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Internal Assessment - 4

Q1) Explain key components of the FDDI network architecture. Describe the dual-ring topology and explain the primary and secondary rings. How does FDDI use the secondary ring in case of a failure?

Ans 1. FDDI (Fiber Distributed Data Interface) is a high-speed networking standard that was primarily used in 1980s and 1990s for building large-scale local area networks (LANs). It is designed to support data transmission over fiber optic cables at speeds of up to 100 Mbps. The key components of FDDI network architecture and its dual-ring topology are central to understanding how it operates.

The Key Components of FDDI Network Architecture:

1) Transmission Medium: FDDI typically uses fiber optic cables, which provides high bandwidth, low signal degradation over long distances and resistance to electromagnetic interference. In some cases, FDDI could also use copper cables (CDDI) Copper Distributed Data Interface.

2) Data Rate: FDDI supports a transmission rate of 100 mbps which was considered very fast for LANs at the time of its development.

3) Topology :- FDDI utilizes a dual-ring topology, which provides both primary and secondary rings for data transmission.

4) Token Passing Protocol :- Similar to Token Ring networks, FDDI uses a token-passing protocol for media access control. A token circulates the network and a device can only transmit data when it has possession of the token. This ensures collision-free transmission.

5) Stations :- Devices connected to an FDDI network are called stations. These are of two types :-

Single-attached stations (SAS) : Only connected to one ring.

Dual-attached stations (DAS) : Connected to both the primary and secondary rings.

Dual-Ring Topology

FDDI uses a dual-ring topology for fault tolerance and reliability. The two rings are known as the primary ring and the secondary ring.

1. Primary Ring :

- The primary ring is the main data transmission path in the network. Under normal conditions, all network traffic flows through the ring.
- Data travels in one direction, typically clockwise, around the ring.

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How FDDI Uses the Secondary Ring Case of Failure

The dual-ring topology provides FDDI with fault-tolerance capabilities. If a failure occurs in the primary ring (such as a break in the Fiber optic cable or a malfunctioning station), FDDI automatically switches to using the secondary ring. There are two ways FDDI can recover from a failure:

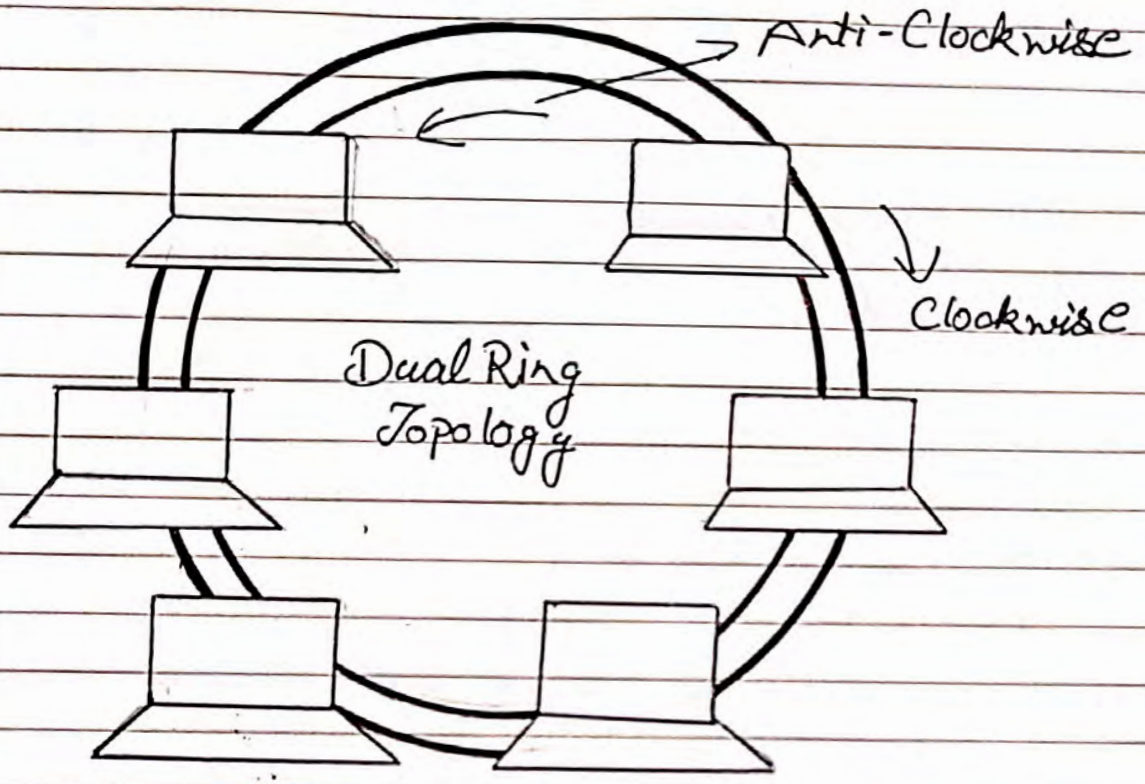
Wrap Mode:

