Lab 4 : PIM Sparse Mode Basics

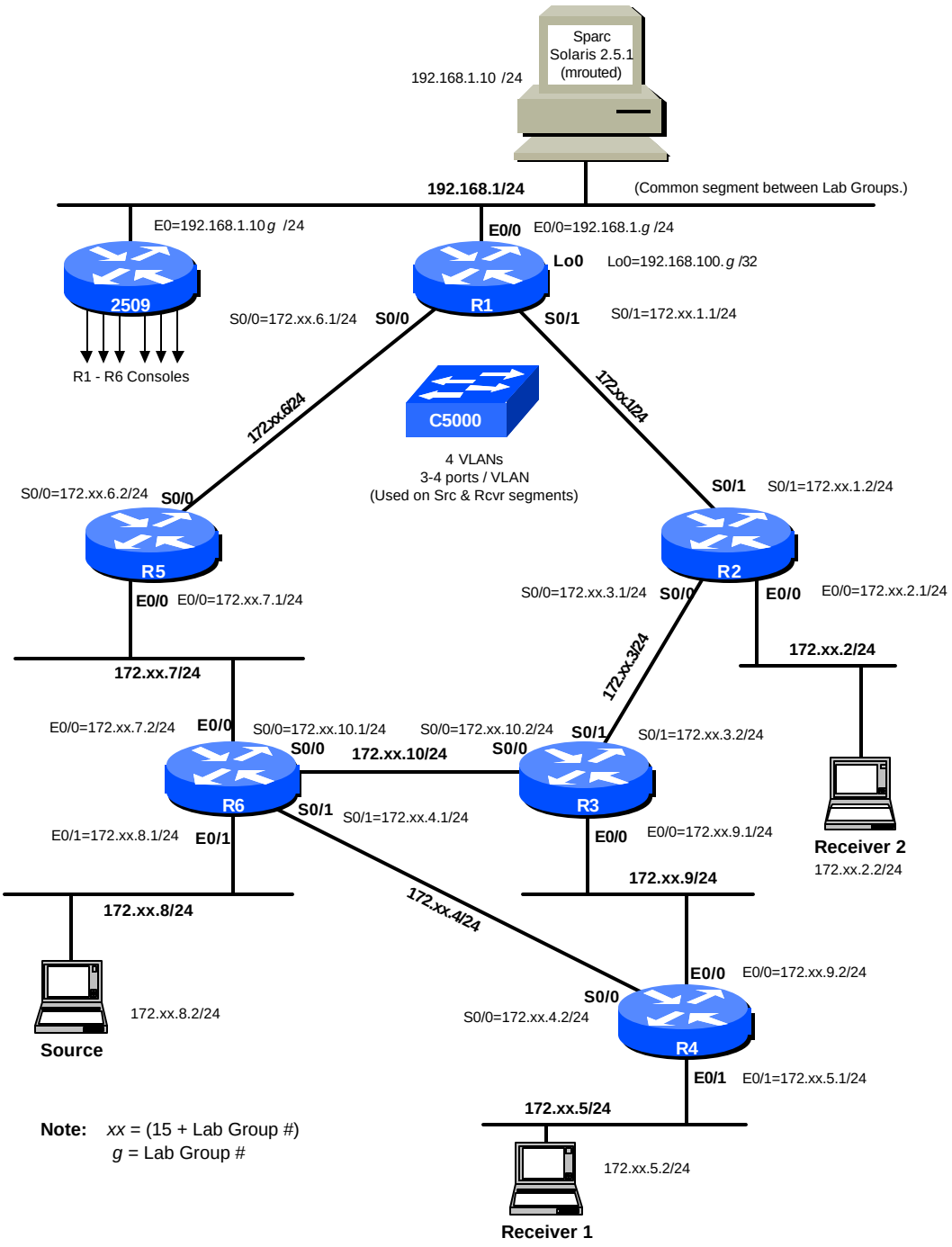

Figure 1 - Sparse Mode Lab Configuration

1. Lab Objectives

- Understand the operation of PIM Sparse mode protocol mechanics
  1. PIM Sparse mode control traffic
  2. Communication with the RP
- Observe formation and maintenance of the Shared Tree for packet delivery
- Observe the cutover to Shortest Path Tree from Shared Tree
- State maintenance and protocol timers

2. Configuration Issues

Ensure that all the interfaces of your router shown in the topology are configure for PIM Sparse mode.

