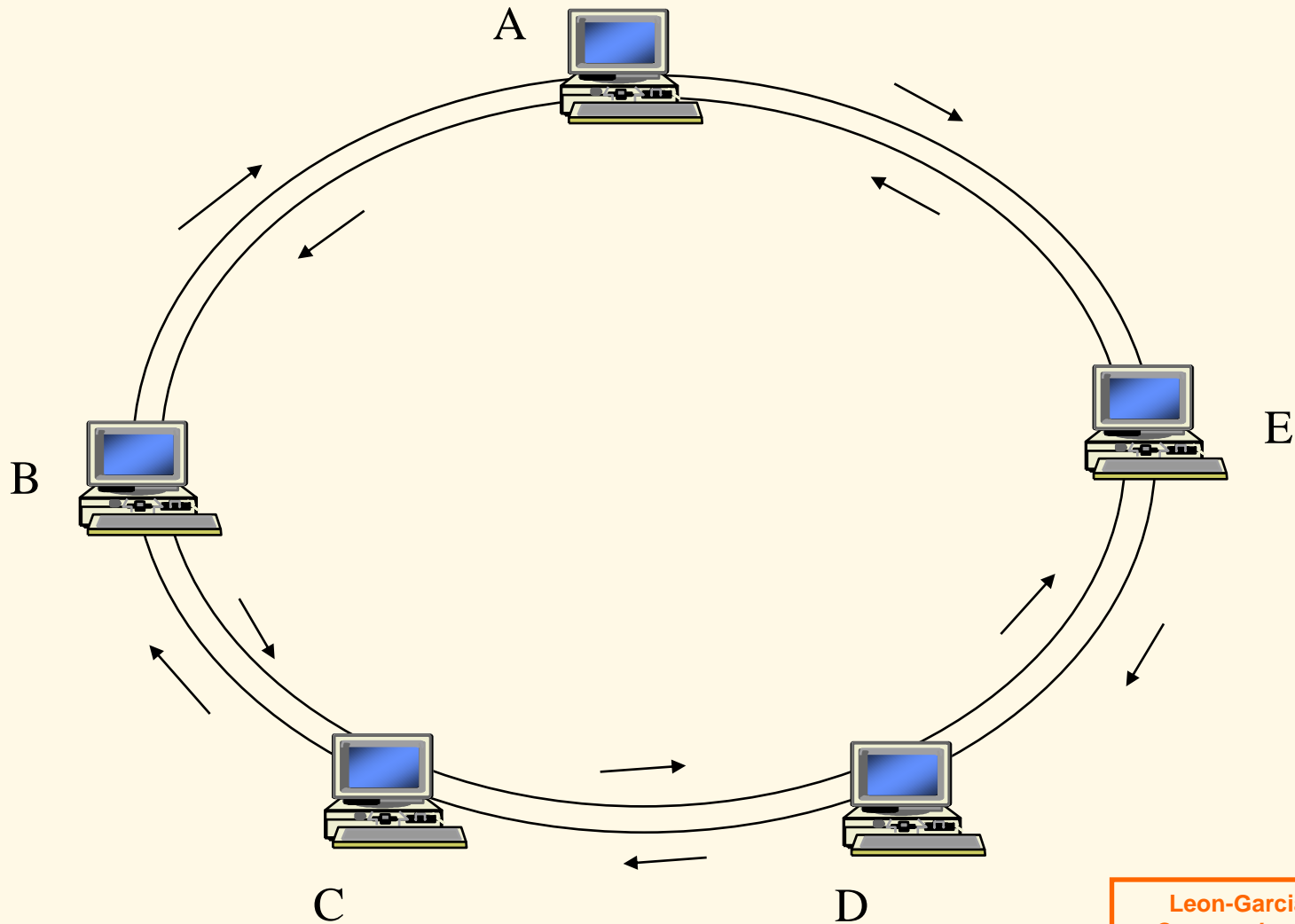# Fiber Distributed Data Interface (FDDI)

