UNIT IV

PHYSICAL LAYER AND DATA LINK LAYER

By SUCHETA RAUT

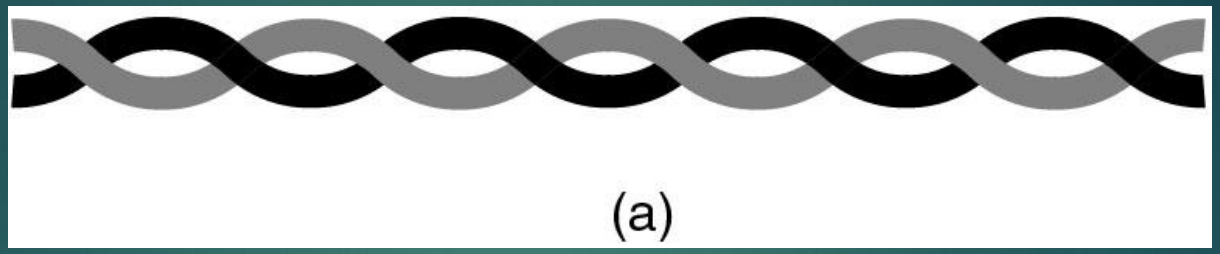
Three kinds of Transmission media

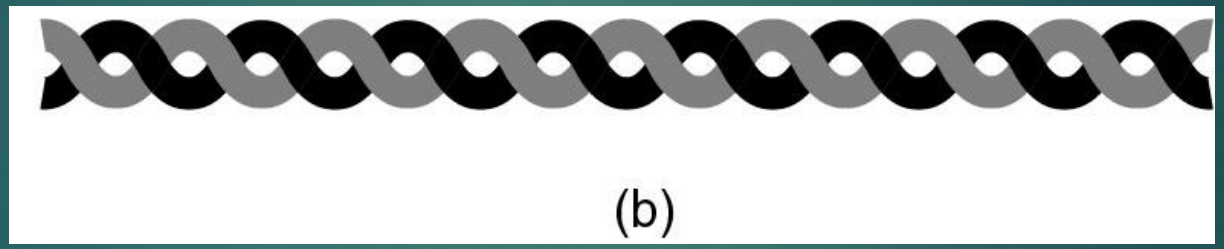
- Guided (copper wire & Fiber optics)
- Wireless (terrestrial radio)
- Satellite

Guided Transmission Data

- Magnetic Media
- Twisted Pair
- Coaxial Cable
- Fiber Optics

Twisted Pair



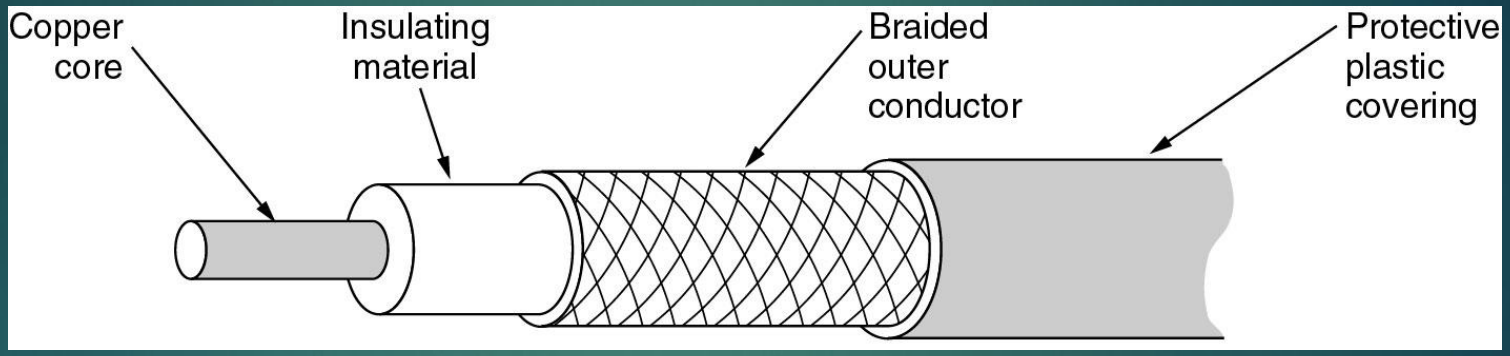


(a) Category 3 UTP.

(b) Category 5 UTP.

BW it support up to few MHZ

Coaxial Cable

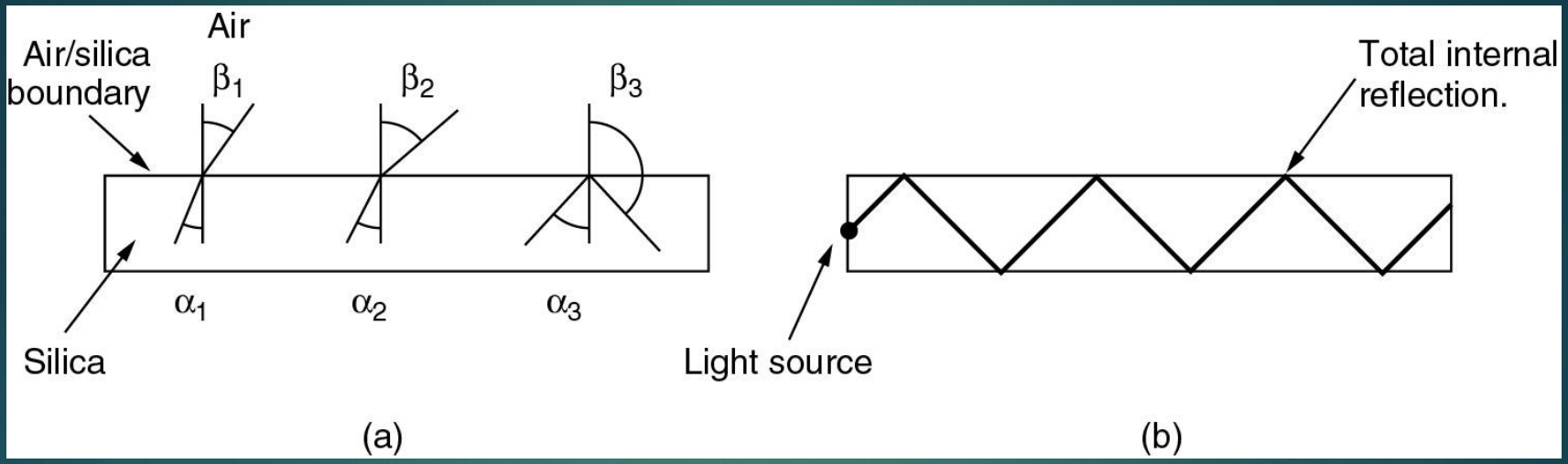


- 1) 50 ohm cable
- 2) 75 ohm cable

Adv. High BW and excellent noise immunity

BW it support up to GHZ

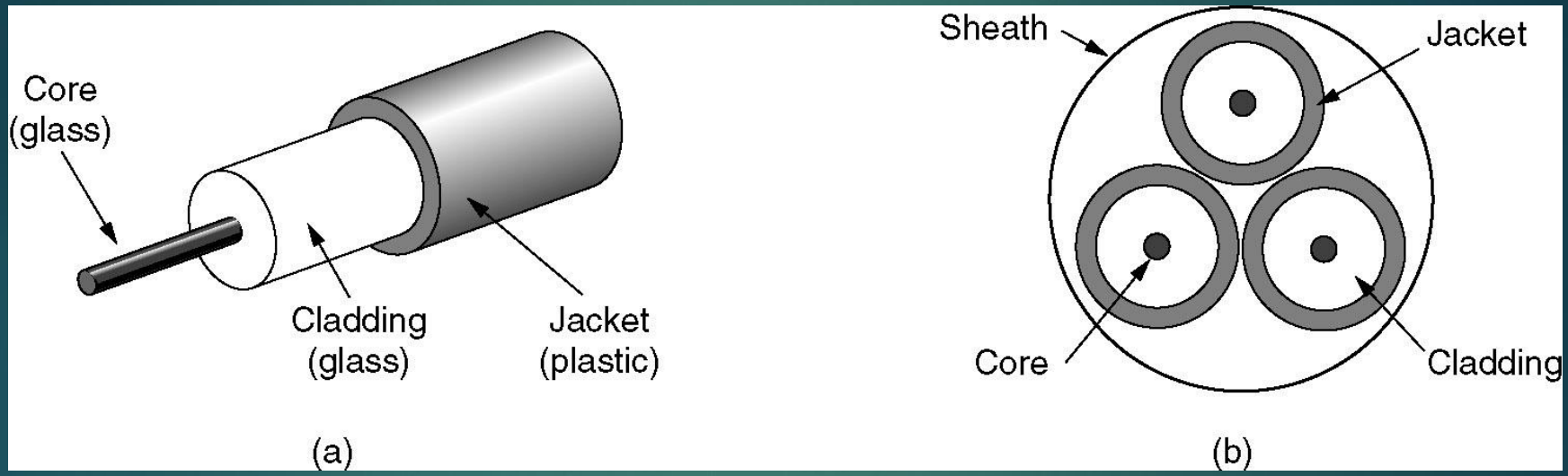
Fiber Optics



(a) Three examples of a light ray from inside a silica fiber impinging on the air/silica boundary at different angles.

(b) Light trapped by total internal reflection.

Fiber Cables



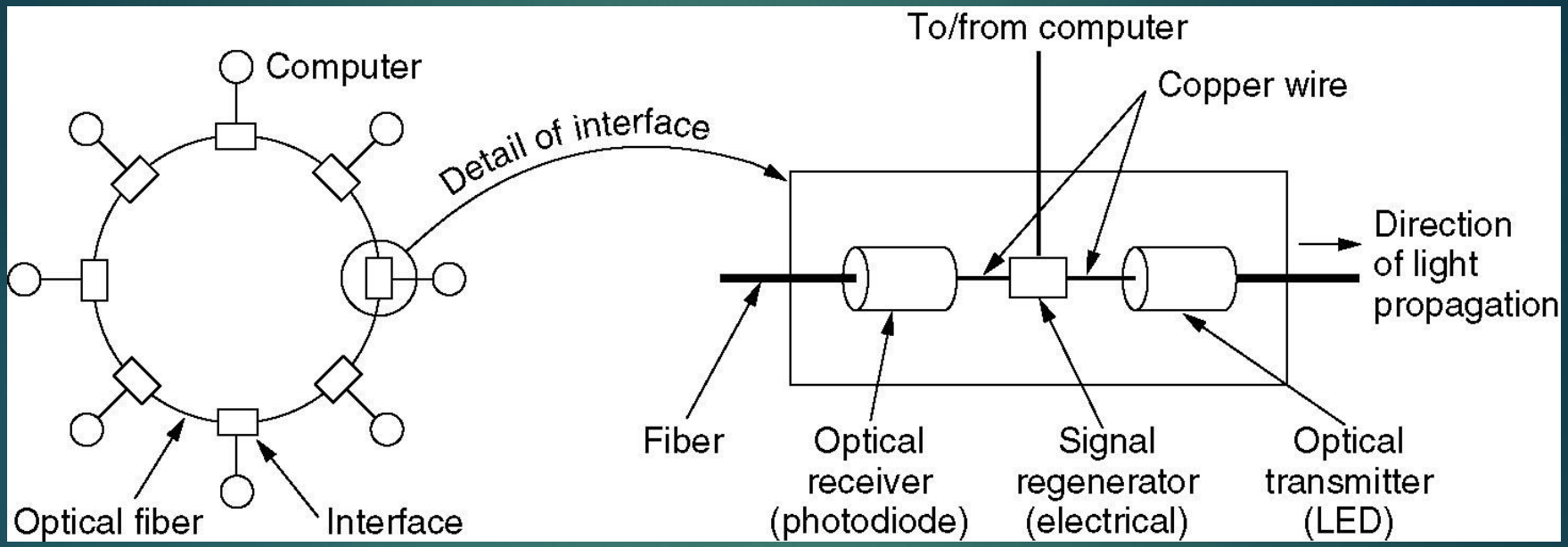
(a) Side view of a single fiber.

(b) End view of a sheath with three fibers.

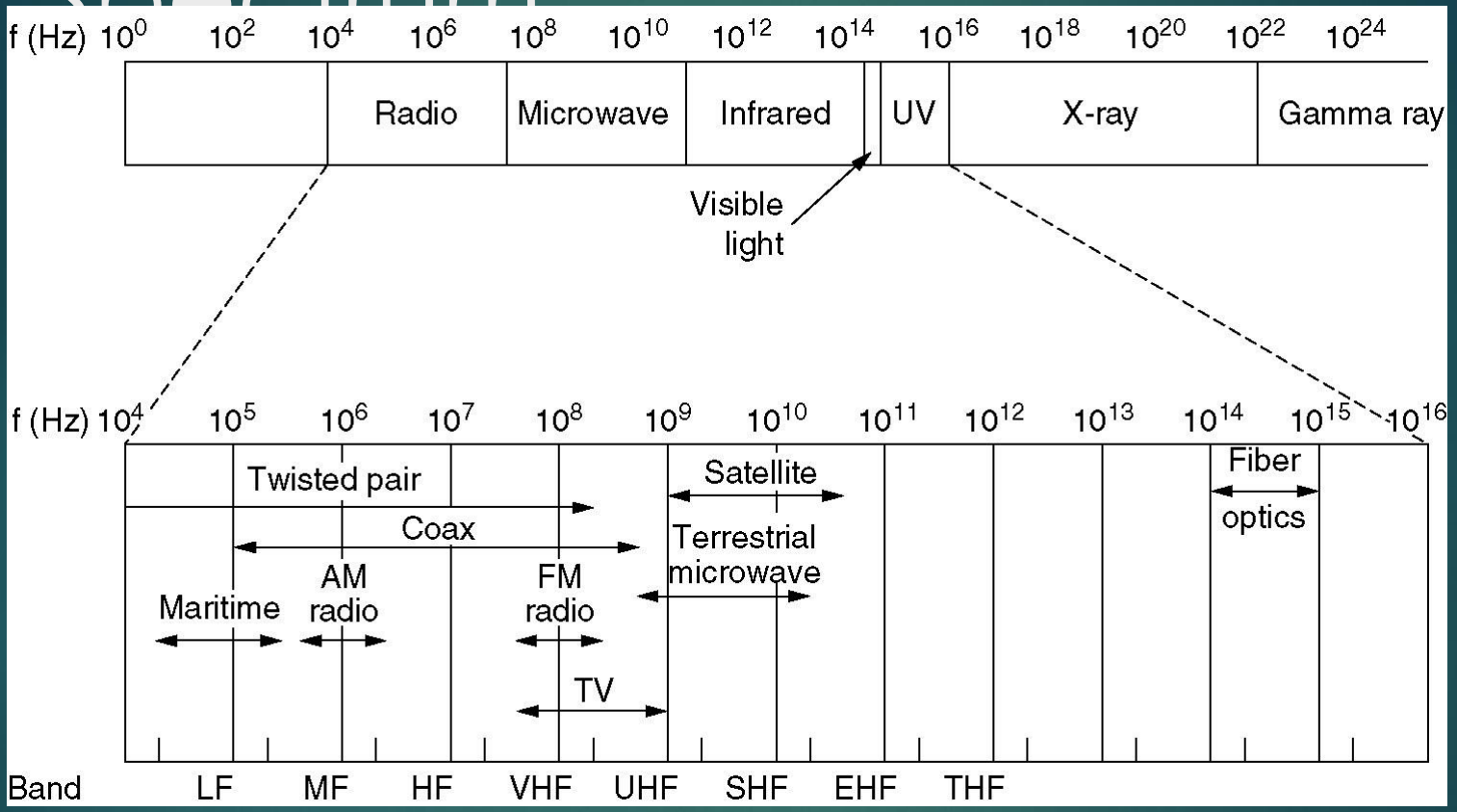
Fiber Cables (2)

Item	LED	Semiconductor laser
Data rate	Low	High
Fiber type	Multimode	Multimode or single mode
Distance	Short	Long
Lifetime	Long life	Short life
Temperature sensitivity	Minor	Substantial
Cost	Low cost	Expensive

Fiber Optic Networks

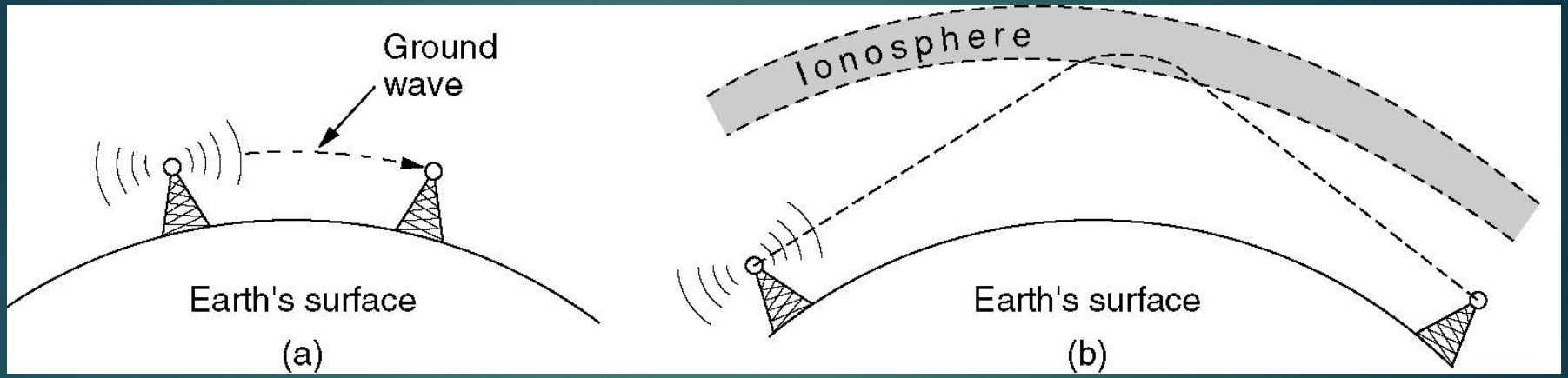


The Electromagnetic Spectrum



The electromagnetic spectrum and its uses for communication.

Radio Transmission



(a) In the VLF, LF, and MF bands, radio waves follow the curvature of the earth.

(b) In the HF band, they bounce off the ionosphere.

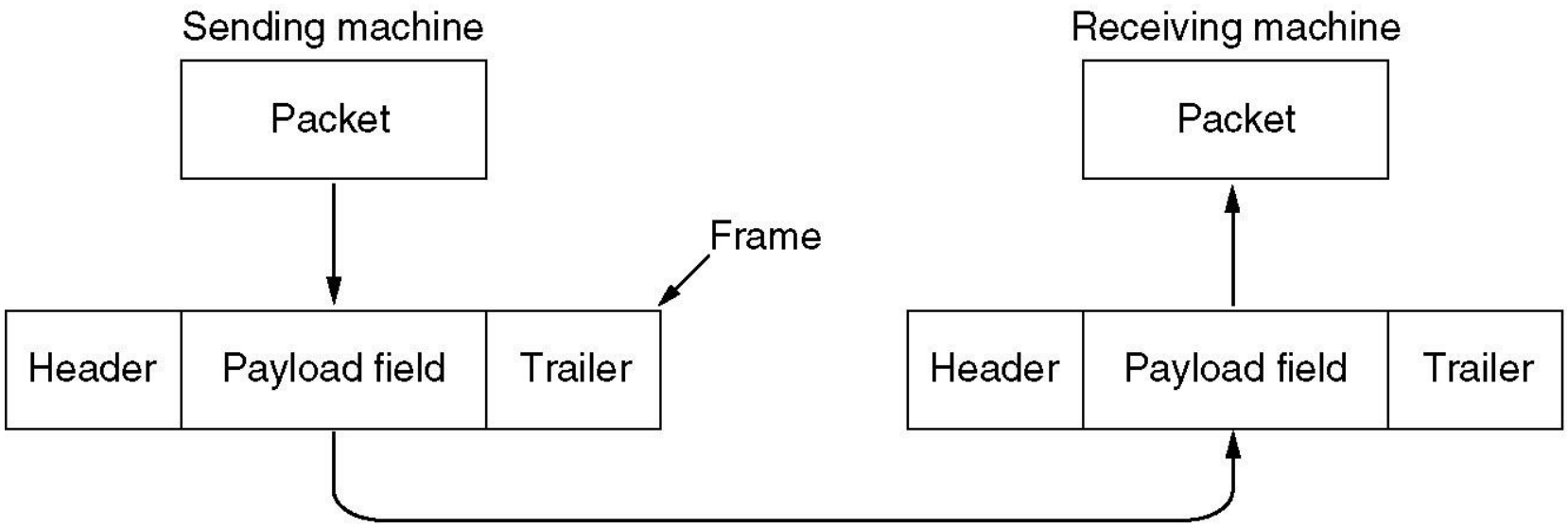
Data Link Layer Design Issues

- Services Provided to the Network Layer
- Framing
- Error Control
- Flow Control

Functions of the Data Link Layer

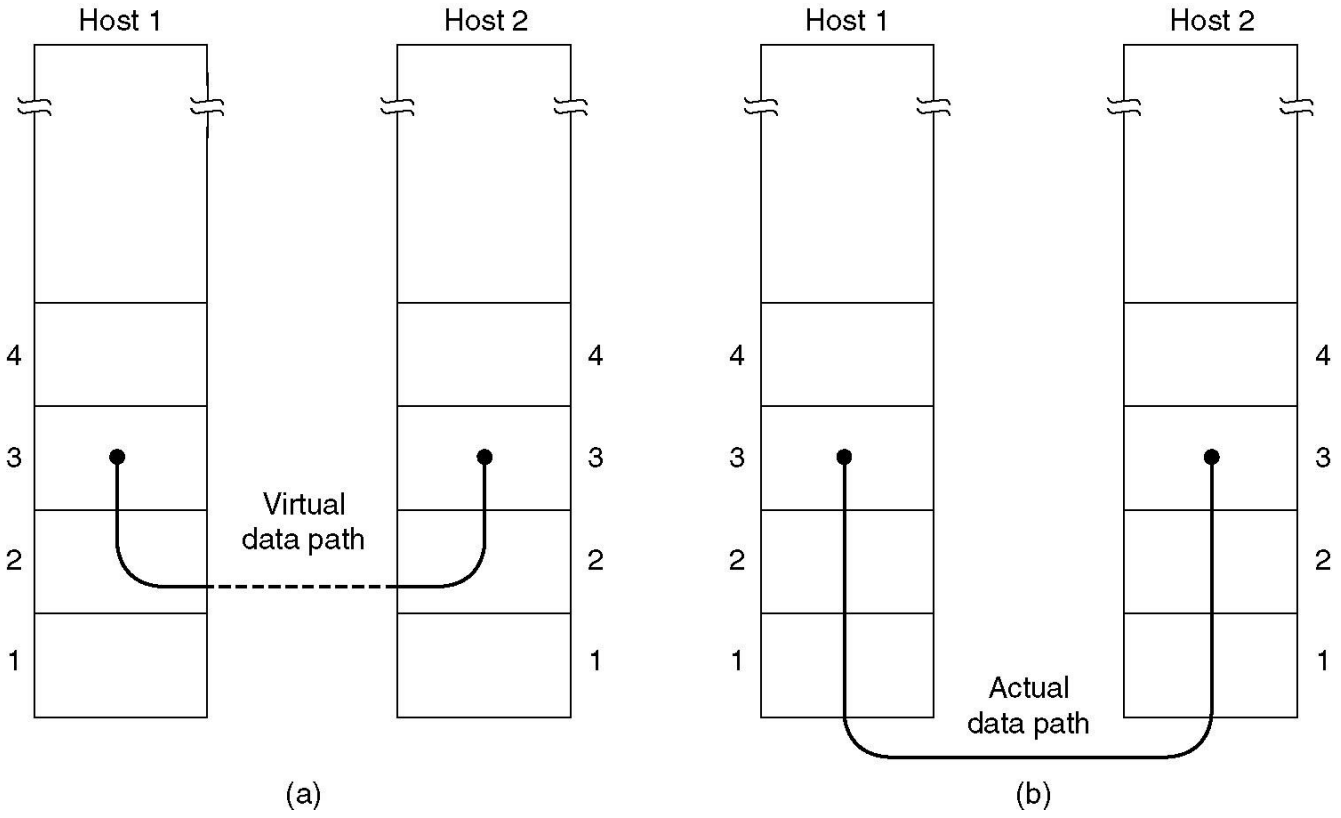
- Provide service interface to the network layer
- Dealing with transmission errors
- Regulating data flow
  - Slow receivers not swamped by fast senders

Functions of the Data Link Layer (2)



Relationship between packets and frames.

Services Provided to Network Layer



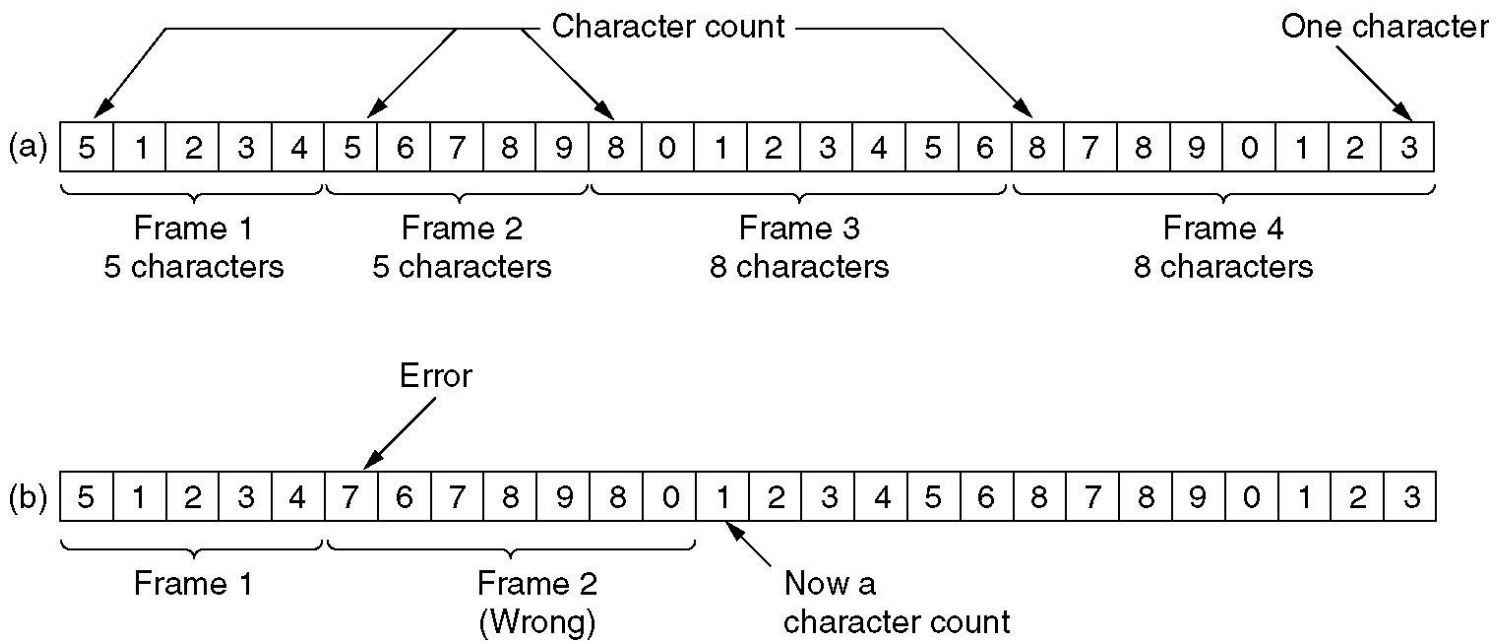
(a) Virtual communication.

(b) Actual communication.

