SET 4573: Data Communication and Switching System

Chapter 5: Local Area Network

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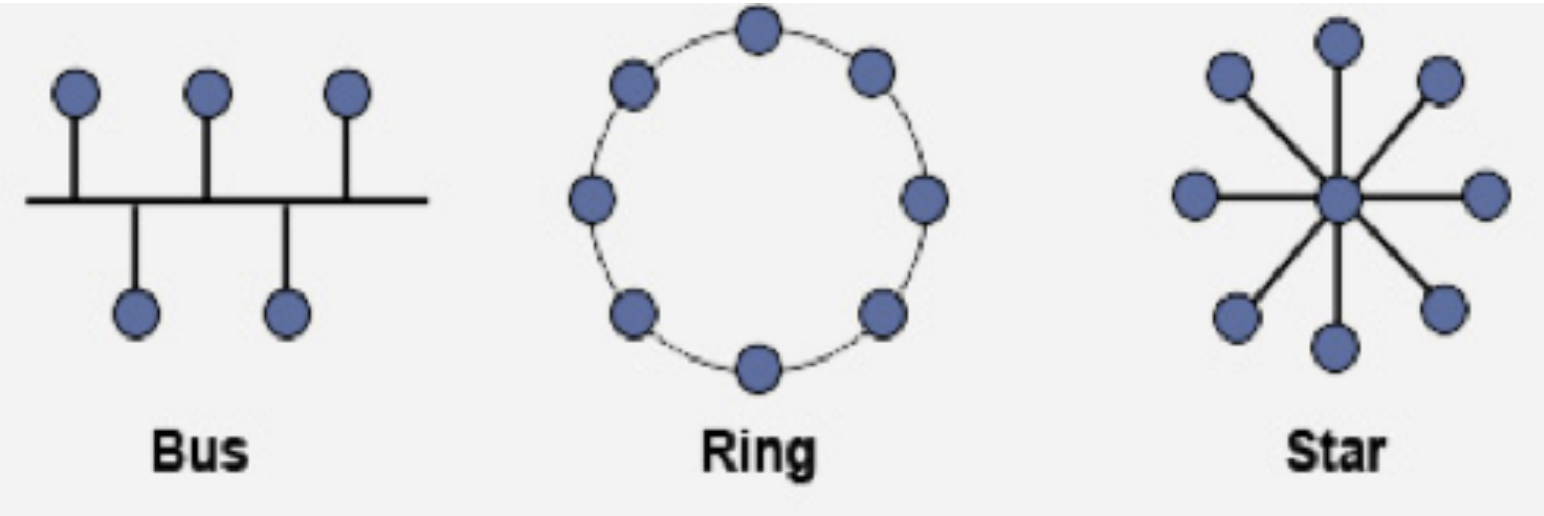
Local Area Network (LAN)

- LAN is
  - a group of workstation/PC connected together to make use the networking capability to share files, applications and connect to printer
  - typically owned, controlled and managed privately by an organization
  - cover relatively a short distance
  - the most common is Ethernet

LAN Architecture

- Topologies
  - Bus, Ring, Star
- Transmission medium
  - twisted-pair, coaxial cable, fiber
- Medium Access Control
  - CSMA/CD, token ring, switching

LAN Topologies



Bus Topology

- Every workstation connected to a single medium called ‘bus’
- transmission propagates throughout the medium from each workstation
- transmission is broadcasted to every workstation
- full duplex connection between workstation and medium to allow for both transmission and reception
- Depends on medium access control to control the frames transmission and to avoid collision
- Less common nowaday

Ring Topology

- a closed loop of repeaters connected to workstation to form a ring
- unidirectional link to send frames
- use token to control the access to the medium
- token is converted to frame to send data
  - the frame circulates past all workstations
  - destination recognizes address and copies the frame
  - frame circulates back to source where it is converted back to token to be used by other workstations
- media access control using 'token' determines when a workstation can send frame

