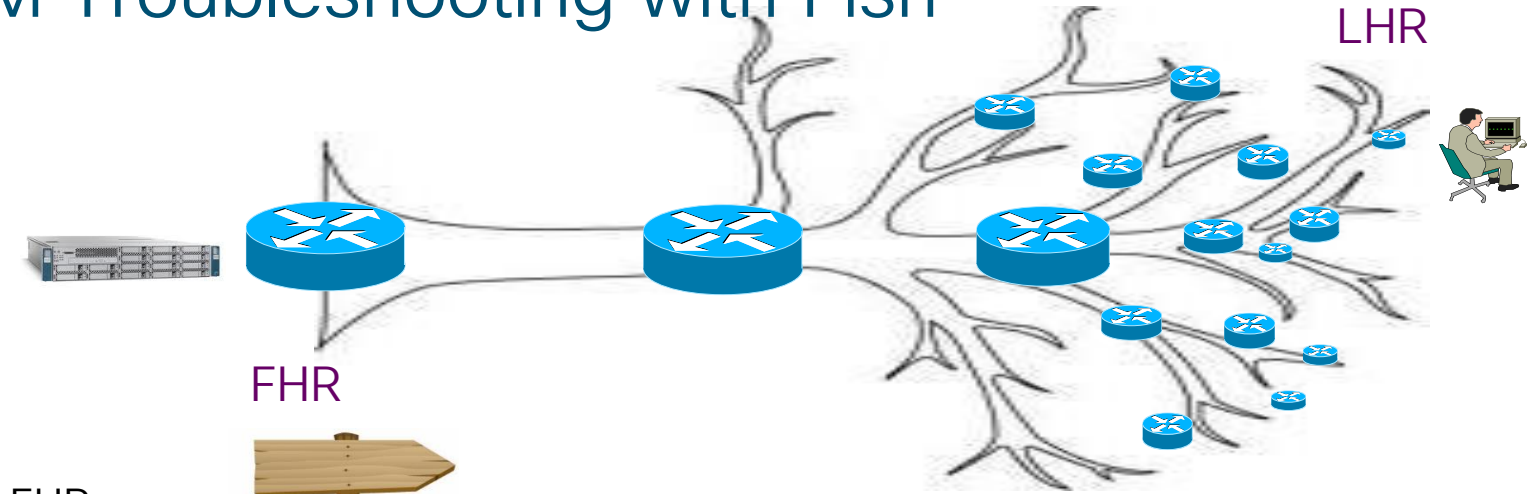
Some Receivers Getting Mcast



Start at LHR of Broken Receiver

- Pull?
- Who, Where, What

SSM Troubleshooting with Fish



Start at FHR

- ❑ S,G w/ OIL?
  - NO? Pick 1 LHR and start there
  - YES? Check to see if traffic coming in from Source

Questions?

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Thank you

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