Chapter 5

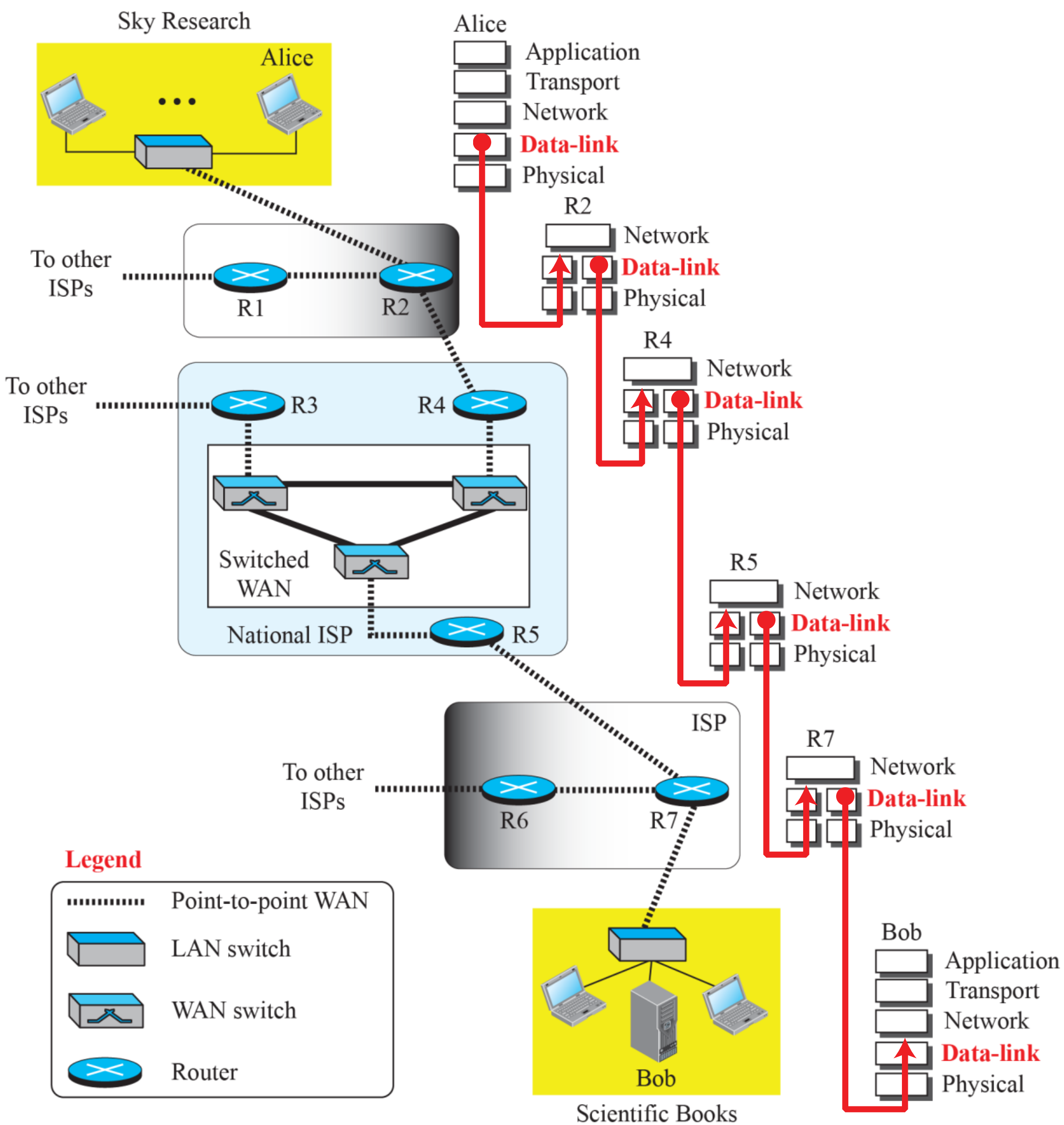
Data-Link Layer:

5-1 INTRODUCTION

The Internet is
- a combination of networks glued together by connecting devices

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

Communication at the data-link layer



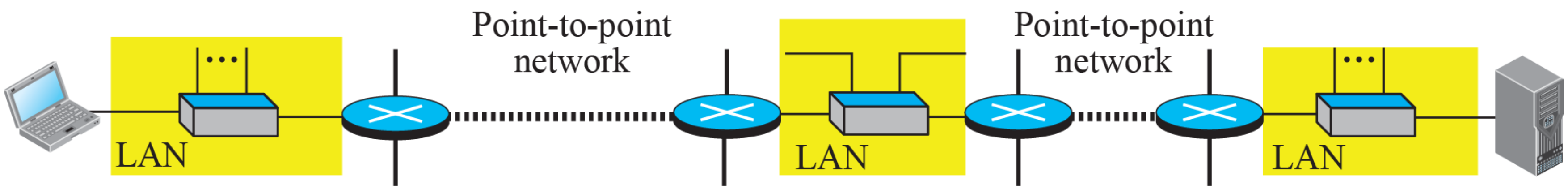
Nodes and Links

- ***Communication at the application, transport, and network layers → end-to-end***

- ***Communication at the data-link layer → node-to node.***

- ***It is customary to refer to the two end hosts and the routers as nodes and the networks in between as links.***

Nodes and Links



a. A small part of the Internet

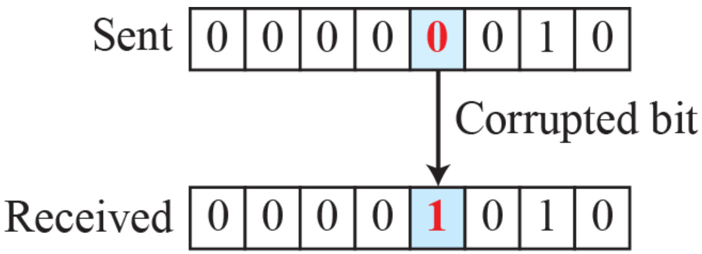
b. Nodes and links

Error Detection and Correction

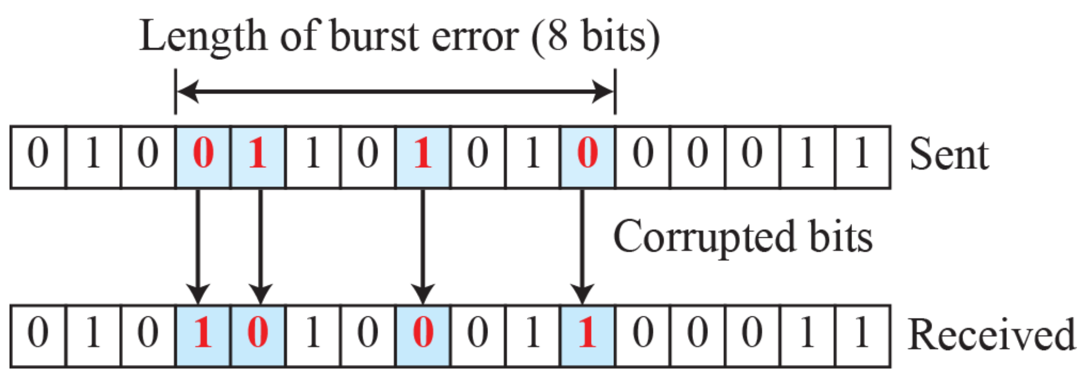
- ***At the data-link layer, if a frame is corrupted between the two nodes, it needs to be corrected before it continues its journey to other nodes.***

