

Address Resolution Protocol



Types of Addresses in Internet

- Media Access Control (MAC) addresses in the network access layer
 - Associated w/ network interface card (NIC)
 - 48 bits or 64 bits
- IP addresses for the network layer
 - 32 bits for IPv4, and 128 bits for IPv6
 - E.g., 123.4.56.7
- IP addresses + ports for the transport layer
 - E.g., 123.4.56.7:80
- Domain names for the application/human layer
 - E.g., www.google.com



IP and MAC Working Together

- *IP addresses are chosen by the local system administrator to suit the local network.*
- *Ethernet addresses are built into the interface hardware by the manufacturer.*
- The two addresses bear absolutely no relationship to one another (as we would expect from the layering principles).



Why?

- Computers need MAC addresses!
- If not – We couldn't use physical layer to send IP packets: we won't know where a particular IP packet should physically be sent.



Translation of Addresses

- Translation between IP addresses and MAC addresses
 - Address Resolution Protocol (ARP) for IPv4
 - Neighbor Discovery Protocol (NDP) for IPv6
- Translation between IP addresses and domain names (Domain Name System (DNS))



ARP Basics

- The Address Resolution Protocol (ARP)
- Usually considered to be a part of the link layer
- The physical layer has (e.g., 6 byte Ethernet) addresses, while the network layer has independent (4 byte) IP addresses



ARP Introduction

- Primarily used to translate IP addresses to Ethernet MAC addresses
 - The device driver for Ethernet NIC needs to do this to send a packet
- Also used for IP over other LAN technologies, e.g., **FDDI**, or **IEEE 802.11**

