Lecture 7 : FDDI

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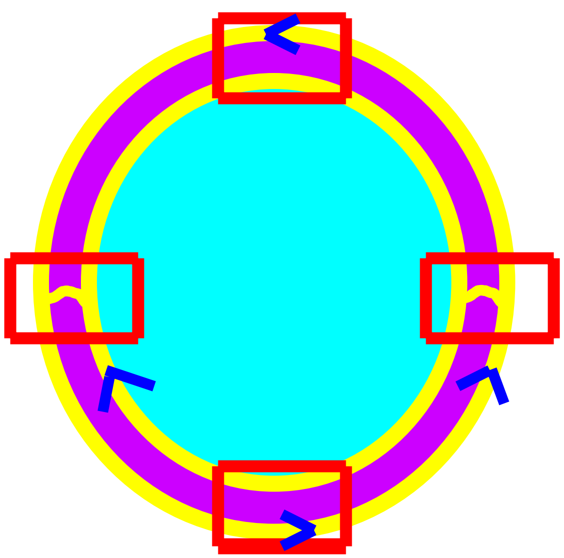
Fibre Distributed Data Interface

- Runs on fibre and not copper
- dual ring
  - two independent rings transmitting data in opposite direction
  - second not used for normal operation
  - used only if primary fails

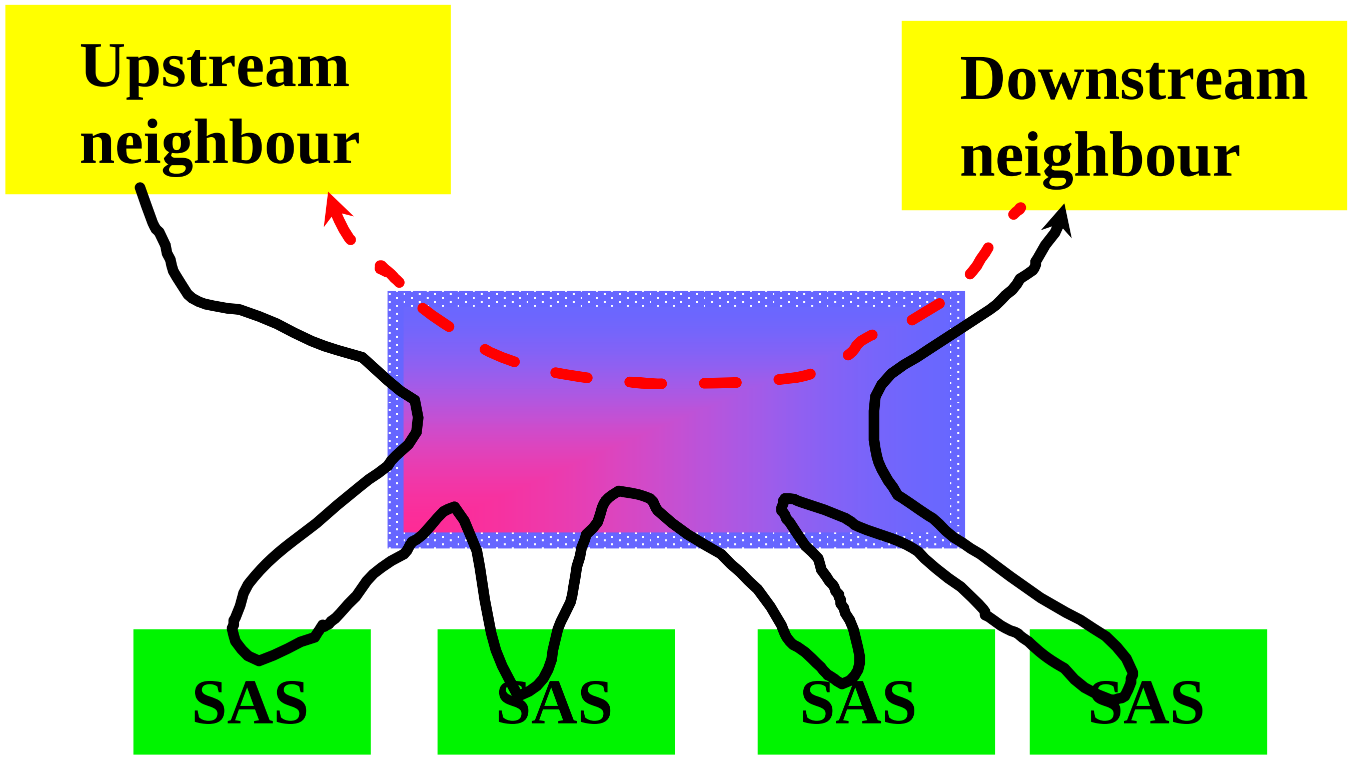
FDDI Ring



FDDI Ring

- Expensive – twice the amount of fibre
  - stations may be allowed to connect on a single cable
    - single attachment station (SAS)
- use concentrator to connect several SASs to dual ring

Fibre Concentrator



Concentrator detects failure of SAS
- Optical bypass to isolated failed SAS

FDDI Ring

- Each NE Adapter hosts some number of bits between its input and output interfaces
  - Variable buffer size
    - $9 \leq$ buffersize ≤ 80 bit
- Station transmits an amount equal to half buffer
- Total time depends on buffer

Delay in FDDI

- Example: 100 Mbps FDDI
- - 10 ns for bit time
- - Each station 10 bit buffer – waits until buffer half full before transmitting
  - station introduces 50 ns delay into TRT

FDDI –Physical Characteristics

- 500 stations with a maximum distance of 2km between any pair
- maximum network length : 200km
- 100 km connecting all stations (dual ring)

FDDI –Physical Characteristics

- FDDI encoding:
  - 4B/5B encoding
  - Replace 4B with 5B code such that no more than one leading zero,
  - no more than two trailing zeros and no more than 3 consecutive zeros

Asynchronous vs. Synchronous Traffic

- Synchronous traffic
  - Traffic is delay sensitive
  - station transmits data whether token is late or early
  - But synchronous cannot exceed one TTRT in one TRT
- Asynchronous traffic
  - Station transmits only if token is early

Measurement of Token Rotation Time (TRT)

- Target Token Rotation Time (TTRT – agreed upon time)
- Time between successive token arrival – TRT observed by any node
- TRT > TTRT
  - token late station does not transmit data
- TRT < TTRT
  - station holds token until TTRT
  - down stream station may not be able to transmit

Token Maintenance

- Process of setting up TTRT
- Monitor ring to ensure token has not been lost
- Fix TTRT – each node bids for the TTRT
- Idle time between valid transmissions that a given node experiences is
  - ring latency + time to transmit a full frame
  - 2.5 ms maximally sized ring
- If timer expired then claim token
  - TTRT lower used
  - Lower TTRT – new node enters the bidding process by