- ***Most link-layer protocols simply discard the frame and let the upper-layer protocols handle the retransmission of the frame.***

Single-bit and burst error

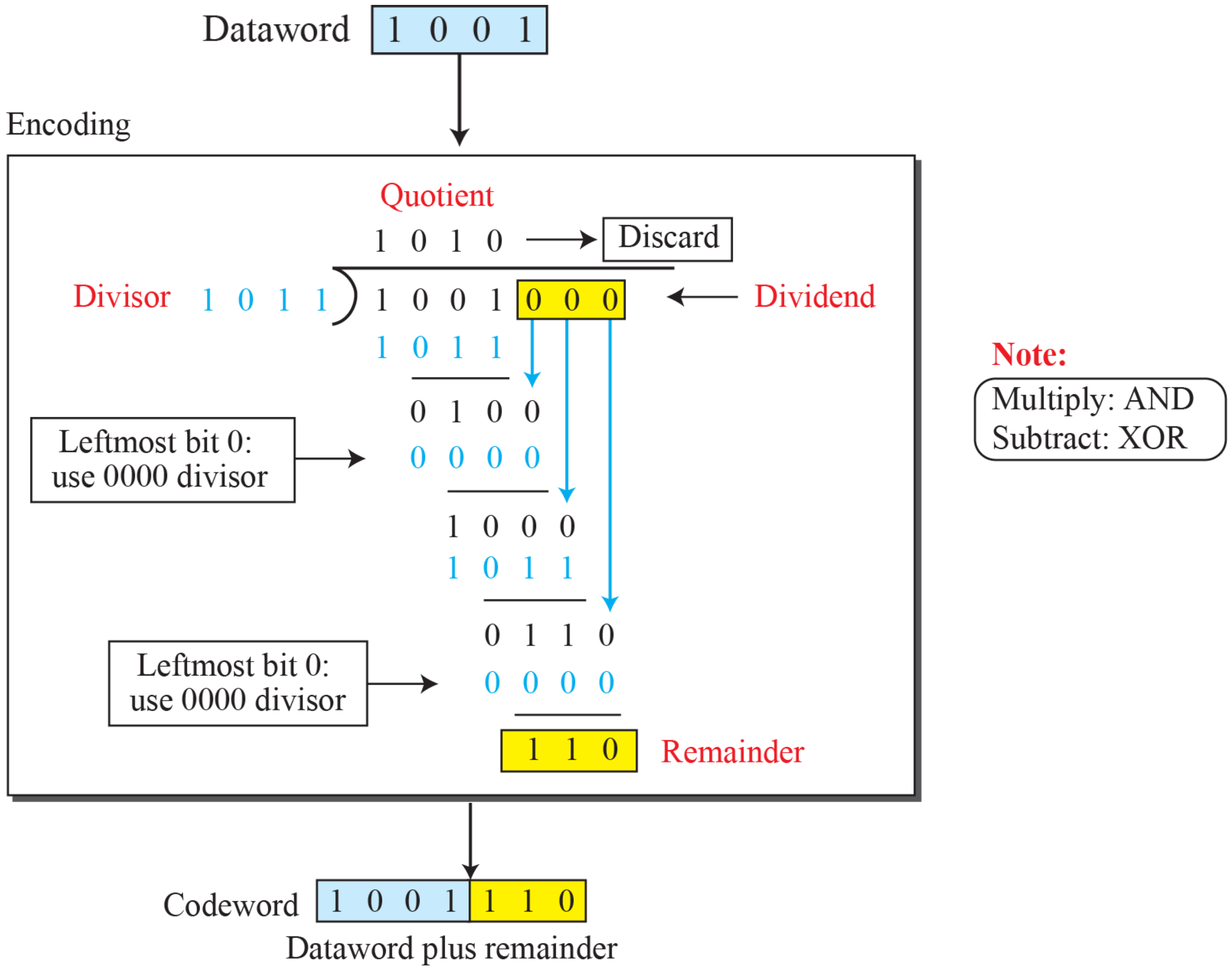


a. Single-bit error

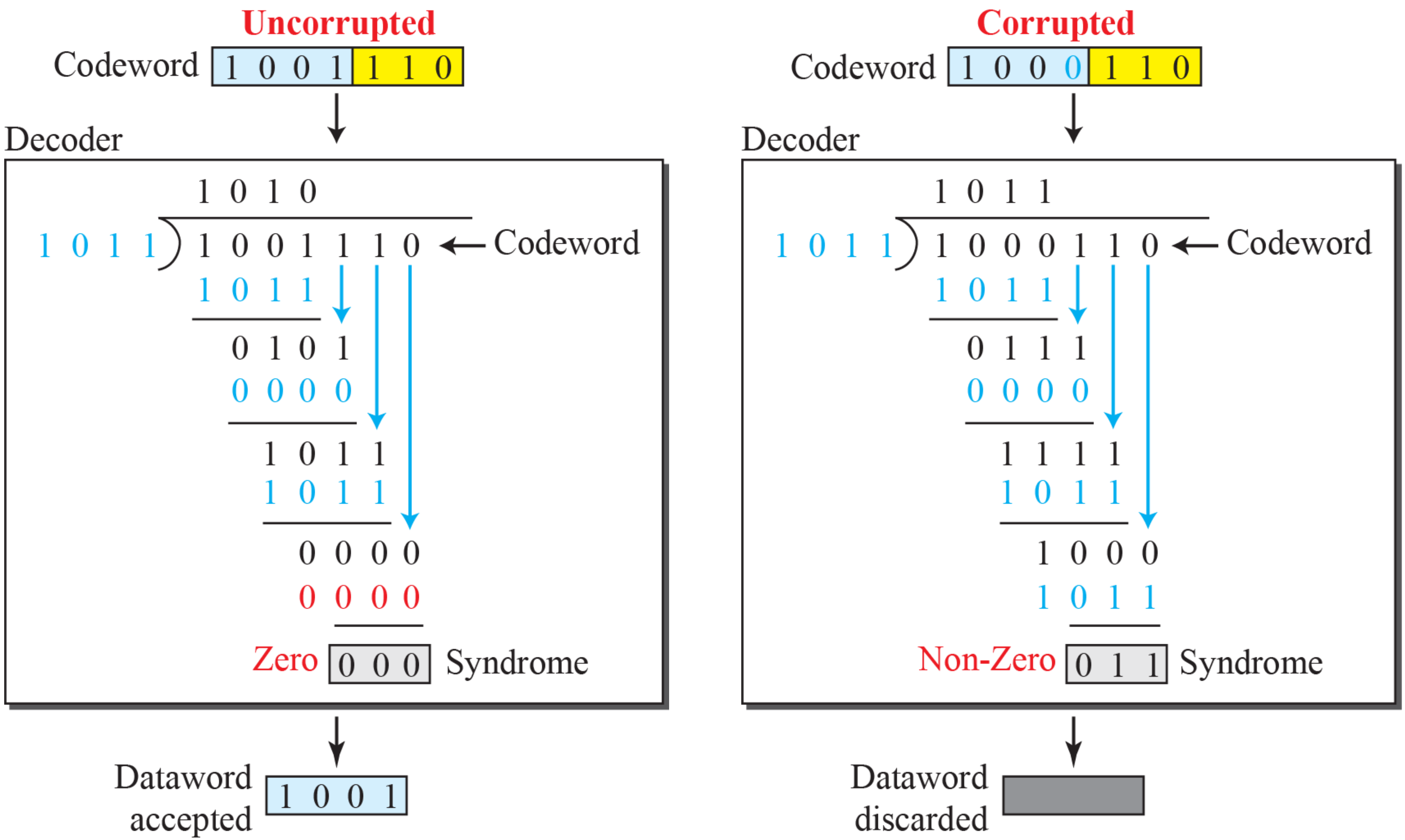


b. Burst error

Division in CRC encoder