Four methods of Framing

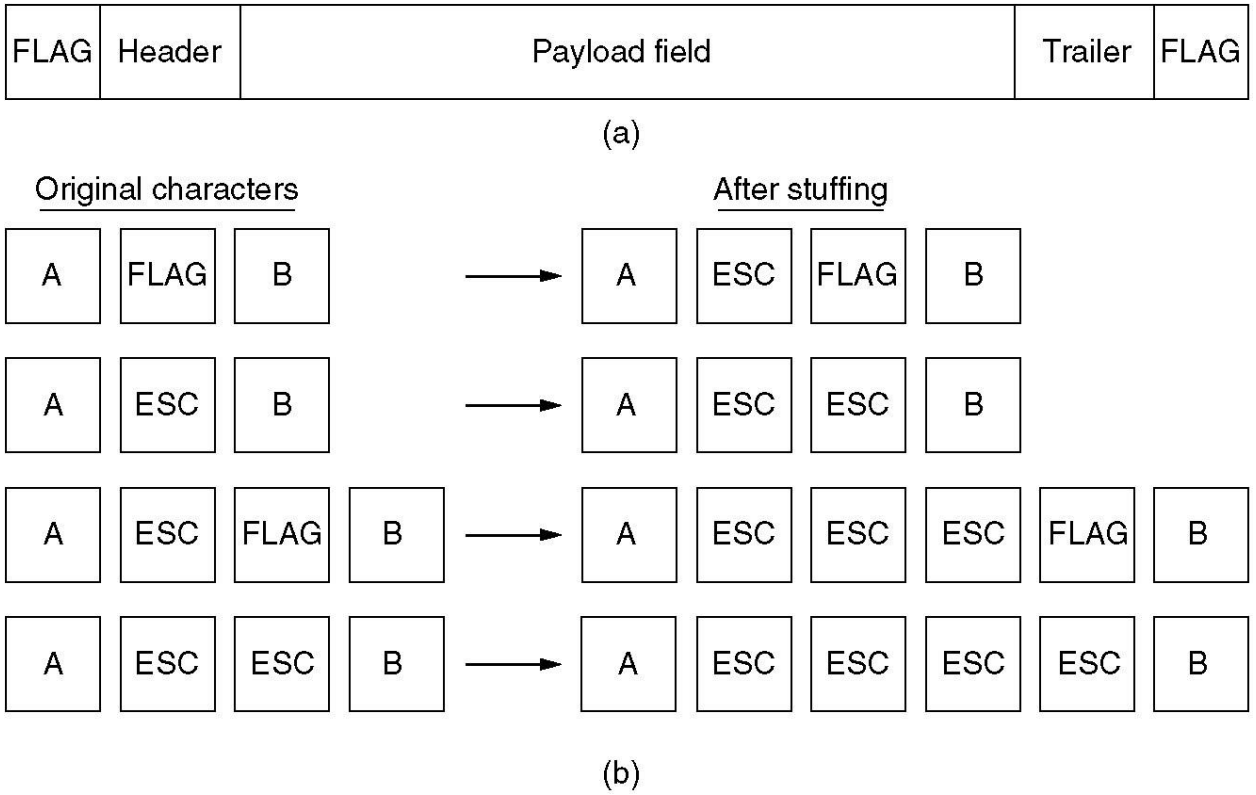
- Character Count
- Flag byte with byte stuffing
- Starting and ending flags, with bit stuffing
- Physical layer coding violations

Framing(Character Count)



A character stream. (a) Without errors. (b) With one error.

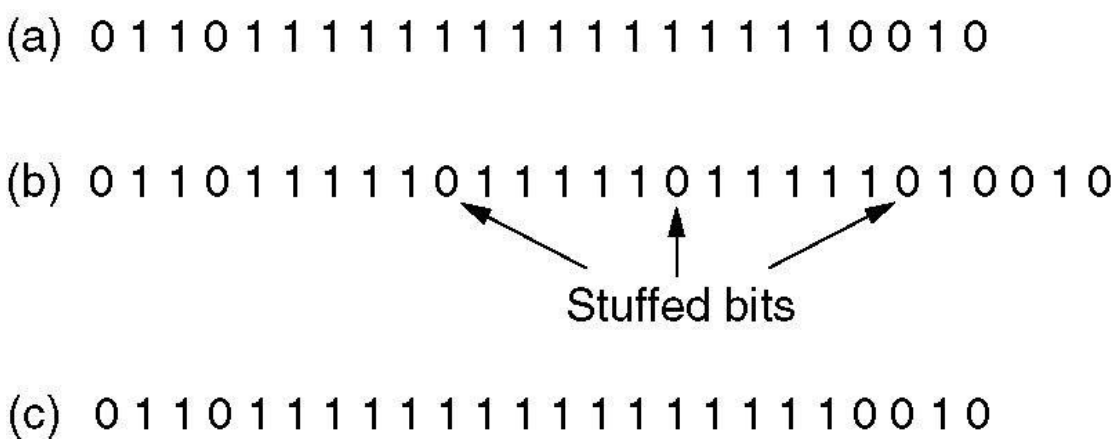
Framing (2) (Flag byte with byte stuffing)



(a) A frame delimited by flag bytes.

(b) Four examples of byte sequences before and after stuffing.

Framing (3)(Starting and ending flags, with bit stuffing)

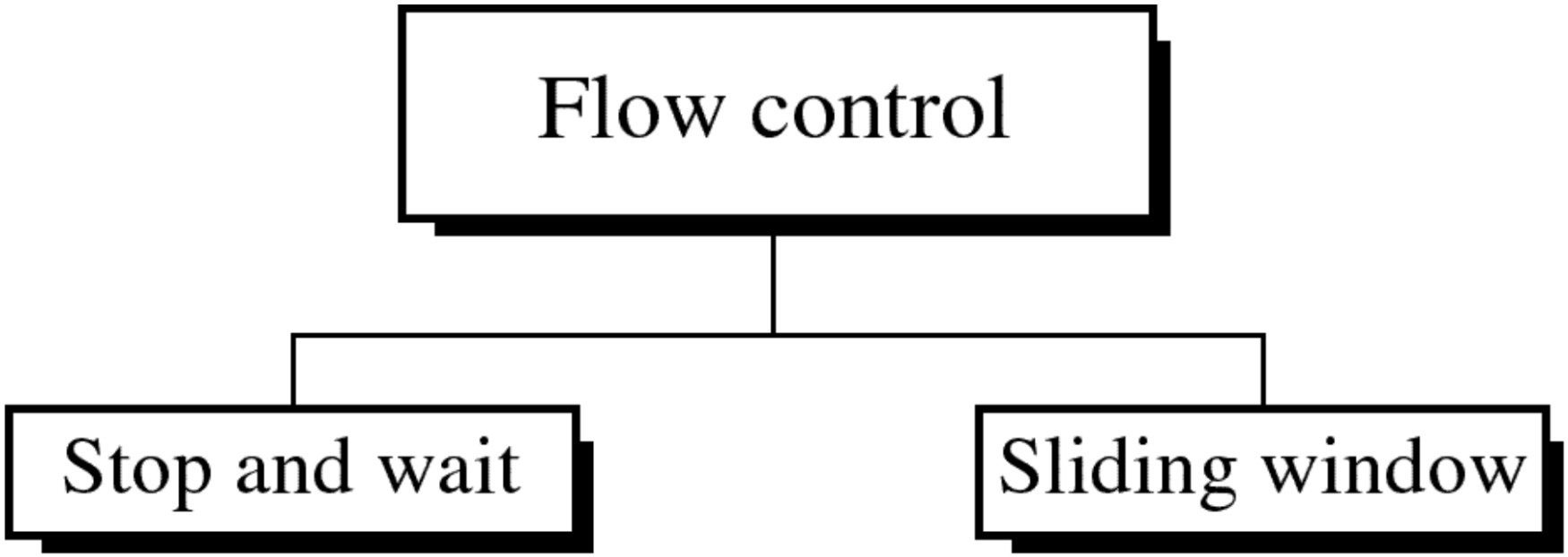


Bit stuffing

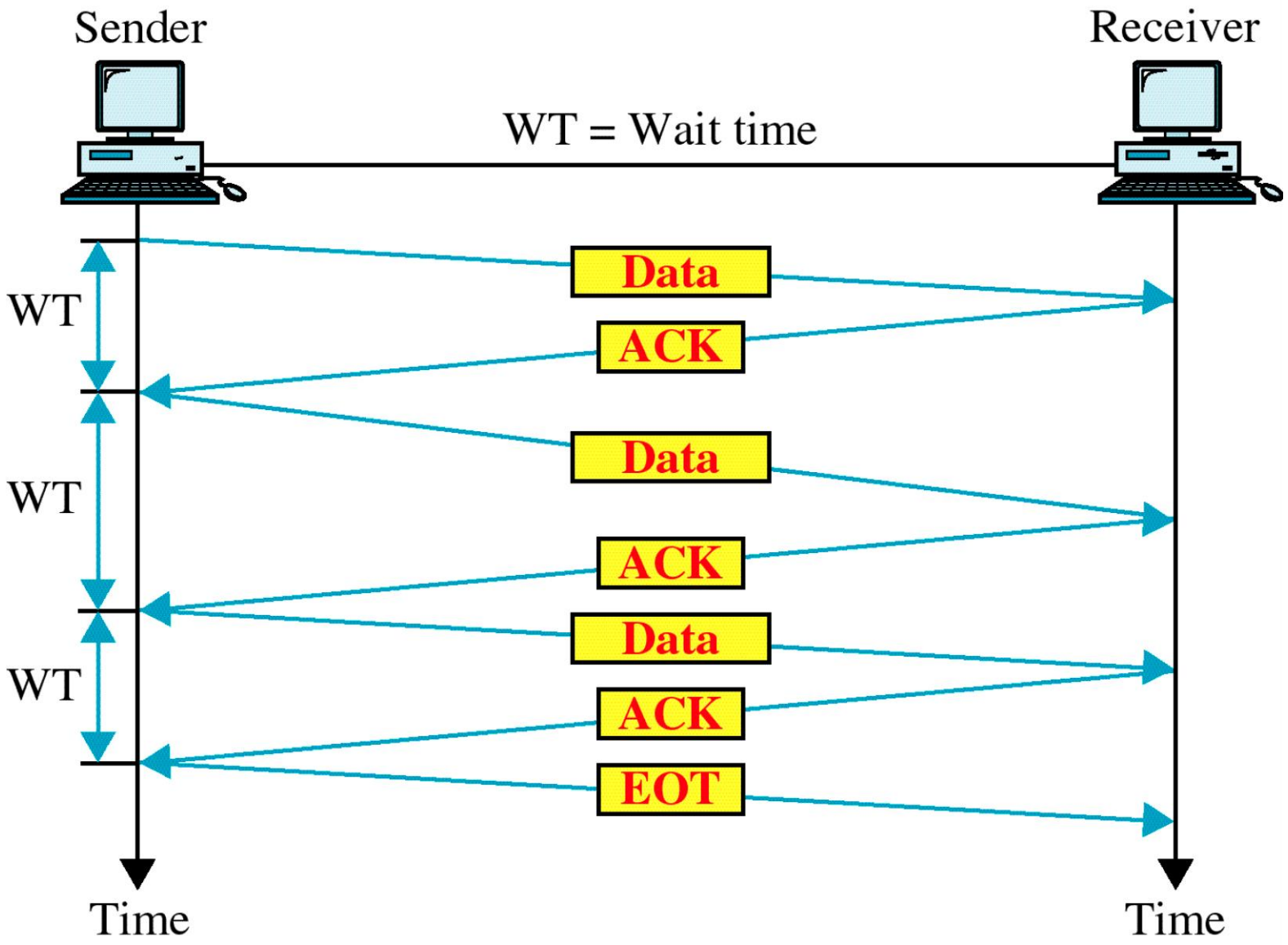
(a) The original data.

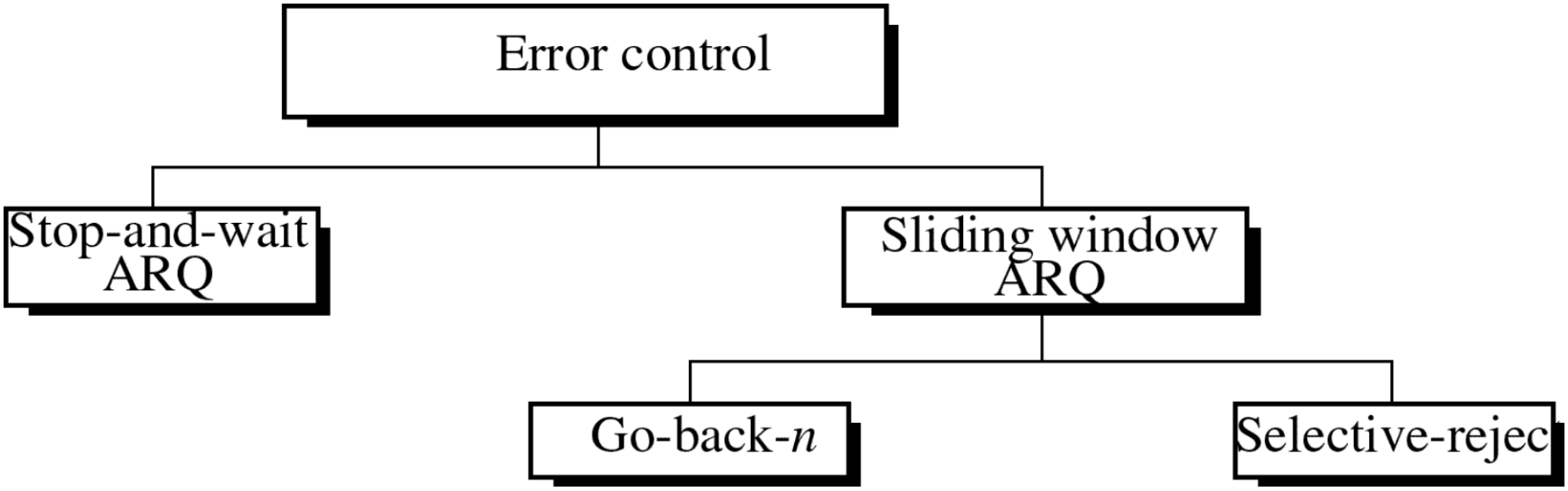
(b) The data as they appear on the line.

(c) The data as they are stored in receiver's memory after destuffing.


Flow control
Stop and wait
Sliding window
Send one frame at a time
Send several frames at a time

Stop and Wait

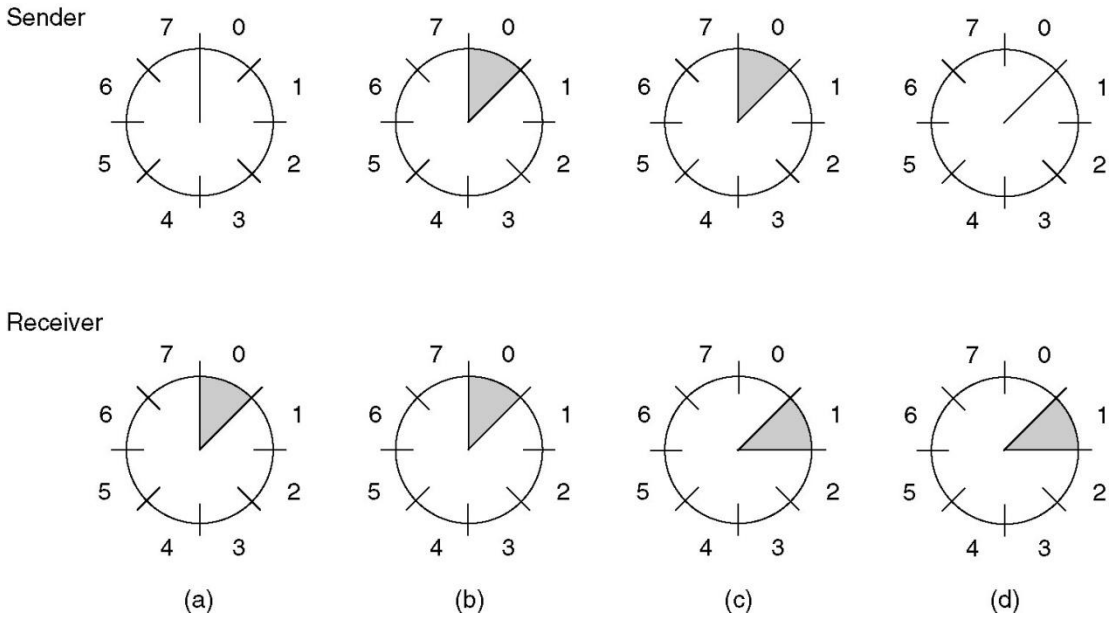



Error control
Stop-and-wait ARQ
Sliding window ARQ
Go-back-n
Selective-rejec

Sliding Window Protocols

- A One-Bit Sliding Window Protocol
- A Protocol Using Go Back N
- A Protocol Using Selective Repeat

Sliding Window Protocols (2)



A sliding window of size 1, with a 3-bit sequence number.

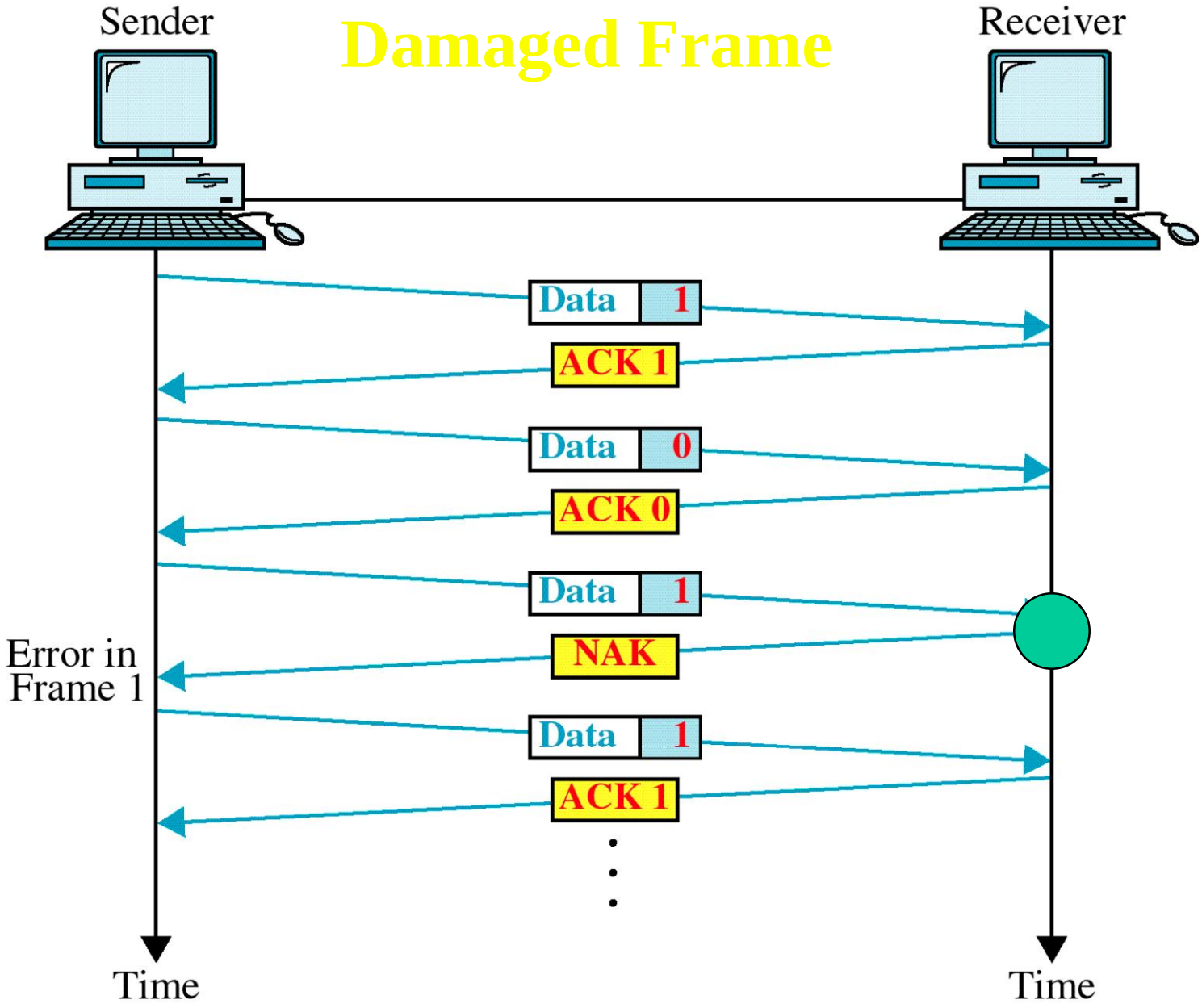
(a) Initially.

(b) After the first frame has been sent.

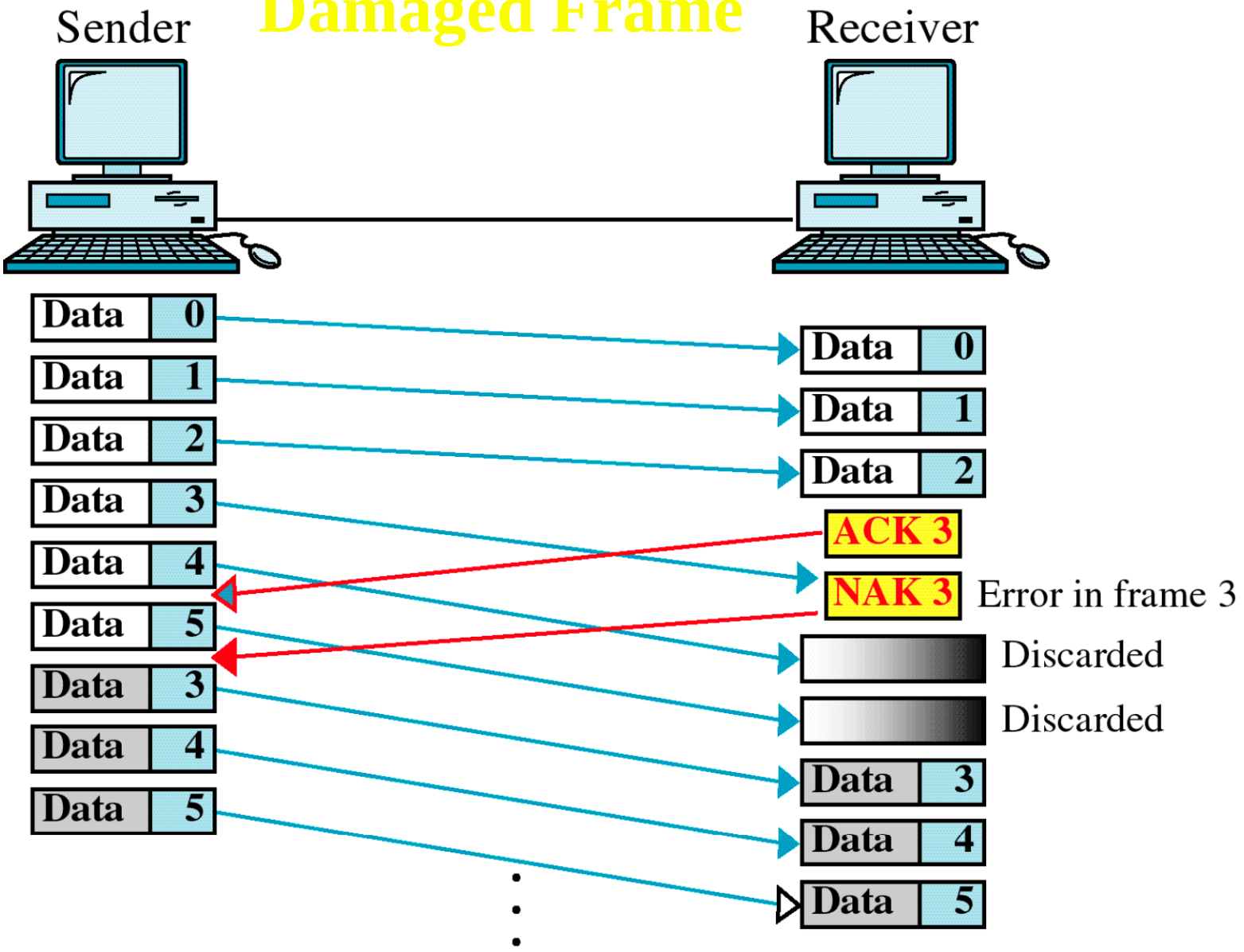
(c) After the first frame has been received.

(d) After the first acknowledgement has been received.