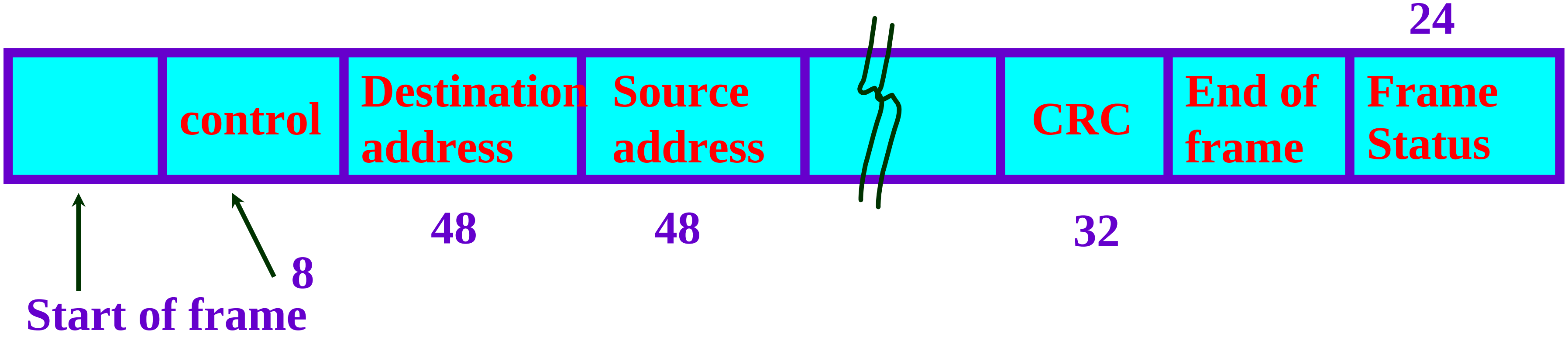
FDDI: Analysis

- Worst Case
  - Nodes with asynchronous traffic use one TTRT
  - Next nodes with synchronous traffic in one TTRT
- TRT at a node = 2 * TTRT
  - Synchronous traffic TTRT
  - Next no asynchronous – token late

FDDI Analysis

- No back to back transmission of TTRT
  - When does a node transmit asynchronous data
    - TRT + ε = TTRT => Transmit
    - Total TRT = TTRT + full FDDI frame
- if claim frame makes it all the way back to the original sende
  - node knows it is only active bidder => safely claim the token

FDDI Frame Format



7.2 FDDI Analysis

Let TTRT = T (average token interval time)

Let $\alpha_0, \alpha_1, \ldots, \alpha_{m-1}$ be the THT for each of the m stations

$$\alpha_0 + \alpha_1 + \ldots + \alpha_{m-1} \le T$$

Let $t_0, t_1, \ldots, t_{m-1}$ be the time of arrival of token at stations 0, 1, ..., m - 1

$t_i, i > 0$ is the time at which token reaches station i = i mod m in cycle i/m

$t_{-m}, \ldots, t_{-1}$, be the times at which token arrives at m, ..., 1 in the previous cycle

FDDI Analysis

If t_i - $t_{i\text{-}m}$ < T, low priority frames transmitted

If t_i - $t_{i\text{-}m}$ > T, no low priority frames transmitted

Both case high priority traffic transmitted

Time at which token reaches next node is

$$t_{i+1} = t_{i\text{-}m} + T + \alpha_i, \text{for } t_i - t_{i-m} < T, i \geq 0$$

$$t_{i+1} = t_i + \alpha_i, \text{for } t_i - t_{i-m} > T, i \geq 0$$

where $\alpha_i = \alpha_{i \bmod m}$ is the allocated transmission plus propagation time for node (i mod m)

FDDI Analysis

$$\text{Special case}: \alpha_i = 0, \text{ for all } i$$

$$t_{i+1} \leq \max(t_i, t_{i-m} + T), \; i \geq 0$$

$$\text{Since } t_{i-m} \leq t_i$$

$$t_{i+1} \leq t_i + T$$

$$\text{Similarly for } 1 \leq j \leq m+1$$

$$t_{i+j} \leq t_i + T$$

$$\text{Hence } t_{i+m+1} \leq t_i + T, \text{ for all } i \geq 0$$

FDDI Analysis

Iterate over multiples of $m+1$

$t_i \le t_{i \bmod (m+1)} + i/(m+1)T$ all $i > 0$

The $m+1$ occurs to ensure that when stations

are heavily loaded every cycle a different transmits

First cycle station 0 transmits

Next cycle station 1 transmits , ...

t_m - station 0 transmits T

$t_{2m} = T \Rightarrow$ station 0 cannot tra nsmit - token late

station 1 transmits $\Rightarrow$ fair share to all stations

Utilisation

$$U = \frac{1}{1 + a/N}$$

N - *number of stations*

a - *propagation delay*

1 - *time take to transmit a packet*

$N \rightarrow \infty \; U \rightarrow 1$

Wireless LANs

- Infrared, radio
  - Within room → Satellite communication
- IEEE 802.11
  - Limited geography
  - Primary challenge
    - Mediate access to a shared medium