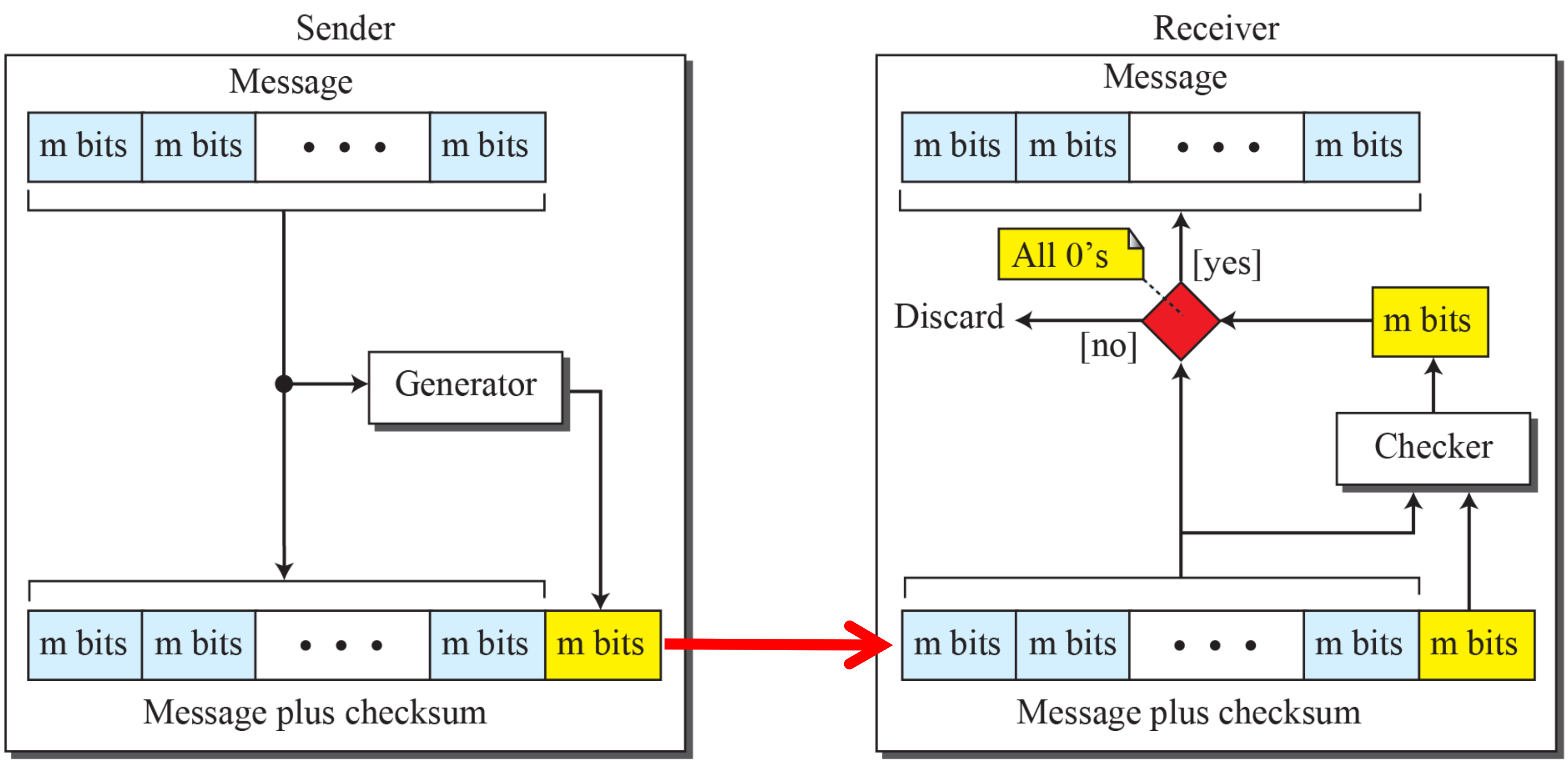
Division in the CRC decoder for two cases



Standard polynomials

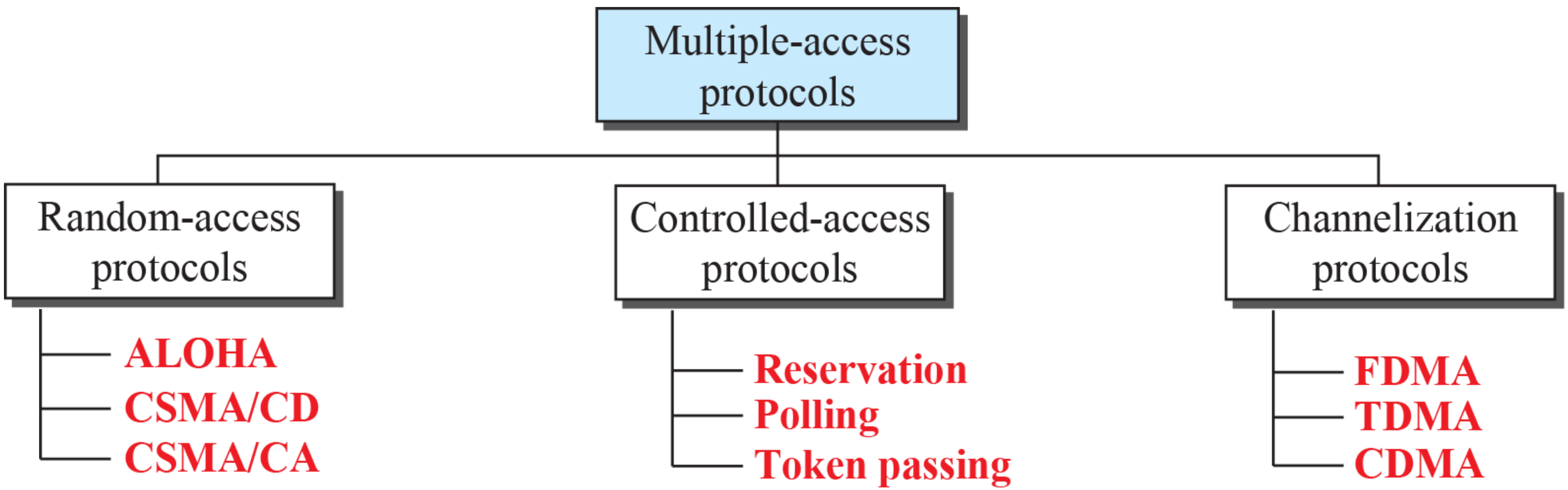
Name	*Binary*	*Application*
CRC-8	100000111	ATM header
CRC-10	11000110101	ATM AAL
CRC-16	10001000000100001	HDLC
CRC-32	100000100110000010001110110110111	LANs

