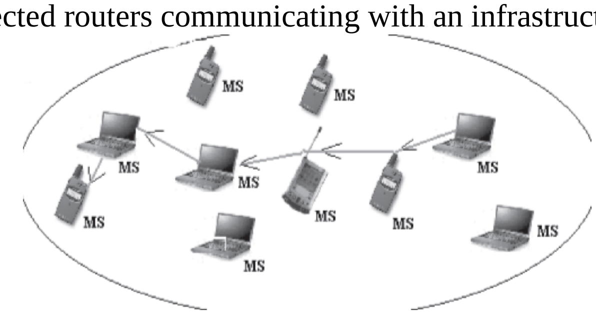
Q.2 a. What do you mean by ad hoc networks? Explain MANET in detail.

Answer:

An ad hoc (also written ad-hoc or adhoc) network is a local network with wireless or temporary plug-in connection, in which mobile or portable devices are part of the network only while they are in close proximity.

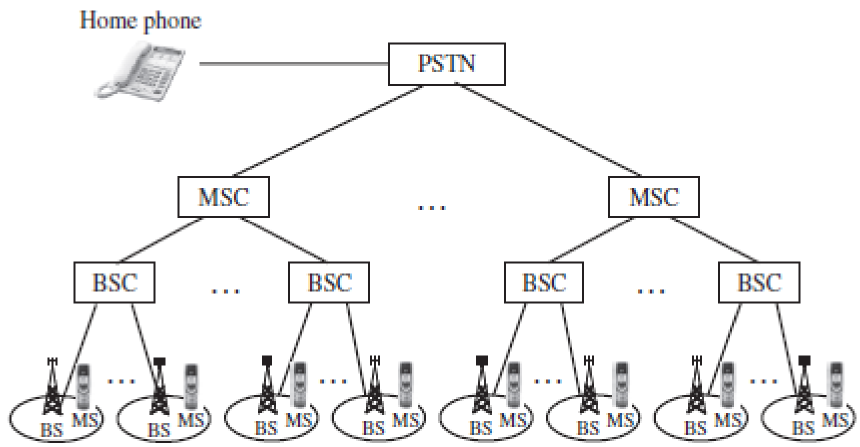
A mobile ad hoc network (MANET) is an autonomous system of mobile nodes, mobile hosts (MHs), or MSs (also serving as routers) connected by wireless links, the union of which forms a network modeled in the form of an arbitrary communication graph. The routers are free to move at any speed in any direction and organize themselves randomly. Thus, the network's wireless topology may dynamically change in an unpredictable manner. There is no fixed infrastructure, and information is forwarded in peer-to-peer (p2p) mode using multihop routing. MANETs are basically peer-to-peer (p2p) multihop mobile wireless networks where information packets are transmitted in a store-and-forward method from source to destination, via intermediate nodes, as shown in Figure. As the nodes move, the resulting change in network topology must be made known to the other nodes so that prior topology information can be updated. Such a network may operate in a stand-alone fashion, or with just a few selected routers communicating with an infrastructure network.



b. Explain the concept of cellular communication with neat diagram.

Answer:

The cellular concept was a major breakthrough in solving the problem of spectral congestion and user capacity. It offered very high capacity in a limited spectrum allocation without any major technological changes. The cellular concept is a system-level idea which calls for replacing a single, high power transmitter (large cell) with many low power transmitters (small cells), each providing coverage to only a small portion of the service area. Each base station is allocated a portion of the total number of channels available to the entire system, and nearby base stations are assigned different groups of channels so that all the available channels are assigned to a relatively small number of neighboring base stations. Neighboring base stations are assigned different groups of channels so that the interference between base stations (and the mobile users under their control) is minimized. By systematically spacing base stations and their channel groups throughout a market, the available channels are distributed throughout the geographic region and may be reused as many times as necessary so long as the interference between co channel stations is kept below acceptable levels.



