TOPIC: Multi Access Techniques in Computer Networking

Assignment no :02

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Table of Contents

Assignment Title: Multi-Access techniques in Computer Networking

Introduction:

In computer networking, multi-access methods play a crucial role in determining how multiple devices communicate over a shared medium. This assignment aims to provide a comprehensive understanding of various multi-access methods, their characteristics, advantages, and disadvantages.

1. Definition of Multi-Access Methods:

Multi-access methods refer to the techniques used to enable multiple devices to access a shared communication medium simultaneously.

2. Types of Multi-Access Methods:

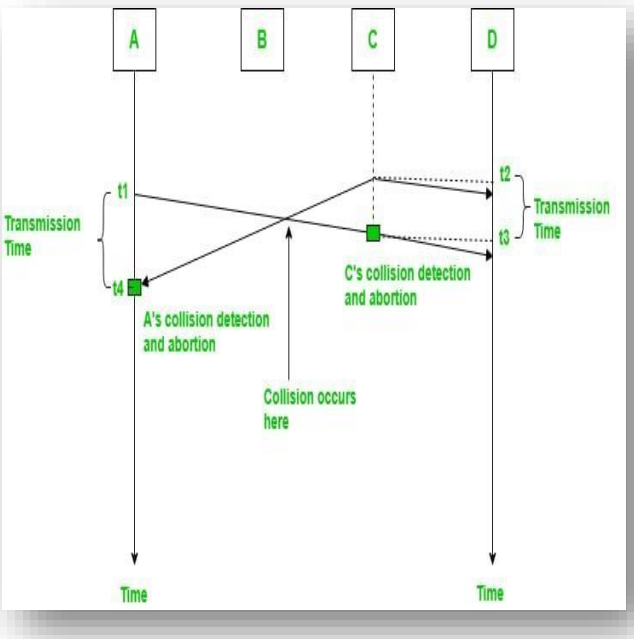
2.1 Carrier Sense Multiple Access (CSMA):

2.1.1 Definition

This technique uses carrier sensing, and nodes try to avoid collisions by transmitting only when the channel is sensed to be "idle".

In other words,

Carrier-sense multiple access (CSMA) is a medium access control protocol that verifies that no other traffic is present before transmitting on a shared medium. This medium could be an electrical bus or a band of the electromagnetic spectrum.



2.1.2 Explanation

In CSMA, a station listens to the medium before transmitting. If the medium is busy, the station

waits until it is idle. If the medium is idle, the station transmits.

CSMA is most notably used in early Ethernet technology for local area networking.

There are two types of CSMA:

CSMA with collision detection: Deferring transmissions until no other stations are transmitting

CSMA with collision avoidance: Nodes attempt to avoid collisions by beginning transmission only after the channel is sensed to be "idle".

2.1.3 Example

Ethernet networks (specifically CSMA/CD)

Explanation: In Ethernet networks, devices use CSMA/CD (Carrier Sense Multiple Access with Collision Detection) to access the shared communication medium. Before transmitting data, devices listen to the medium to ensure it is not in use. If the medium is idle, they transmit their data. However, if collisions occur (i.e., two devices transmit simultaneously), CSMA/CD detects the collision and initiates a back off mechanism to retransmit the data after a random waiting period.

2.1.4 Advantages and disadvantages

Advantages

Simple Implementation: CSMA is relatively easy to implement compared to other methods.

Widely Used in LANs: It is widely used in Local Area Networks (LANs), especially in Ethernet-based networks.

Adaptive: CSMA adapts well to changes in network traffic and is suitable for dynamic environments.

Disadvantages

Susceptible to Collisions: CSMA is susceptible to collisions, especially in high-traffic networks, which can lead to decreased efficiency.

Inefficient: It can be inefficient, particularly in congested networks, as devices may need to wait for the medium to become available.

