MOBILE & WIRELESS COMMUNICATION

Model Test Paper-I
Paper Code: ESC-CSE-308-G

Note: ***Attempt five questions in all, selecting one question from each section. Q. No. 1 is compulsory.***

Q.1. Explain the following :
(a) 2G Vs 3G
(b) Tracking and grade off service
(c) Spread spectrum multiple access
(d) In-building communication

Ans. (a) 2G Vs 3G : Comparison between 2G and 3G technologies :

Parameter	2G	3G
-Band	GSM 900, 1800, 1900	GSM 2 100
-Access technique	TDMA + FDMA	CDMA + FDMA or CDMA + TDMA
-Channel Bandwidth	200 kHz	5 MHz
-Maximum theoretical speed	9.6 to 236 kbps	1.3 to 2 mbps
-Frequency per cell	2 to 6	1
-Cell Size	500 meter to 25 Kilometer	500 meter to 5 Kilometer
-Mobile Phone Security	Simple to design authenticate to mobile	Mobile & Network both authenticate to each other
-Video Telephony	Not Possible	Possible
-Interference Level	Very high	Very less
-Handover	Hard handover	Only soft handover
-Online Game	Not Possible	Possible
-Inter System handover	Not Possible (2G to 3G) 2G mobile can not latch over 3G Network.	Possible (3G to 2G) 3G mobile can latch over 2G networks.
-Technology name	GSM	WCDMA

Ans.(b) Tracking and grade off service : Cellular radio systems rely on trunking to accommodate a large number of users in a limited radio spectrum. The concept of trunking allows a large network of users to share the relatively small number of channels in a cell by providing access to each user, on demand, from a pool of available channels. In a trunked radio

system, each user is allocated a channel on a per unit call basis, and upon termination of the call, the previously occupied channel is immediately returned to the pool of available channels. Trunking ,exploits the statical behaviour of uses so that a fixed number of channels or circuits may accommodate a large, random user community.

The grade of service (GOS) is a measure of the ability of a user to access a trunked system during the bursiest hour. The busy hour is based upon customer demand at the busiest hour during a week, month or year. The busy hours for cellular radio systems typically occur during rush hours, between 4 pm and 6 pm on a Thursday or Friday evening. The grade of service is a benchmark used to define the desired performance of a particular trunked system by specifying a desired likelihood of a user obtaining channel access given a specific number of channels available in the system. It is the wireless designer's job to estimate the maximum required capacity and to allocate the proper number of channels in orderser to meet the GOS. GOS is typically given as the likelihood that a call is blocked, or the likelihood of a call experiencing a delay greater than a certain queuing time.

Ans.(c) Spread spectrum multiple access : Spread Spectrum Multiple Access (SSMA) uses signal which have a transimission bandwidth that is several orders of magnitude greater than the minimum required RF bandwidth. A pseudo-noise(PN) sequence converts a narrowband signal to a wideband noise-like signal before transmission. SSMA also provides immunity to multipath interference and robust multiple access capability. SSMA is not very bandwidth efficient when used by a single user. However, since many users can share the same spread spectrum banwidth without interfering with one another, spread spectrum systems become bandwidth efficient in a multiple user environment. It is exactly this situation that is of interest to wireless system designers. There are two main types of spread spectrum multiple access techniques; frequency hopped multiple access(FH) and direct sequence multiple access (DS). Direct sequence multiple access is also called code division multiple access (CDMA).

Ans.(d) In-building communication : In building communication needs sufficient traffic channels, but the radio spectrum is limited. We may apply the intelligent cell concept to solve this problem.

The number of traffic channels can be increased by treating each floor of a builkding as a cell.

Generally the signal strength loss due to Concrete Building wall is about 20 dB,and signal isolation between two adjacent floors is also 20 dB.

So, let a group of frequency channels M_1 be assigned to the in building use, those M_1 channels will be reused in every floor of building and also in every floor of neighboring buildings (Passive intelligence) as shown in fig.(a).

"Passive" intelligence is used, buildings with less isolation can still achieve high efficiency of spectral reuse by self-surveying the amount of signal leakage into the building on between floors.

A building cannot constructed according to cellular phone structure, because besided the reception of cellular signal there are many other problems that must be considered when we construct a building like building must be earth-quake resist , Fire proofs etç.

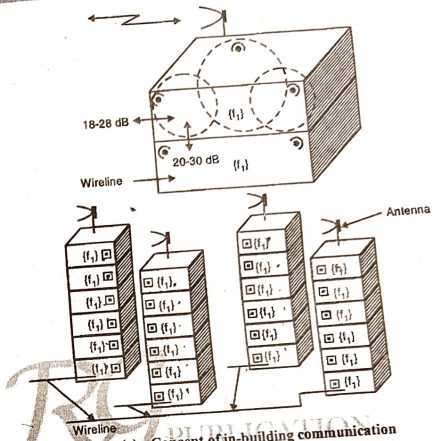


Fig. (a) : Concept of in-building communication

An in-building system configuration that uses both the natural shielding of the building structure, and a means of leading the cellular signal into the building is illustrated in fig. Calls are sent into the building at upconverted (or downconverted) frequency to different floors. These lead-in frequency are converted back to the cellular frequencies as soon as they reach the desired floors.

Section-A

Q.2.(a) Describe wireless local loop system.

Ans. A wireless in Local Loop (WLL) system replaces the copper loop with radio Frquency (RF) loop, maintaining the existing services of a basic telephone system. In the WLL network, the circuit between the subscriber's equipment and the local exchange is called the local loop.

In a WLL system, entire coverage area is divides into a number of hexagonal sub-areas called cells. But you will get service in only one cell. It mean if you have WLL instrument and PSTN exchange connected to you from BTS 1 as per your residential/office address then you will get service in areas served by BTS 1 only. If you want to use service in BTS 2 area then you can't use. But if WLL is based on CDMA then you can use all services of cellular system.

In a WLL system architecture, BSC (Base Station Controller) is the heart of a WLL system. It interfaces with the Public Switched Telephone Network (PSTN), BTS and a Operation

Maintainence Centre (OMC) to perform call processing, voice coding etc. BTS is the interface between the BSC and subscriber stations. It performs jobs related to wireless resource management, power control functions call processing and testing. One BTS has an antenna system, which may be ominidirectional or directional. It placed at the centre of the hexagonal cell and serves subscribers within the cell.

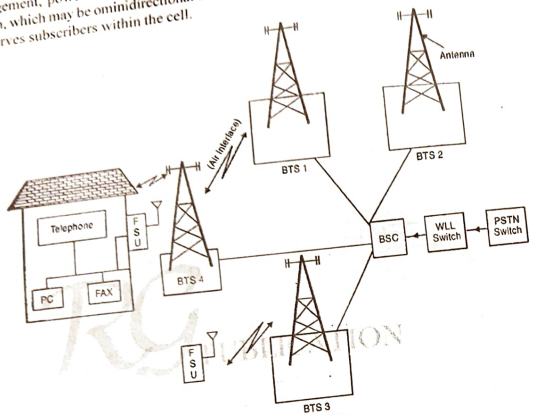


Fig. : WLL system architecture

Advantages of Wireless Local Loop : WLL offers a number of advantages over wired approach to subscriber loop support. These includes :

(i) Cost : Wireless systems are less expensive than wired systems.

(ii) Installation Time : WLL systems can be installed rapidly. Only problem is selection of frequencey band and authorization to use it. Once it is obtained it can be easily installed.

(iii) Mobile Cellular Technology : Current cellular systems are to expensive and donot provide sufficient facilities to act as realistic alternative to WLL. A major advantage of WLL over mobile cellular is that, because subscriber unit is fixed, the subscriber can use a directional antenna pointed at the base station Antenna, providing improved signal quality in both the directions.

Disadvantages of Wireless Local Loop :

(i) *The technology is more costly due to the need for research and development* : Moreover, some network operators fear technological obsolescence , that if a commitment is made to a specific WLL technology today, then within a few years it may be surpassed by technologies currently under development.

(ii) *The technology has not been tested over a long term of time for reliability and repair costs* : The disadvantages of a wireless local loop solution, lie in the fact that much of the technology particularly on the digital side, is relatively untried.

(iii) *Certain technologies are not available in all areas, which leaves people with the unsupported technology disconnected* : The capital cost of WLL technology, even when it compares favorably to the deployment of copper lines, remains outside the reach of many government or private network operators.

(iv) *Wireless technology requires that data be sent over open space, which makes it susceptible to interception and decreases the security of the transmission.*

Q.2.(b) Explain how a cellular telephone call is made.

Ans. When a telephone call is placed to a mobile user, the MSC dispatches the request to all base station in the cellular system. The mobile identification number (MIN), which is the subscriber's telephone number, is then broadcast as a paging message over all of the forward control channels throughout the cellular system. The mobile receives the paging message sent by the base station which it monitors, and responds by identifying itself over the reverse control channel. The base station relays the acknowledgment sent by the mobile and informs the MSC of the handshake. Then, the MSC instructs the base station to move the call to an unused voice channel within the cell (typically, between ten to sixty voice channels and just one control channel are used in each cell's base station). At this point, the base station signals the mobile to change frequencies to an unused forward and reverse voice channel pair, at which point another data message (called an alert) is transmitted over the forward voice channel to instruct the mobile telephone to ring, thereby instructing the mobile user to answer the phone.

Once a call is in progress, the MSC adjusts the transmitted power of the mobile and changes the channel of the mobile unit and base stations in order to maintain call quality as the subscriber moves in and out of range of each base station. This is called a handoff. Special control signaling is applied to the voice channels so that the mobile unit may be controlled by the base station and the MSC while a call is in progress.

When a mobile originates a call, a call initiation request is sent on the reverse control channel. With this request the mobile unit transmits its telephone number (MIN), electronic sereal number (ESN), and the telephone number of the called party. The mobile also transmits a station class mark (SCM) which indicates what the maximum transmitter power level is for the particular user. The cell base station receives this data and sends it to the MSC. The MSC validates the request, makes connection to the called party through the PSTN, and instruct the base station and mobile user to move to an unused forward and reverse voice channel pair to allow the conversation to beings.

Q.3.(a) Explain architecture of Bluetooth networks.

Ans. Bluetooth architecture : Bluetooth architecture defines two types of networks:

(i) Piconet

(ii) Scattemet

(i) Piconet : Piconet is a Bluetooth network that consists of one primary (master) node and seven active secondary (slave) nodes. Thus, piconet can have upto eight active nodes (1 master and 7 slaves) or stations within the distance of 10 meters. There can be only one primary or master station in each piconet.

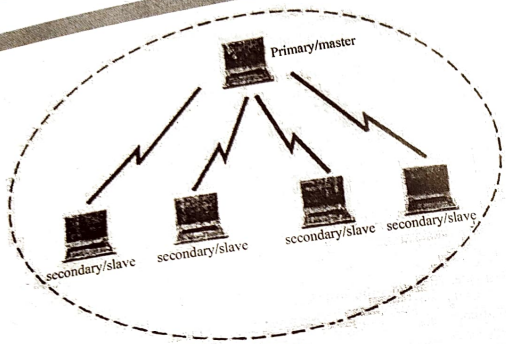


Fig. : Piconet

The communication between the primary and the secondary can be one-to-one or one-to-many. All communication is between master and a slave. Salve-slave communication is not possible. In addition to seven active slave station, a piconet can have upto 255 parked nodes. These parked nodes are secondary or slave stations and cannot take part in communication until it is moved from parked state to active state.

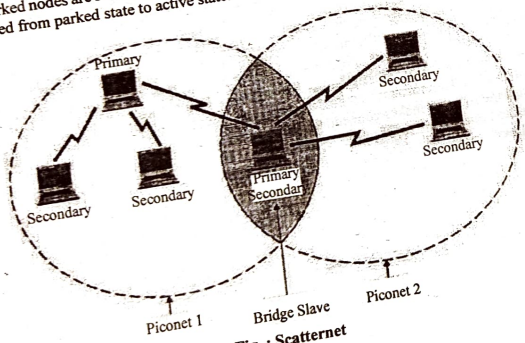


Fig. : Scatternet

(ii) Scatternet : Scattemet is formed by combining various piconets. A slave in one piconet can act as a master or primary in other piconet. Such a station or node can receive messages from the master in the first piconet and deliver the message to its slaves in other piconet where it is acting as master. This node is also called bridge slave. Thus a station can be a member of two piconets. A station cannot be a master in two piconets.

Q.3.(b) Describe IEEE 802.11 standard for wireless local area network.

Ans. Fig.(1) illustrates the evolution of IEEE 802.11 Wireless LAN standards, which also include infrared communications. Fig.(1) shows how both frequency hopping and direct sequence approaches were used in the original IEEE 802.11 standard (2 Mbps user throughput), but as of late 2001 only direct sequence spread spectrum (DS-SS) modems has thus far been standardized for high rate (11 Mbps) user data rates within IEEE 802.11. Not shown in figure (1) is the IEEE 802.11a standard, which will provide up to 54 Mbps throughput in the 5 GHz band. The DS-SS IEEE 802.11b standard has been named Wi-Fi by the Wireless Ethernet Compatibility Alliance, a group that promotes adoption of 802.11b DS-SS WLAN equipment and interoperability between vendors. IEEE 802.11 g is developing Complimetary Code keying Orthogonal Frequency Division Multiplexing (CCK-OFDM) standards in both the 2.4 GHz (802.11b) and 5 GHz(802.11a) bands, and will support roaming capabilities and dual band use for public WLAN networks, while supporting backward compactibility with 802.11b technology.

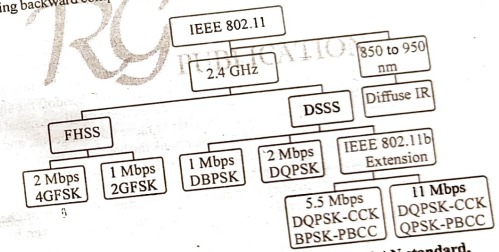


Fig. (1) : Overview of the IEEE 802.11 Wireless LAN standard.

Section-B

Q.4. (a) Explain various hands off stratgies.

Ans. Handoff : At any instant, each mobile station is logically in a cell and under the control of the cell's base station. When a mobile station moves out of a cell, the base station notices the MS's signal fading away and requests all the neighbouring BSs to report the strength they are receiving. The BS then transfers ownership to the cell getting the strongest signal and the MSC changes the channel carrying the call. The process is called handoff.

There are two types of handoff strategies :

(i) Hard Handoff and

(ii) Soft Handoff.

(i) Hard Handoff : A hard handoff is one in which the channel in the source cell is released and only then the channel in the target cell is engaged. Thus, the connection to the source is broken before the connection to the target is made-for this reason such handoffs are also known as *break-before-make*. Hard handoffs are intended to be instanteous in order to minimize the disruption to the call. A hard handoof is perceived by network engineers as an event during the call.

An advantage of the hard handoff is that at any moment in time one call uses only one channel. The hard handoff event is ended very short and usually is not perceptible by the user. In the old analog systems it could be heard as a click or a very short beep, in digital systems it is unnoticable. Another advantage of hard handoff is that the phone's hardware does not need the capability of receiving two or more channels in parallel, which makes it cheaper and simpler. A disadvantage is that if a handoff fails the call may be temporarily disrupted or even terminated abnormally. Technologies, which utilise hard handoffs, usually have procedures which can re-establish the connection to the source cell if the connection to the target cell cannot be made. However re-establishing this connection may not always be possible.

(ii) Soft Handoffs : A soft handoff is one in which the channel in the source cell is retained and used for a while in parallel with the channel in the target cell. In this case the connection to the target is established before the connection to the source cell is broken, hence this handoff is called *make-before-break*. The interval, during which the two connections are used in paralle, may be brief or substantial. For this reason the soft handoff is perceived by network engineers as a state of the call, rather than a brief event. A soft handoff may involve using connections to more than two cells. When a call is in the state of soft handoff the signal of the best of all used channels can be utilised for the call at a given moment or all the signal can be combined to produce a clearer copy of the signal. The later is more advantageous, and when such combining is performed both in the downlink and the uplink the handoff is termed as softer. Softer handoffs are possible when the cells involved in the handoff have a single cell site.

One advantage of the soft handoffs is that the connection to the source cell is broken only when a reliable connection to the target cell has been established and therefore the chances that the call will be terminated abnormally due to failed handoff are lower. However, by far a bigger advantage comes from the mere fact that simultaneously-cannels in multiple cells are maintained the call could only fail if all the channels are faded at the same time.

Q.4. (b) Describe specturm allocation in cellular mobile system.

Ans. Specturm Allocation : The electromagnetic spectrum is an aspect of the physical world, like land, water, and air. Use or radio frequency bands of the electromagnetic specturm is regulated by governments in most countries, in a process known as *frequency allocation* or *spectrum allocation*. Like weather and internationally traded goods, radio propagation and RF technology do not stop at national boundaries. Giving technical and economic reasons, governments have sought to harmonise spectrum allocation standards.

A number of forums and standards bodies work on standards for frequency alloca including :

- ITU (International Telecom Union)
- CEPT (Conference of European the Post Telecom)
- ETSI (Europen Telecom standard Institute)
- International Special Committee on Radio Interference
- ANSI (American National Standard Institude)

High demand sections of the electromagnetic specturm may sometimes be allocated through auctions. In india frequency allocations is done by TRAI – (Telephone Regular authority of India) through auctions of different operators for different purposes in coordination with International authorities. The range of "radio frequencies" is a matter of international convention. At the international radio conference at Atlantic City in 1947, Hertzian (ratio) waves were defined as electromagnetic waves of frequencies between 10 Kc/s AND 3000000 Mc/s. The lower limit was dropped in subsequent international ratio regulations. More recently there have been proposals to raise the upper limit.

As a matter of physics, many objects and actions generate low level, wide band radiation. The frequency allocation process traditionally has not been concerned with many types of radiation.

In many countries specturm allocation is one of the major problem that is facing by the ratio communication industry. In setting of spectrum allocation policy it must be keep in mind that minimum bandwidth is given to the operator and with this minimum bandwidth operator must provide high usage with customer satisfaction.

A mobile telephone system would operate with in a limited assigned frequency band and would serve an almost unlimited number of users in unlimited areas. Following are the major approaches in spectrum allocation.

(i) Single sideband, which divides the allocated frequency band into maximum numbers of channels.

(ii) Cellular, which reuses the allocated frequency in different geographical areas.

(iii) Spread spectrum or frequency hoped, which generators many code over a wide frequency band.

Q.5.(a) Explain cell splitting and sectoring ?

Ans. Cell Splitting: Cell splitting is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power. Cell splitting increases the capacity of a cellular system since it increases the number of times that channels are reused. By defining new cells which have a smaller radius than the original cells and by installing these smaller cells (called microcells) between the existing cells, capacity increases due to the additional number of channels per unit area. Fig.(a) illustrates cell splitting from Radius R to R/2 to R/4.

If the radius of the new smaller cell is *R*/2, in order to cover the entire service area with smaller cells, approximately four times as many cells would be required. The increased number of cells would increase the number of clusters over the coverge region, which in turn would increase the number of channels, and thus capacity, in the coverage area.

Sectoring: Another way to increase capacity is to keep the cell radius unchanged and seek methods to decrease the D/R radio. Sectoring increases S/I so that the cluster size may be reduced. In this approach, first the S/I is improved using directional antennas, then capacity improvement is achieved by reducing the number of cells in a cluster, thus increasing the frequency

reuse. However, in order to do this successfully, it is necessary to reduce the relative interference in a cellular system may be decreased by replacing a single Omni-directional antenna at the base station by several directional antennas, each radiating within a specified sector. By using directional antennas, a given cell will receive interference and transmit with only a fraction of the available co-channel cells. The technique for decreasing co-channel interference and thus increasing system performance by using directional antennas is called sectoring. The factor by which the co-channel interference is reduced depends on the amount of sectoring used. A cell is normally partitioned into three 120^0 sectors or six 60^0 sectors as shown in Fig.(b).

