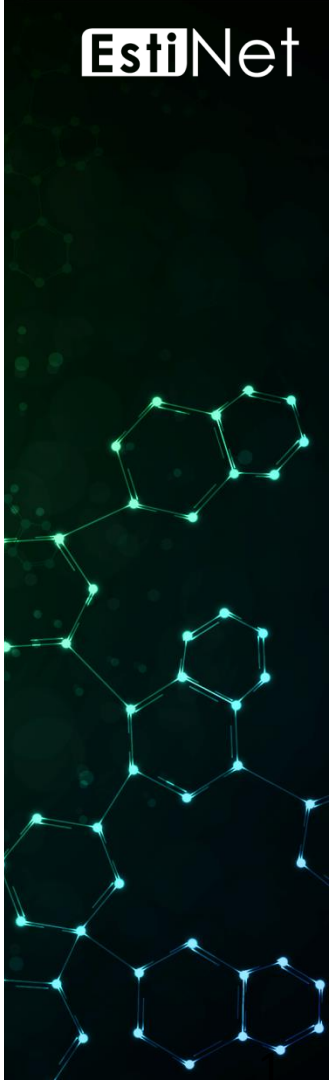
The Addressing of Data Link Layer



Outline

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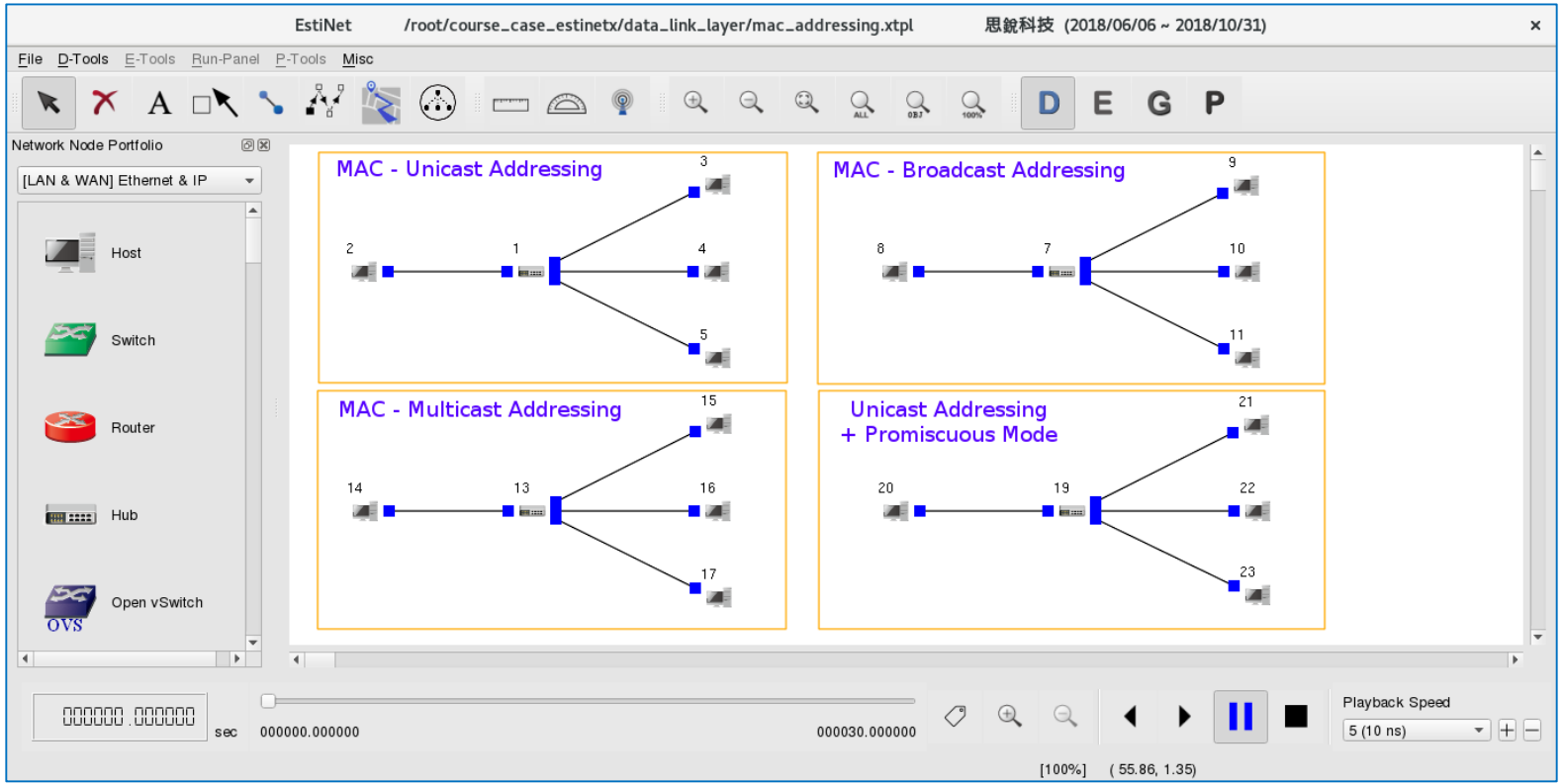
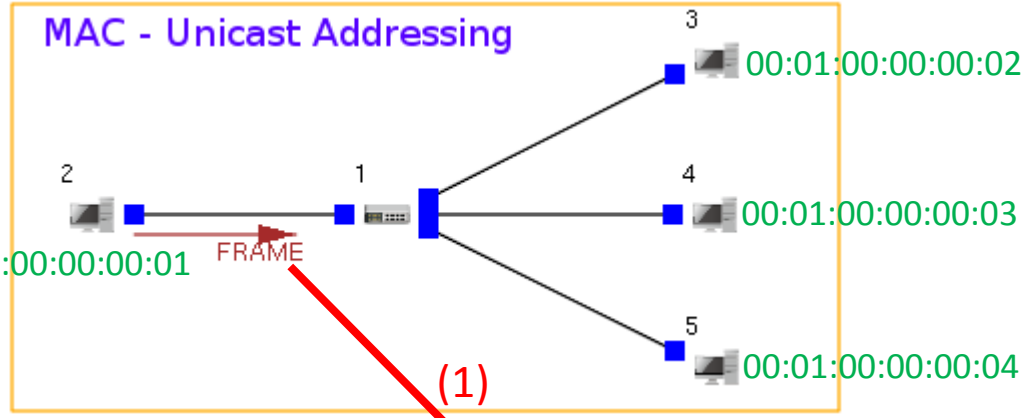
- Broadcast Addressing
- Multicast Addressing
- Promiscuous Mode
- Summary
- Appendix

