Noida Institute of Engineering and Technology, Greater Noida

Data Link layer

Unit: 2

Computer Networks
(ACSE0602)

B Tech(CSE) 6th Sem

Sanjay Kumar Nayak

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Computer Science and Engineering

Noida Institute of Engineering and Technology, Greater Noida

ALUMINI MEET

06 March 2024

PRACHI BALIYAN

DATA ANALYST

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I Sanjay Kumar Nayak ,Assistant Professor in Computer Science & Engineering .My total teaching experience is 17 years in NIET Greater Noida. I have completed My B.Tech and M.Tech from UPTU (AKTU).

Sanjay Kumar Nayak
CSE
Department

Curriculum

NOIDA INSTITUTE OF ENGG. & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology
Computer Science and Engineering
EVALUATION SCHEME
SEMESTER-VI

Sl. No.	Subject Codes	Subject Name	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	ACSE0601	Advanced Java Programming	3	0	0	30	20	50		100		150	3
2	ACSE0602	Computer Networks	3	1	0	30	20	50		100		150	4
3	ACSE0603	Software Engineering	3	0	0	30	20	50		100		150	3
4		Departmental Elective -III	3	0	0	30	20	50		100		150	3
5		Departmental Elective -IV	3	0	0	30	20	50		100		150	3
6		Open Elective-I	3	0	0	30	20	50		100		150	3
7	ACSE0651	Advanced Java Programming Lab	0	0	2				25		25	50	1
8	ACSE0652	Computer Networks Lab	0	0	2				25		25	50	1
9	ACSE0653	Software Engineering Lab	0	0	2				25		25	50	1
10	ACSE0659	Mini Project	0	0	2				50			50	1
11	ANC0602 / ANC0601	Essence of Indian Traditional Knowledge / Constitution of India, Law and Engineering	2	0	0	30	20	50		50		100	
12		MOOCs (For B.Tech. Hons. Degree)											
		GRAND TOTAL										**1100**	**23**

List of MOOCs (Coursera) Based Recommended Courses for Third Year (Semester-VI) B. Tech Students

Syllabus

B. TECH THIRD YEAR			
Course Code	**ACSE0602**	**L T P**	**Credits**
Course Title	**COMPUTER NETWORKS**	**3 1 0**	**4**
Course objective: Objective of this course is to develop an understanding of computer networking basics, different components of computer networks, various protocols, modern technologies and their applications.			
Pre-requisites: Basic knowledge of Computer system and their interconnection, operating system, Digital logic and design and hands on experience of programming languages.			
Course Contents / Syllabus			
UNIT-I	**Introduction**		**8 Hours**
Goals and applications of networks, Categories of networks, Organization of the Internet, ISP, The OSI reference model, TCP/IP protocol suite, Network devices and components, Mode of communications **Physical Layer:** Network topology design, Types of connections, LAN, MAN and MAN Transmission media, Signal transmission and encoding, Network performance and transmission impairments, Switching techniques and multiplexing, IEEE standards.			
UNIT-II	**Data Link layer**		**8 Hours**
Framing, Error Detection and Correction, Flow control (Elementary Data Link Protocols, Sliding Window protocols). Medium Access Control and Local Area Networks: Channel allocation, Multiple access protocols, LAN standards, Link layer switches & bridges.			
UNIT-III	**Network Layer**		**8 Hours**
Point-to-point networks, Logical addressing, Basic internetworking (IP, CIDR, ARP, RARP, DHCP, ICMP), IPv4, Routing, forwarding and delivery, Static and dynamic routing, Routing algorithms and protocols, Congestion control algorithms, IPv6.			
UNIT-IV	**Transport Layer**		**8 Hours**
Process-to-process delivery, Transport layer protocols (UDP and TCP), Connection management, Flow control and retransmission, Window management, TCP Congestion control, Quality of service.			
UNIT-V	**Application Layer**		**8 Hours**
Domain Name System, World Wide Web and Hyper Text Transfer Protocol, Electronic mail, File Transfer Protocol, Remote login, Network management, Data compression, VPN, Cryptography – basic concepts, Firewalls.			
Course outcome: After completion of this course students will be able to			
CO 1	Build an understanding of the fundamental concepts and Layered Architecture of computer networking.		K2, K6
CO 2	Understand the basic concepts of link layer properties to detect error and develop the solution for error control and flow control.		K2, K6
CO 3	Design, calculate, and apply subnet masks and addresses to fulfil networking requirements and calculate distance among routers in subnet.		K3, K4, K6
CO 4	Understand the duties of transport layer, Session layer with connection management of TCP protocol.		K2, K4
CO 5	Discuss the different protocols used at application layer.		K2

Books

Text books:

1. Behrouz Forouzan, “Data Communication and Networking” Fourth Edition-2006, Tata McGraw Hill
2. Andrew Tanenbaum “Computer Networks”, Fifth Edition-2011, Prentice Hall.
3. William Stallings, “Data and Computer Communication”, Eighth Edition-2008, Pearson.

Reference Books:

1. Kurose and Ross, “Computer Networking- A Top-Down Approach”, Eighth Edition-2021, Pearson.
2. Peterson and Davie, “Computer Networks: A Systems Approach”, Fourth Edition-1996, Morgan Kaufmann

Course Objective

The objective of this course is to understand introduction of computer networks with suitable transmission media and different networking devices. Network protocols which are essential for the computer network are need to explain such as data link layer protocols and routing protocols.

A detail explanation of IP addressing , TCP/IP protocols and application layer protocols are covered in this course.

Course Outcome

At the end of the course the student should be able to:

CO 1	Build an understanding of the fundamental concepts and Layered Architecture of computer networking.	K2, K6
CO 2	Understand the basic concepts of link layer properties to detect error and develop the solution for error control and flow control.	K2, K6
CO 3	Design, calculate, and apply subnet masks and addresses to fulfil networking requirements and calculate distance among routers in subnet.	K3, K4, K6
CO 4	Understand the duties of transport layer, Session layer with connection management of TCP protocol.	K2, K4
CO 5	Discuss the different protocols used at application layer.	K2

PO's

1.Engineering knowledge
2. Problem analysis
3. Design/development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Life-long learning

CO-PO Mapping

Computer Networks(ACSE0602)									Year of Study: 2023-24			
CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ACSE0602.1	3	2	2		2				2		2	3
ACSE0602.2	3	3	2									3
ACSE0602.3	3	3	3	3	2				2		2	3
ACSE0602.4	3	2	2		2							3
ACSE0602.5	3	3	2		2	3		2				3
AVERAGE	**3**	**2**	**2**		**2**	**2**	**2**	**2**		**2**	**2**	**3**

PSO's

On successful completion of graduation degree, The computer Science & Engineering graduates will be able to:

PSO1: identify, analyze real world problems and design their ethical solutions using artificial intelligence, robotics, virtual/augmented reality, data analytics, block chain technology, and cloud computing.

PSO2: design and develop the hardware sensor devices and related interfacing software systems for solving complex engineering problems.

PSO 3: understand inter-disciplinary computing techniques and to apply them in the design of advanced computing.

PSO 4: conduct investigation of complex problem with the help of technical, managerial, leadership qualities, and modern engineering tools provided by industry sponsored laboratories.

PSO's

CO	PSO1	PSO2	PSO3	PSO4
ACSE0602.1	2	2	2	2
ACSE0602.2	2	2	2	2
ACSE0602.3	2	2	2	3
ACSE0602.4	2	2	2	2
ACSE0602.5	2	2	2	2
AVERAGE	2	2	2	2

Program Educational Objectives

PEO 1: To have an excellent scientific and engineering breadth so as to comprehend, analyze, design and provide sustainable solutions for real-life problems using state-of-the-art technologies.

PEO 2: To have a successful career in industries, to pursue higher studies or to support entrepreneurial endeavors and to face the global challenges.

PEO 3: To have an effective communication skills, professional attitude, ethical values and a desire to learn specific knowledge in emerging trends, technologies for research, innovation and product development and contribution to society.

PEO 4: To have life-long learning for up-skilling and re-skilling for successful professional career as engineer, scientist, entrepreneur and bureaucrat for betterment of society.

Result Analysis

COMPUTER NETWORKS (ACSE0602)	
Department wise Result of VI sem.	100
Subject wise result	99
Faculty wise result	99

End semester Question paper templates

Printed Pages—3 ECS601

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 110601 Roll No.

B.Tech.

(SEM. VI) THEORY EXAMINATION 2013-14

COMPUTER NETWORK

Time : 3 Hours *Total Marks : 100*

Note :— (1) Attempt **all** questions.

(2) All questions carry equal marks.

1. Attempt any **four** parts of the following : **(5×4=20)**
   (a) Discuss the TCP/IP protocol suite on the basis of protocol layering principle.
   (b) Define topology and explain the advantage and disadvantage of Bus, Star and Ring topologies.
   (c) Explain briefly the bus backbone and star backbone.
   (d) Explain the user access in ISDN.
   (e) Compare twisted pair, co-axial and fiber optic cable.
   (f) Explain the various types of Switching Methods with suitable examples.

2. Attempt any **four** parts of the following : **(5×4=20)**
   (a) State drawbacks of stop and wait protocols.
   (b) What is piggybacking ?
   (c) Which are the requirements of CRC ?

ECS601/DQJ-21746 1 [Turn Over

   (d) How can you compare pure ALOHA and Slotted ALOHA ?
   (e) Explain about CSMA/CD and CSMA/CA and its uses.
   (f) Differentiate between 802.3, 802.4 and 802.5 IEEE Standards.

3. Attempt any **two** parts of the following : **(10×2=20)**
   (a) What is meant by fragmentation ? Is fragmentation needed in concentrated virtual circuit internets, or in any datagram system.
   (b) Give an IP address, how will you extract its net-id and host-id and compare IPv4 and IPv6 with frame format.
   (c) (i) What is meant by unicast and multicast routing with suitable diagrams ?
   (ii) Write a short note on Leaky bucket algorithm.

4. Attempt any **two** parts of the following : **(10×2=20)**
   (a) Explain about the TCP header and working of TCP protocol and differentiate between TCP and UDP with frame format.
   (b) Define cryptography with the help of block diagram of Symmetric and Asymmetric key cryptography.
   (c) Write short notes on :
   (i) Digital audio
   (ii) Audio compression
   (iii) Streaming audio.

ECS601/DQJ-21746 2

5. Attempt any **two** parts of the following : **(10×2=20)**
   (a) Explain the two mail access protocols in brief :
   (i) POP3
   (ii) IMAP
   (iii) SMTP
   (b) Write a short note on :
   (i) FTP
   (ii) DNS
   (iii) MIME
   (iv) TFTP
   (c) Explain about e-mail architecture and services.

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Prerequisite and Recap

- **Fundamental of computer**
- **Types of Network and OSI Model, TCP/IP Model**
  - ✓ **Encoding**
  - ✓ **Packet switching**

Content

- Functions of data link layer
- Sub layers of data link layer
- Project 802
- PDU format
- MAC frame
- IEEE LAN standards
- Ethernet
- Token Ring
- FDDI
- DQDB
- Data Link Layer Protocols
- Multiple Access Protocol
- Flow control
- Error control

Unit Objective

The objective of this course is to understand the duties of data link layer, medium access protocol like ALOHA, CSMA,TOKEN RING & FDDI. Study the flow conrol and error control methods. Study the IEEE 802 project about network.

The data link layer is the second layer from the bottom in the OSI (Open System Interconnection) network architecture model. It is responsible for the node-to-node delivery of data. Its major role is to ensure error-free transmission of information. DLL is also responsible for encoding, decode and organizing the outgoing and incoming data.

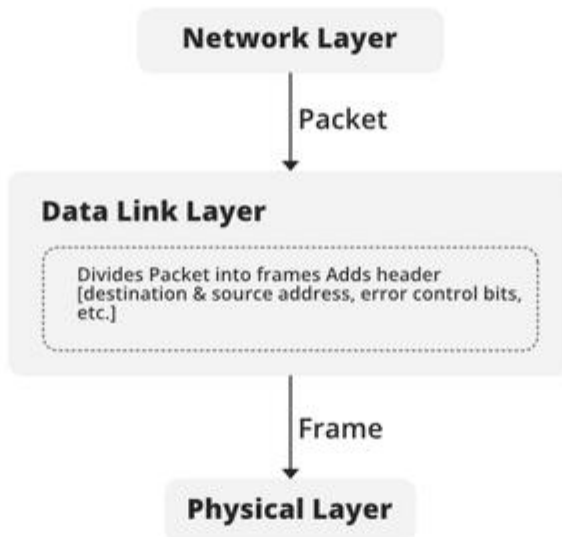
The data link layer is further divided into two sub-layers, which are as follows:

Logical Link Control (LLC)

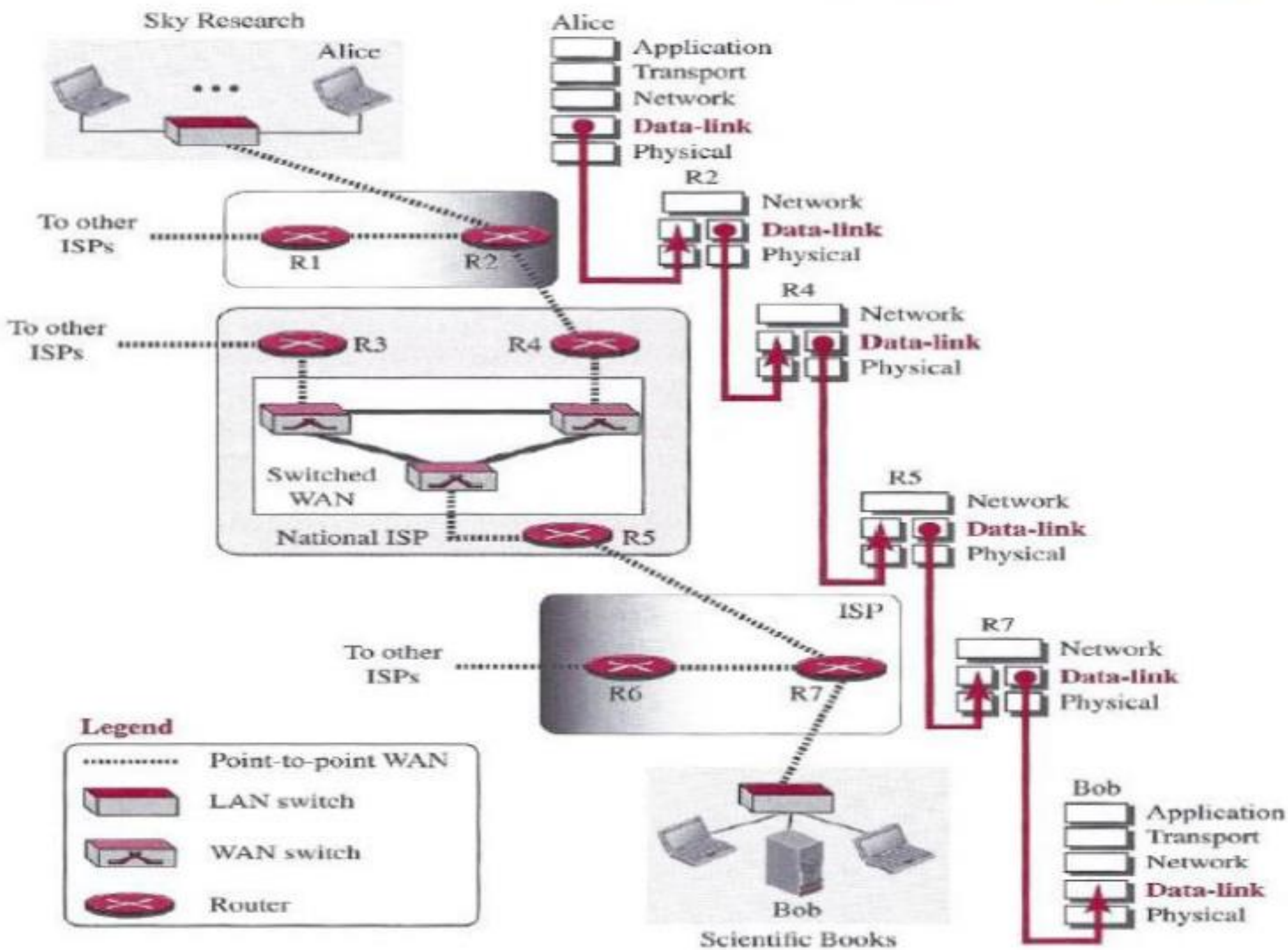
This sublayer of the data link layer deals with multiplexing, the flow of data among applications and other services, and LLC is responsible for providing error messages and acknowledgments as well.

Media Access Control (MAC)

MAC sublayer manages the device's interaction, responsible for addressing frames, and also controls physical media access.


Network Layer
Packet
Data Link Layer
Divides Packet into frames Adds header [destination & source address, error control bits, etc.]
Frame
Physical Layer

Communication at the data-link layer



Data link layer Functions

Objective: Study about basic concept of Data link layer functions & protocols.

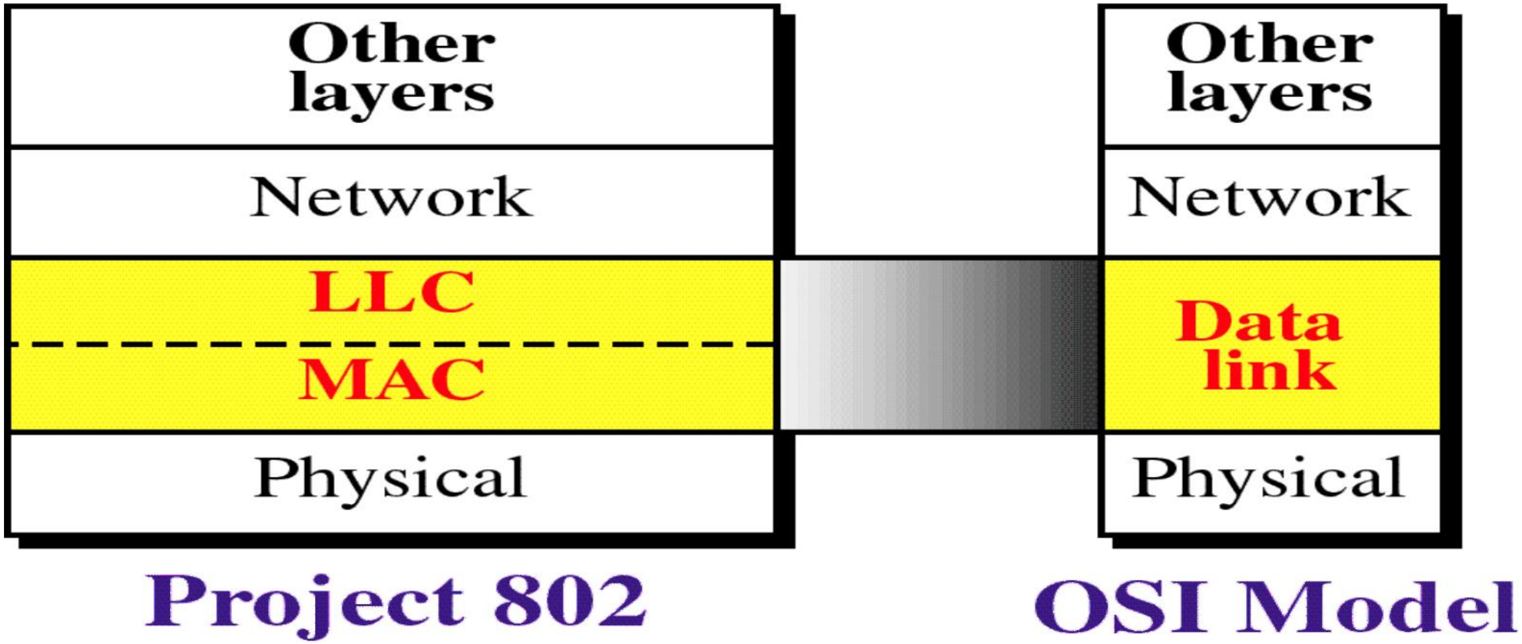
- Node to node delivery of data
- Framing
- Flow control
- Error control
- MAC addressing

Data Link Layer

Local Area Networks

- **Project 802**
- **Ethernet**
- **Token Ring**
- **FDDI**

OSI Model and Project 802

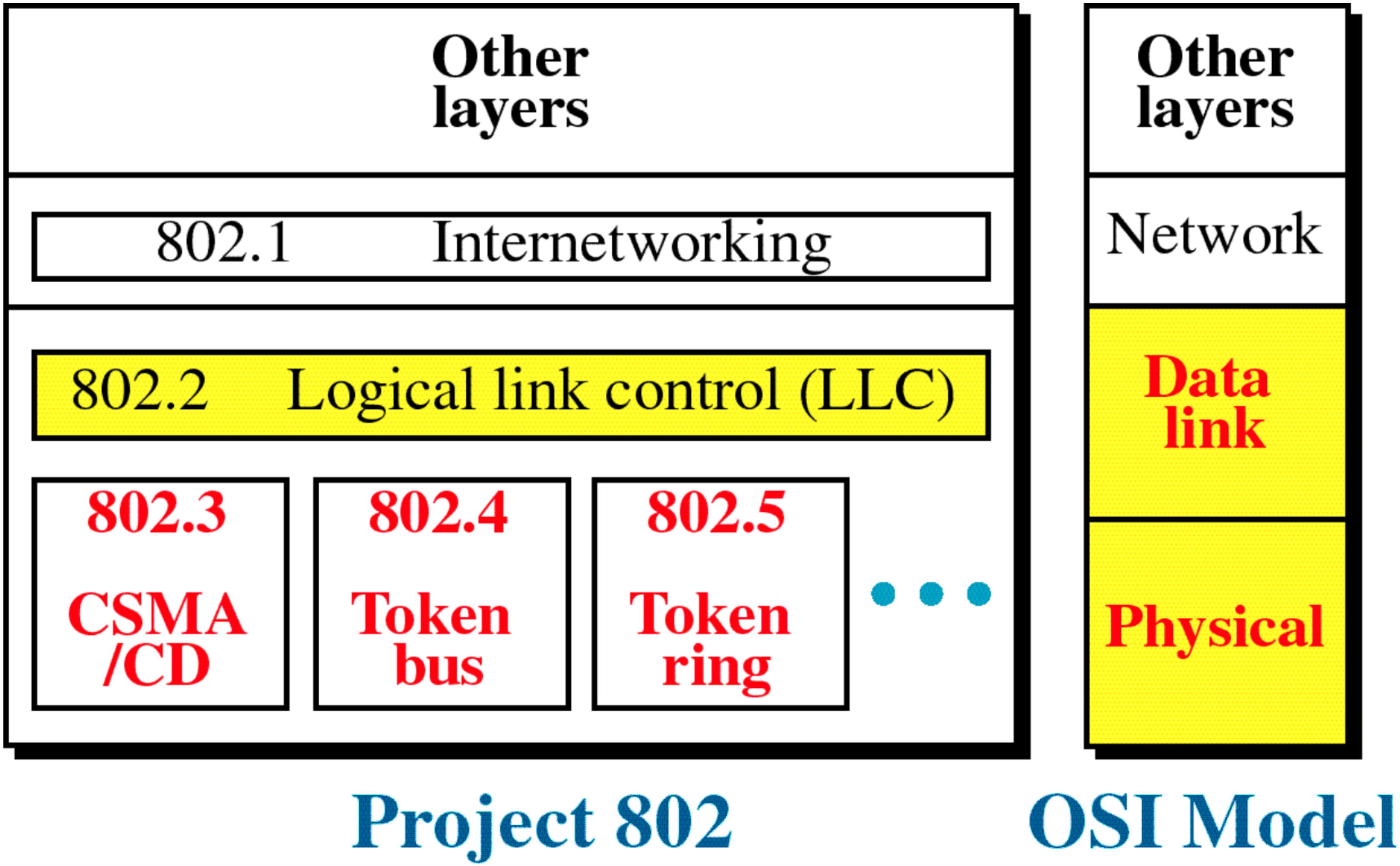


Logical link control / Data link control (LLC /DLC):
Deals with issues common to Point to point link and broadcast link

Media access control (MAC):
Deals only with issues specific to broadcast link

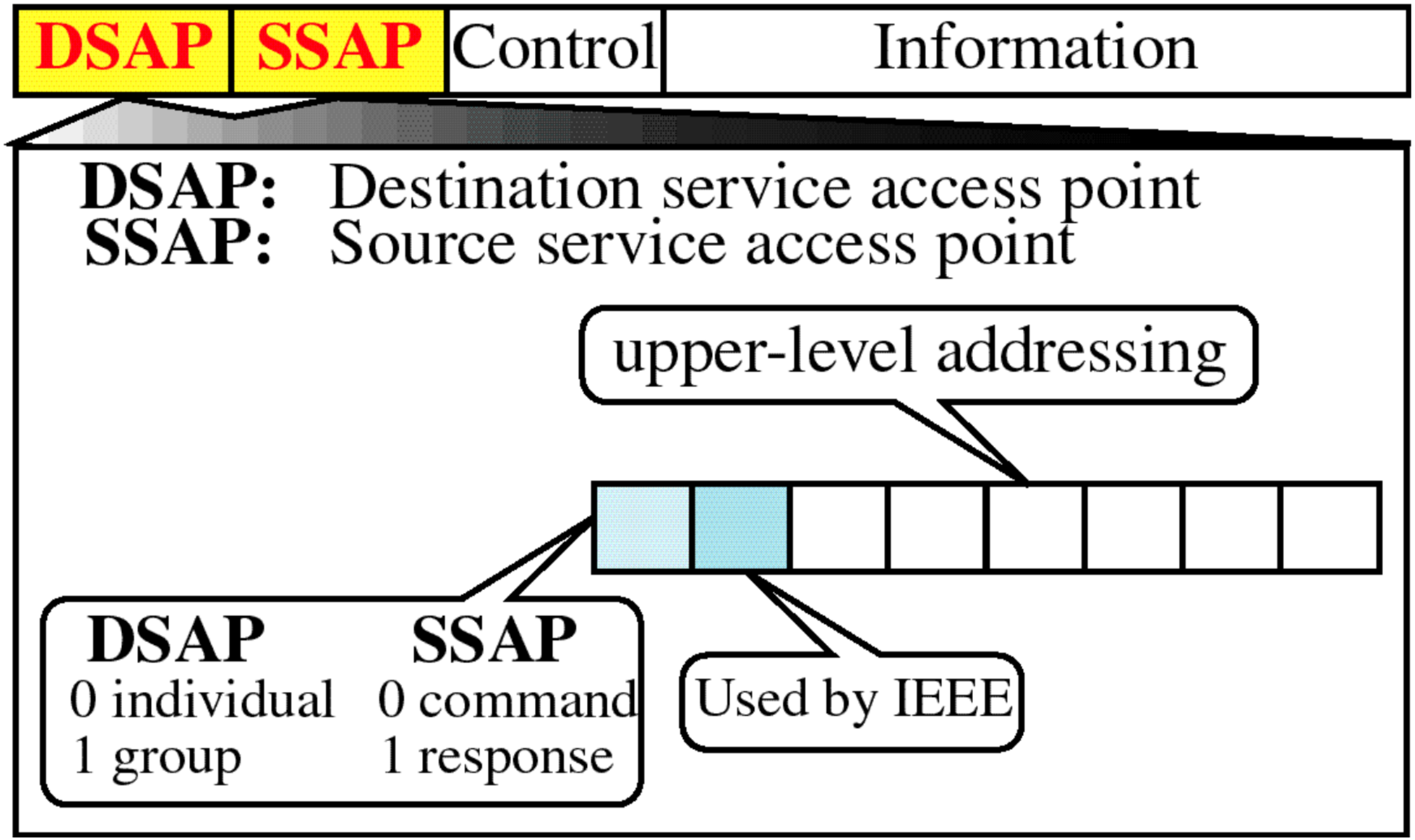
OSI Model and Project 802

Project 802

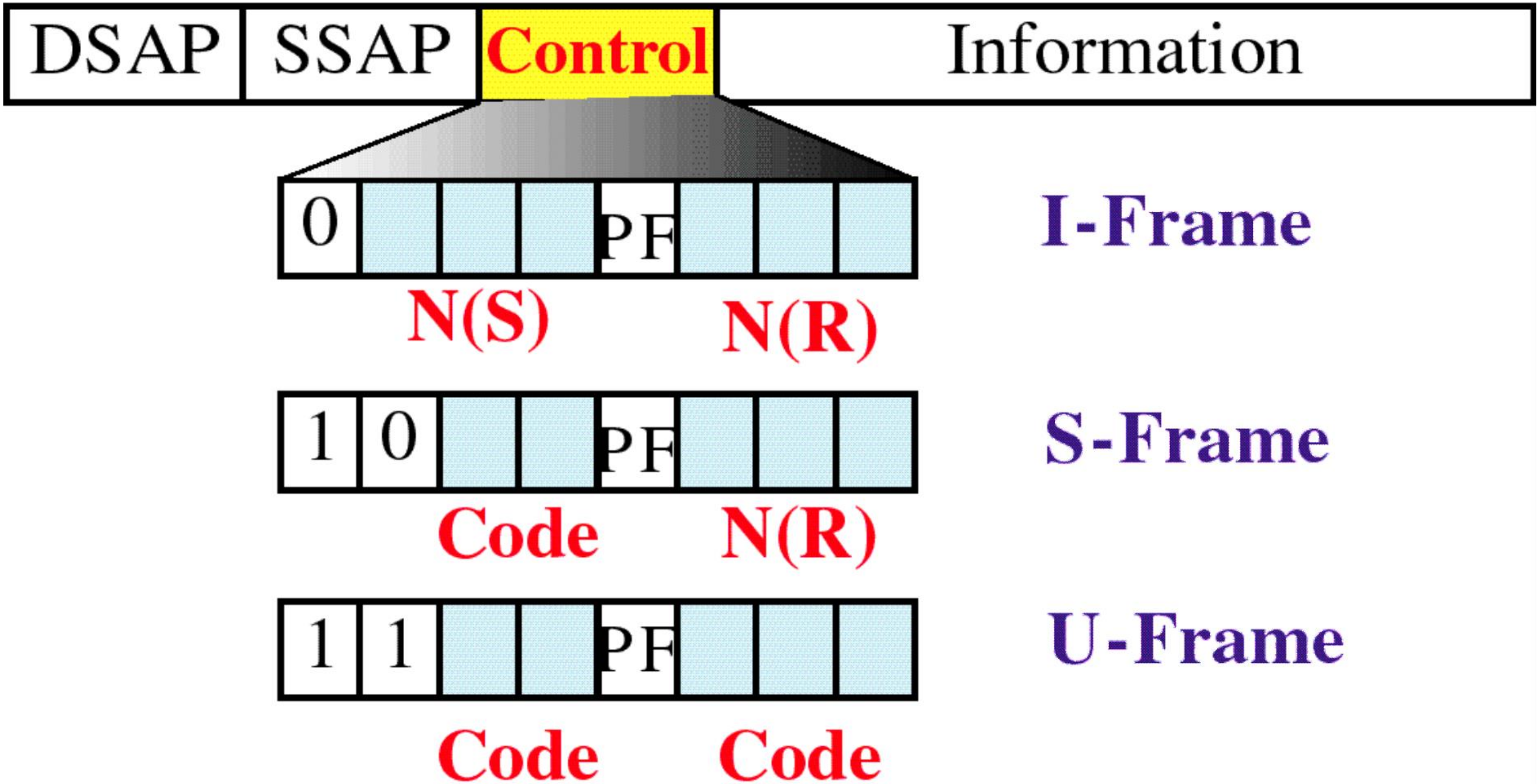


Data Link Layer

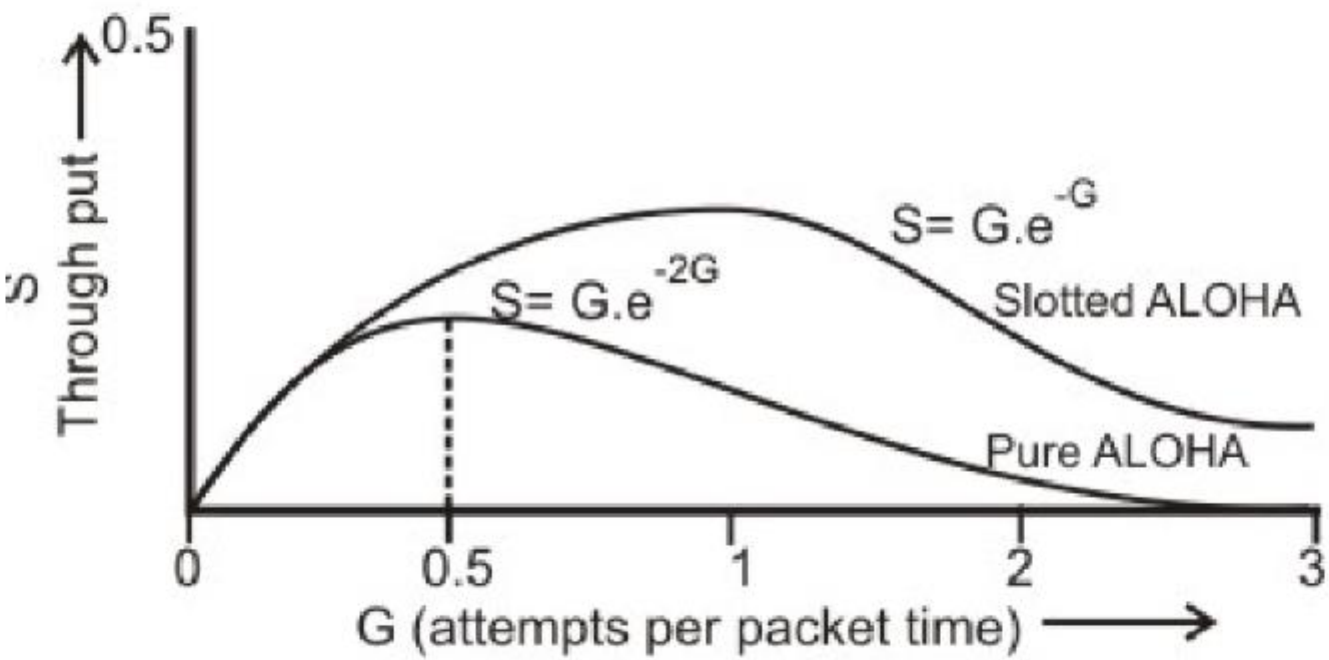
PDU Format



PDU Control Field

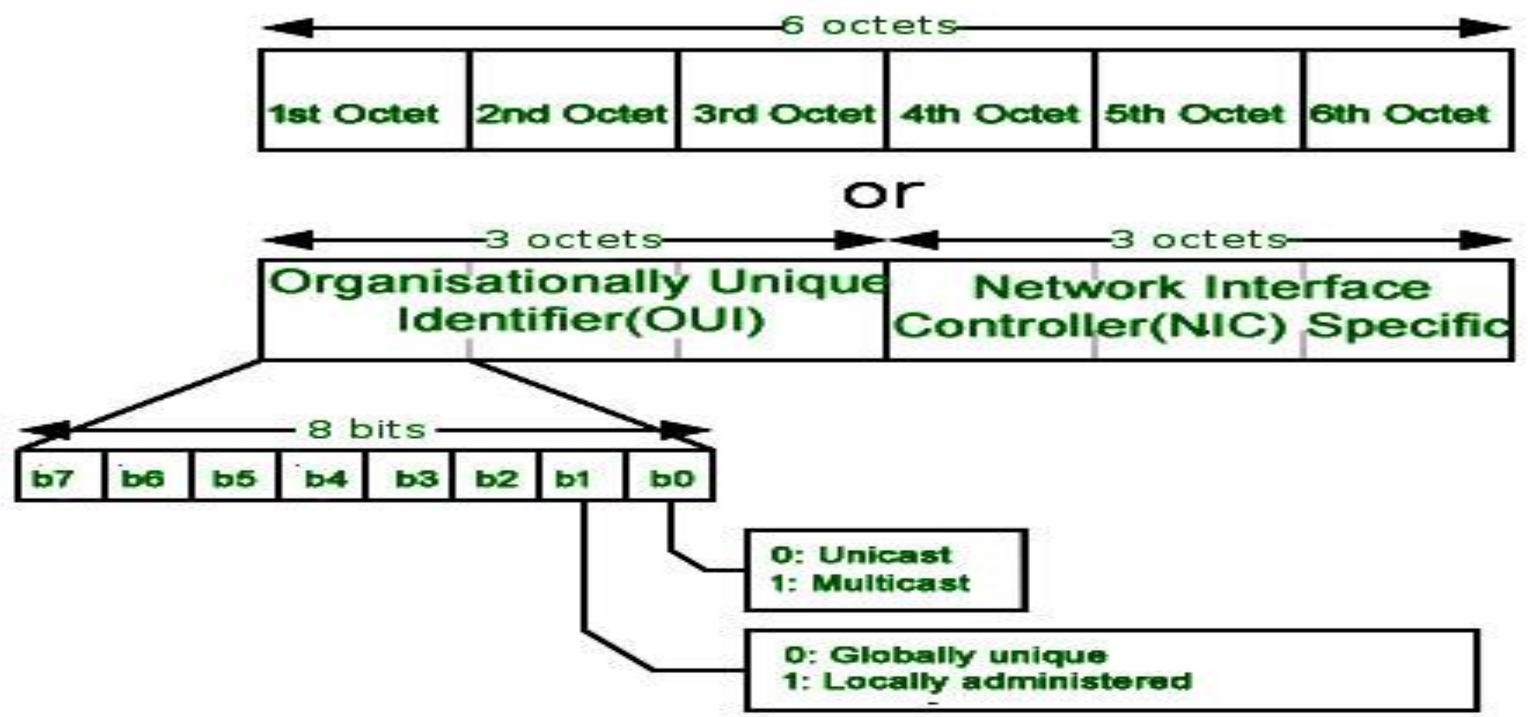


Throughput vs Offered Load



MAC Address

The MAC address is used by the Media Access Control (MAC) sublayer of the Data-Link Layer. MAC Address is worldwide unique since millions of network devices exist and we need to uniquely identify each.



Data Link Layer

Format of MAC Address

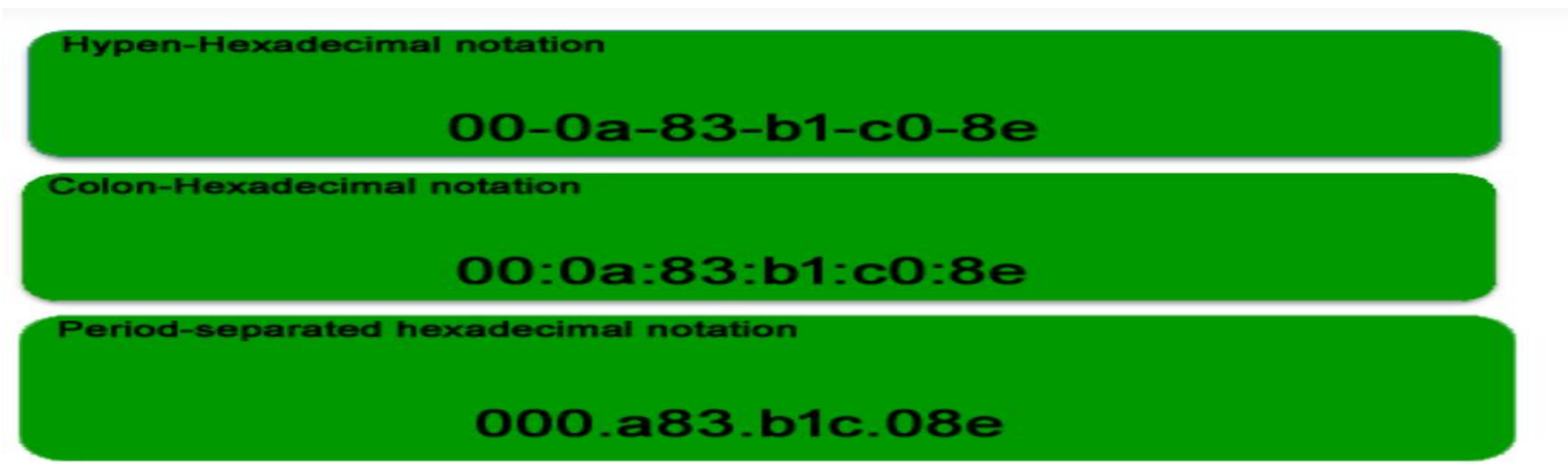
- MAC Address is a 12-digit hexadecimal number (6-Byte binary number), which is mostly represented by Colon-Hexadecimal notation.
- The First 6 digits (say 00:40:96) of the MAC Address identify the manufacturer, called the OUI (**Organizational Unique Identifier**).
- IEEE Registration Authority Committee assigns these MAC prefixes to its registered vendors.

Here are some OUI of well-known manufacturers:

```
CC:46:D6 - Cisco
3C:5A:B4 - Google, Inc.
3C:D9:2B - Hewlett Packard
00:9A:CD - HUAWEI TECHNOLOGIES CO.,LTD
```

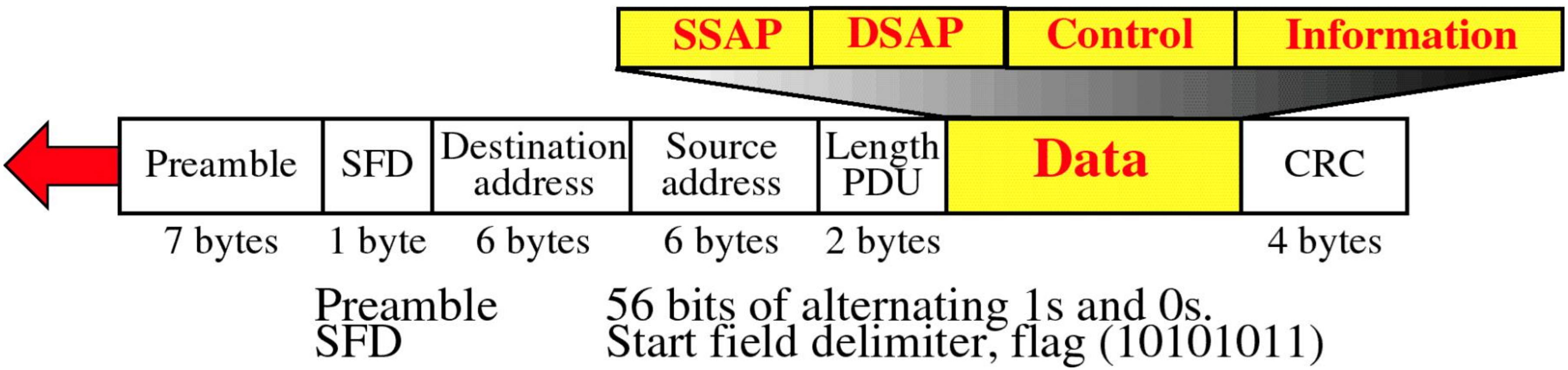
Data Link Layer

- The rightmost six digits represent **Network Interface Controller**, which is assigned by the manufacturer.
- MAC address is represented by Colon-Hexadecimal notation.
- Colon-Hexadecimal notation is used by *Linux OS* and Period-separated Hexadecimal notation is used by *Cisco Systems*.
- MAC address can be represented using any of the following formats:

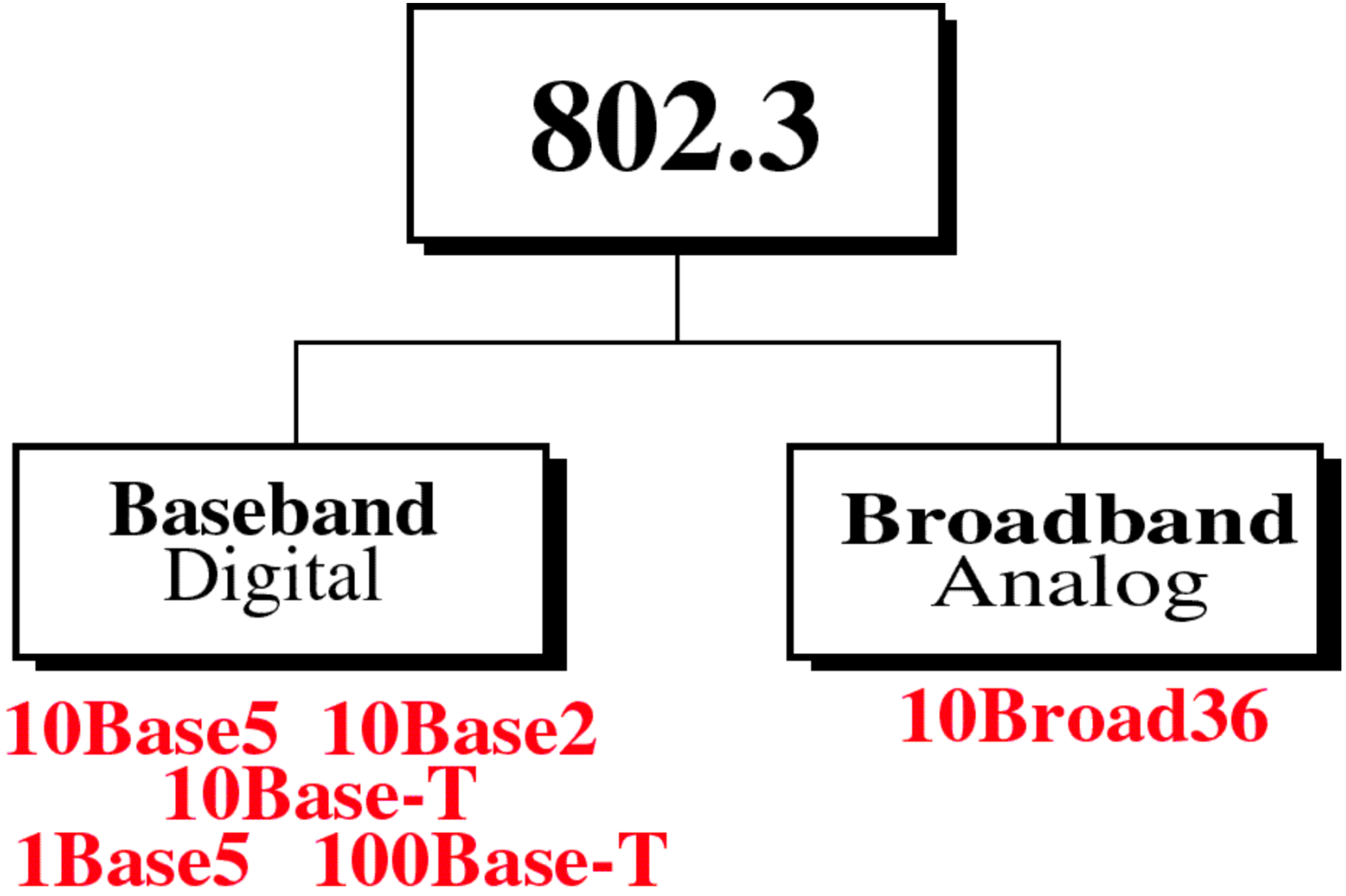


Data Link Layer

MAC Frame

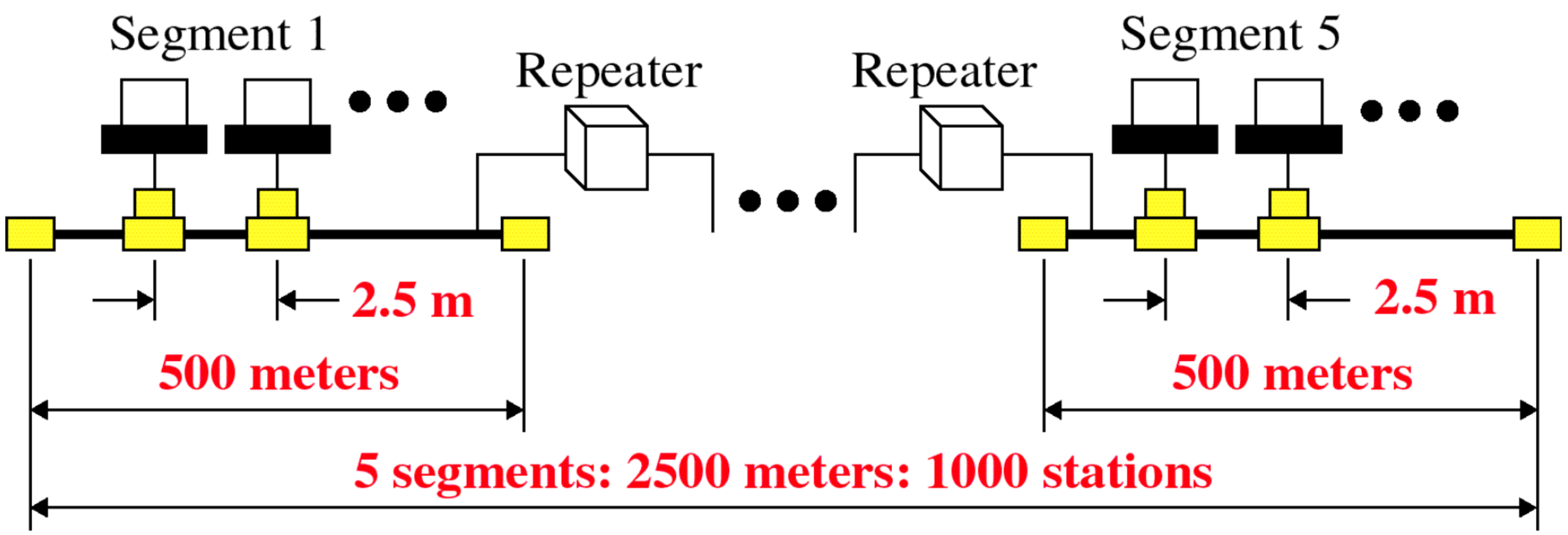

SSAP
DSAP
Control
Information
Preamble
SFD
Destination address
Source address
Length PDU
Data
CRC
7 bytes
1 byte
6 bytes
6 bytes
2 bytes
4 bytes
Preamble 56 bits of alternating 1s and 0s.
SFD Start field delimiter, flag (10101011)

