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SUBJECT : MOBILE COMPUTING- UNIT - I

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WELCOME TO ALL

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UNIT- I SYLLABUS

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UNIT- I SYLLABUS
MAC Protocol

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Medium Access Control Protocol (or) MAC Protocol

Medium Access Control Protocol (or) MAC Protocol:

Medium access control (MAC) is a sub layer of the data link layer (DLL) in the seven-layer OSI network reference model. MAC is responsible for the transmission of data packets to and from the network-interface card, and to and from another remotely shared channel.

Protocol:

A **protocol** is a standard set of rules that allow electronic devices to communicate with each other. These rules include what type of data may be transmitted, what commands are used to send and receive data, and how data transfers are confirmed.

Medium Access Control Protocol (or) MAC Protocol

Protocol:

A protocol is a set of rules and guidelines for communicating data. Rules are defined for each step and process during communication between two or more computers. Networks have to follow these rules to successfully transmit data.

Medium Access Control Protocol (or) MAC Protocol

3.1. Properties Required of MAC Protocols:

The design of MAC protocol depends upon the specific environment in which it is to operate and the specific characterise of the application for which it is being designed. In spite of the wide variations of the characteristics of different protocols, a good MAC protocol needs to possess the following features:

- It should implement some rules that help to enforce discipline when multiple nodes contend for a shared channel.
- It should help maximize the utilization of the channel.
- Channel allocation needs to be fair. No node should be discriminated against at any time and made to wait for an unduly long time for transmission.
- It should be capable of supporting several types of traffic having different maximum and average bit rates.
- It should be robust in the Face of equipment failures and changing network conditions.

Medium Access Control Protocol (or) MAC Protocol

Many MAC layer protocols for wireless networks have already been proposed, standardized, and are in use. It is also an area of active research, and many protocols are being proposed by researchers and practitioners that work with improved efficiency or overcome some problem in specific wireless environment.

At present, IEEE 802.11 has emerged as a popular and standard MAC protocol for wireless networks, IEEE 802.11 – based network cards and routers are available in the market that can be used to inexpensively and easily set up wireless LANs (commonly referred to as Wi-fi hotspots).

Wireless network can be divided mainly into two categories:

a. Infrastructure – based wireless networks that include the WLANs, and

b. Infrastructure –less wireless networks that include the mobile ad hoc networks (MANETs).

IEEE 802.11:

They are created and maintained by the Institute of Electrical and Electronics Engineers (**IEEE**) LAN/MAN Standards Committee (**IEEE** 802). The base version of the standard was released in 1997, and has had subsequent amendments.

Medium Access Control Protocol (or) MAC Protocol

3.2. Wireless MAC Protocols: Some Issues

The MAC protocol in a wireless medium in much more complex than its wired counterpart. First, it is difficult to implement a collision detection scheme in a wireless environment, since collision are hard to be detected by the transmitting nodes.

Also , in infrastructure-less networks, the issue of hidden and exposed terminals make a MAC protocol extremely inefficient, unless special care is taken to overcome these problems.

The transmitted signal power during collision would be millions of time larger than the power received due to collision by the antenna.