- Configure Loopback0 interface as shown in Figure 1.
- On all routers configure *"ip multicast-routing"*
- On all routers configure *"ip pim rp-address 192.168.100.g"* where *"g"* is your Lab Group number (e.g. 1, 2, 3, …).
- On all interfaces configure *"ip pim sparse-mode"*.
- On all routers configure *"ip pim spt-threshold infinity"*. This command ensures the packets will travel from Source to Receiver via the RP on the Shared tree.
- Ensure you can successfully ping and RPF check to the RP from your router.

3. Exercises

3.1. PIM Sparse mode protocol basics

In this section we will explore the basic operation of a PIM Sparse Mode network and will observe the creation of multicast state in each of the routers in the network.

3.1.1. Shared Tree formation - Receivers

PART I

1. Insure that your routers are configured as shown in Figure-1 with and that no multicast sources or receivers are active. (Note: You may ignore the 224.0.1.40 group. This is the "RP-Announce" group and is automatically joined by the routers in order to receive Auto-RP information.)

2. Using the "*show ip mroute summary*" command, verify that no ip multicast state exists for multicast group `224.1.1.1`. **Inform your instructor when you are ready to proceed!**
3. Your instructor will activate multicast Receiver 1 shown in the configuration diagram so that it "joins" the `224.1.1.1` group.
4. On each of the routers, examine the multicast state for group `224.1.1.1` using the *"show ip mroute 224.1.1.1"* command and answer the following questions.

Questions :

1) What is the incoming interface for the (*, G) entry for group `224.1.1.1` on the following routers?

R1:	**R2:**	**R3:**
R4:	**R5:**	**R6:**

2) What interfaces are on the *"oil"* (outgoing interface list) of the (*, G) entry for group `224.1.1.1` on each router and what's their status, Forward or Prune?

R1:	**R2:**	**R3:**
R4:	**R5:**	**R6:**

3) Why do only some of the routers have state for group `224.1.1.1` and others don't?

4) Why is the incoming interface in the (*, G) entry on router R1 listed as "NULL"?

PART II

1. Your instructor will activate multicast Receiver 2 shown in the configuration diagram so that it also "joins" the `224.1.1.1` group.
2. On each of the routers, examine the multicast state for group `224.1.1.1` using the *"show ip mroute 224.1.1.1"* command and answer the following questions.

Questions :

1) What is the incoming interface for the (*, G) entry for group `224.1.1.1` on the following routers?

R1: **R2:** **R3:**

R4: **R5:** **R6:**

2) What interfaces are on the *"oil"* (outgoing interface list) of the (*, G) entry for group `224.1.1.1` on each router?

R1: **R2:** **R3:**

R4: **R5:** **R6:**

3.1.2. Shared Tree Formation - Senders

1. Your instructor will activate the multicast Source so that it begins sending traffic to group `(*,224.1.1.1).`
2. On each of the routers, examine the multicast state for group `224.1.1.1` using the *"show ip mroute 224.1.1.1"* command and answer the following questions.

Questions :

1. What is the incoming interface in the (S, G) entry for group `224.1.1.1` on the following routers?

R1: **R5:** **R6:**

2. What interfaces are in the outgoing interface list for the (S, G) entry for group `224.1.1.1` on the following routers?

R1: **R5:** **R6:**

3. Why don't all of the routers have an (S, G) entry for Source "S" in the mroute table.

3.1.3. Switching to Shortest Path Tree (SPT)

PART I

1. Insure that your network is configured as shown in Figure-1.
2. If they are not already, activate the multicast Source and Receiver 1 on group `224.1.1.1`. ***Make sure Receiver 2 is not active at this time!*** (Allow the multicast state in the network to stabilize.)
3. Shutdown interface Serial0/1 on R6.

Questions :

1) What is the current status of the Flags associated with the (*,G) and (S,G) entries for group `224.1.1.1`?

