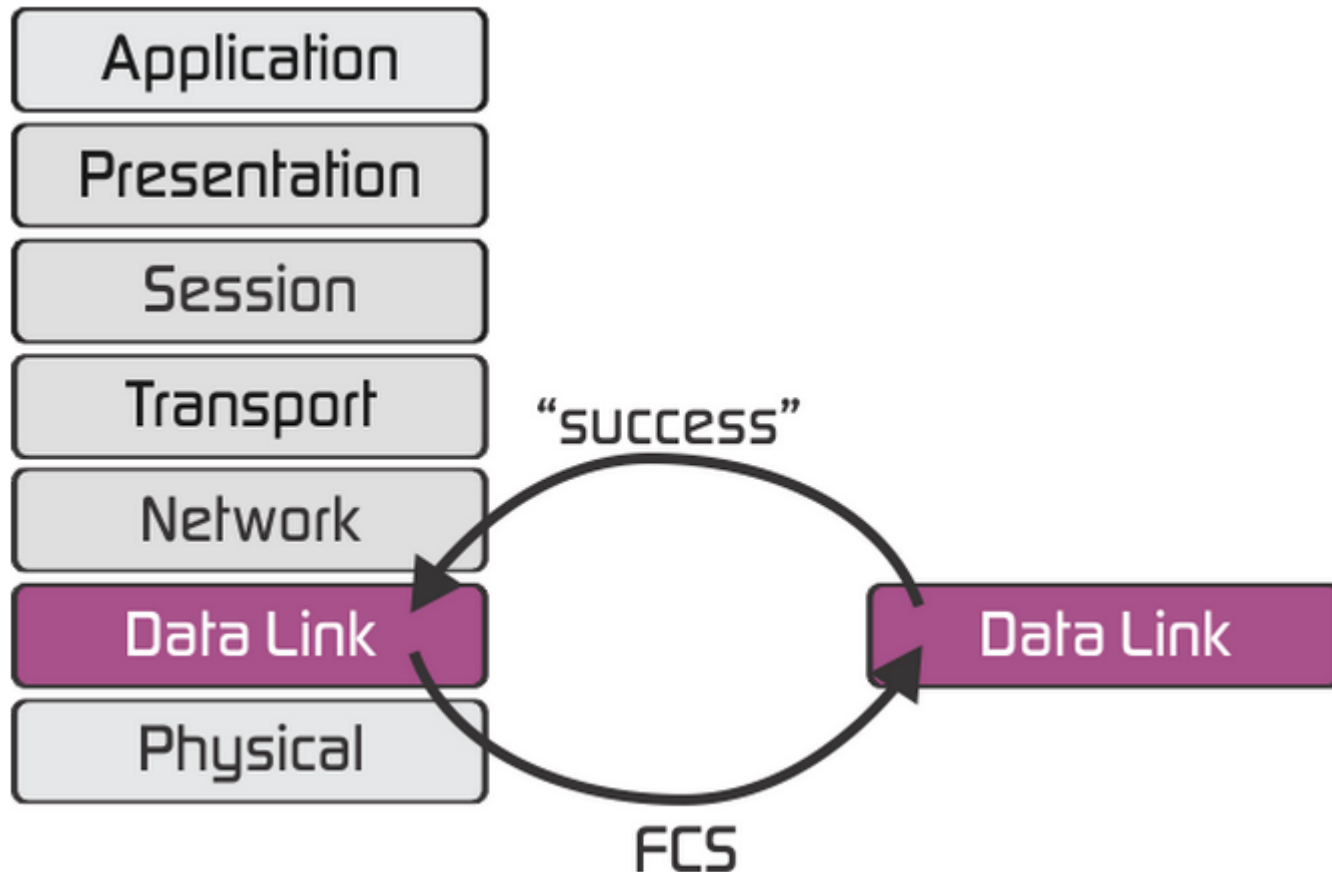# Chapter 9

Introduction To Data-Link Layer

Objective

- data-link layer: point-to-point and broadcast links.

- link-layer addressing: three types of link-layer addresses.

- Address Resolution Protocol (ARP): it maps the addresses at the network layer to addresses at the data-link layer.

INTRODUCTION

- The Internet is a combination of networks glued together by connecting devices (routers or switches).

- If a packet is to travel from a host to another host, it needs to pass through these networks.