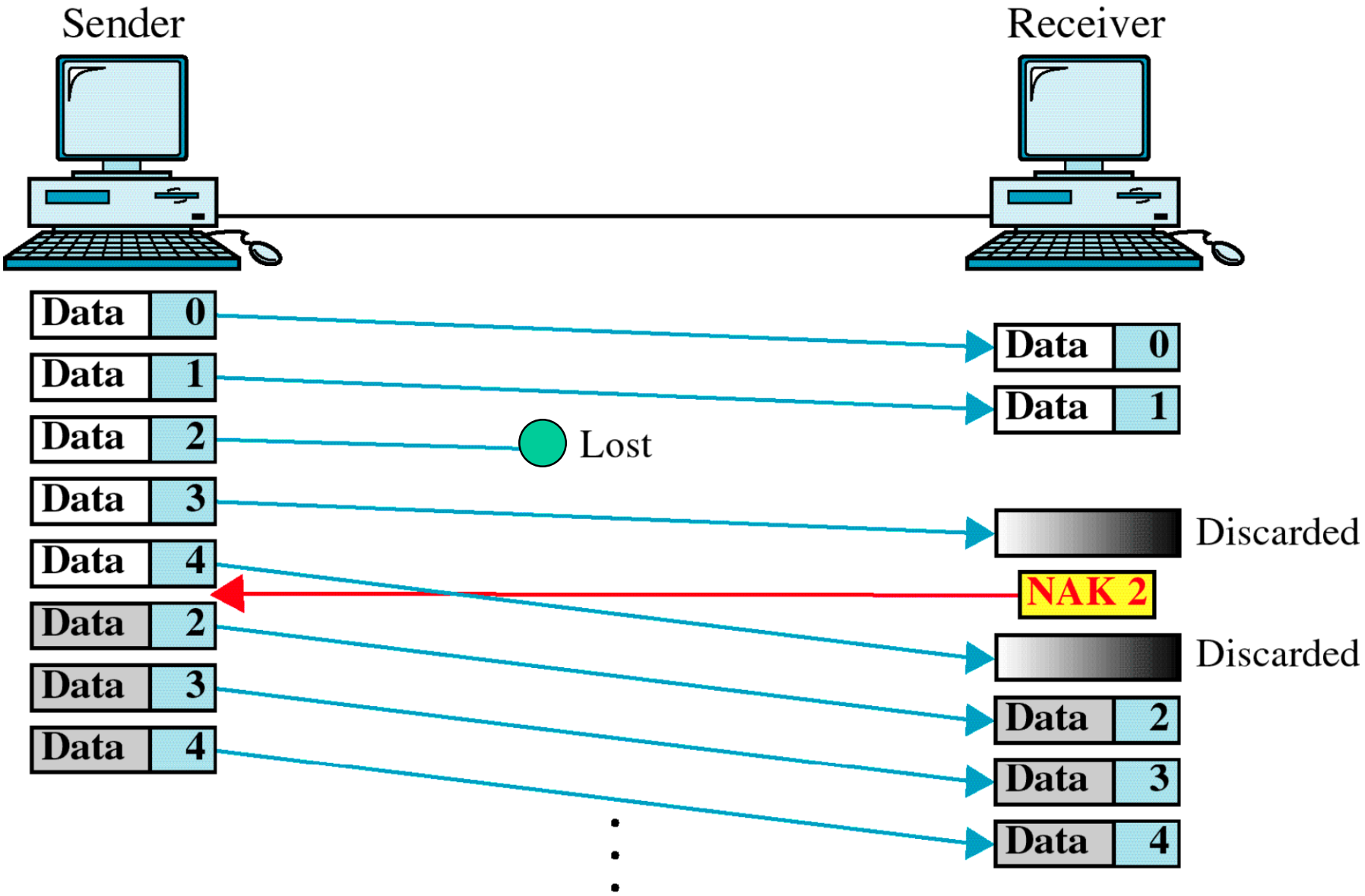
Damaged Frame



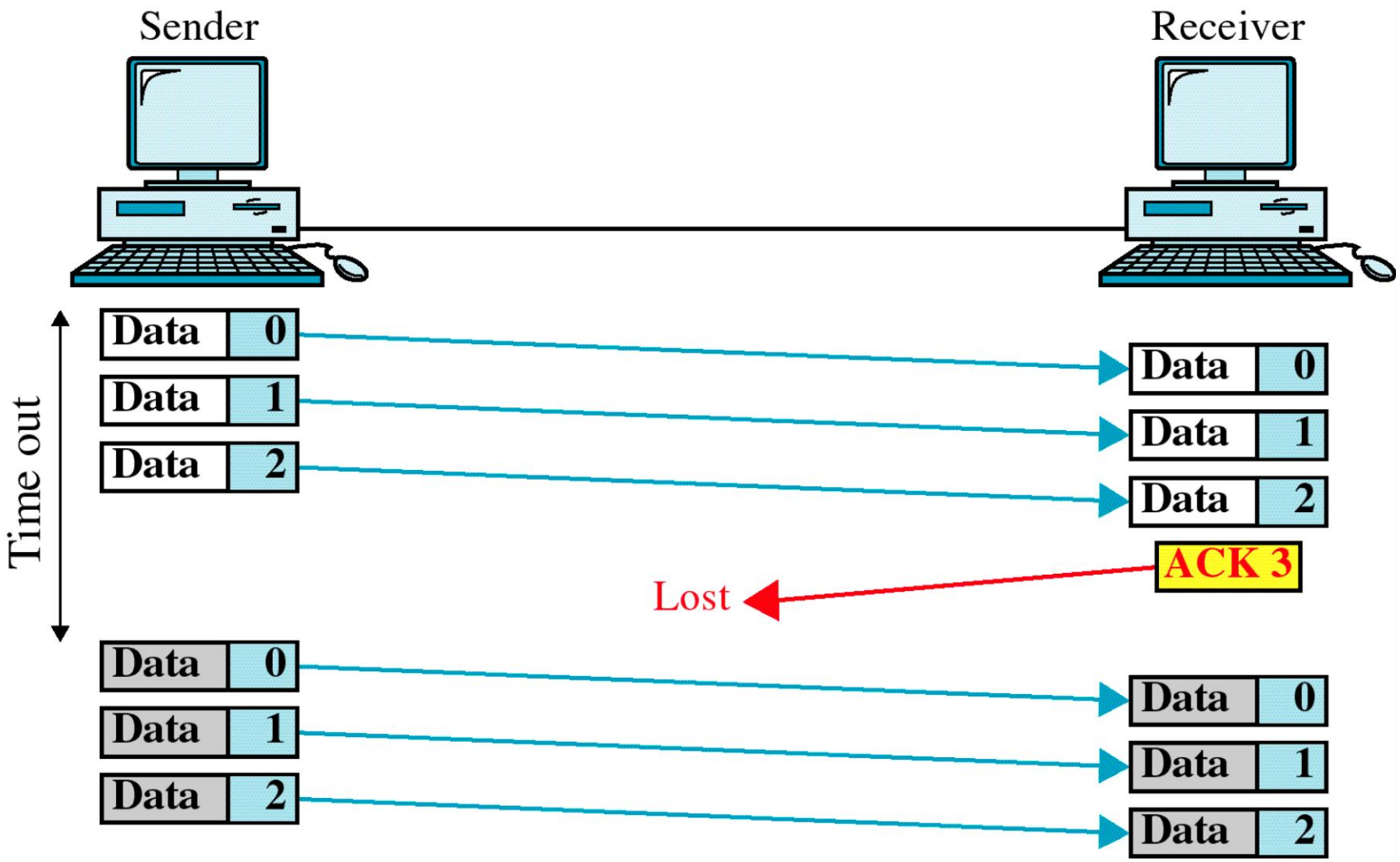
Damaged Frame



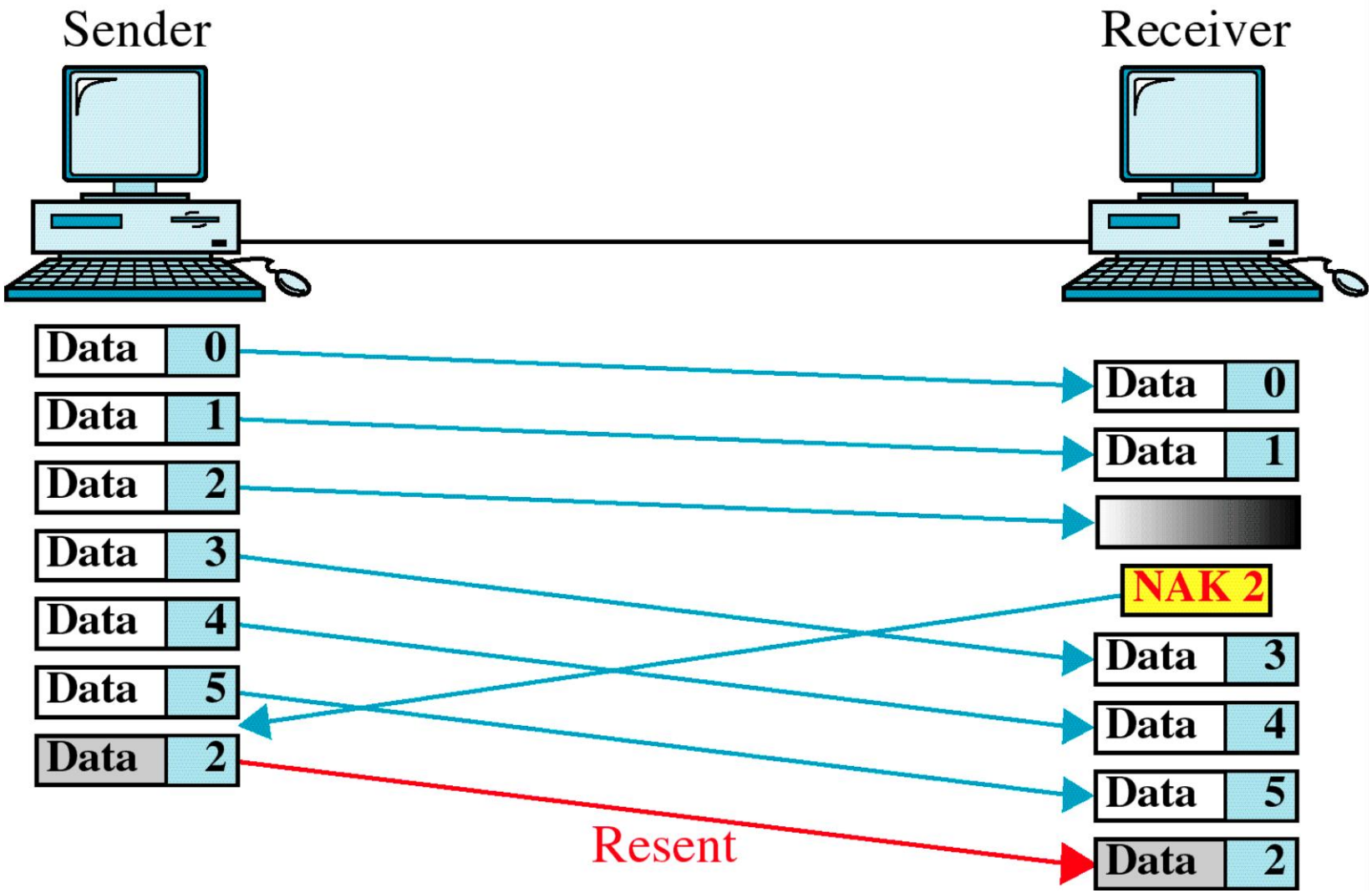
Lost Frame


Sender
Receiver
Data 0
Data 1
Data 2
Data 3
Data 4
Data 2
Data 3
Data 4
Lost
Data 0
Data 1
Discarded
NAK 2
Discarded
Data 2
Data 3
Data 4

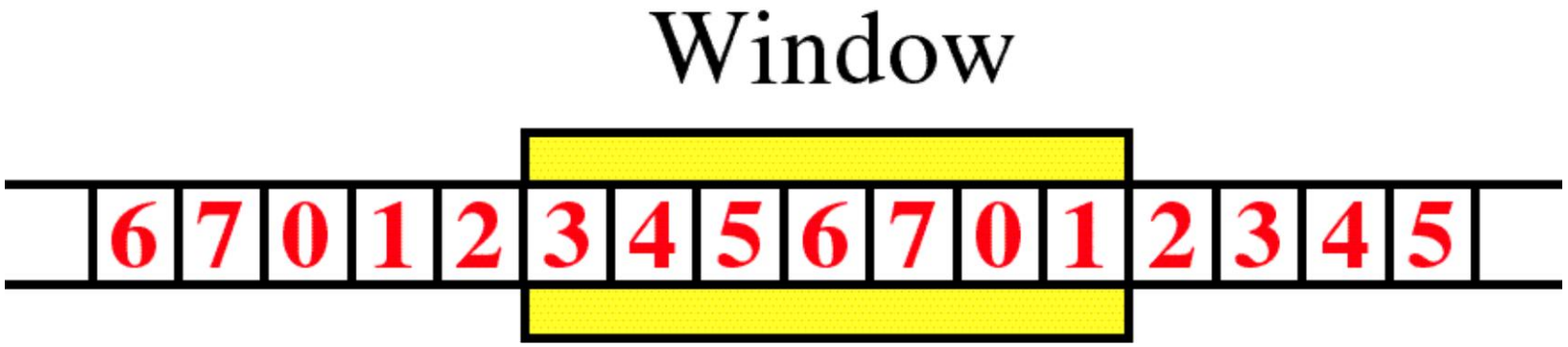
Lost ACK


Sender
Receiver
Time out
Data 0
Data 1
Data 2
Data 0
Data 1
Data 2
ACK 3
Lost
Data 0
Data 1
Data 2
Data 0
Data 1
Data 2

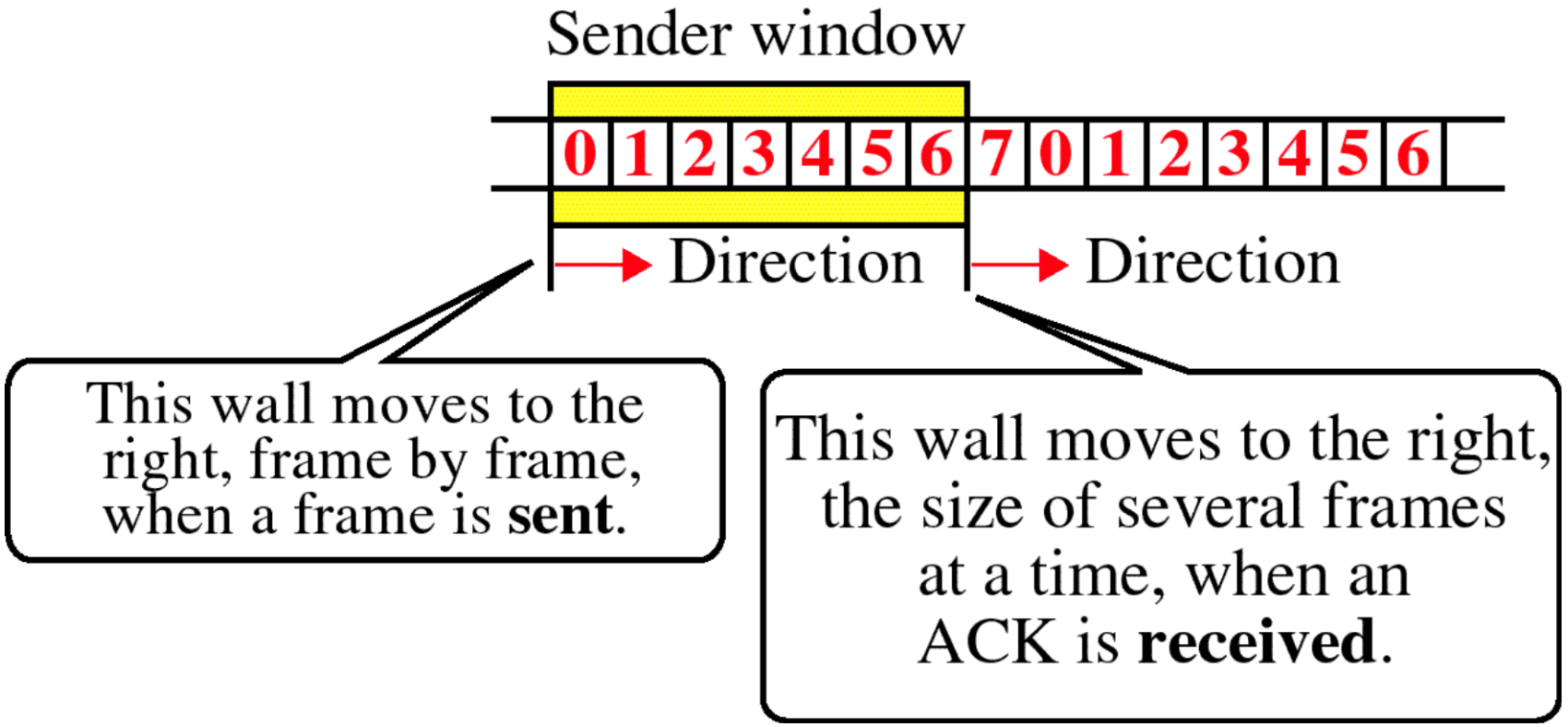
Selective Reject



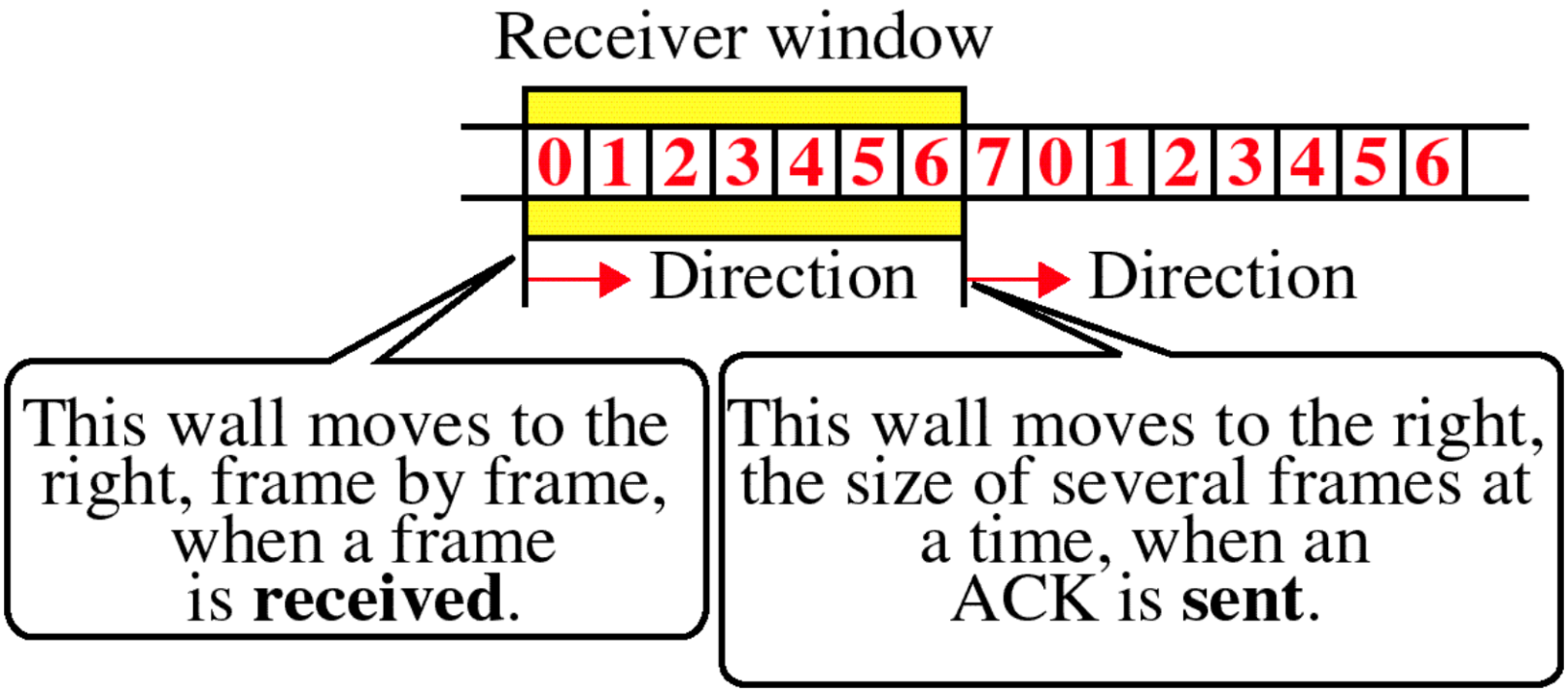
Sliding Window



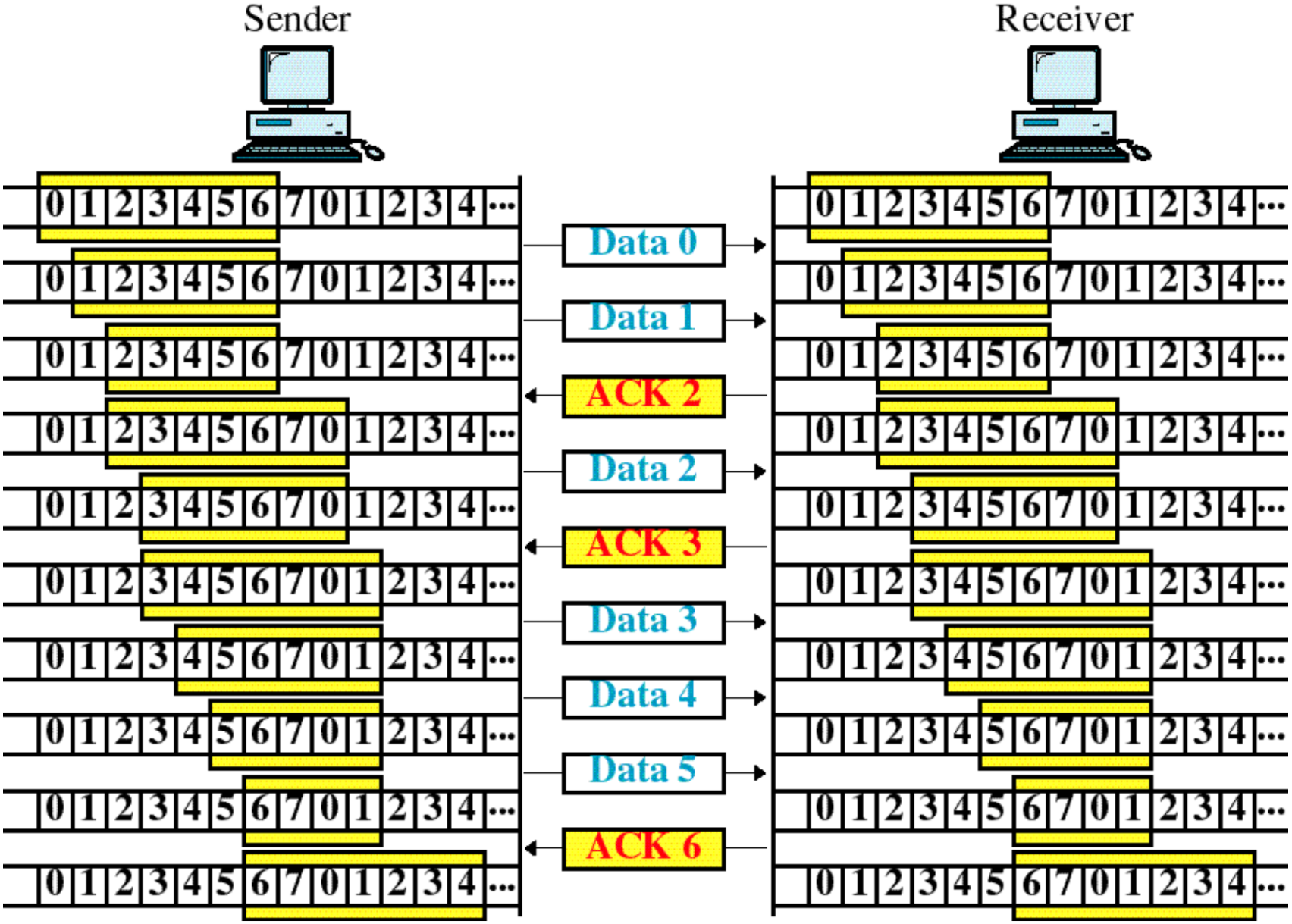
Sender Sliding Window



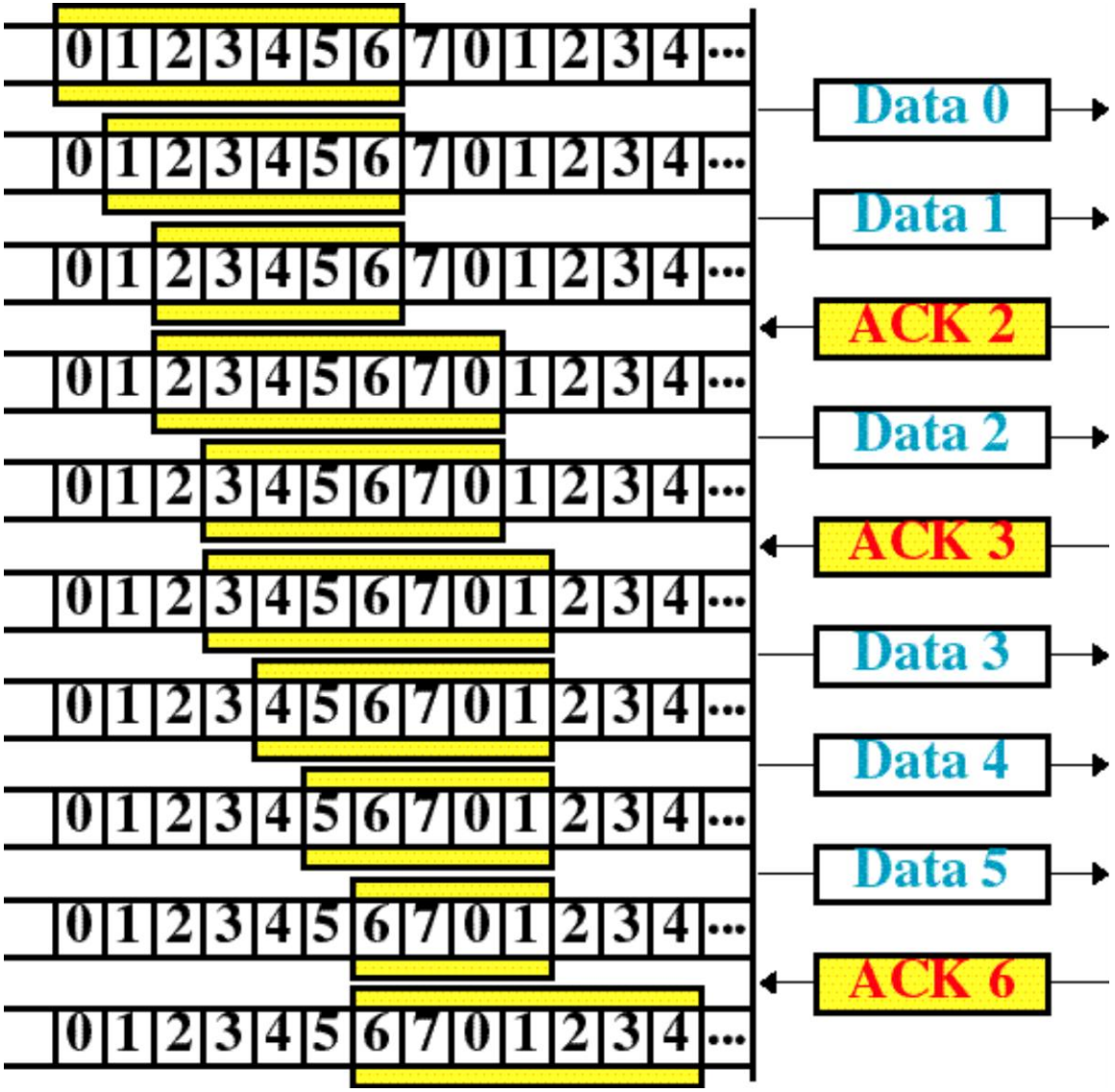
Receiver Sliding Window



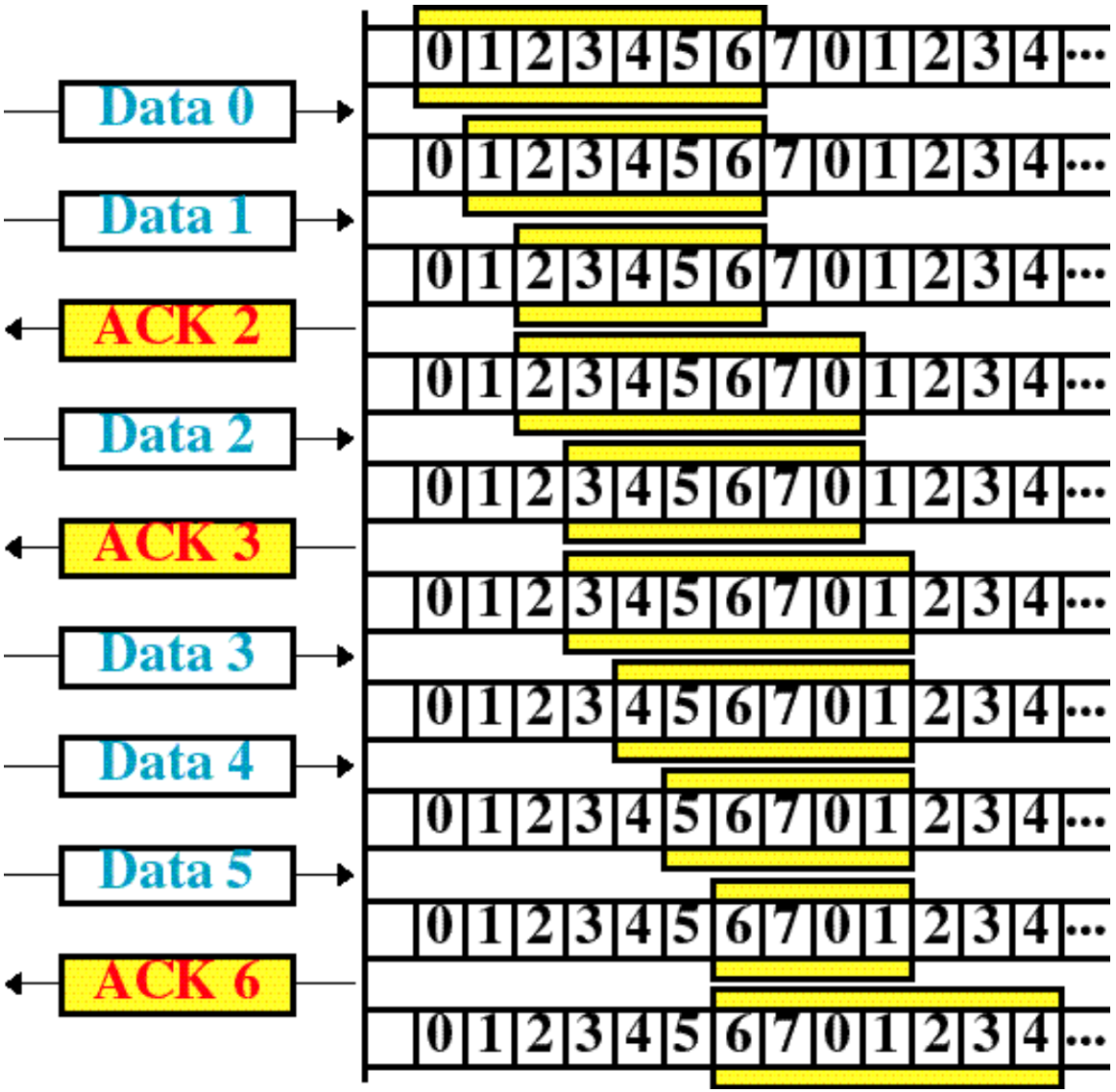
Sliding Window Example



Sender


0 1 2 3 4 5 6 7 0 1 2 3 4 ...
Data 0
Data 1
ACK 2
Data 2
ACK 3
Data 3
Data 4
Data 5
ACK 6

