Part I Syllabus – Fundamental Underlying Layers

Date	Subject	File
Week 1: 9/Jan/2023 11/Jan/2023	Introduction: course logistics and Internet history	M1-L1-Introduction.pptx
	Layered Network Architecture	First part of M1-L2-Network Layer & Physical Resilience.pptx
Week 2: 16/Jan/2023 18/Jan/2023	Physical Layer: Network Resilience	Second part of M1-L2-Network Layer & Physical Resilience.pptx
	Data link layer – Flow control	M1-L3-DLL-Flow Control.pptx
Week 3: 25/Jan/2023	Data link layer – Error control	M1-L4-DLL-Error Control.pptx
Week 4: 30/Jan/2023 01/Feb/2023	Local area network – Introduction	M1-L5-LAN-Introduction.pptx
	Local area network – MAC	M1-L6-LAN-MAC.pptx
Week 5: 06/Feb/2023 08/Feb/2023	Local area network – Ethernet	First part of M1-L7-LAN-Ethernet.pptx
	Local area network – Ethernet Evolutions	Second part of M1-L7-LAN-Ethernet.pptx
Week 6: 13/Feb/2023 15/Feb/2023	Local area network – WLAN	M1-L8-LAN-WLAN.pptx
	Mobile Access Networks	M1-L9-Mobile.pptx
Week 7: 20/Feb/2023 22/Feb/2023	E-learning for Network paradigms	M1-L10-Paradigms.pptx
	Network paradigms	M1-L10-Paradigms.pptx

Additional Materials

- **The related content talked today in https://eclass.teicrete.gr/modules/document/file.php/TP326/%CE%98%CE%B5%CF%89%CF%81%CE%AF%CE%B1%20(Lectures)/Computer_Networking_A_Top-Down_Approach.pdf is as follow:**
  - Chapter 5

- **https://www.techtarget.com/searchnetworking/definition/local-area-network-LAN**

Mingling Among a Cocktail party

SC2008/CZ3006/CE3005
Computer Network

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)