Medium Access Control Protocol (or) MAC Protocol

3.2.1. The Hidden and Exposed Terminal Problems in an Infrastructure less Network

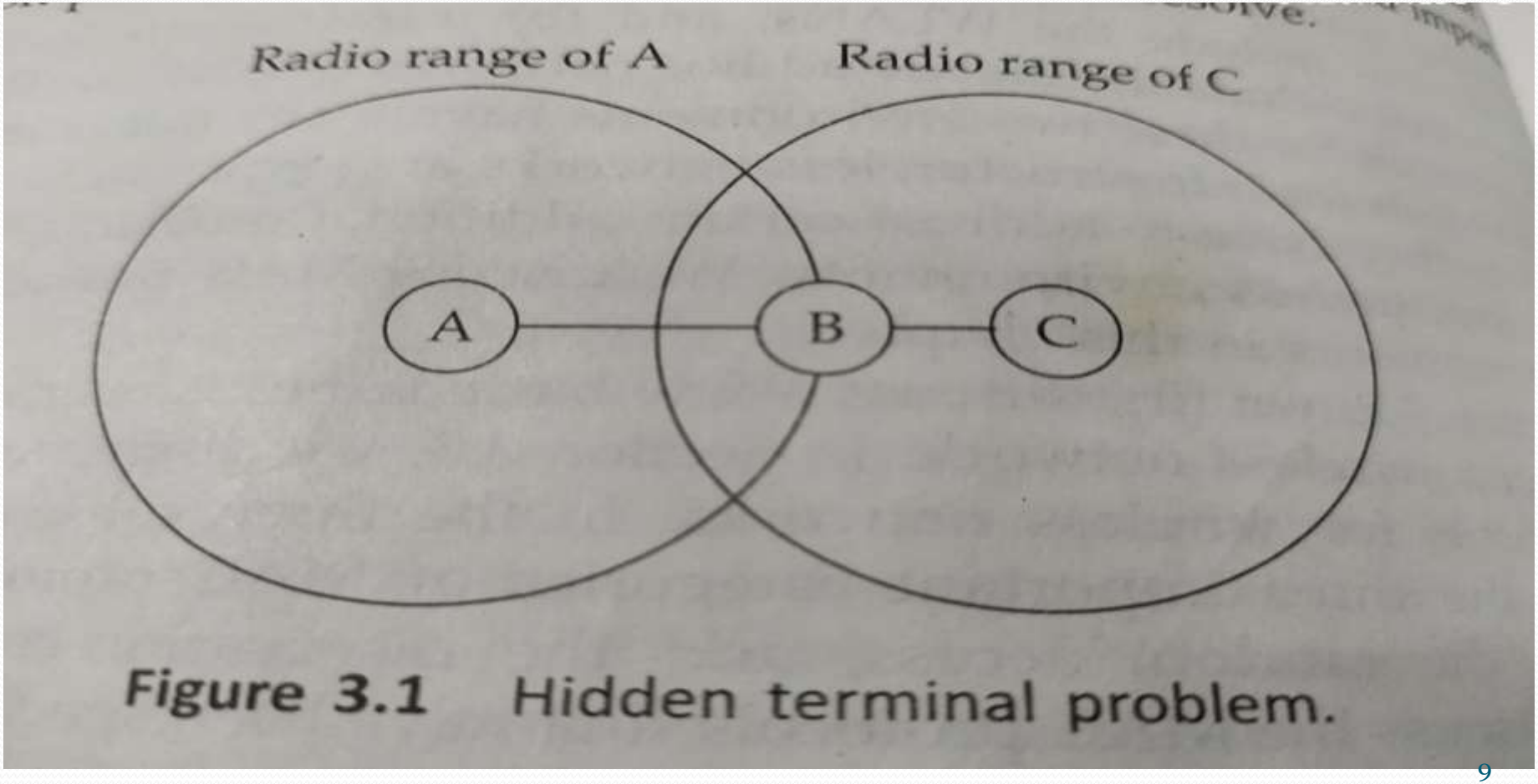


Figure 3.1 Hidden terminal problem.

3.2.1. The Hidden and Exposed Terminal Problems in an Infrastructure less Network

The hidden terminal problem arise when at least three nodes(A, B, and C), as shown in fig.3.1, communicate among each other. As shown in fig.3.1, the node A is in the radio range of the node B, and B is also within the radio range of C.

The nodes A and C are not in the radio range of each other. Therefore, if both A and C start to transmit to B at the same time, the data received at node B would get garbled. Such a situation can arise because A and C are “hidden” from each other, because they are outside each other’s transmission range.

In this situation, when one node starts to sense the medium before transmission, it cannot sense that the other node is also transmitting. This creates a very difficult and important arbitration problem that a MAC protocol needs to resolve.