Receiver

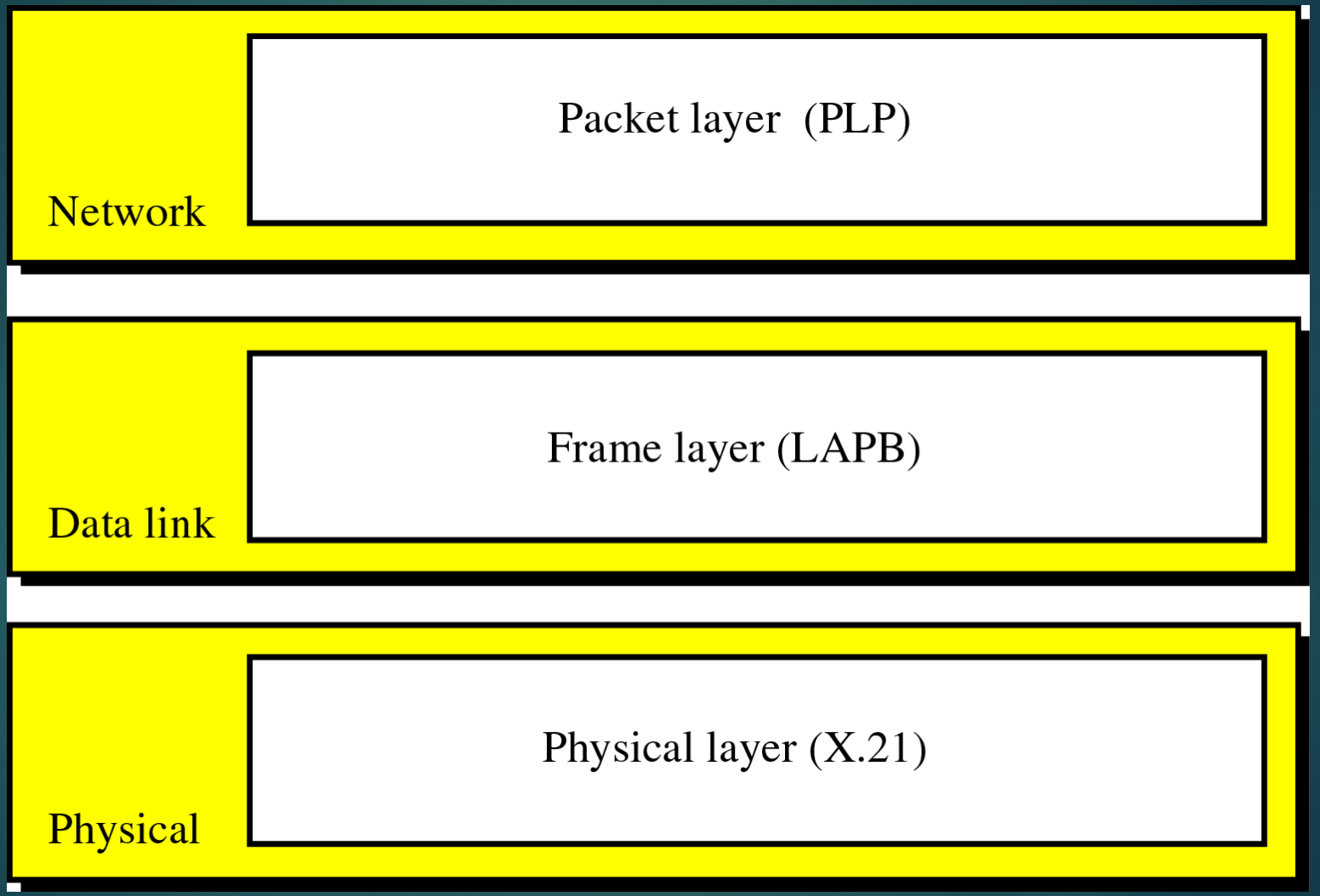

Data 0
Data 1
ACK 2
Data 2
ACK 3
Data 3
Data 4
Data 5
ACK 6
0 1 2 3 4 5 6 7 0 1 2 3 4 ...

X.25

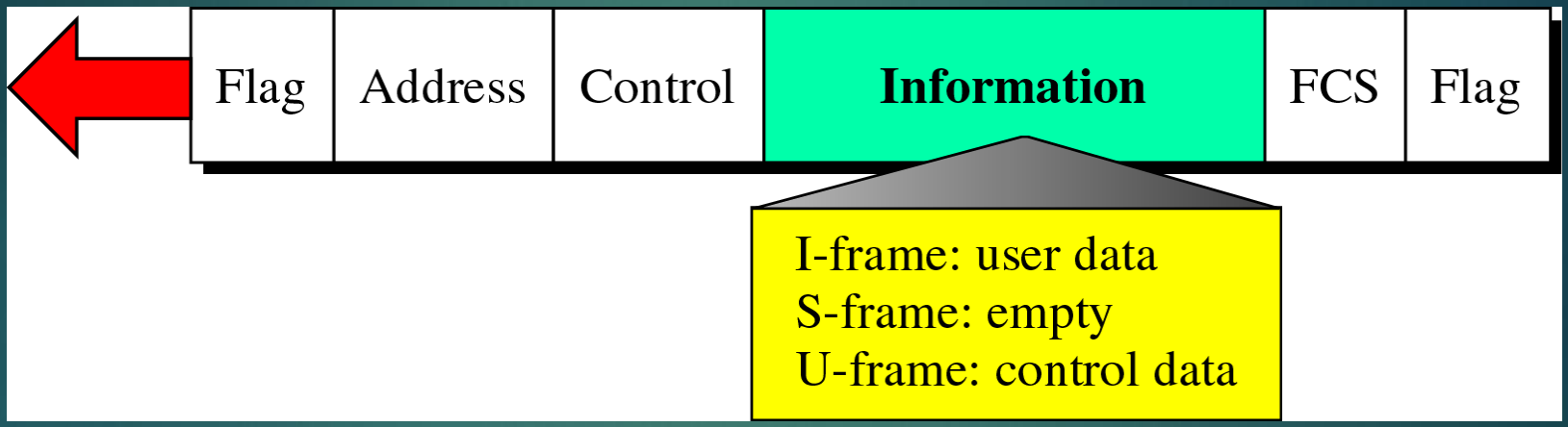
X.25



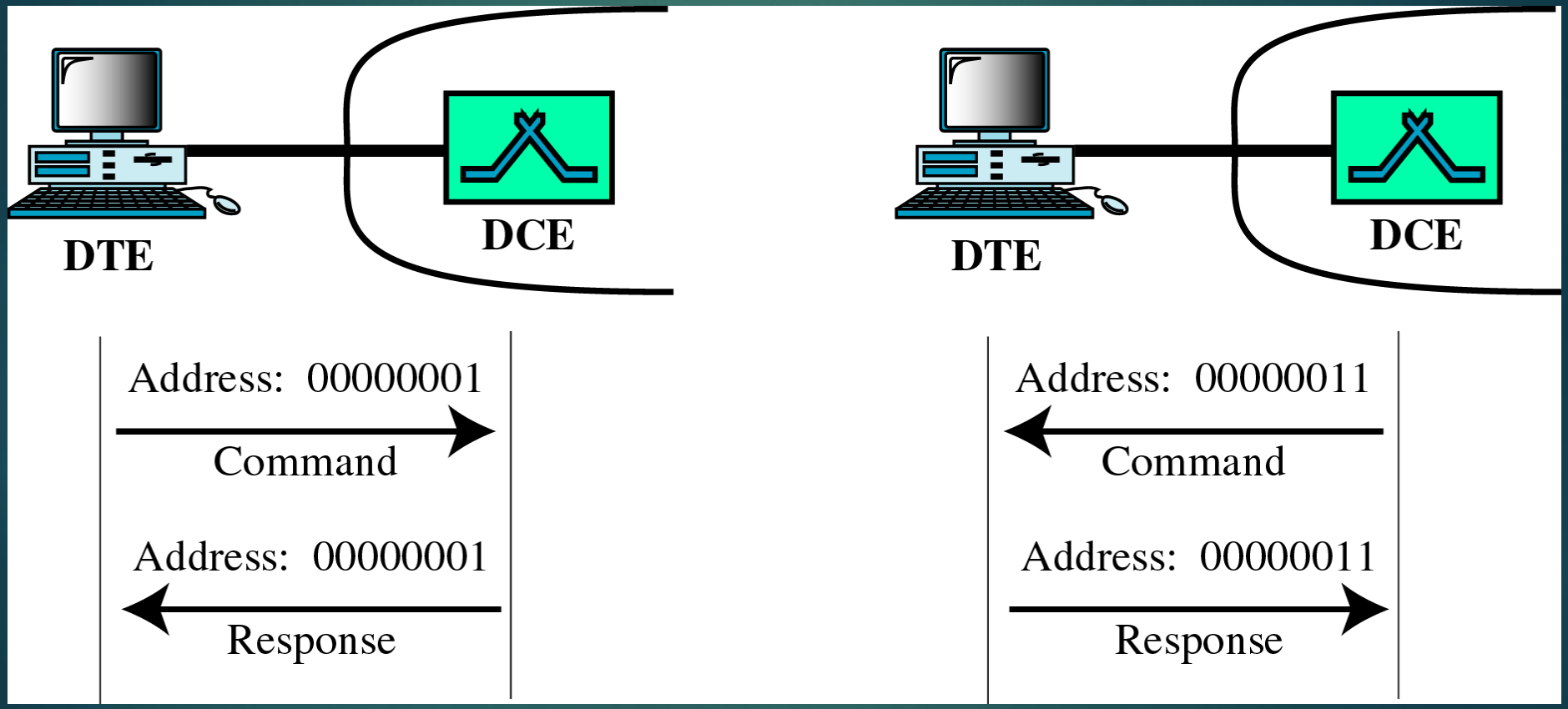
X.25 Layers in Relation to the OSI Layers