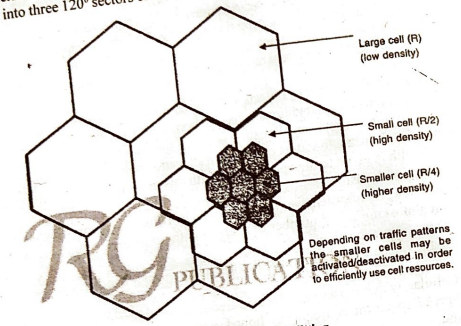


Fig. (a) :An example of cell splitting

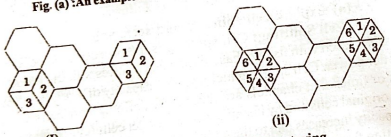


Fig. (b) : (I) 120° sectoring; (ii) 60° sectoring

Q.5.(b) Explain various performance criteria for cellular mobile systems.

Ans. For specification of cellular system following are the performance criteria :

(i) Voice Quality : Voice quality is complicated parameter for design engineers. Because it depends person to person and also all mobile users not uses a common equipment, so in this area designer cannot decide that how to build a system without knowing the voice quality that will satisfied the users.

In Military, Airforce communication, this is not a problem, because Armed forces must use the asssigned equipment. But in general, the voice quality depend upon the following criterion,

a set value x at which y percent of customers rate the system voice quality is good or excellent (from transmitter to receiver). Generally following scaled used for circuit merits (CM) in respect of voice quality.

Circuit Merit	Score	Quality scale
CM 1	1	(Unsatisfactory) not understable
CM 2	2	Poor(Understable, but repetitions are required)
CM 3	3	Fair(Occasional repetitions required)
CM 4	4	Good(Understable, but some noise)
CM 5	5	Excellent

If percentage of customers choosing CM 4, CM 5, the cost of system increases.

The average circuit merits obtained from all the listensrs is called Mean Opinion Score (MOS) usually MOS ≥ 4.

(ii) Service Quality : Following parameter are required to judge the service quality.

– Coverage Area.
– Grade of Service
– Number of Droped Calls.

(iii) Coverage Area : If a system serve as for as possible large area, it is good. But it is not possible to serve 100 percent area due to irregular Geo-graphical structure.

Due to following regions, full coverage of area is not possible.

– The transmitted power must be very high to illuminate weak spots (where reception is not faithful). Which increases the cost.

– The higher the transmitted power, higher the interference.

Hence, a system usually cover 90% area in flat parts, while 60 to 75% in Hill Parts.

(iv) Grade of Services : The grade of service is very good if number of block calls out of 100 is two or less than 2 in peak hour. However, the blocking probability at each cell site is different. To decrease the block calles or blocking probability requires a good system plan and sufficient number of radio channel as well as number of BTS.

(v) Droped Calls : To measure the droped calls, there is a parameter named call drop rate. If during Q calls, $Q-1$ calls are completed then call drop rate is $1Q$, if $Q-2$ calls are completed then call drop rate is $2/Q$.

As for as possible call drop rate must be low. A high drop rate can be caused either coverage problems or handoff problems related to channel availability.

Section-C

Q.6.(a) What do you mean by CSMA ? Explain its various types.

Ans. Carrier sense multiple access (CSMA) : CSMA is a contention-based protocol that was developed to overcome the drawbacks of ALOHA system. This protocol tends to reduce the chances of collisions and thus, improving the performance of the network. This protocol operates on the principle of carrier sensing which states that any station, before attempting to use the channel, must sense it to check whether any other station is using the channel or not. A stattion sends the data only if it finds the channel free, that is when there is no other carrier.

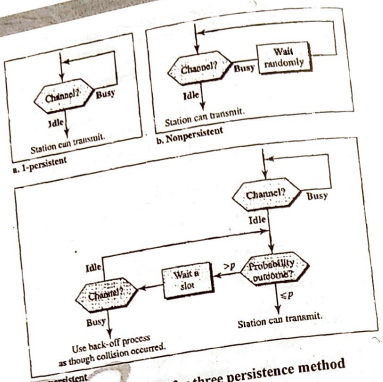


Fig : Flow diagram for three persistence method

There are three variations or types of CSMA protocol, which are as follows:

(i) *Non-persestent CSMA* : In this scheme, if a station wants to transmit a frame and it finds that the channel is busy (someother station is transmitting) then it has to wait for fixed interval of time. After this time, it again checks the status of the channel and if the channel is free transmits.

(ii) *1-Persistent CSMA* : In this scheme, the station which wants to transmit, continuously monitors the channel until it is idle and then transmits immediately. The disadvantage of this strategy is that if two stations transmit simultaneously a collision takes place. Retransmission starts only after finding the channel free.

(iii) *P-Persistent CSMA* : The possibility of such collisions and retransmissions is reduced in the P-Persistent CSMA. In this scheme, all the waiting stations are not allowed to transmit simultaneously as soon as the channel becomes idle. A station is assumed to be transmitting with a probability p. For example, if p= 1/6 and if 6 stations are waiting then on an average, only one station can transmit while others will wait.

Q.6.(b) What do you mean by channel capacity ? Find the expression for radio capacity of a cellular system.

Ans. Channel capacity : Channel capacity of a radio system is defined as the maximum number of channels or users that can be provided in a fixed frequency band.

For a cellular system Radio Capacity is given by

$$m' = \frac{B_t}{(B_c)(N)} \qquad ...(i)$$

where B_t = Total allocated spectrum for the system

B_c = Channel bandwidth

N = Number of cell in frequency reuse pattern

Parameter, m' is determined by the required carrier-to-interference $\left(\frac{C}{I}\right)$ ratio and the channel bandwidth B_c. As shown in Fig., the M closest co-channel cells may be considered as first order interference, in which case $\left(\frac{C}{I}\right)$ is given by

$$\left(\frac{C}{I}\right) = \frac{D_0^{-\alpha_0}}{\sum_{i=1}^{M} D_i^{-\alpha_i}} \qquad ...(ii)$$

where α_0 is the path exponent in the desired cell, D_0 is the distance from the desired base station to the mobile, D_i in the distance of the i^{th} cell from the mobile, and α_i is the path loss exponent to the i^{th} interfering base station. If only the sixth closest interfering cells are considered, and all are approximately at the same distance D and have similar path loss exponents equal to that in the desired cell, them $\left(\frac{C}{I}\right)$ is given by

$$\left(\frac{C}{I}\right) = \frac{D_0^{-\alpha_0}}{6D^{-\alpha}} \qquad ...(iii)$$

Now if it is assumed that maximum interference occurs when mobile is at the cell edge $D_0 = R$, and if the $\left(\frac{C}{I}\right)$. For each user is requires to be greater than some minimum $\left(\frac{C}{I}\right)_{min}$, which is the minimum $\left(\frac{C}{I}\right)$ that still provides acceptable signal quality at the receiver, then the following equation hold for acceptable performance :

$$\frac{1}{6}\left(\frac{R}{D}\right)^{-\alpha} \geq \left(\frac{C}{I}\right) \qquad ...(iv)$$

Since $q = \frac{D}{R}$. Equation (iv) can be written as

$$\left(\frac{C}{I}\right)_{min} = \frac{1}{6}\left(\frac{1}{q}\right)^{-\alpha} \qquad ...(v)$$

Thus co-channel reuse factor q is obtained from Equation (v).

$$q = \left[\frac{1}{6}\left(\frac{C}{I}\right)_{min}\right]^{(1/\alpha)} \qquad ...(vi)$$

As we know that,

$$q = \sqrt{3}\,N$$

$$N = \left(\frac{q^2}{3}\right) \qquad ...(vii)$$

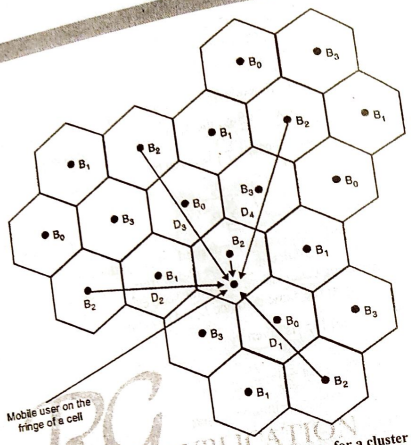


Fig. : Illustration of forward channel interference for a cluster size of N = 4

Substituting Equation (vii) into Equation (i) we get following expression for cellular system capacity

$$m = \frac{B_t}{B_c\left(\frac{q^2}{3}\right)} \qquad ...(viii)$$

Form equations (vi) and (viii) we obtain

$$m = \frac{B_t}{B_c\left[\frac{6}{3^{\alpha/2}}\left(\frac{C}{I}\right)_{min}\right]^{2/\alpha}}$$

Q.7. Write notes on :

(a) Traffic routing in wireless in wireless networks.

(b) CSMA Protocols.

Ans.(a)Traffic routing in wireless in wireless networks : Traffic routing in a wireless network is a very important phenomenon . For any wirleless network, traffic capacity depends upon the type of traffic carrying by the network. Mean it is voice, data, or any other type of signalling. For example, a subscriber's telephone call (voice traffic) requires dedicated network access to provide real-time communications, where as control and signalling traffic may be bursty in nature and may be able to share network resources with other bursty users.

Alternatively, some traffic may have an urgent delivery schedule while some may have no need to be sent in real time.

The type of traffic careried by a network determines the routing services, protocols, and call handling techniques which must be employed.

Two routing services are provided by the netwroks. These are *common-Oriented services* (virtual circuit routing) and *connectionless services* (datagram services).

Common-Oriented services **:** In connection oriented routing, the communication path between the mobile unit(message source) and destination is fixed for the entire duration of message, there is a need to dedicated setup path between the called and calling parties and if path is dedicated and fixed then whatever is transmitted, it will arrive to the destination as it is transmitted. In a connection oriented service, there is always possibility become noisy and if it become noisy, then at destination we will not get exact meassage, so to get exact message, again whole of the data is to be re-transmitted or made a provision, like an efficient error control technique so that data can be protected.

Connectionless services : In connectionless routing, data is always sent in packet form. Several packet form a message and then each individual packet in connectionless service is routed individually. In such transmission, several packet may travel different routes and arrive at the receiver is random order so there is need to re-arrange at the receiver to get exact message.

In packet transmission, some packet may be lost before arriving at the receiver and some packet may get sufficient redundancy to enable the entire message to be recreated at the receiver.

So this technique avoid always re-transmission instead of that requires. More overhead information for each packet.

Typical packet overhead information includes the packet source address, destination address, routing information, information needed to properly order packets at the receiver.

Ans.(b)Carrier Sense Multiple Access (CSMA) Protocols : ALOHA protocols do not listen to the channel before transmission, and therefore do not exploit information about the users. By listening to the channel before engaging in transmission, greater efficiences may be achieved. CSMA protocols are based on the fact that each terminal on the network is able to monitor the status of the channel before transmitting information. If the channel is idle (i.e., no carrier is detected), then the user is allowed to transmit a packet based on a particular algorithm which is common to all transmitters on the network.

In CSMA protocols, *detection delay* and *propagation dealy* are two important parameters. Detection delay is a function of the receiver hardware and is the time required for a terminal to sense whether or not the channel is idle. Propagation delay is a relative measure of how fast it takes for a packet to travel from a base station to a mobile terminal. With a small detection time, a terminal detects a free channel quite rapidly, and small propagation delay means that a packet is transmitted through the channel in a small interval of time relative to the packet duration.

Propagation delay is important, since just after a user begins sending a packet another user may be ready to send and may be sensing the channel at the same time. If the transmitting

packet has not reached the user who is poised to send the latter user will sense an idle channel and will also end send its packet, resulting in a collision between the two packets. Propagation delay impacts the performance of CSMA Protocols. If t_p is the propagation time in seconds, R_b is the channel bit rate, and m is the expected number of the bits in a data packet, then the propagation delay t_d (in packet transmission units) can be expressed as

$$l_d = \frac{t_p R_b}{m}.$$

Section-D

Q.8. Explain architchture of CDMA networks and compare CDMA networks with GSM networks.

Ans.Code Division Multiple Access (CDMA) : In code division multiple access (CDMA) systems, the narrowband message is multiplied by a very large bandwidth signal called the *spreading signal*. The spreading signal is a pseudonoise code sequence that has a chip rate which is orders of magnitudes greater than the data rate of the message. All users in a CDMA system, as seen from Fig., use the same carrier frequency and may transmit simultaneously. Each user has its own pseudorandom codeword which is approximately orthogonal to all other codewords. The receiver performs a time correlation operation to detect only the specific desired codeword. All other codewords appear as noise due to decorrelation. For detection of the message signal, the receiver needs to know the code word used by the transmitter. Each user operates independently with no knowledge of the other users.

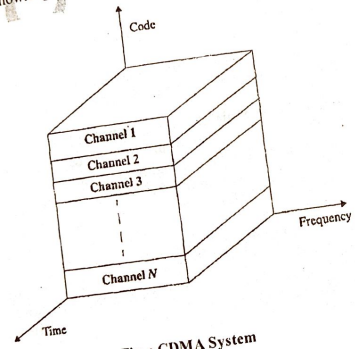


Fig. : CDMA System

In CDMA, the power of multiple users at a receiver determines the noise floor aft decorrelation. If the power of each user with in a cell is not controlled such that they do n appear equal at the base station receiver, then the near-far problem occurs.

The features of CDMA including the following :

- Many users of a CDMA system share the same frequency. Either TDD or FDD may be used.
- Unlike TDMA or FDMA, CDMA has a soft capcity limit. Increasing the number of users in a CDMA system raisers the noise floor in a linear manner. Thus, there is no absolute limit on the number of users in CDMA. Rather, the system performance gradually degrades for all users as the number of users is increased, and improves as the numbers of users is decreased.
- Multipath fading may be substantially reduced because the signal is spread over a large spectrum. If the spread spectrum bandwidth is greater than the coherence bandwidth of the channel, the inherent frequency diversity will mitigate the effects of small scale fading.
- Channel data rates are very high in CDMA systems. Consequently, the symbol (chip) duration is very short and usually much less than the channel delay spread. Since PN sequences have low autocorrelation. multipath which is delayted by more than a chip will appear as noise. A RAKE receiver can be used to improve reception by collecting time delayed versions of the required signal.
- Since CDMA uses co-chanel cells, it can use macroscopic spatial diversity to provide soft handoff. Soft handoff is performed by the MSC, which can simultaneously monitor a particular user from two or more base stations. The MSC may chose the best version of the signal at any time without switching frequencies.
- Self jamming is a problem is CDMA system. Self jamming arises from the fact that the spreading sequences of different users are not exactly orthogonal, hence in the despreading of a particular PN code, non-zero contributions to the receiver decision statistic for a desired user arise from the transmission of other users in the system.
- The near far problem occurs at a CDMA receiver if an undesired has a high detected power as compared to the desired user.

Comparision between CDMA networks with GSM networks :

	CDMA	GSM
Stands for	Code Division Multiple Access	Global system for Mobile communication
Storage Type	Internal Memory	SIM (subscribe identity module) card
Global market share	25%	75%
Dominance	Dominant standard in the U.S	Dominant standard worldwide except the U.S.
Data transfer	EVDO/3G/4G/LTE	GPRS/E/3G/4G/LTE
Network	There is one physical channel and a special code for every device in the coverage network. Using this code, the signal of the device is multiplexed and the same physical channel is used to send the signal.	Every cell has a corresponding network tower, which serves the mobile phones in that cellular area.

International roaming	Less Accessible	Most Accessible
Frequency band	Single (850 MHz)	Multiple (850/900/1800/1900 MHz)
Network service	Handset specific	SIM specific. User has option to select handset of his choice.

Q.9. Explain operation of mobile ad hoc networks.

Ans. Mobile ad-hoc networks : Mobile IP requires.e.g. a home agent, tunnels, and default routers. DHCP requires servers and broadcast capabilities of the medium reaching all participants or relays to servers. Cellular phone networks require base stations, infrastructure networks etc.

However, there may be several situations where users of a network cannot rely on an infrastructure, it is too expensive or there is none at all. In these situations mobile ad-hoc networks are the only choice. The ad-hoc setting up of a connection with an infrastructure is not the main issue here. These network should be mobile and use wireless communications. Examples for the use of such mobile, wireless, multi-hop ad-hoc networks, which are only called ad-hoc networks here for simplicity, are :

- **Instant intrastructure :** Unplanned meetings, spontaneous interpersonal communication etc. cannot rely on any infrastructure. Infrastructures need planning and administration. It would take too long to set up this kind of infrastructure; therefore, ad-hoc connectivity has to be set up.
- **Disaster relief :** Infrastructures typically break down in disaster areas. Hurricanes cut phone and power lines, floods destroy base stations, fires burn servers. Emergency teams can only rely on an infrastructure they can set up themselves. No forward planning can be done, and the set-up must be extremely fast and reliable. The same applies to many military activities which is, to be honest, one of the major driving forces behined mobile ad-hoc networking research.
- **Remote areas :** Even if infrastructures could be planned ahead, it is some-times too expensive to set up an infrastructure in sparsely populated areas. Depending on the communication pattern, ad-hoc networks or satellite infrastructures can be a solution.
- **Effectiveness :** Services provided by existing infrastructures might be too expensive for certain applications. If, for example, only connection-oriented cellular networks exits, but an application sends only a small status information every other minute, a cheaper ad-hoc packet oriented network might be a better solution. Registration procedure might take too long, and communication overheads might be too high with existing network. Application-tailored ad-hoc networks can offer a better solution.

Over the last few years ad-hoc networking has attracted a lot of research interest. This has led to creation of a working group at the IETF that is focussing on mobile ad-hoc networking, called MANET (MANET, 2002), (Corson, 1999). Fig.(1) shows the relation of MANET to mobile IP and DHCP. while mobile IP and DHCP handle the connection of mobile devices to a

fixed infrastructure, MANET comprises mobile routers, too. Mobile devices can be connected either directly with an infrastructure using Mobile IP for mobility support and DHCP as a source of many parameters, such as an IP address. MANET research is responsible for developing protocols and components to enable ad-hoc networking between mobile devices. It should be noted that the separation of end system and router is only a logical separation. Typcially, mobile nodes in an ad-hoc scenario comprise routing and end system functionality.

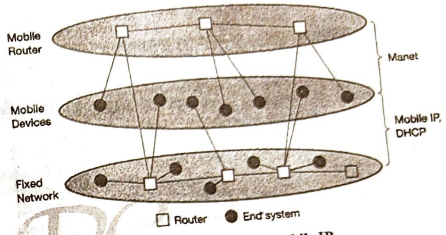


Fig. : MANET and mobile IP

One of the first ad-hoc wireless networks was the packet radio network started by ARPA in 1973. It allowed up to 138 nodes in the ad-hoc network and used IP packets for data transport. This made an easy connection possible to the ARPAnet, the starting point of today's Internet. Twenty radio channels between 1718.4–1840 MHz were used offering 100 or 400 kbit/s The system used DSSS with 128 or 32 chips/bit.

A variant of distance vector routing was used in this ad-hoc network (perlman, 1992). In this approach, each node sends a routing advertisements every 7.5 s. These advertisements contain a neighbor table with a list of link qualities to each neighbor. Each node updates the local routing table according to the distance vector algorithm based on these advertisements. Received packets also help to update the routing table. A sender now transmits a packets to its first hop neighbor using the local neighbor table. Each node forwards a packet received based on its own local neighbor table. Several enhancements to this simple scheme are needed to avoid routing loops and to refect the possibly fast changing topology.

MOBILE & WIRELESS COMMUNICATION

Model Test Paper-II

Paper Code : ECS-CSE-308-G

Note : Attempt five questions in all, selecting one question from each Section. Question No. 1 is compulsory. All questions carry equal marks.

Q.1. (a) Explain the Cordless Telephone System.

Ans. Cordless telephone systems are full duplex communication systems that use radio to connect a portable handset to a dedicated base station, which is then connected to a dedicated telephone line with a specific telephone number on the public switched telephone network (PSTN).