- We are now interested in communication at the data-link layer.
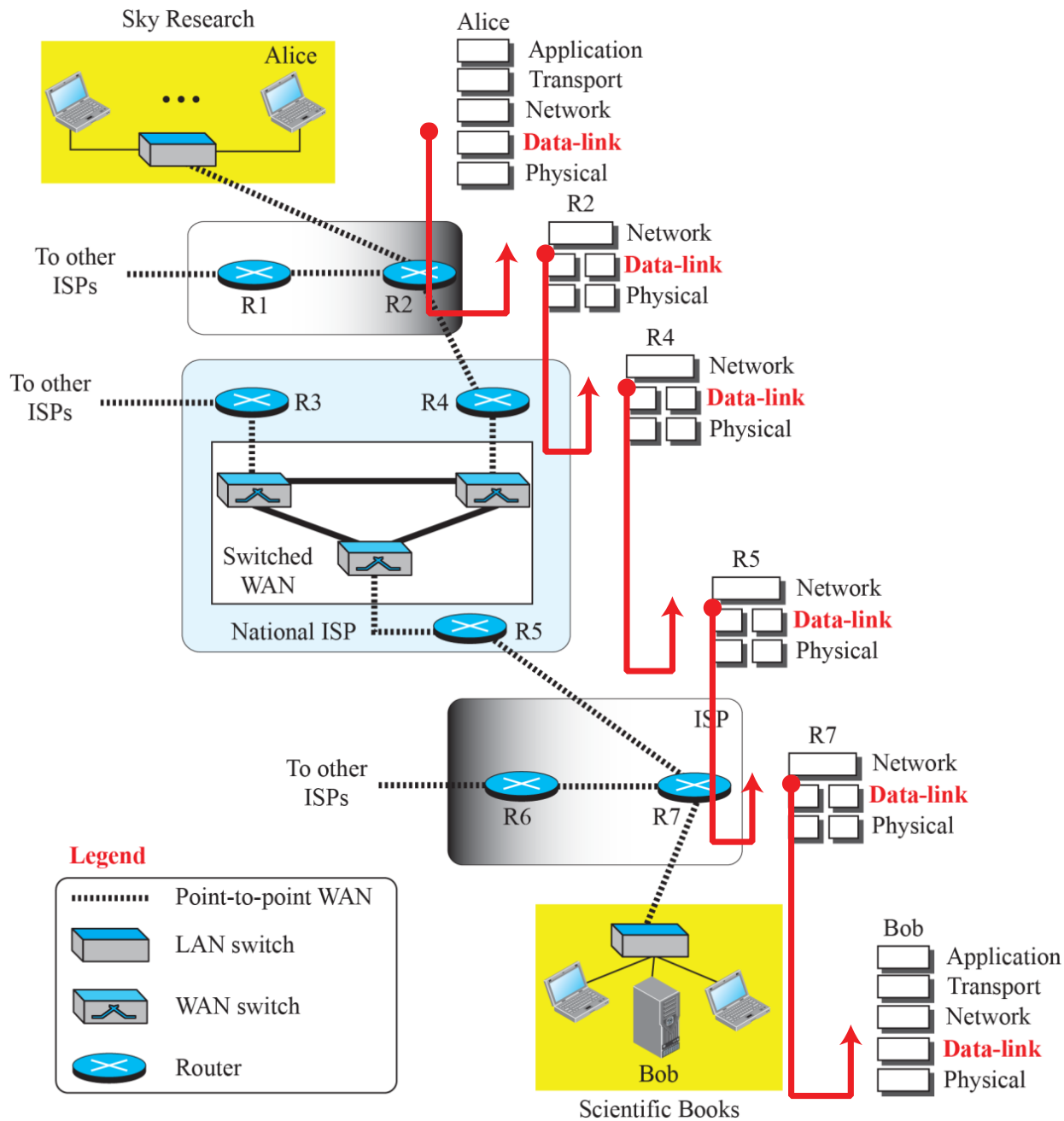
Communication at the data-link layer

Nodes and Links

- Communication at the data-link layer is node-to-node. A data unit from one point in the Internet needs to pass through many networks (LANs and WANs) to reach another point.

- Theses LANs and WANs are connected by routers. It is customary to refer to the two end hosts and the routers as nodes and the networks in between as links.
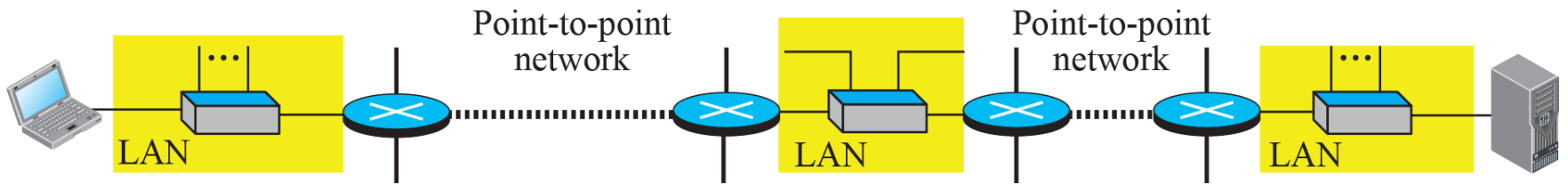
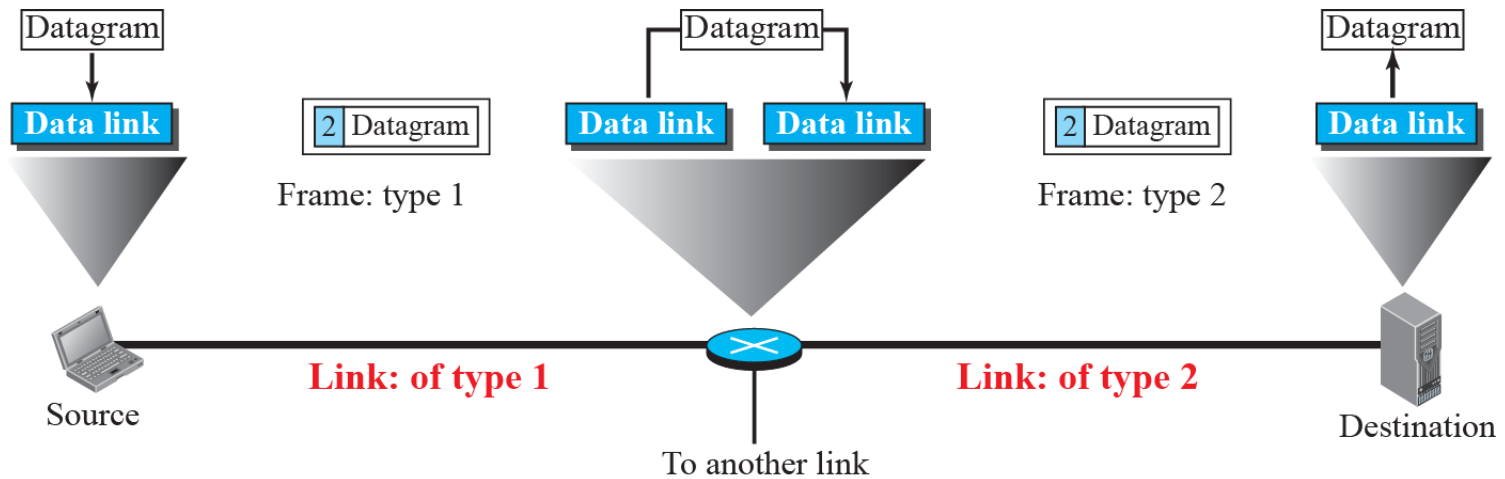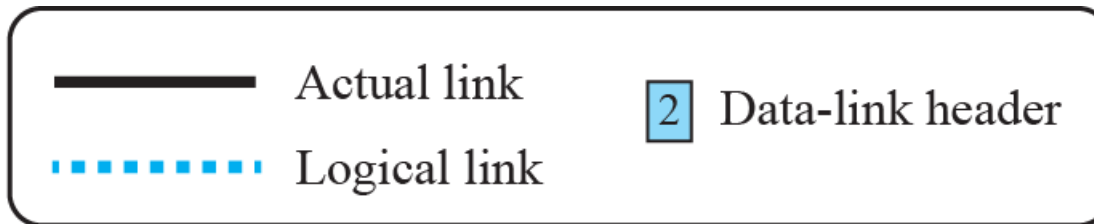a. A small part of the Internet

b. Nodes and links

Nodes and Links

Services

- The data-link layer is located between the physical and the network layers.

