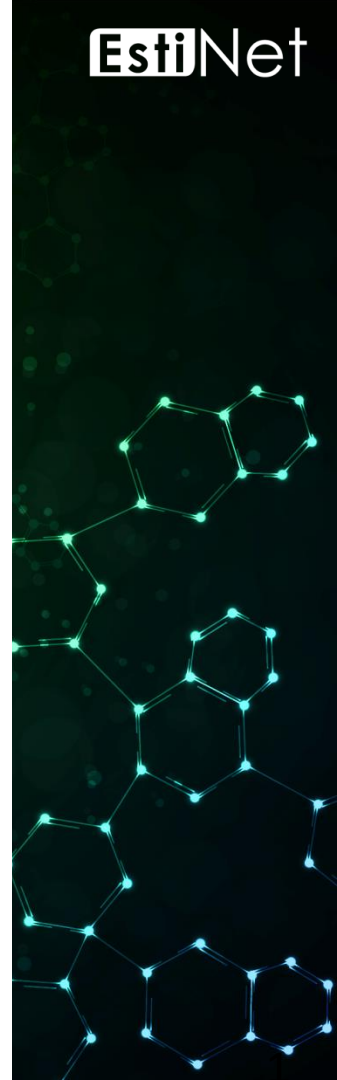


# IPv4 Addressing



# Outline

- ◆ Unicast Addressing
- ◆ Multicast Addressing
- ◆ Broadcast Addressing
- ◆ Summary

# <Simulation Case> ipv4\_addressing.xtpl

The screenshot displays the EstiNet simulation environment for the file `ipv4_addressing.xtpl`. The interface is divided into three main simulation areas:

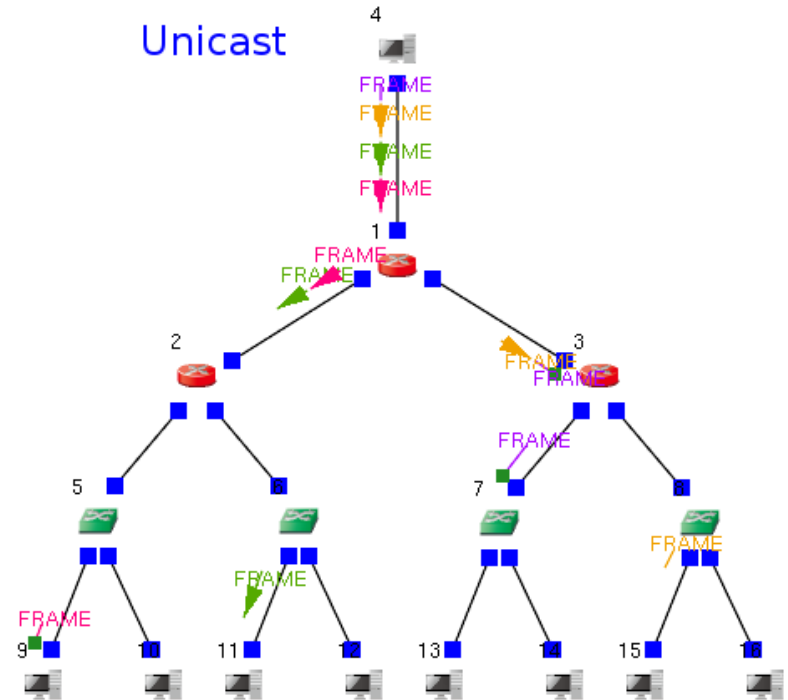
- Unicast:** A tree topology with root node 4. It shows frames being sent from node 1 to various leaf nodes (5, 7, 9, 11, 13, 15) in different colors (green, purple, pink).
- Multicast:** A tree topology with root node 20. It shows red frames being sent from node 17 to multiple leaf nodes (21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31).
- Broadcast:** A mesh topology with nodes 33-48. It shows frames of various colors (blue, orange, red) being sent from nodes 34 and 35 to other nodes in the network.