R1: (*, G): **R2: (*, G):** **R3: (*, G):**
(S, G):

R4: (*, G): **R5: (*, G):** **R6: (*, G):**
(S, G): **(S, G):**

2) What interface(s) are on the outgoing interface list on router R6 and what is their status?

(*, G) Oif:

(S, G) Oif:

PART II

1. Your instructor will momentarily stop the multicast Source from sending packets to group `224.1.1.1`.
2. Quickly configure the following command on router R4 and inform your instructor when you have done so:

   "ip pim spt-threshold 0".

   (The above command will force PIM to transition to the SPT when the 1st packet arrives from Source to Receiver1.)
3. Inform your instructor when you have complete the above step and he/she will reactivate the multicast Source.

4. Use the *"sh ip mroute 224.1.1.1"* command to answer the following questions :

Questions :

1) What is the new status of the Flags associated with the (*,G) and (S,G) entries for group `224.1.1.1.` Write this information in the space provided below:

R1: (*, G):	**R2: (*, G):**	**R3: (*, G):**
(S, G):	**(S, G):**	**(S, G):**
R4: (*, G):	**R5: (*, G):**	**R6: (*, G):**
(S, G):	**(S, G):**	**(S, G):**

2) What is the significance of the new "T" (SPT) Flag in the (S, G) entries in R3 and R4?

3) What is the significance of change in the "J" Flag in the new (S, G) entry on R4?

4) What is the significance of change in the "R" Flag in the new (S, G) entry on R2?

5) Now what interface(s) are on the outgoing interface list on router R6 and what is(are) their status?

3.1.4. 2nd Receiver Scenario

1. Make sure that router R2 has the following command in its configuration:

   ip pim spt-threshold 0

2. When you are ready, your instructor will activate Receiver 2 to "join" group `224.1.1.1`.
3. Using the information from the "*show ip mroute*" command, answer the following questions.

Questions:

1) Did router R2 join the SPT or the Shared Tree?

2) Why did/didn't router R2 join the SPT.

3.2. PIM Sparse mode protocol mechanics

In this section we will explore the detailed mechanics of a PIM Sparse Mode network and will observe the creation of multicast state in each of the routers in the network.

3.2.1. Shared Tree formation - Receivers

1. Insure that your routers are configured as shown in Figure-1 with and that **no** multicast Sources or Receivers are active.
2. Make sure that no "*ip igmp join-static <group>*" commands are left over from previous lab exercises.
3. Make sure that the following command is configured on all routers in the network.

   ip pim spt-threshold infinity

4. Using the "*show ip mroute summary*" command, verify that no ip multicast state exists for multicast group `224.1.1.1`. (Use the "*clear ip mroute **</u>*" command to clear out the state.)
5. On your router enable the following debugs :

   debug ip pim 224.1.1.1 : Displays all PIM messages related to the group

debug ip mrouting : Displays all changes to the multicast routing table

debug ip mpacket : Displays all multicast packets routed

Inform your instructor when you are ready to proceed!

6. On routers R1, R2, R3 and R4 (chose one), observe the debug messages while your instructor activates multicast Receiver 1 so that it "joins" the `224.1.1.1` group.
7. Observe the formation of the (*, G) state for group `224.1.1.1` state in all the routers between the Receiver 1 and the RP i.e. routers R1, R2, R3 and R4.
8. Note how the (*,G) state is periodically maintained by RP REACHABLE messages generated by the RP
9. Also note the periodic JOIN messages being sent out by each router to the RP.

Questions :

1) How is the Shared tree built?

2) What is the significance of the initial (*,G) entries in routers R2, R3 and R4?

3.2.2. Shared Tree Formation - Senders

1. Your instructor will now activate the multicast Source so that it begins sending traffic to group `(*,224.1.1.1)`.
2. On routers R1, R5 and R6, observe the outputs of the *debugs* and also the output of a "*sh ip mroute 224.1.1.1"*.
3. On routers R1 (the RP) and R6, observe the use of REGISTER messages and REGISTER-STOP messages on initiation of the packet transmissions by the Source.
4. Observe the JOIN messages sent down from the RP towards the Source via the path R1-R5-R6. This is the mechanism used to connect the Source to the Shared tree.
5. On all the routers observe the output of *"sh ip mroute 224.1.1.1"* and note the state being built.
6. Observe the periodic PIM control traffic flowing along the shared tree.

