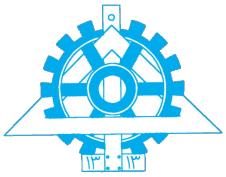
In the name of Allah

بسم الله‌الرحمن الرحیم

Multicast and realtime service Laboratory Manual



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Simple multicast exercises

For all the exercises in this section, the network topology is given in Fig. 0.1[1], where all the hosts are connected to a single network segment using their default IP addresses, i.e. from 128.238.66.100 to 128.238.66.107.

Host	IP Address	Subnet Mask
shakti	128.238.66.100	255.255.255.0
vayu	128.238.66.101	255.255.255.0
agni	128.238.66.102	255.255.255.0
apah	128.238.66.103	255.255.255.0
yachi	128.238.66.104	255.255.255.0
fenchi	128.238.66.105	255.255.255.0
kenchi	128.238.66.106	255.255.255.0
guchi	128.238.66.107	255.255.255.0

128.238.66.0 subnet

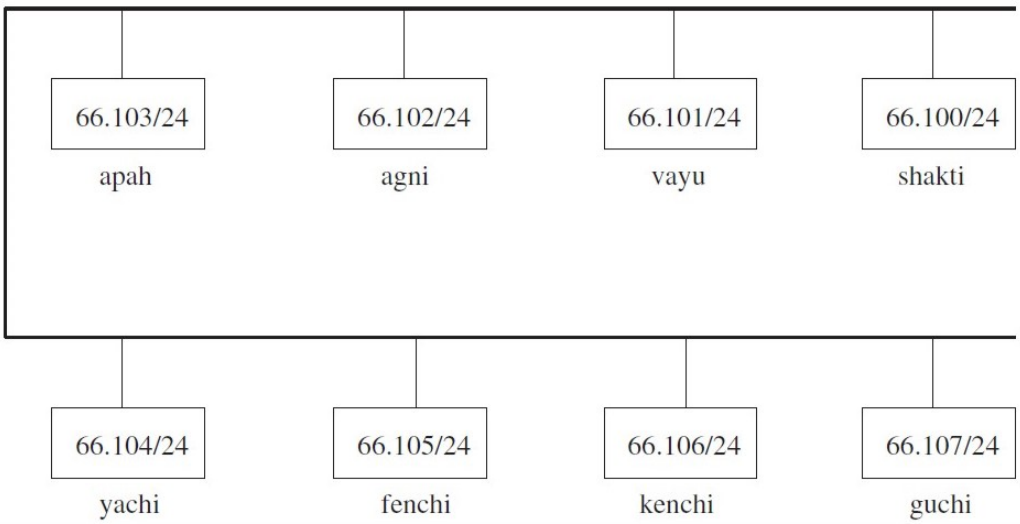

Figure 0.1: A single segment network

1 Linux multicast routing table

Execute **netstat -rn** to display the routing table of your host. If there is no entry for the 224.0.0.0 subnet, you need to provide a default route for multicast traffic, by:
route add -net 224.0.0.0 netmask 240.0.0.0 dev eth0[2]
Save the new routing table.

[1] 1.3 in Reference

[2] This command can be appended to the `/etc/rc.local` file, so that it will be executed automatically when the system bootstraps. Each time when the network interface is brought down and up again by the **ifconfig** command, you may need to run the **route** command to re-insert the multicast routing entry.

Lab Report

Submit the routing table you saved.

2 Multicast Membership

Execute **netstat -g** to show the multicast group memberships for all the interfaces in your host.

Lab Report

How many multicast groups did the interface belong to? What were the groups? Explain the meaning of the group IDs.

3 Multicast Ping

Execute **ping 224.0.0.1**. Examine the **ping** output to see which hosts reply.
Ping a broadcast address using **ping -b 128.238.66.255**. Examine the **ping** output to see which hosts reply.

Lab Report

Which hosts replied when the multicast address was pinged? Which hosts replied when the broadcast address was pinged?
In each case, was there a reply from your host?

4 Multicast vs Unicast

Execute **wireshark** to capture an Ethernet unicast frame, an Ethernet multicast frame, and an Ethernet broadcast frame.
To generate an Ethernet unicast frame, run **socket -i -u -n1** *remote-host* **echo**.
Execute **socket -i -u -n1 230.11.111.10 2000** to generate an Ethernet multicast frame.
Generate another Ethernet multicast frame, but with a different group address of `232.139.111.10`.
To generate an Ethernet broadcast frame, you may **ping** a remote host that has no entry in the ARP table of you host. Recall that the ARP request is broadcast.
Save the frames captured for the lab report.

