

# Physical and Data Link Layers

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# Networks Devices

## LANs

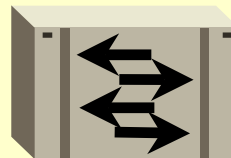
Bridge



Hub



Switch



Router



ATM Switch



## WANs

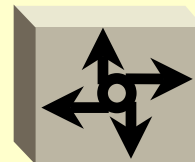
X.25 or  
Frame Relay  
Switch



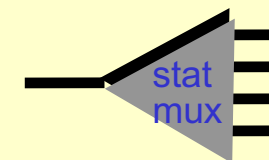
Modem  
CSU/DSU  
TA/NT1



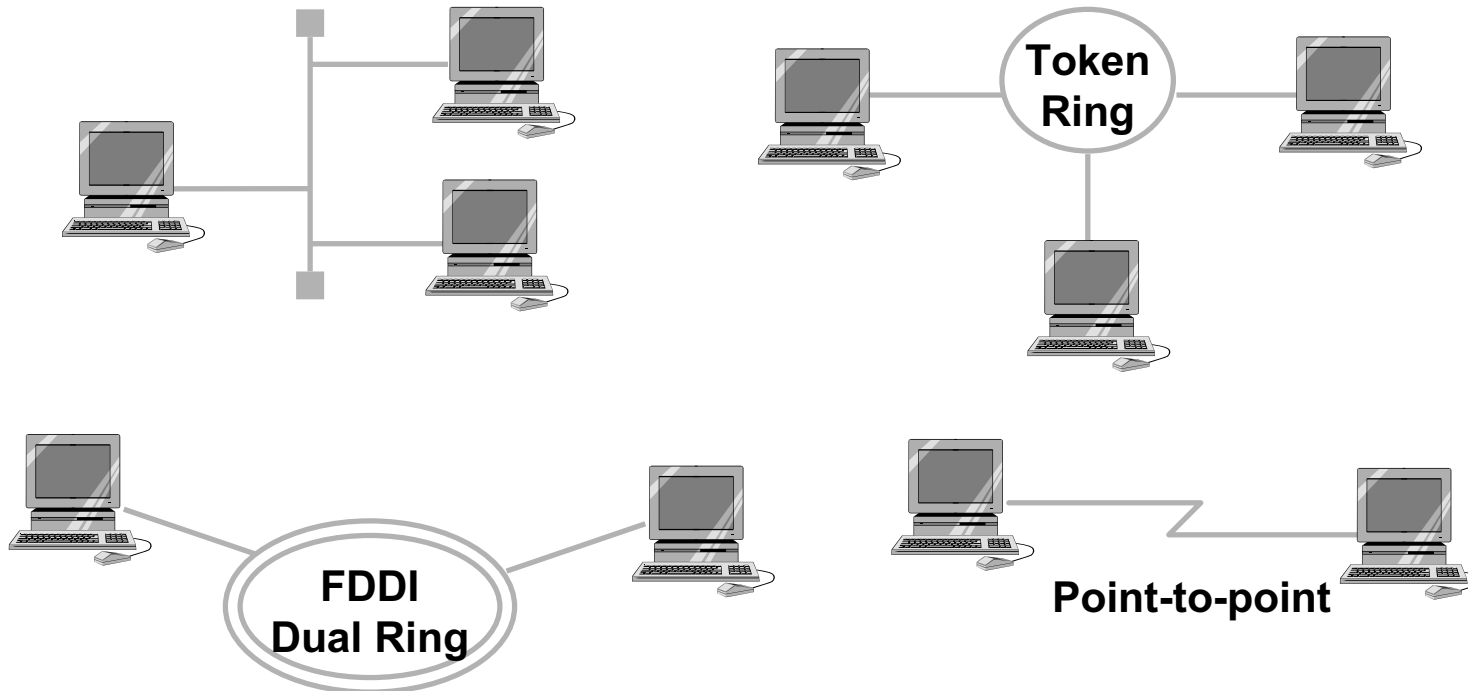
Comm.  
Server



Multiplexer



# Common Data Links



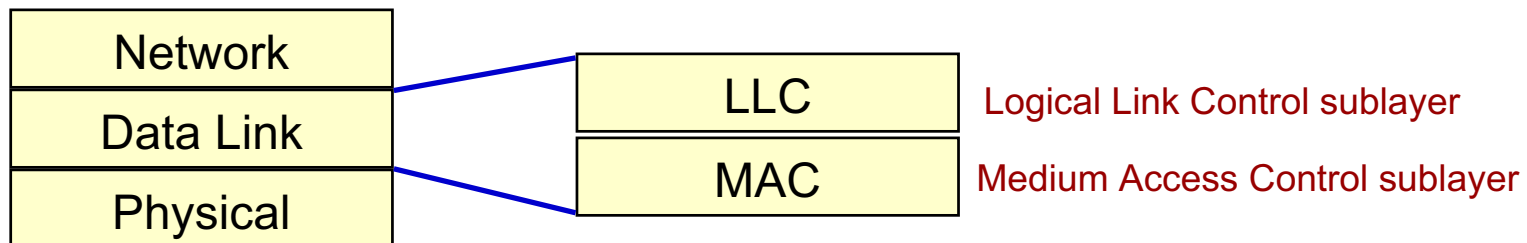
# LAN/WAN layers comparison

	LAN				WAN					
Data Link (frames)	E t h e r n e t	802.2 LLC				Dial on Demand	SDLC	HDLC	X.25 Link Frame Relay	ISDN PPP
Physical (bits, signals, clocking)		802.3	802.4	802.5	FDDI	EIA/TIA-232 EIA/TIA-499	V.24 V.35 HSSI	G.703 EIA-530		

