

CS8601 - MOBILE COMPUTING**UNIT I INTRODUCTION 9**

Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA

UNIT II MOBILE TELECOMMUNICATION SYSTEM 9

Introduction to Cellular Systems - GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security – GPRS- UMTS – Architecture – Handover – Security

UNIT III MOBILE NETWORK LAYER 9

Mobile IP – DHCP – AdHoc- Proactive protocol-DSDV, Reactive Routing Protocols – DSR, AODV , Hybrid routing –ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET) –MANET Vs VANET – Security.

UNIT IV MOBILE TRANSPORT AND APPLICATION LAYER 9

Mobile TCP- WAP – Architecture – WDP – WTLS – WTP –WSP – WAE – WTA Architecture – WML

UNIT V MOBILE PLATFORMS AND APPLICATIONS 9

Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues

TOTAL 45 PERIODS**TEXT BOOKS:**

1. Jochen Schiller, –Mobile Communications||, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, –Fundamentals of Mobile Computing||, PHI Learning Pvt.Ltd, New Delhi – 2012

REFERENCES

1. Dharma Prakash Agarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems",Thomson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, –Principles of Mobile Computing||, Springer, 2003.
3. William.C.Y.Lee,–Mobile Cellular Telecommunications-Analog and Digital Systems||, Second Edition,TataMcGraw Hill Edition ,2006.
4. C.K.Toh, –AdHoc Mobile Wireless Networks||, First Edition, Pearson Education, 2002.
5. Android Developers : <http://developer.android.com/index.html>
6. Apple Developer : <https://developer.apple.com/>
7. Windows Phone DevCenter : <http://developer.windowsphone.com>
8. BlackBerry Developer : <http://developer.blackberry.com>

UNIT I - INTRODUCTION

Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA

2 Marks

1) What are the challenges in mobile communication? [Nov 2018]

- **Portability**
Portable computers face physical challenges (volume, weight, power consumption, cost), pragmatic challenges (increased chance of data loss, small user-interface issues), and systems issues.
- **Wireless communications**
- **Mobility**

2) State the objectives of MAC protocols. [Nov 2018]

- Collision avoidance
- Energy efficiency
- Scalability
- Latency
- Throughput
- Bandwidth utilization

3) List the issues of wireless MAC? [Apr 2018]

- The three important issues are:
 - Half Duplex operation → either send or receive but not both at a given time
 - Time varying channel
 - Burst channel errors

4) “MAC protocol designed for infrastructure based wireless network may not work satisfactory in infrastructure-less environment.” – Justify.

[Nov 2017]

Because,

- Hidden and Exposed terminal problems makes MAC protocols inefficient.
- It is for a transmitting node to detect collisions.

**5) Distinguish between mobile computing and wireless networking?
List out the difference between Mobile Computing and Wireless Networking. [Nov 2017][May 2017] [Apr 2018]**

| Mobile Computing | Wireless Networking |
|------------------|---------------------|
| | |

- | | |
|--|--|
| <ul style="list-style-type: none"> • Accessing information and remote computational services while on the move. • That mobile computing is based on wireless networking and helps one to invoke computing services on remote servers while on the move. | <ul style="list-style-type: none"> • Provides the basic communication infrastructure necessary to make this possible. • wireless networking is an important ingredient of mobile computing. |
|--|--|

6) List some random assignment schemes.**[May 2017]**

- ALOHA
- Slotted ALOHA
- CSMA
- CSMA/CD
- CSMA/CA

7) What are the limitations of Mobile Computing?**[Nov 2016]**

- Insufficient bandwidth
- Security standards
- Power consumption
- Transmission interferences
- Potential health hazards
- Human interface with device

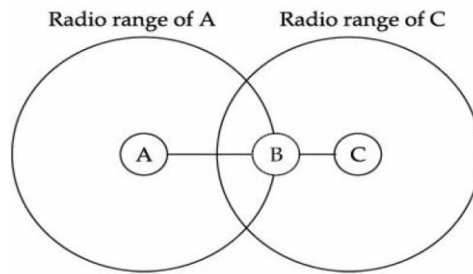
8) What are the different Random Assignment Scheme in MAC? [Nov 2016]

- ALOHA
- Slotted ALOHA
- CSMA
- CSMA/CD
- CSMA/CA

9) List the advantages of Mobile Computing.**[May 2016]**

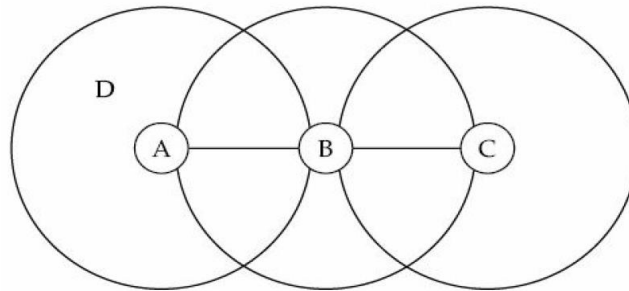
- Location Flexibility
- Saves Time
- Enhanced Productivity
- Ease of Research
- Entertainment
- Streamlining of Business Processes

10) Explain hidden and exposed terminal problems in infrastructure less network.**[May 2016]****Hidden Terminal** problem



- Note that 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.

Exposed Terminal problem



- 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.
- 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.

11) What is Mobile Computing?

- Mobile computing (**sometimes called ubiquitous computing and also at times called nomadic computing**) is the ability to compute remotely while on the move.
- This is a new and fast emerging discipline that has made it possible for people to access information from anywhere and at anytime.

Mobile computing as encompassing two separate and distinct concepts:

- Mobility and Computing.

12) Define computing?

Computing denotes the capability to automatically carry out certain processing related to service invocations on a remote computer.

13) Formulate a reason why Collision Detection is based protocol not suitable for wireless networks?

- Because, in a wireless network, it is very difficult for a transmitting node to detect a collision, since any received signal from other nodes would be too weak compared to its original signal and can easily be masked by noise.
- As a result the transmitting node would continue to transmit the frame which leads to corrupted frame. In wired network, when a node detects a

collision, it immediately stops transmitting, thereby minimizing channel wastage.

14) Define Mobility?

Mobility, on the other hand, provides the capability to change location while communicating to invoke computing services at some remote computers.

15) What is main advantage of mobile computing?

- The tremendous **flexibility** it provides to the users.
- The user need not be tethered to the chair in front of his desktop, but can move locally or even to faraway places and at the same time achieve what used to be performed while sitting in front of a desktop.

16) Compare Wired Networks and Mobile Networks.

| S.No | Wired Networks | Mobile Networks |
|------|---|--|
| 1 | Users cannot get any information at any place (does not support mobility) | Users can get information at any place (Supports Mobility) |
| 2 | Bandwidth is high | Bandwidth is low |
| 3 | Low bandwidth variability | High bandwidth variability |
| 4 | Listen on wire | Hidden Terminal problem |
| 5 | Productivity is low | Productivity is high |
| 6 | High Power Machines | Low Power machines |
| 7 | High Resource machines | Low Resource machines |
| 8 | Need physical access | Need proximity |
| 9 | Low delay | Higher delay |
| 10 | Connected Operations | Disconnected Operations |

17) What are the applications of mobile computing?

- Credit Card Verification
- Stock Information Collection/Control
- In companies
- In courts
- For Estate Agents
- Vehicles
- Stock Broker
- Emergency services
- Taxi/Truck Dispatch
- Electronic Mail/Paging

18) Point out the problems faced by devices in Wireless Transmission?

- Lower Bandwidth
- Bandwidth Fluctuations
- Host mobility
- Intermittent disconnections
- High bit error rate
- Poor link reliability
- Higher delay
- Power consumption

19) List out various forms of Wireless networks?

- WLANs (Wireless LANs),
- Mobile Cellular Networks,
- Personal Area Networks (Pans),
- And Ad Hoc Networks, etc.

20) What are the two basic types of wireless network?

Wireless networks can be classified into two basic types.

1. One is an extension of **wired networks**. It uses fixed infrastructures such as
2. The other type of **wireless network is an ad hoc network**

21) List out types of computer network?

1. Controller Area Networks (CANs)
2. Local Area Networks (LANs)
3. Internetworks.

22) Define CAN?

- A Controller Area Network (CAN) is essentially a very small network that is typically used to connect the different components of an embedded controller.
- The end-to-end length of a CAN is usually less than 50 meters. Since the propagation time of a CAN is very small, it behaves more like a local bus in a computer.

23) Define LANs?

- A Local Area Network (LAN) is typically deployed in a building or a campus and is usually privately owned.

For example,

- LAN can be used to connect a number of computers within an organization to share data and other resources such as files, printers, FAX services, etc.
- LANs typically operate at data rates exceeding 10 Mbps and many present-day LANs (gigabit Ethernets) operate at 1 Gbps.

24) Define Internetwork?

Several LANs can be interconnected using switches to realize internetworks or internet in short. In an internet, a node in a LAN communicates with a node in another LAN using packet switching.

25) List out Component of wireless System?

A wireless communication system is built from various types of basic components. The following are some of these basic types of components.

- *Transmitter*
- *Receiver*
- *Antenna*
- *Filters*
- *Amplifiers*
- *Mixers*

26) Write short notes about WLANs?**Wireless Local Area**

- Networks (WLANs) provide connectivity between computers over short distances using the wireless medium.

