Fiber Distributed Data Interface (FDDI)

Computer Networks

Spring 2012

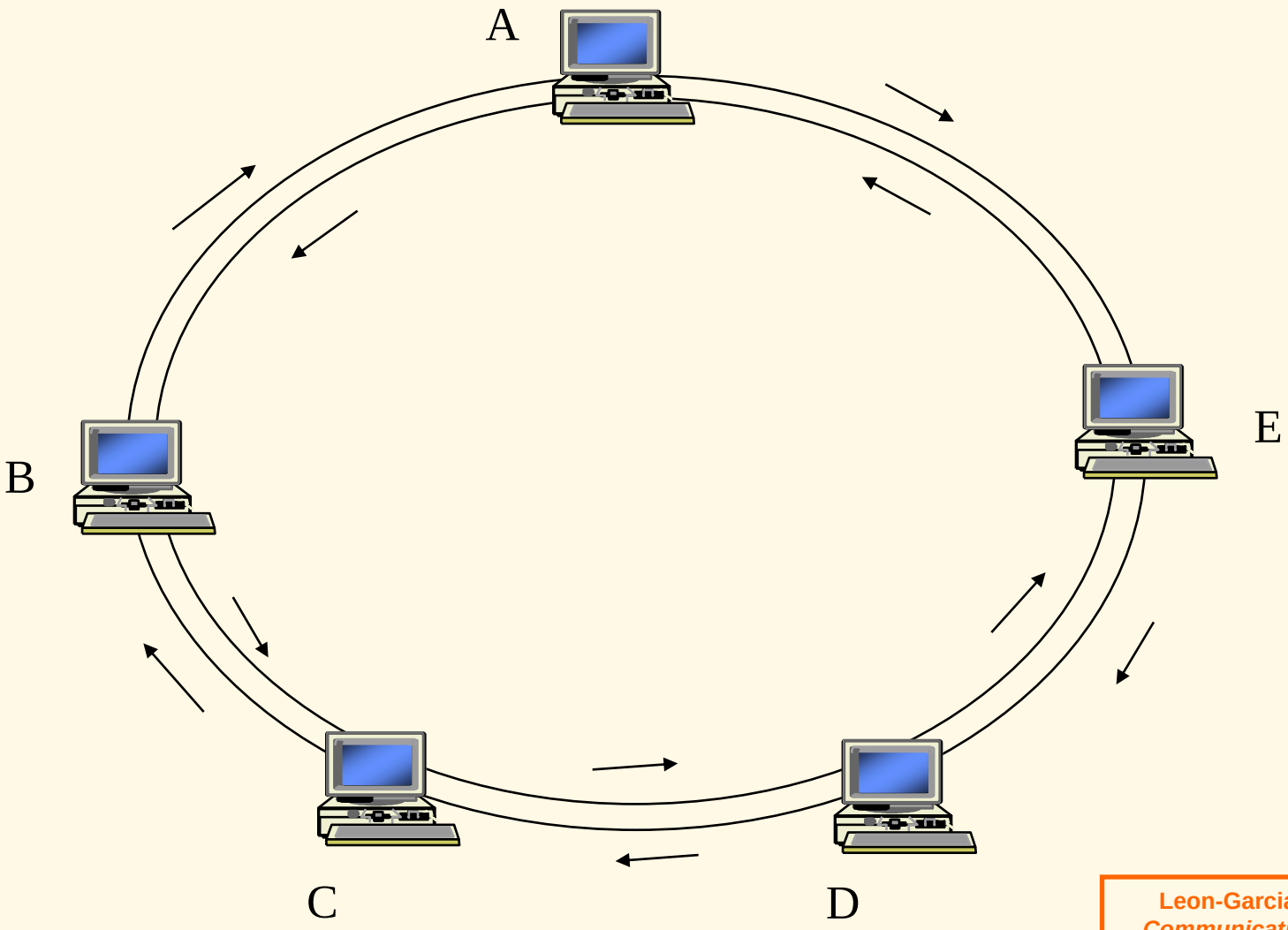
FDDI Oultine

- FDDI
  - 100 Mbps Dual Ring
  - Multiple-Token
  - Self-Healing Ring
- Target Token Rotation Time (TTRT)
- 4B/5B Encoder