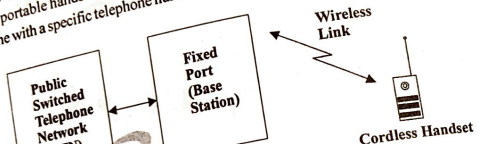


Fig. (a) :A Cordless Telephone system

Q.1.(b) What is EDGE.

Ans. EDGE technology is a modulation technique for GSM networks. An Enhanced Data Rates for GSM Evolution (EDGE) is used to increase network capacity and data rates in mobile networks. EDGE provides data rates up to 384 Kbps.

Q.1.(c) Explain the efficiency of TDMA.

Ans. The efficiency of a TDMA system is a measure of the percentage of transmitted data that contains information as opposed to providing overhead for the access scheme. The frame efficiency, η_f, is the percentage of bits per frame which contains transmitted data. Note that the transmitted data may include source and channel coding bits, so the raw end-user efficiency of a system is generally less than η.

The frame efficiency η_f is given as

$$h_f = \frac{Number\ of\ bits\ /\ frame\ containing\ transmitted\ data}{Total\ number\ of\ bits\ /\ frame}$$

$$\eta_f = \left(1 - \frac{b_{OH}}{b_T}\right) \times 100\%$$

Q.1.(d) What do you mean by Frequency Reuse?

Ans. Frequency reuse is a technique of reusing frequencies and channels within a communications system to improve capacity and spectral0efficiency. Frequency reuse is one of the fundamental concepts on which commercial wireless systems are based that involves the partitioning of an RF radiating area (cell) into segments of a cell. One segment of the cell uses a frequency that is far enough away from the frequency in the bordering segment that it does not provide interference problems. Frequency re-use in mobile cellular systems means that each cell has a frequency that is far enough away from the frequency in the bordering cell that it does not provide interference problems. The same frequency is used at least two cells apart from each other. This practice enables cellular providers to have many times more customers for a given site license.

Q.1.(e) What is Wireless Data Service ?

Ans. Wireless Data Services : Circuit switching is insufficient for dedicated mobile data services such as facsimile (fax), electronic mail (e-mail), and short messaging. First generation cellular systems that provide data communications using circuit switching have difficulty passing modem signals through the autio filters of receivers designed for analog, FM, common air-interfaces. Inevitably, voice filtering must be deactived when data is transmitted over first generation cellular networks, and a dedicated data link must be established over the common air-interface. The demand for packet data serivces has, until recently, been significantly less than the demand for voice services, and first generation subscriber equipment design has focused almost solely on voice only cellular communications. However, in 1993, the US cellular industry developed the cellular digital packet data (CDPD) standard to co-exist with the conventional voice only cellular system. In the 1980s, two other data only mobile services called ARDIS and RAM Mobile Data (RMD) were developed to provide packet ratio connectivity throught a network.

Section-A

Q.2.(a) What are the examples of wireless common system?

Ans. Examples of wireless communication system : Must people are familiar with a number of mobile redio communication system used in everyday life. Garage door openers, remote controllers for home entertainment equipment, cordless telephones, hand-help walkie-talkies, pagers (also called paging receivers or "beepers"), and cellular telephones are all examples of mobile radio communication systems.

Mobile radio transmission systems may be classified as simplex, half-duplex or full-duplex.

In *simplex systems*, communication is possible in only one direction. Paging systems, in which messages are received but not acknowledged, are simplex systems.

Half-duplex radio systems allow two-way communication, but use the same radio channel for both transmission and reception. This means that at any given time, a user can only transmit or receive information. Constraints like "push-to-talk" and "release-to-listen" are fundamental features of half-duplex systems.

Full duplex systems, on the other hand, allow simultaneous radio transimssion and reception between a subscriber and a base station, by providing two simultaneous but separate

channels (frequency division duplex, or FDD) or adjacent time slots on a single radio channel (time division duplex, or TDD) for communication to and from the user.

Frequency division duplexing (FDD) provides simultaneous radio transmission channels for the subscriber and the base station, so that they both may constantly transmit while simultaneously receiving signals from one another. At the base station, separate transmit and receive antennas are used to accommodate the two separate channels. At the subscriber unit, however, a single antenna is used for both transmission to and reception from the base station, and a device called a duplexer is used inside the subscriber unit to enable the same antenna to be used for simultaneous transmission and reception. To facilitate FDD, it is necessary to separate the transmit and receive frequencies by about 5% of the nominal RF frequency, so that the duplexer can provide sufficient isolation while being inexpensively manufactured.

Time division duplexing (TDD) uses the fact that it is possible to share a single radio channel in time, so that a portion of the time is used to transmit from the base station to the mobile, and the remaining time is used to transmit from the mobile to the base station. If the data transmission rate in the channel is much greater than the end-user's data rate, it is possible to store information bursts and provide the appearance of full duplex operation to a user, even though there are not two simutaneous radio transmission at any instant. TDD is only possible with digital transmission formats and digital modulation, and is very sensitive to timing. It is for this reason that TDD has only recently been used, and only for indoor or small area wireless applications where the physical coverage distances (and thus the radio propagation time delay) are much smaller than the many kilometers used in conventional cellular telephone 0systems.

Q.2.(b) Compare the various wireless system.

Ans. Table (1) and Table (2) illustrate the types of service, level of infrastructure, cost and complexity required for the subscriber segment and base station segment of each of the mobile or portable radio systems.

Table (1) : Comparison of Mobile Communication Systems – Mobile Station

Service	Coverage Range	Required infra-structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote control	Low	Low	Low	Low	Infrared	Transmitter
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Transmitter
Paging System	High	High	Low	Low	< 1 GHz	Receiver
Cordless Phone	Low	Low	Moderate	Low	< 1 GHz	Transceiver
Cellular Phone	High	High	High	Moderate	< 2 GHz	Transceiver

faxes

Table (2) : Comparison of Mobile Communication Systems – Base Station

Service	Coverage Range	Required infra-structure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote control	Low	Low	Low	Low	Infrared	Receiver
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Receiver
Paging System	High	High	High	High	< 1 GHz	Transmitter
Cordless Phone	Low	Low	Low	Moderate	< 1 GHz	Transceiver
Cellular Phone	High	High	High	High	< 2 GHz	Transceiver

Q.3.(a) Explain in detail 3rd generation wireless network.

Ans. 3G is the generation of wireless technology offers high data transfer rates for handheld devices. It can transfer both voice data (e.g telephone calls) and nonvoice data (e.g., downloading information and exchanging mails). 3G also provides some multimedia services that are a combination of both voice and data.

Data transfer rates for 3G are as follows:

- For a stationary device, the data transfer rate is 2.05 Mbit/s
- For slowly moving objects it is 384 kbit/s
- For fast moving objects, such as a handset in a moving vehicle, it is 128 kbit/s

The features of 3G are :

- Connectivity is always up because it uses IP connectivity, which is packet based.
- It supports multimedia services.
- It supporsts instant messaging with audio and video clips
- It supports quick download of large files such a PowerPoint presentation and

Some of the 3G standards are :

- CDMA 2000, WCDMA, and TD-SCDMA, based on CDMA
- FDMA/TDMA and TDMA -SC(EDGE), based on TDMA

Following are the advantages and disadvantages of 3G

Advantages :

- It provides both fixed and variable data rates.
- It provides securtiy and reliability
- 3G uses IP connectivity, which is packet based and not circuit based.
- In 3G, data rates are asymmetric.

Disadvantages :

- The cost of upgrading base stations and cellular infrastructure to 3G is high.
- Power requirement is high, which requires larger handsets and larger batterics.

Q.3.(b) Write short notes :

(i) Bluetooth

(ii) Paging system

Ans. (i) Bluetooth : Bluetooth is a wireless communication of low cost, low power, short range radio technlogy, originally it was developed as a cable replacement to connect devices such as mobile phone handsets, headsets, portable computers. By enabling standardised wireless communication between any electrical devices, Bluetooth technology is used to designed a personal area network, which is a kind of close range wireless network. Bluetooth technology implemented partly in hardware and partly as software running on a microprocessor.

Bluetooth is a radio standard and communications protocol primarily designed for low power consumption, with a short range (power class dependent :1 meter, 10 meters, 100 meters) based arround low-cost transceiver microchips in each device. Bluetooth lets these-devices communicate with each other when they are in range. The devices use a radio communication system, so they do not have to be in line of sight of each other, and can even be in other rooms so long as the received transmission is powerful enough. As a result of different antenna designs transmission path attenuations, and other variables, observed ranges are variable; however transmission power levels must fall into one of three classes :

Class	Maximum Permitted Power (mW)	Maximum Permitted Power (dBm)	Range (approximate)
Class 1	100 mW	20 dBm	⊔ 100 meters
Class 2	2.5 mW	4 dBm	⊔ 10 meters
Class 3	1 mW	0 dBm	⊔ 1 meters

(ii) Paging system : Paging systems are communication systems that send brief messages to subscriber. Depending on the type of service, the message may be either a numeric message, an alphanumeric, message, or a voice message. Paging systems are typically used to notify a subscrciber of the need to call a particular telephone number or travel to a known location to receive further instructions. In modern paging systems, news headlines, stock quotations and faxes may be sent. A message is sent to a paging subscriber via the paging system access number (usually a toll-free telephone number) with a telephone keypad or modem. The issued message is called a *page*. The paging system then transmits the page throughout the service area using base station which broadcast the page on a radio carrier.

Paging systems vary widely in their complexity and coverage area. While simple paging systems may cover a limited range of 2 to 5 km, or may even be confined to within individual buildings, wide area paging systems can provide worldwide coverage. Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated. Wide area paging systems consist of network of telephone lines, many base station transmitters, and radio towers that simultaneously broadcast a page from each base station (this is called *simulcasting*). Simulcast transmitters may be located within the same service area or in different cities or countries. Paging systems are designed to provide reliable communication to subscribers wherever they are; whether inside a building, driving on a highway, or flying in an airplane. This necessitates large transmitter powers (on the order of kilowatts) and low data rates (a couple thousand bits per second) for maximum coverage from each base station.

Section-B

Q.4.(a) Explain the operation of cellular system.

Ans. In the operation of the system for having a mobile communication there are four parts along with a gandoff mechanism have to be operated.

The four parts are,

(i) Mobile unit initialization.

(ii) Mobile originated call.

(iii) Networrd originated call.

(iv) Call termination.

and a handoff procedure.

(i) Mobile unit initialization : Consider a subscriber moving in a vehicle who wants to make a call through cell phone. The user activates the receiver of his mobile phone. There are 416 designated channels among which 21 channels are used as set-up channels. As the user activates the mobile unit at first the receiver scans all the 21 set-up channels. It searches for a strongest signal, and as it finds the one it locks on to it for a period of time. Each cell site is allotted a unique set-up channel and the locking on to a stronger signal means that selecting a nearest cell site. Such a procedure is user -independent.

(ii) Mobile originated call : If the user wants to make a call then be places the called number into a register known as originating register in the mobile unit and check for the correct number and then presses the send command button for sending operation. Thereafter set-up channel obtained from self location scheme is used for sending the request for service.

At the cell site it is received and the correct directive antenna is selected for the voice channel for further use. Simultaneously a request is sent from the cell site to the MSC through high-speed data link. With the help of MSC the cell site connects the mobile unit through the best directive antenna.

(iii) Network originated call : The network originated call deals with operations when the calls originate from land-line subscriber. If subscriber wants to make call to a mobile number then the telephone office will recognize it and it will be forwarded to the MTSO/MSC. In connection with it the MTSO sends a paging message to the cell site where the mobile number is available. A relavant search algorithm is used for it.

Every cell site then sends a page (brief message) through the set up channel. MTSO finds the strongest set up channel of the respective cell site and locks on to it and then responds for the page information. Then the subscriber's mobile unit tunes to the assigned voice channel. It also initiates an user alert. Such a method of call intiaiton from MTSO is said to be network originated call.

(iv) Call termination : In call termination procedure once the communication gets over the respective voice channels are made free. That is whenever the mobile subscriber turns off his transmitter a tone is transmitted to the call site for informing that the call is over such a tone is called as signalling tone. Then both the subscriber and call site ends make the voice channels free. Using the strongest set-up channels the mobile unit monitors the page informations. This procedure is called as call termination.

(v) Hand off procedure : The aim of hand-off procedure is to caintain a call in progress inspite of the movement of the mobile unit. When mobile unit moves from one cell to another cell

the call in progress is handed over from the base transceiver station of the old cell where it
subscriber was present to base transceiver station of the new cell where he enters. The call
progress is then monitored and controlled by the new cell site. It goes on like this and the call
progress is not disturbed though the mobile unit is in movement.

Q.4.(b) Discuss in detail Channel Assignment Strategies. (U

Ans. Channel Assignment Strategies : For efficient utilization of the radio spectrum
a frequency reuse scheme that is consistent with the objectives of increasing capacity and minimizing
interference is required. A variety of channel assignment strategies have been developed
achieve these objectives. Channel assignment strategies can be classified as either fixed
dynamic. The choice of channel assignment strategy impacts the performance of the syst
particularly as to how calls are managed when a mobile user is handed off from one cell
another.

(i) Fixed Channel Assignment Strategy : In a fixed channel assignment strategy
each cell is allocated a predetermined set of voice channels . Any call attempt within the cell
only be served by the unused channels in that particular cell. If all the channels in that cell
occupied, the call is blocked and the subscriber does not receive service. Several variations
the fixed assignment strategy exist. In one approach, called the *borrowing strategy*, a cell
allowed to borrow channels from a neighbouring cell if all of its own channels are alre
occupied. The Mobile Switching Center (MSC) supervises such borrowing procedures and ensu
that the borrowing of channel does not disrupt or interfere with any of the calls in progress in
donor cell.

(ii) Dynamic Channel Assignment Strategy : In a dynamic channel assignme
strategy, voice channels are not allocated to different cells permanently. Instead, each time a
request is made, the serving base station requests a channel from the MSC. The switch
allocates a channel to the requested cell following an algorithm that takes into account the likeliho
of future blocking within the cell, the frequency of use of the candidate channel, the re
distance of the channel, and other cost functions. Accordingly, the MSC only allocates a gi
frequency if that frequency is not presently in use in the cell or any other cell which falls wit
the minimum restricted distance of frequency reuse to avoid co-channel interference. Dyna
channel assignment reduces the likelihood of blocking , which increases the trunking capacity
the system, since all the available channels in a market are accessible to all of the cells. Dyna
channel assignment strategies require the MSC to collect real-time data on channel occupan
traffic distribution, and *Radio Signal Strength Indications* (RSSI) of all channnels on a continu
basis. This increases the storage and computational load on the system but provides the advanta
of increased channel utilization and decresed probability of a blocked call.

Q.5. Write short notes on :

(i) Handoff strategies.

(ii) Trunking and grade of services.

(iii) Improving coverage and capacity.

Ans. (i) Handoff strategies : At any instant, each mobile station is logically in
and under the control of the cell's base station. When a mobile station moves out of a cell
base station notices the MS's signal fading away and requests all the neighbouring BSs to

the strength they are receiving. The BS then transfers ownership to the cell getting the strongest signal and the MSC changes the channel carrying the call. The process is called handoff.

There are two types of handoff strategies :

(a) Hard Handoff and

(b) Soft Handoff

(a) Hard Handoff : A hard handoff is one in which the channel in the source cell is released and only then the channel in the target cell is engaged. Thus, the connection to the source is broken before the connection to the target is made-for this reason such handoffs are also known as *break-before-make*. Hard handoffs are intended to be instanteous in order to minimize the disruption to the call. A hard handoof is perceived by network engineers as an event during the call.

An advantage of the hard handoff is that at any moment in time one call uses only one channel. The hard handoff event is ended very short and usually is not perceptible by the user. In the old analog systems it could be heard as a click or a very short beep, in digital systems it is unnoticable. Another advantage of hard handoff is that the phone's hardware does not need the capability of receiving two or more channels in parallel, which makes it cheaper and simpler. A disadvantage is that if a handoff fails the call may be temporarily disrupted or even terminated abnormally. Technologies, which utilise hard handoffs, usually have procedures which can re-establish the connection to the source cell if the connection to the target cell cannot be made. However re-establishing this connection may not always be possible.

(b) Soft Handoffs : A soft handoff is one in which the channel in the source cell is retained and used for a while in parallel with the channel in the target cell. In this case the connection to the target is established before the connection to the source cell is broken, hence this handoff is called *make-before-break*. The interval, during which the two connections are used in paralle, may be brief or substantial. For this reason the soft handoff is perceived by network engineers as a state of the call, rather than a brief event. A soft handoff may involve using connections to more than two cells. When a call is in the state of soft handoff the signal of the best of all used channels can be utilised for the call at a given moment or all the signal can be combined to produce a clearer copy of the signal. The later is more advantageous, and when such combining is performed both in the downlink and the uplink the handoff is termed as softer. Softer handoffs are possible when the cells involved in the handoff have a single cell site.

Ans. (ii) Trunking and grade of services : Cellular radio systems rely on trunking to accommodate a large number of users in a limited radio spectrum. The concept of trunking allows a large network of users to share the relatively small number of channels in a cell by providing access to each user, on demand, from a pool of available channels. In a trunked radio system, each user is allocated a channel on a per unit call basis, and upon termination of the call, the previously occupied channel is immediately returned to the pool of available channels. Trunking exploits the statical behaviour of uses so that a fixed number of channels or circuits may accommodate a large, random user community.

The grade of service (GOS) is a measure of the ability of a user to access a trunked system during the bursiest hour. The busy hour is based upon customer demand at the busiest hour during a week, month or year. The busy hours for cellular radio systems typically occur

during rush hours, between 4 pm and 6 pm on a Thursday or Friday evening. The grade of service is a benchmark used to define the desired performance of a particular trunked system by specifying a desired likelihood of a user obtaining channel access given a specific number of channels available in the system. It is the wireless designer's job to estimate the maximum required capacity and to allocate the proper number of channels in orderser to meet the GOS. GOS is typically given as the likelihood that a call is blocked, or the likelihood of a call experiencing a delay greater than a certain queuing time.

Ans. (iii) Improving coverage and capacity : Various methods of increasing the capacity are:

1. To obtain additional spectrum for new subscribers, simple but expensive,
2. Change the cellular topology

Cell splitting - cells in areas of high uses can be split into smaller cells

Cell sectoring - cells are divided using directional antennas into a number of sectors each with their own set of channels

3. Micro cell - antennas move to buildings, lamp posts. Very small cells, possibly with antenna in every room
4. Antenna and cluster.

Cell Splitting: Cell splitting is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power. Cell splitting increases the capacity of a cellular system since it increases the number of times that channels are reused. By defining new cells which have a smaller radius than the original cells and by installing these smaller cells (called microcells) between the existing cells, capacity increases due to the additional number of channels per unit area. Fig.(a) illustrates how splitting from Radius R to R/2 to R/4.

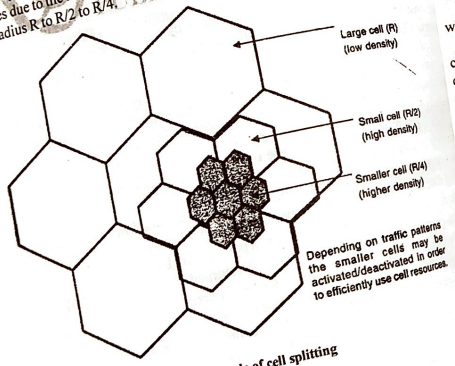


Fig. (a) :An example of cell splitting

If the radius of the new smaller cell is *R*/2, in order to cover the entire service area with smaller cells, approximately four times as many cells would be required. The increased number of cells would increase the number of clusters over the coverge region, which in turn would increase the number of channels, and thus capacity, in the coverage area.