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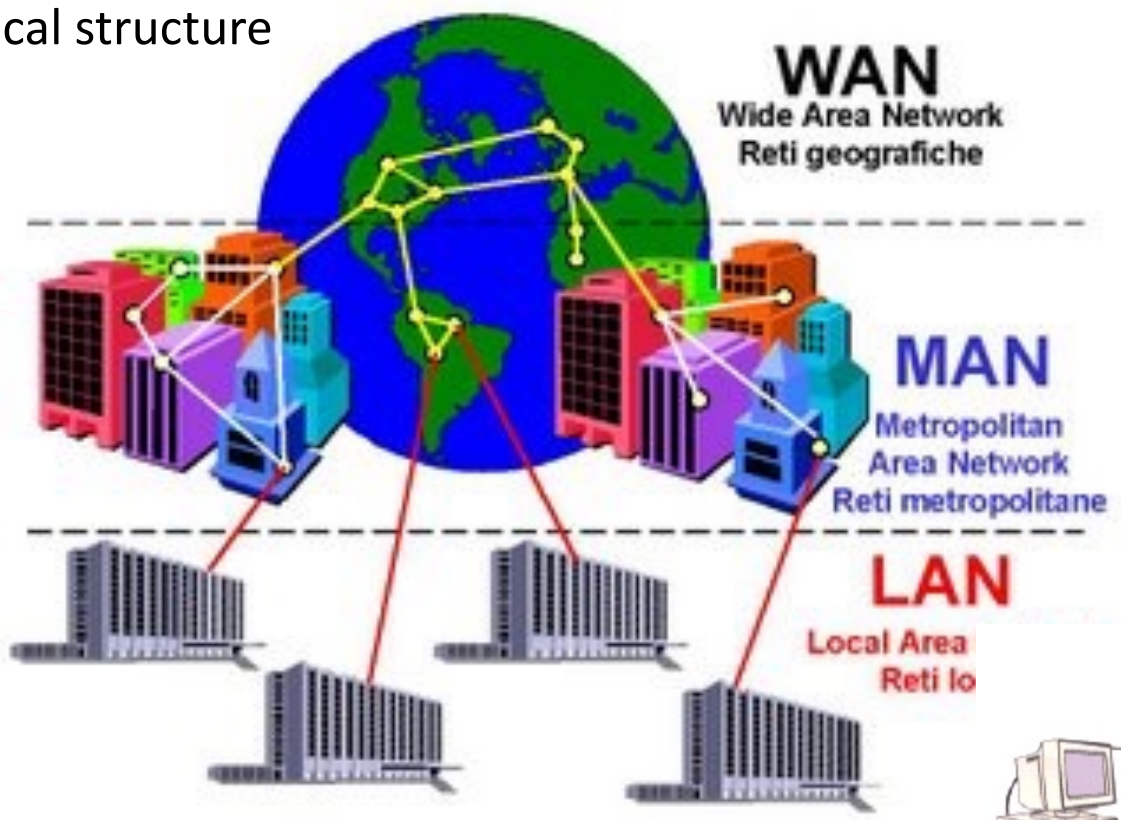
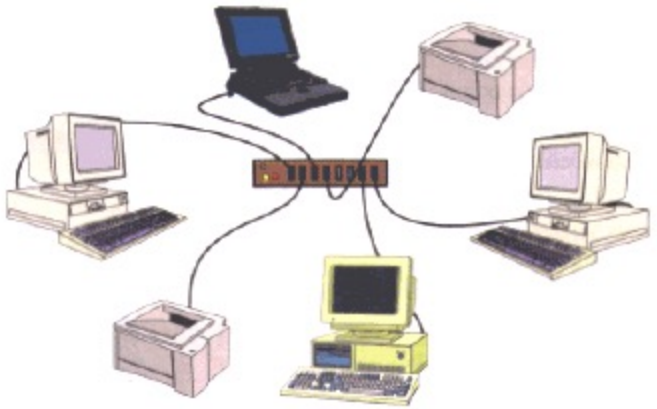
WAN/MAN/LAN

hierarchical structure





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LAN (Local Area Networks)

