

Lecture 22: Link Layer III

Sejong University Spring 2019: Computer Networks

2019. 5. 27.

Cheol Jeong

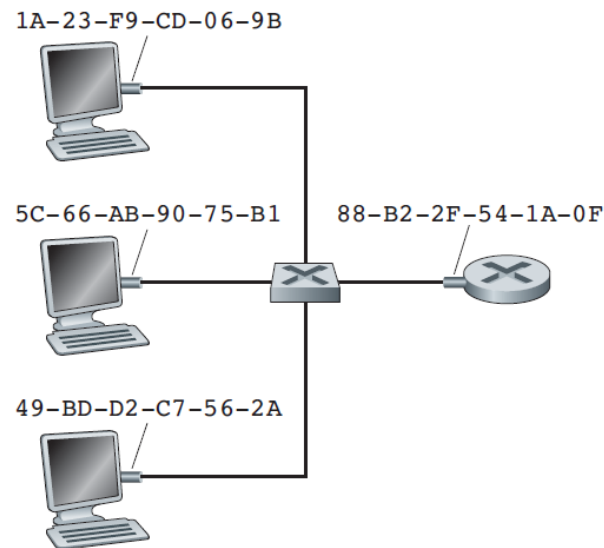
This material can only be used for students that signed up for this class at Sejong University and must not be distributed outside of the class. The contents are mainly based on the text book, “Computer Networking: A Top-Down Approach” by J. F. Kurose and K. W. Ross (7th Edition).

Contents of Chapter 6

- ◇ Introduction to the link layer
- ◇ Error-detection and –correction techniques
- ◇ Multiple access links and protocols
- ◇ **Switched local area networks**
 - ◆ Link-layer addressing and ARP
 - ◆ Ethernet
 - ◆ Link-layer switches
 - ◆ Virtual local area networks (VLANs)
- ◇ Link virtualization: A network as a link layer
- ◇ Data center networking

Link-layer Addressing

- ◆ **An adapter has a Mac address.**
 - ◆ *aka* a LAN address, a physical address
 - ◆ E.g., 6 bytes long (Ethernet, 802.11 wireless LAN)
 - ◆ Each interface connected to a LAN has a **unique** MAC address.
 - ◆ An adapter passes the datagram up the protocol stack only if the MAC address in the received frame matches to its own MAC address OR the MAC address is FF-FF-FF-FF-FF-FF (special MAC **broadcast** address).

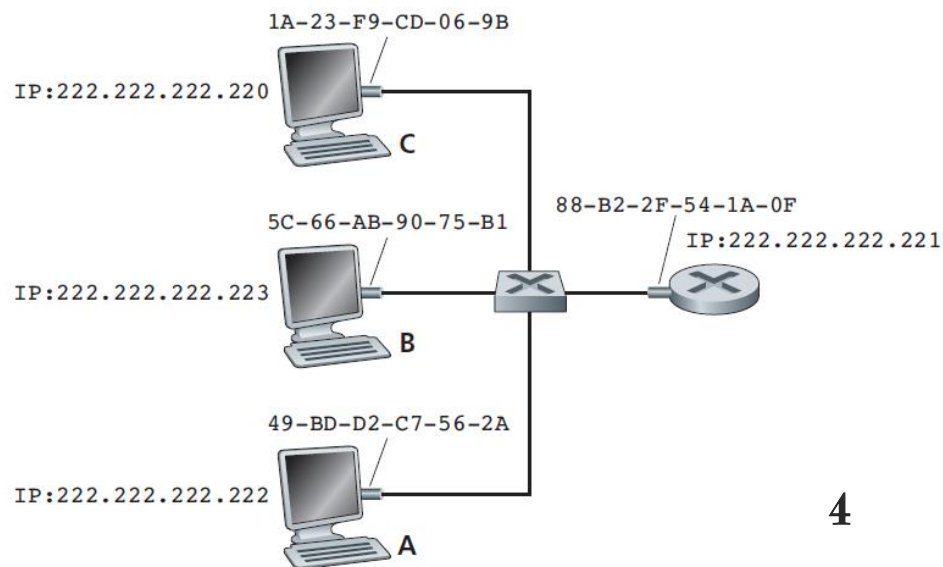


Link-layer Addressing

◆ Address resolution protocol (ARP)

