Part I Syllabus

Lecture	Date	Subject
1	11/08/2020	Introduction
		Network layer & physical resilience
2	18/08/2020	Data link layer – Flow control
		Data link layer – Error control
3	25/08/2020	**Local area network – Introduction**
4	01/09/2020	Local area network – MAC
		Local area network – Ethernet
5	08/09/2020	Local area network – WLAN
		Mobile Access Networks: From 1G to 5G
6	22/09/2020	Packet switch network – Network paradigm

Mingling Among a Cocktail party

CE3005/CZ3006 Computer Networks

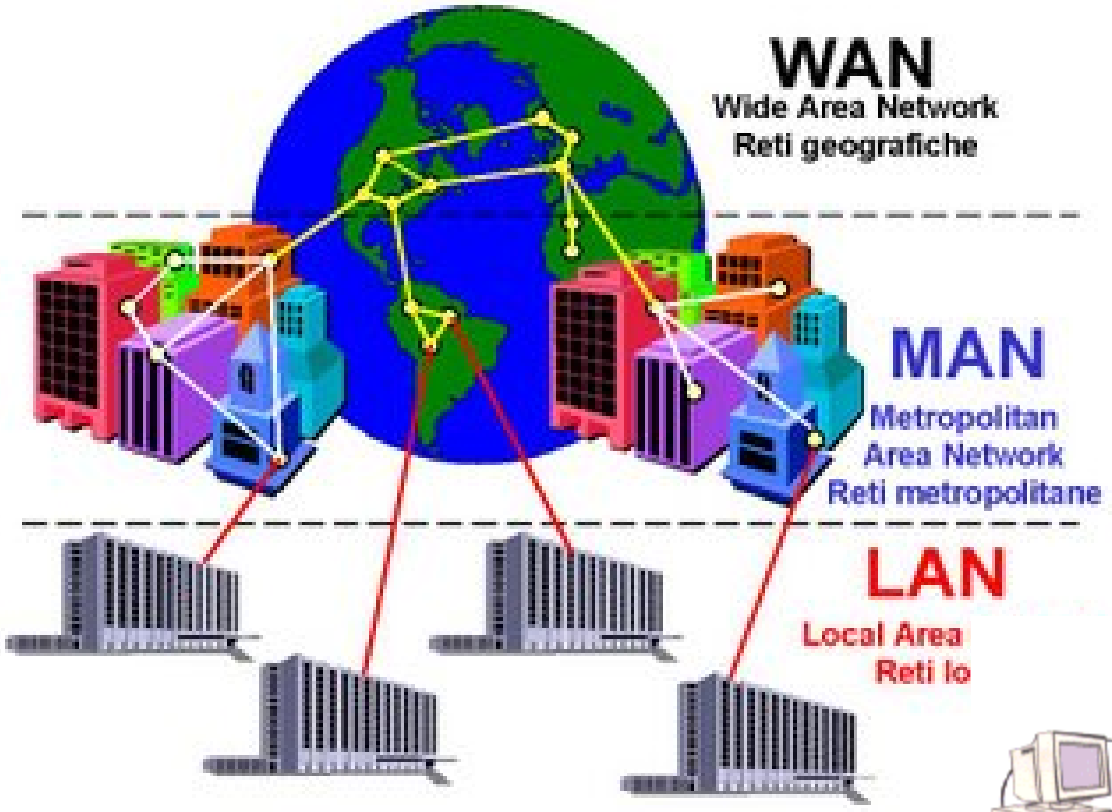
Lecture 5
Local Area Network (LAN): Introduction