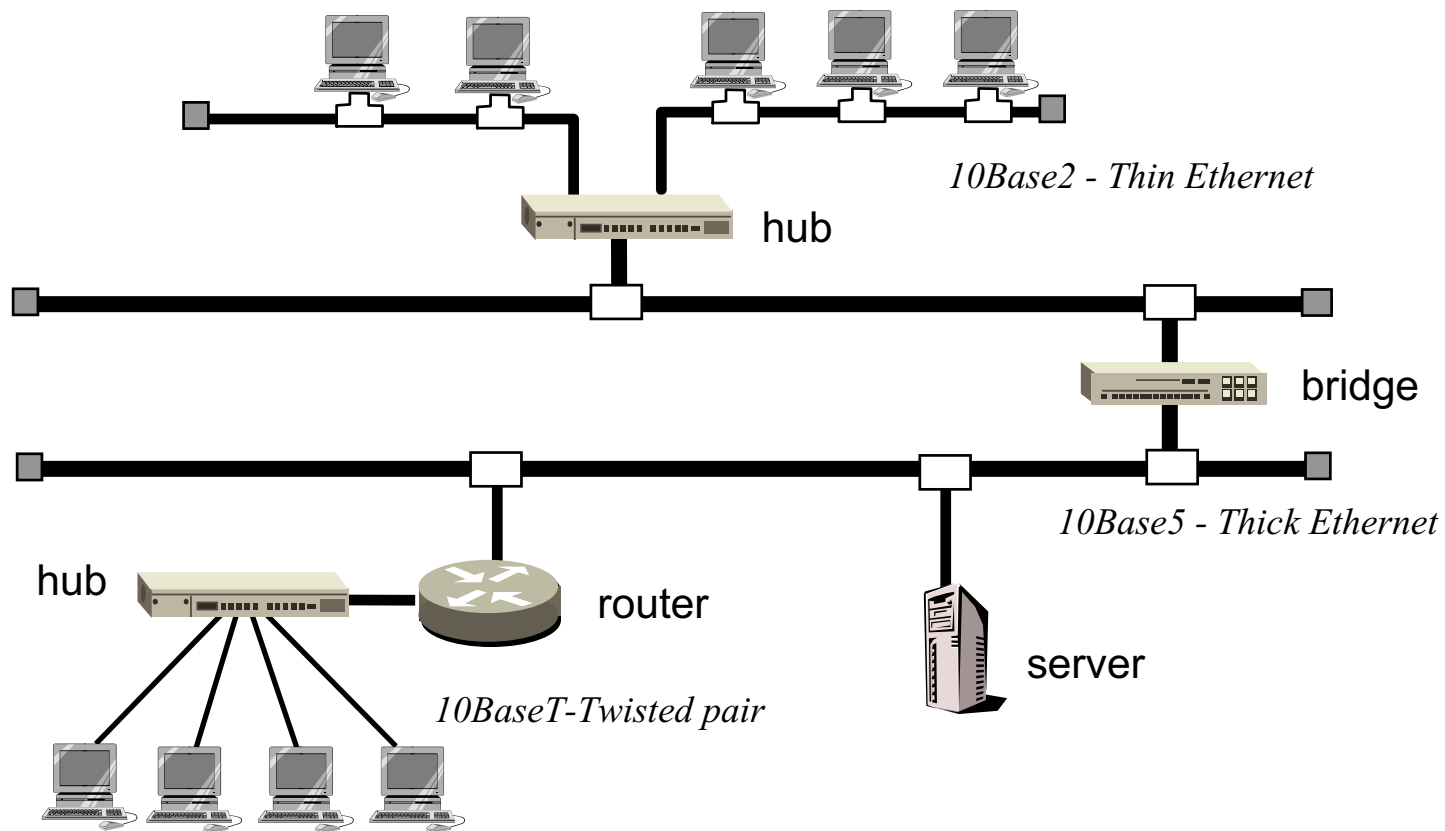
- **Separate physical and data link layer for LAN and WAN**

# Medium Access Control

- **Protocol for controlling access to transmission medium**
- **Defined as part of Data Link layer**
- **The protocol performs:**
  - perform functions related to medium access (MAC sublayer)
  - concerned with the transmission of a link-level between two nodes (LLC sublayer)