A BS consists of a base transceiver system (BTS) and a BSC. Both tower and antenna are a part of the BTS, while all associated electronics are contained in the BSC. The home location register (HLR) and visitor location register (VLR) are two sets of pointers that support mobility and enable the use of the same telephone numbers worldwide. HLR is located at the MSC where the MS is registered and where the initial home location for billing and access information is maintained. In simple words, any incoming call, based on the called number, is directed to HLR of the home MSC and then HLR redirects the call to the MSC (and the BS) where the MS is currently located. VLR basically contains information about all visiting MSs in that particular MSC area.

Q.3 a. Explain the working of Turbo code encoder and decoder with the help of block diagrams.

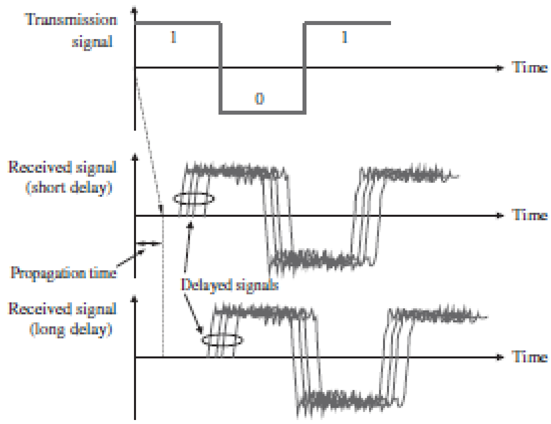
Answer: Refer Page no. 92 and Fig 4.9 & 4.10 from Text Book-I

b. What is intersymbol interference (ISI)? Does it affect the transmission rate of a digital channel? Explain clearly.

Answer:

Intersymbol interference (ISI) :
Intersymbol interference(**ISI**) is a form of distortion of a signal in which one symbol interferes with subsequent symbols. This is an unwanted phenomenon as the

previous symbols have similar effect as noise, thus making the communication less reliable. ISI is usually caused by multipath propagation or the inherent non-linear frequency response of a channel causing successive symbols to "blur" together. The presence of ISI in the system introduces errors in the decision device at the receiver output. Therefore, in the design of the transmitting and receiving filters, the objective is to minimize the effects of ISI, and thereby deliver the digital data to its destination with the smallest error rate possible.



Effect on transmission rate:

In a time-dispersive medium, the transmission rate *R* for a digital transmission is limited by the delay spread. If a low bit-error-rate (BER) performance is desired, then

$$R \leq \frac{1}{2\tau_d}$$

In a real situation, R is determined based on the required BER, which may be limited by the delay spread (τ_d) .

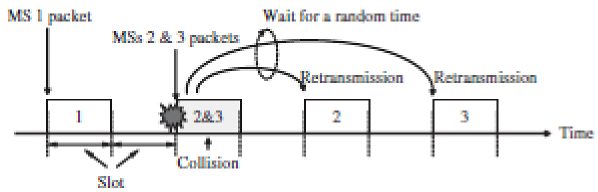
Q.4 a. How do you characterize traffic load of a cell? Derive expressions for them.

Answer: Refer Pages 108-109 from Text Book-I

b. Explain in detail, slotted ALOHA protocol and how it improves throughput as compared to pure ALOHA protocol.

Answer:

Slotted ALOHA is a modification of pure ALOHA having slotted time with the slot size equal to the duration of packet transmission T . If a MS has a packet to transmit, before sending it waits until the beginning of the next slot. Thus, the slotted ALOHA is an improvement over pure ALOHA by reducing the vulnerable period for packet collision to a single slot. It means that a transmission will be successful if and only if exactly one packet is scheduled for transmission for the current slot. Figure shows a collision mechanism in slotted ALOHA where a collision is observed to be a full collision; thus, no partial collision is possible.



