Chapter 7

ARP and RARP

Objectives

Upon completion you will be able to:

- ***Understand the need for ARP***
- ***Understand the cases in which ARP is used***
- ***Understand the components and interactions in an ARP package***
- ***Understand the need for RARP***

ARP and RARP

Hosts and Routers are recognized by ***Logical Addresses.***

Logical addresses are universal.

At physical level hosts and routers recognized by *Physical Address*.

Physical address *are local addresses. Ex. MAC Addresses.*

Delivery requires two levels of addressing. Mapping is required.

Static Mapping: *Storing mapping information in a table.*
Physical addresses may change because of change in NIC card or mobile host move from one network to another.

Dynamic Mapping: *Machine knows one of the two addresses, it can use protocol to find the other one.*

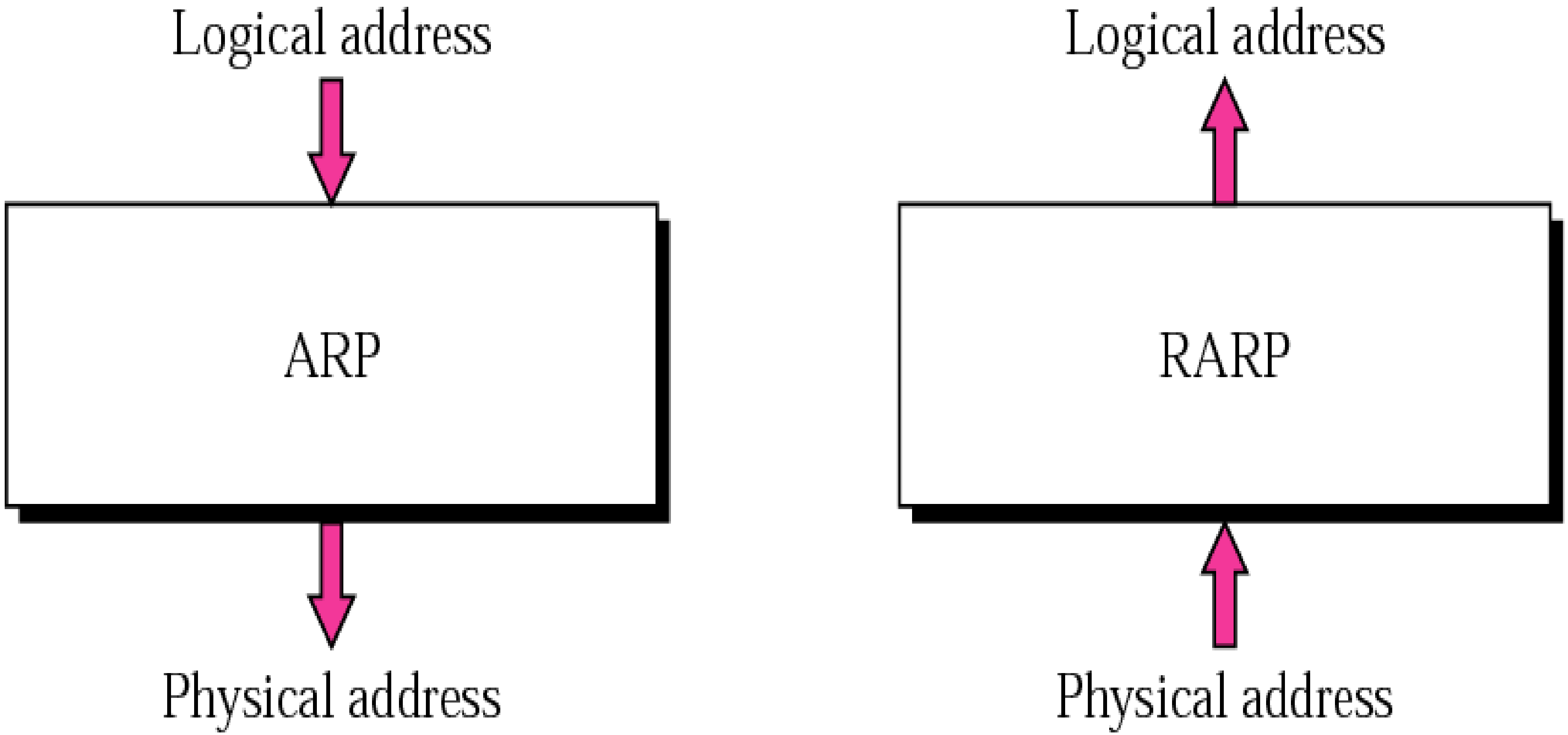
ARP and RARP

Dynamic Mapping: *Machine knows one of the two addresses, it can use protocol to find the other one.*