Lab Report

Compare the source and destination MAC addresses of the frames you captured.
Use one of the multicast frames captured to explain how a multicast group address is mapped to a multicast MAC address. For the two multicast frames captured, do they have the same destination MAC address? Why?

5 Simple UDP Multicast client and server

Start the multicast client **netspy** on all the hosts, by executing:
netspy 224.111.111.111 1500
Then, start the multicast sender **netspyd** on `shakti`, by executing:
netspyd 224.111.111.111 1500 1
Execute **wireshark** on every host to capture multicast IP datagrams.
Login to `shakti` from a remote machine, e.g. `kenchi`, using **telnet** or **ssh**.
Save the captured multicast datagram sent by **netspyd** and exit the **telnet** (or **ssh**) session.

Lab Report

From the **tcpdump** output, how many messages are sent by **netspyd** when a new user logged in to `shakti`? From the **netspy** outputs on all the hosts, how many copies of the message are received in total?
Did `shakti`, where the multicast sender, **netspyd**, was running, receive the multicast datagram? Why? If yes, through which interface did `shakti` receive this datagram?

6 ping Replay

Keep the **netspy** and the **wireshark** programs running. Execute **ping 224.111.111.111** from `kenchi`. Examine the **wireshark** and **ping** outputs to see which hosts replied. To avoid confusion, students should do this exercise by turns. Terminate the **netspy** programs on several hosts, e.g. `shakti`, `vayu`, and `fenchi`. Execute the **ping** command again. Also, examine the **tcpdump** and the **ping** outputs to see which hosts replied.

IGMP exercises

In the following exercises, students are divided into two groups, Group A and Group B, each with four hosts and one router. The network topology of each group is given in Fig. 7.13, and the corresponding host IP addresses and router IP addresses are given in Table 7.2 and Table 7.3, respectively.

Table 7.2. *Hosts IP addresses for Fig. 7.13*

	GROUP_A		GROUP_B	
Host	Name	IP address	Name	IP address
host1	`shakti`	128.238.63.100/24	`yachi`	128.238.64.100/24
host2	`vayu`	128.238.63.101/24	`fenchi`	128.238.64.101/24
host3	`agni`	128.238.64.103/24	`kenchi`	128.238.65.100/24
host4	`apah`	128.238.64.104/24	`guchi`	128.238.65.101/24

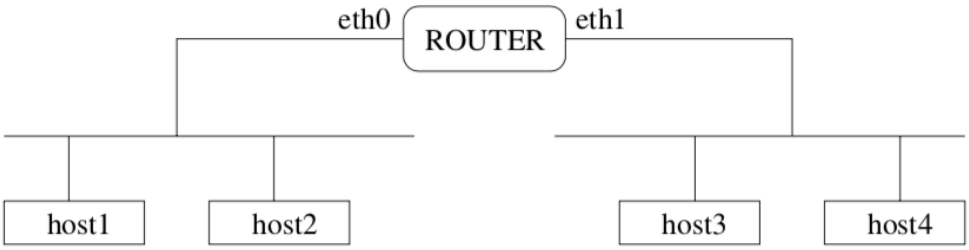

Figure 7.13. The network topology for the exercises in Section 7.5.

Table 7.3. *Router IP addresses for Fig. 7.13*

Group	Name	eth0	eth1
Group A	`router3`	128.238.63.3/24	128.238.64.3/24
Group B	`router4`	128.238.64.4/24	128.238.65.4/24

7 Configuring Router

Connect the hosts and the route in your group as shown in Fig. 7.13. Set the IP address of your host as given in Table 7.2. Note that the IP addresses of the router interfaces are the same as their default IP addresses. Login to the router and run **ip multicast-routing** to enable multicast routing in the *Global Configuration* mode. Then, enable the PIM protocol on each interface, by running **ip pim dense-mode** in the *Interface Configuration* mode.[3] Now the router is enabled to do multicast routing using PIM.
Login to the router, execute **show ip igmp interface** and **show ip igmp group** in the *Privileged EXEC* mode. Examine the multicast group memberships currently recorded in the router and the configurations of the router interfaces.