Data Link Layer

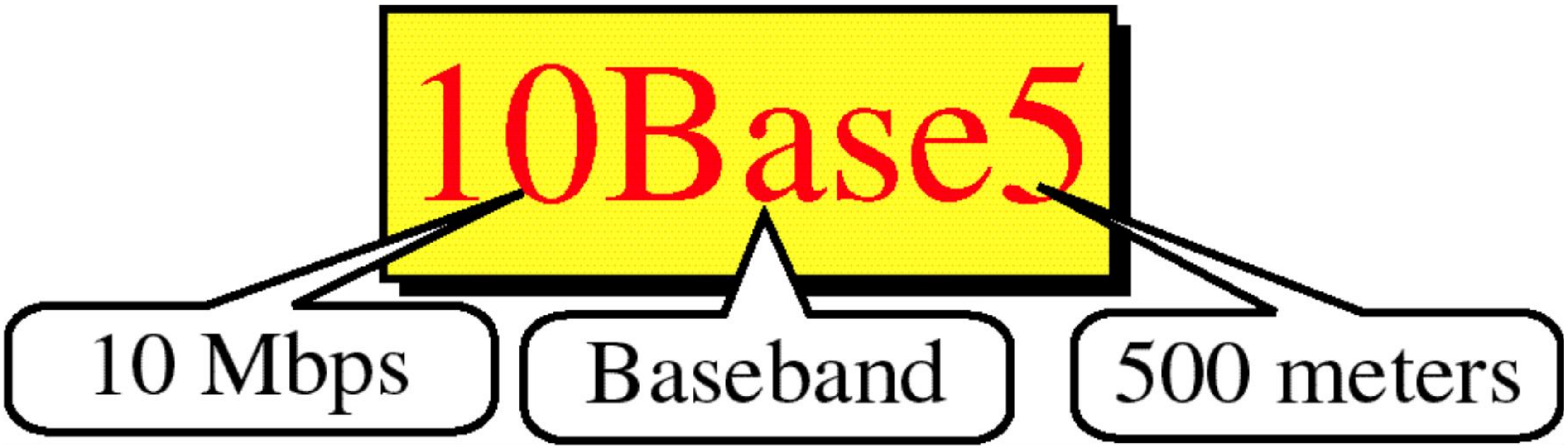


Data Link Layer

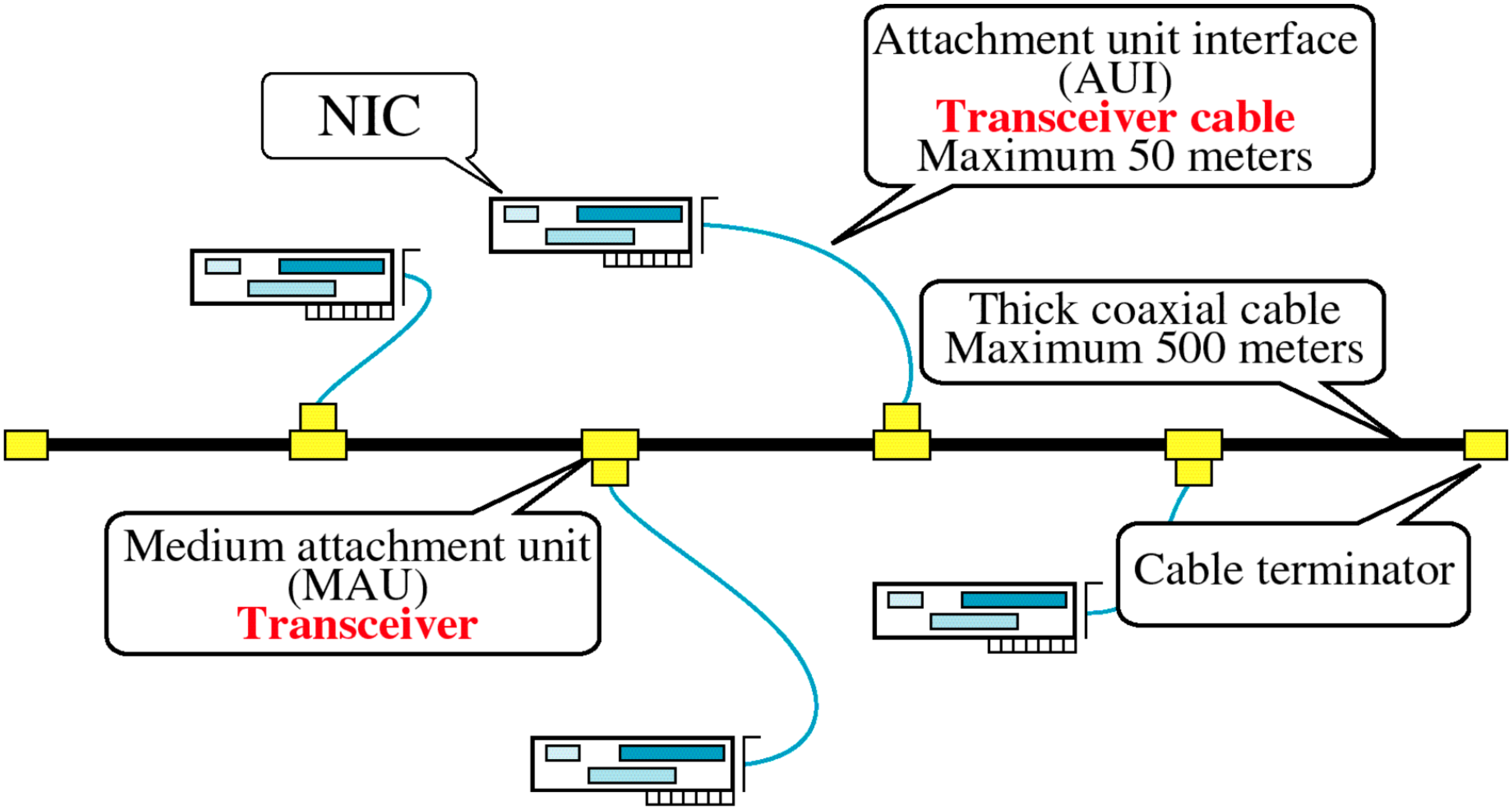
Ethernet Segments



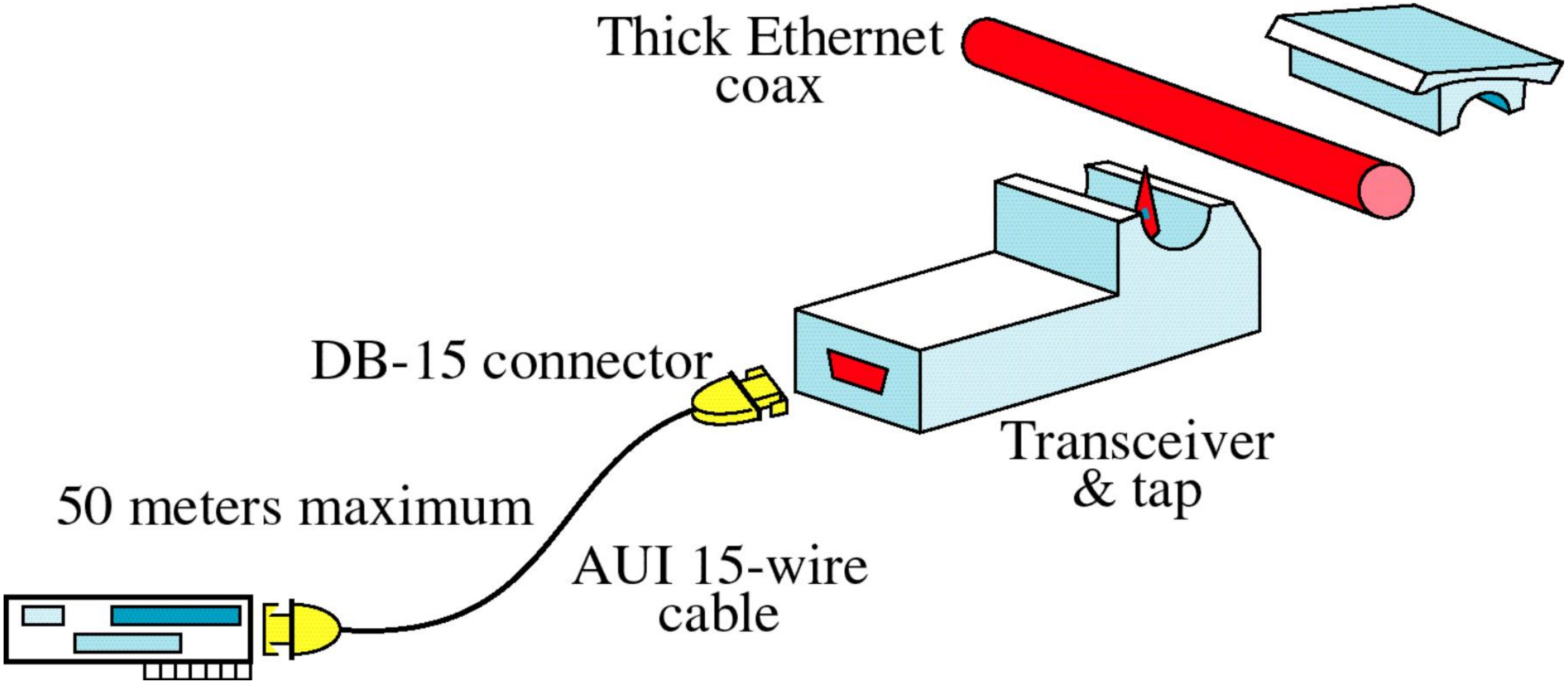
Data Link Layer



10BASE5

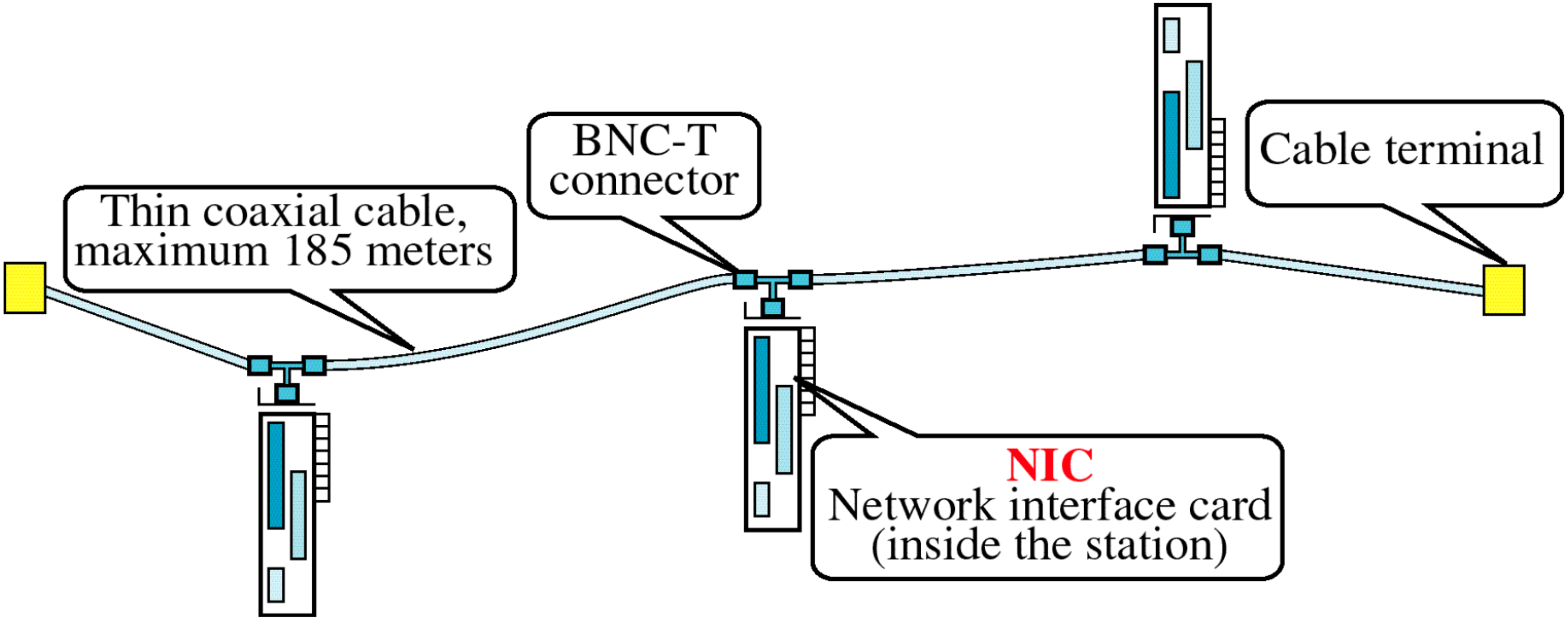

NIC
Attachment unit interface
(AUI)
Transceiver cable
Maximum 50 meters
Thick coaxial cable
Maximum 500 meters
Medium attachment unit
(MAU)
Transceiver
Cable terminator

Transceiver

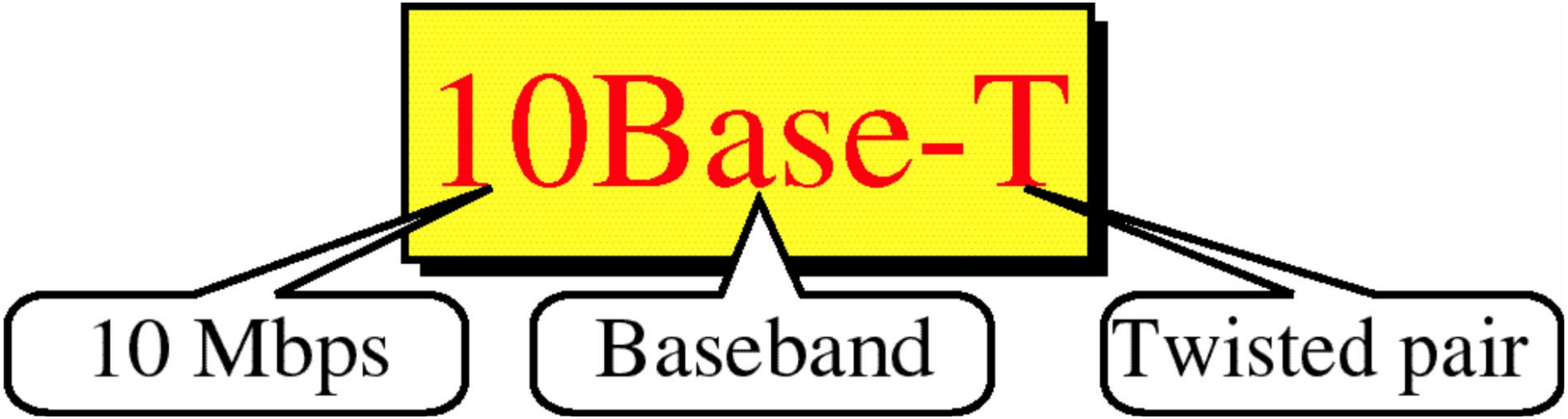


Data Link Layer

10BASE2

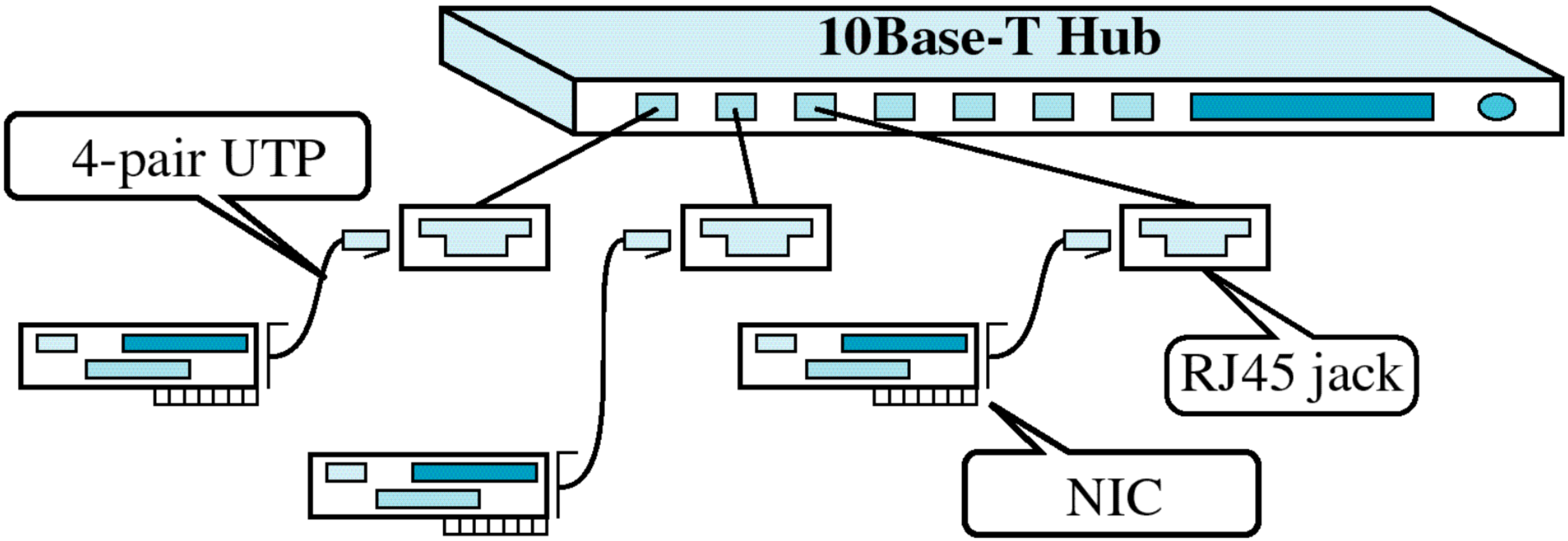

Thin coaxial cable,
maximum 185 meters
BNC-T
connector
Cable terminal
NIC
Network interface card
(inside the station)

Data Link Layer



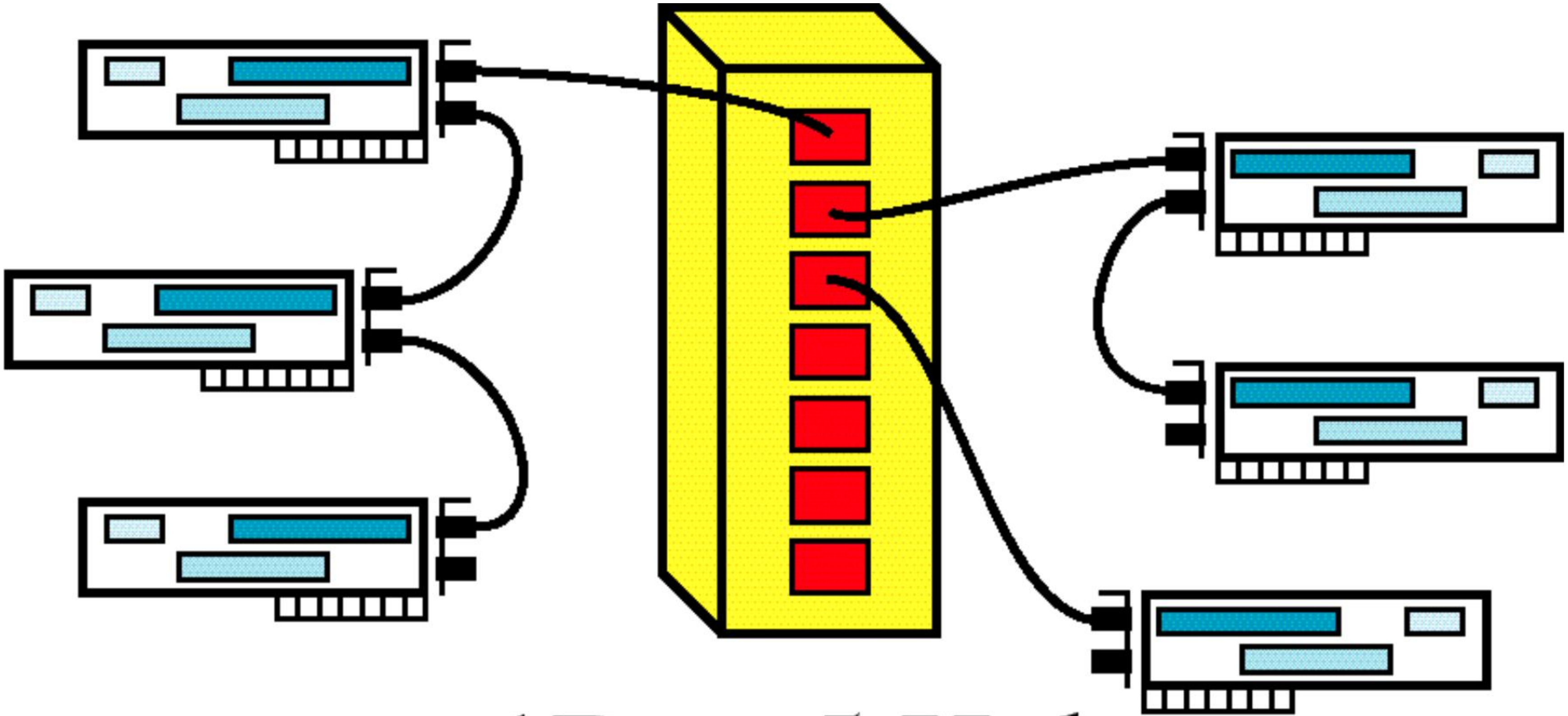
Data Link Layer

10BASET



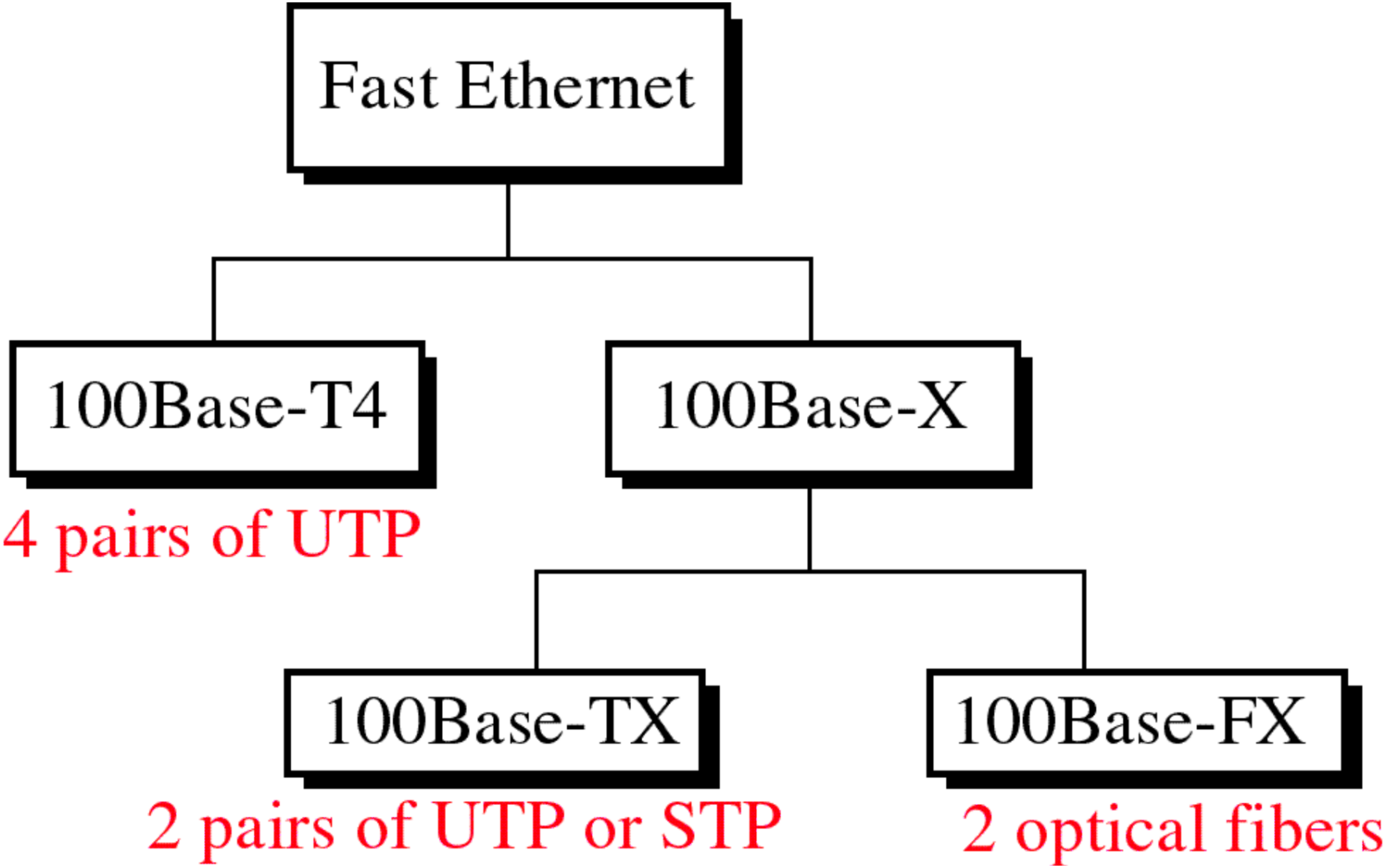
Data Link Layer

1BASE5

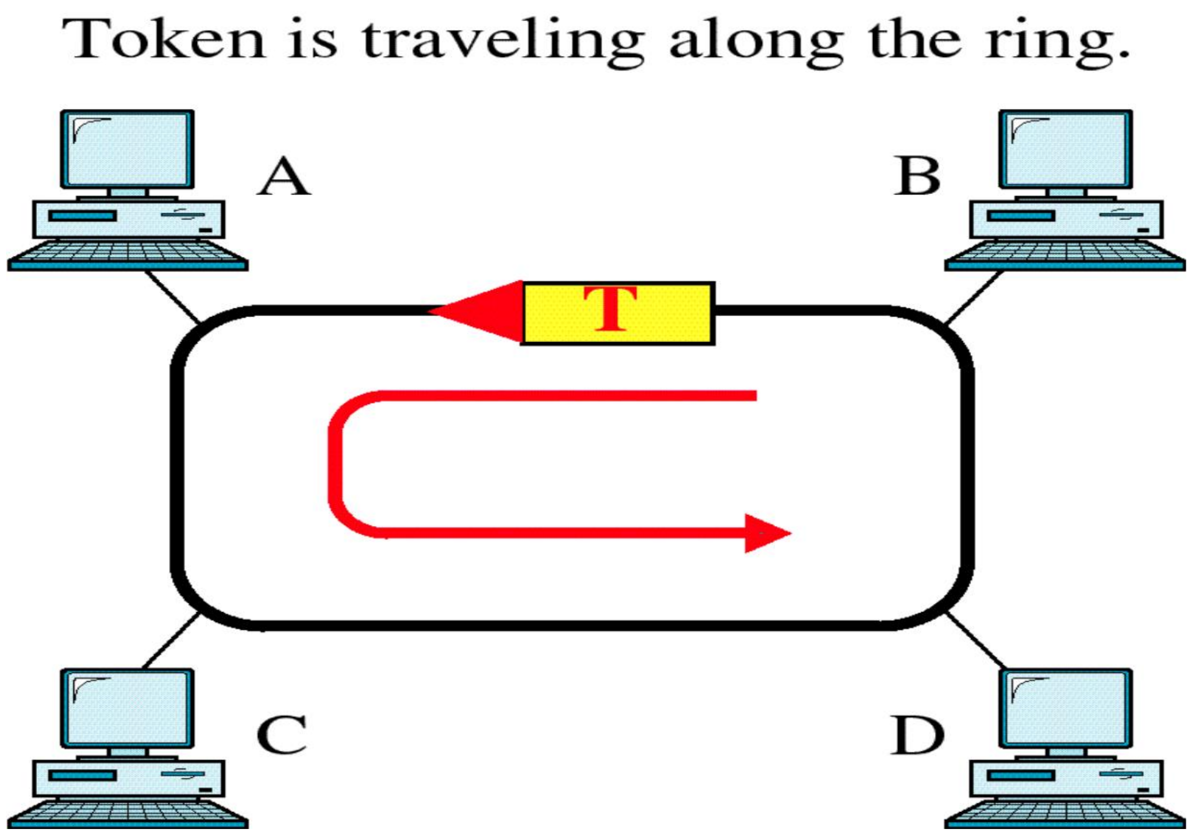


1Base5 Hub

Data Link Layer

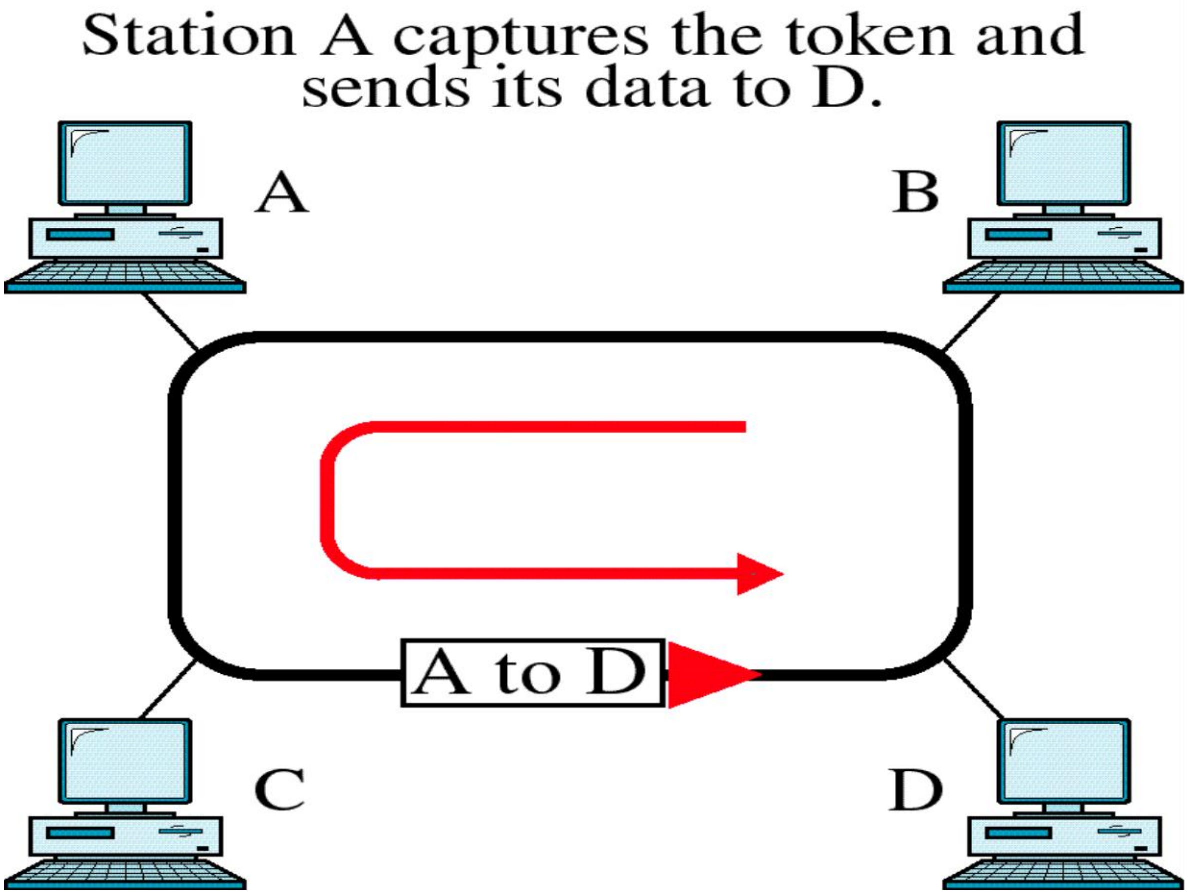


Token Passing



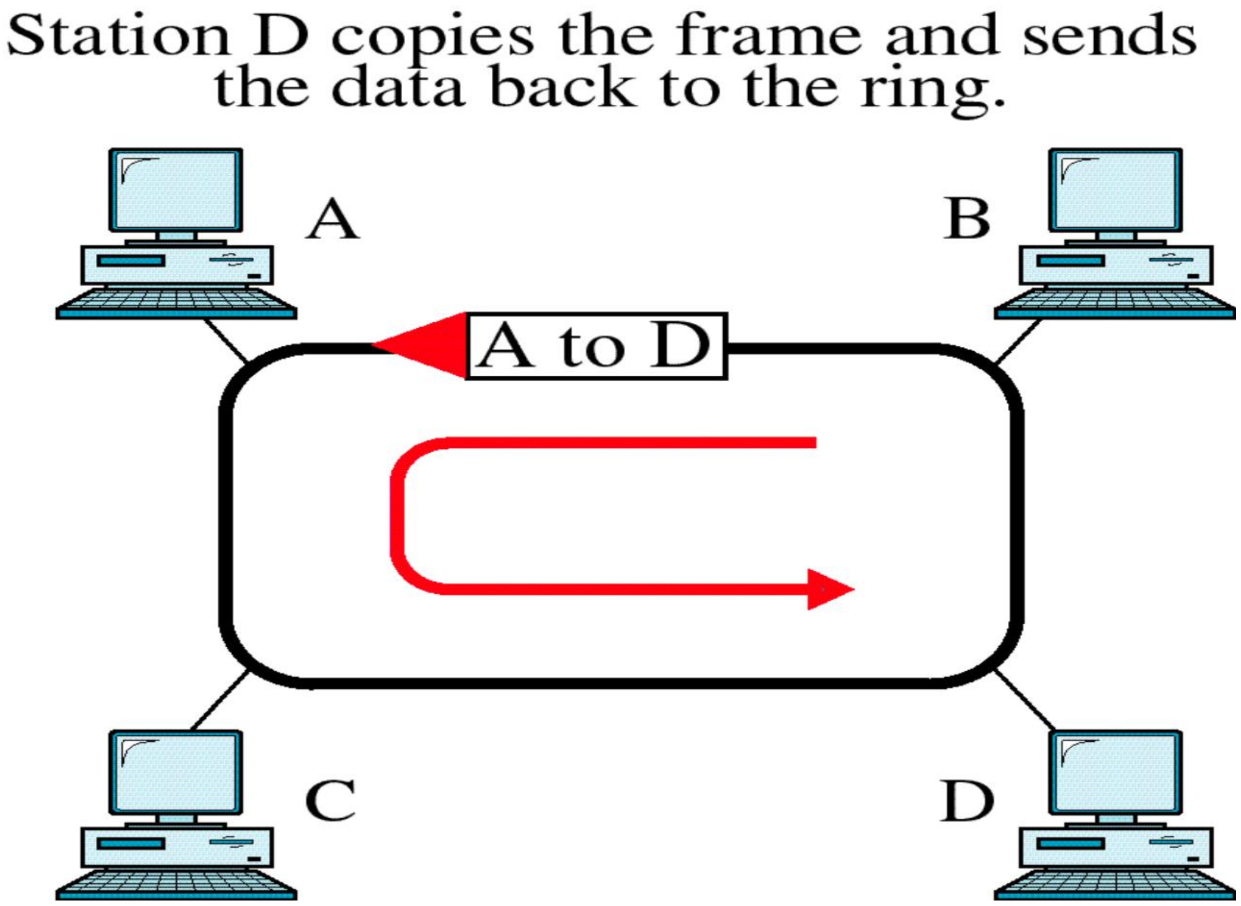
Token Ring

Token Passing



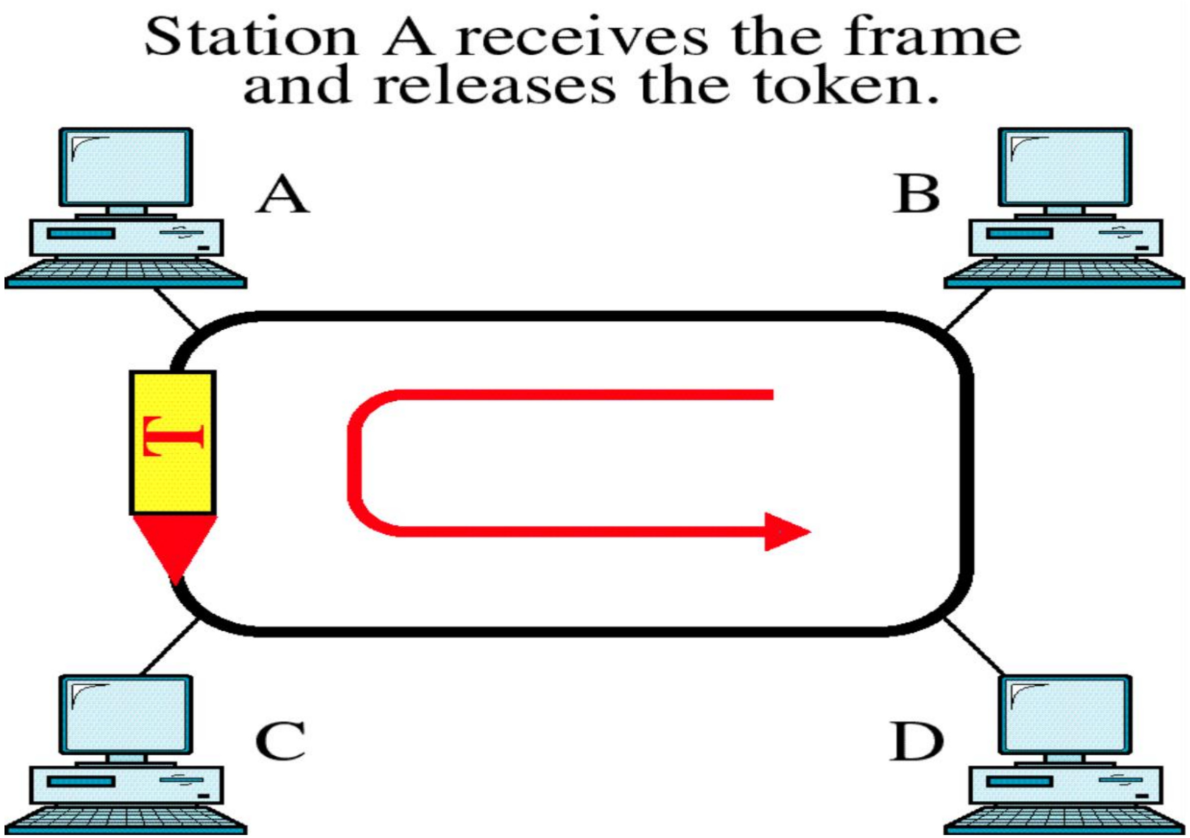
Token Ring

Token Passing

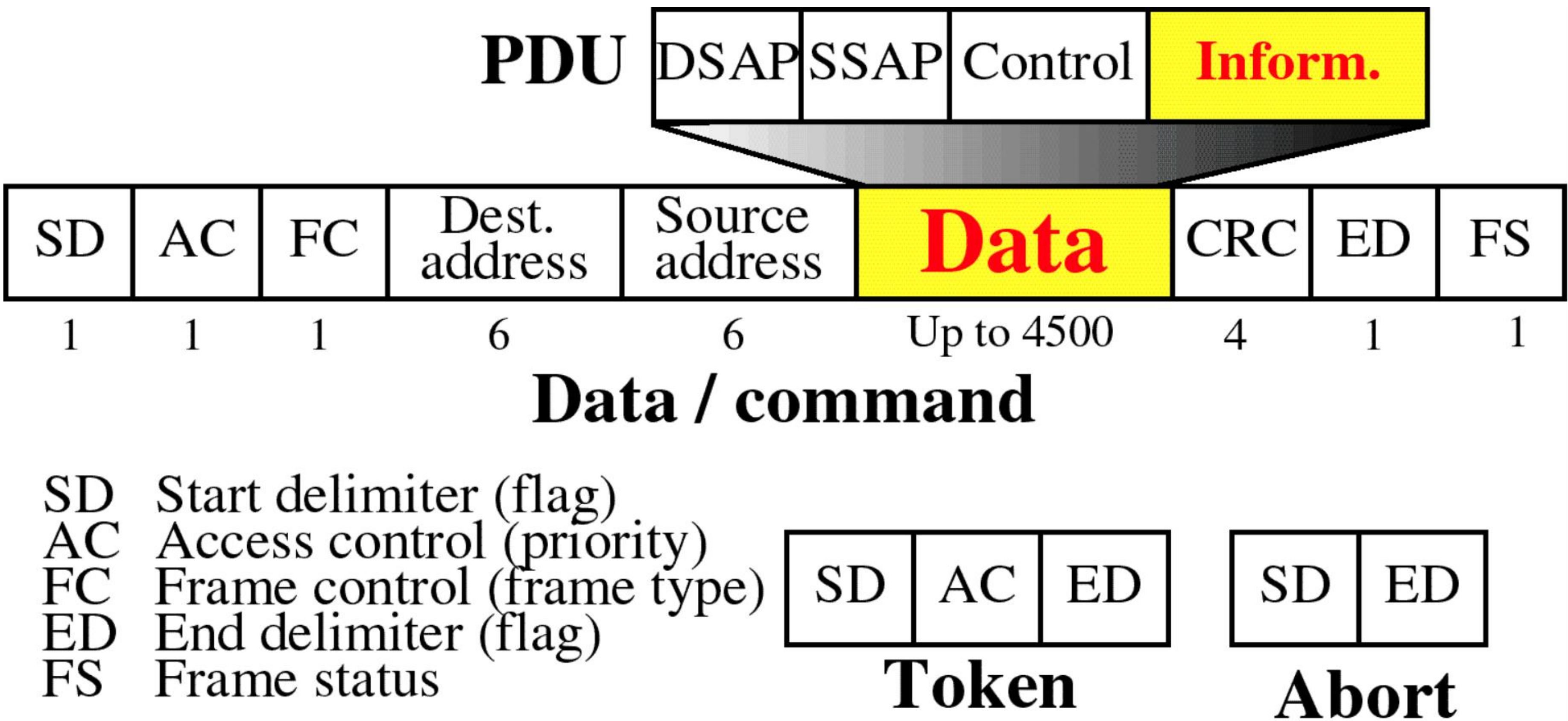


Token Ring

Token Passing

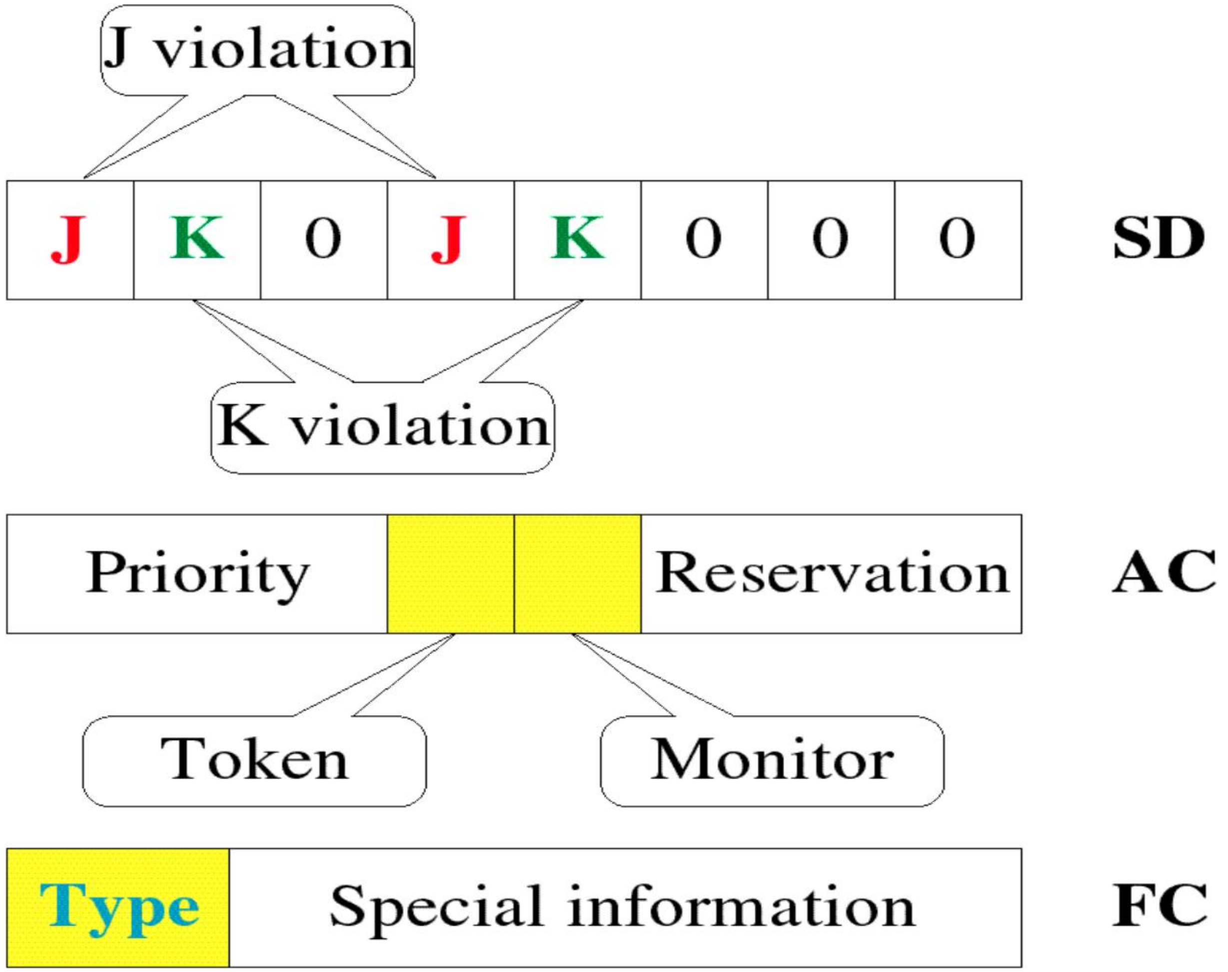


Token Ring Frame



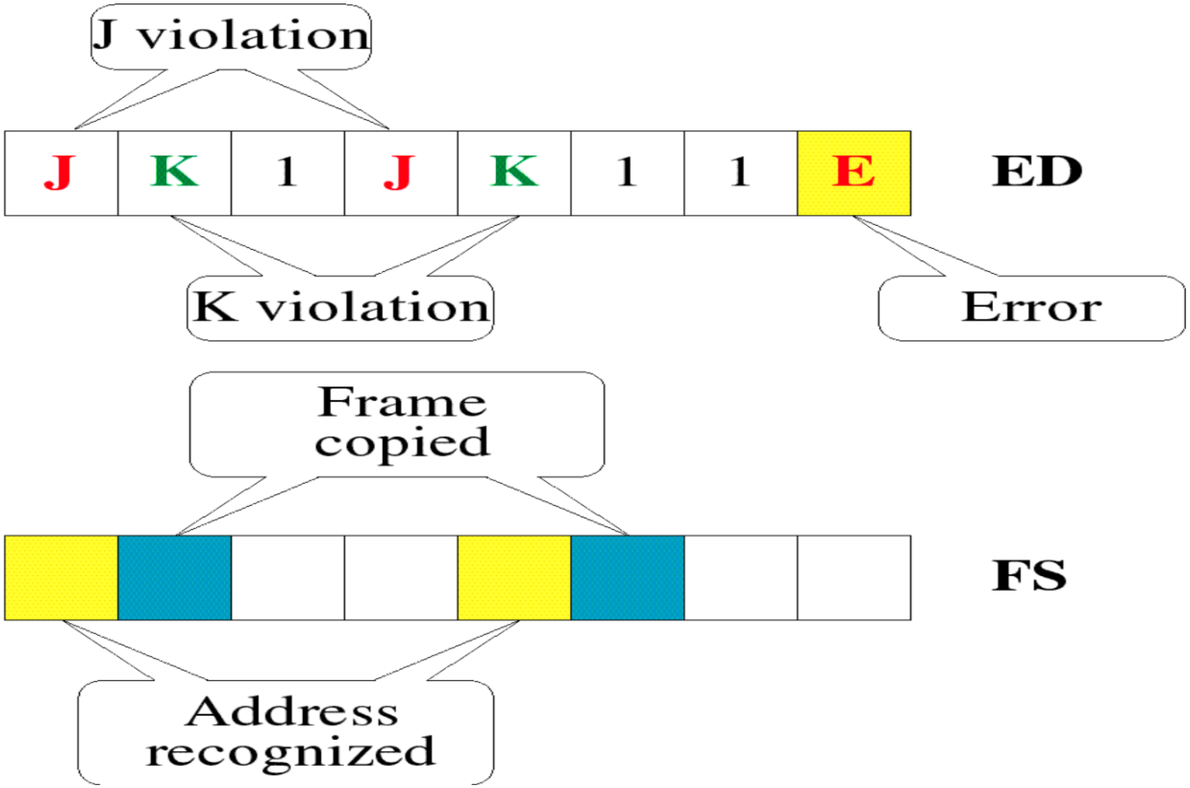
Token Ring

Data Frame Fields



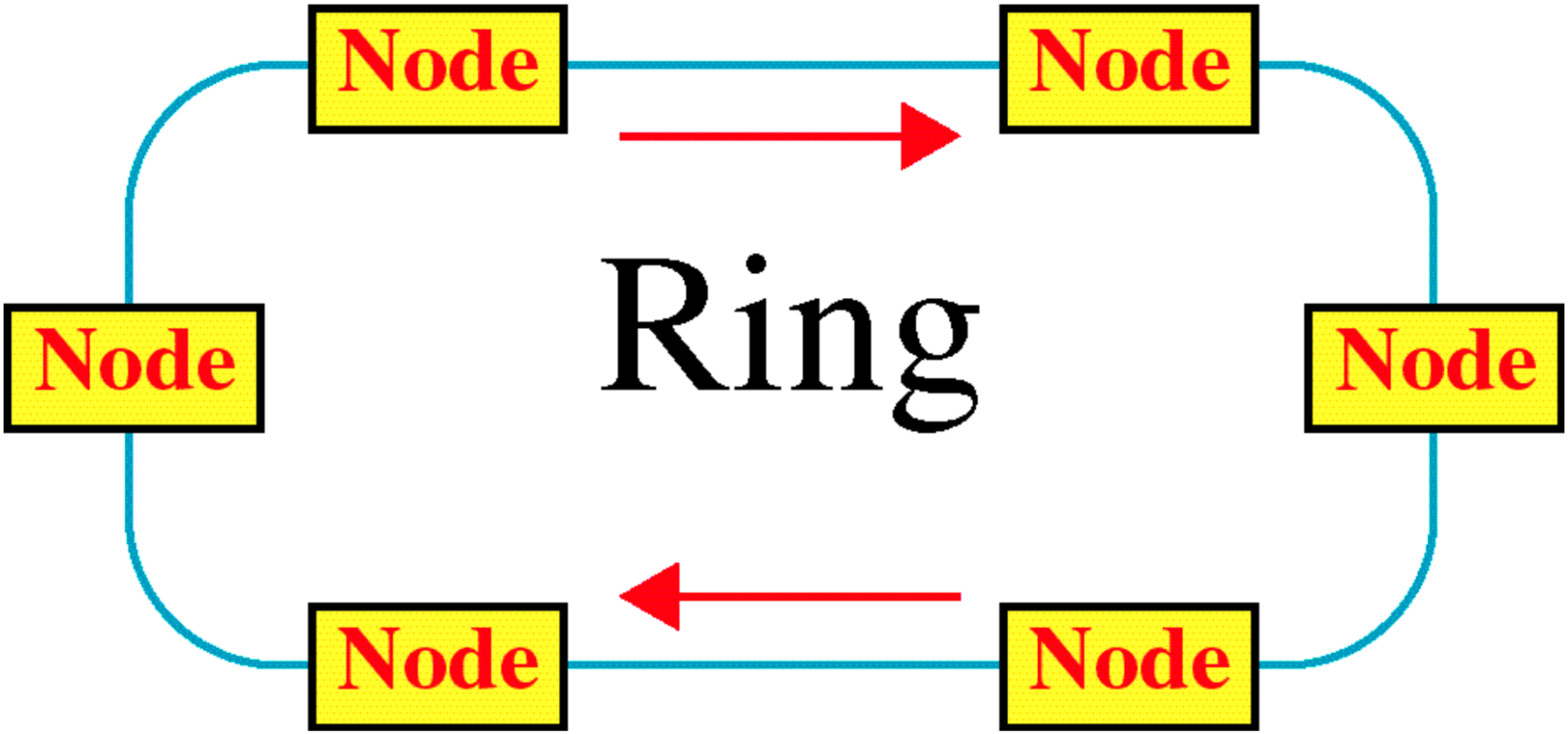
Token Ring

Data Frame Fields

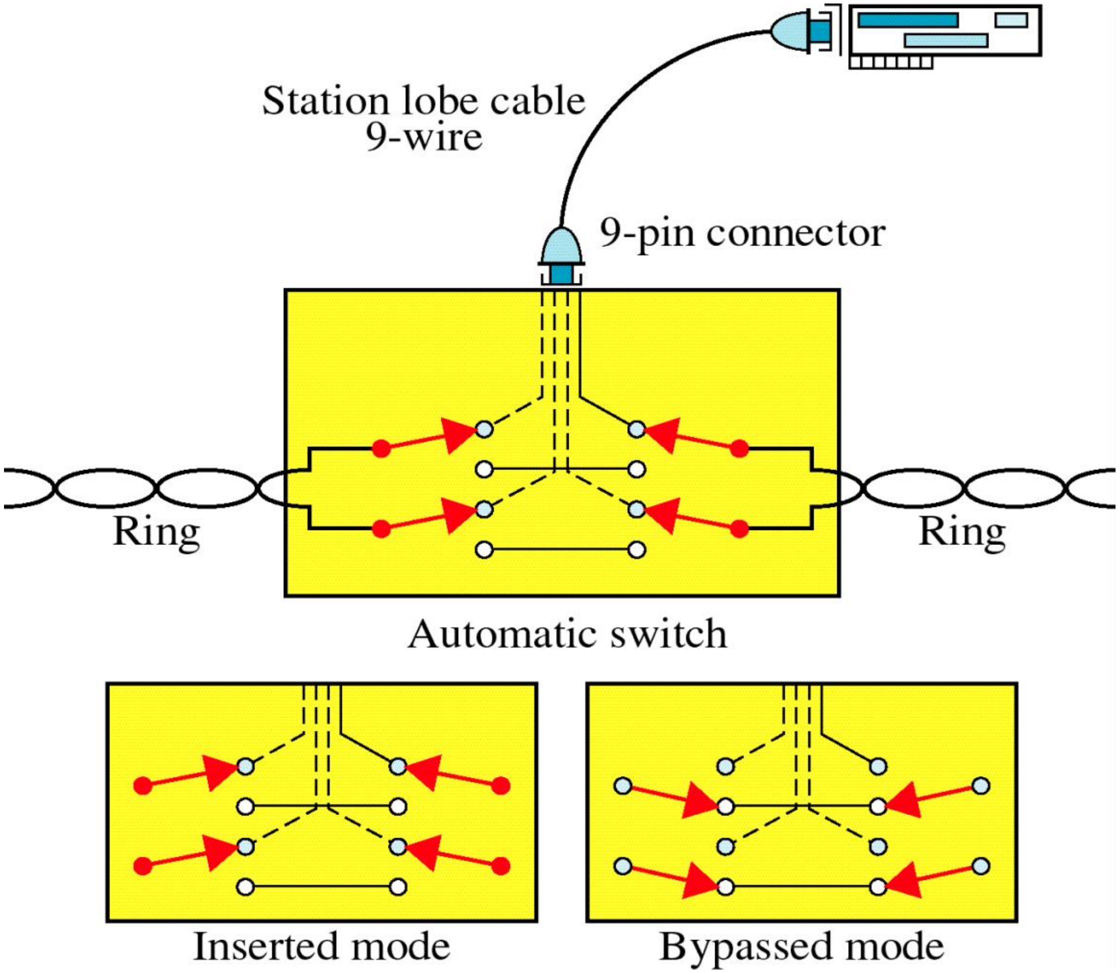


Token Ring

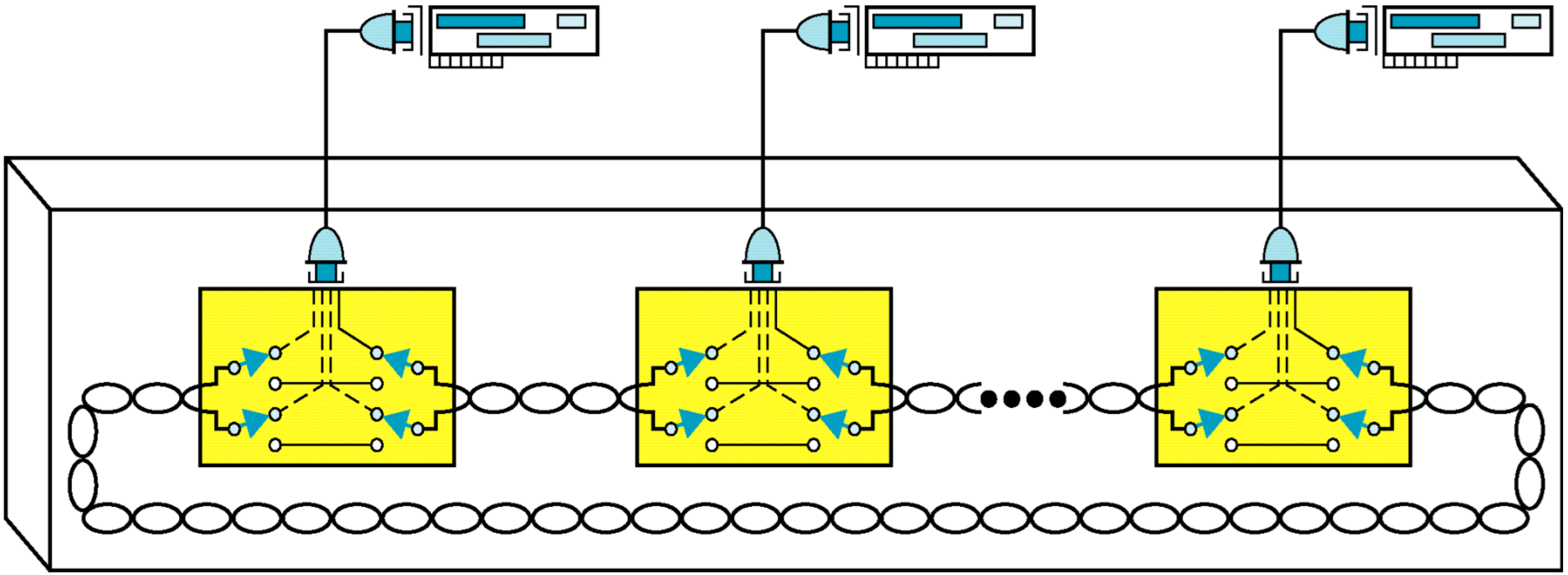
Token Ring process



Token Ring Switch

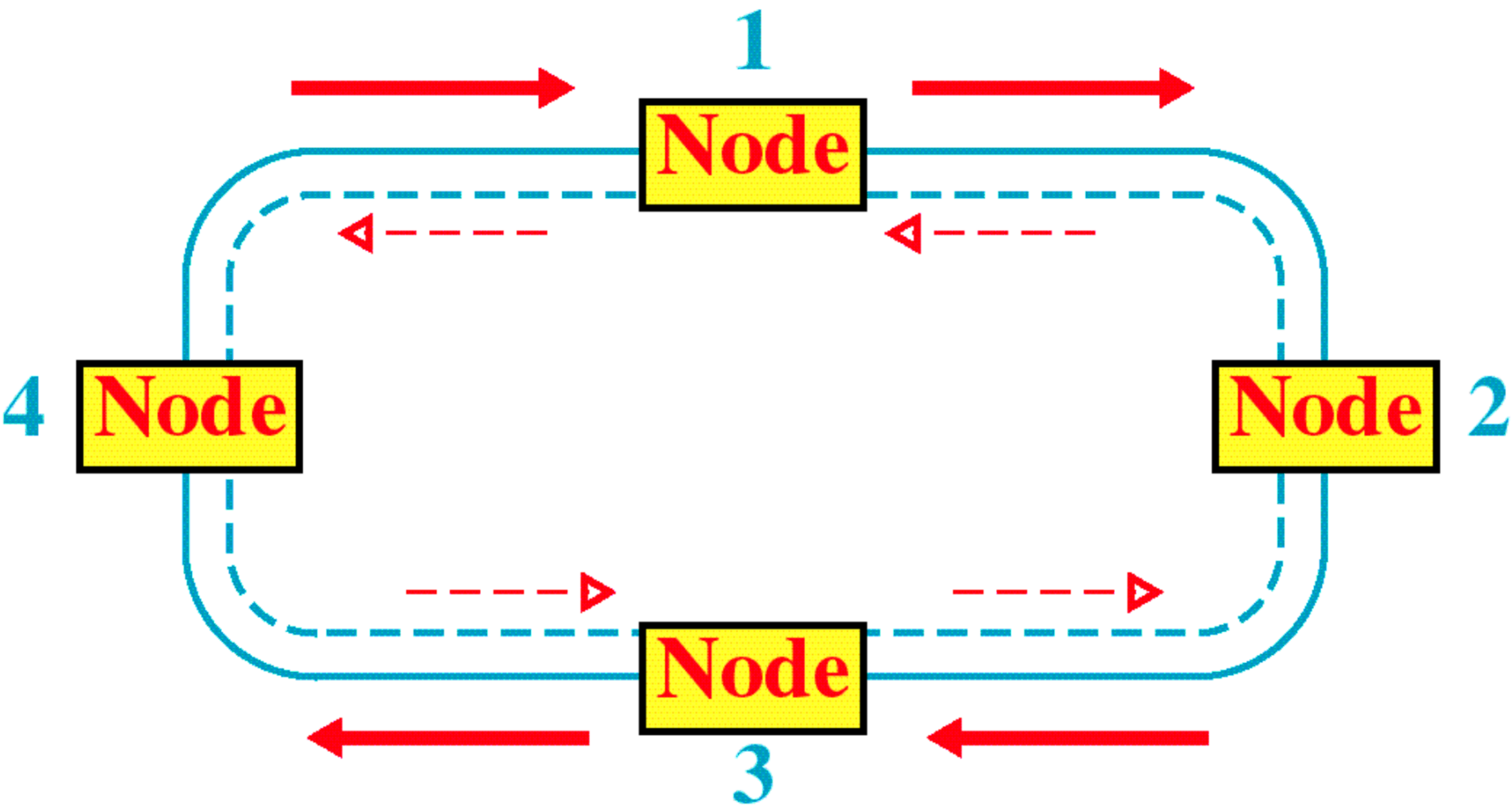


Token Ring MAU



Multistation access unit (MAU)

