Question Bank

UNIT – 2

1. **Explain the process of block coding , incorporate line coding to demonstrate an end to end system.**

Block coding is a technique used to add redundancy to data to detect and correct errors during transmission.

There are 3 methods in block coding :

1) Division: The data is divided into blocks of bits, called data words. Or Sequence of bits divided into groups of m bits .
2) Substitution: substitute m bit group for n bit group, Each block of data (data word) is then substituted with a longer block of bits (code word) that includes redundant bits. This is often referred to as mB/nB coding, where m is the number of bits in the data word and n is the number of bits in the code word (n > m).
3) Combination: The code words are then combined to form the encoded data stream that will be transmitted.

The redundant bits added during substitution help in detecting and correcting errors.

Line Coding:

Line coding is the process of converting the encoded data stream into a digital signal that can be transmitted over a communication channel.

There are 3 steps involved in it :

1) Conversion: The binary data (encoded data stream) is converted into a sequence of digital signals. This involves mapping the binary values to specific voltage levels or light pulses, depending on the transmission medium.
2) Transmission: The digital signal is then transmitted over the communication channel (e.g., a copper wire, fiber optic cable, or wireless medium).
3) Reception: At the receiver's end, the digital signal is converted back into binary data.

End-to-End System :
Combining block coding and line coding.

1) Data Preparation: The original data is divided into blocks
2) Block Coding: Each data word is encoded into a code word with redundant bits for error detection and correction.

3) Line Coding: The encoded data stream is converted into a digital signal using a line coding scheme.
4) Transmission: The digital signal is transmitted over the communication channel.
5) Reception: The receiver converts the digital signal back into binary data.
6) Error Detection and Correction: The received data words are checked for errors using the redundant bits. If errors are detected, they are corrected.
7) Data Reconstruction: The corrected data words are combined to reconstruct the original data.
   This process ensures that the data is transmitted accurately and reliably, even in the presence of noise and interference.

2. Discuss various line coding approaches with a neat diagram. Demonstrate line coding approaches for (i) 0010101110 (ii) 10110001001

Line coding is a method used in digital communication systems to convert binary data into a form suitable for transmission over a communication channel. Different line coding schemes have various characteristics, such as power efficiency, bandwidth requirements, and the ability to maintain synchronization. Below are some common line coding schemes:

1. Unipolar NRZ (Non-Return to Zero)

In Unipolar NRZ, a binary '1' is represented by a high voltage, while a binary '0' is represented by zero voltage. The signal does not return to zero between consecutive bits.

- Advantages: Simple to implement.
- Disadvantages: Has a significant DC component and poor synchronization for long sequences of '0's or '1's.

2. Polar NRZ

In Polar NRZ, binary '1' is represented by a positive voltage, and binary '0' by a negative voltage. Like Unipolar NRZ, the signal does not return to zero between bits.

- Advantages: No DC component.
- Disadvantages: Similar synchronization issues as Unipolar NRZ, with long sequences of the same bit causing difficulty in clock recovery.

3. Manchester Coding

Manchester coding ensures synchronization by encoding each bit with a transition in the middle of the bit period. A binary '1' is represented by a low-to-high transition, and a binary '0' is represented by a high-to-low transition.

- Advantages: Self-clocking signal, no DC component, easy synchronization.
- Disadvantages: Requires double the bandwidth compared to NRZ.

4. Differential Manchester Coding

In Differential Manchester coding, a transition at the start of a bit period indicates a binary '0', and no transition indicates a binary '1'. The signal still makes a mid-bit transition regardless of the bit value.

- Advantages: Provides better resilience to noise and polarity errors.
- Disadvantages: Like Manchester, it requires more bandwidth.

5. Bipolar AMI (Alternate Mark Inversion)

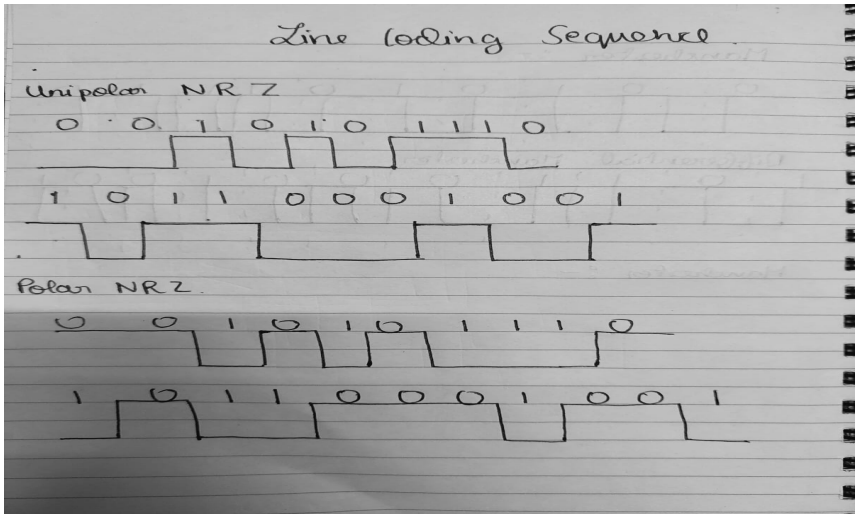
In Bipolar AMI, binary '1's are represented by alternating positive and negative voltages, while binary '0's are represented by zero voltage. This alternating pattern helps to eliminate the DC component.

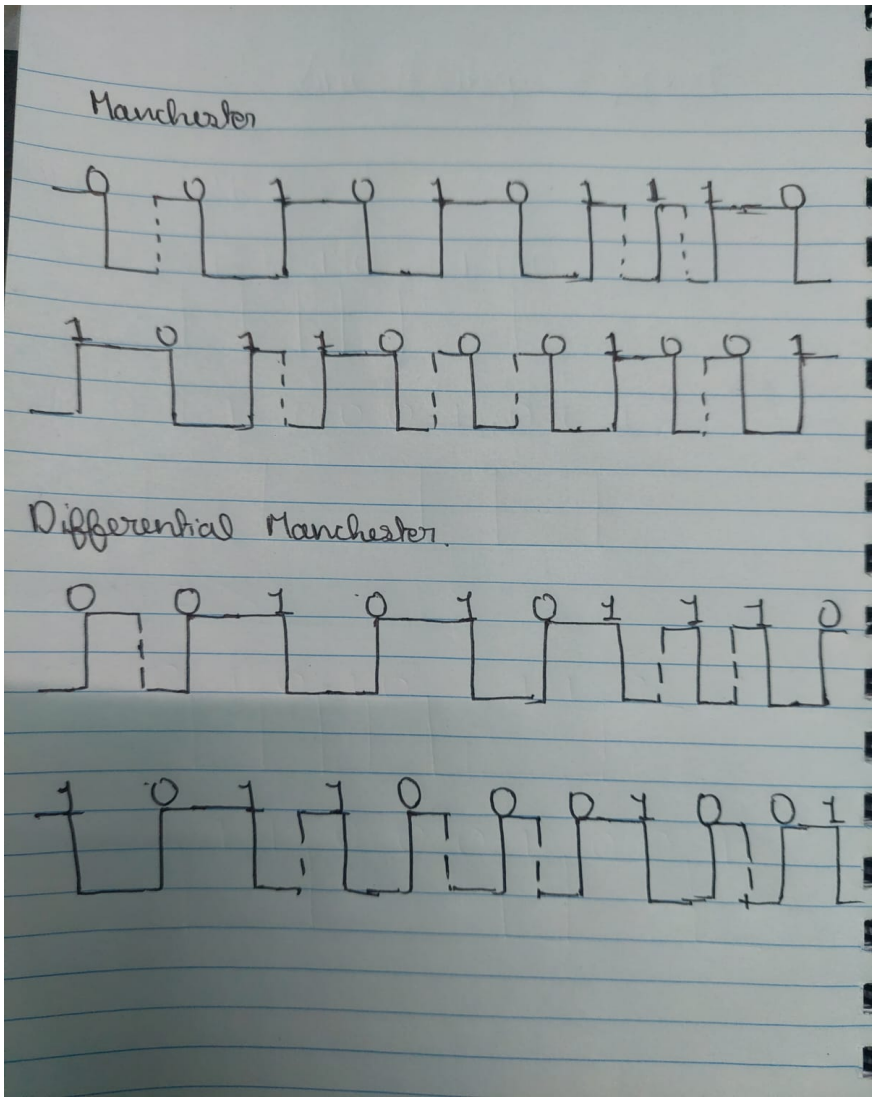
- Advantages: No DC component, more bandwidth-efficient than Manchester coding.
- Disadvantages: Long sequences of '0's may result in synchronization loss.

