Lecture 04-01: Link Layer Intro

CS 356R

Intro to Wireless Networks

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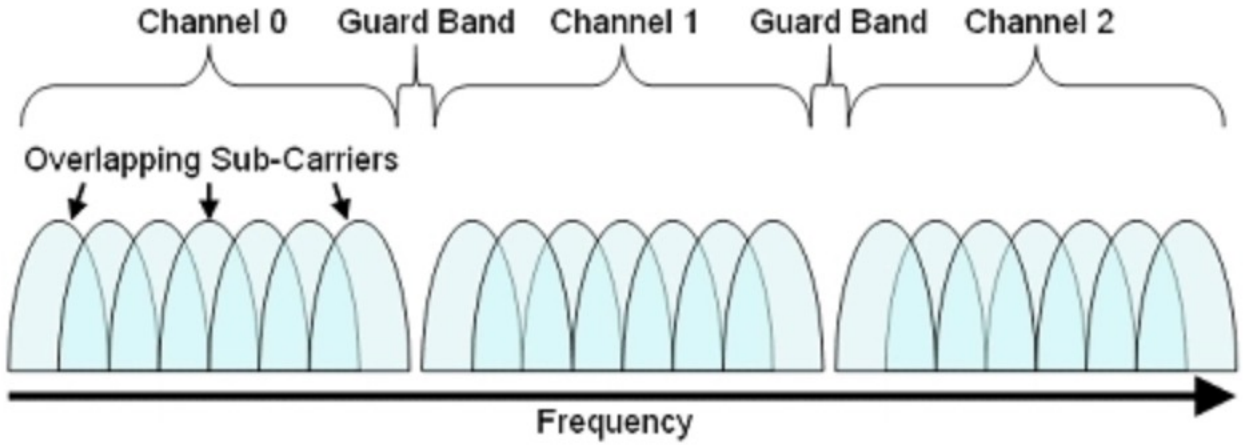
Outline

1. OFDM recap

True/False OFDM does not need guard band

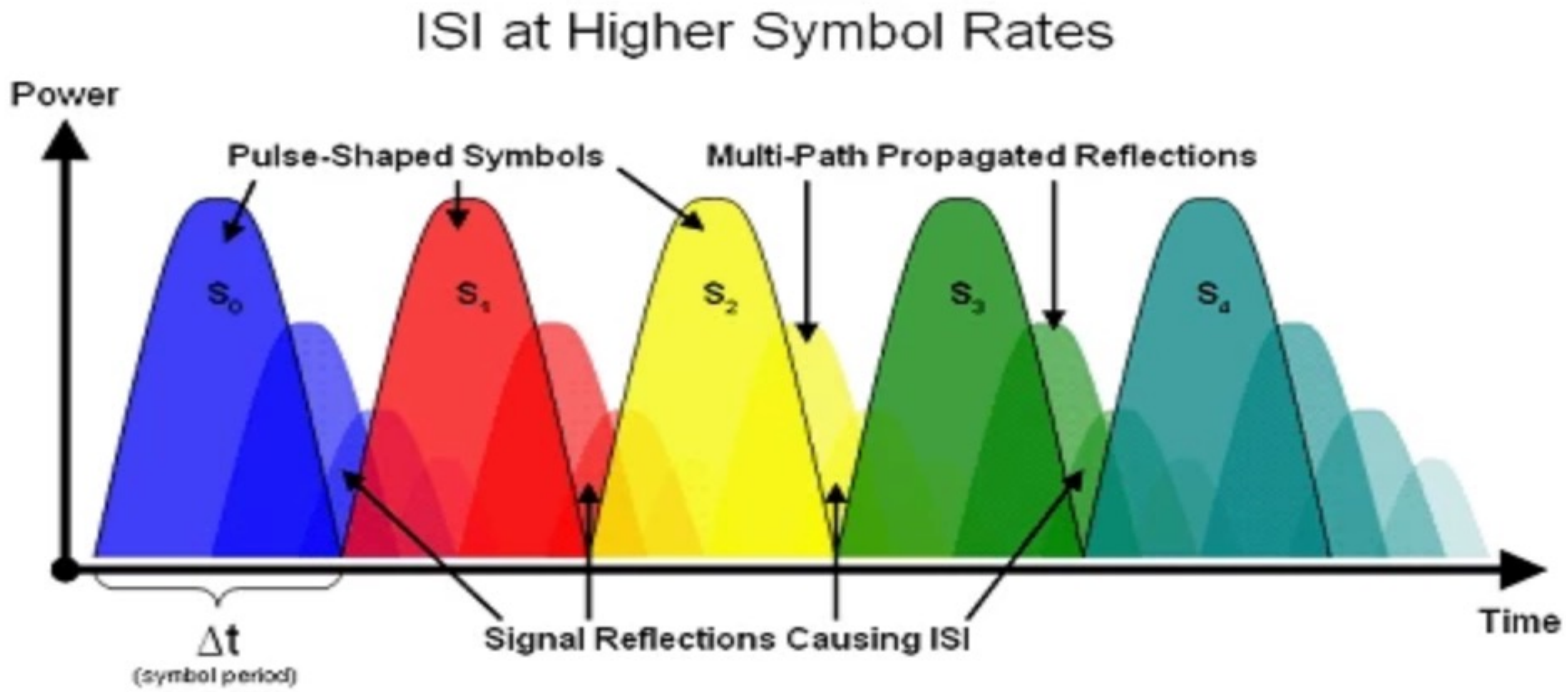
False! OFDM still requires guard band

- Not as much as traditional FDM though
  - Need much smaller bandwidth of guard band

