Chapter 14  LAN Systems

- Ethernet (CSMA/CD)
  - ALOHA
  - Slotted ALOHA
  - CSMA
  - CSMA/CD
- Token Ring /FDDI
- Fiber Channel
  - Fiber Channel Protocol Architecture

From Slotted ALOHA to CSMA

- Slotted ALOHA
  - Time in uniform slots equal to frame transmission time
  - Need central clock (or other sync mechanism)
  - Transmission begins at slot boundary
  - Max utilization 37%
- CSMA: take advantage of small (compare to transmission time) propagation delay
  - All stations know that a transmission has started almost immediately in LAN
  - First listen for clear medium (carrier sense)
  - If medium idle, transmit
  - Collision occurs only if two stations start at the same instant, collision
  - Wait reasonable time (round trip plus ACK contention, No ACK then retransmit
  - Max utilization depends on propagation time (medium length) and frame length
    - Longer frame and shorter propagation gives better utilization

Ethernet (CSMA/CD)

- Carriers Sense Multiple Access with Collision Detection
- IEEE 802.3 Medium Access Control Development
  - Random Access & Contention
    - Stations access medium randomly, content for time on medium
  - ALOHA – Precursor of CSMA/CD: Packet Radio
    - When sender station has frame, it sends
      - Sender station listens (for max round trip time plus small increment)
      - If ACK, fine. If not, retransmit
      - If no ACK after repeated transmissions, give up
    - Receiver station frame check sequence (as in HDLC)
      - If frame OK and address matches receiver, send ACK
      - Frame may be damaged by noise or by another station transmitting at the same time (collision)
      - Any overlap of frames causes collision
      - Max utilization 18%, not desirable -> Slotted ALOHA

- CSMA: collision occupies medium for duration of transmission, waste of capacity
  - If medium is idle, transmit
  - If busy, listen for idle then transmit immediately
  - If two stations are waiting, collision
- CSMA/CD: stations listening whilst transmitting
  - If medium idle, transmit
  - If busy, listen for idle, then transmit
  - If collision detected, jam then cease transmission
  - After jam, wait random time then start again
  - Binary exponential back off
**Collision Detection**

- On baseband bus, collision produces much higher signal voltage than single signal
  - Collision detected if cable signal greater than single station signal
- Signal attenuates over distance
- Limit distance to 500m (10Base5) or 200m (10Base2)
- For twisted pair star-topology activity on more than one port is collision
  - Special collision presence signal generated

**Ethernet**

- 10Mbps -> 100Mbps
  -> Gigabit Ethernet
- Gigabit Ethernet
  - Compatible to 10/100
  - Enhancement of CSMA/CD
    - Carrier extension: At least 4096 bit-times long (512 for 10/100)
    - Frame bursting
    - With switching hub, no need for the enhancement

**Token Ring**

- MAC protocol
  - Small frame (token) circulates when idle
  - Station waits for token
  - Changes one bit in token to make it SOF for data frame
  - Append rest of data frame
  - Frame makes round trip and is absorbed by transmitting station
  - Station then inserts new token
    - when transmission has finished and
    - With/without the leading edge of returning frame arrives (immediate release/delayed release)

**FDDI (Fiber Distributed Data Interface) MAC Protocol**

- As for 802.5 except:
  - Station seizes token by aborting token transmission
  - Once token captured, one or more data frames transmitted
  - New token released as soon as transmission finished (early token release in 802.5)
Fiber Channel - Background

- **I/O channel**
  - Direct point to point or multipoint comms link
  - Hardware based
  - High Speed
  - Very short distance
  - User data moved from source buffer to destination buffer

- **Network connection**
  - Interconnected access points
  - Software based protocol
  - Flow control, error detection & recovery
  - End systems connections

Fiber Channel

- **Best of both technologies**
  - Channel oriented
  - Data type qualifiers for routing frame payload
  - Link level constructs associated with I/O ops
  - Protocol interface specifications to support existing I/O architectures
    - e.g. SCSI
  - Network oriented
    - Full multiplexing between multiple destinations
    - Peer to peer connectivity
    - Internetworking to other connection technologies

Fiber Channel Elements

- End systems - Nodes
- Switched elements - the network or fabric
- Communication across point to point links

Fiber Channel Network

Fiber Channel Protocol Architecture

- **FC-0 Physical Media**
  - Optical fiber for long distance
  - coaxial cable for high speed short distance
  - STP for lower speed short distance

- **FC-1 Transmission Protocol**
  - 8B/10B signal encoding

- **FC-2 Framing Protocol**
  - Topologies
  - Framing formats
  - Flow and error control
  - Sequences and exchanges (logical grouping of frames)

- **FC-3 Common Services**
  - Including multicasting

- **FC-4 Mapping**
  - Mapping of channel and network services onto fiber channel
    - e.g. IEEE 802, ATM, IP, SCSI