- Typical indoor applications of WLANs may be in educational institutes, office buildings and factories where the required coverage distances are usually restricted to less than a few hundred feet.

27) Brief about Access point?

- It is a radio receiver/transmitter (also called transceiver) that connects to the wired network. These are typically mounted on the roofs at different locations of a building.
- The transceiver exchanges signals with the wireless LAN card in desktop or notebook PCs.
- A single access point can support a small group of users. It is connected to a wired network through cables and provides the connectivity between wireless devices and the wired network.

28) Write short notes about Wireless LAN cards?

Wireless LAN cards: End-users access the WLAN through WLAN adapters (wireless network interface cards) in their hand-helds. The LAN card used to be mounted on the motherboard of a computer. Now, it is inbuilt into the motherboards.

29) Define Bridge?

Bridge: It is used for connecting two LANs that may be in two different buildings or on two separate floors within the same building.

30) Write Advantages of Wireless LANs over Wired LANs?**Advantages of Wireless LANs over Wired LANs**

1. Mobility- users get information at any place
2. Simplicity and speedy deployment
3. Flexibility: Wireless technology allows the network to be accessible where wiring is difficult to lay
4. Cost effectiveness

31) Write Bluetooth technology?

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs)

32) Define PANs?

- A personal area network (PAN) is a computer network used for data transmission among devices such as computers, telephones and personal digital assistants.
- PANs can be used for communication among the personal devices themselves (intrapersonal communication)

33) What is piconet?

- A **piconet** is a computer network which links a wireless user group of devices using Bluetooth technology protocols.

- A piconet consists of two or more devices occupying the same physical channel (synchronized to a common clock and hopping sequence).
- It allows one *master* device to interconnect with up to seven active *slave* devices.

34) Describe Mobile ad hoc network?

- An ad hoc network is also known as a **Mobile Ad hoc Network(MANET)**. It is a collection of mobile nodes that form a network on the fly without requiring the support of any fixed infrastructure.
- Wireless sensor networks are a special type of wireless ad hoc networks.

35) List out the Characteristics of Mobile computing?

- Ubiquity
- Location awareness
- Adaptation
- Broadcast

36) List out the three tiers of a mobile computing application?

- Presentation (Tier-1)
- Application (Tier-2)
- Data (Tier-3)

37) Specify the functionalities of Application Tier.

- Moves and Process data between the presentation and data layers.
- Responsible for making logical decisions and performing calculations.

38) What is the use of Data Tier?

- Contains a database where the information is stored and retrieved.
- Responsible for providing the basic facilities of data storage, access and manipulation.

39) Write about MAC protocol?

- MAC protocol is to enforce discipline in the access of a shared channel when multiple nodes contend to access that channel.
- At the same time, two other objectives of any MAC protocol are maximization of the utilization of the channel and minimization of average latency of transmission.

40) Write some of issues of MAC protocol?

- Hidden Terminal Problems
- Exposed Terminal Problems

41) List out classification of MAC protocol?

- Fixed assignment schemes-
- Random assignment schemes
- Reservation-based schemes

42) Define fixed assignment schemes?

In fixed assignment schemes, the resources required for a call are assigned for the entire duration of the call.

43) Define random assignment schemes?

In random assignment schemes are comparable to the connection-less packet-switching schemes. In this, no resource reservations are made, the nodes simply start to transmit as soon as they have a packet to send.

44) Summarize the steps involved in RTS / CTS scheme.

- Sender transmits an RTS packet to the receiver before the actual data. Receiver will send acknowledgement to the sender.
- Actual data transfer commences between the sender and receiver.
- Receiver sends a CTS packet to the sender.
- Transmission.

45) What are the Objectives of MAC Protocol?

- Maximization of the channel utilization
- Minimization of average latency of transmission

46) Define reservation assignment schemes?

In the reservation schemes, a node makes explicit reservation of the channel for an entire call before transmitting. This is analogous to a connection-based packet-switching scheme.

PART B**1) What is Mobile Computing?(4 marks)****Key Points**

- Definition
- Mobility
- Computing
- Advantage - flexibility

Definition

Mobile computing (**sometimes called ubiquitous computing and also at times called nomadic computing**) is the ability to compute remotely while on the move. This is a new and fast emerging discipline that has made it possible for people to access information from anywhere and at anytime.

Mobile computing as encompassing two separate and distinct concepts:

- Mobility and Computing.

Computing denotes the capability to automatically carry out certain processing related to service invocations on a remote computer.

Mobility provides the capability to change location while communicating to invoke computing services at some remote computers.

The main advantage of this type of mobile computing is :

- The tremendous flexibility it provides to the users.
- The user need not be tethered to the chair in front of his desktop, but can move locally or even to far away places and at the same time achieve what used to be performed while sitting in front of a desktop.

2) Compare Mobile Computing vs. Wireless Networking.**Distinguish Between Mobile Computing And Wireless Networking.**

- While **mobile computing** essentially denotes accessing information and remote computational services while on the move
- **Wireless networking** provides the basic communication infrastructure necessary to make this possible.
- That **mobile computing is based on wireless networking** and helps one to invoke computing services on remote servers while on the move: be it be office, home, conference, hotel, and so on.
- It should be clear **that wireless networking is an important ingredient of mobile computing**, but forms only one of the necessary ingredients of mobile computing.
- Mobile computing also requires the applications themselves— their design and development, and the hardware at the client and server sides.
- Wireless networking is increasingly replacing traditional networks because of the low setup time and low initial investment required to set up the wireless network.

WIRELESS NETWORKS

Wireless networks appear in various forms such as

- WLANs (Wireless LANs),
- Mobile Cellular Networks,

- Personal Area Networks (Pans),
- And Ad Hoc Networks, etc.

Wireless networks can be **classified into two basic types**.

1. One is an extension of **wired networks**. It uses **fixed infrastructures** such as Base stations to provide essentially single hop wireless communication with a wired network as illustrated in Fig. 2.1 A two-hop **wireless cellular communication** with another mobile.
2. The other type of wireless network is an ad hoc network. An ad hoc network does not use any fixed infrastructure and is based on multi-hop wireless communication as shown in Fig. 2.2.

One popular example of a fixed infrastructure wireless network is a Wireless LAN (WLAN) that implements the IEEE 802.11 protocol.

Access Point:

- Observe from Fig. 2.1 that only the last hop is through the wireless medium.
- An access point (AP) provides the last hop connectivity of the mobile nodes to a wired network.
- All communication goes through APs which perform bridging* between the wireless and the wired mediums. A station must be recognized by an AP to be able to connect to the network.
- The AP may require authentication and this in turn is used as the basic means to keep out the unauthorized users.
- In an infrastructureless network, the communication between hosts occurs directly or via a few intermediate nodes that form the hops.

For example, station A in **Fig. 2.2** can communicate with station C using either the hops A–B, B– C or A–D, D–C. * A network bridge connects multiple network segments at the data link layer (Layer 2) of the OSI reference model.

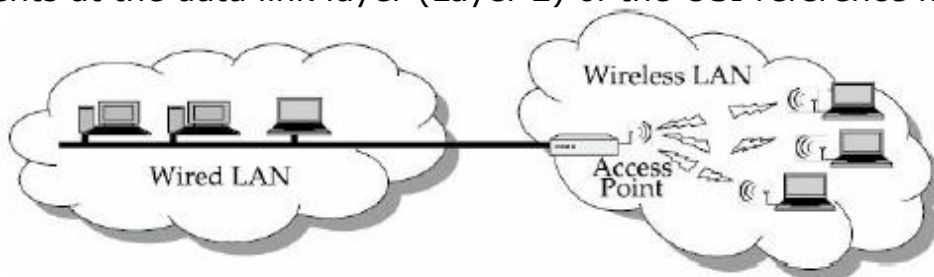


Figure 2.1 Wireless network based on fixed infrastructures.

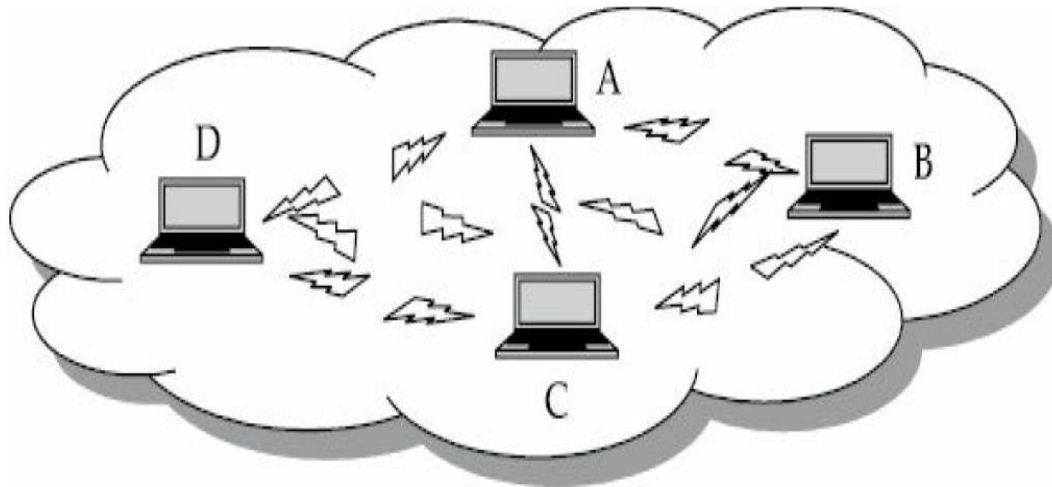


Figure 2.2 *Wireless network having no fixed infrastructures.*

Recent Development

A recent development wireless networking of various types of devices using the

Bluetooth technology,

- The Bluetooth technology can also be used to establish direct wireless connection of cell phones with devices such as printers, cameras, scanners, laptop and desk computers.
- Bluetooth is gradually replacing cables and infrared as the dominant way of exchanging information between devices.
- One of the objectives of the Bluetooth technology is to enable users to easily connect to a wide range of personal computing and telecommunication devices, without the need to buy, carry, or lay out cables.
- In fact, the Bluetooth technology enables setting up of personal area networks (PANs) known as **piconets** and ad hoc networks known as **scatternets**. It provides opportunities for rapid deployment of ad hoc connections, and the possibility of automatic, transparent connections between devices. It promises to eliminate the need to purchase additional or proprietary cabling and configuration exercises needed to connect the individual devices.