Questions :

1) When is the (S,G) entry for the Source formed and how is it sustained?

2) What happens when the Source transmits for the 1st time?

3) What is the significance of the REGISTER & REGISTER-STOP messages?

4) What is the significance of the (*,G) and the (S,G) state, and how are they sustained?

3.2.3. Switching to Shortest Path Tree (SPT)

1. Insure that your network is configured as shown in Figure-1.
2. If they are not already, activate the multicast Source and Receiver 1 on group `224.1.1.1`. ***Make sure Receiver 2 is not active at this time!*** (Allow the multicast state in the network to stabilize.)
3. On your router enable the following debugs :

   debug ip pim 224.1.1.1 : Displays all PIM messages related to the group

   debug ip mrouting : Displays all changes to the multicast routing table

   debug ip mpacket : Displays all multicast packets routed

Inform your instructor when you are ready to proceed!

4. When everyone is ready, your instructor will momentarily stop the multicast Source from sending packets to group `224.1.1.1`.
5. Quickly configure the following command on router R4 and inform your instructor when you have done so:

   "ip pim spt-threshold 0".

(The above command will force PIM to transition to the SPT when the 1st packet arrives from Source to Receiver1.)

6. Your instructor will reactivate the multicast Source to send to group `224.1.1.1`.
7. Using the *debug* output, observe the following :
   - R4 will send an (S, G)JOIN for (S,G) to R6 in order to join the Shortest-Path Tree (SPT).
   - R4 will send an (S, G)RP-bit PRUNE toward the RP (via R3) to prune (S, G) traffic from the Shared Tree (RPT).
   - R3 and R2 will, in turn, send (S, G)RP-bit PRUNE's toward the RP for the (S,G).
   - Once the (S, G)RP-bit PRUNE reaches the RP, it finds it has no other receivers down the Shared Tree for (S, G) traffic and will therefore send a (S, G) PRUNE toward the Source (via R5) in order to prune itself form R6's tree for (S,G) traffic.
   - Note the periodic PIM traffic in the section of the tree no longer carrying traffic between the Source and Receiver1, i.e. R5-R1-R2-R3. You will see mostly periodic JOIN's sent to the RP for (*,G) and RP REACHABLE messages from the RP.

3.2.4. 2nd Receiver Scenario

1. Make sure that router R2 has the following command in its configuration:

   ip pim spt-threshold 0

2. When you are ready, your instructor will activate Receiver 2 to "join" group `224.1.1.1`.

   Note: Since an SPT is being used, multicast packets intended for group `224.1.1.1` no longer travel via the RP. The presence of a new receiver will initiate changes in the Multicast distribution tree.

3. Using the *debug* output, observe the following :
   - Router R6 receives JOIN messages from R3 for the (S,G)
   - Router R2 initiate a PIM JOIN to the RP for the (*,G) as R2 tries to join the Shared tree for the group G. (Note the Flags.)
   - Observe the (*,G) state built in R2 and the flow of traffic to the receiver.
   - On Router R1, the RP, observe the PIM protocol traffic as the RP sends JOIN's towards the Source i.e. to router R5 in order to deliver multicast traffic to Recevier2. Also note the subsequent use of REGISTER messages and

REGISTER-STOP messages when the 1st packets from the Source arrive at the RP enroute to Receiver2. Note the Flags.

- On Router R5, observe as the PIM JOIN's arrive for the (S,G) and the router builds new state and sends JOIN's to R6 for the (S,G). Note the Flags associated with (S,G)
- Finally, observe the periodic PIM traffic along the newly formed tree.

Questions :

1) Explain how the Shared tree is formed and what are the PIM packets that flow through your router in the process.

2) Explain the Flags associated with the (*,G) and the (S,G) entries in the multicast routing table.

3) How is the Shortest Path tree (SPT) formed and what are the PIM packets that flow through your router in the process.

4) What is the role of the RP in Sparse mode?

5) How do the various routers know how to reach the RP?

6) What is the significance of REGISTER & REGISTER-STOP messages?