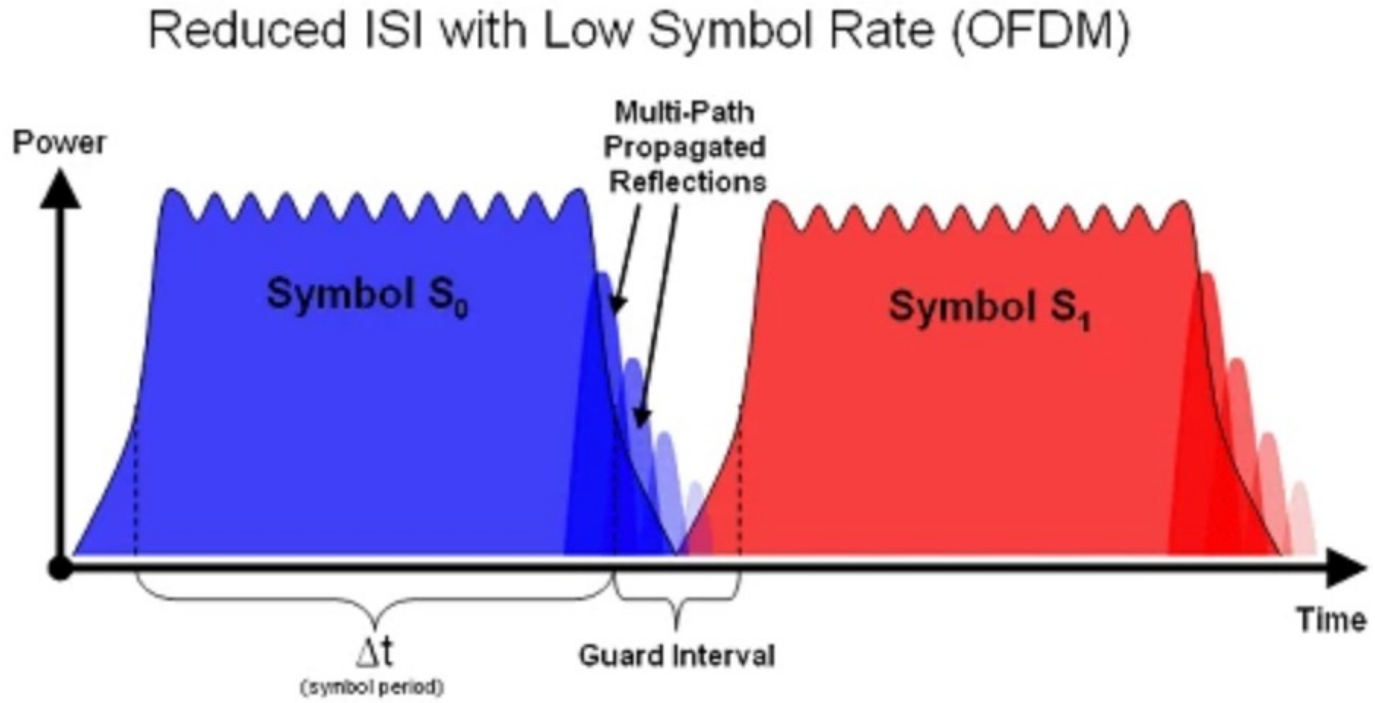


Why smaller guard band is sufficient?

At a higher symbol rate, reflections from multipath make up greater percentage of the symbol period



OFDM has lower symbol rate per subcarrier, which means lower percentage of interference

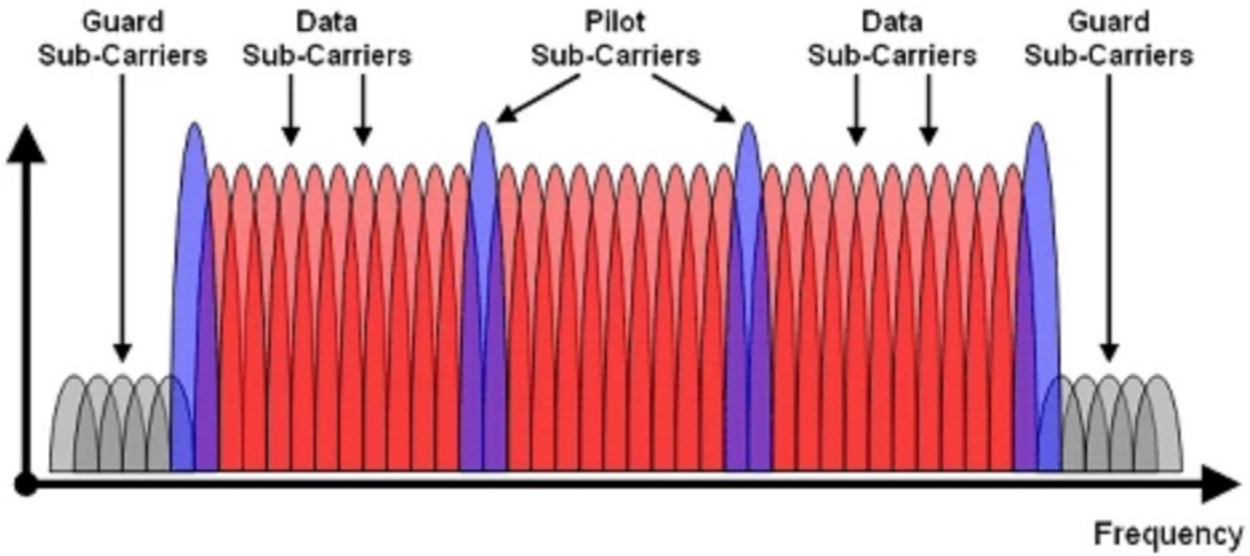


OFDM takes longer time to transmit a symbol thus smaller percentage

Smaller guard interval in time domain
is added to distinguish each symbols

Also, guard band in frequency domain is added between channels

WiMAX example



Due to spectrum spillage/spread because of imperfection of physical system

What is pilot subcarriers in this picture?