Token Ring: FDDI: Fiber Distributed dual Interface



Token Ring: Fiber Distributed dual Interface

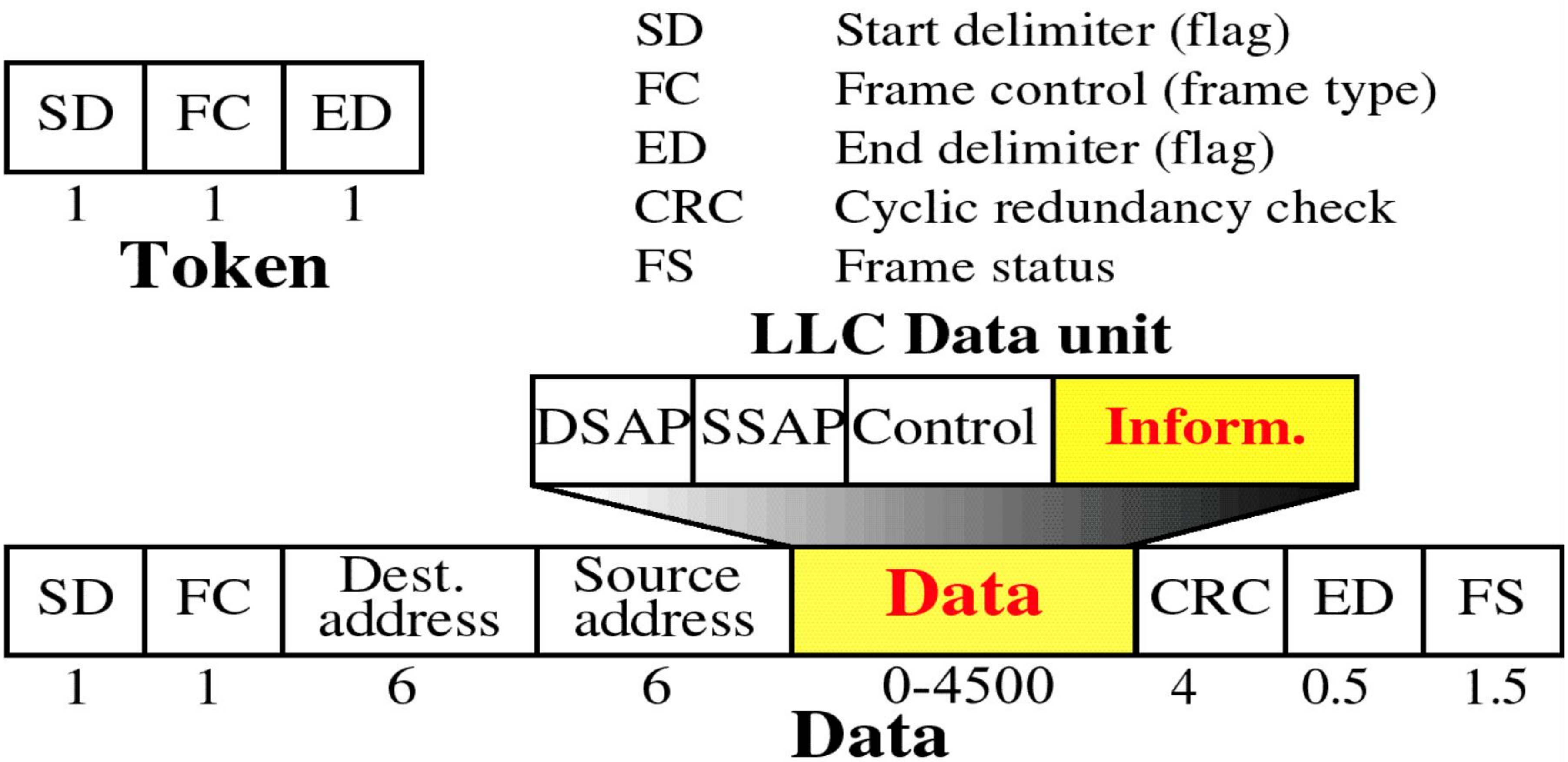
FDDI Example

	1	2	3	4
	Arrive time: 0	Arrive time: 30	Arrive time: 35	Arrive time: 40
1st RND	TRT 30 THT 25 SYN: 5 ASYN: 25	TRT 0 THT –5 SYN: 5 ASYN: 0	TRT –5 THT –10 SYN: 5 ASYN: 0	TRT –10 THT –15 SYN: 5 ASYN: 0
	Arrive time: 45	Arrive time: 50	Arrive time: 60	Arrive time: 65
2nd RND	TRT –15 THT –20 SYN: 5 ASYN: 0	TRT 10 THT 5 SYN: 5 ASYN: 5	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0
	Arrive time: 70	Arrive time: 75	Arrive time: 80	Arrive time: 90
3rd RND	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 10 THT 5 SYN: 5 ASYN: 5	TRT 5 THT 0 SYN: 5 ASYN: 0

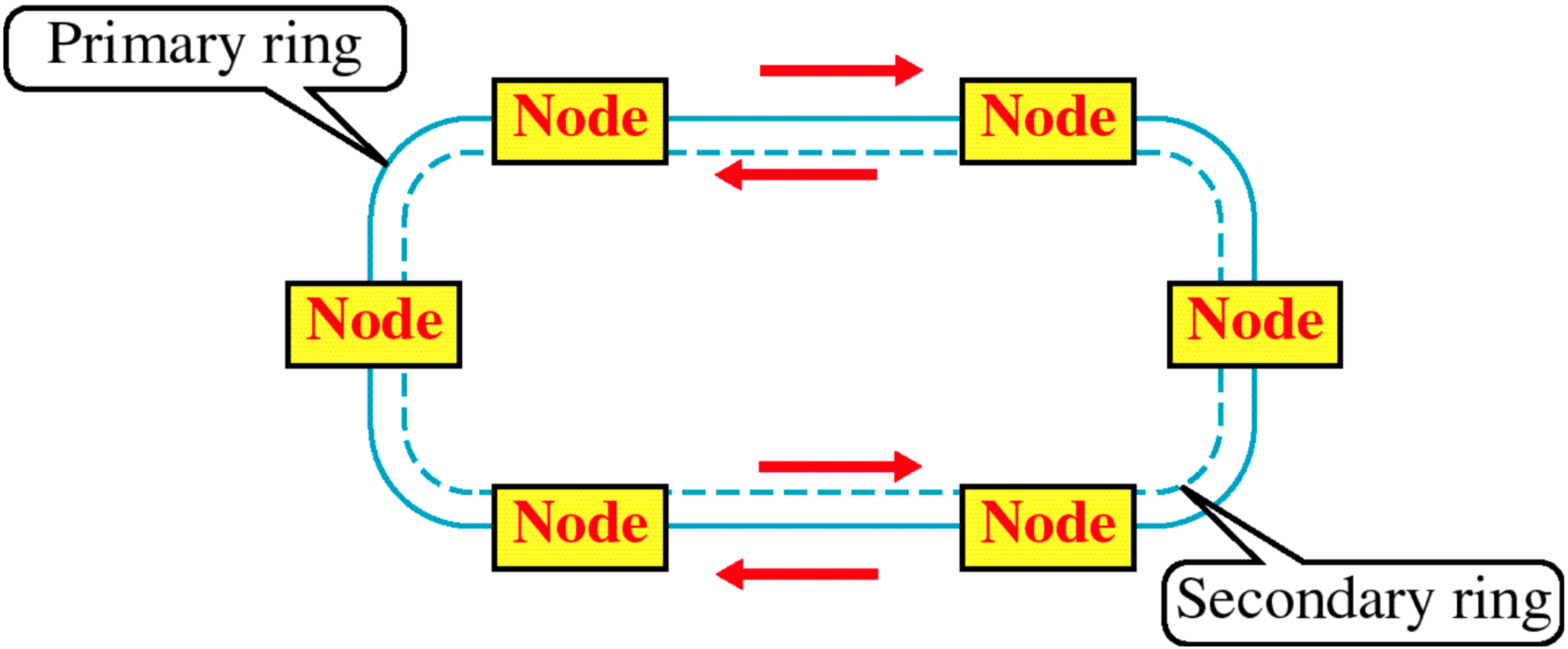
Token Ring: FDDI

	Arrive time: 95	Arrive time: 100	Arrive time: 105	Arrive time: 110
4th RND	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 10 THT 5 SYN: 5 ASYN: 5
	Arrive time: 120	Arrive time: 125	Arrive time: 130	Arrive time: 135
5th RND	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0	TRT 5 THT 0 SYN: 5 ASYN: 0

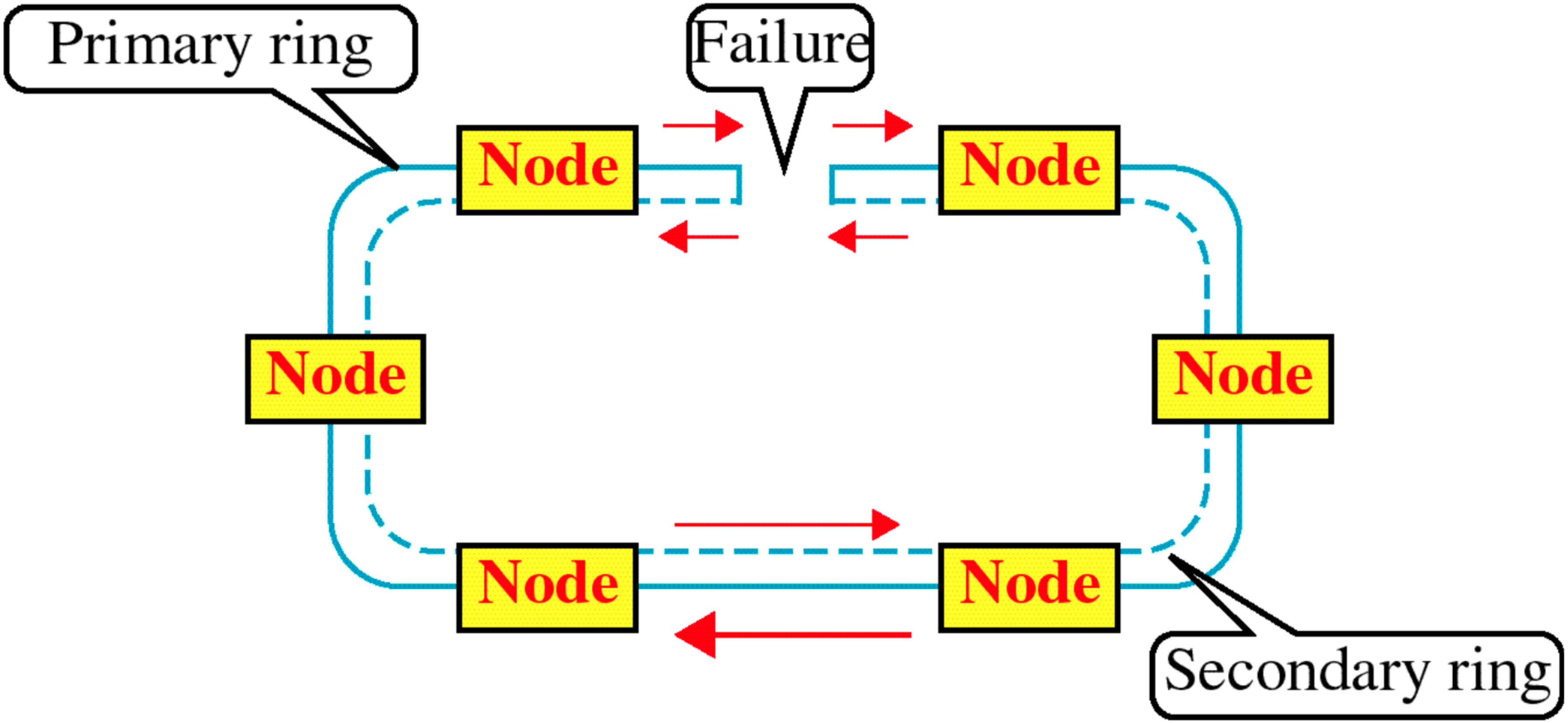
FDDI Frame format



Token Ring: Fiber Distributed dual Interface

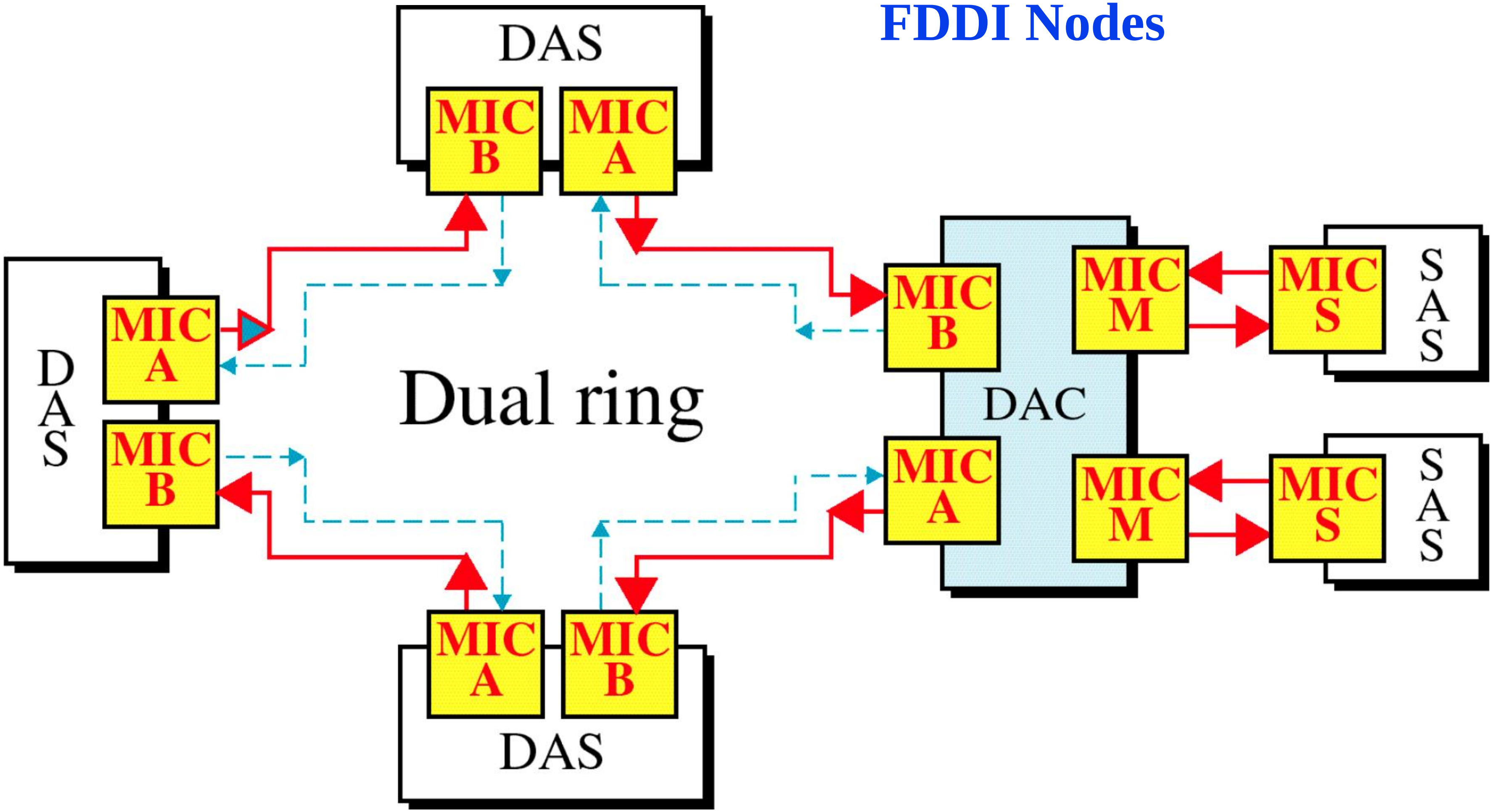


Token Ring: Fiber Distributed dual Interface



Token Ring: Fiber Distributed dual Interface

FDDI Nodes

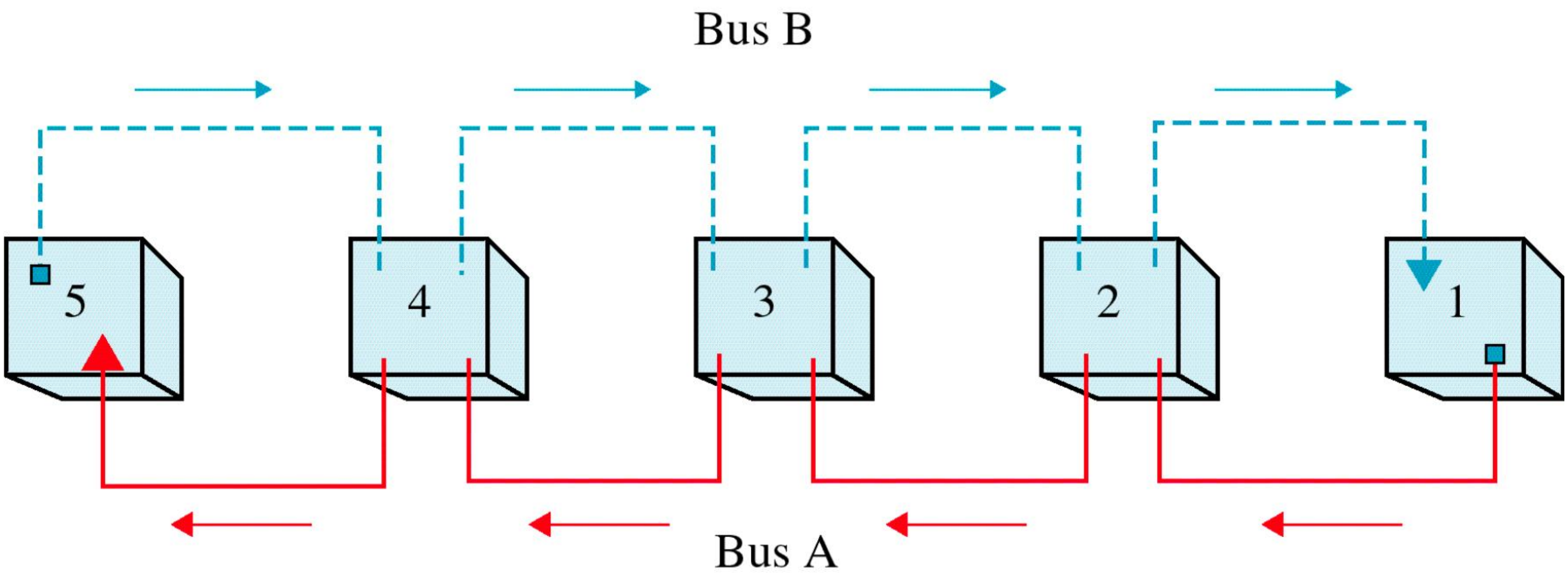


Metropolitan Area Networks : IEEE 802.6 DQDB distributed Queue dual interface

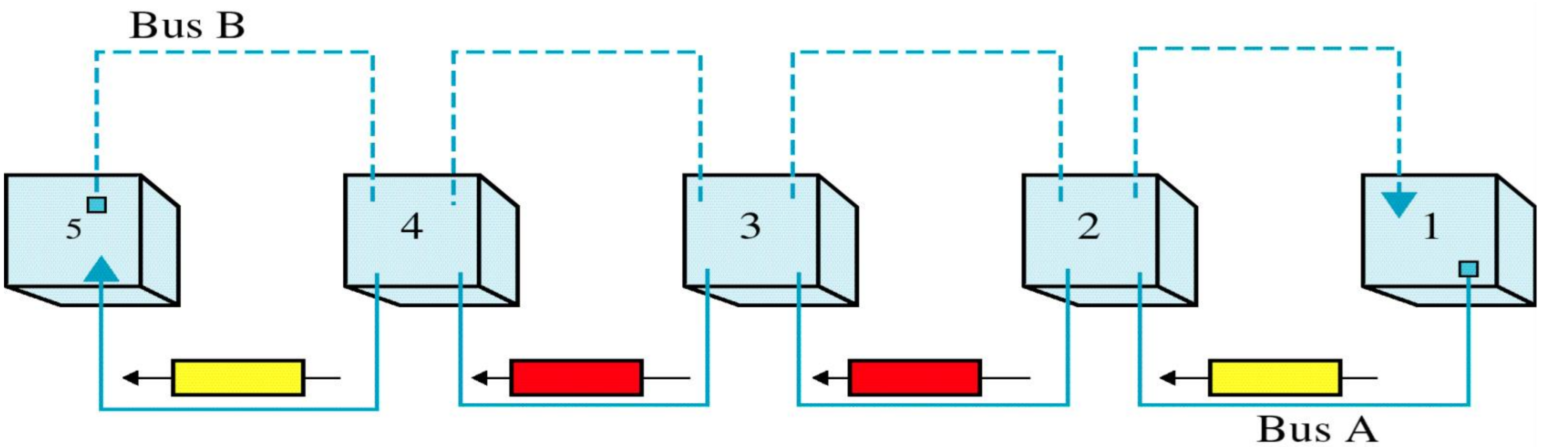
- **IEEE 802.6**
- **DQDB (Distributed Queues, Dual Bus)**
- **SMDS (Switched Megabit Data Services)**

Metropolitan Area Networks : IEEE 802.6 DQDB distributed Queue dual interface

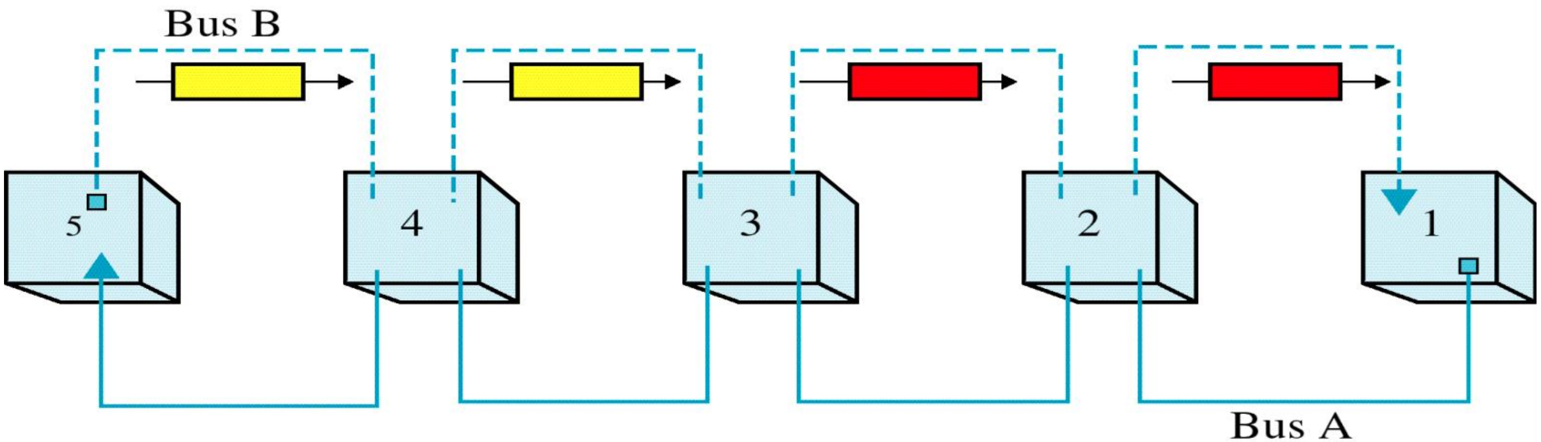
DQDB Buses and Nodes



DQDB Data Transmission



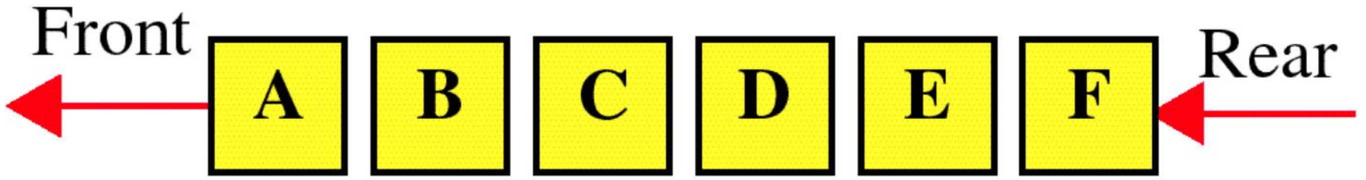
a. Station 2 sends data to station 4.



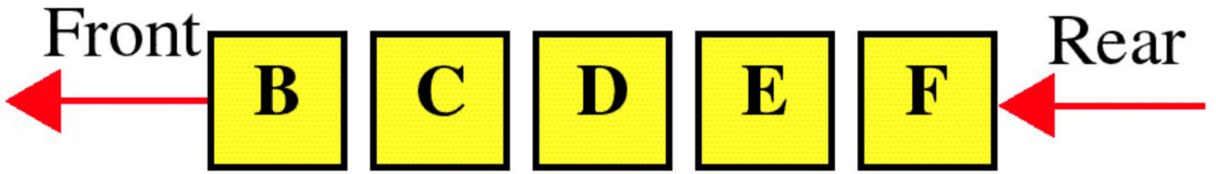
b. Station 3 sends data to station 1.

DQDB distributed Queue dual interface

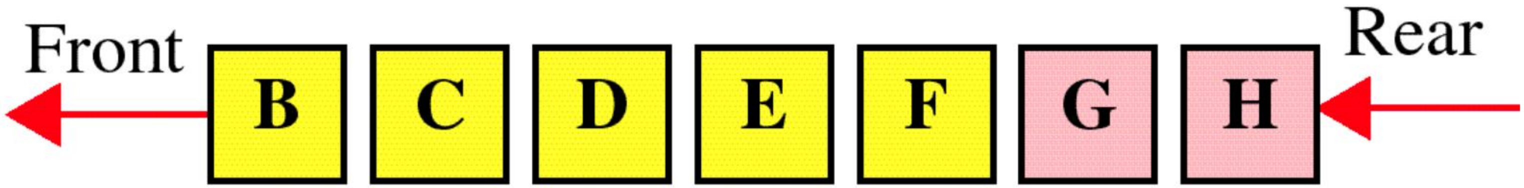
Queues



a. A queue with 5 elements.

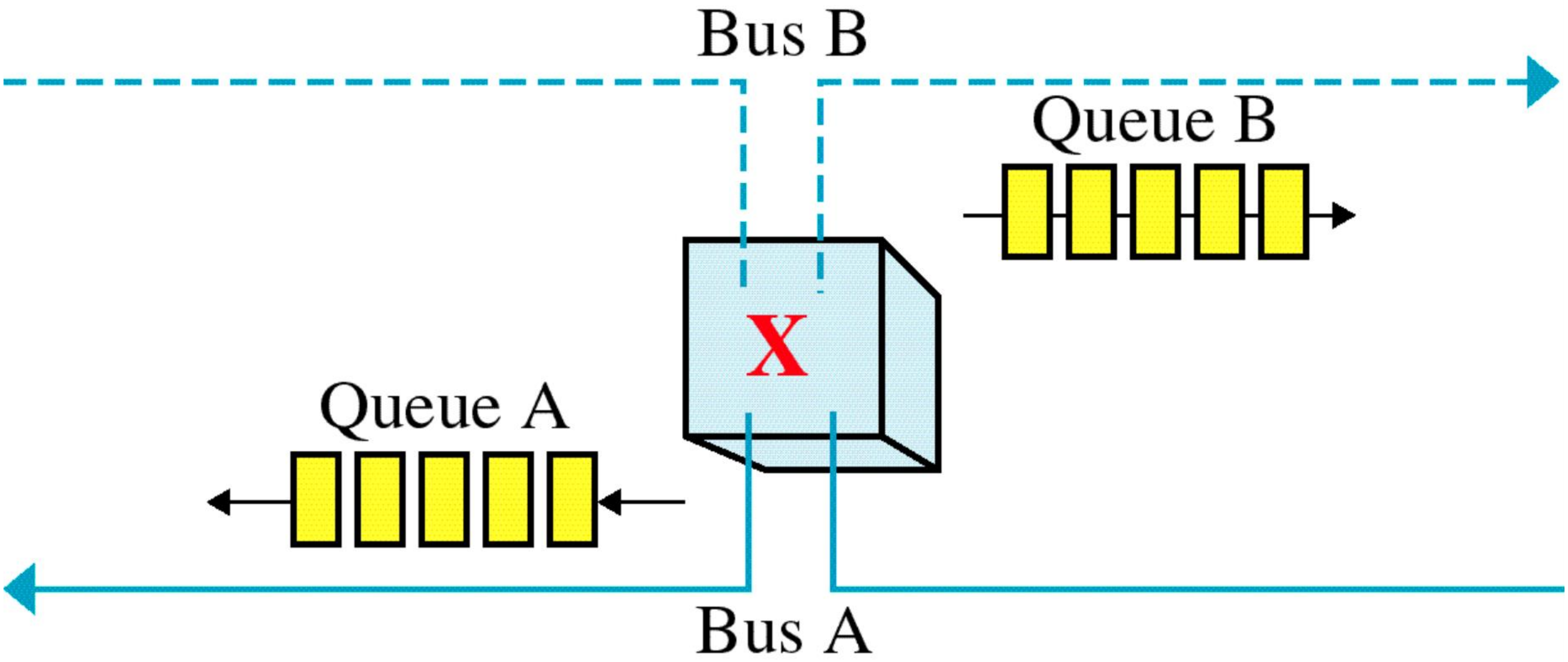


b. After removing first element



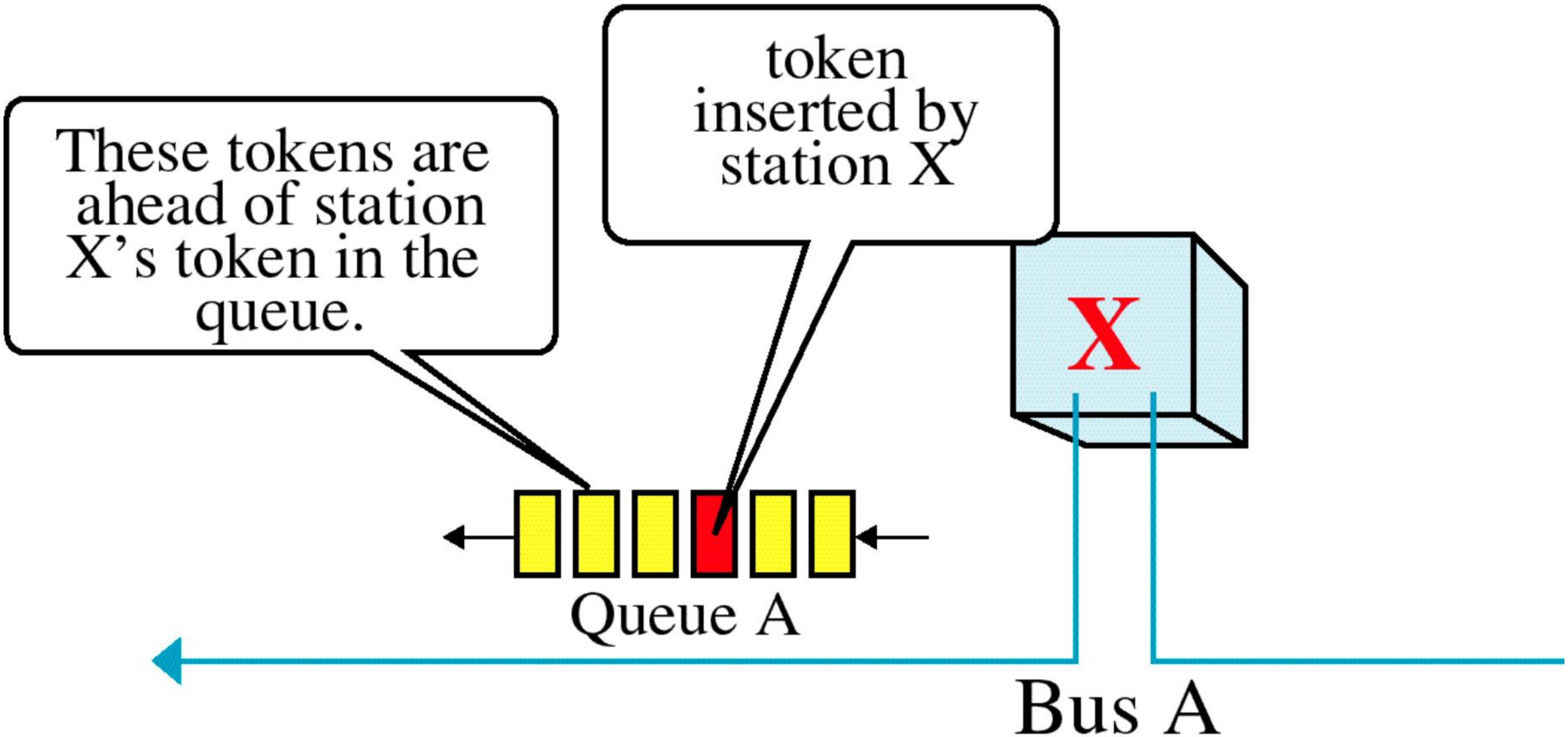
c. After inserting two elements

DQDB distributed Queue dual interface

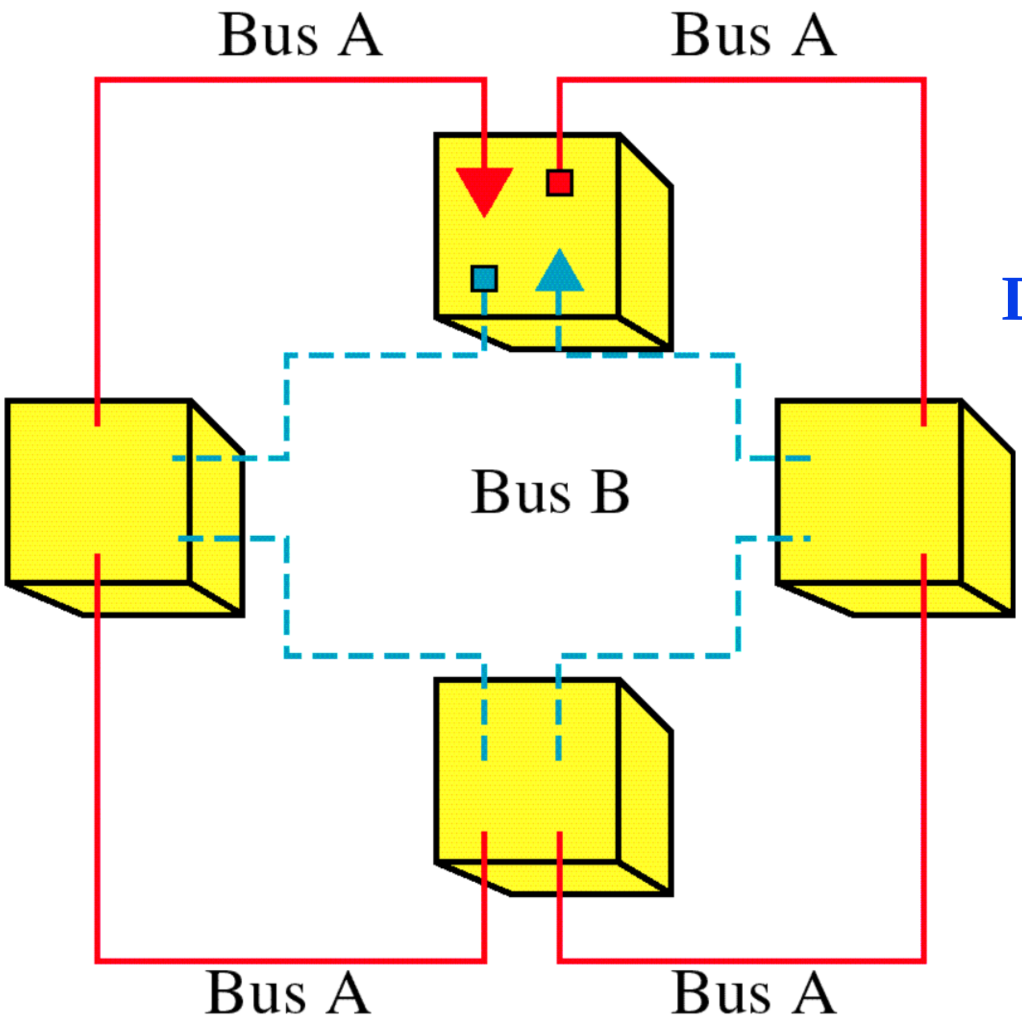


DQDB distributed Queue dual interface

Reservation Token



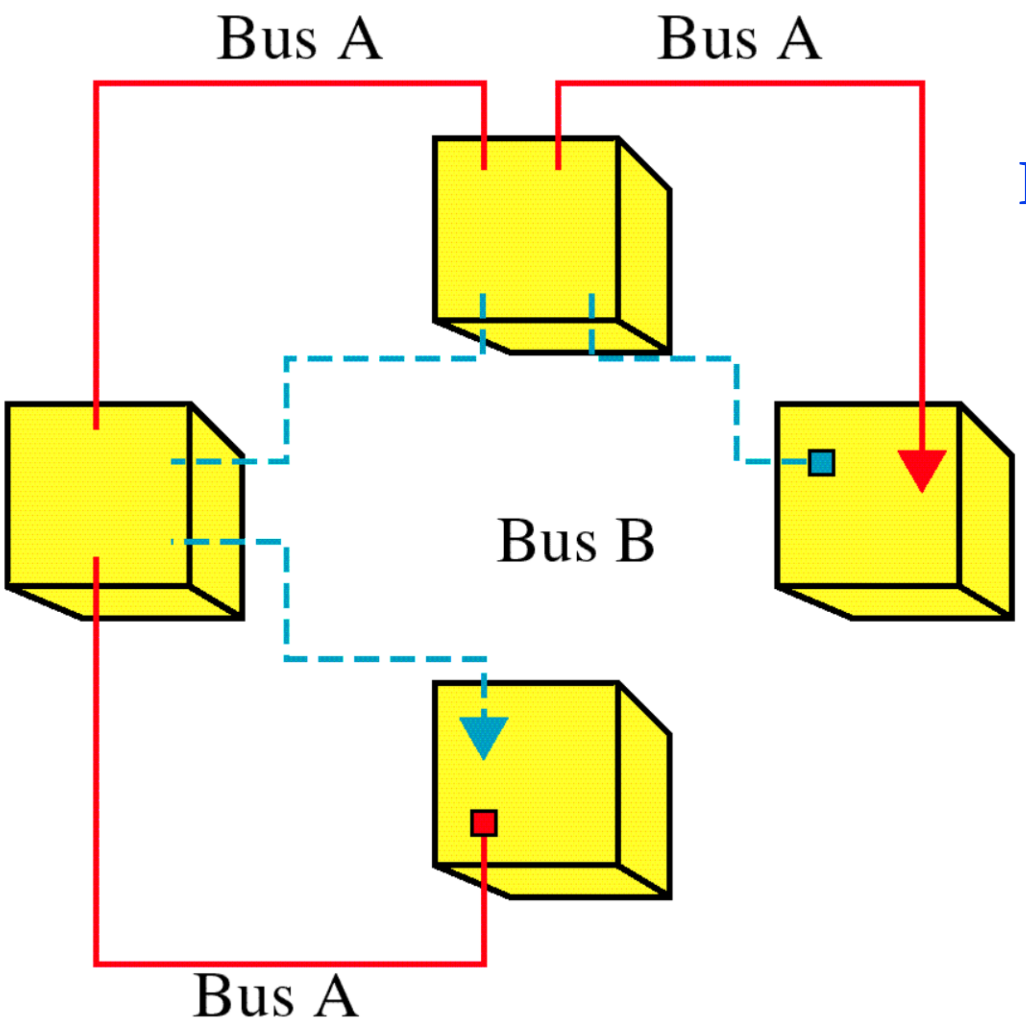
DQDB distributed Queue dual interface



a. Ring without failure.

DQDB Rings

DQDB distributed Queue dual interface

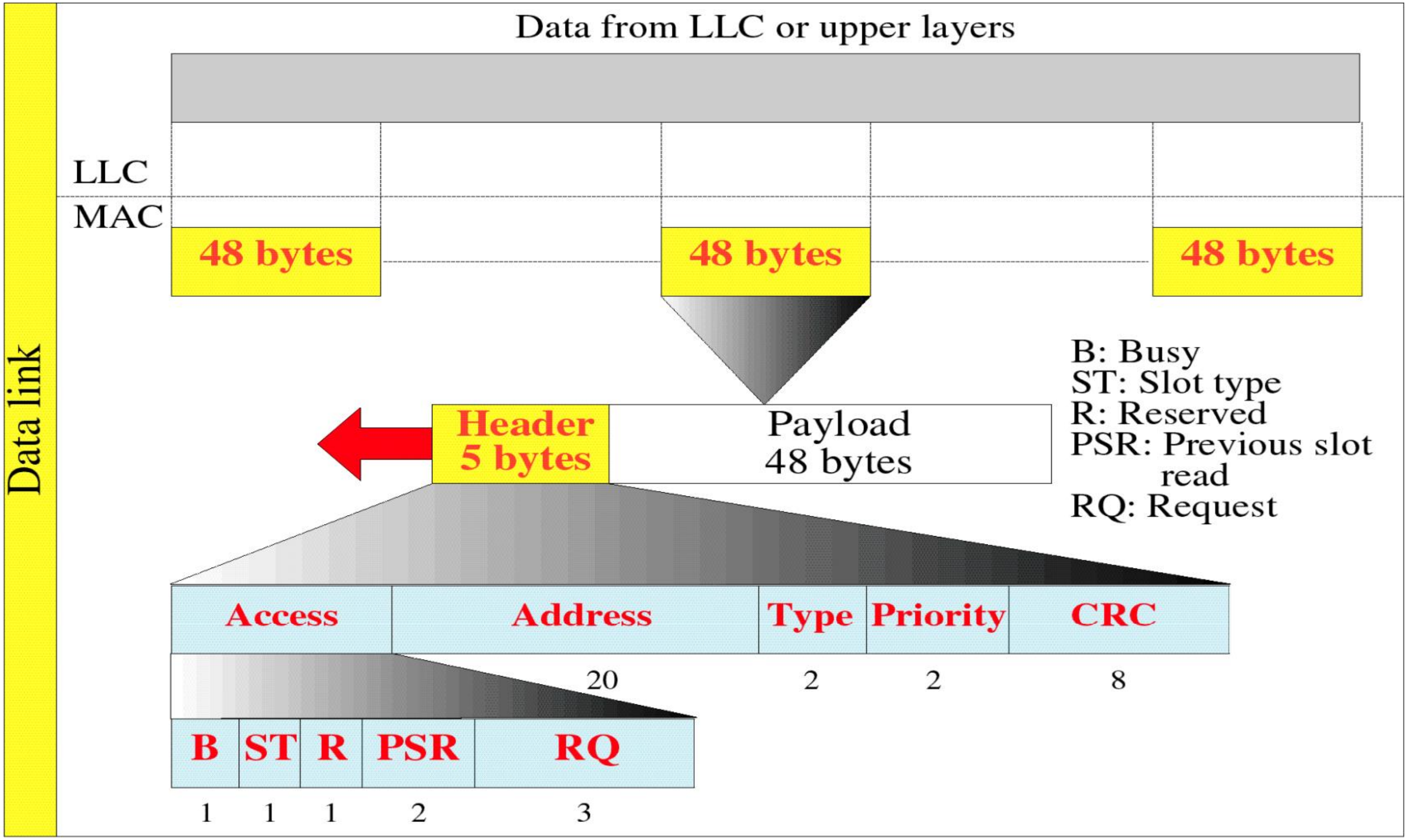


b. Ring with failure.

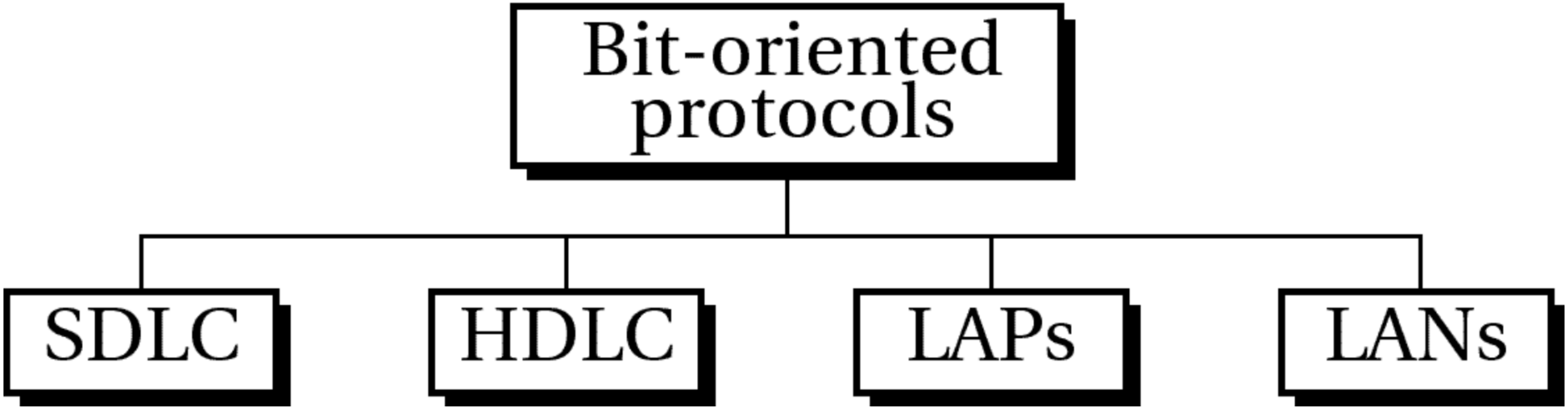
DQDB Rings

DQDB distributed Queue dual interface

DQDB Layers

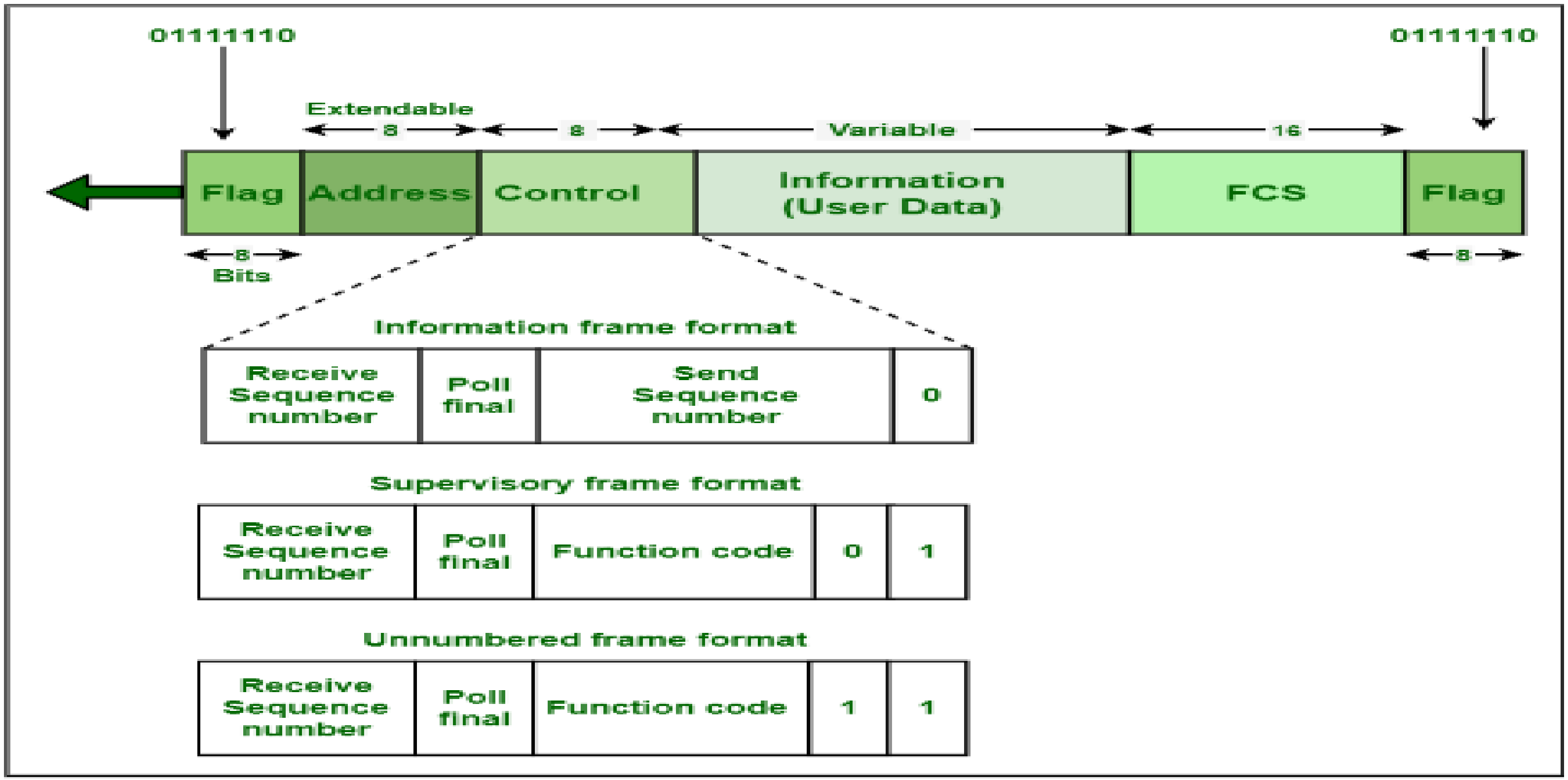


Data Link Layer Protocols



Data Link Layer Protocols

SDLC



Basic SDLC Frame Structure

Data Link Layer Protocols

1.Flag Field –

Flag (F) is beginning frame that represents beginning of frame. This field is used to initiate and terminate occurrence of error by regular checking.

