CHAPTER
Protocols and IEEE Standards

Chapter Objectives

- Discuss different media level protocols including their functioning
- The major protocols chosen for discussion are as follows:
  - CSMA/CD, token passing and polling
- Discuss the IEEE standards that apply to LANs based on different protocols

Chapter Modules

- LAN Protocol: Carrier Sense Multiple Access/Collision Detection (CSMA/CD)
- LAN Protocol: Token Passing
- LAN Protocol: Polling
- IEEE Standards

IEEE and Lower Layer LAN Protocols

IEEE Background

- Institution of Electrical and Electronic Engineering (IEEE)
- A professional non-profit organization
- Project group 802 under IEEE
  - Entrusted with the task of setting standards relating to physical and logical links of nodes in a network
- Standard mostly applies to the Physical and Data Link layers
- Example
  - IEEE 802.3 standard for the Ethernet bus network

The ISO-OSI Model Recalled

- Models the end-to-end communication process
- It is a seven-layer model
- Proposed by International Standard Organization (ISO)
- The model is known as Open Systems Interconnect (OSI)
- IEEE sets the standards at the lower levels of the ISO-OSI model

ISO-OSI Seven Layer Model

Layer 7	**Application**
Layer 6	**Presentation**
Layer 5	**Session**
Layer 4	**Transport**
Layer 3	**Network**
Layer 2	**Data Link**
Layer 1	**Physical**

Focus of
IEEE 802

Comparison of ISO-OSI Model and the DOD (TCP/IP) Model

Application	**Application**
Presentation	
Session	
Transport	**Host-to-Host**
Network	**Internet**
Data Link	**Network Access**
Physical	

Layer Reference to Protocol

Application	**Application**	**FTP, Telnet, SMTP, HTTP, SNMP ..**
Presentation		
Session		
Transport	**Host-to-Host**	**TCP, UDP**
Network	**Internet**	**IP, ICMP**
Data Link	**Network Access**	**Ethernet, Token-Ring ...**
Physical		