6. Return to zero (RZ)

RZ coding represents a binary '1' with a positive voltage for half the bit period, returning to zero for the rest. A binary '0' uses a negative (or zero) voltage followed by a return to zero.

- Advantages**:** Easy synchronization and clock recovery due to the return to zero within each bit period.
- Disadvantages**:** Bandwidth inefficient (requires two transitions per bit).


Line coding Sequence
Unipolar NRZ
0 0 1 0 1 0 1 1 1 0
1 0 1 1 0 0 0 1 0 0 1
Polar NRZ


Manchester
Differential Manchester

3. Define the purpose of multiplexing in computer networks. Justify multiplexing with respect to analog and digital.

The purpose of multiplexing in computer networks is to combine multiple data streams or signals into a single transmission medium, allowing for more efficient use of network resources. This technique enables multiple users or applications to share the same communication channel simultaneously, thereby increasing the overall capacity and reducing costs associated with data transmission.

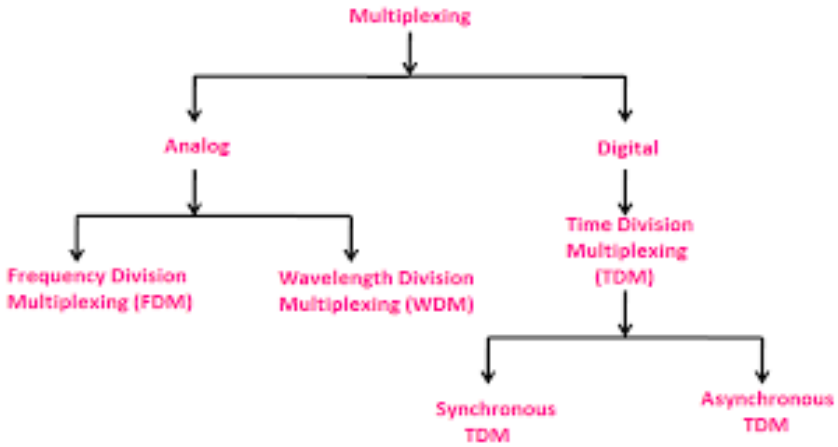
Some key purposes of multiplexing include:

- Efficient bandwidth utilization
- Cost reduction in network infrastructure
- Increased data transmission capacity
- Support for multiple users or applications on a single channel

Multiplexing is used in various forms of communication, including telecommunications, computer networks, and broadcasting, to optimize the use of available resources and improve overall system performance.

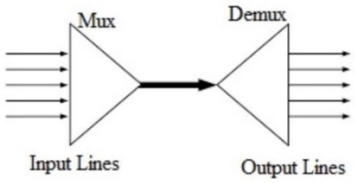
Analog Multiplexing: In analog systems, multiplexing allows multiple analog signals to be combined and transmitted over a single channel. This is particularly useful in applications like radio broadcasting, where multiple audio channels can be transmitted simultaneously over a single frequency band. We typically use Frequency Division Multiplexing (FDM) or Wavelength Division Multiplexing (WDM).

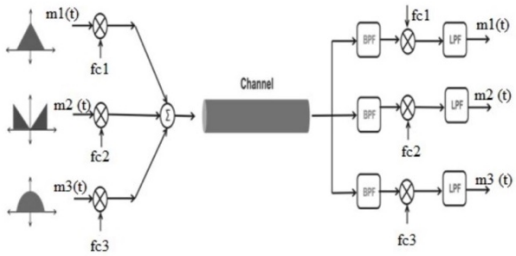
Digital Multiplexing: In digital networks, multiplexing enables the transmission of multiple digital data streams over a single link. This is crucial for efficient data transfer in modern computer networks, allowing multiple users or applications to share the same communication channel simultaneously. We use Time Division Multiplexing (TDM).



4. Is FDM a spectrum based multiplexing approach? Explain with diagram and example.

In FDM, the available frequency spectrum is divided into multiple non-overlapping frequency bands, or channels. Each channel is then assigned to a different user or data stream. This allows multiple signals to be transmitted simultaneously over a single medium without interfering with each other.





FDM Block Diagram

The frequency division block diagram shown in the previous page includes a transmitter and a receiver. In FDM, the different message signals like m1(t), m2(t) & m3(t) are modulated at the different carrier frequencies like fc1, fc2 & fc3. The different modulated signals are separated from each other within the frequency domain. These modulated signals are merged together to shape the composite signal which is transmitted over the transmission medium. To avoid interference between the two message signals, a guard band is also kept in between these two signals. A guard band is used to separate two wide ranges of frequencies. This ensures that communication channels that are used simultaneously do not experience interference which would affect in reduced quality of transmissions.

5. Which among the multiplexing is a suitable approach for minimal error transaction. Justify with scenarios and case study.

Time Division Multiplexing (TDM) is often considered one of the most suitable approaches for achieving minimal error in data transmission, especially in scenarios where strict control over bandwidth and timing is critical. TDM is favoured for several reasons, particularly in environments where error minimization is essential, and deterministic performance is required.

What is TDM?

In Time Division Multiplexing (TDM), multiple data streams are combined into a single signal by dividing time into multiple slots, with each data stream allocated its own time slot. The key characteristic of TDM is that each channel gets the entire bandwidth of the communication medium for a fraction of time, meaning that signals from multiple devices or sources can be sent over a single channel, but only one at a time.

Suitability of TDM for Minimal Error Transmission

1. Predictable and Controlled Transmission : TDM ensures that each data stream has a dedicated time slot, which avoids overlap or collision between different data streams. In contrast to Frequency Division Multiplexing (FDM) or Code Division Multiple Access (CDMA), where interference can arise due to shared frequency or coding, TDM avoids this problem by clearly separating the transmission times for each data stream. This significantly reduces errors.

Scenario : In mission-critical applications, such as air traffic control systems, precise, error-free communication is required. TDM ensures that each control tower and aircraft have dedicated time slots to transmit data without interference, reducing the chance of errors or lost signals.

2. Low Interference: Since TDM assigns specific time slots to each data stream, there is less chance of interference between streams. This is especially useful in digital communication networks, where signals might get distorted if multiple transmissions occur simultaneously.

Case Study : Telecommunication systems often rely on Synchronous TDM to minimize transmission errors between switching exchanges. For example, Integrated Services Digital Network (ISDN) uses TDM to send voice, video, and data across the same communication lines. By allocating time slots for each type of data (voice, video), errors are minimized because each signal gets its own undisturbed transmission window.

3. Error Detection and Correction Mechanisms : TDM allows for efficient error detection and correction. Time slots can be allocated for control signals that carry error-checking and synchronization information. In cases where errors are detected, the system can quickly retransmit the affected data in the next available time slot.

Scenario : In industrial automation systems where sensors are constantly transmitting data to a central control unit, TDM can help in managing data traffic from multiple sensors by assigning time slots. In cases of packet loss or transmission errors, the system can use error detection protocols (like parity bits or checksums) to identify the fault and request retransmission in the next available slot.

