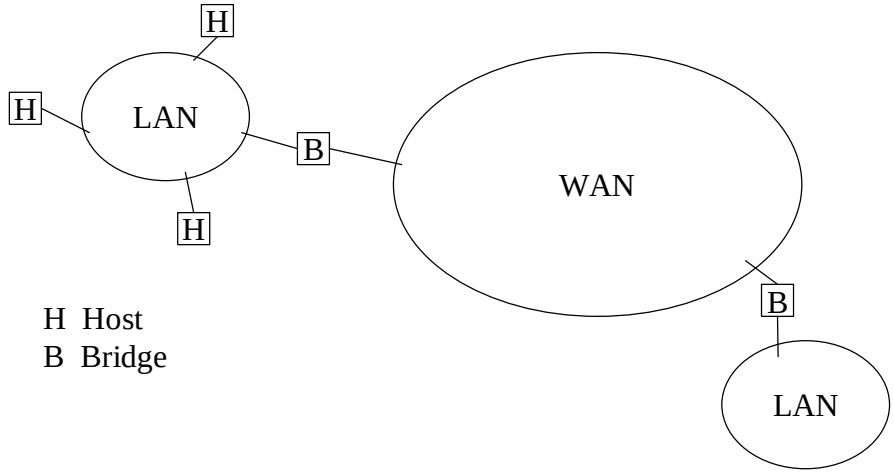
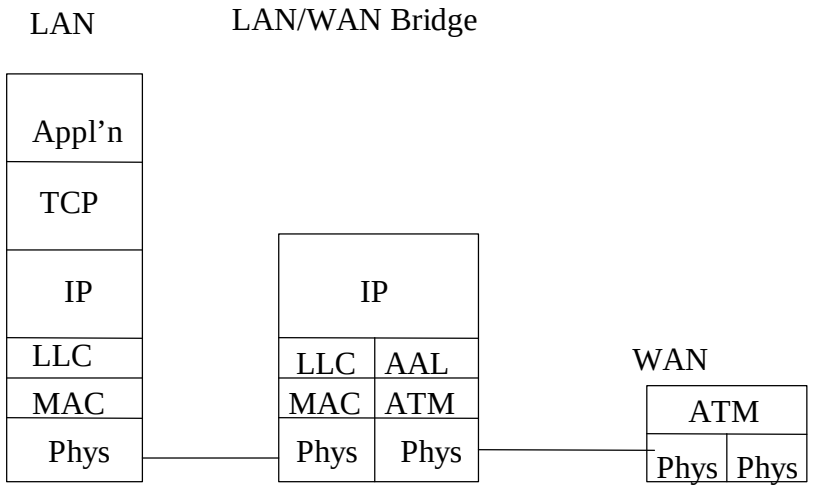
Local Area Networks

Interconnecting LANs and WANs
LAN protocol architecture
Basic LAN Architecture

LANs and WANs



Protocol Interconnection



LAN Applications (1)

- High speed office networks
  - Desktop data processing
  - High capacity local storage
  - server based systems: functionally distributed systems
- Back end networks and storage area networks
  - Interconnecting large systems (mainframes and large storage devices)
    - High data rate
    - High speed interface
    - Distributed access
    - Limited distance
    - Limited number of devices

LAN Applications (2)

- Backbone LANs
  - Interconnect lower speed local LANs
  - High Reliability
  - High Capacity
  - Low Cost connection to each LAN
  - Higher cost connection of LAN to backbone
  - Providing large scale computing and communications to a whole site
    - e.g. University

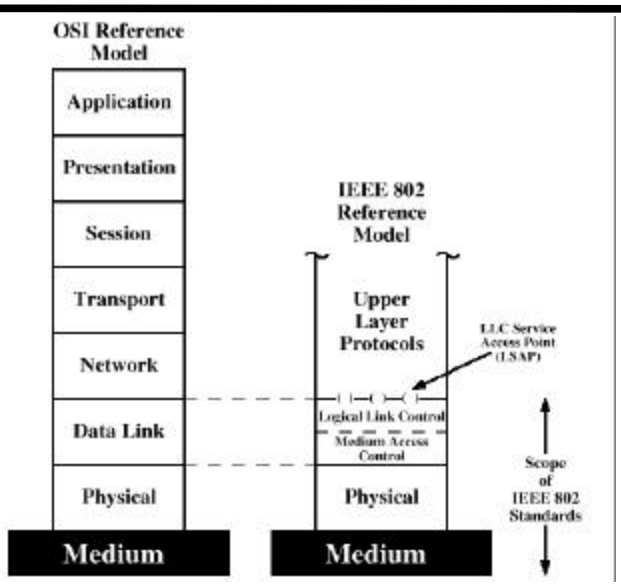
LAN Architecture

- Protocol architecture
- Topologies
- Media Access Control (MAC)
- Logical Link Control (LLC)