<Simulation Case>
mac_addressing.xtpl



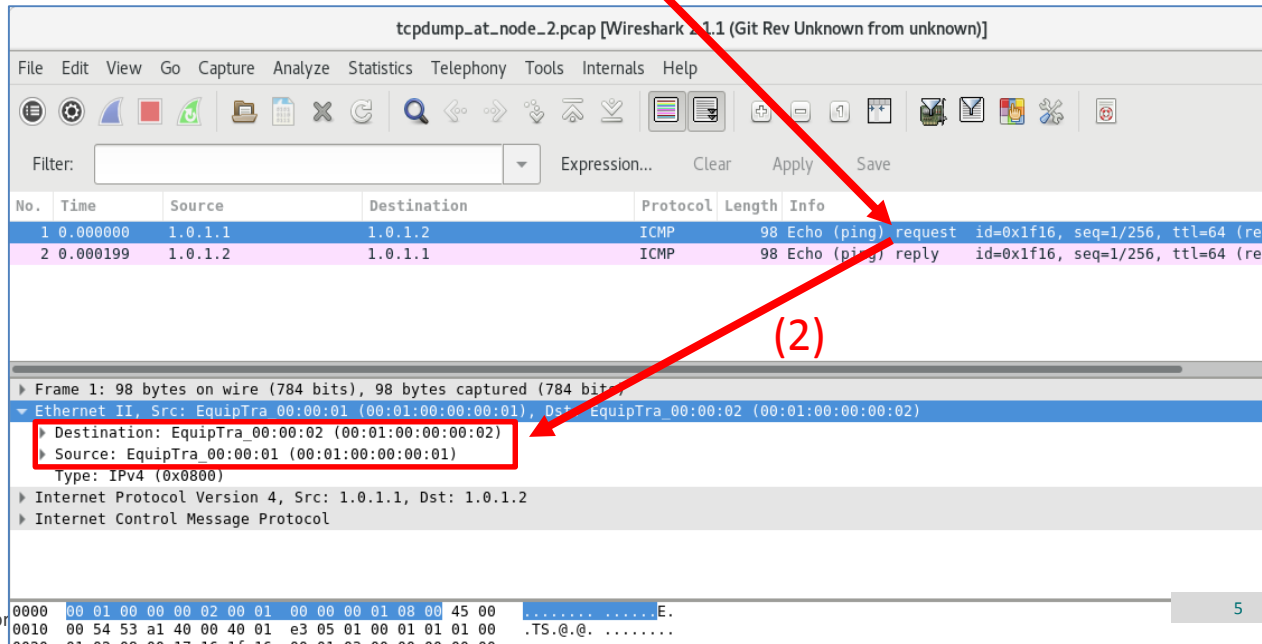
Unicast Addressing

Fill the destination address of a data-link-layer frame with a unicast address to address a single target node.



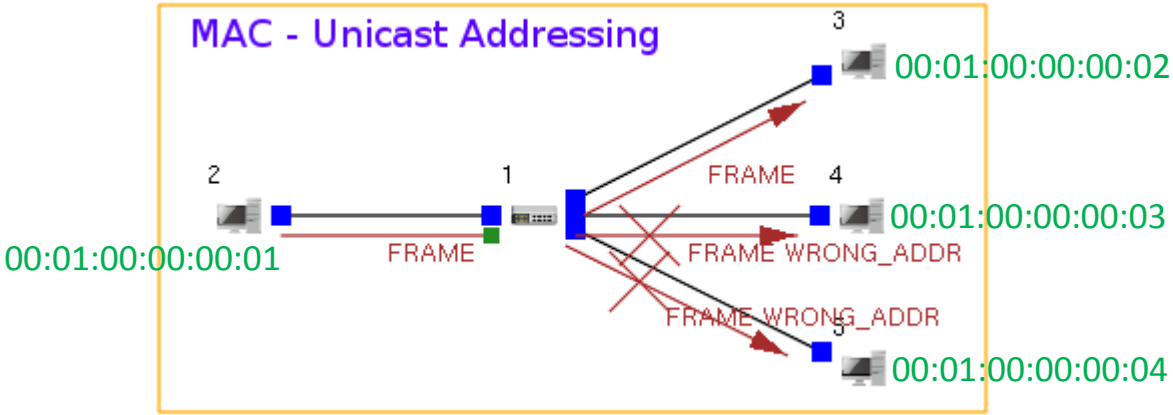
(1) Node 2 sends a echo-request frame.

(2) In the frame's header, the source address is filled with Node 2's MAC address while the destination address is filled with Node 3's MAC address.

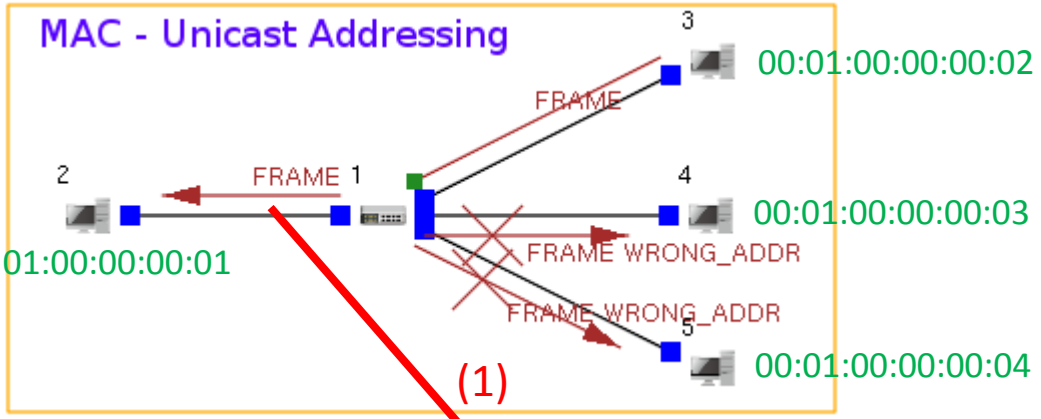


A frame receiver decides if the frame is for itself according to the frame's destination address.

- Among the three nodes receiving the frame, only Node 3 accepts the frame. That is because the frame's destination address is filled with Node 3's MAC address.
- Node 4 and Node 5 drop the frame because they are not the target of the frame.



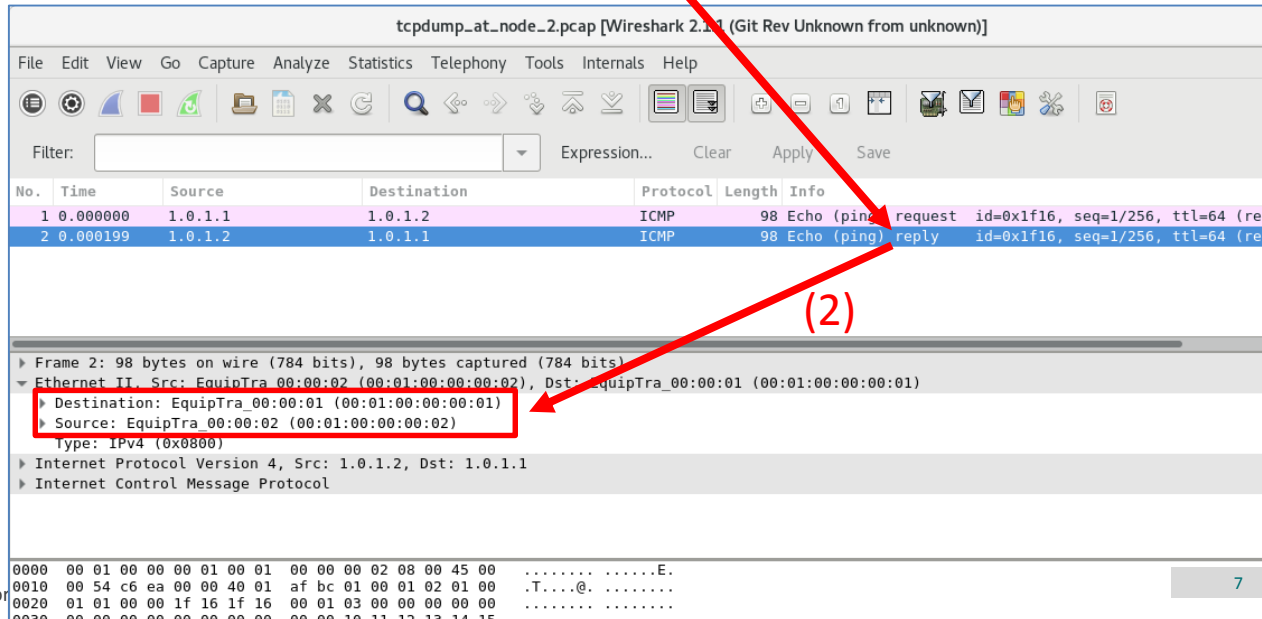
The node that accepts the echo-request frame responds to the request.



(1) Node 3 sends a echo-reply frame.