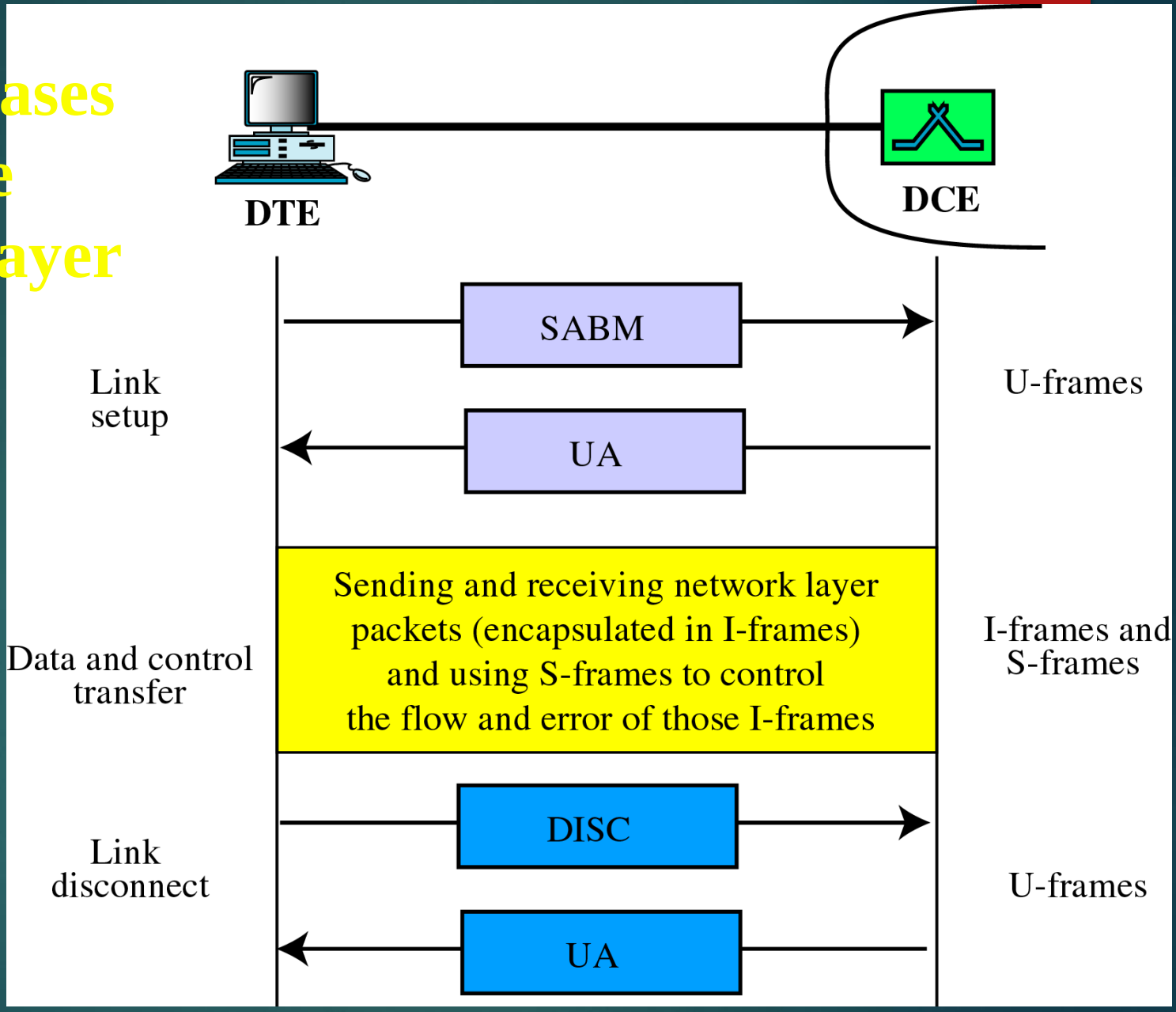
Format of a Frame



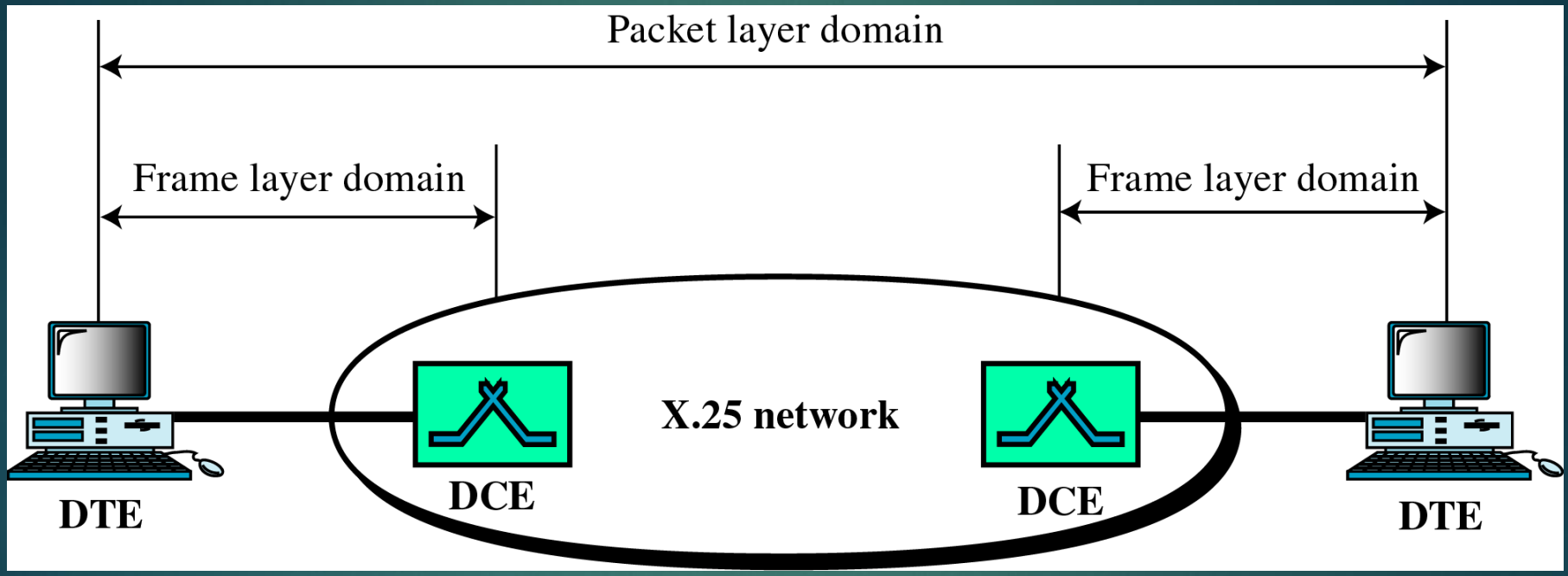
Addressing at the Frame Layer



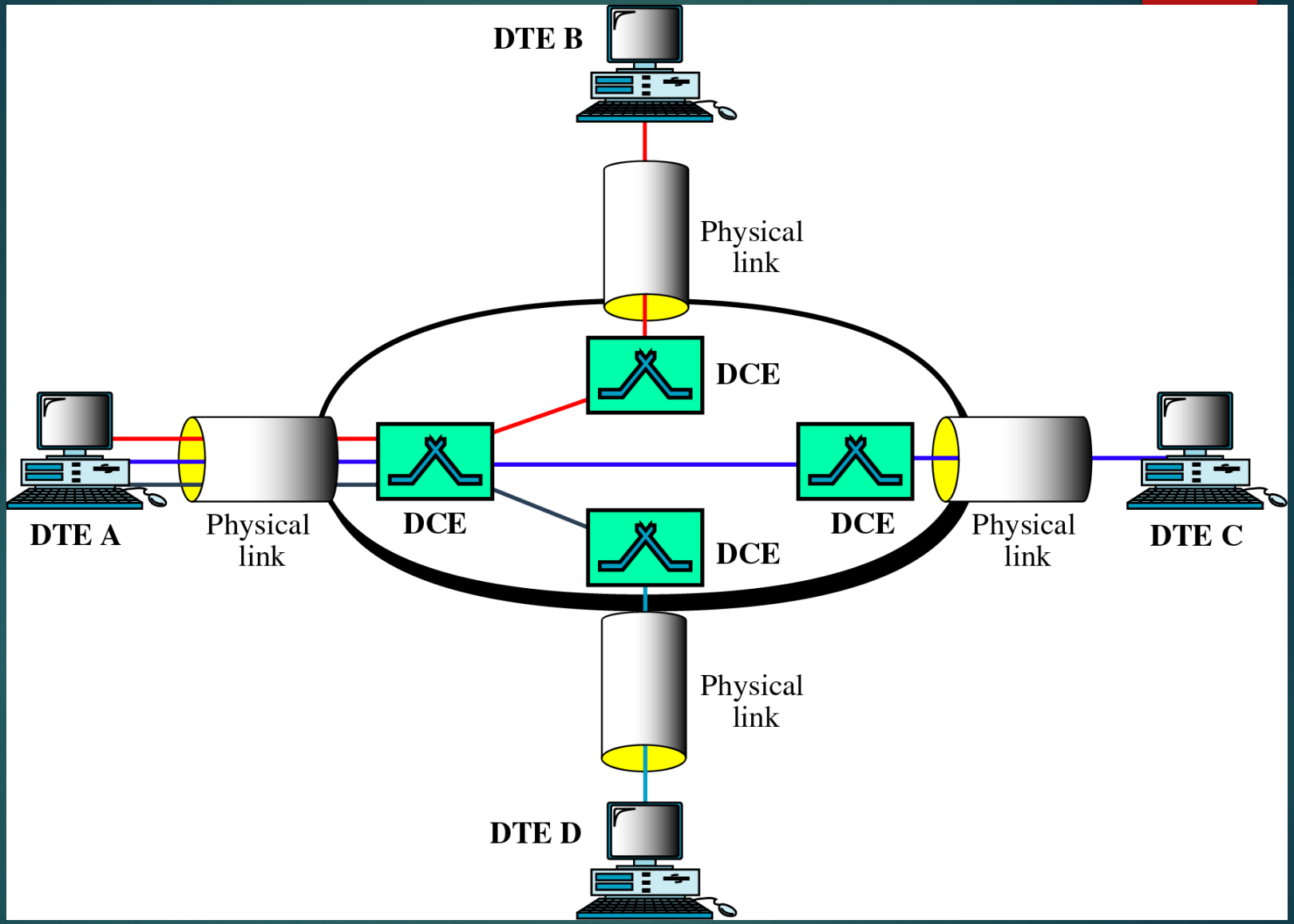
Three Phases of the Frame Layer



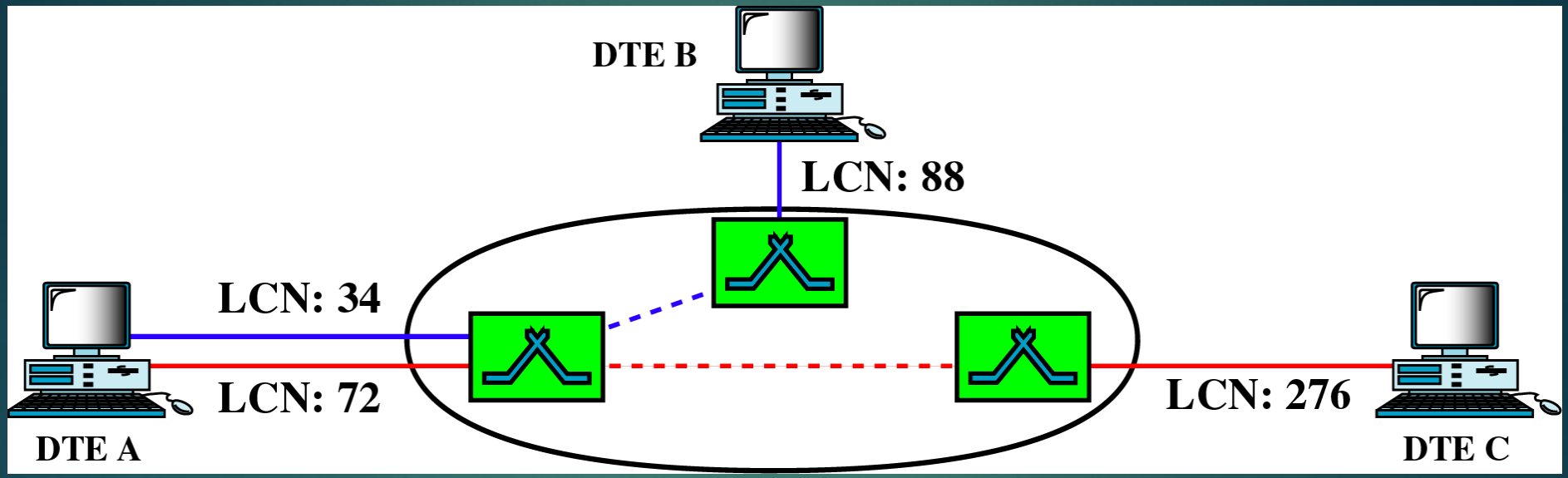
Frame Layer and Packet Layer Domains



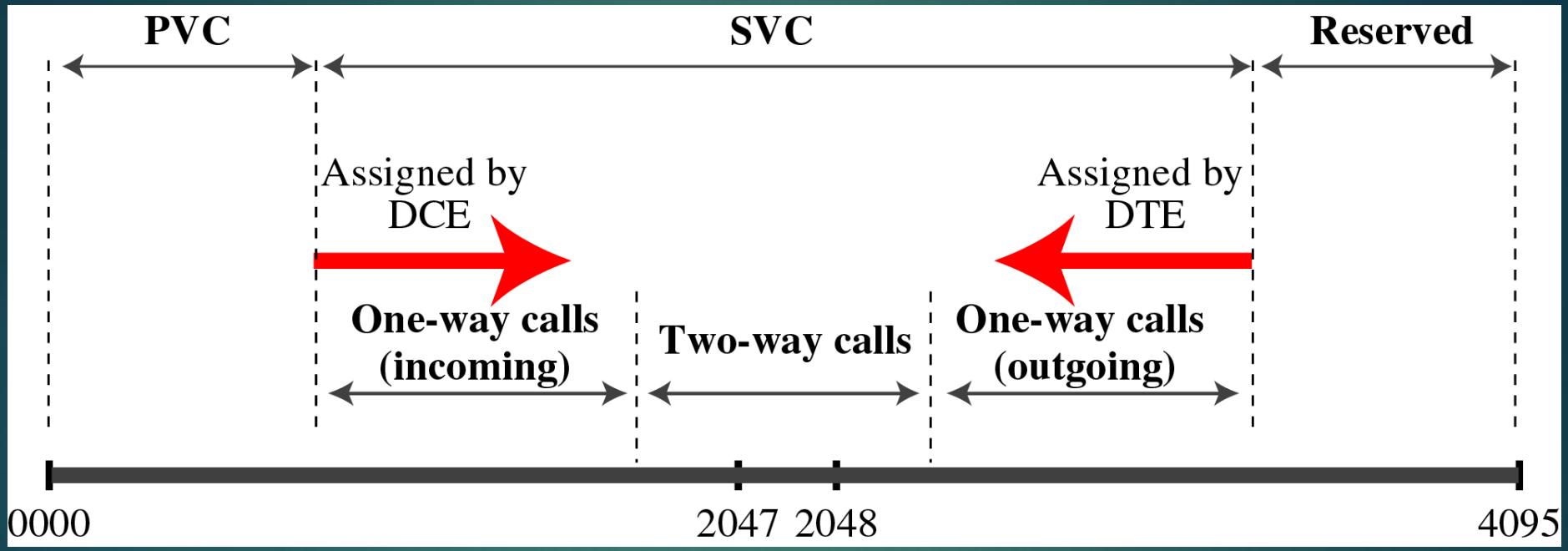
Virtual Circuits in X.25



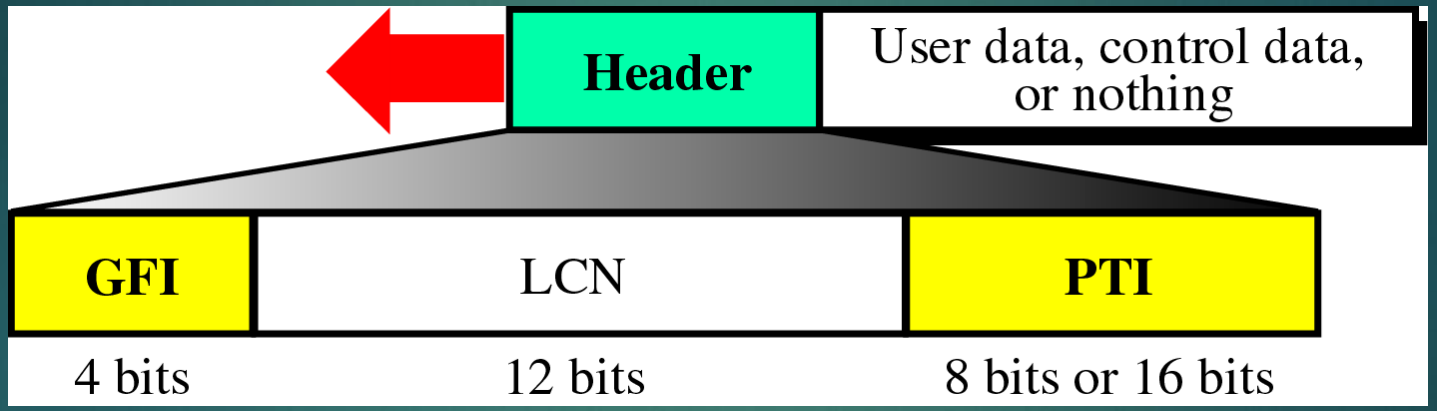
LCNs in X.25



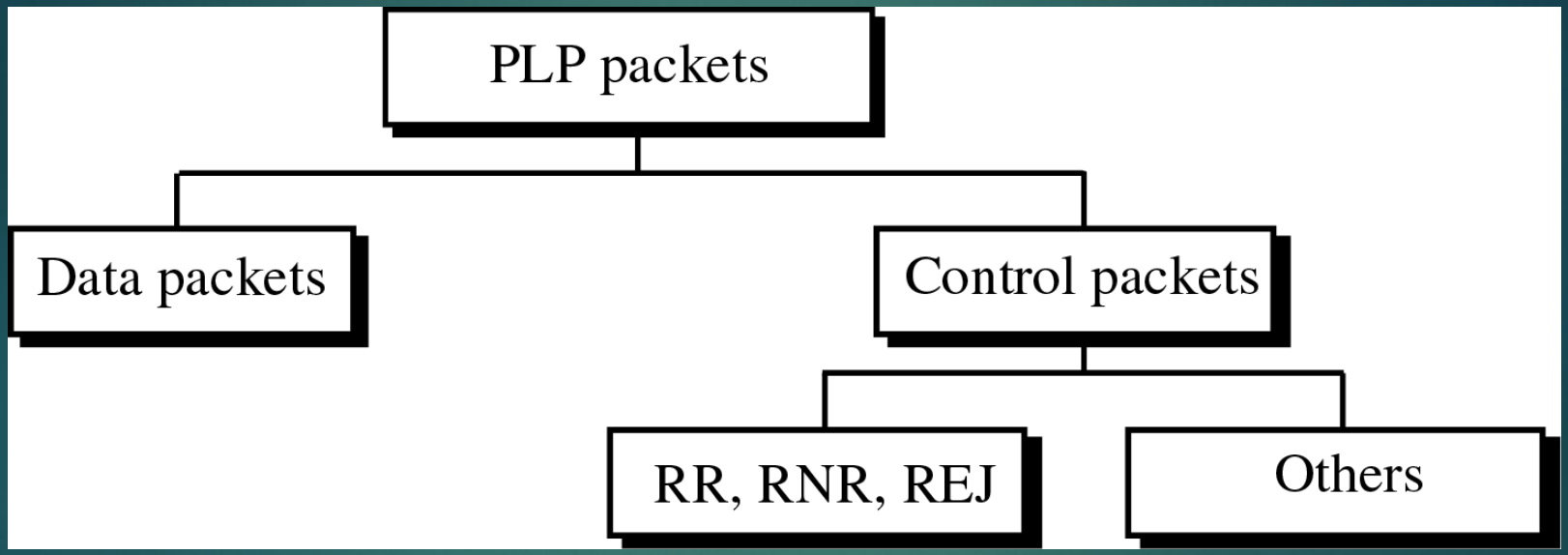
LCN Assignments



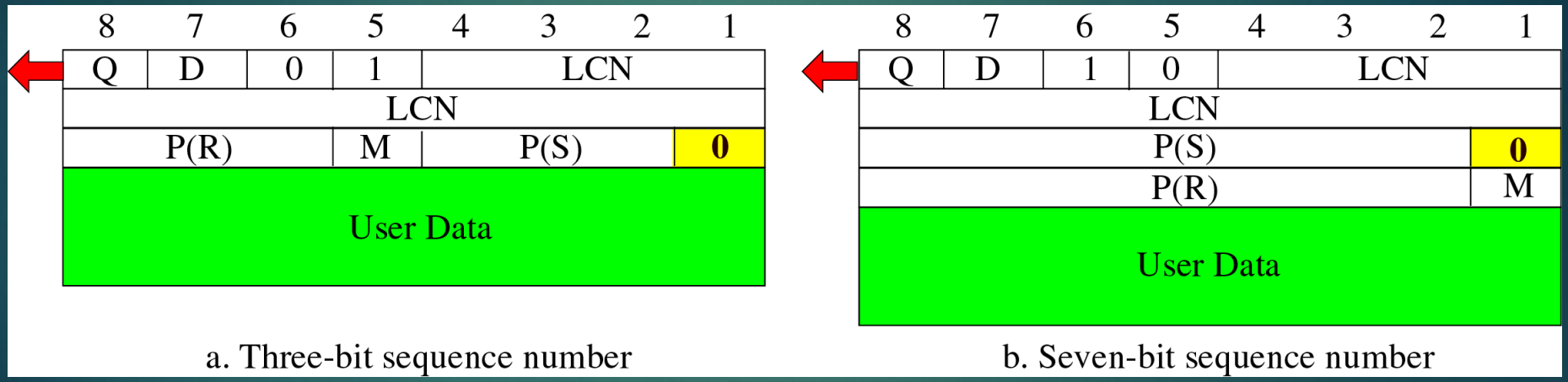
PLP Packet Format



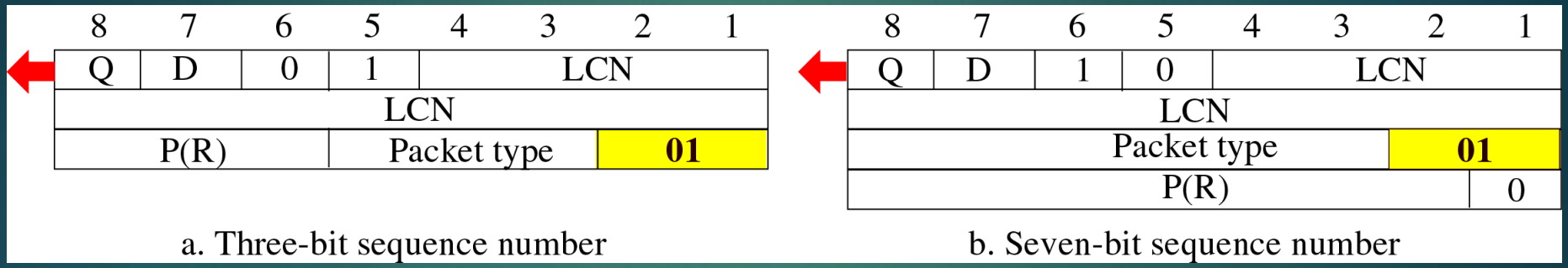
Categories of PLP Packets



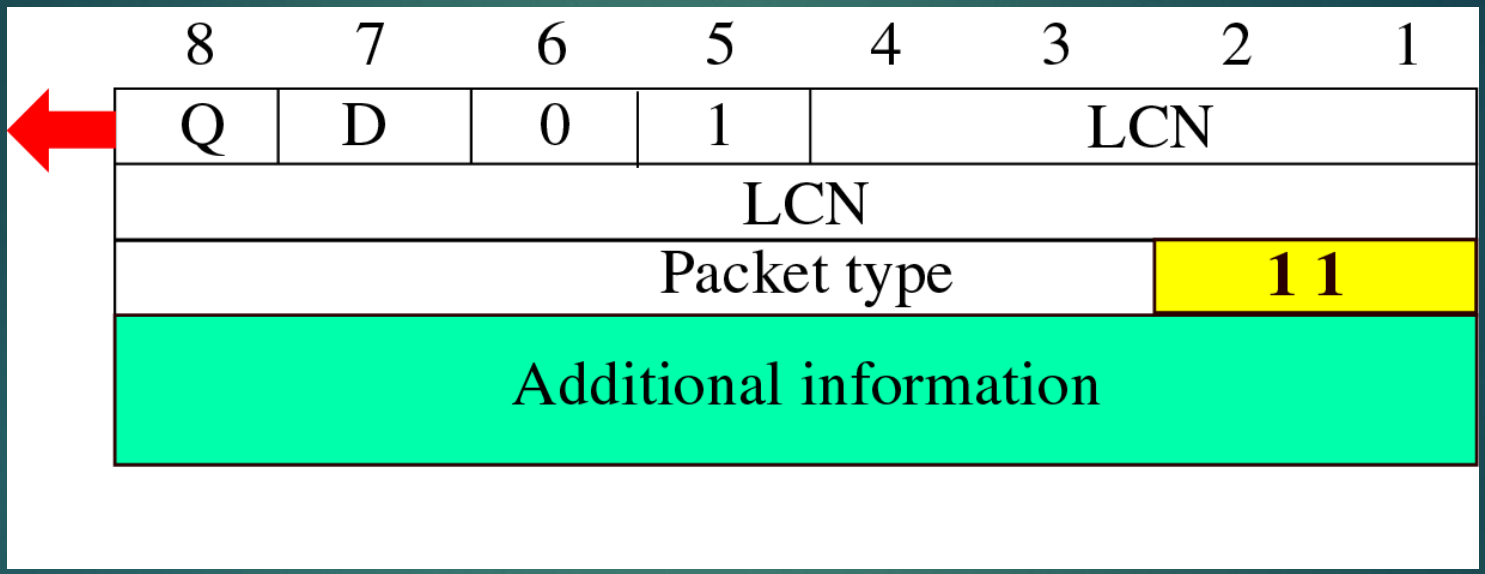
Data Packets in the PLP Layer



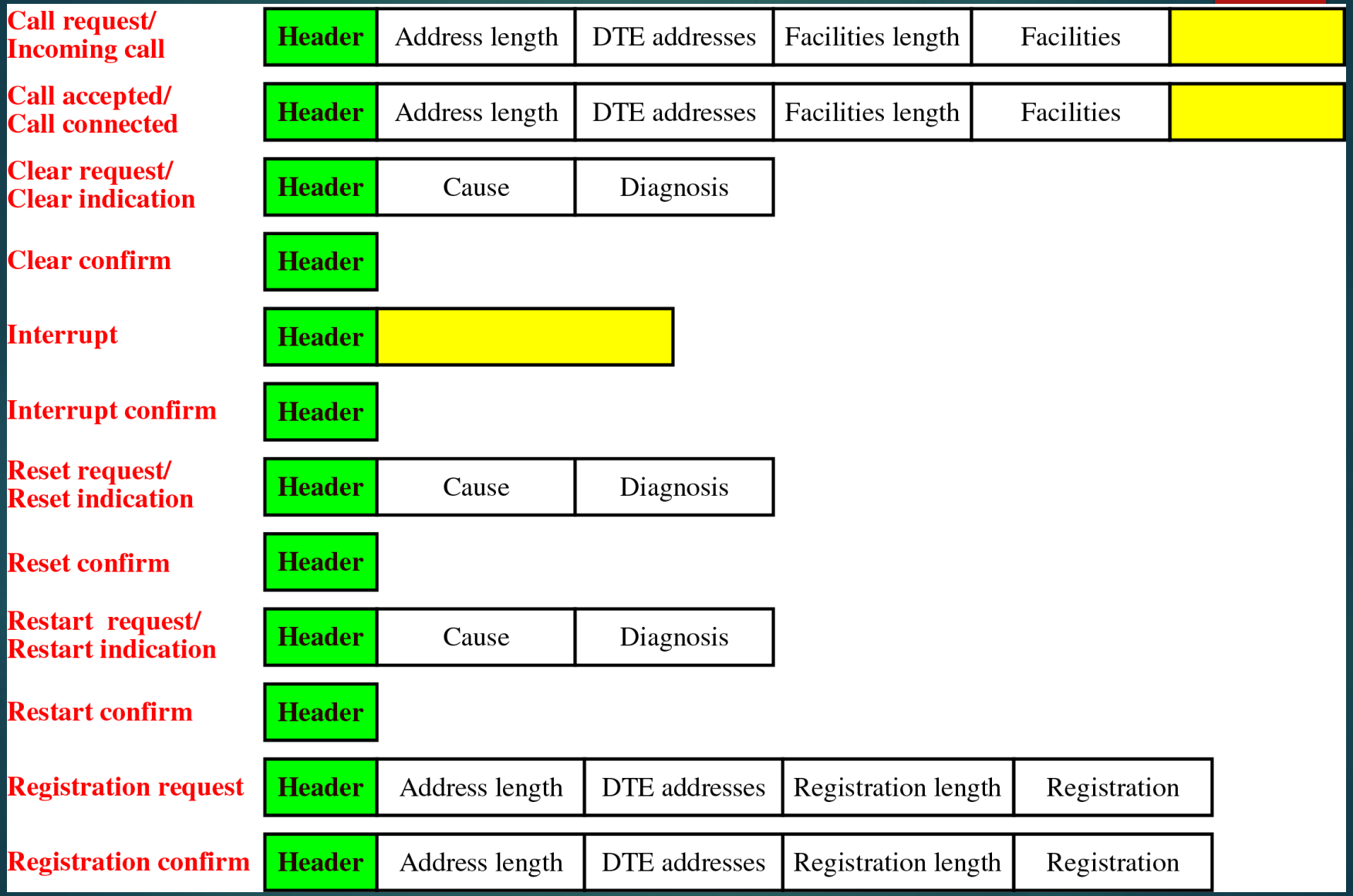
RR, RNR, and REJ Packets



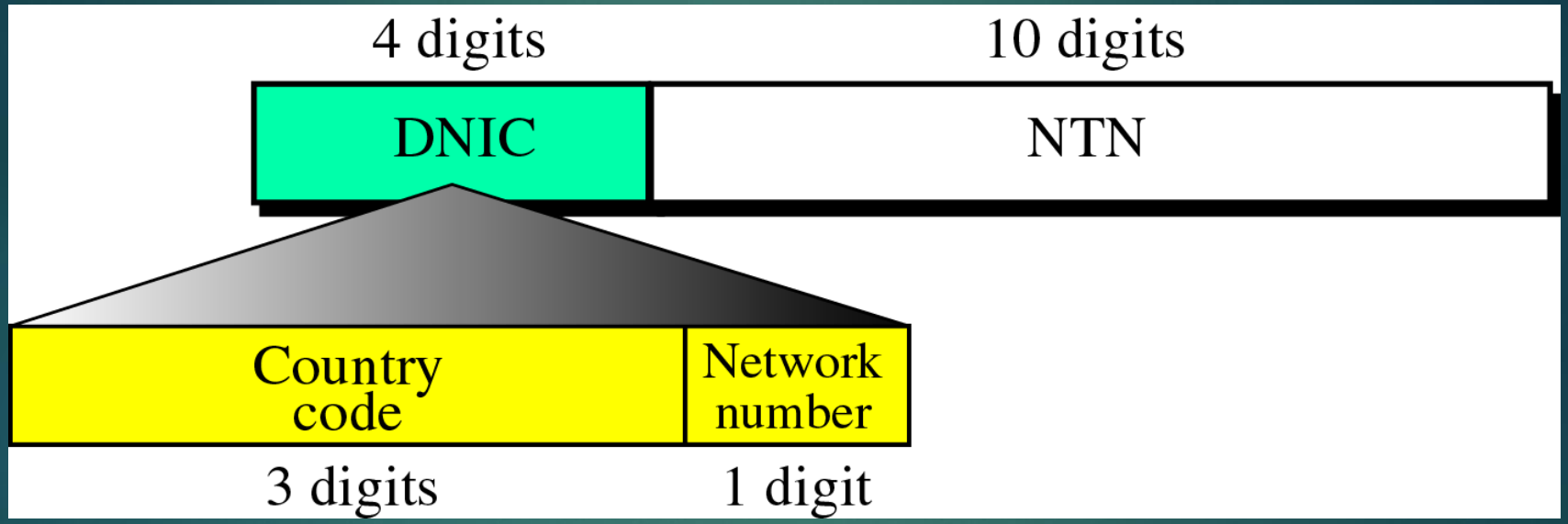
Other Control Packets



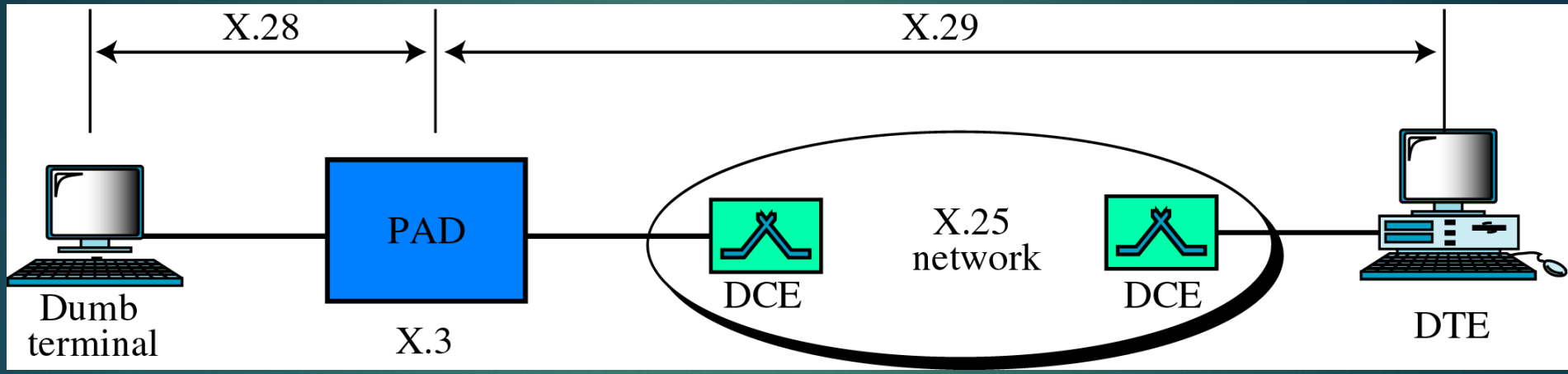
Control Packet Formats



X.25 Address Format

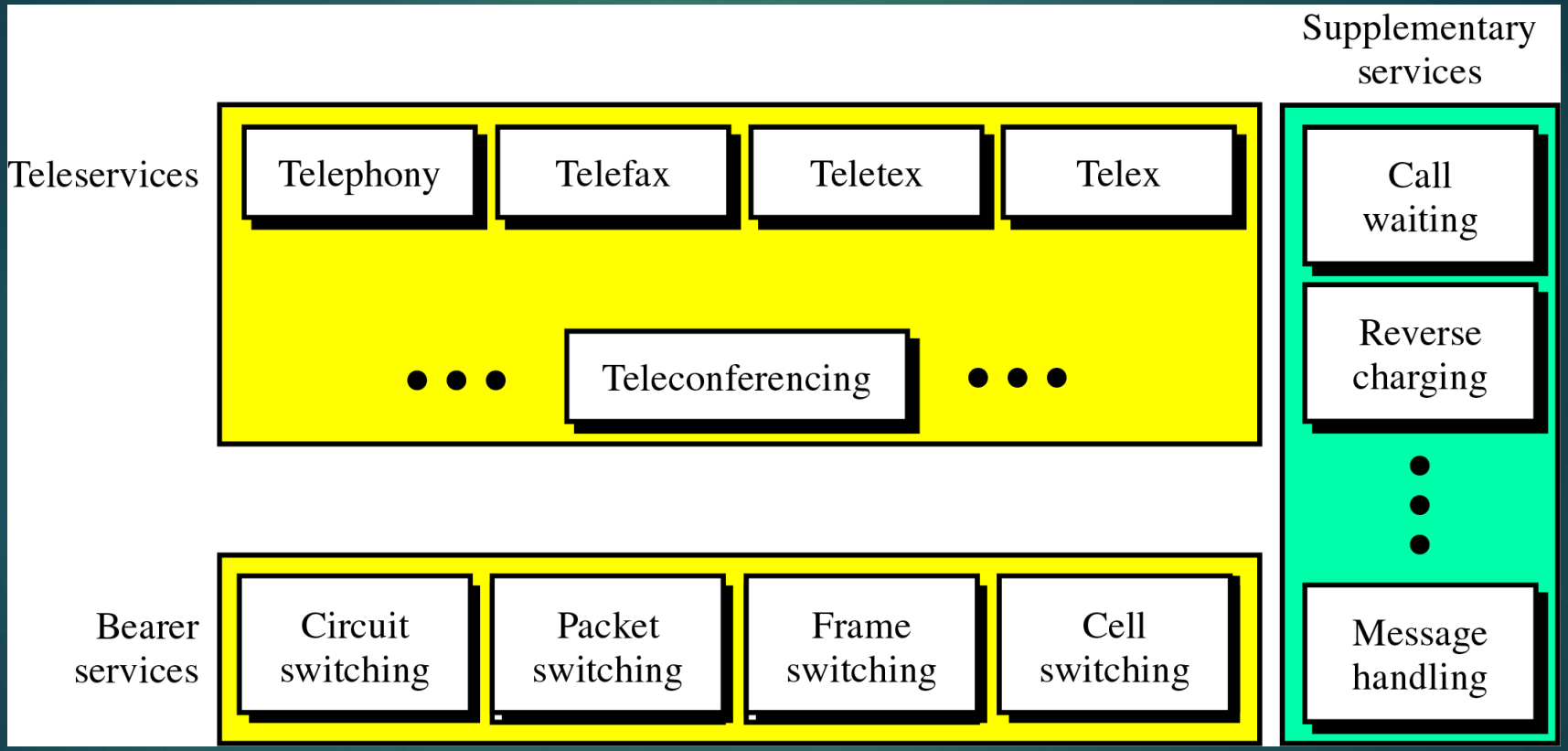


Triple-X Protocols

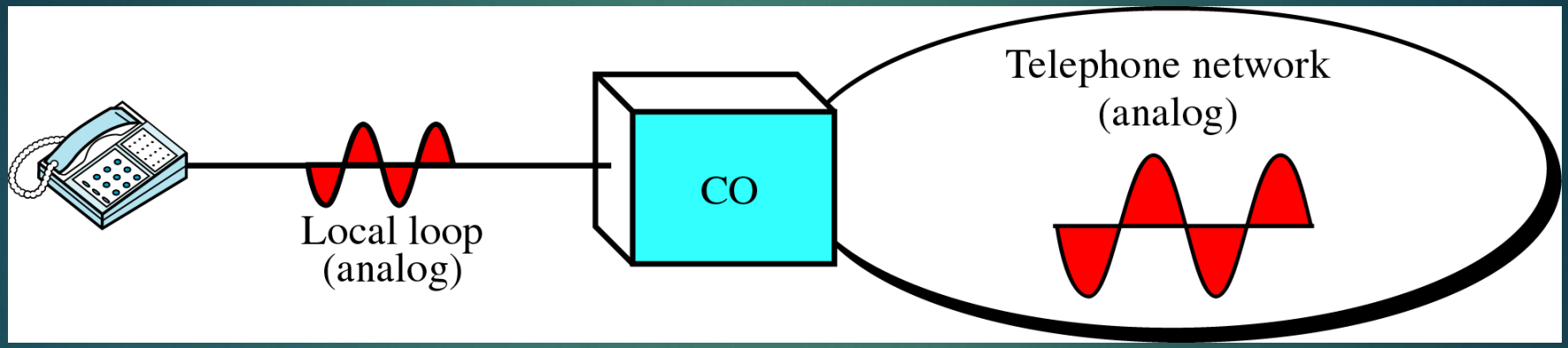


Integrated Services Digital Network (ISDN)

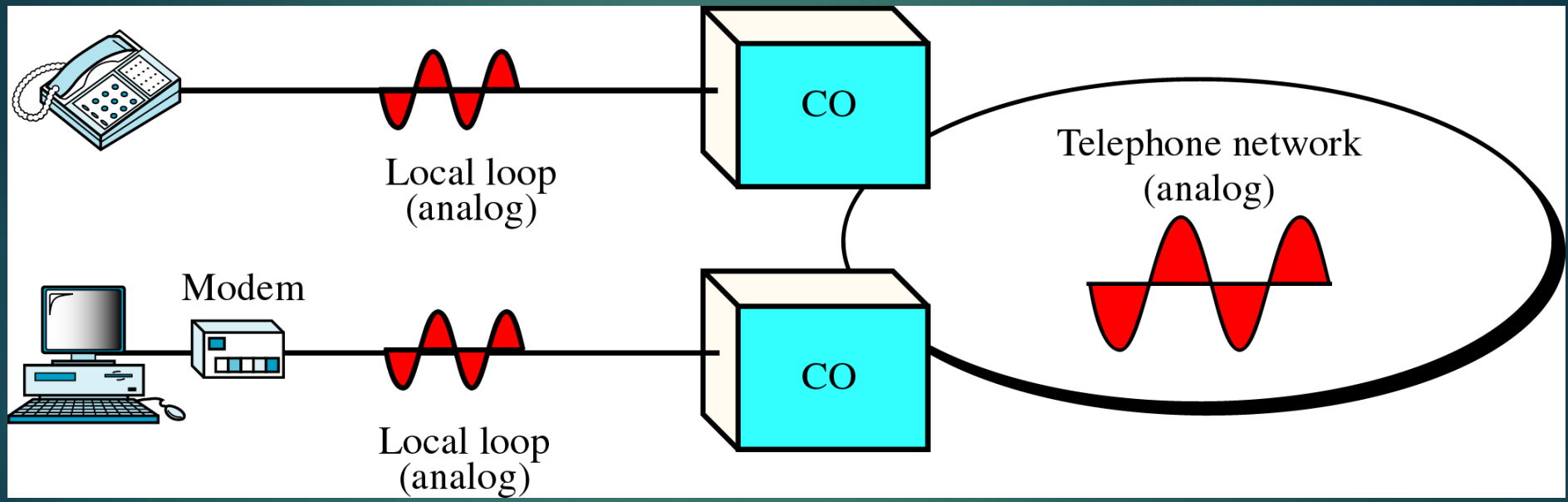
ISDN Services



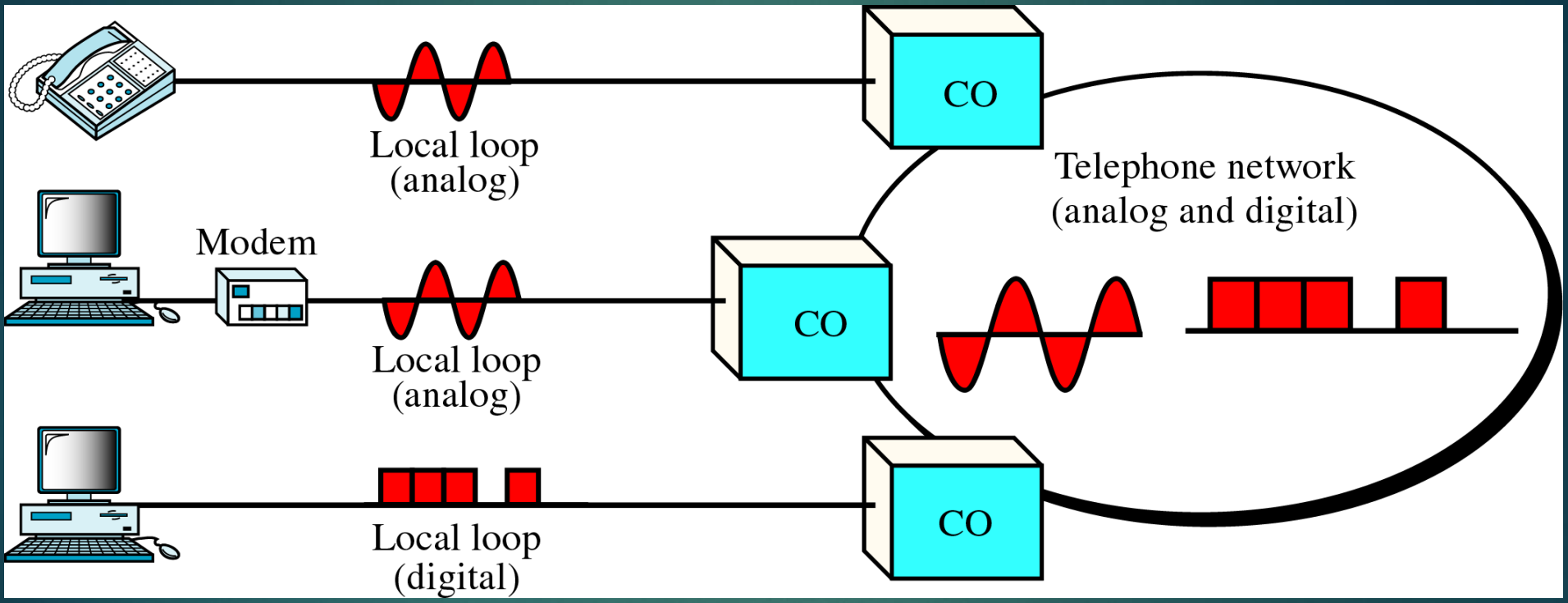
Voice Communication over an Analog Telephone Network



