CNL
Communications & Networking
Laboratory

ECE 462 – Data and Computer Communications

Lecture 19: LAN Protocols

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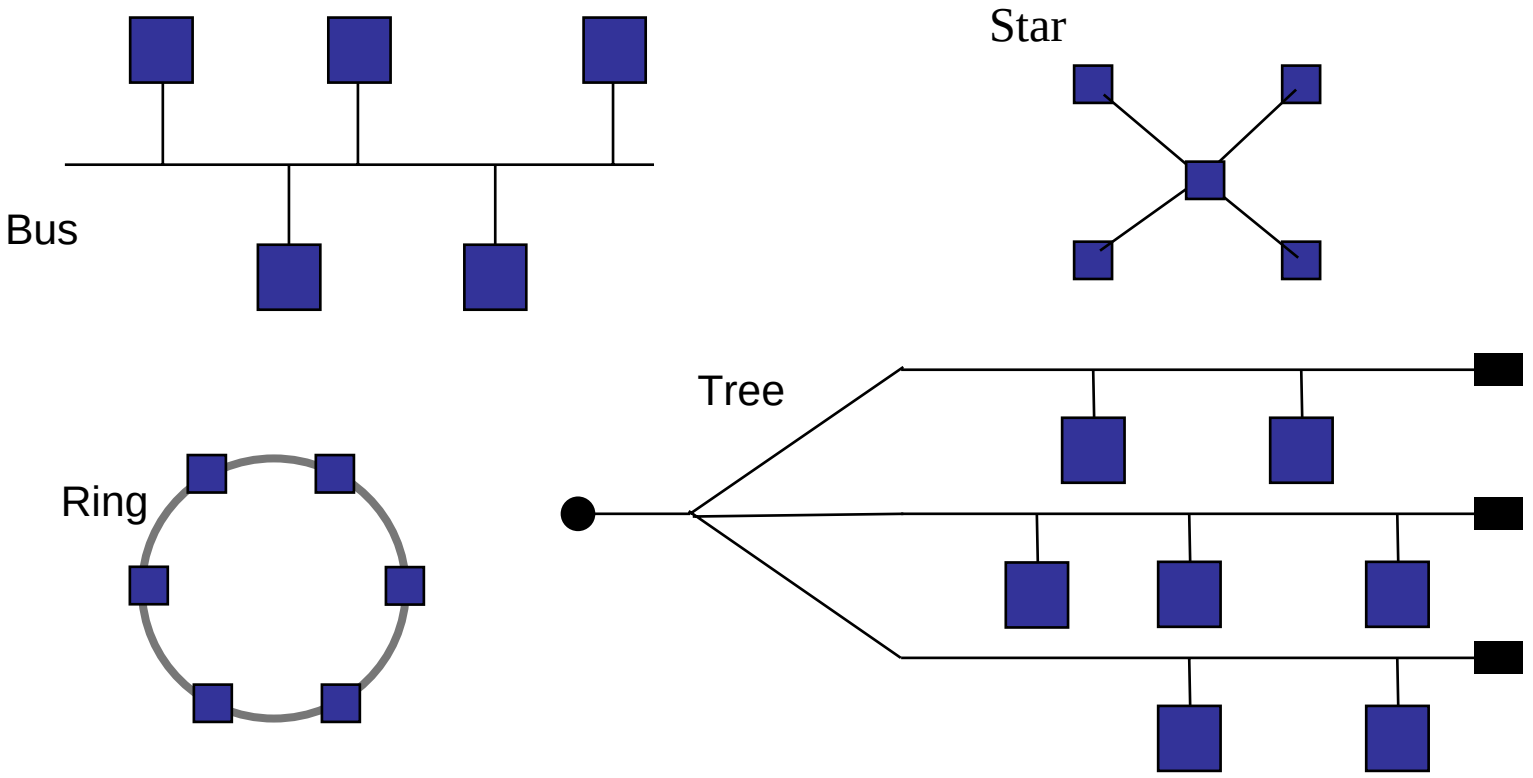
LAN Logical Topologies