Pilot channel is added for channel estimation and synchronization purpose

- **Pilot subcarriers transmit with a known data sequence**
- **Used channel equalization**
  - Determine the difference between ideal signal and actual signal received
- **Ex) 802.11a**
  - pilot subcarriers occupy subcarriers -21, -7 , 7, and 21
  - All use simple BPSK

Outline

1. OFDM recap
2. Link Layer Intro

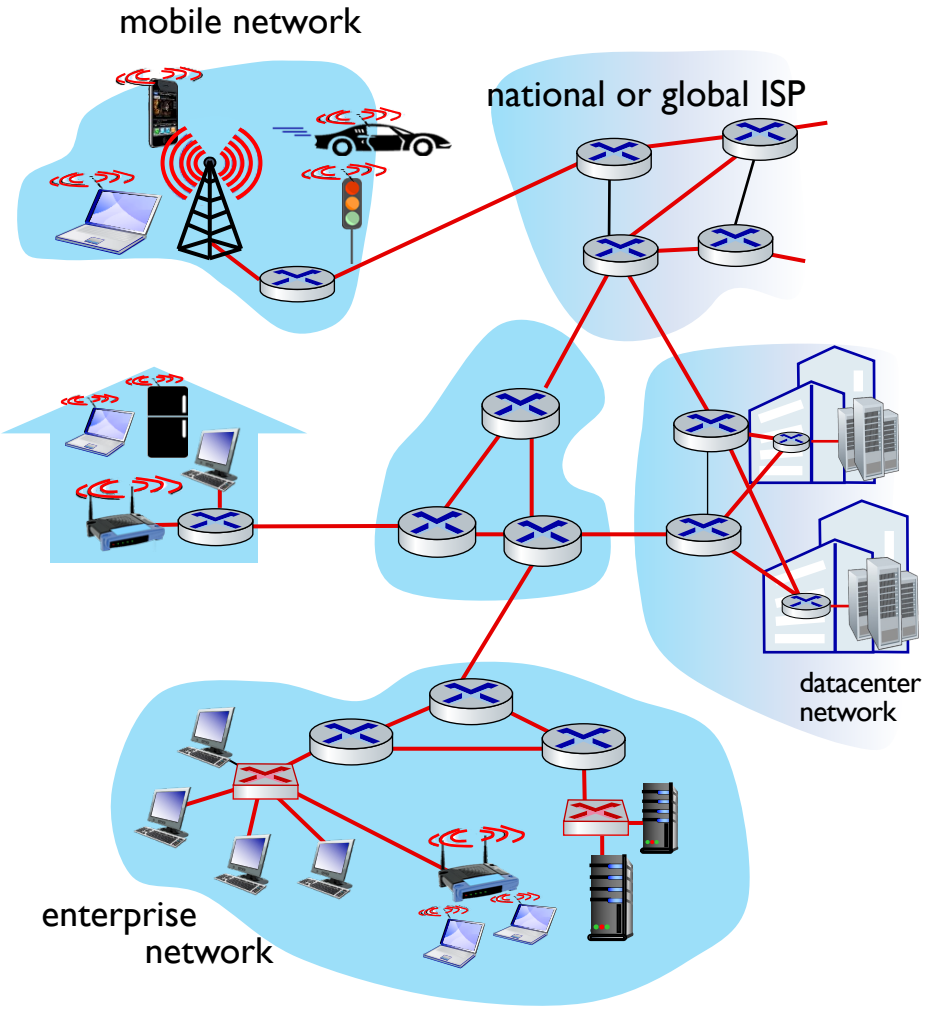
Example Protocols	Layers	Responsible for
FTP, HTTP, SMTP	Application	application specific needs
TCP, UDP	Transport	process to process data transfer
IP	Network	host to host data transfer across different network
Ethernet, WiFi	Link	data transfer between physically adjacent nodes
802.3 PHY	Physical	bit-by-bit or symbol-by-symbol delivery

Link layer: introduction

terminology:

- hosts, routers: nodes
- communication channels that directly connect physically adjacent nodes: links
  - wired , wireless
  - LANs
- layer-2 packet: frame, encapsulates datagram

link layer has responsibility of transferring datagram from one node to physically adjacent node over a link

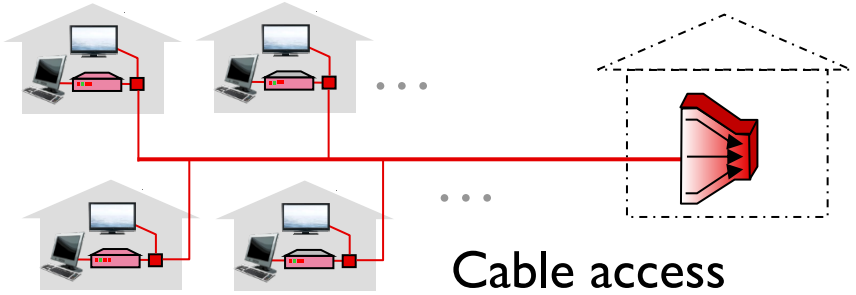


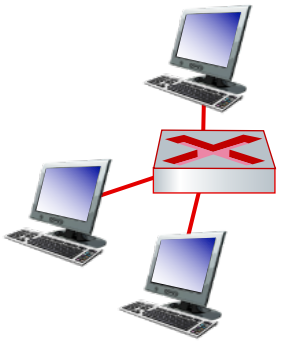
Link layer: context

- datagram transferred by different link protocols over different links:
  - e.g., WiFi on first link, Ethernet on next link
- each link protocol provides different services
  - e.g., may or may not provide reliable data transfer over link

Link layer: services

- framing, link access:
  - encapsulate datagram into frame, adding header, trailer
  - channel access if shared medium
  - "MAC" addresses in frame headers identify source, destination
- reliable delivery between adjacent nodes
  - we already know how to do this!
  - seldom used on low bit-error links
  - wireless links: high error rates