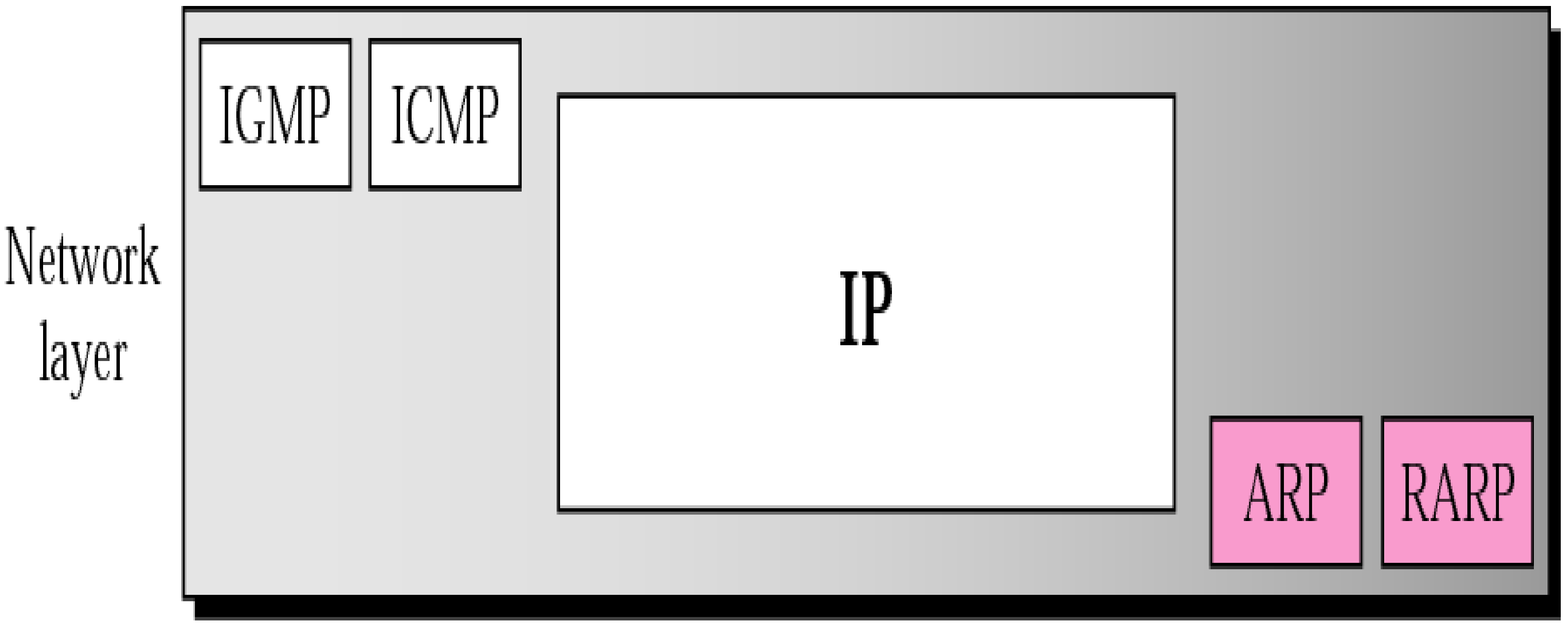
ARP: *Maps Logical address to physical address*

RARP*: Maps Physical address to 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



7.1 ARP

ARP associates an IP address with its physical address. On a typical physical network, such as a LAN, each device on a link is identified by a physical or station address that is usually imprinted on the NIC.

The topics discussed in this section include:

Packet Format
Encapsulation
Operation
ARP over ATM
Proxy ARP

ARP

Sender has logical address of receiver.

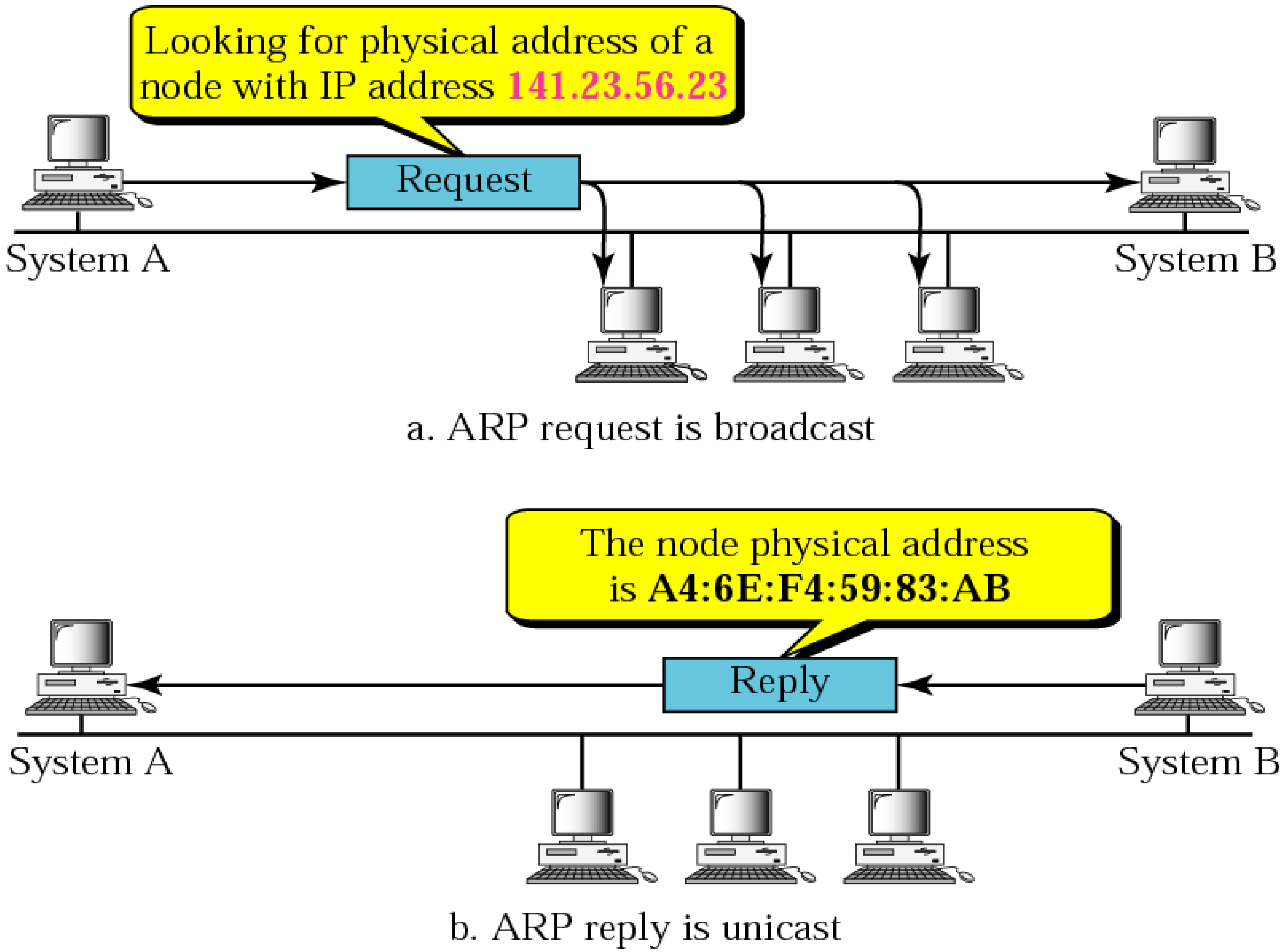
Sender asks receiver to announce its physical address.

