

# Chapter 5

## Link Layer

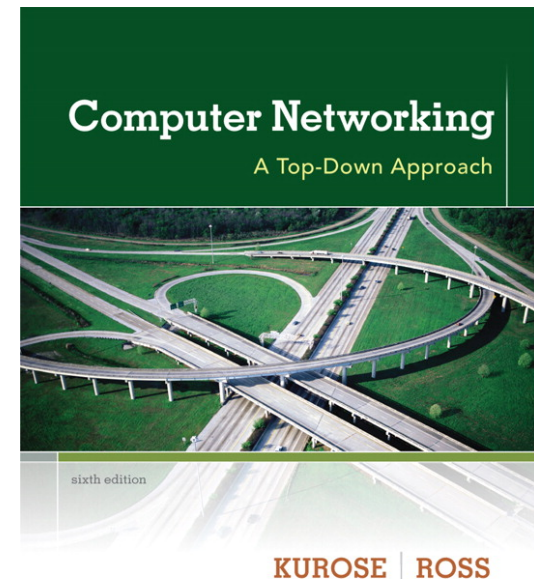
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Thanks and enjoy! JFK/KWR

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*Computer  
Networking: A Top  
Down Approach  
6<sup>th</sup> edition  
Jim Kurose, Keith Ross  
Addison-Wesley  
March 2012*

# MAC addresses and ARP

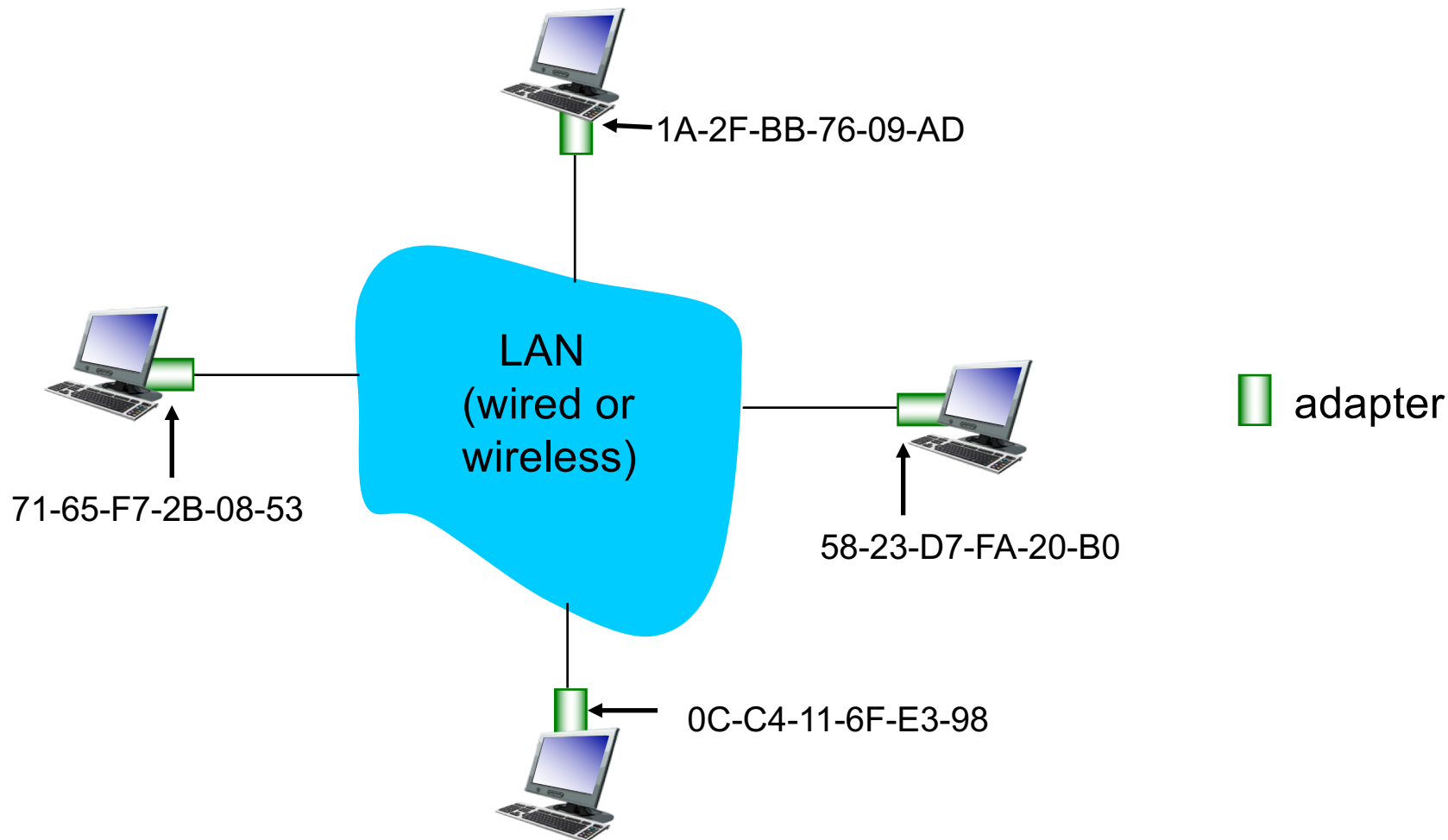
- ❖ 32-bit IP address:
  - *network-layer* address for interface
  - used for layer 3 (network layer) forwarding
- ❖ MAC (or LAN or physical or Ethernet) address:
  - function: *used ‘locally’ to get frame from one interface to another physically-connected interface (same network, in IP-addressing sense)*
  - 48 bit MAC address (for most LANs) burned in NIC ROM, also sometimes software settable
  - e.g.: 1A-2F-BB-76-09-AD