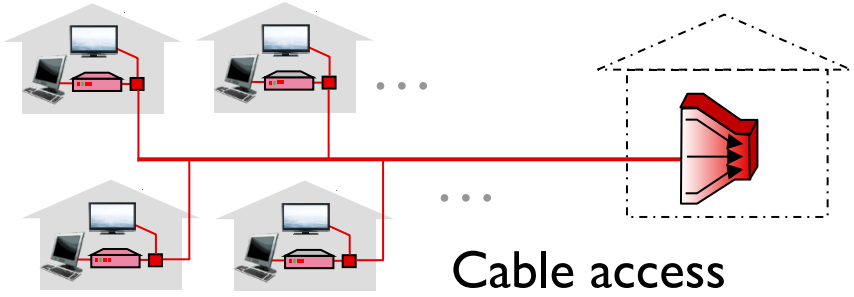




Why both link-level and end-end reliability?

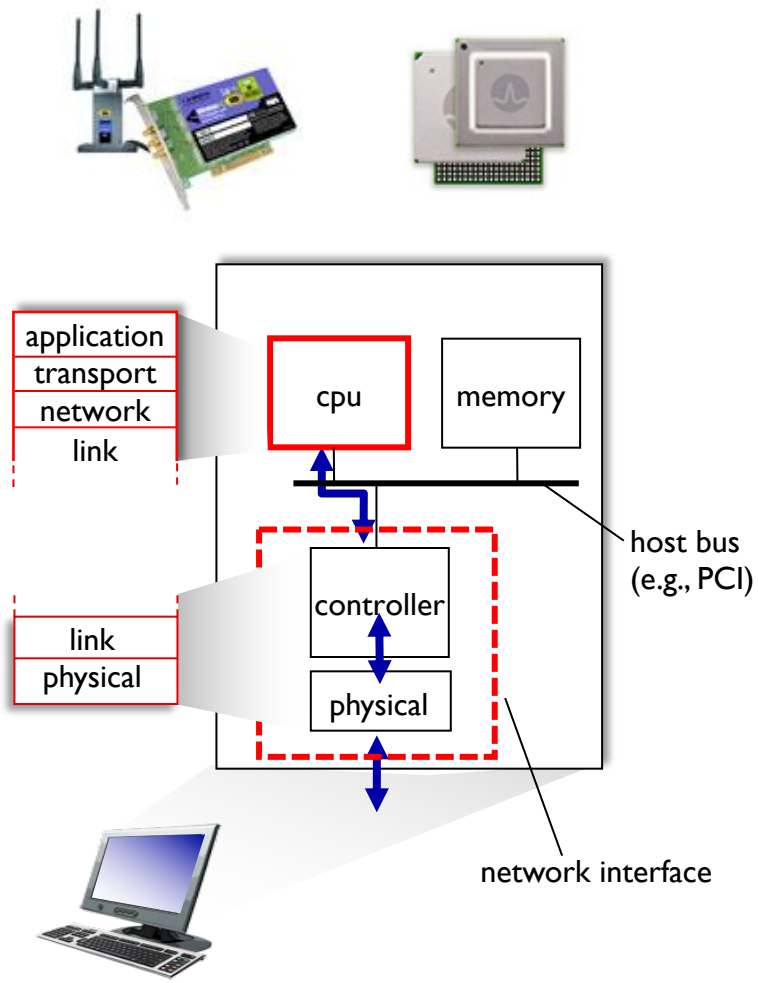
Link layer: services (more)

- flow control:
  - pacing between adjacent sending and receiving nodes
- error detection:
  - errors caused by signal attenuation, noise.
  - receiver detects errors, signals retransmission, or drops frame
- error correction:
  - receiver identifies and corrects bit error(s) without retransmission
- half-duplex and full-duplex:
  - with half duplex, nodes at both ends of link can transmit, but not at same time

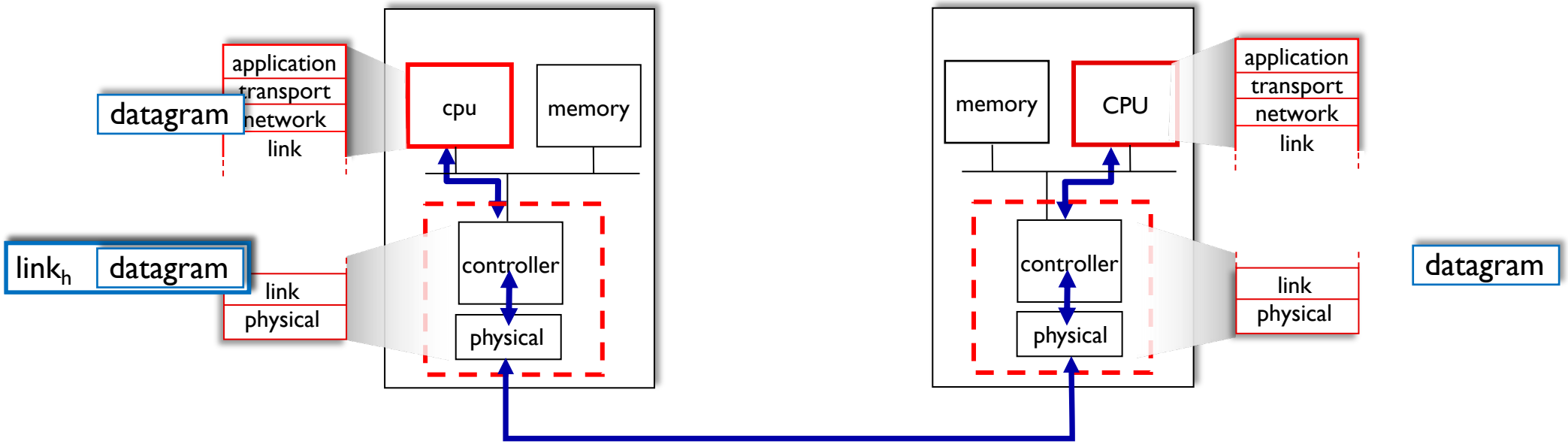


Host link-layer implementation

- in each-and-every host
- link layer implemented on-chip or in network interface card (NIC)
  - implements link, physical layer
- attaches into host's system buses
- combination of hardware, software, firmware