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

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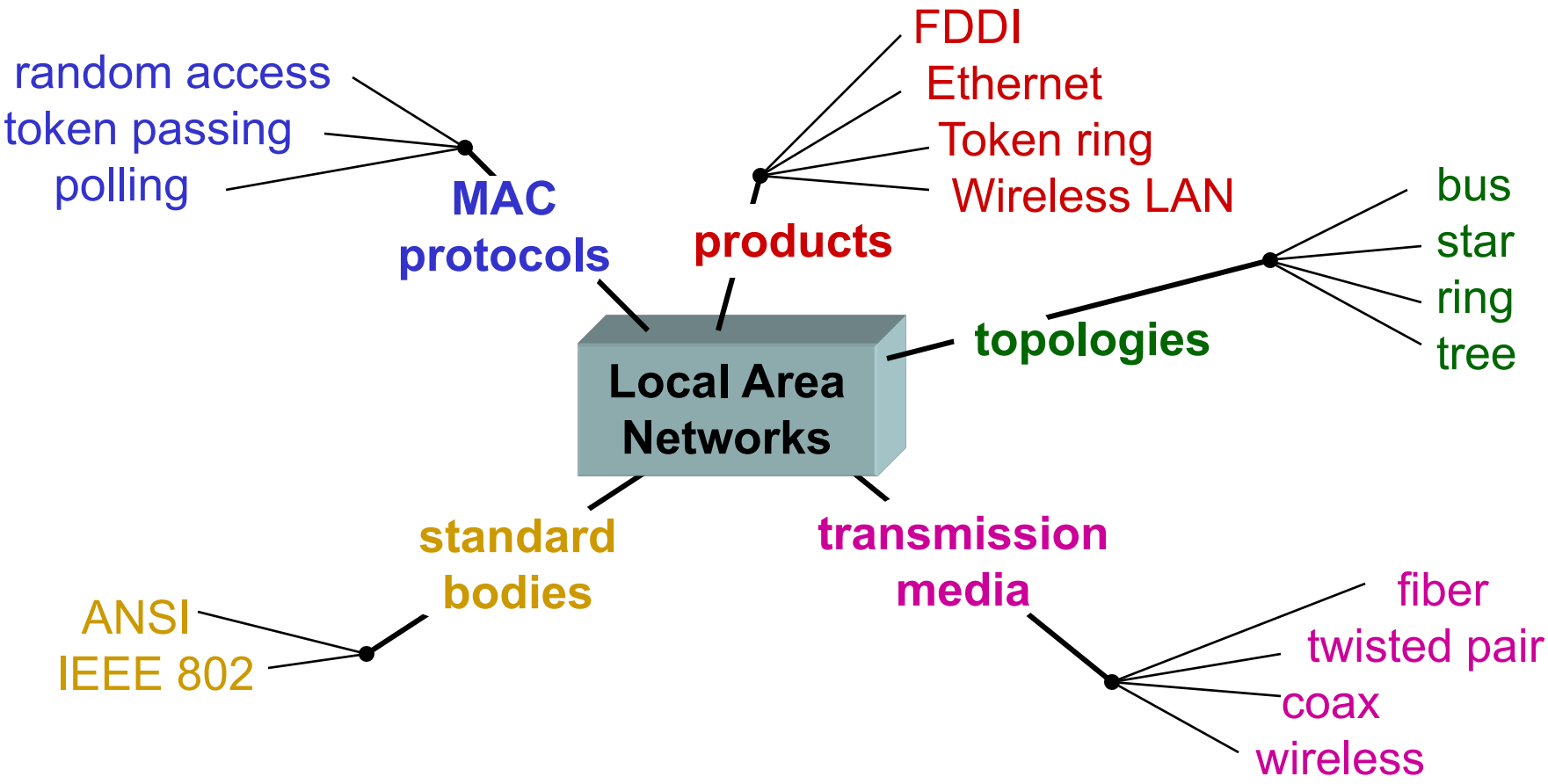
LAN Taxonomy



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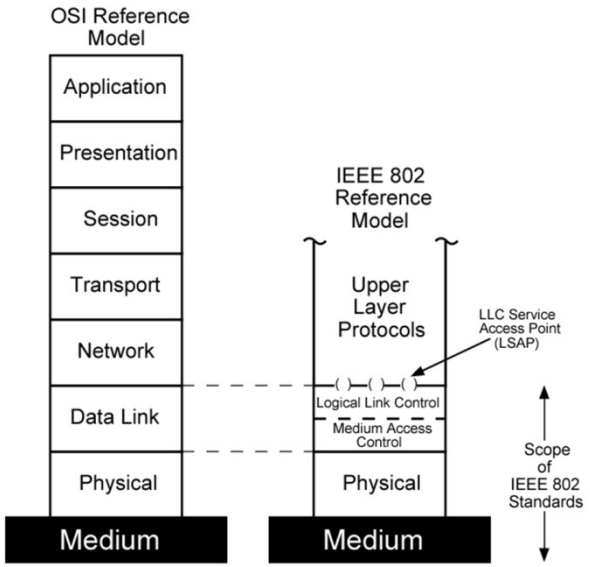
LAN Protocol Architecture

- **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



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IEEE 802 Layers - Physical

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

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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, error 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