- ◆ Translate between the network-layer addresses (e.g. IP addresses) and the link-layer addresses (MAC addresses)
- ◆ DNS vs ARP
 - ◆ DNS resolves host names for hosts anywhere in the Internet.
 - ◆ ARP resolves IP addresses only for hosts and router interfaces **on the same subnet.**
- ◆ ARP query – ARP response
 - ◆ Encapsulated in link-layer frames

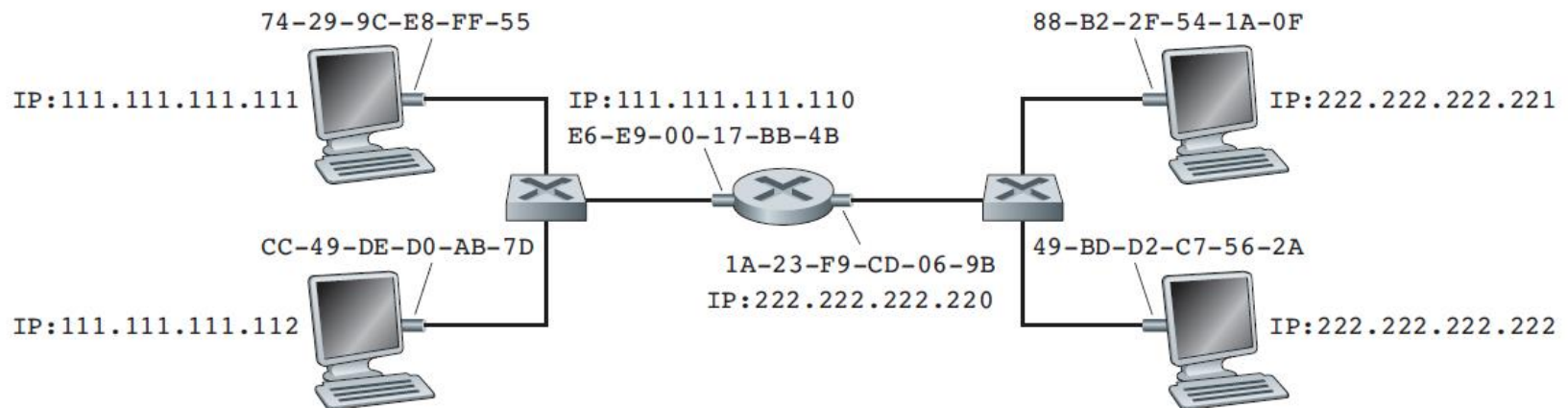
IP Address	MAC Address	TTL
222.222.222.221	88-B2-2F-54-1A-0F	13:45:00
222.222.222.223	5C-66-AB-90-75-B1	13:52:00



Link-layer Addressing

◇ Sending a datagram off the subnet

- ◆ The MAC address for a frame is the MAC address for a router or host, that receives the frame directly on the link.
- ◆ E.g., when 111.111.111.111 sends a datagram to 222.222.222.222, which one is the appropriate MAC address in the frame transmitted from 111.111.111.111?



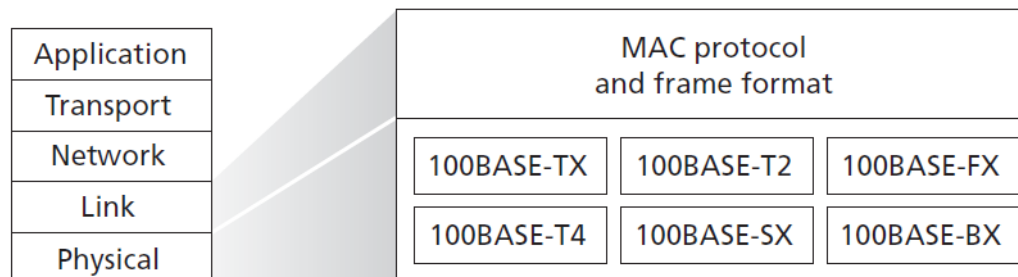
Ethernet

Original Ethernet

- ◆ Invented by Bob Metcalfe and David Boggs in the mid-1970s
- ◆ 2.95 Mbps and linked up to 256 hosts separated by up to one mile
- ◆ Bus topology, a broadcast LAN in which all transmitted frames travel to and are processed by *all* adapters connected to the bus