FDDI

- FDDI uses a ring topology of multimode or single mode optical fiber transmission links operating at 100 Mbps to span up to 200 kms and permits up to 500 stations.
- Employs dual counter-rotating rings.
- 16 and 48-bit addresses are allowed.
- In FDDI, token is absorbed by station and released as soon as it completes the frame transmission {multi-token operation}.

FDDI: Dual Token Ring



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FDDI Repair

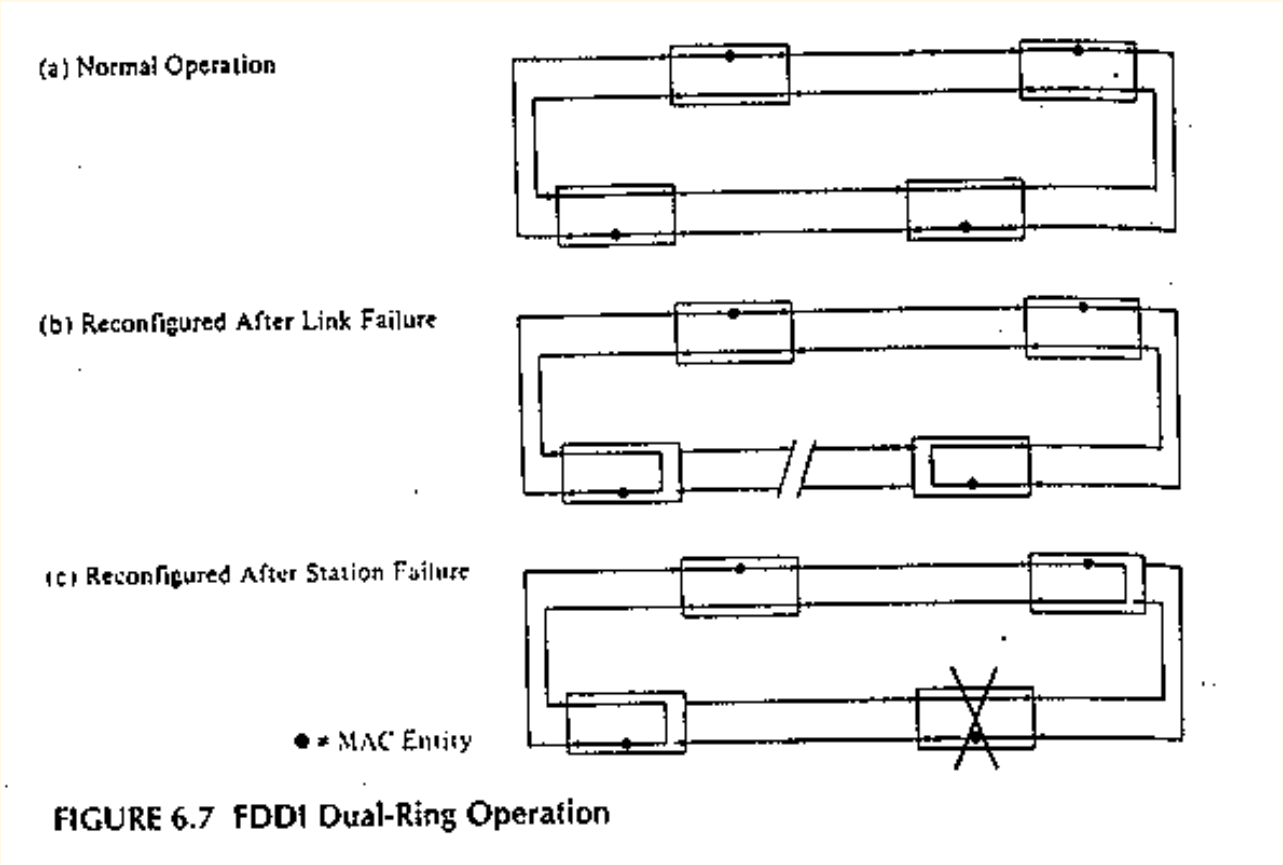
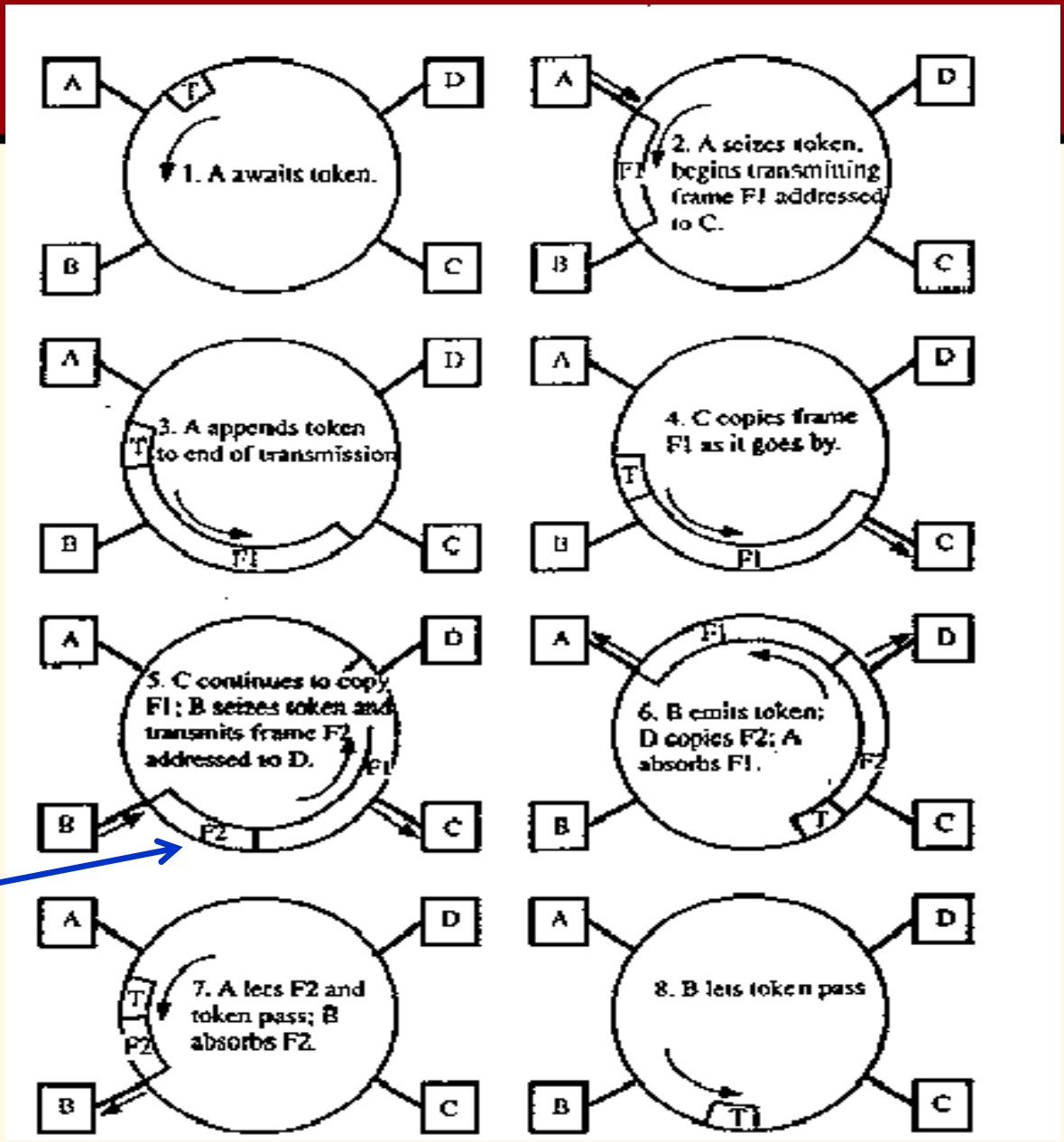


FIGURE 6.7 FDDI Dual-Ring Operation

Self-healing dual ring

FDDI Ring Operation

Multi-token implies more than one frame on the ring at the same time.