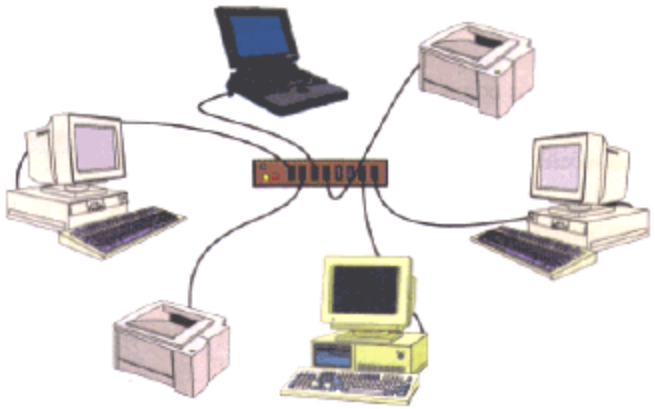
Contents

- **Local Area Network**
  - Definition and Taxonomy
  - Protocol Architecture
- **LAN Topologies**
  - Bus, Tree, Ring and Star
  - Choice of topology
- **Transmission Media**
- **Medium Access Control**
  - Functions and Features
  - Static Channel Allocation
  - Dynamic Channel Allocation

Local Area Network (LAN)

WAN/MAN/LAN

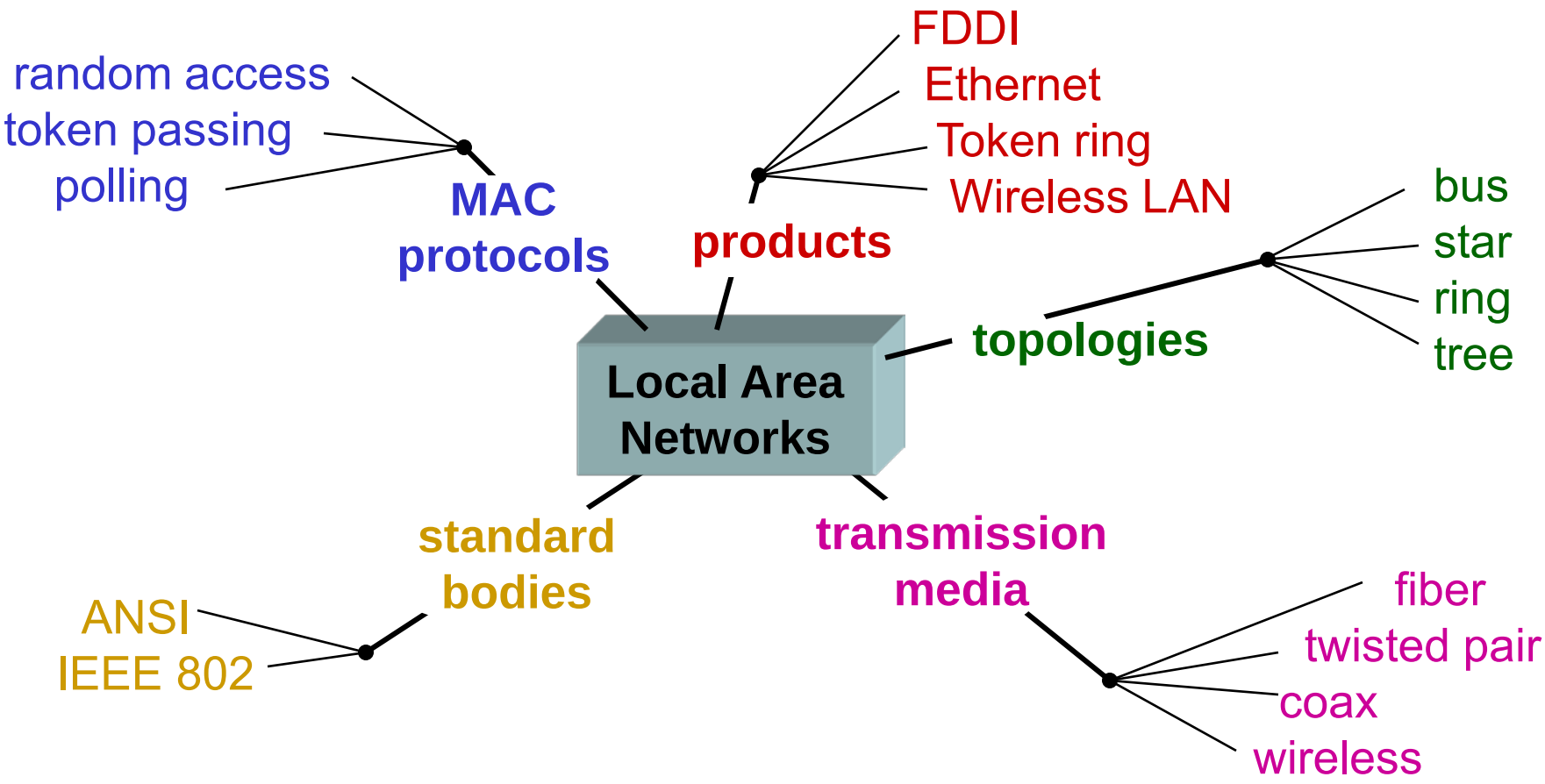

WAN
Wide Area Network
Reti geografiche
MAN
Metropolitan
Area Network
Reti metropolitane
LAN
Local Area
Reti lo



LAN (Local Area Networks)

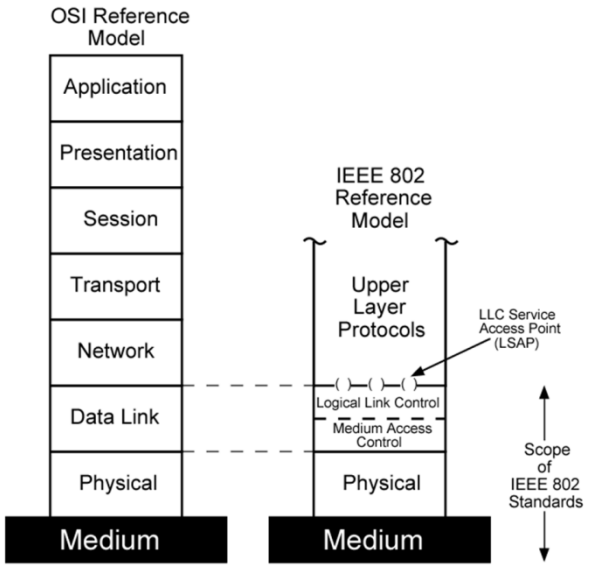
- **LAN is a computer network that covers a small area (home, office, building, campus)**
  - a few kilometers
- **LANs have higher data rates (10Mbps to 40Gbps) as compared to WANs**
- **LANs (usually) do not involve leased lines; cabling and equipments belong to the LAN owner.**
- **LAN consists of**
  - Shared transmission medium
    - now so valid today due to switched LANs
  - regulations for orderly access to the medium
  - set of hardware and software for the interfacing devices

LAN Taxonomy



LAN Protocol Architecture

- **Corresponds to lower two layers of OSI model**
  - But mostly LANs do not follow OSI model
- **Current LANs are most likely to be based on Ethernet protocols developed by IEEE 802 committee**
- **IEEE 802 reference model**
  - Logical link control (LLC)
  - Media access control (MAC)
  - Physical