- The data-link layer provides services to the network layer; it receives services from the physical layer.

- Let us discuss services provided by the data-link layer.

A communication with only three nodes

Two Categories of Links

- Although two nodes are physically connected by a transmission medium such as cable or air, we need to remember that the data-link layer controls how the medium is used.

- We can have a data-link layer that uses the whole capacity of the medium.

- In other words, we can have a point-to-point link or a broadcast link.

Two Categories of Links

- Point-to-point links is a connection between individual pairs of devices. A point-to-point transmission with one sender and one receiver is called unicasting.

- Broadcast links is a communication channel that is shared by all the devices in the network.

- The difference between point-to-point and broadcast is that in broadcast networks, the packets are sent by any device and received by all the other devices.

Two Sublayers

- To better understand the functionality of and the services provided by the link layer, we can divide the data-link layer into two sublayers: data link control (DLC) and media access control (MAC).

- This is not unusual because, LAN protocols actually use the same strategy.
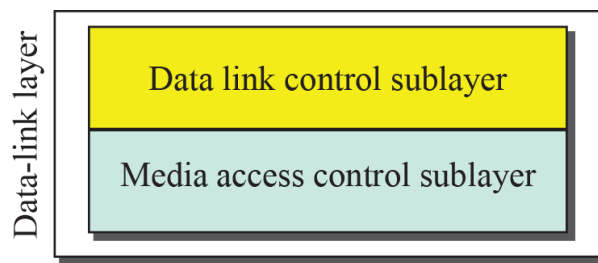
a. Data-link layer of a broadcast link
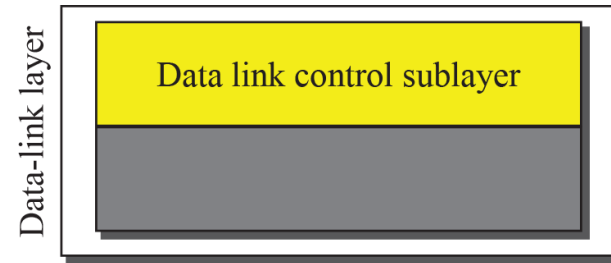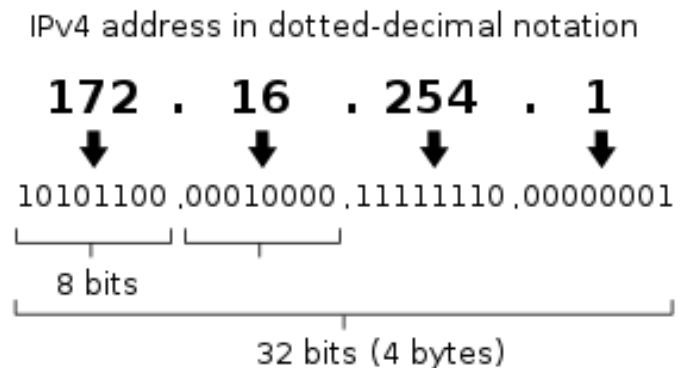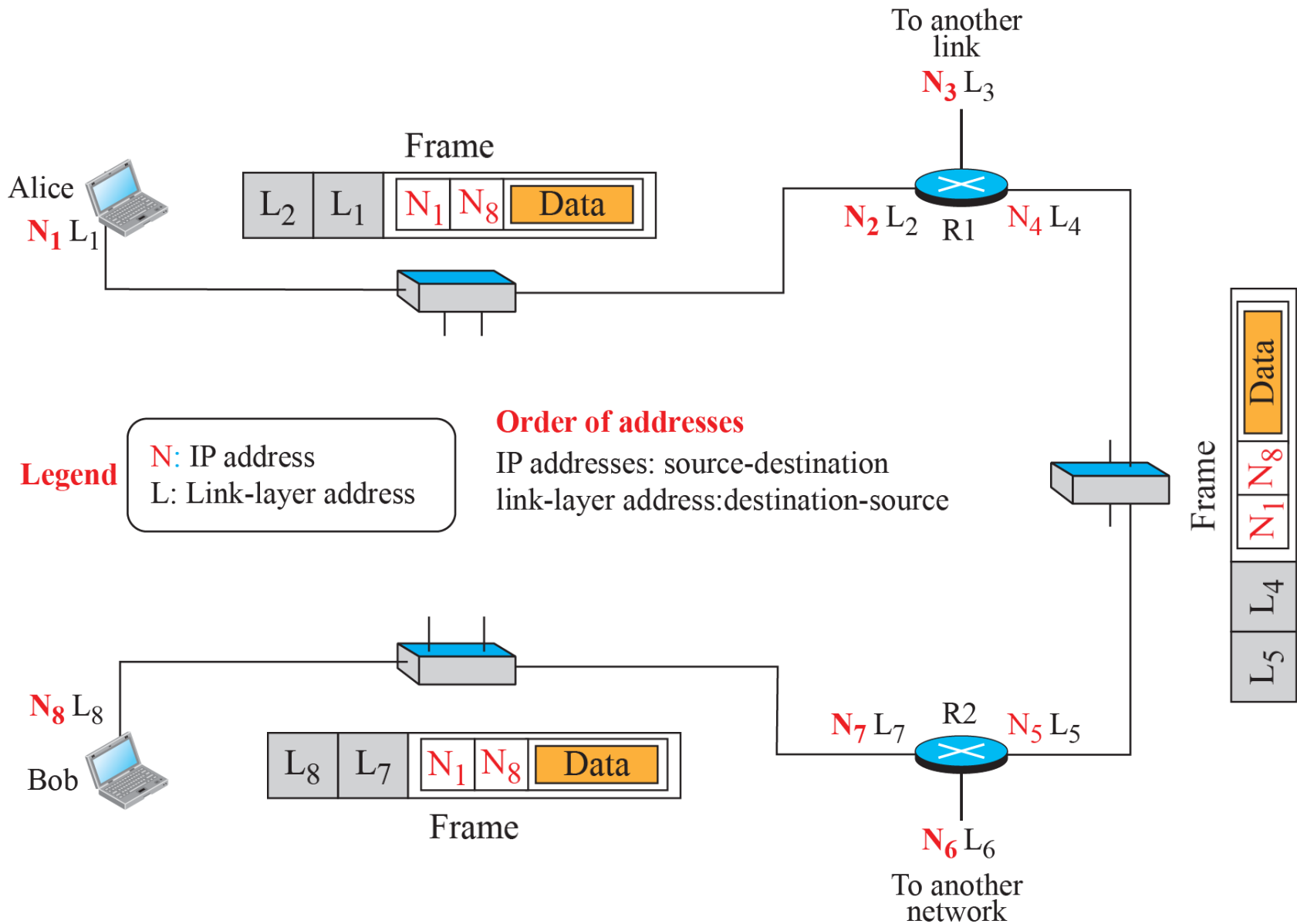
b. Data-link layer of a point-to-point link