4. Synchronization and Precision : One of the major advantages of TDM is the synchronization between the sender and receiver. Each side knows exactly when a particular signal will be

transmitted, which greatly enhances the accuracy of data recovery and minimizes the chances of data corruption or misinterpretation.

Case Study: In optical fiber communication, where data is transmitted over long distances at high speeds, Dense Wavelength Division Multiplexing (DWDM) might be more efficient in terms of bandwidth, but TDM is often preferred for short-haul fiber communications. TDM allows precise synchronization between transmitting and receiving devices, reducing the need for complex error correction mechanisms and lowering the chance of miscommunication.

5. Suitability for Digital Data Transmission : TDM is inherently more suited to digital data transmission, which relies on strict timing and order. Since TDM handles digital data in an organized time-division manner, the process of detecting and correcting errors is more straightforward. TDM is also compatible with packet-based networks where data is sent in discrete bursts (such as Ethernet networks), making error checking more effective.

Scenario: In modern cellular networks such as 4G LTE, TDM can be used to allocate resources for specific users or data streams based on time. This ensures that users receive error-free communication, even when multiple users are sharing the same network resources.

6. What is an error with respect to communication. Explain different types of errors occurred during transaction with a neat diagram.

In digital systems, the Analog signals will change into digital sequence (in the form of bits). This sequence of bits is called as "Data stream". The change in position of single bit also leads to catastrophic (major) error in data output. Almost in all electronic devices, we find errors and we use error detection and correction techniques to get the exact or approximate output. The data can be corrupted during transmission (from source to receiver). It may be affected by external noise or some other physical imperfections in this case the input data is not same as the received output data. This mismatched data is called “Error”

Types of Error

In a data sequence, if 1 is changed to 0 or 0 is changed to 1, it is called “Bit Error”

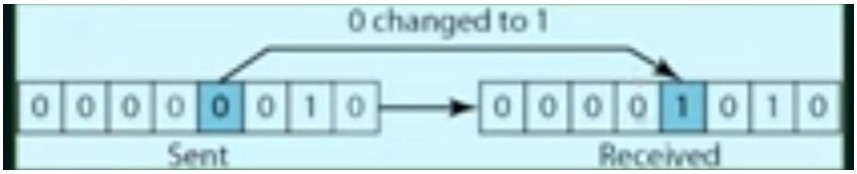
There are 3 types of errors occur in data transmission from transmitter to receiver. They are

- Single Bit Error
- Multiple Bit Error
- Burst Error

Single Bit Error

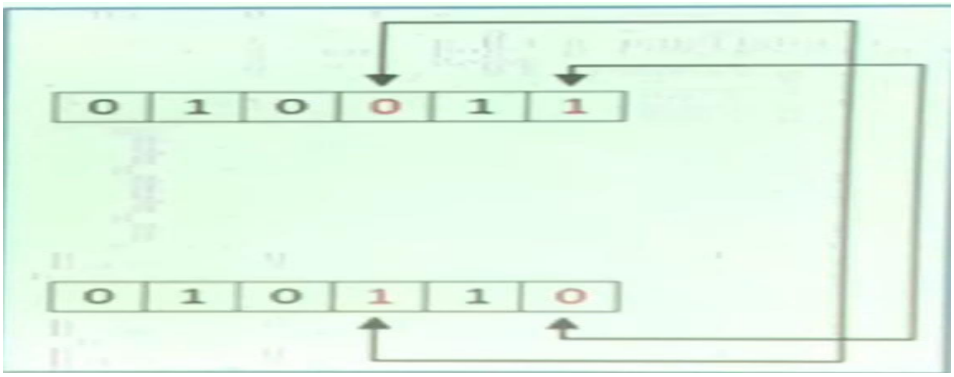
The change in one bit in the whole data sequence is called “Single bit error”. Occurrence of Single bit error is very rare in serial communication system. This type of error occurs only in

parallel communication system, as data is transferred bit wise in single line. There is chance that single line to be noisy.

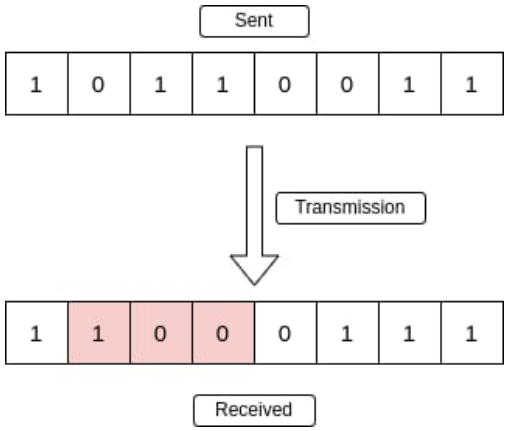


Multiple Bit Error

If there is change in two or more bits of data sequence of transmitter to receiver, it is called "Multiple bit error". This type of error occurs in both serial type and parallel type data communication networks.



Burst Error



The change of set of bits in data sequence is called "Burst error". The burst error is calculated in from the first bit change to last bit change. Here we identify the error form 2nd bit to 4th bit. The numbers between 2th and 4th bits are also considered as error. These set of bits are called "Burst error". These burst bits changes from transmitter to receiver, which may cause a major error in data sequence. This type of errors occurs in serial communication, and they are difficult to solve

7. Explain the terms

1. Redundancy

2. Burstime

3. Data word

4. Demultiplexing

1. Redundancy

Redundancy involves having multiple components or systems in place to ensure that if one fails, others can take over. This is crucial for maintaining reliability and availability. For example, in data storage, redundancy means keeping duplicate copies of data in different locations. If one location experiences a failure, the data can still be accessed from another location, ensuring that important information is not lost.

2. Burst Time

Burst time refers to the total time a process or task needs to run from start to finish without any interruptions. Think of it as the time a computer program takes to complete its execution once it starts running. This concept is important in scheduling and managing tasks in operating systems to ensure efficient processing.

3. Data Word

A data word is a fixed-sized unit of data that is handled as a single entity during transmission or processing. Imagine it as a block of data that moves together through a system. For instance, in computer memory, data is often read and written in words, which could be 16, 32, or 64 bits long, depending on the system architecture.

4. Demultiplexing

Demultiplexing is the process of taking a combined signal that carries multiple streams of data and separating it back into its original individual streams. This is used in various network technologies:

1. Time-division multiplexing (TDM): Here, data streams are interleaved in time. Demultiplexing separates these time-interleaved streams back into their original sequences.
2. Frequency-division multiplexing (FDM): In this method, different data streams are transmitted at different frequencies. Demultiplexing extracts each frequency-specific stream.
3. Wavelength-division multiplexing (WDM): Used in optical networks, this technique involves different data streams transmitted on different wavelengths of light. Demultiplexing separates these wavelength-specific signals.

8. Is parity check an error correction or error detection approach. Justify.

A parity check is an **error detection** method, not an error correction technique because:

Error Detection: The purpose of a parity check is to identify errors during data transmission. A parity bit is added to the data to ensure that the total number of 1s in the data (including the parity bit) is either even (for even parity) or odd (for odd parity). When the data is received, the parity is recalculated. If it doesn't match the expected value, an error has occurred.

Limitations: Parity checks can only detect certain types of errors. For instance, they are guaranteed to detect any situation where an odd number of bits are altered. However, if an even number of bits are changed, the parity might still look correct, even though the data is corrupted.

No Correction: Unlike more advanced methods such as Hamming codes or Reed-Solomon codes, parity checks don't have the capability to correct errors. They simply signal that something went wrong, but they don't offer any way to pinpoint the exact bit or bits that are incorrect. In practice, if an error is detected, the data usually needs to be retransmitted.