Ad Hoc Network

- An ad hoc network is also known as a **Mobile Ad hoc Network(MANET)**. It is a collection of mobile nodes that form a network on the fly without requiring the support of any fixed infrastructure.
- Wireless sensor networks are a special type of wireless ad hoc networks.

3) Explain in detail of Mobile Computing Applications?(4 marks)

Explain the various applications of Mobile Computing. (8) [May 2017]

Describe the applications of Mobile Computing. (8) [Nov 2016]

Key Points

- For Estate Agents
- Emergency Services
- In courts
- In companies
- Stock Information Collation/Control
- Credit Card Verification
- Taxi/Truck Dispatch
- Electronic Mail/Paging

Mobile Computing Applications

Mobile computing technology makes **it possible for people to send or extract information while on the move.**

For example,

A stock broker travelling in a car may wish to issue stock transaction orders from a mobile phone or to receive share price quotations.

Positive Points

Its ease of deployment and scalability is two important positive points in favor of data transmissions over the wireless medium.

Difficult

But when data is being transmitted on air, all the wireless devices present in the transmission range can receive the data. This, therefore, opens up very difficult security issues that must be overcome to ensure privacy of data.

For Estate Agents

- Estate agents can work either at home or out in the field. With mobile computers they can be more productive. They can obtain current real estate information by accessing multiple listing services, which they can do from home, office or car when out with clients.
- They can provide clients with immediate feedback regarding specific homes or neighborhoods, and with faster loan approvals, since applications can be submitted on the spot. Therefore, mobile computers allow them to devote more time to clients.

Emergency Services

- Ability to receive information on the move is vital where the emergency services are involved.
- Information regarding the address, type and other details of an incident can be dispatched quickly, via a CDPD system using mobile computers, to one or several appropriate mobile units which are in the vicinity of the incident.
- Here the reliability and security implemented in the CDPD system would be of great advantage.

In courts

- Defense counsels can take mobile computers in court. When the opposing counsel references a case which they are not familiar, they can use the computer to get direct, real-time access to on-line legal database services, where they can gather information on the case and related precedents.
- Therefore mobile computers allow immediate access to a wealth of information, making people better informed and prepared.

In companies

- Managers can use mobile computers in, say, critical presentations to major customers. They can access the latest market share information.
- At a small recess, they can revise the presentation to take advantage of this information. They can communicate with the office about possible new offers and call meetings for discussing responds to the new proposals.
- Therefore, mobile computers can leverage competitive advantages.

Stock Information Collation/Control

- In environments where access to stock is very limited ie: factory warehouses. The use of small portable electronic databases accessed via a mobile computer would be ideal.
- Data collated could be directly written to a central database, via a CDPD network, which holds all stock information hence the need for transfer of data to the central computer at a later date is not necessary.
- This ensures that from the time that a stock count is completed, there is no inconsistency between the data input on the portable computers and the central database.

Credit Card Verification

- At Point of Sale (POS) terminals in shops and supermarkets, when customers use credit cards for transactions, the intercommunication required between the bank central computer and the POS terminal, in order to effect verification of the card usage, can take place quickly and securely over cellular channels using a mobile computer unit.
- This can speed up the transaction process and relieve congestion at the POS terminals.

Taxi/Truck Dispatch

- Using the idea of a centrally controlled dispatcher with several mobile units (taxis), mobile computing allows the taxis to be given full details of the dispatched job as well as allowing the taxis to communicate information about their whereabouts back to the central dispatch office.
- This system is also extremely useful in secure deliveries i.e. Securicor. This allows a central computer to be able to track and receive status information from all of its mobile secure delivery vans. Again, the security and reliability properties of the CDPD system shine through.

Electronic Mail/Paging

- Usage of a mobile unit to send and read emails is a very useful asset for any business individual, as it allows him/her to keep in touch with any colleagues as well as any urgent developments that may affect their work.
- Access to the Internet, using mobile computing technology, allows the individual to have vast arrays of knowledge at his/her fingertips.
- Paging is also achievable here, giving even more intercommunication capability between individuals, using a single mobile computer device.

4) Detail about Characteristics of Mobile Computing?

List the characteristics of mobile systems? (6)
Explain the characteristics of Mobile Computing. (8)
Characteristics of Mobile Computing

[Apr 2018]
[May 2016]

Key Points

- Ubiquity
- Location awareness
- Adaptation
- Broadcast
- Personalization

A **computing environment** is said to be **"mobile"**, when either the sender or the receiver of information can be on the move while transmitting or receiving information.

Characteristics

Ubiquity:

- The dictionary **meaning of ubiquity is present everywhere**. In the context of mobile computing, ubiquity means the ability of a user to perform computations from anywhere and at anytime.
- **For example**, a business executive can receive business notifications and issue business transactions as long he is in the wireless coverage area.

Location awareness:

- A hand-held device equipped with global positioning system (GPS) can transparently provide information about the current location of a user to a tracking station.
- Many applications, ranging from strategic to personalized services, require or get value additions by location-based services
- **For example**, a person travelling by road in a car, may need to find out a car maintenance service that may be available nearby. He can easily locate such a service through mobile computing where an application may show the nearby maintenance shop.

A few other example applications include traffic control, fleet management and emergency services.

1. In a traffic control application, the density of traffic along various roads can be dynamically monitored, and traffic can be directed appropriately to reduce congestions.
2. In a fleet management application, the manager of a transport company can have up-to-date information regarding the position of its fleet of vehicles, thus enabling him to plan accurately and provide accurate information to customers regarding the state of their consignments.
3. Location awareness can also make emergency services more effective by automatically directing the emergency service vehicles to the site of the call.

Adaptation:

- Adaptation in the context of mobile computing implies the ability of a system to adjust to bandwidth fluctuation without inconveniencing the user.

- In a mobile computing environment, adaptation is crucial because of intermittent disconnections and bandwidth fluctuations that can arise due to a number of factors such as handoff, obstacles, environmental noise, etc.

Broadcast:

- Due to the broadcast nature of the underlying communication network of a mobile computing environment, efficient delivery of data can be made simultaneously to hundreds of mobile users.
- **For example**, all users at a specific location, such as those near a railway station, may be sent advertising information by a taxi service operator.

Personalization:

- Services in a mobile environment can be easily personalized according to a user's profile. This is required to let the users easily avail information with their hand-held devices.
- **For example**, a mobile user may need only a certain type of information from specific sources. This can be easily done through personalization.

5) Explain in detail of Structure of Mobile Computing Application?

Discuss in detail the structure of mobile computing? (6) [Apr 2018]

Explain the structure of Mobile Computing Application. (8) [May 2016]

Describe architecture of Mobile Computing. (8) [Nov 2017]

Key Points

1. Presentation (Tier-1) - user interface
2. Application (Tier-2) - making logical decisions and performing calculations
3. Data (Tier-3) - data storage, access, and manipulation

Structure of Mobile Computing Application

A mobile computing application is usually structured in terms of the functionalities implemented.

- The simple three-tier structure of a mobile computing application is depicted in Fig. 2.3.
- Figure 2.4 shows a specific scenario of the types of functionalities provided by each tier.
- The three tiers are named presentation tier, application tier and data tier.

1. Presentation (Tier-1)
2. Application (Tier-2)
3. Data (Tier-3)

Figure 2.3 The three tier structure of a mobile computing application.

Presentation tier

- The topmost level of a mobile computing application concerns the user interface. A good user interface facilitates the users to issue requests and to present the results to them meaningfully.
- Obviously, the programs at this layer run on the client's computer. This layer usually includes web browsers and customized client programs for dissemination of information and for collection of data from the user.