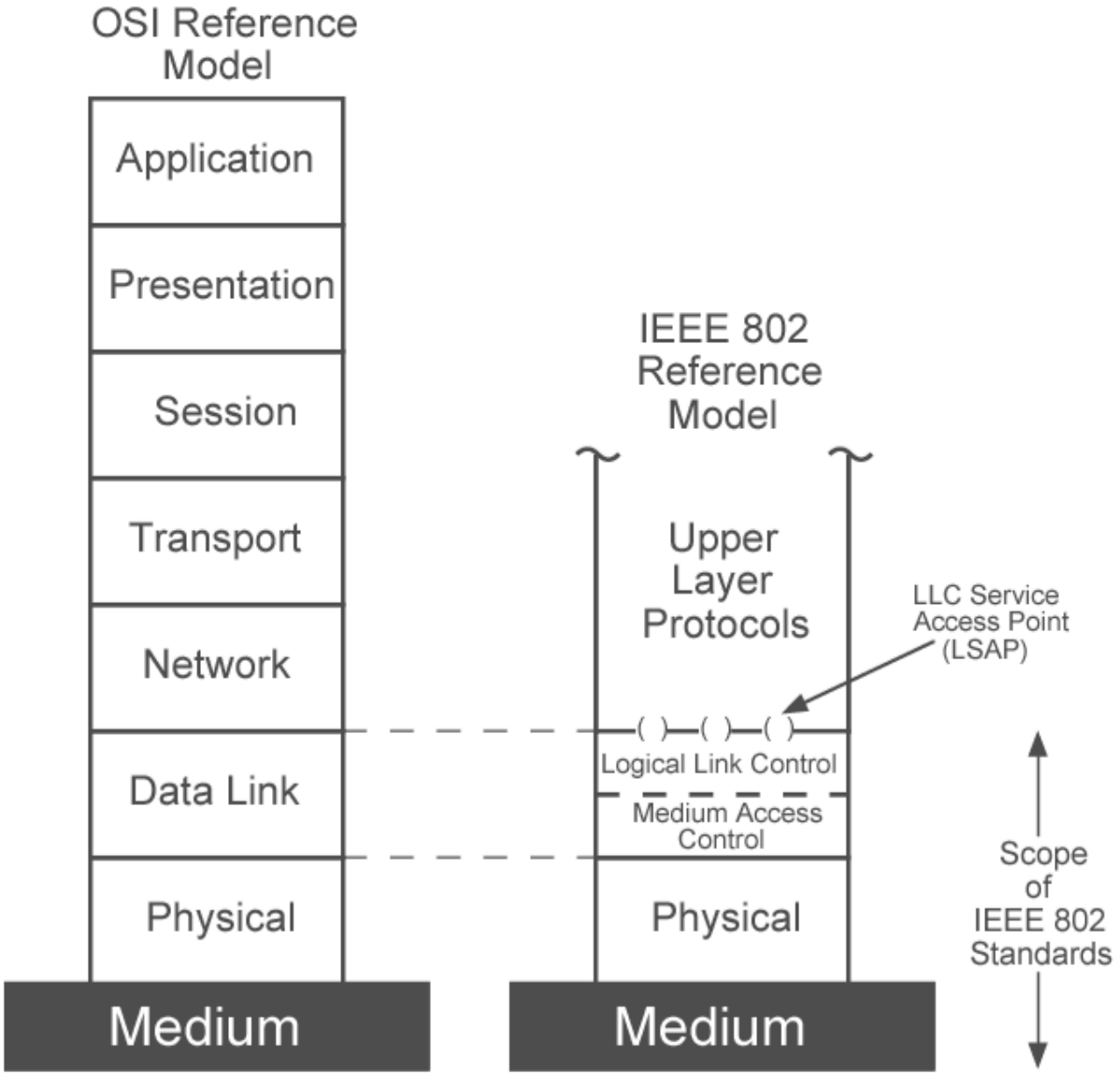
Star Topology

- each workstation connects to central node (hub, switch)
  - via point to point link
- each workstation send frame to the central node which in turn will 'broadcast' to the destination(s)
- central node can broadcast frame or switch the connection to a particular destination
- most popular topology

Media Available

- Voice grade unshielded twisted pair (UTP)
  - Cat. 3 phone, cheap, low data rates
- Shielded twisted pair / baseband coaxial
  - Cat. 5, 6 and 7, more expensive, higher data rates up to Gbps
- Broadband cable
  - even more expensive, higher data rate
- Optical fibre
  - security, high capacity, small size, high cost

LAN Protocol Architecture



IEEE 802 Layer 1

- Physical
  - medium used for bit transmission
  - responsible for encoding and decoding of signal
  - preamble/postamble generation/removal
  - generate baseband digital signal bit for transmission/reception

IEEE 802 Layer 2

- Logical Link Control
  - interface to higher levels
  - deals with flow and error control
- Media Access Control
  - assemble data into frame to be transmitted
  - disassemble frame when received
  - control access to transmission medium
    - Ethernet (CSMA/CD)
    - Token Ring (Token)