- the basic LAN function is to reach all other stations without complex routing



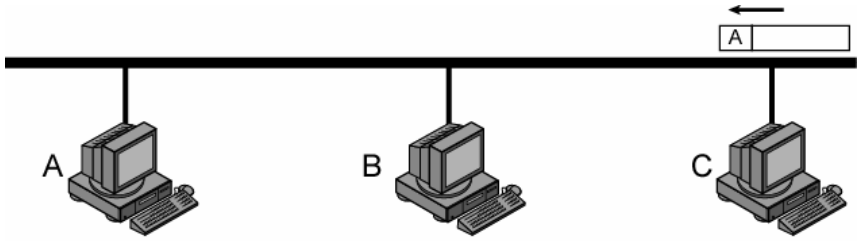
LAN Architecture

- Topologies
  - Tree, Ring, Star
  - Bus
    - Special case of tree (one trunk, no branches)
- Transmission medium
- Layout
- Medium access control

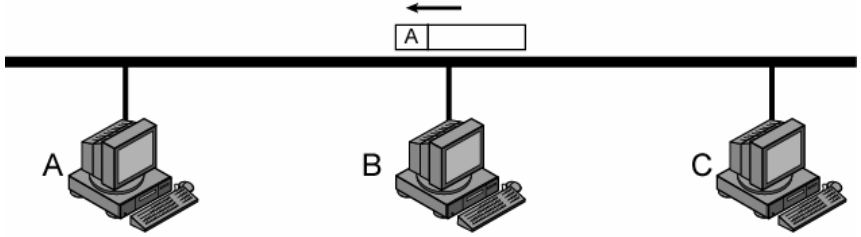
Bus and Tree

- 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
  - To avoid hogging
    - Data in small blocks - frames
- Terminator absorbs frames at end of medium