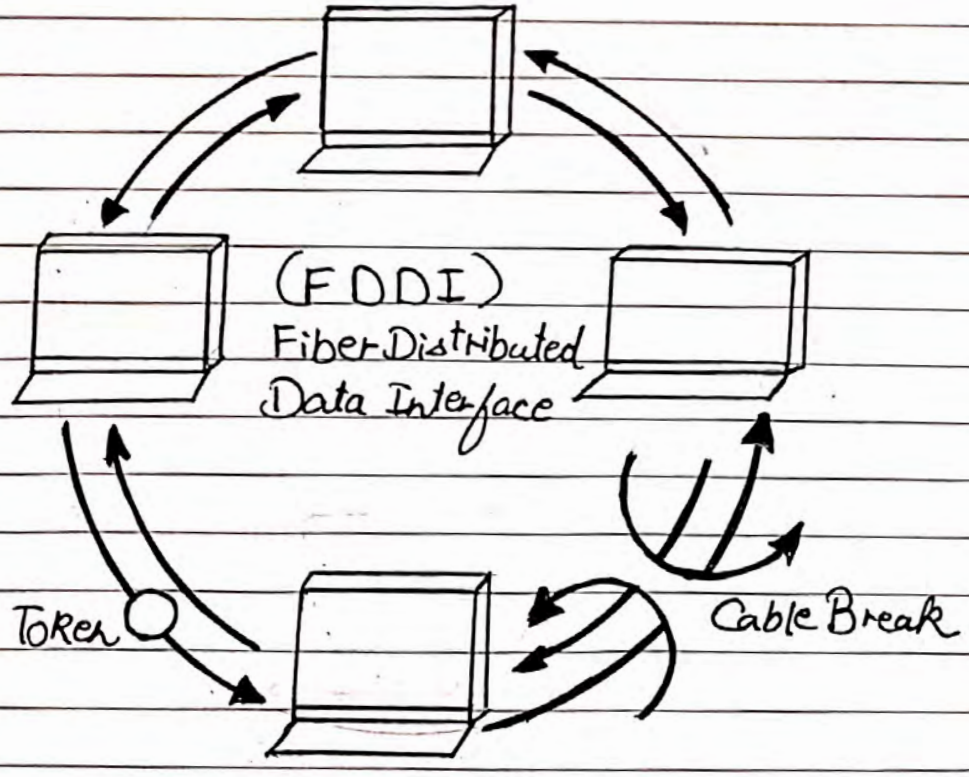
If a break occurs at a specific point in the network, the network will enter wrap mode. The data transmission path will be modified so that the traffic on the primary ring wraps around at the point of failure and switches to the secondary ring.

Dual Ring Mode:

If the failure is localized to a specific station or connection, the network will continue to use both rings, with traffic being re-routed away from the failed segment.

Stations that remain functional will communicate by using both the primary and secondary rings, but they will avoid the damaged section of the network.