When any host needs to know Physical address of another machine host it sends a ARP query Packet.

Query includes Sender's physical and IP address and receivers only IP address.

*Query packet is **broadcast** over the network.*

Figure 7.3 *ARP operation*



ARP

Every host receives and processes ARP query packet.

Only receiver sends back ARP response packet containing receivers IP address and Physical address.

Response packet is unicast.

ARP packet

<table>
<tr><td colspan="2">Hardware Type</td><td>Protocol Type</td></tr>
<tr><td>Hardware length</td><td>Protocol length</td><td>Operation
Request 1, Reply 2</td></tr>
<tr><td colspan="3">Sender hardware address
(For example, 6 bytes for Ethernet)</td></tr>
<tr><td colspan="3">Sender protocol address
(For example, 4 bytes for IP)</td></tr>
<tr><td colspan="3">Target hardware address
(For example, 6 bytes for Ethernet)
(It is not filled in a request)</td></tr>
<tr><td colspan="3">Target protocol address
(For example, 4 bytes for IP)</td></tr>
</table>

ARP Packet Format

Hardware Type: *16-bit, ethernet is given type 1.*

Protocol Type: *16-bit defining protocol. For Ipv4 it is 0800_{16}*

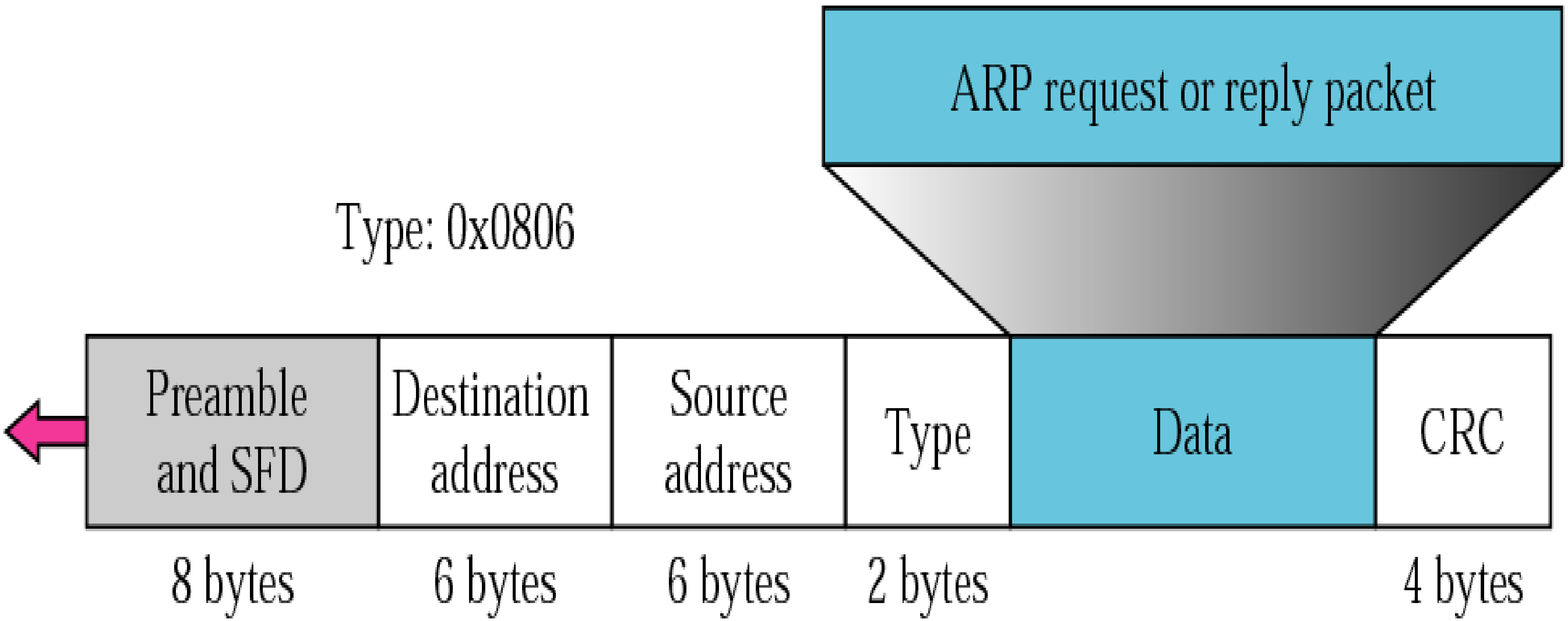
Hardware Length*: Length of physical address in bytes. For ethernet it is 6.*

Protocol Length: *8-bit defining length of logical address. For Ipv4 it is 4.*

Operation: *16-bit defines type of packet. Type 1- Request 2- Reply.*

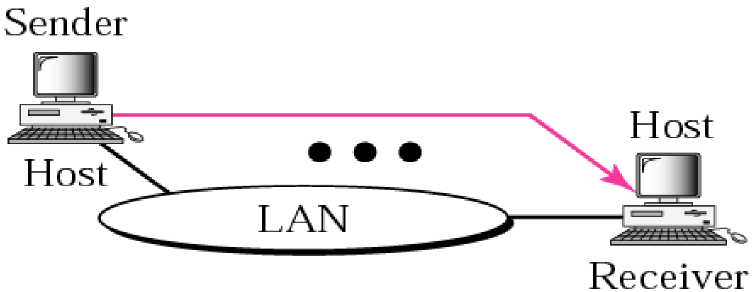
Sender H/w address: Sender protocol addr, Target H/W addr, Target protocol addr.