2.Address Field –

Address (A) filed follows just after beginning flag. It is used to identifies and determines secondary station that is transmitting frame. This is done because frame contains information or data regarding group address, specific address. Broadcast address, etc.

3.Control Field –

Control (C) field follows just after address field. It is used to specify functions of particular frame.

.

Data Link Layer Protocols

This field can be present in three types of format as given below :

1. **(i). Unnumbered (U) format :**
   It is required to perform various functions such as to establish disconnect link, to report some procedural errors, to transfer or transmit data especially when location or address of data in frame sequence is not needed to be checked.
2. **(ii). Supervisory (S) format :**
   It is required to perform various functions such as to acknowledge received frames, to convey ready or busy conditions, report frame numbering errors, etc. This format does not contain any information field.
3. **(iii). Information (I) format :**
   It is required to perform various functions such as to transfer data or information, to control sequence in which frames are needed to sent and number of frames

Data Link Layer Protocols

4. Information Field –

Information (I) field follows just after control field. This field is an optional field that mainly contains information data. The data is needed to be transmitted on data link is present in this field.

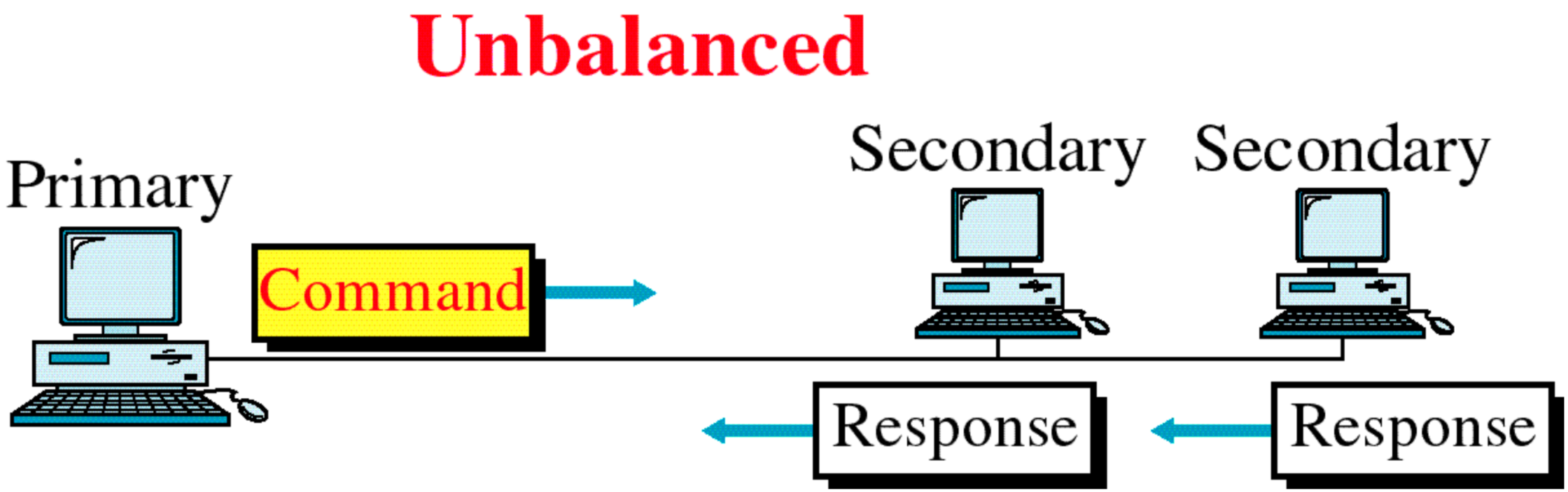
5. **FCS Field –**

Frame Check Sequence (FCS) field follows just after information field. This field especially allows and grants permission to receiving stations to simply ensure and check transmission accuracy of frame. This field simply checks received frame for any kind of error that might have been occurred by link connection.

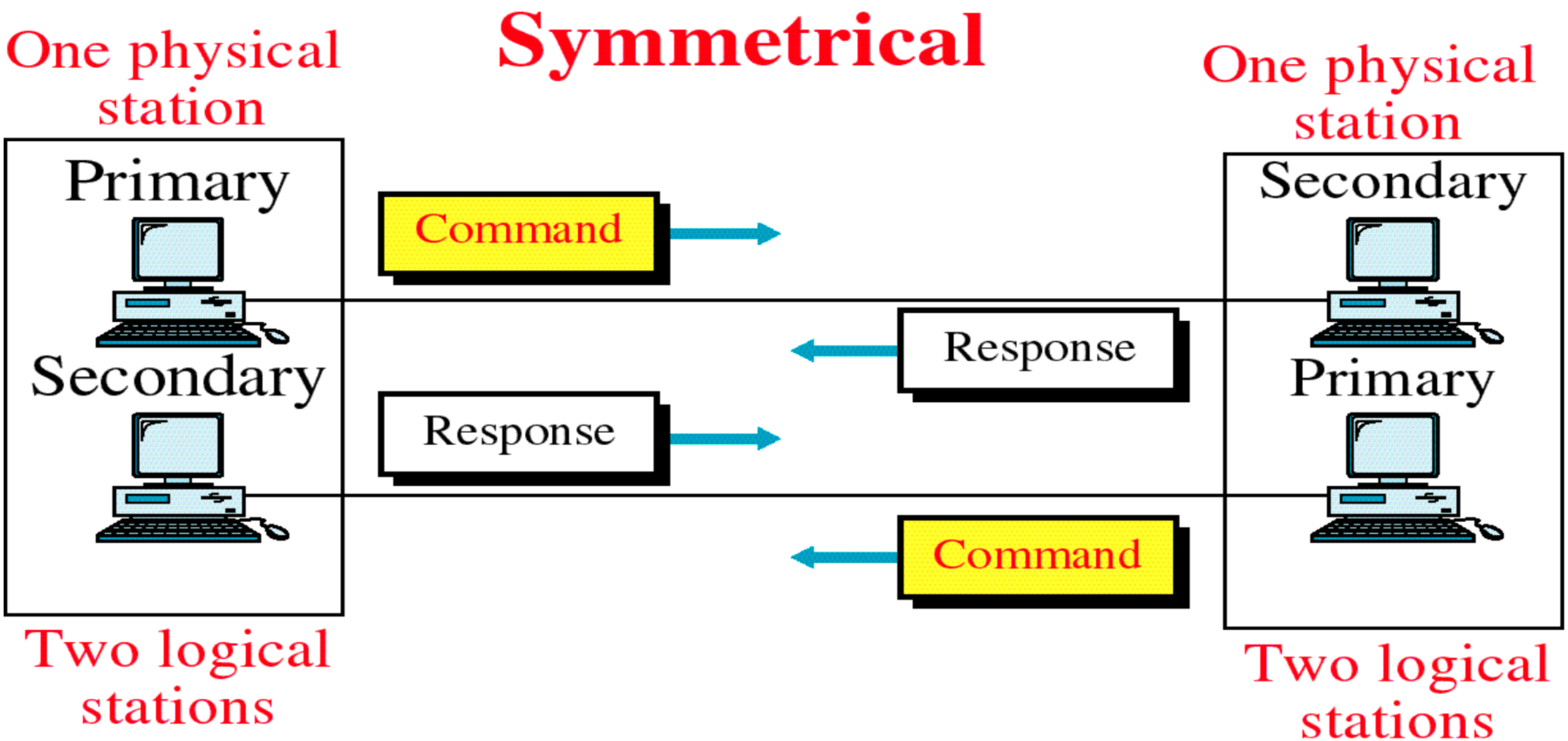
6.**Ending Flag Field –**

This field indicates ending of frame.

HDLC Configuration

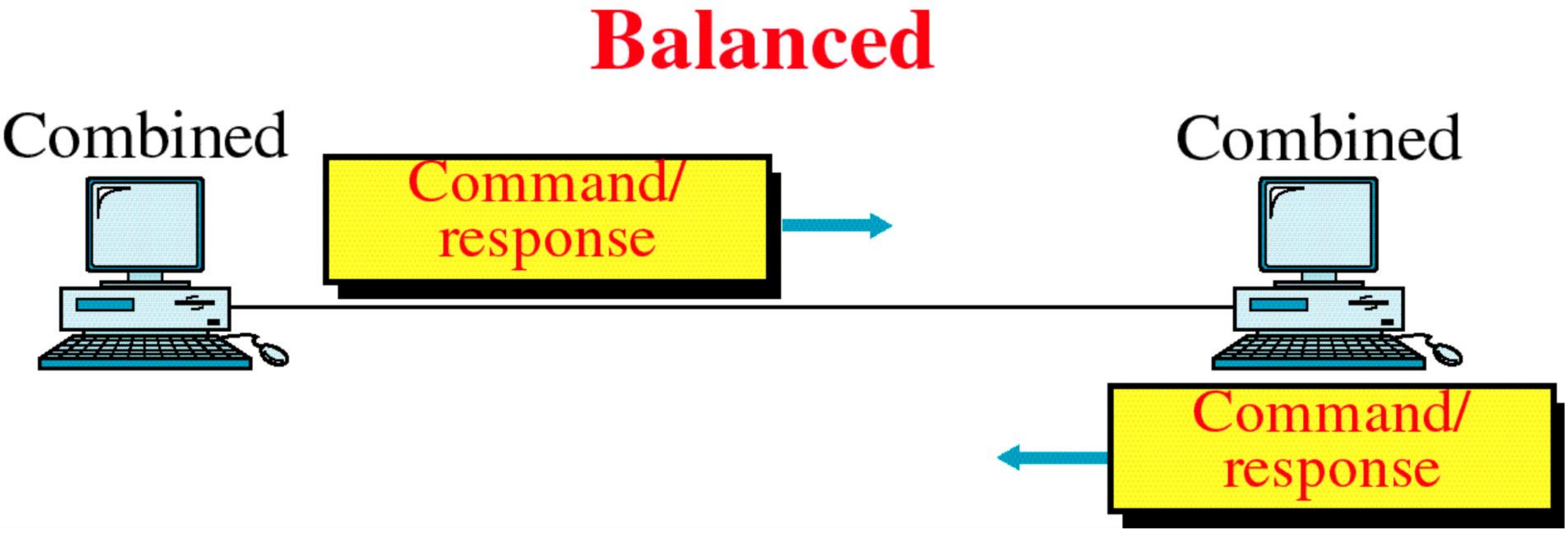


HDLC Configuration



Data Link Layer Protocols

HDLC Configuration

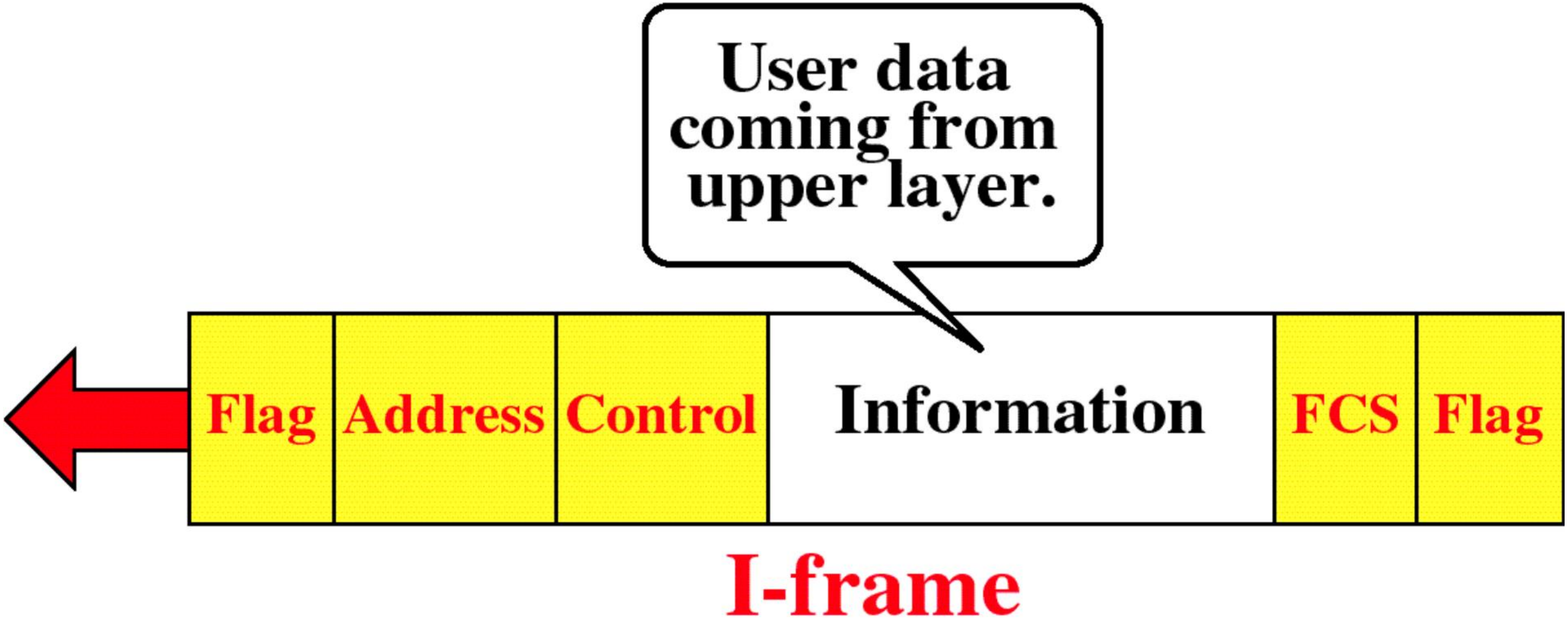


Data Link Layer Protocols

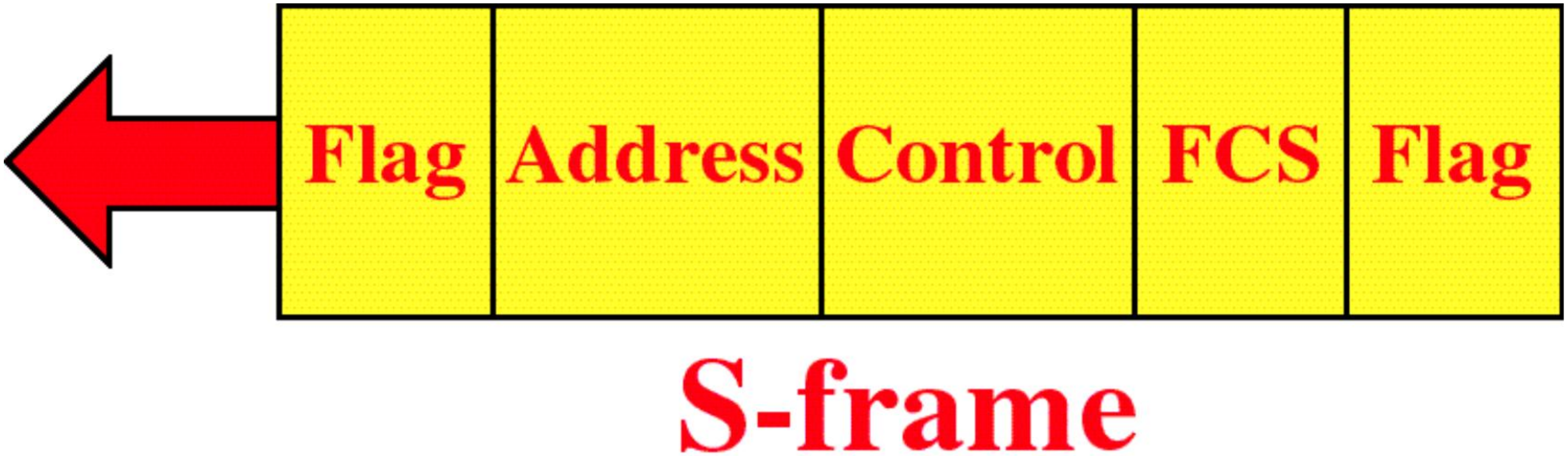
HDLC Modes

	NRM	ARM	ABM
Station type	Primary & secondary	Primary & secondary	Combined
Initiator	Primary	Either	Any

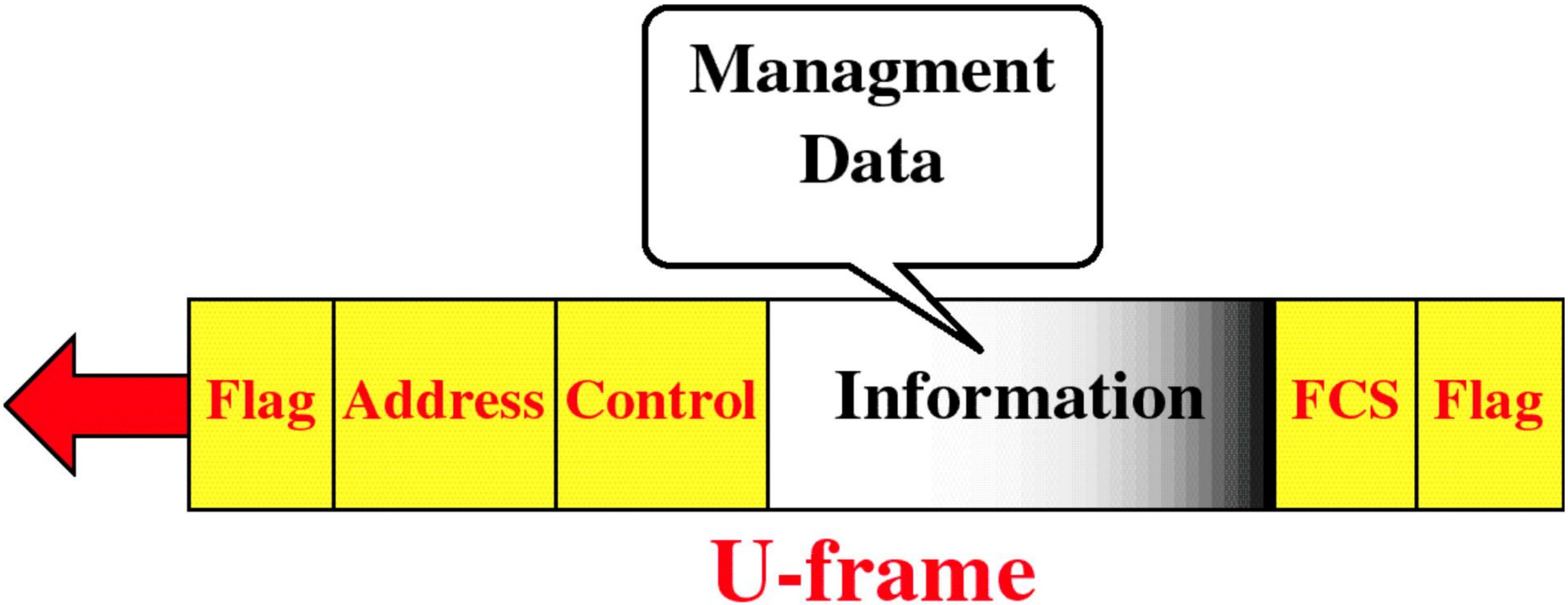
HDLC Frame Types



HDLC Frame Types

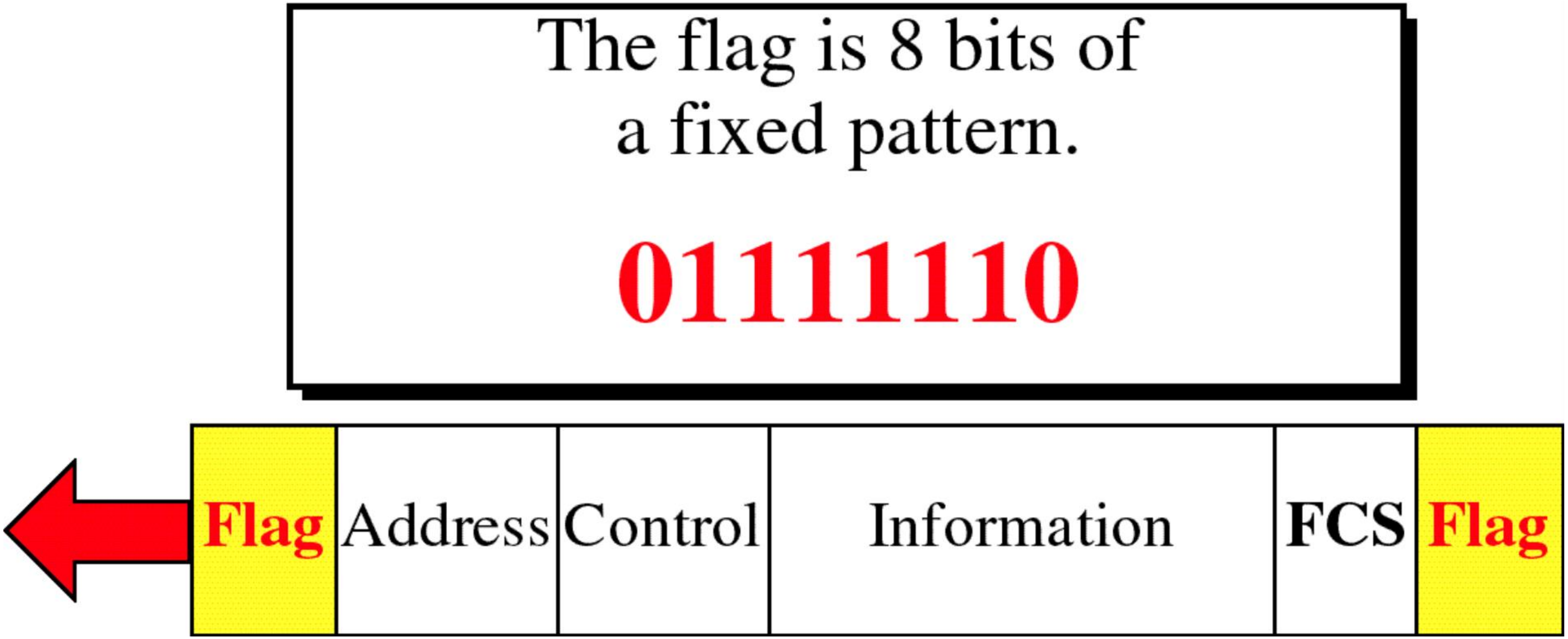


HDLC Frame Types



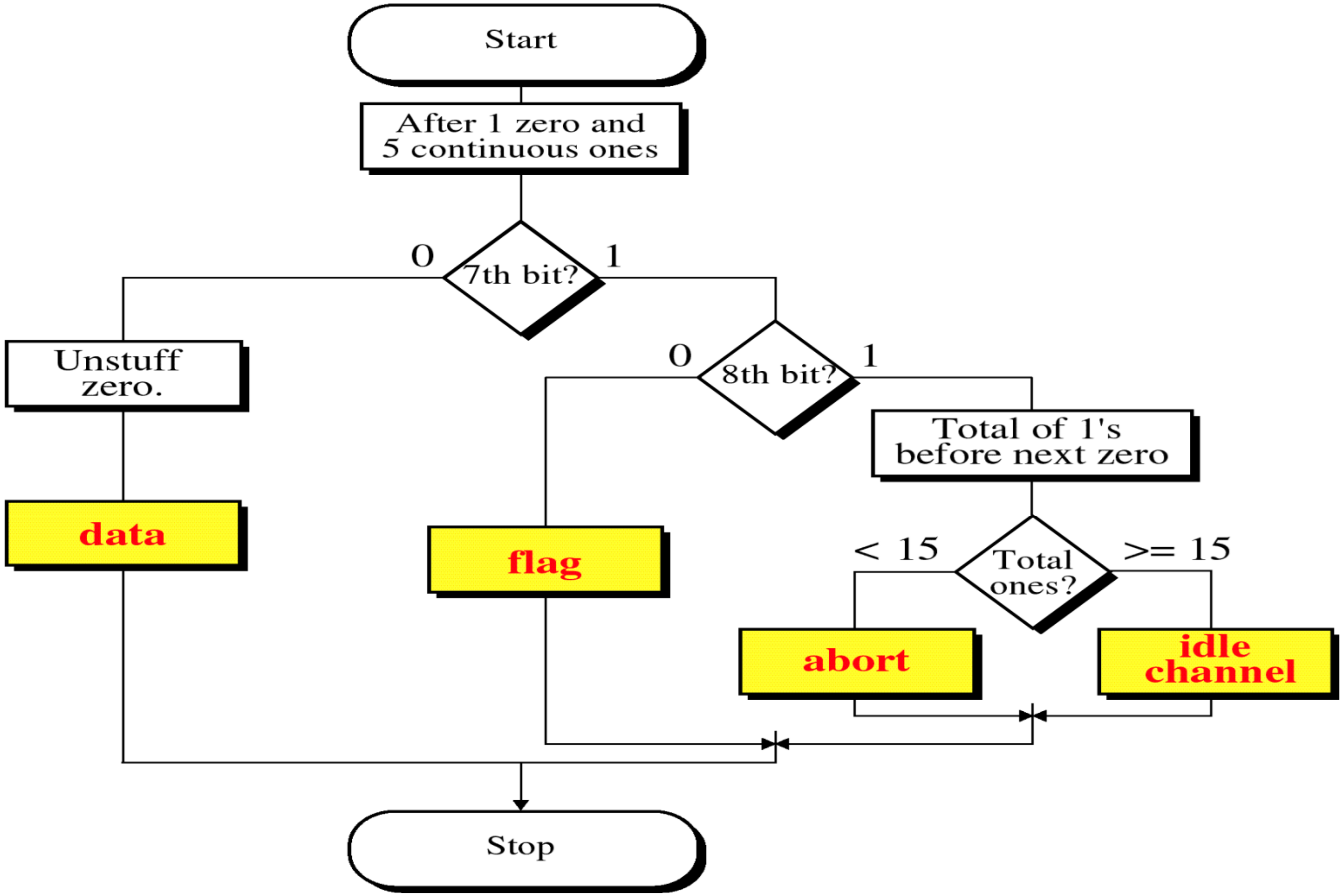
Data Link Layer Protocols

HDLC Flag Field



Data Link Layer Protocols

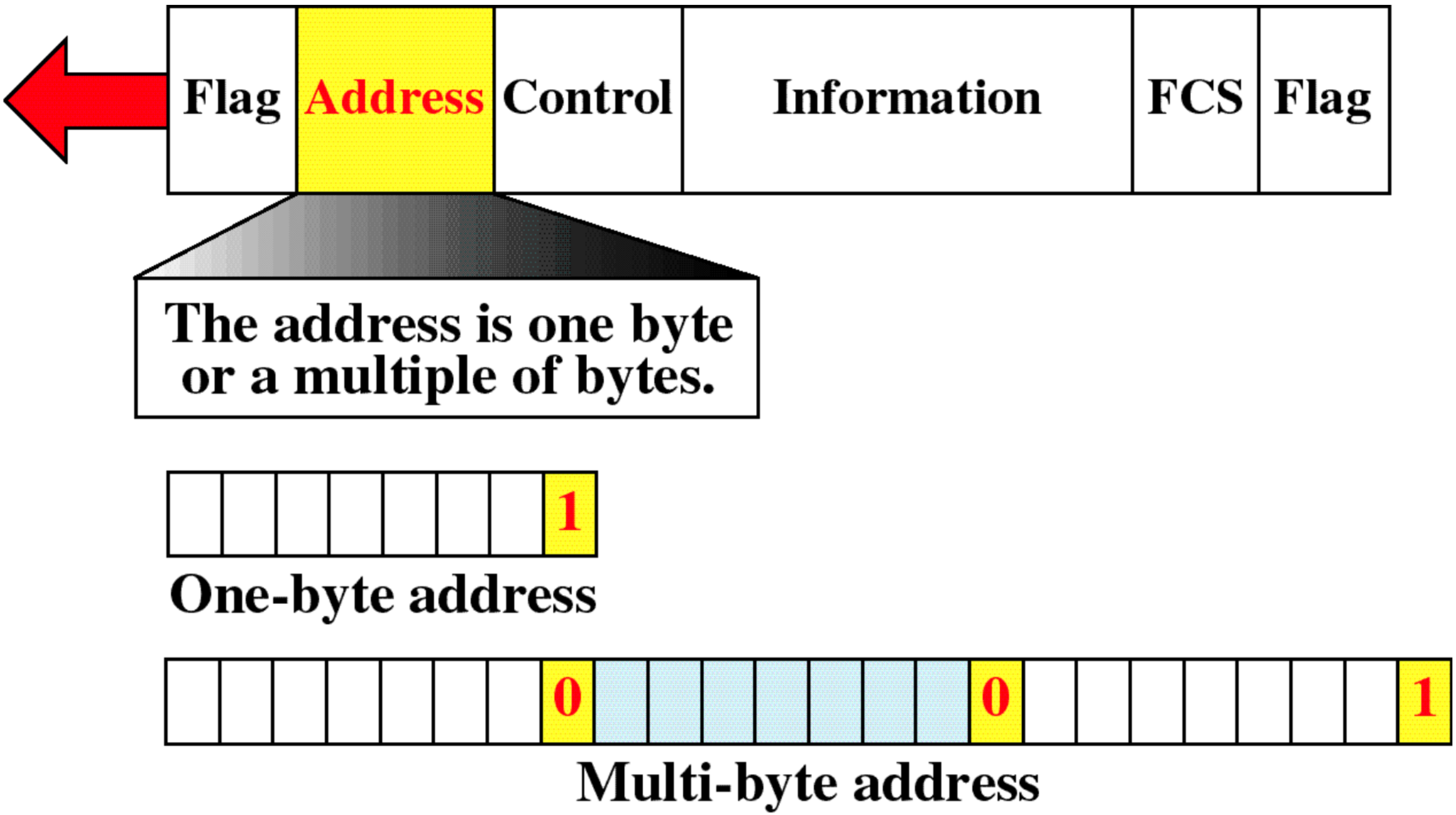
Bit de-stuffing



Data Link Layer Protocols

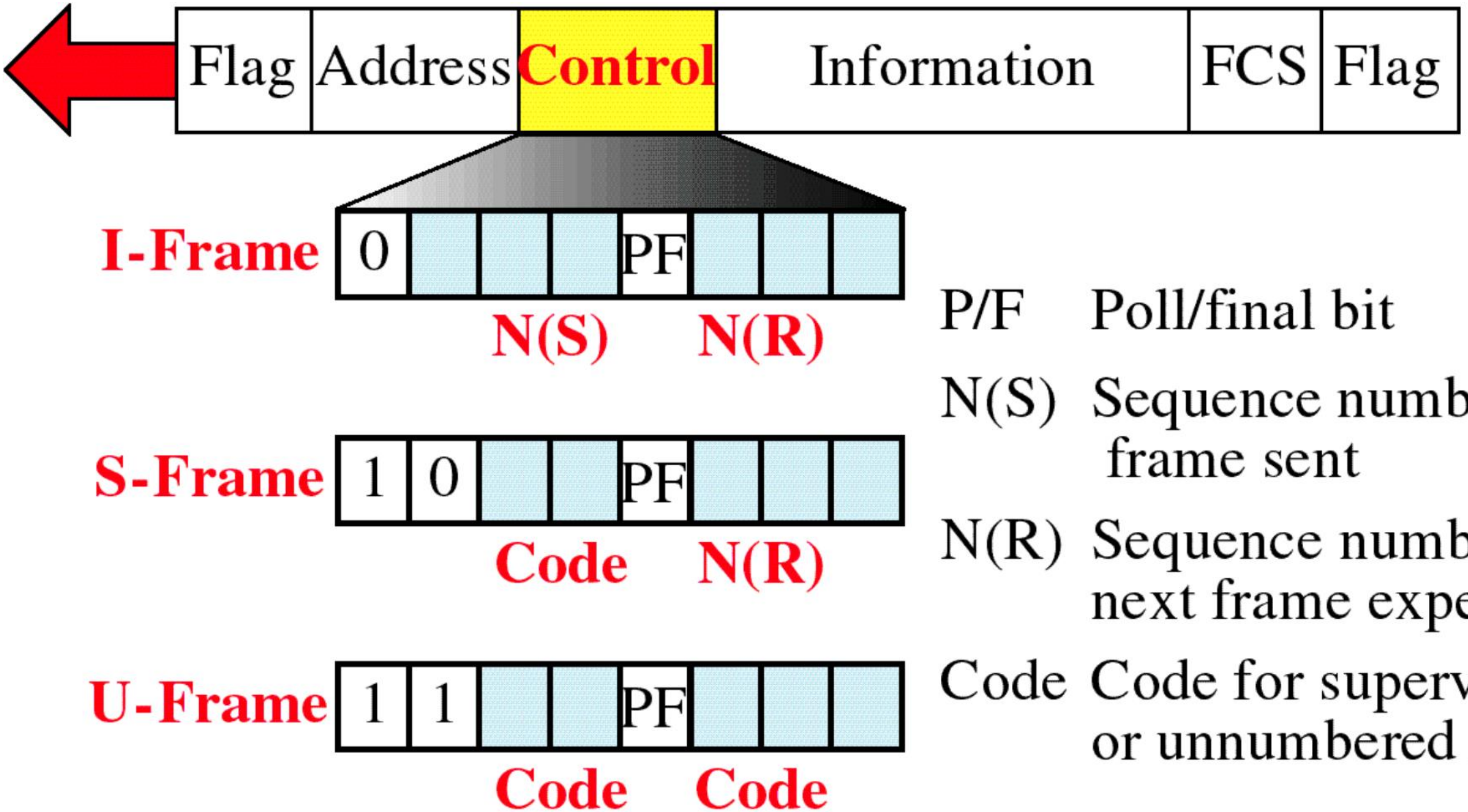
Data Link Layer Protocols

HDLC Address Field



Data Link Layer Protocols

HDLC Control Field



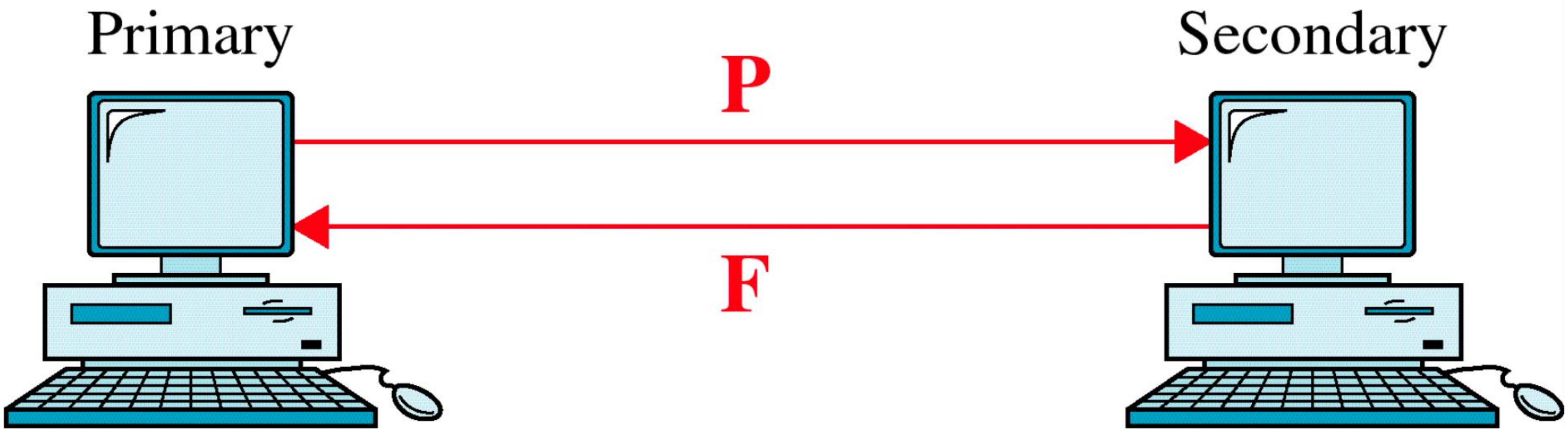
P/F Poll/final bit

N(S) Sequence number of frame sent

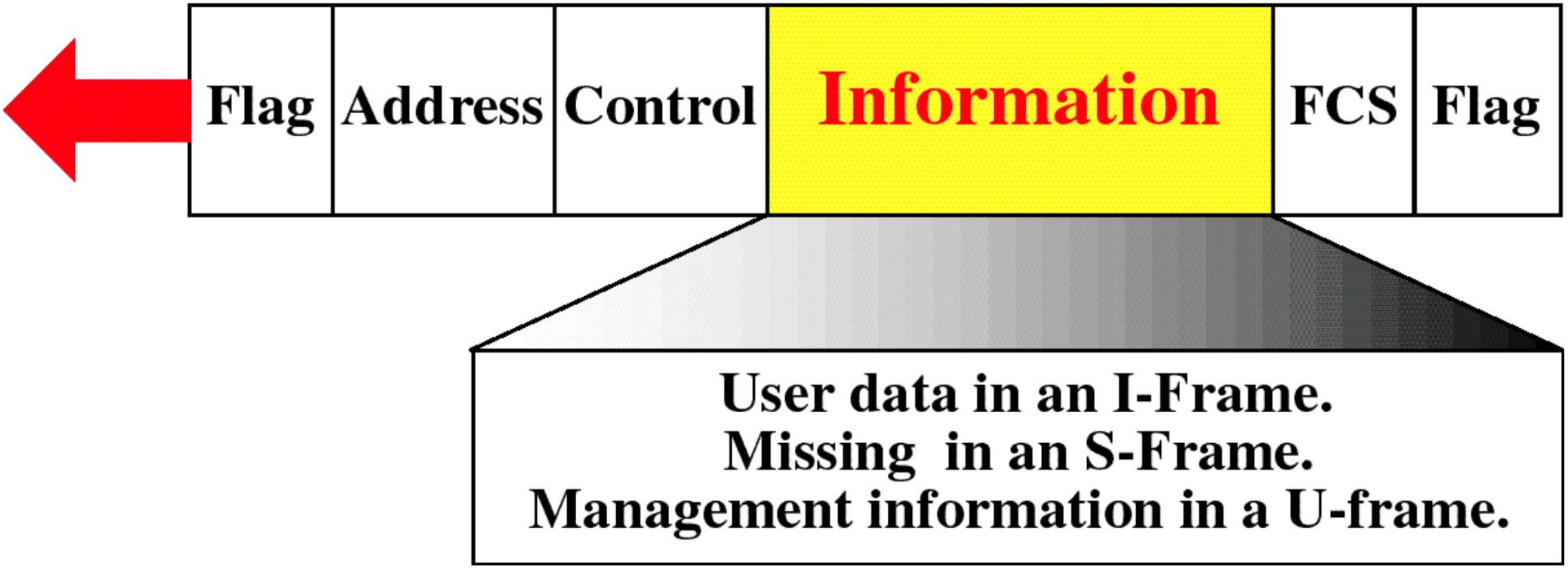
N(R) Sequence number of next frame expected

Code Code for supervisory or unnumbered frame

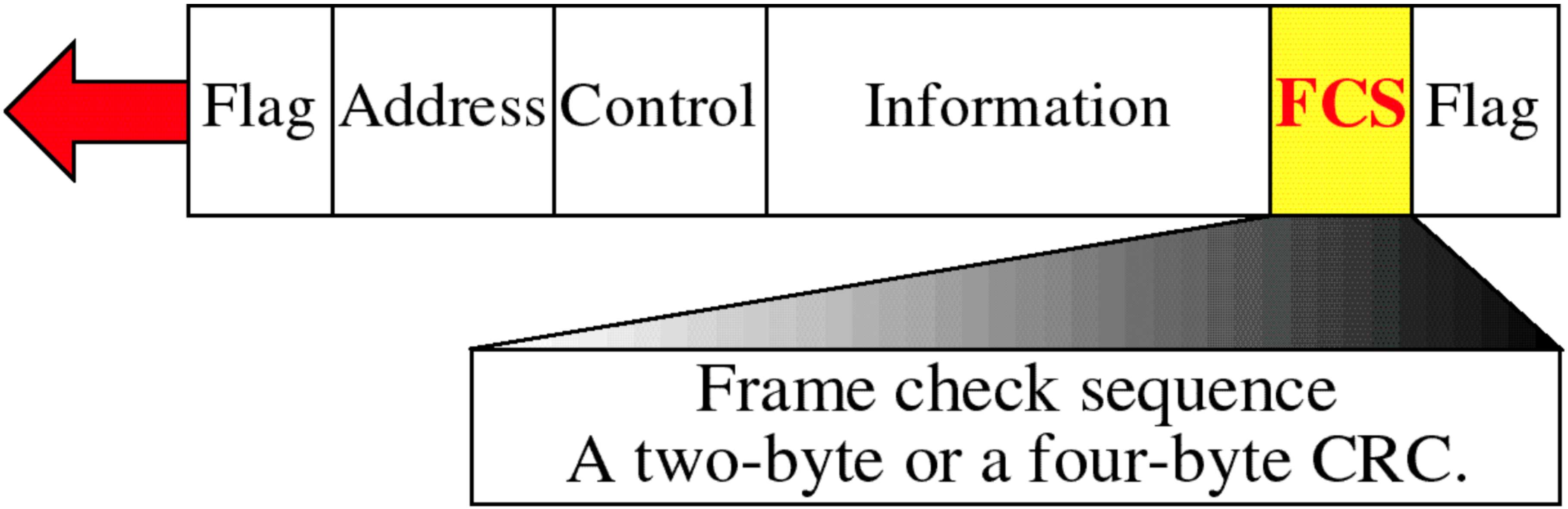
Poll/Final



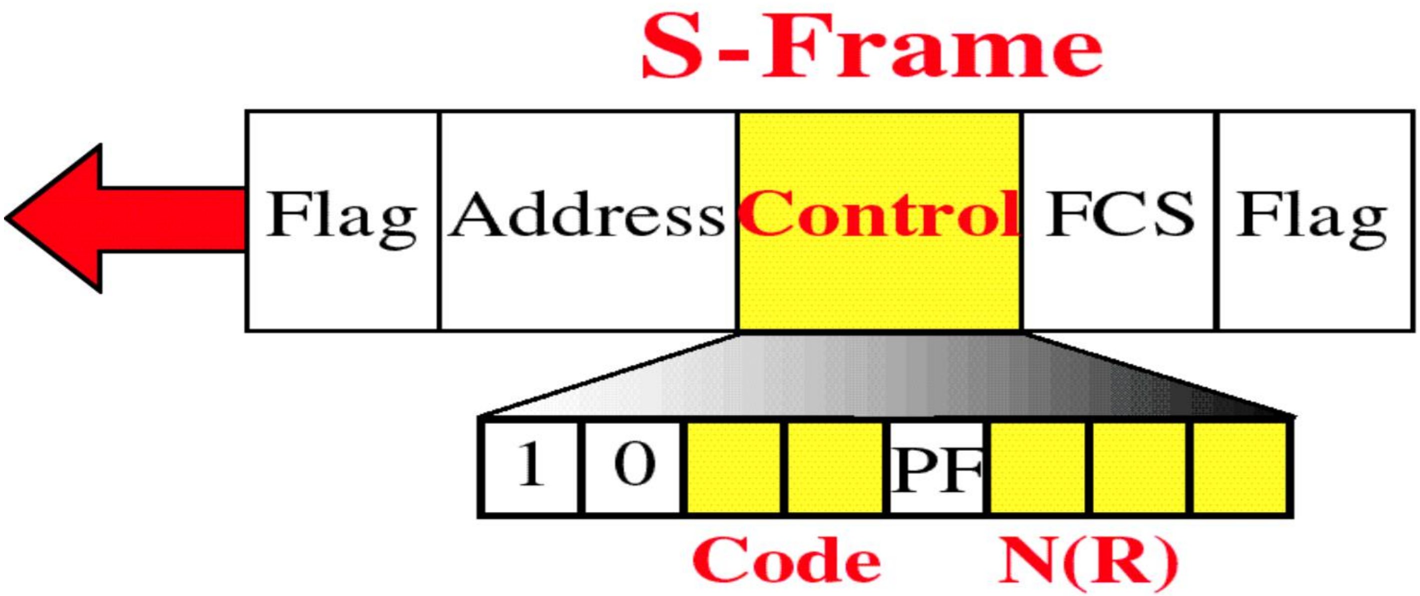
HDLC Information Field



HDLC FCS Field

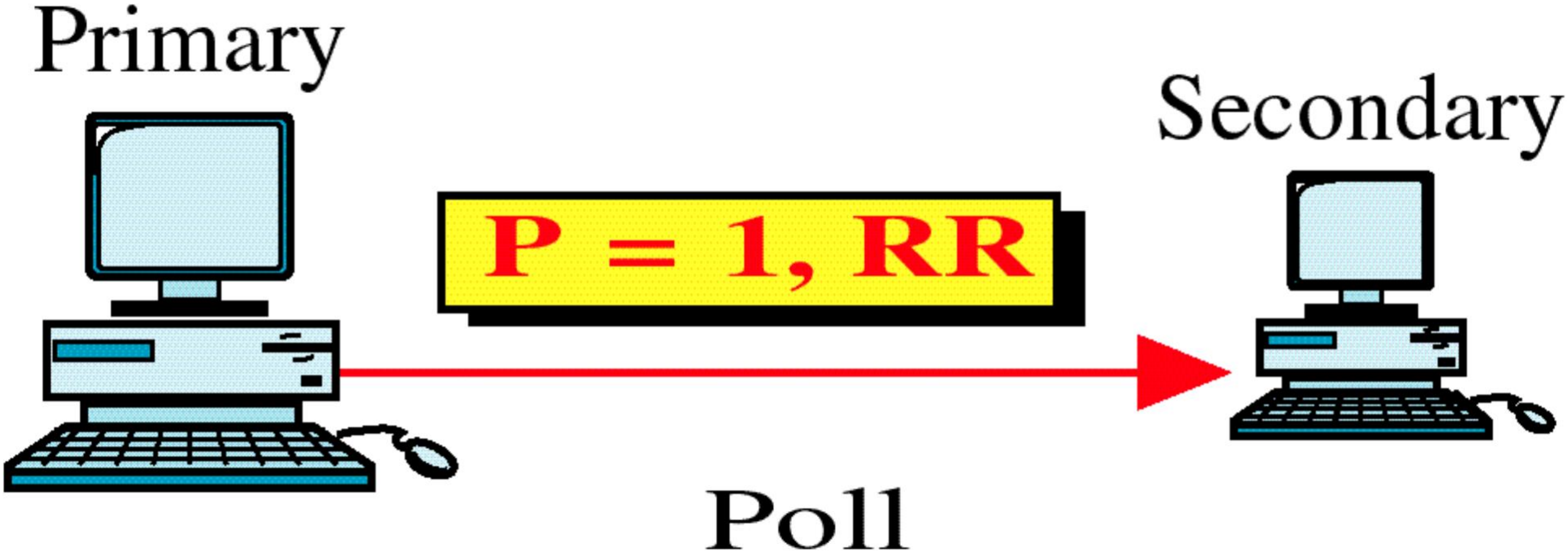


Data Link Layer Protocols



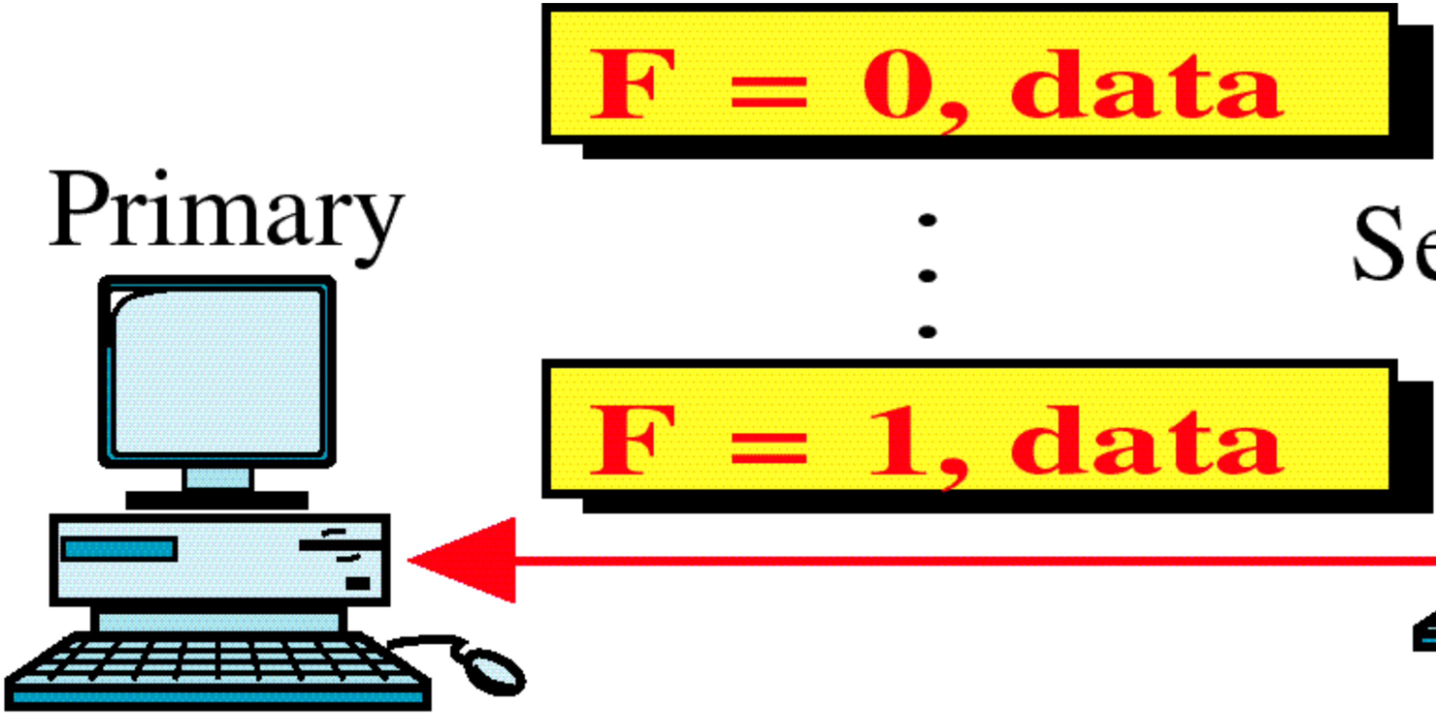
Code	Command	
00	RR	Receive ready
01	REJ	Reject
10	RNR	Receive not ready
11	SREJ	Selective-reject

