ARP and RARP

Outline

- ARP
- ARP Package
- RARP

Logical Addresses

The hosts and routers are recognized at the network level by their *logical addresses*

- A **logical address is an internet address**
- Called a *logical address because it is usually* implemented in software.
- The logical addresses in the TCP/IP are called **IP address and are 32 bits long**

Physical Address

However, hosts/routers are recognized at the physical layer by their *physical address*

A **physical address is an local address**

Called a *physical address because it is usually* implemented in hardware

Example:
48-bit MAC (Media Access Control) addresses in Ethernet

Translation

- We need both the physical address and the logical address for packet delivery
- Thus, we need to be able to map a logical address to its corresponding physical address and vice versa
- Solutions:
  - ***Static mapping***
  - ***Dynamic mapping***

Static Mapping

- Create a table that associates a logical address with a

  physical address and store in each machine
- However, physical addresses may change
- A machine could change its NIC resulting in a new physical address

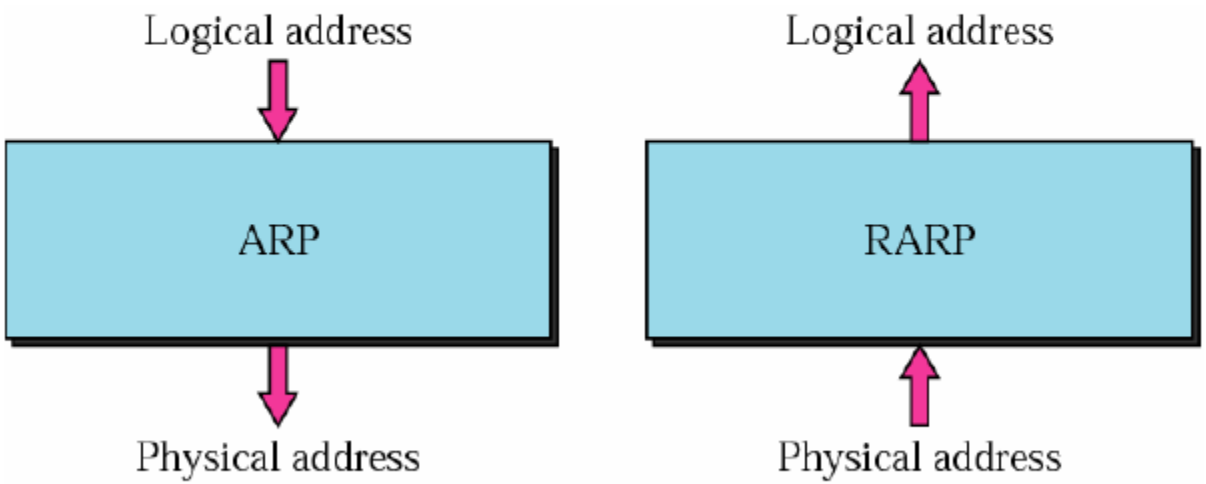
Dynamic Mapping

- Use a protocol to find another address
- **ARP**: Address Resolution Protocol

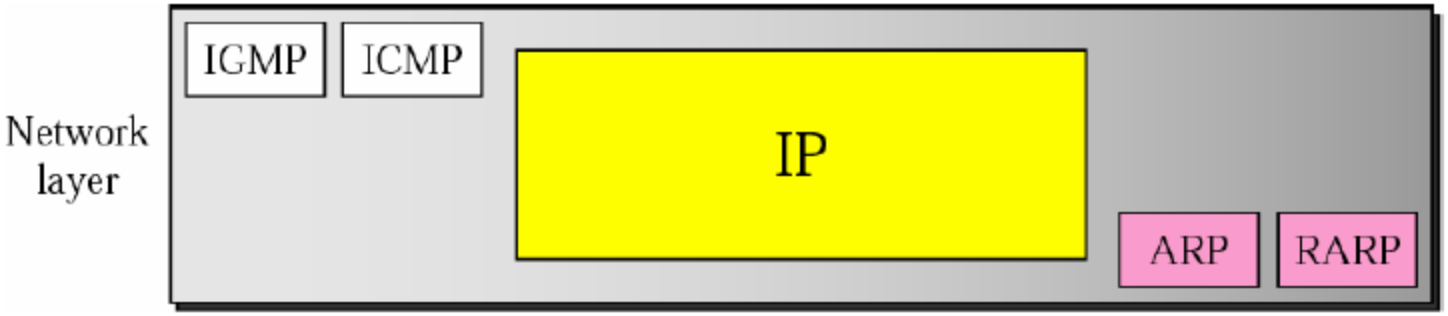
  Map a logical address to a physical address
- **RARP**: Reverse Address Resolution Protocol

  Map a physical address to a logical address

ARP and RARP


Logical address
ARP
Physical address
Logical address
RARP
Physical address

Position of ARP and RARP in TCP/IP Protocol Suite



A R P

ARP Operation

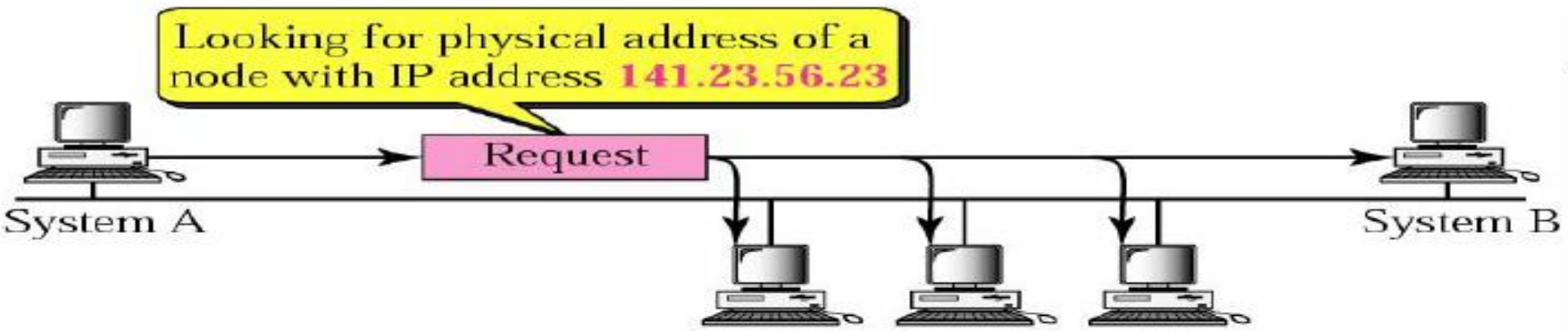
- To find the physical address of another host or router on its network
  - Send an ARP request message