Figure 7.5 *Encapsulation of ARP packet*



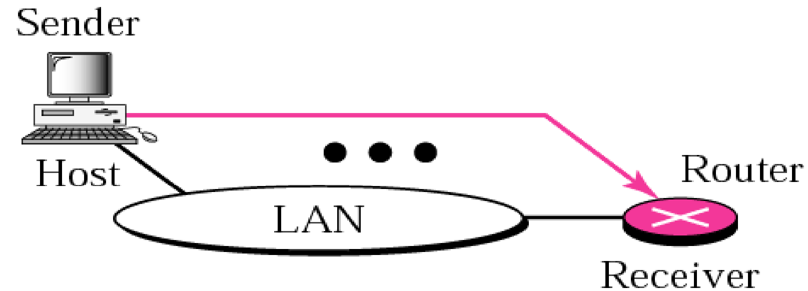
Four cases using ARP

Target IP address:
Destination address in the IP datagram



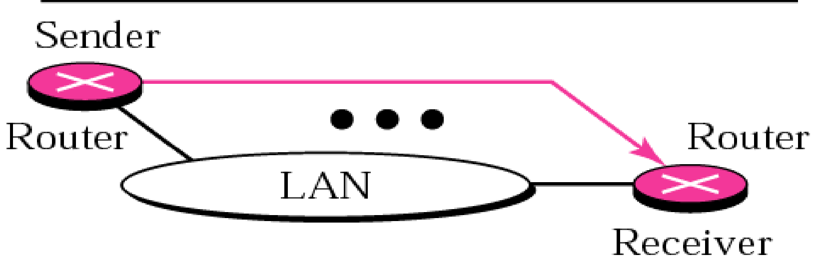
Case 1. A host has a packet to send to another host on the same network.

Target IP address:
IP address of a router



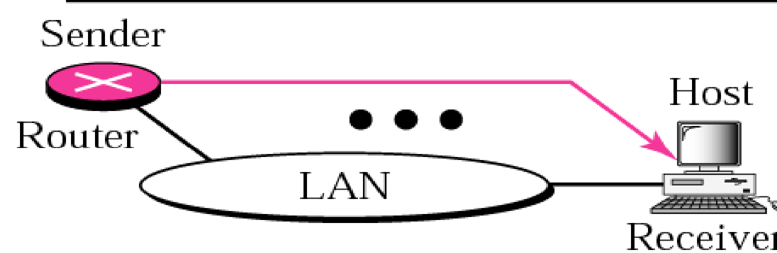
Case 2. A host wants to send a packet to another host on another network.
It must first be delivered to a router.

Target IP address:
IP address of the appropriate router found in the routing table



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.

Target IP address:
Destination address in the IP datagram



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

Note:

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

Example 1

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 (which is unknown to the first host). The two hosts are on the same Ethernet network. Show the ARP request and reply packets encapsulated in Ethernet frames.

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Example 1 *(Continued)*

Solution

Figure 7.7 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. For information on binary or hexadecimal notation see Appendix B.