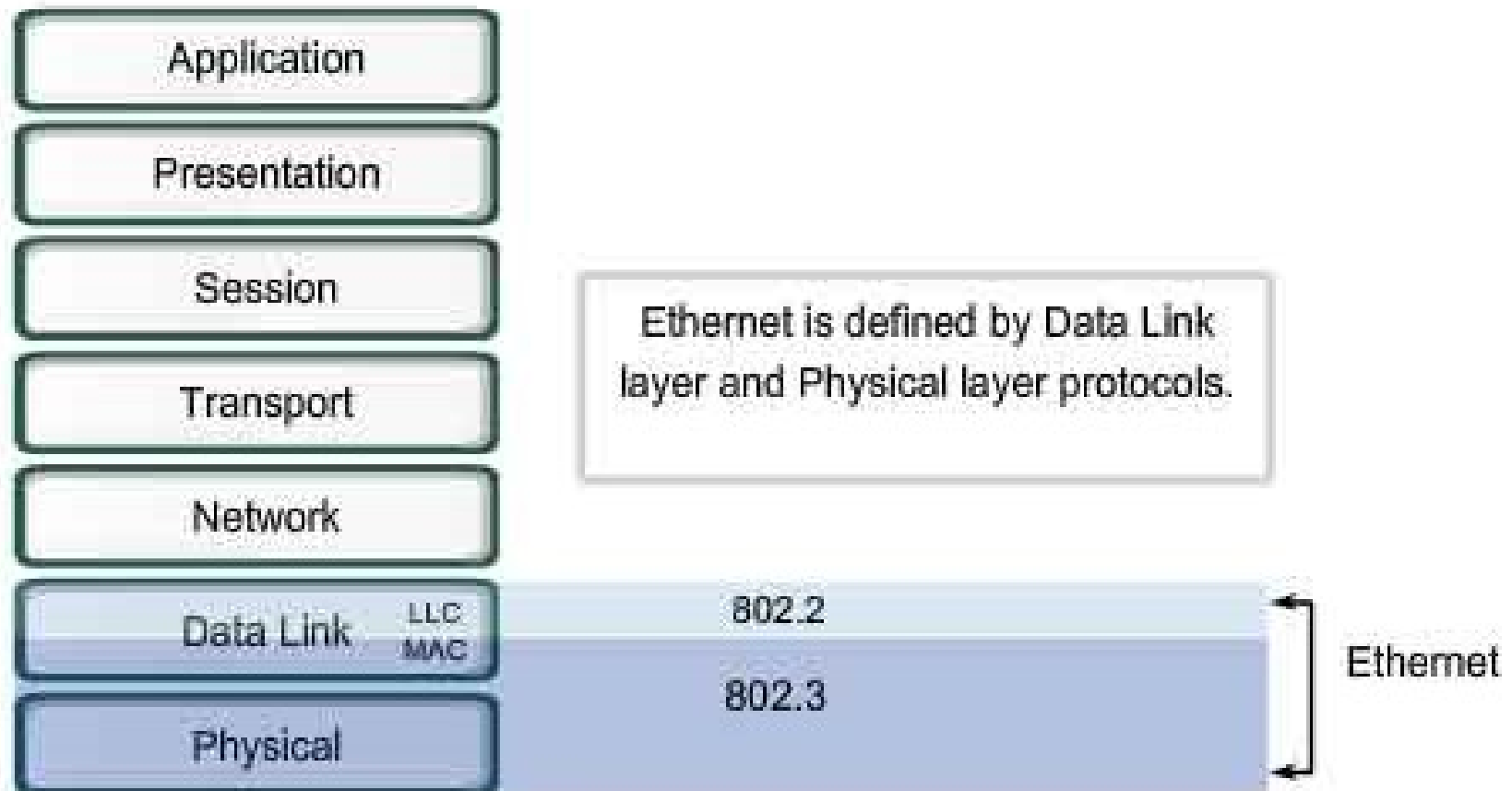


What is ARP used for?

- Suppose want to send a packet over (say) an Ethernet.
- We only know the destination's IP address to build the Ethernet frame we have to know the Ethernet address that the destination has.
- This is what ARP does: Find the hardware address corresponding to an IP address



