PIM-SM Mechanics Lab: SSM, ASM, BiDir

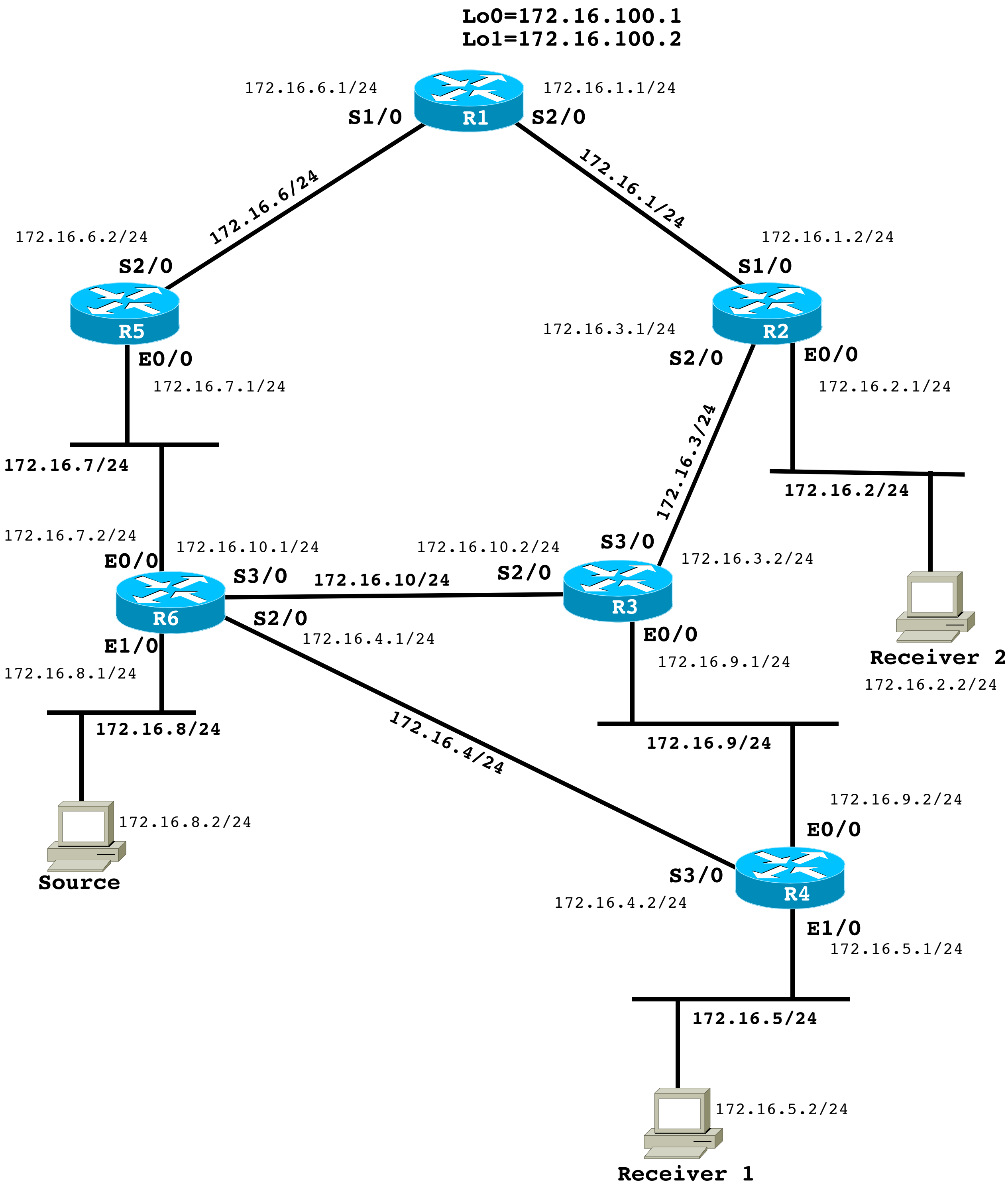

Figure 1 - Sparse Mode Lab Configuration

PIM-SM Mechanics Lab: SSM, ASM, BiDir

1. Lab Objectives

The student will understand the three modes of PIM Sparse Mode operation:

- SSM: source specific multicast
- ASM: any source multicast
- Bidir: bidirectional multicast

The lab will start with SSM to introduce the concept of the shortest-path (SPT): how a last-hop router sets up the shortest-path when it is provided with source and group information (S,G). In SSM, (S,G) is discovered by receipt of an IGMPv3 host report from directly connected receivers. SSM is the recommended mode for new multicast deployments.