8 Multicast Message

Start **netspy** on all the hosts, by using:
netspy 224.111.111.111 1500
Start **netspy** on `host1` (`shakti` in Group A and `yachi` in Group B), by using:
netspyd 224.111.111.111 1500 16
Login to the router. Run **show ip igmp interface** and **show ip igmp group** in the *Privileged EXEC* mode again to examine the current membership records.
Try if you can **ping** a host on the other side of the router. Login to `host1` from `host2` in your group, then logout. See if the multicast messages sent by **netspyd** reach the other side of the router.

Lab Report

Can you ping a host on the other side of the router? Will the router forward a multicast IP datagram to the other side? Justify your answers.

9 IGMP Types

Execute **wireshark** in one console to capture IGMP messages. At the same time, execute **wireshark** in another console to monitor the capture process. When you see three or more IGMP queries in the second **wireshark** output, terminate both **wireshark** programs.
Analyze the IGMP messages you captured. Print and save two different IGMP messages.
Repeat the above experiment. Terminate **netspy** on `host2` and `host4`. Terminate the **wireshark** programs and analyze the IGMP leave message you captured.

Lab Report

What is the value of the Time-to-Live (TTL) field for the IGMP messages? Why do we not set the TTL to a larger number?
What is the default frequency at which the router sends IGMP queries?

[3] As usual,each router should be configured by one person to avoid confusion.

10 Router Join To Multicast-Group

Login to the router. See if you can make a router interface (e.g., Ethernet0) join a multicast group of 224.0.0.2, using: **ip igmp join-group 224.0.0.2**

Lab Report

Explain why the above command fails.

Multicast routing exercises

For the rest of the exercises in this chapter, the network topology is given in Fig. 7.14. The exercises will be jointly performed by all the students. The IP addresses of the hosts and router interfaces are given in Fig. 7.14.

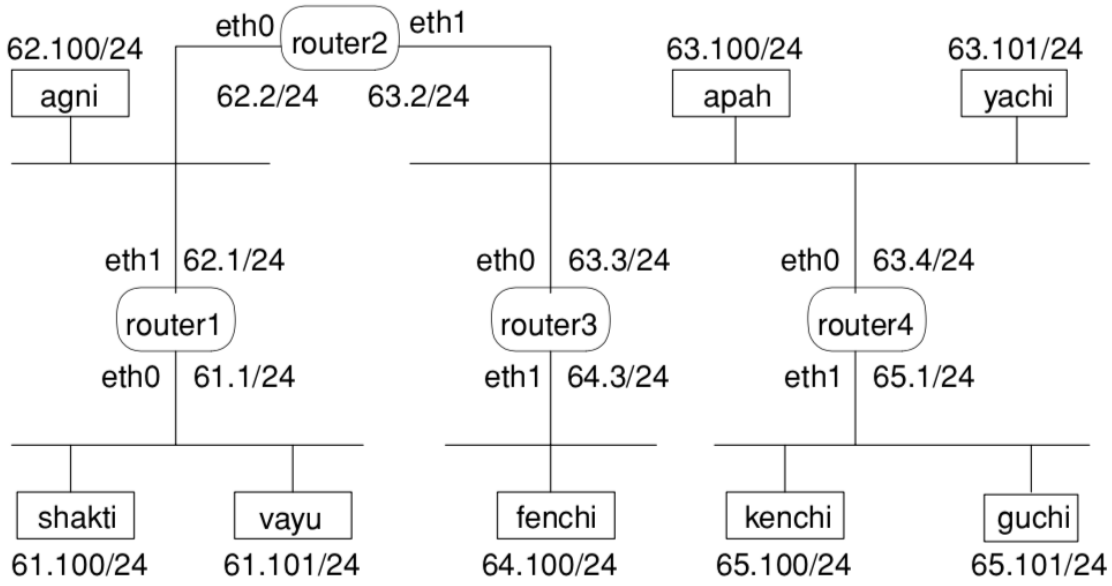

Figure 7.14. The network topology for the exercises in Section 7.6 and 7.7.

