Data Communication
(DC)

Lecture 3a

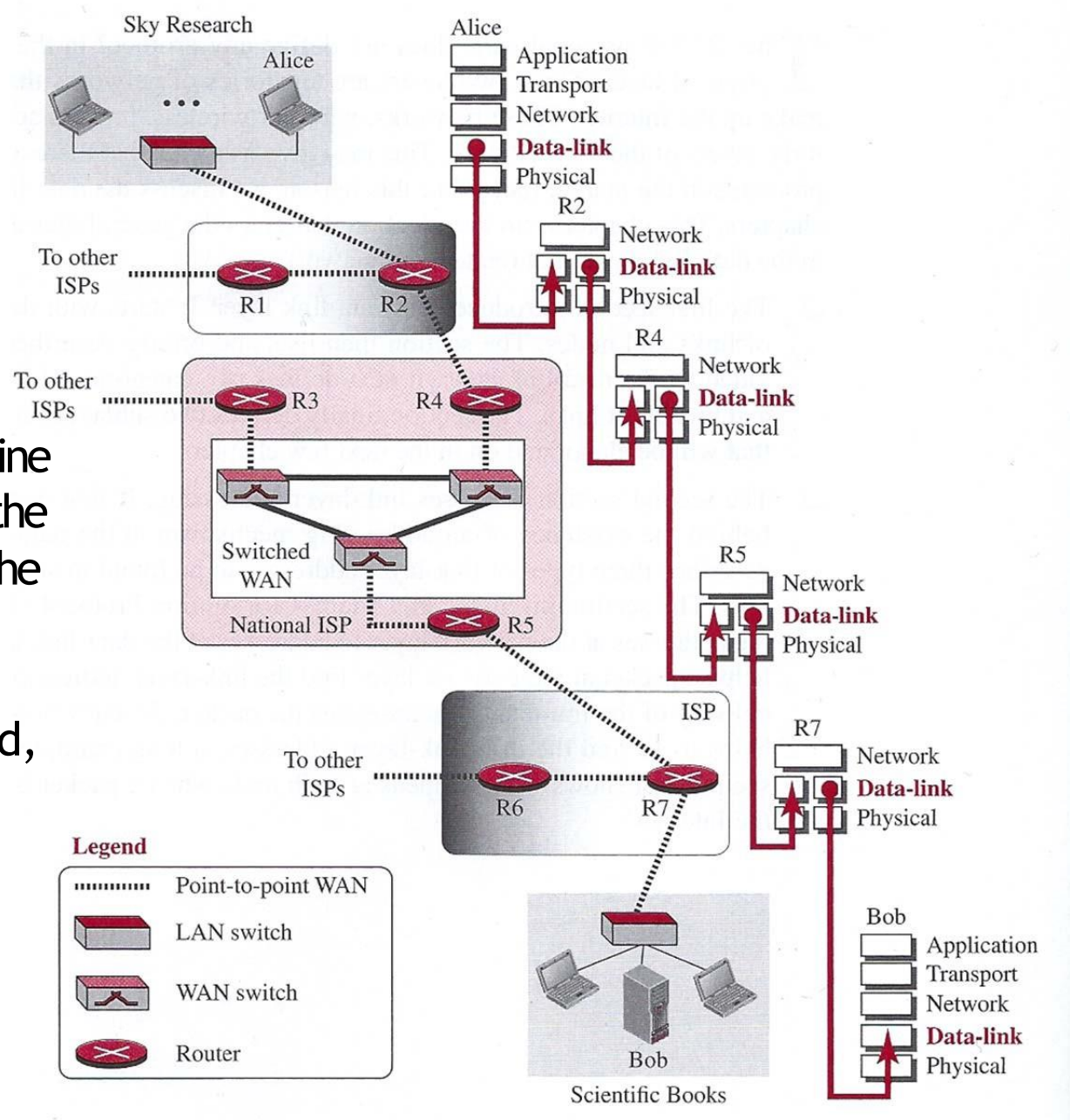
Overview of the contents

- **Nodes and links**
- **Services**
- **Two categories of links**
- **Link-layer addressing**
- **Three types of addresses**
- **Address Resolution Protocol (ARP)**

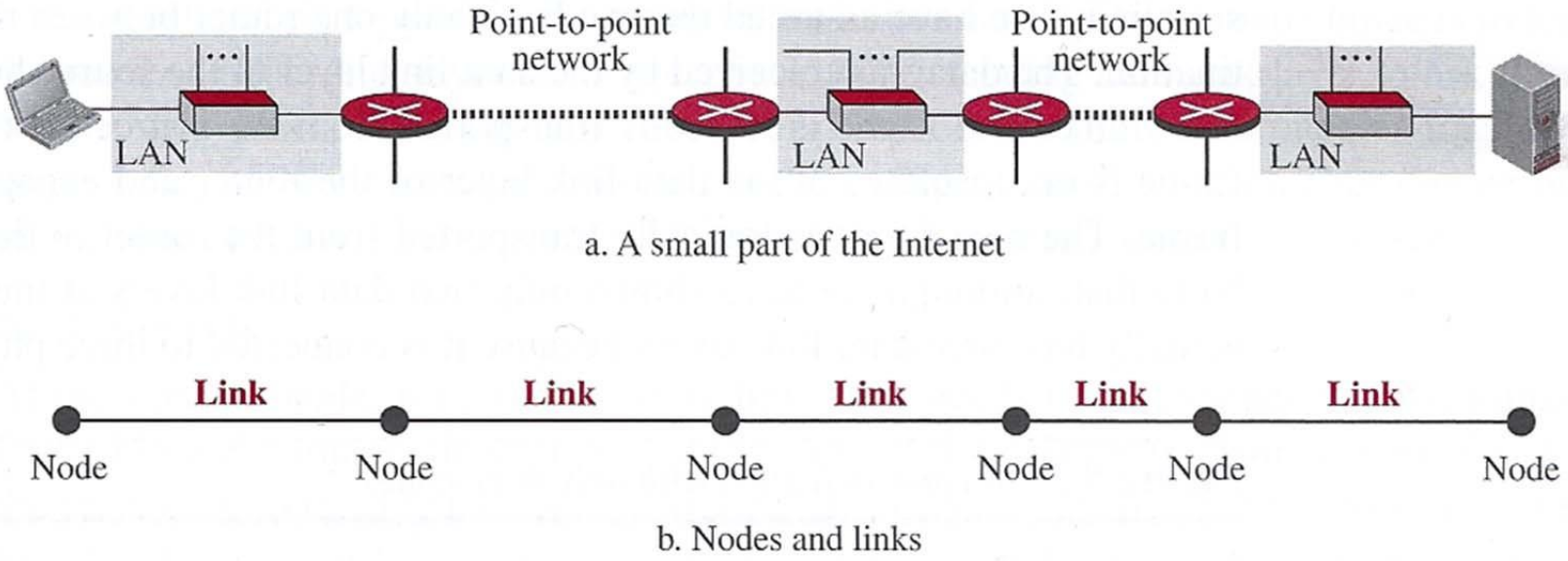
Data Link layer

The TCP/IP protocol suite does not define any protocol in the Data Link Layer or the Physical Layer. These two layers form the networks by themselves.