Ethernet

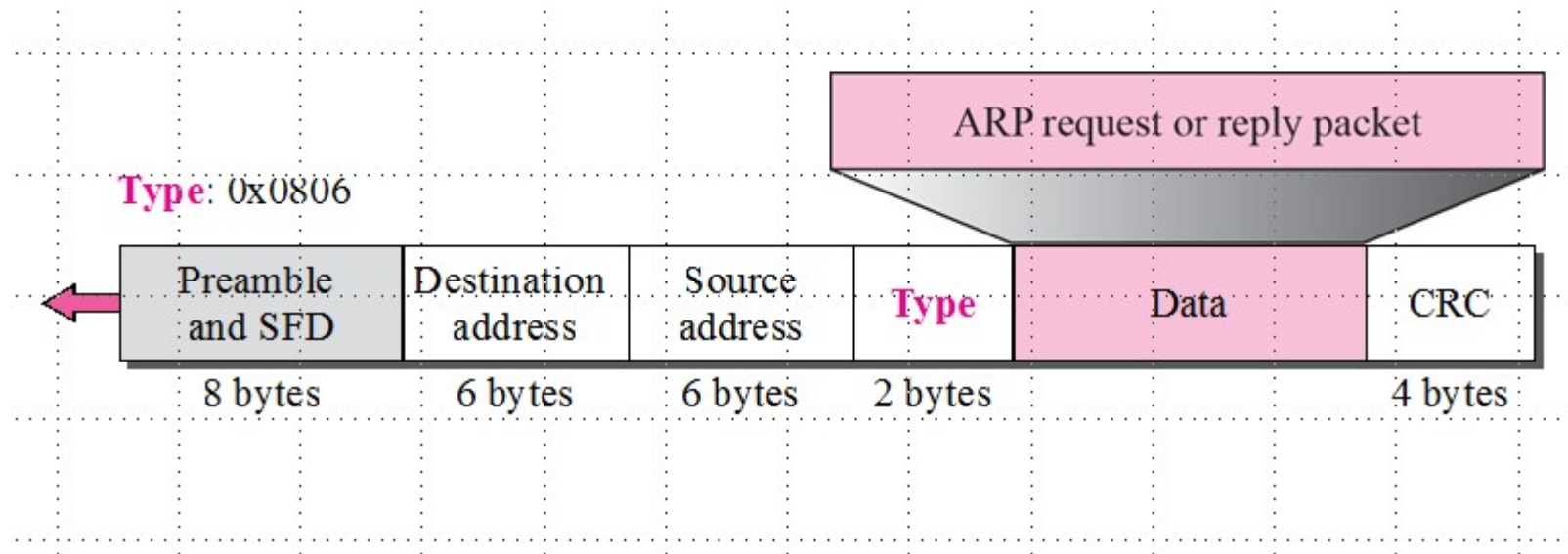


ARP Packet

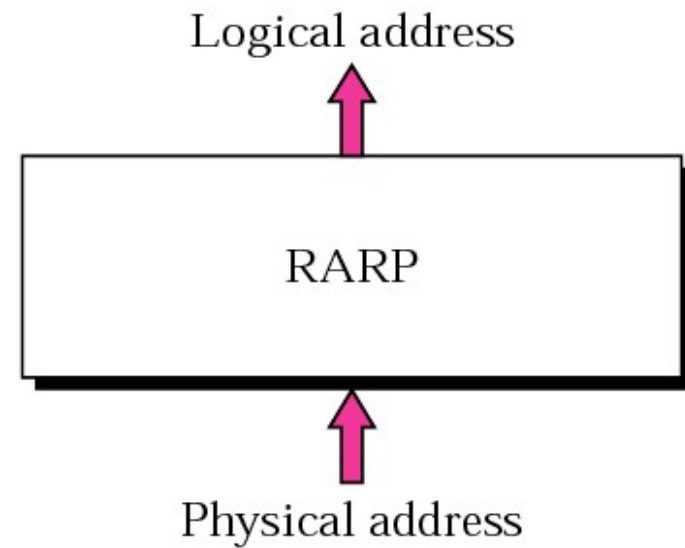
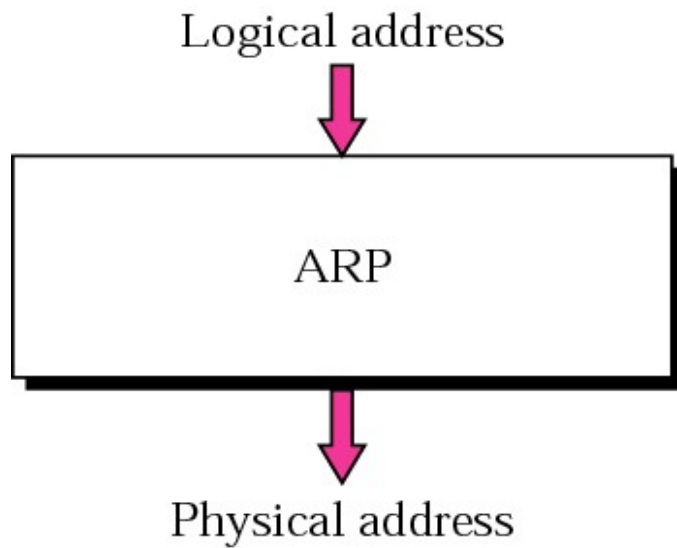
Hardware Type		Protocol Type
Hardware length	Protocol length	Operation Request 1, Reply 2
Sender hardware address (For example, 6 bytes for Ethernet)		
Sender protocol address (For example, 4 bytes for IP)		
Target hardware address (For example, 6 bytes for Ethernet) (It is not filled in a request)		
Target protocol address (For example, 4 bytes for IP)		