FDDI Oultine

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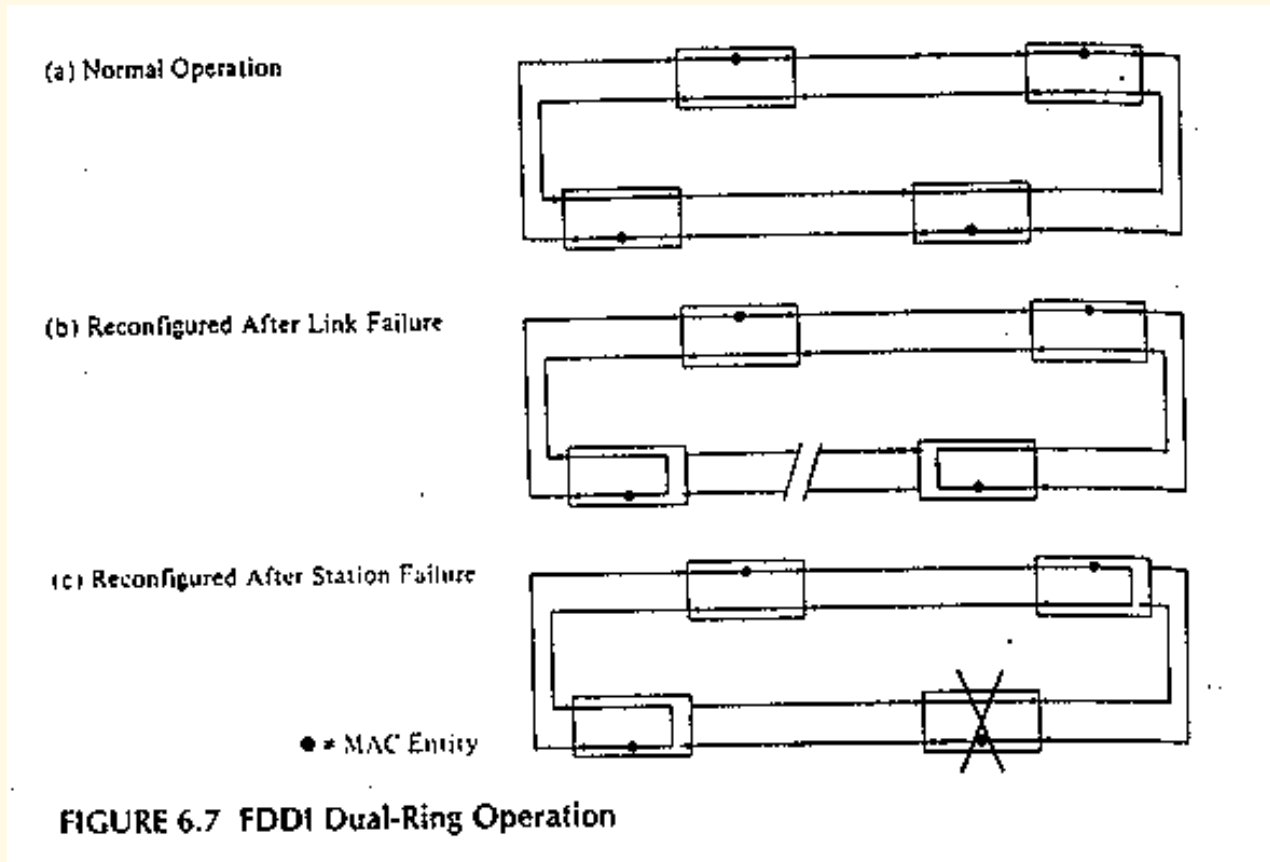- Target Token Rotation Time (TTRT)
- 4B/5B Encoder

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

FDDI Repair

(a) Normal Operation

(b) Reconfigured After Link Failure

(c) Reconfigured After Station Failure

● = MAC Entity

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.