/

hexadecimal (base 16) notation  
(each “number” represents 4 bits)

# LAN addresses and ARP

each adapter on LAN has unique **LAN** address



# LAN addresses (more)

- ❖ MAC address allocation administered by IEEE
- ❖ manufacturer buys portion of MAC address space (to assure uniqueness)
- ❖ analogy:
  - MAC address: like Social Security Number
  - IP address: like postal address
- ❖ MAC flat address → portability
  - can move LAN card from one LAN to another
- ❖ IP hierarchical address *not* portable
  - address depends on IP subnet to which node is attached

# ARP: address resolution protocol

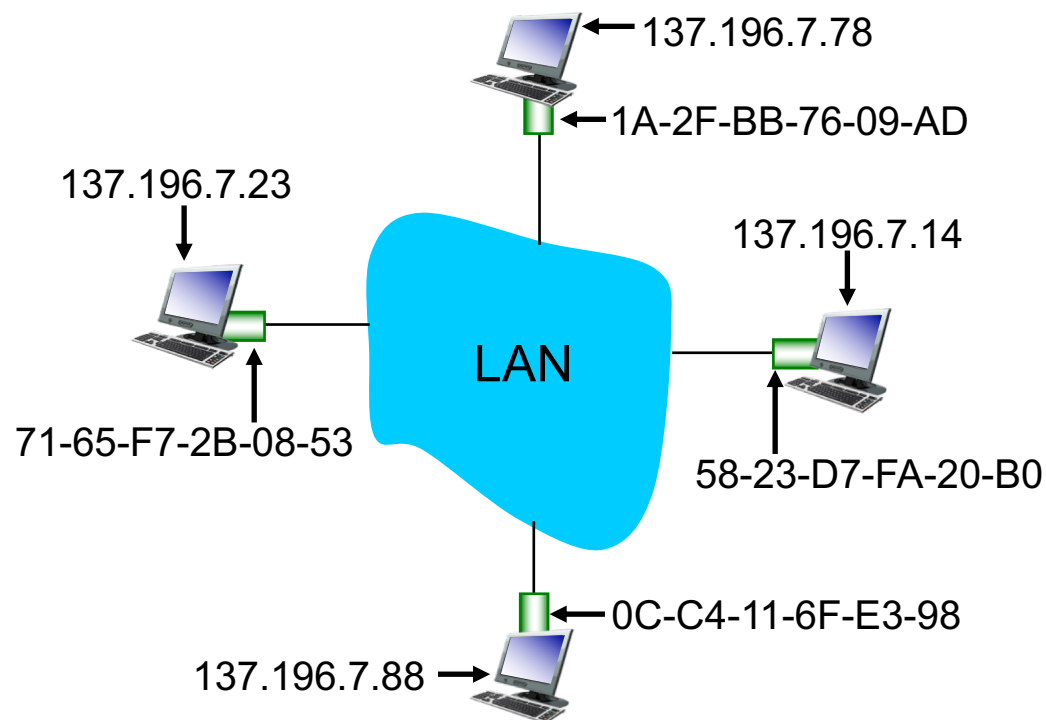
*Question:* how to determine interface's MAC address, knowing its IP address?