3.2.1. The Hidden and Exposed Terminal Problems in an Infrastructure less Network

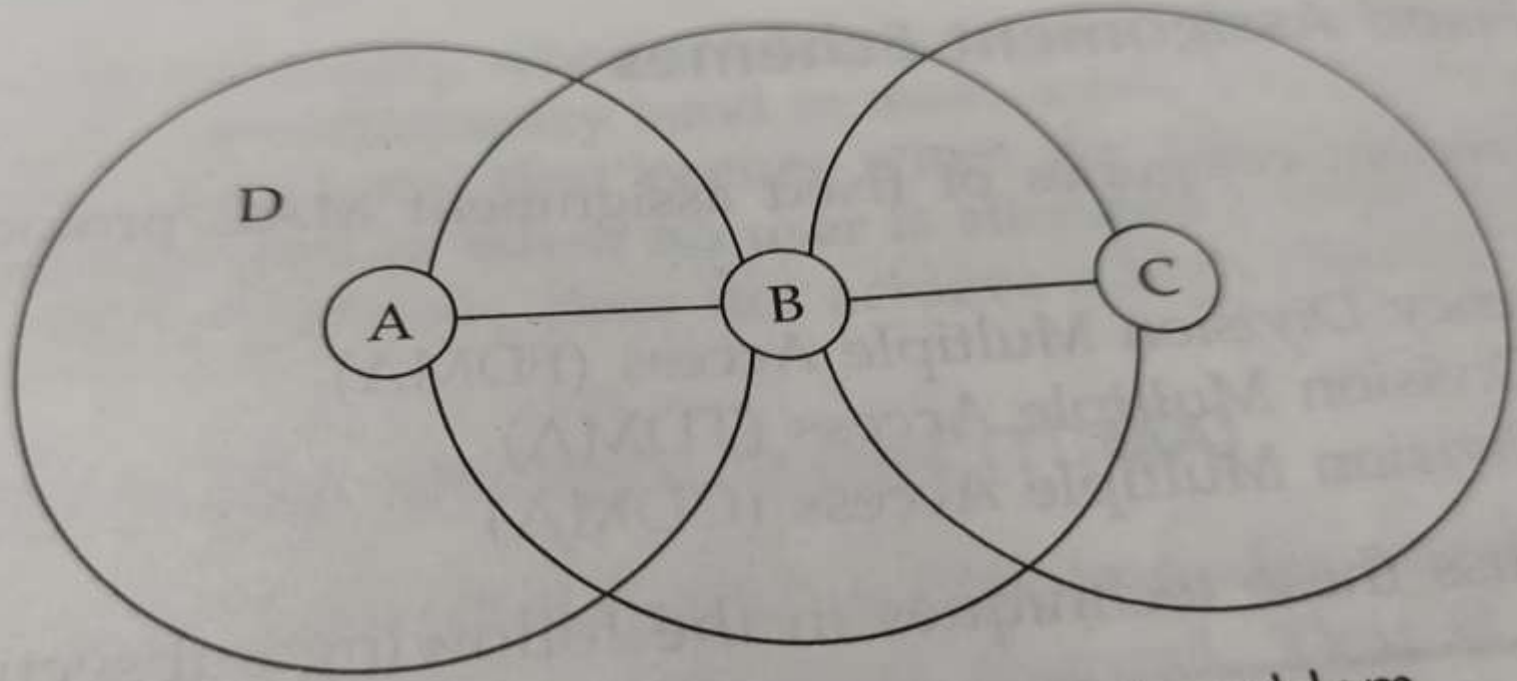


Figure 3.2 Exposed terminal problem.

3.2.1. The Hidden and Exposed Terminal Problems in an Infrastructure less Network

A related problem called exposed terminal could arise in a scenario such as that depicted in fig.3.2 . As show in fig.3.2, node D is within node A's transmission range. Node B is within the transmission range of both the nodes A and C, but the nodes A and C are not within each other's transmission range.