- ARP request message
  - The physical address of the sender
  - The IP address of the sender
  - The physical address of the receiver is ***0s***
  - The IP address of the receiver

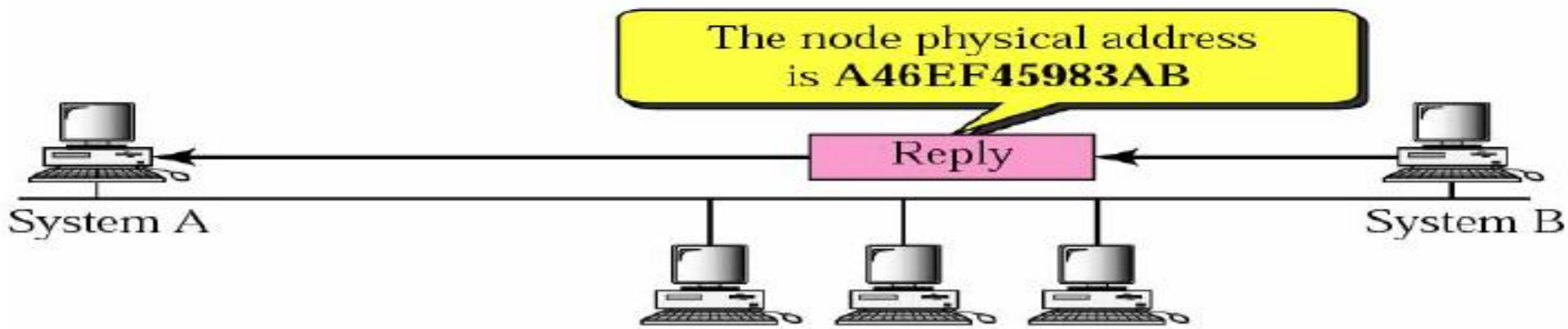
ARP Operation (Cont.)

- Then, ARP request message is broadcast by the physical layer
  - For example: in Ethernet, MAC header's destination address is all *1s (broadcast address)*
  - Received by every station on the physical network
- The intended recipient send back an ARP reply message
  - ARP reply message packet is ***unicast***

ARP Operation (Cont.)



a. ARP request is broadcast



b. ARP reply is unicast

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)		

Packet Format

- **HTYPE** (Hardware type):
  - 16-bit field defining the underlying type of the network
    - Ethernet is given the type 1
    - ARP can be used on any physical network

- **PTYPE** (Protocol type)
  - 16-bit field defining the protocol
    - IPv4 is 0x(0800)
    - ARP can be used with any higher-level protocol
- **HLEN** (Hardware length)
  - 8-bit field defining the length of the physical address in bytes
    - Ethernet has the value of 6

- **PLEN** (Protocol length)
  - 8-bit field defining the length of the logical address in bytes
    - IPv4 has the value of 4
- **OPER** (Operation)
  - 16-bit field defining the type of packet
    - (1) = ARP request, (2) = ARP reply

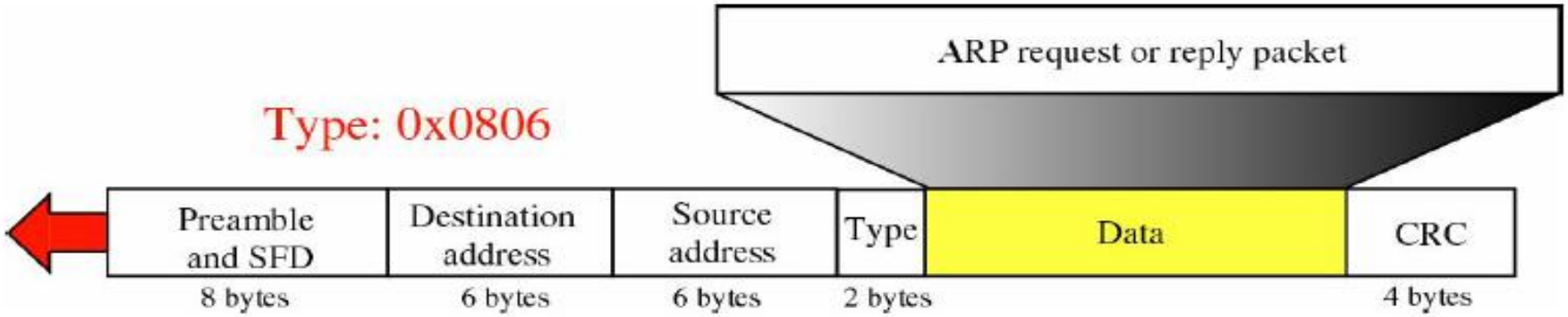
- **SHA** (Sender hardware address)
  - A variable-length field defining the physical address of the sender

- **SPA** (Sender protocol address)
  - A variable-length field defining the logical address of the sender

- **THA** (Target hardware address)
  - A variable-length field defining the physical address of the target
  - For an ARP request operation packet
    - ***This field is all 0s***
- **TPA** (Target protocol address)
  - A variable-length field defining the logical address of the target

Encapsulation of ARP Packet

- An ARP packet is encapsulated directly into a data link frame
- Type field indicates that the data carried by the frame is an ARP packet.