*ARP table:* each IP node (host, router) on LAN has table

- IP/MAC address mappings for some LAN nodes:

< IP address; MAC address; TTL >

- TTL (Time To Live): time after which address mapping will be forgotten (typically 20 min)



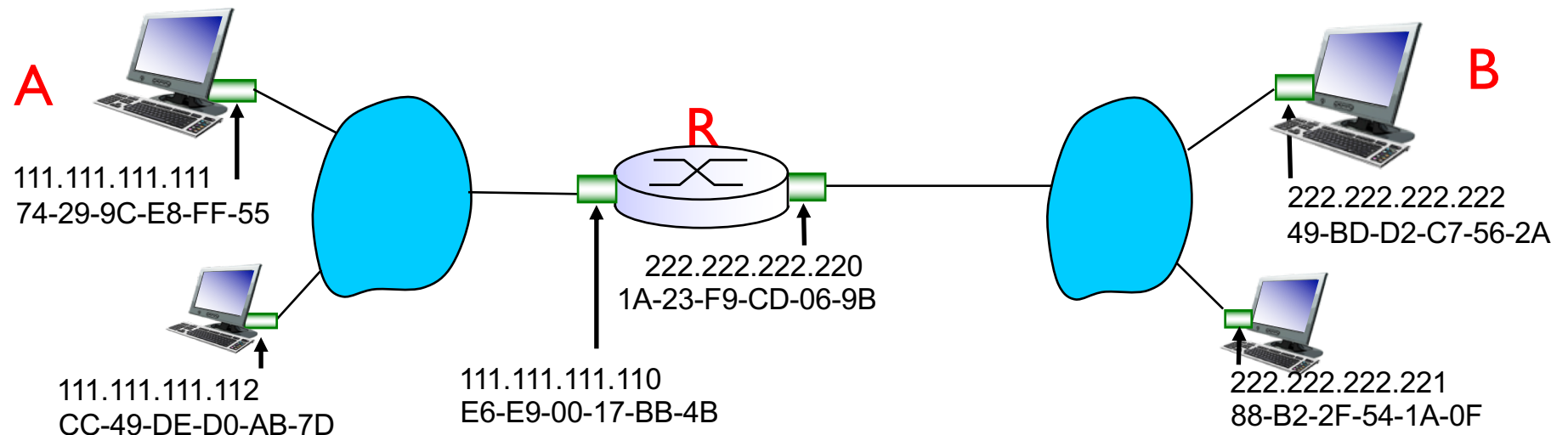
# ARP protocol: same LAN

- ❖ A wants to send datagram to B
  - B's MAC address not in A's ARP table.
- ❖ A **broadcasts** ARP query packet, containing B's IP address
  - dest MAC address = FF-FF-FF-FF-FF-FF
  - all nodes on LAN receive ARP query
- ❖ B receives ARP packet, replies to A with its (B's) MAC address
  - frame sent to A's MAC address (unicast)
- ❖ A caches (saves) IP-to-MAC address pair in its ARP table until information becomes old (times out)
  - soft state: information that times out (goes away) unless refreshed
- ❖ ARP is “plug-and-play”:
  - nodes create their ARP tables *without intervention from net administrator*