The lab with then move to ASM, any source multicast. It is important to understand that some define ASM to include bidirectional PIM. In this lab, ASM is the standard PIM operation as defined in the sparse-mode RFC 4601. This includes:

- Receipt of IGMP host reports for (*,G) creation on the last-hop router
- Receipt of multicast data packets on the first-hop router to create (S,G)
- PIM registration by the first-hop router with the PIM RP or rendezvous point.
- Creation of the shared-tree or RP-tree (RPT) between the PIM-RP and all last-hop routers
- Switching from the shared-tree to the shortest-path tree (SPT) by the last-hop router

The lab ends with bidirectional PIM where only the shared-path is established between the PIM-RP and each last-hop router, but unlike other PIM modes, the data packets can travel upstream as well as downstream. This includes:

- RP configuration for bidir
- Designated Forwarder (DF) election

Throughout each lab segment the student should:

- Observe formation and maintenance of the Shared Tree for packet delivery.
- State maintenance and protocol timers
- PIM DR (designated router) election
- Mroute state creation on receipt of IGMP report messages from receivers
- Mroute state creation on receipt of PIM control messages.

1.1. Accessing the lab topology

You will be given a username and a password which you will use to log on to a web page which will display the information you need to accomplish this lab. Certain server limitations may require you to delay this logon until instructed to do so. When given the appropriate clearance by the instructor

- Connect your web browser to: http://<address-to-be-assigned>/iou/
- Log on with your assigned username and password
- Click on the "START" tab
- Under "Lab Templates": select the "PIM-Mechanics" lab
- Press the "recreate userspace" button.
- Click on the "ACCESS" tab

The list shown is the access information needed to telnet to each of your virtual routers and hosts. You may use the network map under "Access option 2" or you may telnet to the routers/hosts using whatever terminal application (such as emacs) that you desire.

The student needs to know that certain configuration mistakes have been intentionally introduced to provide a challenge. If you do not get the expected results, move on to the next section and see if that helps. If you choose some of the optional steps, you may have to undo those steps in order to move on to the next section successfully.

Ensure that all routers shown in the topology can ping each other.

Check out the router configurations using "show running"

Check out the multicast management commands, use these commands through out all of the following exercises:

- Show ip mroute
- Show ip pim interface
- Show ip pim neighbor
- Show ip igmp interface
- Show ip igmp group
- Show ip pim rp map

IMPORTANT: you MUST save your router configurations with the "write" command any time you wish to stop the routers AND you MUST save the current state of your lab using the following steps

- Click on the "SAVE" tab
- Add a unique name to the empty field for the file name. (If you accept the default you can not revert to previous lab states)
- Click on the "Create Gzipped Tar Archieve of your own Configuration Files" button. Next time you go to the "Start" tab, this file will be available to you.

2. Source Specific Multicast (SSM)

Source specific multicast (SSM) builds only the shortest-path tree between the source and all last-hop router with directly connected receivers. The receivers use IGMPv3 (or MLDv2 in IPv6) to specify the (S,G) they want the router to join. NOTE: the SPT is built without any reliance on multicast data packets from the source. For ASM, the SPT is built the same way that it is receipt of a multicast data packet down the shared-tree that triggers creation of (S,G) and joining to the SPT, making ASM somewhat less reliable than SSM because it depends on data-triggered events.