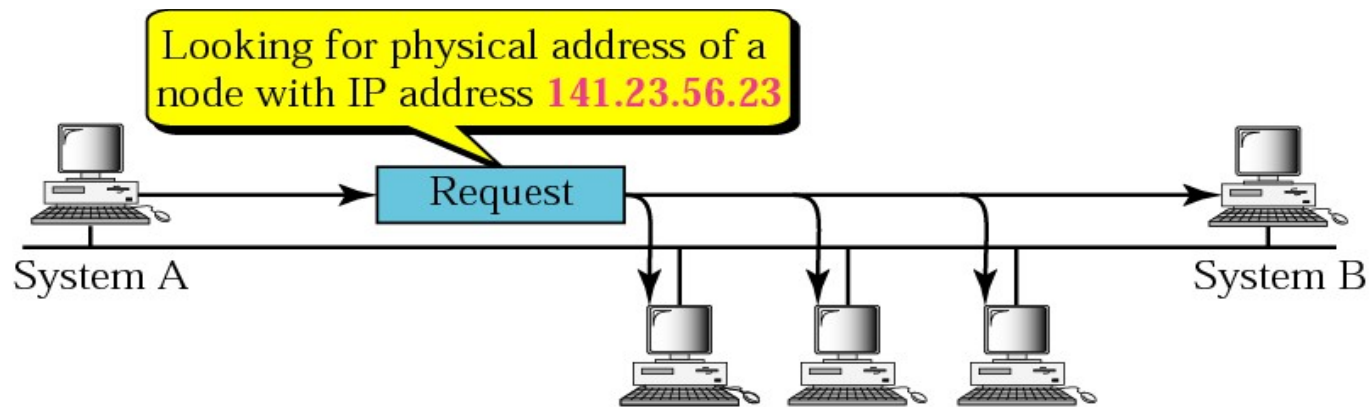


Encapsulation of ARP packet

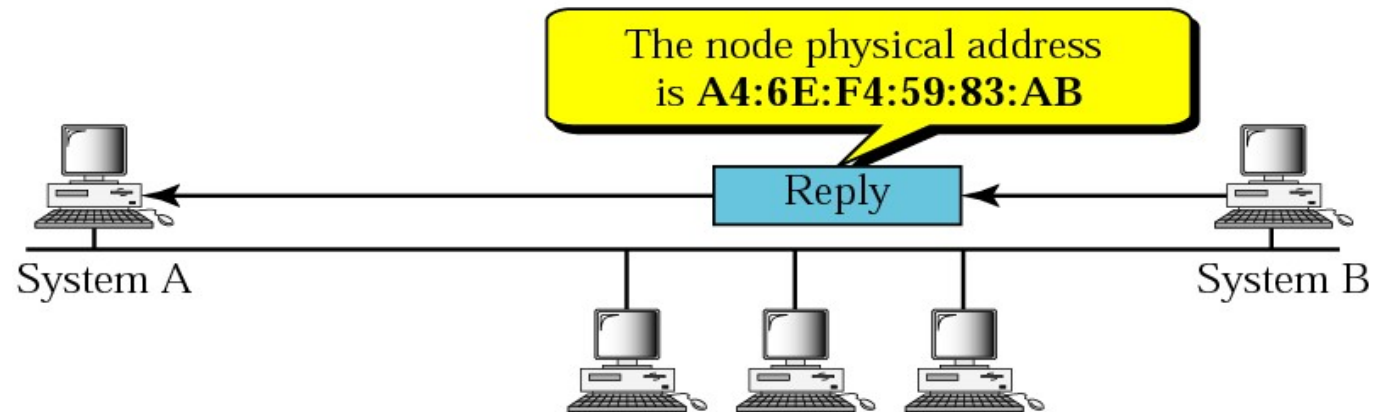


ARP Vs RARP

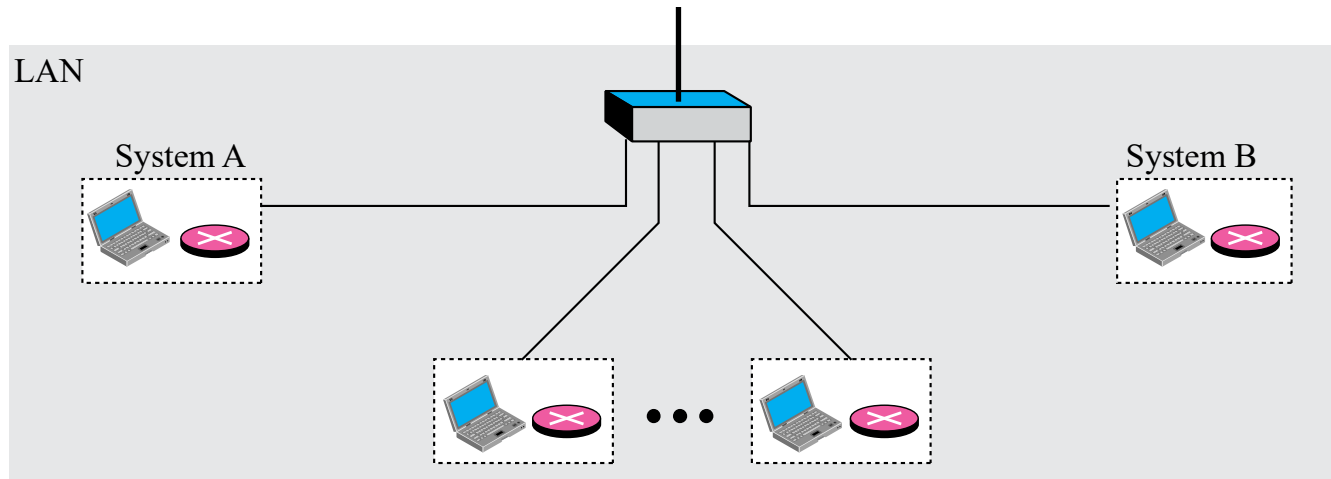




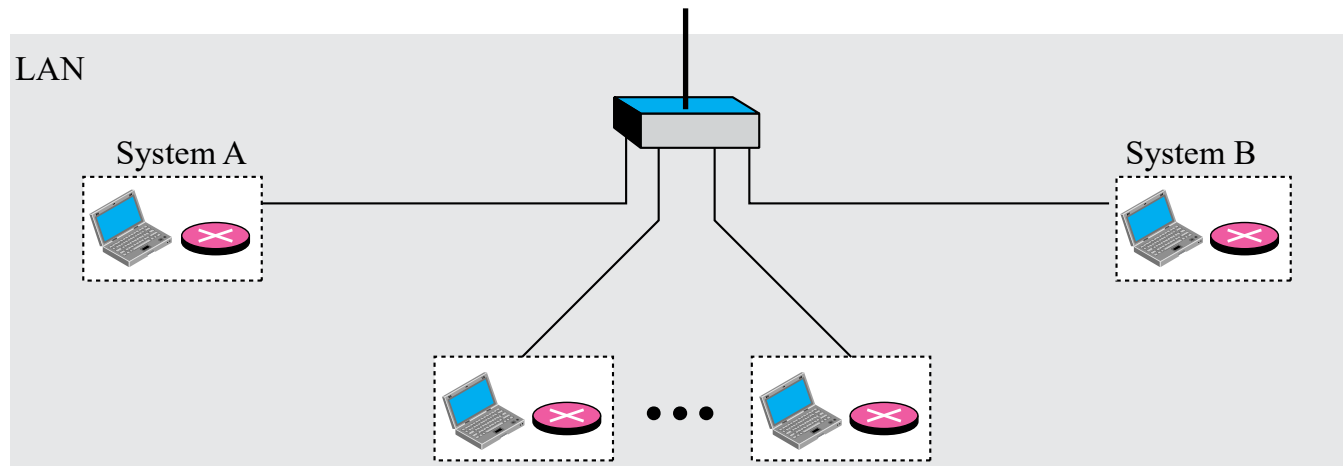
a. ARP request is broadcast



b. ARP reply is unicast



a. ARP request is multicast



b. ARP reply is unicast