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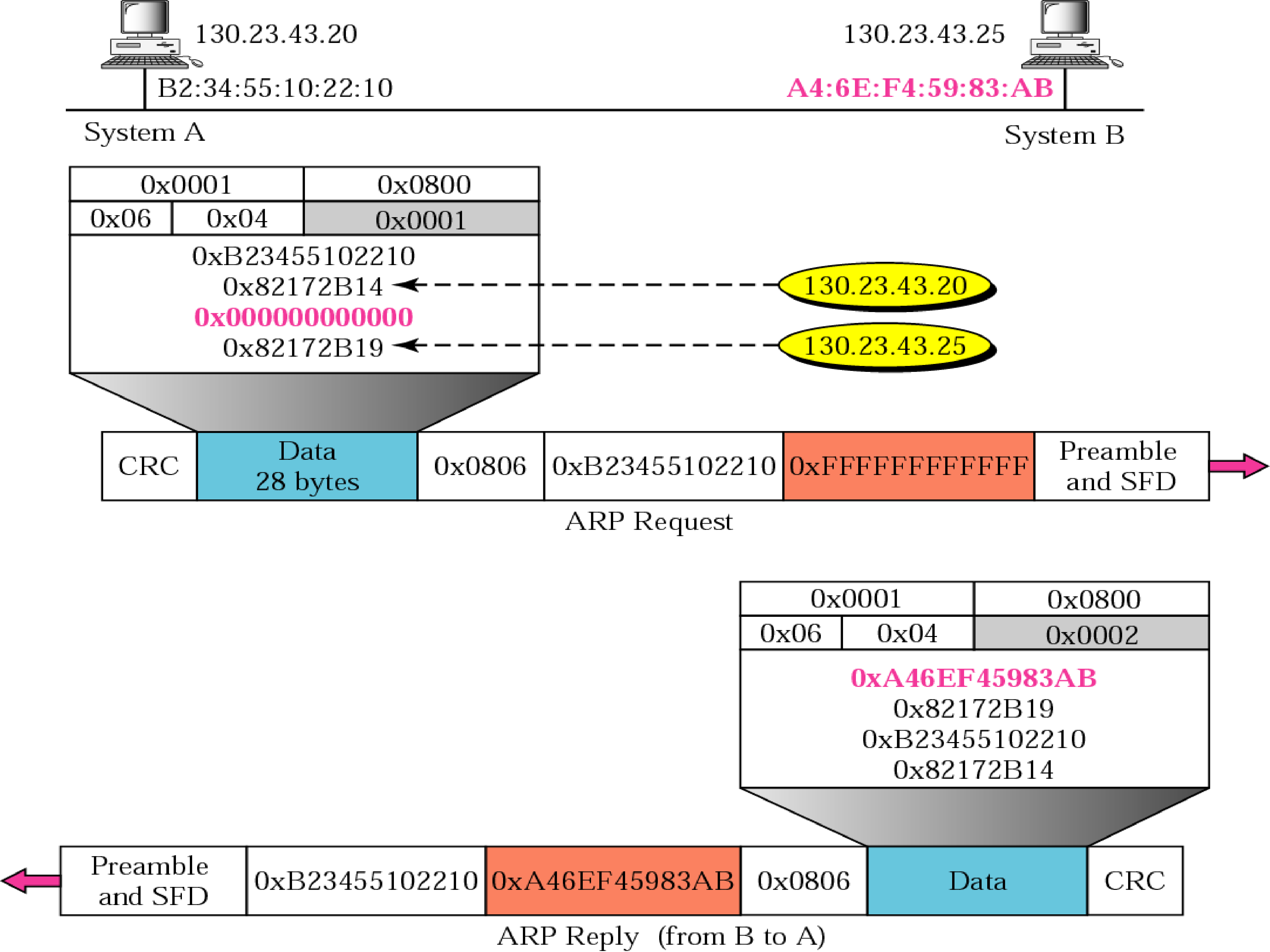
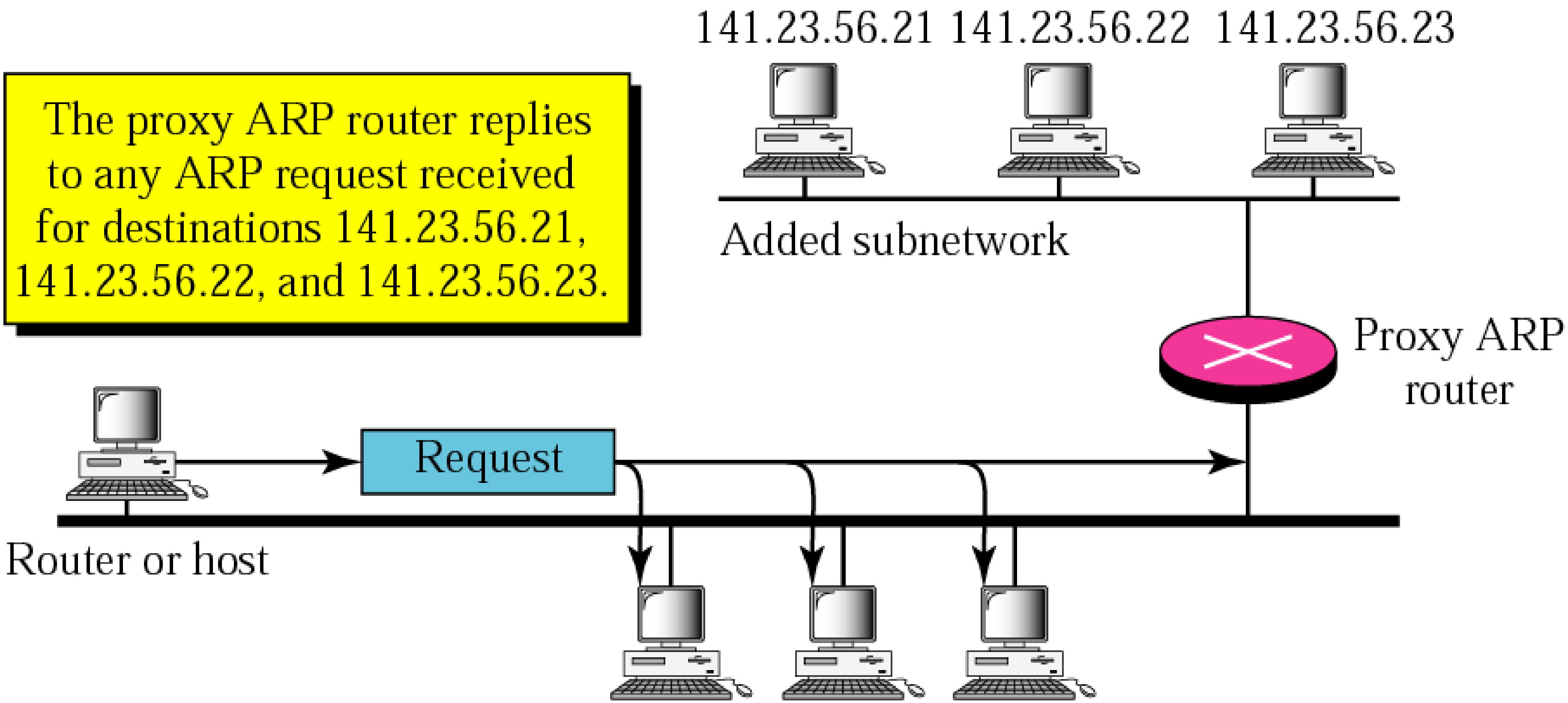

130.23.43.20
B2:34:55:10:22:10
System A
130.23.43.25
A4:6E:F4:59:83:AB
System B
0x0001
0x0800
0x06
0x04
0x0001
0xB23455102210
0x82172B14
0x000000000000
0x82172B19
130.23.43.20
130.23.43.25
CRC
Data
28 bytes
0x0806
0xB23455102210
0xFFFFFFFFFFFF
Preamble
and SFD
ARP Request
0x0001
0x0800
0x06
0x04
0x0002
0xA46EF45983AB
0x82172B19
0xB23455102210
0x82172B14
Preamble
and SFD
0xB23455102210
0xA46EF45983AB
0x0806
Data
CRC
ARP Reply (from B to A)

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.
141.23.56.21
141.23.56.22
141.23.56.23
Added subnetwork
Proxy ARP router
Request
Router or host

7.2 ARP PACKAGE

In this section, we give an example of a simplified ARP software package to show the components and the relationships between the components. This ARP package involves five modules: a cache table, queues, an output module, an input module, and a cache-control module.