Use of P/F Field



Data Link Layer Protocols

Use of P/F Field



Positive response to poll

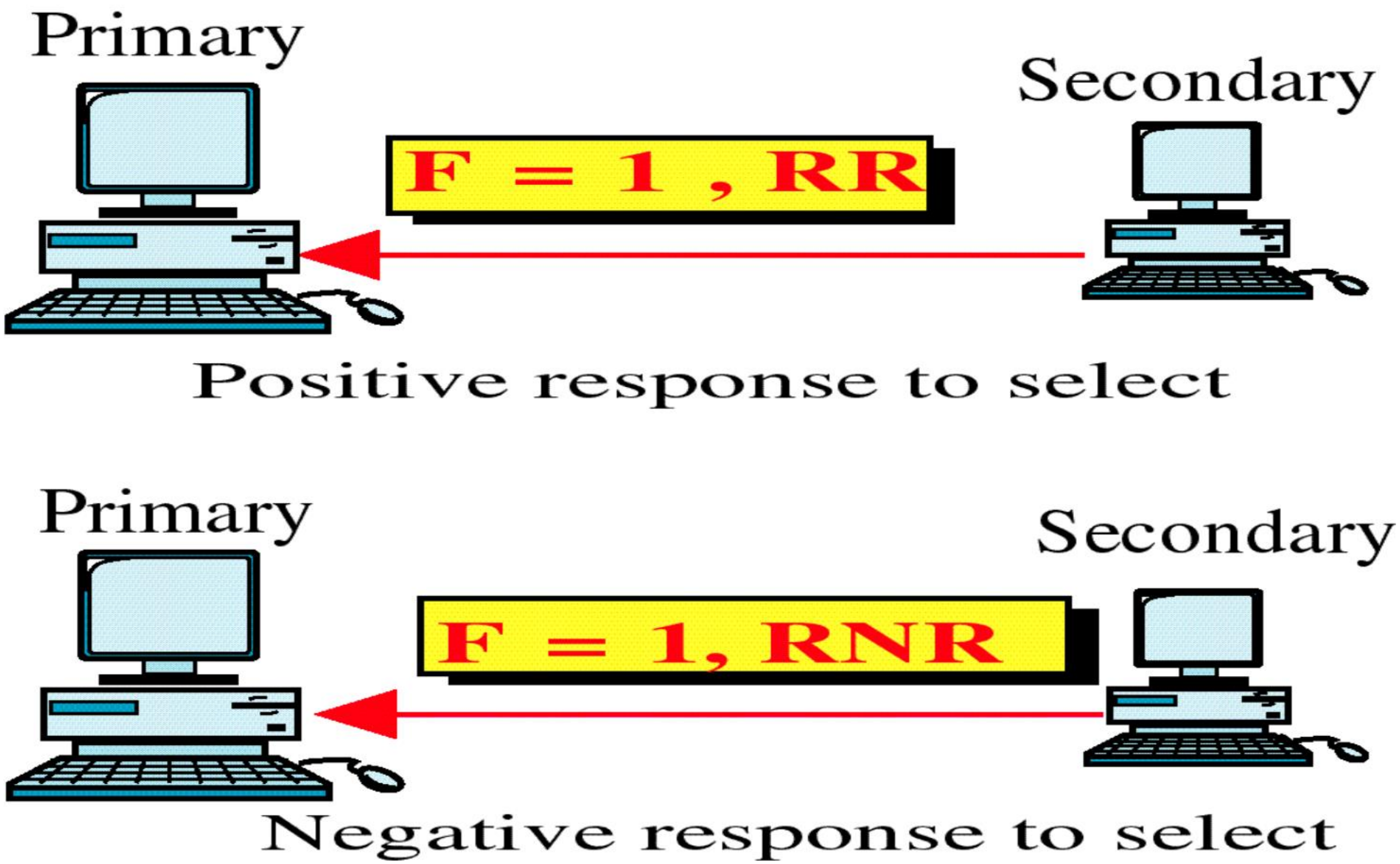
Use of P/F Field

Data Link Layer Protocols

Use of P/F Field

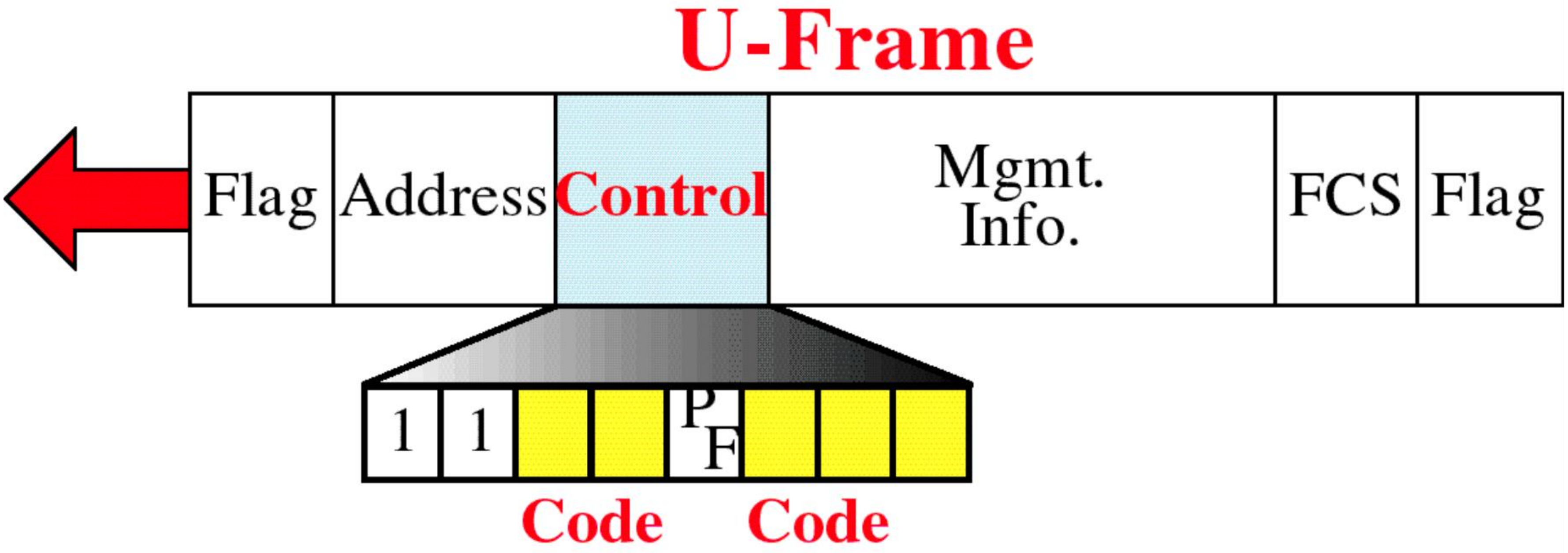
Data Link Layer Protocols

Use of P/F Field



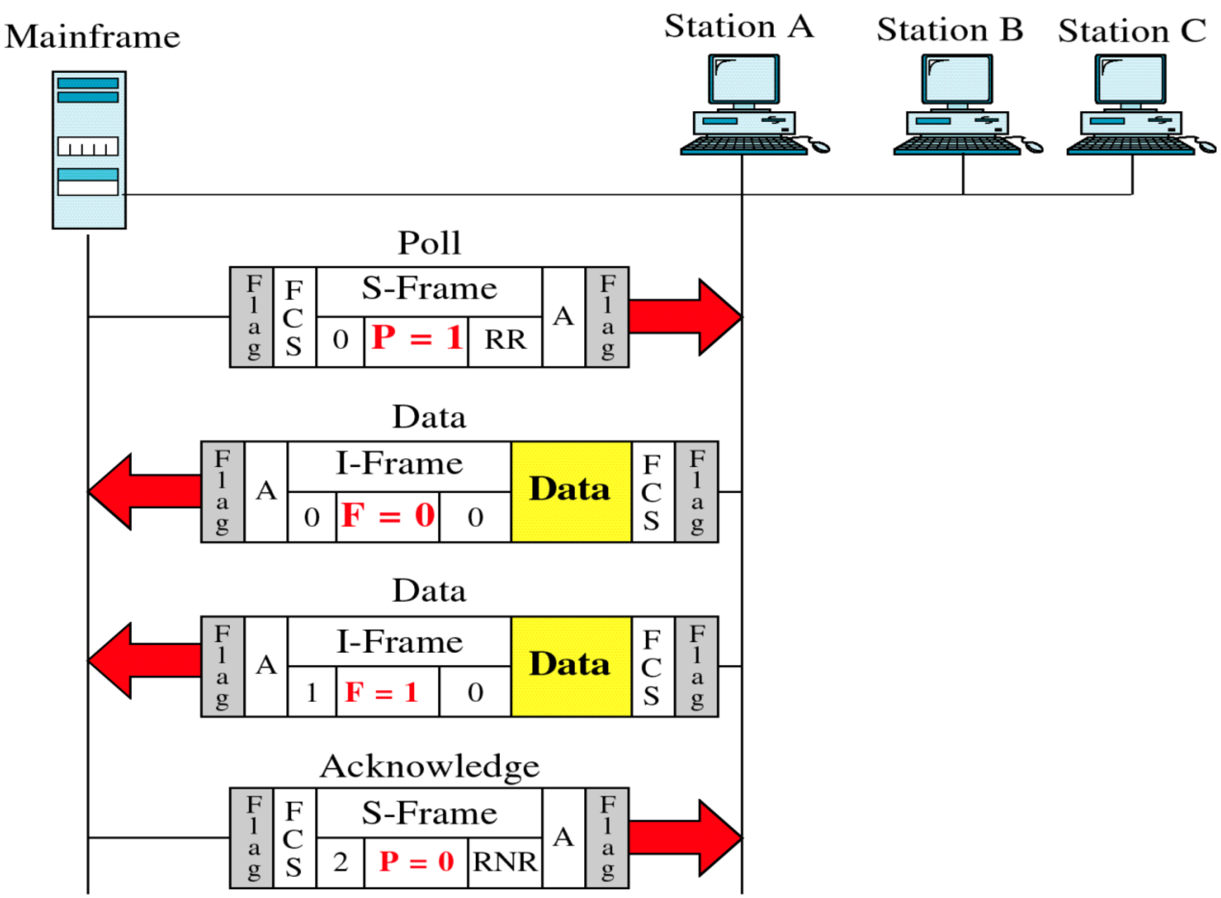
Data Link Layer Protocols

U-Frame Control Field

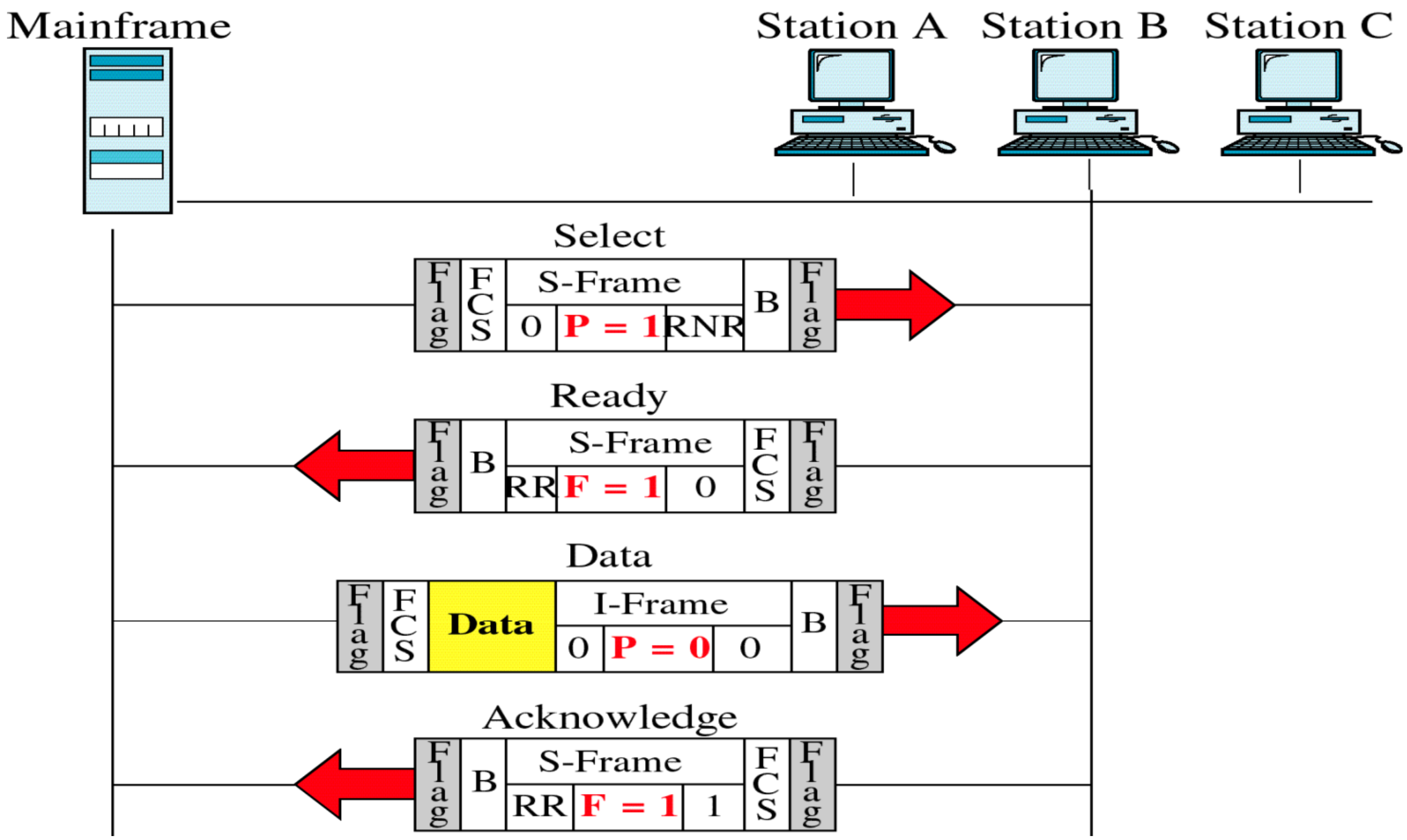


Data Link Layer Protocols

Polling Example

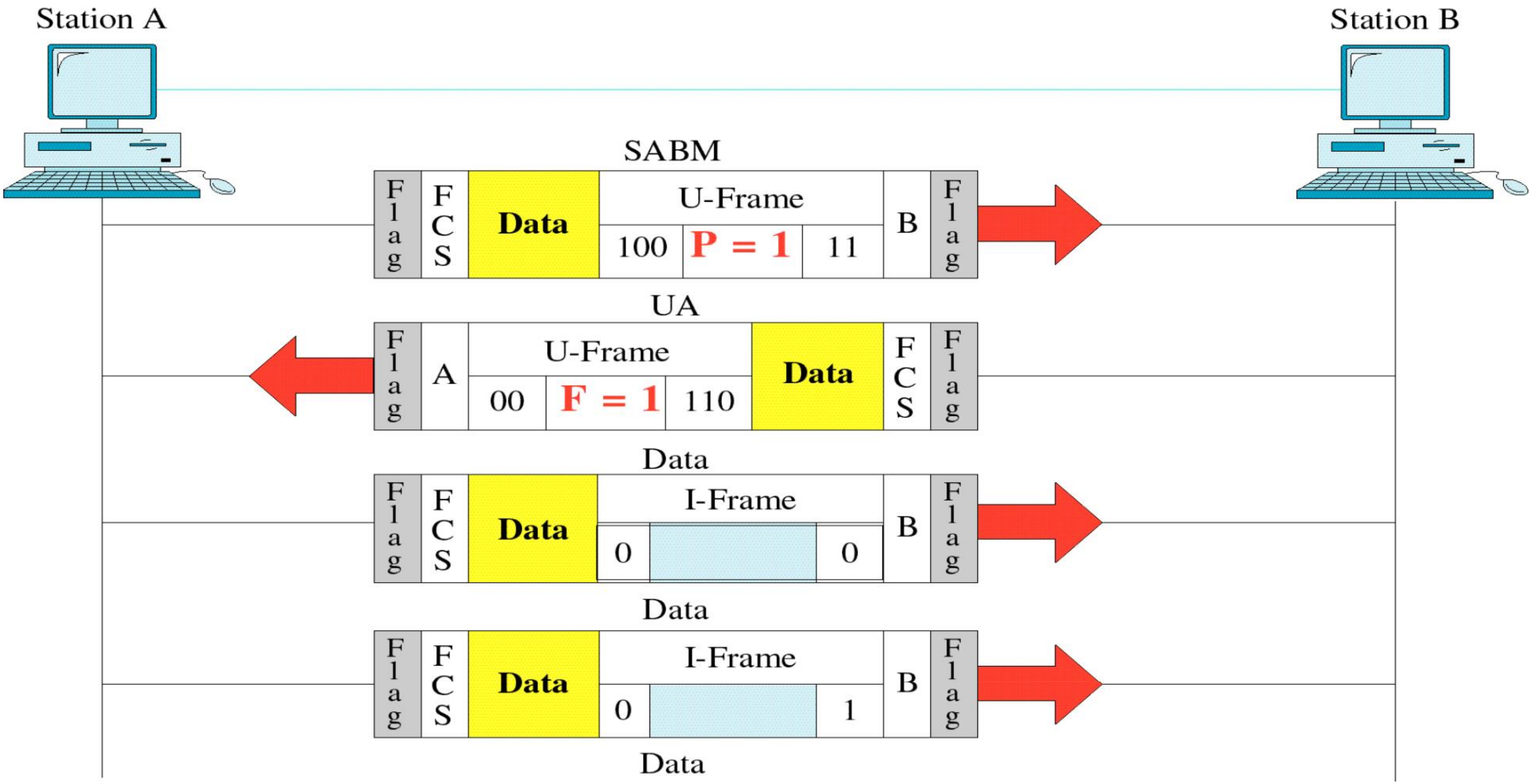


Selecting Example



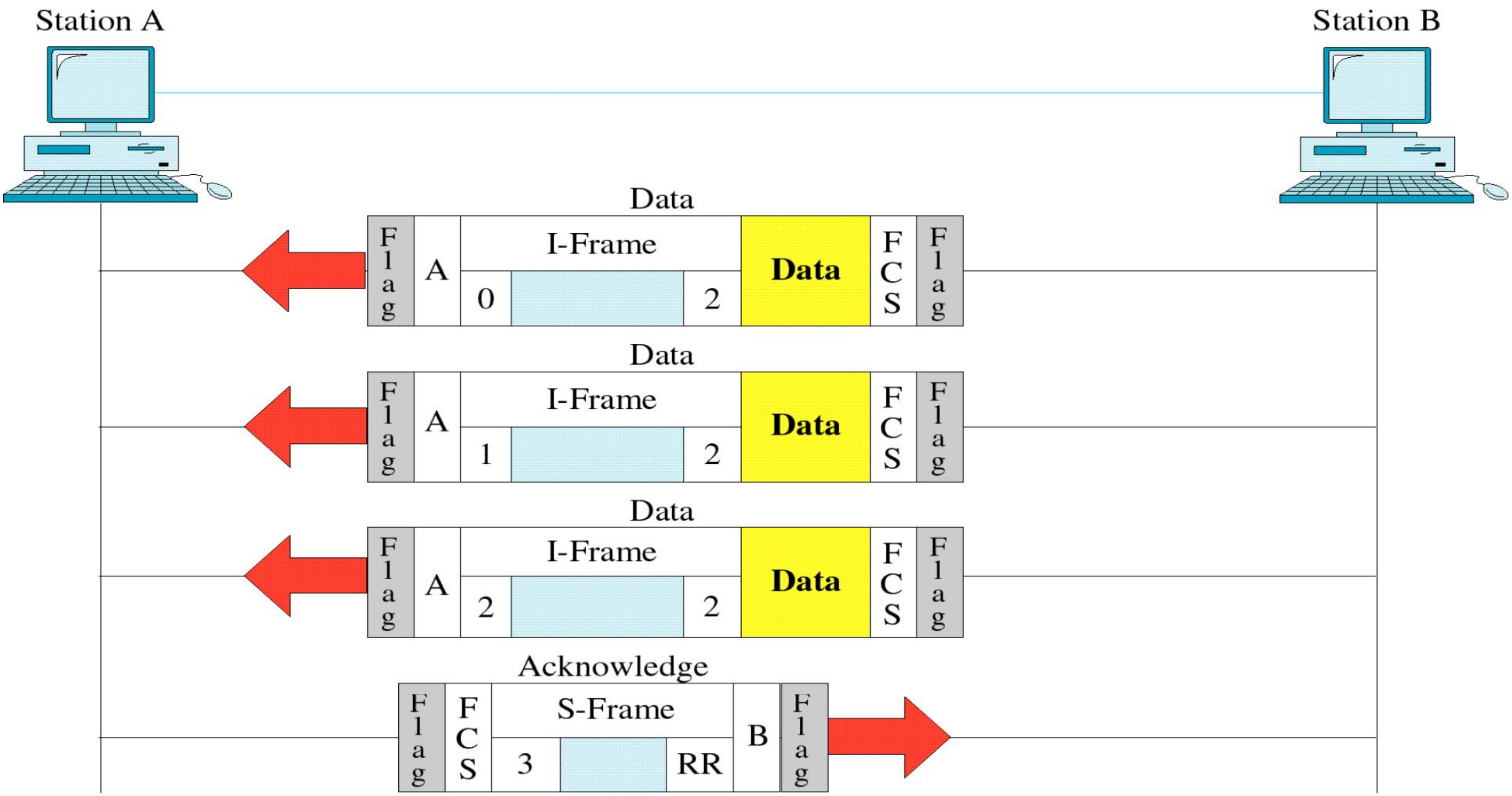
Data Link Layer Protocols

Peer-to-Peer Example



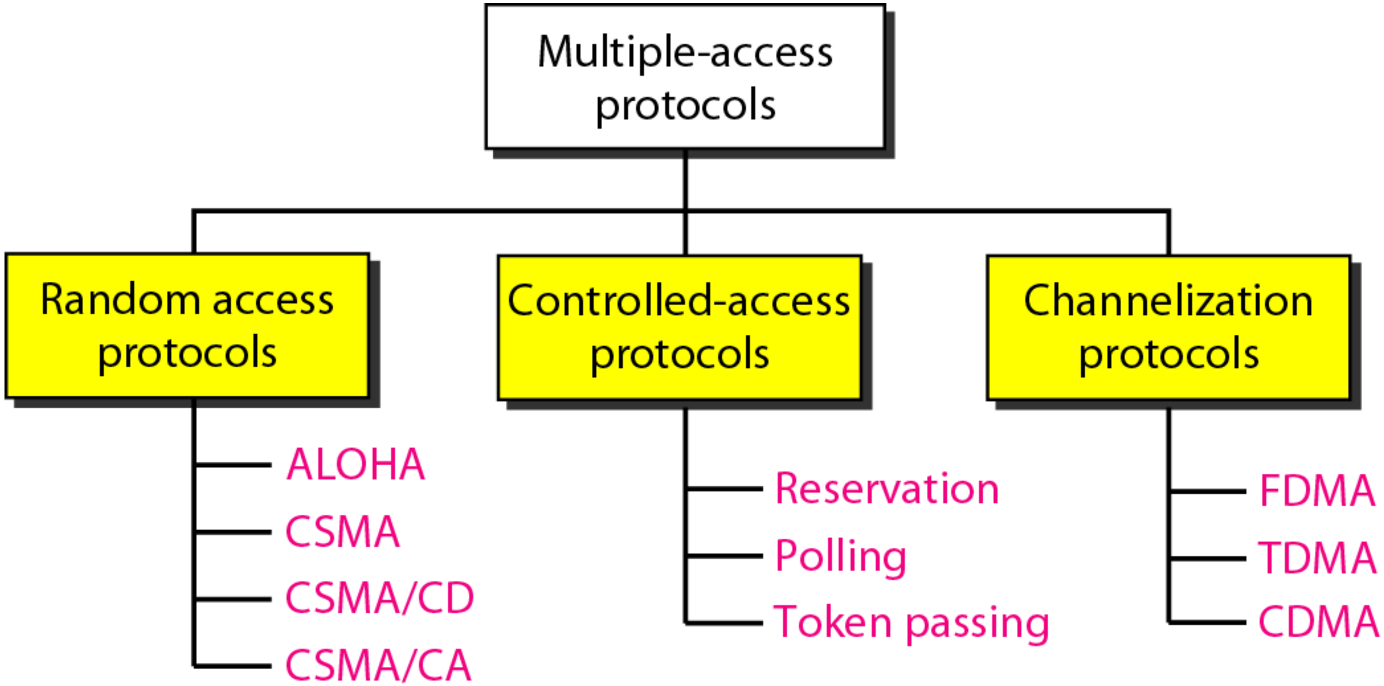
Data Link Layer Protocols

Peer-to-Peer Example



Multiple Access Protocols

Objective: Study about basic concept of Multiple Access Protocols



Multiple Access Protocols

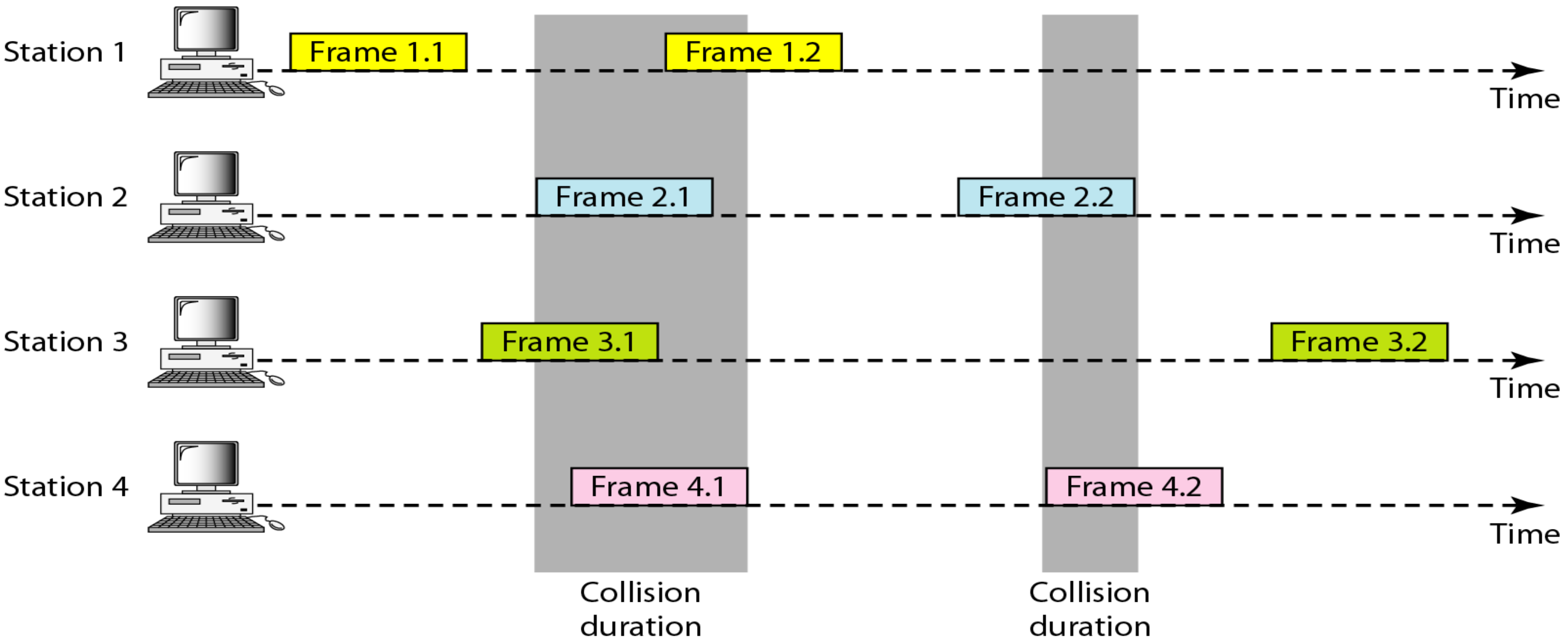
RANDOM ACCESS Protocols

In random access or contention methods, no station is superior to another station and none is assigned the control over another. No station permits, or does not permit, another station to send. At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send.

- ALOHA
- Carrier Sense Multiple Access
- Carrier Sense Multiple Access with Collision Detection
- Carrier Sense Multiple Access with Collision Avoidance

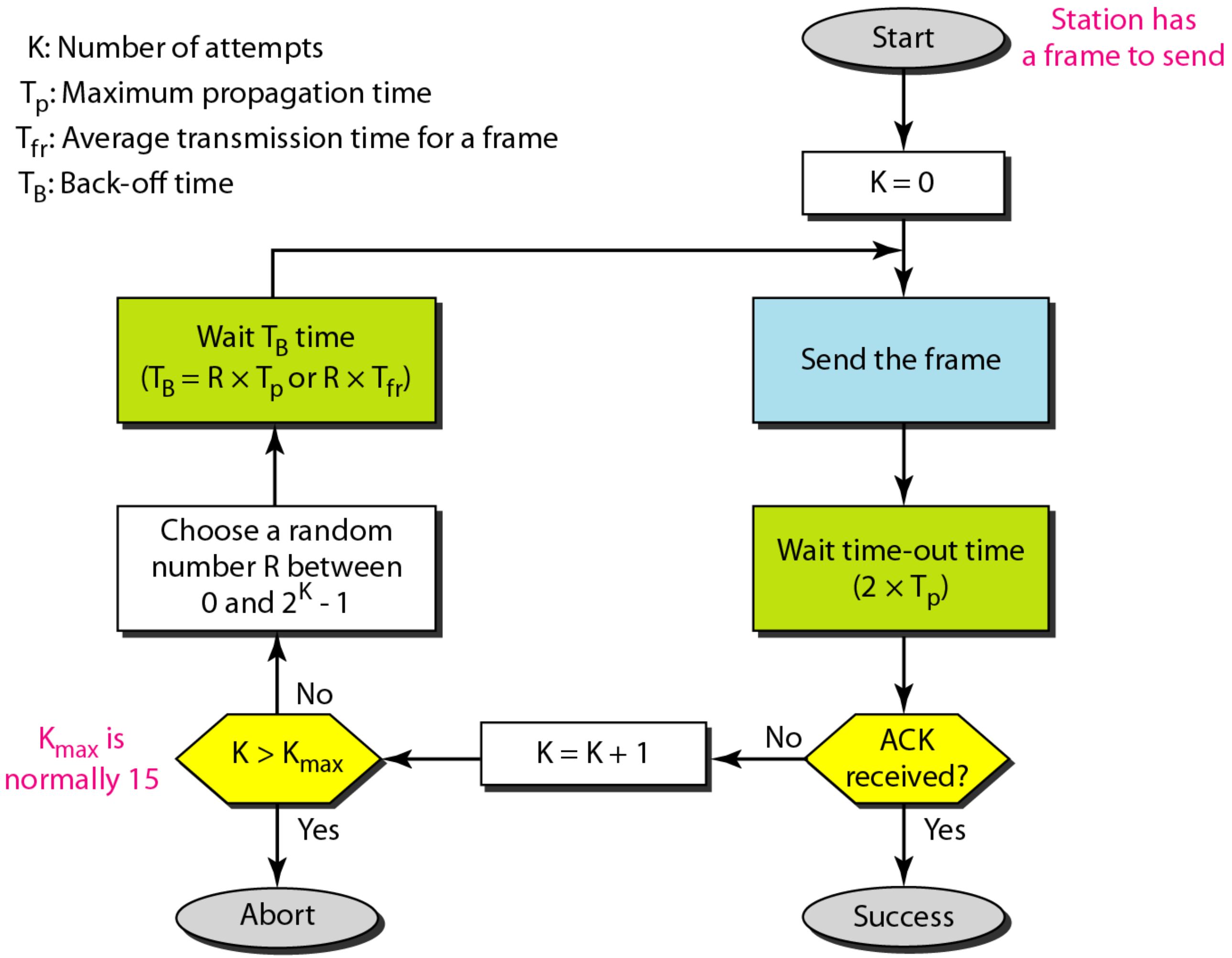
Multiple Access Protocols

Frames in a pure ALOHA network



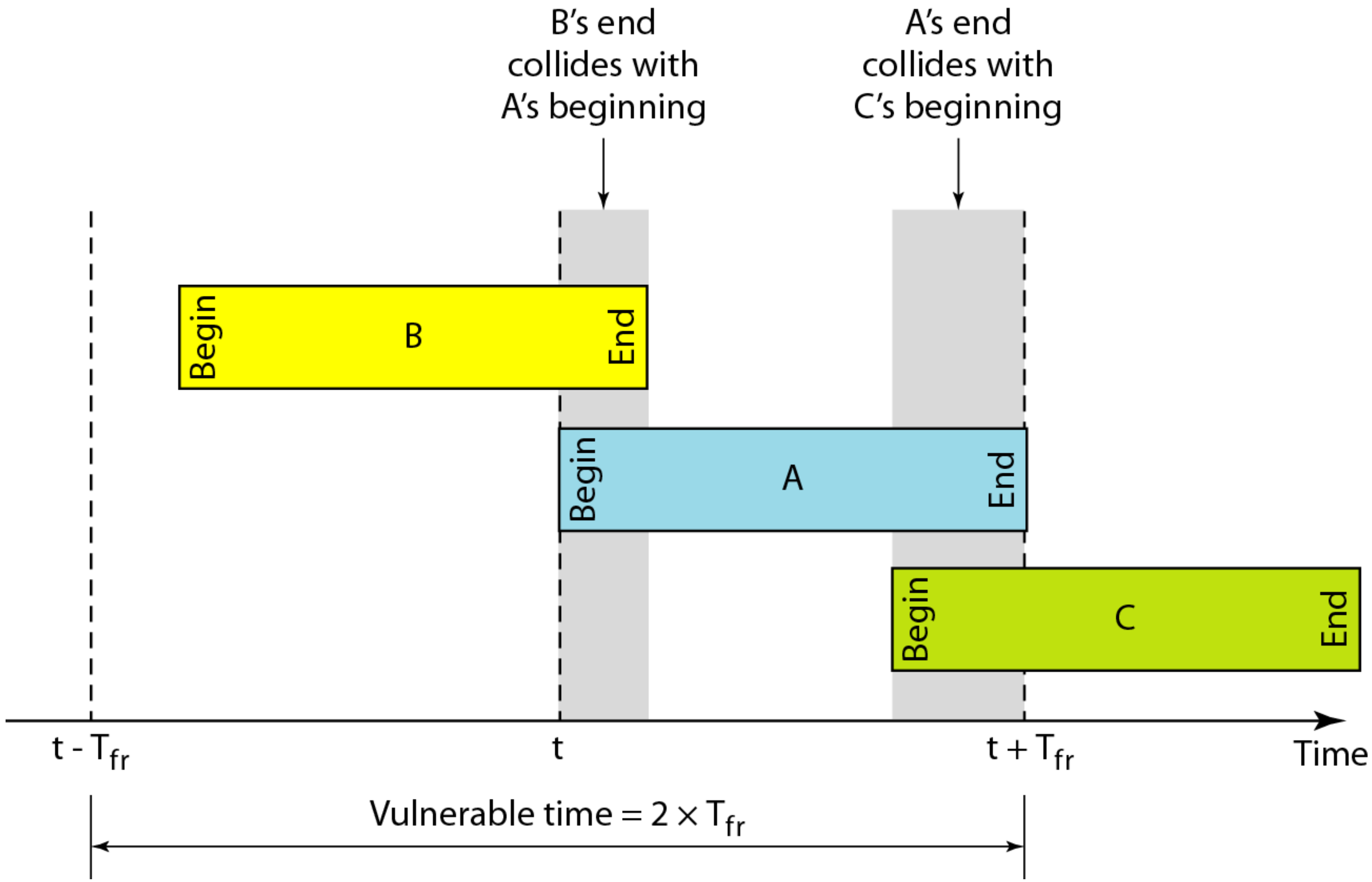
Multiple Access Protocols

Procedure for pure ALOHA protocol



Multiple Access Protocols

Vulnerable time for pure ALOHA protocol



Multiple Access Protocols

The throughput for pure ALOHA is

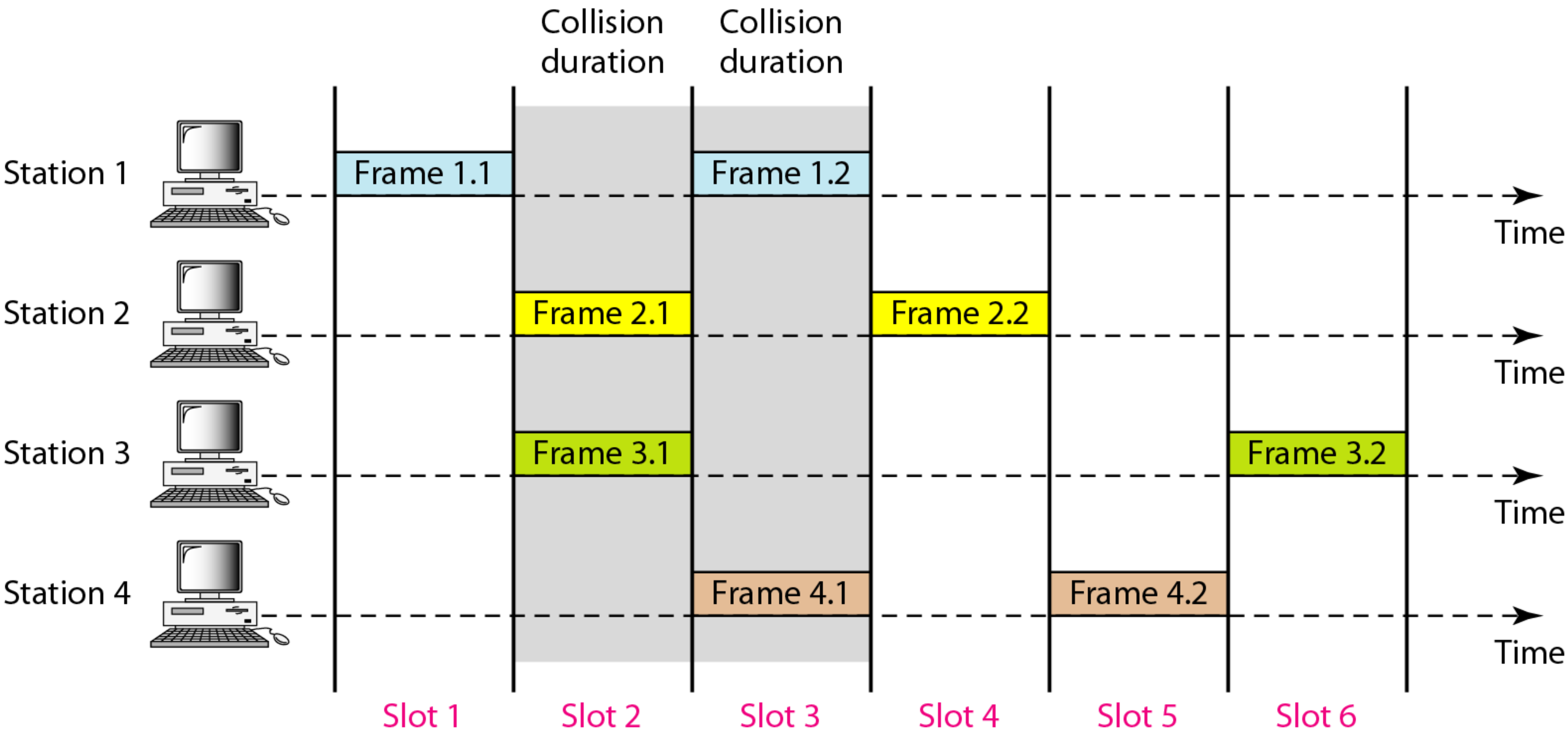
$S = G \times e^{-2G}$.

The maximum throughput

$S_{max} = 0.184$ when G= (1/2).

Multiple Access Protocols

Frames in a slotted ALOHA network



Multiple Access Protocols

The throughput for slotted ALOHA is

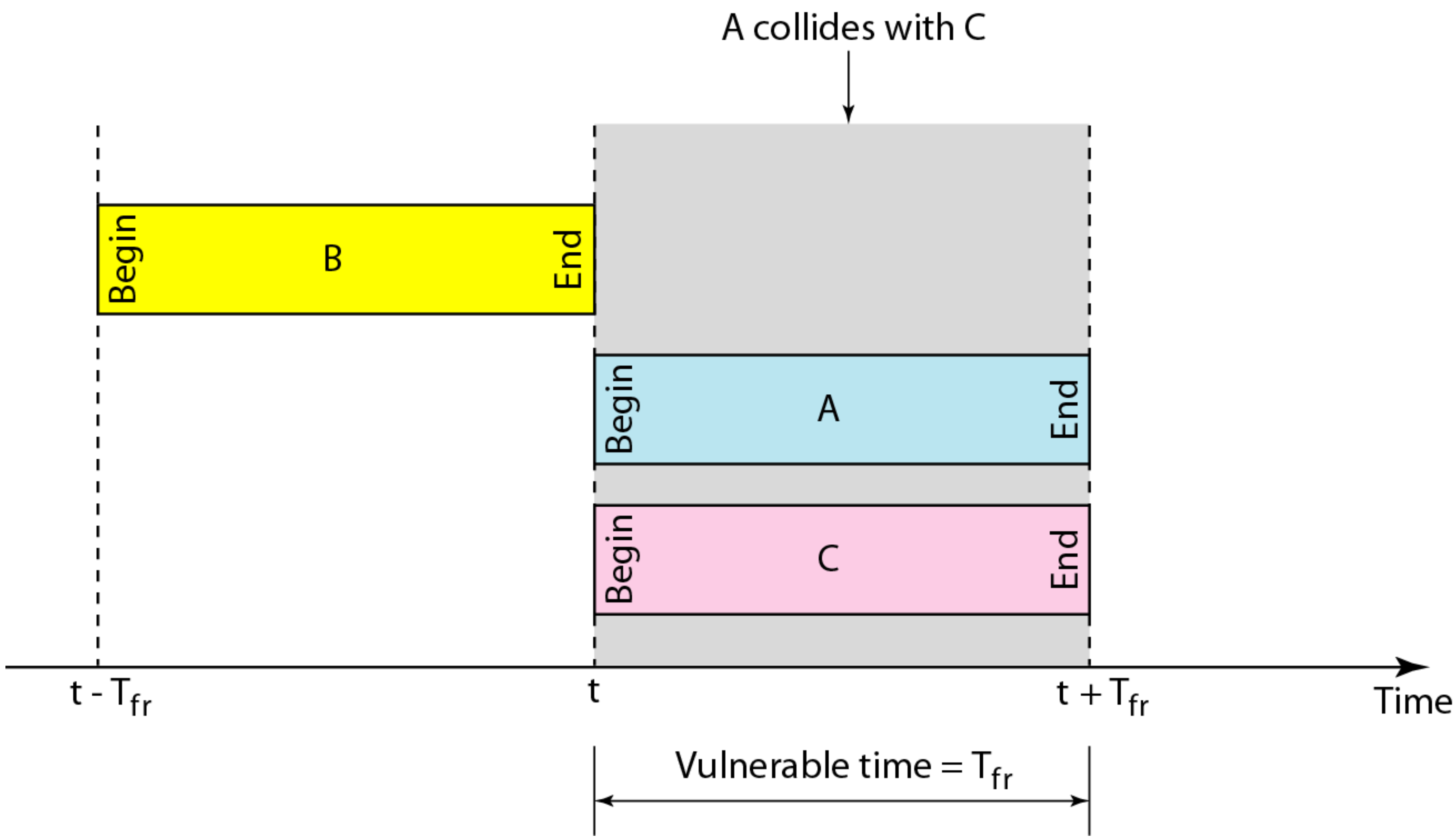
$S = G \times e^{-G}$.

The maximum throughput

$S_{max} = 0.368$ when $G = 1$.

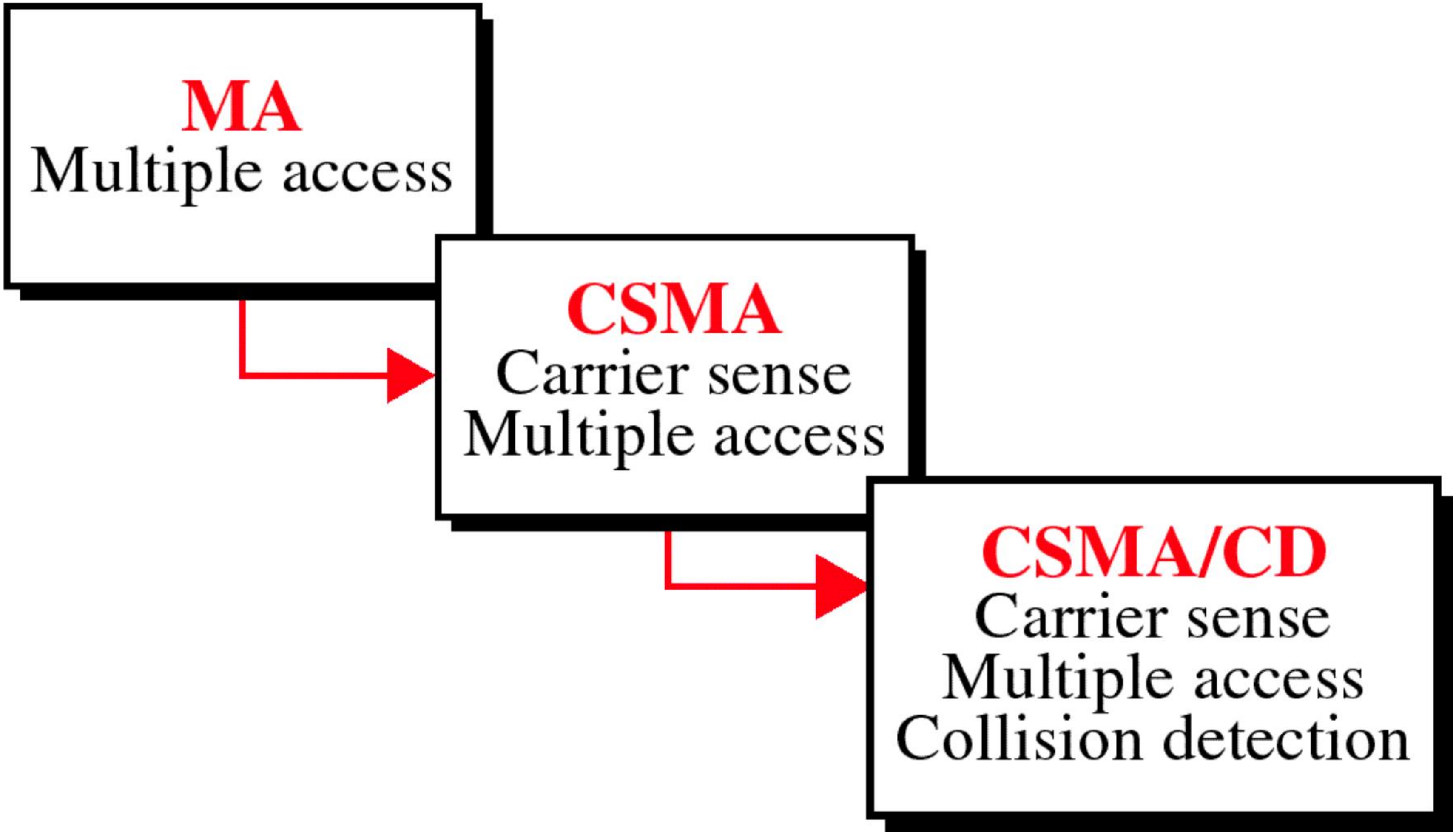
Multiple Access Protocols

Vulnerable time for slotted ALOHA protocol



Multiple Access Protocols

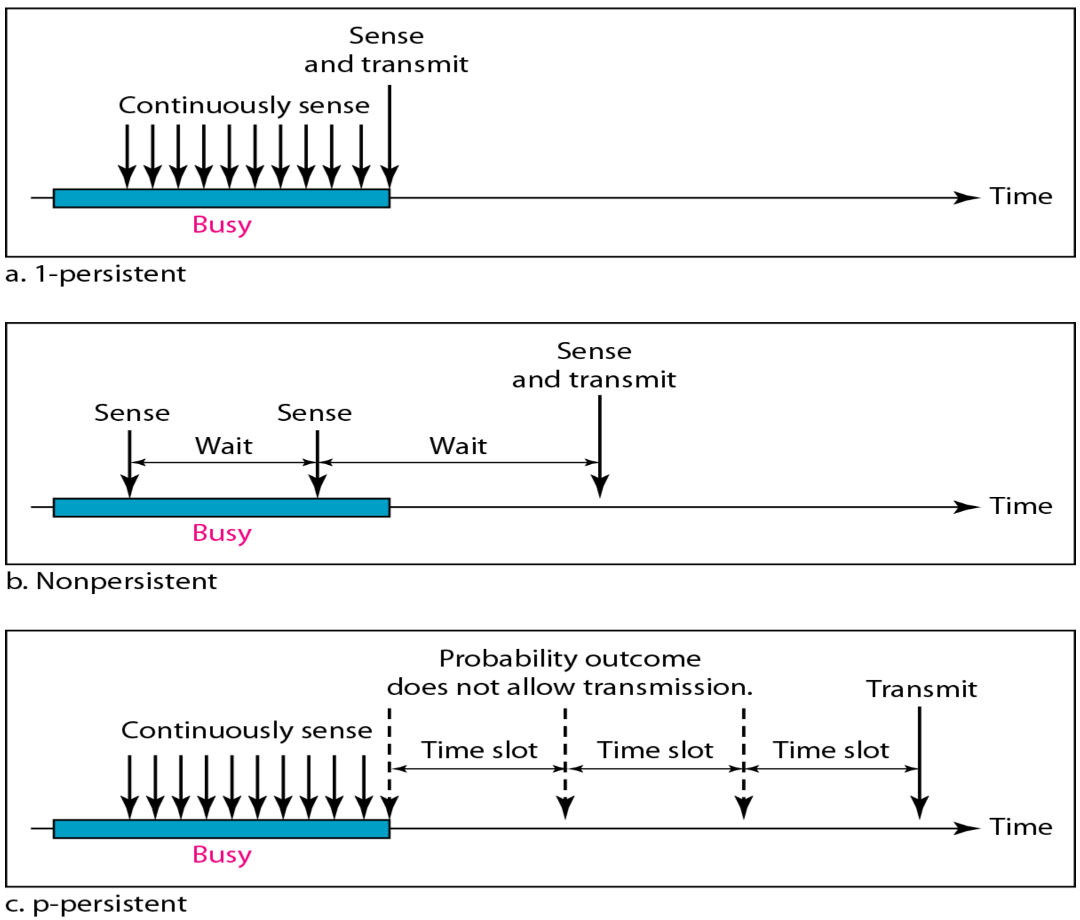
Random access protocol: Evolution of CSMA/CD



Multiple Access Protocols

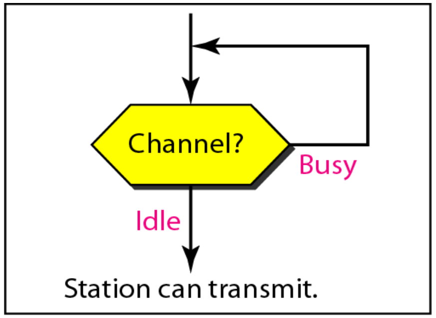
Random access protocol: CSMA

Behavior of CSMA three persistence methods

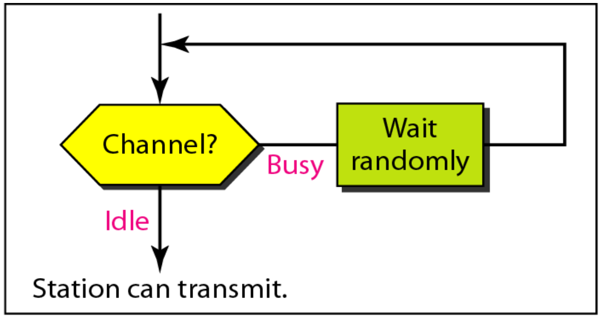


Random access protocol: CSMA

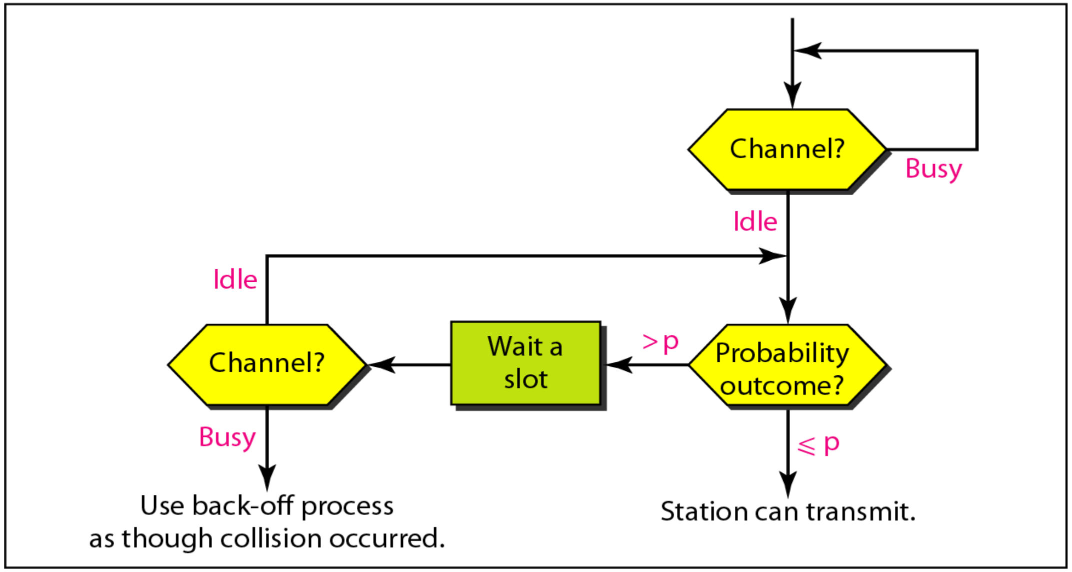
Flow diagram for three persistence methods



a. 1-persistent



b. Nonpersistent



c. p-persistent

Random access protocol: CSMA/CD

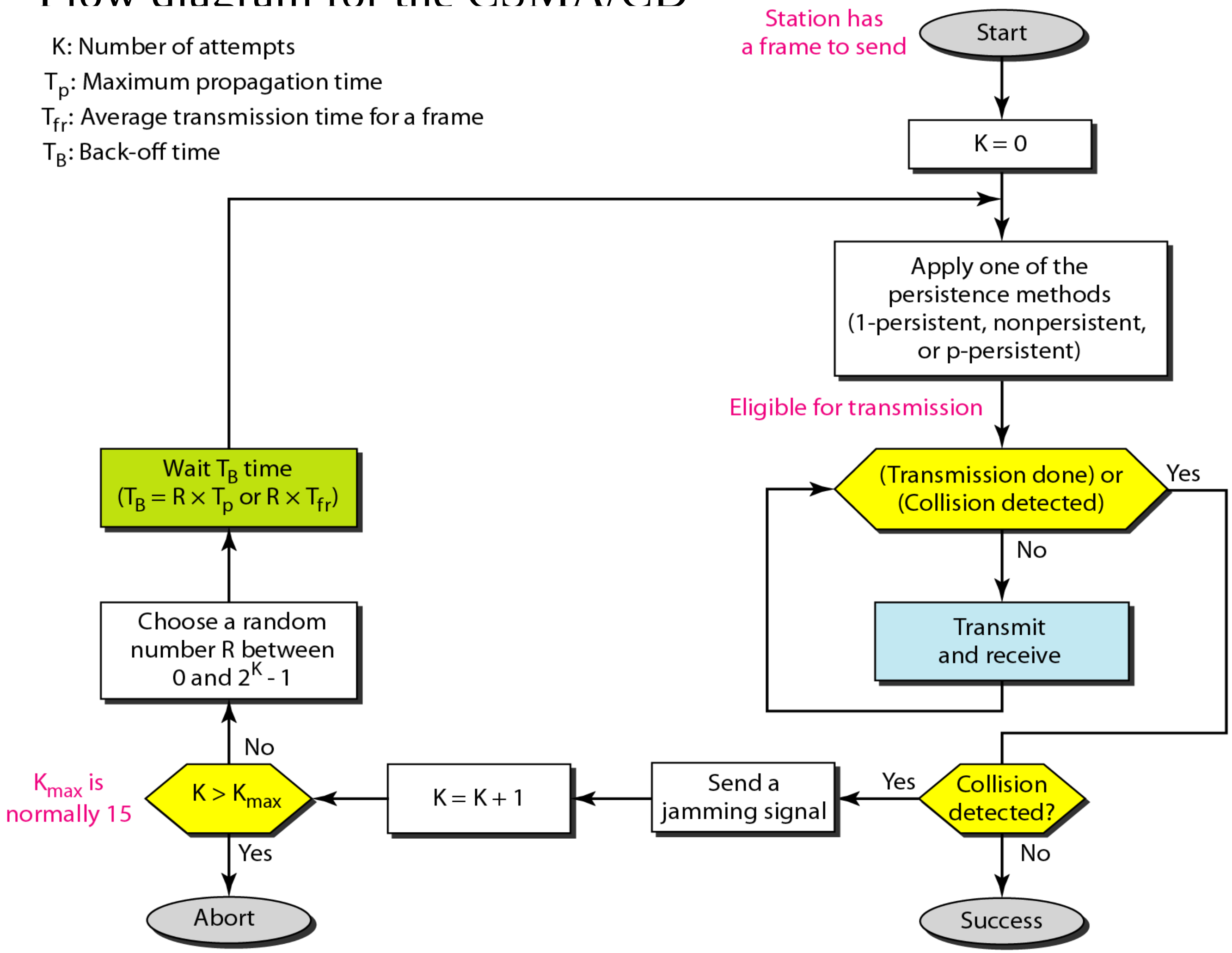
Flow diagram for the CSMA/CD

K: Number of attempts

T_p: Maximum propagation time

T_{fr}: Average transmission time for a frame

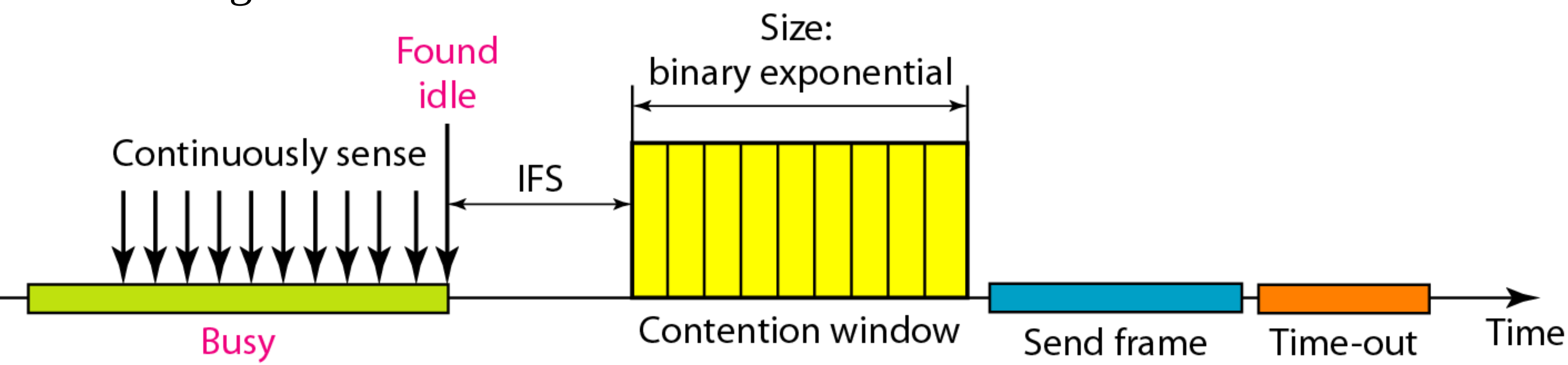
T_B: Back-off time



Multiple Access Protocols

Random access protocol: Evolution of CSMA/CA

Timing in CSMA/CA

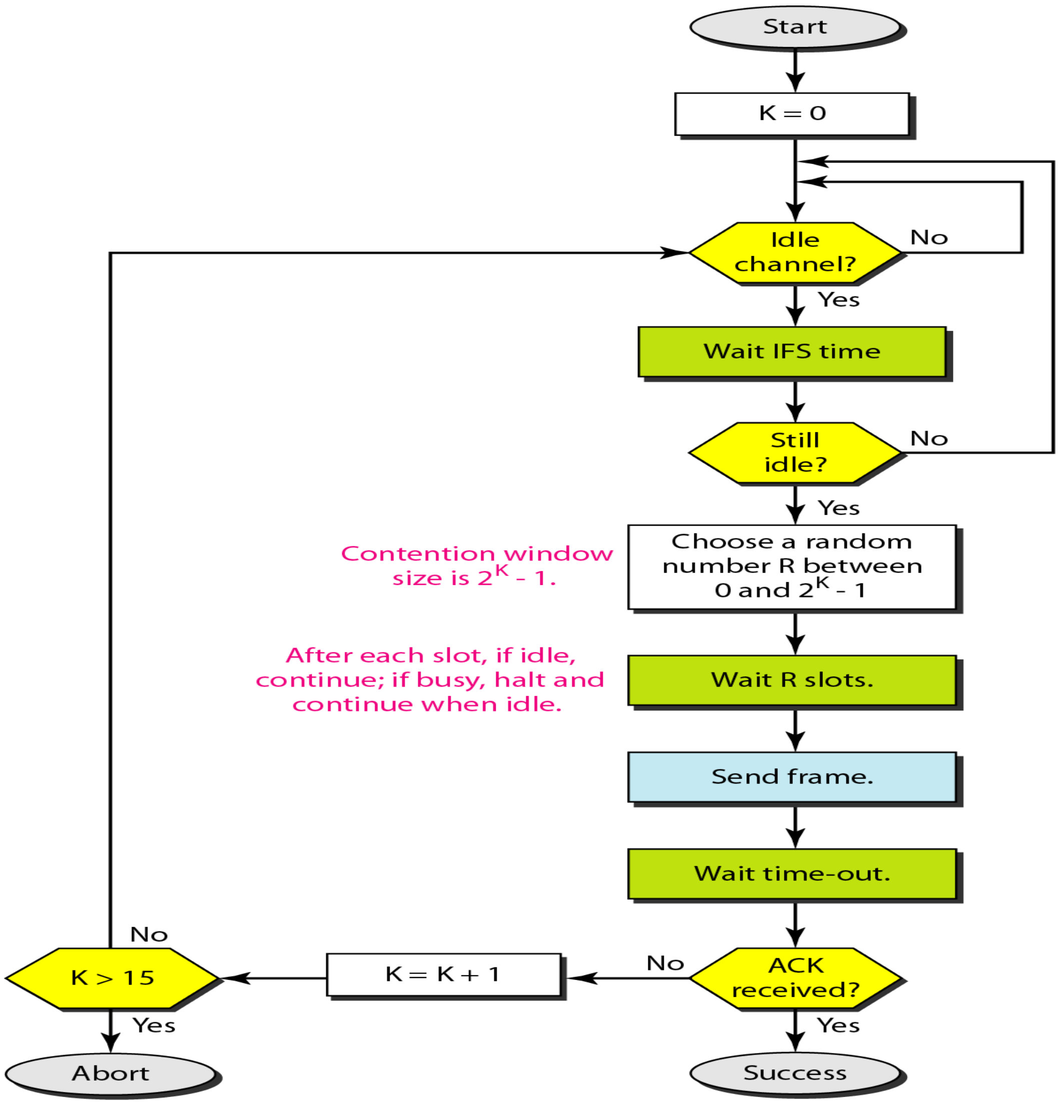


In CSMA/CA, the IFS can also be used to define the priority of a station or a frame.