Dividing the data-link layer into two sublayers

LINK-LAYER ADDRESSING

- IP addresses as the identifiers at the network layer. However, in a internetwork such as the Internet we cannot make a datagram reach its destination using only IP addresses.

- The source and destination IP addresses define the two ends but cannot define which links the packet should pass through.
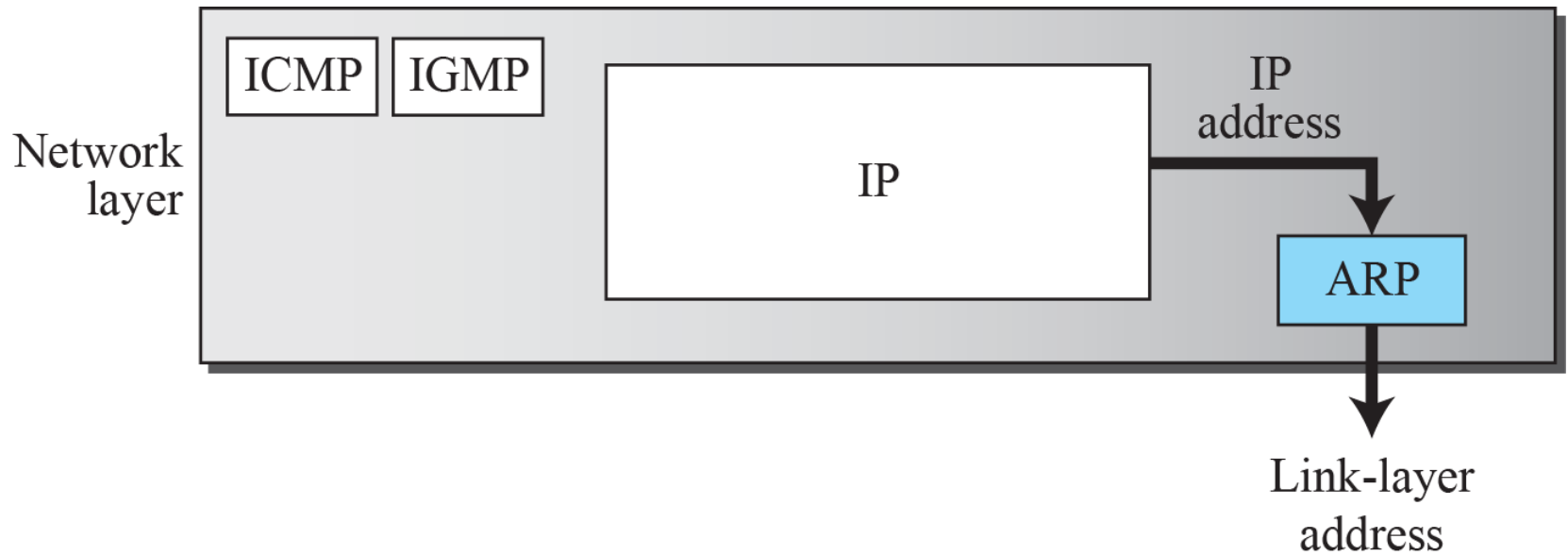
IPv4 address in dotted-decimal notation

172 . 16 . 254 . 1

10101100 . 00010000 . 11111110 . 00000001

8 bits

32 bits (4 bytes)

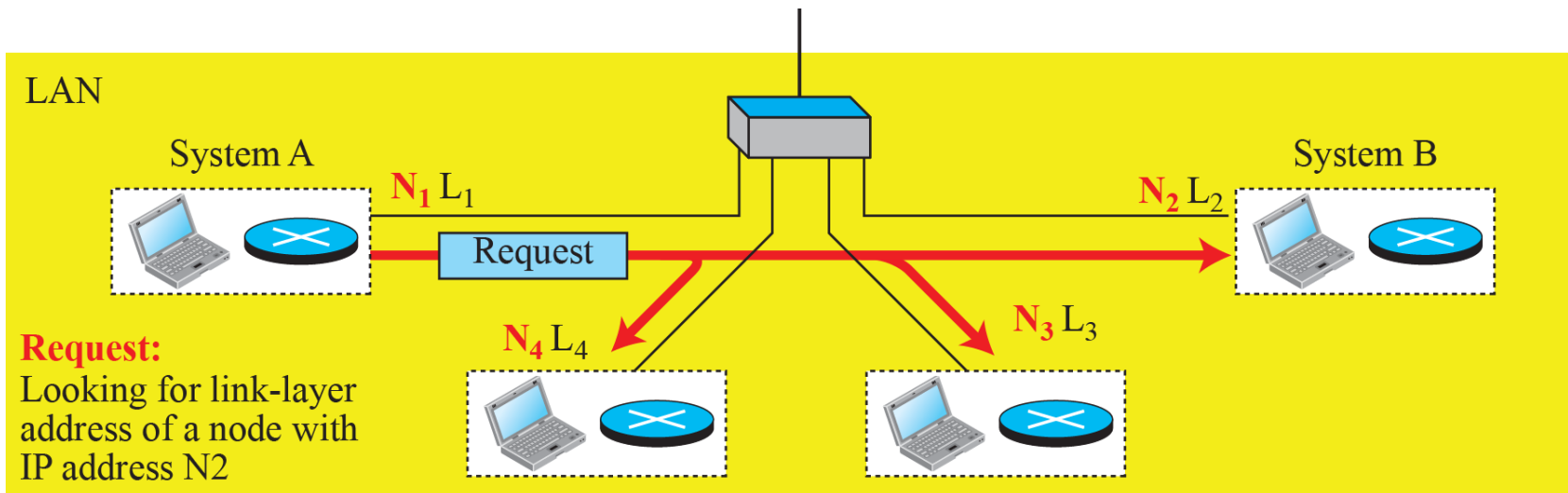*IP addresses and link-layer addresses in a small internet*