At the bottom of the window, there is a playback control panel showing a time counter at `000 106 . 147255 sec`, a progress bar, and playback speed controls set to `7 (1 us)`. The status bar at the bottom right indicates `[84%] ( 53.10, 0.45)`.

# Unicast Addressing

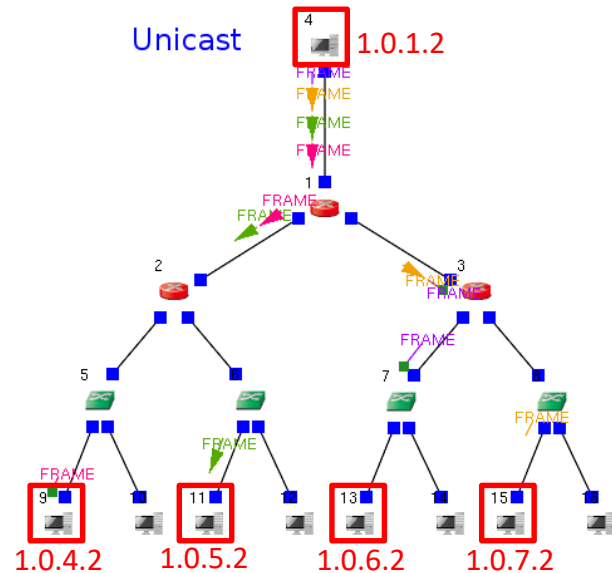
# The Transmission and Reception of Unicast Message

- ◆ On the Internet, if a network message is sent to only one target receiver, the receiver's IP address is filled in the IP header of the message. This kind of addressing is called unicast addressing.
- ◆ The graph on the right side shows that network node 4 sends unicast messages to node 9, 11, 13, and 15, respectively. Messages targeting different destination nodes are displayed in different colors.



# Observing Unicast Message by Wireshark

- From the graph on the right side, it shows all messages' source address is 1.0.1.2 while destination addresses are four network nodes' IP addresses, respectively.



tcpdump\_at\_node\_4.pcap [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	1.0.1.2	1.0.6.2	UDP	88	49635→5200 Len=46
2	0.000000	1.0.1.2	1.0.7.2	UDP	88	53823→5200 Len=46
3	0.000000	1.0.1.2	1.0.5.2	UDP	88	46431→5200 Len=46
4	0.000000	1.0.1.2	1.0.4.2	UDP	88	52774→5200 Len=46
5	0.000500	1.0.1.2	1.0.4.2	UDP	88	52774→5200 Len=46
6	0.000500	1.0.1.2	1.0.5.2	UDP	88	46431→5200 Len=46
7	0.000500	1.0.1.2	1.0.7.2	UDP	88	53823→5200 Len=46
8	0.000500	1.0.1.2	1.0.6.2	UDP	88	49635→5200 Len=46
9	0.001000	1.0.1.2	1.0.6.2	UDP	88	49635→5200 Len=46
10	0.001000	1.0.1.2	1.0.7.2	UDP	88	53823→5200 Len=46
11	0.001000	1.0.1.2	1.0.5.2	UDP	88	46431→5200 Len=46

▶ Frame 1: 88 bytes on wire (704 bits), 88 bytes captured (704 bits)

▶ Ethernet II, Src: EquipTra\_00:00:0a (00:01:00:00:00:0a), Dst: EquipTra\_00:00:01 (00:01:00:00:00:01)

▶ Internet Protocol Version 4, Src: 1.0.1.2, Dst: 1.0.6.2

▶ User Datagram Protocol, Src Port: 49635, Dst Port: 5200

▶ Data (46 bytes)