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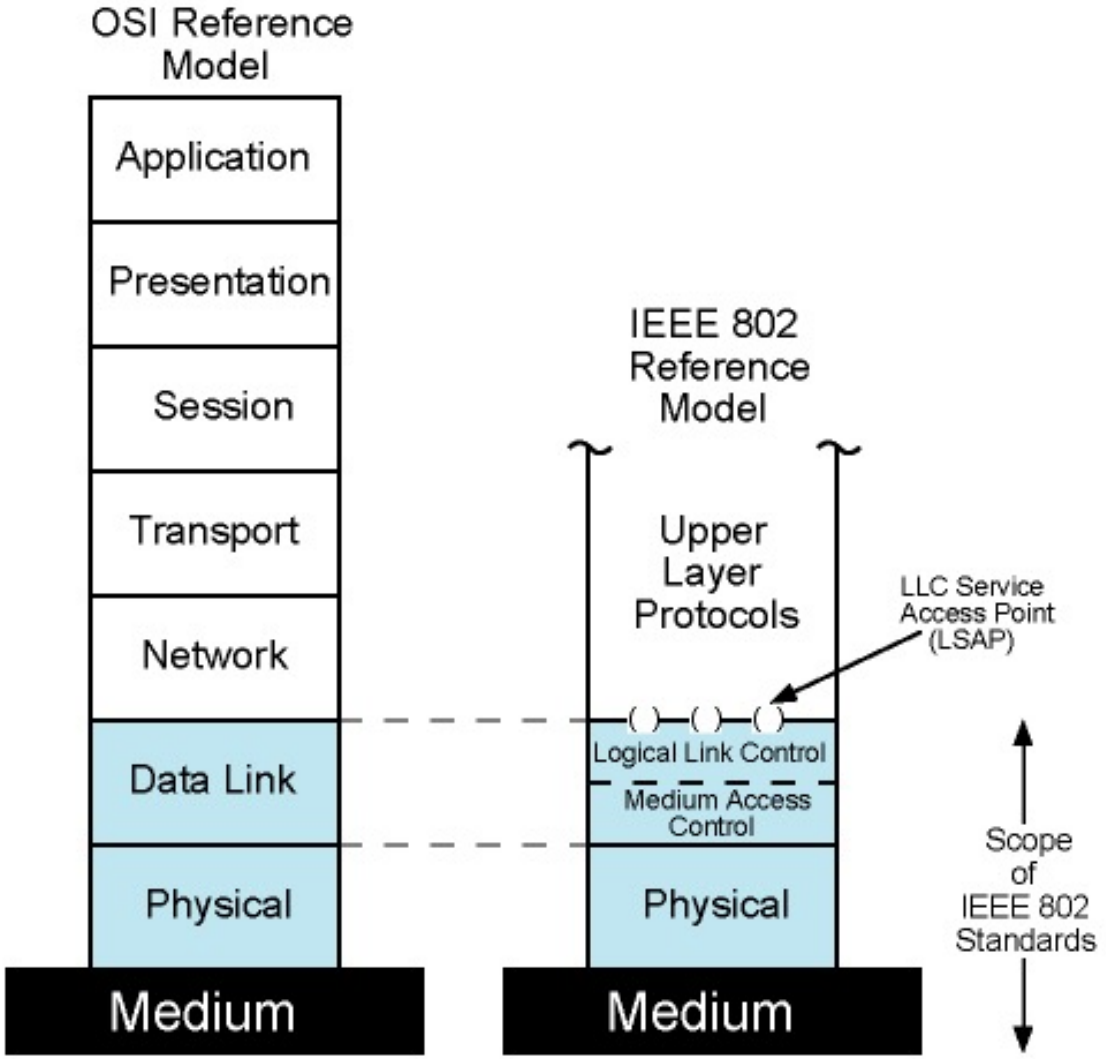
IEEE 802 Protocols vs OSI Model