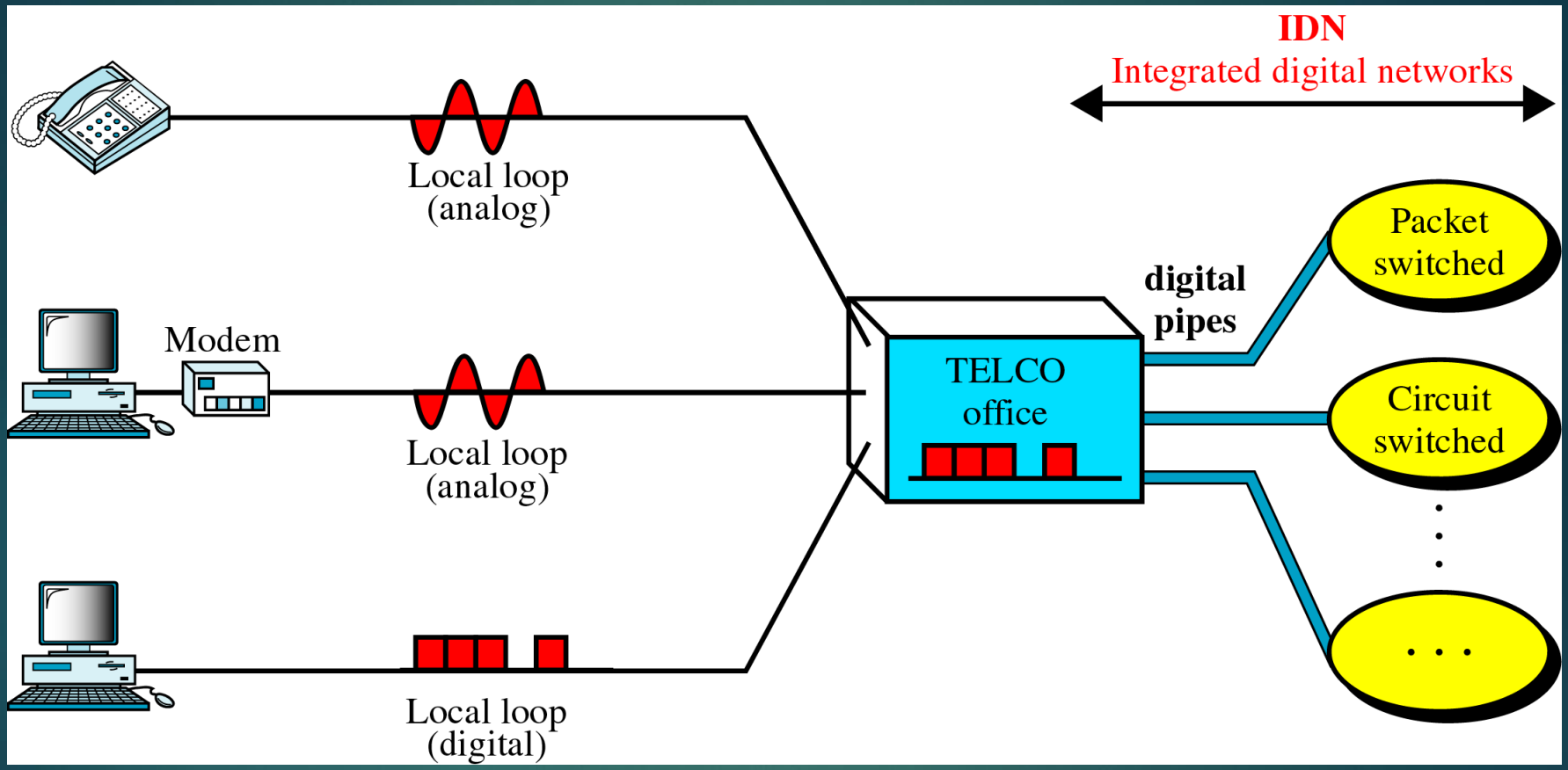
Voice and Data Communication over an Analog Telephone Network



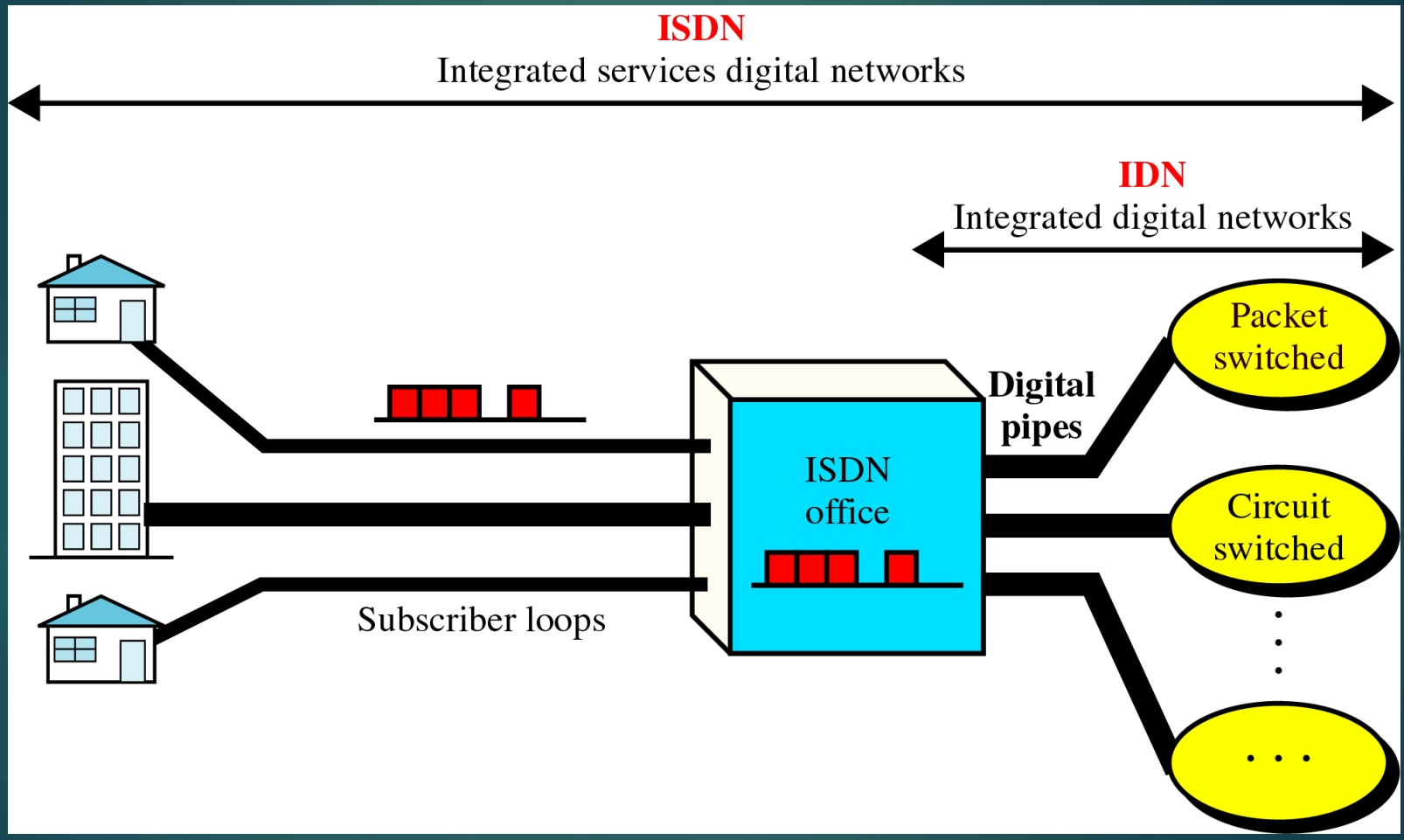
Analog and Digital Services over the Telephone Network



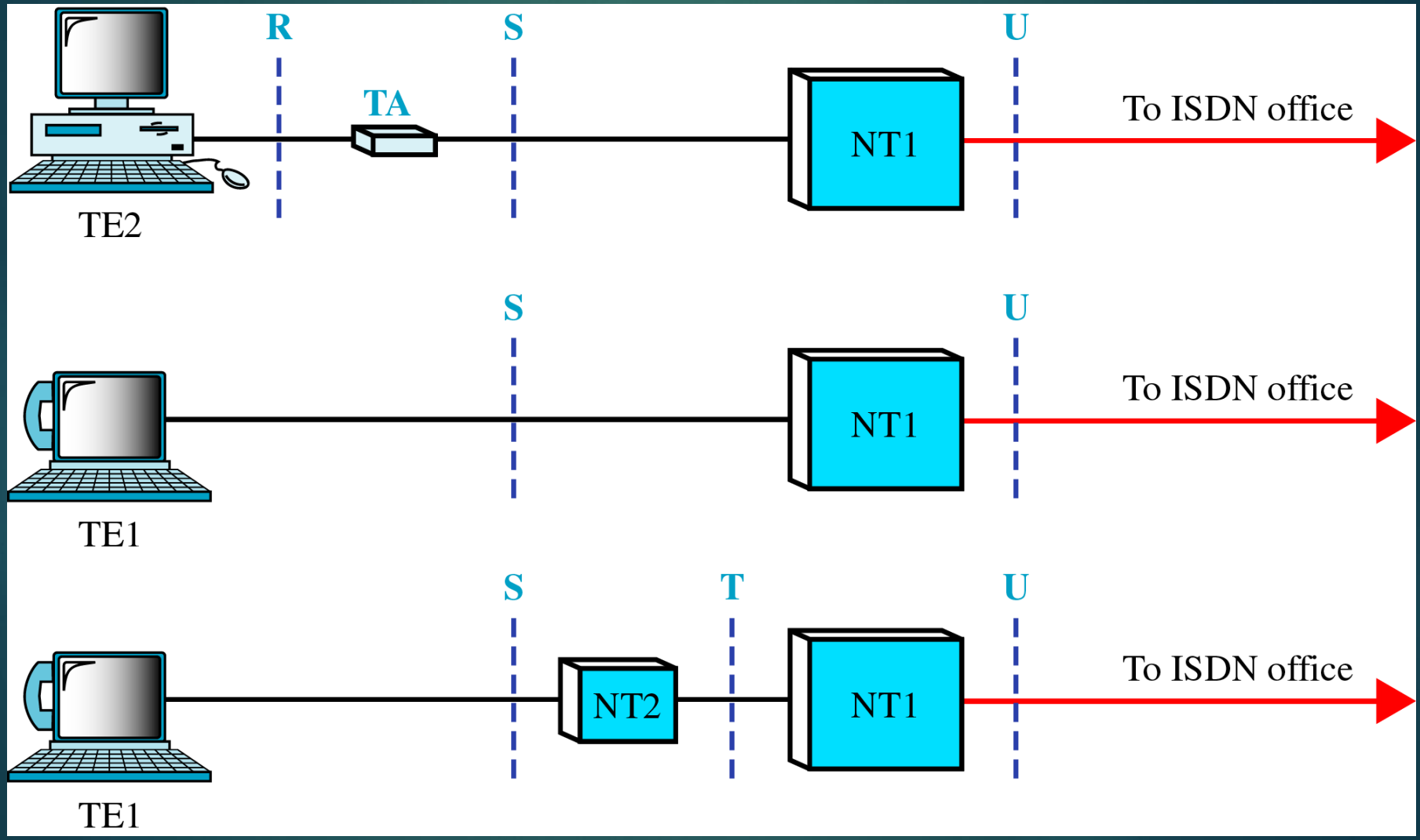
IDN


IDN
Integrated digital networks
Local loop
(analog)
Modem
Local loop
(analog)
Local loop
(digital)
digital
pipes
TELCO
office
Packet
switched
Circuit
switched
. . .

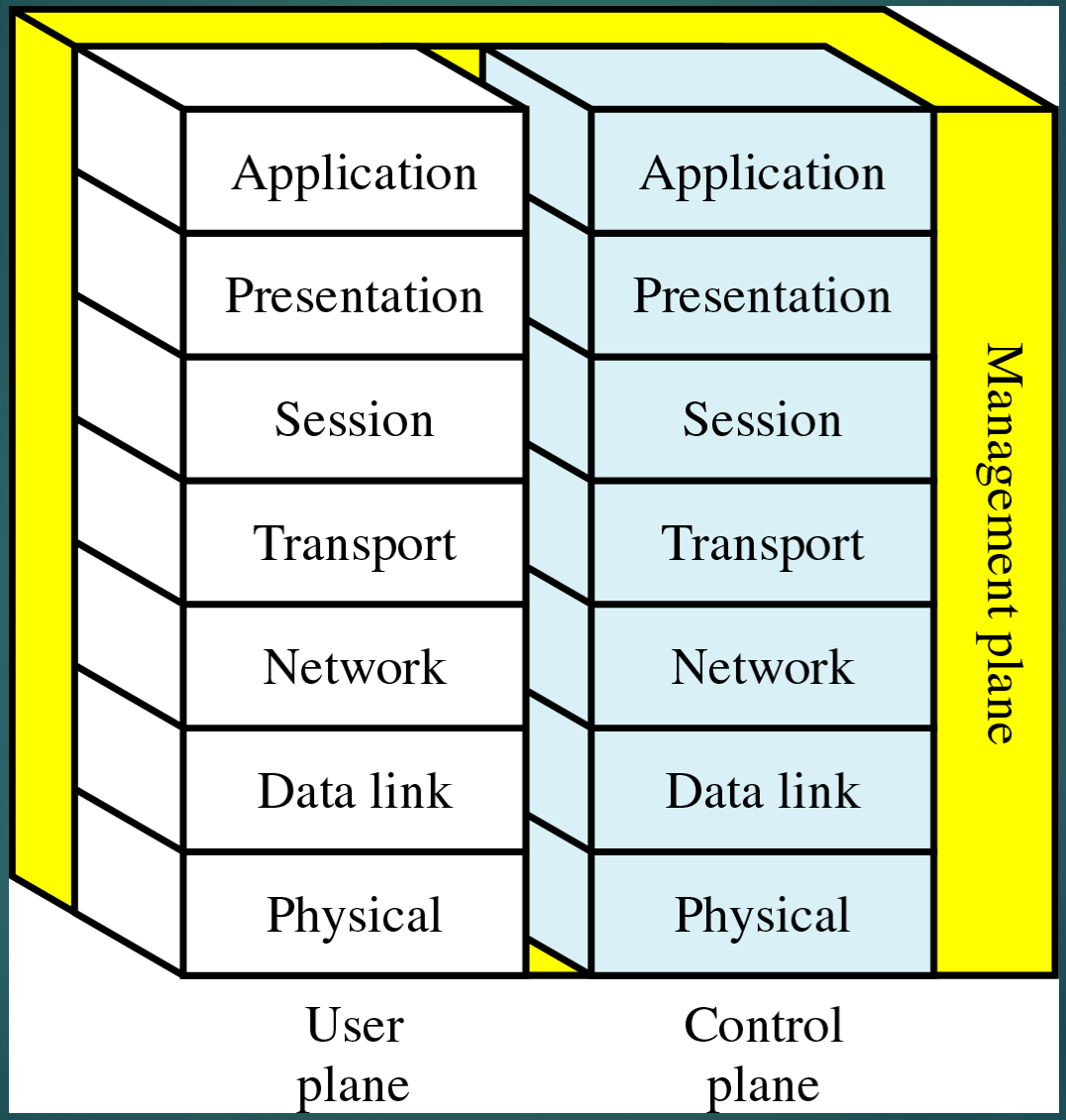
ISDN


ISDN
Integrated services digital networks
IDN
Integrated digital networks
Packet switched
Digital pipes
ISDN office
Circuit switched
Subscriber loops

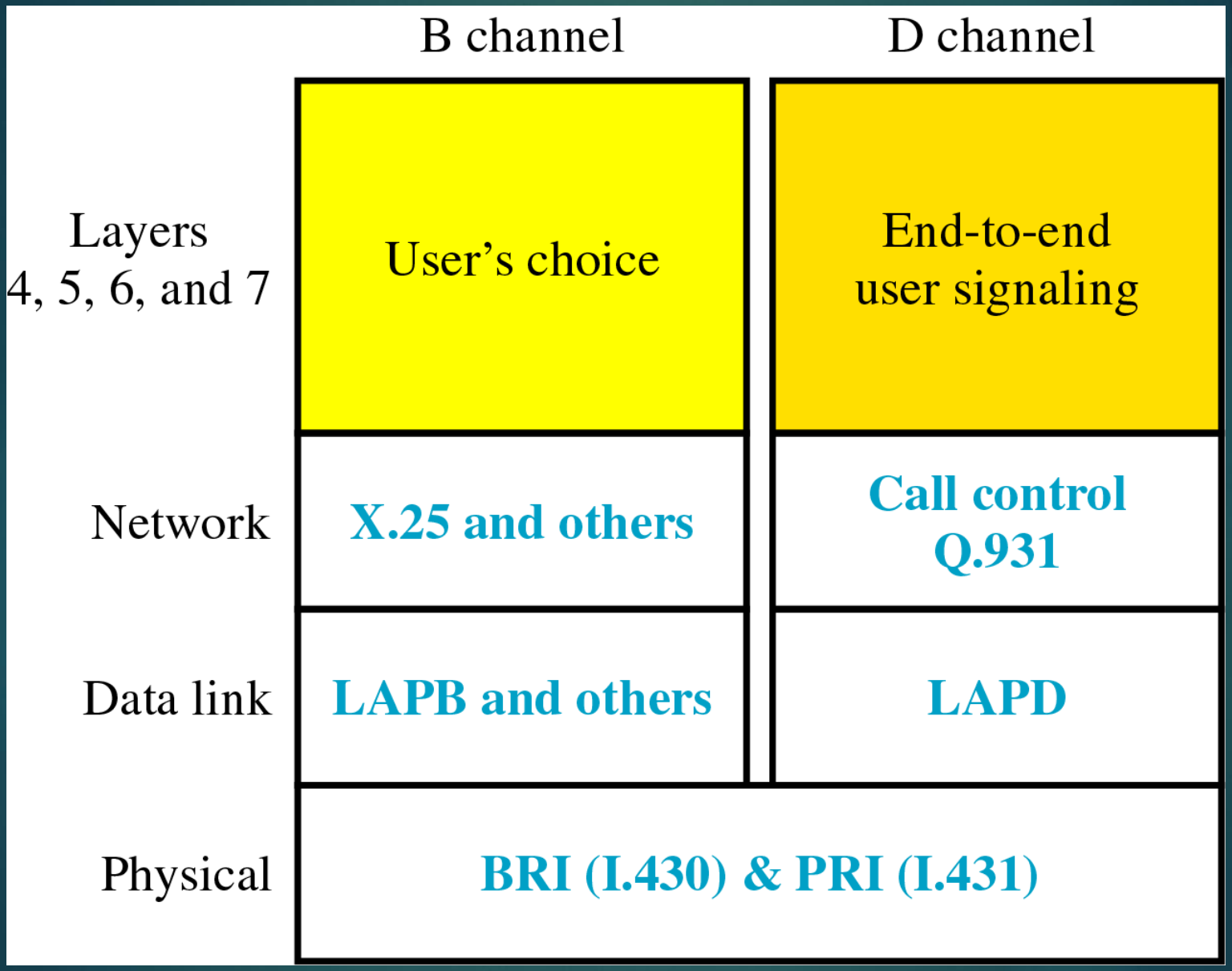
Reference Points



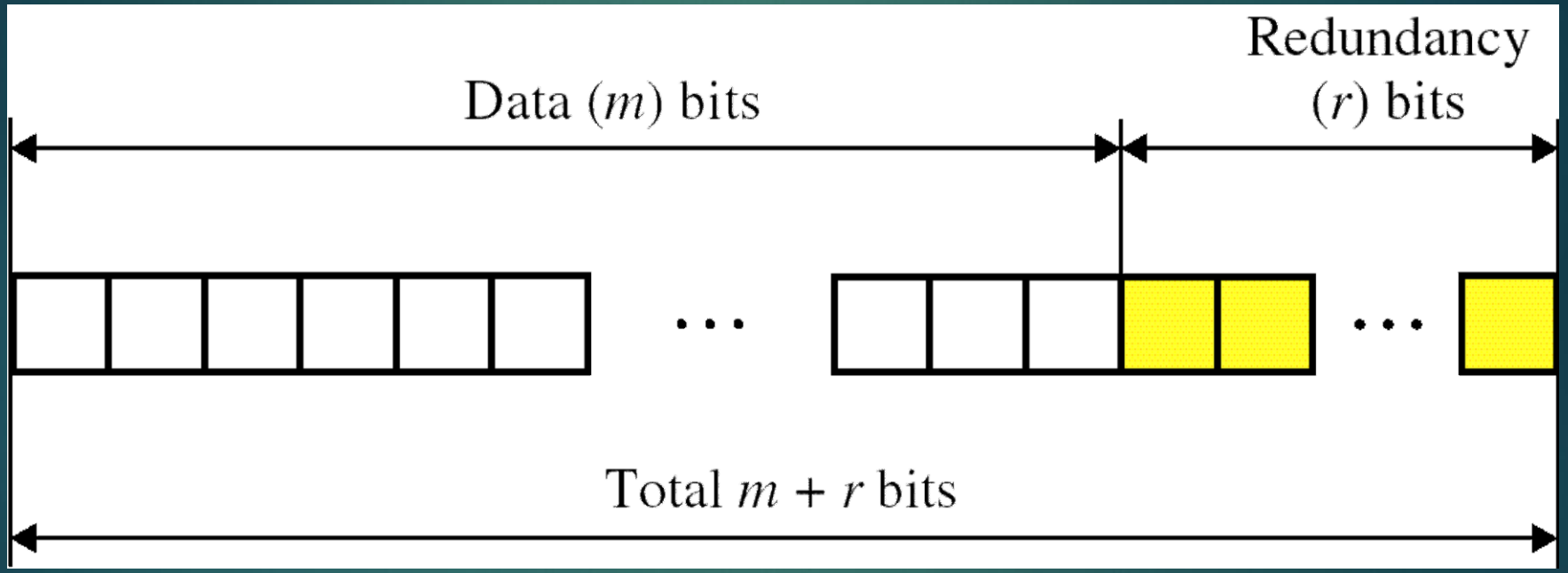
ISDN Layers


Application
Presentation
Session
Transport
Network
Data link
Physical
Application
Presentation
Session
Transport
Network
Data link
Physical
Management plane
User plane
Control plane