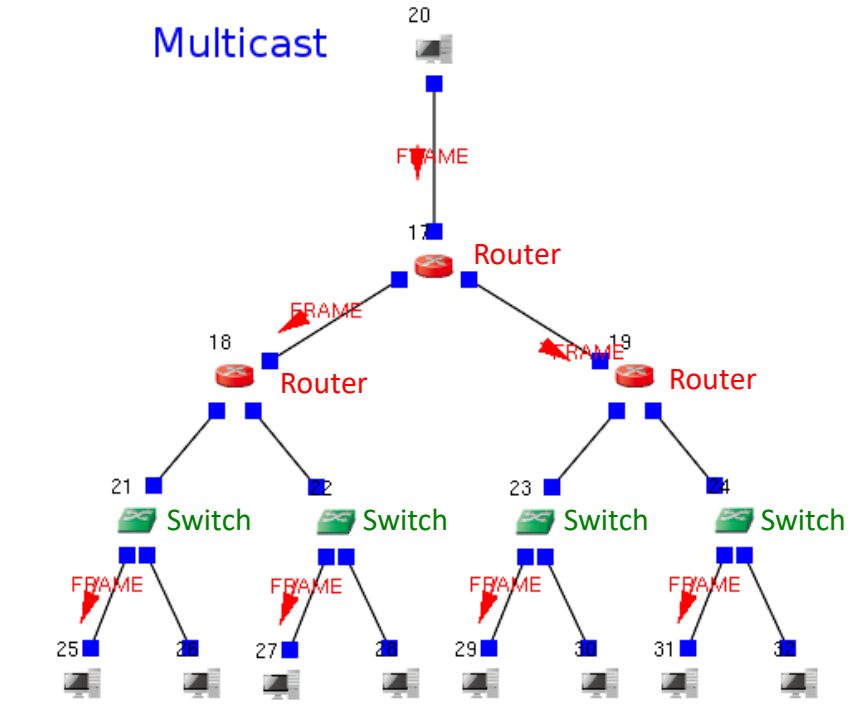
```
0000 00 01 00 00 00 01 00 01 00 00 00 0a 08 00 45 00 .....E.
0010 00 4a 7a 79 40 00 40 11 b7 26 01 00 01 02 01 00 ..Jzy@. .&.....
0020 06 02 c1 e3 14 50 00 36 c4 19 31 2b 20 20 20 20 .....P.6 .1+
0030 20 20 20 31 30 30 2e 30 30 30 30 30 30 00 2b 7f 100.0 00000.+
0040 00 00 80 ed 0f f2 2b 7f 00 00 b0 03 40 00 00 00 .....+. ....@...
```

File: "/root/course\_case\_estinetx/network\_layer/ipv4\_addressing.results/per\_node/node4/tcpdump\_at\_n... Pa... Pr...

# Multicast Addressing

# The Transmission and Reception of Multicast Message

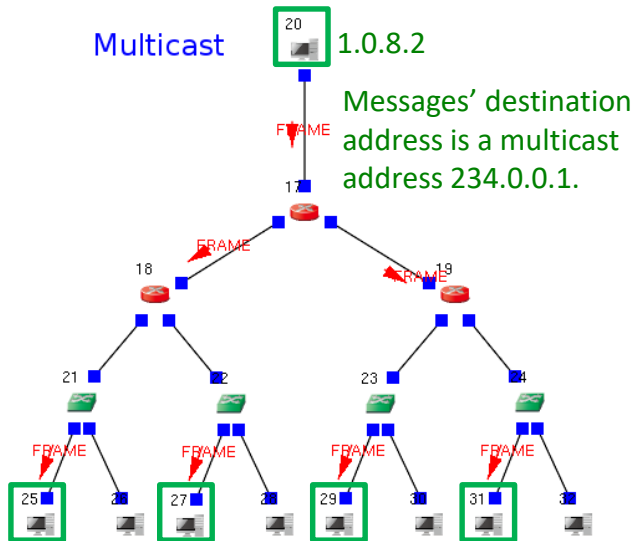
- ◆ On the Internet, if a network message is sent to only those receivers who want the message, a multicast IP address is filled in the IP header of the message. This kind of addressing is called multicast addressing.
- ◆ The graph on the right side shows that network node 20 sends multicast messages to those nodes who want the messages. Node 25, 27, 29, and 31 join a multicast group to receive the multicast messages.
- ◆ Routers and switches have to provide multicast functions so that they forward multicast messages to those who join multicast groups.
- ◆ Multicasting is usually used for real-time audio/video streaming applications. In these applications, many users download the same real-time digital content simultaneously.