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LAN in a Nutshell

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

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

LAN Topologies

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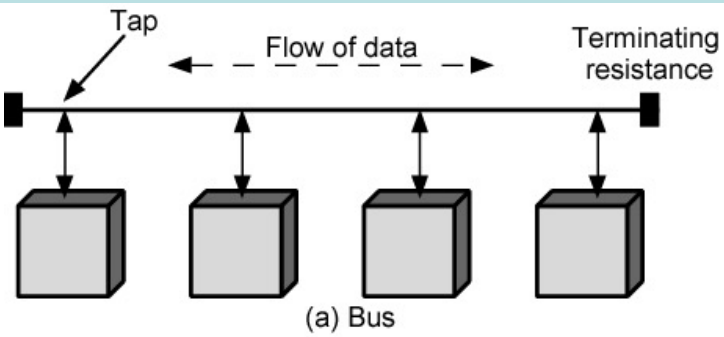
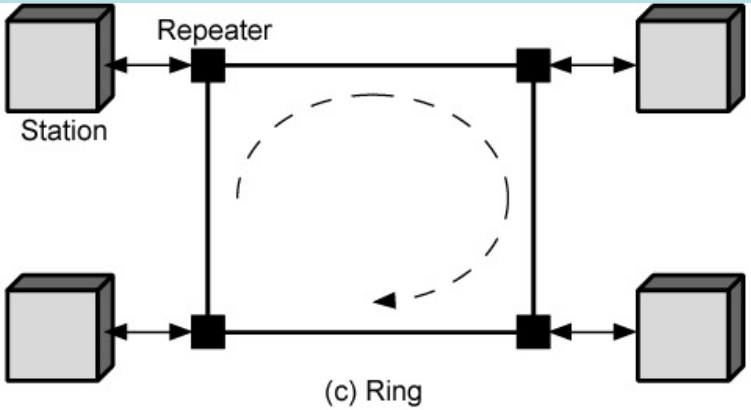
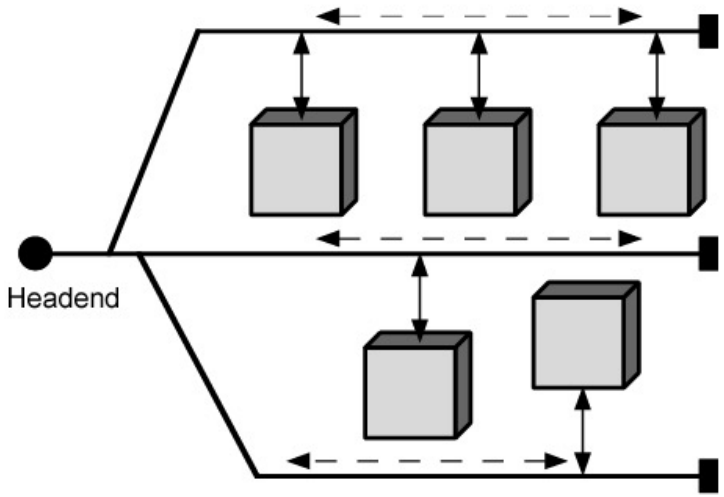
LAN Topologies: Bus, Tree, Ring and Star