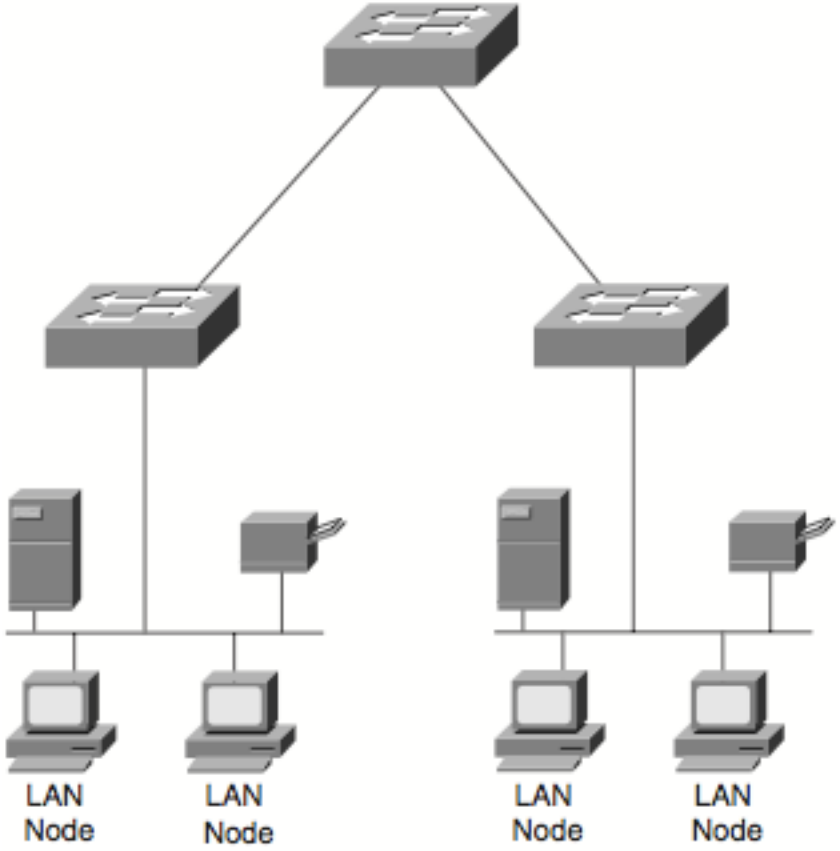
MAC Frame Handling

- MAC layer receives data from LLC layer
- fields
  - MAC control
  - destination MAC address
  - source MAC address
  - LLC
  - CRC
- MAC layer detects errors and discards frames
- LLC optionally retransmits unsuccessful frames

Interconnecting LANs – hub/switch

- hub or switch act as central station in star topology
- each station connected to hub/switch by UTM or fiber
- hub acts as a repeater, switch as 'link connector' between transmitter and receiver
- limited to about 100 m of length for twisted-pair, 500m for fiber
- transmission from a station seen by all others in broadcasting mode