The topics discussed in this section include:

Cache Table
Queues
Output Module
Input Module
Cache-Control Module

ARP components

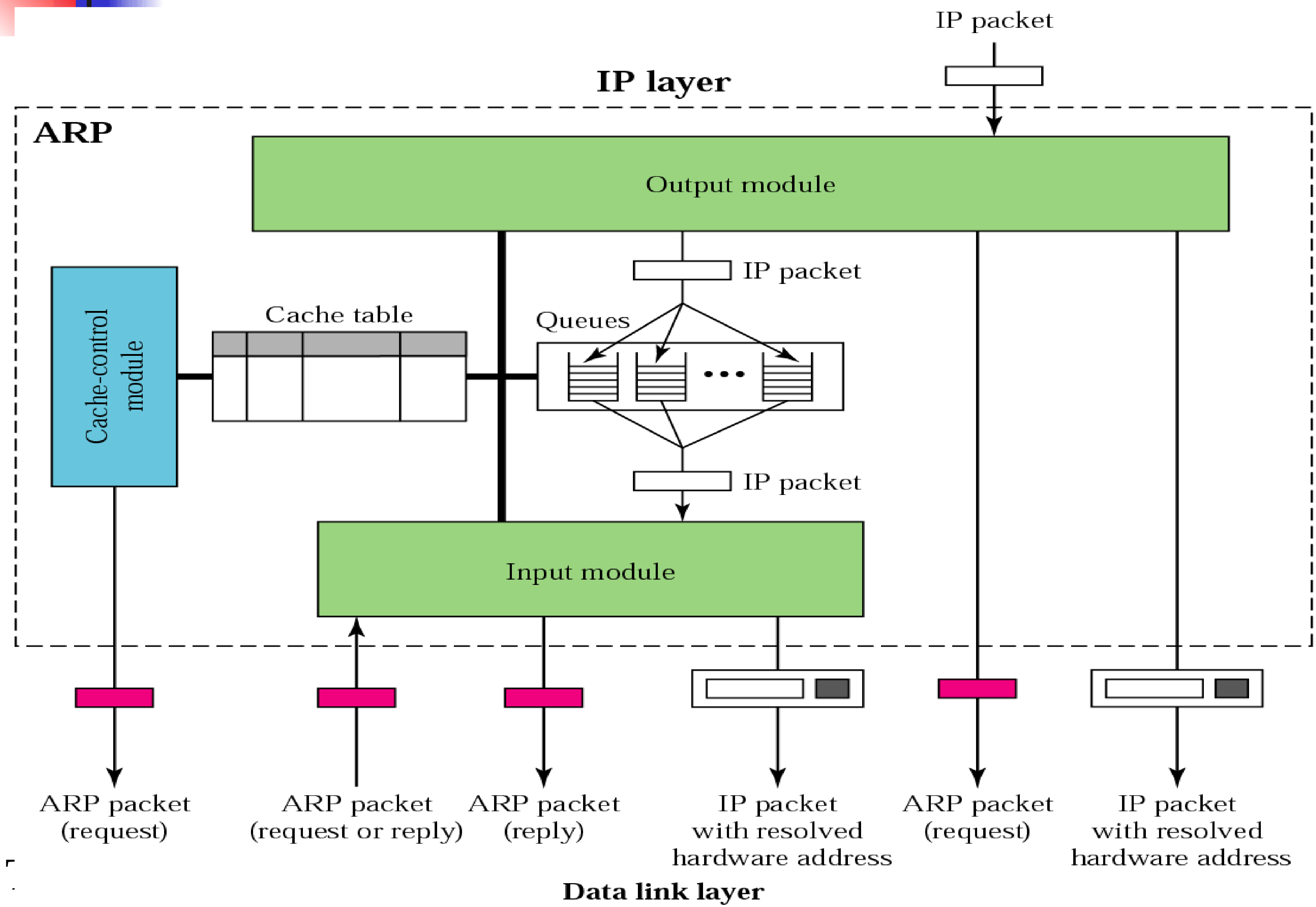


Table 7.1 Original cache table used for examples

State	Queue	Attempt	Time-Out	Protocol Addr.	Hardware Addr.
R	5		900	180.3.6.1	ACAE32457342
P	2	2		129.34.4.8	
P	14	5		201.11.56.7	
R	8		450	114.5.7.89	457342ACAE32
P	12	1		220.55.5.7	
F					
R	9		60	19.1.7.82	4573E3242ACA
P	18	3		188.11.8.71	

Example 2

The ARP output module receives an IP datagram (from the IP layer) with the destination address 114.5.7.89. It checks the cache table and finds that an entry exists for this destination with the RESOLVED state (R in the table). It extracts the hardware address, which is 457342ACAE32, and sends the packet and the address to the data link layer for transmission. The cache table remains the same.

Example 3

Twenty seconds later, the ARP output module receives an IP datagram (from the IP layer) with the destination address 116.1.7.22. It checks the cache table and does not find this destination in the table. The module adds an entry to the table with the state PENDING and the Attempt value 1. It creates a new queue for this destination and enqueues the packet. It then sends an ARP request to the data link layer for this destination. The new cache table is shown in Table 7.2.

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***Table 7.2** Updated cache table for Example 3*

State	*Queue*	*Attempt*	*Time-Out*	*Protocol Addr.*	*Hardware Addr.*
R	5		900	180.3.6.1	ACAE32457342
P	2	2		129.34.4.8	
P	14	5		201.11.56.7	
R	8		450	114.5.7.89	457342ACAE32
P	12	1		220.55.5.7	
P	23	1		116.1.7.22	
R	9		60	19.1.7.82	4573E3242ACA
P	18	3		188.11.8.71	

Example 4

Fifteen seconds later, the ARP input module receives an ARP packet with target protocol (IP) address 188.11.8.71. The module checks the table and finds this address. It changes the state of the entry to RESOLVED and sets the time-out value to 900. The module then adds the target hardware address (E34573242ACA) to the entry. Now it accesses queue 18 and sends all the packets in this queue, one by one, to the data link layer. The new cache table is shown in Table 7.3.