Since the process composed of newly generated and retransmitted packets in a shared channel is Poisson, the probability of successful transmission is given by

$$P_s = e^{-gT} \tag{6.6}$$

and the throughput S_{th} becomes

$$S_{th} = gTe^{-gT}. \tag{6.7}$$

Using the definition of the normalized offered load $G = gT$, Equation (6.7) can be rewritten as

$$S_{th} = Ge^{-G}. \tag{6.8}$$

The maximum throughput $S_{th\,max}$ is obtained by

$$\frac{dS_{th}}{dG} = e^{-G} - Ge^{-G} = 0. \tag{6.9}$$

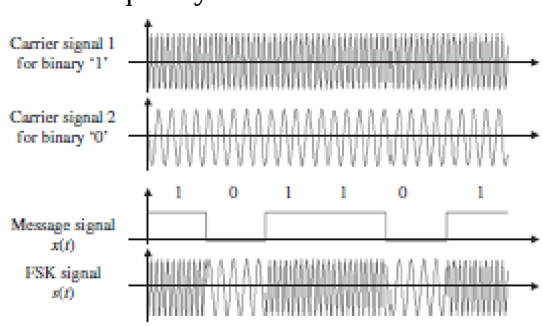
Equation (6.9) indicates that the maximum throughput $S_{th\,max}$ occurs at the offered load $G = 1$. Therefore, substituting $G = 1$ in Equation (6.8), we have

$$S_{th\,max} = \frac{1}{e} \approx 0.368. \tag{6.10}$$

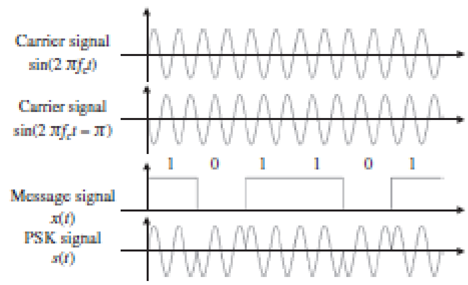
Q.5 a. Explain frequency shift key (FSK) and phase shift key (PSK) with suitable waveform. (6)

Answer:

Frequency shift key: Frequency shift keying (FSK) is used for modulating a digital signal over two carriers by using a different frequency for a "1" or a "0". The difference between the carriers is known as the frequency shift. The waveforms of FSK are shown in Figure



Phase Shift Key: In digital transmission, the phase of the carrier is discretely varied with respect to a reference phase and according to the data being transmitted. Phase shift keying (PSK) is a method of transmitting and receiving digital signals in which the phase of a transmitted signal is varied to convey information. For example, when encoding, the phase shift could be 0◦ for encoding a "0" and 180◦ for encoding a "1," thus making the representations for "0" and "1" apart by a total of 180◦. This kind of PSK is also called binary phase shift keying (BPSK) since 1 bit is transmitted in a single modulation symbol. Figure shows the waveforms of BPSK. PSK has a perfect SNR but must be demodulated synchronously, which means a reference carrier signal is required to be received at the receiver to compare with the phase of the received signal, which makes the demodulation circuit complex.



b. What do you mean by dynamic channel allocation (DCA)? Explain distributed and centralised dynamic channel allocation (DCA).

Answer:

Dynamic channel allocation (DCA) : DCA implies that traffic channels are allocated dynamically as new calls arrive in the system; it is achieved by keeping all free channels in a central pool. This also means that when a call is completed, the channel currently being used is returned to the central pool.

Centralized Dynamic Channel Allocation:
In these schemes, a traffic channel is selected for a new call from a central pool of free channels, and a specific characterizing function is used to select one among candidate free channels. The simplest scheme is to select the first available free channel that can satisfy the reuse distance. An alternative is to pick a free channel that can minimize the future blocking probability in the neighborhood of the cell that needs an additional channel; this is defined as locally optimized dynamic assignment.

Another scheme of channel reuse optimization maximizes the use of every channel in the system by appropriate allocation of channels, thereby maximizing system efficiency.