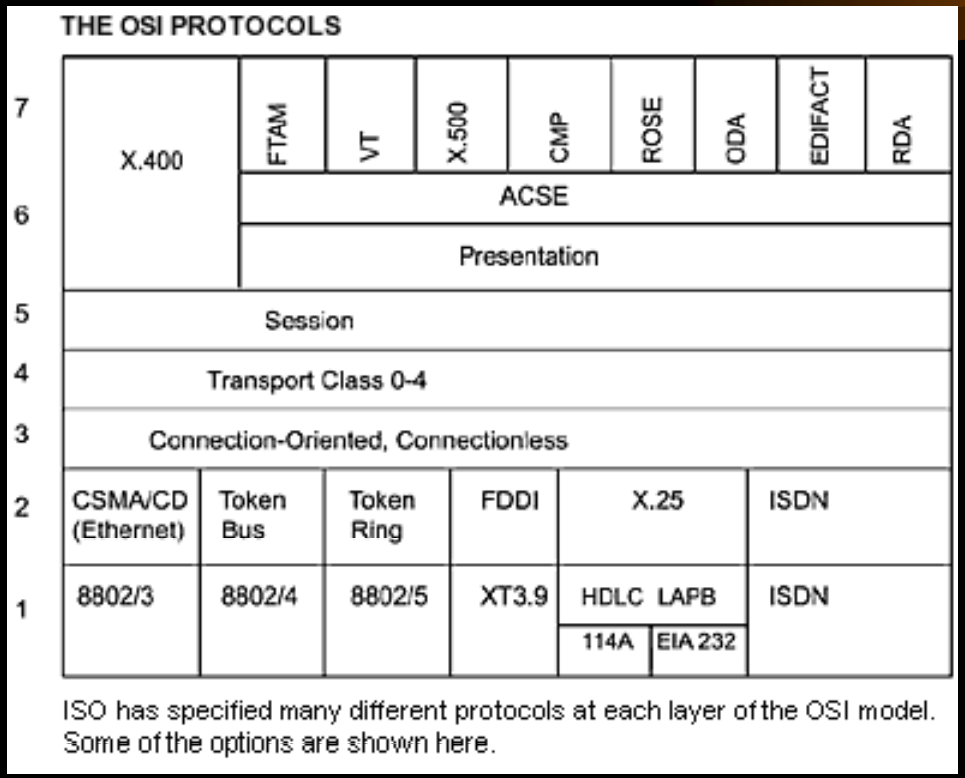
Network Protocols

MYRIAD PROTOCOL STACKS

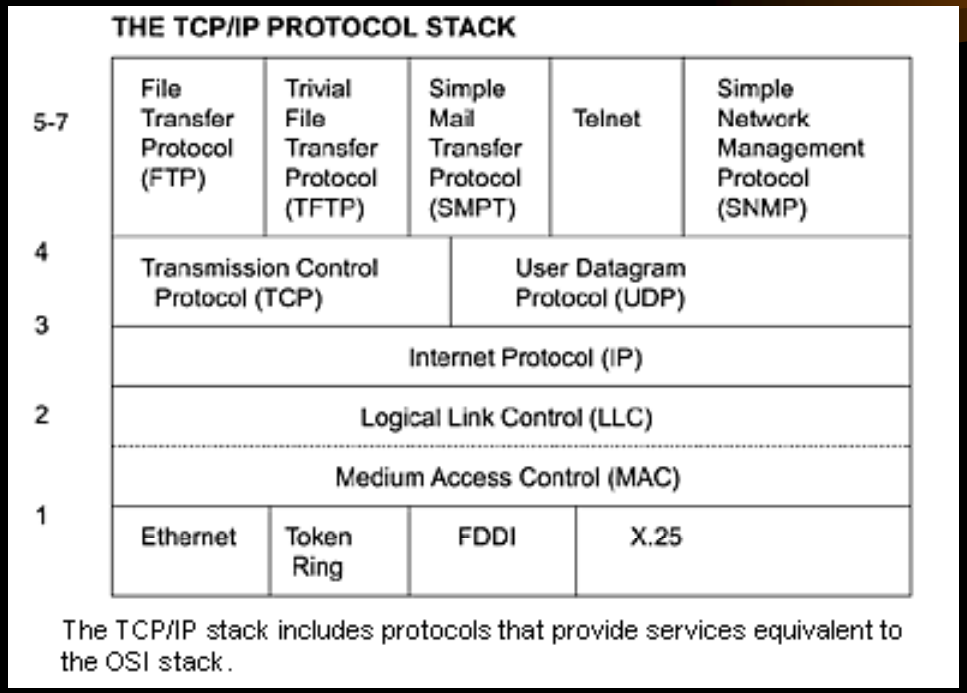
Layer	ISO	TCP/IP	IBM
7. Application	FTAM X.400 JTAM X.500 VT CASE	SMTP FTP NFS Telnet SNMP	
6. Presentation	8923		
5. Session	8327		NetBIOS APPC
4. Transport	8073 (TPO) 8602 (CONS)	UDP TCP	NetBEUI APPC
3. Network	8208 (X.25) 8473 (CLNS) 9542 (ES-IS) 8348 (CONS)	IP	APPC
2. Data-Link	8802.2 LLC 8802.3/4/5	LLC Ethernet	LLC HDLC SDLC MAC
1. Physical	8802.3 Ethernet 8802.4 Token Bus 8802.5 Token Ring	Ethernet FDDI Token Ring	Token Ring Ethernet

The OSI model is not a single definition of how data communications takes place. It states how the processes should be divided and offers several options. In addition to the OSI protocols, as defined by ISO, networks can use the TCP/IP protocol suite, the IBM Systems Network Architecture (SNA) suite, and others. TCP/IP and SNA roughly follow the OSI structure.

Another Look at Network Protocols



Network Protocols in the TCP/IP Model



The TCP/IP stack includes protocols that provide services equivalent to the OSI stack.

IEEE 802 Focus

- OSI Reference
  - Data Link layer
  - Physical layer
- Areas of applications
  - Network cards and cables
  - WAN connectivity etc.