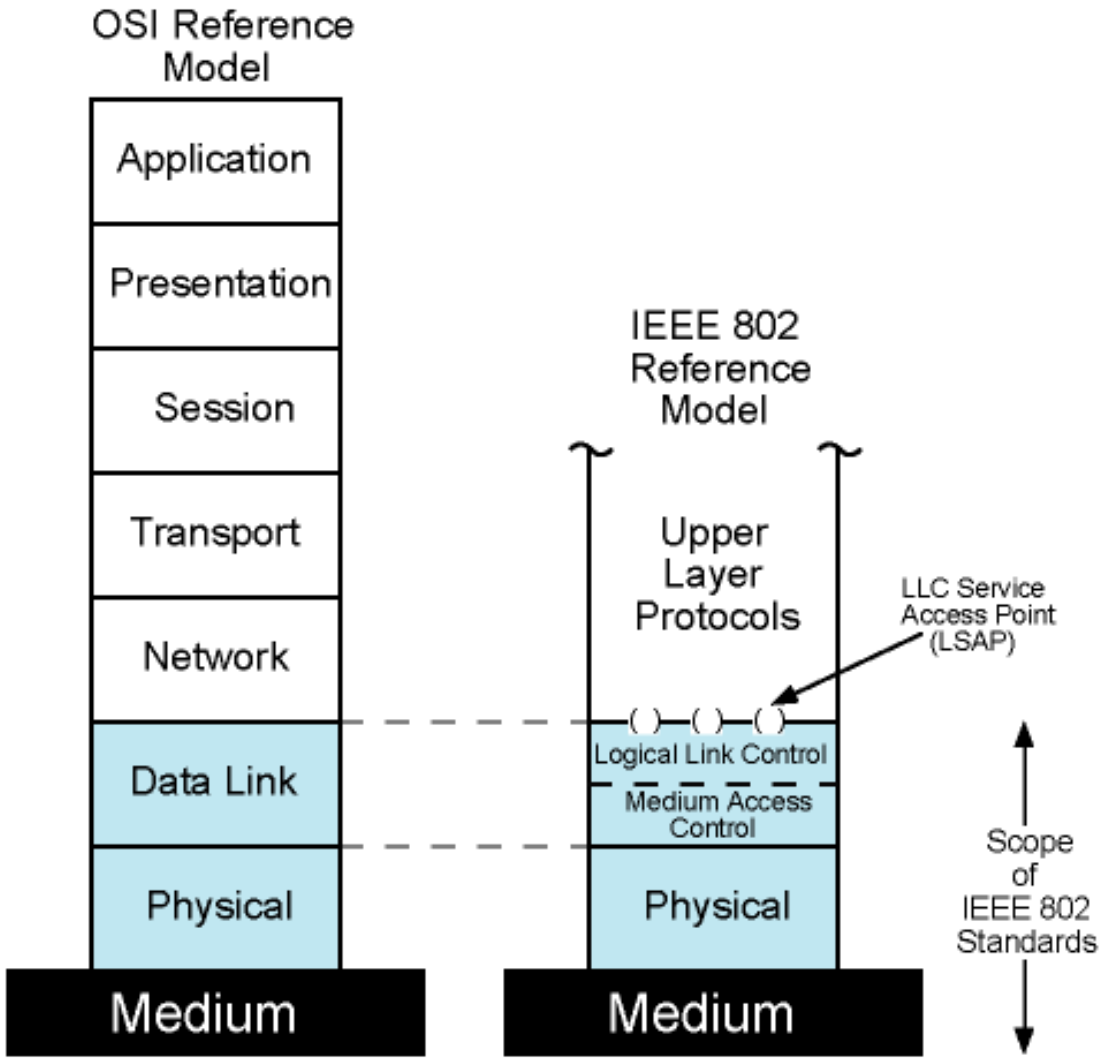
IEEE 802 Layers - Physical

- **Signal encoding/decoding**
- **Preamble generation/removal**
  - for synchronization
- **Bit transmission/reception**
- **Specification for topology and transmission medium**
- **WiFi vs. LiFi**

IEEE 802 Layers - DLL

- **OSI layer 2 (Data Link) is divided into two in IEEE 802**
  - Logical Link Control (LLC) layer
  - Medium Access Control (MAC) layer
- **LLC layer**
  - Interface to higher levels
  - flow control
  - Based on classical Data Link Control Protocols (so we have already covered it earlier)
- **MAC layer**
  - Prepare data for transmission
  - Error detection
  - Address recognition
  - Govern access to transmission medium
    - Not found in traditional layer 2 data link control