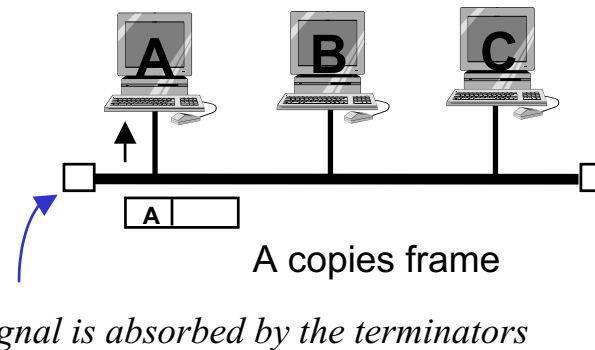
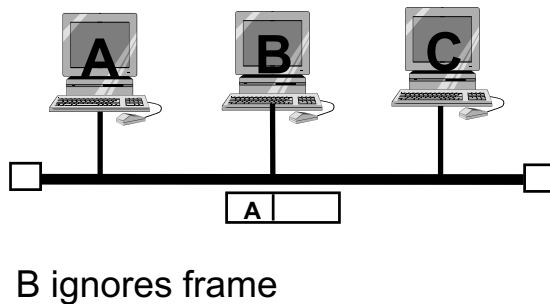
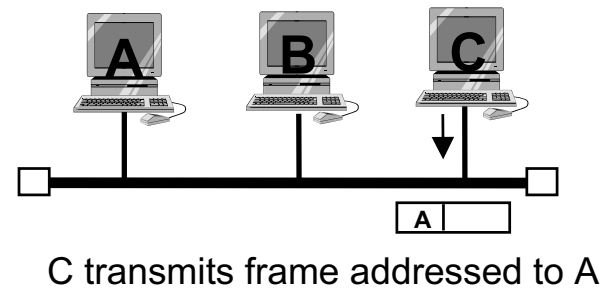
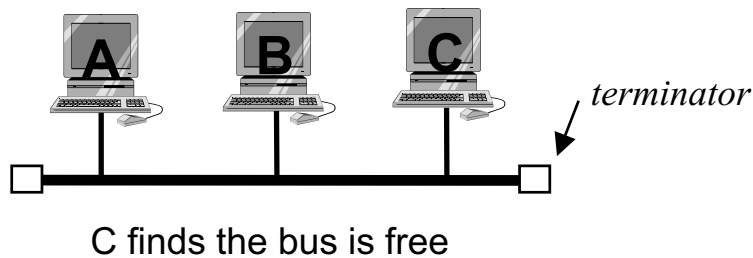


# Ethernet and IEEE 802.3

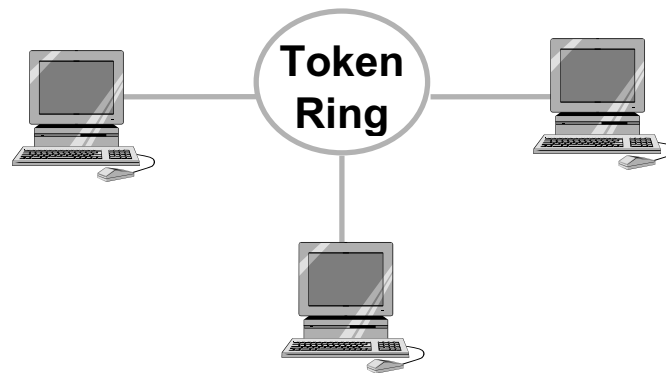


# Ethernet/802.3 Operation

- Every node can receive a transmission by all other nodes
  - need addressing scheme to identify a destination
  - only destination copies frame to it, all other nodes have to discarded the frame