- Different subgroups under 802 that focus on different activities of the LAN

IEEE 802 Subgroups and their Responsibilities

- 802.1
  - Internetworking
- 802.2
  - Logical Link Control (LLC)
- 802.3
  - CSMA/CD
- 802.4
  - Token Bus LAN

Continued

IEEE 802 Subgroups and their Responsibilities (Cont.)

- 802.5
  - Token Ring LAN
- 802.6
  - Metropolitan Area Network
- 802.7
  - Broadband Technical Advisory Group
- 802.8
  - Fiber-Optic Technical Advisory Group

Continued

IEEE 802 Subgroups and their Responsibilities (Cont.)

- 802.9
  - Integrated Voice/Data Networks
- 802.10
  - Network Security
- 802.11
  - Wireless Networks
- 802.12
  - Demand Priority Access LANs
  - Ex: 100BaseVG-AnyLAN

Ethernet Protocol Standards

- 10 Mbps
  - IEEE 802.3
- 100 Mbps
  - IEEE 802.3u
- 1 Gbps
  - IEEE 802.3ab
  - Uses all 4 pairs of the RJ-45 cable (www.techfest.com/networking/lan/ethernet1.htm)
- 10 Gbps
  - IEEE 820.3ae

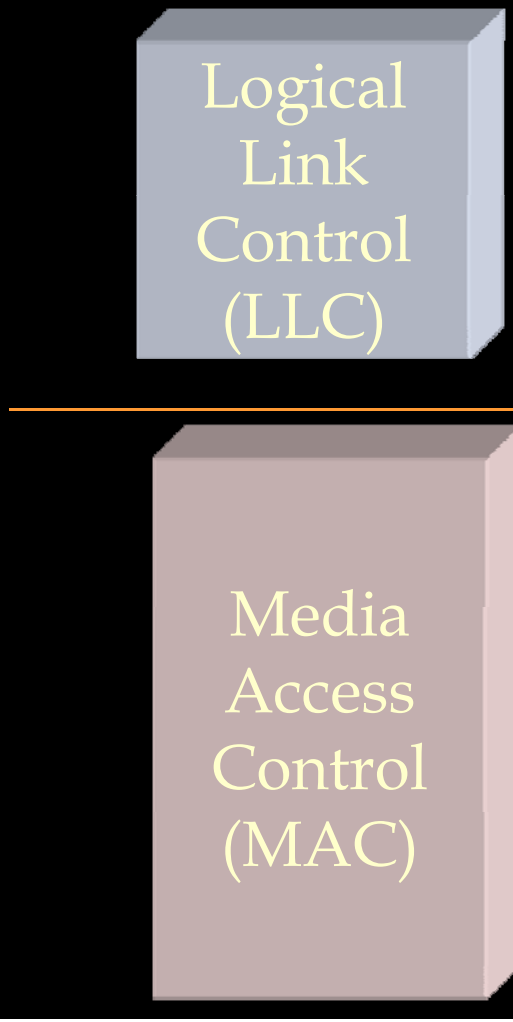
Wireless LAN Protocols

- **802.11**
  - 1-2 Mbps, 2.4 GHz, FHSS and DSSS
- IEEE 802.11a
  - 54 Mbps, 5 GHz, Orthogonal Frequency Division Multiplexing
- IEEE 802.11b
  - 11 Mbps, 2.4 GHz, DSSS
- IEEE 802.11g
  - 20+ Mbps, 2.4 GHZ
  - 108 Mbps, 2.4 GHz (Extreme G)