IEEE 802 Protocols vs OSI Model



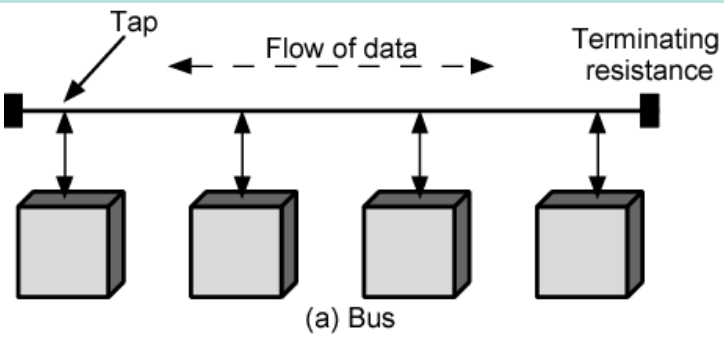
LAN in a Nutshell

Physical Data Link	LLC	IEEE 802.2 Logical Link Control Protocol						
	MAC	**802.3** **CSMA /CD**	**802.4** **Token Bus**	**802.5** **Token Ring**	**802.6** **DQDB**	**802.11** **CSMA /CA**	**802.12** **Round Robin**	**802.14** **HFC**
		Coax **UTP** **STP** **Fiber**	**Coax** **Fiber**	**UTP** **STP** **Fiber**	**Fiber**	**Radio** **Infrared**	**UTP**	**Coax**
		B,T,S	**B,T,S**	**R**	**DB**	**---**	**S, T**	**T**

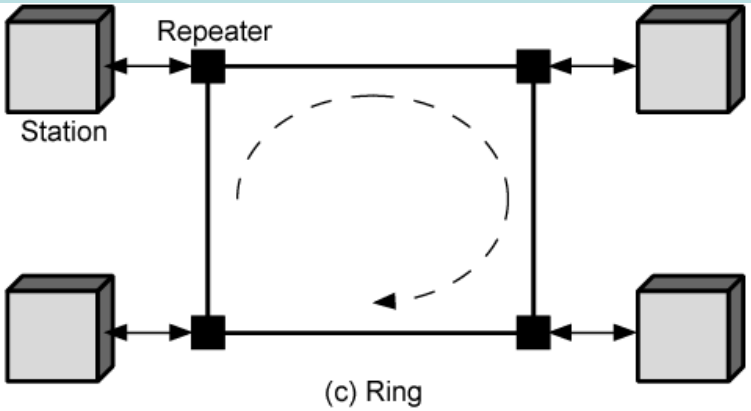
Topologies (see next slide): **B**us, **T**ree, **S**tar, **R**ing, **D**ual**B**us

LAN Topologies

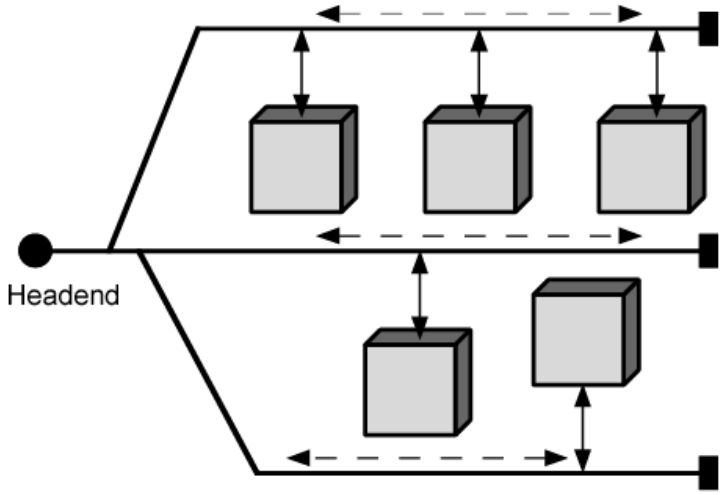
LAN Topologies: Bus, Tree, Ring and Star