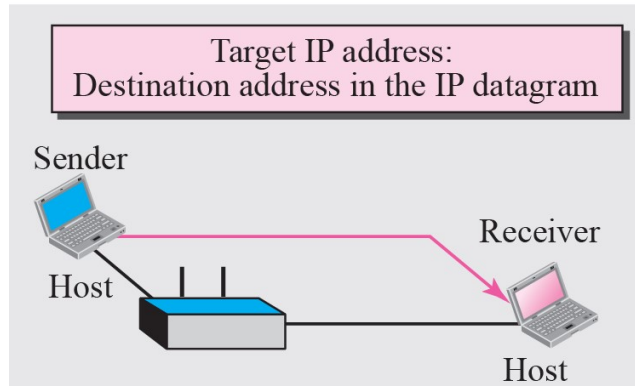
Note

*An ARP request is broadcast;
an ARP reply is unicast.*

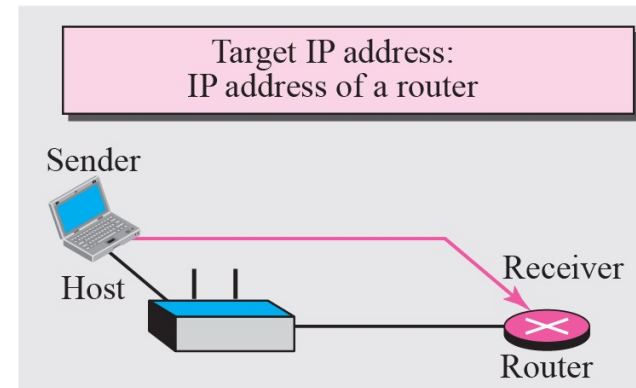


Four cases using ARP

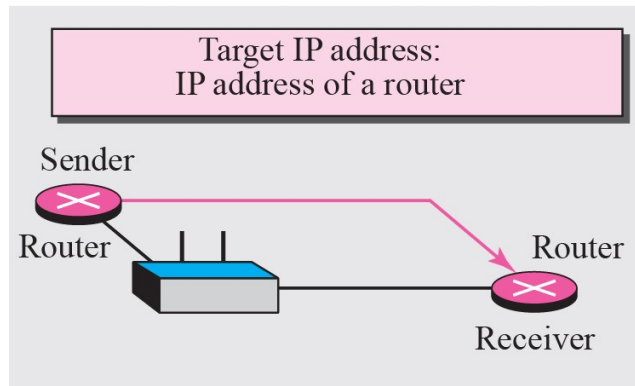
Case 1: A host has a packet to send to a host on the same network.



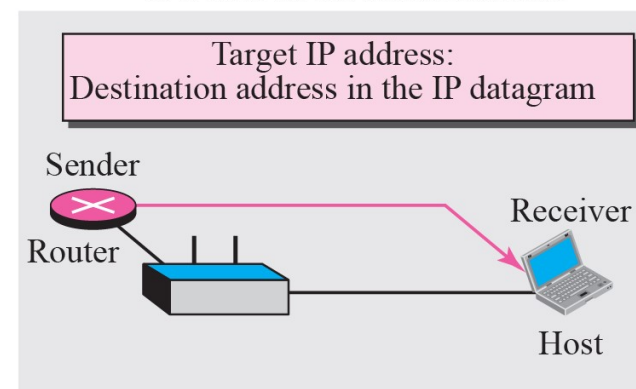