Newer Wireless Protocol

- IEEE 802.11n

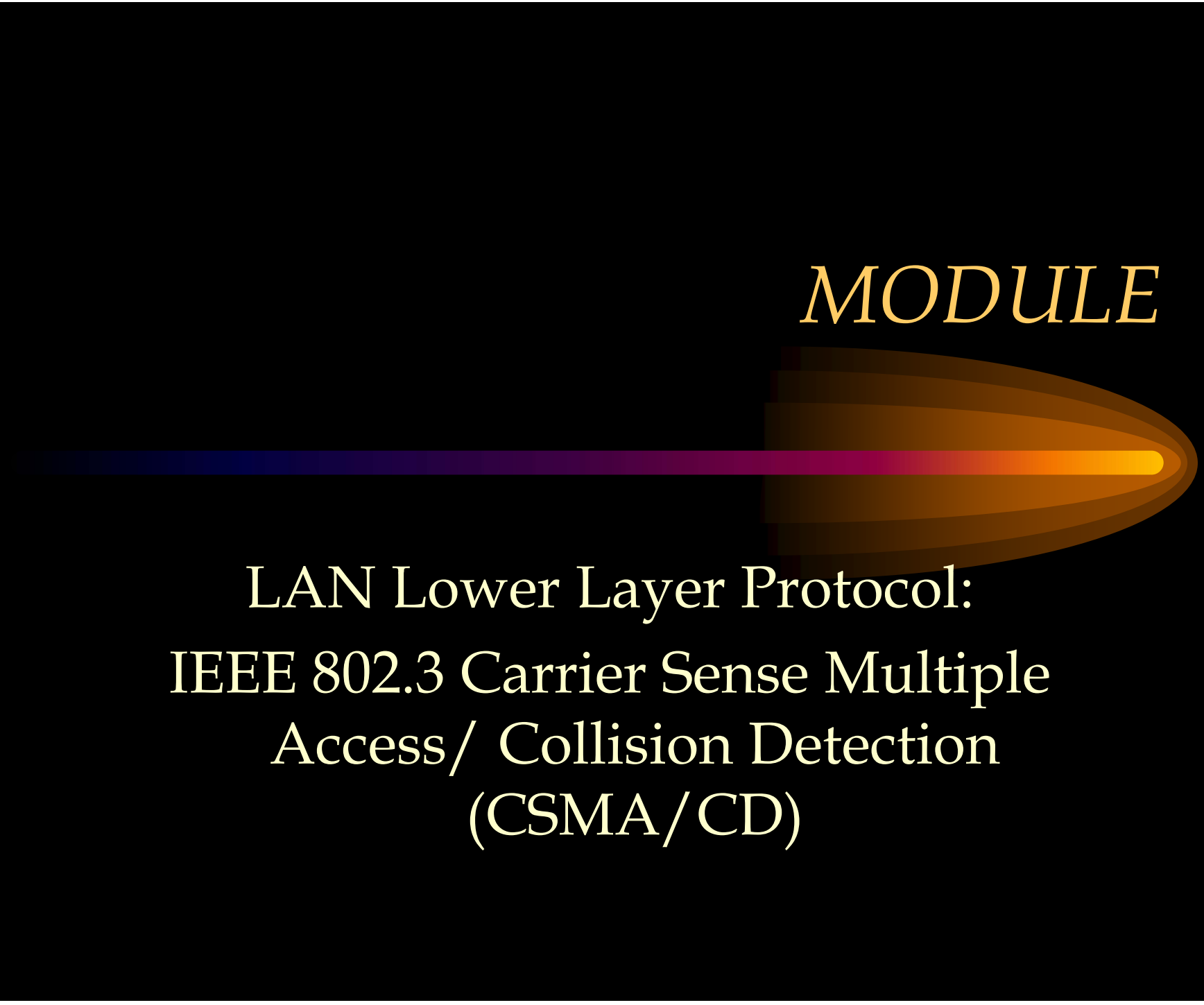
A Perspective of IEEE 802 Standards in Network Communication



802.2

802.3
802.4
802.5
802.12

802.1 applies to both.