Sectoring: Another way to increase capacity is to keep the cell radius unchanged and seek methods to decrease the D/R radio. Sectoring increases S/I so that the cluster size may be reduced. In this approach, first the S/I is improved using directional antennas, then capacity improvement is achieved by reducing the number of cells in a cluster, thus increasing the frequency reuse. However, in order to do this successfully, it is necessary to reduce the relative interference in a cellular system may be decreased by replacing a single Omni-directional antenna at the base station by several directional antennas, each radiating within a specified sector. By using directional antennas, a given cell will receive interference and transmit with only a fraction of the available co-channel cells. The technique for decreasing co-channel interference and thus increasing system performance by using directional antennas is called sectoring. The factor by which the co-channel interference is reduced depends on the amount of sectoring used. A cell is normally partitioned into three 120° sectors or six 60° sectors as shown in Fig.(b).

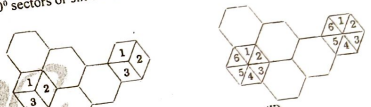


Fig. (b) : (I) 120° sectoring; (ii) 60° sectoring

Microcell Zone : When we employed the sectoring concept, handoff is increased which increases the load on the switching and control link elements of the mobile system.

A solution to this problem was presented by lee. This proposal is based on a microcell concept for N = 7 cell reuse. Following figure explain clearly this concept, in the figure we are considering a three zone site (may be more or less) are connected to a single base station and share the same radio equipment.

The zones are connected by co-axial cable, fiberoptic cable, or microwave link to the base station. As a mobile travels within the cell, it is served by the zone with the strongest signal. This approach is superior to sectoring since Antennas are placed at the outer edges of the cell, and any base station channel may be assigned to any zone by the base station.

As a mobile travels frame one zone to another within the cell, it retains the same channel. Thus, like in a sectoring, a handoff is not required at the MSC when the mobile travels between zones within the cell. The base station simply switches the channel to a different zone site. In this way, a given channel active only in the particular zone in which the mobile is travelling and hence the base station radiation is localized and interference is reduced.

The channel are distributed in time and space by all three zones and are also re-used in co-channel cells in the normal fashion. This technique is use-full along highways or along urbn traffic corridors.

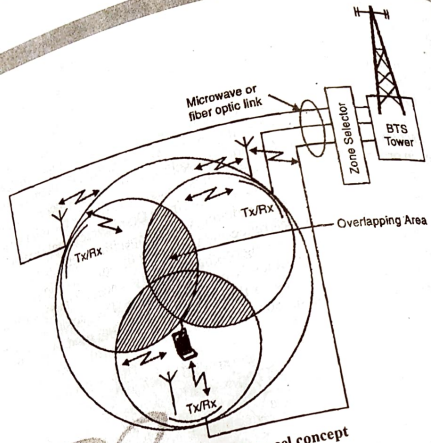


Fig.(c) : The Microcel concept

Antenna and clusters : Generally in hexagonal model base station transmitters a
placed in centre. And maximally, an omnidirectional antennas are used in centre excited cel
The factor *N* is called the cluster size. If the cluster size *N* is reduced, while the cell size is k
constant more clusters are required to cover a given area and hence more capacity is achieve
A larger size of *N* causes the ratio between the cell radius and the distance between a
channel cells to decrease which results weaker co-channel Interference and small cluster is
indicated that co-channel cells are located much closer together.

Section-C

Q.6.(a) Explain the following :
(i) TDFH
(ii) DS/FHMA

Ans. Time Division Frequency Hopping (TDFH) : This multiple access techniq
an advantage in severe multipath or when severe co-channel interference occurs. The subscri
can hop to a new frequency at the start of a new TDMA frame, thus avoiding a severe fad
eresure event on a particular channel. This techique has been adopted for the GSM standa
where the hopping sequence is predefined and the subscriber is allowed to hop only on diffe
frequencies which are assigned to a cell. This scheme also avoids co-channel interference
between neighboring cells if two interfering base station transmitters are made to transmit

different frequencies at different times. The use of TDFH can increase the capacity of GSM by several fold.

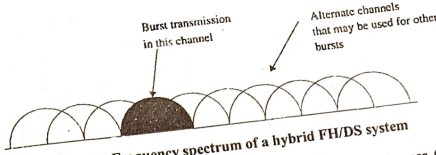


Fig.(1) : Frequency spectrum of a hybrid FH/DS system

(ii) Hybrid direct Sequence/Frequency Hopped Multiple Access (DS/FHMA):
This technique consists of a direct sequence modulated signal whose center frequency is made to hop periodically in a pseudorandom fashion. Fig.(1) shows the frequency spectrum of such a signal [Dix94]. Direct sequence, frequency hopped systems have an advantage in that they avoid the near-far effect. However, frequency hopped CDMA systems are not adaptable to the soft handoff process since it is difficult to synchronize the frequency hopped base station receiver to the multiple hopped signals.

Q.6.(b) Explain the 5 features of TDMA over FDMA.

Ans. The features of TDMA include the following important things :

(i) TDMA shares a single carrier frequency with several users. Where each user makes use of non-overlapping time slots. The number of time slots per frames depends upon various factors such as modulation technique, bandwidth etc.

(ii) Data transmission for users of a TDMA is not continuous but produce in bursts. This result low battery consumption.

(iii) Because of discontinuous transmission in TDMA , the handoff process is much simpler for a subscriber unit.

(iv) Adaptive equalization is usually in necessary TDMA system, since the transmision rates are generally very high as compared to FDMA channels.

(v) In TDMA, the guard time should be minimized.

(vi) High synchronization overhead is required in TDMA systems because of burst transmission.

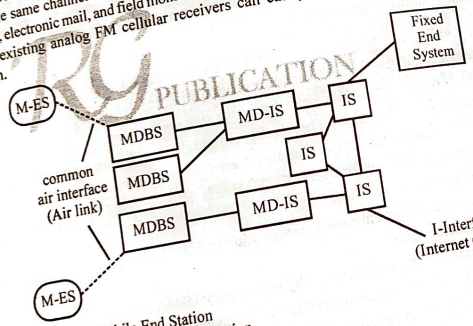
(vii) TDMA has an advantage in that it is possible to allocate different number of time slots per frame to distinct users. Thus, bandwidth can be supplied on demand to different users by concatenating or reassigning time slot based on priority.

Q.7. Explain CDPD network with block diagram.

Ans. CDPD provides mobile packet data connectivity to existing data network and other cellular system without any additional bandwidth requirements. It also capitalizes on the unused air time which occurs between successive radio channel assignments by the MSC.

CDPD directly overlays with existing cellular infrastructure and uses existing base station equipment, making it simple and inexpensive to install. Furthermore, CDPD does not use the MSC, but rather has its own traffic routing capabilities. CDPD occupies voice channels purely on a secondary, noninterfering basis, and packet channels are dynamically assigned (hopped) to different cellular voice channels as they become vacant, so the CDPD radio channel varies with time.

As with conventional, first generation AMPS, each CDPD channel is duplex in nature. The forward channel serves as a beacon and transmits data from the PSTN side of the network while the reverse channel links all mobile users to the CDPD network and serves as the access channel for each subscriber. Collision may result when many mobile users attempt to access the network simultaneously. Each CDPD simplex link occupies a 30 kHz RF channel, and data is sent at 19200 bps. Since CDPD is packet-switched, a large number of modems are able to access the same channel on an as needed, packet-by-packet basis. CDPD supports broadcast dispatch, electronic mail, and field monitoring applications. GMSK BT = 0.5 modulation is used so that existing analog FM cellular receivers can easily detect the CDPD format without redesign.



M-ES : Mobile End Station
MDBS : Mobile Data Base Station
MD-IS : Intermediate Server for CDPD traffic

Fig.(1) : The CDPD network

CDPD transmissions are carried out using fixed-length blocks. User data is protected using a Reed-Solomon (63.47) block code with 6-bit symbols. For each packet, 282 user bits are coded into 378 bit blocks, which provide correction for up to eight symbols.

Two lower layer protocols are used in CDPD. The *mobile data link protocol* (MDLP) is used to convey information between data link layer entities (layer 2 devices) across the CDPD air interface. The MDLP provide logical data link connections on a radio channel by using an address contained in each packet frame. The MDLP also provides sequence control to maintain the sequential order of frames across a data link connection, as well as error detection and flow control. The *radio resource management protocol* (RRMP) is a higher, layer 3 protocol used to manage the radio channel resources of the CDPD system and enables an M-ES to find and utilize a duplex radio channel without interfering with standard voice services. The RRMP handles base-station identification and configuration messages for all M-ES station, and provides information that the M-ES can use to determine usable CDPD channel without knowledge of the history of channel of pawer commands. CDPD version 1.0 uses the X.25 *wide area network* (WAN) subprofile and frame relay capabilites for internal subnetworks.

Table lists the link layer characteristics for CDPD. Fig.(1) illustrates a typical CDPD network.

Table Link layer characteristics for CDPD

Protocols	MDLP, RRMP,X.25
Channel Data Rate (bps)	19200
Channel Bandwidth (kHz)	30
Spectrum Efficiency (b/Hz)	0.64
Random Error Strategy	cover with burst protect
Burst Error Strategy	RS 63,47 (6 bits per symbols)
Fading performance	withstands 2.2 ms fade
Channel Access	slotted DSMA/CD

Q.8. Explain CDMA Cellular Radio N/W.

Ans. CDMA cellular network : A cellular network is a mobile network that provides services by using a large number of base stations with limited power, each covering only a limited area. This area is called a cell. The limited power makes it possible to re-use the same frequency a few cells away from the base station without causing interference. In this way a geographic large area can be covered with only a limited set of frequencies. A cellular network is a very efficient manner of using the scarce frequency resources.

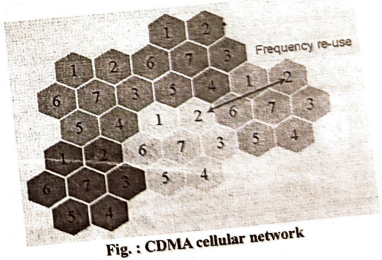


Fig. : CDMA cellular network

The size of a cell can vary according to the number of users that have to be served in a certain area and the amount of traffic per user. If there is much traffic in an area the cell size will be smaller than in rural areas. This idea of frequency-reuse is given in the figure.

In a CDMA system all cells can operate on the same frequency. The users are seperated by the use of different codes. The basic concept of a cellular CDMA network remains the same. It are only the codes instead of the frequencies that have to be distributed over the cells in such a way that the interference remains beneath a certain threshold.

Q.9. What do you mean by GEO, LEO and MEO ? Describe how these satellites can be used for mobile communication.

Ans. Geostationary (or geosynchronous) earth orbit (GEO) : A Geo-synchronous Earth orbit Satellite is one which is placed at an altitude of 22,300 miles above the Earth. This orbit is synchronized with a side real day (i.e., 23hours 56minutes). This orbit can have inclination and eccentricity. It may not be circular. This orbit can be tilted at the poles of the earth. But it appears stationary when observed from the Earth.

The same geo-synchronous orbit, if it is circular and in the plane of equator, it is called a geo-stationary orbit. These Satellites are placed at 35,900kms (same as geosynchronous) above the Earth's Equator and they keep on rotating with respect to earth's direction (west to east). These satellites are considered stationary with respect to earth and hence the name implies.

Geo-Stationary Earth Orbit Satellites are used for weather forecasting, satellite TV, satellite radio and other types of global communications.

Medium earth orbit (MEO): Medium earth orbit (MEO) satellite networks will orbit at distances of about 8000 miles from earth's surface. Signals transmitted from a MEO satellite travel a shorter distance. This translates to improved signal strength at the receiving end. This shows that smaller, more lightweight receiving terminals can be used at the receiving end.

Since the signal is travelling a shorter distance to and from the satellite, there is less transmission delay. Transmission delay can be defined as the time it takes for a signal to travel to a satellite and back down to a receiving station.

For real-time communications, the shorter the transmission delay, the better will be the communication system. As an example, if a GEO satellite requires 0.25 seconds for a round trip then MEO satellite requires less than 0.1 seconds to complete the same trip. MEOs operate in the frequency range of 2 GHz and above.

Low earth orbit (LEO) : The LEO satellites are mainly classified into three categories namely, little LEOs, big LEOs, and Mega-LEOs. LEOs will orbit at a distance of 500 to 1 miles above the earth's surface.

This relatively short distance reduces transmission delay to only 0.05 seconds. It further reduces the need for sensitive and bulky receiving equipment. Little LEOs will operate in the 800 MHz (0.8 GHz) range. Big LEOs will operate in the 2 GHz or above range, and Mega LEOs operates in the 20-30 GHz range.

The higher frequencies associated with Mega-LEOs translates into more information carrying capacity and yields to the capability of real-time, low delay video transmission sch

MOBILE

Note : *Attempt five q*
Question No. 1 is compulsory

Q.1. Briefly explain t
(a) Modulation
(b) Wimax
(c) DHCP
(d) Wireless local loo
(e) File system

Ans. (a) **Modulation :** M
source in a way that is suitable
of a wave. By superimposing a
(or sinusoidal signal), video, vo

In the modulation proce
or phase) is varied in accordan
data transmission.

This modulated signal i

The receiver demodulat
signal back.

Ans.(b)Wimax : Wi-M
Fi is an IEEE 802.16 wireless
wireless access.

Wi-Max is real wireless
a couple of hundred meters for
expensive than that of cellular in

Some industry experts say

Wi-Max is primarily aime
the expense of stringing wires (
range of up to 49.6 kms.

Wi-Max 802.16 has a si
GHz and 66 GHz radio frequency

Ans.(c)DHCP : Dynam
management protocol used to dy
network so they can communicate
manages these configurations. Th
Therefore, there is no requireme
network.

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s much traffic in an area the cell size will
euse is given in the figure.
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threshold.

MEO ? Describe how these satellites

arth orbit (GEO) : A Geo-synchronous
de of 22,300 miles above the Earth. This
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Mega-LEOs translates into more information
l-time, low delay video transmission scheme.

MOBILE AND WIRELESS COMMUNICATION

July - 2021

Paper Code:-ESC-CSE-308-G

Note : ***Attempt five questions in all, selecting one question from each Section. Question No. 1 is compulsory. All questions carry equal marks.***

Q.1. Briefly explain the following terms :

(a) Modulation (3)
(b) Wimax (3)
(c) DHCP (3)
(d) Wireless local loop (3)
(e) File system (3)

Ans. (a) Modulation : Modulation is the process of encoding information from a message source in a way that is suitable for transmission. This is achieved by altering the characteristics of a wave. By superimposing a message on to a high frequency signal known as a carrier wave (or sinusoidal signal), video, voice and other data can be transmitted.

In the modulation process, a parameter of the carrier wave (such as amplitude, frequency or phase) is varied in accordance with the modulating signal. This variation acts as a code for data transmission.

This modulated signal is then transmitted by the transmitter.

The receiver demodulates the received modulated signal and gets the original information signal back.

Ans.(b)Wimax : Wi-Max (Worldwide Interoperability for Microwave Access) or Wider-Fi is an IEEE 802.16 wireless Metropolition Area Network (MAN) standard for broadband wireless access.

Wi-Max is real wireless fidelity with connectivity upto several kilometers, as opposed to a couple of hundred meters for 802.11 a/b/g. Because installation of a WLAN is much less expensive than that of cellular infrastructure (cellphone towers).

Some industry experts say that competitor to the cellphone industry and to 3G technologies.

Wi-Max is primarily aimed at making broadband network access widely available, without the expense of stringing wires (as in cable-access broadband). It promises a wireless access range of up to 49.6 kms.

Wi-Max 802.16 has a single carrier modulation scheme that operates between the 10 GHz and 66 GHz radio frequency, and requires line-of-sight towers for the connection to work.

Ans.(c)DHCP : Dynamic Host Configuration Protocol (DHCP) is a network management protocol used to dynamically assign an IP address to nay device, or node, on a network so they can communicate using IP (Internet Protocol). DHCP automates and centrally manages these configurations. There is no need to manually assign IP addresses to new devices. Therefore, there is no requirement for any user configuration to connect to a DHCP based network.

DHCP can be implemented on local networks as well as large enterprise networks, DHCP is the default protocol used by the most routers and networking equipment. DHCP is also called RFC (Request for comments) 2131.

DHCP does the following :

o DHCP manages the provision of all the nodes or devices added or dropped from the network.

o DHCP maintains the unique IP address of the host using a DHCP server.

o It sends a request to the DHCP server whenever a client/node/device, which is configured to work with DHCP, connects to a network. The server acknowledges by providing an IP address to the client/node/device.

DHCP is also used to configure the proper subnet mask, default gateway and DNS server information on the node or device.

There are many versions of DCHP are available for use in IPV4 (Internet Protocol Version 4) and IPV6 (Internet Protocol Version 6).

How DHCP works : DHCP runs at the application layer of the TCP/IP protocol stack to dynamically assign IP addresses to DHCP clients/nodes and to allocate TCP/IP configuration information to the DHCP clients. Information includes subnet mask information, default gateway, IP addresses and domain name system addresses.

DHCP is based on client-server protocol in which servers manage a pool of unique IP addresses, as well as information about client configuration parameters, and assign addresses out of those address pools.

Ans.(d)Wireless local loop : WLL is a system that connects subscribers to the Public Switched Telephone Network (PSTN) using radio signals as a substitute for copper for all or part of the connection between the subscriber and the switch. This includes bordless access systems, proprietary fixed radio access, and fixed cellular systems.

Modern WLL systems are use CDMA technology. A WLL service provider serves one or more cells. Each cell includes a base station antenna mounted on top of a tall building or tower. Individual subscribers have a fixed antenna antenna mounted on a building or a high pole that has an unobstructed line of sight to the base-station antenna. From the base station, there is a wired or wireless link to a switching centre. The switching centre is typically a telephone exchange, which provides connections to the local and long-distance landline telephone networks. An Internet Service Provider (ISP) may be connected to the switching centre by a high-speed data link.

The WLL has a number of advantages over a wired approach to subscriber loop supports, such as the following :

(a) WLL systems are less expensive than wired systems.

(b) WLL systems typically can be installed rapidly.

(c) Subscriber radio units are installed only for those willing subscribers who want the service at a given time. With a wired system, typically a cable is laid out in anticipation of serving every potential subscriber in a local area.

(d) A large geographical area is still not covered with landline telephone service or not covered for high speed data transmission application.

(e) WLL has become cost-competitive with wired local loops, and new requirements are projected to be met with WLL approach.

(f) Cellular systems are quite expensive and do not provide sufficient facilities to act as a realistic alternative to broadband WLL.

(g) A major advantage of WLL over the cellular mobile system is that the fixed subscriber can use a directional antenna pointed at the base-station antenna, providing improved signal quality in both directions.

Ans. (e) File system : A file system defines how files are named, stored, and retrieved from a storage device.

Every time you open a file on your computer or smart device, your operating system uses its file system internally to load it from the storage device.

Or when you copy, edit, or delete a file, the file system handles it under the hood.

Whenever you download a file or access a web page over the Internet, a file system is involved too.

For instance, if you access a page on freeCodeCamp, your browser sends an HTTP request to freeCodeCamp's server to fetch the page. If the requested resource is a file, it's fetched from a file system.

Unit – I

Q.2. Explain Wireless Communication System with block diagram. (15)

Ans. Working of a Wireless Communication : The system basically consists of three elements-Transmitter, Channel and Receiver.

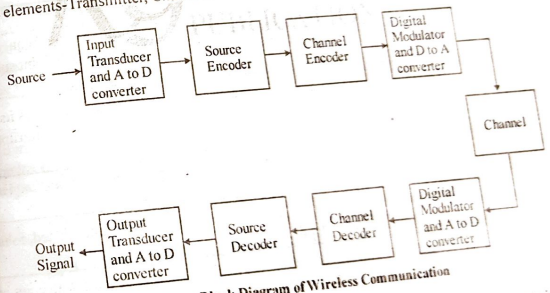


Fig. : Block Diagram of Wireless Communication

– **The Input Transducer :** It takes the physical input signal and converts it into an electrical signal. An analog to Digital Converter of A/D converter this analog signal to digital sequences for further processing.

– **Source Encoder :** This element removes any redundant bits and passes only required information to make effective use of the bandwidth.

– **Channel Encoder :** The channel encoder encodes the signal with some data correction bits like start/stop bits or parity bits to protect the signal from noise due to the external factors.