When these networks are connected, they form the Internet.



Data Link layer

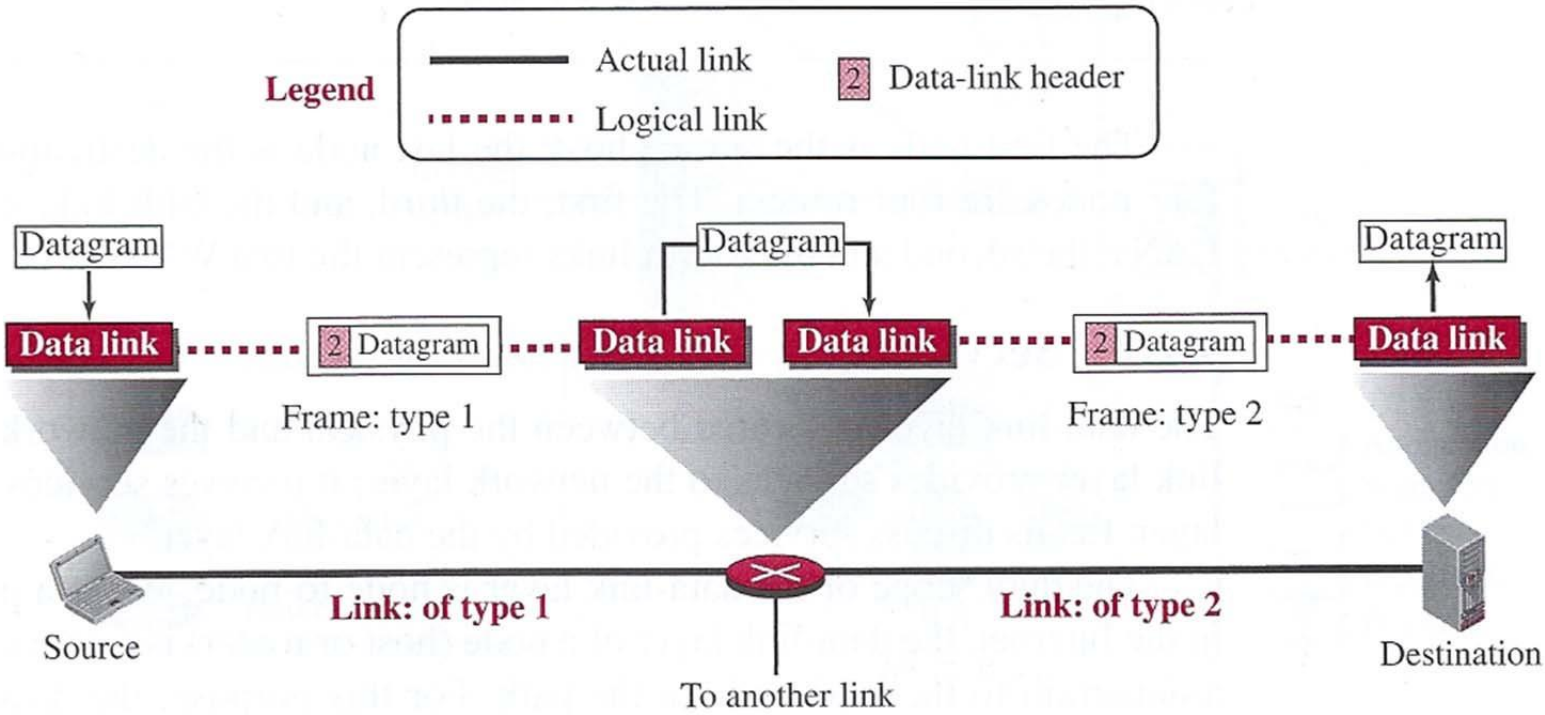


Data Link layer: The purpose of this layer is primarily to perform node-to-node communication.

Nodes: hosts and routers.

links: the networks in between nodes.

Data Link layer



- The sending node encapsulates the datagram in a frame.
- The receiving node decapsulates the datagram from a frame.
- Encapsulation and decapsulation are done for each intermediate node.
- A frame is equipped with a header which contains the receiver and sender info.

Data Link layer: Services

The Data Link Layer offers service to the Network Layer and receives Service from the Physical Layer

- **Framing**

Framing is the first service we have in the Data Link layer. Encapsulation of the datagram with the address information on the receiver and sender nodes.

- **Flow control**

Data Link layer offers flow control to ensure that data does not flood a receiver node. The receiver node is given various options to ask the sender to stop or slow down. Flow control can also be also found in the Transport layer.

- **Error control**

The Data Link layer offers some types of error control including Error detection and Error correction.
A frequently chosen solution is to discard a faulty packet and ask the sender for it to be resent.
Error detection and correction is an issue in every layer.

Data Link layer: Two Categories of Links

It is the Data Link layer that controls how a medium is used.