For a given reuse distance, cells can be identified that satisfy minimum reuse distance; all these cells could be allocated the same channel and are defined as co-channel cells. These co-channel cells can form a set, and each group is looked at carefully while allocating channels. If a cell needs to support a new call, then a free channel from the central pool is selected that would maximize the number of members in its co-channel set. A further modification is to select a channel that would minimize the mean square of the distance between cells using the same channel. Global optimization can be achieved if channel allocation can be evaluated using a graph theoretic model by representing each cell by a vertex and by placing an edge between two vertices as an indication of no co-channel interference. Maximization of the number of edges indicates availability of many vertices after current selection and, in turn, reflects a low blocking probability. DCA schemes handle randomly generated new calls and hence cannot maximize overall channel reuse. Therefore, these schemes are observed to carry less traffic as compared to FCA, especially for higher traffic rates. Therefore, suggestions have been made to reassign channels and change channels for existing calls if that minimizes the distance between cells using the same channel and hence influencing the reuse distance.

Distributed Dynamic Channel Allocation Schemes:
Centralized schemes can theoretically provide near-optimal performance, but the amount of computation and communication among the BSs leads to excessive system latencies and makes them impractical. Therefore, schemes have been proposed that involve scattering channels across a network. However, centralized schemes are still used as a benchmark to compare various decentralized schemes.

Distributed DCA schemes are primarily based on one of the three parameters: co-channel distance, signal strength measurement, and SNR (signal-to-noise ratio). In a cell-based distributed scheme, a table indicates if other co-channel cells in the neighborhood are not using one or more channels and are selecting one of the free channels for the requesting cell. In an adjacent channel interference constraint scheme, in addition to co-channel interference, adjacent channel interference is taken into account while choosing a new channel. The main limitation of this scheme is that a maximum packing of channels may not be possible as the MS's location is not taken into account. In a signal strength measurement–based distributed scheme, channels are allocated to a new call if the anticipated CCIR (co-channel interference ratio) is above a threshold. This could cause the CCIR for some existing calls to deteriorate and hence those would require finding new channels that could satisfy a desired CCIR. Otherwise, those interrupted calls could be dropped prematurely or may also have a further ripple effect, possibly leading to system instability.

Q.6 a. Discuss the 'handoff' strategies employed in the design of a mobile communication system.

Answer:

Handoff basically involves change of radio resources from one cell to another adjacent cell. Handoff depends on cell size, boundary length, signal strength, fading, reflection and refraction of signals, and man-made noise. If we make a simplistic assumption that the MSs are uniformly distributed in each cell, we can also say that the probability of a channel being available in a new cell depends on the number of channels per unit area.

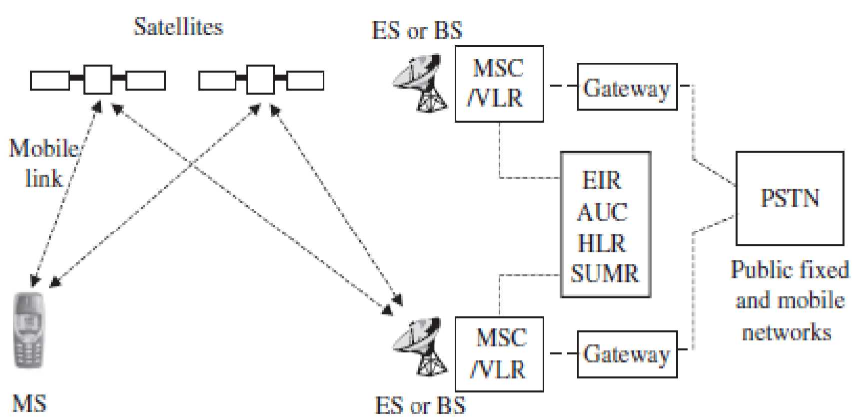
Handoff can be initiated either by the BS or the MS, and it could be due to
1. The radio link
2. Network management
3. Service issues

The need for handoff is determined in two different ways:
1. Signal strength
2. Carrier-to-interference ratio (CIR)

In addition to the power level of the received signal, another important aspect is the value of CIR in a cell at a given location. A low value of CIR may force the BS to change the channel currently being used between the BS and the MS. Handoff could also occur if directional antennas are employed in a cell and a MS moves from one sector to another sector of the cell (or one beam area to another in a SDMA system). The handoff procedure and associated steps depend on the cellular systems, and the specific units involved in setting up a call are as follows:
1. Base station controller (BSC)
2. Mobile station (MS)
3. Mobile switching center (MSC)

b. Draw the satellite system architecture and explain the process of call setup.