Checksum


Sender
Message
m bits
m bits
• • •
m bits
Generator
m bits
m bits
• • •
m bits
m bits
Message plus checksum
Receiver
Message
m bits
m bits
• • •
m bits
All 0's
[yes]
Discard
[no]
m bits
Checker
m bits
m bits
• • •
m bits
m bits
Message plus checksum

MULTIPLE ACCESS PROTOCOLS

Taxonomy of multiple-access protocols

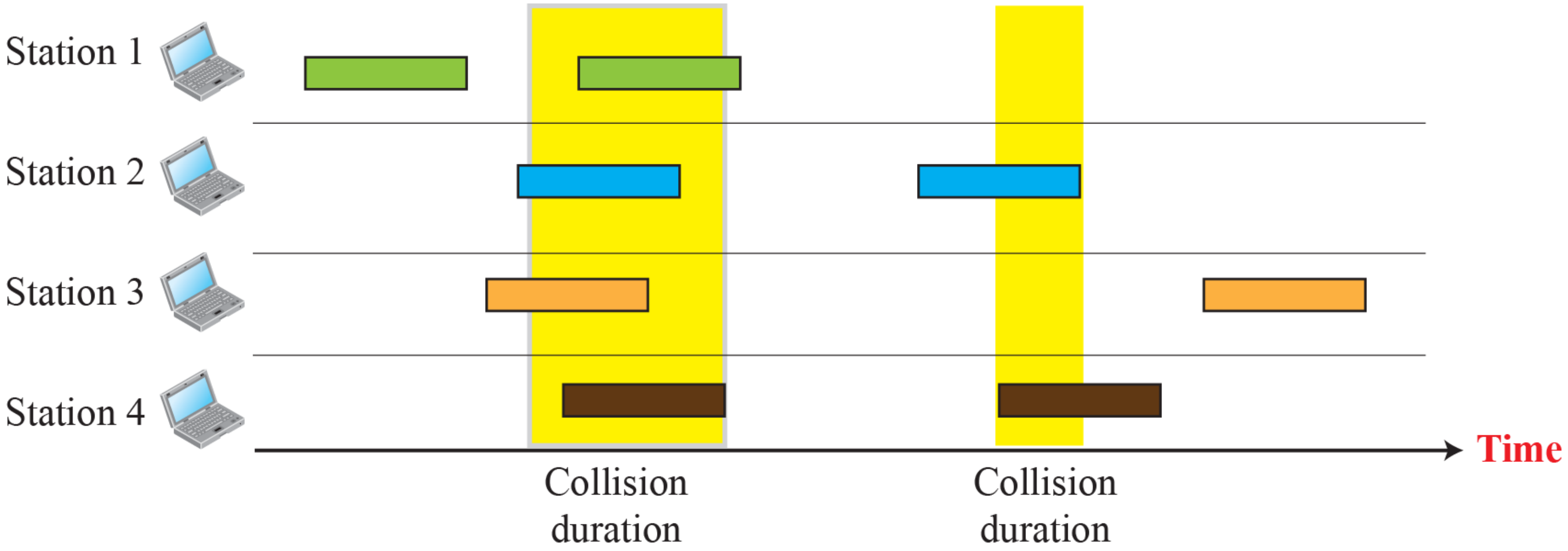


Random Access

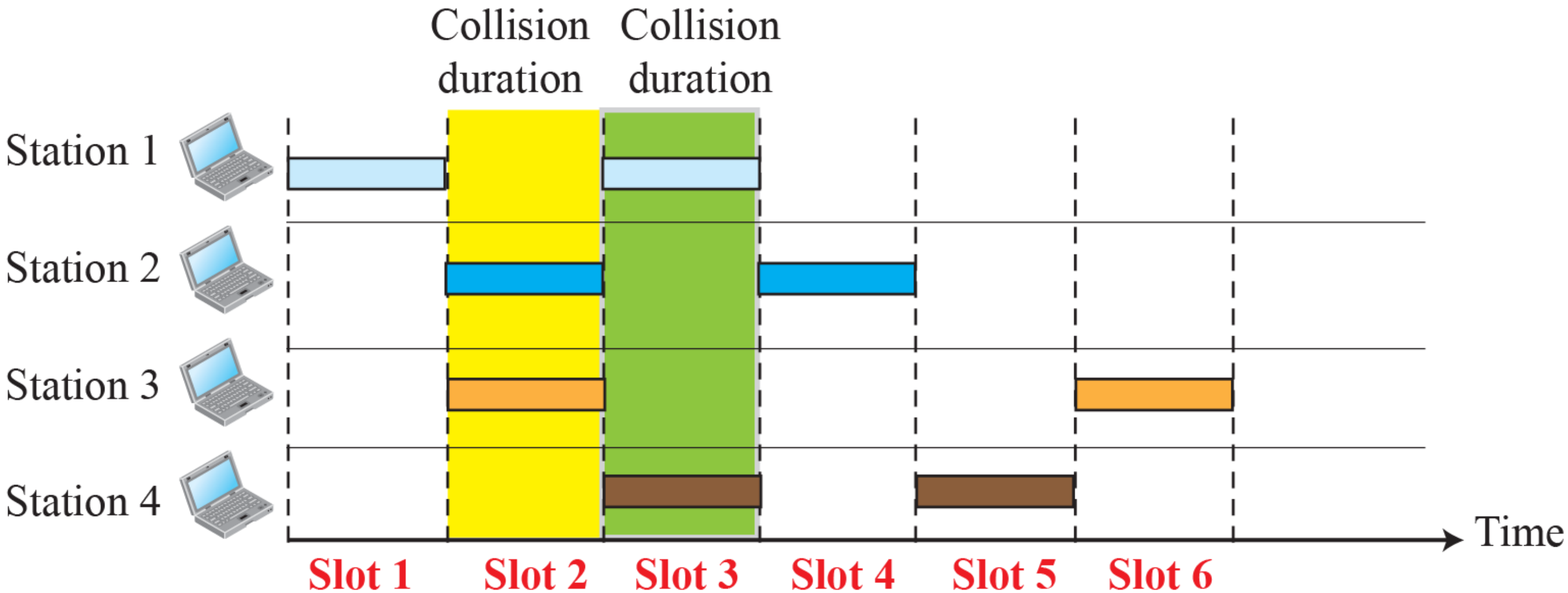
- *A station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send.*