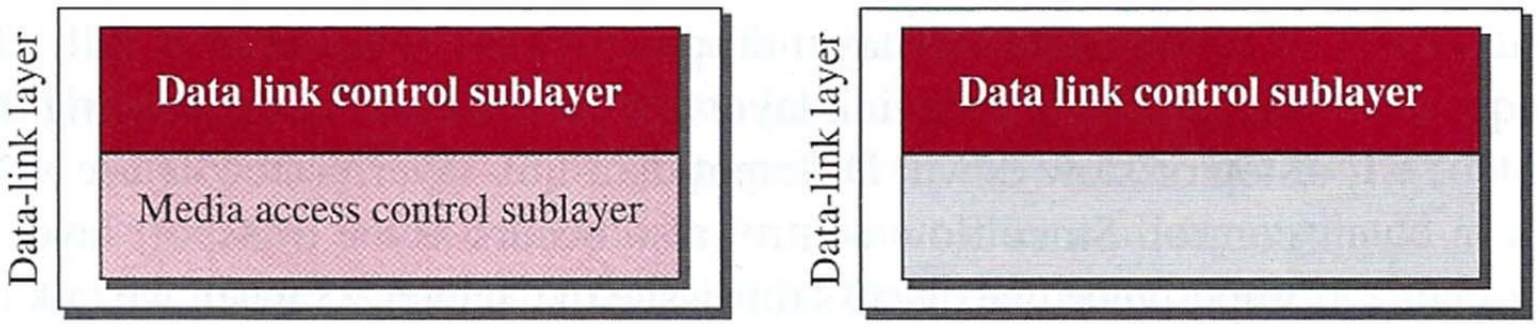
- Data Link layer can use the entire capacity of a link – point-to-point link
- Data Link layer can use only parts of the capacity of a link – Broadcast link (multi-access)

Two Sublayers

To better understand the service that Data Link layer offers. Then we divide the Data Link Layer into two sub-layers

- **D**ata **L**ink **C**ontrol (**DLC**) : this layer takes care of all the issues common to both point-to-point and broadcast links.

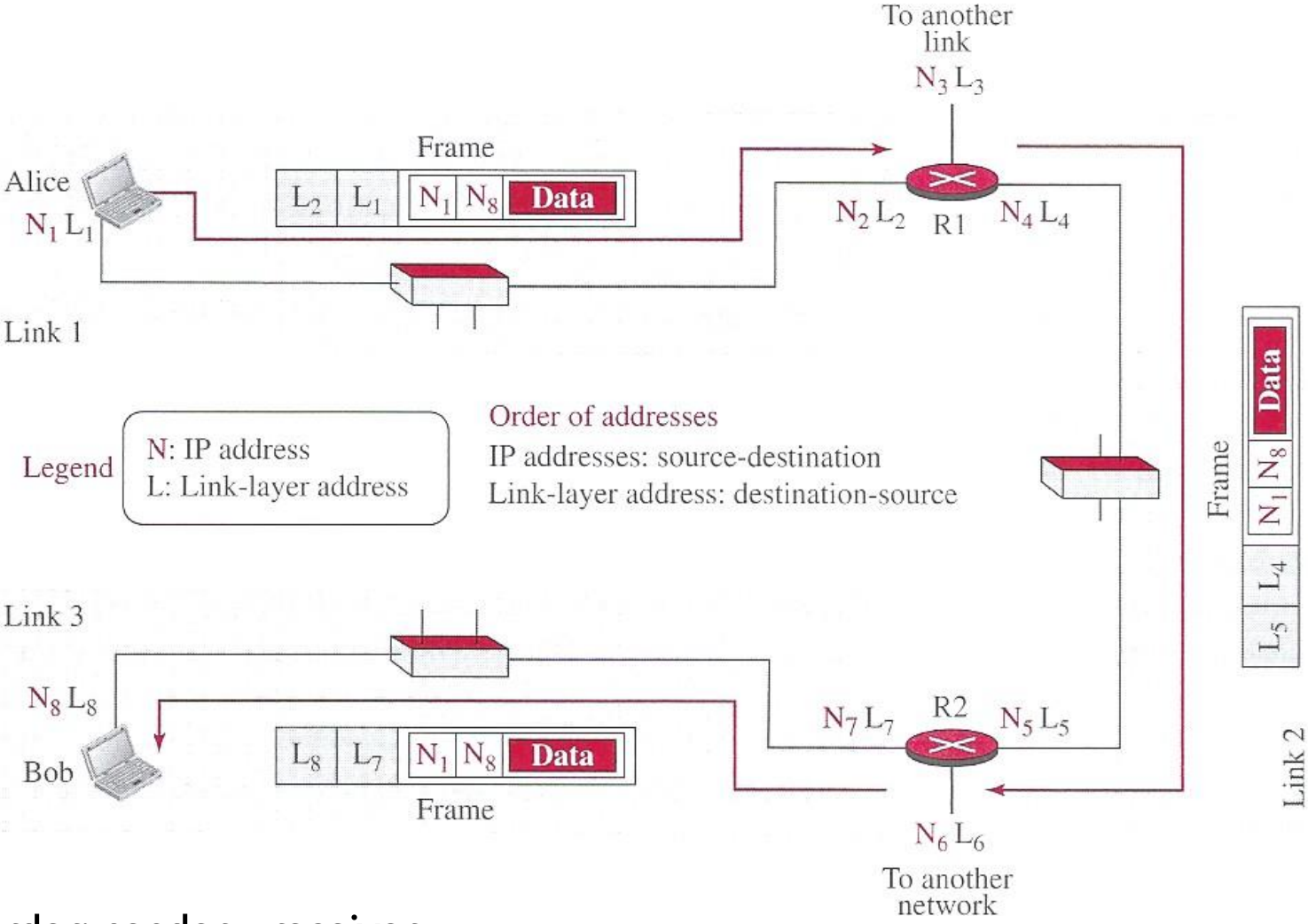
- **M**edia **A**cces **C**ontrol (**MAC**) : Only deals with the issues specific to broadcast links.



a. Data-link layer of a broadcast link

b. Data-link layer of a point-to-point link

Data Link layer: Link-Layer Addressing



Note:

IP address order: sender - receiver

MAC address order: receiver – sender

Note also: the encapsulation from the different layers (network layer N and link layer L)

Data Link layer: Three types of addresses

- **Unicast addressing**: Unicast means **one-to-one communication**. A Unicast address is unique for a node: e.g. – **A3:34:45:11:92:F1**