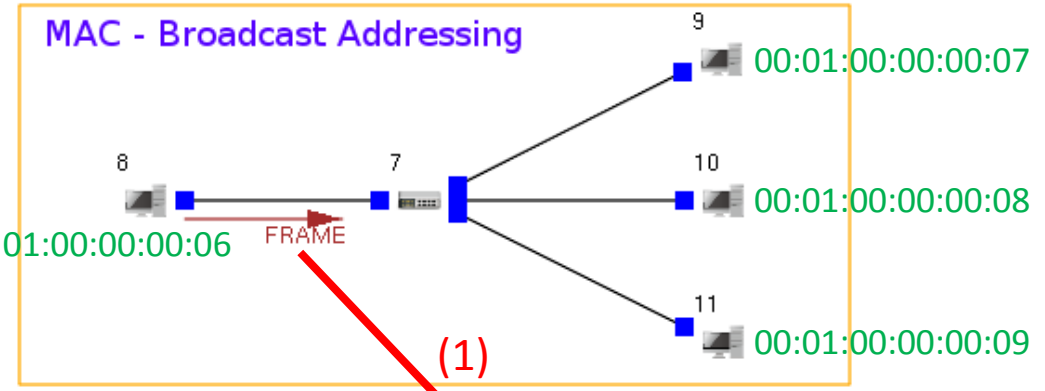
(2) In the frame's header, the source address is filled with Node 3's MAC address while the destination address is filled with Node 2's MAC address.

- Among the three nodes receiving the frame, only Node 2 accepts the frame. That is because the frame's destination address is filled with Node 2's MAC address.
- Node 4 and Node 5 drop the frame because they are not the target of the frame.



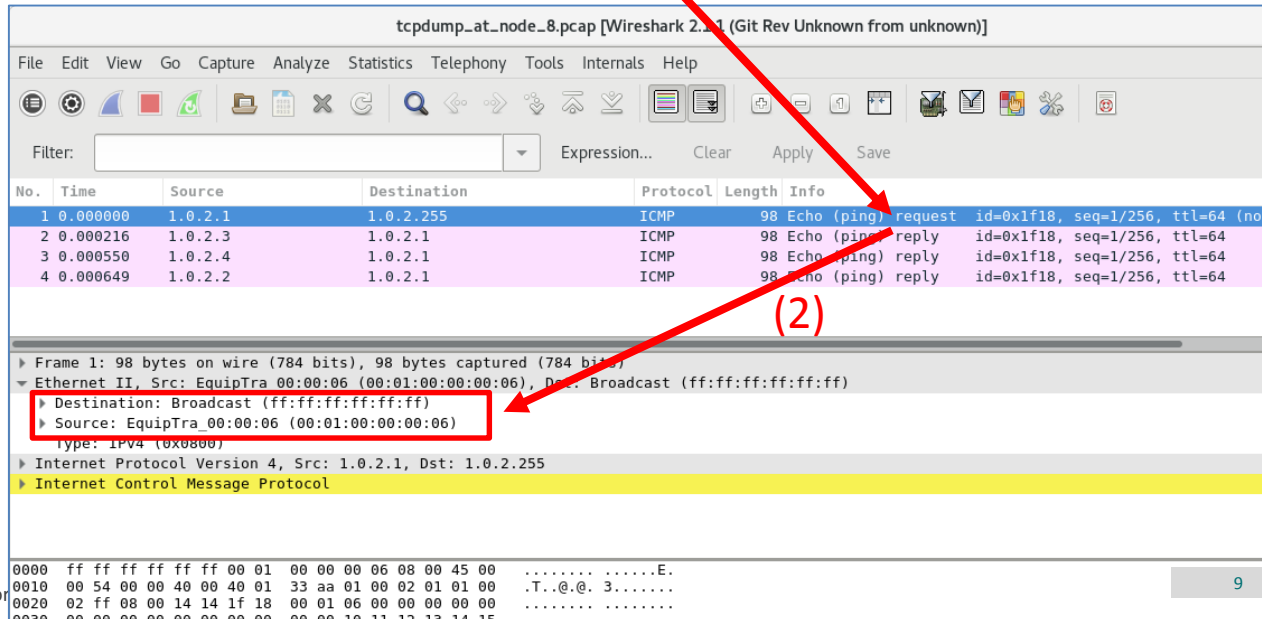
Broadcast Addressing

Fill the destination address of a data-link-layer frame with a broadcast address to address all nodes.



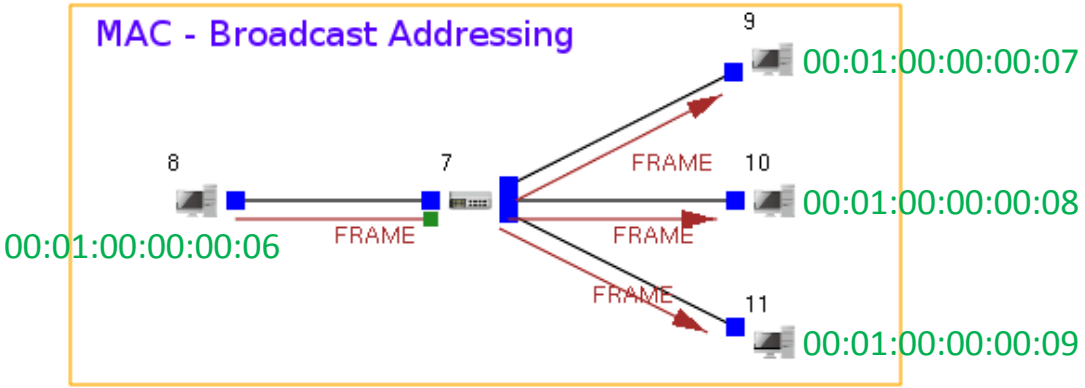
(1) Node 8 sends a echo-request frame.

(2) In the frame's header, the source address is filled with Node 8's MAC address while the destination address is filled with the broadcast MAC address (ff:ff:ff:ff:ff:ff).



A frame receiver decides if the frame is for itself according to the frame's destination address.

- All the three nodes receiving the frame accept the frame because the frame's destination address is filled with the broadcast MAC address. In other words, all nodes are the frame's target.