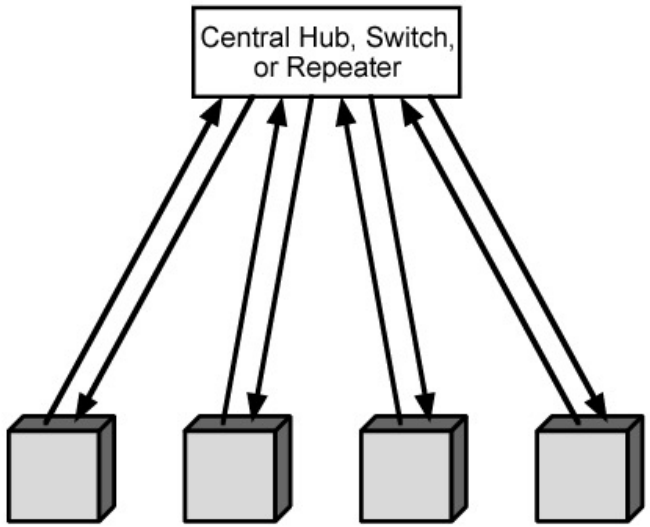
(a) Bus



(c) Ring



(b) Tree



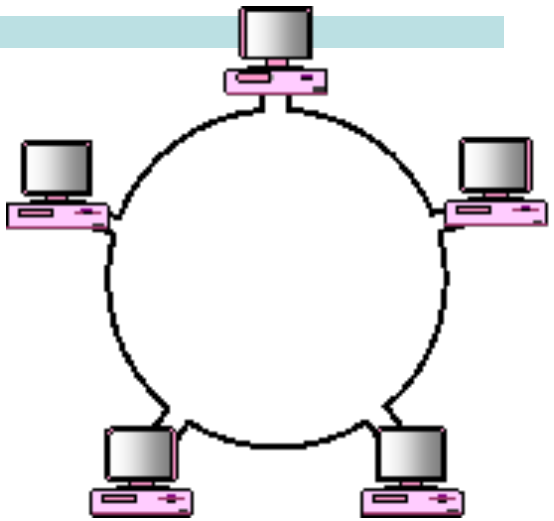
(d) Star

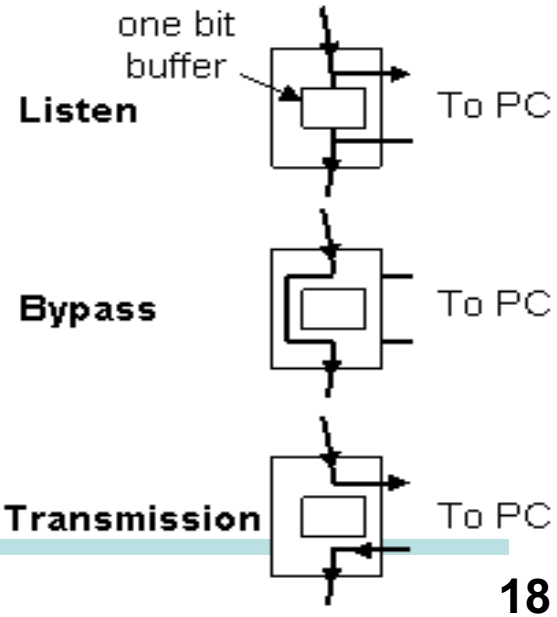
Bus and Tree

- **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

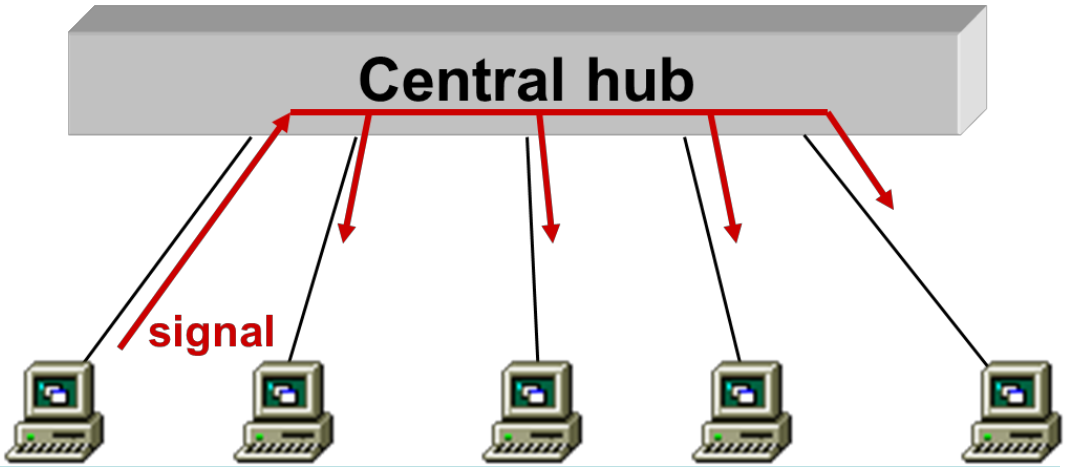
- **Repeaters are joined by point to point links in closed loop**
  - Receive data on one link and retransmit on another
  - Links are unidirectional
  - Stations attach to repeaters
- **Data Frames**
  - Circulate past all stations
  - Destination recognizes address and copies frame
  - Frame circulates 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