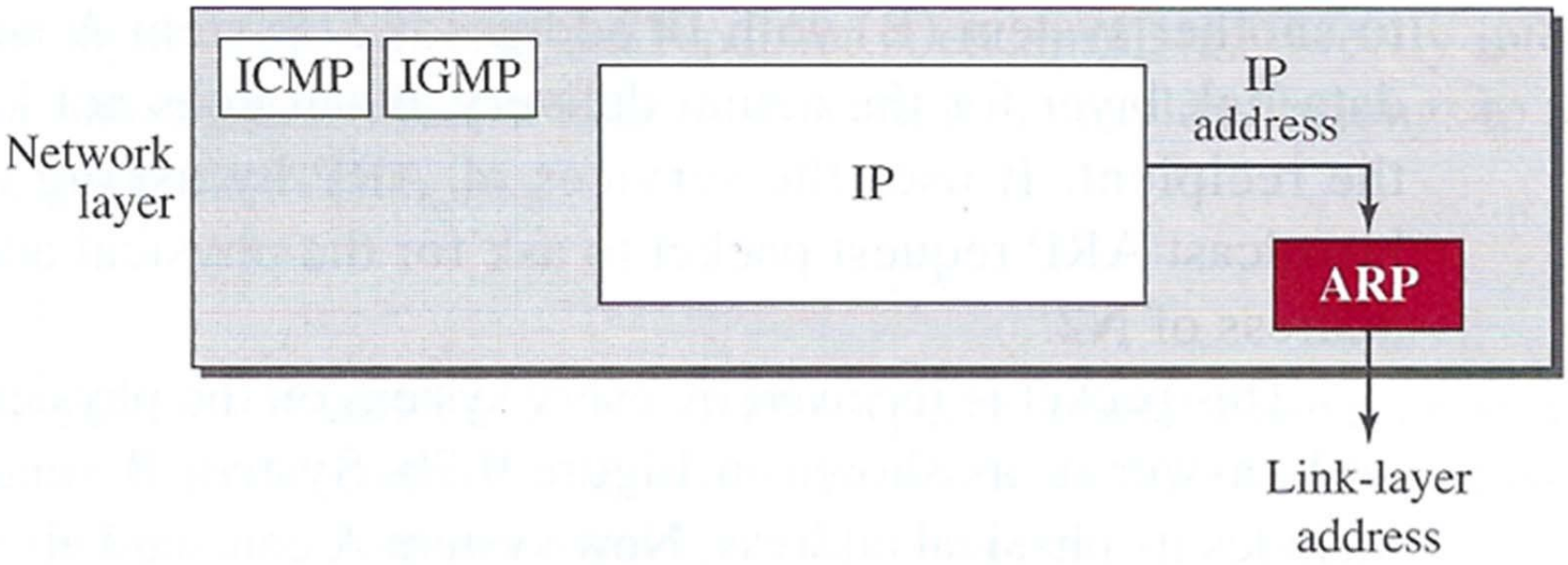
- **Multicast addressing**: Multicast means **one-to-many communication**. Some link layers offer special multicast addresses. But these only apply within the same network and are therefore local. For multicast addresses, the second digit (the 2-digit number in A2) must be an even number, e.g. – **A2:34:45:11:92:F1**

- **Broadcast addressing**: Broadcast means **one-to-all communication**. This means that a frame is sent to all the nodes in a link/network, e.g., – **FF:FF:FF:FF:FF:FF**

Data Link layer: ARP

Address **R**esolution **P**rotocol (**ARP**)

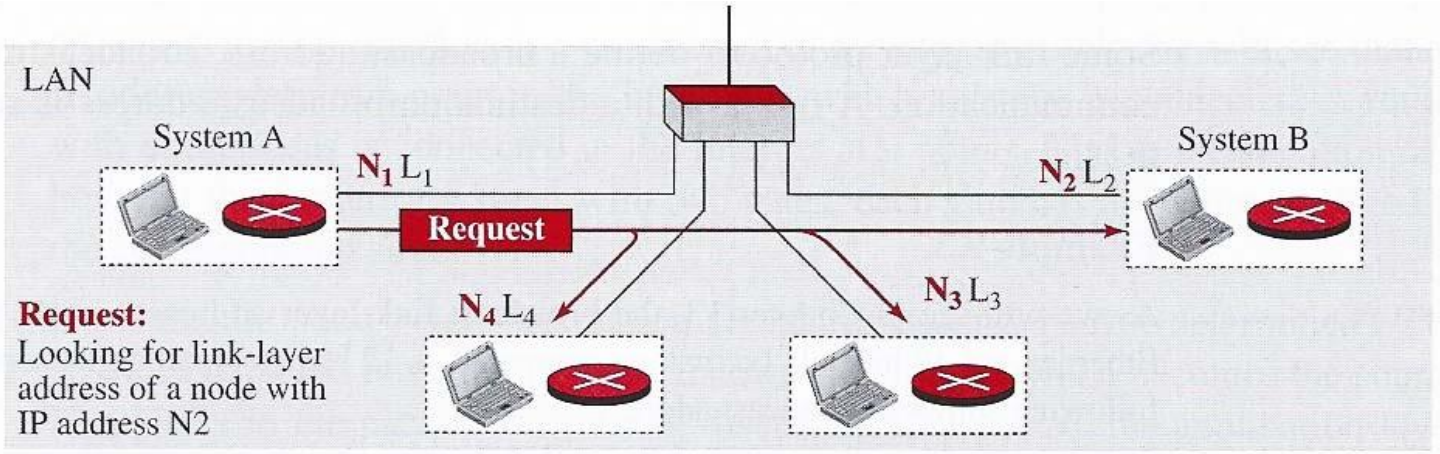
- When an IP datagram is to be sent through the Internet, the IP addresses of the sender and receiver are known.
- However, since the IP datagram is encapsulated and sent from link to link using the Data Link layer, it is essential for a host or router to be able to find the MAC address of the next router or receiver in the chain by using the known IP address of the next router or receiver.
- The ARP protocol is used for this.