Anti-Clockwise
Clockwise
Dual Ring
Topology


(FDDI)
Fiber Distributed
Data Interface
Token
Cable Break

Q2. Differentiate between FDDI's MAC (Media Access Control) and LLC (Logical Link Control) layers, How does FDDI ensure data integrity and reliable transmission across its network?

Ans2. In the context of the FDDI (Fiber Distributed Data Interface) network architecture, the MAC (Media Access Control) and LLC (Logical Link Control) layers serve distinct functions in managing data transmission and ensuring reliable communication. Both layers operate as part of OSI (Open Systems Interconnect) model, where they reside within the Data Link Layer (Layer-2), but they perform different roles.

Major Differences between MAC and LLC Layers:-

MAC (Media Access Control) Layer:

- Position: The MAC layer is a part of the lower sublayer of the Data Link Layer.
- Function: It is responsible for controlling access to the physical transmission medium (i.e., the Fiber optic cables in FDDI). In the MAC layer it determines when and how devices can access the network to transmit data.
- Core Tasks:

1) Token Passing Protocol: FDDI's MAC layer uses a token passing mechanism to control which station can send data at any given time. This prevents collisions and ensures that only one device transmits data on the network at a time.

2) Frame Transmission and Reception: The MAC layer is responsible for formatting data into frames for transmission, attaching MAC addresses, and ensuring the correct device receives the data.

3) Fault Detection and Recovery: The MAC layer monitors network status, detects errors (such as failure in the ring), and initiates recovery processes (like switching) to the secondary ring in case of failure.

- Role in FDDI: Ensures orderly and collision-free access to the network, manages token passing, and facilities smooth data transmission.

LLC (Logical Link Control) Layer:

- Position: The LLC layer is part of the upper sublayer of the Data Link Layer.

- Function: It provides a logical interface between the Data Link Layer and the Network Layer (Layer 3). The LLC is responsible for ensuring reliable data communication between devices by providing mechanisms for error detection and flow control.

Core Tasks:

1) Error Control: The LLC layer detects errors that might occur during transmission (e.g., corrupted frames) and ensures frames are retransmitted if needed.

2) Flow Control: It regulates the rate of data transmission between devices to ensure that the receiver is not overwhelmed by too much data at once.

3) Services Access Points (SAP's): The LLC layer provides multiple Service Access Points, enabling the network to handle different types of protocols simultaneously (eg., TCP/IP, IPX).

4) Role in FDDI: The LLC layer enhances data reliability by managing errors, controlling the flow of data, and providing multiplexing services for upper-layer protocols.

FDDI's Mechanisms for Ensuring Data Integrity and Reliable Transmission:

FDDI is designed for high reliability and robustness, which is particularly important in mission-critical environments. FDDI ensures data integrity and reliable transmission through several mechanisms:

1) Token Passing Protocol

- FDDI uses a token-passing access control mechanism. This ensures that only one device can send data at a passes time, preventing collisions on the network. The station with the token can transmit data, and once done, it passes the token to the next station in the ring.
- The token circulation guarantees that every station gets an opportunity to send data, reducing the chances of data loss due to contention.

2) Dual-Ring Topology for Fault Tolerance: F

- FDDI is dual ring topology (primary and secondary rings) provides fault tolerance. In case of a break or failure in the primary ring, the network automatically switches to the secondary ring through a process called wrap mode or dual-ring recovery. This ensures that data can still be transmitted even if part of the network fails, maintaining network integrity.

3) Cyclic Redundancy Check (CRC):

- FDDI frames contain a Cyclic Redundancy Check (CRC) field that is used for error detection. The CRC helps detect errors during the transmission process, ensuring that corrupted frames can be identified and discarded or retransmitted if necessary.

4) Timed Token Rotation (TTR):

- FDDI uses a mechanism called Timed Token Rotation to ensure that the token circulates around the network within a specified time limit (called the Token Rotation Time). This guarantees predictable network performance and minimizes delays in data transmission, improving reliability in time-sensitive applications.