2.1. Set up

Configure the following:

- On all routers "ip multicast-routing"
  In IOS multicast routing will not operate without this command. In other router operating systems, multicast forwarding is enabled as soon as one interface is configured for PIM. No matter what router OS, it is recommended that PIM be configured on all router interfaces throughout the network if you want it to be reliable.

- On all interfaces "ip pim sparse-mode" or "ip pim sparse-dense-mode". IOS uses sparse-dense-mode to forward PIM auto-RP messages using dense-mode. In other router OS, dense-mode is not available and the auto-RP messages are forwarded on a hop-by-hop basis as the PIM Bootstrap Router (BSR) messages are.
- On all routers "ip pim ssm default". The default group range for ssm is 232.0.0.0/8. In all router implementations, this can be configured for any range the network administrator desires. In some implementations, SSM is on by default.
- Check out the multicast management commands. Ignore the 224.0.1.40 group. This is the Auto-RP "RP-Announce" group. When running IOS this group is automatically joined by routers configured to run PIM. Other Router operating systems may require you to specifically participate in auto-RP.

2.2. Exersises (SSM)

Throughout these exercises you may want to turn on certain debugs to monitor exactly what is happening on each router. Use your own discretion on where and when these commands will be useful. We will specifically enable some of these commands in later sections.

- Debug ip mpacket
- Debug ip mroute
- Debug ip pim
- Debug ip igmp

2.2.1. SSM Tree formation

The SSM shortest-path-tree will be set up when the receiver joins to the multicast group. The source does not need to be sending for state to be created between the receiver and the source. Note how this state is set up in what might be considered "reverse order" because multicast routing is concerned with where the packet comes from and not where the packet is going to.

SSM requires IGMPv3 on the last-hop router or a special configuration command on the last-hop that will map an IGMPv2 (*,G) report to create a specific (S,G) in the MRIB.

Setup:

1. Using the "show ip mroute summary" command, verify that no ip multicast state exists for multicast group 232.1.1.1.

2. On receiver 1 type in the following configurations:
   - ice -- the prompt will change to "Receive(ICE:OFF:Et0/0:1/1)#"
   - add client
   - igmp version 3

• group-addr 232.1.1.1

• include 172.16.8.2

• s (this is a toggle between “start and stop”)

• “quit” or “end” will exit the ice cli but the application will continue running.

Proceed to step 4, then come back to step 3. Monitor the creation of IGMP group state: “show ip igmp group [detail]” and mroute state: “show ip mroute”. NOTE: to resend a new IGMP host report type “stop” followed immediately by “start” (or “s” then “s”).

3. After you have monitored step 2, on R4 shown in the configuration diagram add the following configuration on Eth 1/0 to emulate a local receiver “joining” the `232.1.1.1` group and 172.16.8.2 source (NOTE: the image running on receiver 1 is capable of running IGMPv3 but is currently unable to respond correctly to IGMP queries, therefore you may use this work around:

    1) *”ip igmp version 3*
    2) *“ip igmp static-group 232.1.1.1 source 172.16.8.2”*

4. On each of the routers, examine the multicast state for group `232.1.1.1` using the *”show ip mroute 232.1.1.1”* command (and the other multicast monitoring commands that you may find interesting) and answer the following questions below.

5. [Optional] On receiver 2 add an ice client as outlined in step 2. What happens? Why? What must you do to fix it?

6. [Optional] On receiver 1, change the IGMP version to version 2

   • stop the ice client

   • type “igmp version 2”

   • start the ice client

   What happens? Why?

Questions :

1. What is the incoming interface for the (S, G) entry for group `232.1.1.1` on

the following routers?

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

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

2. What interfaces are on the *"oil"* (outgoing interface list) of the (S, G) entry for group `232.1.1.1` 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 `232.1.1.1` and others don't?

4. What are the flags for the mroute state for group `232.1.1.1` on the following routers, and what do the flags mean?

R4: **R6:**

2.2.2. Adding an SSM source

In this section we will have a source sending to the SSM (S,G). We use another special tool (TGN) to make this happen. Use the same multicast monitor commands described in the introduction. Optionally you may want to turn on "debug ip mpacket".