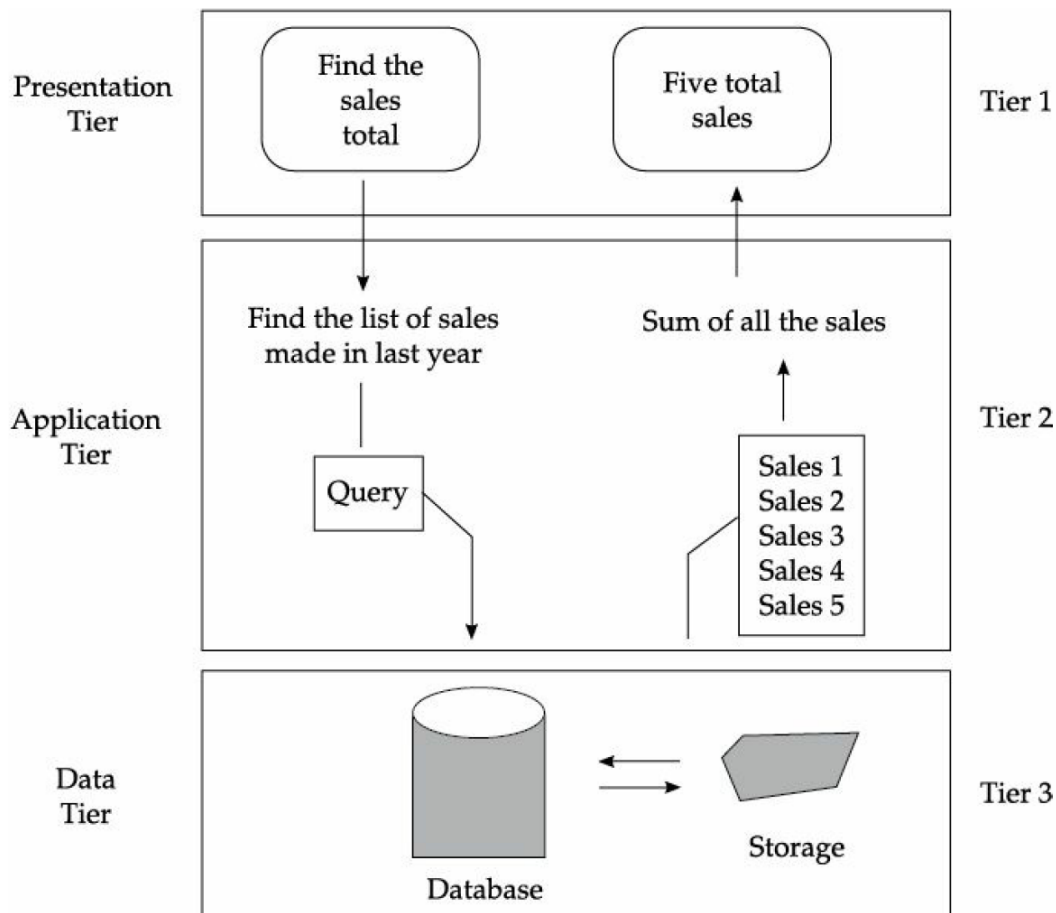


Figure 2.4 Functionalities provided by each tier structure of a mobile computing application.

Application tier

- This layer has the vital responsibility of making logical decisions and performing calculations. It also moves and processes data between the presentation and data layers.
- We can consider the middle tier to be like an “engine” of an automobile. It performs the processing of user input, obtaining information and then making decisions.
- This layer is implemented using technology like Java, .NET services, cold fusion, etc.
- The implementation of this layer and the functionality provided by this layer should be database independent.
- This layer of functionalities is usually implemented on a fixed server.

Data tier

- The data tier is responsible for providing the basic facilities of data storage, access, and manipulation. Often this layer contains a database. The information is stored and retrieved from this database.
- But, when only small amounts of data need to be stored, a file system can be used.
- This layer is also implemented on a fixed server.

6) Explain in detail about the generations of Mobile Communications Technologies and explain the distinguishing features of various generations of wireless networks. (8) [Nov 2016]

First Generation (1G)

- 1G, which stands for "first generation," refers to the first generation of wireless telecommunication technology, more popularly known as cellphones. A set of wireless standards developed in the 1980's, 1G technology replaced 0G technology, which featured mobile radio telephones and such technologies as
 - Mobile Telephone System (MTS),
 - Advanced Mobile Telephone System (AMTS),
 - Improved Mobile Telephone Service (IMTS),
 - Push to Talk (PTT).

Second Generation (2G)

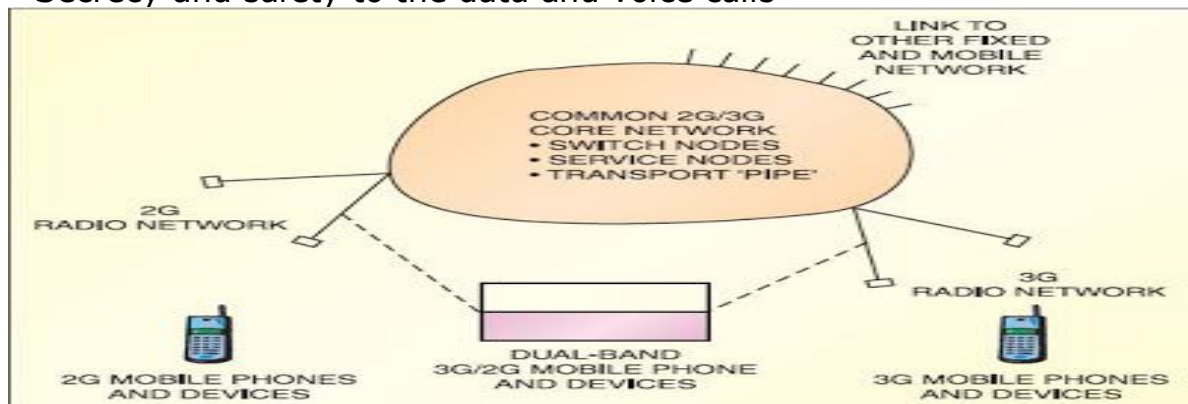
Second generation (2g) telephone technology is based on GSM or in other words global system for mobile communication. Second generation was launched in Finland in the year 1991.

How 2G works, Uses of 2G technology

- **2G network** allows for much greater penetration intensity.
- **2G technologies** enabled the various mobile phone networks to provide the services such as text messages, picture messages and MMS (multi media messages).
- **2G technology** is more efficient.
- **2G technology** holds sufficient security for both the sender and the receiver. All text messages are digitally encrypted. This digital encryption allows for the transfer of data in such a way that only the intended receiver can receive and read it

Benefits

- Voice clarity and Reduces noise
- Environment friendly
- Short Message Service
- Secrecy and safety to the data and voice calls



- The mobile technology using general packet radio service (GPRS) standard has been termed as 2.5G. 2.5G systems enhance the data capacity of GSM and mitigate some of its limitations.
- GPRS adds packet-switched capabilities to existing GSM and TDMA networks. Working on the basis of emails, it sends text and graphics-rich data as packets at very fast speed.
- The circuit-switched technology has a long and successful history but it is inefficient for short data transactions and always-on service.

3G technology

- It make use of TDMA and CDMA. 3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing.
- It is expected that 2mbit/sec for stationary users, while 348kbits when moving or traveling.
- There are many **3G** technologies as W-CDMA, GSM EDGE, UMTS, DECT, WiMax and CDMA 2000. Enhanced data rates for GSM evolution or EDGE is termed to as a backward digital technology, because it can operate with older devices.

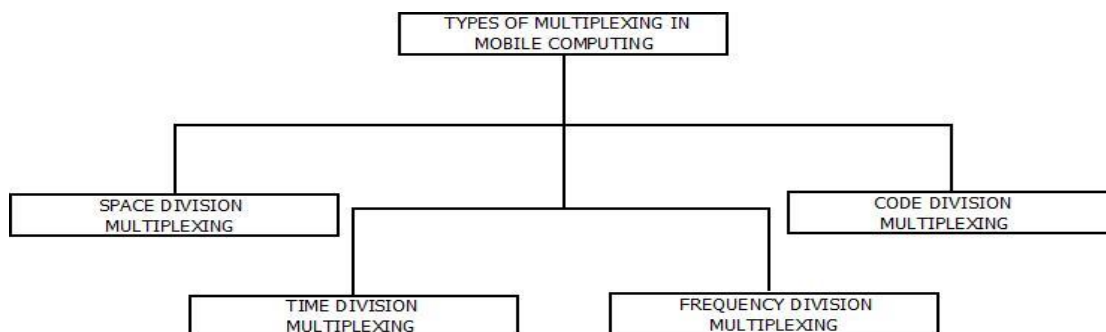
4G Technology

- **4G Technology** is basically the extension in the **3G technology** with more bandwidth and services offers in the 3G.
- The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol.
- **WiMAX** or mobile structural design will become progressively more translucent, and therefore the acceptance of several architectures by a particular network operator ever more common.

7) Explain in detail about Multiplexing techniques in Mobile Computing?