MAC protocol usually inhibit transmission when transmission from another terminal is detected. As result, node A will not be able to transmit to any node when B is transmitting to C. On the other hand, had A transmitted to D, it would have been received correctly by D and B's transmission would have also been correctly received at C. This causes unnecessary delay of node A's transmission to D and wastage of band with.

3.2.1. The Hidden and Exposed Terminal Problems in an Infrastructure less Network

The problem arose only because A and B are within each other's transmission range, though the destination nodes are in the transmission range of only one of the nodes. In other words, the problem occurs because A is exposed to B's transmission.

The overall effect of this problem is that it leads to inefficient spectrum usage as well as unnecessary transmission delays unless these are carefully addressed by a wireless MAC protocol.

3.3. A Taxonomy of MAC Protocols:

A large number of MAC protocols have been proposed. These MAC protocols can be broadly divided into the following three categories.

1. Fixed assignment schemes
2. Random assignment schemes
3. Demand-based schemes

We have schematically shown a categorization of the wireless MAC protocols in Fig. 3.3.

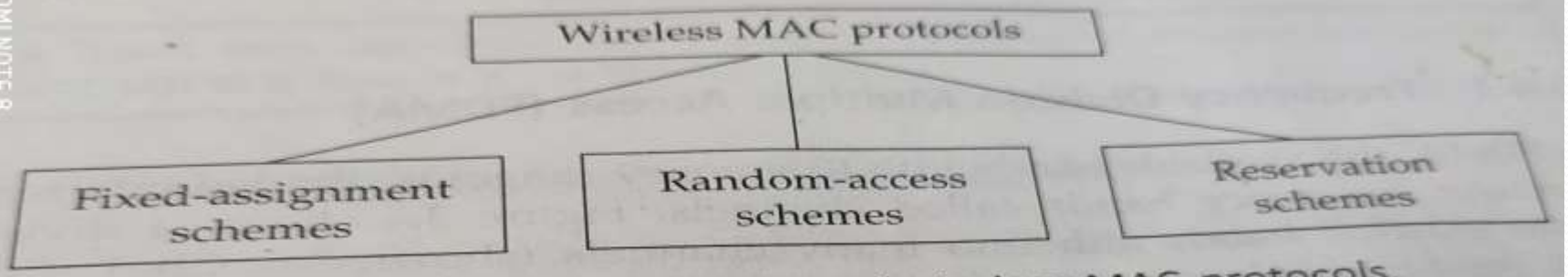


Figure 3.3 A classification of wireless MAC protocols.

3.3. A Taxonomy of MAC Protocols

3.3.1. Fixed assignment schemes:

The fixed assignment schemes are usually called circuit-switched schemes. In the fixed assignment schemes, the resources required for a call are assigned for the entire duration of the call. On the other hand, the random assignment schemes and reservation schemes are called packet-switched schemes.

The random assignment schemes are comparable to the connection-less packet-switching schemes.

3.3. A Taxonomy of MAC Protocols

i.(3.4). Fixed Assignment Schemes

ii.(3.5). Random assignment schemes

iii.(3.6). Demand-based schemes

3.4.1.Frequency Division Multiple Access (FDMA)

3.4.2.Time Division Multiple Access (TDMA)

3.4.3.Code Division Multiple Access (CDMA)

Consider a student's common room (channel) in which many student want to communicate with each other. If the students want to avoid cross-talk in the ongoing process,

then either students could take **turns in speaking** (i.e. Time Division) or

they could speak at **different pitches** (i.e. Frequency Division), or

they could speak in **different languages** (i.e. Code Division).

i.(3.4). Fixed Assignment Schemes

3.4.1.Frequency Division Multiple Access (FDMA)

3.4.2.Time Division Multiple Access (TDMA)

3.4.3.Code Division Multiple Access (CDMA)

3.4.1.Frequency Division Multiple Access (FDMA):

In FDMA, the available bandwidth(frequency range) is divided into many narrower frequency bands called channels. Figure 3.4 shows a division of the existing bandwidth into many channels (shows as Ch 1, Ch 2, etc.).