FDDI

- To accommodate a mixture of stream and bursty traffic, FDDI is designed to handle two types of traffic:
  - Synchronous frames that typically have tighter delay requirements (e.g., voice and video).
  - Asynchronous frames have greater delay tolerances (e.g., data traffic).

- FDDI uses TTRT (Target Token Rotation Time) to ensure that token rotation time is less than some value.

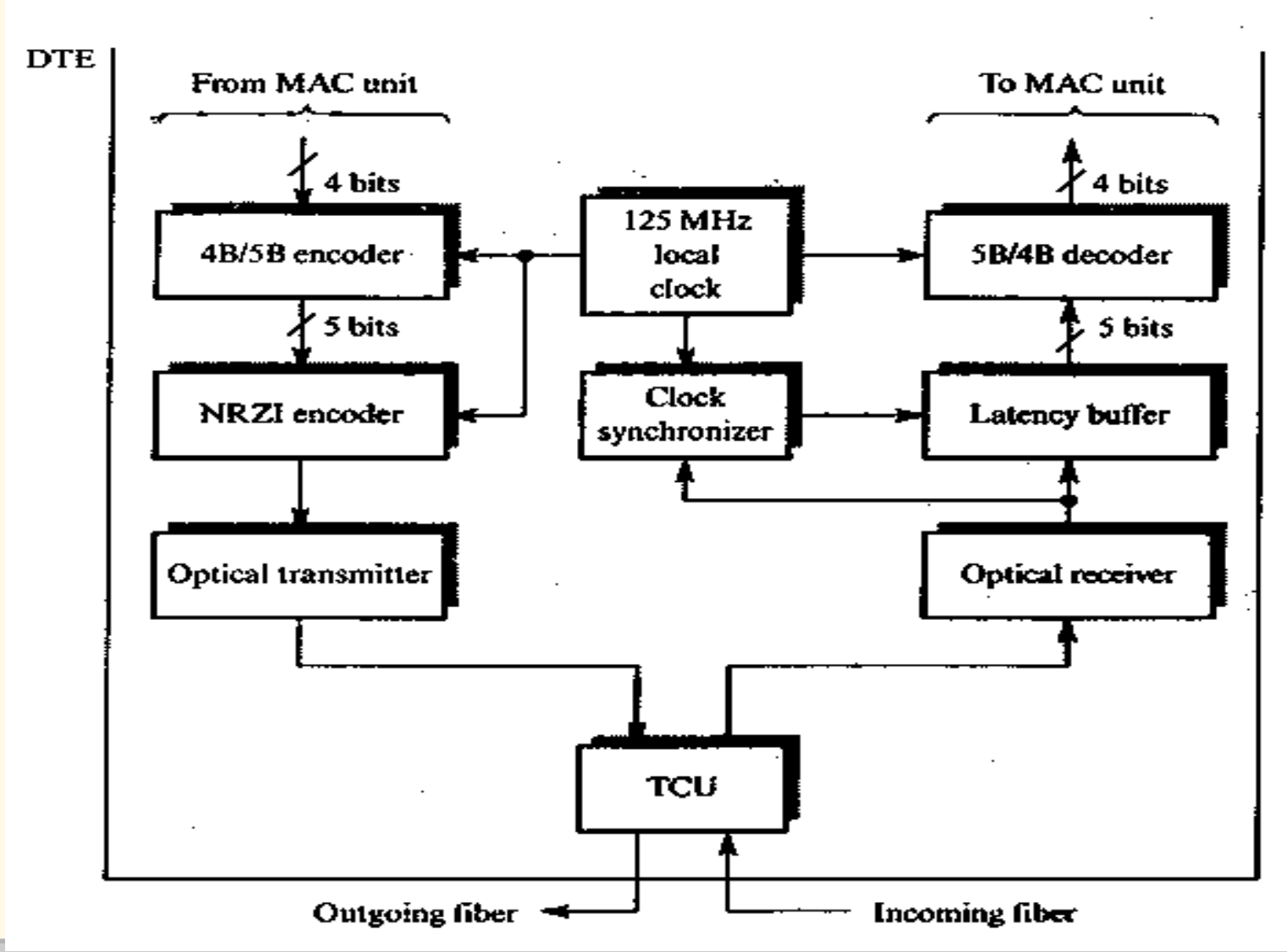
FDDI Data Encoding

- Cannot use differential Manchester because 100 Mbps FDDI would require 200 Mbaud!
- Instead each ring interface has its own local clock.
  - Outgoing data is transmitted using this clock.
  - Incoming data is received using a clock that is frequency and phase locked to the transitions in the incoming bit stream.

FDDI Data Encoding

- Data is encoded using a 4B/5B encoder.
  - For each four bits of data transmitted, a corresponding five-bit codeword is generated by the encoder.
  - There is a maximum of two consecutive zero bits in each symbol.
- The symbols are then shifted out through a NRZI encoder which produces a signal transition whenever a 1 bit is being transmitted and no transition when a 0 bit is transmitted.