# Addressing: routing to another LAN

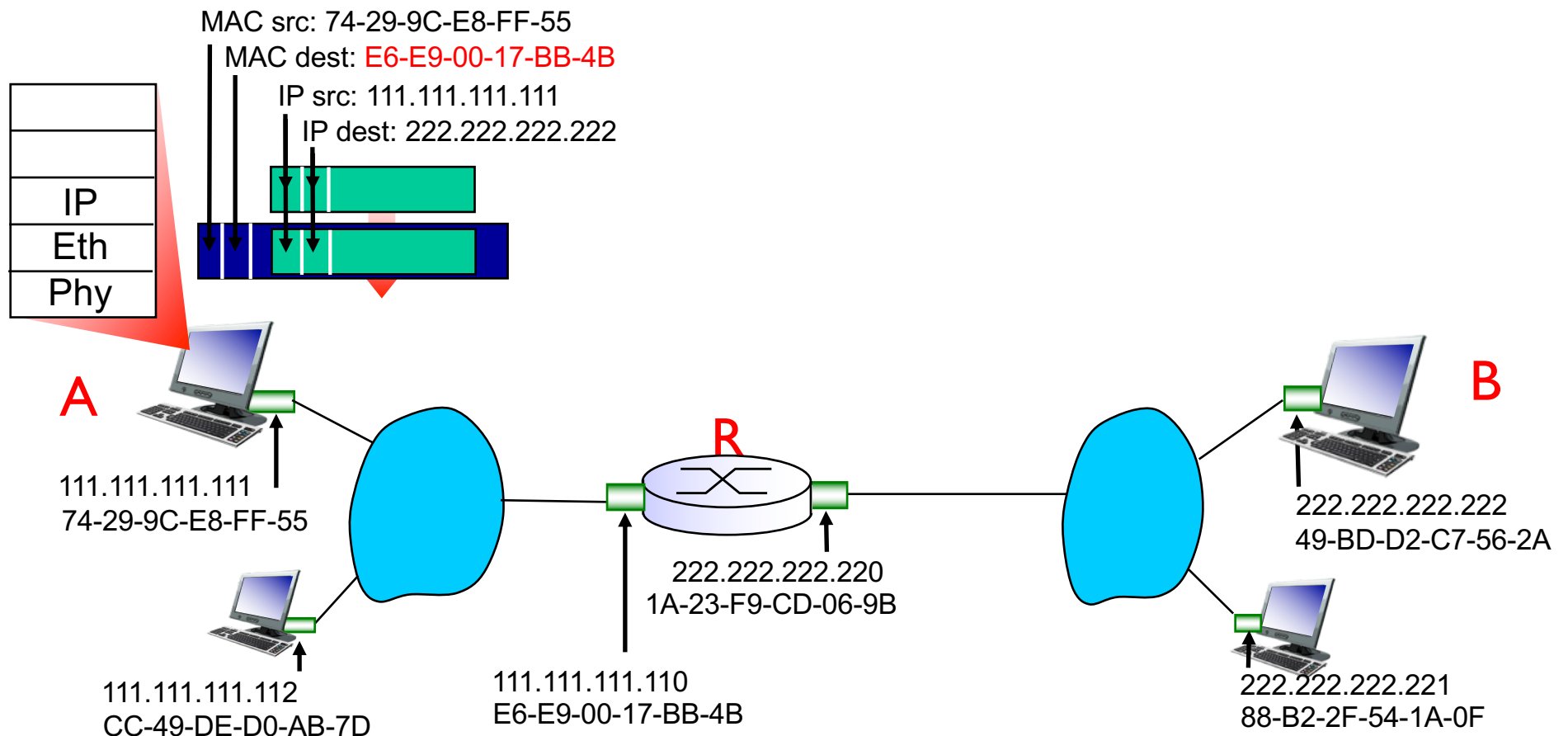
walkthrough: **send datagram from A to B via R**

- focus on addressing – at IP (datagram) and MAC layer (frame)
- assume A knows B's IP address
- assume A knows IP address of first hop router, R (how?)
- assume A knows R's MAC address (how?)