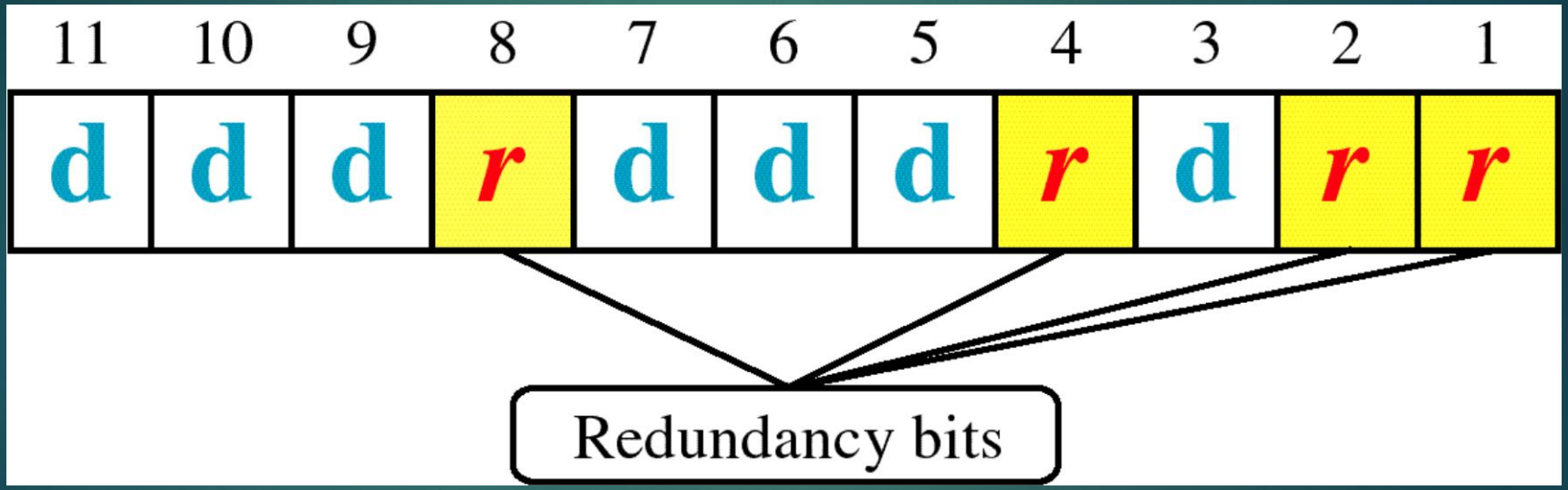
Simplified Layers of ISDN



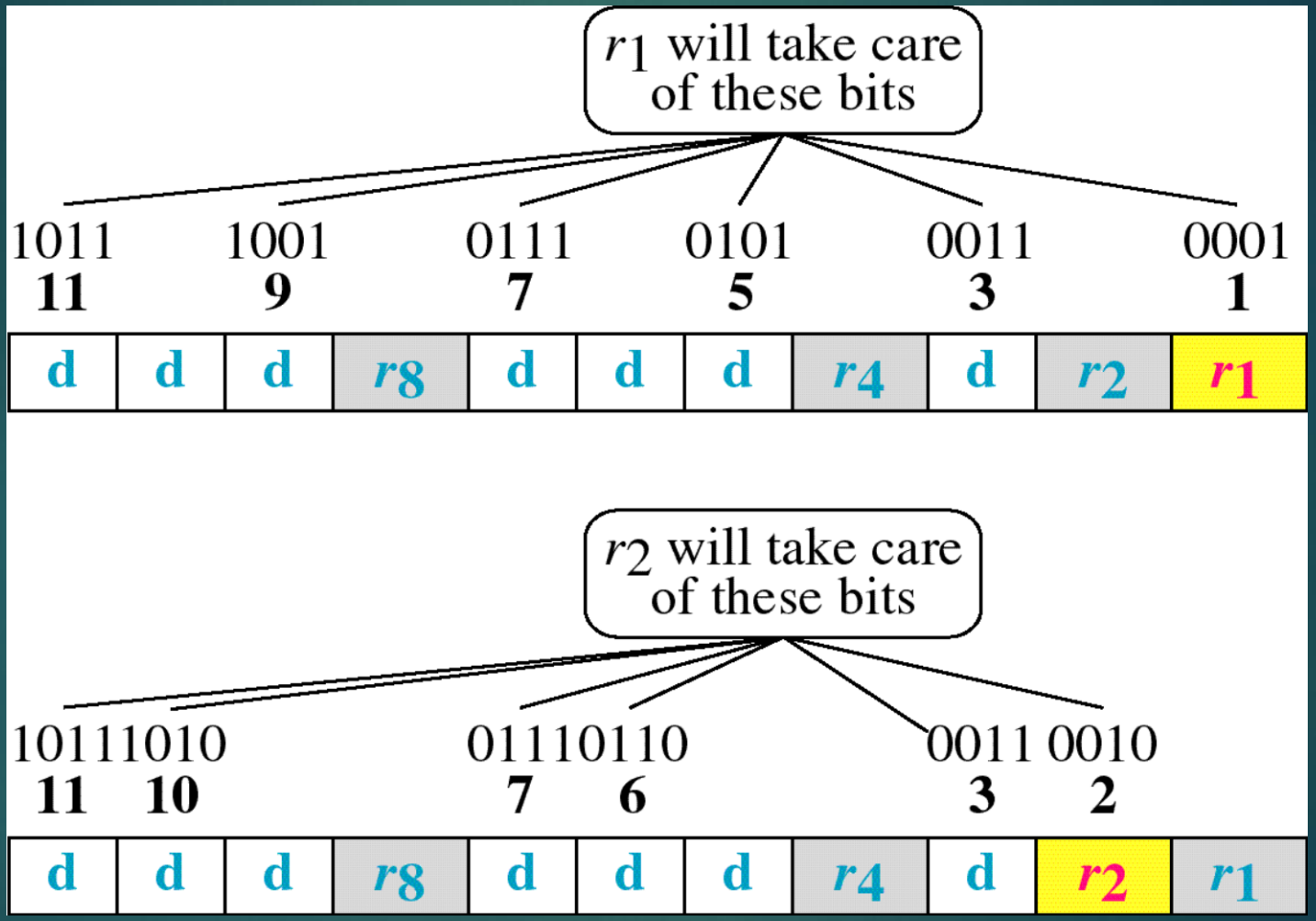
Error Correction



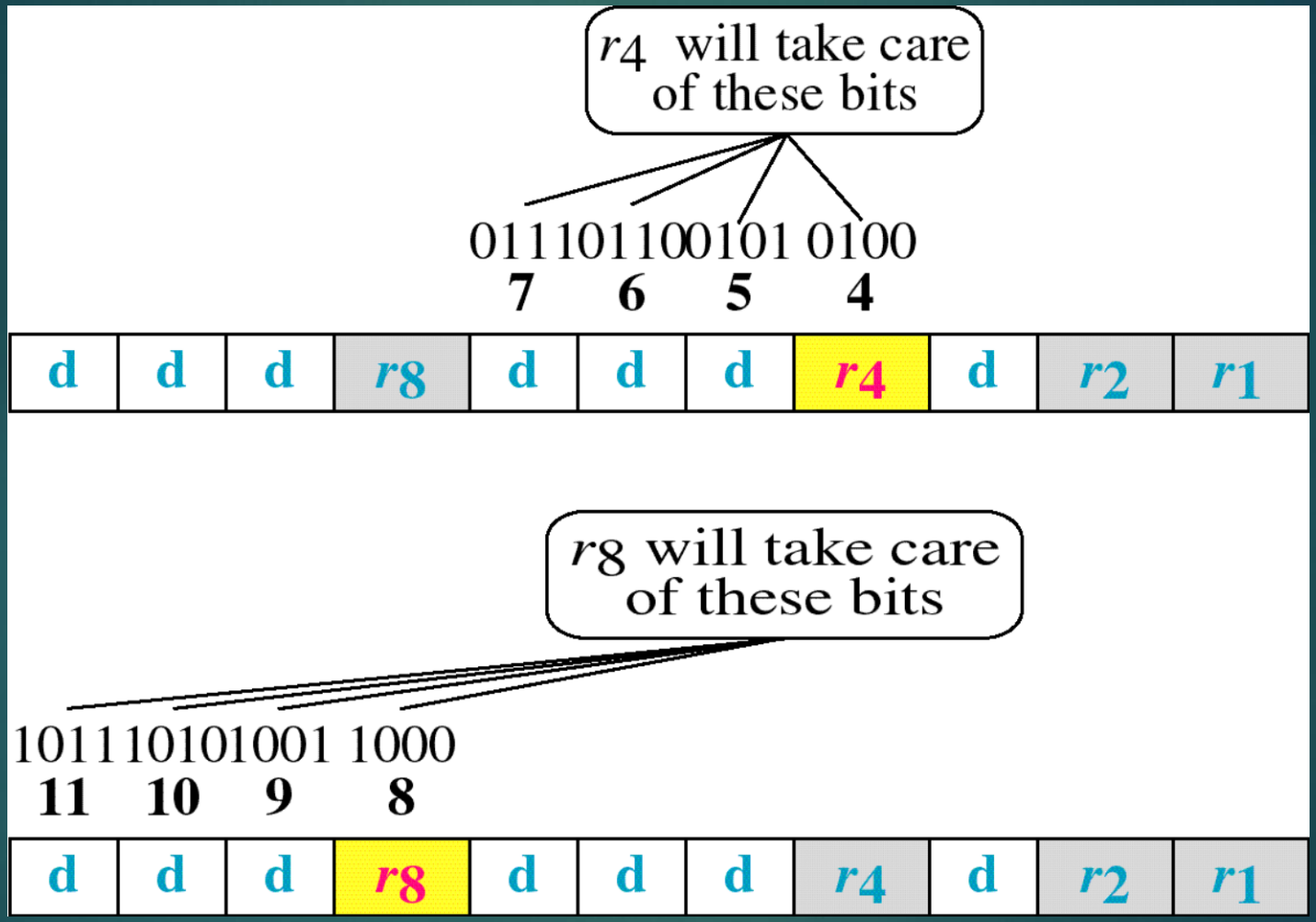
Hamming Code



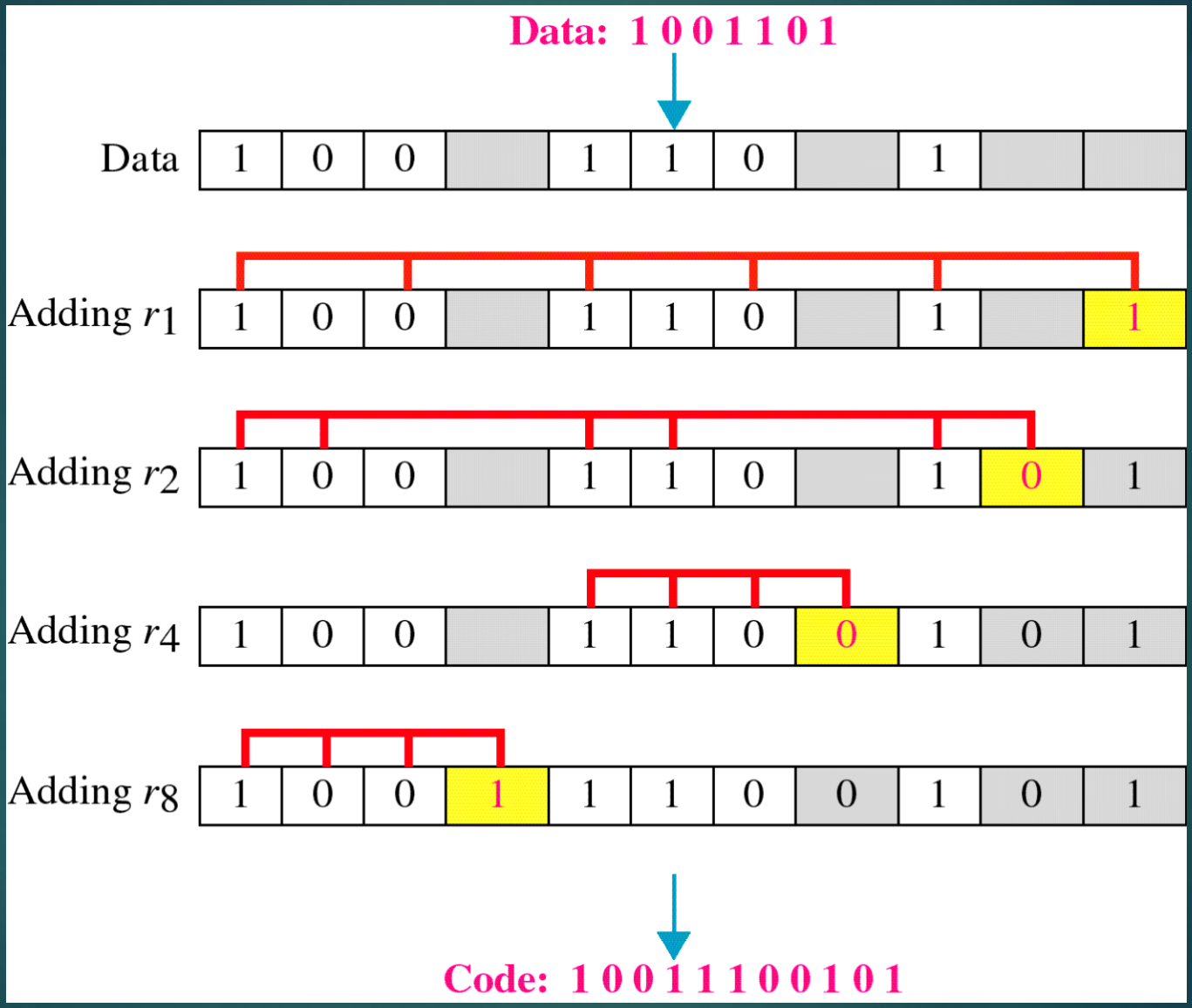
Hamming Code



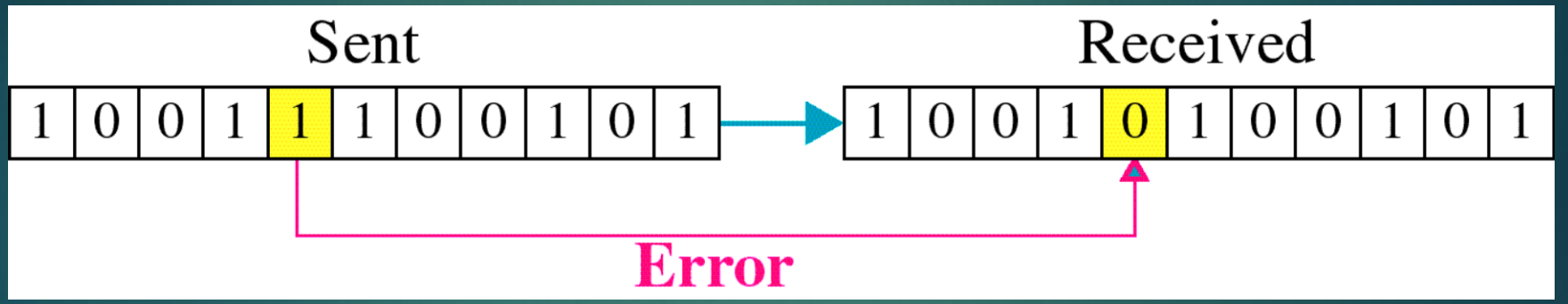
Hamming Code



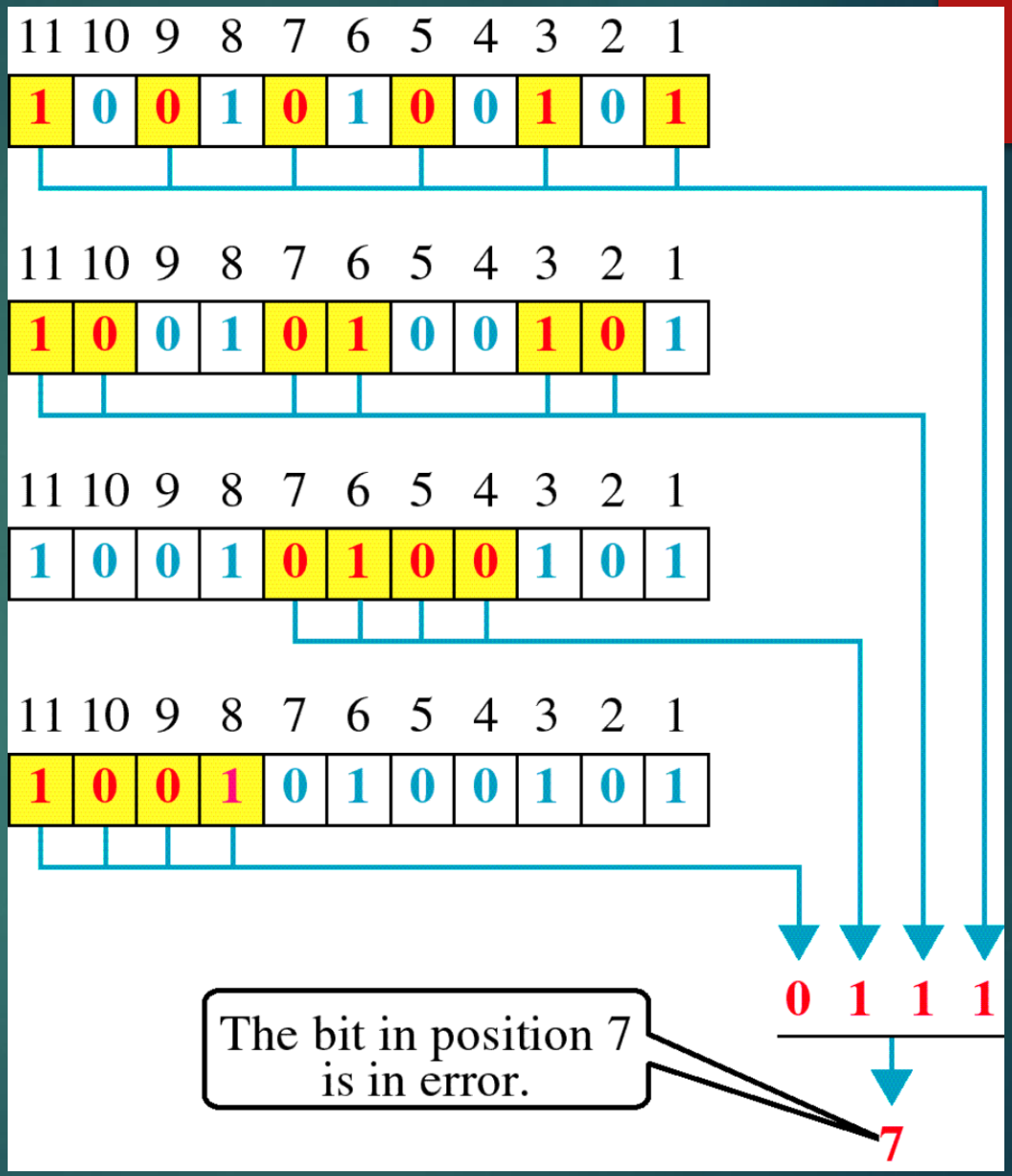
Example of Hamming Code

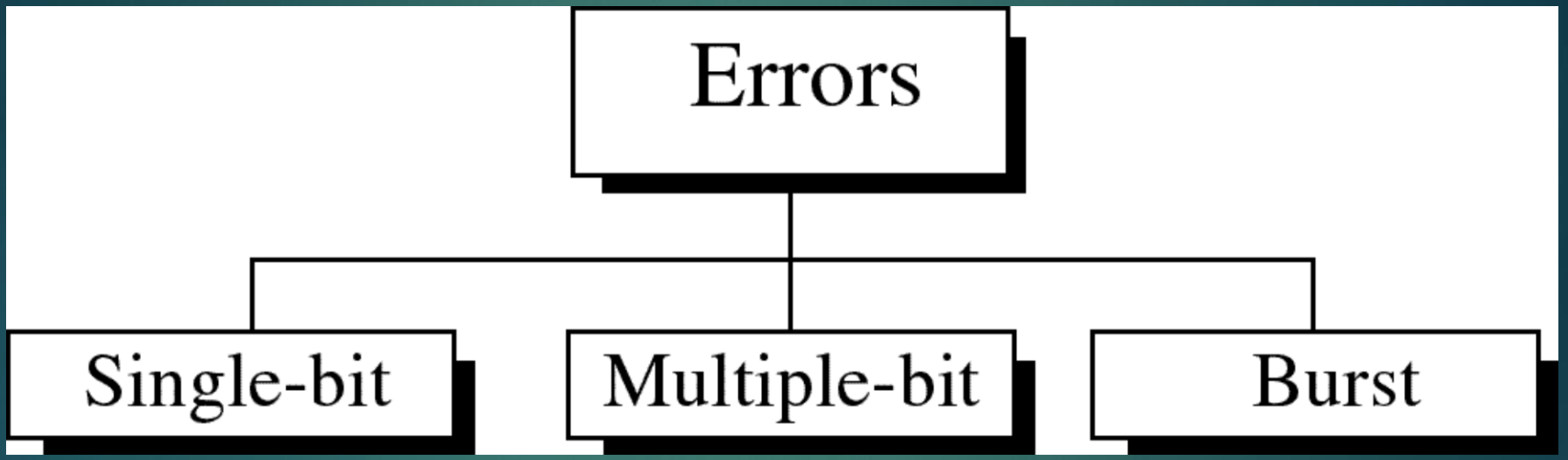


Single-bit error

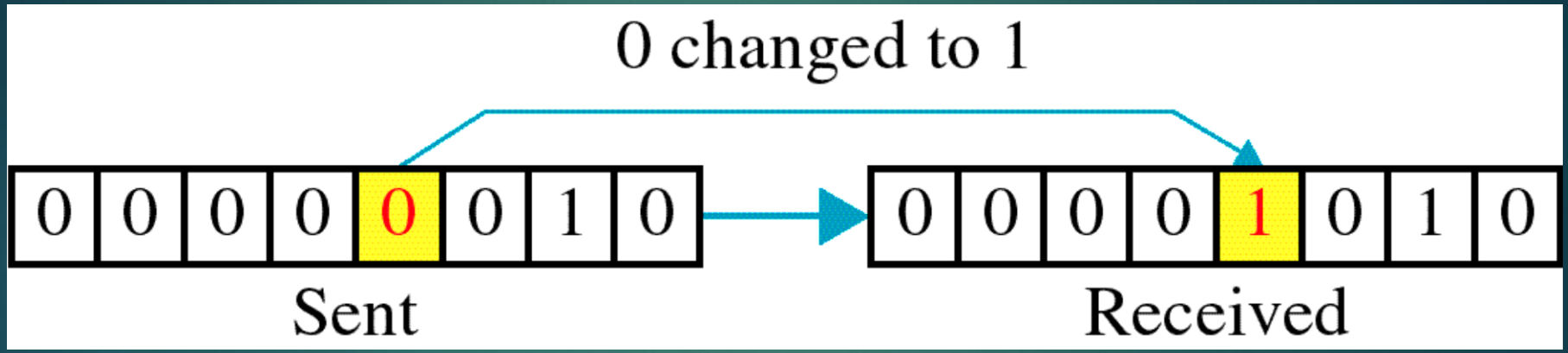


Error Detection

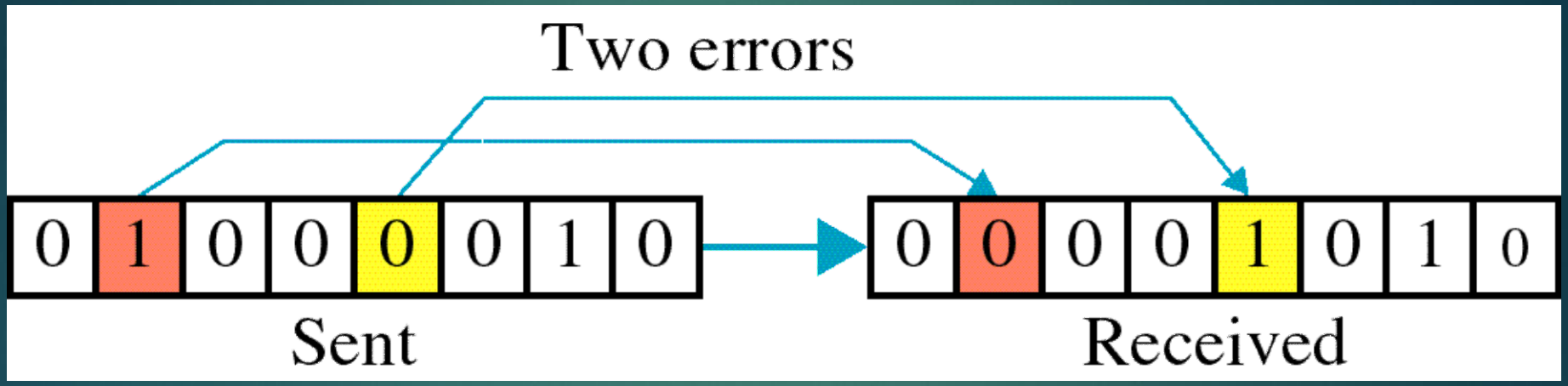



Errors
Single-bit
Multiple-bit
Burst

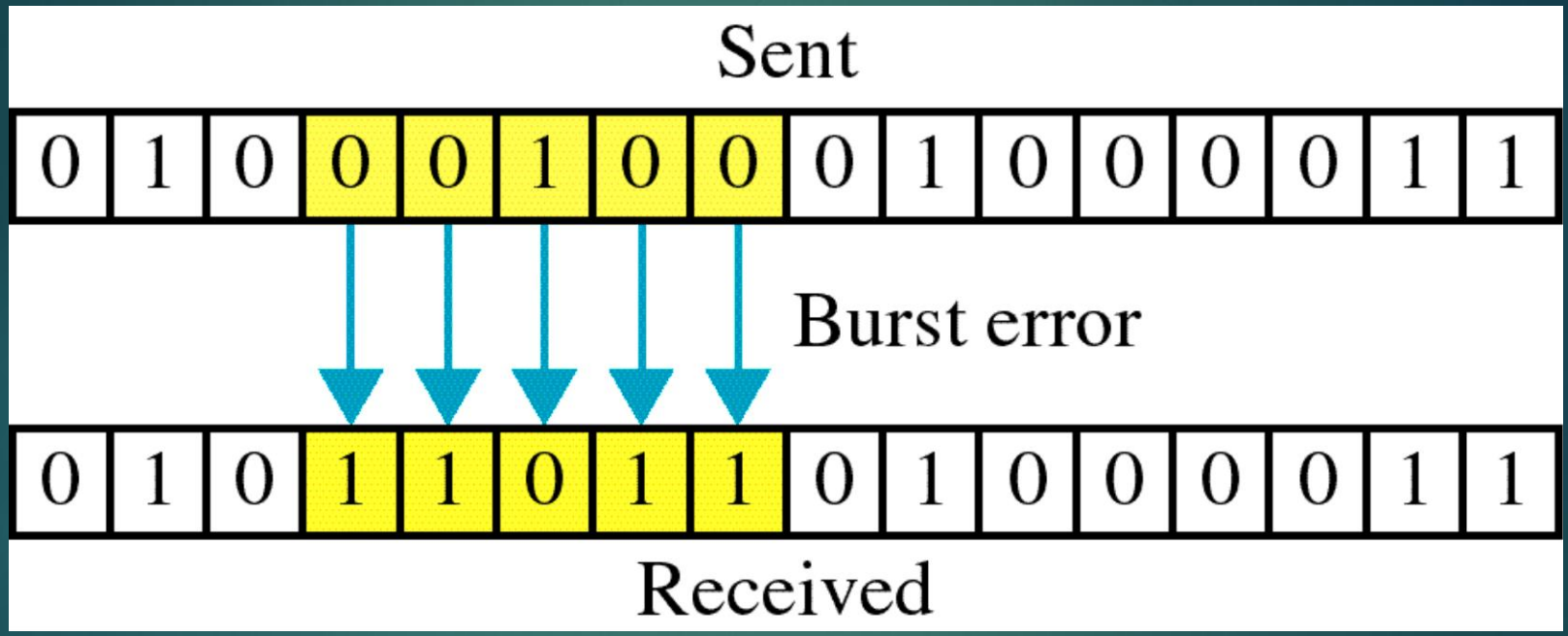
Single-bit error



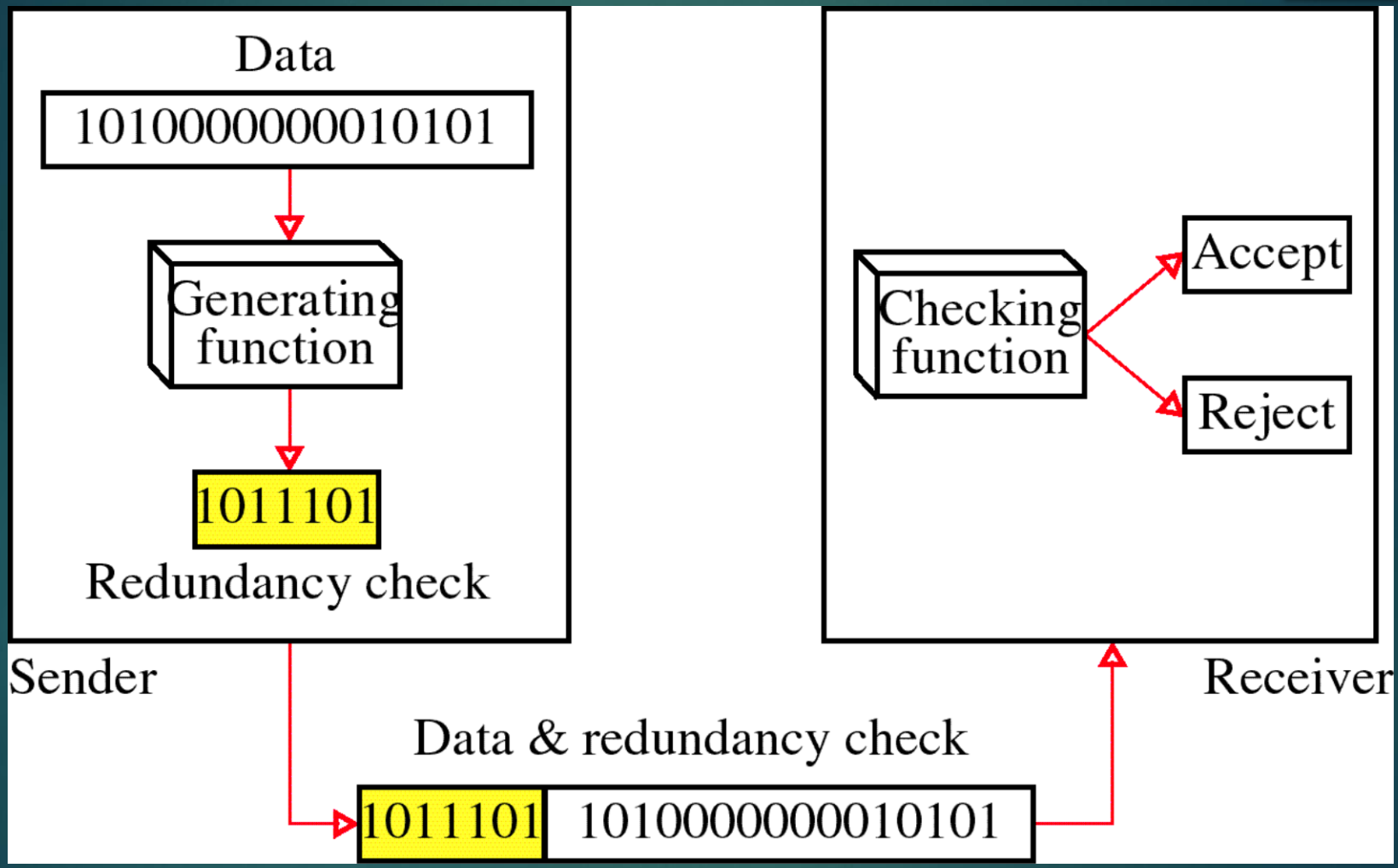
Multiple-bit error

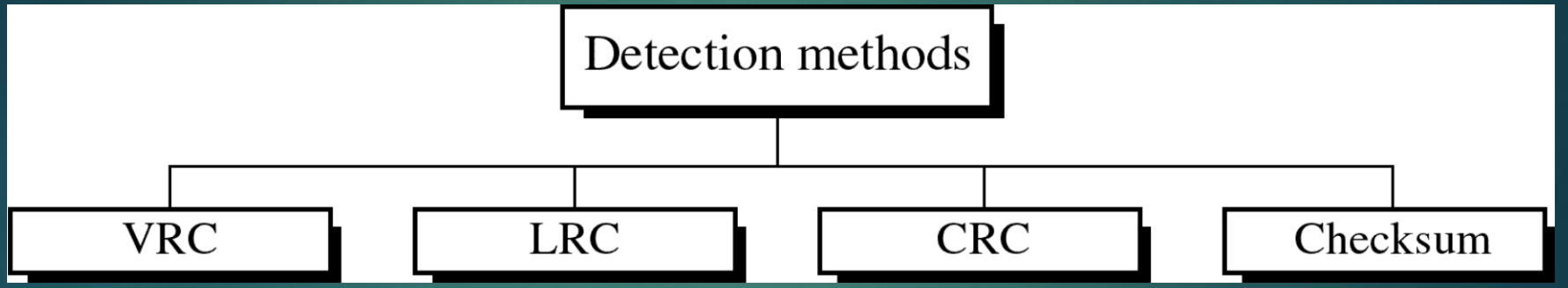


Burst error

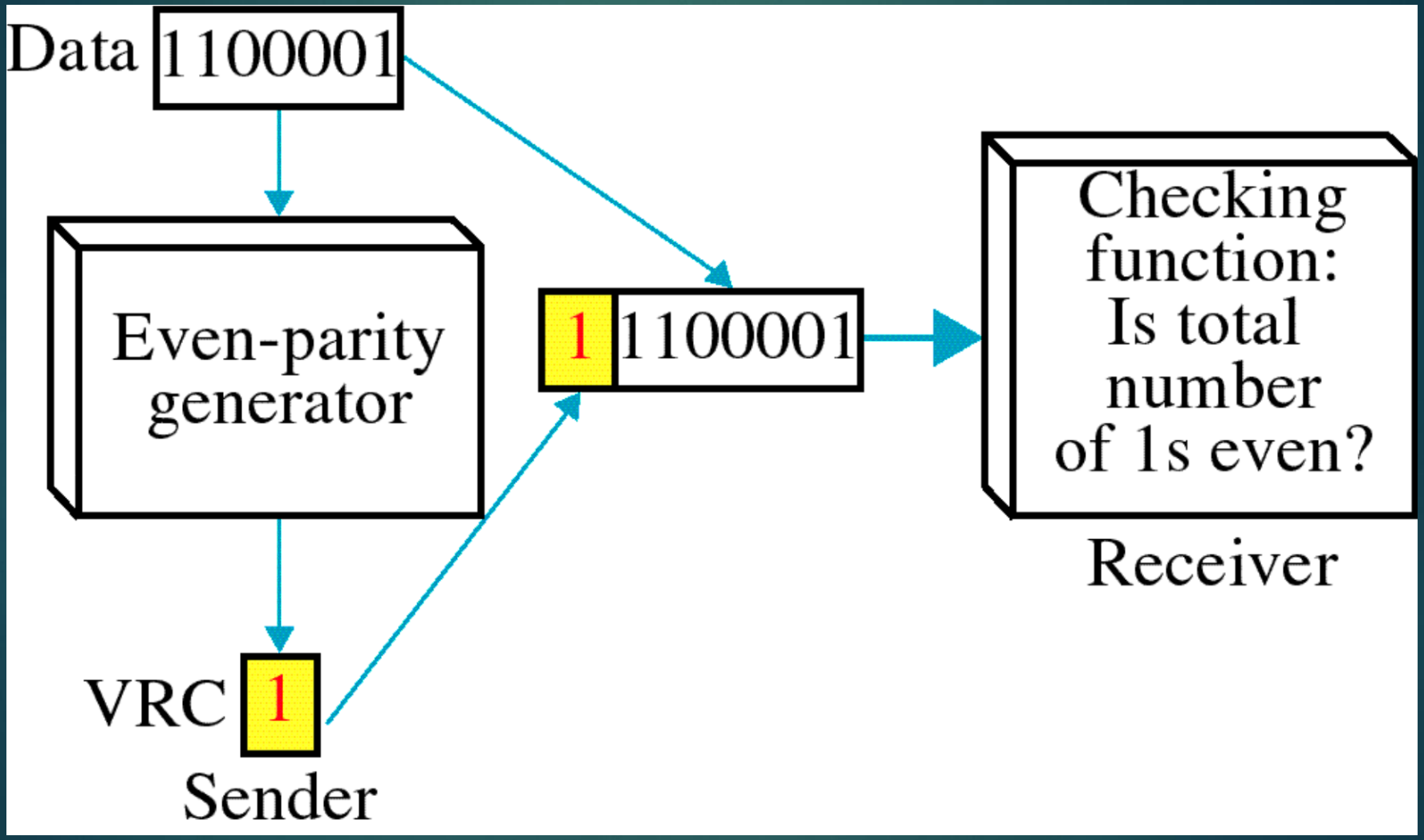

Sent
0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1
Burst error
0 1 0 1 1 0 1 1 0 1 0 0 0 0 1 1
Received