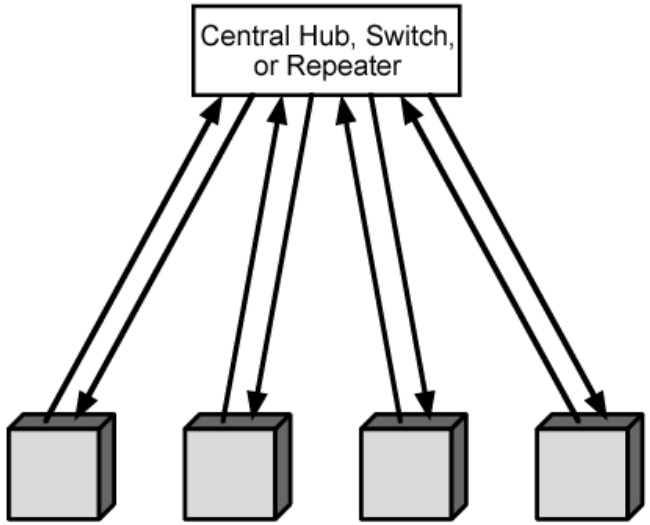
(a) Bus



(c) Ring



(b) Tree



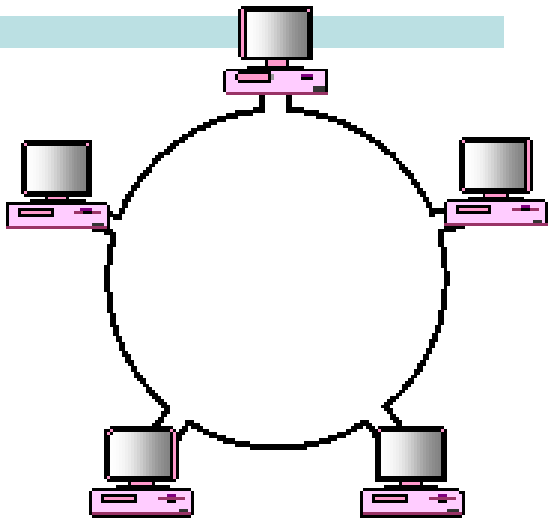
(d) Star

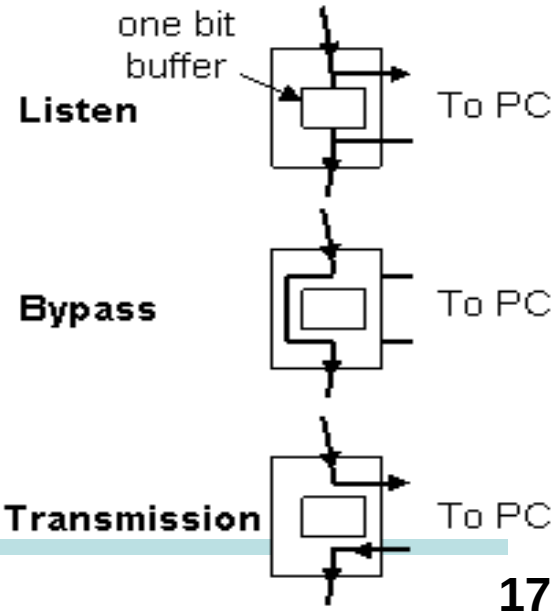
Bus and Tree

- **Multipoint medium**
- **Transmission propagates throughout medium**
- **Heard by all stations**
  - Need to identify target station
    - Each station has unique address
- **Full duplex connection between station and tap**
  - Allows for transmission and reception
- **Need to regulate transmission**
  - To avoid collisions
    - If two stations transmit at same time, signals overlap
  - To avoid continuous transmission from a single station.
    - Solution: Transmit Data in small blocks – frames
- **Terminator absorbs frames at end of medium**