Multiplexing: Introduction

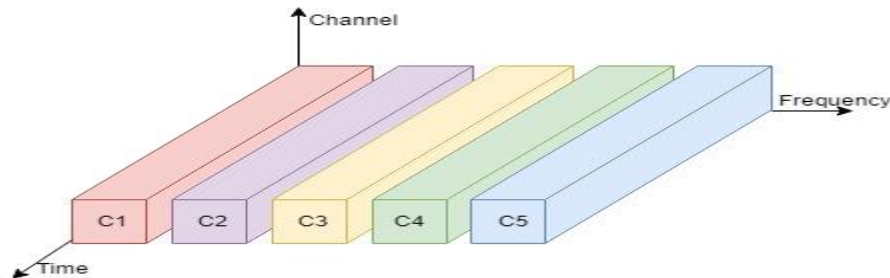
- Multiplexing is a technique in which, multiple simultaneous analog or digital signals are transmitted across a single data link.
- The concept behind it is very simple: Proper Resource Sharing and its Utilization.
- It can be classified into four types. These are:



Multiplexing : Mobile Computing

Multiplexing: Frequency Division Multiplexing(FDM)

- In Frequency Division, the frequency dimension spectrum is split into bands of smaller frequency.
- FDM is used because of the facts that, a number of frequency band can work simultaneously without any time constraint.



Frequency Division

Advantages of FDM

- This concept is applicable on both analog signals as well as digital signals.
- Simultaneous signal transmission feature.

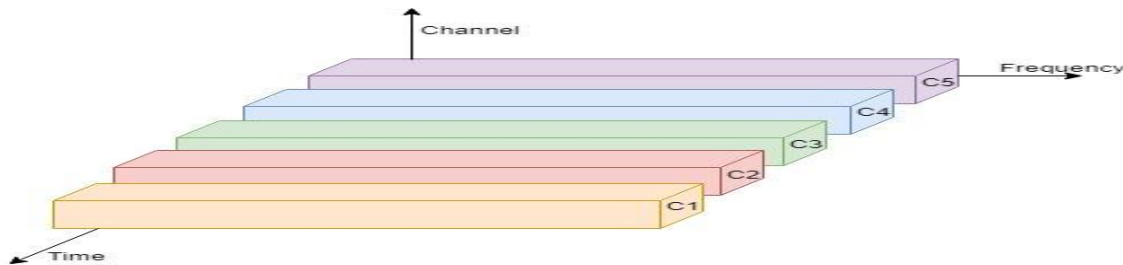
Disadvantages of FDM

- Less Flexibility.
- Bandwidth wastage is high and can be an issue.

For Example: Frequency Division Multiplexing can be used for radio station in a particular region as every radio station will have their own frequency and can work simultaneously without having any constraint of time.

Multiplexing: Time Division Multiplexing(TDM)

- Time Division is used for a particular amount of time in which the whole spectrum is used.
- Time frames of same intervals are made such that the entire frequency spectrum can be accessed at that time frame.



Time Division

Advantages of TDM

- Single user at a time.
- Less complex and more flexible architecture.

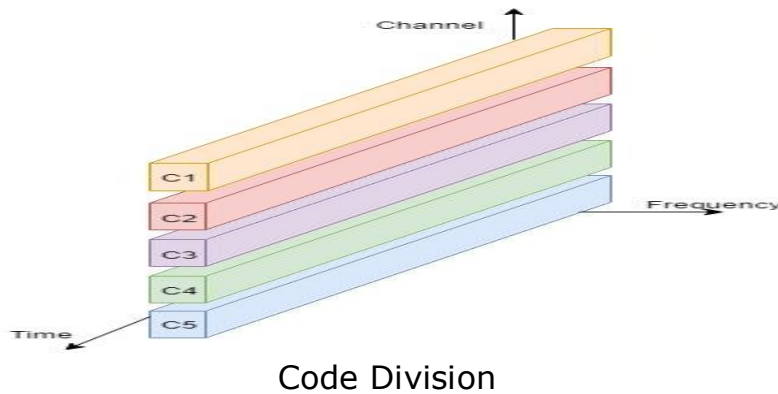
Disadvantages of TDM

- Difficult to implement.

For Example: ISDN(Integrated Service for Digital Network) telephonic service.

Multiplexing: Code Division Multiplexing (CDM)

- In Code Division Multiplexing, every channel is allotted with a unique code so that each of these channels can use the same spectrum simultaneously at same time.



Advantages of CDM

- Highly Efficient.
- Less Inference.

Disadvantages of CDM

- Less data transmission rates.
- Complex in nature.

For Example: Cell Phone Spectrum Technology(2G, 3G etc.).

Multiplexing: Space Division Multiplexing(SDM)

- Space Division can be called as the combination of concepts of Frequency Division Multiplexing and Time Division Multiplexing.
- In SDM, the goal is to pass messages or data parallelly with the use of specific frequency at certain interval of time.
- It means, a particular channel for some amount of time will be used against a certain frequency band.

Advantages of SDM

- High Data transmission rate.
- Optimal Use of Time and Frequency bands.

Disadvantages of SDM

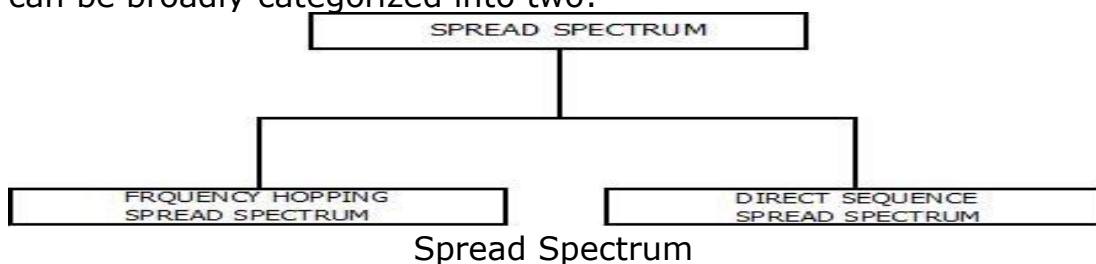
- Inference Problems.
- High inference losses.

For Example: GSM(Global Service For Mobile) Technology.

8) Explain in detail about Spread Spectrum used in Mobile Computing?

Spread Spectrum: Introduction

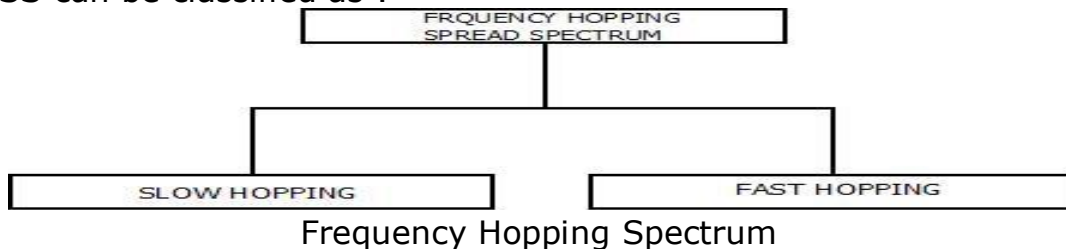
- When transmitted signals of certain frequencies are varied slightly in order to obtain greater bandwidth as compared to initial bandwidth is known as Spread Spectrum.
- Spread Spectrum technology helps in transmission of radio signals because they can easily reduce the noise and other issues that are data resistant.
- It can be broadly categorized into two:



- The major reason of spectrum technology being used is because of its proper bandwidth utilization ability.

Spread Spectrum: Frequency Hopping Spread Spectrum (FHSS)

- The logic behind the use of Frequency hopping Spread spectrum is, in order to utilize bandwidth properly, we need to divide the whole available bandwidth into many channels and spread them between channels which are arranged in a continuous manner.
- The selection of frequency slots is done on random basis and based on their occupancy, frequency signals are transmitted.
- The transmitters and receivers keeps on hopping on channels available for a particular amount of time in milliseconds.
- Hence, frequency division multiplexing and time division multiplexing are implemented simultaneously in FHSS.
- FHSS can be classified as :



- **Slow hopping:** In slow hopping, multiple bits are transmitted on a particular or same frequency.
- **Fast Hopping:** In fast hopping, individual bits are split and are transmitted on different frequencies.

Advantages of FHSS

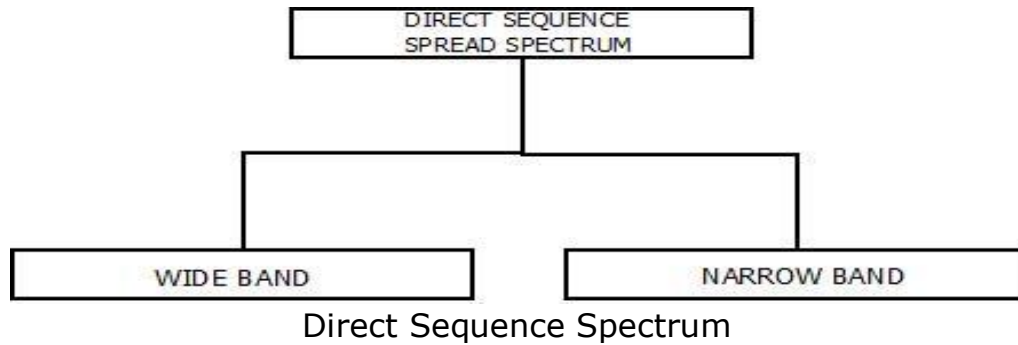
- Secure.
- Simple implementation as compared to DsSS.
- High efficiency.

Disadvantages of FHSS

- Less Robust.