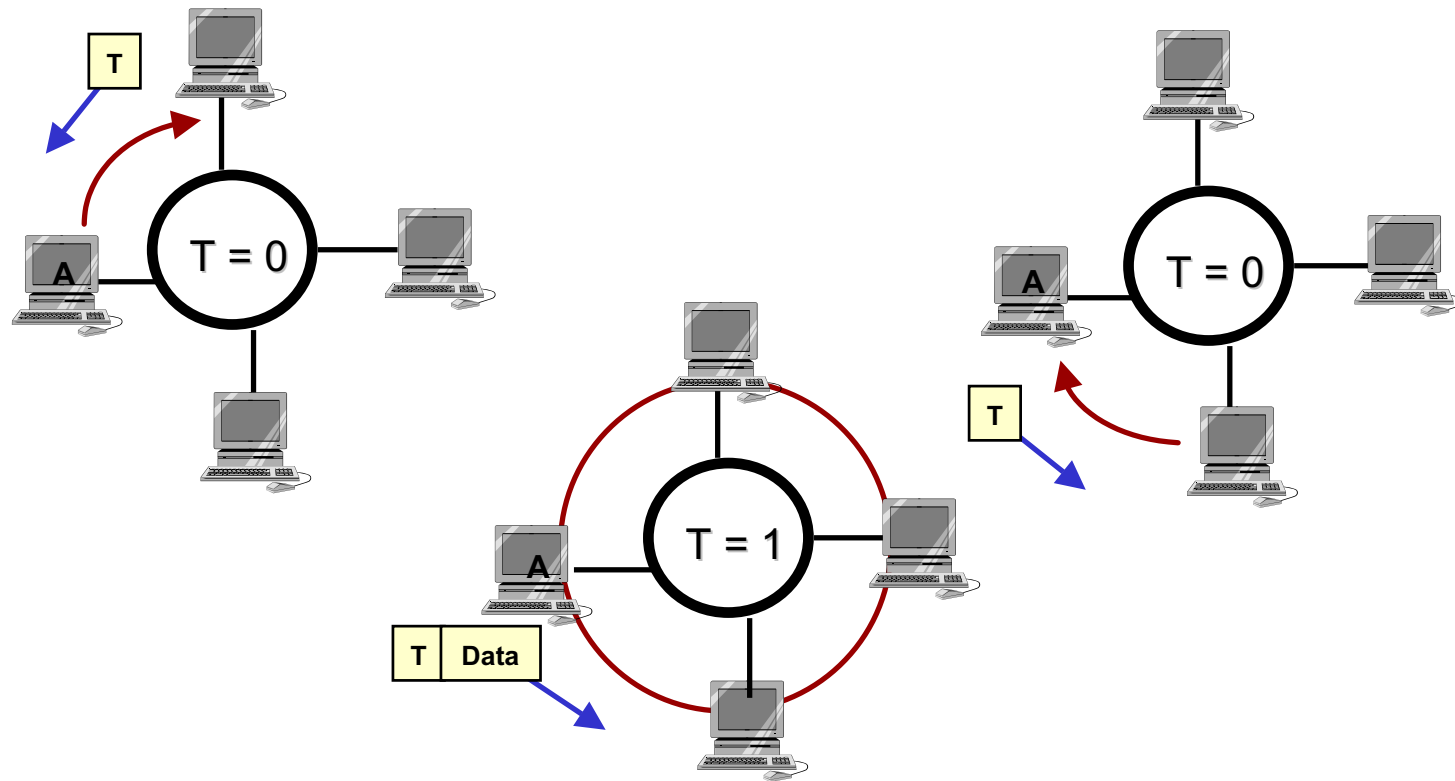


# Token Ring and IEEE 802.5



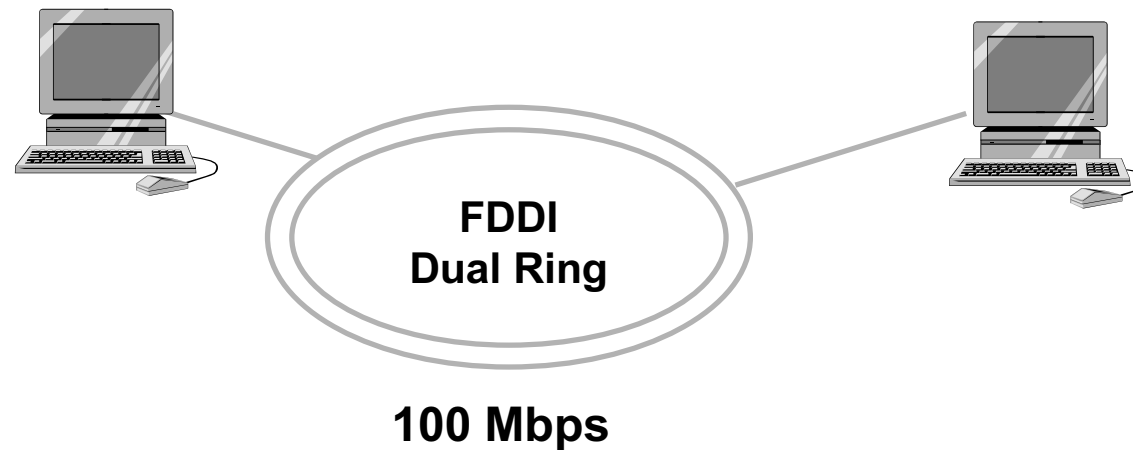
- IBM's token ring is equivalent to IEEE 802.5