In CSMA/CA, if the station finds the channel busy, it does not restart the timer of the contention window; it stops the timer and restarts it when the channel becomes idle.

Multiple Access Protocols

Flow diagram for CSMA/CA



Multiple Access Protocols

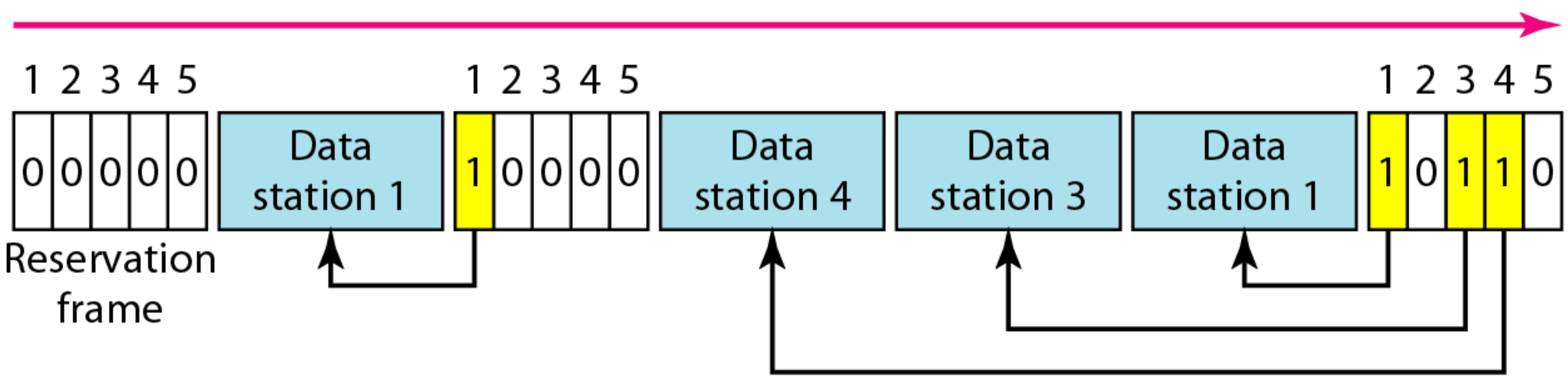
CONTROLLED ACCESS

In controlled access, the stations consult one another to find which station has the right to send. A station cannot send unless it has been authorized by other stations. We discuss three popular controlled-access methods.

- Reservation
- Polling
- Token Passing

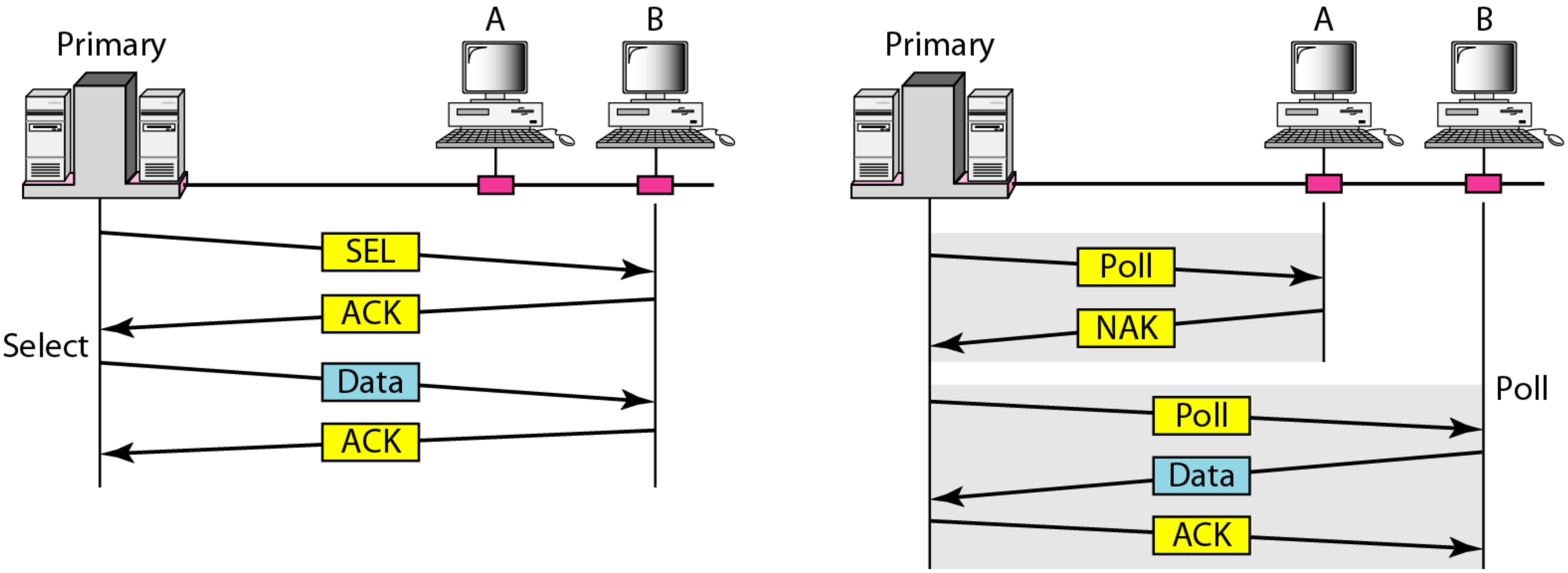
Multiple Access Protocols: Controlled Access

Reservation access method



Multiple Access Protocols: Controlled Access

Select and poll functions in polling access method



Questions

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the requirement to make this frame collision-free?

Solution

Average frame transmission time T_{fr} is 200 bits/200 kbps or 1 ms. The vulnerable time is 2×1 ms = 2 ms. This means no station should send later than 1 ms before this station starts transmission and no station should start sending during the one 1-ms period that this station is sending.

Questions

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second   b. 500 frames per second

c. 250 frames per second.

Solution

The frame transmission time is 200/200 kbps or 1 ms.

a. If the system creates 1000 frames per second, this is 1 frame per millisecond. The load is 1. In this case $S = G\times e^{-2G}$ or $S = 0.135$ (13.5 percent). This means that the throughput is $1000 \times 0.135 = 135$ frames. Only 135 frames out of 1000 will probably survive.

Solution cont…

b. If the system creates 500 frames per second, this is (1/2) frame per millisecond. The load is (1/2). In this case $S = G \times e^{-2G}$ or $S = 0.184$ (18.4 percent). This means that the throughput is $500 \times 0.184 = 92$ and that only 92 frames out of 500 will probably survive. Note that this is the maximum throughput case, percentagewise.

c. If the system creates 250 frames per second, this is (1/4) frame per millisecond. The load is (1/4). In this case $S = G \times e^{-2G}$ or $S = 0.152$ (15.2 percent). This means that the throughput is $250 \times 0.152 = 38$. Only 38 frames out of 250 will probably survive.

Questions

A slotted ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second b. 500 frames per second

c. 250 frames per second.

Solution

The frame transmission time is 200/200 kbps or 1 ms.

a. If the system creates 1000 frames per second, this is 1 frame per millisecond. The load is 1. In this case $S = G\times e^{-G}$ or S = 0.368 (36.8 percent). This means that the throughput is $1000 \times 0.0368 = 368$ frames. Only 386 frames out of 1000 will probably survive.

Questions

b. If the system creates 500 frames per second, this is (1/2) frame per millisecond. The load is (1/2). In this case S = G × e^{-G} or S = 0.303 (30.3 percent). This means that the throughput is 500 × 0.0303 = 151. Only 151 frames out of 500 will probably survive.

c. If the system creates 250 frames per second, this is (1/4) frame per millisecond. The load is (1/4). In this case S = G × e^{-G} or S = 0.195 (19.5 percent). This means that the throughput is 250 × 0.195 = 49. Only 49 frames out of 250 will probably survive.

Questions

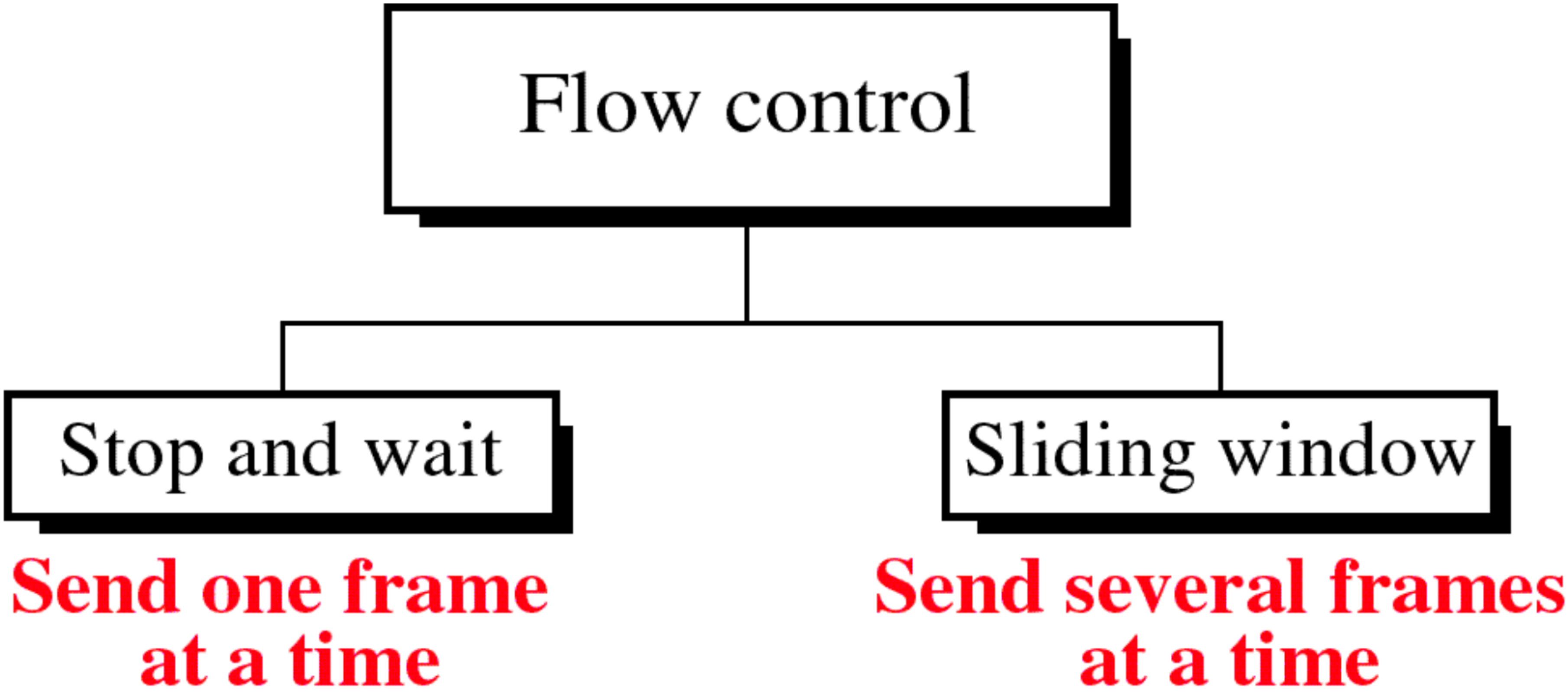
A network using CSMA/CD has a bandwidth of 10 Mbps. If the maximum propagation time (including the delays in the devices and ignoring the time needed to send a jamming signal, as we see later) is 25.6 μs, what is the minimum size of the frame?

Solution

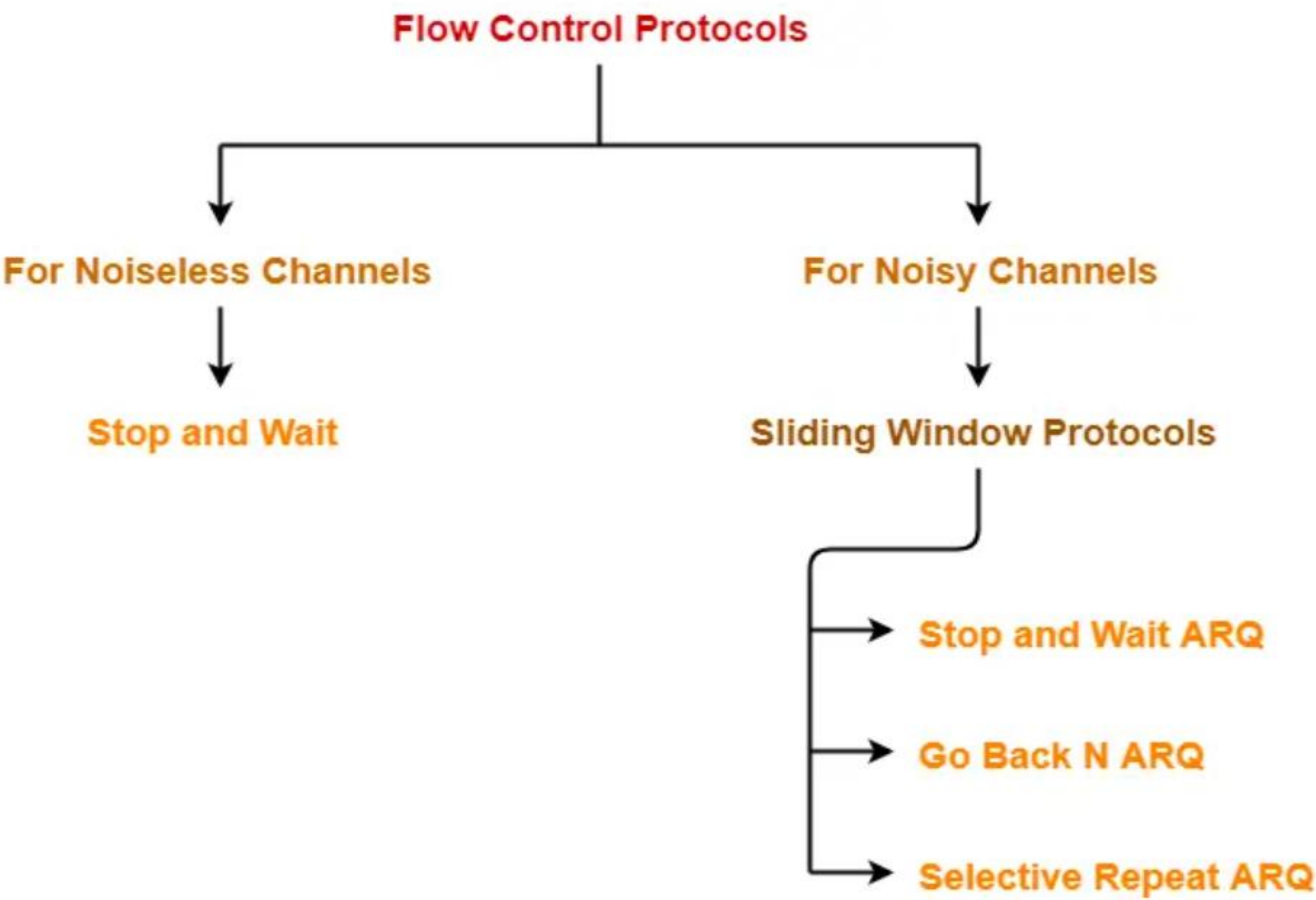
The frame transmission time is $T_{fr} = 2 \times T_p = 51.2$ μs. This means, in the worst case, a station needs to transmit for a period of 51.2 μs to detect the collision. The minimum size of the frame is 10 Mbps × 51.2 μs = 512 bits or 64 bytes. This is actually the minimum size of the frame for Standard Ethernet.

Flow Control

Objective: Study about basic concept of Flow control and its type.

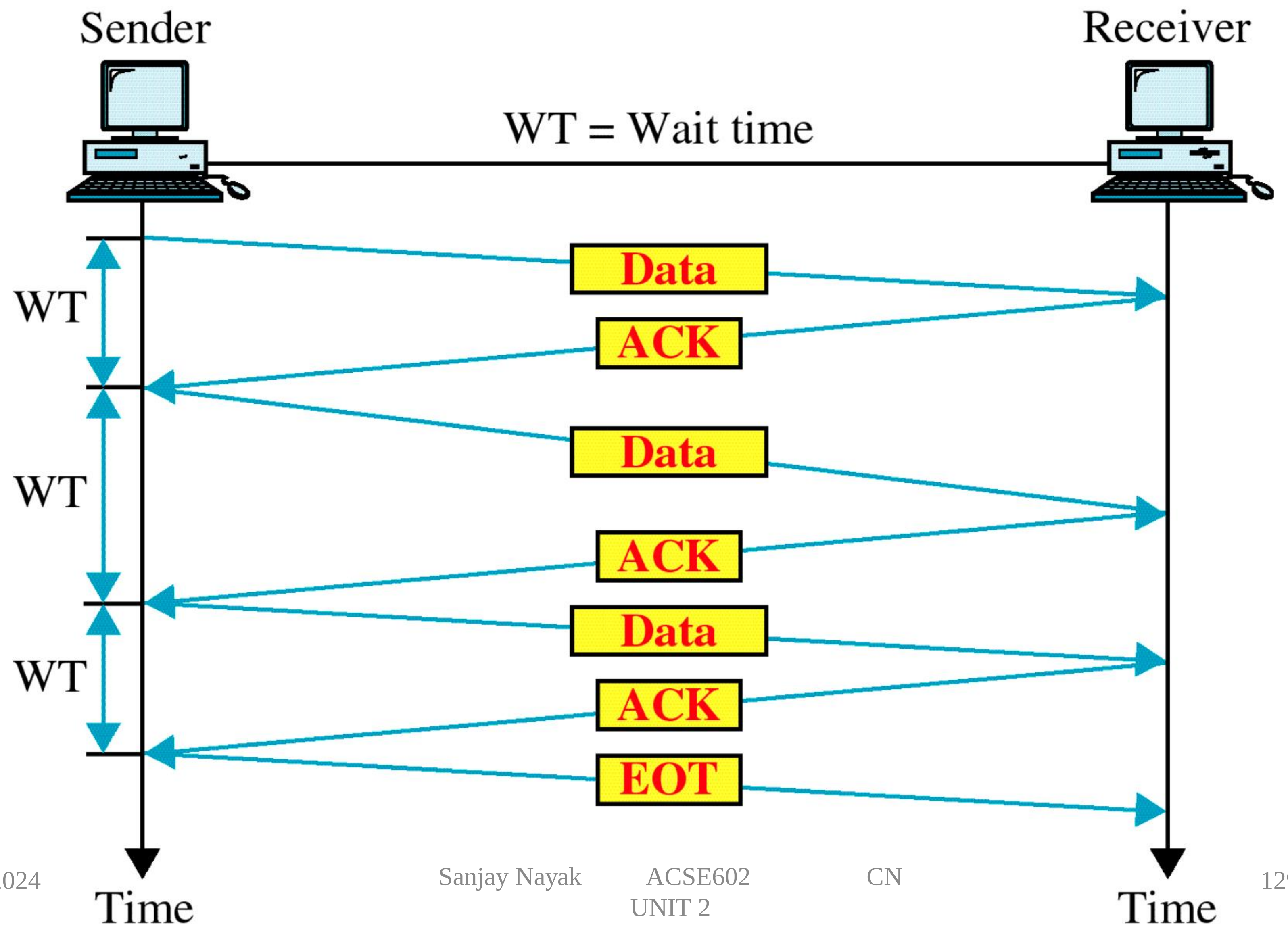


Flow Control



Flow Control

Stop and Wait

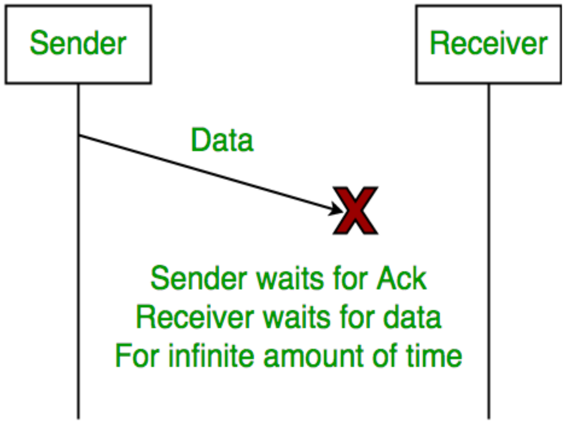


Flow Control

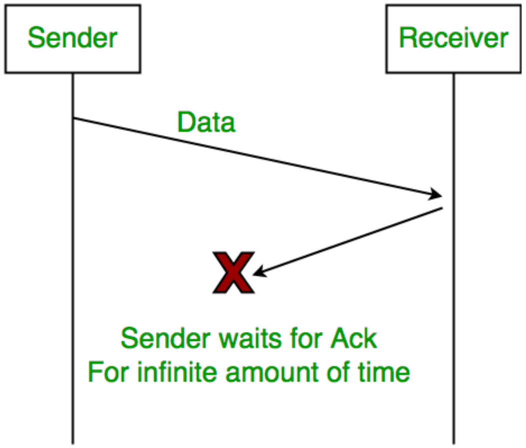
Simple Stop and Wait

Problems :

1. Lost Data



2. Lost Acknowledgement:

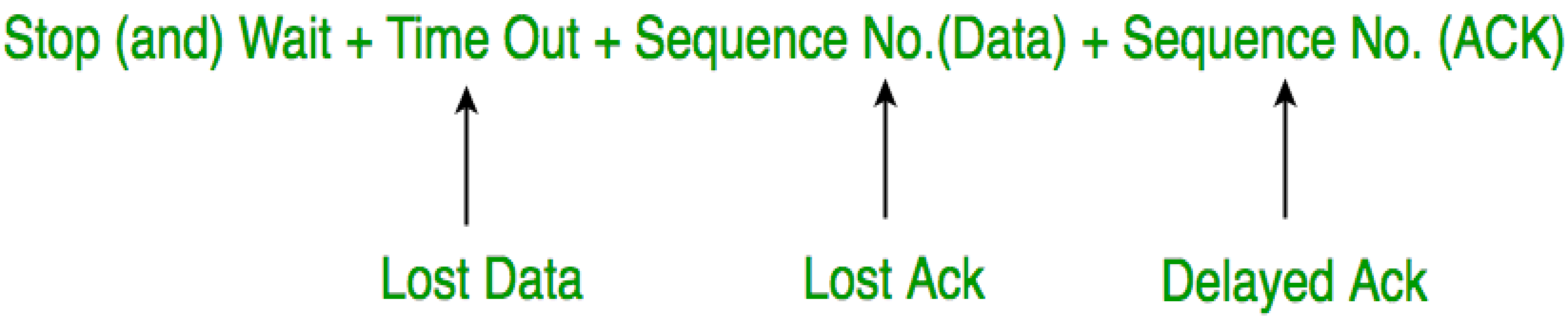


3. Delayed Acknowledgement/Data: After a timeout on the sender side, a long-delayed acknowledgement might be wrongly considered as acknowledgement of some other recent packet.

Flow Control

Stop and Wait ARQ

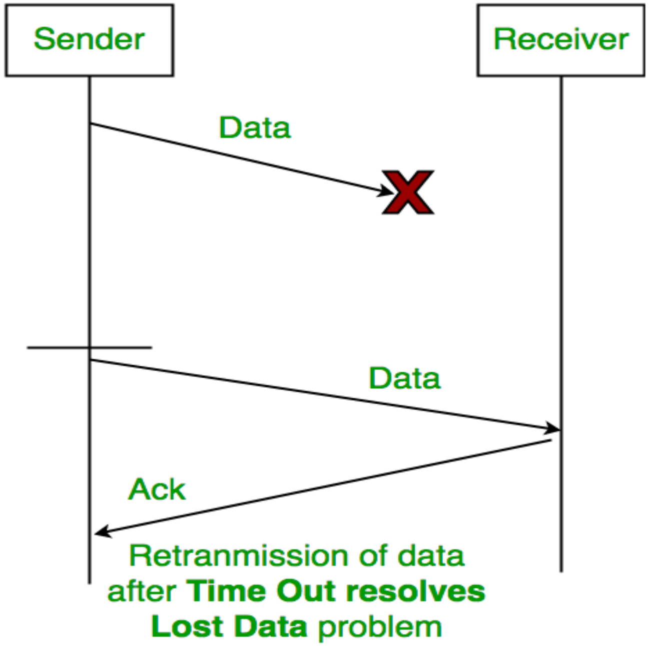
3 problems are resolved by Stop and Wait for ARQ (Automatic Repeat Request) that does both error control and flow control.



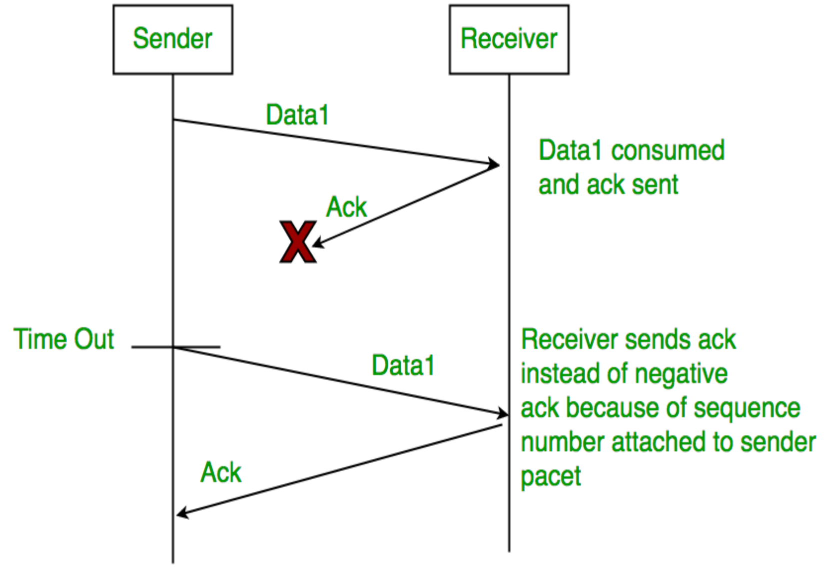
Flow Control

Stop and Wait ARQ

1. Time Out:



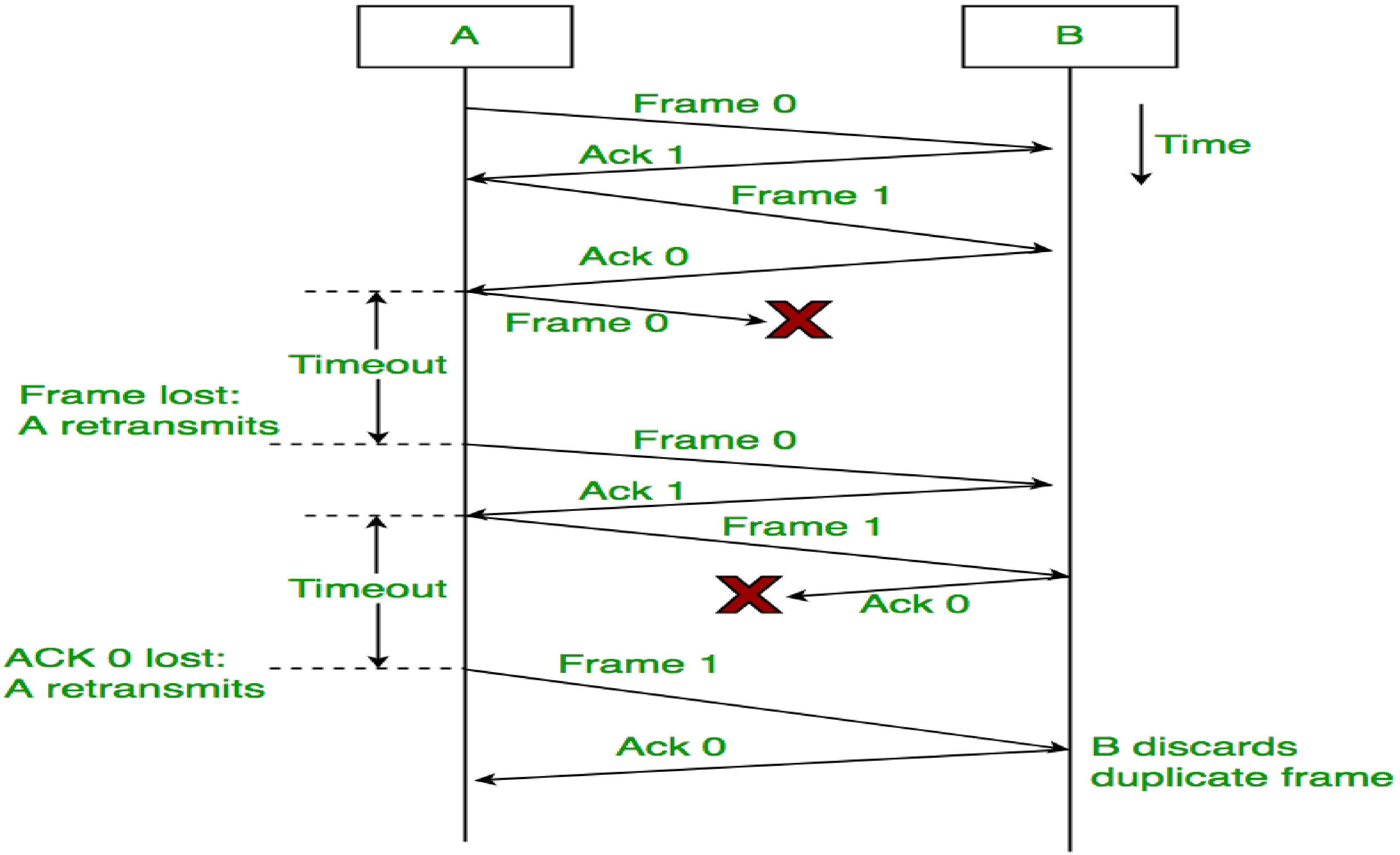
2. Sequence Number (Data)



3. Delayed Acknowledgement:

This is resolved by introducing sequence numbers for acknowledgement also.

Working Stop and Wait ARQ



Flow Control

Advantages of Stop and Wait ARQ :

- **Simple Implementation:** Stop and Wait ARQ is a simple protocol that is easy to implement .making it an inexpensive and efficient option.
- **Error Detection:** Detects errors in the transmitted data by using checksums or cyclic redundancy checks (CRC). If an error is detected, the receiver sends a negative acknowledgment (NAK) to the sender, indicating that the data needs to be retransmitted.
- **Reliable:** Stop and Wait ARQ ensures that the data is transmitted reliably and in order..
- **Flow Control:** Stop and Wait ARQ can be used for flow control, where the receiver can control the rate at which the sender transmits data.

- **Backward Compatibility:** Stop and Wait ARQ is compatible with many existing systems and protocols, making it a popular choice for communication over unreliable channels.

Flow Control

Disadvantages of Stop and Wait ARQ :

- Low Efficiency
- High Latency
- Limited Bandwidth Utilization
- Limited Error Recovery

DAILY QUIZ

1.Sliding window ARQ generally implemented in (CO2)

a) Go-Back-N ARQ
b) Go-Reject-N ARQ
c) Selective reject ARQ
d) A &C

2. HDLC is an acronym for _______. (CO2)

a) High-duplex line communication
b) High-level data link control
c) Half-duplex digital link combination
d) Host double-level circuit

3. Which among the following represents the objectives/requirements of Data Link Layer? (CO2)

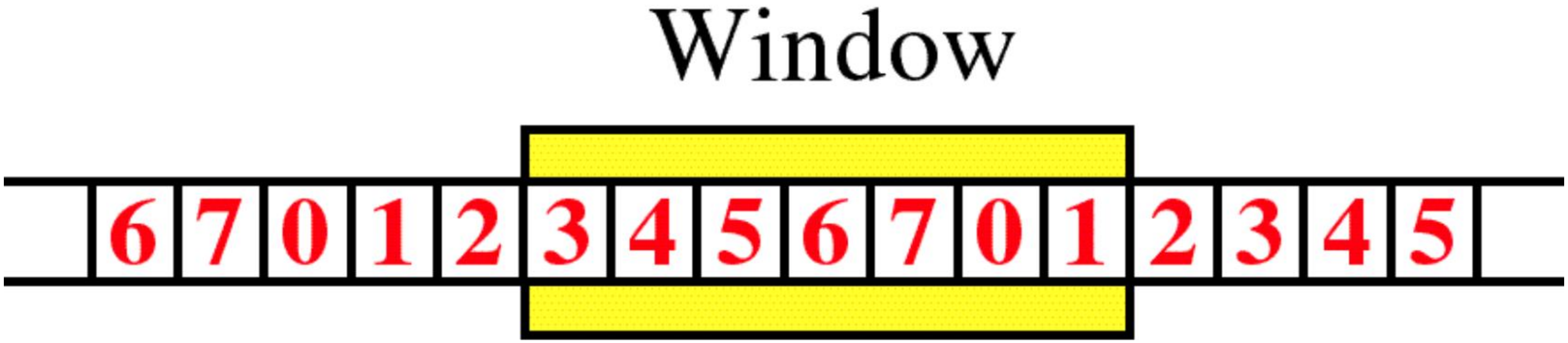
a. Frame Synchronization
b. Error & Flow Control
c. Both a & b
d. None of the above

4. Which feature of Go-Back-N ARQ mechanism possesses an ability to assign the sliding window in the forward direction? (CO2)

a. Control Variables
b. Sender Sliding Window
c. Receiver Sliding Window
d. Resending of frames

Flow Control

Sliding Window



Window size : n
Frame no. from: 0 to n

Window size – 7
Frame no. from 0 to 7

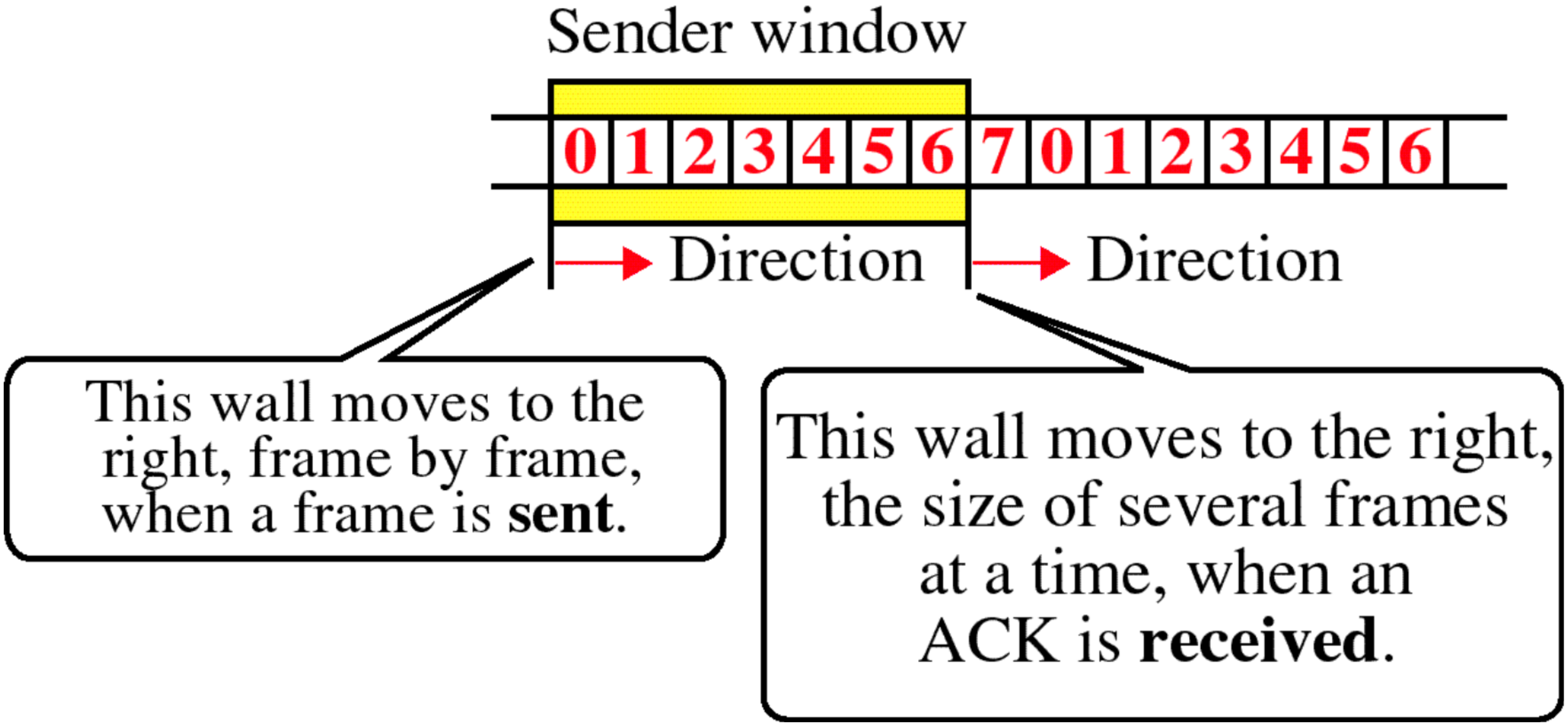
7 frames can be transmitted without getting acknowledgement