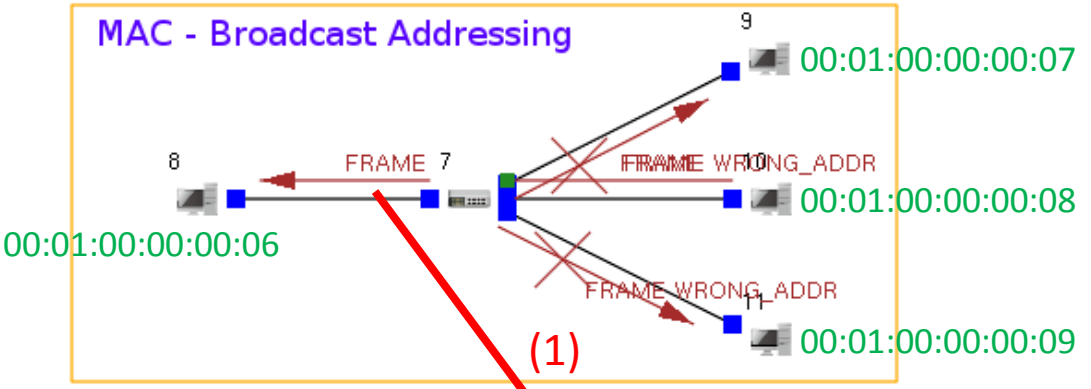


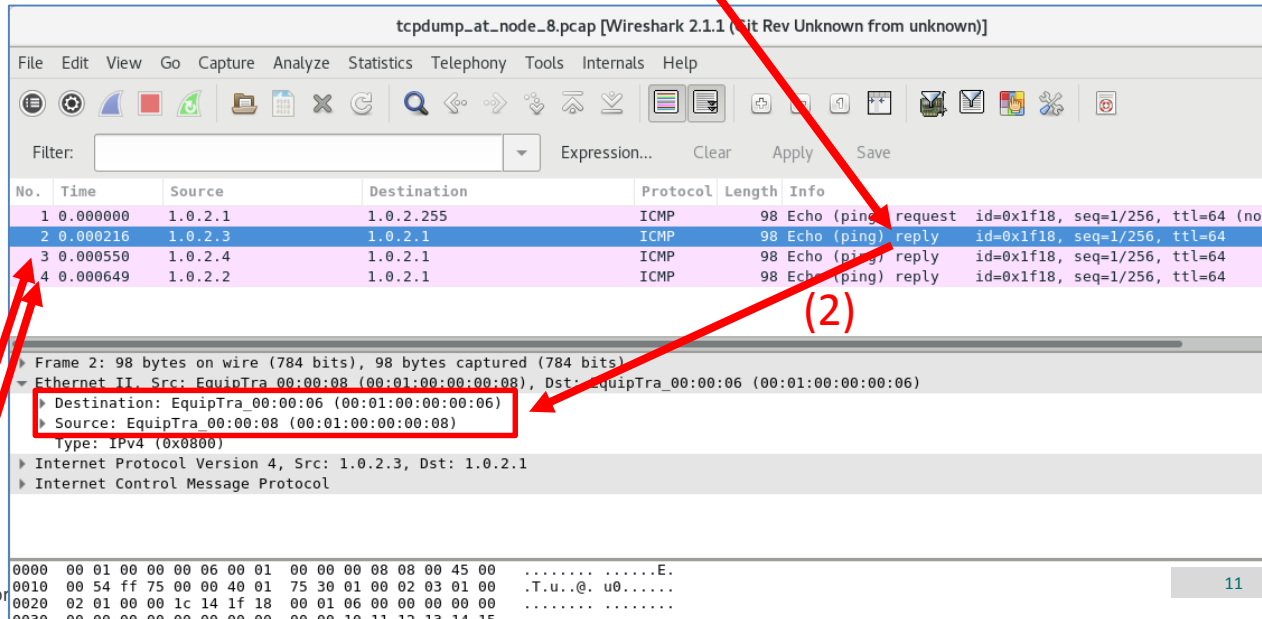
The node that accepts the echo-request frame responds to the request.

(1) Node 10 sends a echo-reply frame.

(2) In the frame's header, the source address is filled with Node 10's MAC address while the destination address is filled with Node 8's MAC address.

- Node 9 and Node 11 also send a echo-reply frame to Node 8.
- If there are more than one node send frames simultaneously, a frame collision occurs. The retransmission mechanism of data link layer makes the three echo-reply frames be sent back to Node 8 eventually.

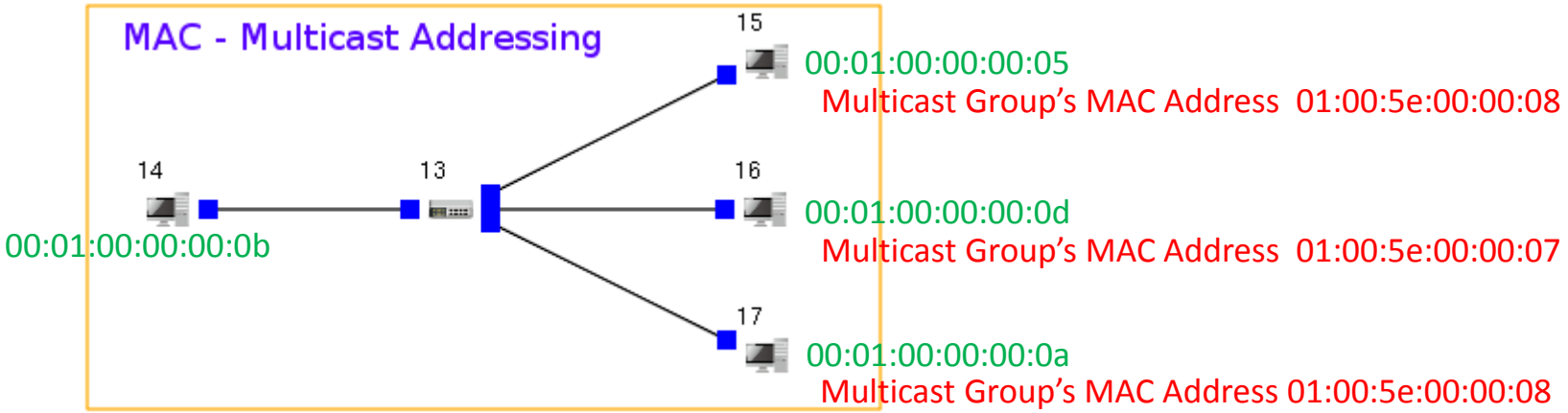




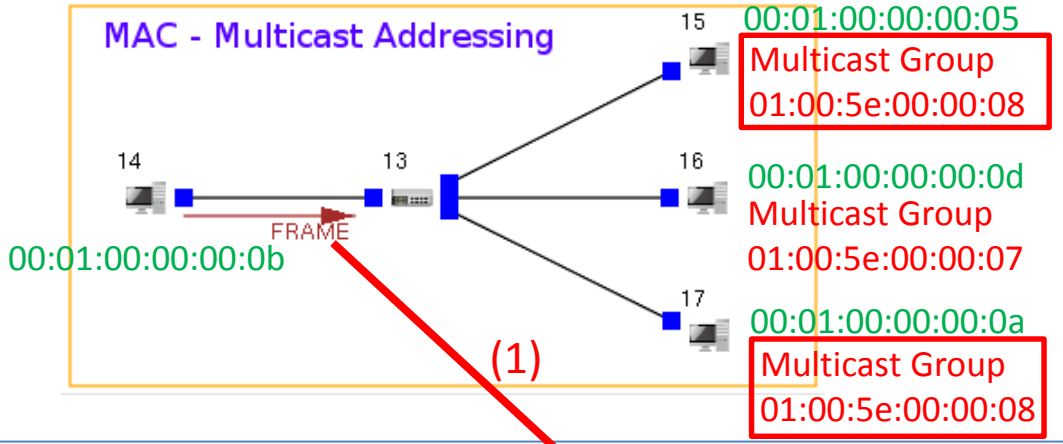
Multicast Addressing

Multicast Group

- The target nodes of a multicast frame are those nodes that join a specific multicast group.
- The following graph shows that Node 15 and Node 17 join the same multicast group while Node 16 joins another multicast group.