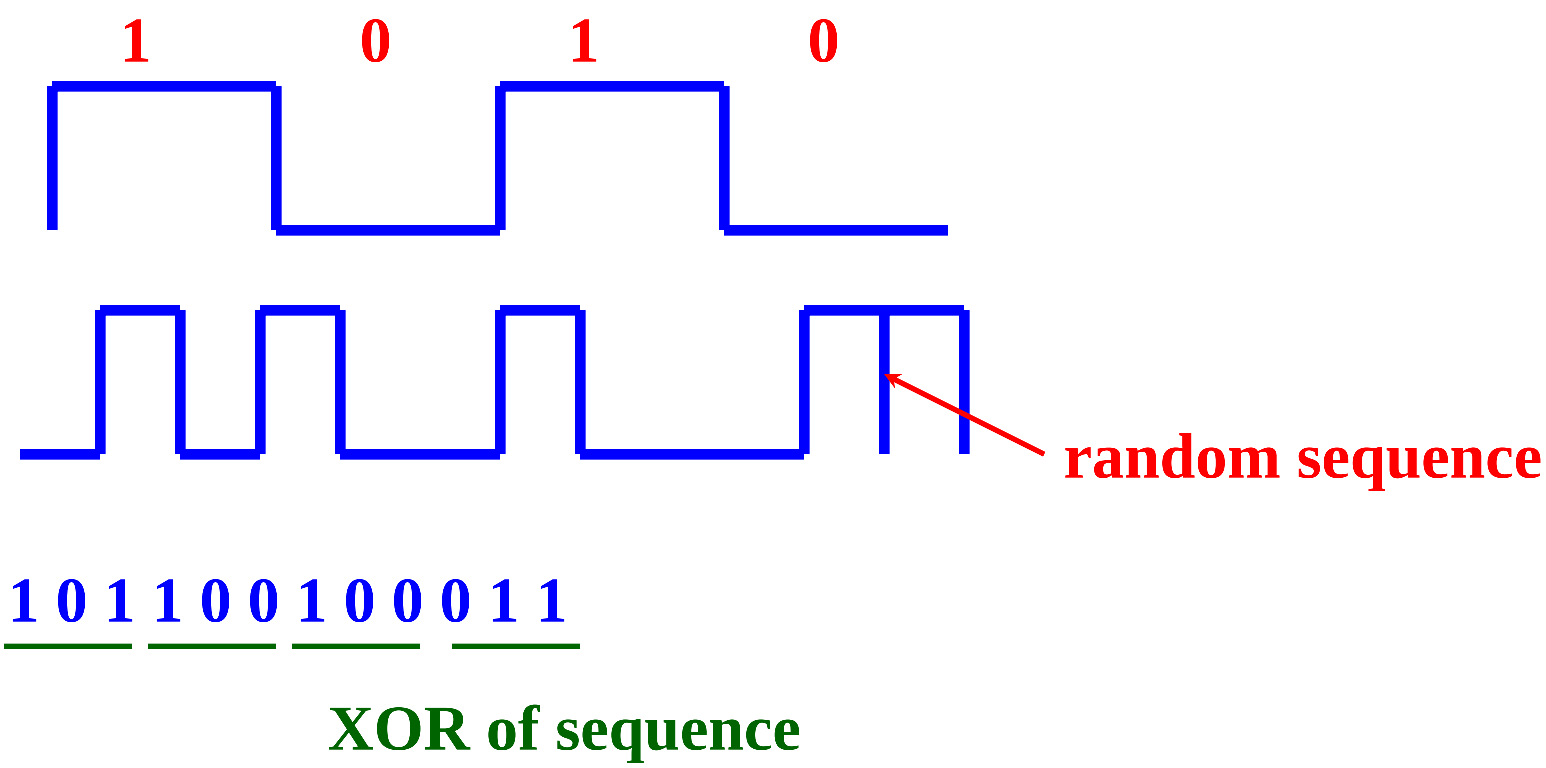
Physical Properties

- Three different mechanisms
- Two based on spread spectrum
  - Up to 2 Mbps
- One – on diffused infrared
  - ½ Mbps

Transmission in Wireless Media

- Spread spectrum:
  - frequency hopping (randomly choose frequencies)
  - direct sequence
- Direct sequence:
  - represent each bit by multiple bits in the transmitted signal