- Local clock is 125MHz. This yields 100 Mbps (80% due to 4B/5B).

FDDI

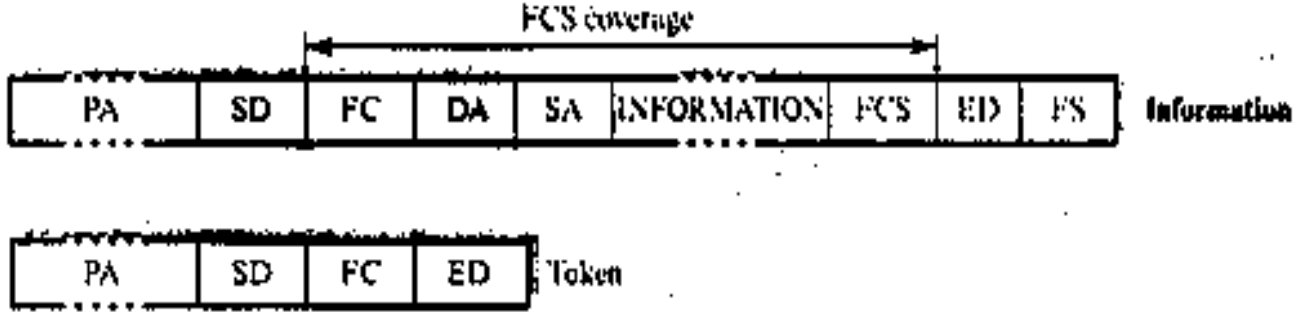

DTE
From MAC unit
To MAC unit
4 bits
4 bits
4B/5B encoder
125 MHz local clock
5B/4B decoder
5 bits
5 bits
NRZI encoder
Clock synchronizer
Latency buffer
Optical transmitter
Optical receiver
TCU
Outgoing fiber
Incoming fiber

FDDI

(a)

Data symbols		Control symbols	
4-bit data group	5-bit symbol		
0000	11110	IDLE	11111
0001	01001	J	11000
0010	10100	K	10001
0011	10101	T	01101
0100	01010	R	00111
0101	01011	S	11001
0110	01110	QUIET	00000
0111	01111	HALT	00100
1000	10010		
1001	10011		
1010	10110		
1011	10111		
1100	11010		
1101	11011		
1110	11100		
1111	11101		

(b)



PA = Preamble (16 or more symbols)
SD = Start delimiter (2 symbols)
FC = Frame control (2 symbols)
DA = Destination address (4 or 12 symbols)
SA = Source address (4 or 12 symbols)
FCS = Frame check sequence (8 symbols)
ED = End delimiter (1 or 2 symbols)
FS = Frame status (3 symbols)

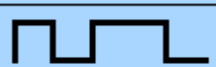
Figure 7.15
FDDI line coding and framing detail:
(a) 4B5B codes;
(b) frame formats.