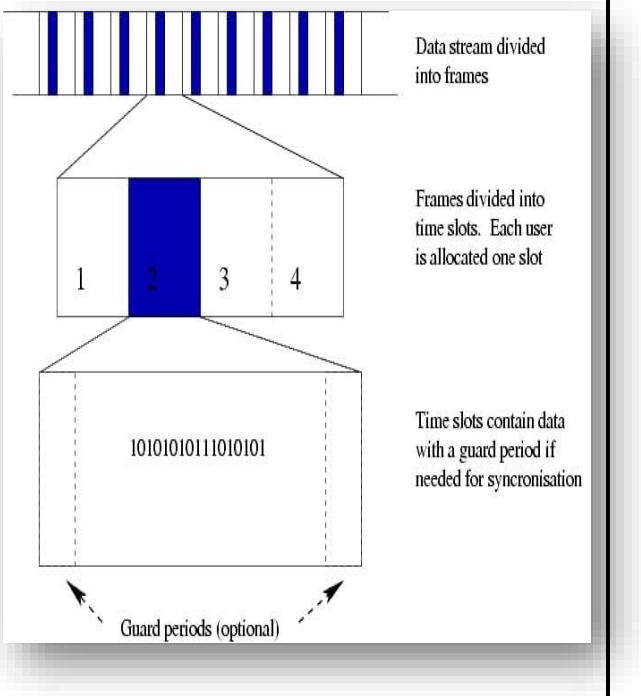
2.2 Time Division Multiple Access (TDMA):

2.2.1 Definition

Time-division multiple access (TDMA) is a digital modulation technique that allows multiple users to access a single radio-frequency (RF) channel without interference.

2.2.2 Explanation

TDMA does this by dividing the signal into different time slots, with each user transmitting in rapid succession, one after the other, each using its own time slot. A central controller sends a bit stream to all users, which synchronizes their clocks, creating channels by assigning users non-overlapping time slots.



TDMA is one of two ways to divide the limited spectrum available over an RF cellular channel. The other way is known as frequency division multiple access (FDMA).

TDMA is used in digital cellular telephone and mobile radio communication. In a system with N users, each user can use the total bandwidth W, but only a fraction 1/N of the time. Synchronization is one of the major technical problems for implementing TDMA. It can also be inefficient if some nodes are much busier than others, since no data are passed during time slots.

2.2.3 Example

GSM (Global System for Mobile Communications) cellular networks

Explanation: In GSM networks, TDMA is used to divide the available frequency spectrum into time slots. Each mobile device is assigned a unique time slot during which it can transmit and receive data. By synchronizing the time slots, multiple devices can share the same frequency band without interfering with each other, enabling efficient utilization of the spectrum.

2.2.4 Advantages and disadvantages

Advantages

Efficient Use of Bandwidth: TDMA efficiently utilizes available bandwidth by dividing it **into time slots, allowing multiple devices to transmit data without interference.**

Deterministic Access: Each device is allocated a specific time slot, providing deterministic access to the medium.

Suitable for Bursty Data: TDMA is suitable for transmitting bursty data, as devices can be allocated time slots dynamically.

Disadvantages

Synchronization Overhead: TDMA requires strict synchronization among devices to maintain time slots, which can introduce overhead.

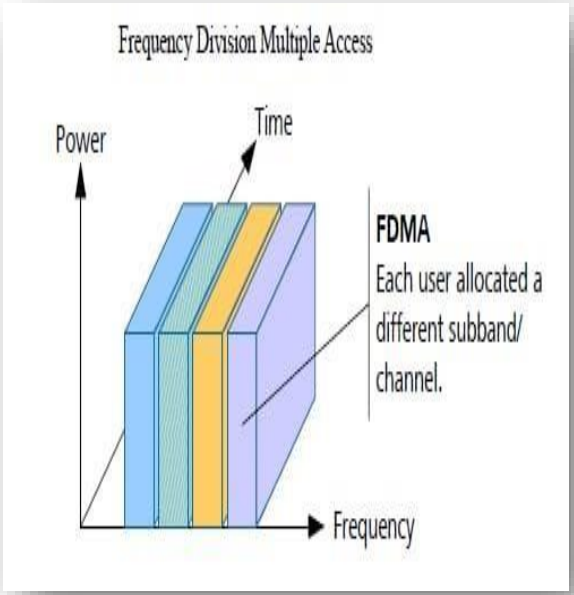
Fixed Allocation: Time slots are allocated statically, which may lead to inefficient use of resources if traffic patterns change dynamically.

2.3 Frequency Division Multiple Access (FDMA):

2.3.1 Definition

Frequency Division Multiple Access (FDMA) is a telecommunications technique that allows users to divide a communication medium, such as a radio frequency band, between them. FDMA is the most common method for multiple access (MA) in satellite communication systems.

2.3.2 Explanation



FDMA works by:

Dividing the communication channel's total bandwidth into segments

Assigning each segment exclusively to a user

Using guard bands between each segment to prevent user interference.

Each user is assigned a frequency band and can communicate continuously using this frequency slot

Each frequency (channel) can only support one conversation and user at a time.