Case 2: A host has a packet to send to a host on another network.



Case 3: A router has a packet to send to a host on another network.



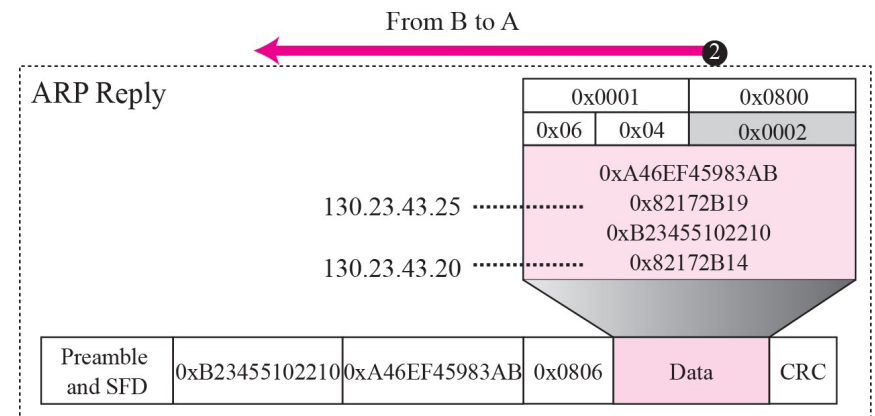
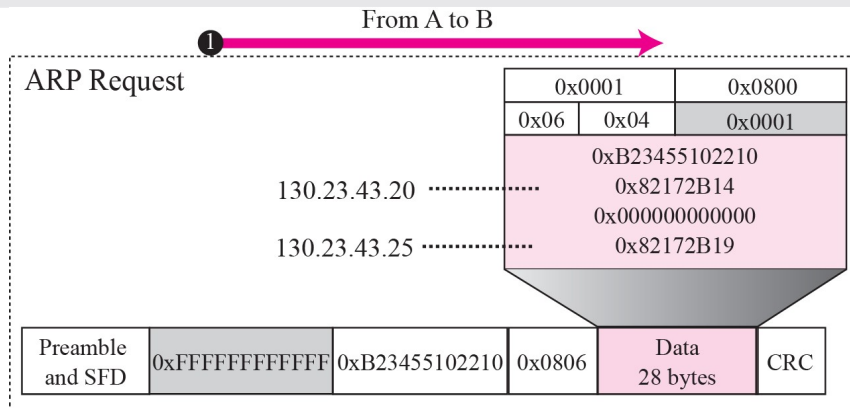
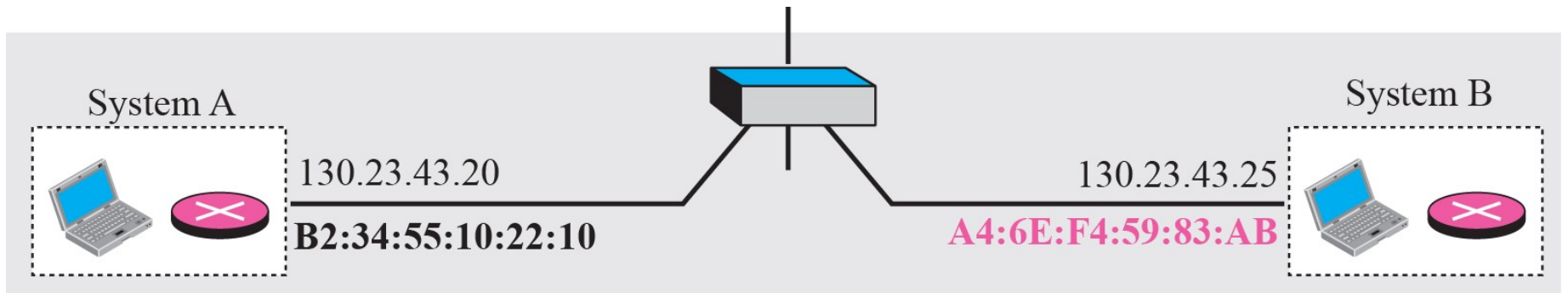
Case 4: A router has a packet to send to a host on the same network.