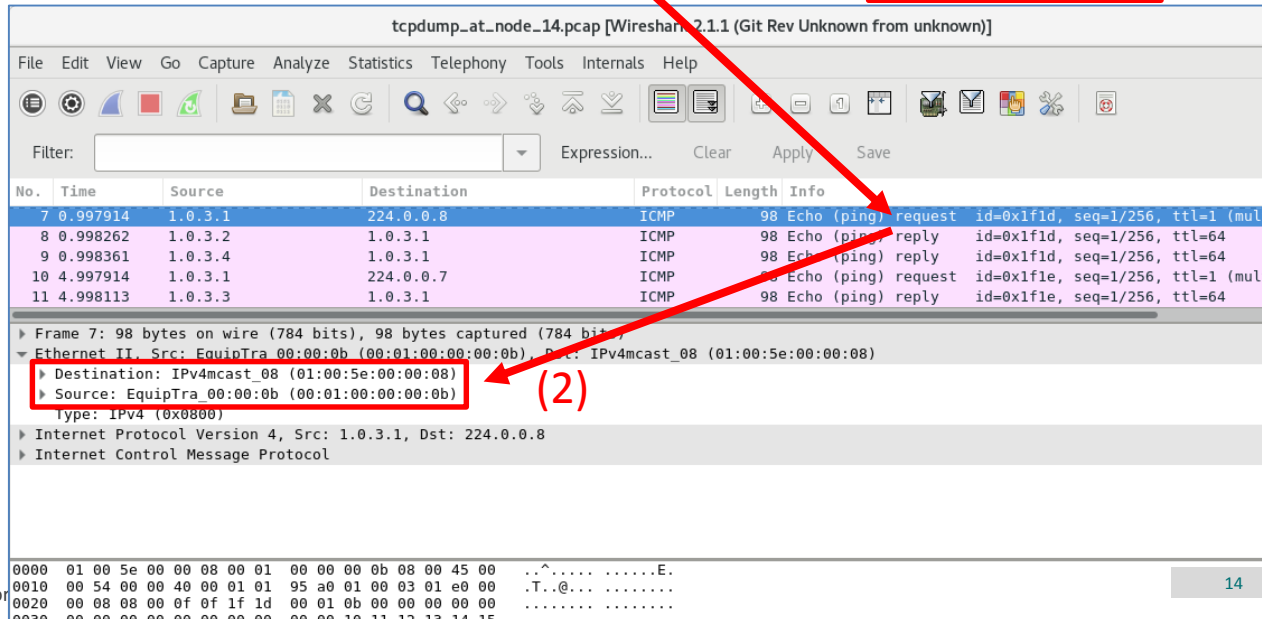


Fill the destination address of a data-link-layer frame with a multicast address to address those nodes that join a specific multicast group.



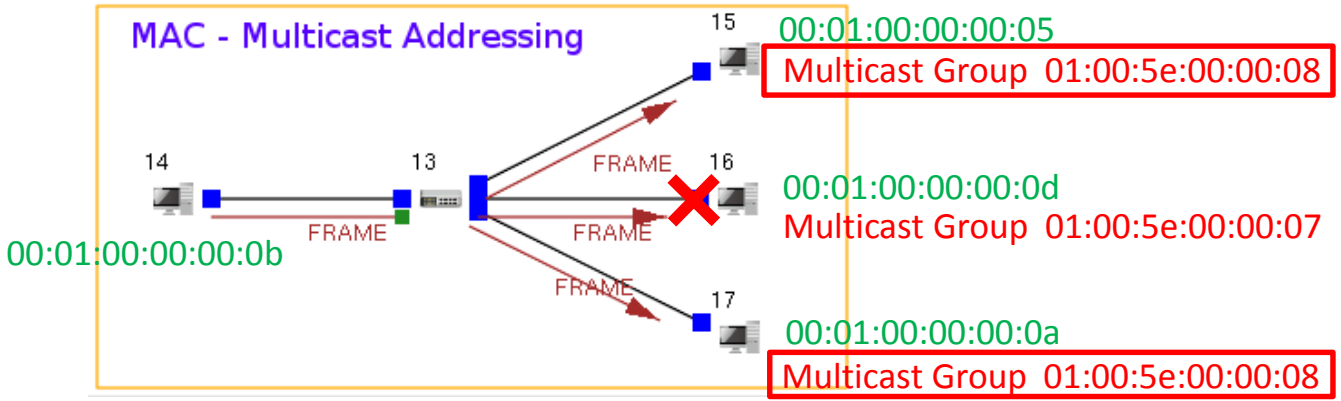
(1) Node 14 sends a echo-request frame.

(2) In the frame's header, the source address is filled with Node 14's MAC address while the destination address is filled with a multicast group's MAC address (01:00:5e:00:00:08).

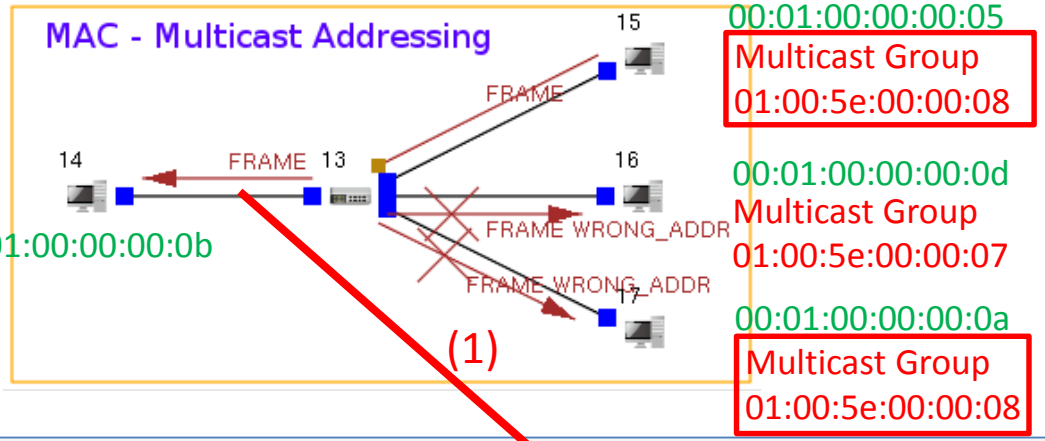


A frame receiver decides if the frame is for itself according to the frame's destination address.

- In the implementation of EstiNet X network simulator, the MAC module does not filter multicast addresses. Thus, all the three nodes receiving the frame accept the frame first and hand it over to the multicast processing procedure on the upper layer. In fact, the frame that targets multicast group 01:00:5e:00:00:08 is eventually discarded by Node 16. Only Node 15 and Node 17 eventually accept the frame.



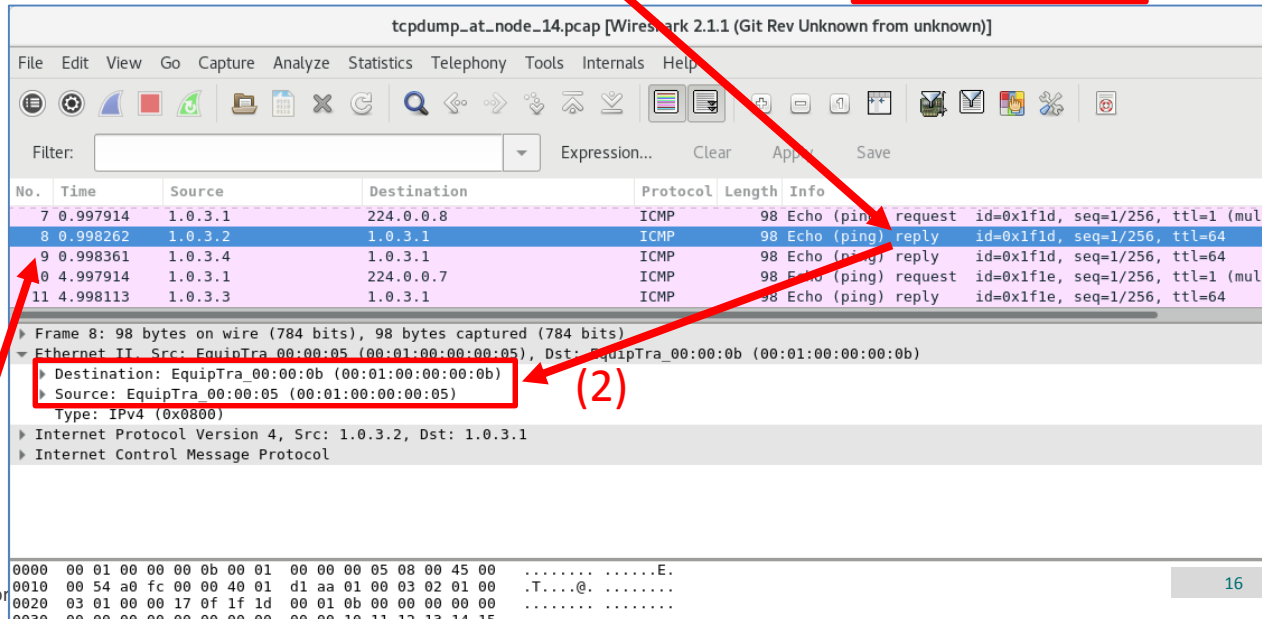
The node that accepts the echo-request frame responds to the request.