Operations

- The sender knows the target's IP address
- IP asks ARP to create an ARP request message:
  - The sender physical address
  - The sender IP address
  - The target physical address field is filled with 0s
  - The target IP address
- The message is passed to the data link layer to encapsulate in a data link frame
  - **Physical destination address is" *broadcast address"***

Operations (Cont.)

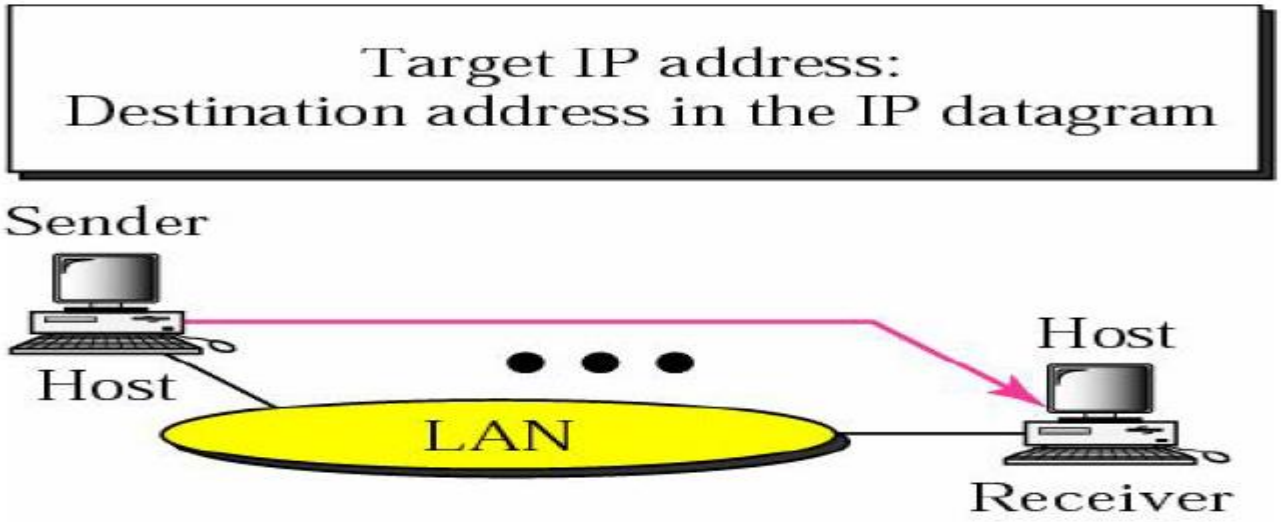
- Every host or routers receives the frame and since the destination address is broadcast, pass it to the ARP
  - All machines' ARP except the one targeted drop the Packet
- The target reply with an ARP reply message that contains its physical address and is unicast
- The sender receives the reply message and knows the target's physical address

Four Cases to Use ARP

- ***Case 1:***

  The sender is a host and wants to send a packet to another host on the same network

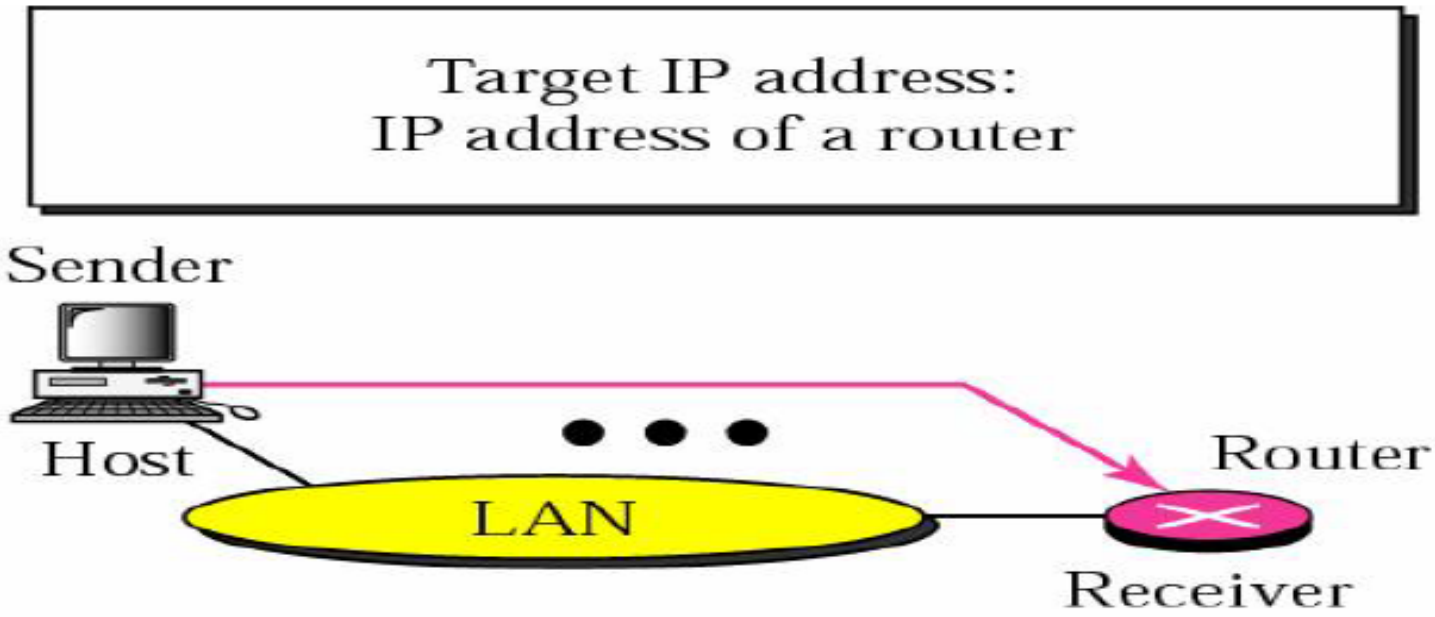
Use ARP to find another host's physical address