Flow Control

Sender Sliding Window

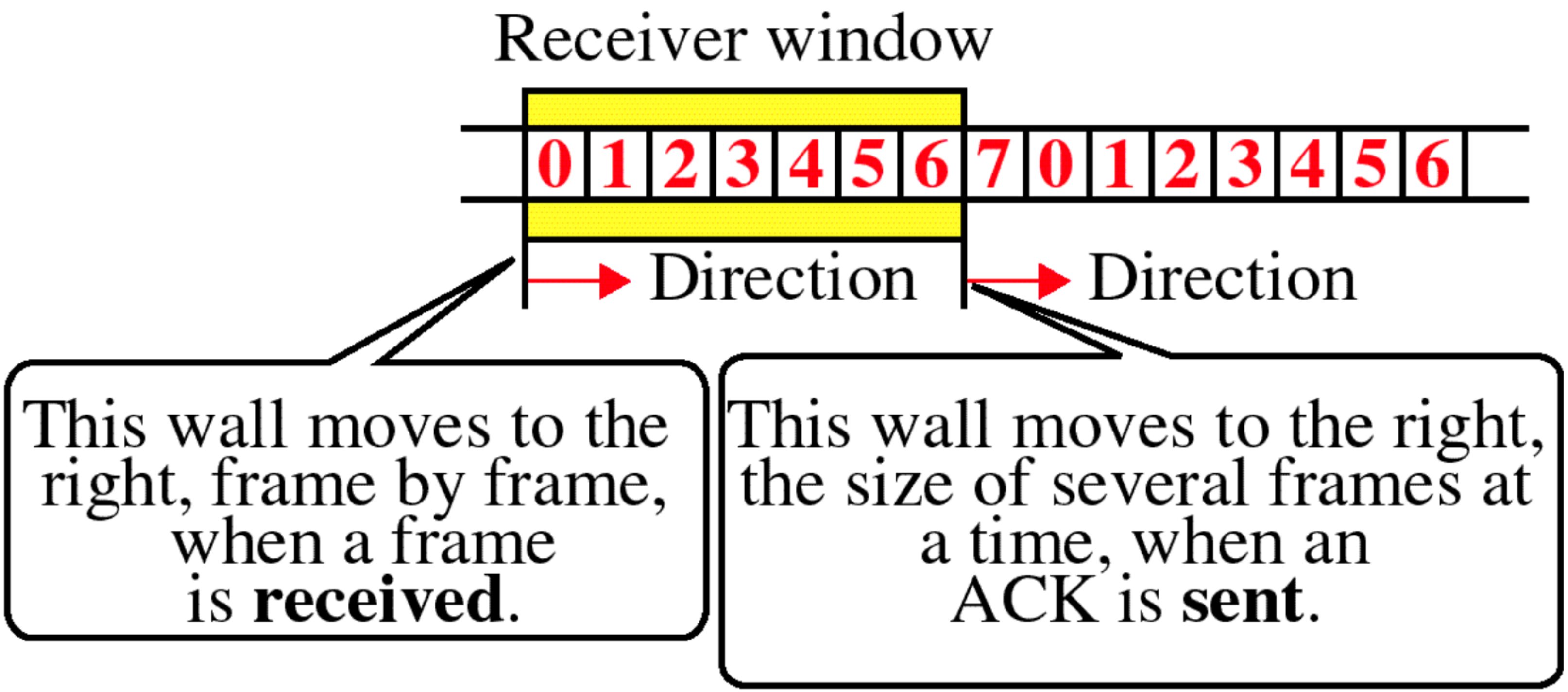
Window size : n
Frame no. from: 0 to n

Window size : 7
Frame no. from 0 to 7

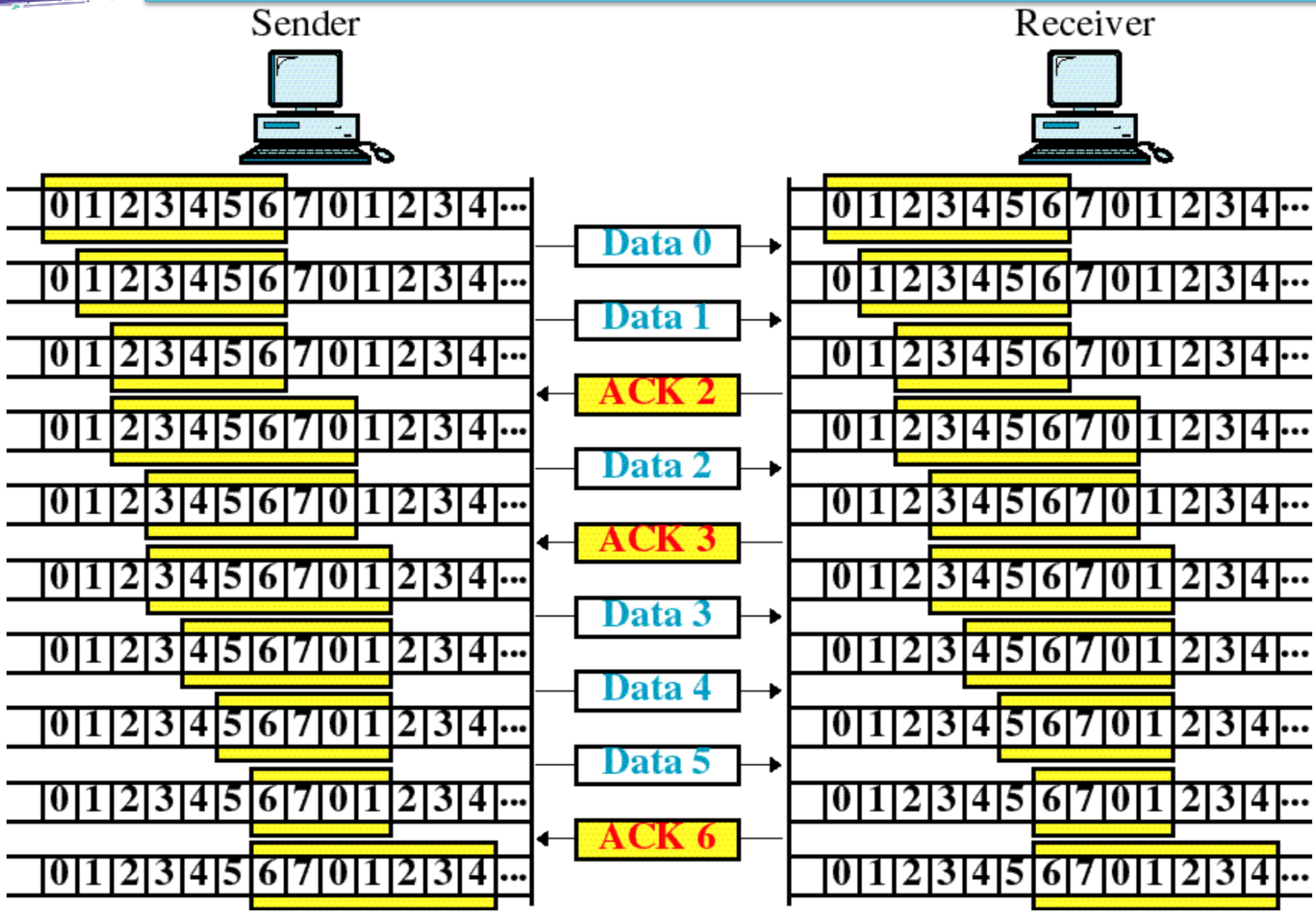


Flow Control

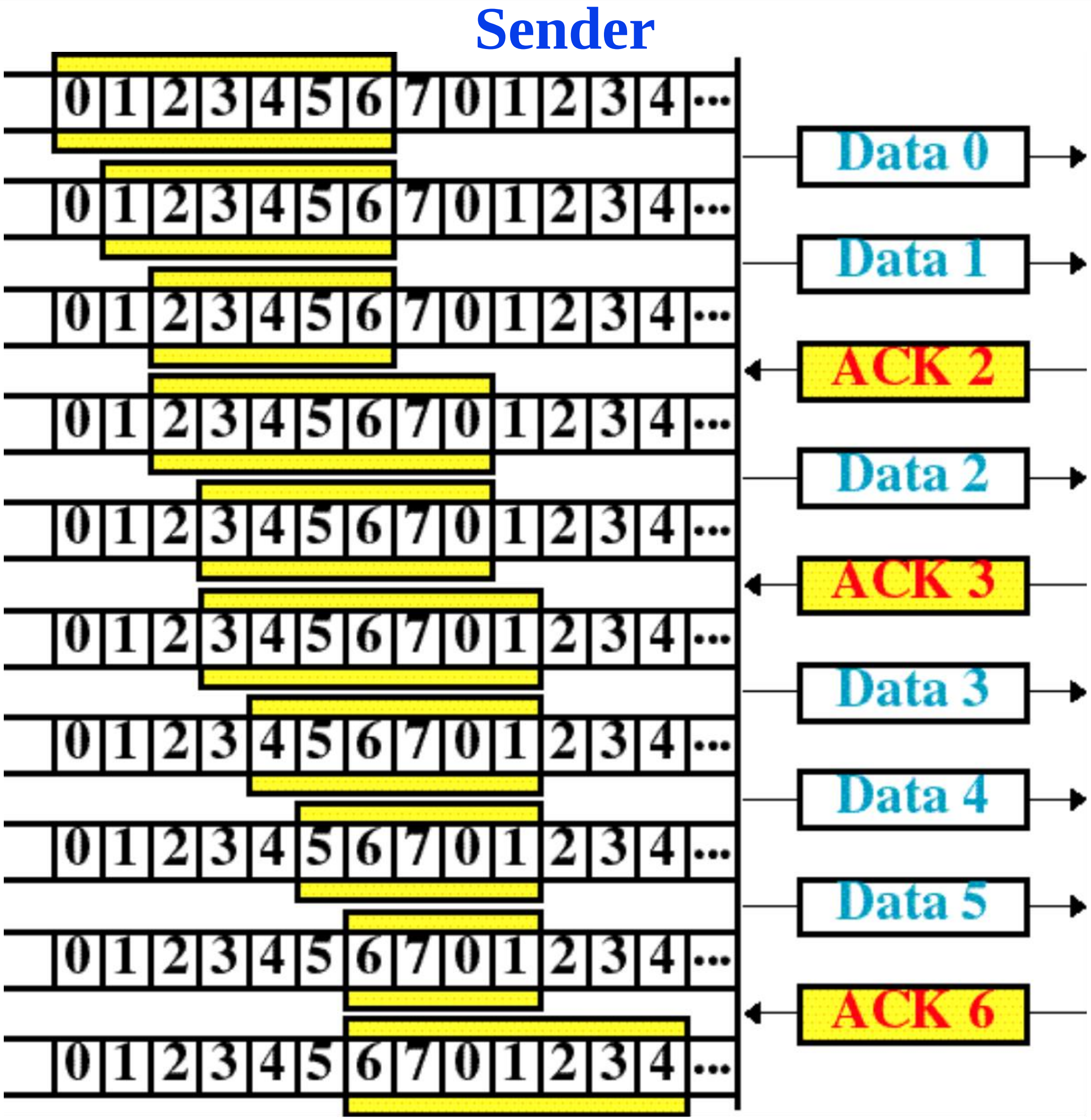
Receiver Sliding Window



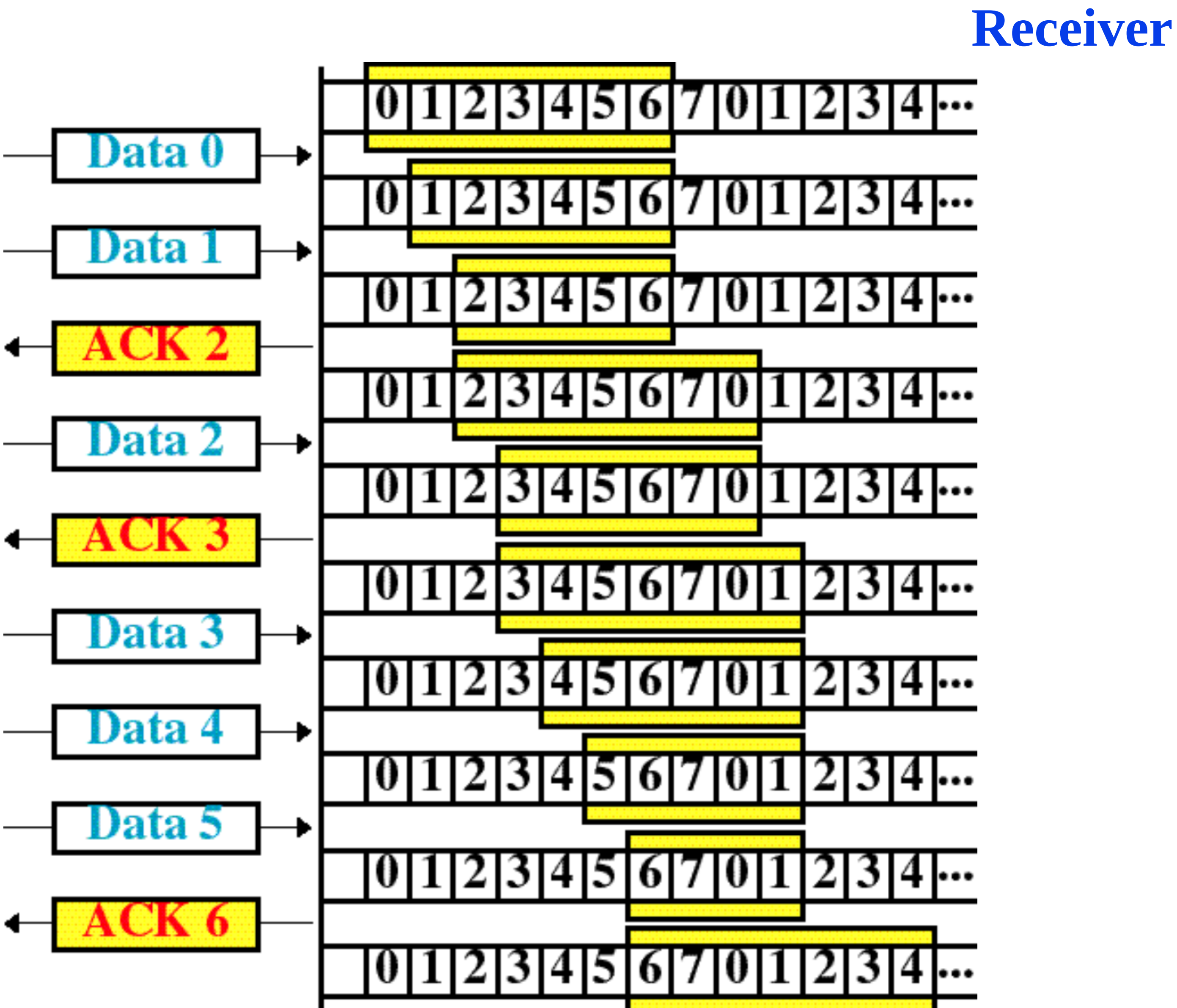
Flow Control: Example sliding window



Flow Control : Example sliding window

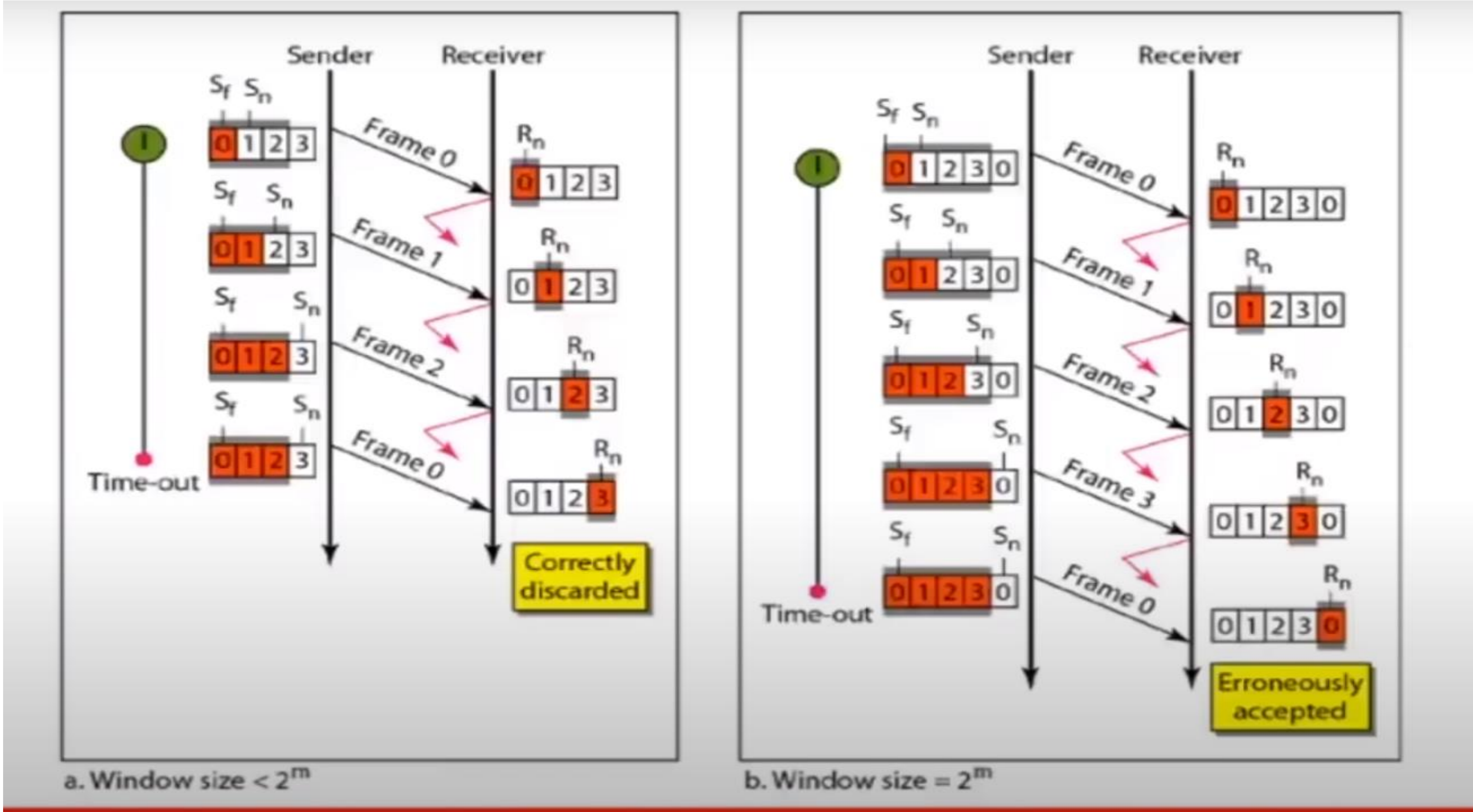


Flow Control : Example sliding window



Flow Control

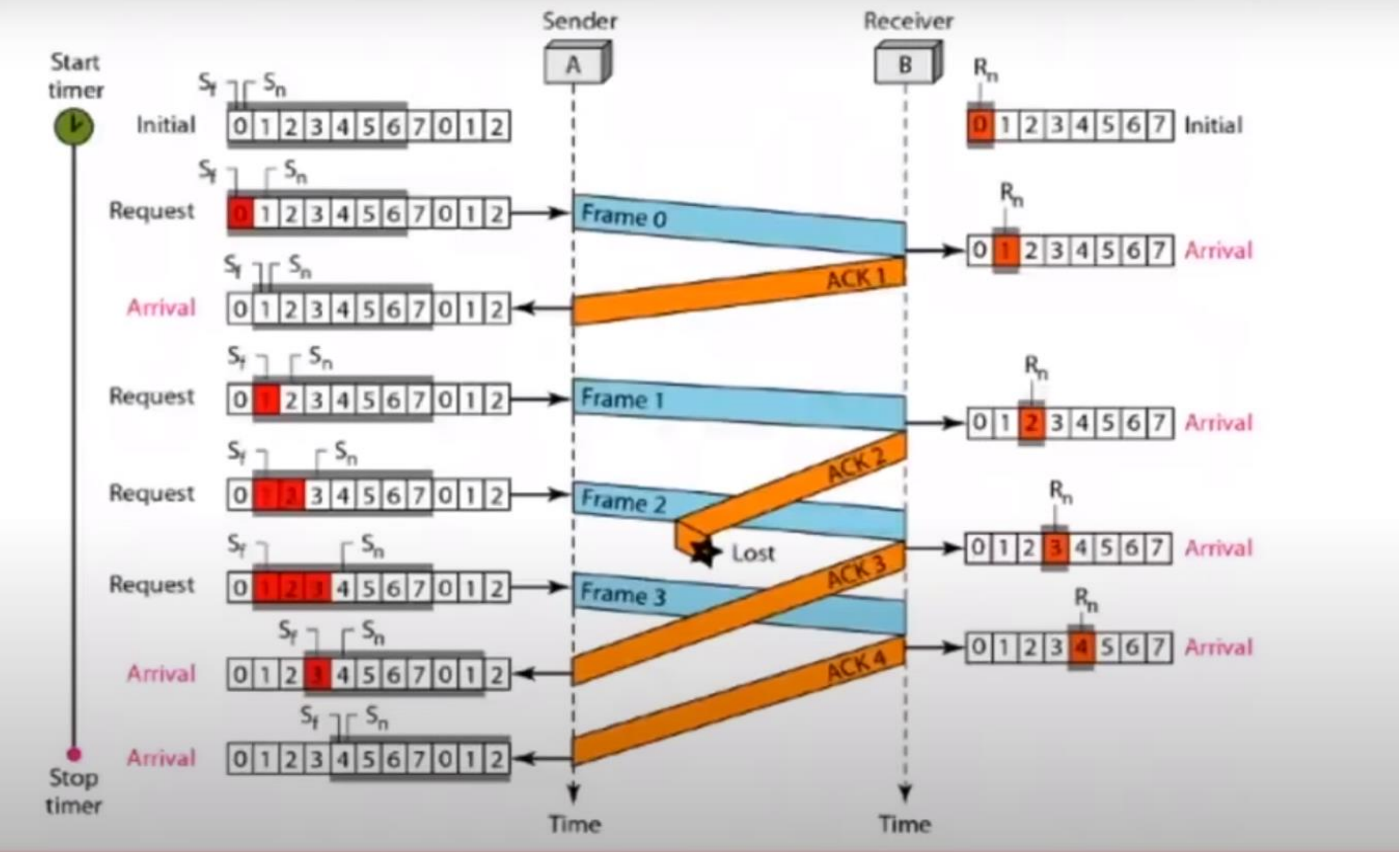
Go Back N ARQ :



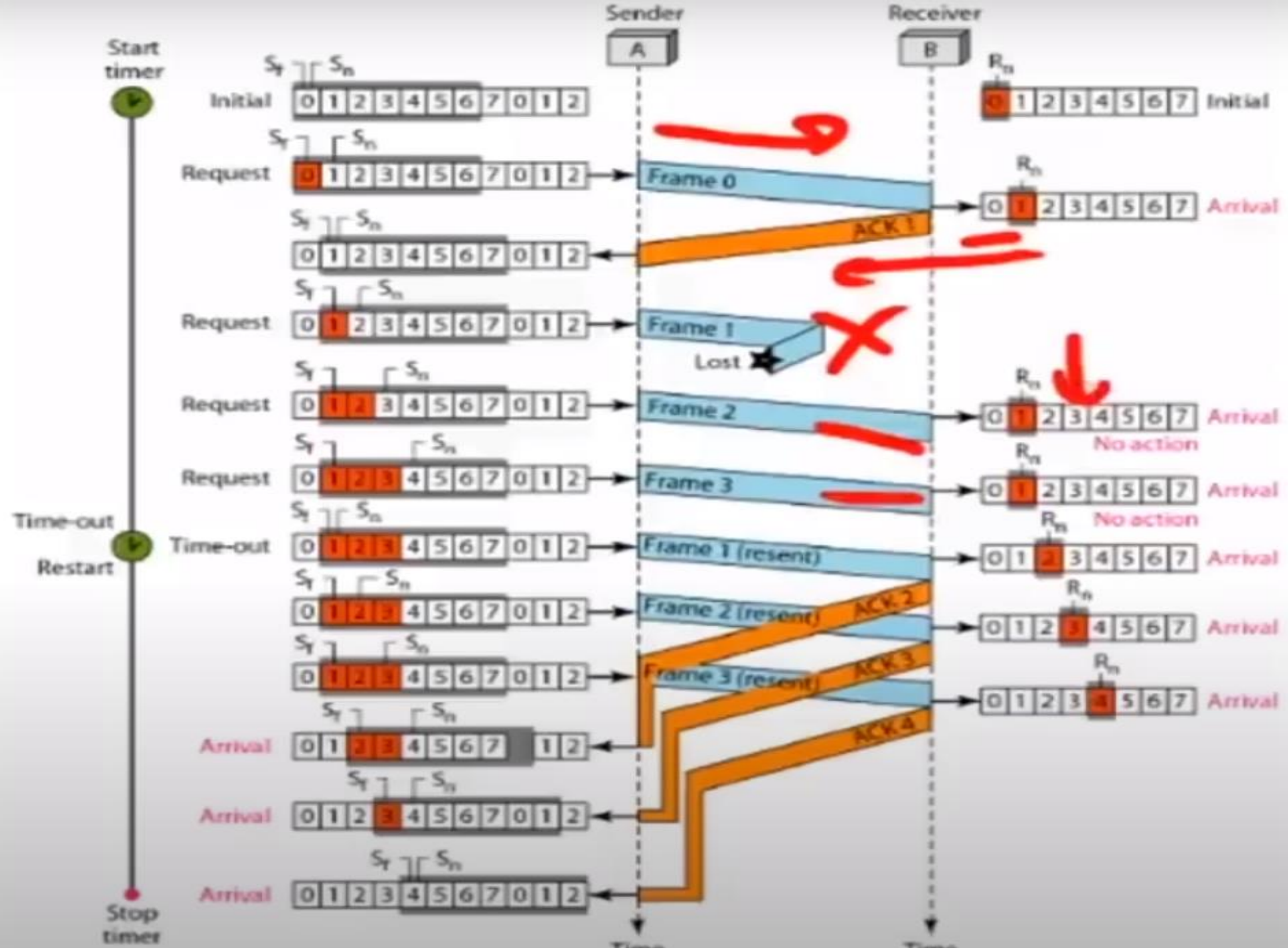
Go Back N-some cases

Figure 11.16 shows an example of Go-Back-N. This is an example of a case where the forward channel is reliable, but the reverse is not. No data frames are lost, but some ACKs are delayed and one is lost. The example also shows how cumulative acknowledgments can help if acknowledgments are delayed or lost. After initialization, there are seven sender events. Request events are triggered by data from the network layer; arrival events are triggered by acknowledgments from the physical layer. There is no time-out event here because all outstanding frames are acknowledged before the timer expires. Note that although ACK 2 is lost, ACK 3 serves as both ACK 2 and ACK 3.

Flow Control

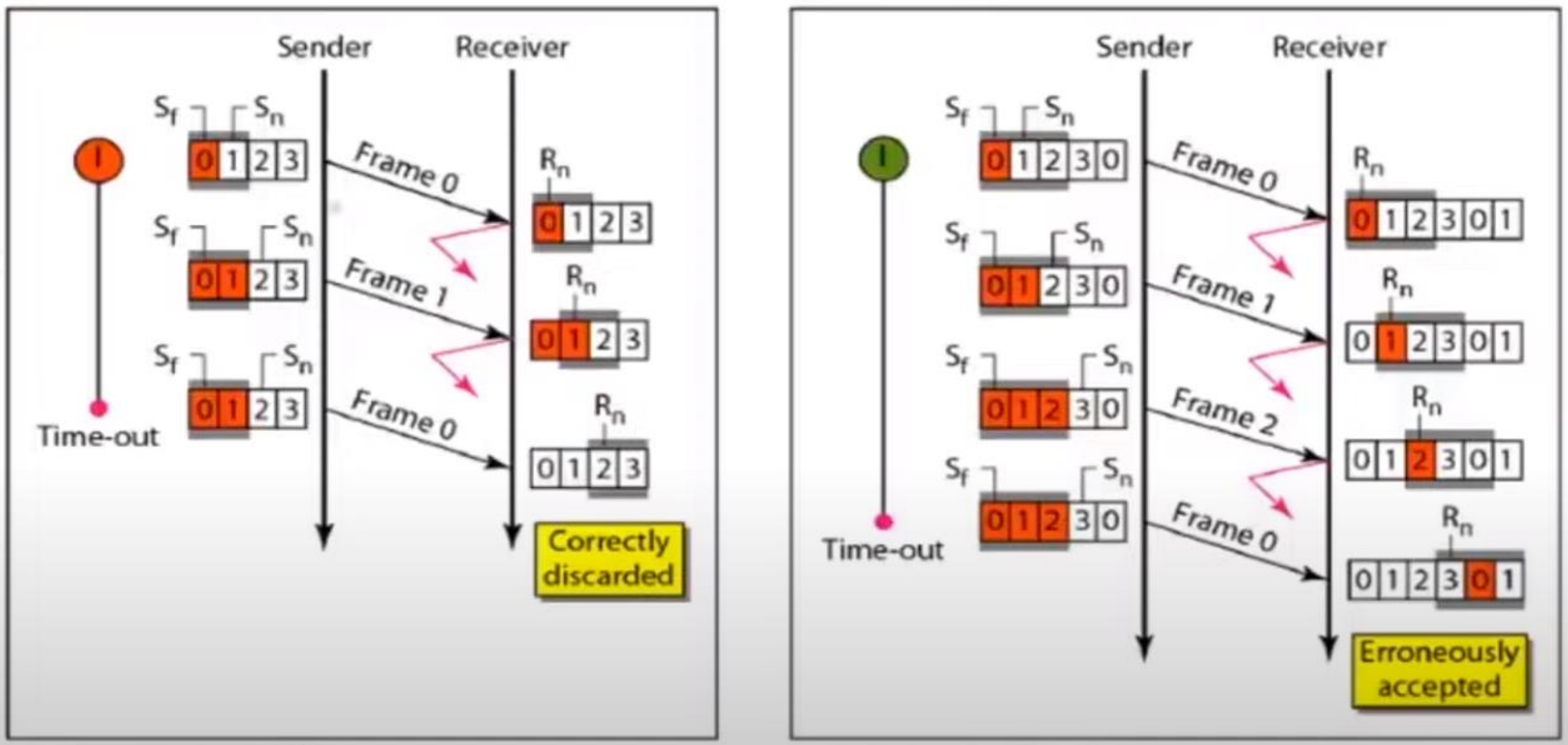


Flow Control



Selective Repeat

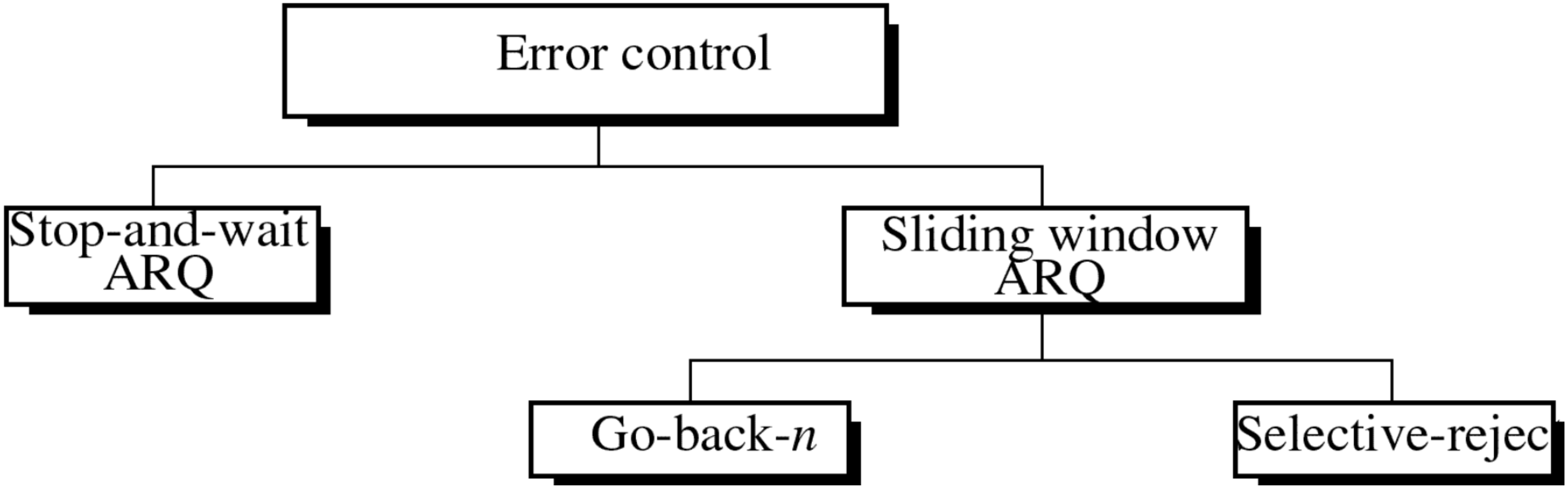
Figure 11.21 *Selective Repeat ARQ, window size*



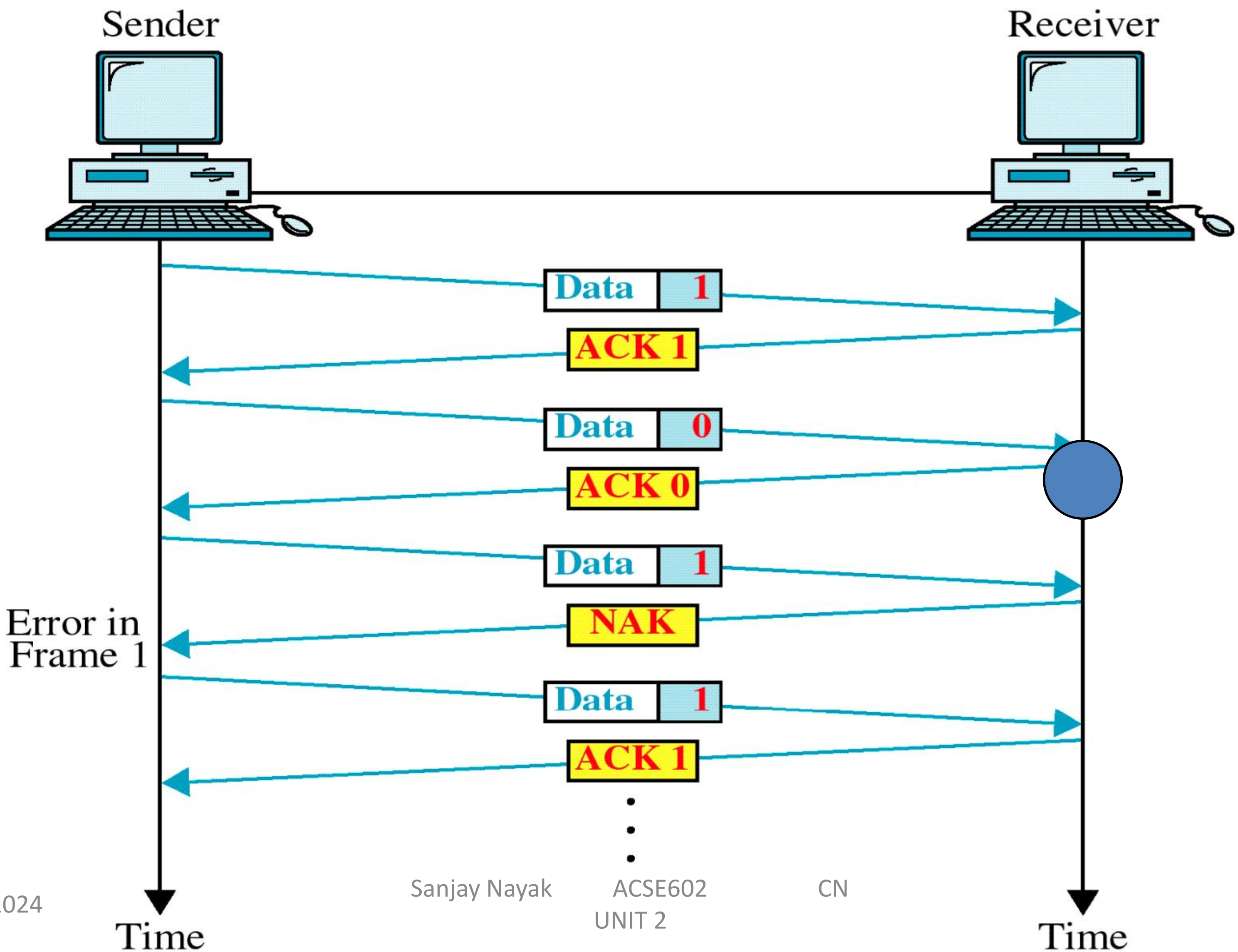
a. Window size = 2^{m-1}

b. Window size > 2^{m-1}

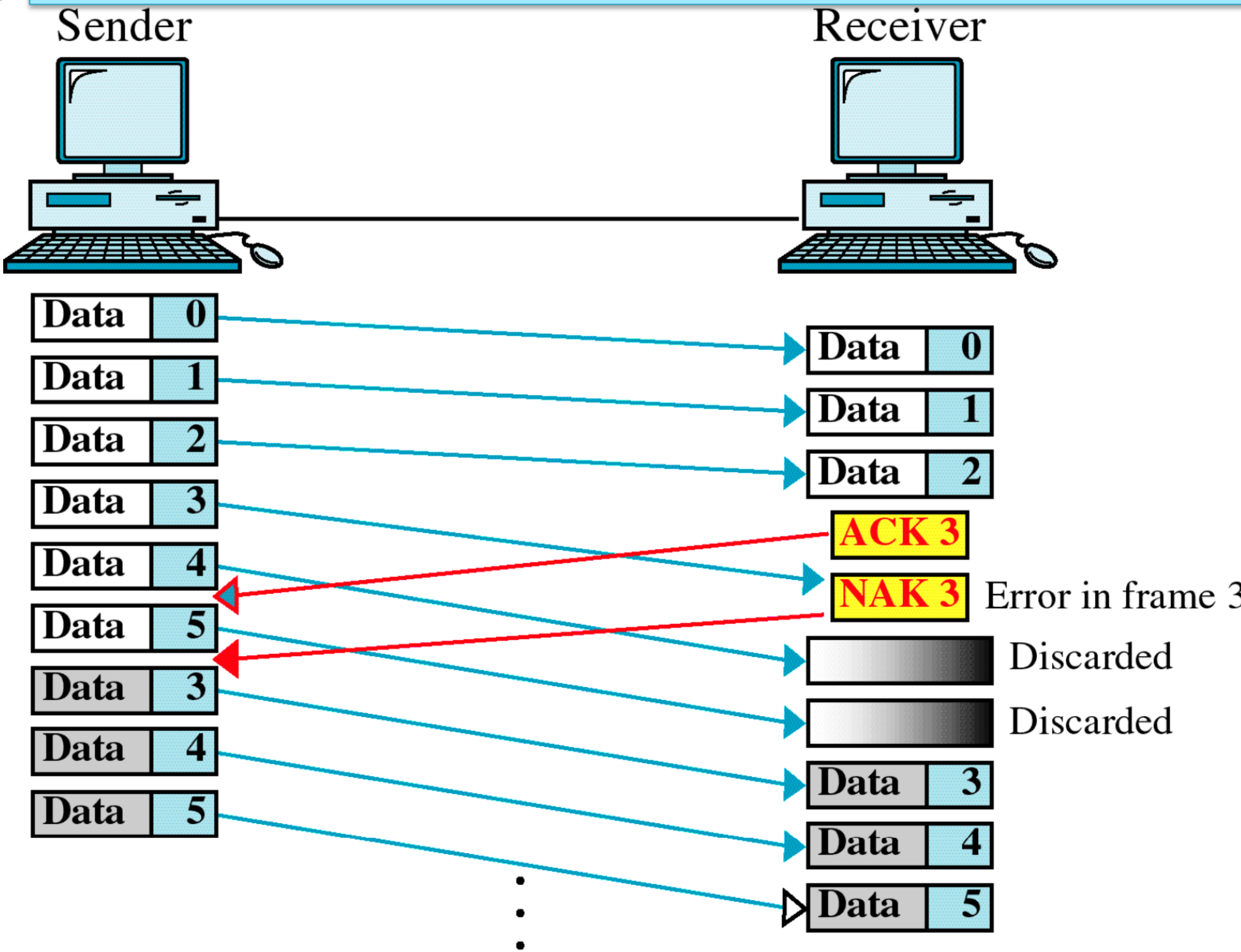
Flow Control and error control



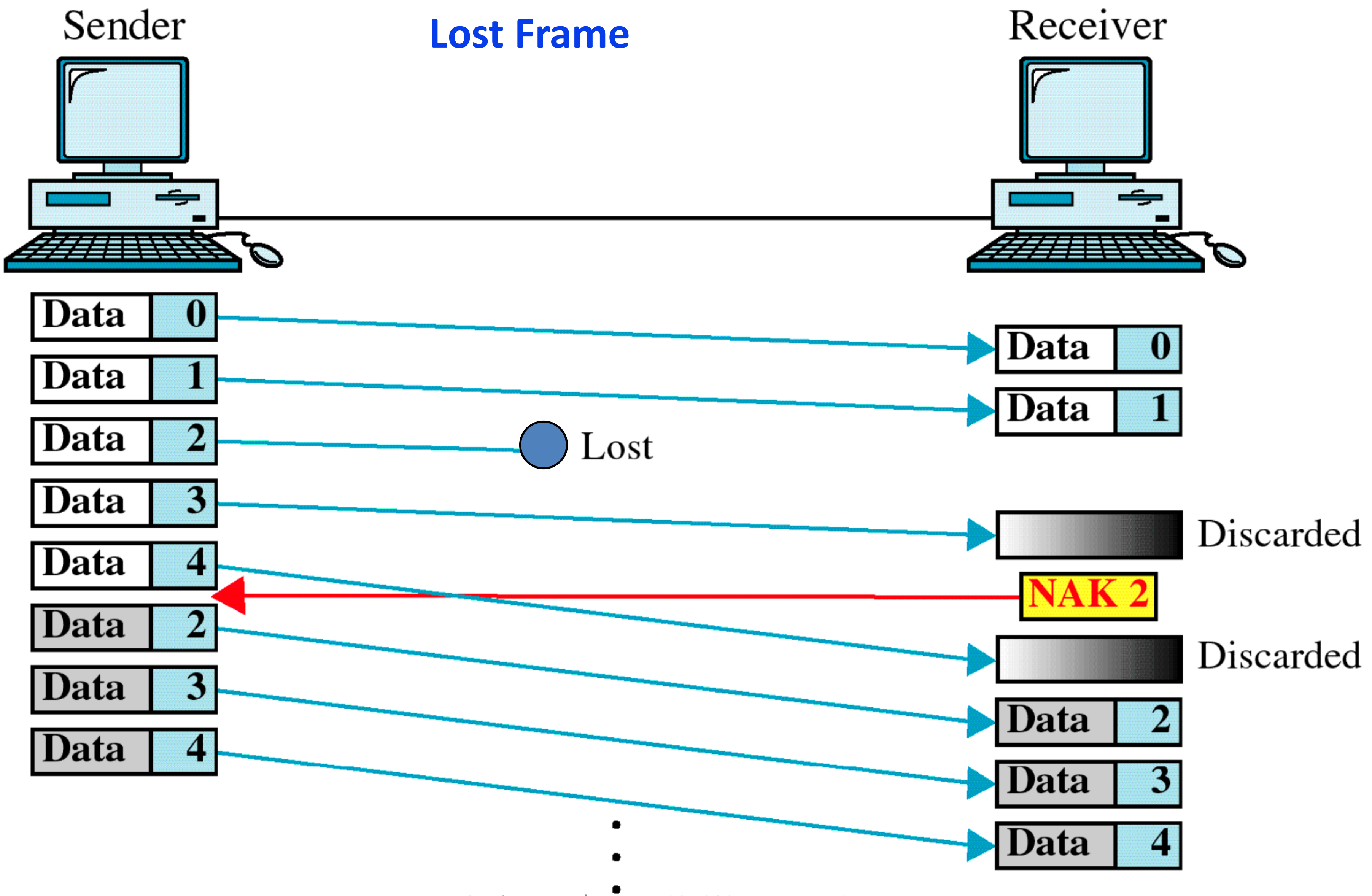
Flow Control and error control: Damaged Frame



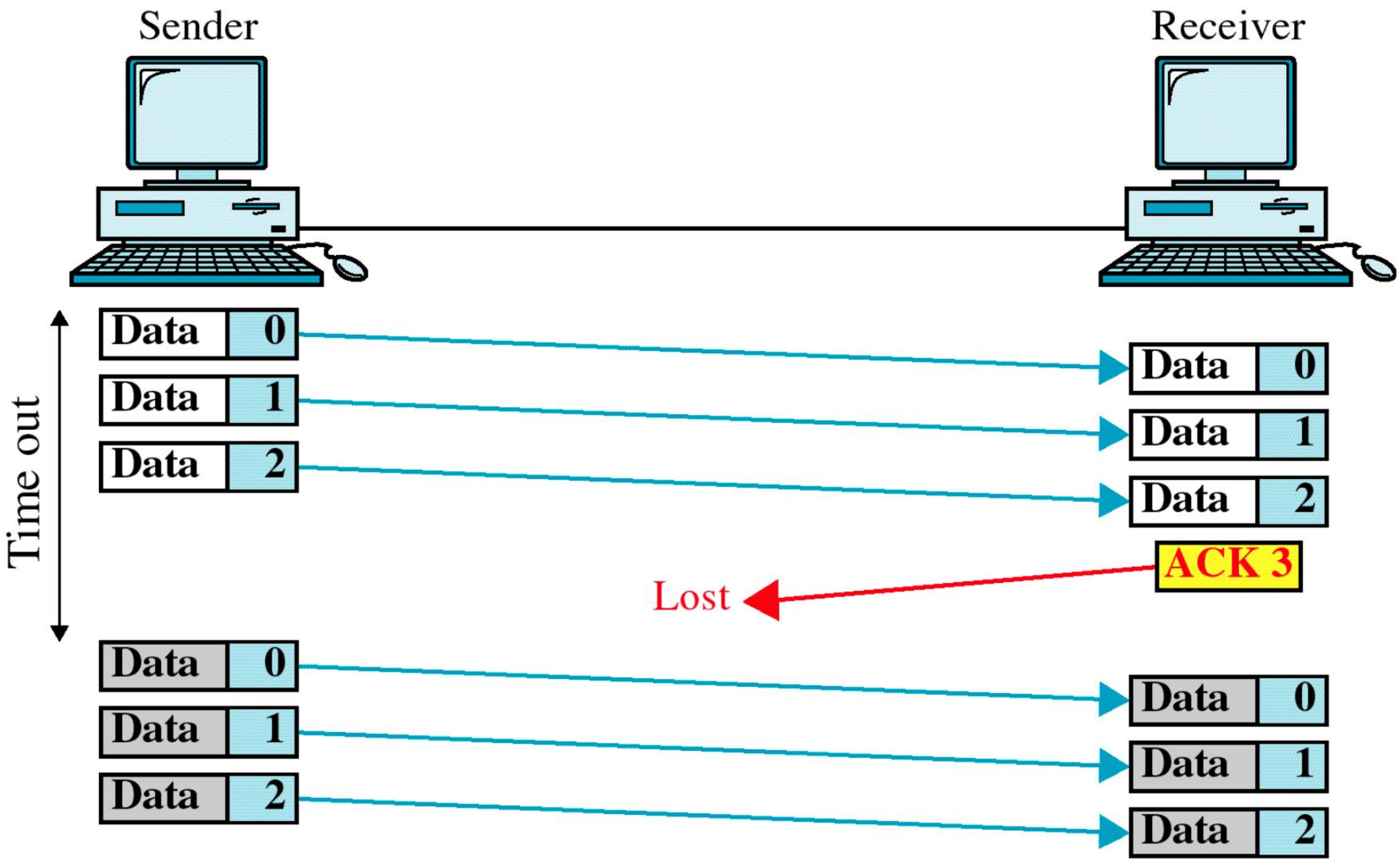
Flow Control and error control



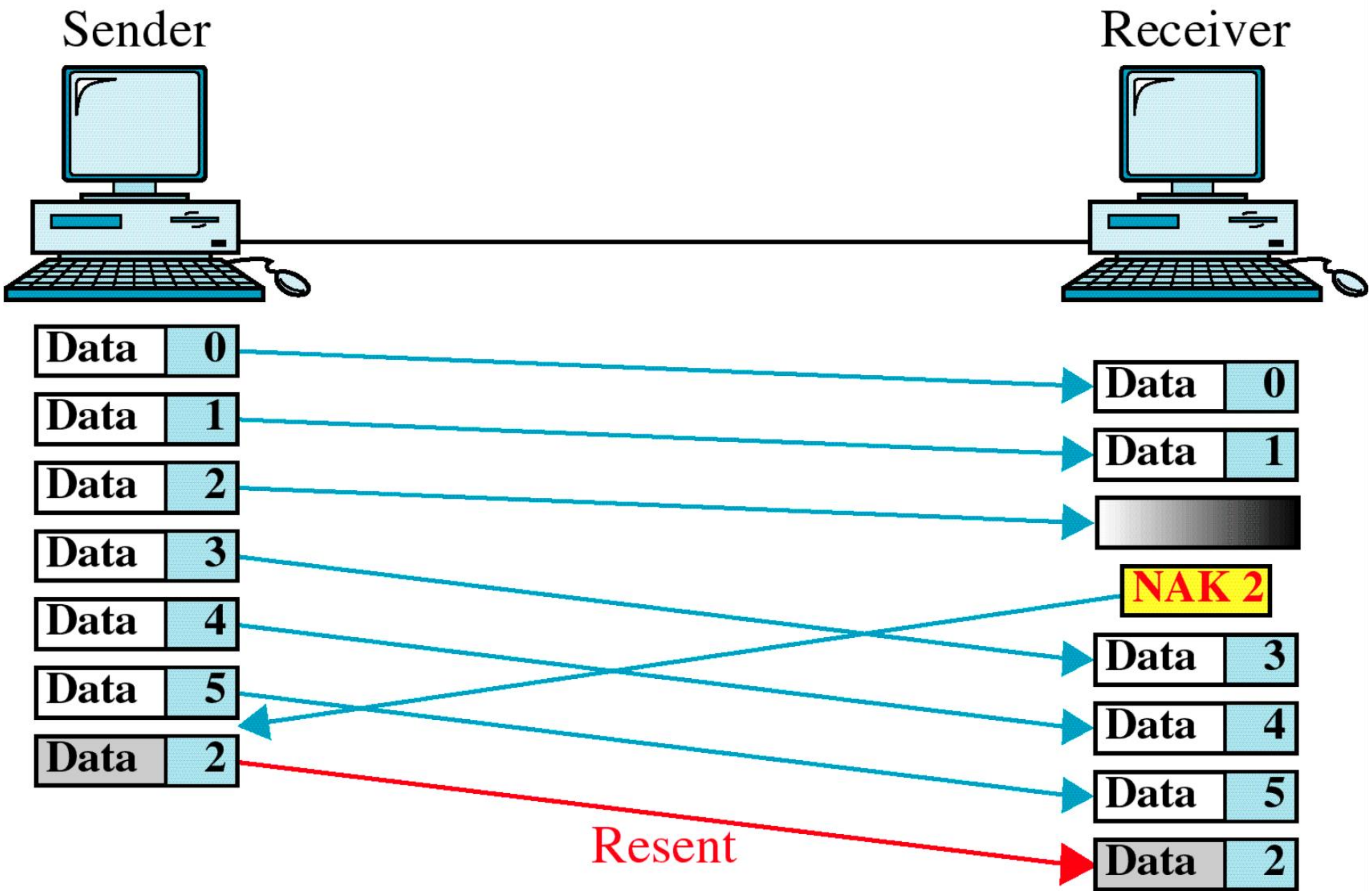
Flow Control and error control



Flow Control and error control



Flow Control and error control



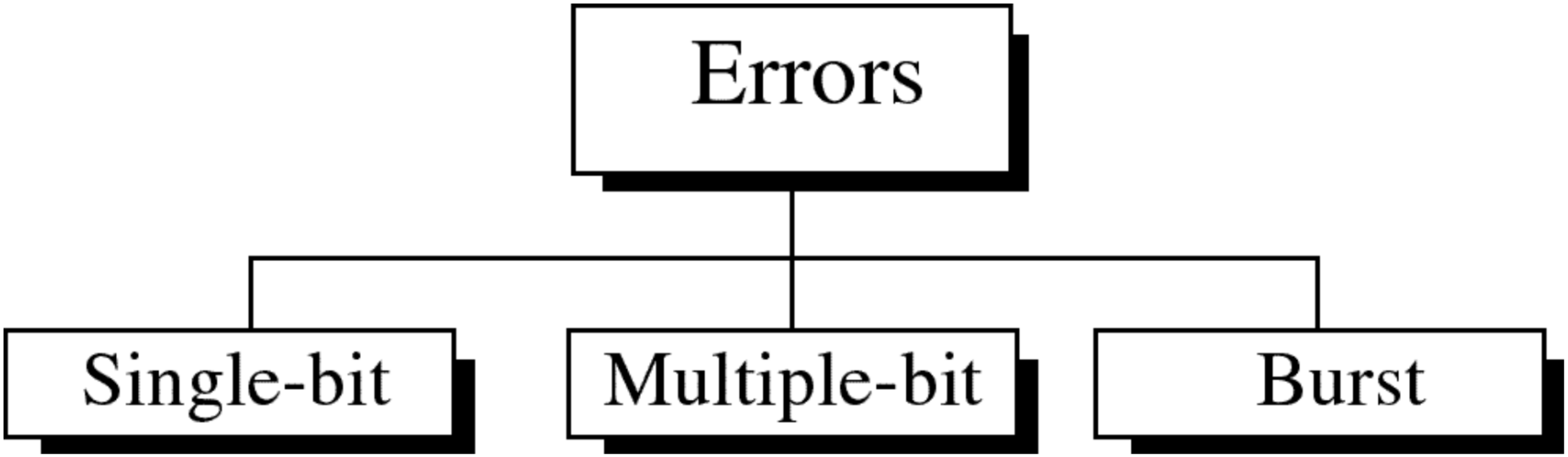
NIET Greater Noida
GET FUTURE READY

Error Detection and Correction

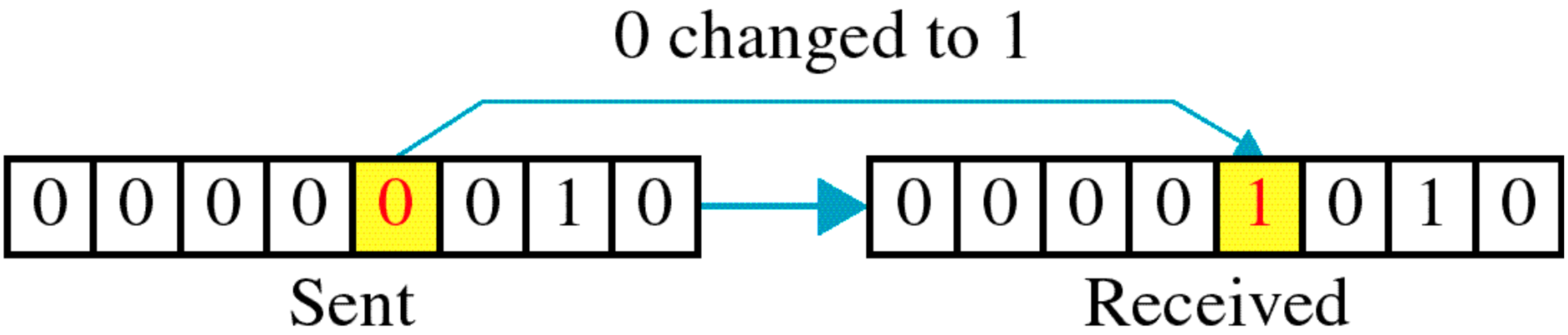
Objective: Study about basic concept of Error detection and correction methods