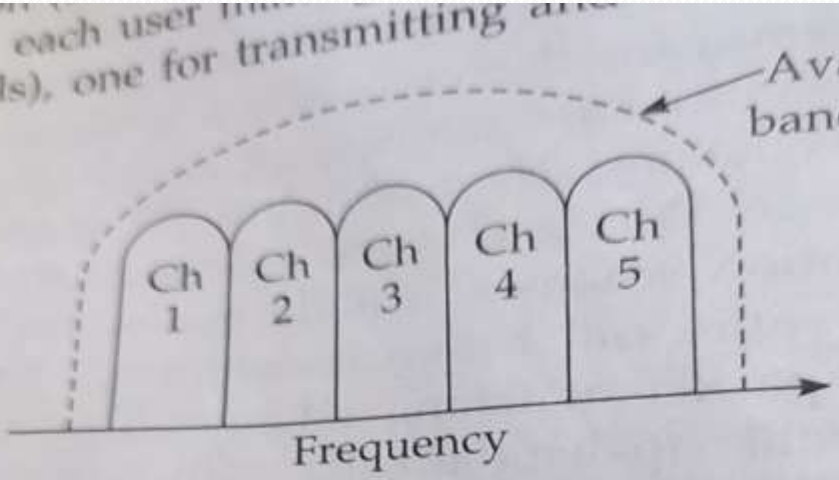


Figure 3.4 Channels in Frequency Division Multiple Access (FDMA) scheme.

i.(3.4). Fixed Assignment Schemes

3.4.1.Frequency Division Multiple Access (FDMA)

For full duplex communication to take place, each user is allocated a forward link(channel) for communicating from it (mobile handset) to the base station(BS), and a reverse channel for communicating from the BS to it.

Thus, each user making a call is allocated two unique frequency bands(channels), one for transmitting and the other for receiving signals during the call. When a call is underway, no other user would be allocated the same frequency band to make a call.

Unused transmission time in a frequency band that occurs when the allocated caller pauses between transmission, or when no user is allocated a band, goes idle and is wasted. FDMA, therefore, does not achieve a high channel utilization.

i.(3.4). Fixed Assignment Schemes (3.4.2.TDMA)

3.4.2.Time Division Multiple Access (TDMA)

TDMA is an access method in which multiple nodes are allotted different time slots access the same physical channel. That is, the timeline is divided into fixed-sized time slots and these are divided among multiple nodes who can transmit.

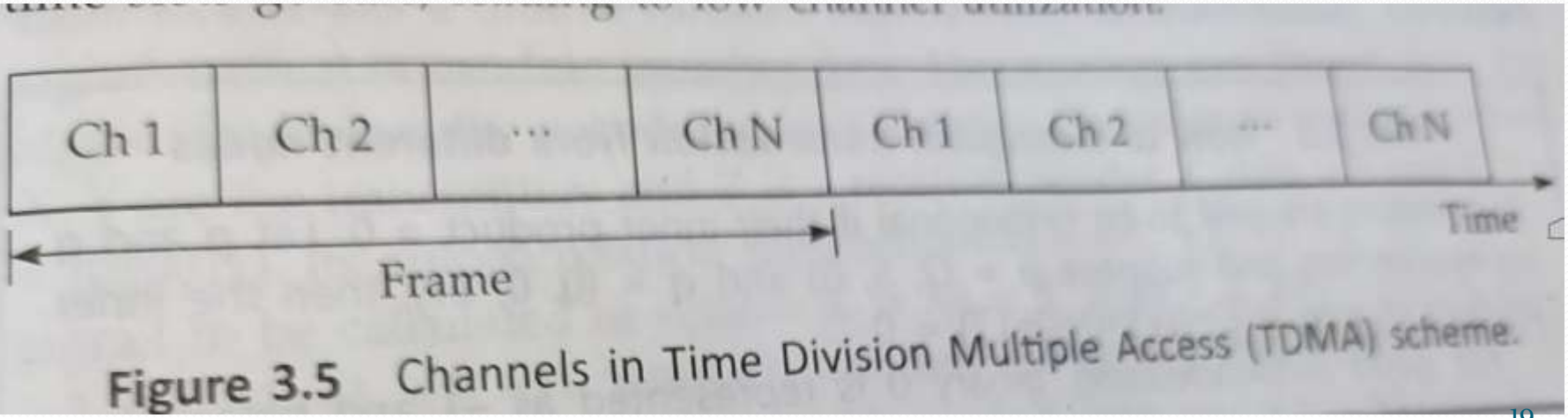


Figure 3.5 Channels in Time Division Multiple Access (TDMA) scheme.