MODULE
LAN Lower Layer Protocol:
IEEE 802.3 Carrier Sense Multiple Access/ Collision Detection (CSMA/CD)

An Overview of CSMA/CD

- CSMA/CD has two components as mentioned
- First is the Carrier Sense Multiple Access (CSMA) component
- Second is the Collision Detection (CD) component

CSMA Component of CSMA/CD

- CSMA (Carrier Sense Multiple Access)
  - Check the bus for traffic
  - If the bus is free, then transmit
  - If it is busy, wait for a random period of time before attempting to transmit again

CD Component of CSMA/CD

- Two stations may check the data bus simultaneously
- Both may find the line free and engage in the transmission of data
- Both transmission will collide
- CD component will detect this collision
  - Inform the workstations of the collision
- Each station will wait for a random period of time before attempting to transmit again

CSMA/CD Usage

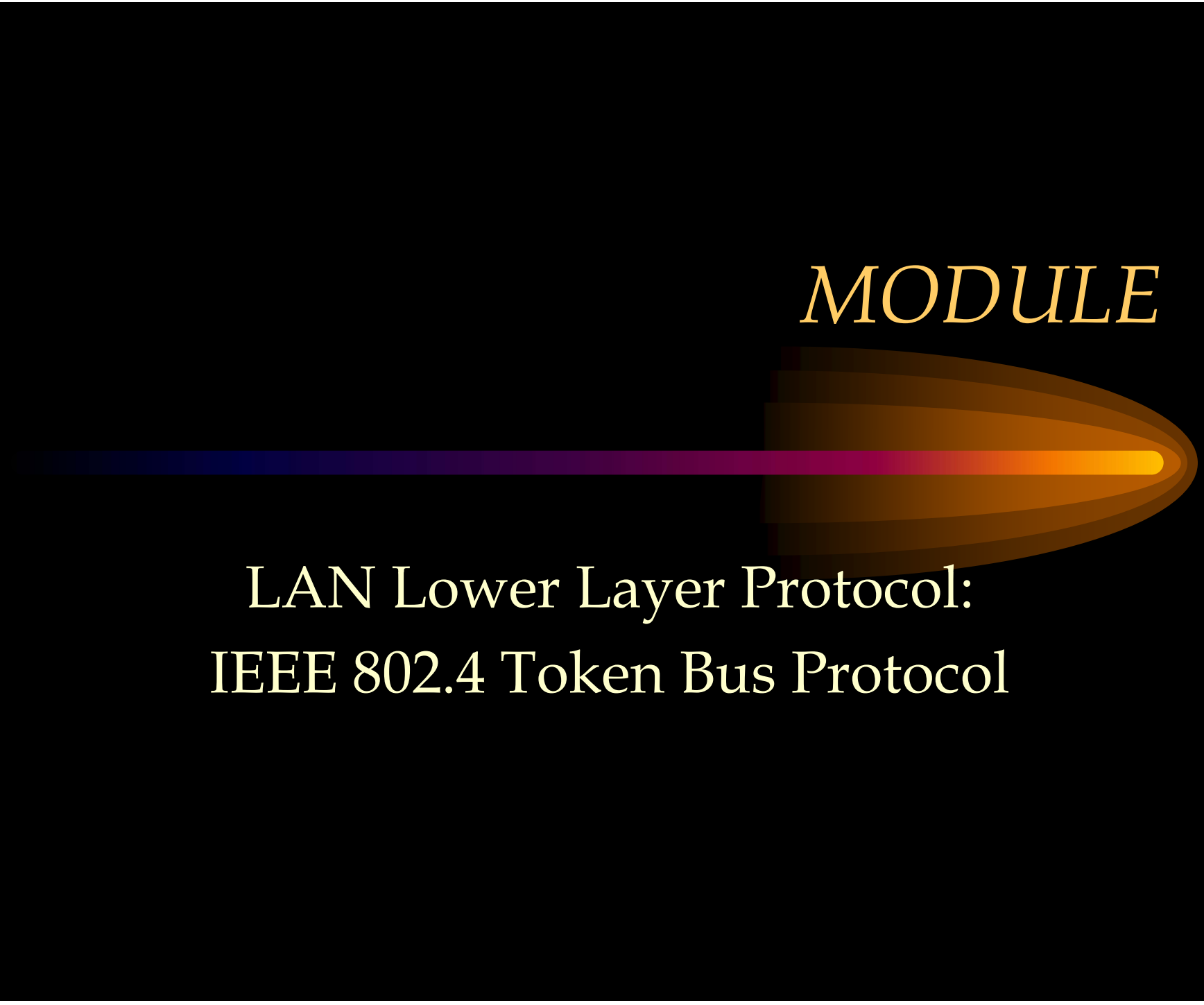
- Used extensively in bus LANs

CSMA/CD Standards

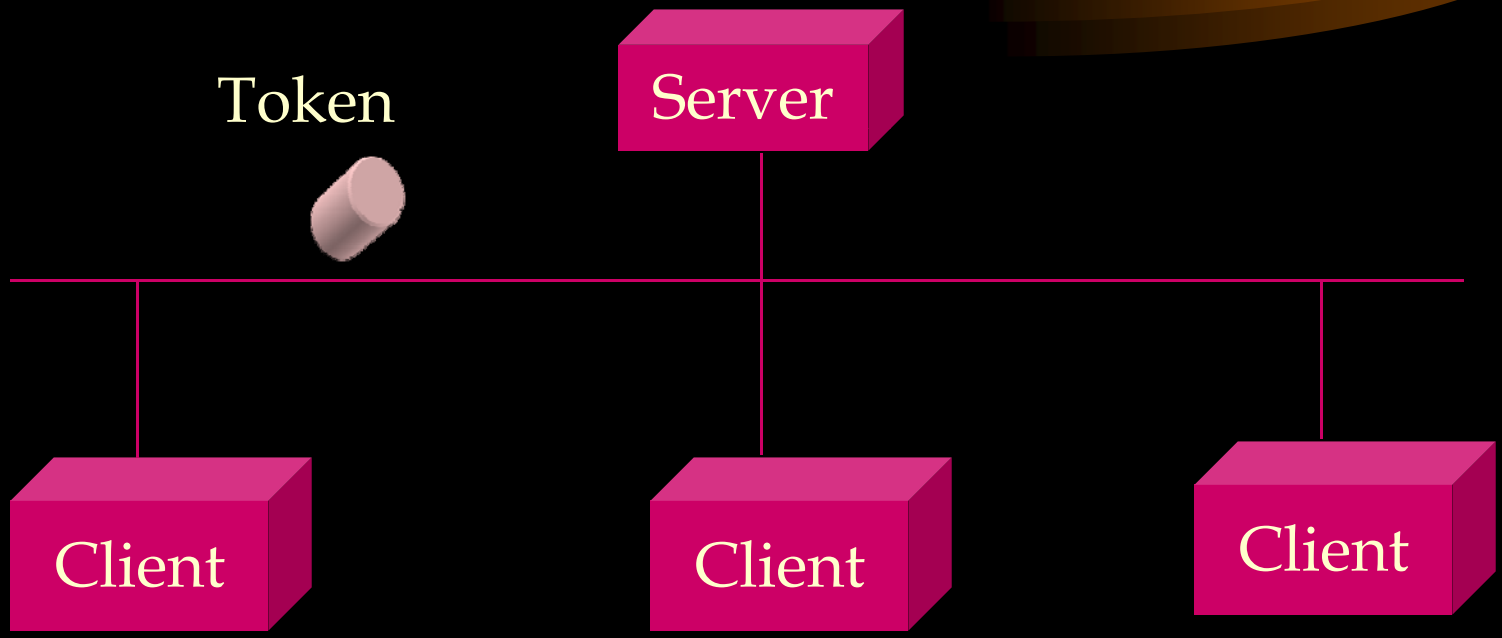
- Highly standardized protocol
- Different protocol standards for different speeds of communication
- 10 Mbps Ethernet standard
  - IEEE 802.3

IEEE 802.3

- 10G bps Ethernet
  - IEEE 802.3z
- 1G bps Ethernet
  - IEEE 802.3ab
- 100M bps Ethernet
  - IEEE 802.3u
- 10M bps Ethernet
  - IEEE 802.3


MODULE
LAN Lower Layer Protocol:
IEEE 802.4 Token Bus Protocol

Token Bus



A token is distributed to each client in turn.

Token Bus Data Pickup

- A token is sent from one node to the other
- The client wanting to transmit grabs an empty token
- Data is attached
- Token leaves for the next node and its travel on the bus until it reaches the address to which the data is destined

Cont.

Token Bus Data Delivery

- Token delivers the data to the addressee
- Acknowledgement is returned to the sender
- Token is passed to the next node
- The process continues
- If there is an error in delivering the information, a request for retransmission attached to the token and it is sent to the sender