Today's Ethernet

- ◆ Star topology using a store-and-forward packet switch
- ◆ 10 Mbps, 100 Mbps, and 40 Gigabit Ethernet (IEEE 802.3z)
- ◆ E.g. 100 Mbps Ethernet standards

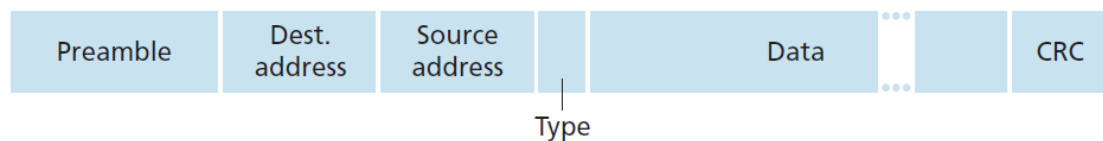


Ethernet

◆ Ethernet

- ◆ Connectionless and unreliable service
- ◆ Both a link-layer *and* a physical-layer specification
- ◆ Unaware of whether its is transmitting a new datagram or a datagram that contains data that has already been transmitted at least once
- ◆ CSMA/CD protocol

Ethernet



◆ Ethernet frame structure

- ◆ Data field (46 to 1500 bytes)
 - ◆ MTU: 1500 bytes
- ◆ Destination address (6 bytes)
 - ◆ MAC address of the destination adapter
- ◆ Source address (6 bytes)
 - ◆ MAC address of the adapter that transmits the frame onto the LAN
- ◆ Type field (2 bytes)
 - ◆ E.g., IP, ARP
- ◆ Cyclic redundancy check (CRC) (4 bytes)
- ◆ Preamble (8 bytes)
 - ◆ 10101010 ... 10101011

Link-layer Switches

◆ Switches

- ◆ Transparent to the hosts and routers in the subnet

◆ Filtering

- ◆ Determine whether a frame should be forwarded to some interface or should just be dropped

◆ Forwarding

- ◆ Determine the interfaces to which a frame should be directed, and then move the frame to those interfaces

◆ Switch table

Address	Interface	Time
62-FE-F7-11-89-A3	1	9:32
7C-BA-B2-B4-91-10	3	9:36
...

Link-layer Switches

- ◇ **Rules for switch filtering and forwarding**
 - ◆ Case 1) There is no entry for the destination address.
 - ◆ The switch broadcasts the frame to the output buffers preceding all output interfaces.
 - ◆ Case 2) There is an entry in the table, associating the destination address with input interface.
 - ◆ The switch discards the frame.
 - ◆ Case 3) There is an entry in the table, associating the destination address with one of output interfaces.
 - ◆ The switch performs its forwarding function.

Link-layer Switches

◇ Self-learning

- ◆ The switch table is built automatically, dynamically, and autonomously using
 - ◆ The MAC address in the frame's source address field
 - ◆ The interface from which the frame arrived
- ◆ The switch deletes an address in the table if no frames are received with that address as the source address after some period of time.

◇ Switches are **plug-and-play** devices.

- ◆ Require no intervention from a network administrator or user

Switches vs. Routers

Switches

- ◆ Layer-2 packet switch
- ◆ Use MAC addresses
- ◆ Plug-and-play
- ◆ Spanning tree topology restricted

Routers

- ◆ Layer-3 packet switch
- ◆ Use IP addresses
- ◆ No plug-and-play
- ◆ No restriction on the topology, i.e., optimal routing is possible