Answer:



Generic satellite system architecture is shown in Figure, with the ES (BS) constituting the heart of the overall system control. The ES performs functions similar to the BSS of a cellular wireless system. The ES keeps track of all MSs located in the area and controls the allocation and deallocation of radio resources. This includes the use of frequency band or channel in FDMA, time slot for TDMA, and code assignment for CDMA. Both MSC and VLR are important parts of the BS and provide functions similar to those for the cellular network. The databases EIR, AUC, and HLR also perform the same operations as in conventional wireless systems and are an integral part of the overall satellite system. The HLR–VLR pair supports the basic process of mobility management. A satellite user mapping register (SUMR) is also maintained at the BS to note the locations of all satellites and to indicate the satellite assigned to each MS. All these systems are associated with the BS to minimize the weight of satellites. In fact, satellites can be considered to function as relay stations with a worldwide coverage, given that most of the intelligence and decision-making process is performed by the BS. These BSs are also connected to the PSTN and ATM backbone through the appropriate gateway so that calls to regular household phones as well as to cellular devices can be routed and established. For an incoming call from the PSTN, the gateway helps to reach the closest BS, which, in turn, using the HLR–VLR pair, indicates the satellite serving the most recently known location of the MS. The satellite employs a paging channel to inform the MS about an incoming call and the radio resource to be used for the uplink channel. For a call originating from a MS, it accesses the shared control channel of an overhead satellite and the satellite, in turn, informs the BS for authentication of the user/MS. The BS then allocates a traffic channel to the MS via the satellite and informs the gateway about additional control information, if it is necessary to route the call through the backbone. Thus, there may be an exchange of control signalling between the MS, the satellite beam, the ES, and the PSTN gateway. Call setup may involve satellite communication before the actual traffic can be exchanged and can vary in the range of a few hundred nanoseconds (~ 300 ns).

Q.7 a. Explain Interfaces, Planes and Layer of GSM in a cellular network.

Answer: Refer Page Nos 235-236 from Text Book-I

b. Enlist the various types of operations supported by IS-41.

Answer:

- Registration in a new MSC
- Calling an idle MS in a new system
- Call with unconditional call forwarding
- Call with no answer
- Calling a busy MS
- Handoff measurement request
- Recovery from failure at the HLR

Q.8 a. Discuss the important and innovative applications of MANET's.

Answer: Refer Page Nos 305-306 from Text Book-I

b. With the help of example, explain TORA. (8)

Answer: Refer Page No 315 article 13.6.3 from Text Book-I

Q.9 Write short notes on:
(i) WLAN (wireless local area network)
(ii) Switched Beam and Adaptive Beam

Answer:

(i) **WLAN (wireless local area network):**
The increased demands for mobility and flexibility in our daily life are demands that lead the development from wired LANs to wireless LANs (WLANs). Today a wired LAN can offer users high bit rates to meet the requirements of bandwidth consuming services like video conferences, streaming video etc. With this in mind a user of a WLAN will have high demands on the system and will not accept too much degradation in performance to achieve mobility and flexibility.

A wireless LAN is based on a cellular architecture where the system is subdivided into cells, where each cell (called Base Service Set or BSS*) is controlled by a Base station (called Access point or AP). Wireless LAN standards that are currently being explored in the field of communications technology are:

1. IEEE 802.11.
    a. 802.11a
    b. 802.11b
    c. 802.11g
2. HiperLAN/2.
3. Bluetooth.
4. HomeRF.

Classification of Wireless LAN:
1. ad hoc wireless LANs
2. wireless LANs with infrastructure

(ii) Ultrawideband technology (UWB): Refer Page No 425 from Text Book-I

TEXT BOOK

I. Introduction to Wireless and Mobile Systems, Second Edition (2007), Dharma Prakash Agrawal and Qing-An Zeng, Thomson India Edition.