Protocol Architecture

- Lower layers of OSI model
- IEEE 802 reference model
- Physical
- Logical link control (LLC)
- Media access control (MAC)

IEEE 802 v OSI



802 Layers - Physical

- Encoding/decoding
- Preamble generation/removal
- Bit transmission/reception
- Transmission medium and topology

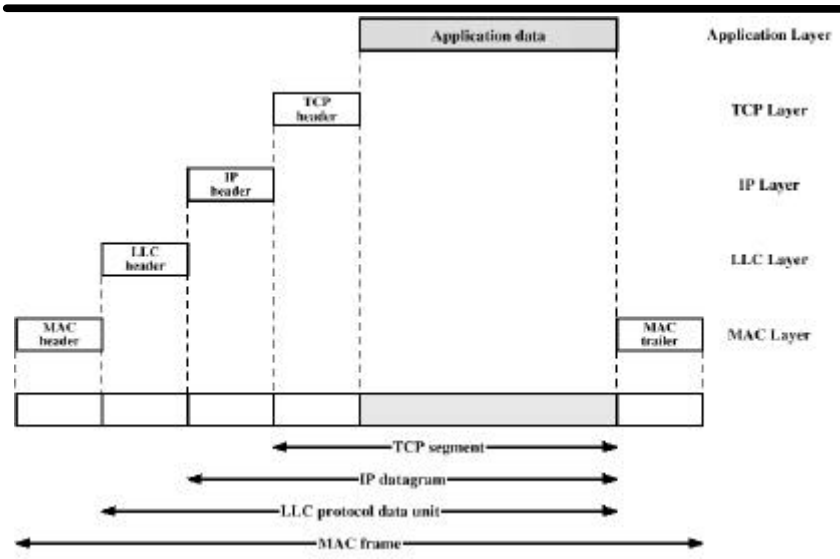
802 Layers - Logical Link Control

- Interface to higher levels
- Flow and error control
  - relatively independent of nature of LAN