Interfaces communicating



sending side:

- encapsulates datagram in frame
- adds error checking bits, reliable data transfer, flow control, etc.

receiving side:

- looks for errors, reliable data transfer, flow control, etc.
- extracts datagram, passes to upper layer at receiving side

Outline

1. OFDM recap
2. Link Layer Intro
3. Link Layer Address vs IP Address

One network interface has two addresses

- Network layer address
  - IP address
  - IPv4 looks like 192.168.86.250 (32 bit)
  - IPv6 looks like 2001:db8:3333:4444:5555:6666:7777:8888 (128 bit)

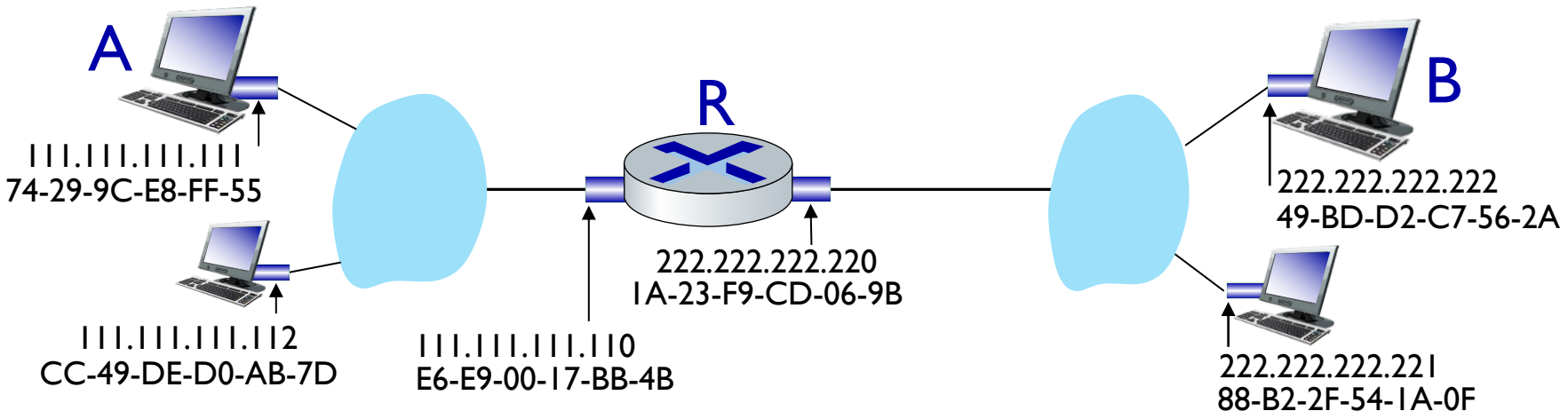
- Link layer address
  - MAC address
  - Looks like 14:7d:da:d9:eb:fb (48 bit)

Why 2 types of addresses?