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

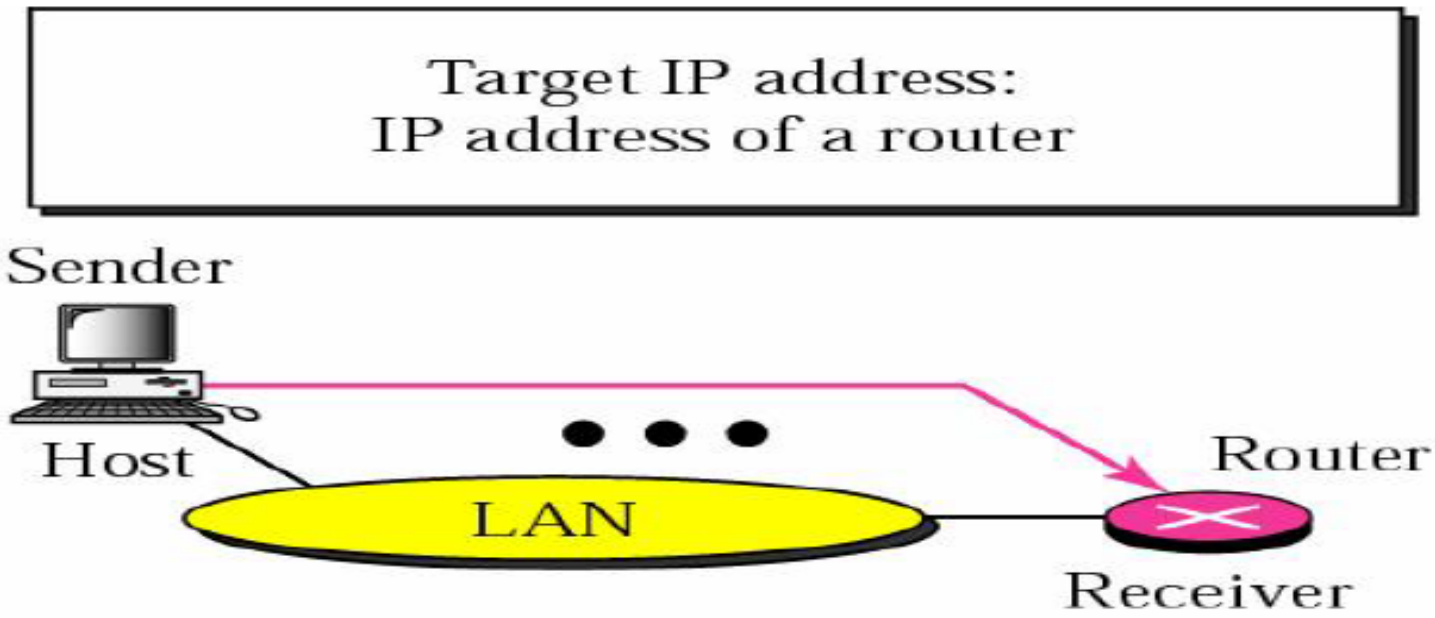
- ***Case 2:***

The sender is a host and wants to send a packet to another host on another network



Case 2. A host wants to send a packet to another host on another network.
It must first be delivered to a router.

- Sender looks at its routing table
- Find the IP address of the next hop (router) for this destination
- Use ARP to find the router's physical address



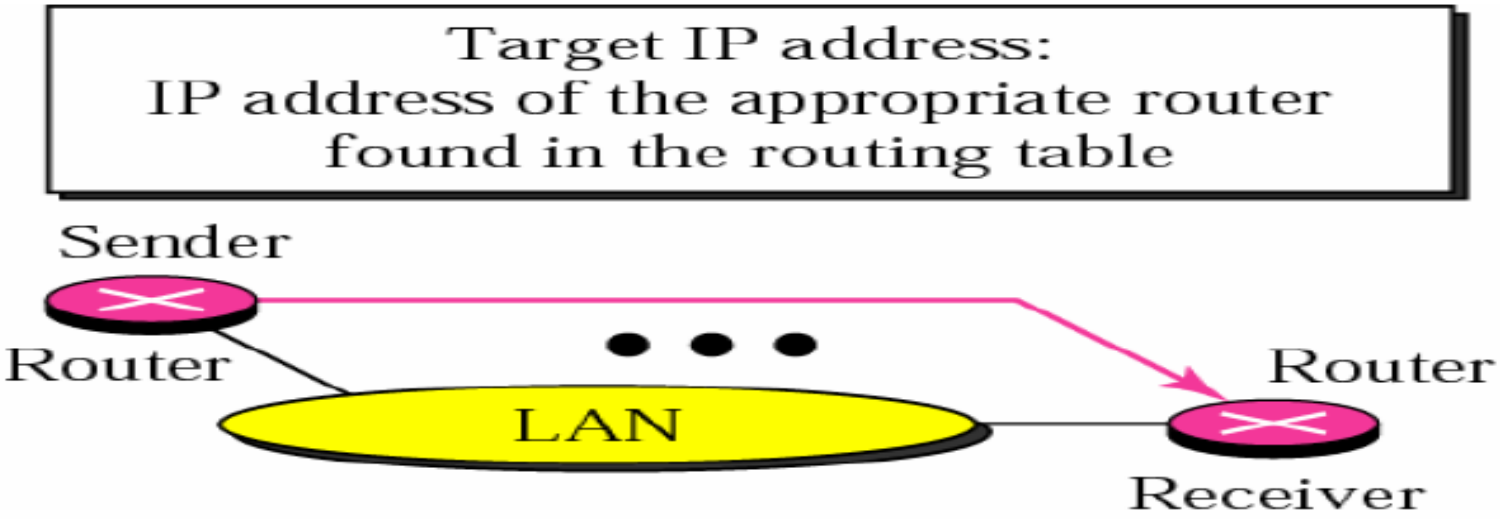
Case 2. A host wants to send a packet to another host on another network.
It must first be delivered to a router.