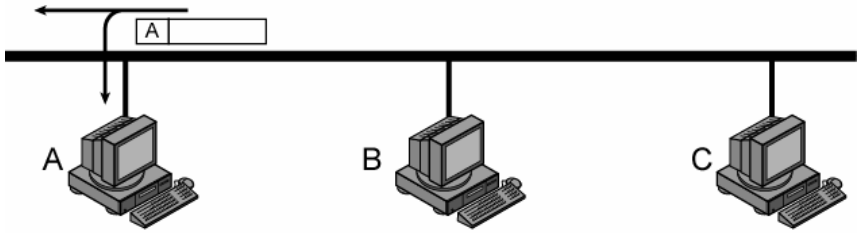
Frame Transmission on Bus LAN



C transmits frame addressed to A



Frame is not addressed to B; B ignores it

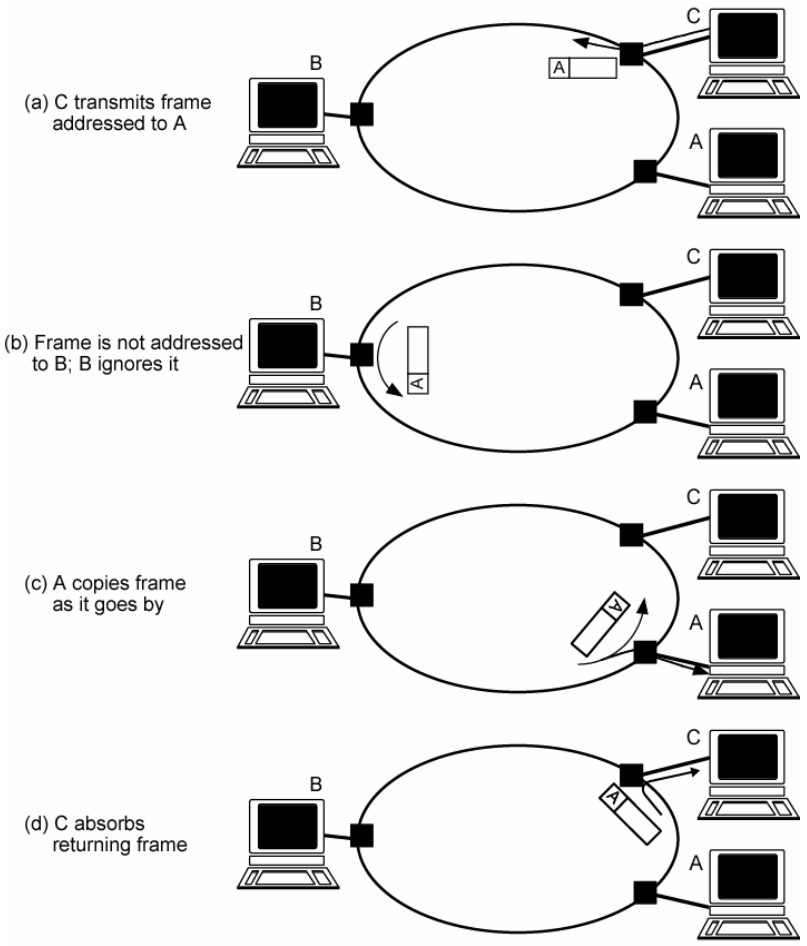


A copies frame as it goes by

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

Frame Transmission Ring LAN



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

Choice of Topology

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

Bus LAN Transmission Media

- Twisted pair
  - Early LANs used voice grade cable
  - Didn't scale for fast LANs
  - Not used in bus LANs now
- Baseband coaxial cable
  - Uses digital signalling
  - Original Ethernet
- Broadband coaxial cable
  - As in cable TV systems
  - Analog signals at radio frequencies
  - Expensive, hard to install and maintain
  - No longer used in LANs
- Optical fiber
  - Expensive taps
  - Better alternatives available
  - Not used in bus LANs
- All hard to work with compared with star topology twisted pair
- Coaxial baseband still used but not often in new installations

Ring and Star Usage

- Ring
  - Very high speed links over long distances
  - Single link or repeater failure disables network
- Star
  - Uses natural layout of wiring in building
  - Best for short distances
  - High data rates for small number of devices

Choice of Medium

- Constrained by LAN topology
- Capacity
- Reliability
- Types of data supported
- Environmental scope

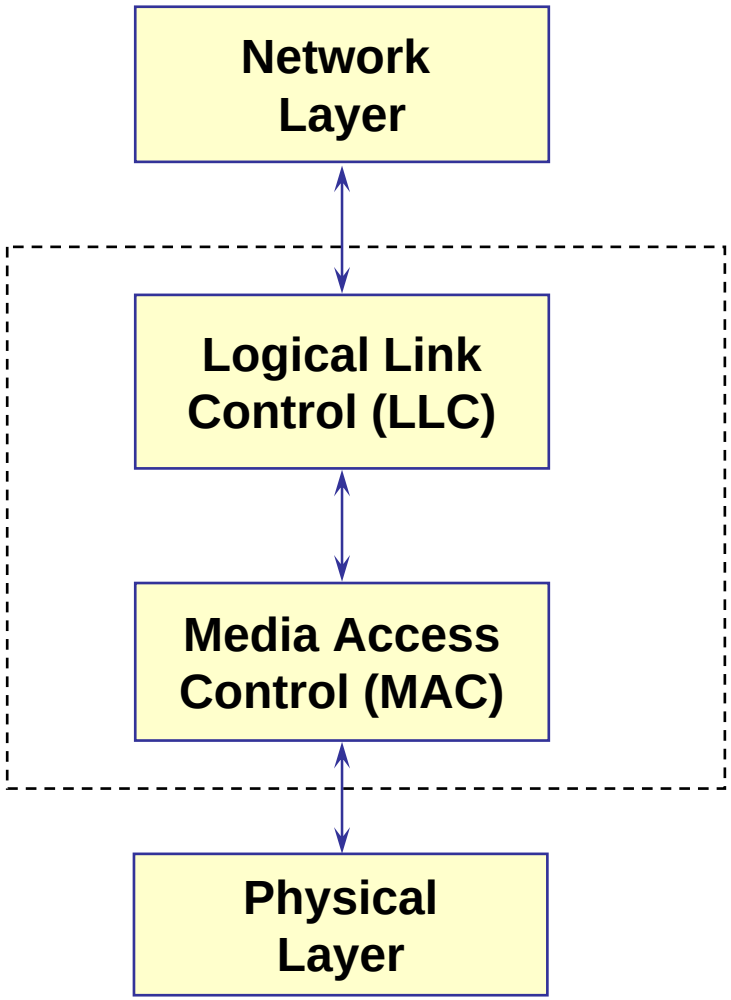
Media Available

- Voice grade unshielded twisted pair (UTP)
  - Cat 3
  - Cheap
  - Well understood
  - Use existing telephone wiring in office building
  - Low data rates
- Shielded twisted pair and baseband coaxial
  - More expensive than UTP but higher data rates
- Broadband cable
  - Still more expensive and higher data rate
- High performance UTP
  - Cat 5 and above
  - 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
    - Prices are coming down as demand and product range increases