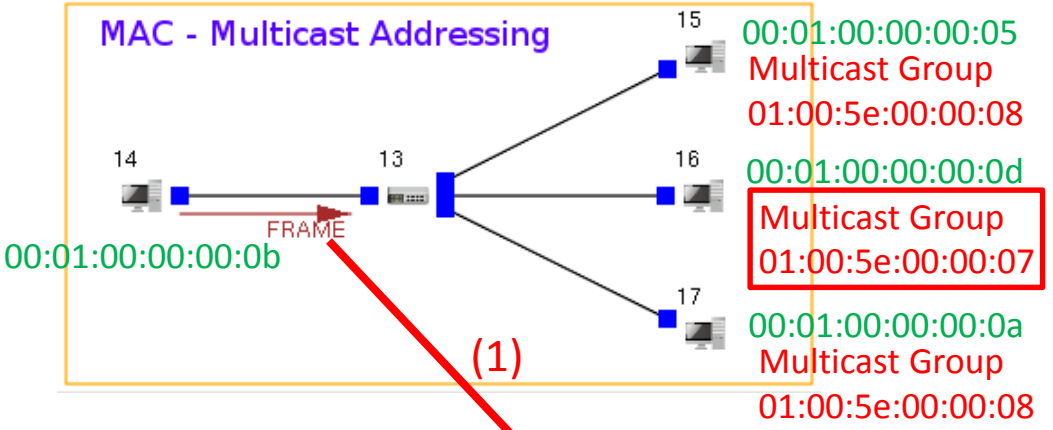
(1) Node 15 sends a echo-reply frame.

(2) In the frame's header, the source address is filled with Node 15's MAC address while the destination address is filled with Node 14's MAC address.

- Node 17 also sends a echo-reply frame to Node 14.
- If two nodes send frames simultaneously, a frame collision occurs. The retransmission mechanism of data link layer makes the two echo-reply frames be sent back to Node 14 eventually.

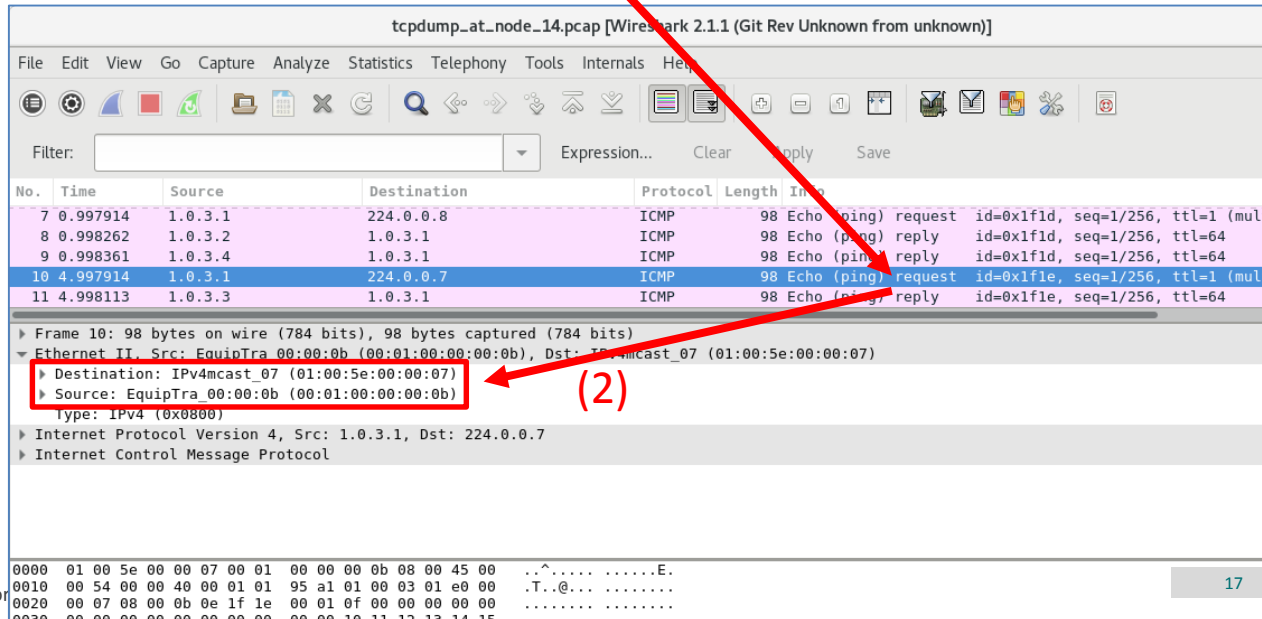


Fill the destination address of a data-link-layer frame with a multicast address to address those nodes that join a specific multicast group.



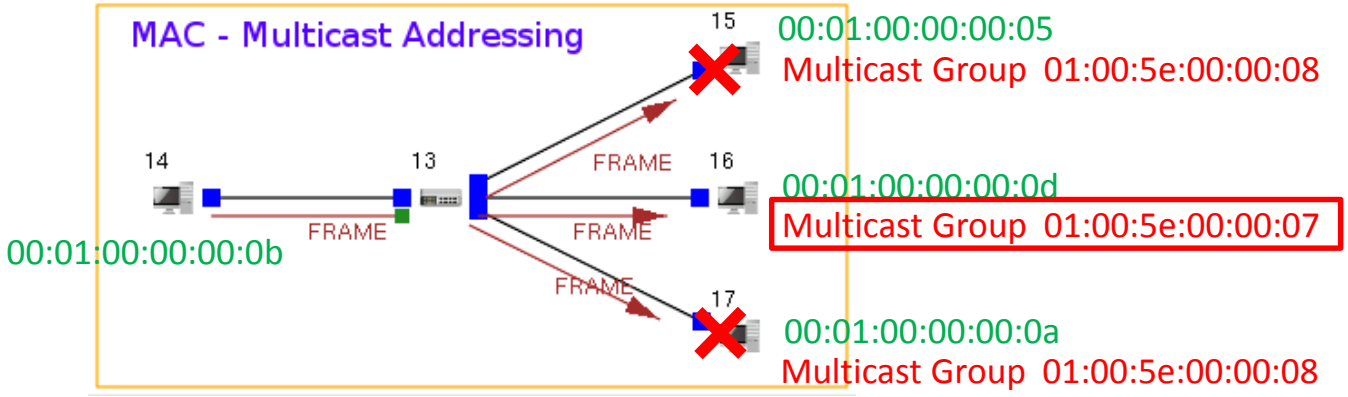
(1) Node 14 sends a echo-request frame.

(2) In the frame's header, the source address is filled with Node 14's MAC address while the destination address is filled with a multicast group's MAC address (01:00:5e:00:00:07).

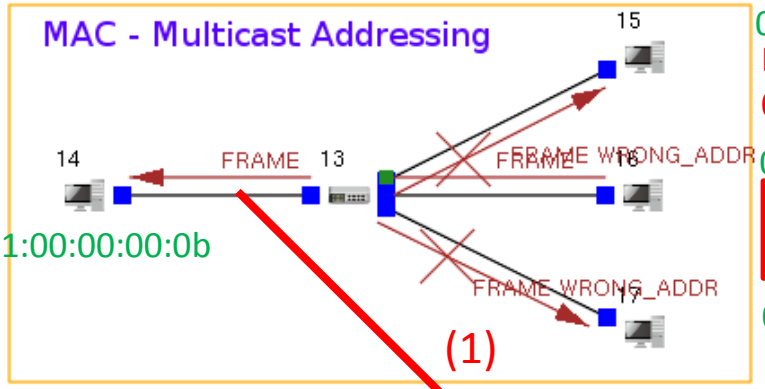


A frame receiver decides if the frame is for itself according to the frame's destination address.