- ***Case 3:***

  the sender is a router and received a datagram

  destined for a host on another network

- Router check its routing table
- Find the IP address of the next router
- Use ARP to find the next router's physical address



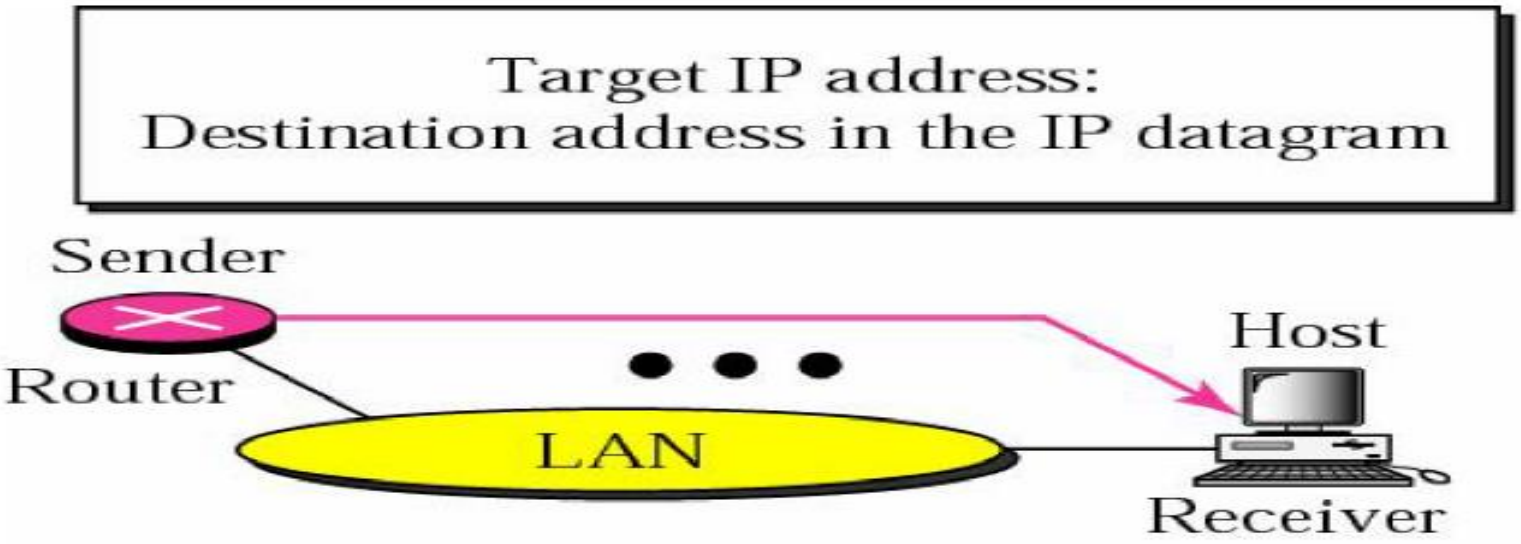
Case 3. A router receives a packet to be sent to a host on another network. It must first be delivered to the appropriate router.

- ***Case 4:***

the sender is a router that has received a

datagram destined for a host in the same network

Use ARP to find this host's physical address



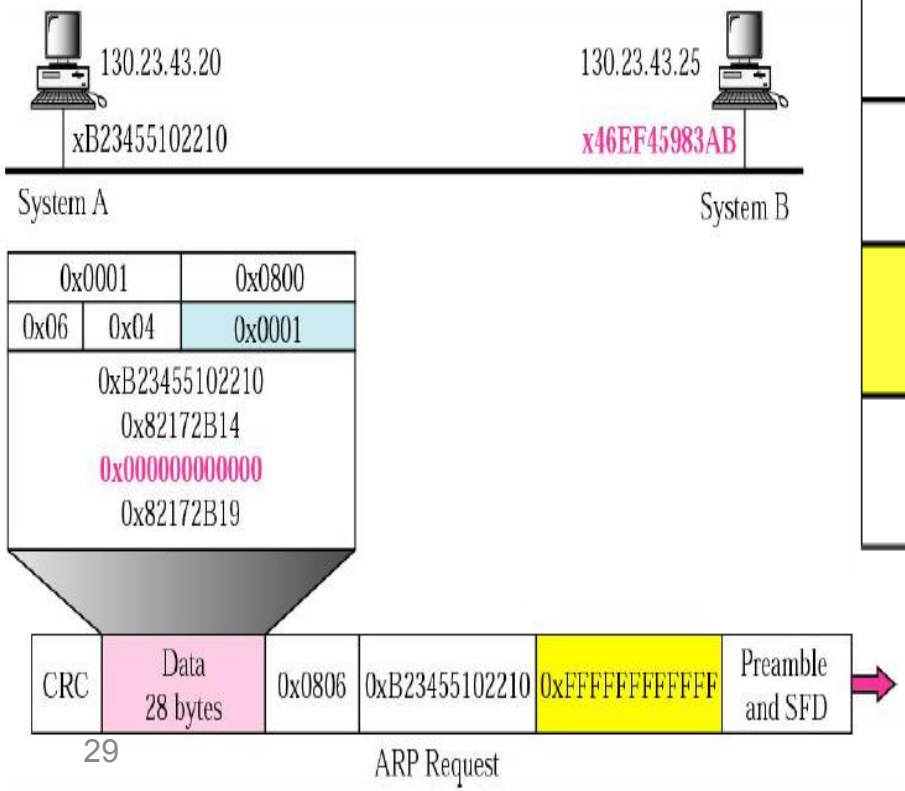
Case 4. A router receives a packet to be sent to a host on the same network.