Spread Spectrum: Direct Sequence Spread Spectrum (DSSS)

- Direct Sequence Spread Spectrum is another type of spread spectrum in which data that needs to be transmitted is split into smaller blocks.
- Then, each data block is attached with a high data rate bit sequence and is transmitted from sender end to receiver end.
- At the receiver's end with the help of data rate bit sequence, data blocks are recombined again to generate the original data which was sent by the sender.
- If in case the data is lost, with the help of those data rate bits data blocks can be recovered.
- This split of data into smaller blocks is done to reduce noise and unintentional inference.



Advantages of DSSS

- Signals are difficult to detect.
- Less chances of jamming.
- Less reluctant to noise.

Disadvantages of DSSS

- Slow.
- Requirement of wide-band channels.

Applications of Spread Spectrum

- LAN technology
- Satellite communication technology.

9) Explain in detail about MAC Protocols and its properties?

Key Points

Responsibility
Two objectives
Features

MAC Protocols

- In a wireless network, multiple nodes may contend to transmit on the same shared channel at the same time.
- It is the **responsibility** of the medium access control (MAC) protocol to perform this task.
- The MAC protocol is a sub layer of the data link layer protocol and it directly invokes the physical layer protocol.
- The primary responsibility of a MAC protocol is to enforce discipline in the access of a shared channel when multiple nodes contend to access that channel.
- At the same time, **two other objectives** of any MAC protocol are maximization of the utilization of the channel and minimization of average latency of transmission.
- However, a MAC protocol must be fair and ensure that no node has to wait for an unduly long time, before it is allowed to transmit.

Properties Required of MAC Protocols

In a general sense 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.

10) Write in detail of Wireless MAC Protocols: Some Issues

Explain the wireless MAC issues in detail. (8)

[May 2017]

Wireless MAC Protocols: Some Issues

Key Points

Hidden Terminal Problems

Exposed Terminal Problems in an Infrastructure-less Network

- A MAC protocol in a wireless medium is much more complex than its wired counterpart.
- First, a collision detection scheme is difficult to implement in a wireless environment, since collisions 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.

Explain Hidden and exposed terminal problem in infrastructure-less network . (8)

[Nov 2017]

Explain in detail about hidden terminal problem and exposed terminal problem. (13)

[Nov 2018]

The Hidden and Exposed Terminal Problems in an Infrastructure-less Network

The **Hidden Terminal** problem arises when at least three nodes (A, B, and C), as shown in Fig. 3.1, communicate among each other.

- As shown in this figure, B is in the radio range of A, and B is also within the radio range of C. However, the nodes A and C are not in the radio range of each other.
- Note that 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.

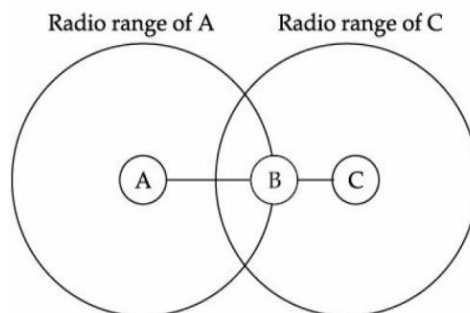


Figure 3.1 Hidden terminal problem

A related problem called **Exposed Terminal** could arise in a scenario such as that depicted in Fig. 3.2.

- MAC protocols usually inhibit transmission when transmission from another terminal is detected.
- As a 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.
- 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**.

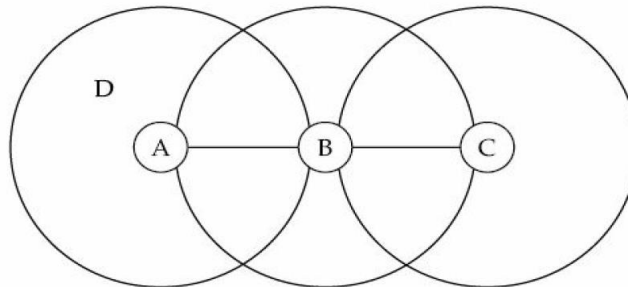


Figure 3.2 Exposed terminal problem.

11) Explain about Taxonomy of MAC Protocols?

Explain the various taxonomy of MAC protocols in detail. (16) [May 2016]

Explain MAC protocols for Adhoc Network. (8) [May 2017]

Key Points

- Fixed assignment schemes - are usually called circuit-switched schemes
 - Frequency Division Multiple Access (FDMA)
 - Time Division Multiple Access (TDMA)
 - Code Division Multiple Access (CDMA)
- Random assignment schemes are called packet-switched schemes
 - ALOHA
 - Slotted ALOHA
 - CSMA
 - CSMA/CD
 - CSMA/CA
- Reservation-based schemes - are called packet-switched schemes
 - MACA

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 - are usually **called circuit-switched schemes**
 2. Random assignment schemes
 3. Reservation-based schemes - are **called packet-switched schemes**
- **In fixed assignment schemes**, the resources required for a call are assigned for the entire duration of the call.
 - **In random assignment schemes** are comparable to the connection-less packet-switching schemes. In this, no resource reservations are made, the nodes simply start to transmit as soon as they have a packet to send.
 - **In the reservation schemes**, a node makes explicit reservation of the channel for an entire call before transmitting. This is analogous to a connection-based packet-switching scheme.
 - **The reservation-based MAC schemes are suitable to handle calls with widely varying traffic characteristics.**

- 12) What are the Fixed Assignment schemes of MAC protocol? Explain their mechanism in detail. Compare and contrast them FDMA, TDMA AND CDMA. (16) [Nov 2017]**
Explain fixed assignment scheme with neat diagram. (8) [May 2017]

Fixed Assignment Schemes

A few important categories of fixed assignment MAC protocols are the following:

1. Frequency Division Multiple Access (FDMA)
2. Time Division Multiple Access (TDMA)
3. Code Division Multiple Access (CDMA)

An analogy to the fixed assignment solution to the multiple access issues of a shared medium

An analogy may be drawn to the fixed assignment solution to the multiple access issues of a shared medium in the following way: Consider a students' common room (channel) in which many students want to communicate with each other. If the students want to avoid cross-talk in the ongoing process, then either the 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). The last analogy captures the essence of CDMA, when the students who are speaking the same language understand each other, but the rest of the students cannot. In CDMA, each communicating pair shares a decryption code using which lets them understand only the communication between them. In this case many codes occupy the same channel, but only the users who share a specific code will be able to understand each other.

1) Frequency Division Multiple Access (FDMA)

- In FDMA, the available bandwidth (frequency range) is divided into many narrower frequency bands called channels. Figure 3.3 shows a division of the existing bandwidth into many channels (shown as Ch 1, Ch 2, etc.).

- 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. Obviously, 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 transmissions, or when no user is allocated a band, goes idle and is wasted. FDMA, therefore, does not achieve a high channel utilization.

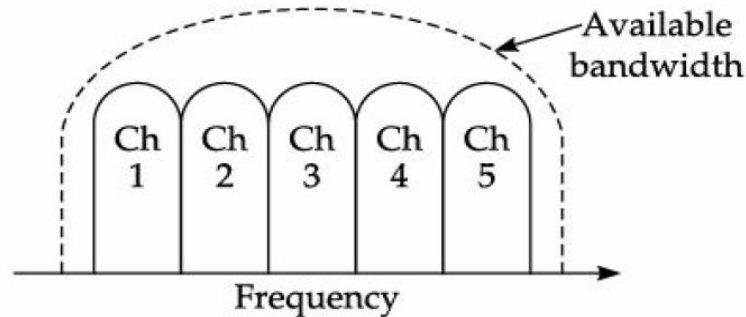


Figure 3.3 Channels in Frequency Division Multiple Access (FDMA) scheme.

2) Time Division Multiple Access (TDMA)

- TDMA is an access method in which multiple nodes are allotted different time slots to 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.
- Note that in this case, all sources use the same channel, but take turns in transmitting. Figure 3.4 shows the situation where time slots are allocated to users in a round robin manner, with each user being assigned one time slot per frame. See Box 3.2. Obviously, unused time slots go idle, leading to low channel utilization.

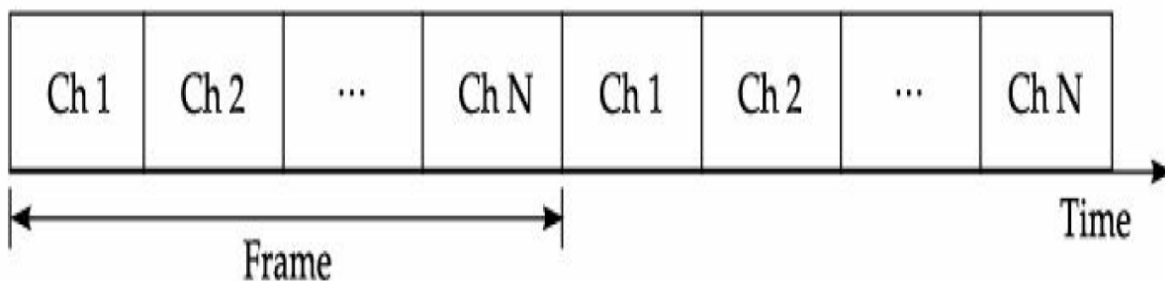


Figure 3.4 Channels in Time Division Multiple Access (TDMA) scheme.

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. 3.5, a special coding scheme is used that allows signals from multiple users to be multiplexed over the same physical channel.
- As shown in the figure, three different users who have been assigned separate codes are multiplexed on the same physical channel.