Routing to another subnet with addressing

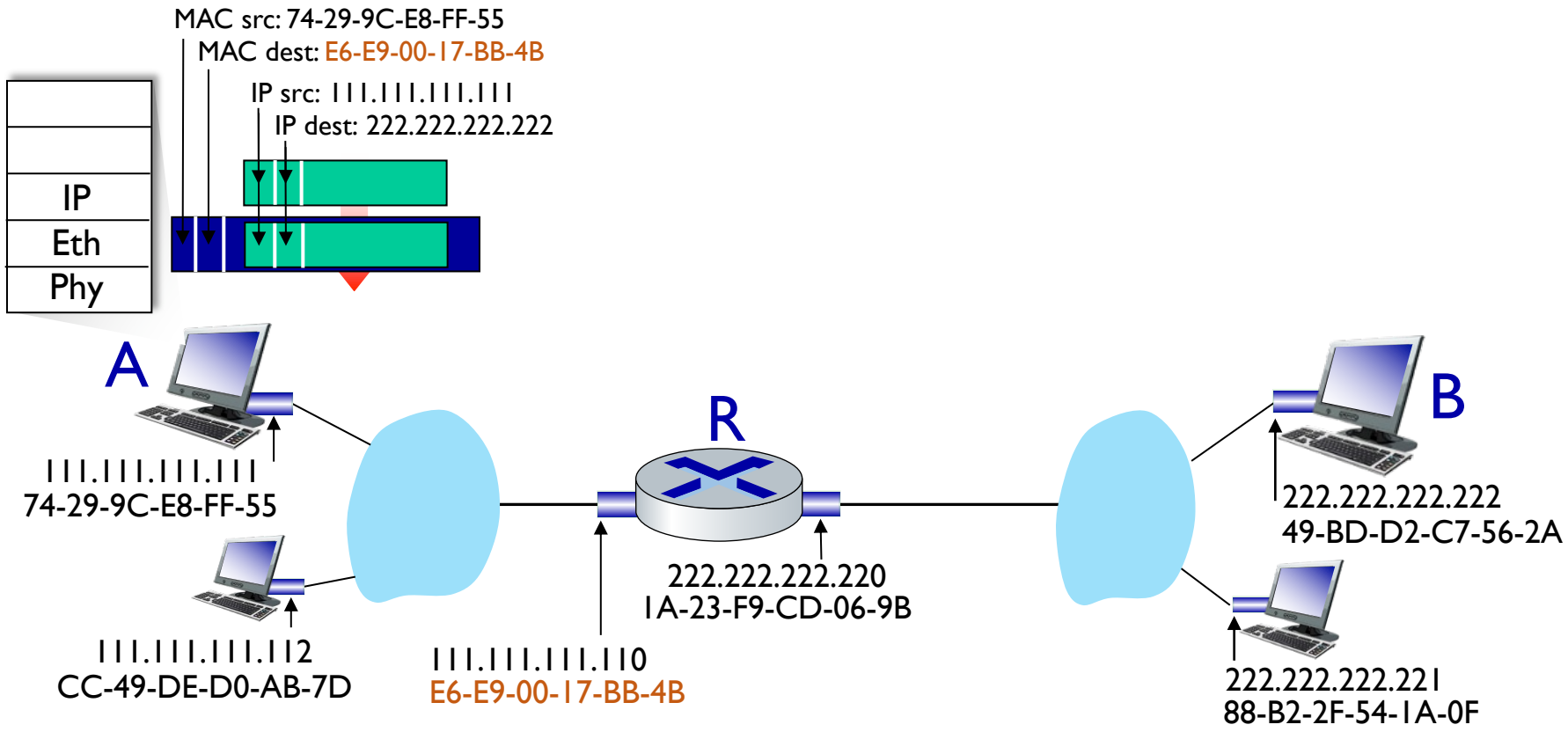
Sending a datagram from A to B via R

- assume that:
  - A knows B's IP address (how?)
  - A knows IP address of first hop router, R (how?)
  - A knows R's MAC address (how?)



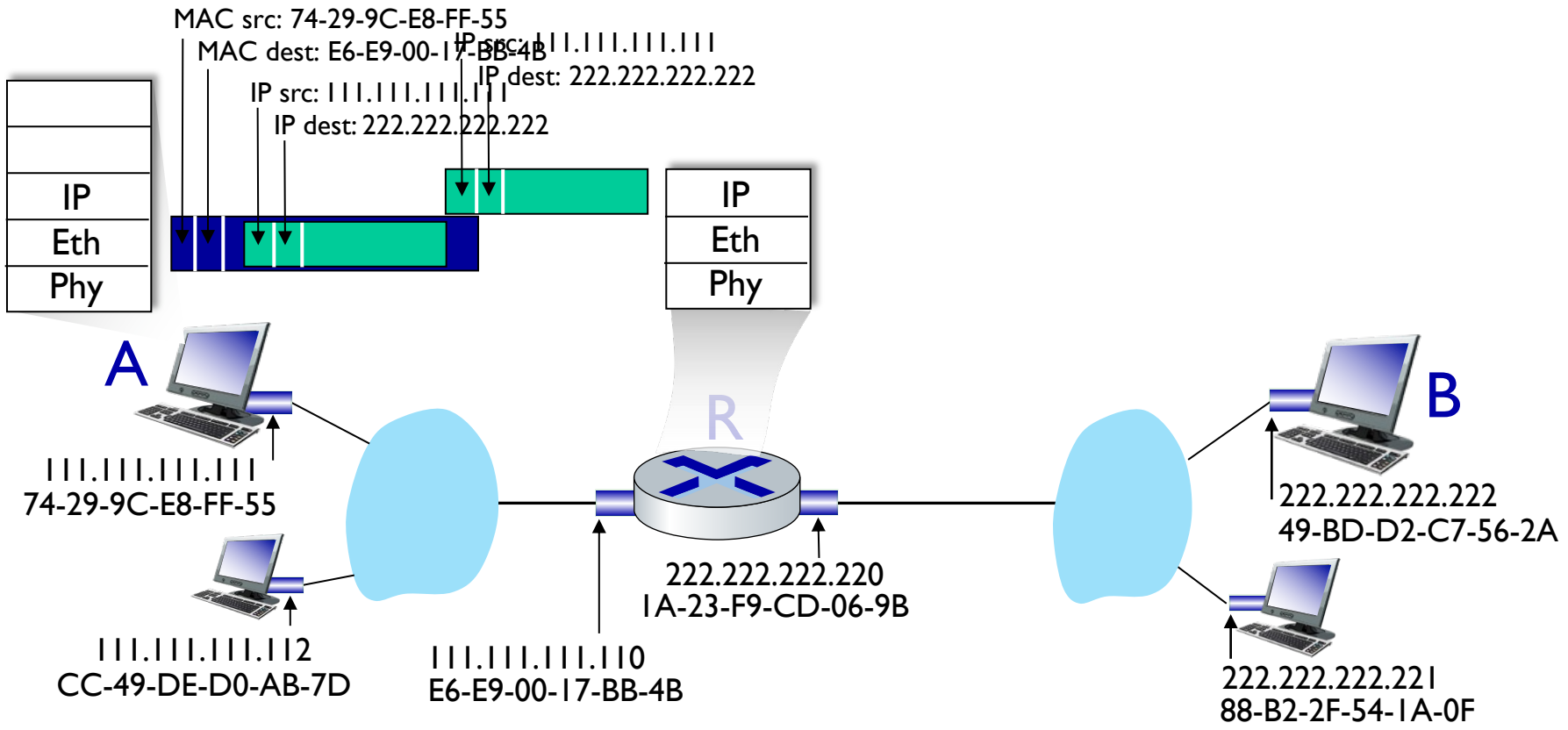
Routing to another subnet with addressing

- A creates IP datagram with IP source A, destination B
- A creates link-layer frame containing A-to-B IP datagram
  - R's MAC address is frame's destination