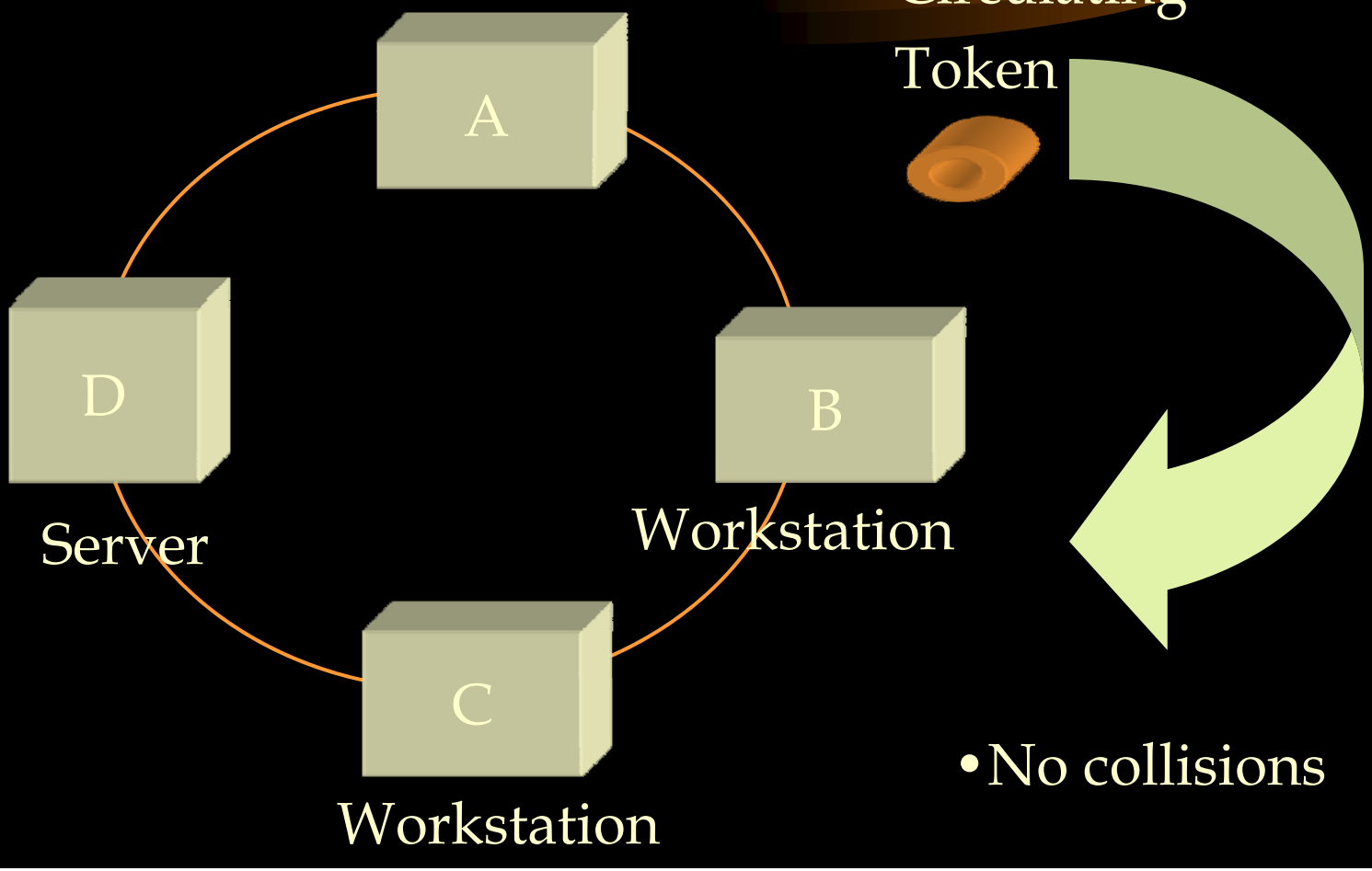
Token Bus Standard and Applications

- IEEE 802.4
- It can be used in both broadband and baseband transmission

MODULE

LAN Lower Layer Protocol: IEEE 802.5 Token Passing Protocol

Token Passing Protocol in Operation



- No collisions

Comparison with CSMA/CD

- Absence of collision
- Offers a systematic method of transmitting information
- In theory, it is superior to CSMA/CD
- More sophisticated to implement
- Protocols used in the newer and most popular networks are, however, based on CSMA/CD

The Token

- Token
  - Data packet that could carry data
  - Circulates around the ring
  - Offers an opportunity for each workstation and server to transmit data

The Transmitting Workstation

- Waits for a free token in order to be able to attach the data to be transmitted to the token
- On finding a free token, attach the following:
  - Sender's address
  - Receiver's address
  - Data block to be transmitted
  - Error checking details
  - etc.

At the Receiving End

- Data is received and checked for errors
- Outcomes at the receiving end
  - Data received without errors
  - Date received with errors

Error-free Delivery of Data

- An acknowledgment is attached to the token
- Acknowledgment is passed to the sender
- Token is set free for other nodes to transmit information
- At this time, the next workstation on the ring will receive an opportunity

Correcting Errors in Delivery

- A request for retransmission is attached to the token
- Token carries the message for retransmission to the sender
- The data is thus retransmitted

Token Regeneration

- The token is regenerated at regular intervals to sustain the timing of circulation of the token

Usage of Token Passing

- Used extensively in ring LANs
  - Especially in the IBM token-ring LAN
- A version of this protocol is also used on certain types of bus LANs
  - Token-bus networks
- Used in large fiber-optics backbones
  - Used for the construction of very large networks

Usage in Practice

- Used in backbones
- Uses in a number of IBM shops
- Overall, the usage of Ethernet surpasses the usage of Token-Ring networks that are based on the Token-Passing protocol

Token Passing Standards

- IEEE 802.5
  - For the token-ring LANs
- IEEE 802.4
  - For the token-bus LANs
- A FDDI protocol is used on large fiber-optic ring backbones