Data Link layer: ARP

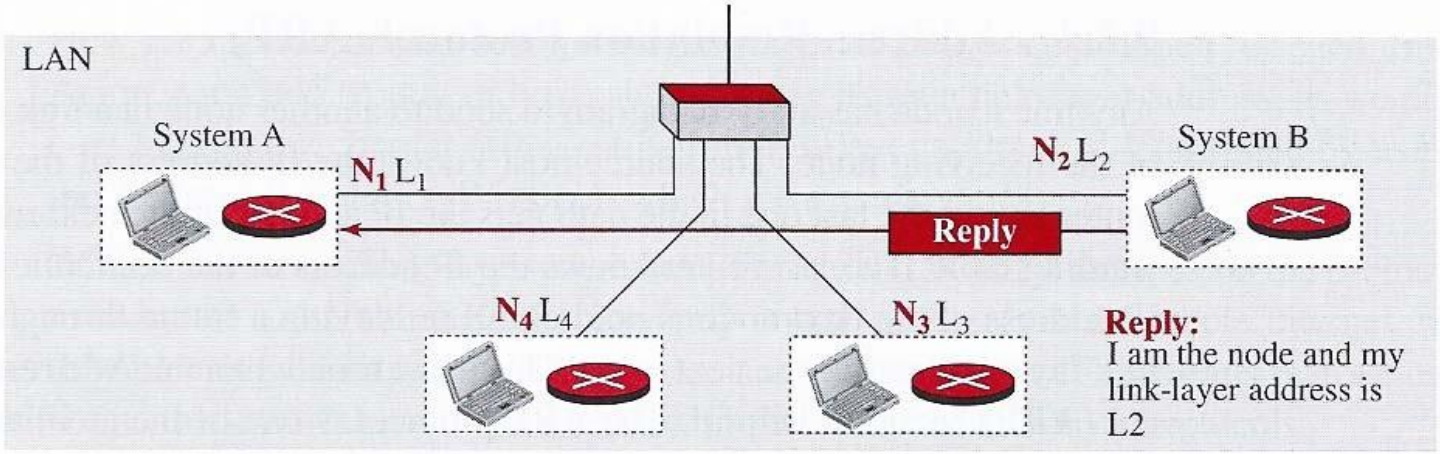
When a host or router needs to find a Data Link layer address of another host or router in its network, an ARP request packet is sent. The package contains the IP and MAC address of the sender and the IP address of the receiver (the MAC address of the receiver is not known, but you want to find)

The request is sent to a broadcast address so that it reaches all nodes in the local network.



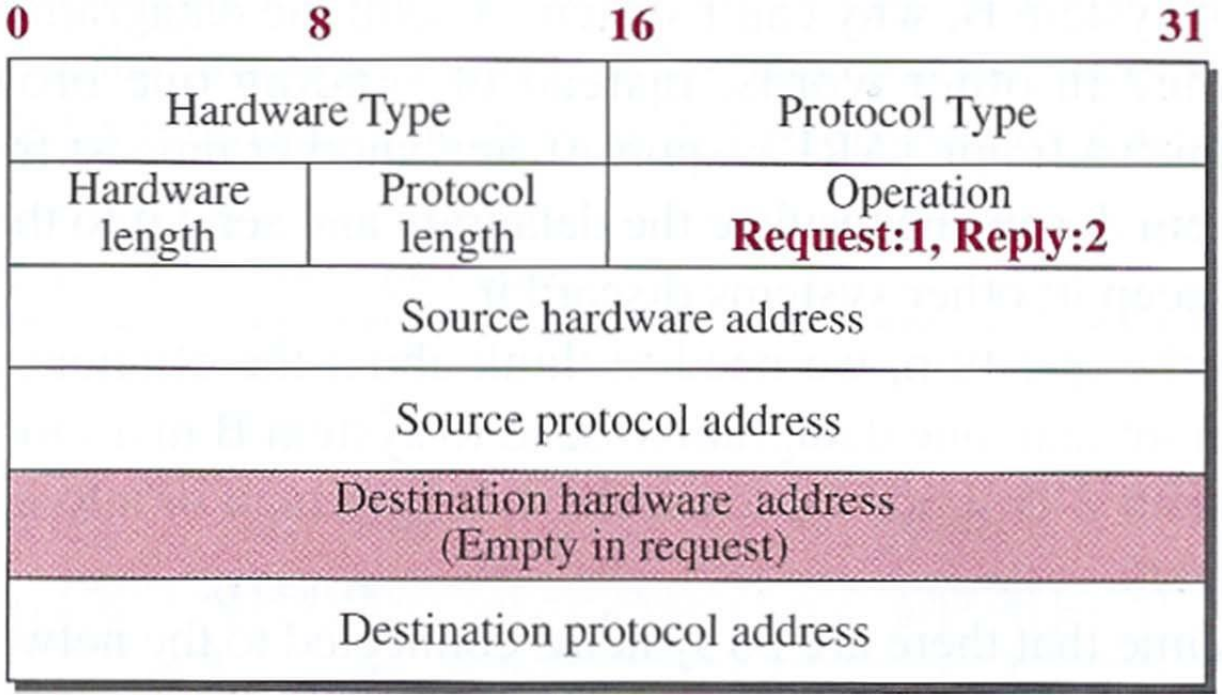
a. ARP request is broadcast

The intended node sends an ARP reply packet back to the sender as Unicast communication (one-to-one)