– **Digital Modulator :** The signal is modulated by a high frequency carrier so that it can travel in the medium. It can use Amplitude modulation, Frequency modulation and Phase modulation.

– **Channel :** Channel can be any physical medium where signal can be transmitted to the receiver end.

– **Digital demodulator :** At the receiver end the first step is to demodulate the received signal and is converted again from analog to digital format.

– **Channel Decoder :** It does the error correction to eliminate the noise at the receiver end. This helps to recover the original signal back.

– **Source Decoder :** Here the signal is again digitised by sampling and quantizing so that we get error-free information.

– **Output transducer :** It brings back the original signal as it was given input to the input transducer. And hence the transmission of the physical signal is completed safely to reach at the receiver end.

Q.3.(a) Differentiate between FDMA and TDMA. (7.5)

Ans. Comparision between TDMA and FDMA are as follows :

S. No.	Approach	TDMA	FDMA
1.	Idea	Segment sending time into disjoint time-slots, demand driven or fixed patterns.	Segment the frequency band into disjoint sub-bands
2.	Terminals	All terminals are active for short periods of time on the same frequency.	Every terminal has its own frequency uninterrupted.
3.	Signal separation	Synchronization in the time domain	Filtering in the frequency domain
4.	Advantages	Established, fully digital very flexible	Simple established, robust
5.	Disadvantages	Guard space needed (multi-path propagation), synchronization difficult	Inflexible, frequencies are a scarce resource
6.	Comment	Standard in fixed networks, together with FDMA/SDMA used in many mobile networks.	Typically combined with TDMA (frequency hopping patterns) and SDMA (frequency reuse).

Q.3.(b) Write a short note on Broadcasting techniques. (7.5)

Ans. Wireless Broadcast Transmission Technologies

There are three leading wireless broadcast link technologies – each based on a different transmission method:

- OFDM / COFDM solutions
- Cellular network solutions
- Video over WiFi solutions

OFDM Technology : OFDM is a method of encoding digital data on multiple carrier frequencies. OFDM / COFDM based wireless video link systems consist of transmitters and receivers, The transmitter is positioned on the camera; the receiver is located inside the OB-van or at the event's media centre where the content is gathered and transmitted forward. OFDM-based solutions usually provide very high picture quality, performance and range, as they are "stand-alone" and don't rely on other networks or equipment. In order to transmit the broadcast content to viewers. These systems typically belong to the high-end broadcast quality level.

Video Links over Cellular Networks : In wireless video links over cellular networks, the transmitter is positioned on the camera or in a backpack carried by the cameraman, transmitting the content over the cellular network and from there to the broadcaster's servers. The receiver is usually a software on the server. Cellular systems often encounter congestion. In crowded events with many phone users, 3G & 4G networks may not provide the bandwidth required to maintain good image quality. Another typical problem is the high latency (up to 3 seconds) of the system.

Video Links over WiFi : In video over WiFi systems. The transmitter is located on the camera and the receiver is either near the WiFi access point in the same location or at the TV station beyond the internet cloud. The main advantage of WiFi video link solutions is their low cost, making the a perfect choice for low-budget productions. The disadvantages are comprised picture quality and stability, crowded frequencies and the fact that they share resources with other applications and users.

Combining two solutions can overcome some of these inherent technological limitations. For example when employing OFDM in a congested cellular environment, the OFDM link can be used to "jump" the first few hundred meters away from the cellular congestion. This solution enables the cellular transmitter to connect to a clear cell,far away from the event, avoiding congestion ad transmitting the braodcast live with minimal delay.

Unit – II

Q.4. Describe the protocol architecture of IEEE 802.11 in detail. (7.5)

Ans. IEEE 802.11 System Architecture : The IEEE 802.11 WLAN standard could be used to provide communication between a number of subscriber terminals as a client/server wireless configuration in infrastructure mode, or as an ad-hoc network using peer-to-peer mode, or a fairly complicated distributed network. The IEEE 802.11 standard defines two basic modes of system architectures to provide connectivity to wireless terminals.

– An *infrastructural mode*, where a number of wireless terminals are either configured as a client/server mode via a wireless LAN Access Point (AP), or as a distributed wireless

network connected to a wired LAN via a number of access points that acts as gateways between the wireless terminals and the wired network. In this mode of operation, the number of wireless terminals are connected to a backbone network through wireless access points.

An *infrastructure-less ad-hoc mode*, where wireless terminals do not require the presence of an access point, and form a network by directly communicating, and co-coordinating, with each other to exchange information through the system. In the ad-hoc system architecture mode, wireless terminals communicate in a peer-to-peer basis.

The key components for all these system architectures are wireless Network Interface Cards (Wireless NIC) installed within wireless terminals and WLAN access points. The WLAN interface cards could be operated in continous aware mode (radio always on) or power-saving polling mode (radio in sleep state to save more power) in which the AP keeps data in its buffer for the wireless terminals and sends a signal to wake them up.

Each access point has a radio coverage area, that is, a limited range of operation, which is typically 200-500 metres in an open environment. The AP is usually placed high on the side walls on the interiors of a building or at the ceiling of a room/corridor and supports a large number of (usually, 115 to 250) wireless terminal users transmitting, receiving, and buffering data between the WLAN and the wired network. Wireless terminals operating within an access point's coverage area are capable of receiving signals from that access point.

In the client/server configuration, many wireless terminals such as laptops equipped with wireless interface cards are physically close to each other, typically 20 to 500 metres. They can be linked to a common AP which functions as a central hub that serves as a bridge between them and the existing wired LAN. The wireless access cards installed as an add-on unit with the wireless terminals provide the interface between the PCs and the antenna, while the AP serves as the WLAN hub.

Fig.(1) illustrates the infrastructure-based WLAN system architecture as client/server wireless configuration.

Fig.(2) illustrates the infrastructure-based WLAN system architecture as a distributed wireless network configuration. As indicated in the figure, an acess point may be implemented as part of a wireless terminal. In fact, the AP may be a logic within a wireless terminal that provides access to the DS by enabling DS services in addition to acting as a wireless terminal. The AP provides access to a Distribution System (DS) through the wireless medium to a number of wireless terminals located within the radio coverage of the AP. It is essential that all participating wireless terminals must execute the same MAC protocol and compete for access to the same shared wireless medium using CSMA/CA protocol. The access-point, together with the wireless terminals associated with it operating within its radio coverage, form a Basic Service Set (BSS). In a BSS, wireless terminals do not communicate directly with one another.

If one wireless terminal in the BSS wants to establish communication with another wireless terminal in the same BSS, the MAC frame is first sent from the calling wireless terminal to the AP, and then from the AP to the called wireless terminal. Thus, the AP can be thought of functioning as a relay point, and a BSS can be referred as a cell. Thus, the two wireless terminals that are communicating within the same BSS get the call routing service from the single AP of that BSS. Distribution services are provided between BSSs; these services may be implemented in an AP or in another special-purpose device attached to the DS.

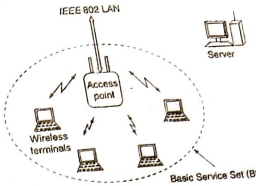


Fig.(1) : Infrastructure-based WLAN client/server architecture

To integrate the IEEE 802.11 architecture with a traditional wired LAN, a portal is deployed. The portal logic is implemented in a device such as a bridge or router which is a part of the wired LAN and attached to the Distribution System (DS). A BSS is also connected to a backbone DS through an access point. The DS can be a switch, a bridged IEEE wired LAN, or another wireless network. Typically, the DS is a wired backbone LAN but can be any communication network. A distribution system connects several BSSs via the AP to form a single network and thereby extends the wireless coverage area.

In other words, the collection of BSSs connected by a wired network (also called a distribution system) is known as an Extended Service Set (ESS). The distribution system connects the wireless networks via the APs with a portal, which forms the interworking unit to other LANs. Thus, an ESS consists of two or more basic service sets interconnected by a distribution system. The ESS has its unique identifier termed as the ESSID. The ESS appears as a single logical LAN to the logical link control layer.

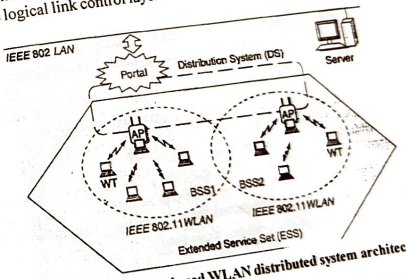


Fig.(2) : Infrastructure-based WLAN distributed system architecture

If a wireless terminal in one BSS wants to establish communication with another wireless terminal located in a different BSS, the MAC frame containing the ESSID is first sent from the calling wireless terminal to the AP of its home BSS, and then relayed by the AP over the DS on

its way to the destination BSS and then finally called to remote wireless terminal via its AP. Thus, the AP can be thought of functioning as a bridge as well as a relay point, and an ESS can be referred as a cellular network. The ESSID is used to identify different network and may be cannot participate in the WLAN. (7.5)

Q.5. Explain the following : (7.5)

(a) GSM

(b) Bluetooth

Ans. (a) GSM : GSM system architecture consist various number of component which connected to various elements to provide GSM service. But mainly it is divided in four part.

(i) BSS (Base Station Subsystem) (ii) NSS (Network Switching System)

(iii) NMS (Network Management System) (iv) MS (Mobile Station)

Simplified structure of GSM architecture is shown in Fig.(a). Thick line picture represent to carry traffic and dashed line is to use for signalling only.

Abbreviations:

MS	Mobile Station
BTS	Base Transceiver Station
BSC	Base Station Controller
MSC	Mobile Service Switching Center
GMSC	Gateway MSC
VLR	Visitor Location Register
HLR	Home Location Register
EIR	Equipment Identity Register

MSC (Mobile Service Switching Center). MSC is responsible for following:

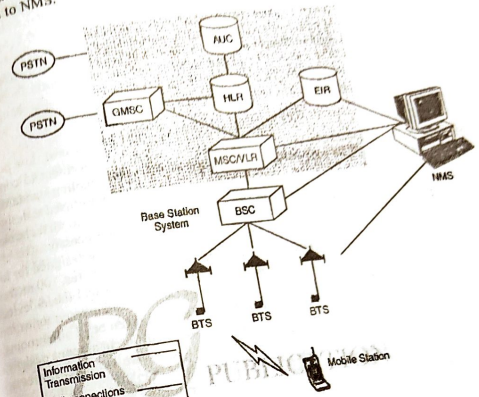
1. Call establish, supervision, call terminate.
2. Mobility management (to keep record of mobile subscriber).
3. Initiation of Paging (to search a particular subscriber is case of mobile terminated call).
4. Collection of charging information and send to billing gateway for further processing. This charging information based on various parameter that is called call tarrif.

It is important to note that VLR is a intergrated part of MSC, it is not isolated cabinet. VLR is only subscriber data base associated with MSC.

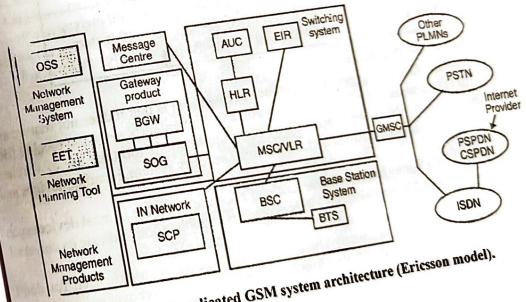
Base Station Controller (BSC) : BSC manages all the ratio-related functions of GSM network. It is a high capacity switch that provides functions such as MS handover, radio channel assignment and the collection of cell configuration data. More than channel assignment and the collection of cell configuration data. More than one BSC can be control by single MSC. Following are the functions of BSC.

1. Connection establishment between the MS and the NSS.
2. Mobility management.
3. Statistical raw data collection.
4. BTS and TC control.
5. Power control of MS, which depend upon measurement report sent by MS to network.

Statistical raw data consist information from the BTS, TC, and collected in BSC and forwarded to NMS.



Fig(a) : Simple GSM system architecture.



Fig(b) : Complicated GSM system architecture (Ericsson model).

Base Transceiver Station (BTS) : BTS is connected with BSC through TC and it consist TRx, Directional Coupler, combiner etc. Antenna is directly connected with BTS. BTS also consist A_5 algorithm. Functions of BTS are as follows.

1. Air interface signalling (towards MS)
2. Ciphering (speech coding)
3. Speech processing (channel coding, interleaving, burst formating).
4. Generation of alarms report.
5. Baseband/radio frequency transformation.
6. Modulation of voice/data.

Ans.(b) Bluetooth : Bluetooth is a wireless communication of low cost, low power, short range radio technology, originally it was developed as a cable replacement to connect devices such as mobile phone handsets, headsets, portable computers. By enabling standardised wireless communication between any electrical devices, Bluetooth technology is used to designed a personal area network, which is a kind of close range wireless network. Bluetooth technology implemented partly in hardware and partly as software running on a microprocessor.

Bluetooth is a radio standard and communications protocol primarily designed for low power consumption, with a short range (power class dependent :1 metre, 10 metres, 100 metres) based arround low-cost transceiver microchips in each device. Bluetooth lets these-devices communicate with each other when they are in range. The devices use a radio communication system, so they do not have to be in line of sight of each other, and can even be in other rooms, so long as the received transmission is powerful enough. As a result of different antenna designs, transmission path attenuations, and other variables, observed ranges are variable; however, transmission power levels must fall into one of three classes :

Class	Maximum Permitted Power (mW)	Maximum Permitted Power (dBm)	Range (approximate)
Class 1	100 mW	20 dBm	100 meters
Class 2	2.5 mW	4 dBm	10 meters
Class 3	1 mW	0 dBm	1 meters

Advantages of Bluetooth

(1) Wireless : One of the major advantages of bluetooth is that it does not require any form of wires for it to transmit data. Through this you can conveniently send and receive files without needing to worry about the cables. Many other applications too take use of wireless bluetooth technology. Such applications include personal security system, locating devices and health monitoring.

(2) Availability : Today bluetooth is an exclusive feature available in most devices such as smart phones and tablets. These numerous kinds of devices with bluetooth indicate its universal availability.

(3) Usability : Due to its simplicity bluetooth can be used by any rookie user. You don't have to be knowledgeable in the field of technology for using bluetooth. Moreover pairing process is relatively easy in bluetooth. There is no any software or driver installation process involved

here. Additionally the pairing process is even made simpler. All you have to do is turn on bluetooth on both of the devices and make them discoverable. As long as they are in the coverage range, the devices will be connected instantly. Some devices requires you of entering PIN authentication.

(4) Efficiency : Another primary advantages of bluetooth is its energy efficiency which drives to low power consumption. This is generally because of the low power signals being used by the bluetooth. Especially for the Bluetooth Low Energy (BLE) standard. This makes them ideal for electronic devices with small form factor, so that the minimal battery life can be maintained.

Unit – III

Q.6. What is Mobile IP ? Explain its goals. Also explain about IP packet delivery. (15)

Ans. Mobile IP is a communication protocol (created by extending Internet Protocol, IP) that allows the users to move from one network to another with the same IP address. It ensures that the communication will continue without user's sessions or connections being dropped.

Mobile IP Functional Entities : Mobile IP introduces the following new functional entities:

(i) *Mobile Node* (MN)–Host or router that changes its point of attachment from one network to another.

(ii) *Home Agent* (HA)–Router on a mobile node's home network that intercepts datagrams destined for the mobile node, and delivers them through the care-of address. The home agent also maintains current location information for the mobile node.

(iii) *Foreign Agent* (FA)–Router on a mobile node's visited network that provides routing services to the mobile node while the mobile node is registered.

Its **goal** is to provide the ability of a host to stay connected to the internet regardless of their location. Mobile IP is able to track a mobile host without needing to change the mobile host's long-term IP address.

IP packet delivery : The following explains how an IP packet is delivered from a CN connected via a router to the internet, as are the home network and the foreign network.

Fig. illustrates packet delivery to and from the MN

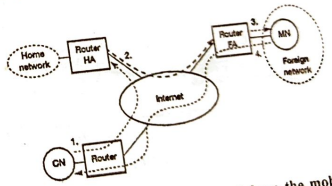


Fig. Packet deliveries to and from the mobile node

As shown the packet is delivered in 4 Steps :

Step 1: CN sends an IP packet with MN as a destination address and CN as a source. CN does not need to know anything about the MN's current location and sends the packet as usual to the IP address of MN.

The internet, not having information on the current location of MN, routes the packet to the router responsible for the home network of MN. This is done using the standard routing mechanisms of the internet.

Step 2: The HA now intercepts the packet, knowing that MN is currently not in its home network.

A new header is put in front of the old IP header showing the COA as new destination and HA as source of the encapsulated packet

Step 3: The foreign agent now decapsulates the packet, i.e., removes the additional header, and forwards the original packet with CN as source and MN as destination to the MN.

Again, for the MN mobility is not visible. It receives the packet with the same sender and receiver address as it would have done in the home network.

Step 4: The MN sends the packet as usual with its own fixed IP address as source and CN's address as destination

The router with the FA acts as default router and forwards the packet to CN.

Q.7.(a) What do you understand by Snooping TCP ? Explain in detail. (7.5)

Ans. Snooping TCP : One of the disadvantages of I-TCP is that a single TCP connection is split into two, thus losing the original end-to-end semantic. Snooping TCP is a transparent extension of TCP, leaving its end-to-end connection intact.

The main concept in snooping TCP is that packets are buffered close to the MH for fast local retransmission in case of packet loss. This buffering can be done at the FA. Fig.(1) shows how this done. All packets destined for the MH are buffered at the FA, which also 'snoops' the packet flow in both directions. Lost packets on the wireless link (both directions) will retransmitted (locally immediately by the MH or by the FA, respectively, from the buffer, performing a much faster retransmission compared to the CN. The timeouts for acknowledgments can be much shorter, because they consists of a one-hop delay and processing time.

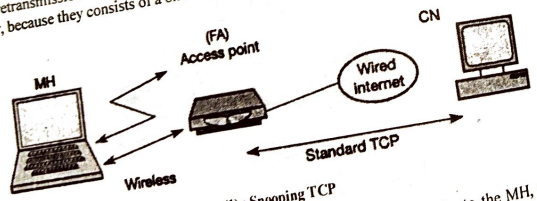


Fig.(1) : Snooping TCP

Transparency is achieved in the following way. For data transfer to the MH, the FA buffers data until it receives an acknowledgement (ACK) from the MH. Packet loss is detected

by duplicated ACKs or timeout. In this way, fast retransmission is possible, which is transparent to the fixed network. For data transfer from the MH, the FA detects packet loss on the wireless link via sequence numbers and answers directly with a negative acknowledgement (NACK) to the MH. The MH can now retransmit data with only a very short delay.

Snooping TCP has the following advantages :

- It maintains end-to-end semantics.
- No change is required to the CN.

But several problems also exist, giving rise to the following disadvantages :

- Snooping TCP does not isolate the wireless link as well as I-TCP.
- It may need change to MH to handle NACKs.
- Snooping may become useless if end-to-end encryption schemes are applied between CN and MH.

Q.7.(b) Explain operation of mobile ad hoc networks. (7.5)

Ans. Mobile ad-hoc networks : Mobile IP requires,e.g. a home agent, tunnels, and default routers. DHCP requires servers and broadcast capabilities of the medium reaching all participants or relays to servers. Cellular phone networks require base stations, infrastructure networks etc.