Mutual Agreement: Both the sender and receiver need to agree on whether they're using even or odd parity for the system to work correctly. This highlights its role in error detection, as the primary goal is to catch transmission errors, not to fix them. Therefore, a parity check is an effective way to detect errors but lacks the ability to correct them, which is why it's classified as an error detection approach.

9. Consider a set m= {12,13,4,3,6} for the process of checksum and demonstrate the checksum operation with detailed steps.

The checksum is a network method to check for any error or damage to the data transmitted to the receiver side from the sender side. The checksum method applies the bit addition and bit complement method to perform the checksum implementation.

Steps involved in the checksum error-detection method:

Step 1: Check and make a wrapping text/entity (maximum size of data being transferred). For the given data set m= {12,13,4,3,6} we can consider 15 to be the maximum size that can be transferred i.e. 4 bits.

Step 2: Add 0 at the end of the data set and sum the elements of the set.

12	1100
13	1101
4	0100
3	0011
6	0110
0	0000
38	100110

Step 3: Now that the sum bit exceeds our wrapping size (i.e. 4 bits), the extra carry bits are to be added to the summation result.

0110 10
1000

Step 4: Perform the 1's Complement for the bit addition result, thus obtaining the checksum value.

1000	8
0111	7

Step 5: Replace 0 with the checksum value and sum the elements of the set. Begin the data transmission to the receiver.

12	1100
13	1101
4	0100
3	0011
6	0110
7	0001
45	101101

Step 6: Remove the extra carry bits and add to the summation result.

1101 10
1111

Step 7: Perform 1's complement on the result. If the complement result is 0, the data received is correct and without any error if not it is a corrupted bit of the data sent.

1111	15
0000	0

The result is 0 therefore it is a non-corrupted bit of data. Receiver assumes that no error occurred in the data during the transmission and accepts the data.

For a corrupted bit of data:

For the above data change/corrupt one element in the data set and perform the summation.

12	1100
13	1101
2	0010
3	0011
6	0110
7	0001
43	101011

Remove the extra carry bits and add to the summation result.

1011
10
1101

Perform 1s compliment on the result.

1101	13
0010	2

We get a non-zero result and the receiver assumes that an error occurred in the data during the transmission. Receiver discards the data and asks the sender for retransmission.

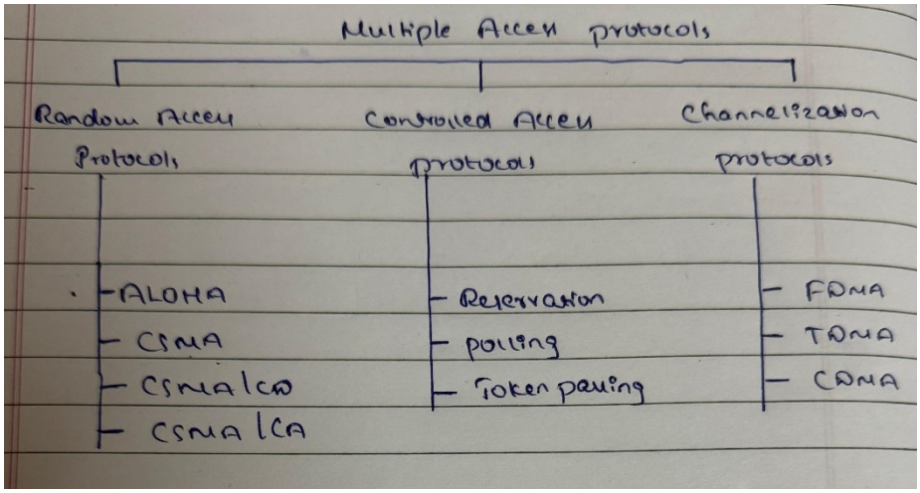
10. Justify multiple access protocol and demonstrate it with various example.

* Multiple access protocol is a set of rules used in communication systems to regulate how multiple users or devices share a common communication channel.

* The main goal is to avoid collisions and ensure efficient use of the channel so that data can be transmitted reliably.

Types of Multiple Access Protocols :

1) Random Access Protocols.
2) Controlled Access Protocols.
3) Channelization Protocols.



Random Access Protocols :

- In Random access protocol, all stations have same superiority that is no station has more priority than another station.
- Any station can send data depending on medium's state.

Features

- There is no fixed time for sending data.
- There is no fixed sequence of stations sending data.

The Random access protocols are further subdivided as:

1) ALOHA :
   *It was designed for wireless LAN but is also applicable for shared medium.
   *In this, multiple stations can transmit data at the same time and can hence lead to collision and data being garbled.

   Types of ALOHA :
   a) PURE ALOHA
   b) SLOTTED ALOHA

Pure ALOHA :

*When a station sends data it waits for an acknowledgement.
* If the acknowledgement doesn't come within the allotted time then the station waits for a random amount of time called back-off time (Tb) and re-sends the data.
*Since different stations wait for different amount of time, the probability of further collision decreases.

Slotted ALOHA :

*It is similar to pure aloha, except that we divide time into slots and sending of data is allowed only at the beginning of these slots.

* If a station misses out the allowed time, it must wait for the next slot. *This reduces the probability of collision.

2)CSMA

*Carrier Sense Multiple Access ensures fewer collisions as the station is required to first sense the medium before transmitting data.

*If it is idle then it sends data, otherwise it waits till the channel becomes idle.

*There is still chance of collision in CSMA due to propagation delay.

CSMA Access Modes

a) 1-Persistent
b) Non-Persistent
c) O-Persistent

***1-Persistent:** The node senses the channel, if idle it sends the data, otherwise it continuously keeps on checking the medium for being idle and transmits unconditionally (with 1 probability) as soon as the channel gets idle.

***Non-Persistent:** The node senses the channel, if idle it sends the data, otherwise it checks the medium after a random amount of time (not continuously) and transmits when found idle.

***P-Persistent:** The node senses the medium, if idle it sends the data with p probability. If the data is not transmitted ((1-p) probability) then it waits for some time and checks the medium again, now if it is found idle then it send with p probability. This repeat continues until the frame is sent. It is used in Wifi and packet radio systems.

***O-Persistent:** Superiority of nodes is decided beforehand and transmission occurs in that order. If the medium is idle, node waits for its time slot to send data.

3)Carrier sense multiple access with collision detection (CSMA/CD) :

*The CSMA method does not tell us what to do in case there is a collision.

*Carrier sense multiple access with collision detection (CSMA/CD) adds to the CSMA algorithm to deal with the collision. In CSMA/CD, the size of a frame must be large enough so that collision can be detected by the sender while sending the frame.

*The frame transmission delay must be at least *two times* the maximum propagation delay.

4) **CSMA/CA**

*Carrier sense multiple access with collision avoidance.

*The process of collisions detection involves sender receiving acknowledgement signals.

* If there is just one signal(its own) then the data is successfully sent but if there are two signals(its own and the one with which it has collided) then it means a collision has occurred.

*To distinguish between these two cases, collision must have a lot of impact on received signal.

CSMA/CA Avoids Collision By

a) Interframe Space
b) Contention Window
c) Acknowledgement

Controlled Access Protocols :

*Controlled Access Protocols (CAPs) in computer networks control how data packets are sent over a common communication medium.

*These protocols ensure that data is transmitted efficiently, without collisions, and with little interference from other data transmissions.

The three controlled-access methods are:

a) Reservation
b) Polling
c) Token Passing

Reservation

*In the reservation method, a station needs to make a reservation before sending data.

*The timeline has two kinds of periods:

a) Reservation interval of fixed time length
b) Data transmission period of variable frames.