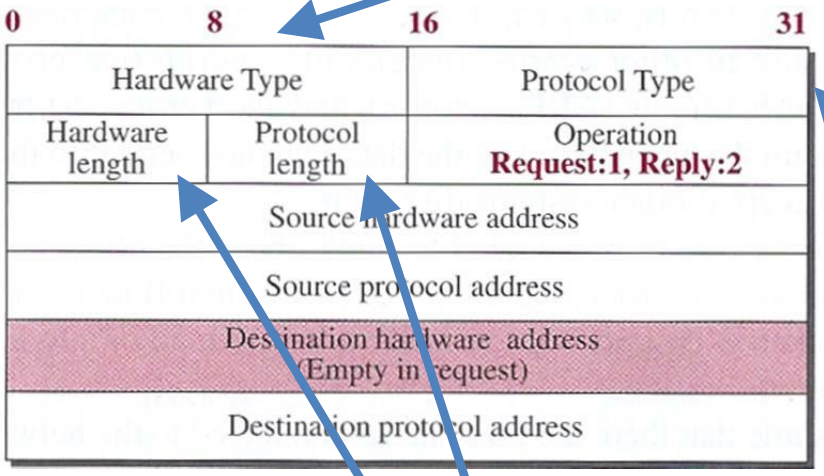
b. ARP reply is unicast

Data Link layer: ARP-Package format



Hardware: LAN or WAN protocol
Protocol: Network-layer protocol

Data Link layer: ARP-Package format



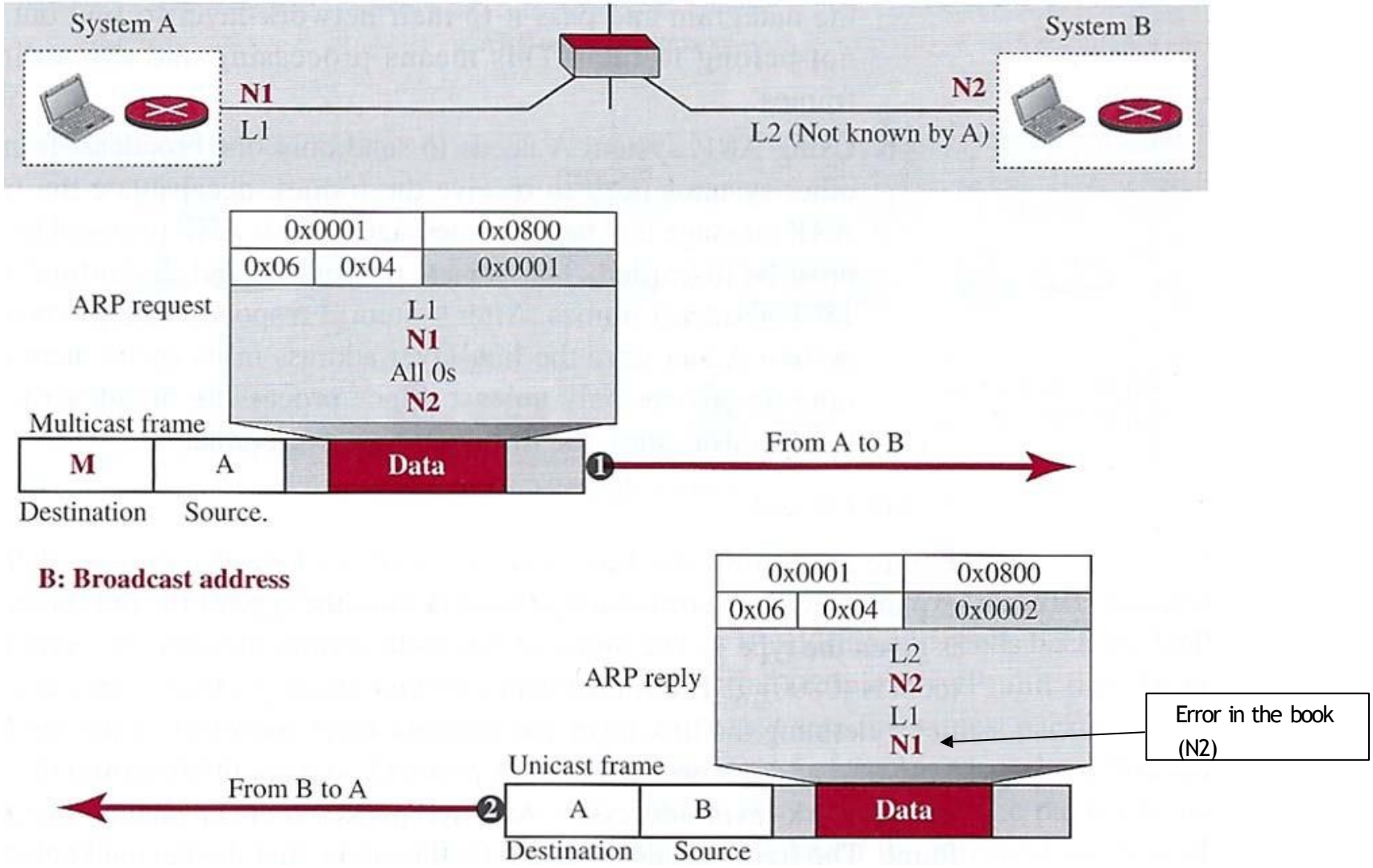
Number	Hardware Type
1	Ethernet
3	X.25
4	Proteon ProNET Token Ring
6	IEEE 802 Networks
7	ARCnet
11	Apple LocalTalk
14	SMDS
15	Frame Relay
16	ATM
17	HDLC
18	Fibre Channel
19	ATM
20	Serial Link

Number	Protocol Type
0x0800	IPv4
0x86DD	IPv6

Protocol address length: Depends on the selected Protocol type.

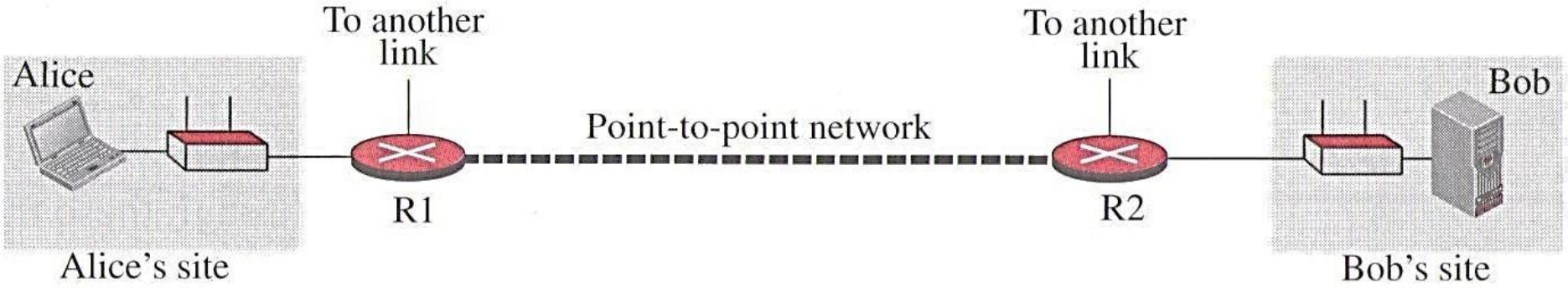
Hardware address length: Depends on the selected Hardware type.