- In the implementation of EstiNet X network simulator, the MAC module does not filter multicast addresses. Thus, all the three nodes receiving the frame accept the frame first and hand it over to the multicast processing procedure on the upper layer. In fact, the frame that targets multicast group 01:00:5e:00:00:07 is eventually discarded by Node 15 and Node 17. Only Node 16 eventually accepts the frame.

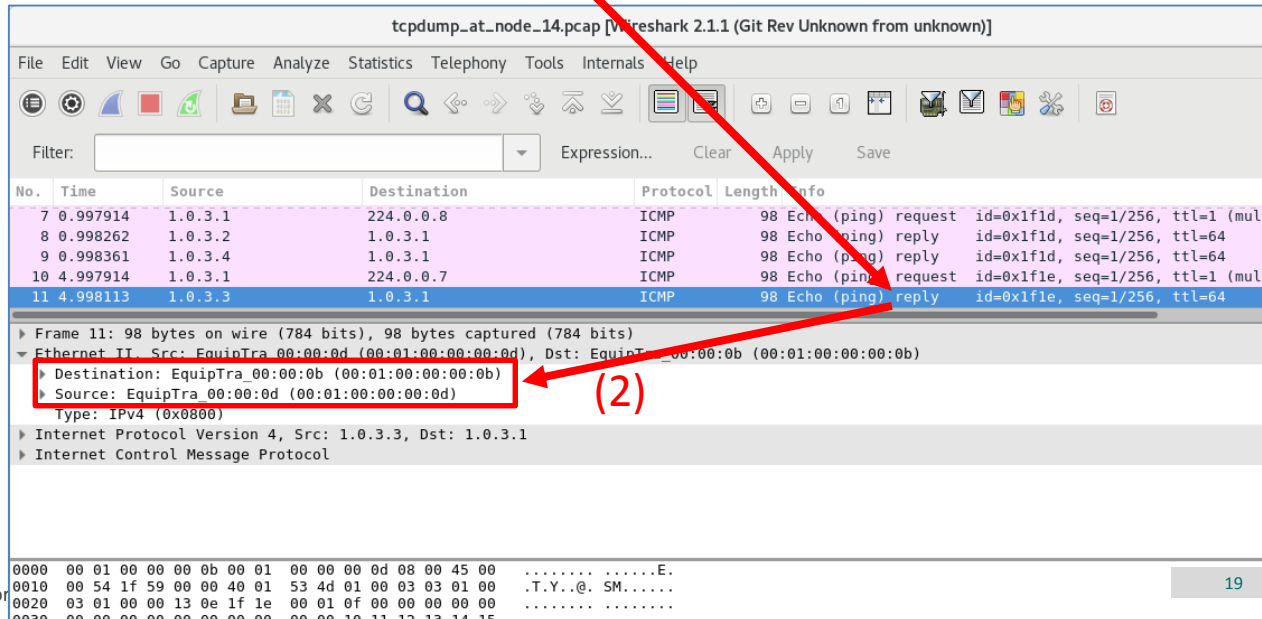


The node that accepts the echo-request frame responds to the request.



(1) Node 16 sends a echo-reply frame.

(2) In the frame's header, the source address is filled with Node 16's MAC address while the destination address is filled with Node 14's MAC address.

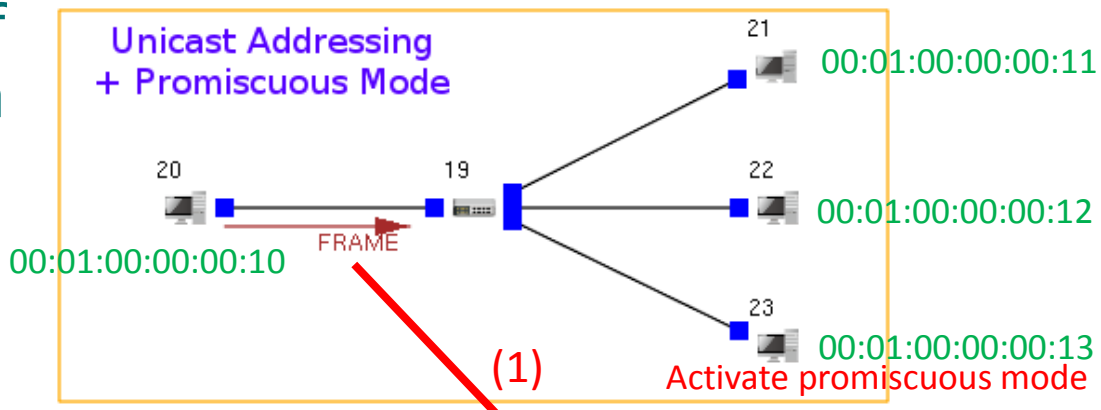


Promiscuous Mode

Promiscuous Mode

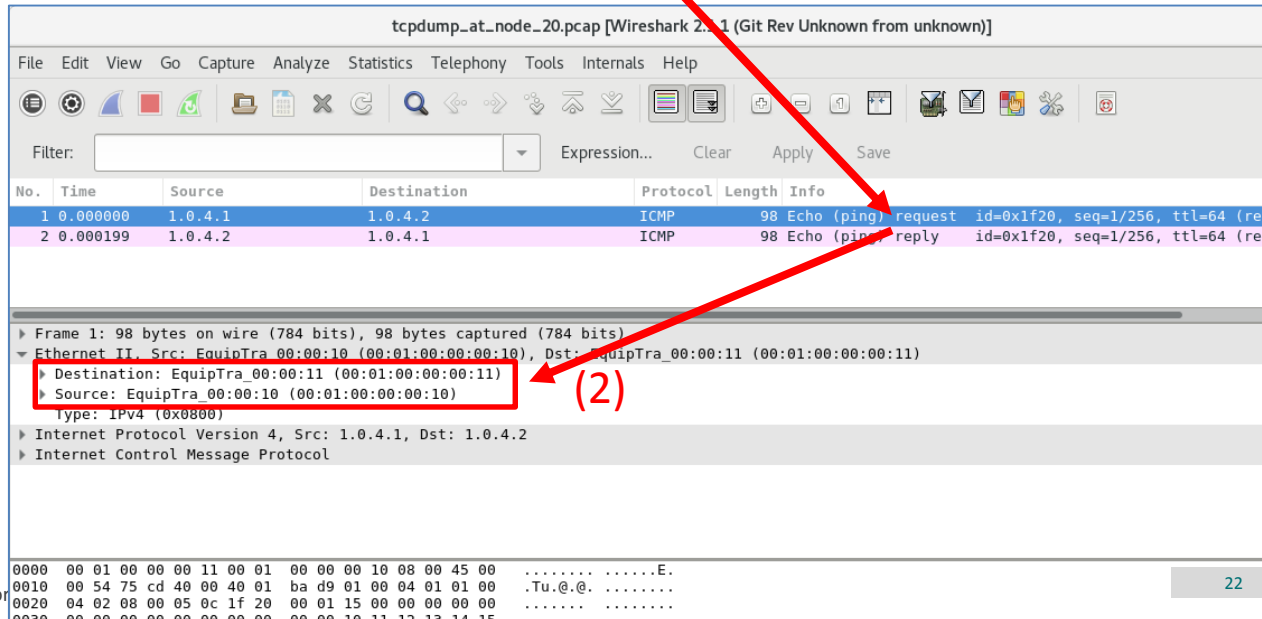
- The data link layer of a network node filters an incoming frame according to the frame's destination address to see if the frame is for this network node.
- If a network node wants to stop the filtering mechanism, it activates the promiscuous mode. In this way, the network node accepts all incoming frames. Some network packet analyzer software, such as Wireshark, uses this way to analyze all network packets.