- If there are M stations, the reservation interval is divided into M slots, and each station has one slot.
- Suppose if station 1 has a frame to send, it transmits 1 bit during the slot 1. No other station is allowed to transmit during this slot.
- In general, i th station may announce that it has a frame to send by inserting a 1 bit into i th slot. After all N slots have been checked, each station knows which stations wish to transmit.
- The stations which have reserved their slots transfer their frames in that order.
- After data transmission period, next reservation interval begins.

2. Polling

- Polling process is similar to the roll-call performed in class. Just like the teacher, a controller sends a message to each node in turn.
- In this, one acts as a primary station(controller) and the others are secondary stations. All data exchanges must be made through the controller.
- The message sent by the controller contains the address of the node being selected for granting access.
- Although all nodes receive the message the addressed one responds to it and sends data if any. If there is no data, usually a “poll reject”(NAK) message is sent back.
- Problems include high overhead of the polling messages and high dependence on the reliability of the controller.

3. Token Passing

- In token passing scheme, the stations are connected logically to each other in form of ring and access to stations is governed by tokens.
- A token is a special bit pattern or a small message, which circulate from one station to the next in some predefined order.
- In Token ring, token is passed from one station to another adjacent station in the ring whereas incase of Token bus, each station uses the bus to send the token to the next station in some predefined order.
- In both cases, token represents permission to send. If a station has a frame queued for transmission when it receives the token, it can send that frame before it passes the token to the next station. If it has no queued frame, it passes the token simply.
- After sending a frame, each station must wait for all N stations (including itself) to send the token to their neighbours and the other N – 1 stations to send a frame, if they have one.

- There exists problems like duplication of token or token is lost or insertion of new station, removal of a station, which need be tackled for correct and reliable operation of this scheme.

3. Channelization

In channelization, the available bandwidth of the link is shared in time, frequency and code to multiple stations to access channel simultaneously.

Frequency Division Multiple Access (FDMA) :
* The available bandwidth is divided into equal bands so that each station can be allocated its own band.
*Guard bands are also added so that no two bands overlap to avoid crosstalk and noise.

Time Division Multiple Access (TDMA) :

*In this, the bandwidth is shared between multiple stations.

* To avoid collision time is divided into slots and stations are allotted these slots to transmit data.

* There is a overhead of synchronization as each station needs to know its time slot.
*This is resolved by adding synchronization bits to each slot.

Code Division Multiple Access (CDMA) :

* One channel carries all transmissions simultaneously.

* There is neither division of bandwidth nor division of time.

* For example, if there are many people in a room all speaking at the same time, then also perfect reception of data is possible if only two person speak the same language.

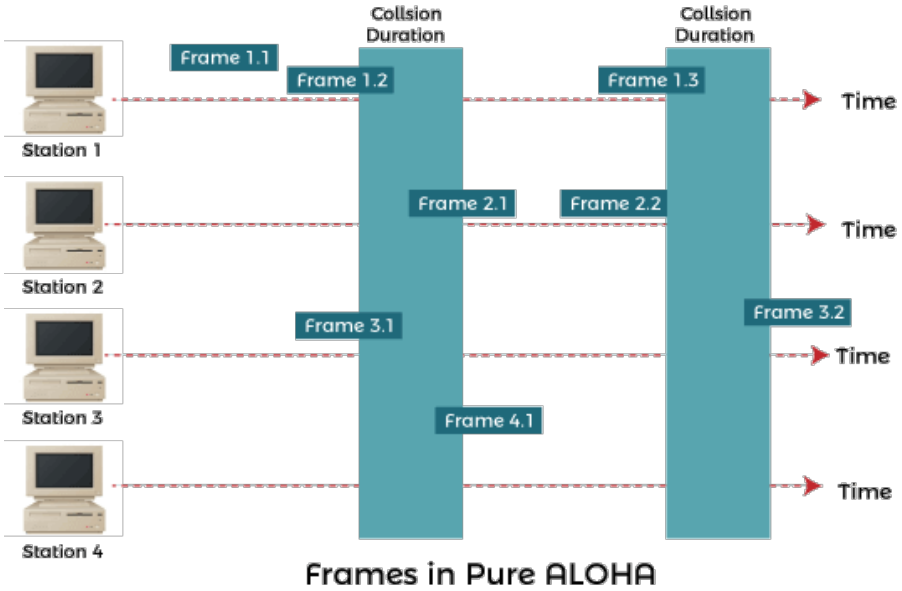
12. Describe ALOHA with respect to pure and slotted approaches

ALOHA is a simple communication protocol used for sharing a common channel between multiple users in a computer network.

Aloha can be divided into two main approaches: Pure Aloha and Slotted ALOHA.

a) Pure Aloha

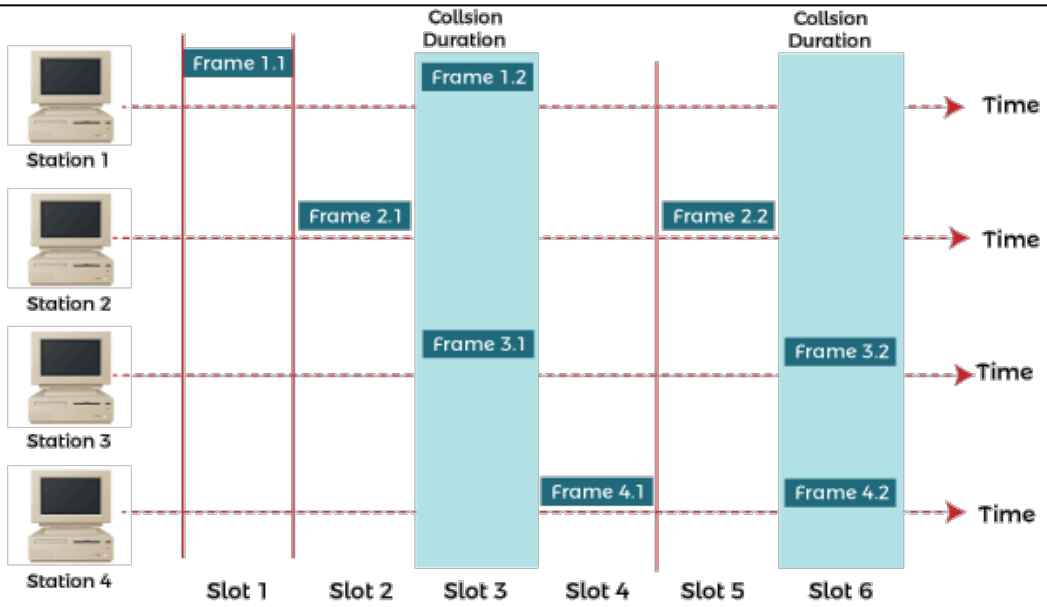
Pure ALOHA is a simple network protocol that allows users to transmit data at any time without having to wait for a specified period of time .If two or more users send data simultaneously A collision will occur and data will be lost. The user detected a collision without response. Then wait a few seconds before transmitting again. Despite its ease of use, Pure ALOHA has the lowest throughput of approximately 18.4%, mainly due to the high probability of collisions. Its simplicity makes it ideal for low-traffic networks or early wireless communications systems.



Frames in Pure ALOHA

b) Slotted ALOHA

Slotted ALOHA is an improved version of the ALOHA protocol. It is designed to reduce collisions in network communications. In Slotted ALOHA, time is divided into equal-sized slots. And users can send data only at the beginning of the channel. This structured approach reduces the chance of collisions due to transmission synchronization. When a collision occurs the user will wait a random amount of time before transmitting again. The protocol's performance is higher than Pure ALOHA, with a peak throughput of approximately 36.8%. Slotted ALOHA is more efficient in medium to high traffic networks due to its time slot structure. This reduces data loss.