# Addressing: routing to another LAN

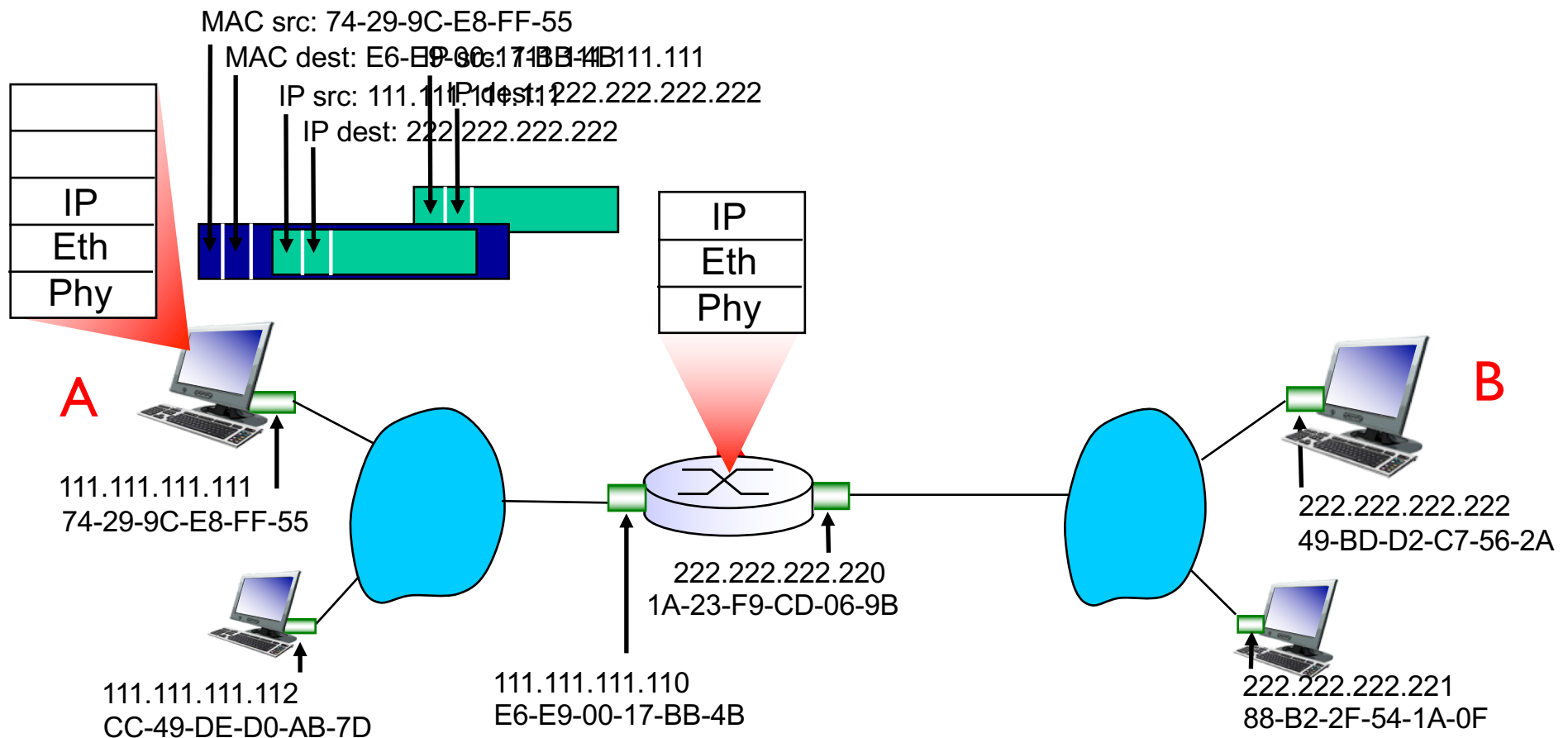
- ❖ A creates IP datagram with IP source A, destination B
- ❖ A creates link-layer frame with R's MAC address as dest, frame contains A-to-B IP datagram