i.(3.4). Fixed Assignment Schemes

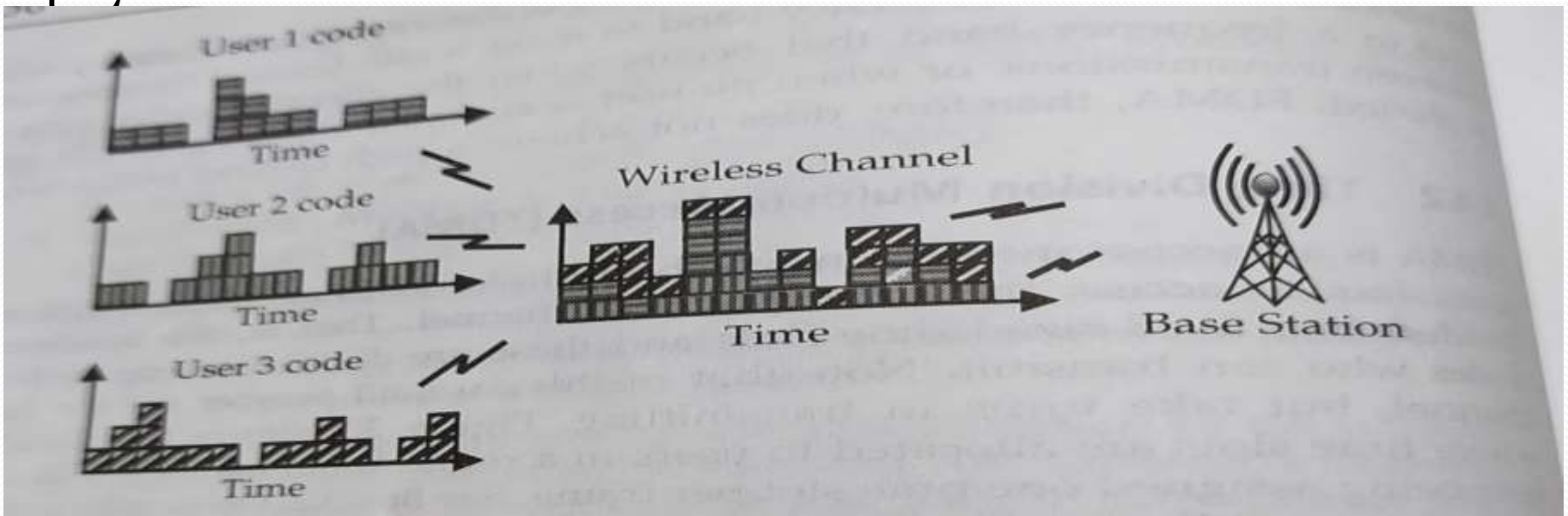
3.4.2.TDMA

Note that in this case, all sources use the same channel, but take turns in transmitting. Fig 3.5 shows the situation where time slots are allocated to users in a round robin manner, with each user being assigned one tine slot per frame. Unused time lots go idle, leading to low channel utilization.

i.(3.4). Fixed Assignment Schemes

3.4.3.Code Division Multiple Access (CDMA)

In CDMA, multiple users are allotted different codes that consist of sequences of 0 and 1 to access the same channel. As shown in Fig.3.6, a special coding scheme is used that allows signals from multiple users to be multiplexed over the same physical channel.



re 3.6 Schematic of operation of Code Division Multiple Access (CDMA) scheme.

i.(3.4). Fixed Assignment Schemes

As shown in the figure, three different users who have been assigned separate codes are multiplexed on the same physical channel.