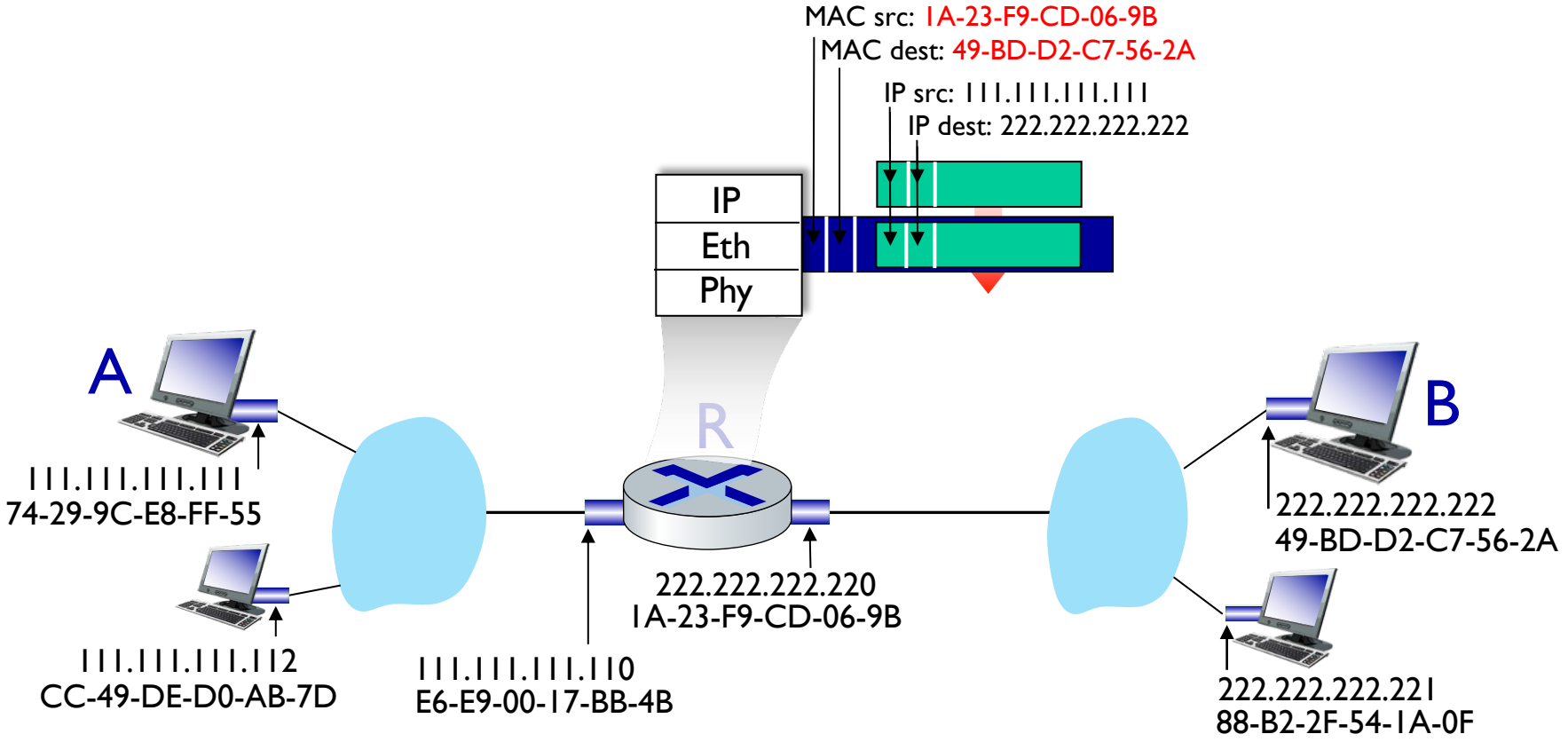
Routing to another subnet with addressing

- frame sent from A to R
- frame received at R, datagram removed, passed up to IP



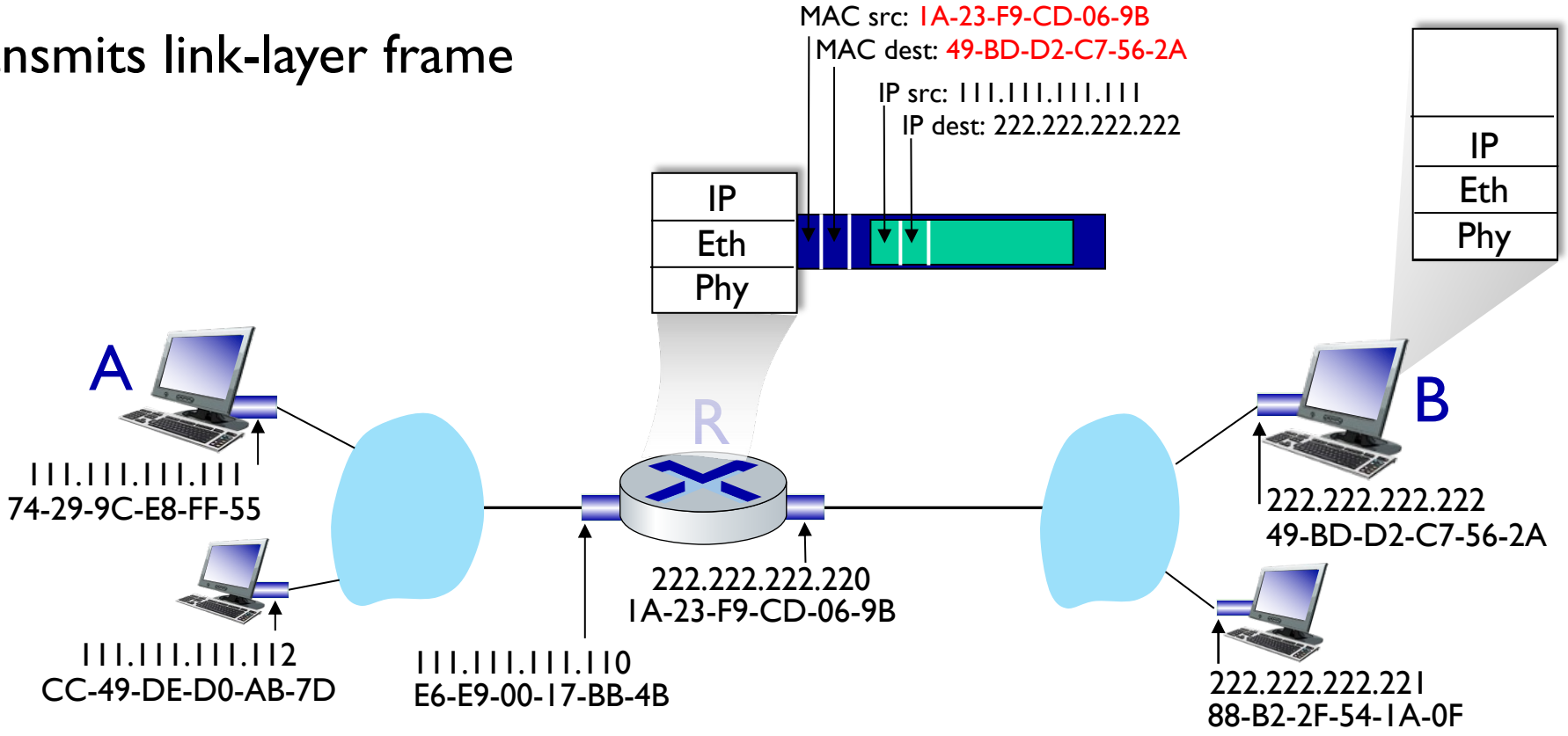
Routing to another subnet with addressing