Fill the destination address of a data-link-layer frame with a unicast address to address a single target node.



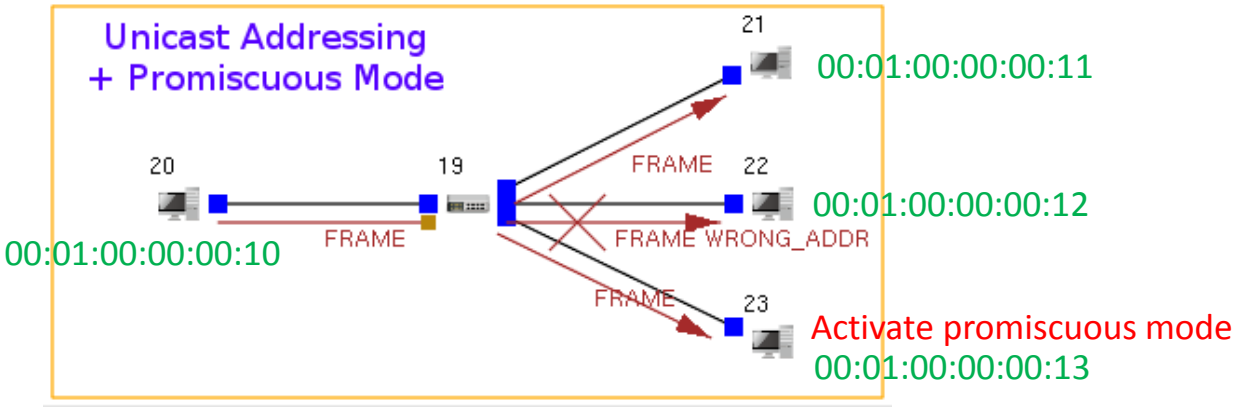
(1) Node 20 sends a echo-request frame.

(2) In the frame's header, the source address is filled with Node 20's MAC address while the destination address is filled with Node 21's MAC address.

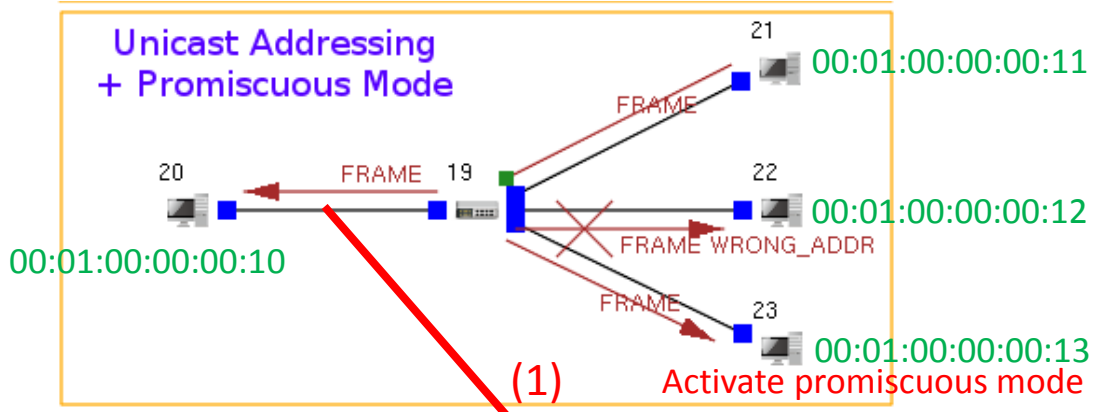


A frame receiver decides if the frame is for itself according to the frame's destination address.

- The frame is accepted by not only Node 21 but also Node 23. The former accepts the frame because it is the frame's target node. The latter accepts the frame because it activates the promiscuous mode.
- Node 22 drops the frame because it is not the target of the frame.



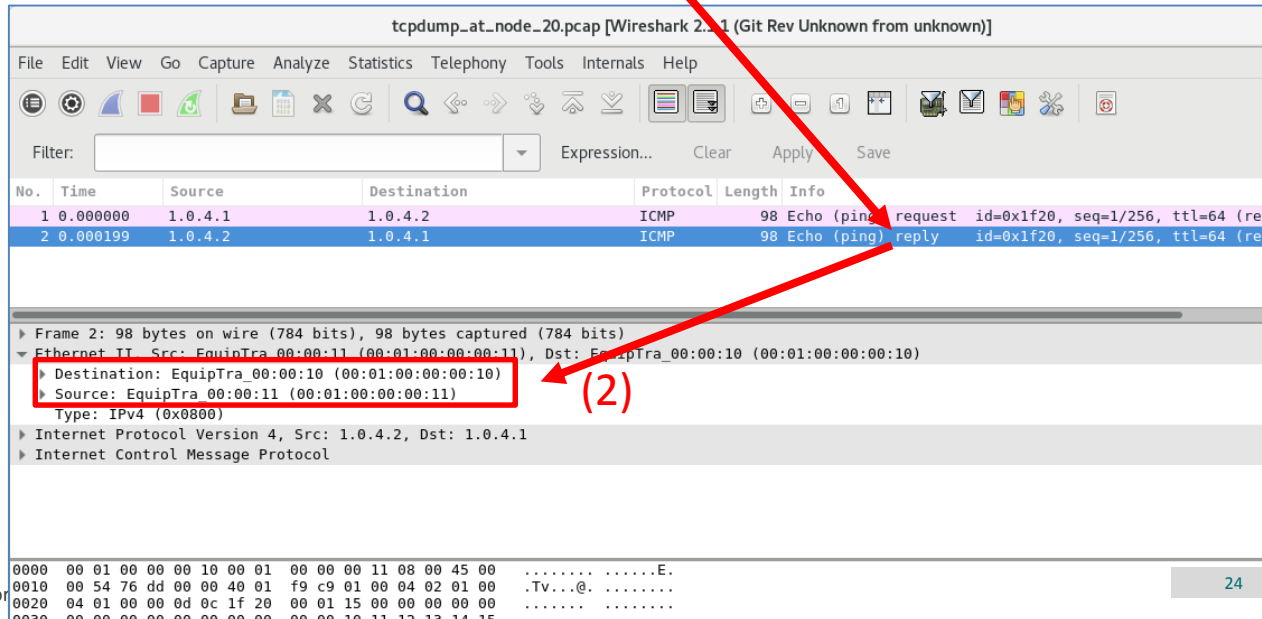
The node that accepts the echo-request frame responds to the request.



(1) Node 21 sends a echo-reply frame.

(2) In the frame's header, the source address is filled with Node 21's MAC address while the destination address is filled with Node 20's MAC address.

- The frame is also accepted by Node 23 that activates the promiscuous mode.



Summary

Review of Points

- What kinds of addressing does the data link layer have? What characteristics does each addressing have? What kinds of network application is each addressing suitable for?
- What will happen after a network node activates the promiscuous mode? What kinds of network application is this mode suitable for?

Appendix

Special Parameter Configuration for This Simulation Case

- Broadcast Addressing
  - On those nodes that are the target of a broadcast echo-request frame, the command “sysctl net.ipv4.icmp_echo_ignore_broadcasts=0” has to be executed so that these nodes can send back echo-reply frames.
- Multicast Addressing
  - All nodes have to execute the command ”ip route add 224.0.0.0/4 dev eth0” so that the multicast frames are able to be sent out. (note that eth0 is the interface name)
  - On the node that is the target of a broadcast echo-request frame, the command “ttcp -r -4 -u 224.x.x.x” has to be executed to let the node join a multicast group.
  - On those nodes that are the target of a multicast echo-request frame, the command “sysctl net.ipv4.icmp_echo_ignore_broadcasts=0” has to be executed so that these nodes can send back echo-reply frames.
- Promiscuous Mode
  - Execute the command “ip link set eth0 promisc on” on a node to activate the promiscuous mode. (note that eth0 is the interface name)