Example 1

- A host with IP address 130.23.43.20 and physical address 0xB2:34:55:10:22:10
- Another host with IP address 130.23.43.25 and physical address 0xA4:6E:F4:59:83:AB.
- The two hosts are on the same Ethernet Network
- Show the ARP request and reply packets encapsulated in Ethernet frames

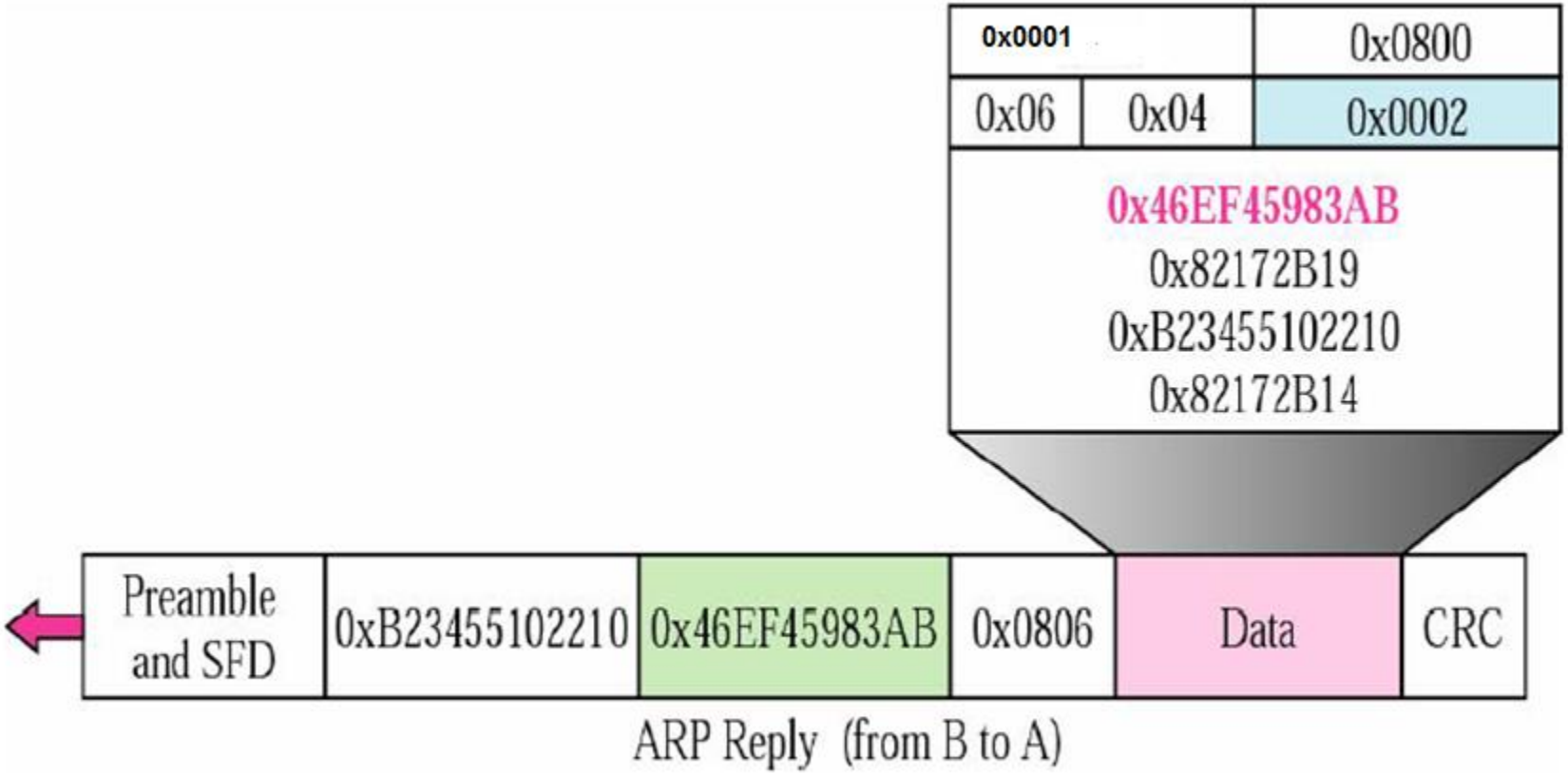
Solution

Request:



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)		

reply:


0x0001
0x0800
0x06
0x04
0x0002
0x46EF45983AB
0x82172B19
0xB23455102210
0x82172B14
Preamble and SFD
0xB23455102210
0x46EF45983AB
0x0806
Data
CRC
ARP Reply (from B to A)

examples

A router with IPv4 address (125.45.23.12) and Ethernet physical address 23: 45 : AB: 4F : 67: CD has received a packet for a host destination with IP address (125.11.78.10). Show the entries in the ARP request packet sent by the router. Assume no sub-netting

0x0001		0x0800
0x06	0x04	0x0001
0x2345AB4F		
0x67CD		0x7B2D (125.45)
0x170C (23.12)		0x0000
0x00000000		
0x7B0D4E0A (125.11.78.10)		

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)		