# Observing Multicast Message by Wireshark

- From the graph on the right side, it shows all messages' source address is 1.0.8.2 while destination address is a multicast address 234.0.0.1.



Node 25, 27, 29, and 31 join the multicast group 234.0.0.1.

tcpdump\_at\_node\_20.pcap [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
2	0.000500	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
3	0.001000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
4	0.001500	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
5	0.002000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
6	0.002500	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
7	0.003000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
8	0.003500	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
9	0.004000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
10	0.004500	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46
11	0.005000	1.0.8.2	234.0.0.1	UDP	88	32819-5200 Len=46

▶ Frame 1: 88 bytes on wire (704 bits), 88 bytes captured (704 bits)

▶ Ethernet II, Src: EquipTra\_00:00:28 (00:01:00:00:00:28), Dst: IPv4mcast\_01 (01:00:5e:00:00:01)

▶ Internet Protocol Version 4, Src: 1.0.8.2, Dst: 234.0.0.1

▶ User Datagram Protocol, Src Port: 32819, Dst Port: 5200

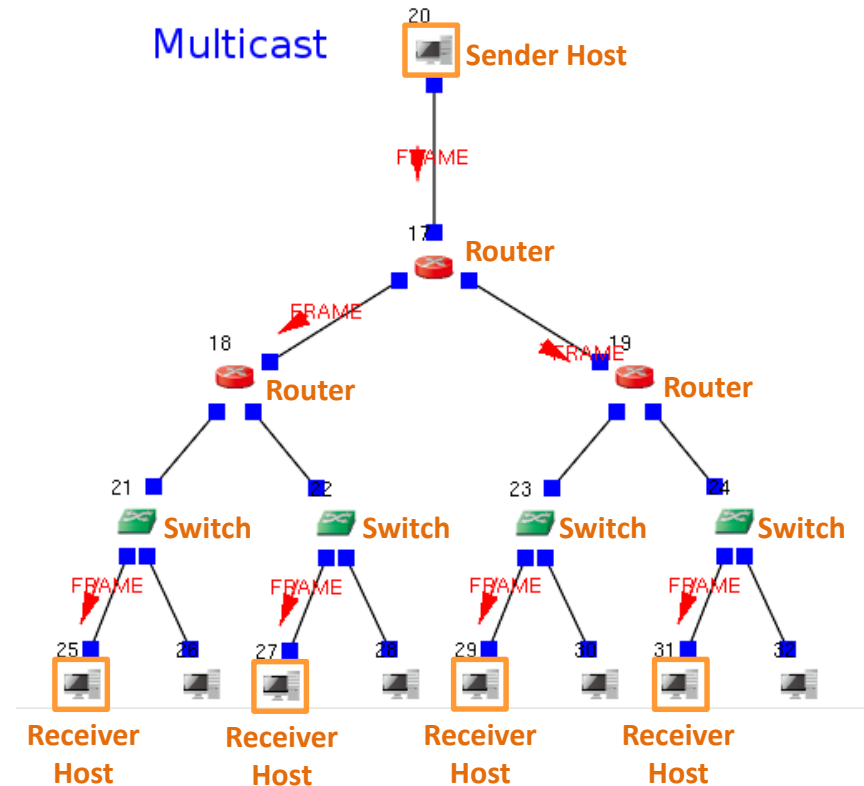
▶ Data (46 bytes)

```
0000 01 00 5e 00 00 01 00 01 00 00 00 28 08 00 45 00  ..^.....(..E.
0010 00 4a 69 57 40 00 1e 11 00 49 01 00 08 02 ea 00  ..Jiw@...I.....
0020 00 01 80 33 14 50 00 36 fd 48 31 2b 20 20 20 20  ...3.P.6 .H1+
0030 20 20 20 31 30 30 2e 30 30 30 30 30 00 fc 7f    100.0 00000...
0040 00 00 1c 08 40 00 00 00 00 00 f8 4f 64 70 20 7f  ....@.....0dp ..
```