Protocol Architecture

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

DLC Refinement for Local Area Networks



Data Link Control Layer

Scope of IEEE 802

802 Layers - Physical

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

802 Layers – Logical Link Control

- Interface to higher layers
- Flow and error control

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

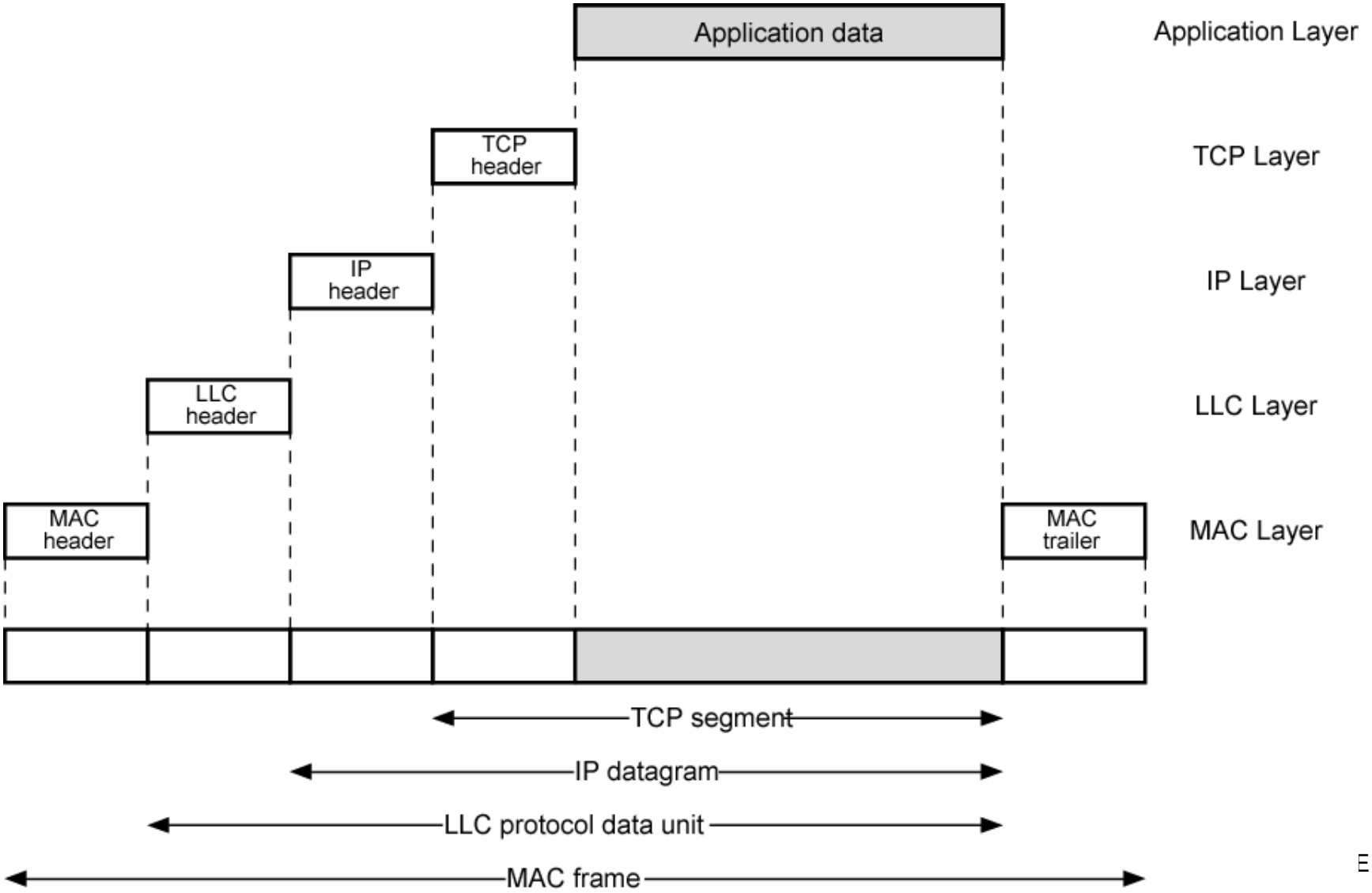
LLC Protocol

- 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

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

LAN Protocols in Context



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

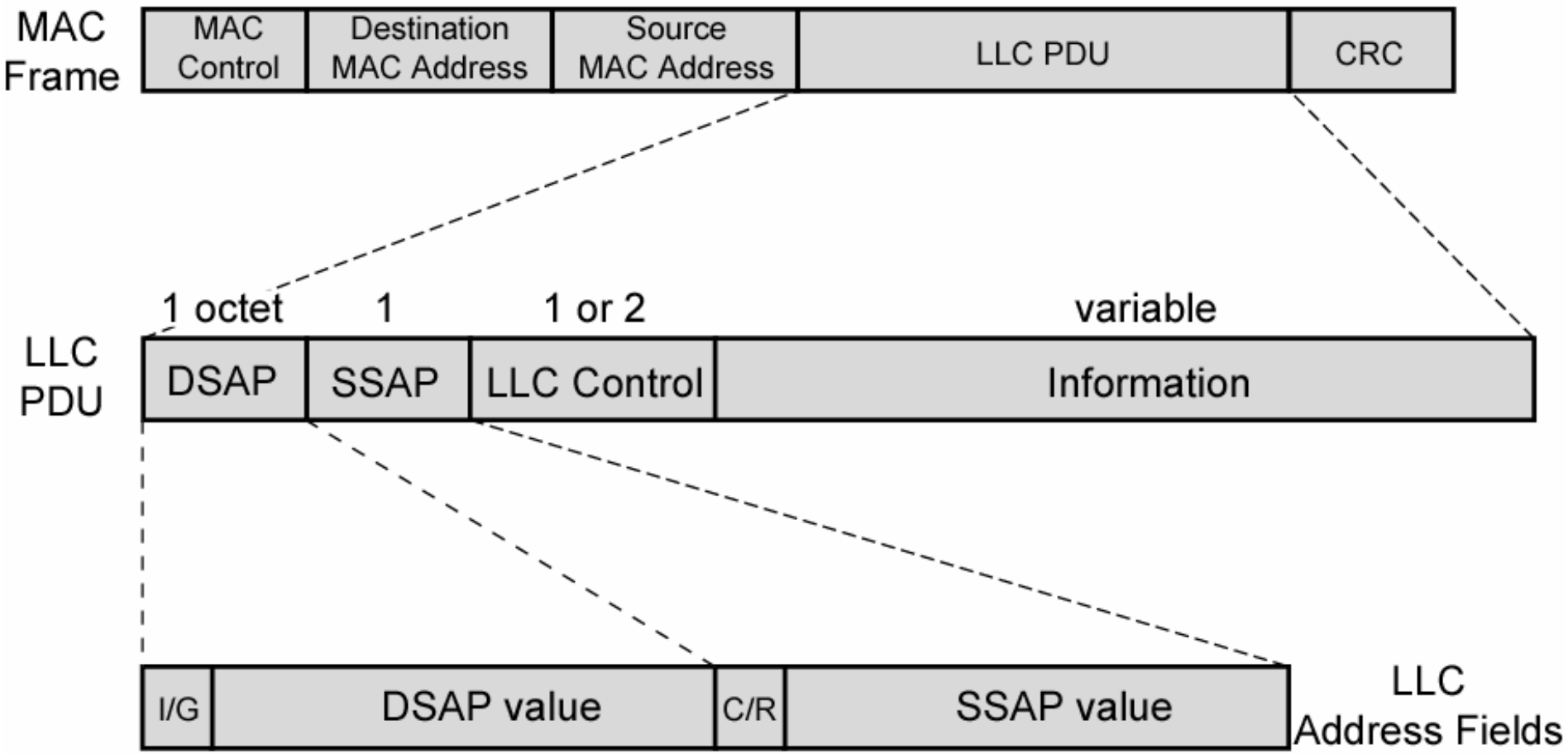
Asynchronous Systems

- 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
- Source MAC address
- LLS
- CRC
- MAC layer detects errors and discards frames
- LLC optionally retransmits unsuccessful frames

Generic MAC Frame Format



I/G = Individual/Group
C/R = Command/Response

Ethernet Frame Structure

64 bits	48 bits	48 bits	16 bits	368 to 12,000 bits	32 bits
Preamble	Destination	Source	Type	Frame Data	CRC

- 48-bit address is installed at the factory for each interface
- Destination must be on the same LAN as the Source
- Frame Type describes the payload; thus each frame is self-identifying (example: TCP/IP packet)
- Minimum frame size = slot time = 512 bits
- Interframe gap = 96 bits
- Jamming signal size = 32 - 48 bits