802 Layers - 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
  - Each for a different type of LAN

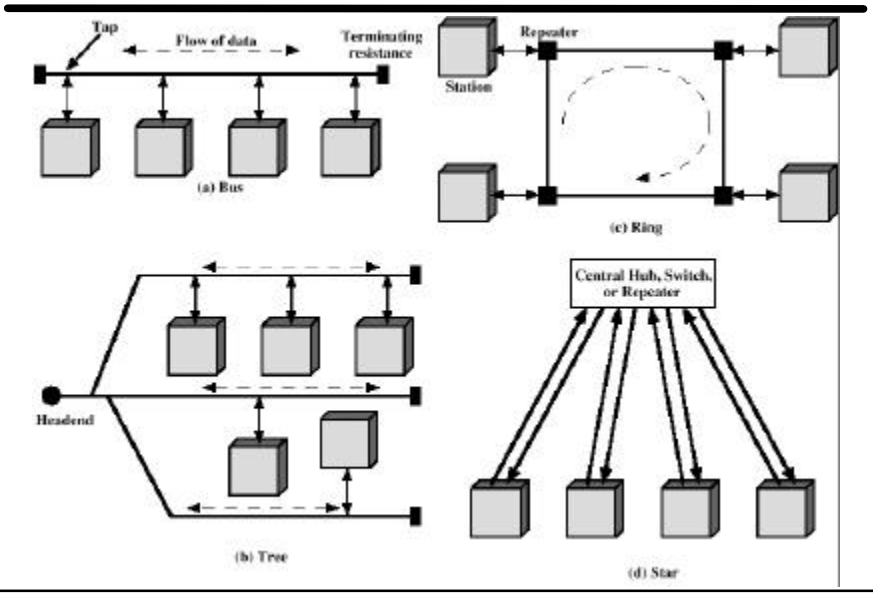
LAN Protocols in Context



Topologies

- Tree
- Bus
  - Special case of tree
    - One trunk, no branches
- Ring
- Star

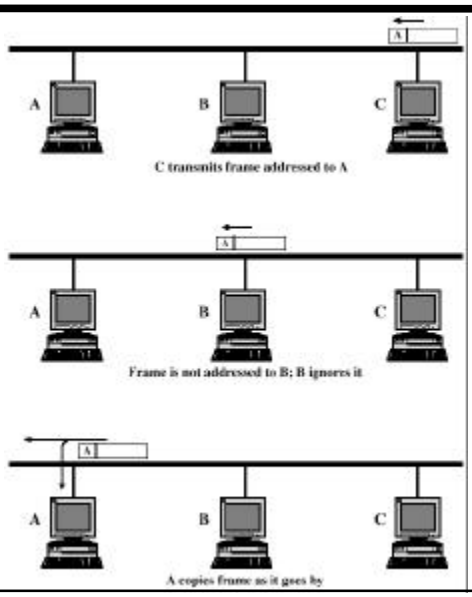
LAN Topologies



Bus and Tree

- Multipoint medium
- Transmission propagates throughout medium
- All transmissions go to 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
  - To avoid hogging
    - Data in small blocks - frames
- Terminator absorbs frames at end of medium

Frame Transmission - Bus LAN



Ring Topology

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

Star Topology

- Each station connected directly to central node
  - Usually via two point to point links
- Central node can broadcast
  - Physical star, logical bus
  - Only one station can transmit at a time
- Central node can act as frame switch

Media Access Control

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

Asynchronous Systems

- Round robin
  - Good if many stations have data to transmit over extended period
- Reservation
  - Good for stream traffic
- Contention
  - Good for bursty traffic
  - All stations contend for time
  - Distributed
  - Simple to implement
  - Efficient under moderate load
  - Tend to collapse under heavy load

MAC Frame Format

- MAC layer receives data from LLC layer
- MAC control
- Destination MAC address (48 bits)
- Source MAC address (48 bits)
- LLC PDU
- CRC (32 bits)
- MAC layer detects errors and discards frames
- LLC optionally retransmits unsuccessful frames

Logical Link Control

- Transmission of link level PDUs between two stations
- Must support multiaccess, shared medium
- Relieved of some link access details by MAC layer
- Addressing involves specifying source and destination LLC users
  - Referred to as service access points (SAP)
  - Typically higher level protocol

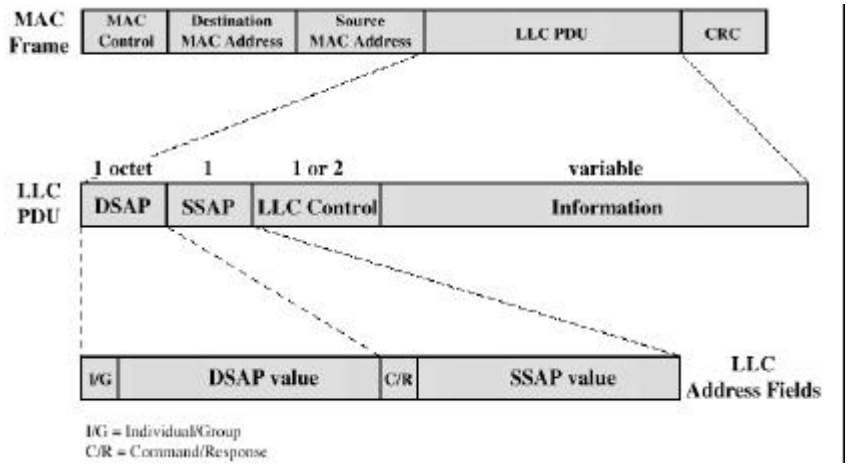
LLC Services

- Based on HDLC
- Unacknowledged connectionless service
- Connection mode service
- Acknowledged connectionless service

LLC Protocol

- Modeled after HDLC
- Asynchronous balanced mode to support connection mode LLC service (type 2 operation)
- Unnumbered information PDUs to support Acknowledged connectionless service (type 1)
- Multiplexing using LSAPs

Typical Frame Format



Bus LANs

- Signal balancing
  - Signal must be strong enough to meet receiver's minimum signal strength requirements
  - Give adequate signal to noise ratio
  - Not so strong that it overloads receiver
  - Must satisfy these for all combinations of sending and receiving station on bus
  - Usual to divide network into small segments
  - Link segments with amplifies or repeaters

Transmission Media

- Twisted pair
  - Not practical in shared bus at higher data rates
- Baseband coaxial cable
  - Used by Ethernet
- Broadband coaxial cable
  - Included in 802.3 specification but no longer made
- Optical fiber
  - Expensive
  - Difficulty with availability
  - Not used

Baseband Coaxial Cable

- Uses digital signaling
- Manchester or Differential Manchester encoding
- Entire frequency spectrum of cable used
- Single channel on cable
- Bi-directional
- Few kilometer range
- Ethernet (basis for 802.3) at 10Mbps
- 50 ohm cable

Ethernet (CSAM/CD)

- Carriers Sense Multiple Access with Collision Detection
- Xerox - Ethernet
- IEEE 802.3