Setup

1. Setup the source by configuring TGN on the source.
   - Go to the "Status" tab of WebIOU
   - Click on the file "pagent_SSM_config"
   - Copy this file and paste it into the cli of the "Source".
   - To access TGN, type 'tgn' on the command line.
   - "start" and "stop" will provide data packets.
   - "quit" or "end" to exit tgn. NOTE: unless you specifically stop the data

stream, the application will continue running.

2. On each of the routers, examine the multicast state for group `232.1.1.1` using the *"show ip mroute 232.1.1.1 count"* command and answer the following questions.

3. If you have both H1 and H2 joined to the multicast group remember the workaround described in step 4 of 2.2.1.

4. [Optional] Turn on "debug ip pim" and monitor the PIM control messages. You will want to compare the results in this section with those we will have in later sections.

Questions :

1. Which routers have the mroute state for `232.1.1.1?`

2. From a management perspective, does it matter that the source is sending to an SSM group? How is this different from an ASM group?

2.2.3. Adding a second SSM receiver

setup

1. On R2 shown in the configuration diagram add the following config on Eth 0/0 to emulate a local receiver "joining" the `232.1.1.1` group and 172.16.8.2 source:

   - *"ip igmp version 3*
   - *"ip igmp static-group 232.1.1.1 source 172.16.8.2"*

2. On each of the routers, examine the multicast state for group `232.1.1.1` using the *"show ip mroute 232.1.1.1"* command and answer the following questions.

Questions :

1. What is the incoming interface for the (S, G) entry for group `232.1.1.1` on the following routers?

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

2. What interfaces are on the *"oil"* (outgoing interface list) of the (S, G) entry for group `232.1.1.1` on each router and what's their status, Forward or Prune?

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

3. How can you verify if the data is following the path from the source to the receivers?

3. <u>Any Source Multicast (ASM)</u>

Any Source Multicast (ASM) for this lab means "traditional" PIM, which uses a RP to aid in source discovery. Receivers can only tell the last-hop router which multicast group they want to listen to, not which source. This means ASM supports IGMPv2 capable hosts. When the last-hop receives a data packet on the shared-path, it will trigger an (S,G) join toward the source to create the shortest-path. Contrast this with SSM. ASM for this lab does NOT include bidir.

This section uses a static RP configuration. The RP assignments can be discovered through the IOS command "show ip pim rp map". [Note: the command "show ip pim rp" is obsolete and was used for PIMv1. Other router operating systems use this command to show the RP mapping] You optionally may want to configure auto-RP.

PIM last-hop routers will immediately switch to the shortest-path tree on receipt of a multicast packet for which they have (*,G) state. Under certain conditions it is better for a network if the receivers all remain on the shared-tree. For example, if all multicast sources are directly connected to the RP, then the shared-path and the shortest-path are all congruent. Staying on the shared-tree will save a lot of network state and avoid a lot of PIM protocol processing if there is a routing change.

3.1. Setup

1. Ensure that the source (tgn) has stopped sending.

2. Consider unconfiguring the ice clients and the igmp static joins, however since this group (232.1.1.1) is not used in this segment it should not bother you.

3. On all routers configure “ip pim rp-address 172.16.100.1” [Note the router that this IP address is assigned to]

4. Ensure you can successfully ping and RPF check (show ip route) to the RP from each router.

5. Using the “*show ip mroute summary”* command, verify that no unexpected multicast state exists. We will be using 224.1.1.1 for all of the exercises in this section. If it does, track it down. The command “clear ip mroute” often exasperates things because a PIM join from a downstream router will recreate the state you thought you had cleared. It is best to just let this state timeout by itself.

3.2. Exercises

Throughout these exercises you may want to turn on debug to monitor the PIM messages sent between routers. Debug will be specifically turned on in section 3.3. Note when an IGMP host report triggers a PIM join and the type of join and where it is sent. Also watch for PIM register messages. In the first part, even though the routers are configured to remain on the shared-path, there will be (S,G) state. Can you determine in advance where that will be and can you tell why?