Data Link layer: ARP request/reply example

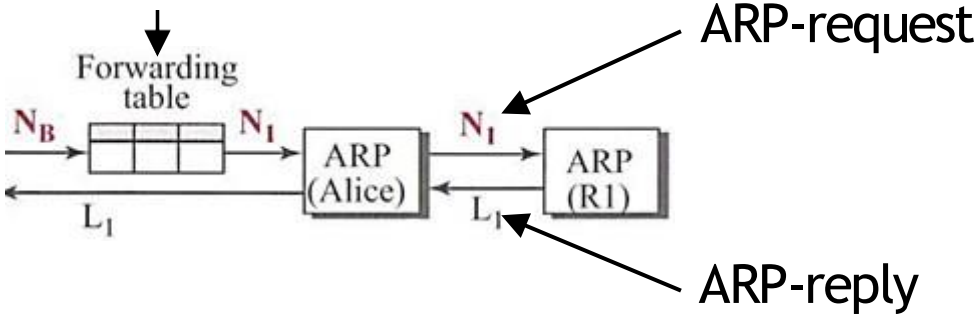


0x001=Ethernet; 0x0800=IPv4; 0x06=MAC-address (6 bytes); 0x04=IP-address (4 bytes in IPv4)

An example of communication



The forwarding table is located in the Network Layer



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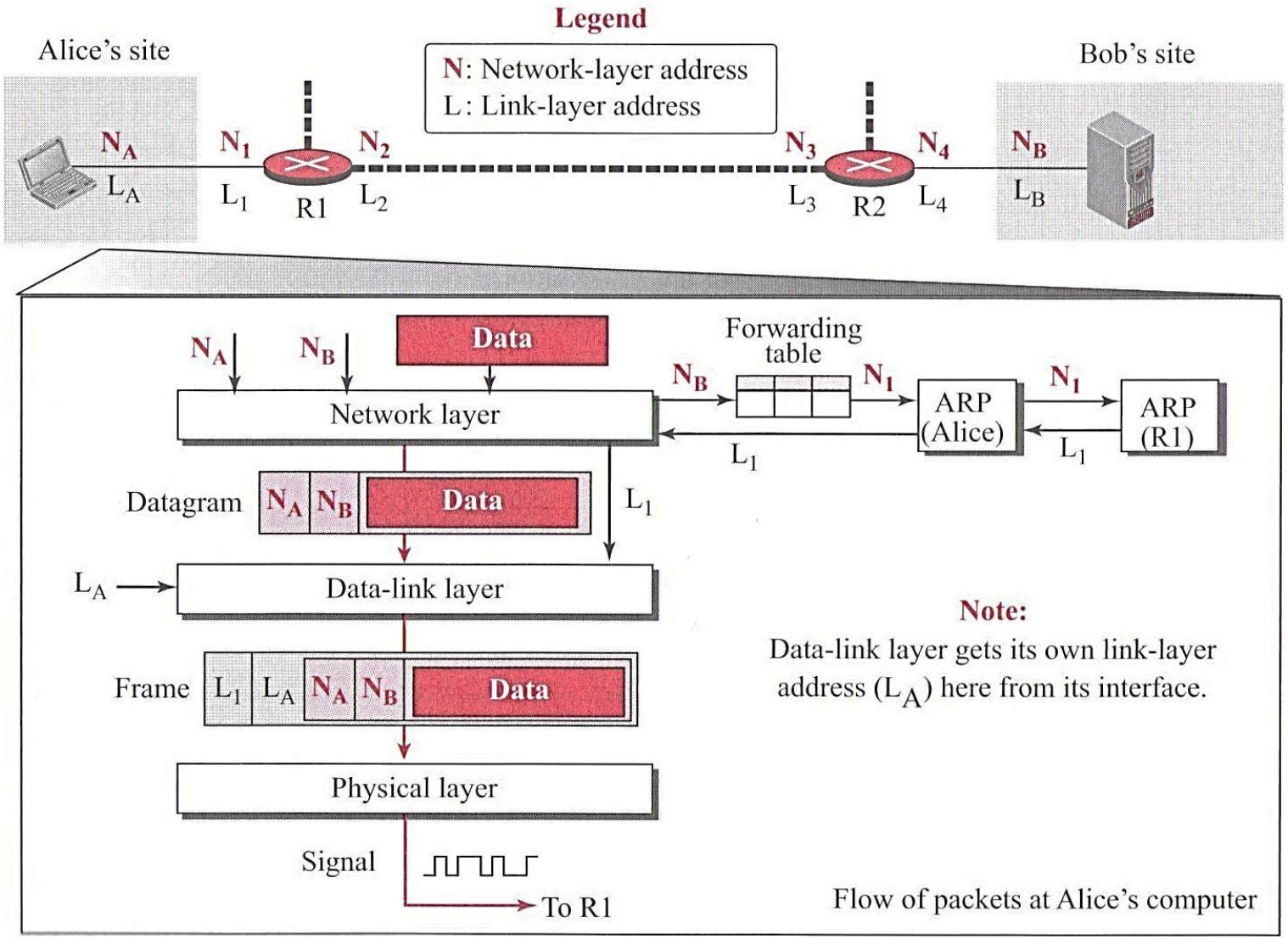