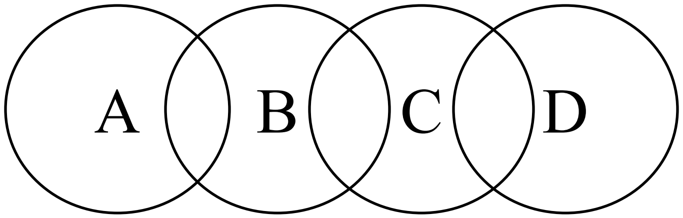
n-Bit Chipping sequence based transmission



n-Bit Chipping Sequence

- n – bit chipping code spreads the signal across frequency band
- that is n time 3 bit chipping sequence.
- 802.11: 79 MHz wide frequency bandwidths
  - 2.4 GHz frequency range
  - 11 bit chipping sequence
- Collision Avoidance in 802.11
  - similar to Ethernet problem

Hidden Nodes



- Each node has a finite range
- A can reach B, C can also reach B
- A and C want to communicate with B
- A and B are unaware of each other
- Collision can happen at B
- A and C are hidden nodes

Exposed Nodes

- Transmission from B to A
  - C is aware of this
    - Since C in the range of B
  - But C can transmit to D

Multiple Access Collision Avoidance

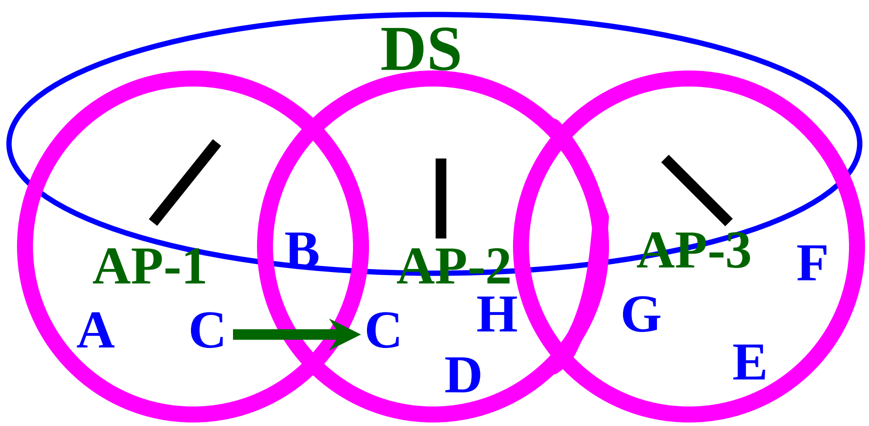
- Sender and receiver exchange control frames:
- Request to Send (RTS) – Sender → Receiver
  - (includes the time for which it wants to hold the medium)
- Clear to Send (CTS) – Receiver → Sender
  - (echoes length field back)
- Any node sees CTS
  - close to Receiver therefore cannot access medium for time = length of frame

Multiple Access Collision Avoidance

- Node sees RTS but not CTS
  - It is not close to receiver
  - It can transmit to some other node
- Two or more nodes send RTS, donot hear CTS
  - Collision, therefore backoff
- Include Ack (MACAW)
  - Receiver to sender after frame successfully received
- Issues: Nodes mobile – require a distributed system

Distributed System

- Problem of mobility
  - Some nodes are mobile, some are connected to a wired infrastructure
    - Access points (AP)
    - Each AP connected to a distribution system
    - Each node selects its own AP



Scanning for AP

- Node sends a Probe frame
- All APs nodes within reach reply with a probe response frame
- Node selects one and sends that AP an associate request
- AP responds with association response
- Node uses this when it moves / changes
- New AP notifies old AP
- Nodes scan APs and APs also send Beacon frames

Frame Format

Ctrl	Duration	Addr 1	Addr 2	Addr 3	Seq ctrl	Addr 4	Payload	CRC
16	16	48	48	48	16	48	0-18, 496	32

- Addr1 – destination AP
- Addr 2 – destination address
- Addr 3 – source AP
- Addr 4 – source address

- Ctrl
    - Type - 6 bit (CTS, RTS, Scanning)
    - ToDS - 1 bit
    - From DS – 1bit