File: "/root/course\_case\_estinetx/network\_layer/ipv4\_addressing.results/per\_node/node20/tcpdump\_at\_..." Pa... Pr...

# The Configuration of Multicasting Simulation

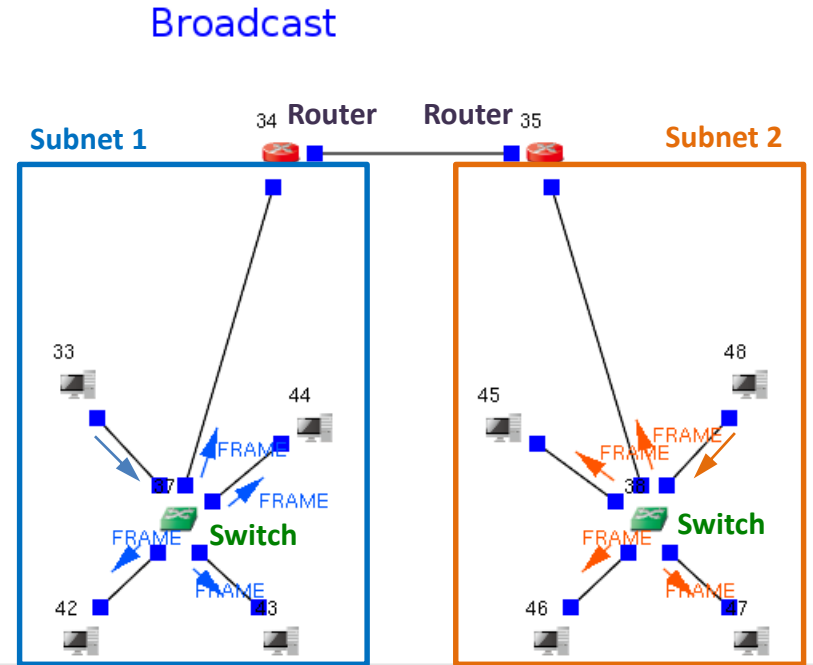
- ◆ Receiver Host
  - In simulator, a receiver host executes the command “`rtg -4 -u ... 234.0.0.1`” to join the multicast group 234.0.0.1 and receive UDP messages whose destination IP address is 234.0.0.1.
  - When a receiver host joins a multicast group, it sends IGMP messages to tell network devices which multicast group it joins.
- ◆ Switch
  - If a switch’s port receives the IGMP message sent from the receiver host, that port joins the multicast group 234.0.0.1. Later, when a switch receives a message whose destination IP address is 234.0.0.1, the switch forwards the message to all ports which join the multicast group 234.0.0.1.
- ◆ Router
  - If a router’s NIC receives the IGMP message sent from the receiver host, that NIC joins the multicast group 234.0.0.1. Later, when a router receives a message whose destination IP address is 234.0.0.1, the router forwards the message to all NIC’s which join the multicast group 234.0.0.1.
  - In simulator, each router executes the command “`pimd`” to determine the multicast routing path among routers. Multicast messages are forwarded by routers according to the multicast routing path.
- ◆ Sender Host
  - In simulator, the sender host executes the command “`stg -4 ... 234.0.0.1`” to send UDP messages whose destination IP address is 234.0.0.1. These messages are forwarded by routers and switches and eventually reach those receiver hosts.