# Token Ring/802.5 Operation



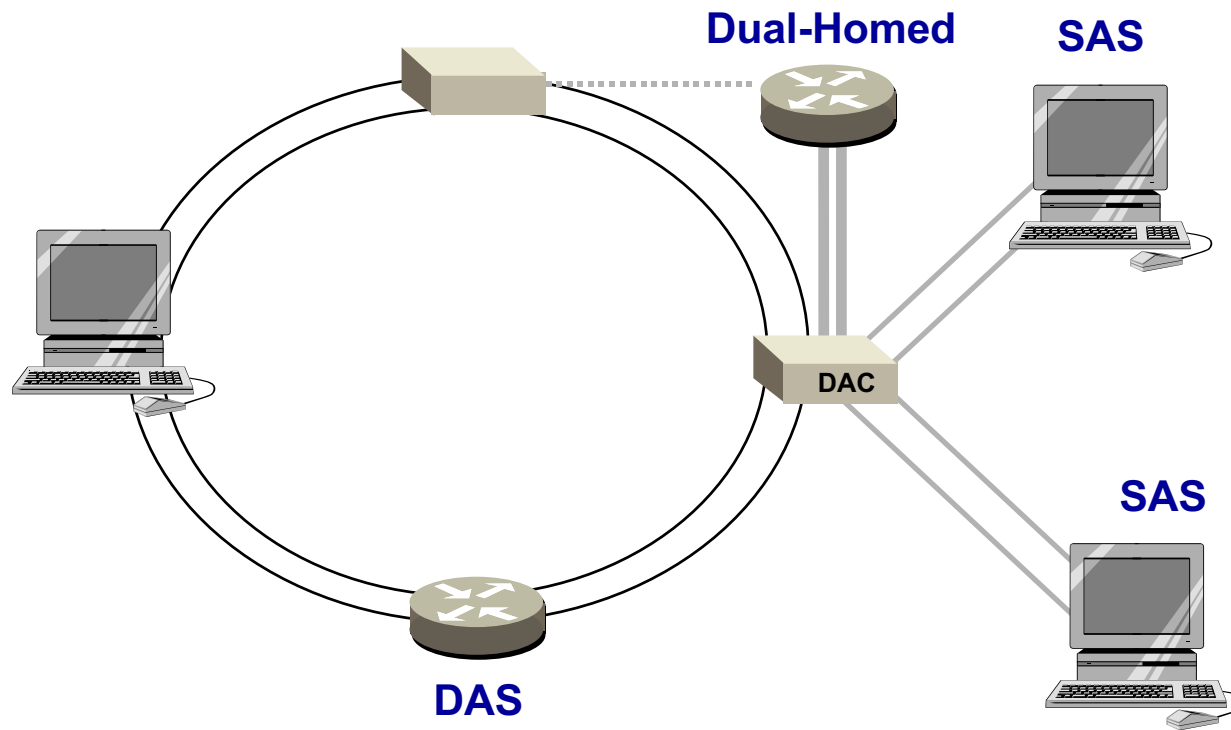
- **Token Ring LANs continuously pass a token or a Token Ring frame**