3.2.1. Setting up the shared tree

Remember to monitor what happens during each of the setup steps so you will be able to answer the questions. Hint, look ahead to the questions.

Setup:

1. 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.

2. Activate multicast Receiver 1 so that it joins the `224.1.1.1` group by configuring the command *”ip igmp join-group 224.1.1.1”* on eth0/0. [Optionally you may want to set up a new ice client by following the steps in section 2.2.1, but this time make it a igmp version 2 client. Note what happens on the router]

3. 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"? If other router operating systems had a non-NULL entry here would that be "wrong"?

3.2.2. Adding a second branch to the shared-tree

Setup:

1. Activate multicast Receiver 2 shown in the configuration diagram so that it also "joins" the `224.1.1.1` group. (See Part I)

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.

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:**

3.2.3. Keeping senders on the shared-tree

When the sources start sending, what happens to state on each of the routers?

Setup:

1. Activate the multicast Source so that it begins sending traffic to group `(*,224.1.1.1).`

    - Copy the config in file "pagent_ASM_config" and paste it into the cli of the "Source". The file can be viewed from the "Status" tab of WebIOU.
    - At the "Source" cli, enter *"tgn"* to access the traffic generator and "*start"* to enable the stream.
    - OPTIONALLY: on the source,
      exit tgn
      type "ping" without any arguments
      answer with the default values except use 224.1.1.1 and some large number for the number of packets to send.
      To stop the source type 'control-^ x'

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.

4. What is special about the path from the source to the RP, why is there (S,G) state along that path?

3.2.4. Switching to the shortest-path

The last hop is responsible for switching from the shared-path to the shortest-path. In this section we will first reestablish the shared-path without the source, then we will have the source send. You may want to have debug on the last-hop router to monitor what happens during this switch.

The spt-threshold was originally developed to have low-rate senders remain on the shared-path and high-rate senders switch to the shortest-path. However, in practice this did not work too well due to the bursty nature of some content. This resulted in some sources switching back and forth between the shared and shortest paths creating havoc in the network.

Setup:

1. Stop the source.

2. Have receiver 2 leave the 224.1.1.1 multicast group

3. Remove the "ip pim spt-threshold" command from the last-hop routers R2 and

R4. You may either use the “no” form of the command or “ip pim spt-threshold 0”.

4. Allow all (S,G) state to timeout.

5. Activate the source. You may want to monitor the PIM register process on the first-hop and the RP.

Questions :

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

	IIF	OIF	Flags
R1 (*,G)			
R1 (S,G)			
R2 (*,G)			
R2 (S,G)			
R3 (*,G)			
R3 (S,G)			
R4 (*,G)			
R4 (S,G)			
R5 (*,G)			
R5 (S,G)			
R6 (*,G)			
R6 (S,G)			

2. What is the significance of the new “T” (SPT) Flag in the (S, G) entries?

3. What is the significance of change in the “R” Flag in the new (S, G) entry on

R2 and R3? Does it have anything to do with the P Flag?

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

5. Why do R5 and R6 have (*,G) state? If you were using a different router operating system would these routers have (*,G) state?

6. Wait for 3 minutes, what happens to the (S,G) state on R5? Why?

3.2.5. Having a receiver join to a last-hop with pruned (S,G) state

When a router already has mroute state, it uses the information it already has to join to the shortest path for a given source. In this case receiver 2 is going to join the multicast group, but R2 already has (*,G) and (S,G) state so what happens?

Setup:

1. When you are ready, activate Receiver 2 to “join” group `224.1.1.1`. You may want to turn on igmp and pim debug on R2 to monitor what happens.

Questions:

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

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

HERE JOHN IS WHERE YOU STOPPED.