- *This decision depends on the state of the medium (idle or busy).*

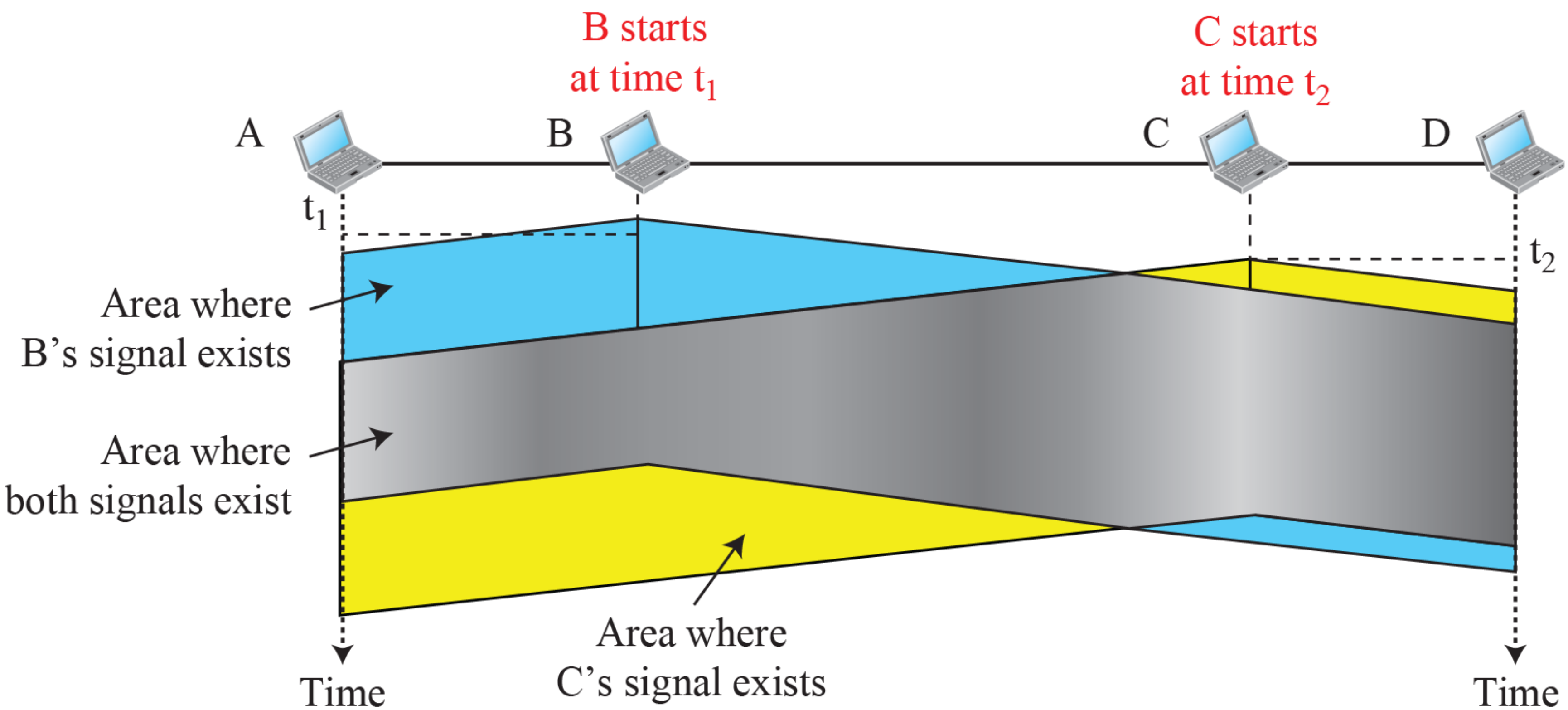
Frames in a pure ALOHA network



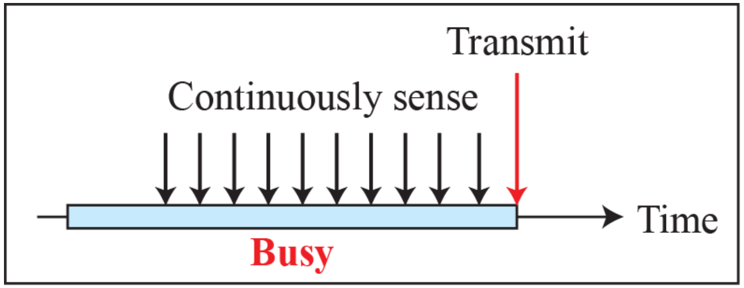
Frames in a slotted ALOHA network



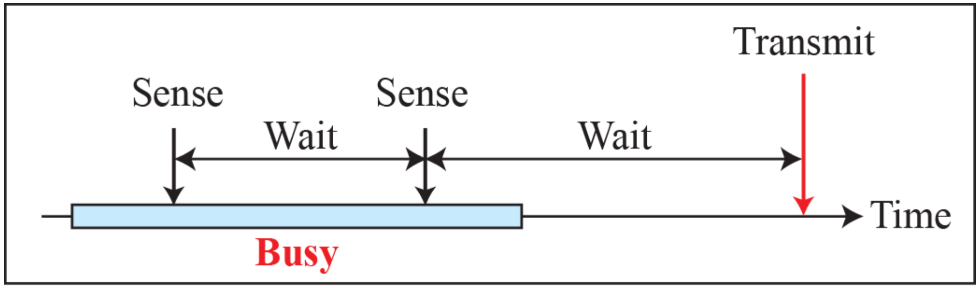
Space/time model of a collision in CSMA (Part I: model)