# Fiber Distributed Data Interface (FDDI)



- **Devices on FDDI maintain connectivity on dual counter-rotating rings**

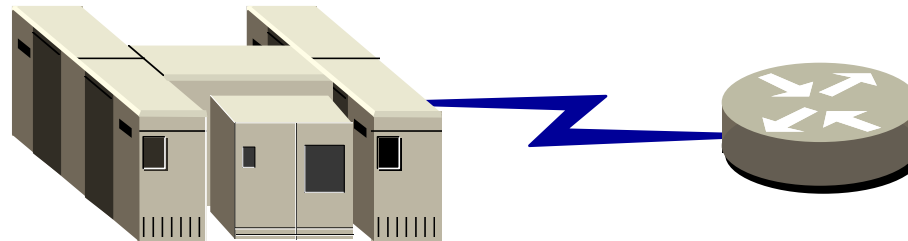
# FDDI



- **Devices attached to FDDI use token passing**

# Common WAN Technologies

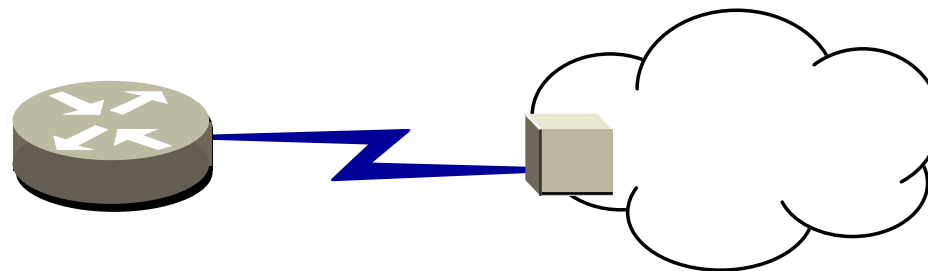
**SDLC**



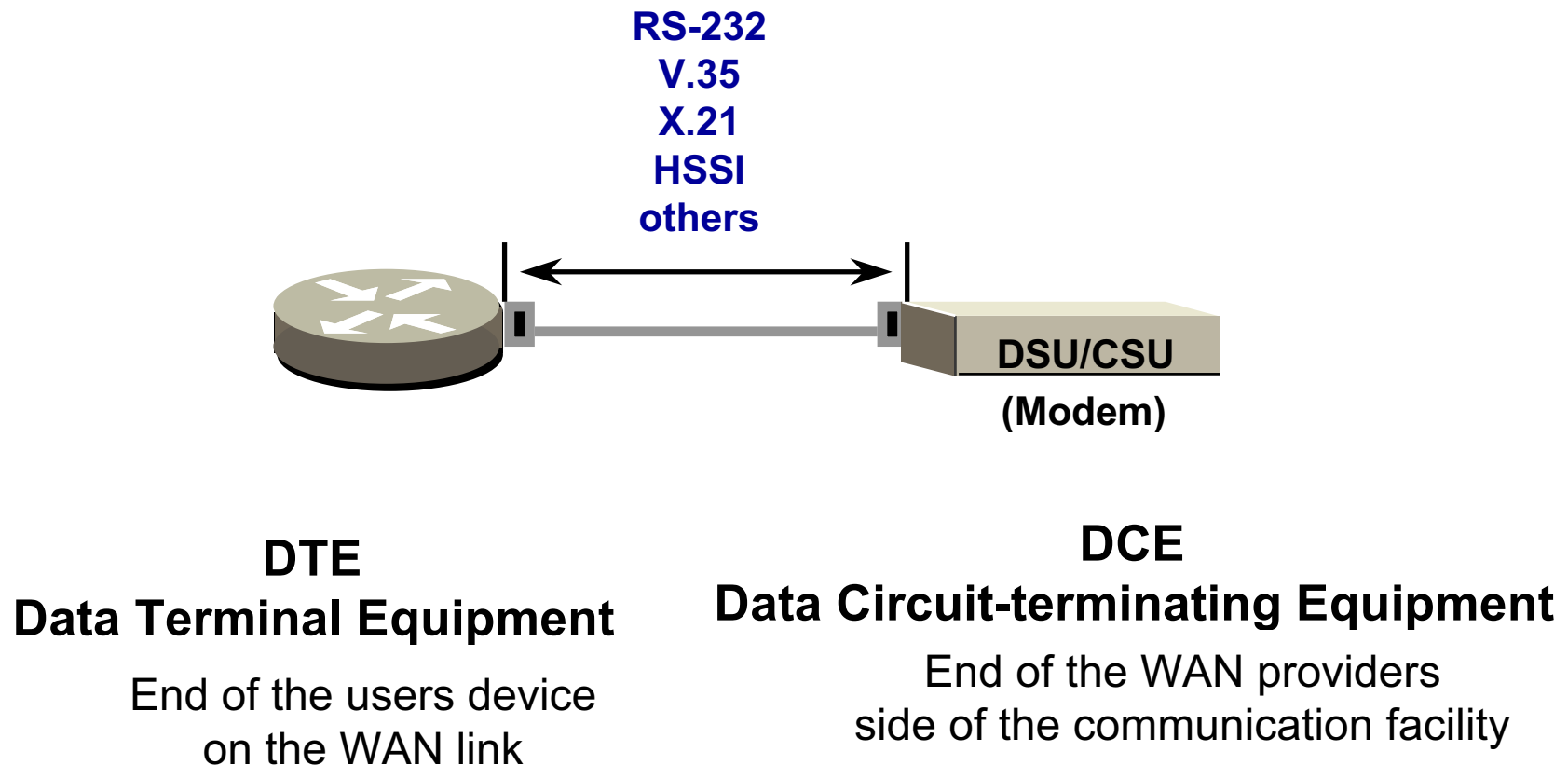
**HDLC  
LAPB  
PPP**



**X.25  
Frame Relay  
ISDN**



# Physical Layer: WAN



# Data Link Layer: WAN protocols

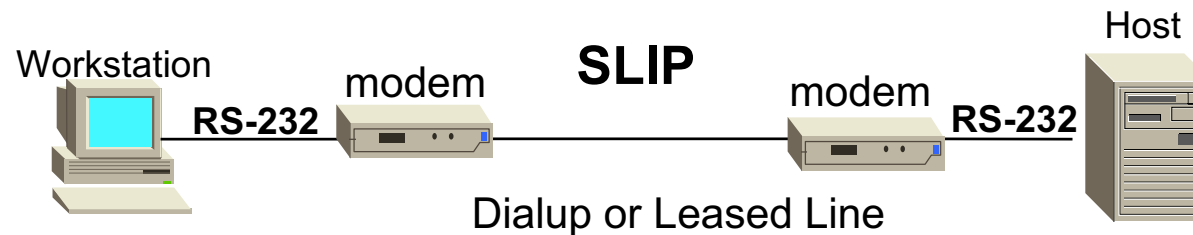


- **SDLC--Synchronous Data Link Control**  
For IBM SNA networks; primary and secondary roles on link
- **HDLC--High-level Data Link Control**  
Common WAN data link
- **LAPB--Link Access Protocol, Balanced**  
DTE-to-DCE data link for X.25; either side initiates a link
- **Frame Relay--Simplified version of HDLC framing for higher speed, unacknowledged data communications**
- **PPP--Point-to-Point Protocol**  
Part of TCP/IP stack for WAN links; can support ISDN