11 Multicast Multi-Hub

Connect the hosts and routers as illustrated in Figure 7.14. Configure the IP addresses of the hosts and router interfaces as given in the figure. Note that most of the router interfaces use their default IP addresses, only the Ethernet0 interface of Router4 needs to be changed to 128.238.63.4.
Enable PIM multicast routing in all the routers (see Exercise 7).
Run **wireshark** on all the hosts.
Execute **netspy 224.111.111.111 1500** on `shakti, agni, apah, fenchi`, and `kenchi`. Execute **netspyd 224.111.111.111 1500 16** on `yachi`. To generate multicast traffic, you can login (by **telnet** or **ssh**) to or logout of `yachi`. Each time when the login user set of `yachi` changes, **netspyd** on `yachi` will send a multicast datagram to group 224.111.111.111, to report the change in its login users.
Can you see the **netspy** messages on the 128.238.65.0 (or the 128.238.61.0) subnet in the **wireshark** output?
Terminate the **netspy** program on `kenchi` (or `shakti`). Can you see the **netspy** messages on the 128.238.65.0 (or the 128.238.61.0) subnet? [4]
Save one of the PIM routing packets. You may use **wireshark** output to analyze it. What is the destination IP address used in this PIM routing packet?

[4] If IGMPv1 is used, a participant does not send a leave message when it leaves the group. In this case, the membership record in the router expires in 120 seconds. During this interval, the router still forwards multicast datagram through the port.

Lab Report

Answer the above questions.

12 Multicast Router Status

In this exercise, try the **mstat** Cisco IOS command to find the multicast tree from a source. The **mstat** command is executable in the *Privileged EXEC* mode. You can always type "?" to get help on the syntax of the command.

13 Multicast TTL

Keep **netspy** running on all the hosts. Ping the multicast group address from yachi, using:
ping 224.111.111.111 -t n
The parameter n is the TTL to be set to the multicast datagrams sent by ping. Try different values of n, e.g. 1, 2, 3, and 16. See how far a multicast datagram can travel with different TTL values.
Now, login to `Router2`, in the *Interface Configuration* mode, set the TTL threshold of the `Ethernet0` interface to 32, using:
ip multicast ttl-threshold 32 [5]
Run the **ping** command with $n = 16$ again. Can you see the multicast datagrams in the 128.238.61.0 and 128.238.62.0 subnet? Try $n = 33$. Answer the same question.

Lab Report

Answer the above questions.
What is the use of the TTL threshold in the router interface?

Multicast video streaming exercise

In the following exercise, we use **jmstudio** for video streaming. The routers and hosts have the same configurations as in Fig. 7.14.

14 Multicast Real-Time Video

Start **vlc** on all the hosts, by using **vlc &**.
On `shakti`, go to the **vlc** menu: `Media/Stream ....` Chose video file `/aaaaaaaaaaaaaaaa.mpeg` and press "stream" button. In "Stream output" add "RTP /MPEG Transport Stream" dialog. Then click the "next" button. In the next window, specify the multicast group address to be **224.123.111.101**, with port number **22224** Then click the "Finish" button. Now the **vlc** on `shakti` is transmitting the video clip using `RTP/RTSP/UDP/IP` to the multicast group **224.123.111.101** on port **22224**.
On all other hosts, go to the **vlc** menu: `Media/Open ....` In the following "Open RTP Session" dialog, specify the same group address, port number as that used in `shakti`.Now you should see the received video is displayed on the screen.
Execute **wireshark** in one console to capture the multicast datagrams. In another console, execute **wireshark** to monitor the capture process. When you see some `RTCP` packets in the second **wireshark** output, terminate both **wireshark** programs.
Analyze the header format of a `RTP` data packet and a `RTCP` Sender (or Receiver) Report packet.

[5] The syntax of this command may be different for different versions of CiscoIOS. You may use"?" to get help.

Appendices

A Configuring a multicast router

*The **no** form of this command cancels the group membership*

A.1 Configuring IGMP

- ip igmp join-group group-address
- no ip igmp join-group group-address
- ip igmp query-interval *new-value-in-seconds*
- no ip igmp query-interval
- show ip igmp groups: *Displays the multicast groups in the attached networks.*
- show ip igmp interface: *Displays multicast related information on a router interface.*
- debug ip igmp: *Displays IGMP packets received and transmitted.*

A.2 Configuring multicast routing

- ip multicast-routing
- no ip multicast-routing
- ip pim [dense-mode | sparse-mode | dense-sparse-mode].
- show ip mroute: *Displays the multicast routing table.*
- show ip mroute summary: *Displays a one-line summary for each entry in the multicast routing table.*
- show ip mroute count: *Displays multicast statistics.*
- show ip dvmrp route: *Displays the DVMRP routing table.*
- show ip pim neighbor: *Lists PIM neighbors discovered by the router.*
- show ip pim interface: *Displays router interface configurations.*

A.3 Cisco IOS multicast diagnostic tools

- mtrace
- mrinfo
- mstat
- ping