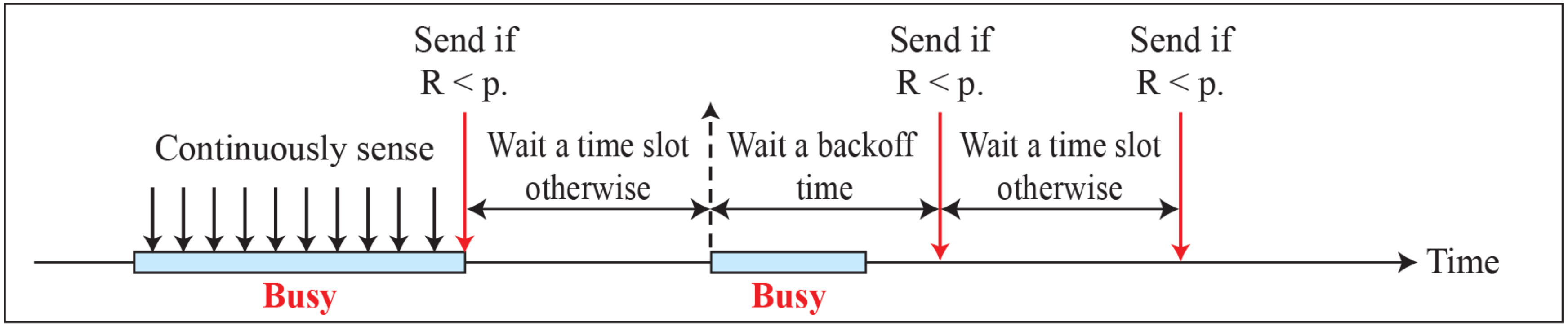
Behavior of three persistence methods



a. 1-persistent

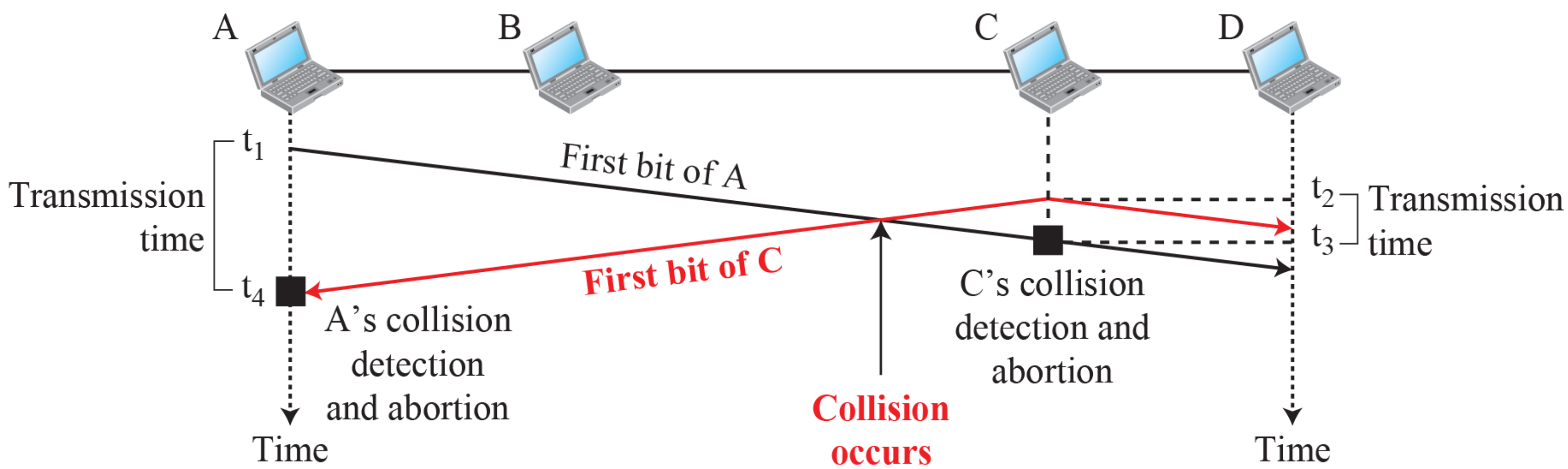


b. Nonpersistent

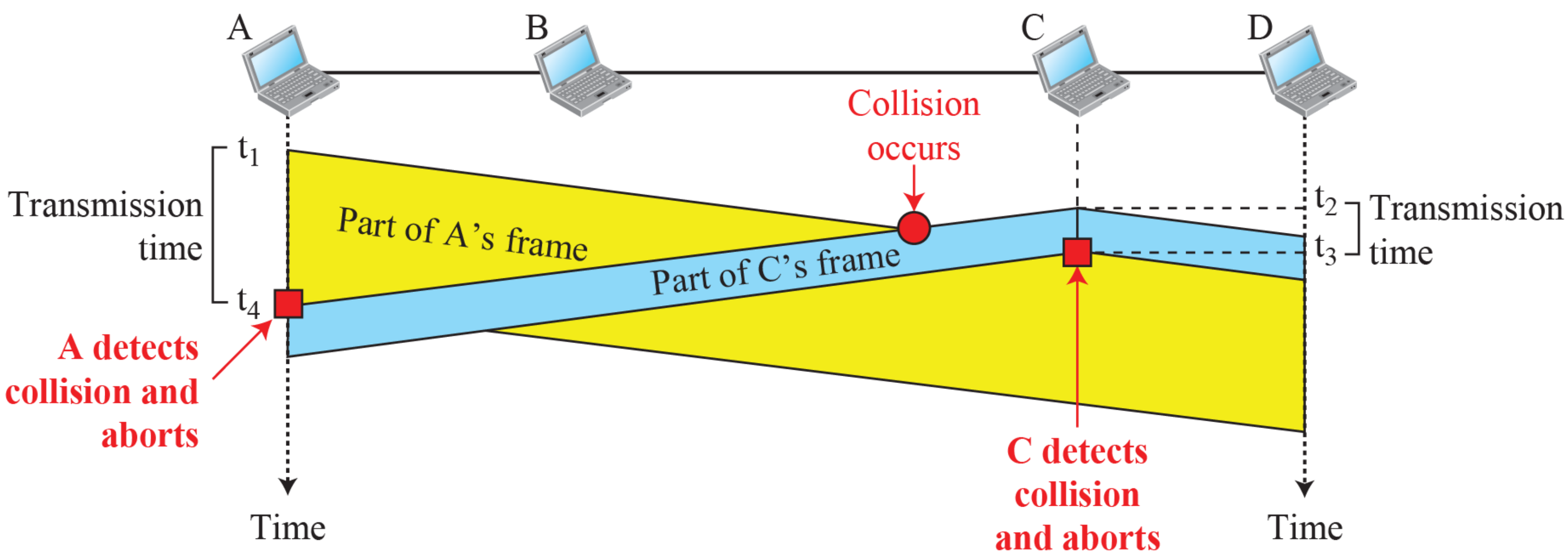


c. *p*-persistent

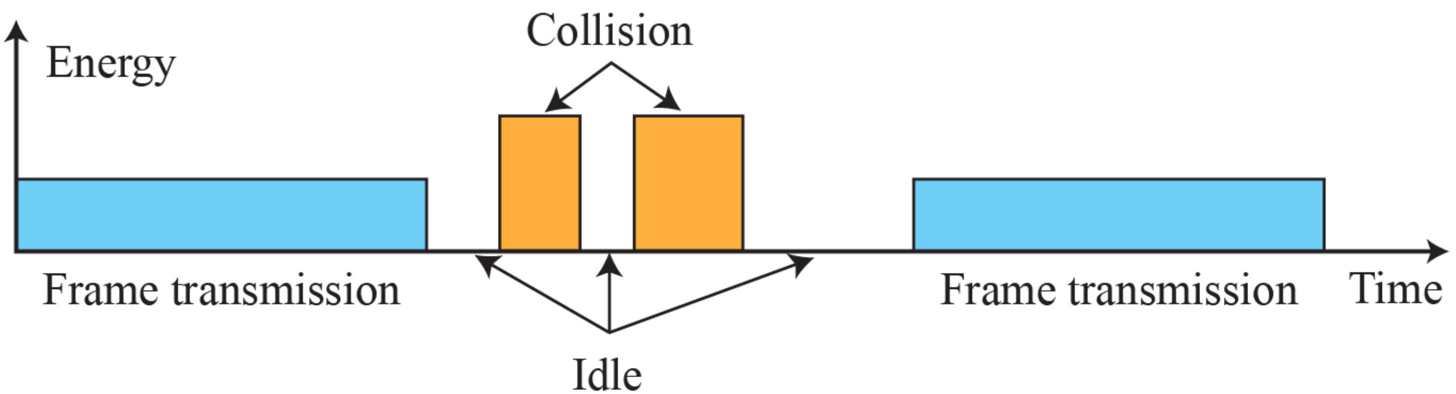