ARP

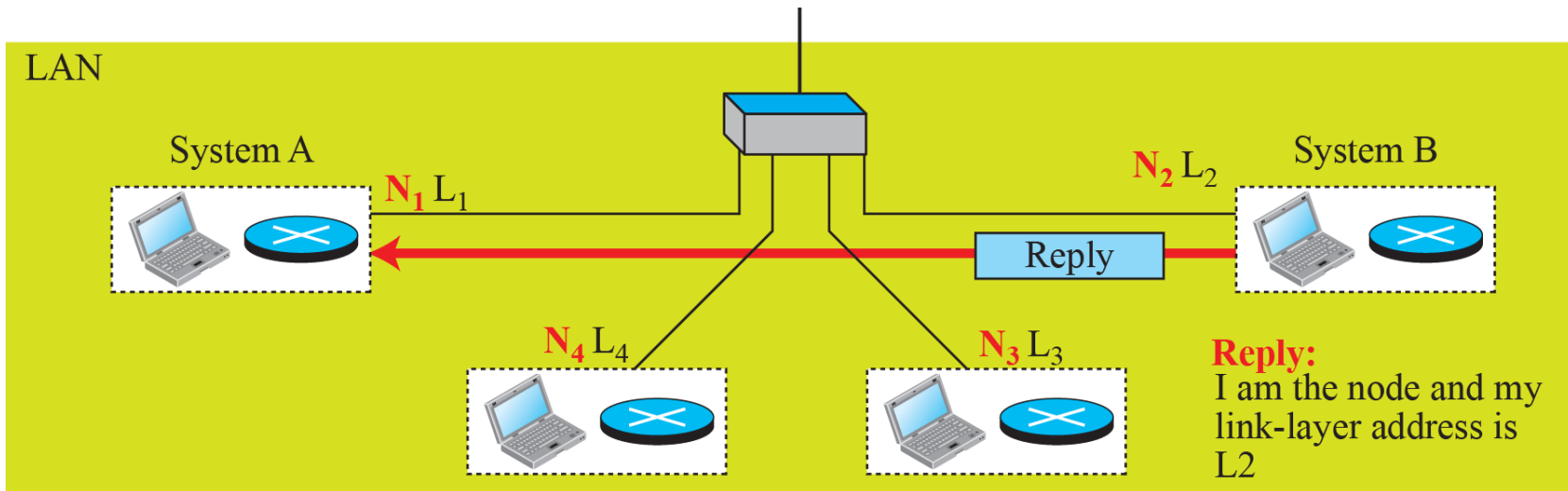- Some link-layer protocols define three types of addresses: unicast, multicast, and broadcast.

- Anytime a node has an IP datagram to send to another node in a link, it has the IP address of the receiving node. However, we need the link-layer address of the next node.

- This is the time when the **Address Resolution Protocol (ARP)** becomes helpful.

Position of ARP in TCP/IP protocol suite

LAN

System A

$N_1 L_1$

Request

Request:
Looking for link-layer
address of a node with
IP address N2

$N_4 L_4$

$N_2 L_2$

System B

$N_3 L_3$

a. ARP request is broadcast

LAN

System A

$N_1 L_1$

Reply

$N_4 L_4$

$N_2 L_2$

System B

$N_3 L_3$

Reply:
I am the node and my
link-layer address is
L2

b. ARP reply is unicast

ARP operation

0	8	16	31
Hardware Type		Protocol Type	
Hardware length	Protocol length	Operation **Request:1, Reply:2**	
Source hardware address			
Source protocol address			
Destination hardware address (Empty in request)			
Destination protocol address			

ARP packet

System A

System B

N1
L1

N2
L2 (Not known by A)

0x0001		0x0800
0x06	0x04	0x0001

ARP request

L1
N1
All 0s
N2

M: Broadcast address

Multicast frame

M	A		Data		❶

Destination   Source.