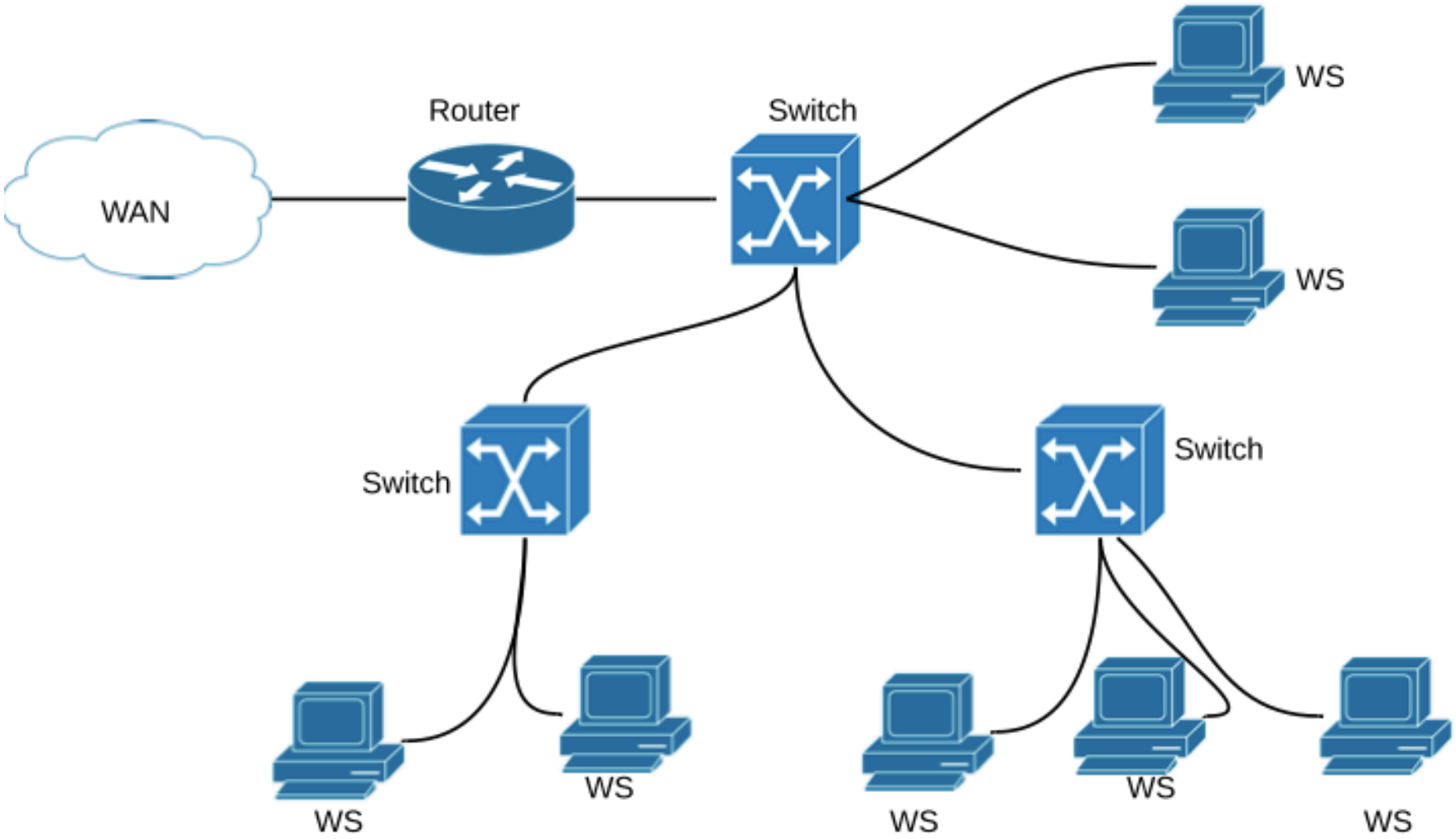
Interconnecting LANs



Buses, Hubs and Switches

- Bus configuration
  - all stations share capacity of bus (e.g. 10Mbps/100Mbps)
  - only one station transmitting at a time, collision avoidance
- Hub (star topology)
  - transmission from any workstation received by hub and retransmitted on all outgoing lines
- Layer 2 switch (star topology)
  - can switch multiple frames between separate ports hence more connections at one time
  - multiplying capacity of LAN
  - interconnect more than one hub to expand the LAN size

Typical LAN Organization



CSMA/CD Description

- with CSMA, collision occupies medium for the duration of transmission
- CSMA/CD rules:
  1. if medium idle, transmit
  2. if busy, listen for idle medium, then transmit
  3. if collision detected, then stop transmission
  4. then wait random time (exponential backoff time) before retrying

Ethernet CSMA/CD algorithm

1. Workstation receives message from upper layer & creates frame
2. If it senses idle medium, then starts to transmit frame. If it senses busy, waits until the medium is idle before transmitting
3. If the workstation detects another transmission while transmitting, stop and send jamming signal to inform others of the collision
4. Then workstation enters **exponential backoff**: after the m^{th} collision, it chooses a K at random from $\{0,1,2,\ldots,2^m-1\}$. Adapter waits K·512 bit times (Kx51.2μs for 10Mbps LAN) and returns to Step 2 to retry transmission

Ethernet Frame Structure

Sender encapsulates IP datagram/packet in Ethernet frame

Preamble (8-octet)	Destination Address (6-octet)	Source Address (6-octet)	Type (2-octet)	DATA (46 to 1500-octet)	FCS (4-octet)

Preamble:

- 7-octet with pattern 10101010 followed by one octet with Start Of Delimiter (SOD) of 10101011
- used to synchronize receiver, sender clock

Ethernet Frame Structure (more)

- Addresses: 6-octet
  - MAC address or Layer 2 address for the receiver and sender
- Type: indicates the Layer 3 protocol that is being transported in the Ethernet frame
  - mostly IP but others may be supported such as Novell IPX and AppleTalk
- CRC: 32-bit error checking method

10Mbps Specification (Ethernet)

Ethernet	**10Base2**	**10Base5**	**10BaseT**	**10BaseFP**
Transmission Medium	Coaxial Cable (50 Ω)	Coaxial Cable (50 Ω)	UTP	850nm optical fiber pair
Signalling Technique	Baseband (Manchester)	Baseband (Manchester)	Baseband (Manchester)	Baseband (ON/OFF)
Topology	Bus	Bus	Star	Star
Max. Segment Length (m)	185	500	100	500
Nodes per segment	30	100	-	33

100Mbps Fast Ethernet

	100BaseTX		100BaseFX	100BaseT4
Transmission Medium	2-pair STP	2-pair, Cat.5 UTP	2-link fiber	4-pair, Cat.3,4 or 5 UTP
Signalling Technique	MLT-3	MLT-3	4B5B, NRZI	8B6T, NRZ
Data Rate	100Mbps	100Mbps	100Mbps	100Mbps
Max. Segment Length (m)	100	100	100	100
Network Span (m)	200	200	400	200