Collision of the first bits in CSMA/CD



Collision and abortion in CSMA/CD



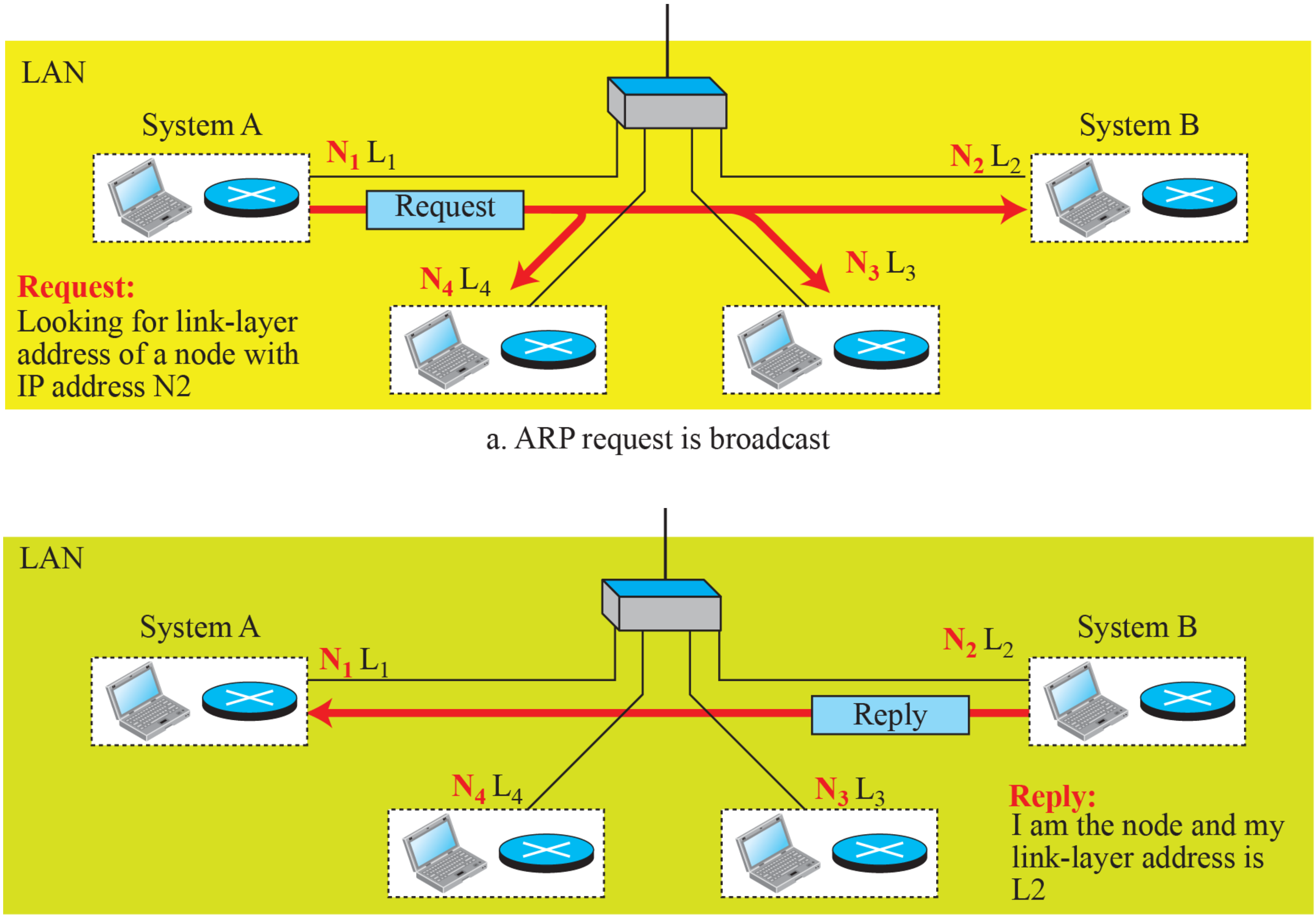
Energy level during transmission, idleness, or collision



LINK-LAYER ADDRESSING

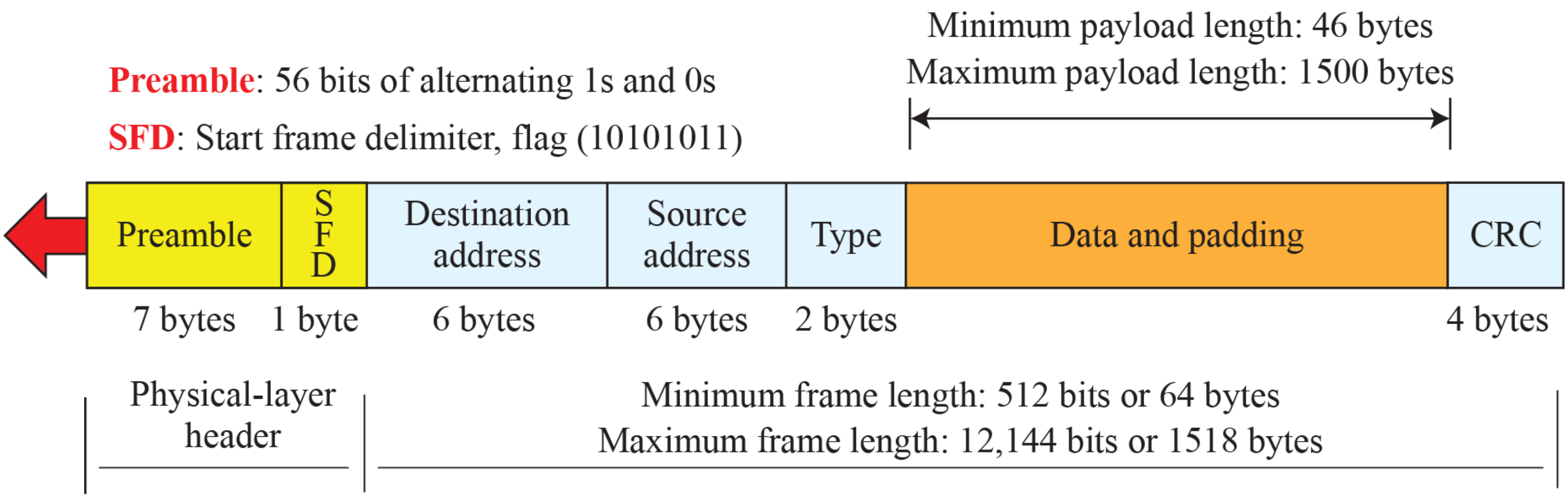
- ***Address Resolution Protocol (ARP)***