5) Frame Sequence Numbering:

- FDDI uses frame sequence numbering to ensure that data frames arrive in the correct order.

If frames are received out of sequence or are missing, the receiving station can detect the problem and request retransmission.

6) Frame Acknowledgement:

- FDDI employs a frame acknowledgment mechanism where the receiving station sends a confirmation to the sender when data is successfully received. This ensures reliable communication, as unacknowledged frames can be retransmitted.

7) Priority Access and Isochronous Data Support:

- FDDI allows certain types of data to have priority access to the network, ensuring that critical data is transmitted without delay. It also supports isochronous data transmission, which is useful for real-time applications like voice and video that require a continuous flow of data without interruptions.

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Q3. Explain how the token-passing method works in FDDI. Compare the mechanisms to Ethernet's CSMA/CD approach for media access.

Ans 3. The token-passing method used in FDDI networks, where devices connected to a network take turns transmitting data. The key data or idea is that a special frame, called a token, is passed around the network. A device can only send data when it has possession of the token.

How Token-Passing Works:

1) Token Circulation: The token is passed in a logical ring topology, where each device is connected to two others, forming a loop. The token is a control message that continuously circulates through the network.

2) Token Possession: When a device receives the token, and sends its data packet. If it doesn't, the device forwards the token to the next device in the ring.

3) Data Transmission: Once the device captures the token, it can transmit its data to transmit. If it does, it. After sending the data, it releases the token back onto the network, making it available for other devices.

4) Random Backoff: After a collision, devices wait for a random period of time before trying again, reducing the likelihood of repeated collisions.

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In CSMA/CD, the possibility of collisions makes the protocol less efficient under heavy load. The time spent detecting and resolving collisions can cause delays and reduce throughput.

Comparision Between FDDI Token-Passing and Ethernet's CSMA/CD:

Aspect	FDDI (Token Passing)	Ethernet (CSMA/CD)
Network Topology	Logical ring	Bus or star topology (shared medium)
Access Control	Token-passing (centralized control)	CSMA/CD (distributed control)
Collision Handling	No collisions (only one device transmits at a time)	Collisions are possible; handled with CD and random backoff
Efficiency	More efficient, especially under high load.	Less effecient under high load due to collisions.
Performance	Predictable performance (deterministic)	Less predictable, varies with load and collisions.

Latency	Low, fixed latency	Variable latency due to collisions and backoff.
Fairness	Fair - every device gets a chance to transmit.	Less fair - high traffic devices can dominate.
Scalability	Scales better in high traffic environments	Performance degrades with heavy traffic.
Cost & complexity	More complex and expensive.	Simpler and cheaper.

Key Differences: →

- Collisions: FDDI avoids collisions entirely through token-passing, while Ethernet relies on CSMA/CD, where collisions are a normal part of network operation.
- Efficiency and Load Handling: FDDI is more efficient in high load scenarios, offering predictable network performance. Ethernet's performance degrades with increased load due to more frequent collisions.
- Deterministic Vs. Non-deterministic: FDDI offers deterministic access (you know when you will get the token), while CSMA/CD is non-deterministic because it is impossible to predict when a device will be able to transmit, especially under high traffic.

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Q4. Describe how FDDI handles data frames, including error detection and correction mechanisms.

Ans4. Fiber Distributed Data Interface (FDDI) is a high-speed networking standard primarily used in the 1980s and 1990s for backbone networks and large local area networks (LANs). It is based on a token-passing protocol and operates over fiber optic cables, though it can also work over copper cables (CDDI - Copper Distributed Data Interface). FDDI provides data transfer rates of 100 Mbps and includes mechanisms for error detection and correction to ensure reliable data transmission.

How FDDI Handles Data Frames:

1) Token-Passing Mechanism: FDDI uses a dual-ring topology (Primary and Secondary rings) and a token-passing method for medium access control (MAC). A "token" circulates around the network, and only the device holding the token can send data. When a device receives the token, it can transmit its data frame. The device (after completing a full ring).