However, there may be several situations where users of a network cannot rely on an infrastructure, it is too expensive or there is none at all. In these situations mobile ad-hoc networks are the only choice. The ad-hoc setting up of a connection with an infrastructure is not the main issue here. These network should be mobile and use wireless communications. Examples for the use of such mobile, wireless, multi-hop ad-hoc networks, which are only called ad-hoc networks here for simplicity, are :

- **Instant intrastructure :** Unplanned meetings, spontaneous interpersonal communication etc. cannot rely on any infrastructure. Infrastructures need planning and administration. It would take too long to set uo this kind of infrastructure; therefore, ad-hoc connectivity has to be set up.
- **Disaster relief :** Infrastructures typically break down in disaster areas. Hurricanes cut phone and power lines, floods destroy base stations, fires burn servers. Emergency teams can only rely on an infrastructure they can set up themselves. No forward planning can be done, and the set-up must be extremely fast and reliable. The same applies to many military activities which is, to be honest, one of the major driving forces behined mobile ad-hoc networking research.
- **Remote areas :** Even if infrastructures could be planned ahead, it is some-times too expensive to set up an infrastructure in sparsely populated areas. Depending on the communication pattern, ad-hoc networks or satellite infrastructures can be a solution.
- **Effectiveness :** Services provided by existing infrastructures might be too expensive for certain applications. If, for example, only connection-oriented cellular networks exits, but an application sends only a small status information every other minute, a cheaper ad-hoc packet oriented network might be a better solution. Registration procedure might take too long, and communication overheads might be too high with existing network. Application-tailored ad-hoc networks can offer a better solution.

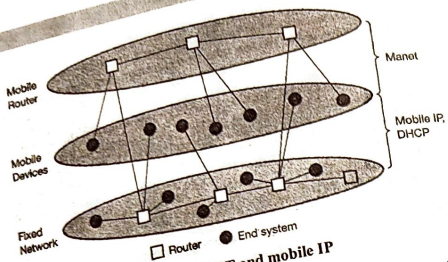


Fig. : MANET and mobile IP

Over the last few years ad-hoc networking has attracted a lot of research interest. This has led to creation of a working group at the IETF that is focussing on mobile ad-hoc networking, called MANET (MANET, 2002), (Corson, 1999). Fig.(1) shows the relation of MANET to mobile IP and DHCP. while mobile IP and DHCP handle the connection of mobile devices to a fixed infrastructure, MANET comprises mobile routers, too. Mobile devices can be connected either directly with an infrastructure using Mobile IP for mobility support and DHCP as a source of many parameters, such as an IP address. MANET research is responsible for developing protocols and components to enable ad-hoc networking between mobile devices. It should be noted that the separation of end system and router is only a logical separation. Typcially, mobile nodes in an ad-hoc scenario comprise routing and end system functionality.

One of the first ad-hoc wireless networks was the packet radio network started by ARPA in 1973. It allowed up to 138 nodes in the ad-hoc network and used IP packets for data transport. This made an easy connection possible to the ARPAnet, the starting point of today's Internet. Twenty radio channels between 1718.4–1840 MHz were used offering 100 or 400 kbit/s The system used DSSS with 128 or 32 chips/bit.

A variant of distance vector routing was used in this ad-hoc network (perlman, 1992). In this approach, each node sends a routing advertisements every 7.5 s. These advertisements contain a neighbor table with a list of link qualities to each neighbor. Each node updates the local routing table according to the distance vector algorithm based on these advertisements. Received packets also help to update the routing table. A sender now transmits a packets to its first hop neighbor using the local neighbor table. Each node forwards a packet received based on its own local neighbor table. Several enhancements to this simple scheme are needed to avoid routing loops and to refect the possibly fast changing topology.

Unit – IV

Q.8. What do you mean by GEO, LEO and MEO ? Describe how these satellites can be used for mobile communication. (15)

Ans. Geostationary (or geosynchronous) earth orbit (GEO) : A Geo-synchronous Earth orbit Satellite is one which is placed at an altitude of 22,300 miles above the Earth. This orbit is synchronized with a side real day (i.e., 23hours 56minutes). This orbit can have inclination and eccentricity. It may not be circular. This orbit can be tilted at the poles of the earth. But it appears stationary when observed from the Earth.

The same geo-synchronous orbit, if it is circular and in the plane of equator, it is called as geo-stationary orbit. These Satellites are placed at 35,900kms (same as geosynchronous) above the Earth's Equator and they keep on rotating with respect to earth's direction (west to east). These satellites are considered stationary with respect to earth and hence the name implies.

Geo-Stationary Earth Orbit Satellites are used for weather forecasting, satellite TV, satellite radio and other types of global communications.

Medium earth orbit (MEO): Medium earth orbit (MEO) satellite networks will orbit at distances of about 8000 miles from earth's surface. Signals transmitted from a MEO satellite travel a shorter distance. This translates to improved signal strength at the receiving end. This shows that smaller, more lightweight receiving terminals can be used at the receiving end.

Since the signal is travelling a shorter distance to and from the satellite, there is less transmission delay. Transmission delay can be defined as the time it takes for a signal to travel up to a satellite and back down to a receiving station.

For real-time communications, the shorter the transmission delay, the better will be the communication system. As an example, if a GEO satellite requires 0.25 seconds for a round trip, then MEO satellite requires less than 0.1 seconds to complete the same trip. MEOs operates in the frequency range of 2 GHz and above.

Low earth orbit (LEO) : The LEO satellites are mainly classified into three categories namely, little LEOs, big LEOs, and Mega-LEOs. LEOs will orbit at a distance of 500 to 1000 miles above the earth's surface.

This relatively short distance reduces transmission delay to only 0.05 seconds. This further reduces the need for sensitive and bulky receiving equipment. Little LEOs will operate in the 800 MHz (0.8 GHz) range. Big LEOs will operate in the 2 GHz or above range, and Mega-LEOs operates in the 20-30 GHz range.

The higher frequencies associated with Mega-LEOs translates into more information carrying capacity and yields to the capability of real-time, low delay video transmission scheme.

Q.9. Explain the following : (7.5)

(a) HTML (7.5)

(b) Wireless Transaction Protocol

Ans. (a) HTML : HTML stands for *HyperText Markup Language*. It is used to design web pages using a markup language. It is the combination of Hypertext and Markup language. Hypertext defines the link between the web pages. A markup language is used to define the text document within tag which defines the structure of web pages. It is a markup language that is used by the browser to manipulate text, images, and other content to display in the required format.

HTML helps to structure our website well. The way a skeleton system gives a structure to the human body, in a similar manner, it acts as a skeleton for a website, without it a website cannot be made. If you want to work as a Software Developer especially in the Web Development domain, then learning HTML is a must, because without knowledge of it you cannot build a website.

· *Base for creating websites* : It is the basic necessity a developer should know while building a website from scratch.

· *Learn web development* : It is the first step towards learning Web Development. Once you learn it, you can build simple, static websites very easily.

· *Can become freelancer* : Since web development has the best scope in freelancing, therefore learning it will surely help you to get the best deals of website development in the market.

Basic Format: It is the basic format of create a simple web page.

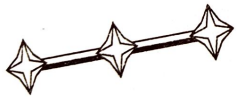
```
<!DOCTYPE html>
<html>
<head>
        <!— Head section of website—>
        <title></title>

</head>
<body>
        <!— Body section of website —>

</body>
</html>
```

Ans.(b) Wireless Transaction Protocol (WTP) : WTP defines the WAP transaction layer. WTP provides functions similar to TCP, except that WTP has reduced the amount of information needed for each transaction. In other words, WTP is "lighter" than TCP, which saves processing and memory costs in a WAP handset.

WTP is message-oriented. The basic unit of interchange is an entire message instead of a stream of bytes. WTP supports three types of transaction : unreliable one-way requests, reliable one-way requests, and reliable two-way, request-reply transaction. To provide reliability, WTP uses unique transaction identifiers, acknowledgments, duplicate removal, and retransmissions. A WTP user can confirm each received message to enhance reliability.



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MOBILE AND WIRELESS COMMUNICATION

July – 2022

Paper Code:-ESE-CSE-308-G

Note : ***Attempt five questions in all, selecting one question from each Section. Question No. 1 is compulsory. All questions carry equal marks.***

Q.1. Define the following :

(a) SDMA (2.5)

(b) DAMA (2.5)

(c) Bluetooth Networking (2.5)

(d) IP Packet delivery (2.5)

(e) GEO (2.5)

(f) LEO (2.5)

Ans.(a) Spread spectrum multiple access : Spread Spectrum multiple access (SSMA) uses which have a transmission bandwidth that is several orders of magnitude greater than the minimum required RF bandwidth, A pseudo-noise (PN) sequence converts a narrowband signal to a wideband noise-like signal before transmission. SSMA also provides immunity to multipath interference and robust multiple access capability. SSMA is not very bandwidth efficient when used by a single user. However, since many users can share the same spread spectrum bandwidth without interfering with one another, spread spectrum systems become bandwidth efficient in a multiple user environment. It is exactly this situation that is of interest to wireless system designers. There are two main types of spread spectrum multiple access techniques; frequency hopped multiple access (FH) and direct sequence muliple access (DS). Direct sequence multiple access is also called code division multiple access (CDMA).

Ans.(b) DAMA : Demand Access Multiple Access(DAMA) is generally used for the earth stations where the traffic condition of that particular station is been changing continuously. It is a process of allocation of satellite channels to a user on demand. There is a great increase in the number of simultaneous uses on demand of allocation of channels that can be served by the system. For example, let us consider telephone voice communication users i.e. they communicate at a random time, some talk for more than minutes, or hours, and some talk for less than minutes or hours. So each user is been allocated a fixed channel. That means, accordingly most of the time the channel will be idle resulting in better utilization of the system. The **Demand Access Multiple Access** [DAMA] has two different types of channels, they are:

• Common Signalling Channel (CSC).
• Communication Channel.

For entering the communication system the user first needs to call the controlling earth station using the Common Signalling Channel (CSC), and then a pair of channels is been allocated to that used for communication by the controller. Packet transmission techniques are been used widely in Demand Access Multiple Access (DAMA)because it determines the source and destination.

Ans.(c)Bluetooth Networking : Bluetooth wireless technology is a short range communications technology intended to replace the cables connecting portable unit and maintaining high levels of security. Bluetooth technology is based on Ad-hoc technology also known as Ad-hoc Pico nets, which is a local area network with a very limited coverage.

The usage of Bluetooth has widely increased for its special features.

• Bluetooth offers a uniform structure for a wide range of devices to connect and communicate with each other.
• Bluetooth technology has achieved global acceptance such that any Bluetooth enabled device, almost everywhere in the world, can be connected with Bluetooth enabled devices.
• Low power consumption of Bluetooth technology and an offered range of up to ten meters has paved the way for several usage models.
• Bluetooth offers interactive conference by establishing an adhoc network of laptops.
• Bluetooth usage model includes cordless computer, intercom, cordless phone and mobile phones.

Ans.(d) IP packet delivery : The delivery of an IP packet to its final destination is accomplished by means of either direct or indirect delivery. Direct delivery occurs when the source and destination of the packet are located on the same physical network. The sender can easily determine whether the delivery is direct or not by extracting the network (IP) address of the destination packet and comparing this address with the addresses of the networks to which it is connected. If a match is found, the delivery is direct. In direct delivery, the sender uses the senders IP address to find the destination physical address. This mapping process can be done by Address Resolution Protocol (ARP).

If the destination host is not on the same network as the source host, the packet will be delivered indirectly. In an indirect delivery, the packet goes from router to router through a number of networks until it reaches one that is connected to the same physical network as its final destination. Thus, the last delivery is always a direct delivery, which always occurs after zero or more indirect deliveries. In an indirect delivery, the sender uses the destination IP address and a routing table to find IP address of the next router to which the packet should be delivered. The sender then uses the ARP to find the physical address of the next router.

Ans.(e) Geostationary orbit (GEO) : Satellites in geostationary orbit (GEO) circle Earth above the equator from west to east following Earth's rotation – taking 23 hours 56 minutes and 4 seconds – by travelling at exactly the same rate as Earth. This makes satellites in GEO appear to be 'stationary' over a fixed position. In order to perfectly match Earth's rotation, the speed of GEO satellites should be about 3 km per second at an altitude of 35 786 km. This is much farther from Earth's surface compared to many satellites.

GEO is used by satellites that need to stay constantly above one particular place over Earth, such as telecommunication satellites. This way, an antenna on Earth can be fixed to always stay pointed towards that satellite without moving. It can also be used by weather monitoring satellites, because they can continually observe specific areas to see how weather trends emerge there.

Satellites in GEO cover a large range of Earth so as few as three equally-spaced satellites can provide near global coverage. This is because when a satellite is this far from Earth, it can cover large sections at once. This is akin to being able to see more of a map from a metre away compared with if you were a centimetre from it. So to see all of Earth at once from GEO far fewer satellites are needed than at a lower altitude.

Ans.(f) Low Earth orbit (LEO) : A low Earth orbit (LEO) is, as the name suggests, an orbit that is relatively close to Earth's surface. It is normally at an altitude of less than 1000 km but could be as low as 160 km above Earth – which is low compared to other orbits, but still very far above Earth's surface.

By comparison, most commercial aeroplanes do not fly at altitudes much greater than approximately 14 km, so even the lowest LEO is more than ten times higher than that. Unlike satellites in GEO that must always orbit along Earth's equator, LEO satellites do not always have to follow a particular path around Earth in the same way – their plane can be tilted. This means there are more available routes for satellites in LEO, which is one of the reasons why LEO is a very commonly used orbit.

LEO's close proximity to Earth makes it useful for several reasons. It is the orbit most commonly used for satellite imaging, as being near the surface allows it to take images of higher resolution. It is also the orbit used for the International Space Station (ISS), as it is easier for astronauts to travel to and from it at a shorter distance. Satellites in this orbit travel at a speed of around 7.8 km per second; at this speed, a satellite takes approximately 90 minutes to circle Earth, meaning the ISS travels around Earth about 16 times a day.

However, individual LEO satellites are less useful for tasks such as telecommunication, because they move so fast across the sky and therefore require a lot of effort to track from ground stations.

Section – A

Q.2.(a) Explain the different generation in cellular wireless networks. (8)

Ans. The aim of each different generation development is to improve the speed and capability of the wireless connection. It is only data that is carried by the later generations though, as voice is still mostly carried using 2G technology.

Cellular communication is progressing through different generations. Initially we had first generation (1G), then second generation (2G). This developed into third generation (3G) and now that has advanced into fourth generation (4G) and fifth generation (5G). All of the names refer to the generation of wireless communications that the technology has gone through.

1G First Generation : This was the first generation of cell phone technology. The very first generation of commercial cellular network was introduced in the late 70's with fully implemented standards being established throughout the 80's.

1G is an analog technology and the phones generally had poor battery life and voice quality was large without much security, and would sometimes experience dropped calls. These are the analog telecommunications standards that were introduced in the 1980s and continued until being replaced by 2G digital telecommunications. The maximum speed of 1G is 2.4 Kbps.

2G Second Generation : Cell phones received their first major upgrade when they went from 1G to 2G. The main difference between the two mobile telephone systems (1G and 2G), is that the radio signals used by 1G network are analog, while 2G networks are digital. Main motive of this generation was to provide secure and reliable communication channel. It implemented the concept of CDMA and GSM. Provided small data service like sms and mms. Second generation 2G cellular telecom networks were commercially launched in 1991.

During 2G Cellular phones are used for data also along with voice. The advance in technology from 1G to 2G introduced many of the fundamental services that we still use today, such as

- SMS
- internal roaming
- conference calls
- call hold and
- billing based on services e.g. charges based on long distance calls and real time billing.

The max speed of 2G with General Packet Radio Service (GPRS) is 50 Kbps or 1 Mbps with Enhanced Data Rates for GSM Evolution (EDGE).

3G Third Generation : This generation set the standards for most of the wireless technology we have come to know and love. Web browsing, email, video downloading, picture sharing and other smartphone technology were introduced in the third generation. Introduced

commercially in 2001, the goals set out for third generation mobile communication were to facilitate greater voice and data capacity, support a wider range of applications, and increase data transmission at a lower cost.

3G has Multimedia services support along with streaming are more popular. In 3G, Universal access and portability across different device types are made possible (Telephones, PDA's, etc.). 3G increased the efficiency of frequency spectrum by improving how audio is compressed during a call, so more simultaneous calls can happen in the same frequency range. 3G technology is capable of allowing internet speeds that can reach 7 Mbps, but this speed is unrealistic and is often approximately 2 to 3 Mbps.

People felt that the speeds reached by 3G technology were better, but that speed and access could still be improved regarding the internet and mobile devices. This encouraged the development of 4G technology, the 4th generation of mobile communication standard.

4G Fourth Generation : 4G is a very different technology as compared to 3G and was made possible practically only because of the advancements in the technology in the last 10 years. Its purpose is to provide high speed, high quality and high capacity to users while improving security and lower the cost of voice and data services, multimedia and internet over IP. Potential and current applications include;

- mobile web access
- IP telephony
- gaming services
- high definition mobile TV
- video conferencing
- 3D television, and
- cloud computing

The development of 4G technology provided two main benefits, increased upload and download speeds and reduced latency. 4G technology is approximately five times (and sometimes more) faster than 3G technology. This meant that the speed at which files could be downloaded was significantly increased. This increase in speed meant that files could be downloaded in a much faster time. Typically, with 3G technology, a 2GB file could take approximately 30 minutes to download. However, with 4G technology that download time could be potentially cut to approximately 3–4 minutes. This significantly improved the experience of mobile devices and internet usage for the user.

5G Fifth Generation : 5G is a generation currently under development, that's intended to improve on 4G. 5G promises significantly faster data rates, higher connection density, much lower latency, among other improvements. Some of the plans for 5G include device to device communication, better battery consumption, and improved overall wireless coverage.

5G technology is set to dramatically affect the use of mobile internet. In order to provide 5G access there is a major restructure occurring on parts of the radio network that is used to transmit data. This restructure is reported to allow data to be transmitted approximately 100 times faster.

The development from 3G to 4G technology and further developments into 5G technology will enable a number of advancements. These may include:

- greater speed in internet access
- faster loading speeds of applications, such as maps
- the ability to have multiple people in video conferencing calls
- more effective location services to allow for real time updates, such as traffic and weather
- the ability to stream high definition (HD).

Q.2.(b) Discuss the multiplexing techniques. (7)

Ans. Multiplexing is a technique by which different analog and digital streams of transmission can be simultaneously processed over a shared link. Multiplexing divides the high capacity medium into low capacity logical medium which is then shared by different streams. Communication is possible over the air (radio frequency), using a physical media (cable), and light (optical fiber). All mediums are capable of multiplexing.

When multiple senders try to send over a single medium, a device called Multiplexer divides the physical channel and allocates one to each. On the other end of communication, a De-multiplexer receives data from a single medium, identifies each, and sends to different receivers.

Different type of multiplexing is used in communication. In this article, the following three major multiplexing techniques are discussed :

(1) Frequency division multiplexing

(2) Wavelength division multiplexing

(3) Time division multiplexing

(1) Frequency Division Multiplexing : In the 20th century, many telephone companies used frequency-division multiplexing for long distance connections to multiplex thousands of voice signals through a coaxial cable system. For shorter distances, cheaper balanced cables were used for various systems like bell systems K-and N-carrier, but they didn't allow large bandwidths. The FDM is an analog multiplexing that combines analog signals. Frequency division multiplexing is applied when the bandwidth of the link is greater than the combined bandwidth of the signals to be transmitted.

In this type of multiplexing, signals are generated by sending different device-modulated carrier frequencies, and these modulated signals are then combined into a single signal that can

be transported by the link. To accommodate the modulated signal, the carrier frequencies are separated with enough bandwidth, and these bandwidth ranges are the channels through which different signals travel. These channels can be separated by unused bandwidth. Some of the examples for the time division multiplexing include radio and television signal transmission.

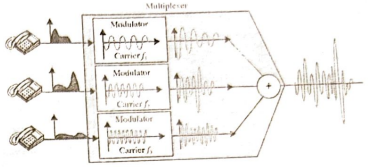


Fig.(1) : Frequency Division Multiplexing

(2) Wavelength Division Multiplexing : Wavelength division multiplexing (WDM) is a technology in fiber optic communications; and, for the high capacity communication systems, wavelength division multiplexing is the most promising concept. This system uses multiplexer at transmitter to join signals and demultiplexer to split the signals apart, at the receiver end. The purpose of WDM is to combine multiple light sources into a single light source at the multiplexer; and, at the demultiplexer the single light is converted into multiple light sources.