ARP operation



b. ARP reply is unicast

Ethernet frame



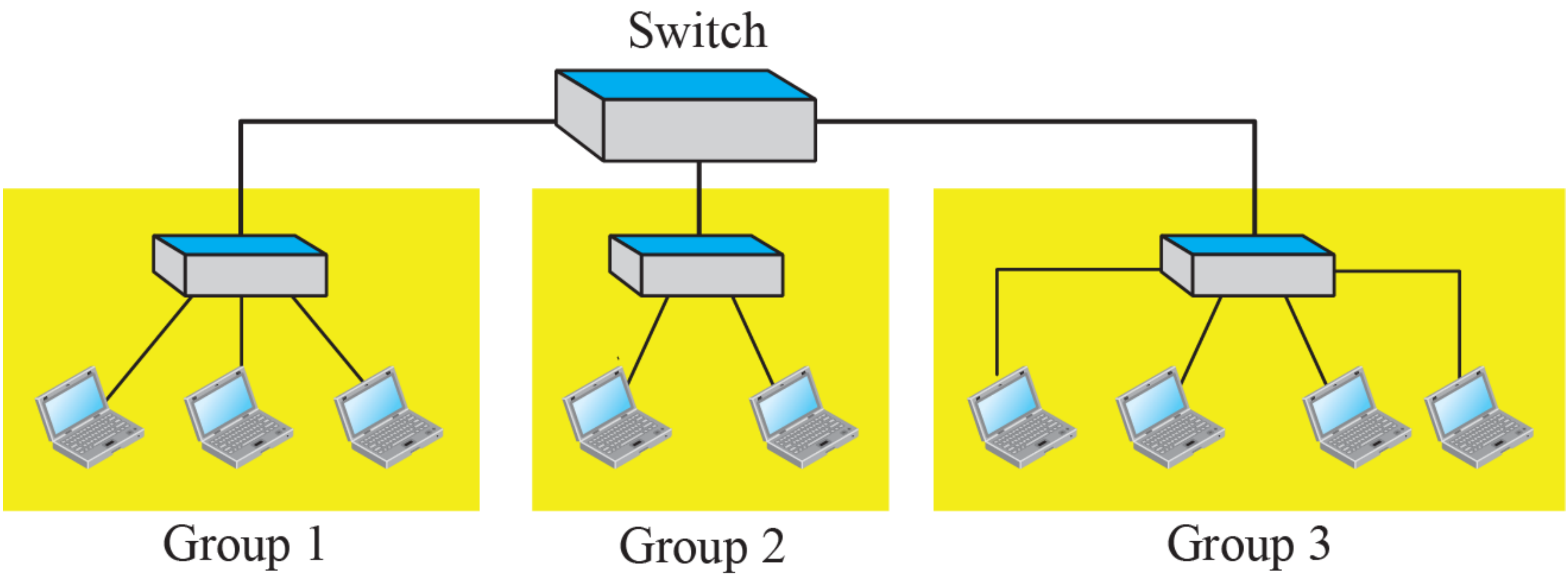
Virtual LANs

- ***A station is considered part of a LAN if it physically belongs to that LAN.***

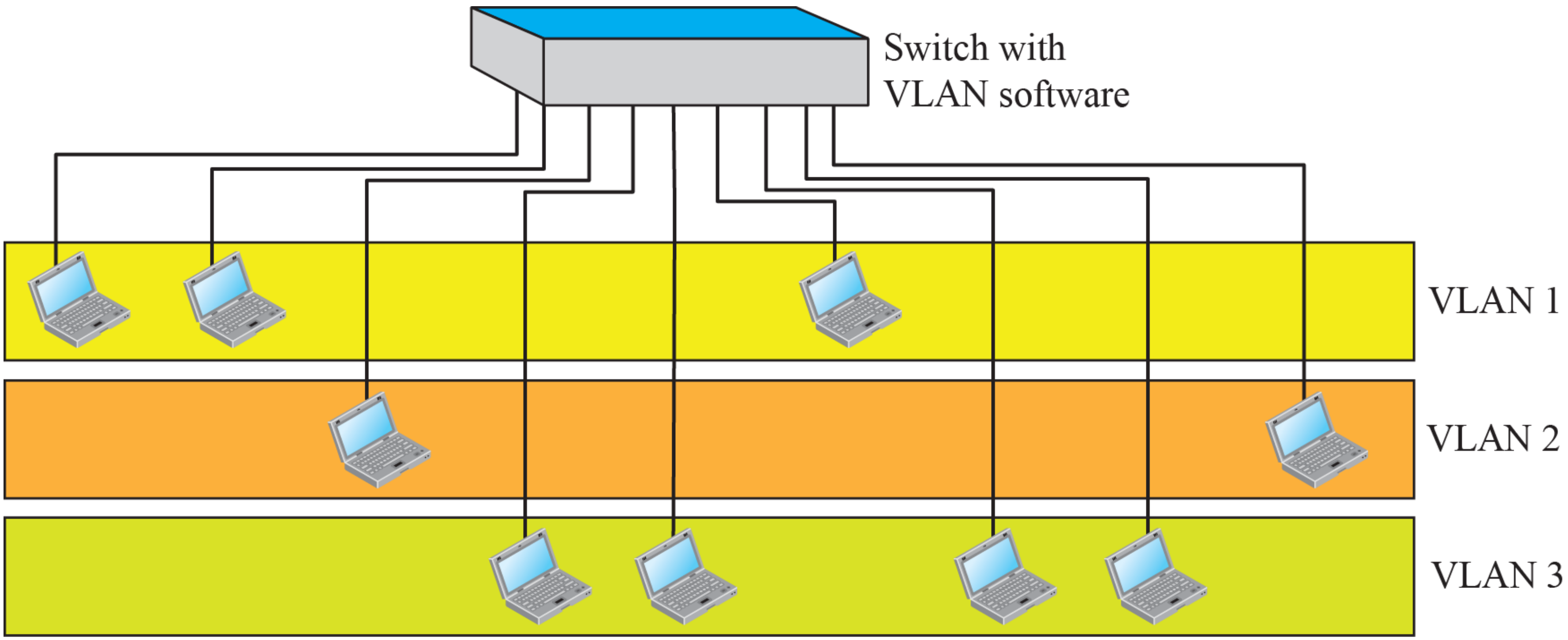
- ***The criterion of membership is geographic.***

- ***What happens if we need a virtual connection between two stations belonging to two different physical LANs? We can roughly define a virtual local area network (VLAN) as a local area network configured by software, not by physical wiring.***

A switch connecting three LANs



switch using VLAN software



Two switches in a backbone using VLAN software