1. A awaits token.
2. A seizes token, begins transmitting frame F1 addressed to C.
3. A appends token to end of transmission.
4. C copies frame F1 as it goes by.
5. C continues to copy F1; B seizes token and transmits frame F2 addressed to D.
6. B emits token; D copies F2; A absorbs F1.
7. A lets F2 and token pass; B absorbs F2.
8. B lets token pass.
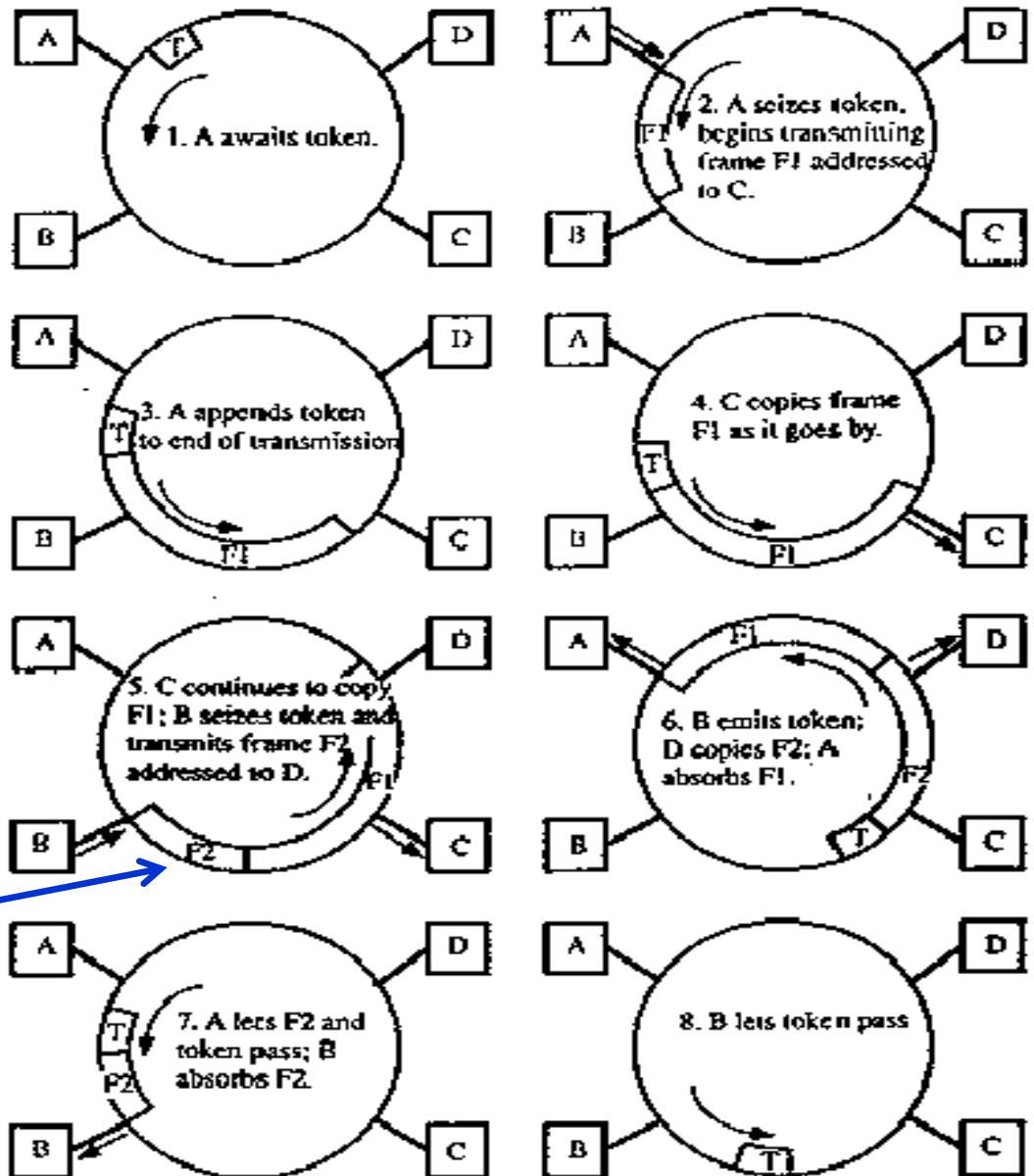
FDDI

- 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.