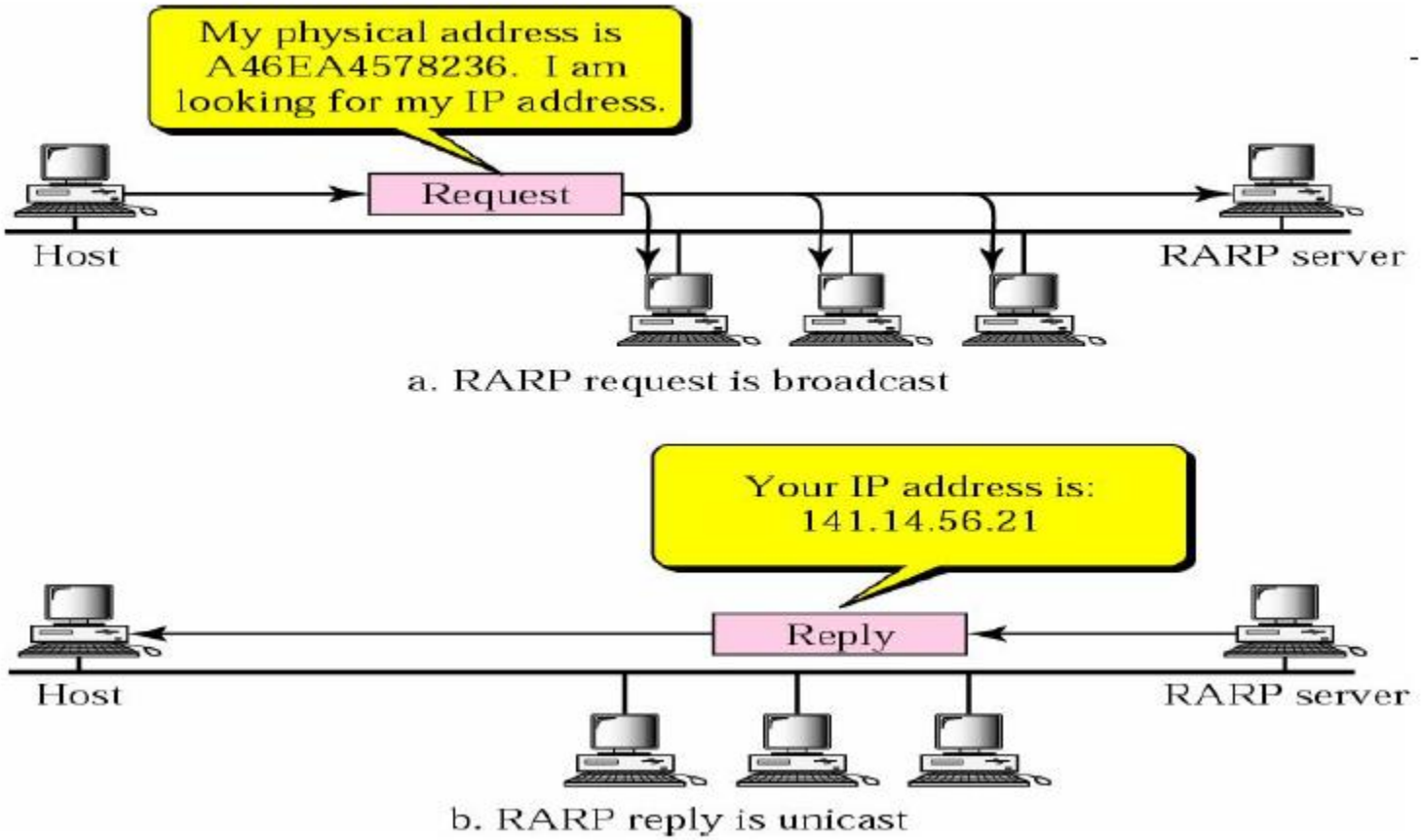
0x0001		0x0800
0x06	0x04	0x0001
0x2345AB4F		
0x67CD		0x7B2D (125.45)
0x170C (23.12)		0x0000
0x00000000		
0x7B0D4E0A (125.11.78.10)		

Show the entries in the ARP packet sent in response

0x0001		0x0800
0x06	0x04	0x0002
0x2345AB4F		
0x67CD		0x7B2D (125.45)
0x170C (23.12)		0xAABB
0xA24F67CD		
0x7B0D4E0A (125.11.78.10)		

RARP

- A diskless machine is usually booted from ROM
- It cannot include the IP address
  - IP address are assigned by the network Administrator
- Obtain its logical address by the physical address using the RARP protocol


My physical address is A46EA4578236. I am looking for my IP address.
Request
Host
RARP server
a. RARP request is broadcast
Your IP address is: 141.14.56.21
Reply
Host
RARP server
b. RARP reply is unicast

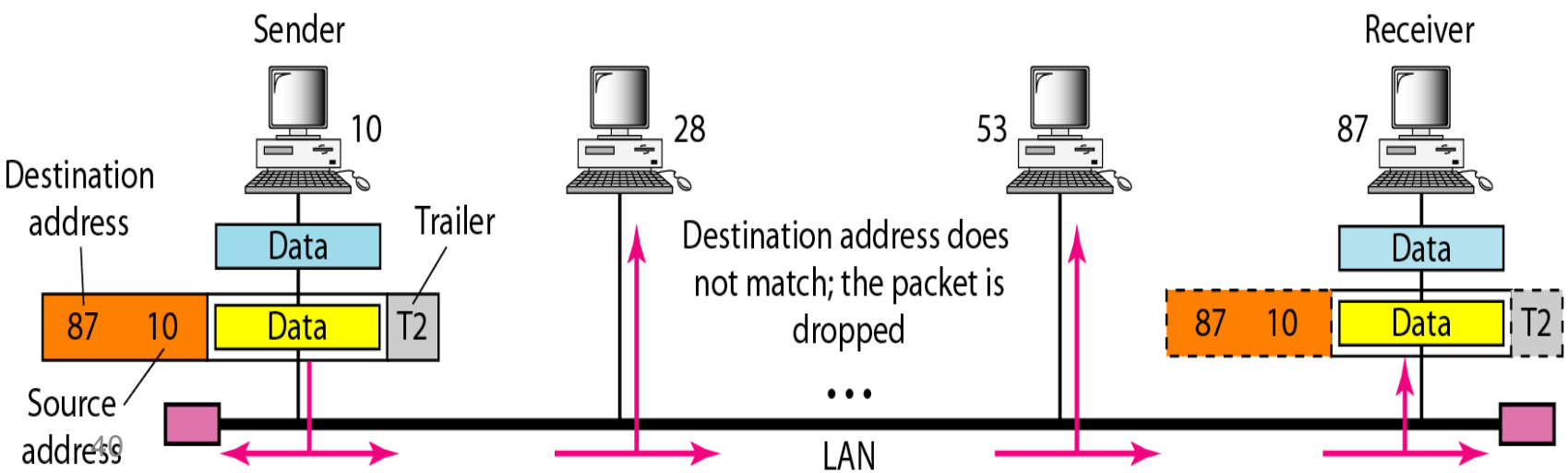
Packet Format

- The format of the RARP packet is the same as the ARP packet
- Except that the operation field is
  - Three for RARP request message
  - Four for RARP reply message