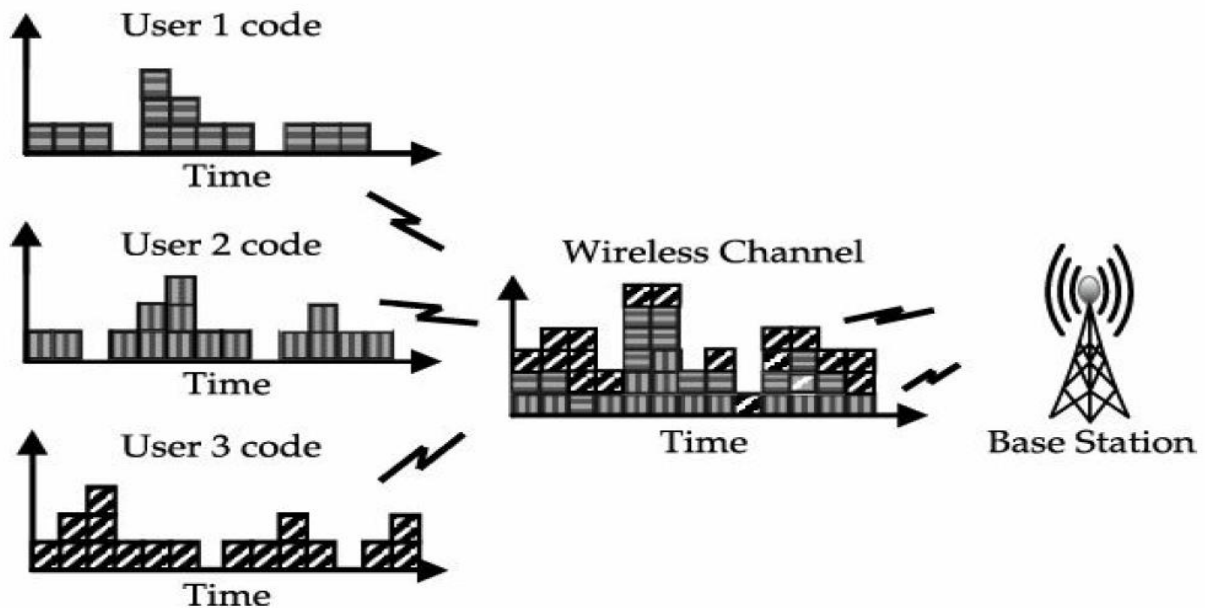


Figure 3.5 Schematic of operation of Code Division Multiple Access (CDMA).

13) Describe the various random assignment schemes that are used in MAC protocol? (8) [Nov 2018]

I) Random Assignment Schemes

There are a number of random assignment schemes that are used in MAC protocols.

- i) ALOHA
- ii) Slotted ALOHA
- iii) CSMA
- iv) CSMA/CD
- v) CSMA/CA

i) ALOHA Scheme

- It is a simple communication scheme, the basic (also called pure) ALOHA scheme, is a simple protocol. If a node has data to send, it begins to transmit.
- Note that 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.
- 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).
- However, the collisions can become **unacceptably** high if the number of contenders for transmission is high.

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

- Thus, the size of the packet is restricted. A node wanting to send a packet, can start to do so only at the beginning of a slot.
- The slotted ALOHA system employs beacon signals that are sent at precise intervals that mark the beginning of a slot, at which point the nodes having data to send can start to transmit.
- Again, this protocol does not work very well if the number of stations contending to send data is high. **In such cases, the CSMA scheme (described next) works better.**

What is CSMA? What are the categories of CSMA? Explain their working with advantages and disadvantages? (7) [Apr 2018]

ii) 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 extensions of the basic CSMA technique are

- The collision detection (CSMA/CD) and the collision avoidance (CSMA/CA) techniques.
- In the CSMA/CD technique, the sender starts to transmit if it senses the channel to be free. But, even if it senses the channel to be free, there can be a collision (why?) during transmission.
- In a **wired network**, the implementation of a **collision detection scheme is simple.**
- However, in a **wireless network** it is very **difficult** for a transmitting node to **detect a collision**, since any received signal from other nodes would be too feeble compared to its own signal and can easily be masked by noise.
- As a result, a transmitting node would continue to transmit the frame, and only the destination node would notice the corrupted frame after it computes the checksum. This leads to retransmissions and severe wastage of channel utilization.
- **In contrast**, in a **wired network when a node detects a collision**, it immediately stops transmitting, thereby minimizing channel wastage.
- **In a wireless network, a collision avoidance scheme works much better** compared to a collision detection-based scheme.
- A collision avoidance scheme is based on the idea that it is necessary to prevent collisions at the moment they are most likely to occur, that is, when the bus is released after a packet transmission.

Advantages and Disadvantages of CSMA

| Advantages | Disadvantages |
|--------------------------------|---------------------------|
| Helps prevent data collisions | Longer waiting times |
| Thanks to feedback, no data is | Causes additional traffic |

| Advantages | Disadvantages |
|--|---|
| unnoticeably lost | |
| Avoids unnecessary data traffic with the RTS/CTS extension | Solves the hidden station problem only by using RTS/CTS extension |
| | Creates the exposed station problem through using RTS/CTS |

14) Discuss the various reservation based schemes in MAC protocol. (5) [Nov 2018]

II) Reservation-based Schemes

- A basic form of the reservation scheme is the RTS/CTS scheme.
- In an RTS/CTS scheme, 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 reserves 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.
- Every node that hears the RTS and CTS messages 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 for sensor networks.

Explain in detail about hidden terminal problem and exposed terminal problem. (13) [Nov 2018]

MACA: MACA stands for Multiple Access Collision Avoidance

- MACA solves the hidden/exposed terminal problems by regulating the transmitter power. A node running MACA requests to use the medium by sending an RTS to the receiver.
- Since radio signals propagate omni-directionally every terminal within the sender's radio range will hear this and then refrain from transmitting. As soon as the receiver is ready to receive data, it responds with a CTS.

Figure 3.6 schematically shows how MACA avoids the hidden terminal problem. Before the start of its transmission, it sends a **Request To Send (RTS)**.

- B receives the RTS that contains the sender's name and the receiver's name, as well as the length of the future transmission.

- In response to the RTS, an acknowledgment from B is triggered indicating **Clear To Send (CTS)**.
- The CTS contains the names of the sender and receiver, and the length of the planned transmission.
- This CTS is heard by C and the medium is reserved for use by A for the duration of the transmission.

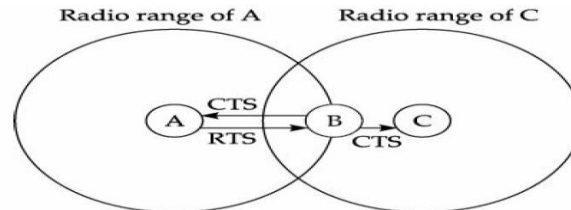


Figure 3.6 Hidden terminal solutions in MACA.

Some other technology that can be employed to solve hidden node problem are :

Increase Transmitting Power from the Nodes:

With the enhancement of the transmission power of access point can solve the hidden terminal problem by allowing the cell around each node to increase in size, encompassing all of the other nodes.

Use Omni directional antennas:

Since nodes using directional antennas are nearly invisible to nodes that are not positioned in the direction the antenna is aimed at, directional antennas should be used only for very small networks.

Remove obstacles:

Keep away the obstacles that affect the performance of access point accessibility.

Move the node:

Provide the mobility features to the nodes.

Use protocol enhancement software:

Pooling and token passing strategy should be used before start data transformation.

- On receipt of a CTS from B, C refrains from transmitting anything for the time indicated in the CTS.
- Thus a collision cannot occur at B during data transmission, and the hidden terminal problem is solved.
- **Figure 3.7** schematically shows how the exposed terminal problem is solved in MACA. Assume that B needs to transmit to A.
- B has to transmit an RTS first as shown in Fig. 3.7.
- The RTS would contain the names of the receiver (A) and the sender (B).
- C does not act in response to this message as it is not the receiver, but A responds with a CTS.
- C does not receive this CTS and concludes that A is outside the detection range.
- Thus C can start its transmission assuming that no collision would occur at A.