WPI

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).
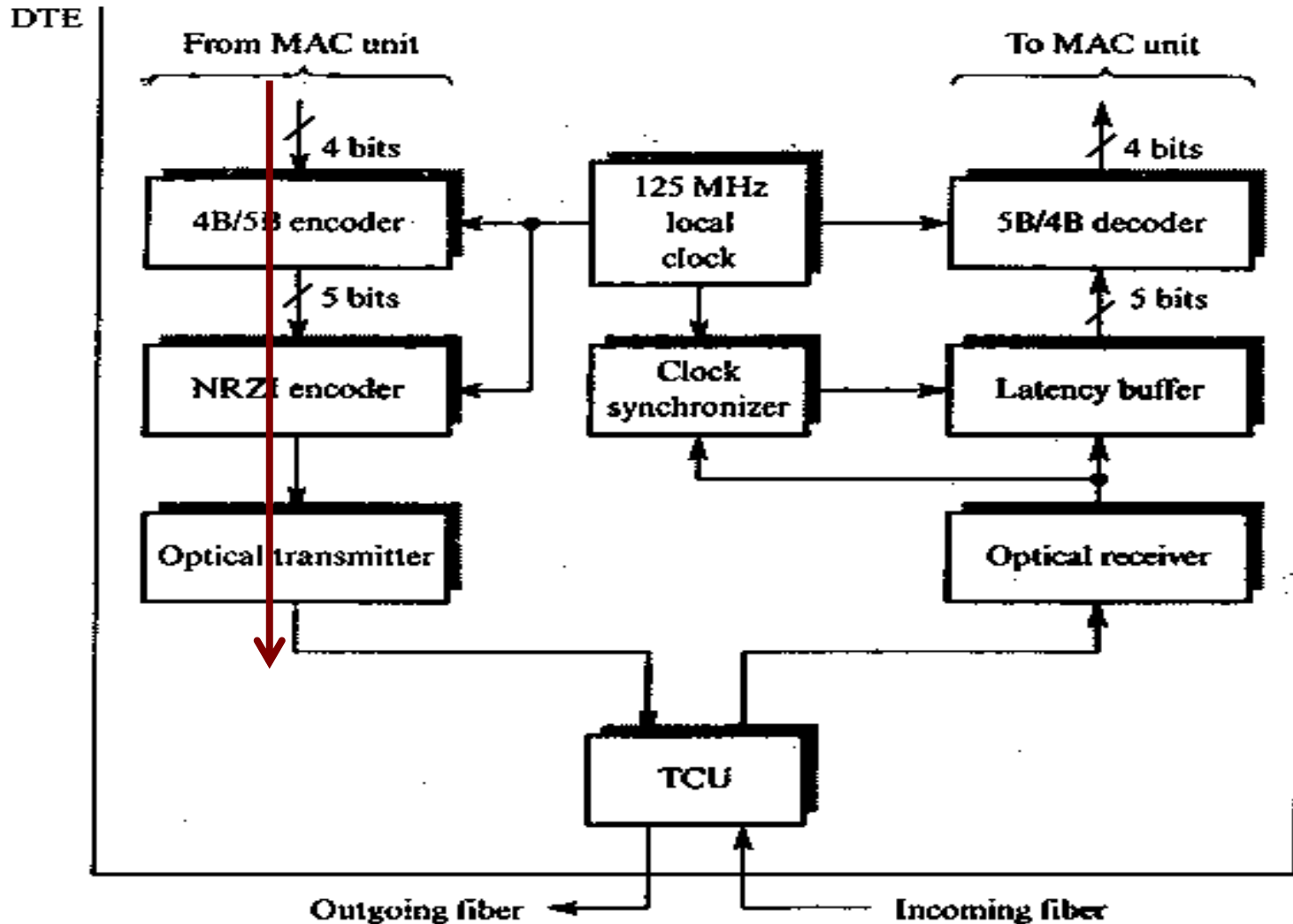
FDDI