From A to All

0x0001		0x0800
0x06	0x04	0x0002

ARP reply

L2
N2
L1
N2

Unicast frame

From B to A

❷	A	B		Data	

Destination   Source

9.18
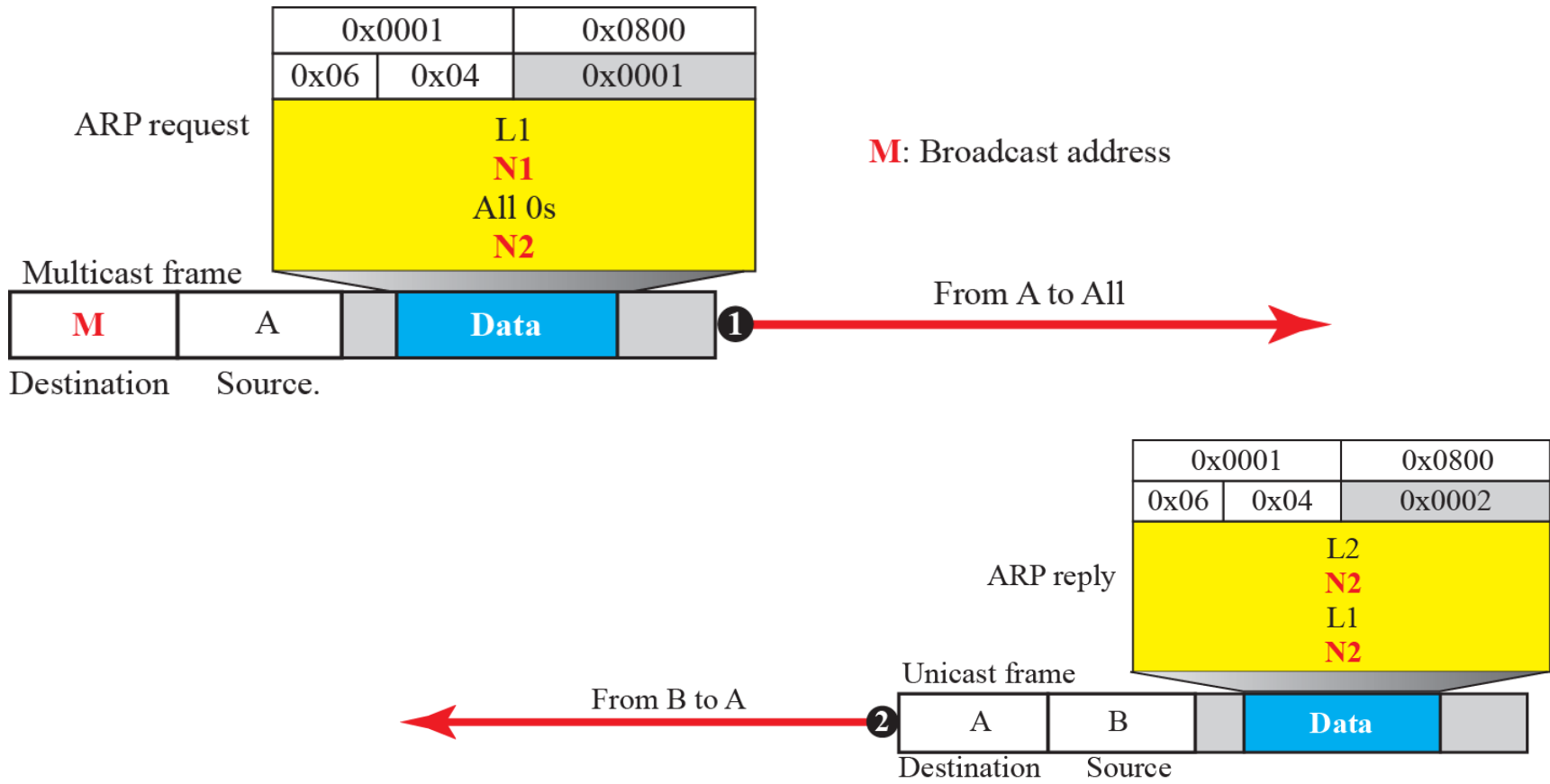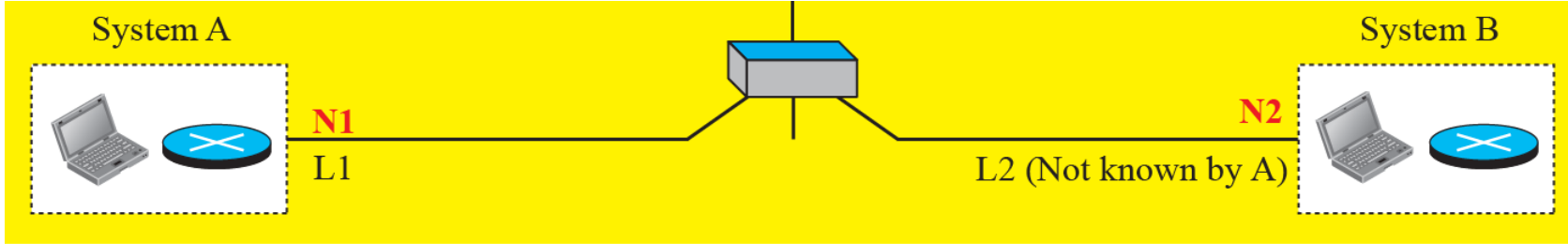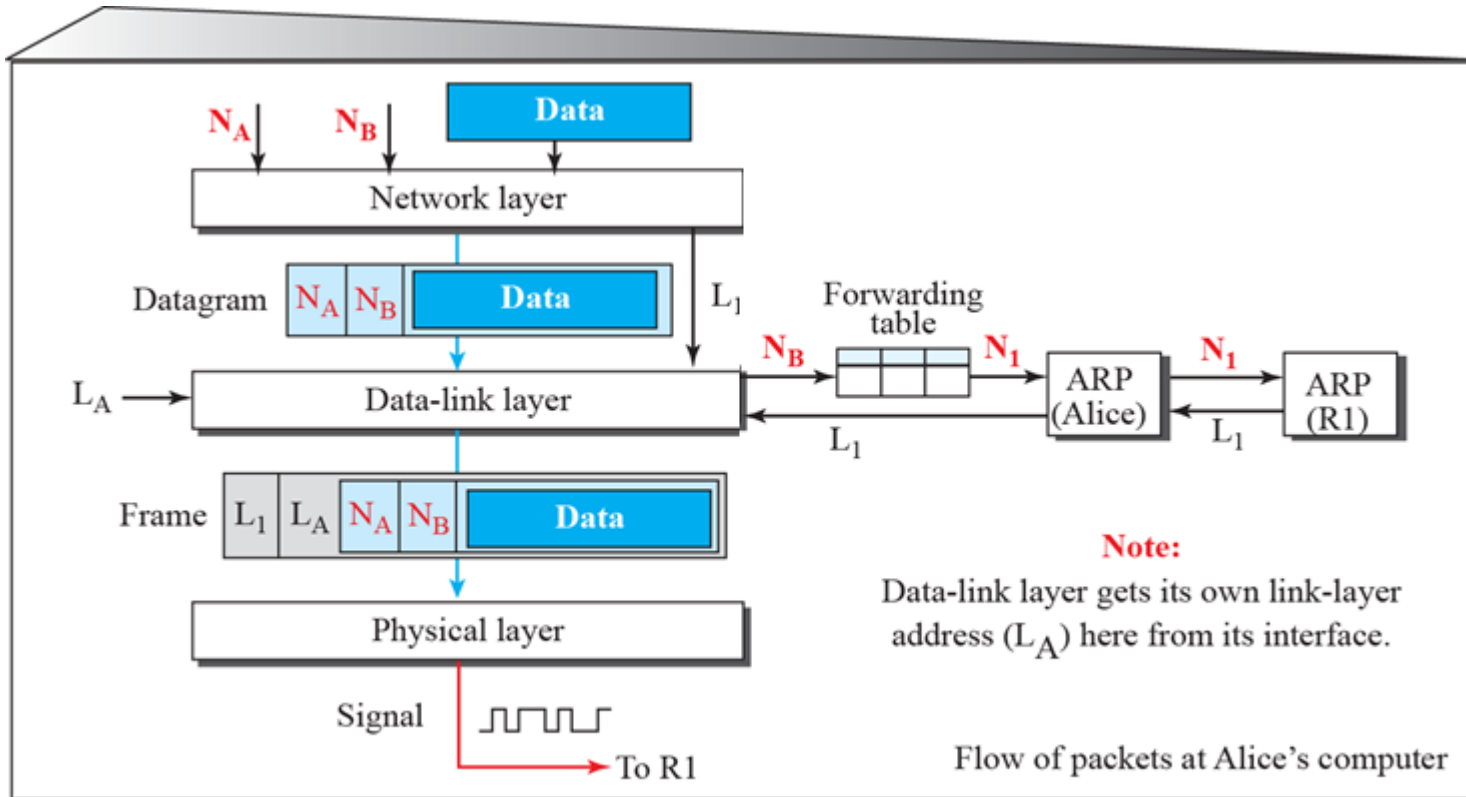