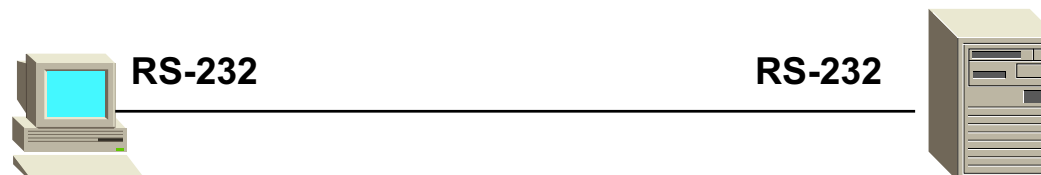
# SLIP : Serial Line IP

- Method for encapsulation IP datagrams on serial line
- RFC 1005 de facto standard
- Popular for connecting home computer to Internet, via modem

## SLIP with Remote Connection

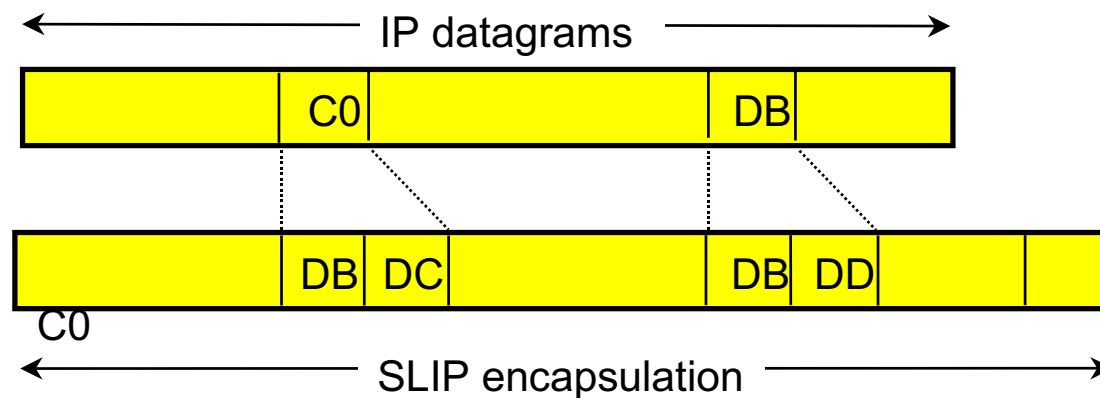


## SLIP with Direct Connection



# SLIP frame format

- **Simple : no header, just a framing character around data**
  - Use 0xC0 (SLIP END) to terminate datagrams
  - SLIP ESC is 0xDB
  - if found 0xC0, substitute with 0xDB 0xDC
  - if found 0xDB, substitute with 0xDB 0xDD



# SLIP deficiencies

- **Need manual configuration of IP address both sides (no negotiating mechanism)**
- **Only one protocol can be used because there is no field to specify type of protocol**
- **No checksum; bad for protocols that depend on CRC!**
- **Slow line make inefficient to carry only 1 byte date with 40 bytes overhead (IP+ TCP header)**
  - CSLIP (Compress SLIP) reduces 40 byte headers to 3-5 bytes
  - known as Van Jacobson Compression (see RFC 1144)
  - smaller headers greatly improve the interactive response time

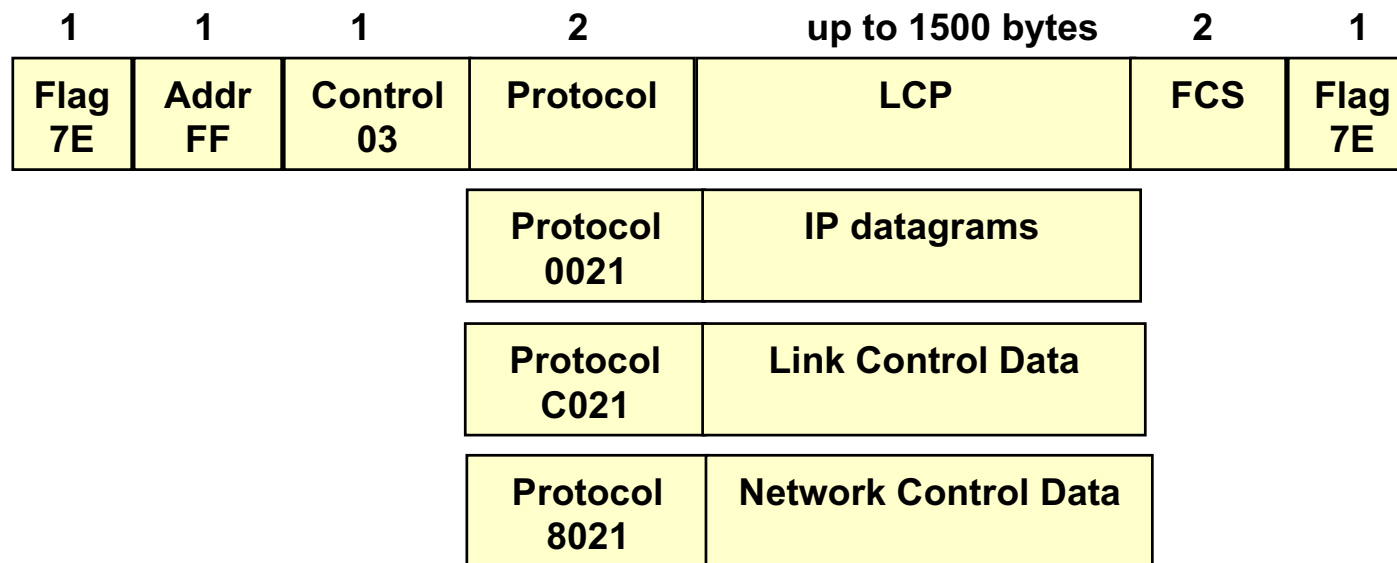
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# PPP: Point-to-Point Protocol