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Table 7.3 Updated cache table for Example 4

State	*Queue*	*Attempt*	*Time-Out*	*Protocol Addr.*	*Hardware Addr.*
R	5		900	180.3.6.1	ACAE32457342
P	2	2		129.34.4.8	
P	14	5		201.11.56.7	
R	8		450	114.5.7.89	457342ACAE32
P	12	1		220.55.5.7	
P	23	1		116.1.7.22	
R	9		60	19.1.7.82	4573E3242ACA
R	18		900	188.11.8.71	E34573242ACA

Example 5

Twenty-five seconds later, the cache-control module updates every entry. The time-out values for the first three resolved entries are decremented by 60. The time-out value for the last resolved entry is decremented by 25. The state of the next-to-the last entry is changed to FREE because the time-out is zero. For each of the three pending entries, the value of the attempts

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Table 7.4 ***Updated cache table for Example 5***

State	*Queue*	*Attempt*	*Time-Out*	*Protocol Addr.*	*Hardware Addr.*
R	5		840	180.3.6.1	ACAE32457342
P	2	3		129.34.4.8	
F					
R	8		390	114.5.7.89	457342ACAE32
P	12	2		220.55.5.7	
P	23	2		116.1.7.22	
F					
R	18		875	188.11.8.71	E34573242ACA

7.3 RARP

RARP finds the logical address for a machine that only knows its physical address.

The topics discussed in this section include:

Packet Format
Encapsulation
RARP Server
Alternative Solutions to RARP

Note:

The RARP request packets are broadcast;

the RARP reply packets are unicast.

Figure 7.10 ***RARP operation***

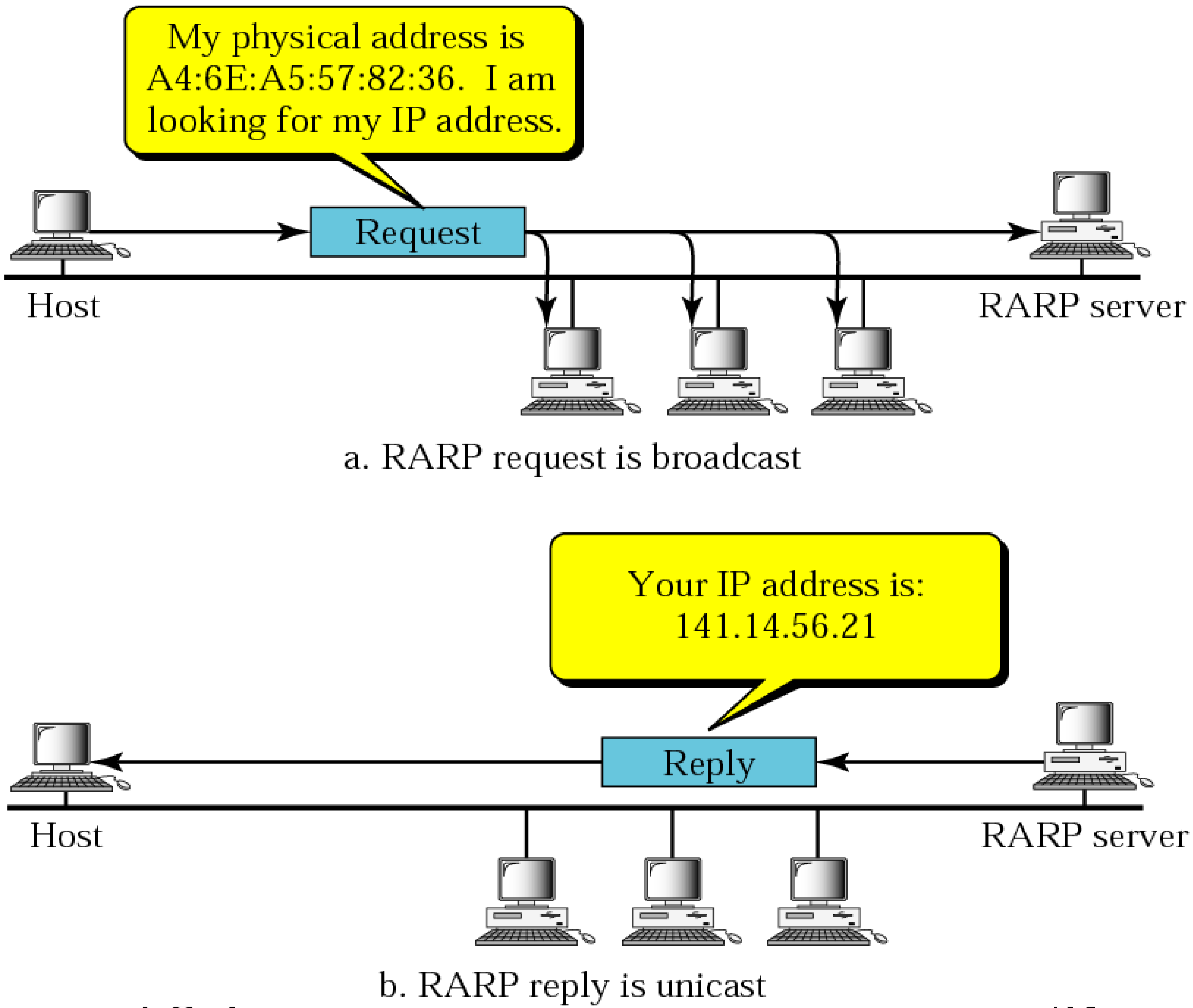
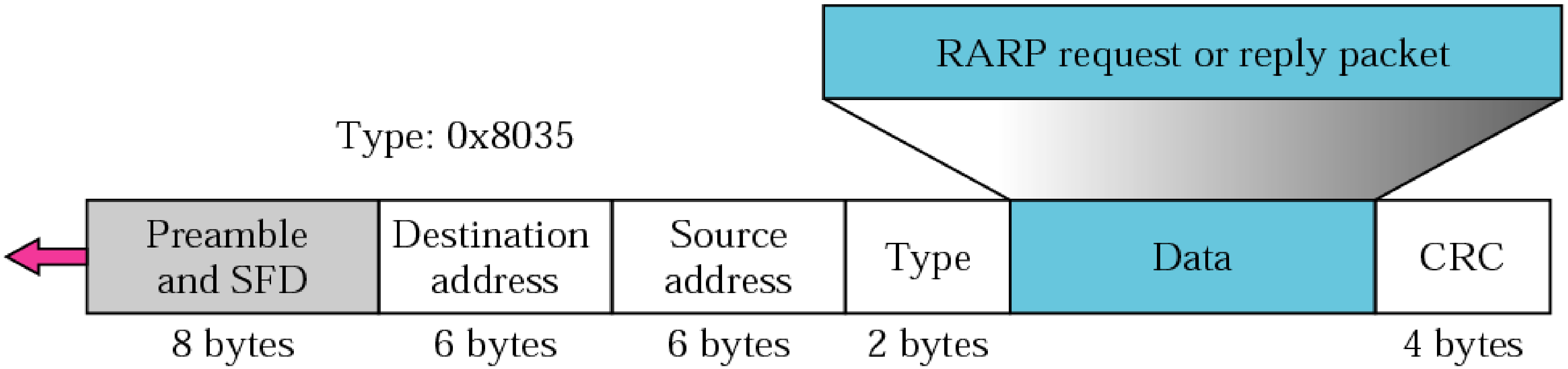