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Choice of Topology

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

Transmission Medium

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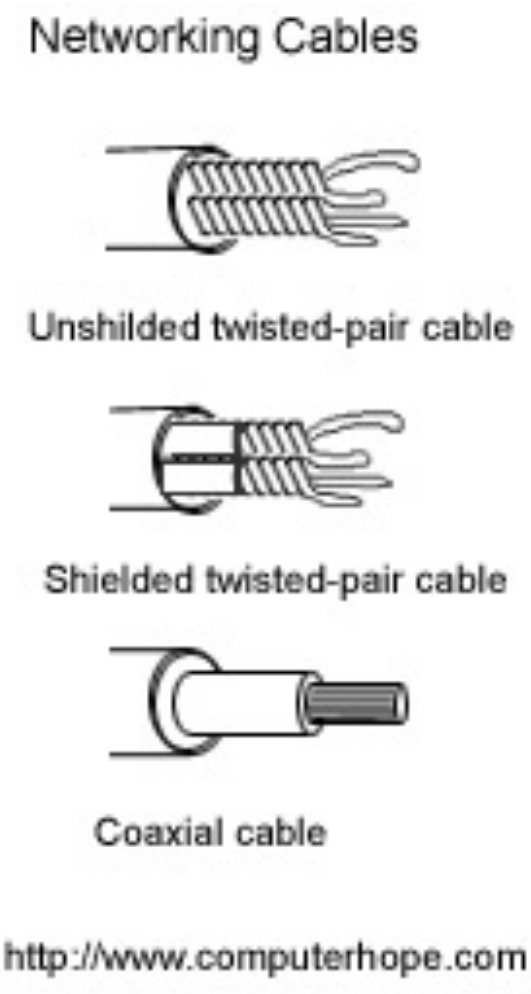
Medium Available (1)

- **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



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Media Available (2)

- **High performance unshielded twisted pair (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**

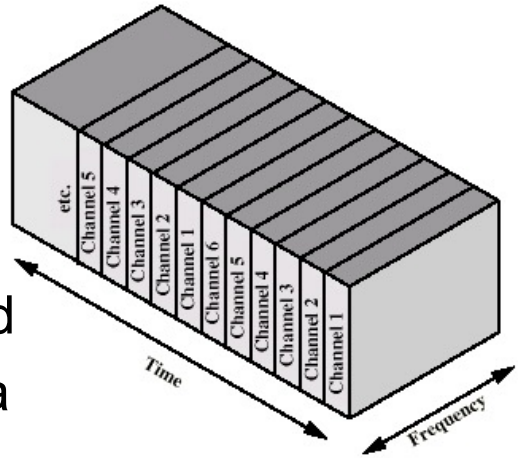
MAC Decision Making Options

- **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

Not Examinable

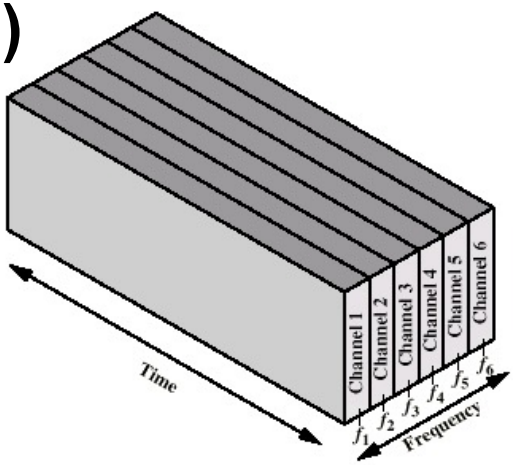
Static Channel Allocation

- **Time Division Multiplexing (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



TDM

- **Frequency Division Multiplexing (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



FDM

- **Code Division Multiplexing (CDM)**

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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.

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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