- **Method for encapsulation IP datagrams on serial line, correct all deficiencies in SLIP**
- **Support either an asynchronous link with 8N1 or bit-oriented synchronous link**
- **Two parts:**
  - LCP (Link Control Protocol) to establish, configure and test connection
  - NCP (Network Control Protocol) support different network layer protocols
- **RFC 1548 specifies encapsulation method**
- **RFC 1322 NCP**

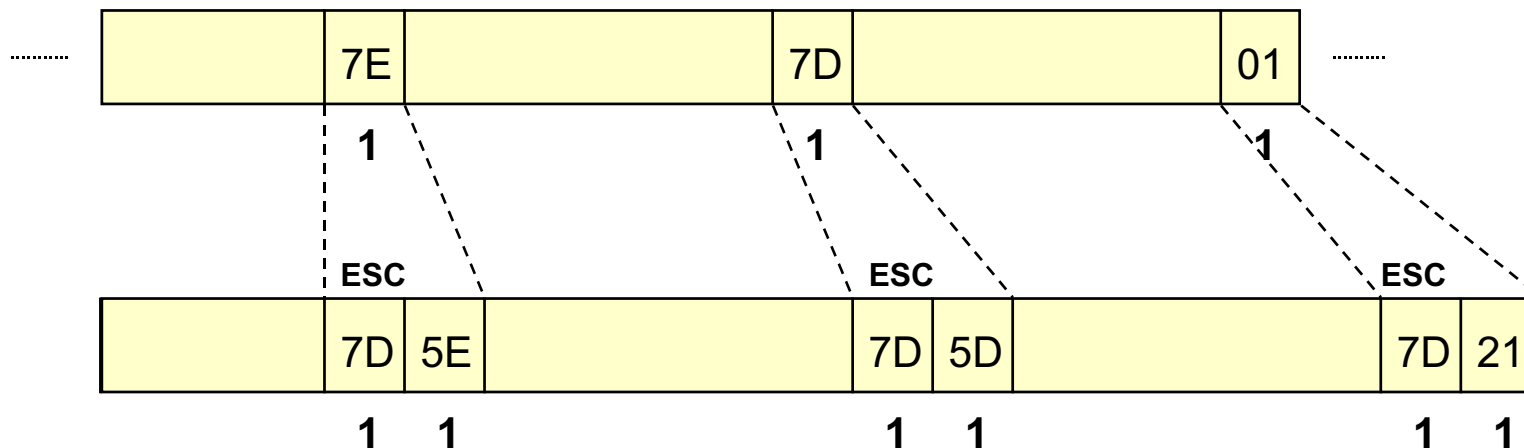
# PPP frame format

- Each frame begins and ends with a *flag* 0x7E.
- Followed by an *address* byte whose value is always 0xFF, and then a control byte, with a value of 0x03.
- To solve flag 0x7E in information field:
  - On a synchronous link is done by the hardware *bit stuffing*.
  - On asynchronous links the 0x7D is used



# PPP framing

- Like ISO HDLC standard and use 0x7D as Escape Character
- Replace 0x7E with 0x7D, 0x5E
- Replace 0x7D with 0x7D, 0x5D
- A byte value less than 0x20 e.g. 0x10 is transmitted with 0x7D, 0x21



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# PPP advantage

- **Support multiple protocols**
- **CRC for every frame**
- **Dynamic negotiation of the IP address for each end**
- **Link control protocol for negotiating data-link options**

# WAN Frame Format Summary

## Link Control Protocol (LCP)

Code	identifier	Length	Data
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## PPP

Flag	Address	Control	Protocol	LCP	FCS	Flag
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## Cisco HDLC

Flag	Address	Control	Proprietary	Data	FCS	Flag
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## SDLC, LAPB, and Frame Relay

Flag	Address	Control	Data	FCS	Flag
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# Loopback Interface

- **channel for client and server on the same host use to communicate**
- **Class A network ID 127 is reserved for the loopback interface**
- **Most system assigns 127.0.0.1 with the name localhost**
- **Loopback interface appears as another link layer to the network layer**

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# Summary

- **The physical layer provides access to the wires of an internetwork**
- **The data link layer provides support for communications over several types of data links:**
  - LAN (Ethernet/IEEE 802.3, Token Ring/IEEE 8025, FDDI)**
  - Dedicated WAN (SDLC, HDLC, PPP, LAPB)**
  - Switched WAN (X.25, Frame Relay, ISDN)**