Ring Topology

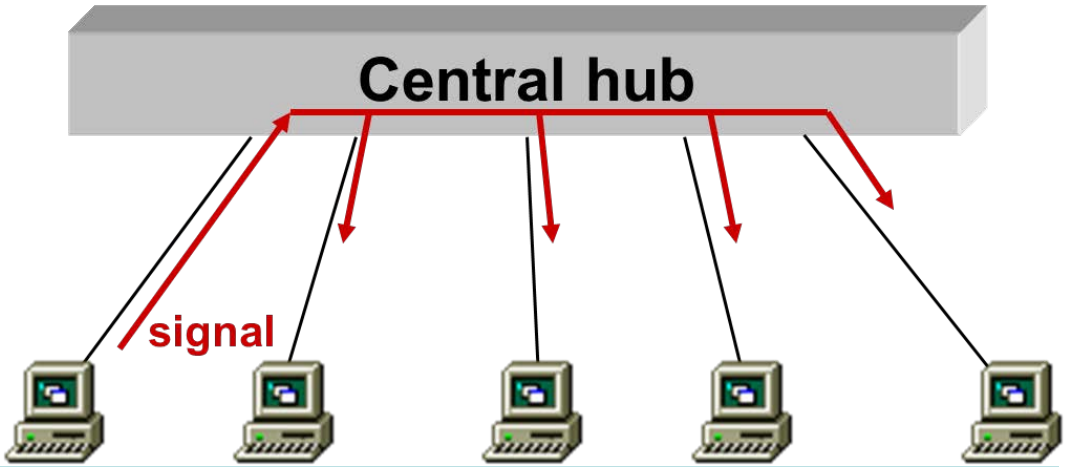
- **Repeaters are joined by point to point links in closed loop**
  - Receive data on one link and retransmit on another
  - Links are unidirectional
  - Stations attach to repeaters
- **Data Frames**
  - Circulate past all stations
  - Destination recognizes address and copies frame
  - Frame circulates back to source where it is removed
- **Medium access control determines when station can insert frame**





Star Topology

- **Each station connected directly to central node**
  - using a full-duplex (bi-directional) link
- **Central node can broadcast (hub)**
  - Physical *star*, but logically like *bus* since broadcast
  - Only one station can transmit at a time; otherwise, collision occurs
- **Central node can act as frame switch**
  - retransmits only to destination
  - today's technology



Choice of Topology

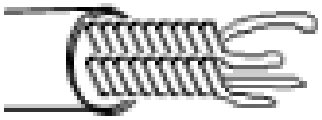
- **Reliability**
- **Expandability**
- **Performance**
- **Needs considering in context of:**
  - Medium
  - Wiring layout
  - Access control

Transmission Medium

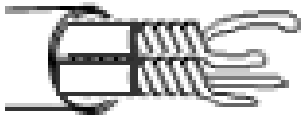
Medium Available (1)

- **Voice grade unshielded twisted pair (UTP)**
  - Cat 3/ Cheap
  - Well understood
  - Use existing telephone wiring in office building
  - Low data rates
- **Shielded twisted pair (STP) and baseband coaxial**
  - More expensive than UTP but higher data rates
- **Broadband cable**
  - Still more expensive and higher data rate

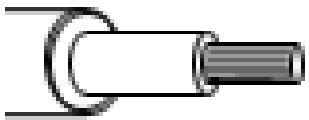
Networking Cables



Unshilded twisted-pair cable



Shielded twisted-pair cable



Coaxial cable

http://www.computerhope.com

Media Available (2)

- **High performance UTP**
  - Cat 5 and above (5e and 6)
  - High data rate for small number of devices
  - Switched star topology for large installations

- **Optical fiber**
  - Electromagnetic isolation
  - High capacity
  - Small size
  - High cost of components
  - High skill needed to install and maintain

- **Wireless Channel**
  - Fading channel

Media Access Control (MAC)