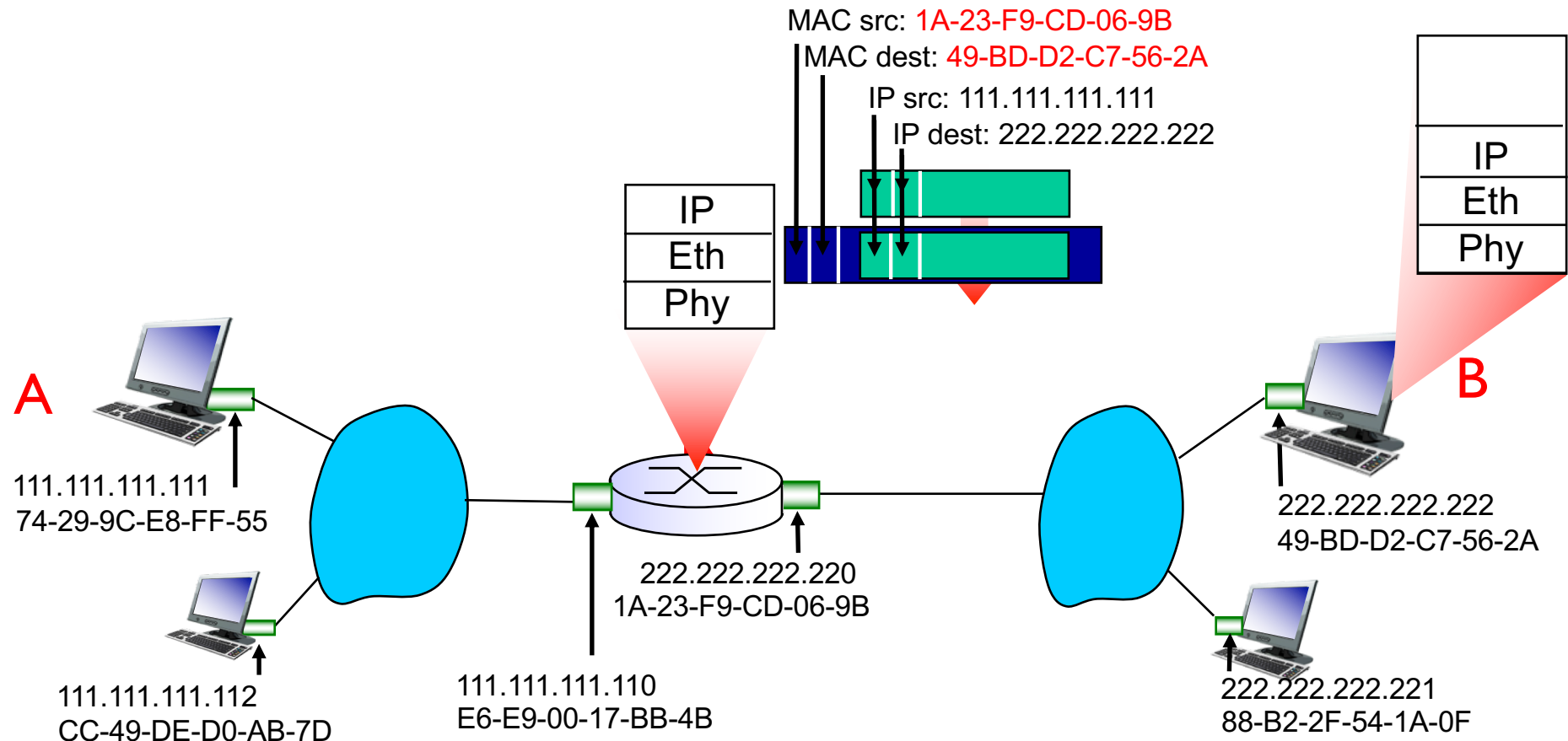
# Addressing: routing to another LAN

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



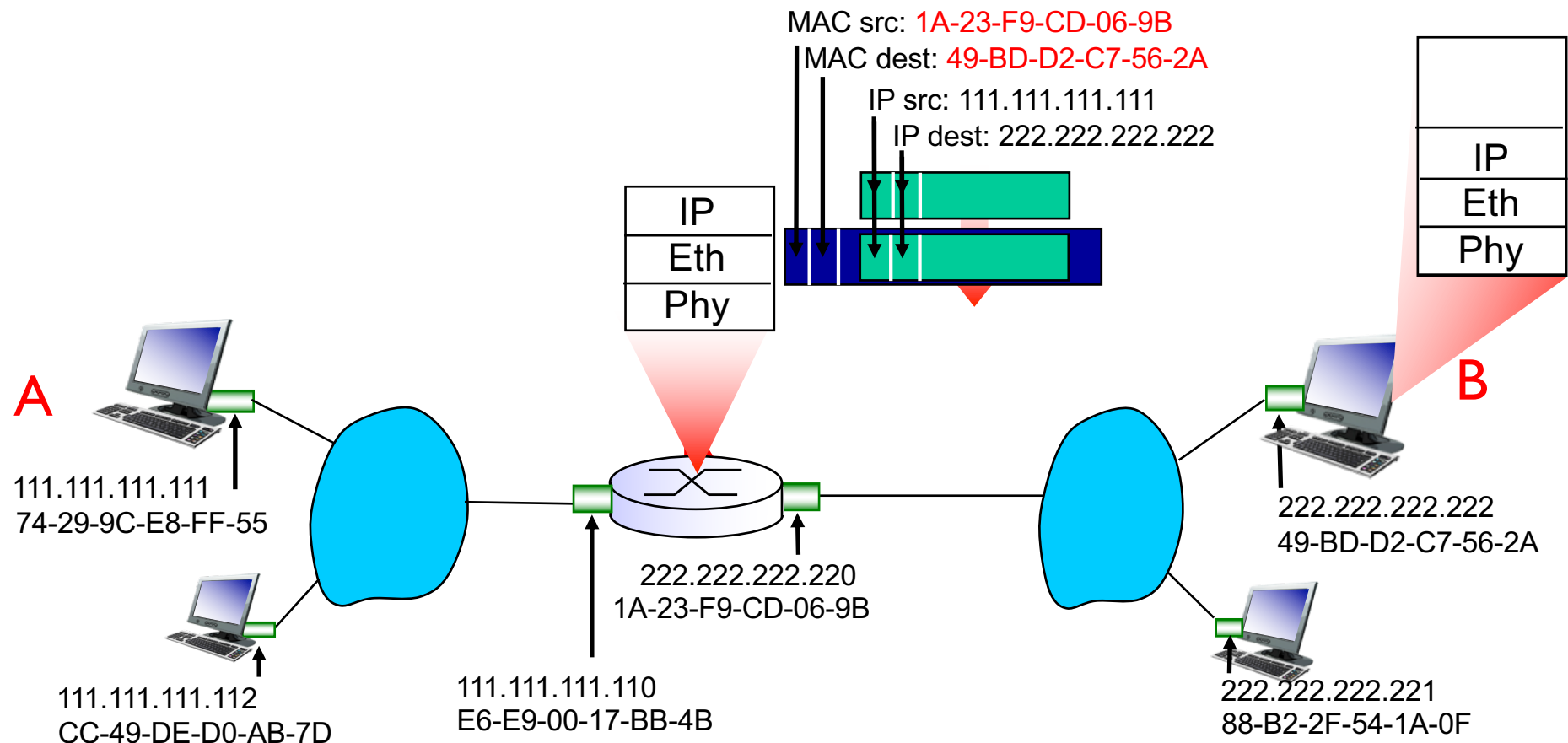
# Addressing: routing to another LAN

- ❖ R forwards datagram with IP source A, destination B
- ❖ R creates link-layer frame with B's MAC address as dest, frame contains A-to-B IP datagram



# Addressing: routing to another LAN

- ❖ R forwards datagram with IP source A, destination B
- ❖ R creates link-layer frame with B's MAC address as dest, frame contains A-to-B IP datagram



# Addressing: routing to another LAN

- ❖ R forwards datagram with IP source A, destination B
- ❖ R creates link-layer frame with B's MAC address as dest, frame contains A-to-B IP datagram