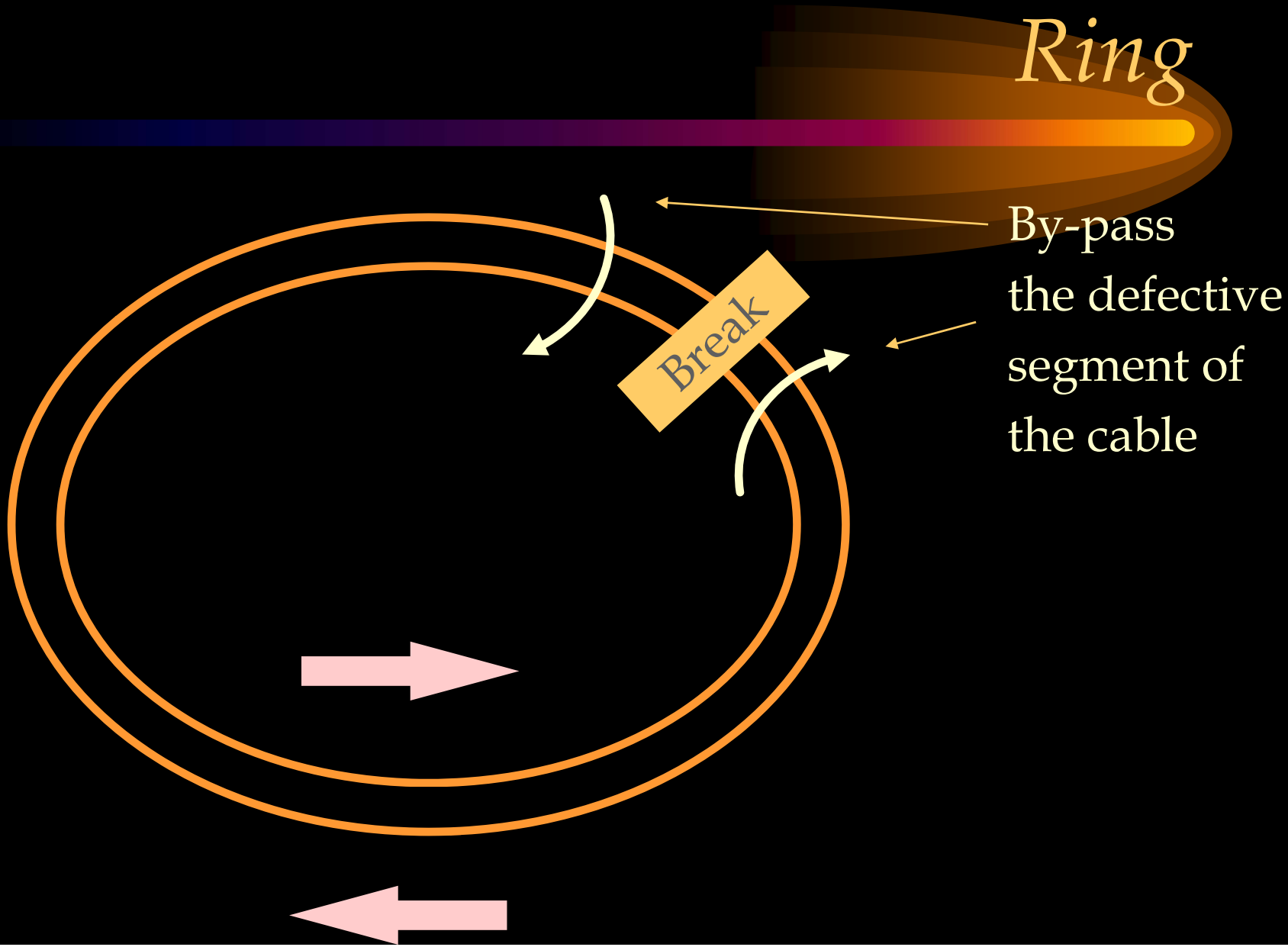
MODULE

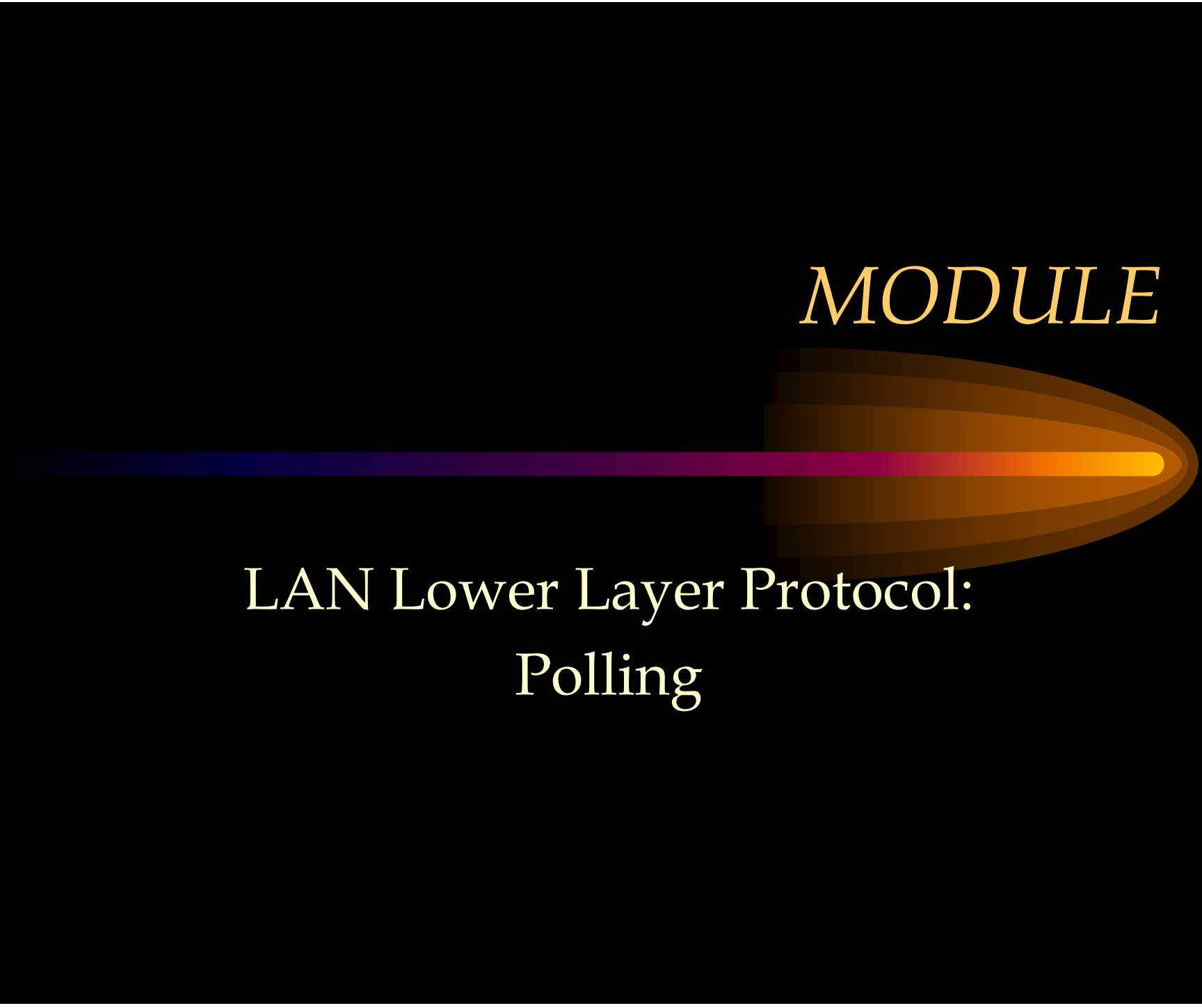
WAN Protocol: Token Passing on FDDI

ANSI X3T9.5 Protocol

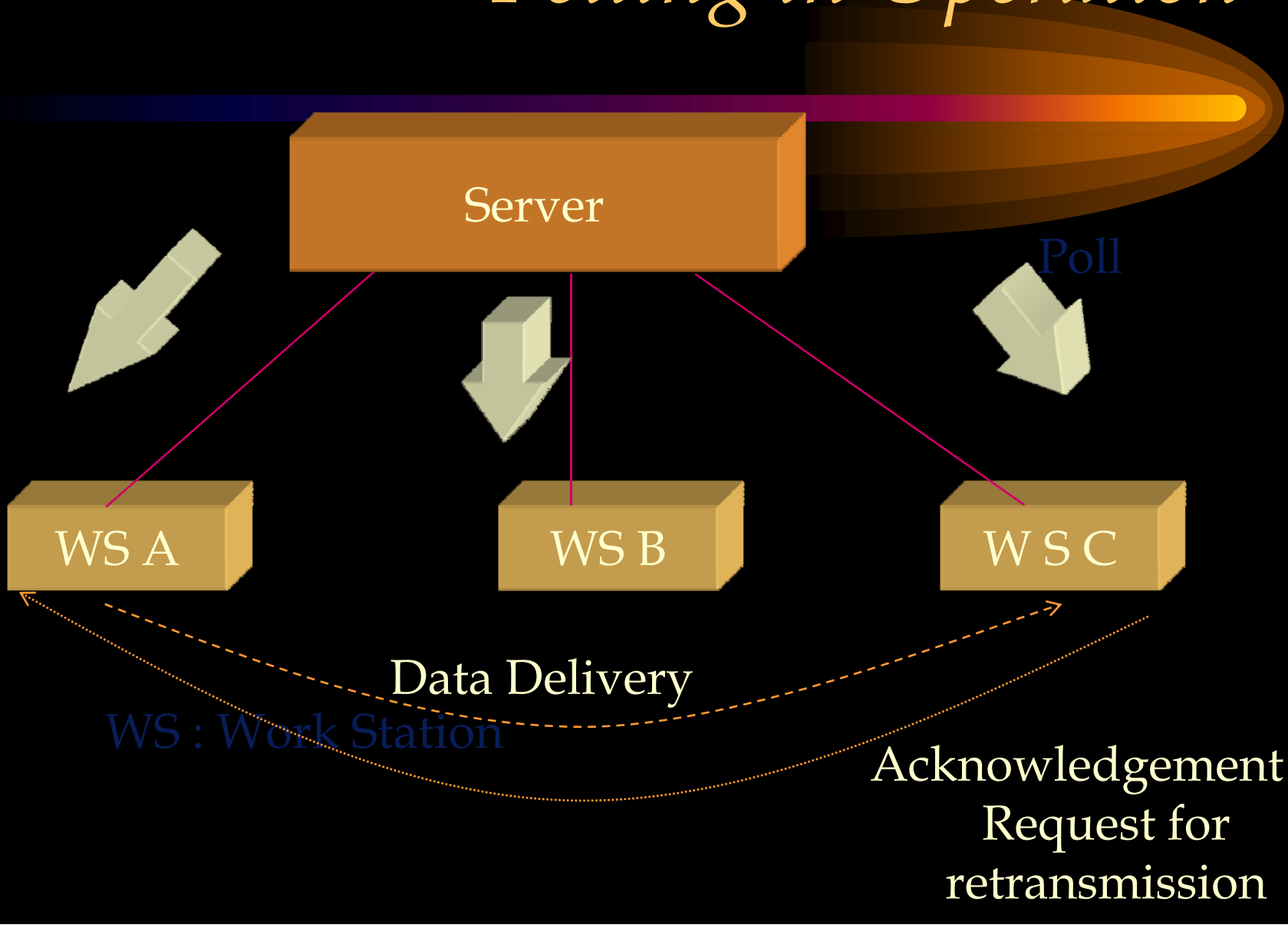
- This wide are network protocol is standardized by ANSI
- Works similar to Token Passing Protocol
- Used in FDDI and CDDI backbone networks
- Usually implemented in dual-ring format for fault tolerance

Reliability: Counter Rotating Ring




MODULE
LAN Lower Layer Protocol:
Polling

Polling in Operation



Polling and Delivery of Data

- Server polls each workstation
- A workstation responds by sending a data packet
- Data packet is delivered to the address found in the packet

At the Receiving End

- If there are no errors :
  - Acknowledgment is returned to the sender
  - The server then continues with the polling process
- If there are errors:
  - A request for retransmission is conveyed to the sender
  - The entire transmission process is then repeated

The Usage of the Polling Protocol

- Mainly used in multi-user micro-computer
  - Based on the physical and logical star topologies
- Example
  - A multi-user microcomputer running the Unix operating systems

Difficulties in Implementing Polling in LANs

- It is difficult to implement the polling protocols in large networks with multiple segments
- Multiple servers in different segments may have problems in polling all the workstations

Polling Implementations

- True multi-user systems such as a Unix based multi-user system