3.3. PIM Sparse mode protocol mechanics and control messages

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. It is recommended that once the desired routing state is set up in each router that you turn the debug messages off so you have the opportunity to look at just the triggered messages and not the periodic messages which will continuously print out. You may find analysis of debug messages difficult when using a terminal window. Many find emacs very helpful when performing this type of analysis. The routers in your test topology all derive their time from the computer server on which they are running. In the “real

world" it is important that all your systems be configured to use network time. It is also recommended that you use the following configurations.
service timestamps debug uptime
service timestamps log datetime msec

3.3.1. Shared Tree formation - Receivers

The shared-tree is set up on the last-hop when it receives an IGMP report from a receiver. We already did this in section 3.2.1, but this time the spt-threashold is set to zero.

Setup:

1. Stop the source
2. Have all receivers leave all multicast groups.
3. Allow all mroute state to timeout on all routers.
4. [Optionally] configure R4 and R2, the last-hop routers, with
   ip pim spt-threshold infinity
   You may find it easier to obtain certain debug information, but it is not required.
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
   debug ip igmp 224.1.1.1 : Displays receipt of igmp control messages.
6. On the routers along the shared path for receiver 2 (do you know which ones these are?) observe the debug messages while you activate multicast Receiver 1 so that it "joins" the `224.1.1.1` group.

Questions :

1. How is the Shared tree built? What are the PIM and IGMP control messages that are sent?
2. How is the shared tree maintained?

3.3.2. PIM registration

The PIM registration process takes place between the first hop and the PIM-RP. Idetify these systems and the cotiue.

Setup:

1. Have all members leave the multicast group
2. Ensure that (*,G) state times out in the network.
3. The shortest path from the Source to the RP is the X-line. Do you know where it is?
4. Activate the multicast Source so that it begins sending traffic to group `(*,224.1.1.1).`

Questions :

1. What happens when the Source transmits for the 1st time?
2. When and where is the (S,G) entry for the Source formed and how is it sustained?
3. What is the significance of the REGISTER & REGISTER-STOP messages?
4. What is the significance of the (*,G) entries? Are they required?
5. Why is there no state on R5?

3.3.3. Switching to Shortest Path Tree (SPT)

The source is already sendig and now we will have a receiver join the multicast group. Note how the shortest-path is set up ad when it is set up. Be especially aware of the path data packets follow to get to the receiver.

Setup:

1. Debug should again be on on each router

2. Ensure the source is still sending to group 224.1.1.1.

3. Have receiver 1 join the multicast group 224.1.1.1. Use the *debug* output to answer the following questions. [Read the questions first]

Questions:

1. What happens on the RP when it receives the (*,G) join?

2. When does R4 send an (S, G) to join the Shortest-Path Tree (SPT)?

3. How does R4 prune the Shared Tree (RPT)?

4. When do R3 and R2 create (S,G) state? What is different about this state?

5. What happens on R5? When is (S,G) state created? Is it maintained?

6. What is the RP-Reachibility message that you sometimes see?.

3.3.4. Second Receiver Joins the group

You have already done this in 3.2.5, but this time you are to closely monitor the debug to see exactly what happens; how state is created and maintained.

setup:

1. Be sure you understand how state was created and maintained in the last section.

2. Be prepared to monitor the debug on all the routers, but try to anticipate which routers will have the most interesting things happen on them.

3. When you are ready, 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.

4. Using the *debug* output, observe the following :

- Observe the (*,G) state built in R2 and the flow of traffic to the receiver.
- Does router R2 initiate a PIM JOIN to the RP for the (*,G)? (Note the Flags.)
- Router R6 receives JOIN messages from R3 for the (S,G)
- Does anything interesting happen o the RP?
- Finally, observe the periodic PIM traffic along the newly formed tree.

Questions :

1. Are there any changes in the shared tree?

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 for receiver 2? How is it different from the SPT formation for receiver 1?

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 was the role of the PIM-DR in each network segment?

4. <u>Bi-Directional PIM (BiDir)</u>

Bidir PIM, like SSM, does not depend on data-triggered events to set up forwarding state. However, bidir will forward multicast packets upstream toward the RP. This means establishment of the shared-tree is more critical than it is for ASM because routing problems ca result I forwarding loops much like what might happen when there is a spanning-tree failure for a layer-2 switch. Although the failure to deliver packets is bad, causing those packets to loop is much worse.