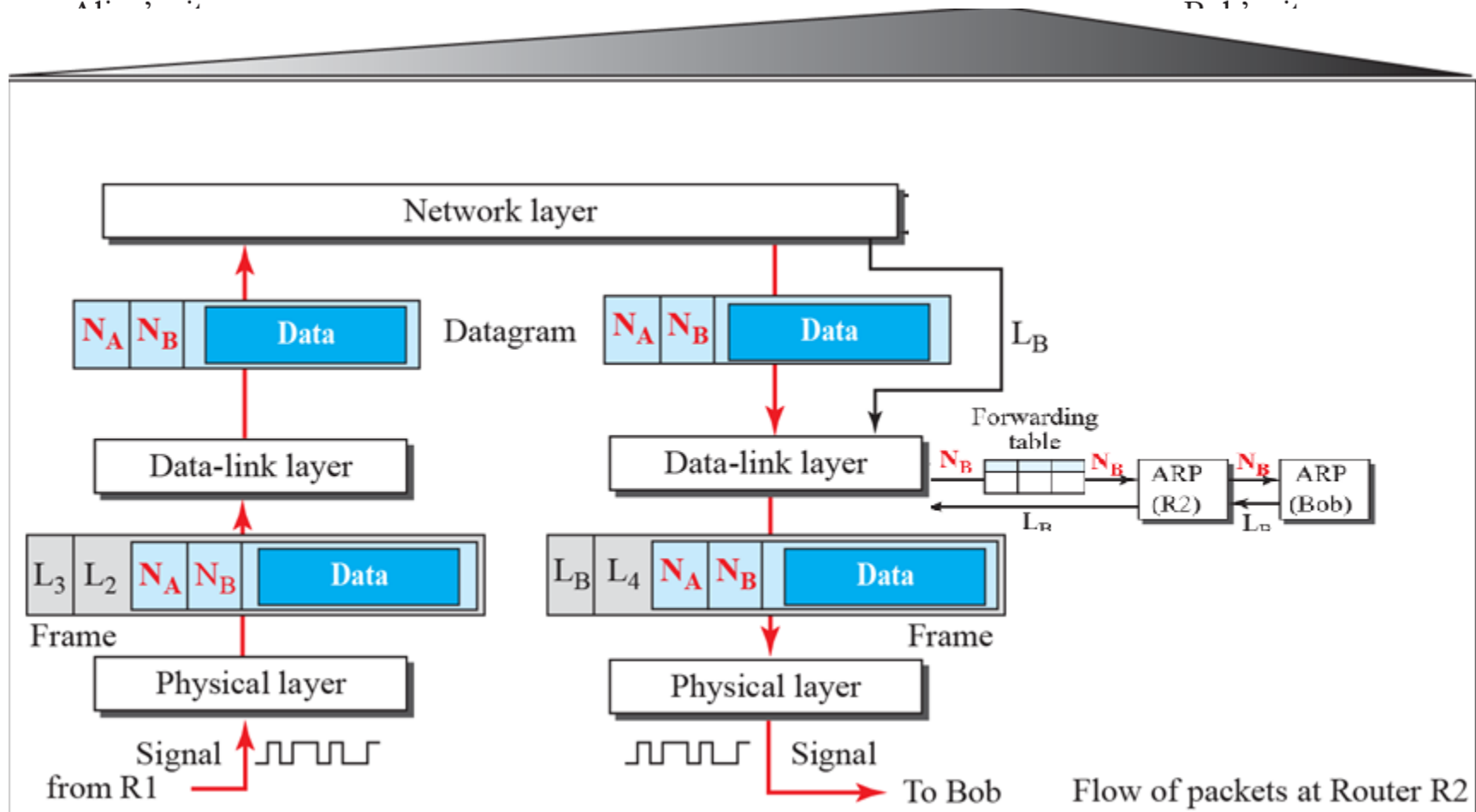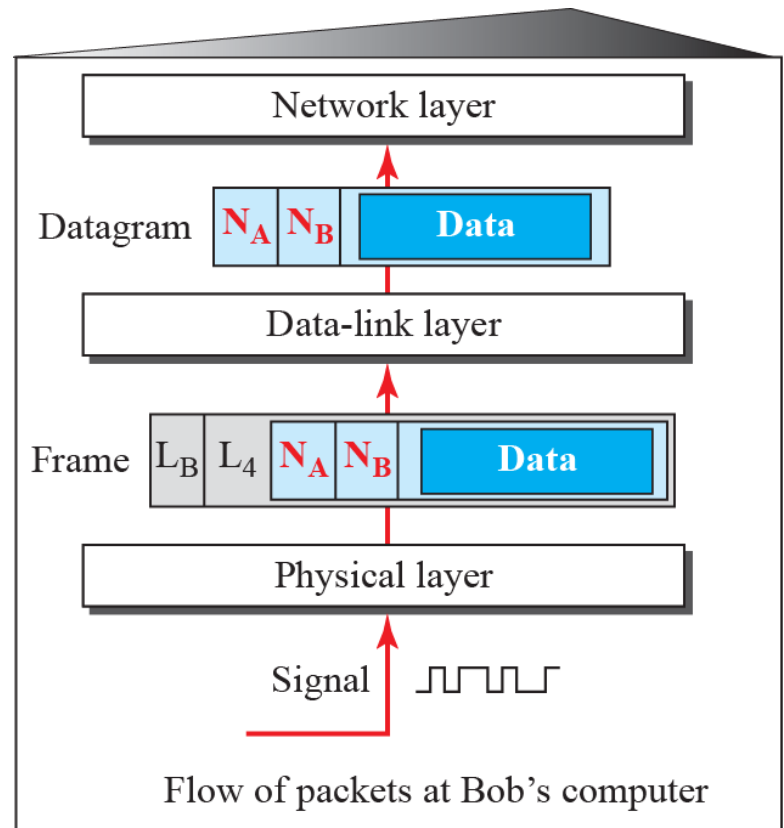
Flow of packets at Alice site
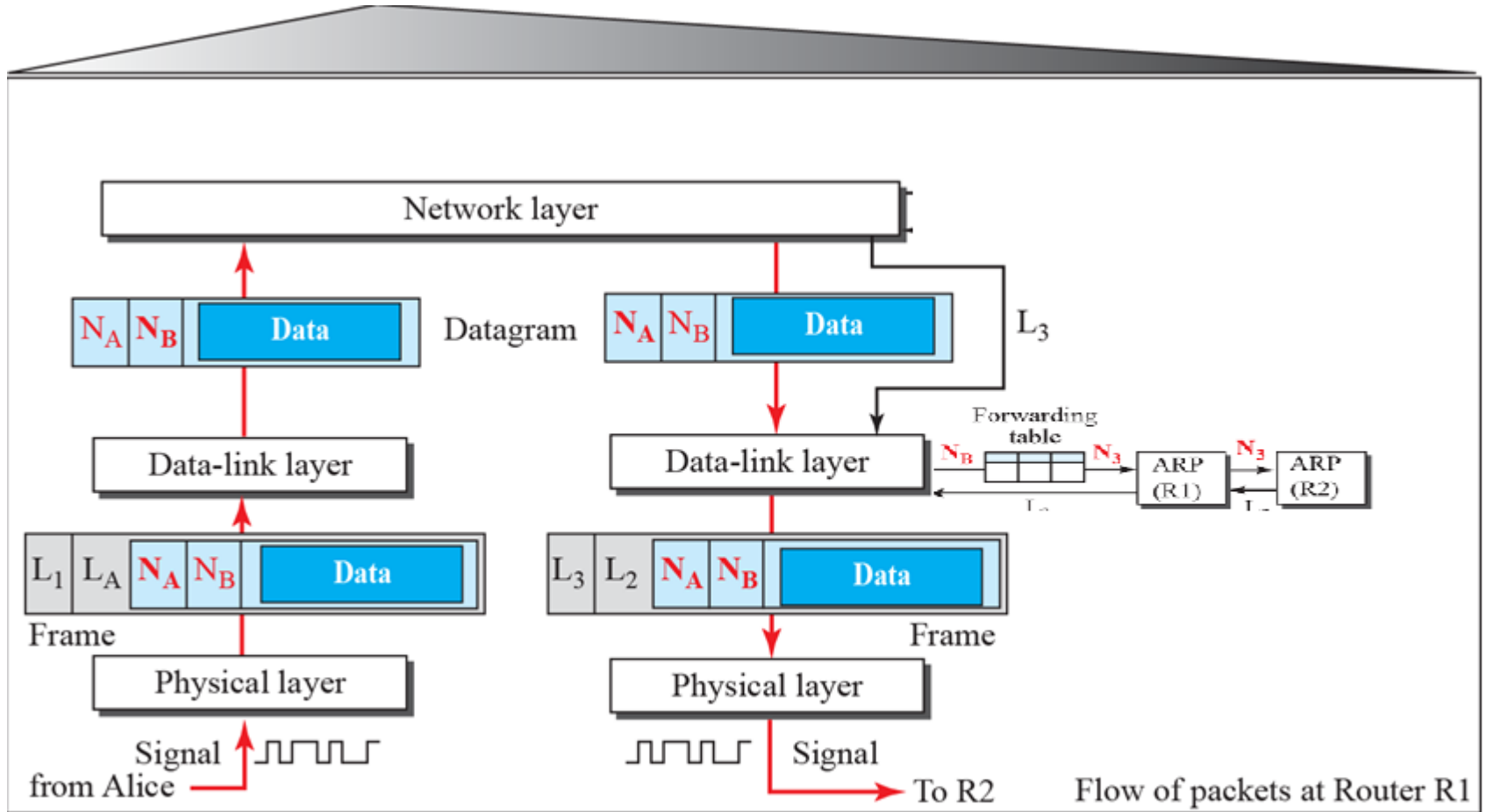
Flow of activities at router R1

Flow of activities at router R2

To another
link

Alice

L_A

Alice's site

L_1 R1 L_2

Point-to-point network

To another
link

L_3 R2 L_4

Bob

L_B

Bob's site

Network layer

Datagram | N_A | N_B | **Data**

Data-link layer

Frame | L_B | L_4 | N_A | N_B | **Data**

Physical layer

Signal

Flow of packets at Bob's computer

Activities at Bob's site