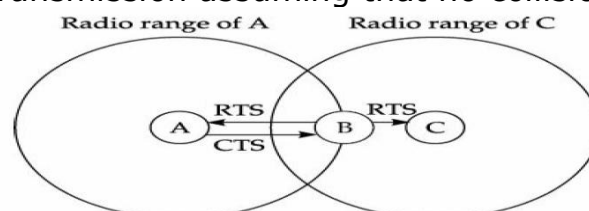


Figure 3.7 Exposed terminal solution in MACA.**15) Differentiate between SDMA, FDMA, TDMA and CDMA.(16)[Nov 2016]****Comparison SDMA/TDMA/FDMA/CDMA**

| Approach | SDMA | TDMA | FDMA | CDMA |
|-------------------|--|--|--|---|
| Idea | segment space into cells/sectors | segment sending time into disjoint time-slots, demand driven or fixed patterns | segment the frequency band into disjoint sub-bands | spread the spectrum using orthogonal codes |
| Terminals | only one terminal can be active in one cell/one sector | all terminals are active for short periods of time on the same frequency | every terminal has its own frequency, uninterrupted | all terminals can be active at the same place at the same moment, uninterrupted |
| Signal separation | cell structure, directed antennas | synchronization in the time domain | filtering in the frequency domain | code plus special receivers |
| Advantages | very simple, increases capacity per km ² | established, fully digital, flexible | simple, established, robust | flexible, less frequency planning needed, soft handover |
| Dis-advantages | inflexible, antennas typically fixed | guard space needed (multipath propagation), synchronization difficult | inflexible, frequencies are a scarce resource | complex receivers, needs more complicated power control for senders |
| Comment | only in combination with TDMA, FDMA or CDMA useful | standard in fixed networks, together with FDMA/SDMA used in many mobile networks | typically combined with TDMA (frequency hopping patterns) and SDMA (frequency reuse) | still faces some problems, higher complexity, lowered expectations; will be integrated with TDMA/FDMA |

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MC SS05

3.26

**Frequency division multiple access (FDMA):**

- It is a technology by which the total bandwidth available to the system is divided into frequencies. This division is done between non overlapping frequencies that are then assigned to each communicating pair (2 phones)
- FDMA is used mainly for analog transmission. Its not that this technology is not capable of carrying digital information, but just that it is not considered to be an efficient method for digital transmission.
- Because just imagine if the frequencies to handle the customers gets over? What if more capacity is required? The only option would be to drill down the existing frequencies to a much narrower amount which will not be very competent.
- In FDMA all users share the satellite simultaneously but each user transmits at single frequency.
- To understand this technology better, just imagine how FM radio works. All the radios have their own frequency bands and they send their signals at the carefully allocated unique frequencies within the available bands.

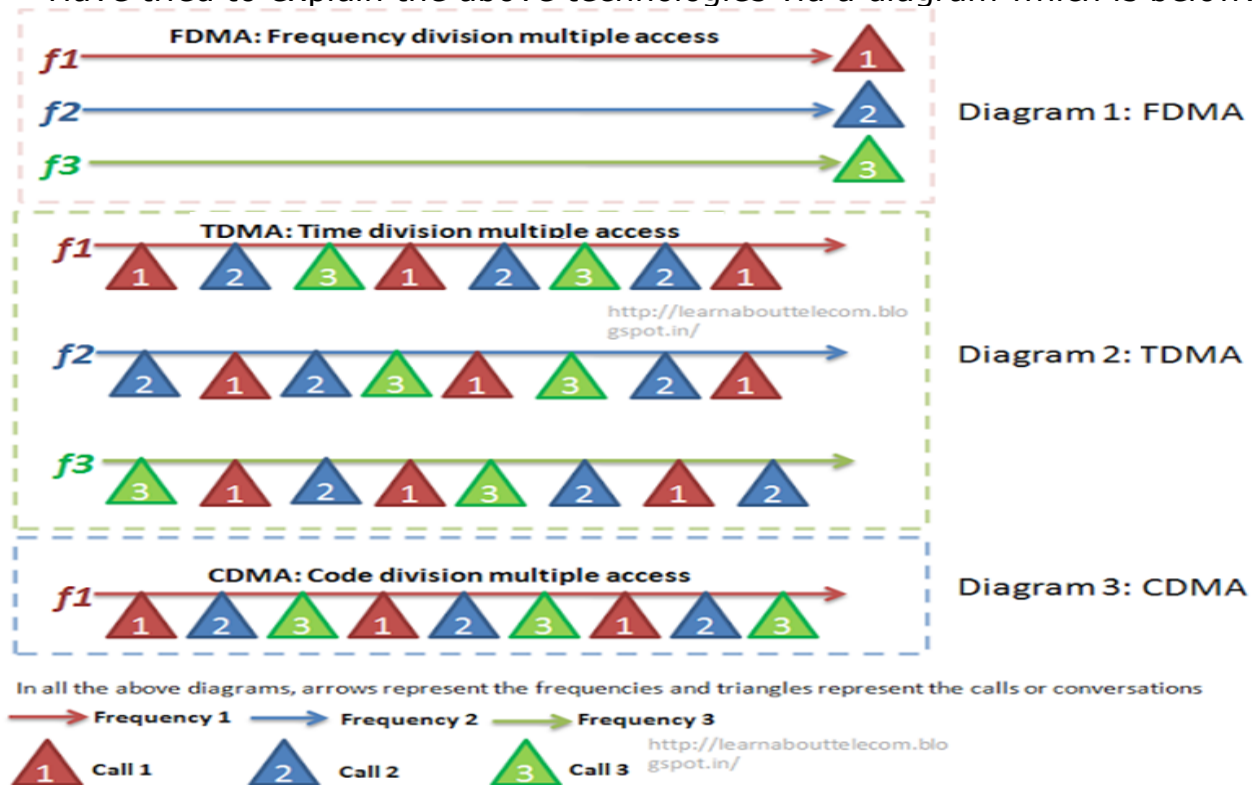
Code division multiple access (CDMA):

- Unlike FDMA, CDMA separates calls by code. Every bit of a conversation is been tagged with a specific and unique code.
- The system gets a call, it allocates a unique code to that particular conversation, now the data is split into small parts and is tagged with the unique code given to the conversation of which they are part of.

- Now, this data in small pieces is sent over a number of the discrete frequencies available for use at any time in the specified range. The system then at the end reassembles the conversation from the coded bits and deliver it.

Time division multiple access (TDMA):

- Unlike FDMA and CDMA, In TDMA the division of calls happens on time basis.
- The system first digitizes the calls, and then combines those conversations into a unified digital stream on a single radio channel.
- Now it divides each cellular channel into three time slots that means three calls get put on a single frequency and then, a time slot is assigned to each call during the conversation, a regular space in a digital stream.
- The users transmit in rapid succession, one after the other, each using its own time slot. This allows multiple stations to share the same transmission medium (e.g. radio frequency channel) while using only a part of its channel capacity.
- This technology enables three different users to use one frequency at the same time.
- Here there is no need for three separate frequencies like in FDMA. As in FDMA, instead of monopolizing a single radio channel for a single call, TDMA efficiently carries three calls at the same time☺
- BTW, this technology is the one used in our GSM system
- Have tried to explain the above technologies via a diagram which is below:



In the above diagram, you will observe:

FDMA: Single frequency is used for single call

CDMA: Single frequency is used for multiple calls

TDMA: Multiple frequencies are used for multiple calls

ANNA UNIVERSITY QUESTIONS**PART A**

1. List the issues of wireless MAC? [Apr 2018]
Refer Q.No.1
2. Distinguish between mobile computing and wireless networking? [Apr 2018]
Refer Q.No.2
3. What are the challenges in mobile communication? [Nov 2018]
Refer Q.No.3
4. State the objectives of MAC protocols. [Nov 2018]
Refer Q.No.5
5. List out the difference between Mobile Computing and Wireless Networking. [Nov 2017][May 2017]
Refer Q.No.6
6. "MAC protocol designed for infrastructure based wireless network may not work satisfactory in infrastructure-less environment." – Justify. [Nov 2017]
Refer Q.No.7
7. List some random assignment schemes. [May 2017]
Refer Q.No.8
8. What are the limitations of Mobile Computing? [Nov 2016]
Refer Q.No.9
9. What are the different Random Assignment Scheme in MAC? [Nov 2016]
Refer Q.No.10
10. List the advantages of Mobile Computing. [May 2016]
Refer Q.No.11
11. Explain hidden and exposed terminal problems in infrastructure less network. [May 2016]
Refer Q.No.12

ANNA UNIVERSITY QUESTIONS**PART B**

1. Differentiate between FDMA, TDMA and CDMA. (16) [Nov 2016]
2. Explain the distinguishing features of various generations of wireless networks. (8) [Nov 2016]
3. Describe the applications of Mobile Computing. (8) [Nov 2016]
4. Explain the characteristics of Mobile Computing. (8) [May 2016]
5. Explain the structure of Mobile Computing Application. (8) [May 2016]
6. Explain the various taxonomy of MAC protocols in detail. (16) [May 2016]
7. Explain Hidden and exposed terminal problem in infrastructure-less network. (8) [Nov 2017]
8. Describe architecture of Mobile Computing. (8) [Nov 2017]
9. What are the Fixed Assignment schemes of MAC protocol? Explain their Mechanism in detail. Compare and contrast them. (16) [Nov 2017]
10. Explain the wireless MAC issues in detail. (8) [May 2017]
11. Explain the various applications of Mobile Computing. (8) [May 2017]
12. Explain fixed assignment scheme with neat diagram. (8) [May 2017]
13. Explain MAC protocols for Adhoc Network. (8) [May 2017]
14. Describe the various random assignment schemes that are used in MAC Protocol? (8) [Nov 2018]
15. Discuss the various reservation based schemes in MAC protocol. (5) [Nov 2018]
16. Explain in detail about hidden terminal problem and exposed terminal Problem. (13) [Nov 2018]
17. Discuss in detail the structure of mobile computing? (6) [Apr 2018]
18. Apply mobile computing to design taxi dispatcher and monitoring service. Explain the components in detail. (7) [Apr 2018]
19. List the characteristics of mobile systems? (6) [Apr 2018]
20. What is CSMA? What are the categories of CSMA? Explain their working with Advantages and disadvantages? (7) [Apr 2018]