Redundancy

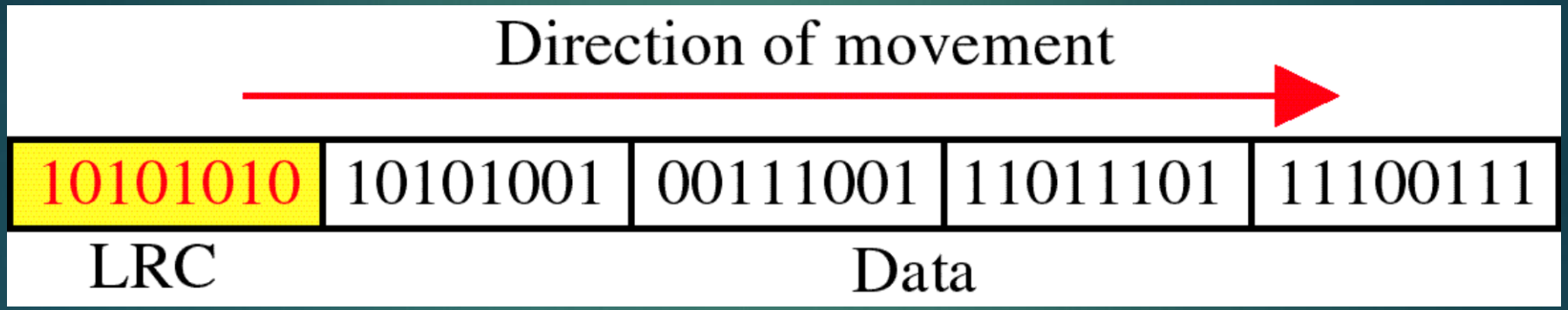

Data
1010000000010101
Generating function
1011101
Redundancy check
Sender
Checking function
Accept
Reject
Receiver
Data & redundancy check
1011101
1010000000010101


Detection methods
VRC
LRC
CRC
Checksum

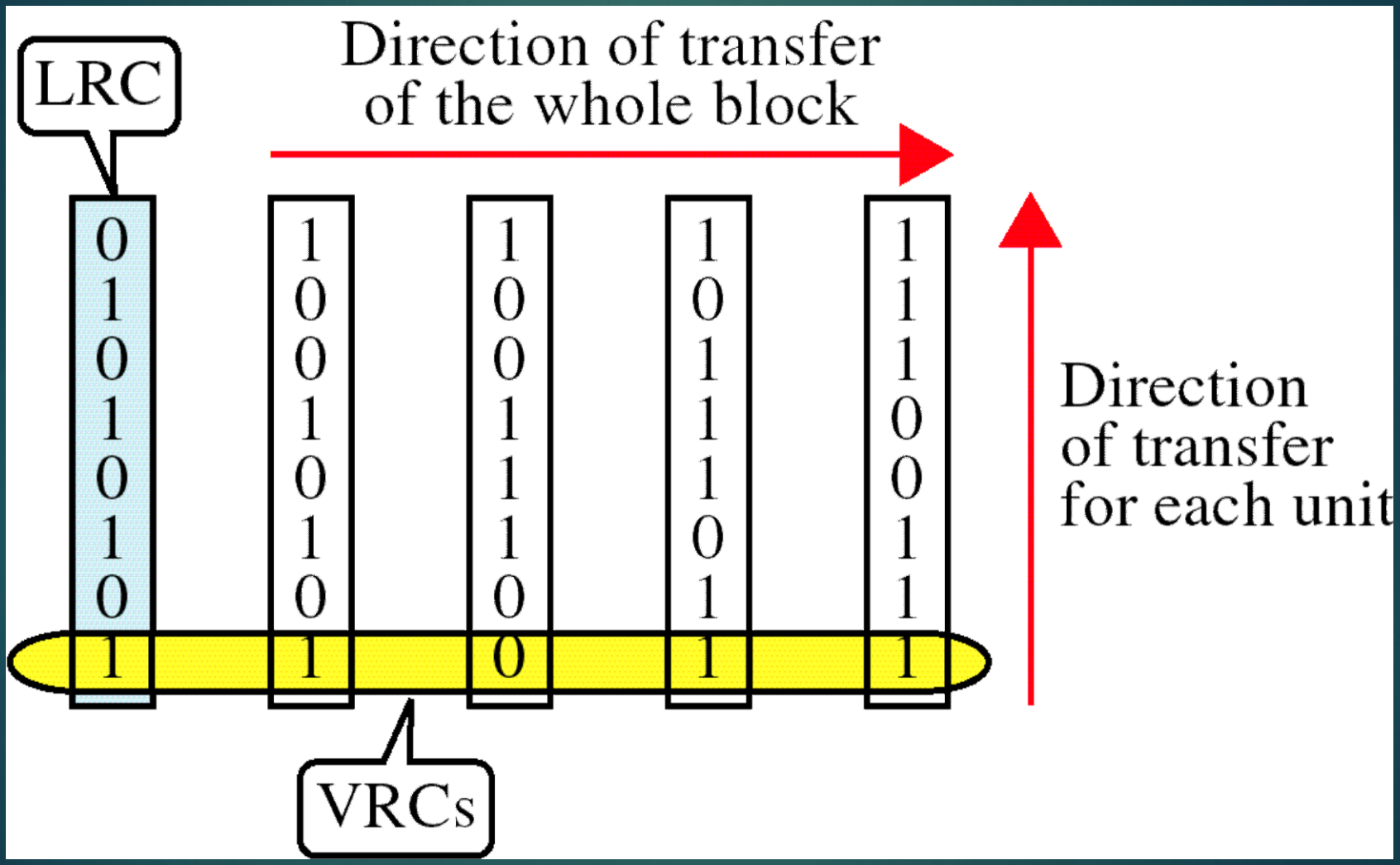
VRC


Data 1100001
Even-parity generator
1 1100001
Checking function: Is total number of 1s even?
Receiver
VRC 1
Sender

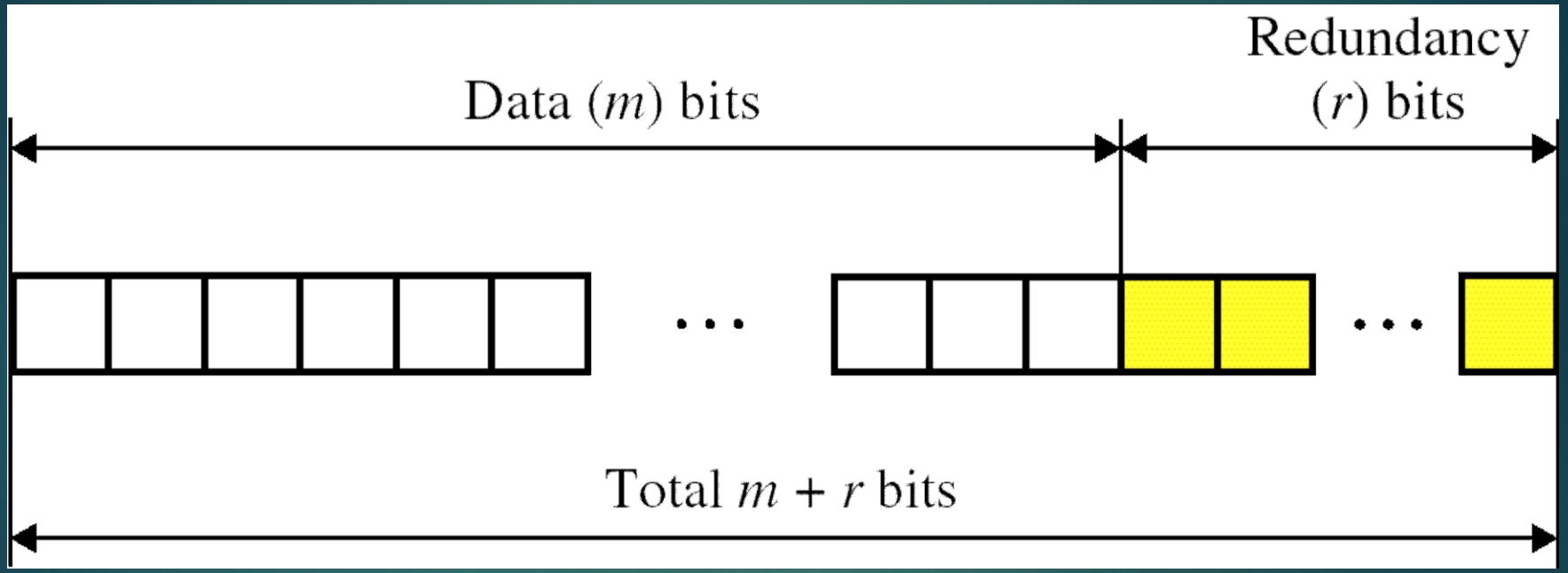
LRC


Direction of movement
10101010
10101001
00111001
11011101
11100111
LRC
Data

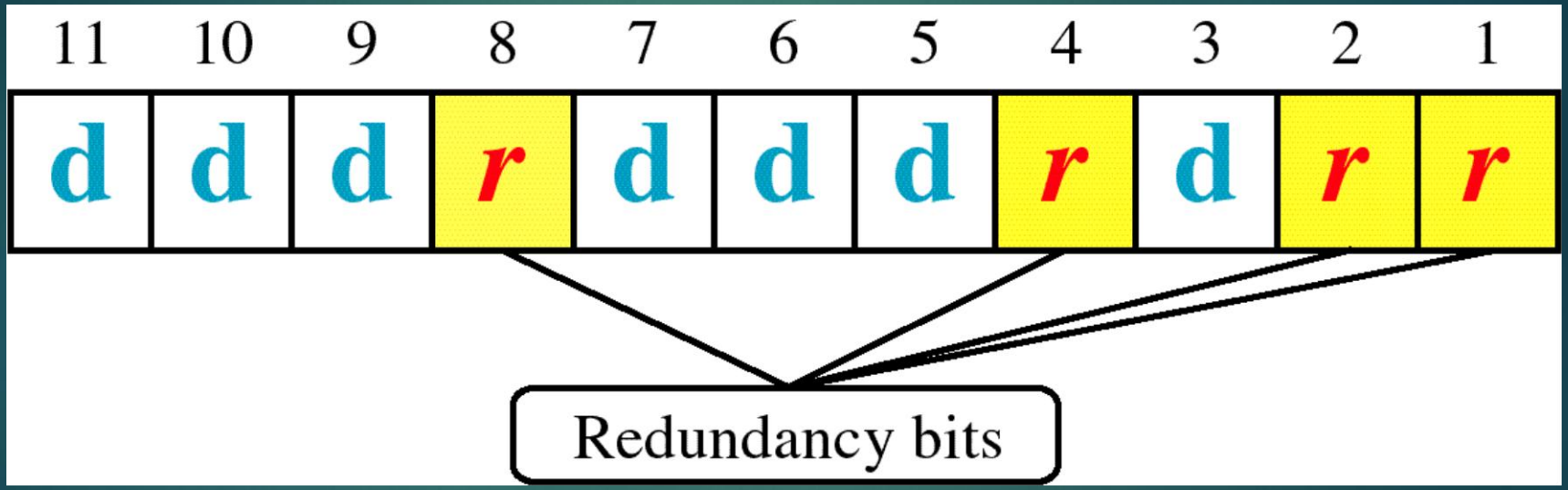
VRC and LRC


LRC
Direction of transfer
of the whole block
0 1 0 1 0 1 0 1
1 0 0 1 0 1 0 1
1 0 0 1 1 1 1 0
1 0 1 1 1 0 1 1
1 1 1 0 0 1 1 1
Direction
of transfer
for each unit
VRCs

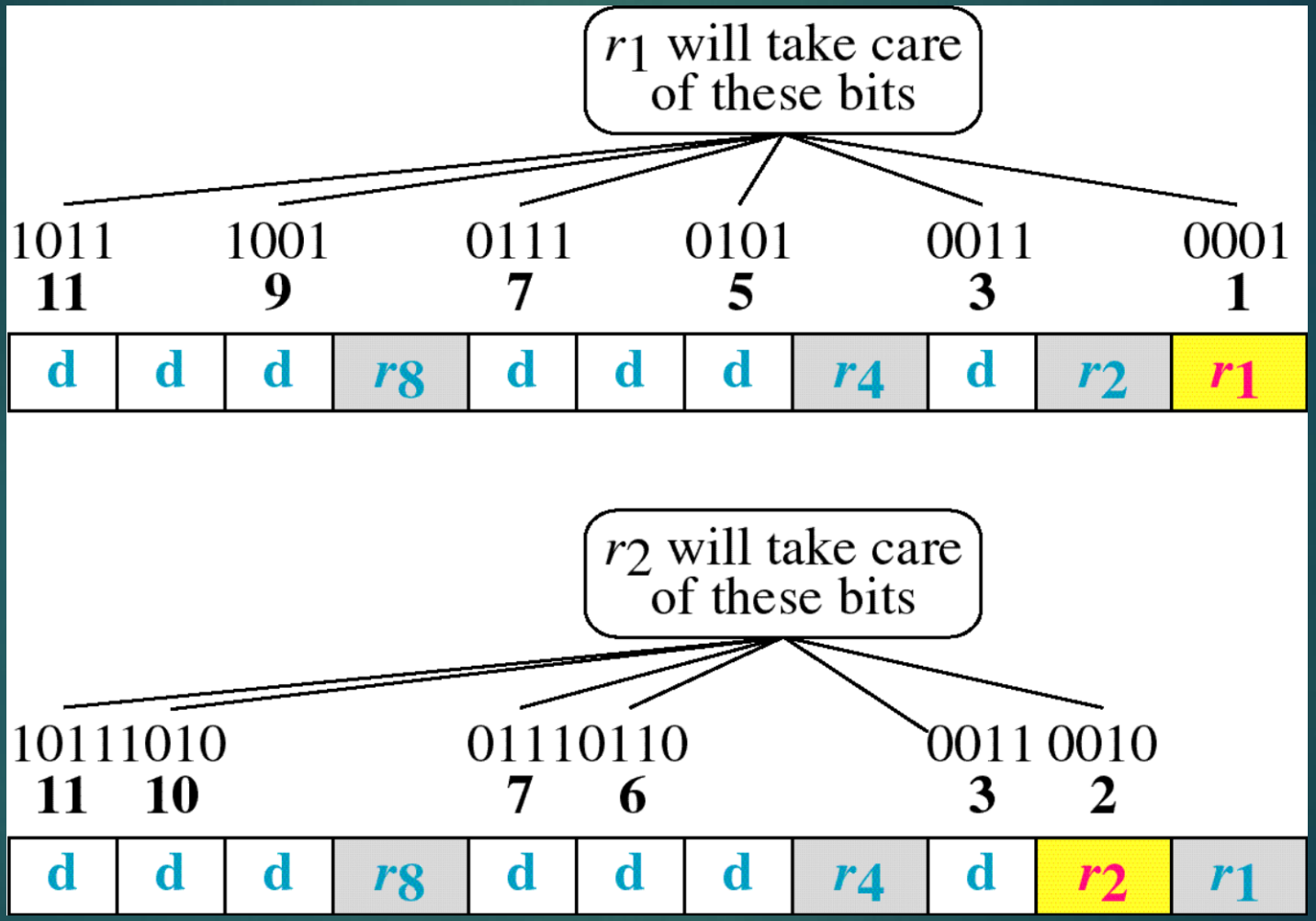
Error Correction



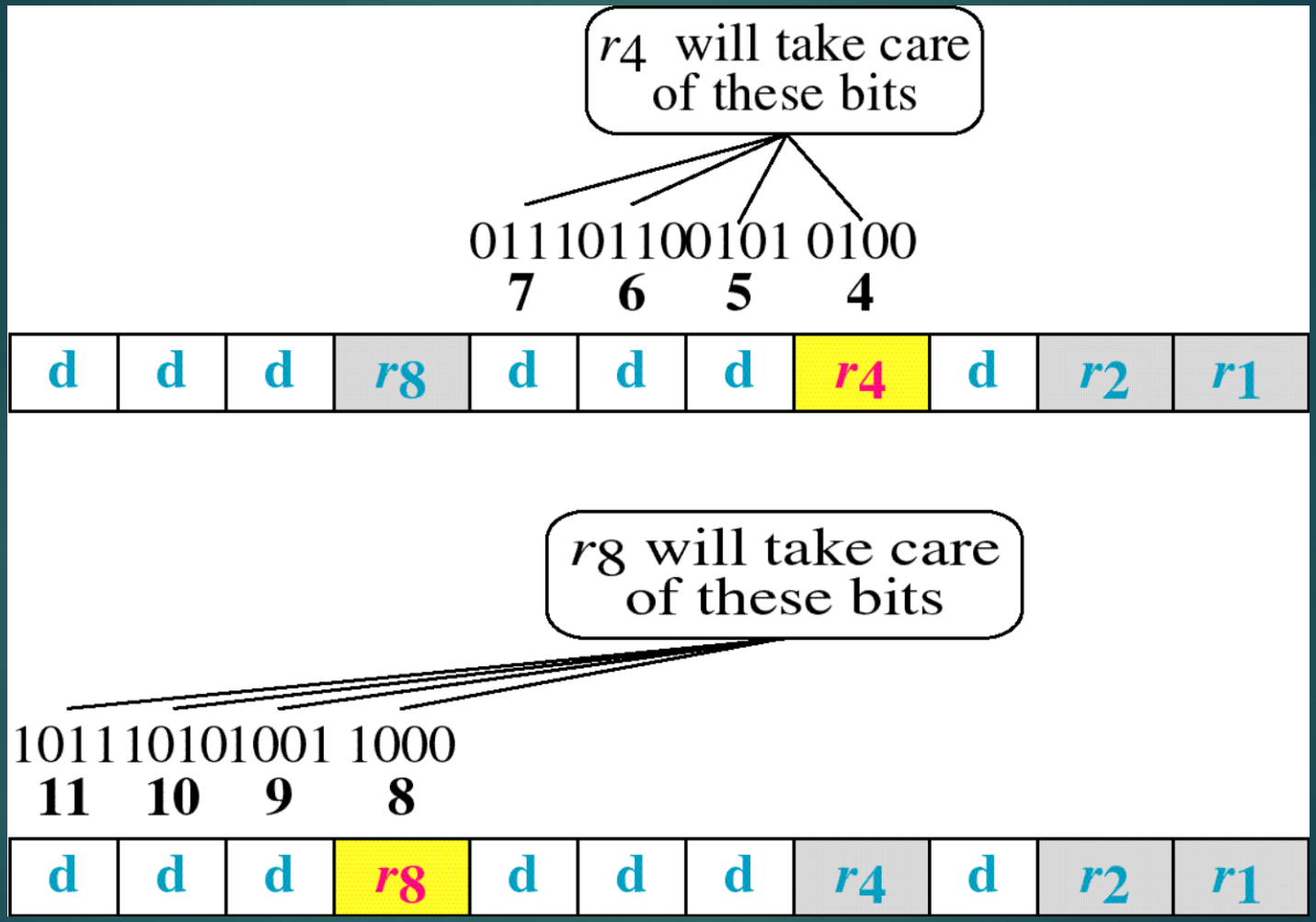
Hamming Code



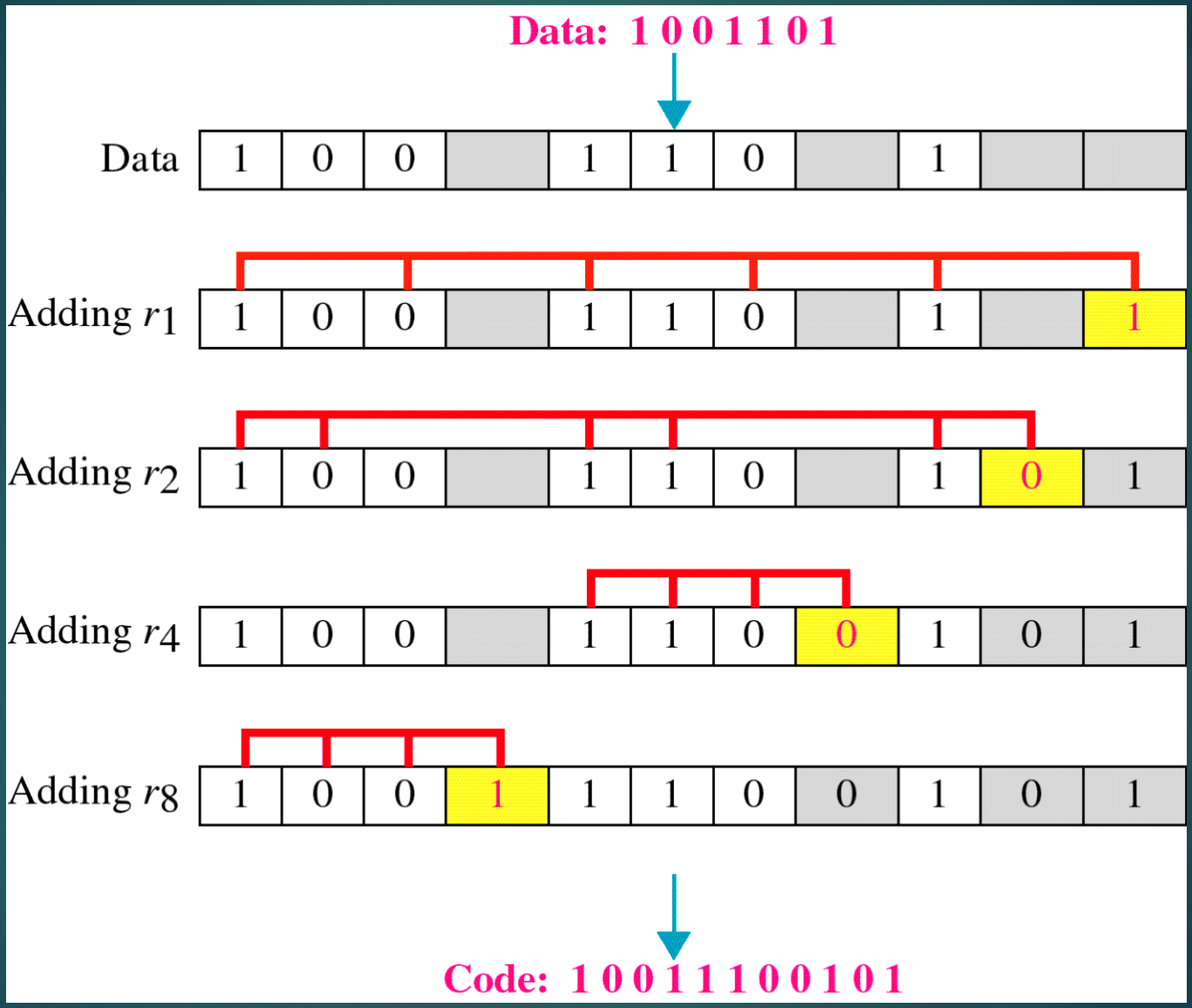
Hamming Code



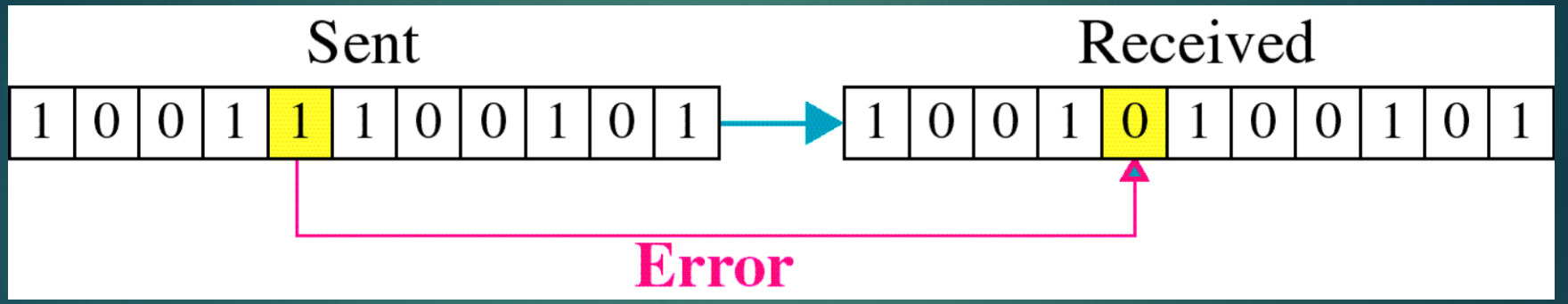
Hamming Code



Example of Hamming Code



Single-bit error



Error Detection