Bidir uses a concept called the designated forwarder (DF) to send data packets upstream.

I this section we will use a locally defied group for the bidir group. The SSM and ASM groups may still be configured o your network.

4.1. Bidir configuration

Setup:

In addition to the configuration for SSM and ASM, add the following:

1. On all routers configure “access-list 45 permit 239.100.0.0 0.0.255.255”

2. On all routers configure “ip pim bidir-enable”.

3. On all routers ***<u>except</u>*** R5 configure “ip pim rp-address 172.16.100.2 45 bidir”. NOTE if you accidentally configure R5 with this rp address you must “*clear ip pim df*” after it is removed when using IOS.

4. On the source eth 0/0 configure “*ip igmp join 239.100.1.1*”

5. On receiver 1 eth 0/0 configure “*ip igmp join 239.100.1.1*”

4.2. Exercises (BiDir)

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

4.2.1. DF election

The DF is elected on a per RP basis. In other words, the DF on a given network is the router with the best unicast metric to the RP address. If a router does not have a configuration for an RP it must –not– participate in the DF election.

Setup:

1. Do a “*show ip pim df*” on every router. Note the DF metric. Compare it to the uicast routig metric.

2. Enable “*debug ip pim df*” on R5.

3. Enable “*debug ip pim 239.100.1.1*” on R6.

Questions:

1. On any given LAN which router will be selected the DF?

2. What is the DF on R4 eth 0/0? Why?

3. What is the DF on R6 eth0/0? Why?

4. What is the (*,G) state on R4 for 239.100.1.1? Why?

5. What is different about this entry when compared to an ASM (*,G) entry?

6. What is the (*,G) state on R6 for 239.100.1.1? Why is it different from the state found on R4?

7. Is there (*,G) state on R5 for 239.100.1.1? Should there be? Why or why not?

8. Configure the bidir RP on R5. What does the debug say? What happens on R6 when R5 is elected the DF?

9. What is the difference between a DF and a DR?

10. Why does PIM sparse-mode use a DR and not a DF?

4.2.2. BiDir tree formation – Receivers

All of the configuration was accomplished in the last section.

Questions:

1. What is the (*,G) state o each router for the 239.100.1.1 group. What are the OIFs? What is the IIF?

	IIF	OIF	Flags
R1 (*,G)			
R1 (S,G)			
R2 (*,G)			
R2 (S,G)			
R3 (*,G)			
R3 (S,G)			
R4 (*,G)			
R4 (S,G)			
R5 (*,G)			
R5 (S,G)			
R6 (*,G)			
R6 (S,G)			

2. How is the shared-tree setup for bidir different from ASM?

4.2.3. Bidir forwarding

Setup:

1. Have receiver 1 and receiver 2 joins the 239.100.1.1 group .

2. The source will be sending to the group 239.1.1.1. You may want to discontinue all other sources. You may use tgn or ping on the source.
   To use tgn:
   Copy the config in file "pagent_BiDir_config" and paste it into the cli of the "Source". The file can be viewed from the "Status" tab of WebIOU.
   At the "Source" cli, enter *"tgn"* to access the traffic generator and "*start"* to enable the stream.

3. On each of the routers, examine the multicast state for group `239.100.1.1` using the *"show ip mroute 239.100.1.1"* command and answer the following questions.

Questions :

1) What is the BiDir-Upstream interface for the (*, G) entry for group `239.100.1.1` 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 `239.100.1.1` on each router and what's their status, Forward or BiDir-Upstream?

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

4. Why is the BiDir-Upstream interface in the (*, G) entry on router R1 listed as

"NULL"? Is that a requirement of the PIM protocol?

5. Using the *"show ip mroute 239.100.1.1 count"* command follow the BiDir tree. Is the stream following the BiDir tree? How can you tell?

6. Does forwarding traffic for a bidir group have any affect on the mroute state?