- **Types of Errors**
- **Detection**
- **Correction**

Error Detection and Correction

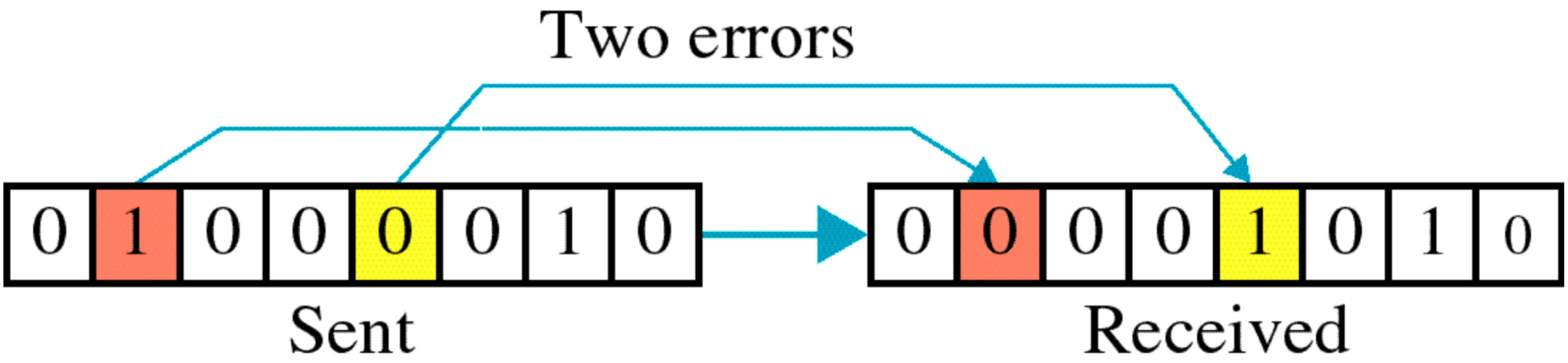


Single-bit error



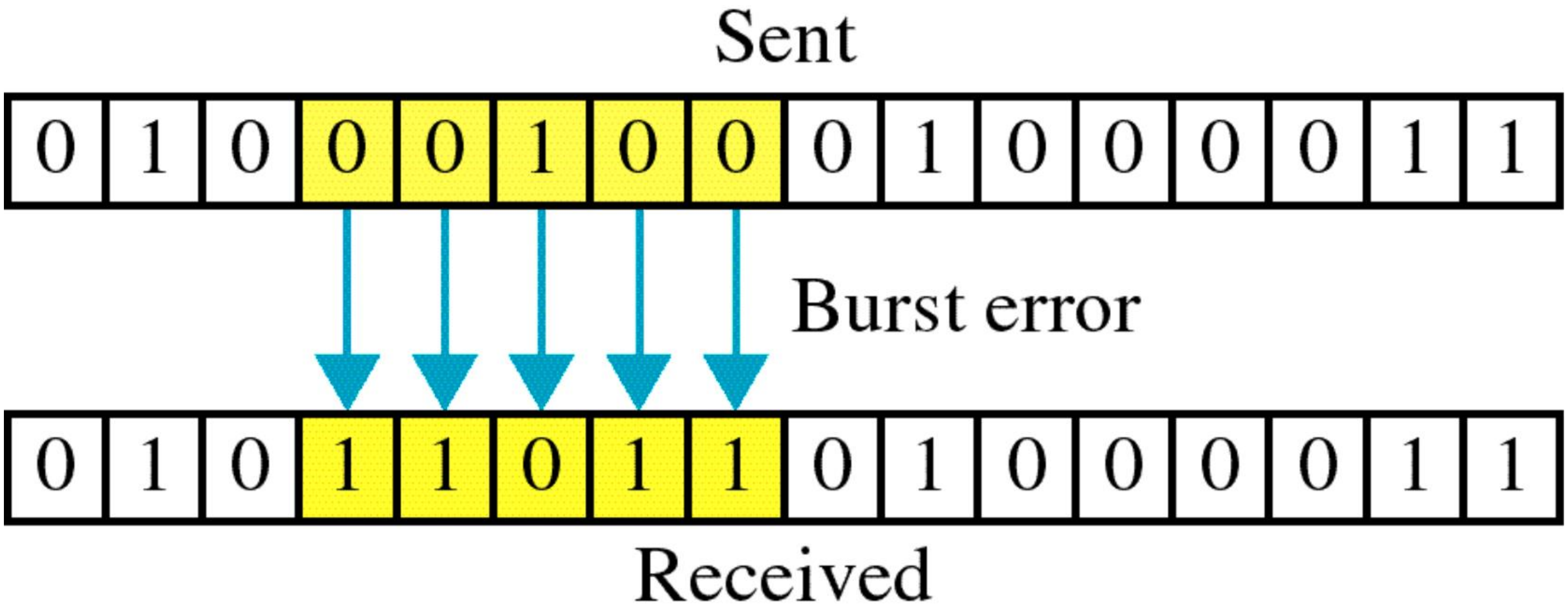
Error Detection and Correction

Multiple-bit error



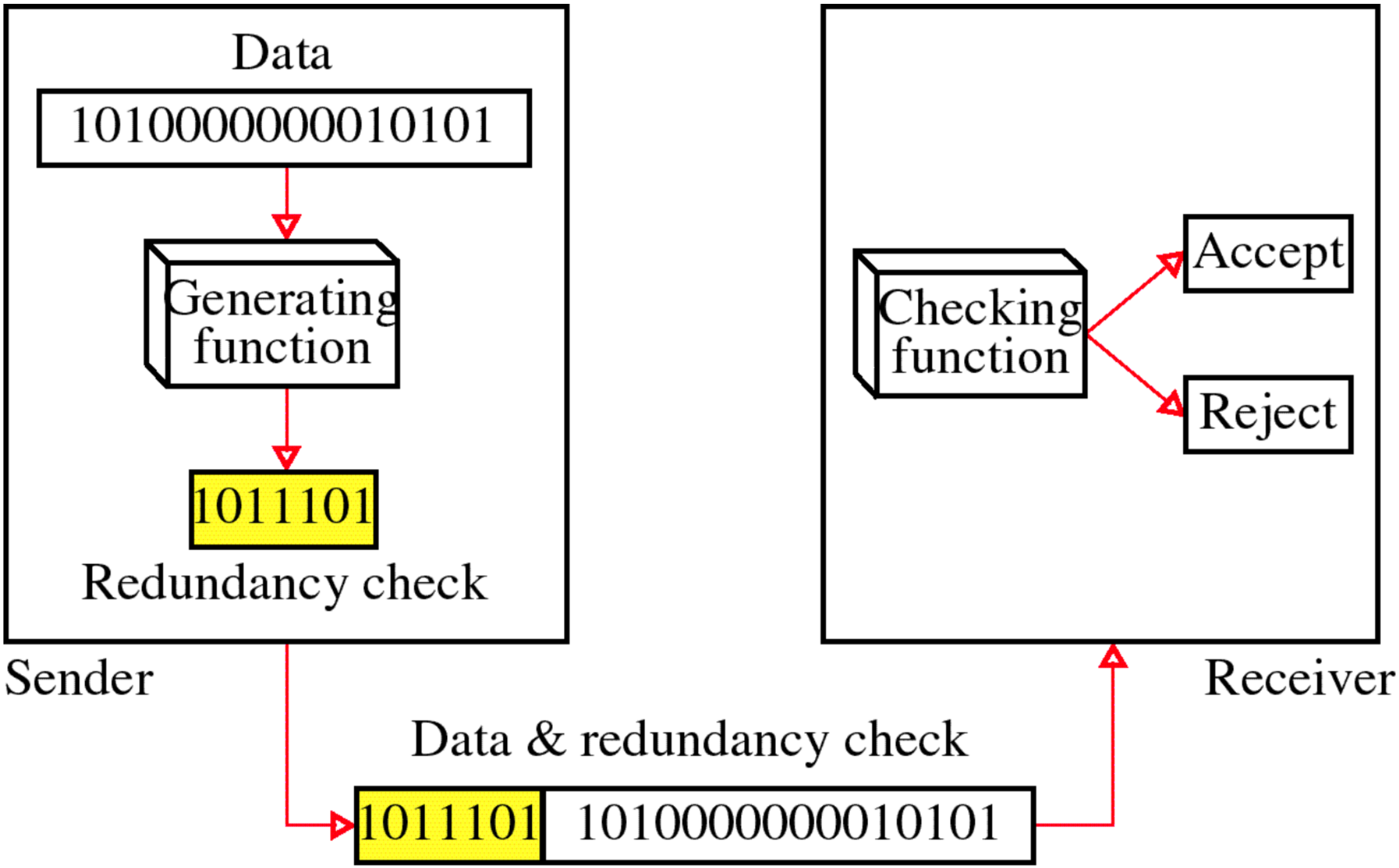
Error Detection and Correction

Burst error

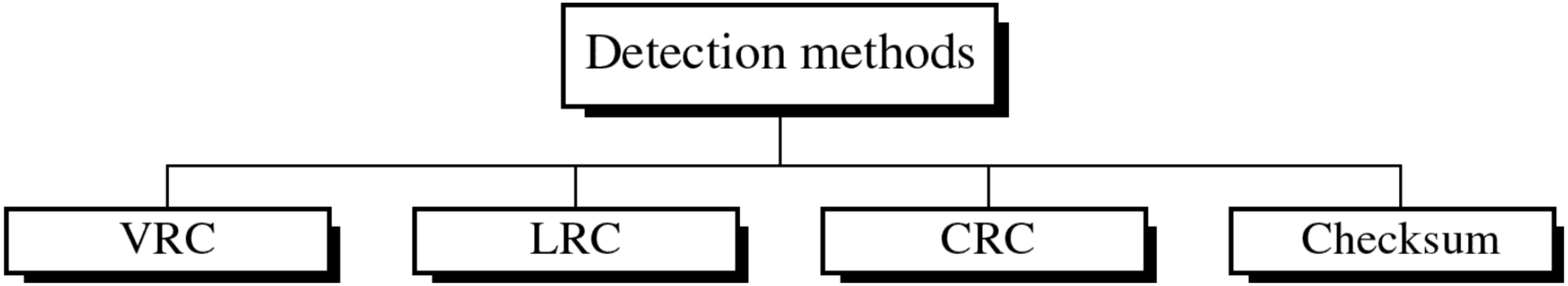


Error Detection and Correction

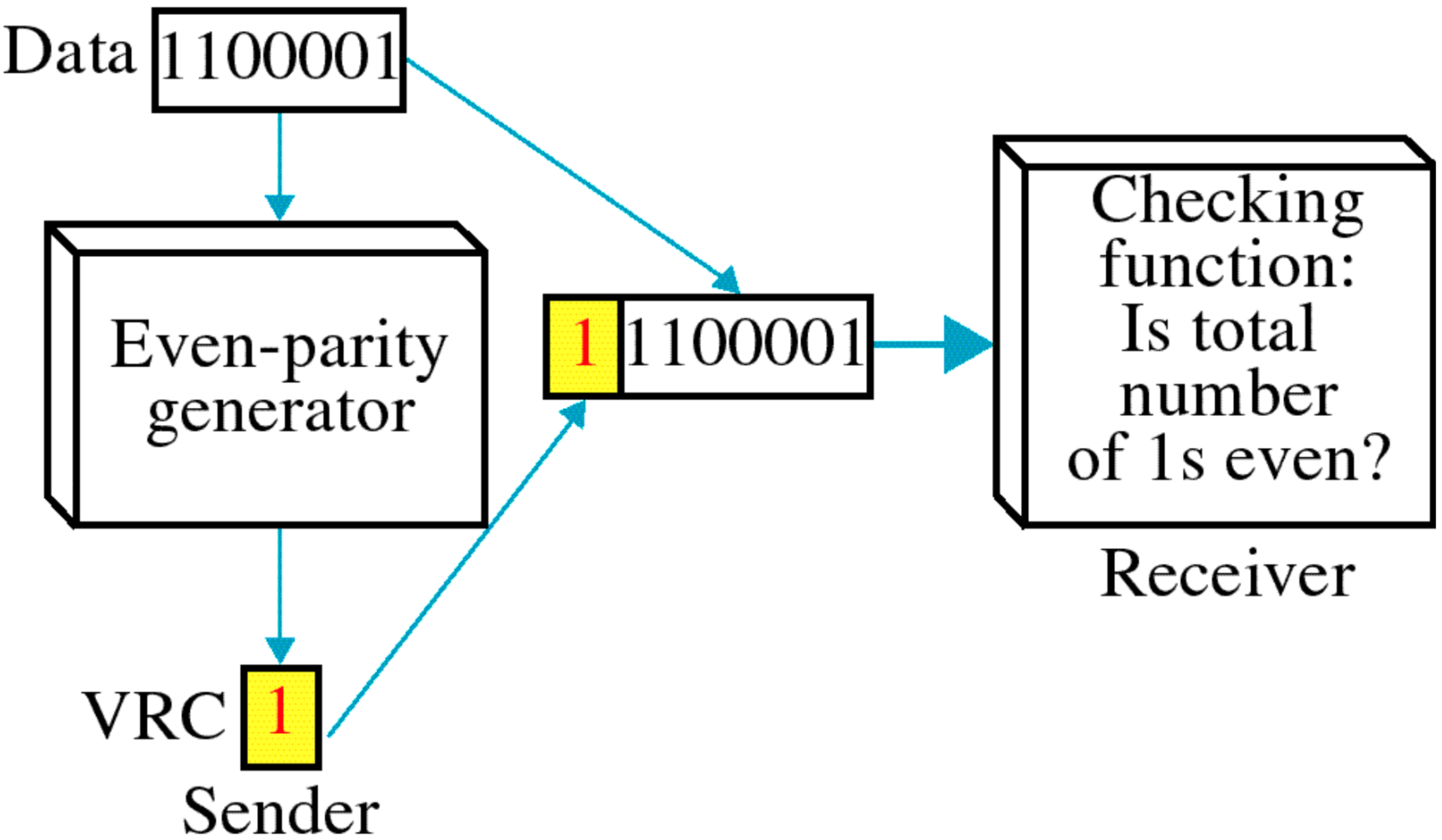
Redundancy



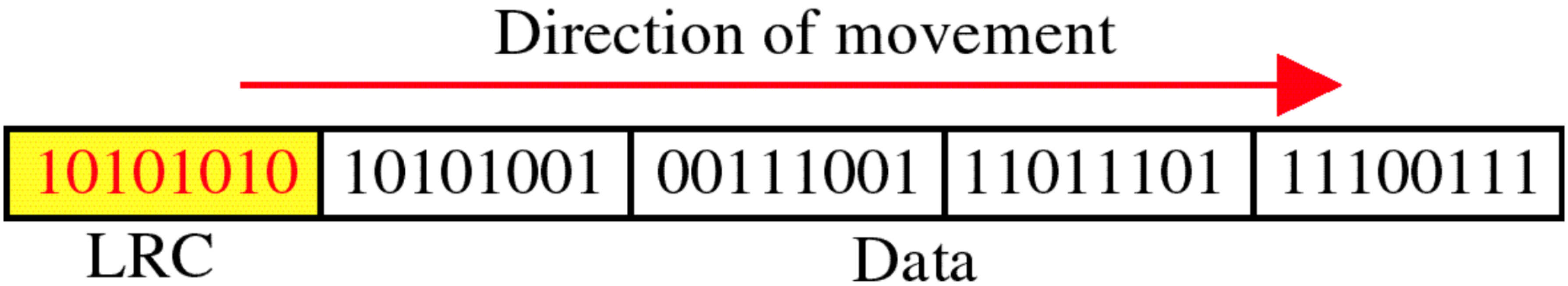
Error Detection and Correction



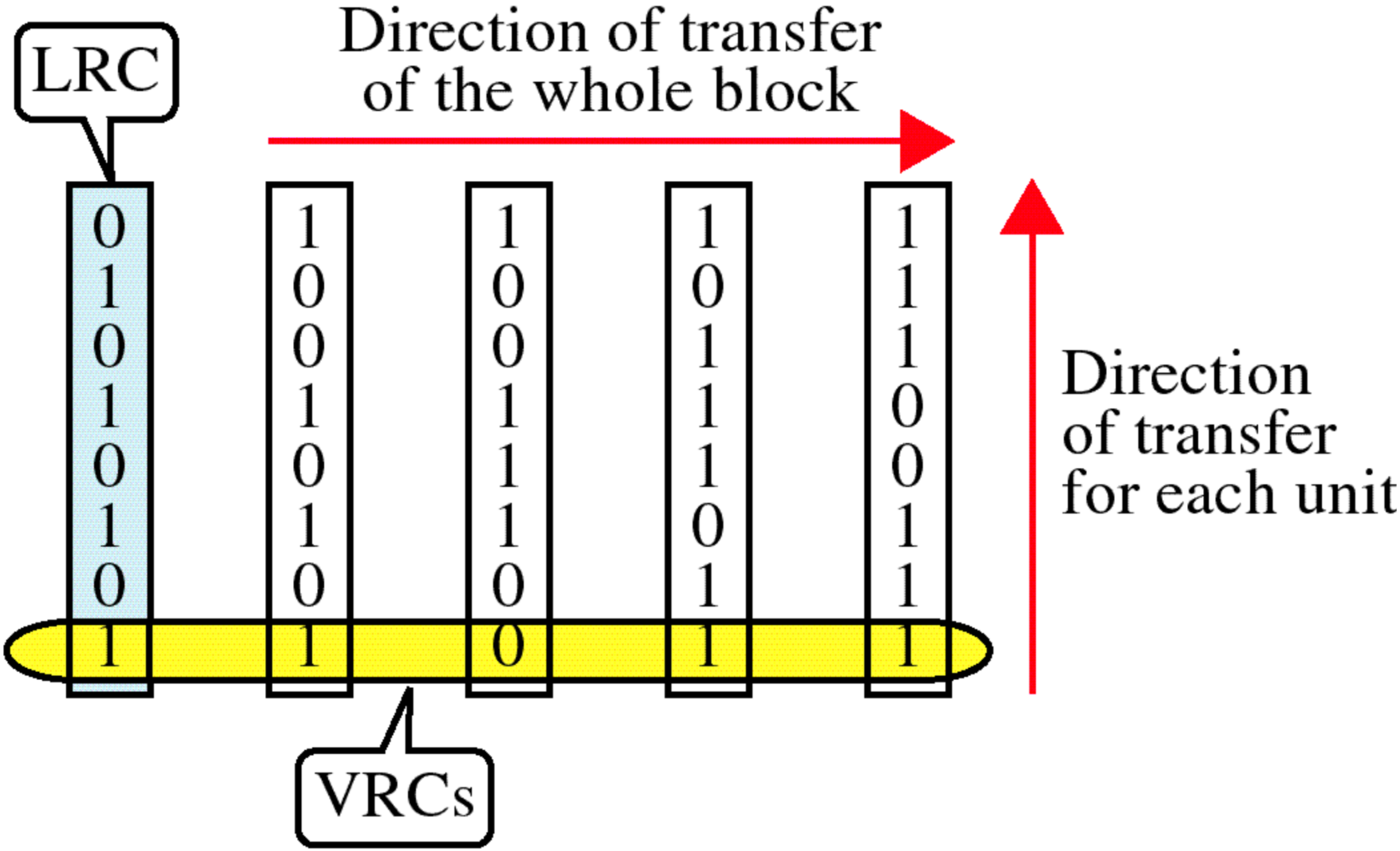
VRC


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

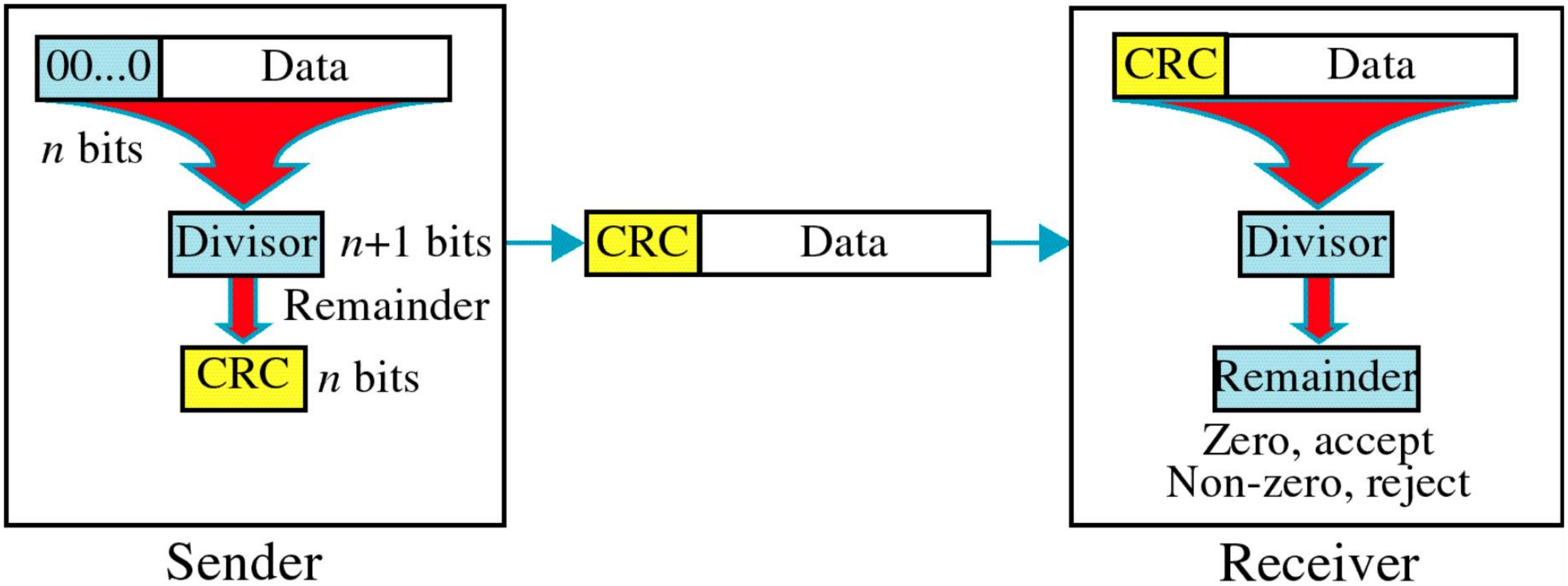
LRC


Direction of movement
10101010
10101001
00111001
11011101
11100111
LRC
Data

VRC and LRC

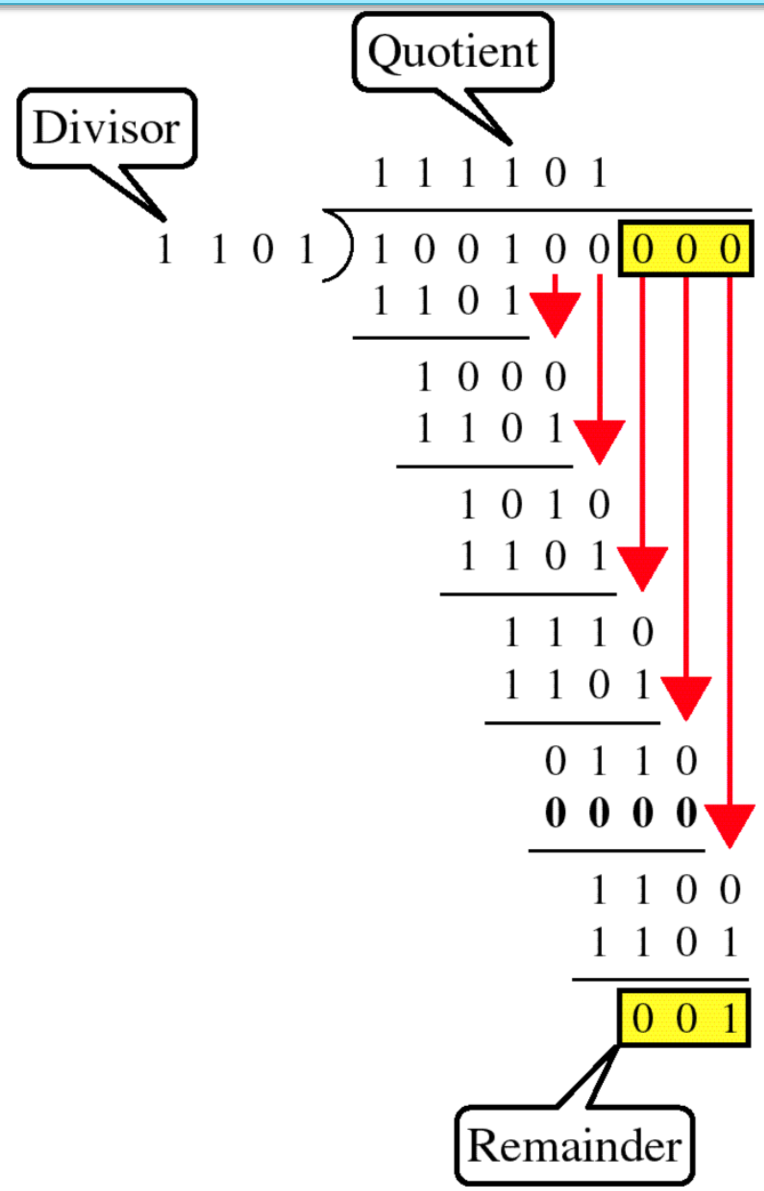

LRC
Direction of transfer of the whole block
0 1 0 1 0 1 0 1
1 0 0 1 0 1 0 1
1 0 0 1 1 1 0 0
1 0 1 1 1 0 1 1
1 1 1 0 0 1 1 1
Direction of transfer for each unit
VRCs

CRC :cyclic Redundancy check



Error Detection

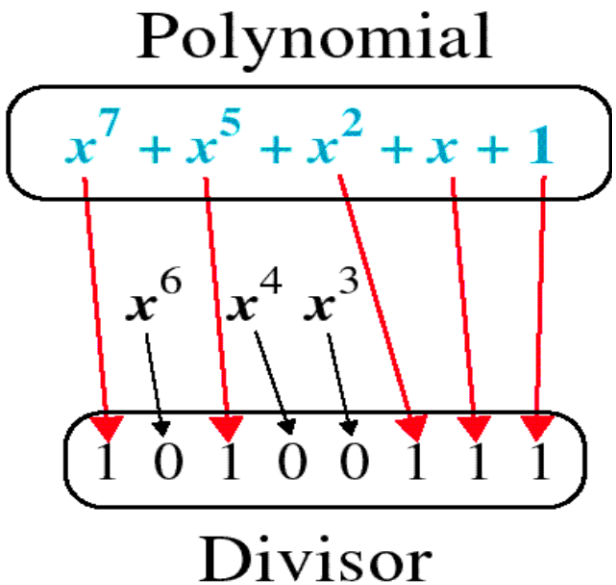
Binary Division



Error Detection: CRC

Polynomial

$$x^7 + x^5 + x^2 + x + 1$$



Error Detection: CRC

Standard Polynomials

CRC-12

$$x^{12} + x^{11} + x^{3} + x + 1$$

CRC-16

$$x^{16} + x^{15} + x^{2} + 1$$

CRC-ITU

$$x^{16} + x^{12} + x^{5} + 1$$

CRC-32

$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + x + 1$$

Error Detection: CRC

original message

1010000

@ means X-OR

Generator polynomial

x^3+1

$1.x^3+0.x^2+0.x^1+1.x^0$

CRC generator

$\boxed{1001}$ 4-bit

If CRC generator is of n bit then append (n-1) zeros in the end of original message

Sender

```
1001 | 1010000000
      @1001
       0011000000
         @1001
          0101 0000
          @1001
           0011000
            @1001
             01010
             @1001
              0011
```

Message to be transmitted

```
1010000000
      +011
1010000011
```

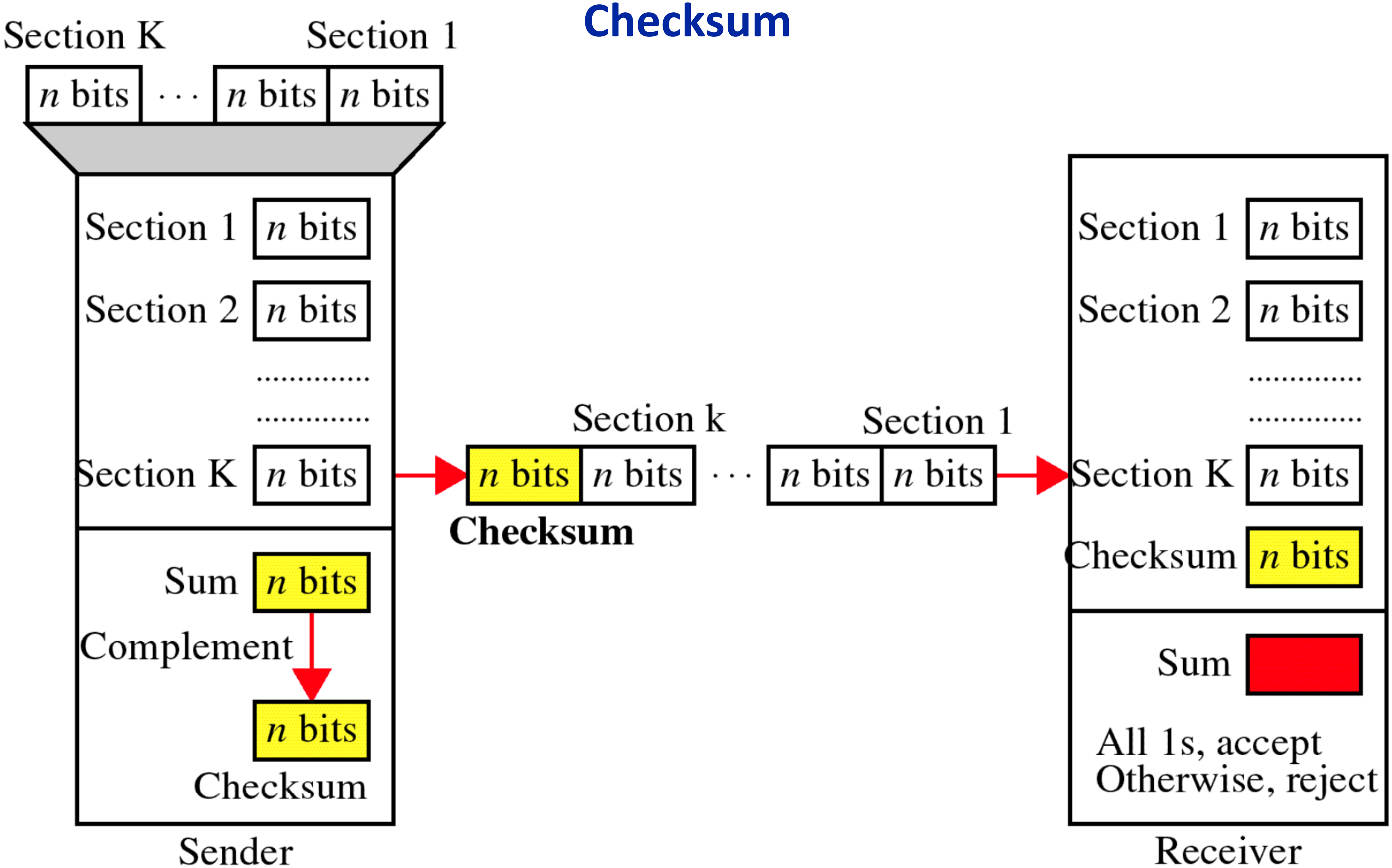
```
1001 | 1010000011
      @1001
       0011000011
         @1001
          0101 0011
          @1001
           0011011
            @1001
             01001
             @1001
              0000
```

Receiver

Zero means data is accepted

Error Detection: CRC

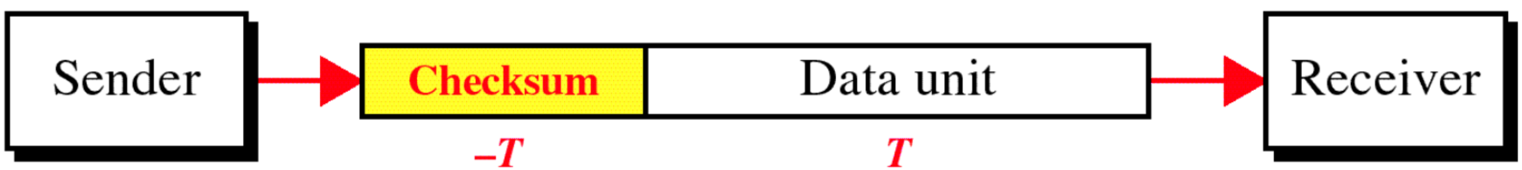
Checksum



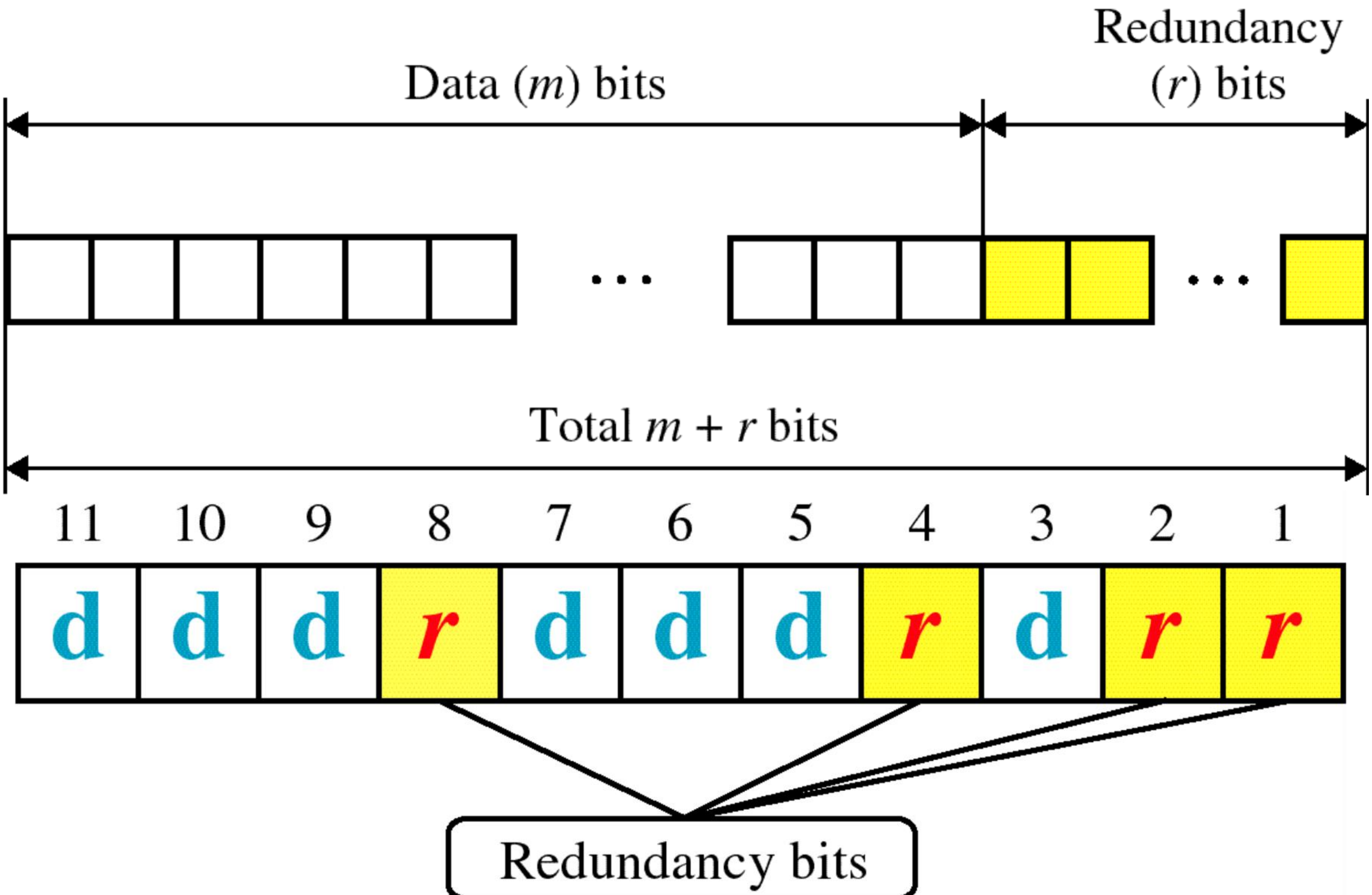
Error Detection: CRC

Data Unit and Checksum

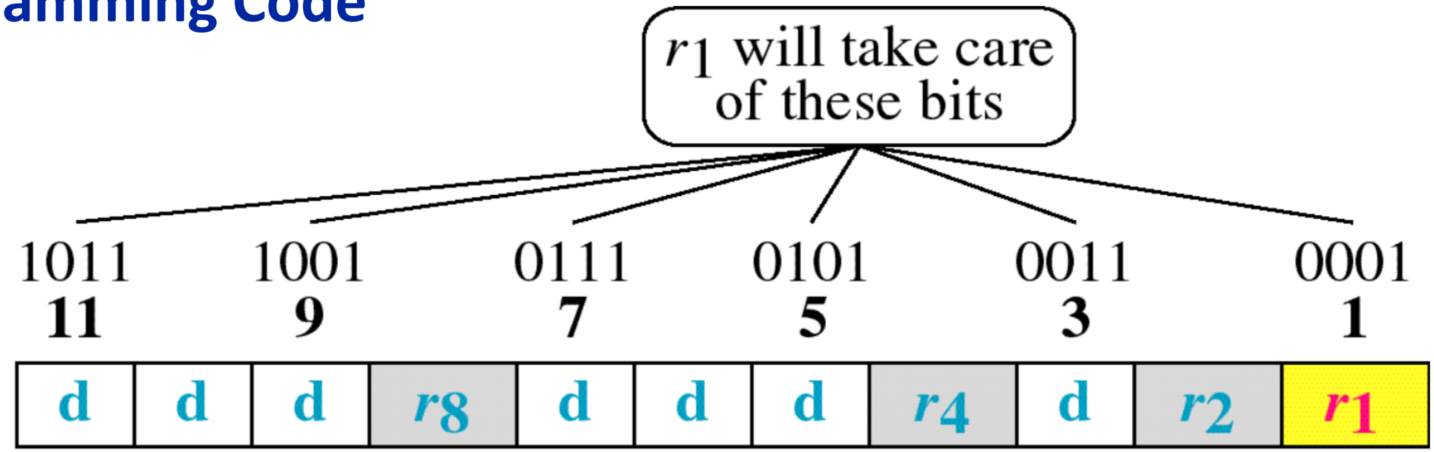
The receiver adds the data unit and the checksum field. If the result is all 1s, the data unit is accepted; otherwise it is discarded.

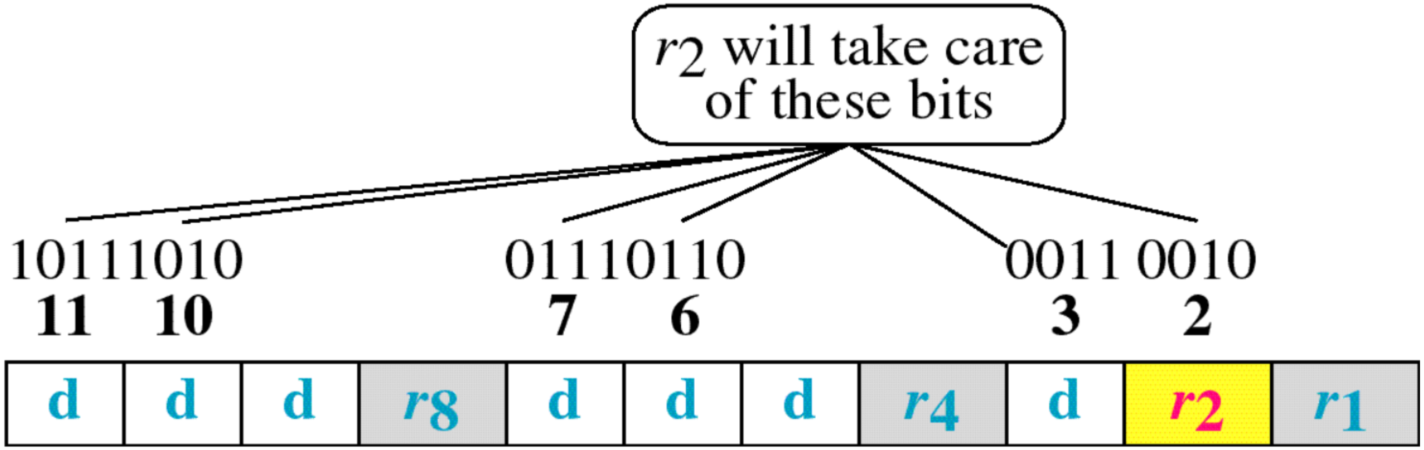


Error Detection and correction : hamming code

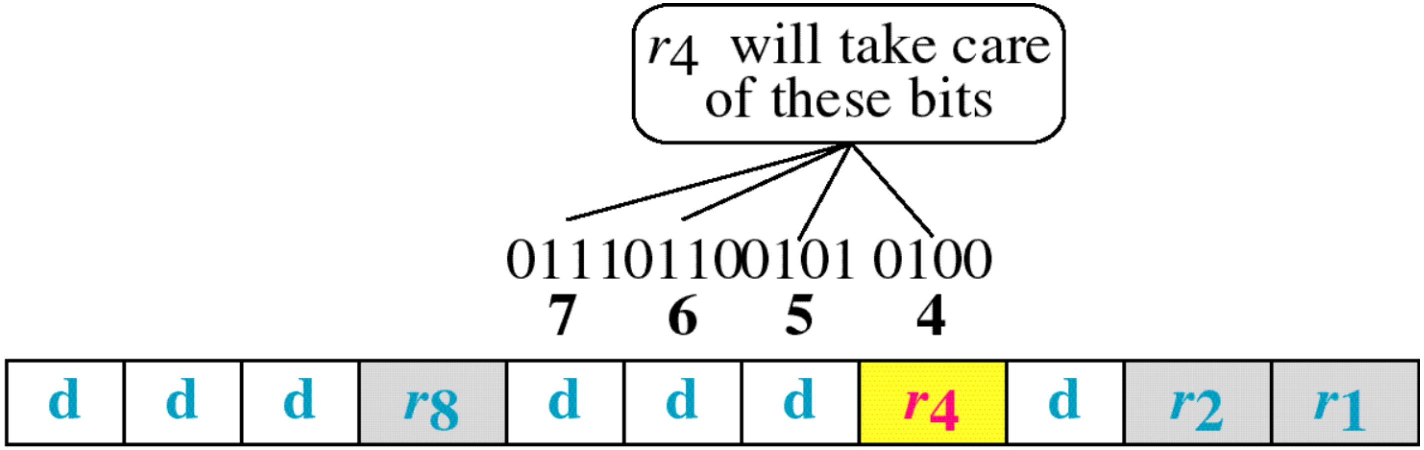


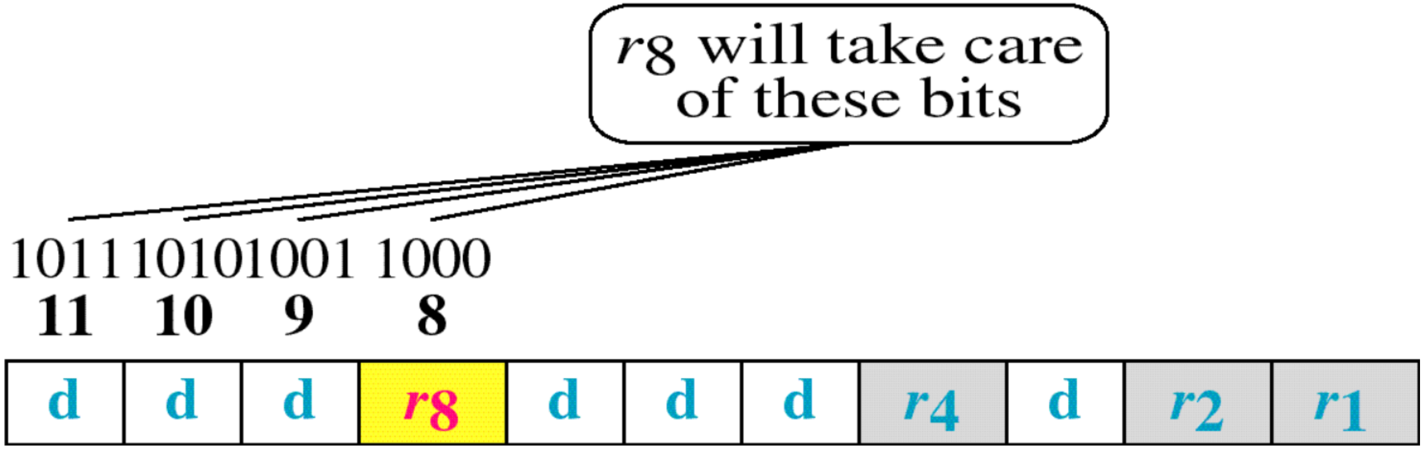
Hamming Code





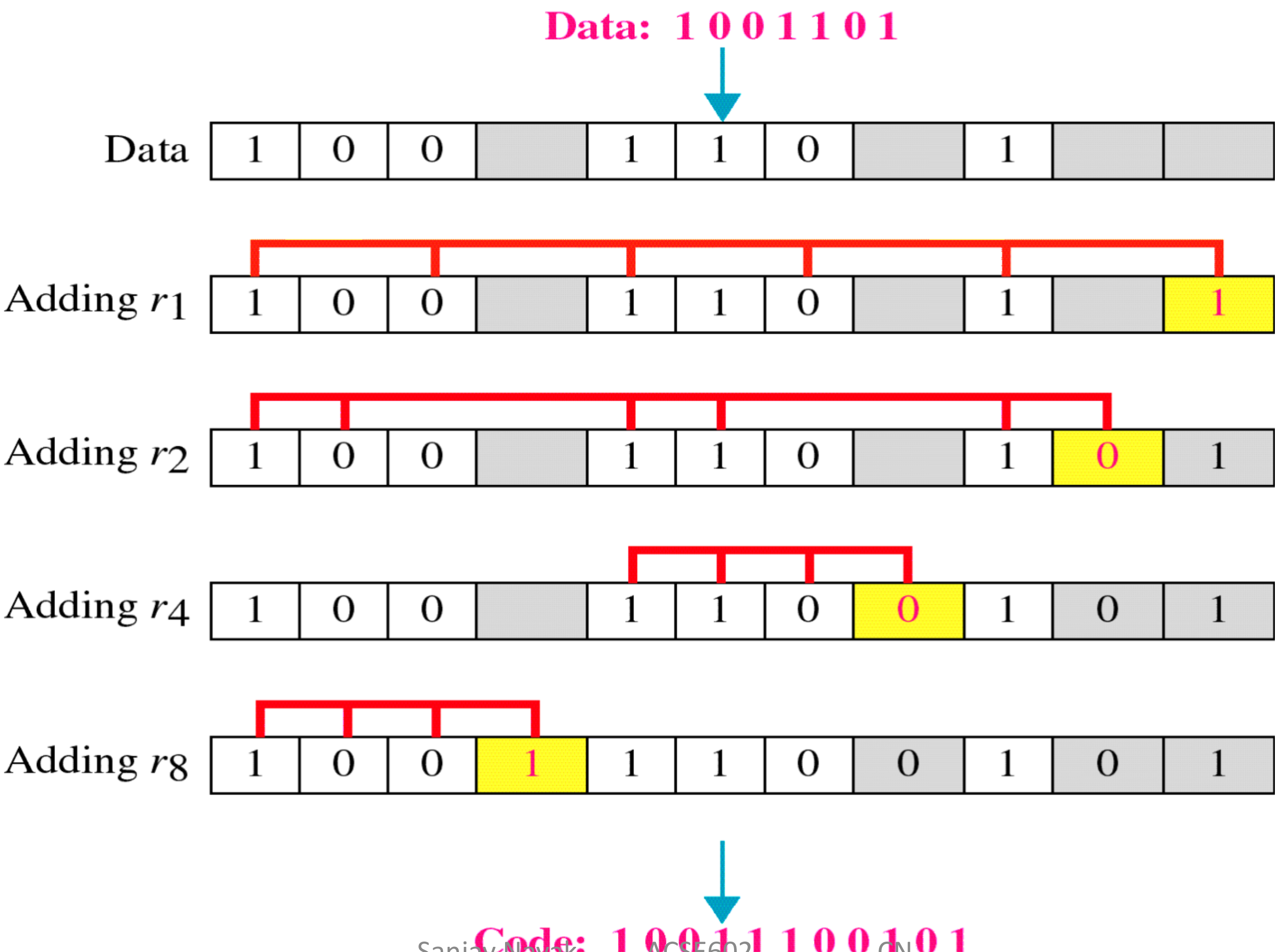
Error Detection and correction : hamming code





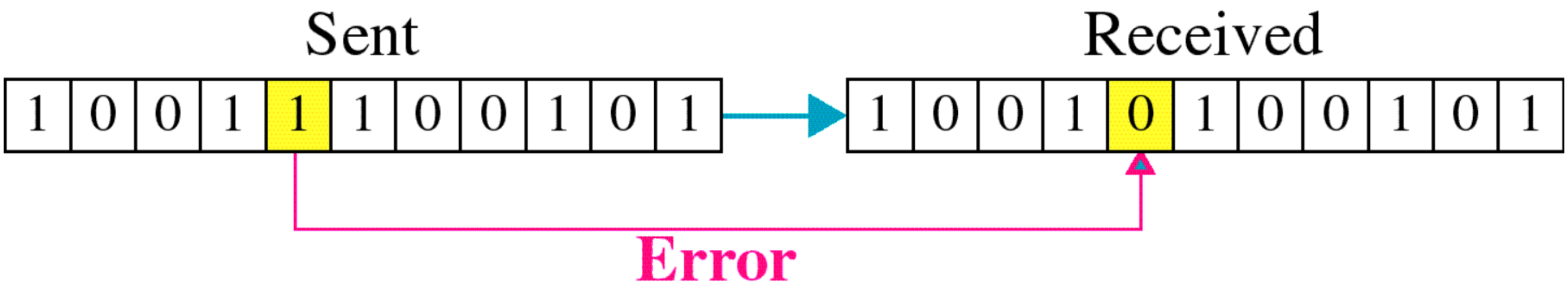
Error Detection and correction : hamming code

Example of Hamming Code



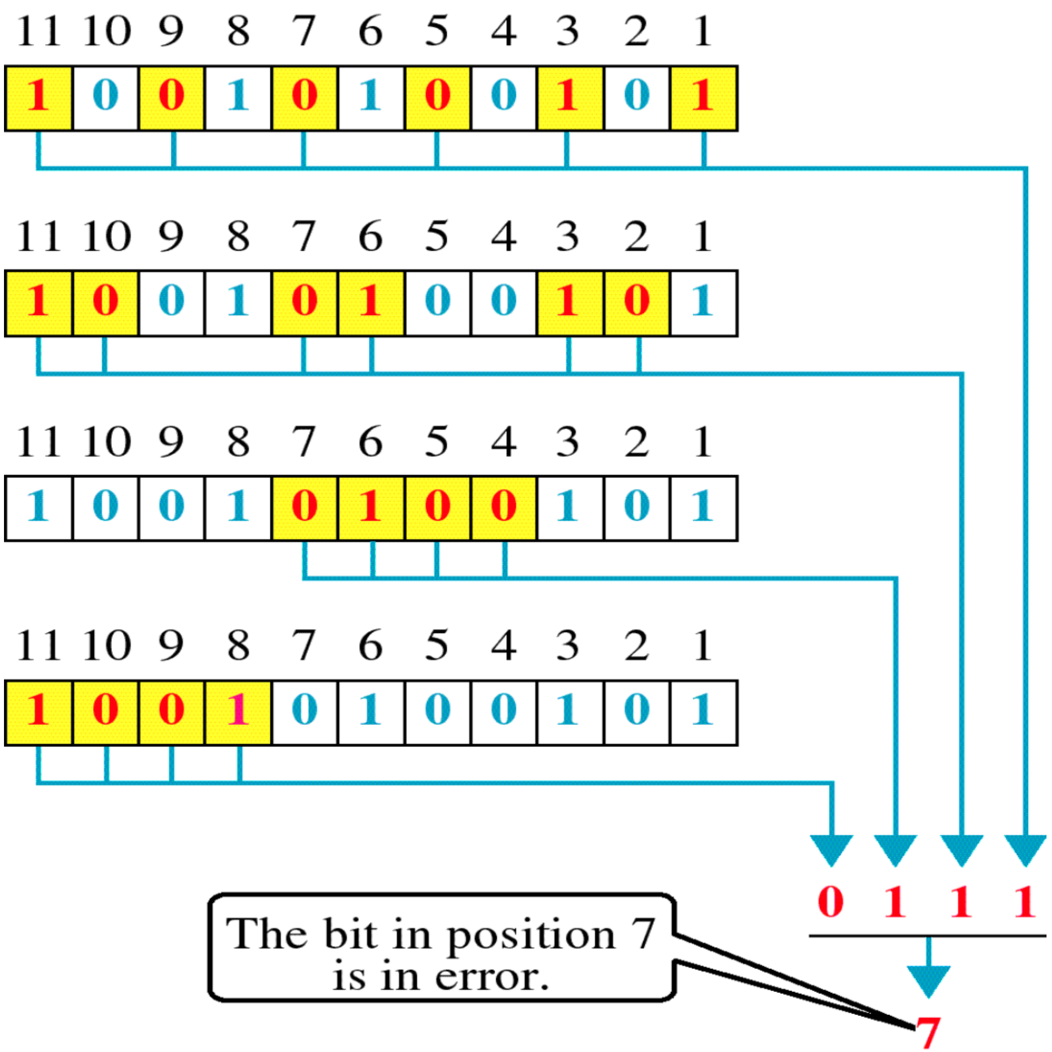
Error Detection and correction : hamming code

Single-bit error



Error Detection and correction : hamming code

Error Detection



Faculty Video Links, Youtube & NPTEL Video Links and Online Courses Details

Youtube /other Video Links

- https://www.youtube.com/watch?v=JFF2vJaN0Cw&list=PLxCzCOWd7aiGFBD2-2joCpWOLUrDLvVV_

- https://www.youtube.com/watch?v=yNedVgNyE8Q

Sanjay Nayak CN KCS603 Unit Number 2

Daily Quiz

1. Let G(x) be the generator polynomial used for CRC checking. What is the condition that should be satisfied by G(x) to detect odd number of bits in error?

   (A) G(x) contains more than two terms
   (B) G(x) does not divide 1+x^k, for any k not exceeding the frame length
   (C) 1+x is a factor of G(x)
   (D) G(x) has an odd number of terms.

2. Data link layer deal with data in the form of –

   a. Bit b. Packet c. **Frame** d. Segment

3. In Bit stuffing we insert-------- after 00000.

   a. 1 b. **0** c. 00 d. 11

Daily Quiz

4. In Ethernet when Manchester encoding is used, the bit rate is:
(A) Half the baud rate. **(B)** Twice the baud rate.
(C) Same as the baud rate. **(D)** None of the above
5. Which of the following is a MAC address?
(A) 192.166.200.50 **(B)** 00056A:01A01A5CCA7FF60
(C) 568, Airport Road **(D) 01:A5:BB:A7:FF:60**
6. Pure and Slotted term related to which type of protocol-
   a. CSMA b. **ALOHA** c. Token ring d. FDDI
7. IEEE 802.5 related to protocol-
   a. Internetworking b. Ethernet c. **Token ring** d. Token Bus
8. IEEE 802.3 related to protocol-
   a. Internetworking b. **Ethernet** c. Token ring d. Token Bus
9. Which combination is correct for IPv6 and IPv4 –
   a. 48 & 32 b. 32 & 48 c. 128 & 48 d. **128 & 32**
10. CRC method is –
   a. **Error Detection** b. Error Correction c. Both d. None of above

Weekly Assignment

1. Name the functions of Data link layer (CO2)
2. Name the error control methods at data link layer. (CO2)
3. Explain the need of flow control. (CO2)
4. Calculate the frame transmission time for the frame length 30 bytes at the speed of 10Mbps. (CO2)
5. Name the IEEE standards for LAN.(CO2)
6. DQDB and FDDI standards.(CO2)
7. Explain the format of token in token ring topology. (CO2)
8. Explain the need of bit stuffing. (CO2)
9. find the checksum for the given data 1010000111001010(CO2)
20. Write the efficiency of pure aloha and slotted aloha protocol(CO2)
11. Calculate CRC code for given data 10011000 with given divisor x3+x2+1(CO2)
12. Calculate hamming code for the given 7 bit data 1101101. (CO2)

Weekly Assignment Unit 2 (CO2)

Max. Marks 30 Max. Time 40 Minutes

Attempt Any Three

Question 1.Discuss the main duties of Data link layer of OSI model.
Question 2. Explain the channel allocation problem in data link layer.
Question 3. Sketch the graph between Throughput(S) and Offered load(G) for pure and slotted ALOHA. Also write Formula of Throughput (S) for Pure & Slotted ALOHA
Question 4. Measurement of a PURE ALOHA channel with an infinite no. of users. Show that 23% slots are idle. Find out a) What is the channel load (G) b) What is the Throughput (S) ? c) Is the channel underloaded or overloaded with reason.

ALL THE BEST

MCQ s

Question: What is the primary function of the Data Link Layer?

1. A) Routing
2. **B) Error detection and correction**
3. C) Flow control
4. D) All of the above

Question: Which sublayer of the Data Link Layer is responsible for Media Access Control (MAC)?

1. A) LLC (Logical Link Control)
2. B) HDLC (High-Level Data Link Control)
3. **C) MAC (Media Access Control)**
4. D) CRC (Cyclic Redundancy Check)

Question: What is the purpose of framing in the Data Link Layer?

1. A) To detect errors
2. **B) To mark the beginning and end of a frame**
3. C) To encrypt data
4. D) To manage flow control

Question: Which addressing method is used by the MAC sublayer?

1. A) IP Addressing
2. **B) Physical Addressing**
3. C) Logical Addressing
4. D) Port Addressing

Question: In Ethernet, what is the size of the MAC address?

1. A) 32 bits
2. **B) 48 bits**
3. C) 64 bits
4. D) 128 bits

MCQ s

Question: Which addressing method is used by the MAC sublayer?

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Question: In Ethernet, what is the size of the MAC address?

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Question: Which protocol is commonly used for point-to-point communication at the Data Link Layer?

1. A) ARP (Address Resolution Protocol)
2. **B) PPP (Point-to-Point Protocol)**
3. C) SNMP (Simple Network Management Protocol)
4. D) ICMP (Internet Control Message Protocol)

Question: What is the purpose of the CRC (Cyclic Redundancy Check) in the Data Link Layer?

1. A**) Error detection**
2. B) Address resolution
3. C) Flow control
4. D) Encryption

Question: Which of the following is a synchronous serial communication protocol used in the Data Link Layer?

1. A) Ethernet
2. B) Token Ring
3. C) **HDLC (High-Level Data Link Control)**
4. D) ATM (Asynchronous Transfer Mode)

MCQ s

1. **Question:** In which OSI layer does the Data Link Layer reside?
    1. A) Layer 1 (Physical Layer)
    2. **B) Layer 2 (Data Link Layer)**
    3. C) Layer 3 (Network Layer)
    4. D) Layer 4 (Transport Layer)
2. **Question:** Which of the following is a half-duplex communication mode?
    1. **A) Simplex**
    2. B) Duplex
    3. C) Full-duplex
    4. D) None of the above
3. **Question:** Which protocol is commonly used for wireless LANs in the Data Link Layer?
    1. A) Ethernet
    2. B) Token Ring
    3. C) IEEE 802.11 (Wi-Fi)
    4. **D) PPP (Point-to-Point Protocol)**

Old Question Papers

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(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 110601 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. VI) THEORY EXAMINATION 2013-14

COMPUTER NETWORK

Time : 3 Hours *Total Marks : 100*

Note :— (1) Attempt all questions.

(2) All questions carry equal marks.

1. Attempt any four parts of the following : (5×4=20)

(a) Discuss the TCP/IP protocol suite on the basis of protocol layering principle.

(b) Define topology and explain the advantage and disadvantage of Bus, Star and Ring topologies.

(c) Explain briefly the bus backbone and star backbone.

(d) Explain the user access in ISDN.

(e) Compare twisted pair, co-axial and fiber optic cable.

(f) Explain the various types of Switching Methods with suitable examples.

2. Attempt any four parts of the following : (5×4=20)

(a) State drawbacks of stop and wait protocols.

(b) What is piggybacking ?

(c) Which are the requirements of CRC ?

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Old Question Papers

(d) How can you compare pure ALOHA and Slotted ALOHA ?

(e) Explain about CSMA/CD and CSMA/CA and its uses.

(f) Differentiate between 802.3, 802.4 and 802.5 IEEE Standards.

3. Attempt any **two** parts of the following : **(10×2=20)**

(a) What is meant by fragmentation ? Is fragmentation needed in concentrated virtual circuit internets, or in any datagram system.

(b) Give an IP address, how will you extract its net-id and host-id and compare IPv4 and IPv6 with frame format.

(c) (i) What is meant by unicast and multicast routing with suitable diagrams ?

(ii) Write a short note on Leaky bucket algorithm.

4. Attempt any **two** parts of the following : **(10×2=20)**

(a) Explain about the TCP header and working of TCP protocol and differentiate between TCP and UDP with frame format.

(b) Define cryptography with the help of block diagram of Symmetric and Asymmetric key cryptography.

(c) Write short notes on :

(i) Digital audio

(ii) Audio compression

(iii) Streaming audio.

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5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Explain the two mail access protocols in brief :

(i) POP3

(ii) IMAP

(iii) SMTP

(b) Write a short note on :

(i) FTP

(ii) DNS

(iii) MIME

(iv) TFTP

(c) Explain about e-mail architecture and services.

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Expected Questions for University Exam

1. Compare CSMA, CSMA/CD and CSMA/CA (CO3)

2. Measurements of a pure aloha channel with a infinite no. of users show that 12% of the slots are idle. (CO3)

a) What is the offered load (G)

b) What is the throughput(S)

c) Is channel overload or under load.

Summary

In this unit we have discussed functions of data link layer and how the data is represent at data link layer using data link layer protocols.

How header is attached to the data received by network layer and error is detected and corrected at receiver site as well as flow control is managed so that receiver will not be overflow by data.

Recap of Unit

- Functions of data link layer
- Sub layers of data link layer
- Project 802
- PDU format,MAC frame
- IEEE LAN standards
- Ethernet
- Token Ring
- FDDI
- DQDB
- Data Link Layer Protocols
- Multiple Access Protocol
- Flow control
- Error control

References

Books:

1. Forouzen, "Data Communication and Networking",TMH

2. A.S. Tanenbaum, Computer Networks, Pearson Education

3. W. Stallings, Data and Computer Communication, MacmillanPress

References

Thank You