Hardware type		Protocol type
Hardware length	Protocol length	Operation Request 3, Reply 4
Sender hardware address (For example, 6 bytes for Ethernet)		
Sender protocol address (For example, 4 bytes for IP) (It is not filled for request)		
Target hardware address (For example, 6 bytes for Ethernet) (It is not filled for request)		
Target protocol address (For example, 4 bytes for IP) (It is not filled for request)		

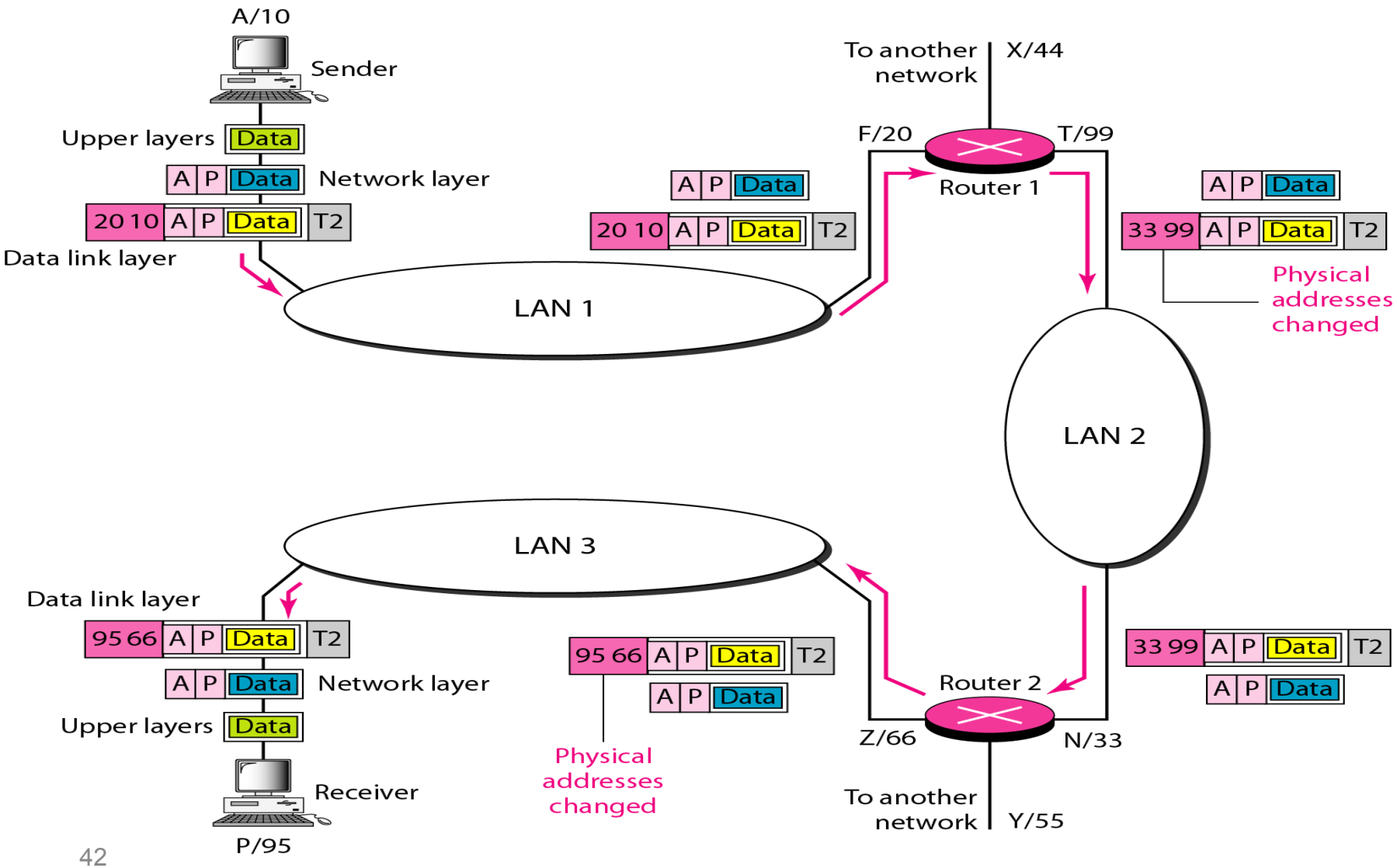
Example

- In Figure : a node with physical address 10 sends a frame to a node with physical address 87.
- The two nodes are connected by a link (bus topology LAN).
- As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver.



Example 2.3

- Figure shows a part of an internet with two routers connecting three LANs.
- Each device (computer or router) has a pair of addresses (logical and physical) for each connection.
- In this case, each computer is connected to only one link and therefore has only one pair of addresses.
- Each router, however, is connected to three networks (only two are shown in the figure).
- So each router has three pairs of addresses, one for each connection.


A/10
Sender
Upper layers
Data
A P Data
Network layer
20 10 A P Data T2
Data link layer
LAN 1
A P Data
20 10 A P Data T2
To another network
X/44
F/20
T/99
Router 1
A P Data
33 99 A P Data T2
Physical addresses changed
LAN 2
LAN 3
Data link layer
95 66 A P Data T2
A P Data
Network layer
Upper layers
Data
Receiver
P/95
95 66 A P Data T2
A P Data
Physical addresses changed
Router 2
Z/66
N/33
33 99 A P Data T2
A P Data
To another network
Y/55