Wavelength Division Multiplexing

Fig.(2) : Wavelength Division Multiplexing

WDM is designed to use the high data rate capability of the fiber optic cable. The data rate of this cable is higher than the metallic transmission cable's data rate. Conceptually, the wavelength division multiplexing is same as the frequency division multiplexing, except for the transmission through the fiber optic channels wherein the multiplexing and demultiplexing involves optical signals.

(3) Time-Division Multiplexing : Time division multiplexing is a technique used to transmit a signal over a single communication channel by dividing the time frame into slots – one

slot for each message signal. Time-division multiplexing is primarily applied to digital signals as well as analog signals, wherein several low speed channels are multiplexed into high-speed channels for transmission. Based on the time, each low-speed channel is allocated to a specific position, where it works in synchronized mode. At both the ends, i.e., the multiplexer and demultiplexer are timely synchronized and simultaneously switched to the next channel.

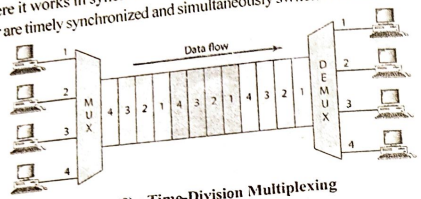


Fig.(3) : Time-Division Multiplexing

Q.3.(a) Explain following terms : (8)

(i) TDMA

(ii) Slotted ALOHA

Ans. (i) TDMA (Time Division Multiple Access) : In TDMA, access time is divided into farmes are again divided into time slots. A basic channel is formed by a particular time slot inside every frame. Usually same frames structure is used. In order to avoid simultaneous transmission and reception of a user. The corresponding time slots for the forwards and return links separated in time.

The TDMA scheme is illustrated in Figure (a) and (b).

TDMA systems transmit data in a buffer and burst method, thus the transmission for any user is non-continuous. This implies that unlike in FDMA systems which accommodate analog FM, digital data and digital modulation must be used with TDMA. The transmission from various users is interlaced into a repeating frame structure as shown in Fig.(c). It can be seen from Fig.(c) that a frame consists of a number of slots. Each frame made up of a preamble contains the address and synchronization information is frame, the preamble contains the address and synchronization information that both the base station and the subscriber use to identify each other. Guard times are utilized to allow synchronization of the receivers between different slots and frames.

The number of TDMA channel slots that can be provided in a TDMA systme is found by multiplying the number of TDMA slots (m) per channel by the number of channels available and is given by :

$$N = \frac{m\left(B_{tot} - 2B_{guard}\right)}{B_c}$$

where B_{tot} is the maximum number of TDMA users supported on each radio channel and B_{guard} is the guard band, one at the low end of the allocated frequency band and one at the high end. Guard band are required to ensure that users at the edge of the band do not "bleed over" into an adjacent radio service where B_c is channel bandwidth.

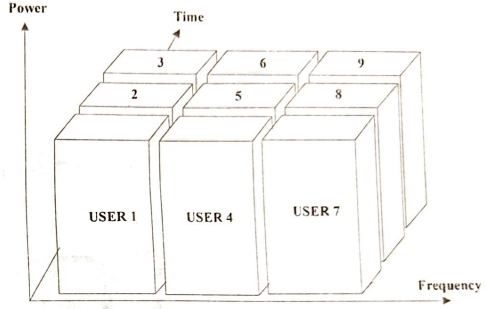


Fig. (a) : TDMA Scheme

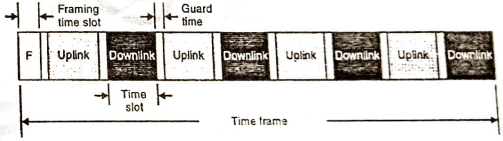


Fig. (b)

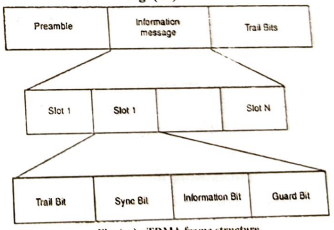


Fig. (c) : TDMA frame structure

Ans.(ii) Slotted ALOHA : In slotted ALOHA, time is divided into equal time slots of length greater than the packet duration τ. The subscribers each have synchronzed clocks and transmit a message only at the beginning of a new time slot, thus resulting in a discrete distribution of packets. This prevents partial collisions, where one packet collides with a portion of another. As the number of users increase, a greater delay will occur due to complete collisions and the resulting repeated transmissions of those packets originally lost. The number of slots which a transmitter waits prior to re–transmitting also determines the delay characteristics of the traffic. The vulnerable period for slotted ALOHA is only one packet duration, since partial collisions are prevented through synchronization. The probability that no other packets will be generated during the vulnerable period is e^{-R}. The throughput for the case of slotted ALOHA is thus given by

$$T = Re^{-R}$$

Figure illustrates how ALOHA and slotted ALOHA systems tradeoff throughput for delay.

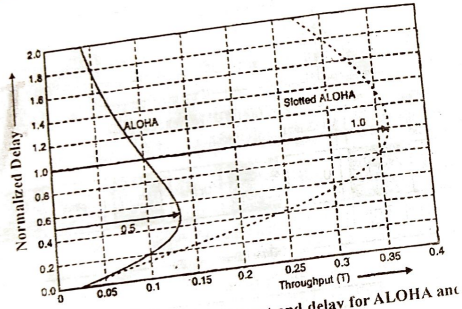


Fig. : Tradeoff between throughput and delay for ALOHA and slotted ALOHA packet radio protocol.

(7)

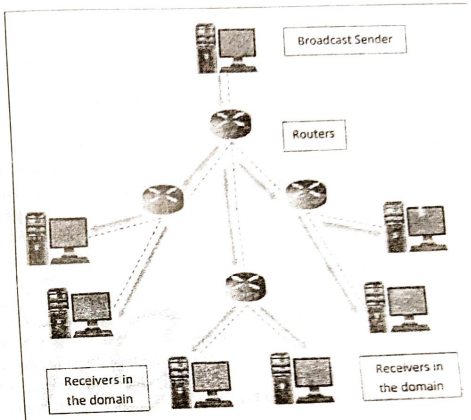
Q.3.(b) Discuss Broadcasting Techniques in detail.

Ans. Broadcasting in computer network is a group communication, where a sender sends data to receivers simultaneously. This is an all -to- all communication model where each sending device transmits data to all other devices in the network domain.

The ways of operation of broadcasting may be :

- A high level operation in a program, like broadcasting in Message Passing Interface.
- A low level networking operation, like broadcasting on Ethernet.

Broadcasting is shown in the following figure :



Advantages of Broadcasting : Broadcast helps to attain economies of scale when a common data stream needs to be delivered to all, by minimizing the communication and processing overhead. It ensures better utilization of resources and faster delivery in comparison to several unicast communication.

Disadvantages of Broadcasting : Broadcasting cannot accommodate a very large amount of devices. Also it does not allow personalisation of the messages according to the individual preferences of the devices.

There are a number of distinguishable types of programs that are broadcast, but they often overlap in technique, subject matter, and style. Radio, for example, broadcasts speech and music, but in an endless number of combinations. Television adds the visual element, greatly increasing the number of possible program forms. Most sizable broadcast organizations, however, have several categories for administrative convenience. But the definitions cannot be too precise, and lines of demarcation are necessarily vague.

Section – B

Q.4.(a) What are the tasks performed by MAC layer in IEEE802.11 protocol architecture ? **(8)**

Ans. The IEEE 802.11 MAC Layer : The basic functions of the MAC layer comprises of medium access control, reliable data delivery, and security. MAC frames can be transmitted between wireless terminals; between wireless terminals and an access point; and between access points over a DS. The IEEE 802.11 WLAN standard defines two types of MAC algorithms for medium access control: Point Coordination Function (PCF) and Distributed Coordination Function (DCF). PCF offers both asynchronous data and an optional time–bounded service types using an infrastructure–based system architecture but needs an access point to control medium access and to avoid contention for time–sensitive or high–priority data exchange. DCF offers only asynchronous service types in an ad–hoc system architecture for peer wireless terminals having bursty data within an IBSS. The asynchronous service supports both broadcast and multi–cast packets based on best–effort delivery mechanism.

The IEEE 802.11 MAC algorithm is also called DFWMAC (Distributed Foundation Wireless MAC) that provides a distributed access control mechanism with an optional centralised control. PCF is a centralised MAC algorithm used to provide contention–free service, and is implemented on top of the DCF, and exploits the features of DCF to assure access to its wireless terminals. The lower sublayer of the MAC layer is DCF which uses a contention algorithm to provide access to all types of traffic data including ordinary asynchronous traffic.

The PF operation consists of polling in a round–robin fashion to all wireless terminals configured for polling by the centralised polling–point coordinator. The point coordinator can seize the medium and lock out all asynchronous traffic while it issues polls and receives responses. At the beginning of a superframe, the point coordinator may optionally seize control and issues polls for a given period of time. This time interval varies because of the variable frame size issued by responding wireless terminals. The remainder of the super–frame is available for contention–based access. At the end of the superframe duration, the point coordinator contends for access tothe medium. If the medium is idle, it gains immediate access and a complete superframe period follows. If the medium is busy, it must wait until the medium is idle to gain access.

The DCF sublayer of the IEEE 802.11 MAC layer simply uses the CSMA algorithm: If a wireless terminal has a MAC frame to transmit, it listens to the medium. If the medium is idle, the wireless terminal may transmit. If the medium is busy, the wireless terminal must wait until the current transmission is complete. The DCF does not include CSMA/CD because collision detection is not practical on a wireless network. The dynamic range of the received signals is very large on the wireless medium, and a transmitting terminal cannot effectively

distinguish incoming weak signals from noise and the back reception of its own transmissions. DCF includes a set of delays including binary exponential back–off technique to ensure the smooth and fair functioning of the CSMA algorithm even in a heavy traffic situation.

The IEEE 802.11 defines specifically CSMA/CA with binary exponential back-off wait time within a pre–specified contention window technique. To current errors due to signal fading and interference in a wireless medium, CSMA/CA with ACK or CSM/CA with RTS/CTS algorithm is usually employed. In CSMA/CA with ACK, the receiving wireless terminal answers directly with an acknowledgement (ACK) of the received MAC frame. If no ACK is received, the sender automatically retransmits the frame. But this may cause further delay and the number of retransmissions is also limited. In CSMA/CA with RTS/CTS algorithm, the standard defines two small control packets: a Request To Send (RTS) packet of 20 bytes, and a Clear To Send (CTS) packet of 14 bytes. If the receiving terminal receives the RTS prior to MAC data frames, it answers with a CTS message. Basically, this mechanism reserves the wireless for one sender terminal exclusively for the duration of transmission of its data.

Q.4.(b) What do you meant by security in GSM ? Explain abot that in detail. **(7)**

Ans. GSM is the most secured cellular telecommunications system available today. GSM has its security methods standardized. GSM maintains end-to-end security by retaining the confidentiality of calls and anonymity of the GSM subscriber.

Temporary identification numbers are assigned to the subscriber's number to maintain the privacy of the user.

The privacy of the communication is maintained by applying encryption algorithms and frequency hopping that can be enabled using digital systems and signalling.

Mobile Station Authentication : The GSM network authenticates the identity of the subscriber through the use of a challenge-response mechanism. A 128-bit Random Number (RAND) is sent to the MS. The MS computes the 32-bit Signed Response (SRES) based on the encryption of the RAND with the authentication algorithm (A3) using the individual subscriber authentication key (Ki). Upon receiving the SRES from the subscriber, the GSM network repeats the calculation to verify the identity of the subscriber.

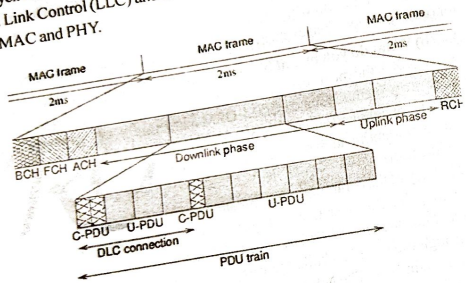
The individual subscriber authentication key (Ki) is never transmitted over the radio channel, as it is present in the subscriber's SIM, as well as the AUC, HLR, and VLR databases. If the received SRES agrees with the calculated value, the MS has been successfully authenticated and may continue. If the values do not match, the connection is terminated and an authentication failure is indicated to the MS.

Signalling and Data Confidentiality : The SIM contains the ciphering key generating algorithm (A8) that is used to produce the 64-bit ciphering key (Kc). This key is computed by applying the same random number (RAND) used in the authentication process to ciphering key generating algorithm (A8) with the individual subscriber authentication key (Ki).

Subscriber Identity Confidentiality : To ensure subscriber identity confidentiality, the Temporary Mobile Subscriber Identity (TMSI) is used. Once the authentication and encryption procedures are done, the TMSI is sent to the mobile station. After the receipt, the mobile station responds. The TMSI is valid in the location area in which it was issued. For communications outside the location area, the Location Area Identification (LAI) is necessary in addition to the TMSI.

Q.5.(a) Draw the physical layer configuratioin of HiperLAN. **(8)**

Ans. HiperLAN 1 Reference Model : HiperLAN 1 defines Data Link Layer and Physical Layer. For Local Area Networks, Data Link Layer is further divided into two sublayers: the Logical Link Control (LLC) and the Medium Access Control (MAC). HiperLAN 1 only deals with MAC and PHY.



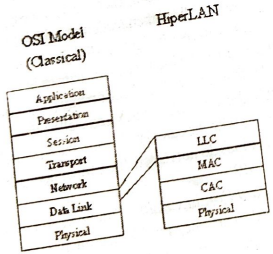


Figure 1 - HiperLAN 1 Reference Model

An intermediate layer, the Channel Access and Control (CAC) sublayer, is introduced in the HiperLAN 1 architecture to deal with the channel access signaling and protocol operation required supporting packet priority. A pseudo-hierarchically independent access mechanism is achieved via active signaling in a listen-before-talk access protocol. The Elimination-Yield Non-Preemptive Multiple Access (EY-NPMA) mechanism codes priority level selection and contention resolution into a single, variable length radio pulse preceding packet data. EY-NPMA provides good residual collision rate performance for even large numbers of simultaneous channel contenders.

Physical Layer

RF carriers : HiperLAN 1 uses the radio frequency band 5,150 MHz to 5,300 MHz. The following table shows the nominal frequency of each carrier. It's required that all transmissions shall be centered on one of the nominal carrier frequencies, and all HiperLAN 1 equipments shall operate on all 5 channels.

Carrier number	Center Frequency (MHz)
0	5 176.4680
1	5 199.9974
2	5 223.5268
3	5 247.0562
4	5 270.5856

Table 1 : Nominal Carrier center frequencies

The carriers numbered 0, 1 and 2 are designated the "default" carriers.

Clear Channel Assessment (CCA) : The HiperLAN 1 clear channel assessment scheme is based on the measurement of the received signal strength only. A threshold is used for determining whether the channel is busy or idle. Because the signal strength will vary with time, the time-domain variation of the received signal strength is used for threshold adaptation.

Modulation : For HiperLAN 1, Gaussian Minimum Shift Keying (GMSK) is used as the high bit rate modulation scheme to modulate a high rate transmission. GMSK is a Constant Envelope modulation scheme, which means that the amplitude of the transmitted signal is constant. This is important, because less stringent linearity can be demanded of the RF amplifier, which in turn means the cost of the radio is lower and, more importantly, the efficiency of the power amplifier (the ratio of actual RF energy transmitted compared to the electrical energy consumed) is quite good.

Frequency Shift Keying (FSK) is used as the low bit rate modulation scheme to modulate a low rate transmission. FSK is specified as follows: (fc is the center frequency.)

Bit value	Nominal frequency
0	f c - 368 kHz
1	f c + 368 kHz

Table 2 : Nominal frequencies for FSK modulation

Q.5.(b) Write down the features of Bluetooth. (7)

Ans. Following is a list of some prominent features of Bluetooth technology :

(1) Bluetooth is also known as IEEE 802.15 standard or specification that uses low power radio communications to link phones, computers and other network devices over a short distance without using any type of connecting wires.

(2) As Bluetooth is an open wireless technology standard so, it is used to send or receive data to connected devices present across a certain distance using a band of 2.4 to 2.485 GHz.

(3) In Bluetooth technology, the wireless signals transmit data and files over a short distance, typically up to 30 feet or 10 meters.

(4) Bluetooth technology was developed by a group of 5 companies known as Special Interes Group formed in 1998. The companies are Ericsson, Intel, Nokia, IBM, and Toshiba.

(5) The range of Bluetooth technology for data exchange was up to 10 meters in older versions of devices, but the latest version of Bluetooth technology i.e., Bluetooth 5.0, can exchange data in the range of about 40-400 meters.

(6) The average speed of data transmission in Bluetooth technology was around 1 Mbps in the very first version. The second version was 2.0+ EDR, which provided the data rate speed of 3Mbps. The third was 3.0+HS, which provided the speed of 24 Mbps. The latest version of this technology is 5.0.

Section – C

Q.6.(a) Briefly explain the configuration of DHCP. (8)

Ans. Dynamic Host Configuration Protocol : Dynamic Host Configuration Protocol (DHCP) is a network management protocol used to dynamically assign an IP address to nay device, or node, on a network so they can communicate using IP (Internet Protocol). DHCP automates and centrally manages these configurations. There is no need to manually assign IP

addresses to new devices. Therefore, there is no requirement for any user configuration to connect to a DHCP based network.

DHCP can be implemented on local networks as well as large enterprise networks. DHCP is the default protocol used by the most routers and networking equipment. DHCP is also called RFC (Request for comments) 2131.

DHCP does the following:

- DHCP manages the provision of all the nodes or devices added or dropped from the network.
- DHCP maintains the unique IP address of the host using a DHCP server.
- It sends a request to the DHCP server whenever a client/node/device, which is configured to work with DHCP, connects to a network. The server acknowledges by providing an IP address to the client/node/device.

DHCP is also used to configure the proper subnet mask, default gateway and DNS server information on the node or device.

There are many versions of DCHP are available for use in IPV4 (Internet Protocol Version 4) and IPV6 (Internet Protocol Version 6).

How DHCP works : DHCP runs at the application layer of the TCP/IP protocol stack to dynamically assign IP addresses to DHCP clients/nodes and to allocate TCP/IP configuration information to the DHCP clients. Information includes subnet mask information, default gateway, IP addresses and domain name system addresses.

DHCP is based on client-server protocol in which servers manage a pool of unique IP addresses, as well as information about client configuration parameters, and assign addresses out of those address pools.

The DHCP lease process works as follows:

- First of all, a client (network device) must be connected to the internet.
- DHCP clients request an IP address. Typically, client broadcasts a query for this information.
- DHCP server responds to the client request by providing IP server address and other configuration information. This configuration information also includes time period, called a lease, for which the allocation is valid.
- When refreshing an assignment, a DHCP clients request the same parameters, but the DHCP server may assign a new IP address. This is based on the policies set by the administrator.

Components of DHCP : When working with DHCP, it is important to understand all of the components. Following are the list of components:

• **DHCP Server :** DHCP server is a networked device running the DCHP service that holds IP addresses and related configuration information. This is typically a server or a router but could be anything that acts as a host, such as an SD-WAN appliance.

• **DHCP client :** DHCP client is the endpoint that receives configuration information from a DHCP server. This can be any device like computer, laptop, IoT endpoint or anything else that requires connectivity to the network. Most of the devices are configured to receive DHCP information by default.

• **IP address pool :** IP address pool is the range of addresses that are available to DHCP clients. IP addresses are typically handed out sequentially from lowest to the highest.

• **Subnet :** Subnet is the partitioned segments of the IP networks. Subnet is used to keep networks manageable.

• **Lease :** Lease is the length of time for which a DHCP client holds the IP address information. When a lease expires, the client has to renew it.

• **DHCP relay :** A host or router that listens for client messages being broadcast on that network and then forwards them to a configured server. The server then sends responses back to the relay agent that passes them along to the client. DHCP relay can be used to centralize DHCP servers instead of having a server on each subnet.