In CDMA, multiple users use the same frequency at the same time scheduling is applied. All the senders send signals simultaneously through a common medium. The bandwidth of this medium is much lager than the space that would be allocated to each packet transmission during FDMA and the signals can be distinguished from each other by means of a special coding scheme that is used.

3.5.Random Assignment Schemes

3.5.Random Assignment Schemes:

There are number of random assignment schemes that are used in MAC protocols. A few important ones are the following:

- ALOHA
- Slotted ALOHA
- CSMA – Carrier Sense Multiple Access
- CSMA/CD – CSMA Collision Detection
- CSMA/CA – CSMA Collision Avoidance

3.5.Random Assignment Schemes

3.5.1 ALOHA Scheme

It is a simple communication scheme that was developed at the university of Hawaii. The basic (is also called pure) ALOHA scheme, is a simple protocol. If a node has data to send, it begins to transmit.

The first step implies that pure ALOHA does not check whether the channel is busy before transmitting. If the frame successfully reaches the destination(receiver), the next frame is sent again. If the frame fails to be received at the destination, it is sent again.

The simple ALOHA scheme works acceptably, when the chances of contention are small(i.e., when a small number of senders send data infrequently). The collisions can become unacceptably high if the number of contenders for transmission is high.

3.5.Random Assignment Schemes

3.5.1 ALOHA Scheme

An improvement over the pure ALOHA scheme is the slotted ALOHA. In the slotted ALOHA scheme, the chances of collisions are attempted to be reduced by enforcing the following restrictions.

a) The time is divided into equal-sized slots in which a packet can be sent.

b) The size of the packet is restricted.

c) A node wanting to send a packet, can start to do so only at the beginning of slot.

3.5.Random Assignment Schemes

3.5.2. The CSMA Scheme

A popular MAC arbitration technique is the Carrier Sense Multiple Access(CSMA). In this technique, a node senses the medium before starting to transmit. If it senses that some transmission is already underway, it defers its transmission. Two popular extension of basic CSMA technique are the collision detection(CSMA/CD) and the collision avoidance(CSMA/CA) techniques.

3. Demand-based schemes or Reservation-based Schemes

A basic form of the reservation scheme is the RTS/CTS scheme. In an RTS/CTS, a sender transmits an RTS(Ready to Send) packet to the receiver before the actual data transmission.

On receiving this, the receiver sends a CTS(Clear to Send) packet, and the actual data transfer commences only after that. When the other nodes sharing the medium sense the CTS packet, they refrain from transmitting until the transmission from the sending node is complete.

In a contention-based MAC protocol, a node wanting to send a message first reverse the medium by using an appropriate control message. For example, reservation of the medium can be achieved by transmitting a “Ready To Send”(RTS) message and the corresponding destination node accepting this request answers with a “Clear To Send”(CTS) message .

Demand-based schemes or Reservation-based Schemes

Every node that hears the RTS and CTS message defers its transmission during the specified time period in order to avoid a collision. A few examples of RTS-CTS based MAC protocols are MACA, MACAW, MACA-BI, PAMAS, DBTMA, MARCH, S-MAC protocols which have specifically been designed foe sensor networks.

Multiple Access with Collision Avoidance (**MACA**)

Multiple Access with Collision Avoidance for Wireless (**MACAW**)

MACA By Invitation (**MACA-BI**)

Power Aware Multi-Access protocol with Signaling (**PAMAS**)

Dual Busy Tone Multiple Access (**DBTMA**)

Multiple Access with Reduced Handshake (MARCH)

Sensor Media Access Control(**S-MAC**).

UNIT-I MAC PROTOCOL COMPLETED

Reference: Fundamentals of Mobile Computing, Second Edition.
by- Prasant Kumar Pattnaik and Rajib Mall.
ISBN : 978-81-203-5181-3

THANKS TO ALL