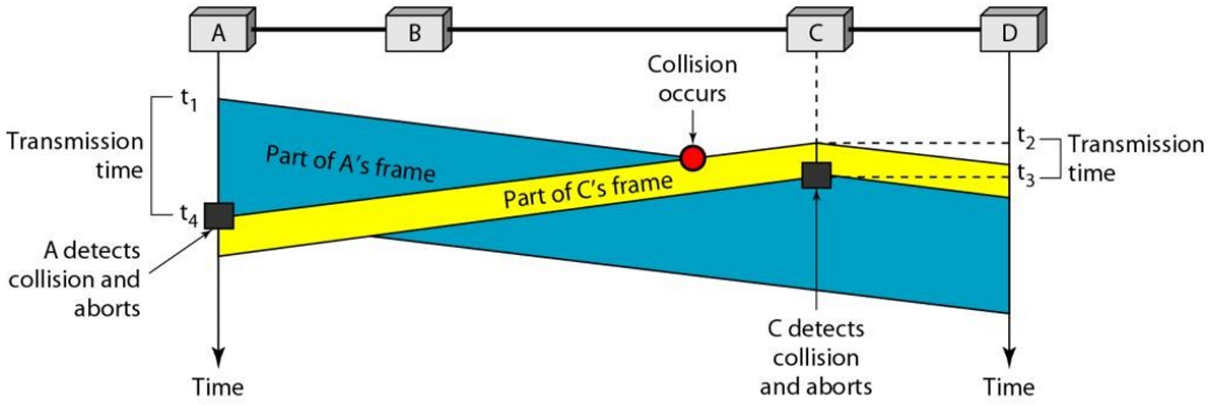
Frames in Slotted ALOHA

13. Explain CSMA/CD with a proper diagram and flowchart

CSMA/CD

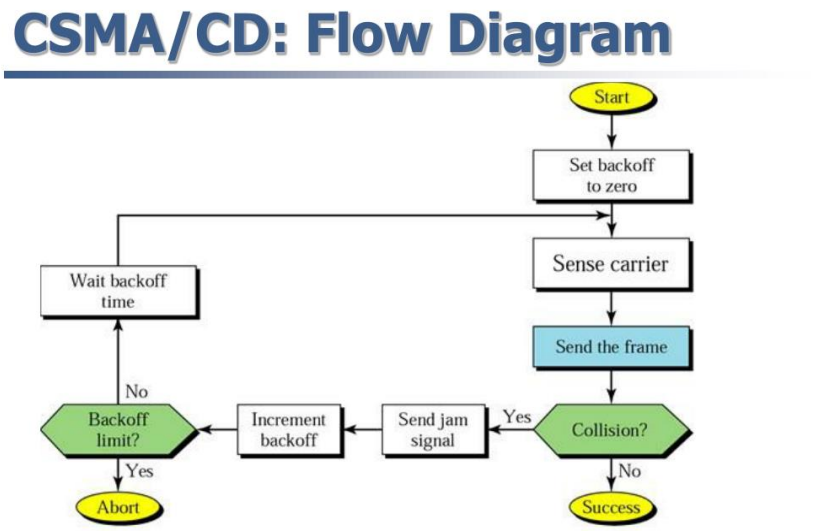
- Carrier Sense Multiple Access with Collision Detection
- In CSMA/CD, the station senses the carrier or channel before transmitting frame.
- The station that places its data onto the channel after sensing the channel continues to sense the channel even after the data transmission.
- If collision is detected, the station aborts its transmission and waits for predetermined amount of time & then sends its data again.
- Station continues to monitors channel after sending a frame

CSMA/CD: Flow Diagram



Set the back off parameter to zero.

- The station that has a ready frame senses the line.
- If no one is transmitting, it sends the frame.
- If there is no collision for a period corresponding to one complete frame, then the transmission is successful.
- If there is a collision detected, the station sends the jam signal to inform the other stations about the collision.
- The station then increments the backoff time and waits for a random backoff time and sends the frame again.
- If the backoff has reached its limit then the station aborts the transmission.



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14. Justify Controlled access protocol and its types.

Controlled Access Protocols (CAPs) in computer networks control how data packets are sent over a common communication medium. These protocols ensure that data is transmitted efficiently, without collisions, and with little interference from other data transmissions. In this article, we will discuss Controlled Access Protocols.

- Justifications for the importance of Controlled access protocol:

1.Collision Prevention

- Minimizes Data Collisions

- Efficient Use of Bandwidth

2. Fair Access

- Equitable Resource Distribution
- Predictable Performance

3. Network Scalability

- Supports Multiple Devices
- Adaptability

4. Improved Reliability

- Error Reduction
- Consistent Quality of Service (QoS

5. Resource Management

- Efficient Traffic Management
- Reduced Latency

→**Types of Controlled Access Protocols are:**

1. Token Passing Protocols:

- Working: A token (a special data packet) circulates in the network. Only the device that possesses the token can transmit data. This method effectively prevents collisions.
- Example: Token Ring

2. Polling Protocols:

- Working: A central controller (like a server) polls devices in a predetermined order, allowing each one to transmit data when it's their turn. This ensures orderly access but can create a bottleneck at the central controller.
- Example: Centralized polling

3. Contention-Based Protocols:

- Working: Devices listen to the channel before transmitting. If the channel is clear, they send their data. If a collision occurs, they back off and attempt to retransmit after a random time.
- Example: Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

4. Time Division Multiple Access (TDMA):

- Working: The available channel is divided into time slots, and each device is assigned a specific time slot during which it can transmit. This method ensures that each device gets a fair share of the bandwidth.

5. Frequency Division Multiple Access (FDMA):

- Working: The available bandwidth is divided into frequency channels, and each device is assigned a specific frequency band for transmission. This is commonly used in cellular networks.

6. Reservation Protocols:

- Working: Devices can reserve a time slot in advance to transmit data, ensuring they have dedicated access to the channel when needed.
- Example: Synchronous Dynamic Reservation Protocol.

15. Is reservation access method an ideal solution for data transfer to avoid errors. Justify the same and discuss the advantages and disadvantages.

By assigning specified network resources, like time slots or bandwidth, to a specific device or data stream, the reservation access technique makes sure that only one user or device is able to transmit data at any given moment. This makes it a desirable choice in some controlled network situations by lowering transmission mistakes and data collisions.

Advantages:

- Collision-Free Transmission: The main benefit is that it reduces the possibility of errors brought on by overlapping transmissions by preventing data collisions. Each device is given the time or space it needs to send.
- Predictable Performance: By allocating specific resources, it guarantees steady performance in real-time systems where timing is crucial, such as video streaming or telecommunications.
- Effective in Managed Settings: It guarantees efficient management of bandwidth and resources in networks with steady traffic (such as private networks), ensuring dependable data delivery free from congestion.

Disadvantages:

- Inefficiency in Dynamic Networks: Fixed reservations may result in resource underutilization in big or unpredictable networks because devices may not use all of the reserved bandwidth, wasting potential capacity.
- Lack of Flexibility: Reservation systems are not appropriate for situations where demand fluctuates quickly because they are less flexible than contention-based techniques when it comes to adjusting to variations in network traffic.

- Difficult Coordination: When reservation systems are implemented, more overhead is incurred, necessitating device synchronization and coordination, which makes larger or more dynamic systems more difficult.

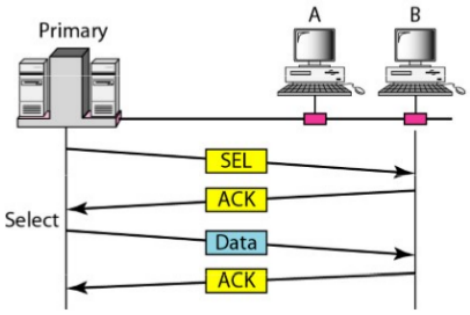
Reservation access is a useful technique for guaranteeing error-free transmission in some stable contexts, but it is less suitable for large-scale or dynamic networks where resource allocation efficiency, scalability, and flexibility are essential. Based on the unique needs and traffic patterns of the network, its utilization should be carefully examined.