# Broadcast Addressing

# The Transmission and Reception of Broadcast Message

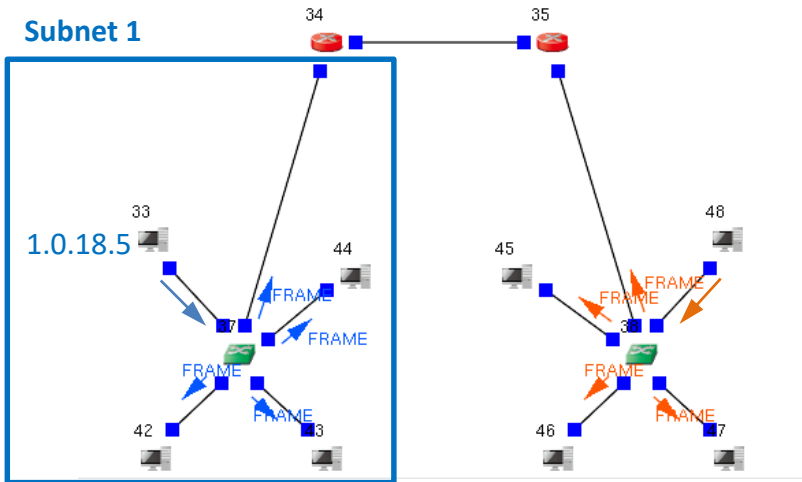
- ◆ In a subnet, a broadcast message is supposed to be received by all NIC's except the one which sends the message. The broadcast address of the subnet is filled in the IP header of the message.
- ◆ In general, a broadcast message cannot travel across the subnet's boundary. In other words, a gateway router does not forward broadcast messages.
- ◆ There are two subnets in the graph on the right side. Take the left subnet as an example. Network node 33 sends a broadcast message. The switch broadcasts the message to all ports except the one from which the message comes. Thus, all hosts and the router in the subnet receive the broadcast message. The router does not forward the broadcast message to other subnets.



# Observing Broadcast Message by Wireshark

- From the graph on the right side, it shows all messages' source address is 1.0.18.5 while destination address is the subnet's broadcast address 1.0.18.255.

Broadcast



tcpdump\_at\_node\_33.pcap [Wireshark 2.1.1 (Git Rev Unknown from unknown)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	EquipTra	00:00:43	Spanning-tree-(for-bridges)	0E STP	53 RST. Root = 32768/0/0
2	0.999583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
3	1.000083	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
4	1.000583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
5	1.001083	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
6	1.001583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
7	1.002083	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
8	1.002583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
9	1.003083	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
10	1.003583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
11	1.004083	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46
12	1.004583	1.0.18.5	1.0.18.255	UDP	88	34389-5200 Len=46

▶ Ethernet II, Src: EquipTra\_00:00:51 (00:01:00:00:00:51), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

▶ Internet Protocol Version 4, Src: 1.0.18.5, Dst: 1.0.18.255

▶ User Datagram Protocol, Src Port: 34389, Dst Port: 5200

▶ Data (46 bytes)

```
0000 ff ff ff ff ff 00 01 00 00 51 08 00 45 00 .....Q.E.
0010 00 4a ed c2 40 00 40 11 25 dd 01 00 12 05 01 00 .J.@.@.%.....
0020 12 ff 86 55 14 50 00 36 1c 29 31 2b 20 20 20 20 ...U.P.6.)!+
0030 20 20 20 31 30 30 2e 30 30 30 30 30 00 fd 7f 100.0 00000...
0040 00 00 1c 08 40 00 00 00 00 00 f8 2f f1 8e 66 7f ...@.@...../..f.
```

File: "/root/course\_case\_estinetx/network\_layer/ipv4\_addressing.results/per\_node/node33/tcpdump\_at\_..." Pa... Pr...

# Summary

# Review of Points

- ◆ What kinds of addressing does IPv4 support? What characters does each addressing have? What network applications is each addressing suitable for?
- ◆ To achieve the transmission and reception of multicast messages, what does a sender host, a receiver host, a switch, or a router have to do?