FDMA is rarely used today, but it still has a place in analog cellular networks and some satellite communications.

2.3.3 Example

Analog radio broadcasting

Explanation: In analog radio broadcasting, FDMA is employed to divide the available frequency spectrum into distinct frequency bands. Each radio station is allocated a specific frequency band within which it broadcasts its signal. As a result, multiple radio stations can operate simultaneously without interfering with each other, allowing listeners to tune in to different stations by selecting different frequencies.

2.3.4 Advantages and disadvantages

Advantages

Simplicity: FDMA is relatively simple to implement, making it suitable for certain applications, especially in analog systems.

Suitable for Analog Transmission: It is well-suited for analog transmission systems, where devices are assigned specific frequency bands.

Disadvantages

Inefficient Spectrum Utilization: FDMA can lead to inefficient utilization of the frequency spectrum, as frequency bands are allocated statically, regardless of actual usage.

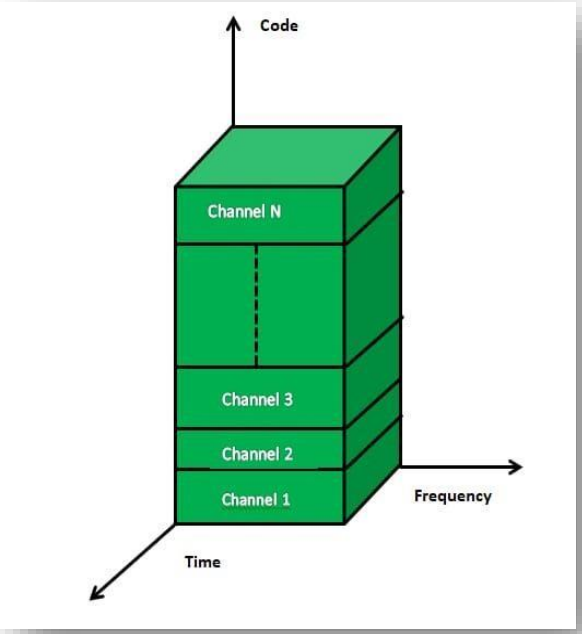
Vulnerable to Interference: Devices operating in neighboring frequency bands may cause interference, affecting the quality of communication

2.4 Code Division Multiple Access (CDMA):

2.4.1 Definition

Code division multiple access (CDMA) is a channel access method that allows multiple transmitters to simultaneously send information over a single communication channel.

2.4.2 Explanation



CDMA is used in second-generation (2G) and third-generation (3G) wireless communications.

In CDMA, each signal occupies the same frequency bandwidth and is transmitted simultaneously in time. The signals are distinguished from one another by the specific spreading codes or frequency hopping pattern.

CDMA has the following characteristics:

Improved capacity: CDMA allows more users to connect at a given time.

Full spectrum: All channels in CDMA use a full spectrum.

Power control: CDMA systems use power control to eliminate interference and noise.

CDMA has been used for a long time, including in World War II. Qualcomm's co-founders Irwin Jacobs, Klein Gilhousen, and Andrew Viterbi made major contributions to CDMA.

CDMA networks are made up of cell clusters. Each cell in a cluster has a transceiver with the necessary transmitting power. Mobile units are distributed around the cell's coverage area.

2.4.3 Example

CDMA2000 and WCDMA (Wideband Code Division Multiple Access) in 3G and 4G cellular networks

Explanation: In CDMA cellular networks, each device is assigned a unique spreading code that is used to modulate the transmitted signal. Multiple devices can transmit simultaneously over the same frequency band, but each device's signal is spread across the entire bandwidth using its unique code. At the receiver end, the intended signal is despread using the corresponding code, while signals from other devices appear as noise and can be filtered out, enabling multiple users to share the same frequency band efficiently.

2.4.4 Advantages and disadvantages

Advantages

Increased Capacity: CDMA allows for increased capacity by allowing multiple devices to transmit simultaneously over the same frequency band using unique codes.

Robust Against Interference: CDMA is robust against interference, as signals from other devices appear as noise and can be filtered out.

Disadvantages

Complexity: CDMA implementation can be complex, requiring sophisticated signal processing techniques and careful planning.

Requires Careful Planning: Effective CDMA operation requires careful planning of code assignments and power control to avoid interference and maintain quality of service.

3. Conclusion

Understanding multi-access methods is essential for designing efficient and reliable communication networks. Each method has its own characteristics, advantages, and disadvantages, making it crucial to select the appropriate method based on specific requirements and constraints.

THE END