Benefits of DHCP : There are following benefits of DHCP:

Centralized administration of IP configuration : DHCP IP configuration information can be stored in a single location and enables that administrator to centrally manage all IP address configuration information.

Dynamic host configuration : DHCP automates the host configuration process and eliminates the need to manually configure individual host. When TCP/IP (Transmission control protocol/Internet protocol) is first deployed or when IP infrastructure changes are required.

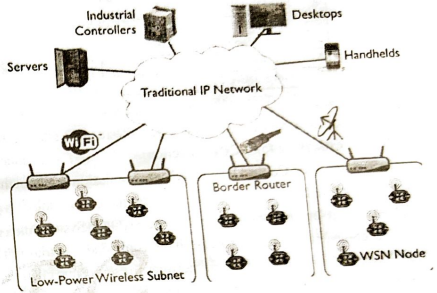
Seamless IP host configuration : The use of DHCP ensures that DHCP clients get accurate and timely IP configuration IP configuration parameter such as IP address, subnet mask, default gateway, IP address of DND server and so on without user intervention.

Flexibility and scalability : Using DHCP gives the administrator increased flexibility, allowing the administrator to move easily change IP configuration when the infrastructure changes.

Q.6.(b) Explain about IPv6 architecture in detail. (7)

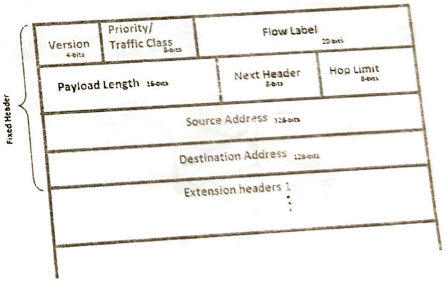
Ans. Internet Protocol version 6 (IPv6) is the most recent version of the Internet Protocol (IP), the communications protocol that provides an identification and location system for computers on networks and routes traffic across the Internet. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion, and is intended to replace IPv4.

IP version 6 (IPv6) is the latest version of IP. IP enables numerous nodes on different networks to interoperate seamlessly. IP version 4 (IPv4) is currently used in intranets and private networks, as well as the Internet. IPv6 is the successor to IPv4, and is based for the most part on IPv4.



IPv4 has been widely deployed and used to network the Internet today. With the rapid growth of the Internet, enhancements to IPv4 are needed to support the influx of new subscribers, Internet-enabled devices, and applications. IPv6 is designed to enable the global expansion of the Internet.

IP version 6 Header Format :



Priority	Meaning
0	No Specific traffic
1	Background data
2	Unattended data traffic
3	Reserved
4	Attended bulk data traffic
5	Reserved
6	Interactive traffic
7	Control traffic

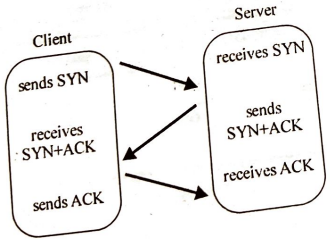
Q.7.(a) Draw the diagram for TCP connection. **(10)**

Ans. TCP (Transmission Control Protocol) is a transmission protocol that ensures data transmission in an ordered and secure manner. It sends and receives the data packets in the same order. TCP is a **four-layer** protocol compared to OSI (Open System Interconnection Model), which is a seven-layer transmission process. It is recommended to transmit data from high-level protocols due to its integrity and security between the server and client.

TCP needs a 4-way handshake for its termination. To establish a connection, TCP needs a 3-way handshake. So, here we will discuss the detailed process of TCP to build a 3-way handshake for connection and a 4-way handshake for its termination.

TCP Connection (A 3-way handshake) : A 3-way handshake is commonly known as SYN-SYN-ACK and requires both the client and server response to exchange the data. SYN means synchronize Sequence Number and ACK means acknowledgment. Each step is a type of handshake between the sender and the receiver.

The diagram of a successful TCP connection showing the three handshakes is shown below :



The three handshakes are discussed in the below steps :

Step 1: SYN

SYN is a segment sent by the client to the server. It acts as a **connection request** between the client and server. It informs the server that the client wants to establish a connection. Synchronizing sequence numbers also helps synchronize sequence numbers sent between any two devices, where the same SYN segment asks for the sequence number with the connection request.

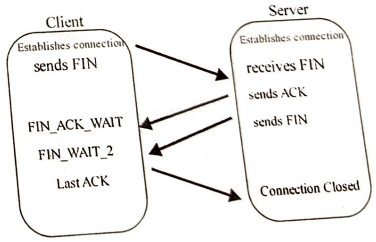
Step 2: SYN-ACK

It is an SYN-ACK segment or an SYN + ACK segment sent by the server. The ACK segment informs the client that the server has received the connection request and it is ready to build the connection. The SYN segment informs the sequence number with which the server is ready to start with the segments.

Step 3: ACK

ACK (Acknowledgment) is the last step before establishing a successful TCP connection between the client and server. The ACK segment is sent by the client as the response of the received ACK and SN from the server. It results in the establishment of a reliable data connection. After these three steps, the client and server are ready for the data communication process. TCP connection and termination are full-duplex, which means that the data can travel in both the directions simultaneously.

TCP Termination (A 4-way handshake) : TCP requires 3-way handshake to establish a connection between the client and server before sending the data. Similarly, to terminate or stop the data transmission, it requires a 4-way handshake. The segments required for TCP termination are similar to the segments to build a TCP connection (ACK and SYN) except the FIN segment. The FIN segment specifies a termination request sent by one device to the other.



Let's discuss the TCP termination process with the help of six steps that includes the sent requests and the waiting states. The steps are as follows:

Step 1: FIN

FIN refers to the termination request sent by the client to the server. The first FIN termination request is sent by the client to the server. It depicts the start of the termination process between the client and server.

Step 2: FIN_ACK_WAIT

The client waits for the ACK of the FIN termination request from the server. It is a waiting state for the client.

Step 3: ACK

The server sends the ACK (Acknowledgement) segment when it receives the FIN termination request. It depicts that the server is ready to close and terminate the connection.

Step 4: FIN _WAIT_2

The client waits for the FIN segment from the server. It is a type of approved signal sent by the server that shows that the server is ready to terminate the connection.

Step 5: FIN

The FIN segment is now sent by the server to the client. It is a confirmation signal that the server sends to the client. It depicts the successful approval for the termination.

Step 6: ACK

The client now sends the ACK (Acknowledgement) segment to the server that it has received the FIN signal, which is a signal from the server to terminate the connection. As soon as the server receives the ACK segment, it terminates the connection.

Q.7.(b) What are the advantages of TCP? (5)

Ans. Advantages of TCP : The following are some of the benefits of TCP:

(1) TCP is connection-oriented.

(2) It establishes a connection between sender and receiver over the network before sending a message.

(3) It uses a congestion control policy to avoid congestions.

(4) Supports data retransmission. If the packets get lost failing to reach their destination, they will be sent back to the sender from the receiver. The sender can retransmit the packets.

(5) Performs in-order delivery by rearranging all packets at the receiving end.

(6) Error detection, such as corrupted and missing packets is easier. It is done through a three-step mechanism – checksum, retransmission, and acknowledgment.

Section – D

Q.8.(a) What are the objectives of WAP Forum ? (8)

Ans. The WAP Forum is the industry association that has developed the de-facto world standard for wireless information and telephony services on digital mobile phones and other wireless terminals. The primary goal of the WAP Forum is to bring together companies from all segments of the wireless industry to ensure product interoperability and growth of the wireless market.

The objectives of the WAP Forum are :

- To bring internet content and advanced data services to digital cellular phones and other wireless terminals.
- To create a global wireless protocol specification that will work across different wireless network technologies.
- To enable the creation of content and applications that scale across a very wide range of wireless bearer networks and wireless device types.
- To embrace and extend existing standards and technology wherever appropriate.

Long Term Goals

- Work toward a unified information space.
- Work toward common standards and technologies.
- Enable the delivery of sophisticated information and services to mobile wireless terminals.

Q.8.(b) Mention all the applications of satellite systems. (7)

Ans. Applications of satellites : Satellites that are launched in to the orbit by using the rockets are called man-made satellites or artificial satellites. Artificial satellites revolve around the earth because of the gravitational force of attraction between the earth and satellites. Unlike the natural satellites (moon), artificial satellites are used in various applications. The various applications of artificial satellites include :

1. Weather forecasting
2. Navigation
3. Astronomy
4. Satellite phone
5. Satellite television
6. Military satellite
7. Satellite internet
8. Satellite radio.

1. Weather forecasting : Weather forecasting is the prediction of the future of weather. The satellites that are used to predict the future of weather are called weather satellites. Weather satellites continuously monitor the climate and weather conditions of earth. They use sensors called radiometers for measuring the heat energy released from the earth surface. Weather satellites also predict the most dangerous storms such as hurricanes.

2. Navigation : Generally, navigation refers to determining the geographical location of an object. The satellites that are used to determine the geographic location of aircrafts, ships, cars, trains, or any other object are called navigation satellites. GPS (Global Positioning System) is an example of navigation system. It allows the user to determine their exact location at anywhere in the world.

3. Astronomy : Astronomy is the study of celestial objects such as stars, planets, galaxies, natural satellites, comets, etc. The satellites that are used to study or observe the distant stars, galaxies, planets, etc. are called astronomical satellites. They are mainly used to find the new stars, planets, and galaxies. Hubble space telescope is an example of astronomical satellite. It captures the high-resolution images of the distant stars, galaxies, planets etc.

4. Satellite phone : Satellite phone is a type of mobile phone that uses satellites instead of cell towers for transmitting the signal or information over long distances.

Mobile phones that use cell towers will work only within the coverage area of a cell tower. If we go beyond the coverage area of a cell tower or if we reach the remote areas, it becomes difficult to make a voice call or send text messages with the mobile phones. Unlike the mobile mobiles, satellite phones have global coverage. Satellites phones uses geostationary satellites and low earth orbit (LEO) satellites for transmitting the information.

When a person makes a call from the satellite phone, the signal is sent to the satellite. The satellite will receives that signal, processes it, and redirects the signal back to the earth via a gateway. The gateway then send the signal or call to the destination by using the regular cellular and landline networks. The usage of satellite phones is illegal in some countries like Cuba, North Korea, Burma, India, and Russia.

5. Satellite television : Satellite television or satellite TV is a wireless system that uses communication satellites to deliver the television programs or television signals to the users or viewers.

TV or television mostly uses geostationary satellites because they look stationary from the earth. Hence, the signal is easily transmitted. When the television signal is send to the satellite, it receives the signal, amplifies it, and retransmit it back to the earth. The first satellite television signal was send from Europe to North America by using the Telstar satellite.

6. Military satellite : Military satellite is an artificial satellite used by the army for various purposes such as spying on enemy countries, military communication, and navigation. Military satellites obtain the secret information from the enemy countries. These satellites also detect the missiles launched by the other countries in the space.

Military satellites are used by armed forces to communicate with each other. These satellites also used to determine the exact location of an object.

7. Satellite internet : Satellite internet is a wireless system that uses satellites to deliver the internet signals to users. High-speed internet is the main advantage of satellite internet. Satellite internet does not use cable systems, but instead it uses satellites to transmit the information or signal.

8. Satellite radio : Satellite radio is a wireless transmission service that uses orbiting satellites to deliver the information or radio signals to the consumers. It is primarily used in the cars. When the ground station transmit signal to the satellite that is revolving around the earth, the satellite receives the signal, amplifies it, and redirects the signal back to the earth (radio receivers in the cars).

Q.9.(a) Explain wireless transmission protocols. **(8)**

Ans. Wireless transaction protocol (WTP) : The wireless transaction protocol (WTP) is on top of either WDP or, if security is required, WTLS (WAP Forum, 2000d). WTP has been designed to run on very thin clients, such as mobile phones. WTP offers several advantages to higher layers, including an improved reliability over datagram services, improved efficiency over connection-oriented services, and support for transaction-oriented services such as web browsing. In this context, a transaction is defined as a request with its response, e.g. for a web page. WTP offers many features to the higher layers. The basis is formed from three classes of transaction service as explained in the following paragraphs. Class 0 provides unreliable message transfer without any result message. Classes 1 and 2 provide reliable message transfer, class 1 without, class 2 with, exactly one reliable result message (the typical request/response case).

WTP achieves reliability using duplicate removal, retransmission, acknowledgements and unique transaction identifiers. No WTP-class requires any connection set-up or tear-down phase. This avoids unnecessary overhead on the communication link. WTP allows for asynchronous transactions, abort of transactions, concatenation of messages, and can report success or failure of reliable messages (e.g., a server cannot handle the request). To be consistent with the specification, in the following the term initiator is used for a WTP entity initiating a transaction (aka client), and the term responder for the WTP entity responding to a transaction (aka server). The three service primitives offered by WTP are TR-Invoke to initiate a new transaction, TR-Result to send back the result of a previously initiated transaction, and TR-Abort to abort an existing transaction. The PDUs exchanged between two WTP entities for normal transactions are the invoke PDU, ack PDU, and result PDU.

A special feature of WTP is its ability to provide a user acknowledgement or, alternatively, an automatic acknowledgement by the WTP entity. If user acknowledgement is required, a WTP user has to confirm every message received by a WTP entity. A user

acknowledgement provides a stronger version of a confirmed service because it guarantees that the response comes from the user of the WTP and not the WTP entity itself.

WTP class 0 : Class 0 offers an unreliable transaction service without a result message. The transaction is stateless and cannot be aborted. The service is requested with the TR-Invoke.req primitive as shown ion fig.(1). Parameters are the source address (SA), source port (SP), destination address (DA), destination port (DP). Additionally, with the A flag the user of this service can determine, if the responder WTP entity should generate an acknowledgement or if a user acknowledgement should be used. The WTP layer will transmit the user data (UD) transparently to its destination. The class type C indicates here class 0. Finally, the transaction handle H provides a simple index to uniquely identify the transaction and is an alias for the tuple (SA, SP, DA, DP), i.e., a socket pair, with only local significance.

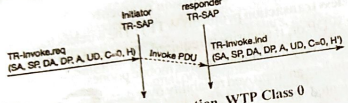


Fig.(1) : Basic transaction, WTP Class 0

The WTP entity at the initiator sends an invoke PDU which the responder receives. The WTP entity at the responder then generates a TR-Invoke.ind primitive with the same parameters as on the initiators side, except for which is now the local handle for the transaction on the responders side. In this class, the responder does not acknowledge the message and the initiator does not perform any retransmission. Although this resembles a simple datagram service, it is recommended to use WDP if only a datagram service is required. WTP class 0 augments the transaction service with a simple datagram like service for occasional use by higher layers.

WTP class 1 : Class 1 offers a reliable transaction service but without a result message. Again, the initiator sends an invoke PDU after a TR-Invoke.req from a higher layer.

This time, class equals ,,1, and no user acknowledgement has been selected as shown in Fig.(2). The responder signals the incoming invoke PDU via the TR-Invoke.ind primitive to the higher layer and acknowledges automatically without user intervention. The specification also allows the user on the responders side to acknowledge, but this acknowledgement is not required. For the initiator the transaction ends with the reception of the acknowledgement. The responder keeps the transaction state for some time to be able to retransmit the acknowledgement if it receives the same invoke PDU again indicating a loss of the acknowledgement.

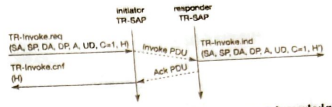


Fig.(2) : Basic transaction, WTP Class 1, no user acknowledgement

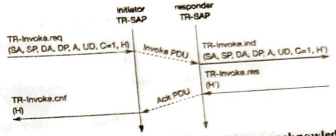


Fig.(3) : Basic transaction, WTP Class 1, with user acknowledgement

If a user of the WTP class 1 service on the initiators side requests a user acknowledgement on the responders side, the sequence diagram looks like Figure. Now the WTP entity on the responders side does not send an acknowledgement automatically, but waits for the TR-Invoke.res service primitive from the user. This service primitive must have the appropriate local handle H for identification of the right transaction. The WTP entity can now send the ack PDU. Typical uses for this transaction class are reliable push services.

WTP class 2 : Finally, class 2 transaction service provides the classic reliable request/response transaction known from many client/server scenarios. Depending on user requirements, many different scenarios are possible for initiator/responder interaction. Three examples are presented below. Figure shows the basic transaction of class 2 without-user acknowledgement. Here, a user on the initiators side requests the service and the WTP entity sends the invoke PDU to the responder. The WTP entity on the responders side indicates the request with the TR-Invoke.ind primitive to a user. The responder now waits for the processing of the request, the user on the responders side can finally give the result UD* to the WTP entity on the responder side using TR-Result.req. The result PDU can now be sent back to the initiator, which implicitly acknowledges the invoke PDU. The initiator can indicate the successful transmission of the invoke message and the result with the two service primitives TR-Invoke.cnf and TR-Result.ind. A user may respond to this result with TR-Result.res. An acknowledgement PDU is then generated which finally triggers the TR-Result.cnf primitive on the responder s side. This example clearly shows the combination of two reliable services (TR-Invoke and TR-Result) with an efficient data transmission/acknowledgement.

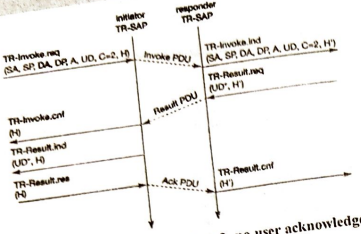


Fig.(4) : Basic transaction, WTP Class 2, no user acknowledgement

An even more reliable service can be provided by user acknowledgement as explained above. The time-sequence diagram looks different [see Fig.(4)]. The user on the responder's side now explicitly responds to the Invoke PDU using the TR-Invoke.res primitive, which triggers the TR-Invoke.cnf on the initiator's side via an ack PDU. The transmission of the result is also a confirmed service, as indicated by the next four service primitives. This service will likely be the most common in standard request/response scenarios as, e.g., distributed computing.

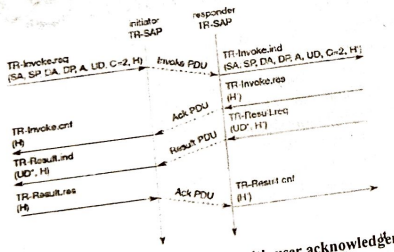


Fig.(5) : Basic transaction, WTP Class 2, with user acknowledgement

If the calculation of the result takes some time, the responder can put the initiator on hold on to prevent a retransmission of the invoke PDU as the initiator might assume packet loss if no result is sent back within a certain timeframe. This is shown in the Figure.

After a time-out, the responder automatically generates an acknowledgement for the Invoke PDU. This shows the initiator that the responder is still alive and currently busy processing the request. WTP provides many more features not explained here, such as concatenation and separation of messages, asynchronous transactions with up to 215 transactions outstanding, i.e., requested but without result up to now, and segmentation/ reassembly of messages.

Q.9.(b) Discuss HTML in detail. (7)

Ans. HTML : HTML stands for *HyperText Markup Language*. It is used to design web pages using a markup language. It is the combination of Hypertext and Markup language. Hypertext defines the link between the web pages. A markup language is used to define the text document within tag which defines the structure of web pages. It is a markup language that is used by the browser to manipulate text, images, and other content to display in the required format.

HTML helps to structure our website well. The way a skeleton system gives a structure to the human body, in a similar manner, it acts as a skeleton for a website, without it a website cannot be made. If you want to work as a Software Developer especially in the Web Development domain, then learning HTML is a must, because without knowledge of it you cannot build a website.

· *Base for creating websites* : It is the basic necessity a developer should know while building a website from scratch.

· *Learn web development* : It is the first step towards learning Web Development. Once you learn it, you can build simple, static websites very easily.

· *Can become freelancer* : Since web development has the best scope in freelancing, therefore learning it will surely help you to get the best deals of website development in the market.

Basic Format: It is the basic format of create a simple web page.

```
<!DOCTYPE html>
<html>
<head>
        <!— Head section of website—>
        <title></title>
```

```
</head>
<body>
        <!— Body section of website —>
</body>
</html>
```