Media Access Control

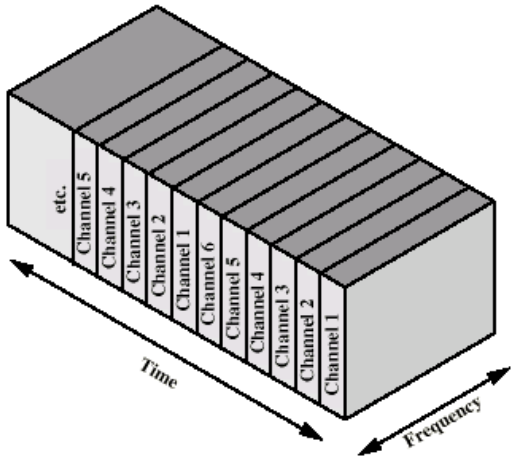
- **Assembly of data into frame with address and error detection fields**
- **Disassembly of frame**
  - Address recognition
  - Error detection
- **Govern access to transmission medium**
  - Not found in traditional layer 2 data link control
- **For the same LLC, several MAC options may be available**

MAC Decision Making Options

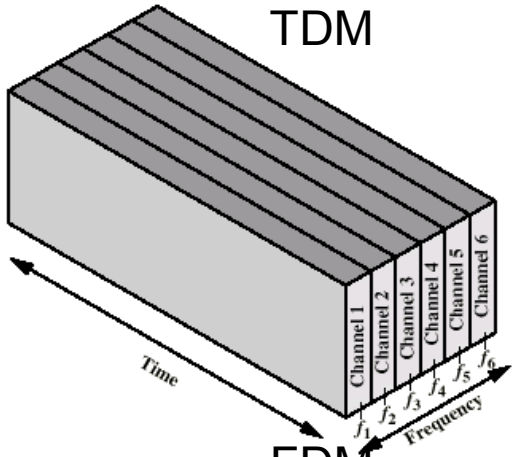
- **Where?**
  - Central
    - Greater control
    - Simple access logic at station
    - Avoids problems of co-ordination
    - Single point of failure
    - Potential bottleneck
  - Distributed
- **How?**
  - Synchronous (static) solutions
    - Specific capacity dedicated to connection
  - Asynchronous (dynamic) solutions
    - In response to demand

Static Channel Allocation

- **TDM**
  - Each user is statically allocated one time slot
  - if a particular user does not have anything to send, that period is wasted
  - User may not utilize the whole channel for a time slot
- **FDM**
  - Channel is divided to carry different signals at different frequencies
  - Efficient if there is a constant (one for each slot) amount of users with continous traffic
- **CDM**



TDM



FDM

Dynamic Channel Allocation (1)

- **Round robin**
  - Each station has a turn to transmit
    - declines or transmits up to a certain data limit
    - overhead of passing the turn in either case
  - Performs well if many stations have data to transmit for most of the time
    - otherwise passing the turn would cause inefficiency
- **Reservation**
  - It is used for stream traffic, where time on the medium is divided into slots, much as with TDM.
  - Reservation can be made in centralized or distributed fashion.

Dynamic Channel Allocation (2)

- **Contention**
  - All stations contend to transmit
  - No control to determine whose turn is it
  - Stations send data by taking risk of collision (with others' packets)
    - however they understand collisions by listening to the channel, so that they can retransmit
  - Several implementation methods: Aloha, CSMA, etc
  - In general, good for bursty traffic
    - Typical traffic types for most networks
  - Efficient under light or moderate load
  - Performance is bad under heavy load

Learning Objectives

- **Local Area Network**
  - Functions of each layer: physical, LLC and MAC
  - 802 Protocol family
- **LAN Topologies**
  - Frame transmission over Bus, Tree, Ring and Star
- **Transmission Media**
- **Medium Access Control**
  - Pros and Cons of Static Channel Allocation
  - Comparison among Dynamic Channel Allocation