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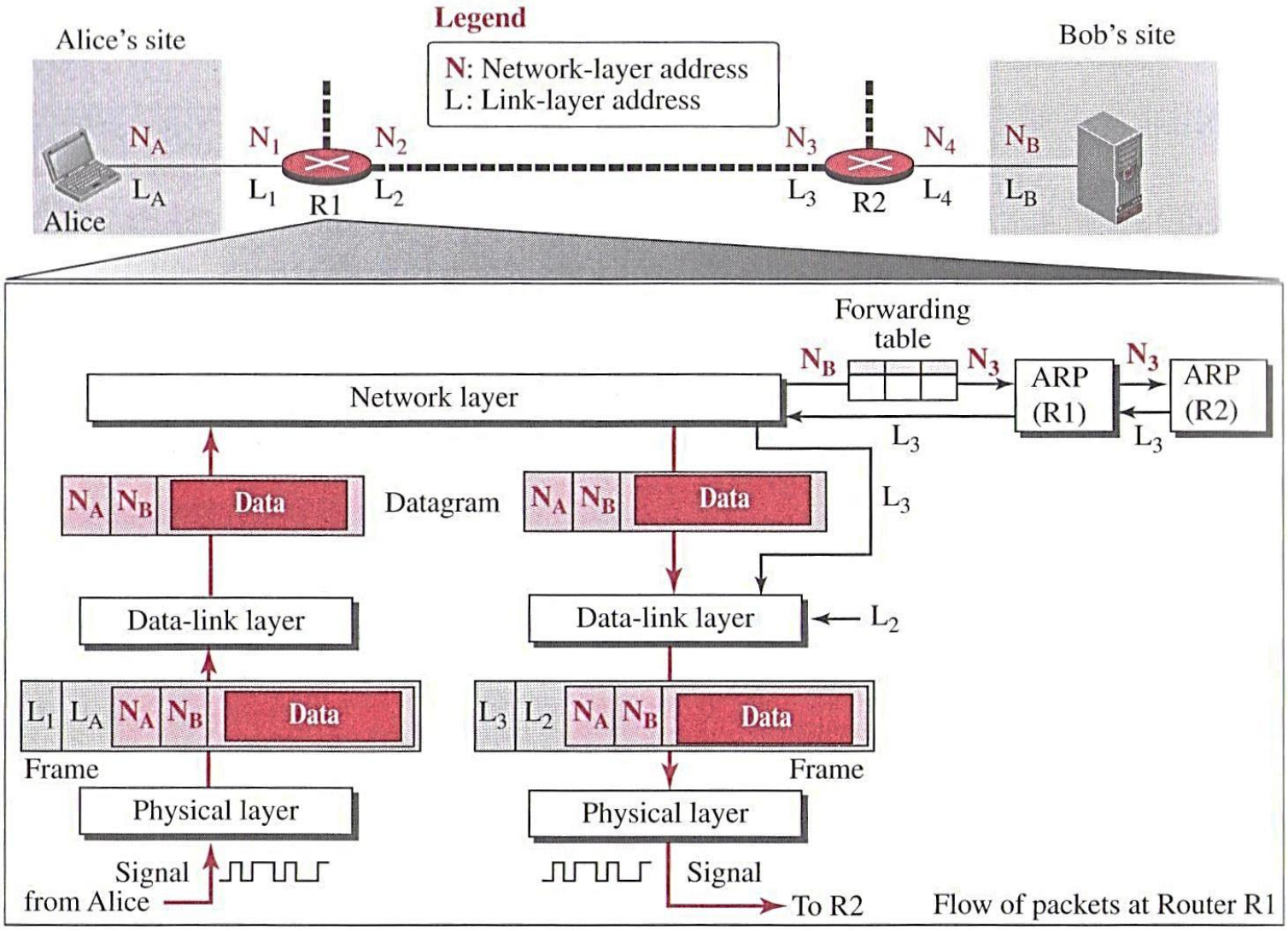
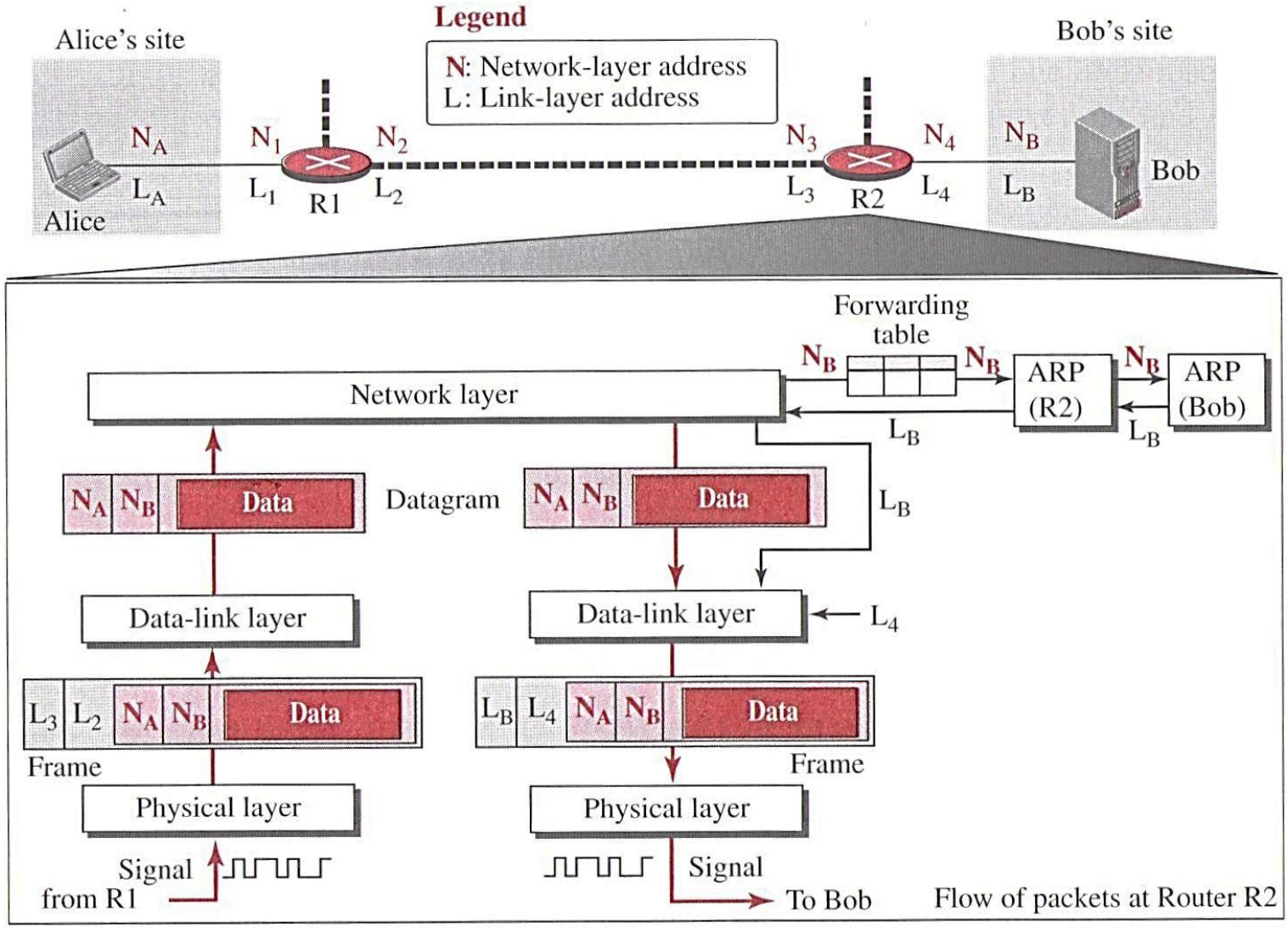


An example of communication



An example of communication