16. What is the functionality of "select and poll" function in polling access methods. Explain with neat diagram.

In polling systems, one device acts as the primary station while the others are secondary. All data must go through the primary device, even if the final recipient is the secondary device. The primary controls communication and decides which secondary can use the channel. When the primary wants to receive data, it uses the poll function to ask secondary devices if they have anything to send. Conversely, when it wants to send data, it uses the Select function to prepare the secondary for receiving.

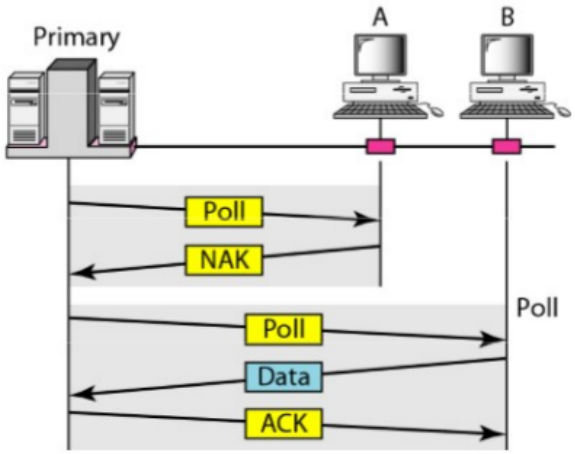
Select:

The select function is used whenever the primary device has something to send. Remember that the primary controls the link. If the primary is neither sending nor receiving data, it knows the link is available. If it has something to send, the primary device sends it. What it does not know, however, is whether the target device is prepared to receive. Before the primary device can send data, it needs to notify the intended secondary about the upcoming transmission and wait for its acknowledgment. To do this, the primary creates a select (SEL) frame that includes a field with the address of the secondary device. This process ensures that the secondary is prepared to receive the incoming data.



Poll:

The poll function is used by the primary device to solicit transmissions from the secondary devices. When the primary is ready to receive data, it must ask (poll) each device in turn if it has anything to send. When the first secondary is approached, it responds either with a NAK frame if it has nothing to send or with data (in the form of a data frame) if it does. If the response is negative (a NAK frame), then the primary polls the next secondary in the same manner until it finds one with data to send. When the response is positive (data frame), the primary reads the frame and returns an acknowledgment (ACK frame), verifying its receipt.



17. Is channelization an ideal approach for bandwidth management. Justify with eg and scenarios.

This is a suitable method for bandwidth management, though it can only be ideal under specific scenarios or requirements. Channelization is the partitioning of a communication medium into several channels capable of carrying their data streams. It finds application in various fields, including telecommunications, networking, or wireless communication.

Advantages of Channelization

1. Resource Utilization of Useful Bandwidth: Since bandwidth is divided into several small-sized channels, numerous users can transmit the signals at the same time without interference. For eg, in FDMA operation, a different user sends his/her signal at different frequencies.

2. Lower Latency: Channelization reduces the latency that is experienced because the dedicated bandwidth can be allocated to the user, which is useful for applications that should be in real time, such as voice over IP (VoIP) or online gaming.
3. QoS: It enables a better management of traffic and gives priority to specific types of data; thus, it is vital in cases that require video conferencing, where the quality cannot be changed.

Disadvantages of Channelization

1. *High Complexity:* Managing several channels would make the system complex. This requires high-level technology that is capable of allocating as well as monitoring channels.
2. *Overutilization:* Where demand for some of the channels keeps changing, there is tendency of over or underutilization of channels. In cases of underutilization, there could be inefficiency.
3. *Interference and Overlap:* Sometimes, badly managed channels may suffer interference in cases where channels are closely spaced, especially in wireless systems.

Examples and Scenarios

1. *Wireless Networks (Wi-Fi):* In Wi-Fi, channelization is used through multiple channels, such as 2.4 GHz and 5 GHz bands. Here, different channels can be shared with different access points or users, which ensure effective bandwidth utilization. Again, in densely populated areas, the number of devices competing to share some few channels increases the interference problem. If we use a speedy snatchy network quite frequently, sometimes our preference may be setback, that's why network slow issues comes in wi-fi.
2. *Telecommunications:* In an old-fashioned telephone FDMA splits the frequency spectrum into a number of channels. With this technique, several calls may be transmitted simultaneously, which in the context of landline services proved very efficient. In contrast today, the modern digital systems switched to more efficient techniques like TDMA or CDMA and TDMA divides the time into slots in a GSM network.
3. *Data Centers:* Channelization can be applied in a data center through VLANs. Here, traffic can be segregated for different applications or departments. This means that bandwidth usage will be better controlled and it makes the type of traffic more secure.
4. In the case of services such as *Netflix, Youtube live stream*, etc., adaptive bitrate streaming can then be viewed as a kind of channelization: different channels are created based on the bandwidth conditions of users. The network is prevented from overloading at the same time that users receive the best experience possible.

Final Verdict

Channelization can be a very appropriate approach for bandwidth management in such specific circumstances where one needs simultaneous data streams and quality of service is an essential issue. But, success will depend on the particular needs and infrastructure in question for the system. Careful planning and management are quite necessary to avoid underutilization and interference. For modern, flexible environments, the best result might come from an integration of channelization with other techniques, including dynamic bandwidth allocation.

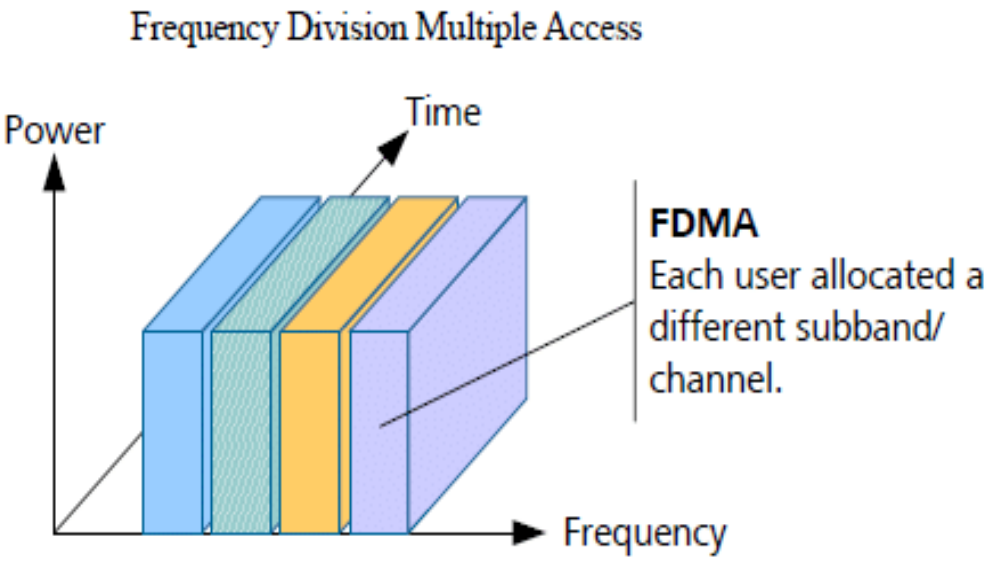
18. With a neat labelled diagram explain frequency digital multiplexing (FDMA).

Frequency Division Multiple Access (FDMA) is a channel access method used in telecommunications to allow multiple users to share the same bandwidth of a communication channel. FDMA works by dividing the available frequency spectrum into smaller frequency bands or channels, and every user is assigned a different frequency band. This allows simultaneous communication without interference.