Figure 7.11 ***RARP packet***

<table>
<tr><td colspan="2">Hardware type</td><td>Protocol type</td></tr>
<tr><td>Hardware
length</td><td>Protocol
length</td><td>Operation
Request 3, Reply 4</td></tr>
<tr><td colspan="3">Sender hardware address
(For example, 6 bytes for Ethernet)</td></tr>
<tr><td colspan="3">Sender protocol address
(For example, 4 bytes for IP)
(It is not filled for request)</td></tr>
<tr><td colspan="3">Target hardware address
(For example, 6 bytes for Ethernet)
(It is not filled for request)</td></tr>
<tr><td colspan="3">Target protocol address
(For example, 4 bytes for IP)
(It is not filled for request)</td></tr>
</table>

Figure 7.12 *Encapsulation of RARP packet*



File Edit View Search Terminal Help

```
gkp@GkpOffice:~$ arp
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.6.239            ether   00:1b:24:8a:c8:bb   C                     eth0
192.168.6.97             ether   00:0f:fe:0d:92:28   C                     eth0
192.168.6.153            ether   00:13:d3:f2:72:51   C                     eth0
192.168.6.74             ether   00:0f:fe:0d:8b:19   C                     eth0
ubuntu.local             ether   00:40:95:30:18:2a   C                     eth0
192.168.6.72             ether   00:0f:fe:0d:92:40   C                     eth0
192.168.6.254            ether   00:11:95:b4:95:06   C                     eth0
192.168.6.92             ether   00:1b:38:92:7c:d9   C                     eth0
gkp@GkpOffice:~$
```

File Edit View Search Terminal Help

```
[sudo] password for gkp:
Interface: eth0, datalink type: EN10MB (Ethernet)
Starting arp-scan 1.6 with 256 hosts (http://www.nta-monitor.com/tools/arp-scan/
)
192.168.6.0     ff:ff:ff:ff:ff:ff       (Unknown)
192.168.6.1     00:19:db:a3:35:eb       MICRO-STAR INTERNATIONAL CO., LTD.
192.168.6.2     00:11:95:8e:b3:ae       D-Link Corporation
192.168.6.4     00:1d:72:08:00:c5       (Unknown)
192.168.6.19    00:1e:68:70:23:e6       (Unknown)
192.168.6.29    00:0f:fe:0d:92:2d       G-PRO COMPUTER
192.168.6.30    00:0f:fe:0d:8e:bd       G-PRO COMPUTER
192.168.6.36    00:0f:fe:40:28:4f       G-PRO COMPUTER
192.168.6.42    00:0f:fe:40:24:40       G-PRO COMPUTER
192.168.6.92    00:1b:38:92:7c:d9       COMPAL ELECTRONICS TECHNOLOGIC CO., LTD.
192.168.6.100   00:1d:92:27:1a:7c       (Unknown)
192.168.6.110   00:0f:fe:40:27:d9       G-PRO COMPUTER
192.168.6.115   f0:4d:a2:64:1f:58       (Unknown)
192.168.6.126   00:21:97:95:04:d9       (Unknown)
192.168.6.130   00:24:54:b2:b9:a8       (Unknown)
192.168.6.131   00:21:85:60:58:3e       (Unknown)
192.168.6.163   88:ae:1d:d1:84:ad       (Unknown)
192.168.6.175   00:0f:fe:40:28:22       G-PRO COMPUTER
192.168.6.187   00:40:95:30:18:2a       R.P.T. INTERGROUPS INT'L LTD.
192.168.6.187   00:0f:fe:3e:f2:c4       G-PRO COMPUTER (DUP: 2)
192.168.6.250   00:00:74:a5:72:4c       RICOH COMPANY LTD.
192.168.6.254   00:11:95:b4:95:06       D-Link Corporation
192.168.6.255   ff:ff:ff:ff:ff:ff       (Unknown)

23 packets received by filter, 0 packets dropped by kernel
Ending arp-scan 1.6: 256 hosts scanned in 1.330 seconds (192.48 hosts/sec).  23
responded
gkp@GkpOffice:~$
```