- R determines outgoing interface, passes datagram with IP source A, destination B to link layer
- R creates link-layer frame containing A-to-B IP datagram.
  Frame destination address: B's MAC address



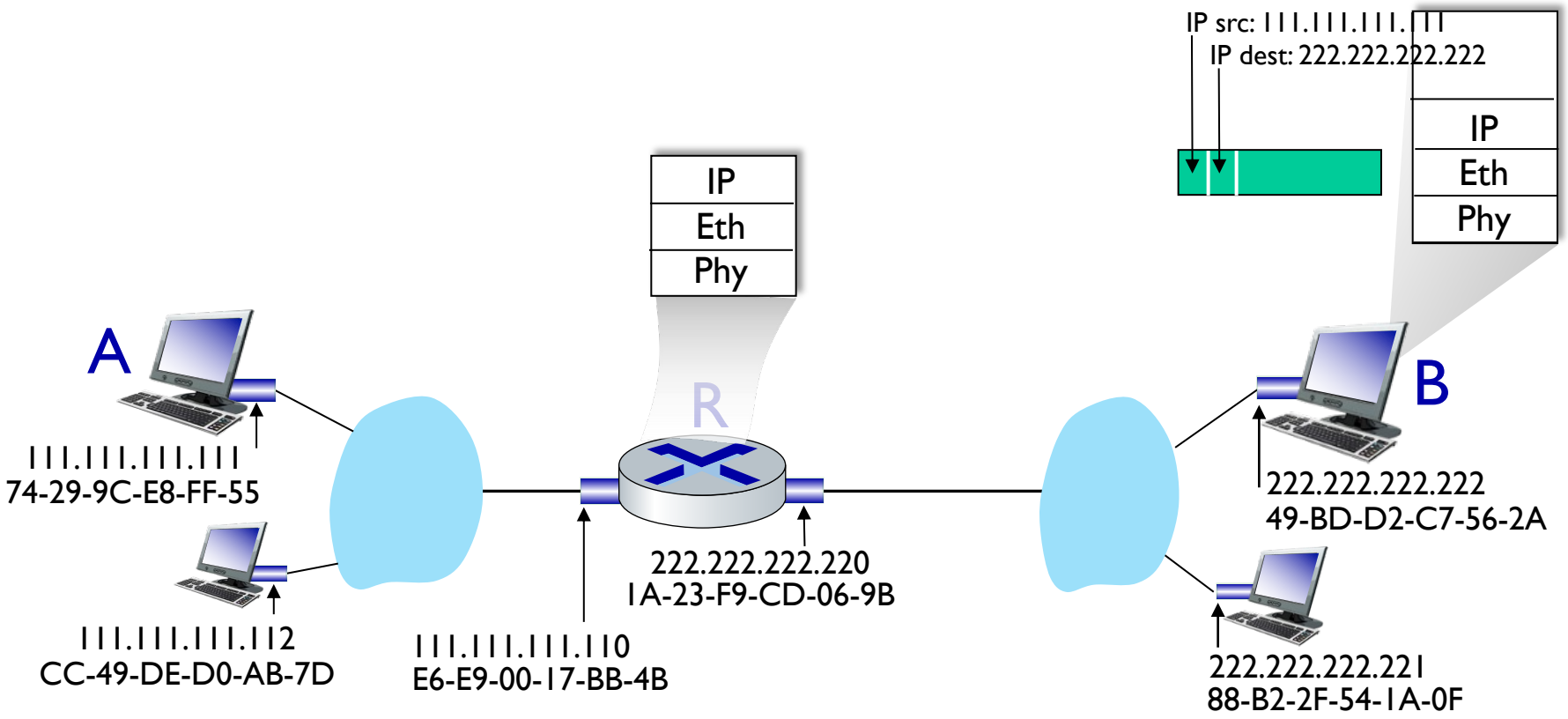
Routing to another subnet with addressing

- R determines outgoing interface, passes datagram with IP source A, destination B to link layer
- R creates link-layer frame containing A-to-B IP datagram. Frame destination address: B's MAC address
- transmits link-layer frame



Routing to another subnet with addressing

- B receives frame, extracts IP datagram destination B
- B passes datagram up protocol stack to IP



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3. Link Layer Address vs IP Address
4. How to share among multiple users in link layer?

Multiple Access Control