2) Data Frame Structure: FDDI frames include a number of fields:

- Preamble: A series of bits used for synchronization.

- Frame Control: Defines the type of frame (e.g. token or data).
- Destination Address: The address of the intended recipient.
- Source Address: The address of the sender.
- Data: The actual data being transmitted.
- Frame Check Sequence (FCS): A cyclic redundancy check (CRC) for error detection.
- End Delimiter: Marks the end of the frame.
- Frame Status: Provides acknowledgment and status information (eg. error conditions).

3) Frame Transmission: When a device receives the token, it transmits a data frame. The frame circulates through the ring, passing through each device until it reaches the destination. Each intermediate device forwards the frame, but only the intended recipient copies the data. Once the frame has circulated back to the sender, the frame is stripped off the network, and the token is regenerated to allow another device to transmit.

Error Detection and Correction Mechanisms:

1) Cyclic Redundancy Check (CRC):

Error Detection: The FDDI frame includes a Frame Check Sequence (FCS) field, which uses CRC for detecting errors. The CRC algorithm checks if the transmitted data or bits have changed during transmission. If an error is detected (i.e., the CRC value calculated at the receiving device does not match the transmitted CRC), the frame is discarded, and a retransmission request is triggered.

2) Token and Frame Status:

Each frame includes a Frame Status field that provides information about whether the frame was successfully received and acknowledged. The status bit help identify transmission errors, and devices can decide whether retransmission is necessary.

3) Dual-Ring Redundancy:

FDDI uses a dual-ring topology for fault tolerance. The primary ring is used for normal data transmission, while the secondary ring is typically idle. If a failure occurs on the primary ring, the system automatically switches to the secondary ring to maintain network operation, ensuring minimal data loss and downtime.

4) Beaconing:

When a fault is detected, a beaconing process starts to identify and isolate the fault. The device closet to the fault sends out beacon frames, and neighboring devices help localize the fault. Once the issue is detected, the network can reroute data using the secondary ring.

5) Timed Token Protocol:

FDDI uses a Timed Token Protocol to prevent frame loss due to network congestion. Each devices is allocated a specific time period in which it can hold the token and transmit data. The time-bound control helps ensure fair access to the network and prevents excessive delays, indirectly contributing to reliability and error handling.

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Qs. FDDI was widely used in the 1990s for backbone networks, but has largely been replaced by Gigabit Ethernet and other technologies. What factors contributed to the decline of FDDI in favour of newer standards?

Ans 5. Fiber Distributed Data Interface (FDDI) was popular in the 1990s for backbone networks, but it was eventually replaced by newer technologies like Gigabit Ethernet. Several factors contributed to the decline of FDDI:

1) Higher Speeds of Gigabit Ethernet

- FDDI : Operated at a speed of 100 mbps.
- Gigabit Ethernet: offered speed of 1 Gbps (ten times faster) with scalable options like 10 Gigabit Ethernet (10 Gbps).
- As network demand grew for higher speeds, Gigabit Ethernet became a more attractive option.

2) Cost - Effectiveness

- FDDI : Used fiber optic cabling, which was expensive to install and maintain at the time.
- Ethernet: Supported cheaper copper cabling (such as Cat 5 and Cat 6), and even fiber Ethernet became more affordable over time.

- Gigabit Ethernet allowed organizations to upgrade their networks without the high costs associated with fiber installations.

3) Simplified Infrastructure

- FDDI: Required a dual-ring topology for fault tolerance, which made network design more complex.
- Ethernet: Used simpler star topologies that were easier to implement and expand.
- Gigabit Ethernet's compatibility with existing Ethernet standards meant that network upgrades were less disruptive and more straightforward.

4) Widespread Adoption and Compatibility

- Ethernet: Already well-established and used in LAN environments. Gigabit Ethernet's backward compatibility with 10/100 Ethernet standard meant easier integration with existing hardware.