Features of FDMA:

1. **Each user is given a differnt frequency band.**
2. **Each frequency band is divided by guard bands** to prevent overlap and interference between two channels.
3. **All users transmit and receive simultaneously** but on different frequencies.

Neat Labelled Diagram of FDMA:



Explanation:

1. **Available Frequency Spectrum**: The total bandwidth is divided into multiple smaller frequency bands.
2. **User Frequency Bands**: Each user is given a unique frequency band for communication. In this example, there are three users, each assigned a different frequency.
3. **Guard Bands**: These are small gaps between adjacent frequency bands to prevent interference between users.

Advantages:

1. **Efficient use of bandwidth** for continuous communication.
2. **Simple implementation** in analog systems.
3. **Reduced interference** due to guard bands between frequencies.

Disadvantages:

1. **Limited scalability**: As more users are added, the available frequency spectrum must be divided further, reducing bandwidth per user.
2. **Wastage of bandwidth**: The use of guard bands can result in some loss of total available bandwidth.

19. With a neat labelled diagram explain Frequency Division Multiple Access (FDMA).

Frequency Division Multiple Access (FDMA) is a technique used in telecommunications to allow multiple users to share the same communication medium by dividing the available frequency spectrum into distinct channels. Each user is assigned a specific frequency band, enabling simultaneous data transmission without interference**.**

Working of FDMA

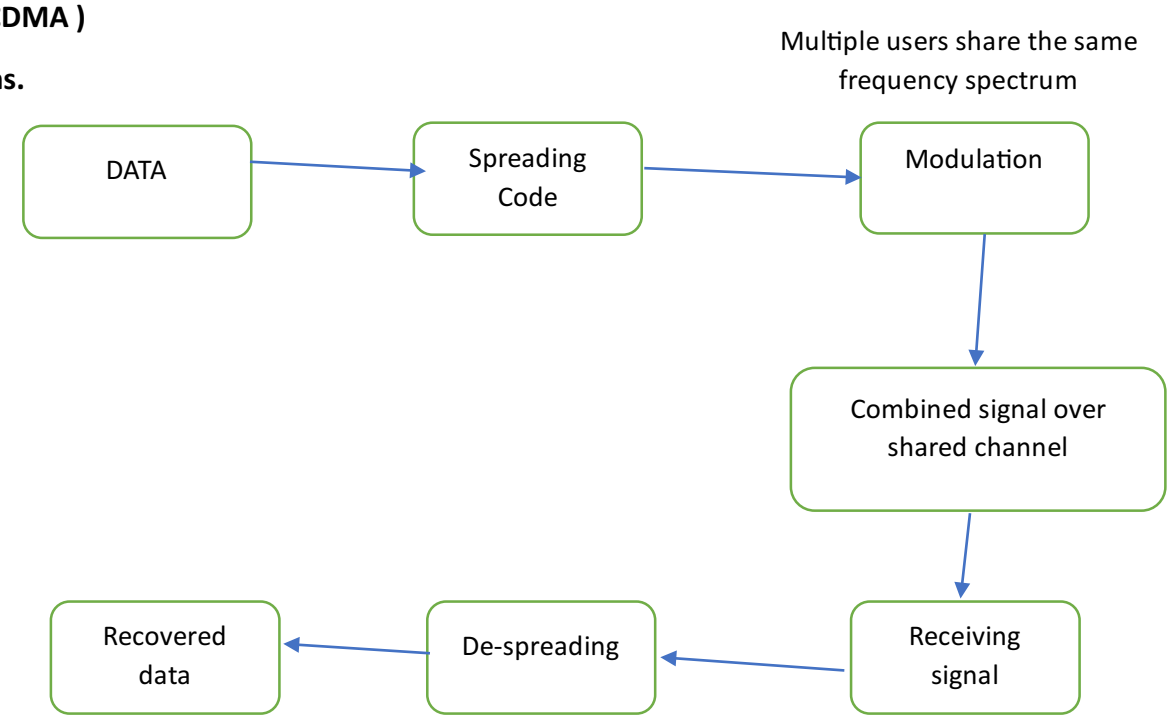
1. Frequency Division: The total available bandwidth is split into multiple non-overlapping frequency channels.
2. Channel Allocation: Each user is assigned a unique frequency channel for exclusive use.
3. Simultaneous Transmission: Users can transmit data simultaneously on different frequencies without interfering with each other.
4. Frequency Spectrum: Represents the total available bandwidth divided into smaller frequency channels.
5. Channels (C1, C2, C3): Each channel is allocated to a specific user or group of users, ensuring exclusive access and minimizing interference

Advantages

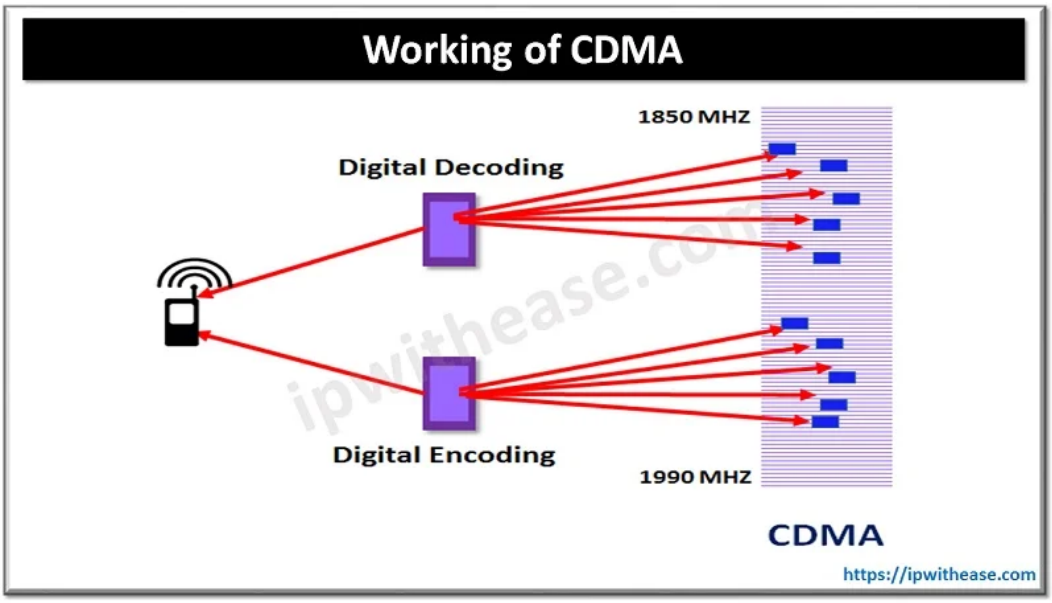
- Simple Implementation: FDMA is relatively easy to implement, requiring no complex algorithms for channel division.
- Stable Connections: Users benefit from stable and continuous connections as they have exclusive access to their frequency channels.
- Efficient Frequency Usage: By dividing the frequency spectrum into multiple channels, FDMA makes efficient use of the available bandwidth.

20) With a neat labelled diagram explain Code Division Multiple Access (CDMA)

Ans.



CDMA stands for Code Division Multiple Access. It is basically a channel access method and is also an example of multiple access. Multiple access basically means that information by several transmitters can be sent simultaneously onto a single communication channel. There are multiple users which are provided or assigned variant CDMA codes and thus the users can access the entire band of frequencies or the whole bandwidth. This method does not limit the frequency range of the user. Hence, with the help of CDMA, multiple users can share a band of frequencies without any kind of undue interference between them. CDMA makes the use of spectrum technology and a special coding scheme (where each transmitter is assigned a code). along with analog to digital conversion(ADC). It is thus used by various radio communication technologies. Mainly, it is used for mobile communication.


Working of CDMA
1850 MHZ
Digital Decoding
Digital Encoding
1990 MHZ
CDMA
https://ipwithease.com