Example

- A host with IP address 130.23.43.20 and physical address B2:34:55:10:22:10 has a packet to send to another host with IP address 130.23.43.25 and physical address A4:6E:F4:59:83:AB. The two hosts are on the same Ethernet network. Show the ARP request and reply packets encapsulated in Ethernet frames.
- *Solution*
- Figure shows the ARP request and reply packets. Note that the ARP data field in this case is 28 bytes, and that the individual addresses do not fit in the 4-byte boundary. That is why we do not show the regular 4-byte boundaries for these addresses. Also note that the IP addresses are shown in hexadecimal.





ARP Cache

- ▶ For every outgoing packet sending ARP request and waiting for responses is inefficient
- ▶ Requires more bandwidth
- ▶ Consumes Time
- ▶ ARP cache maintained at each node
- ▶ Size limit = 512 entries (timer)



Cache Table

- Each host maintains a table of IP to MAC addresses
- Message types:
 - ARP request
 - ARP reply
 - ARP announcement

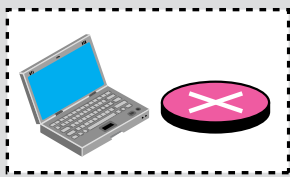
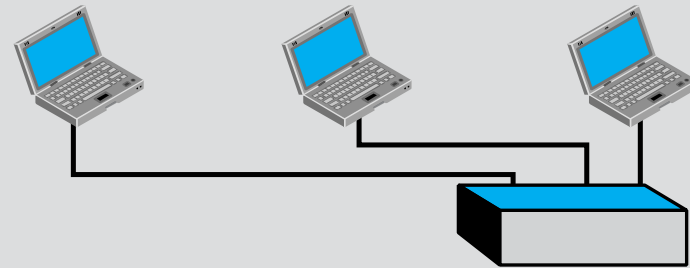


Proxy ARP

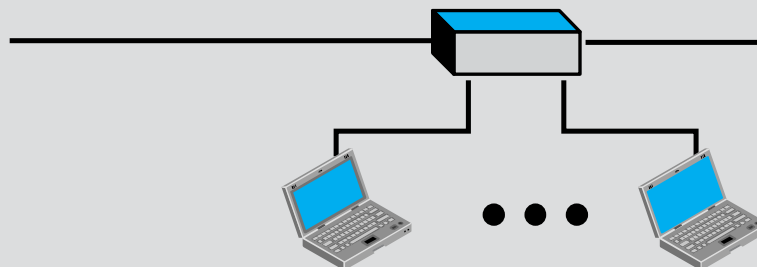
The proxy ARP router replies to any ARP request received for destinations 141.23.56.21, 141.23.56.22, and 141.23.56.23.

Added subnetwork

141.23.56.21 141.23.56.22 141.23.56.23



Router or host



Proxy ARP
router

ssn