(a)

Data symbols

4-bit data group	5-bit symbol
0000	11110
0001	01001
0010	10100
0011	10101
0100	01010
0101	01011
0110	01110
0111	01111
1000	10010
1001	10011
1010	10110
1011	10111
1100	11010
1101	11011
1110	11100
1111	11101

Control symbols

IDLE	11111
J	11000
K	10001
T	01101
R	00111
S	11001
QUIET	00000
HALT	00100

SD

(b)

FCS coverage

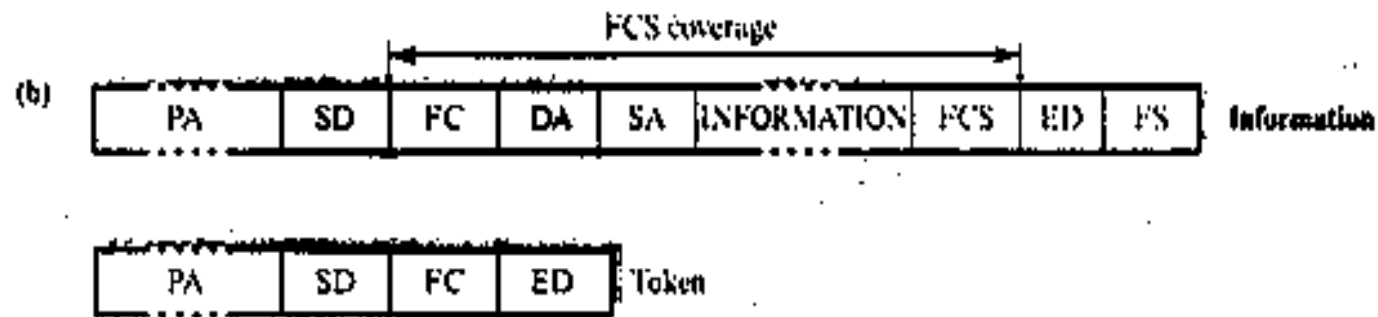| PA	SD	FC	DA	SA	INFORMATION	FCS	ED	FS	Information

PA	SD	FC	ED	Token

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

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)

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)

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

DCC 9th Ed. Stallings

FDDI Frame Structure

Token Frame Format

PRE	SD	FC	ED

Data Frame Format

8	1	1	2 or 6	2 or 6		4	1	1
PRE	SD	FC	Destination Address	Source Address	Information	FCS	ED	FS
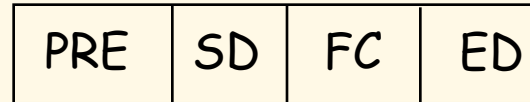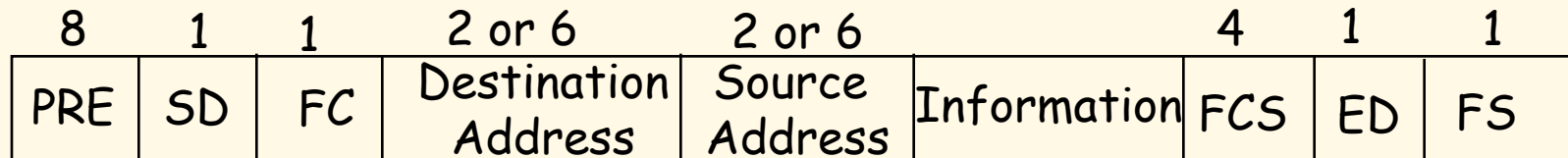
Preamble

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

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**