4B/5B Codes

Table 16.5 4B/5B Code Groups (page 1 of 2)

Data Input (4 bits)	Code Group (5 bits)	NRZI pattern	Interpretation
0000	11110		Data 0
0001	01001		Data 1
0010	10100		Data 2
0011	10101		Data 3
0100	01010		Data 4
0101	01011		Data 5
0110	01110		Data 6
0111	01111		Data 7
1000	10010		Data 8
1001	10011		Data 9
1010	10110		Data A
1011	10111		Data B
1100	11010		Data C

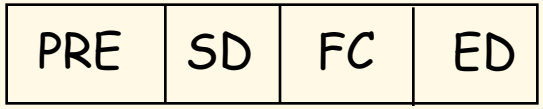
Table 16.5 4B/5B Code Groups (page 2 of 2)

1101	11011		Data D
1110	11100		Data E
1111	11101		Data F
	11111		Idle
	11000		Start of stream delimiter, part 1
	10001		Start of stream delimiter, part 2
	01101		End of stream delimiter, part 1
	00111		End of stream delimiter, part 2
	00100		Transmit error
	other		invalid codes

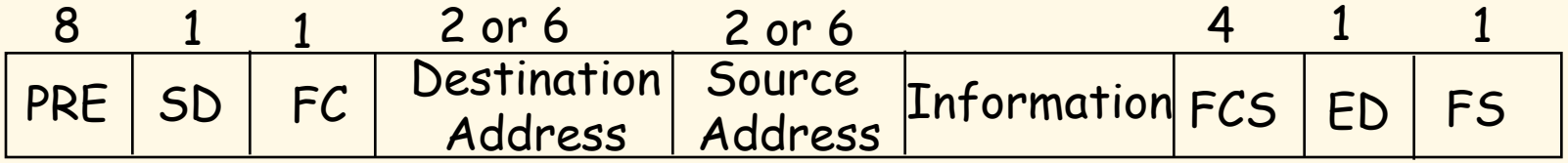
DCC 9th Ed. Stallings

FDDI Frame Structure

Token Frame Format



Data Frame Format



Preamble

Frame Control CLFFZZZZ

C = Synch/Asynch
L = Address length (16 or 48 bits)
FF = LLC/MAC control/reserved frame type

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More FDDI Details

- FDDI Transmission on optical fiber requires ASK (e.g., coding is done via the absence or presence of a carrier signal {Intensity Modulation}.)
- Specific 5-bit codeword patterns chosen to guarantee no more than three zeroes in a row to provide for adequate synchronization.
- 1300 nm wavelength specified.
- Dual rings (primary and secondary) – transmit in opposite directions.
- Normally, second ring is idle and used for redundancy for automatic repair (self-healing).

IEEE 802.5 versus FDDI

802.5 Token Ring

- Shielded twisted pair
- 4, 16 Mbps
- No reliability specified
- Differential Manchester
- Centralized clock
- Priority and Reservation bits
- Three distinct token operations are possible.

FDDI

- Optical Fiber
- 100 Mbps
- Reliability specified (dual ring)
- 4B/5B encoding
- Distributed clocking
- Timed Token Rotation Time (TTRT)
- Multi-token operation

FDDI Summary

- FDDI
  - 100 Mbps Dual Ring
  - Multiple-Token
  - Self-Healing Ring
- Target Token Rotation Time
  - Two classes of traffic
- 4B/5B Encoder