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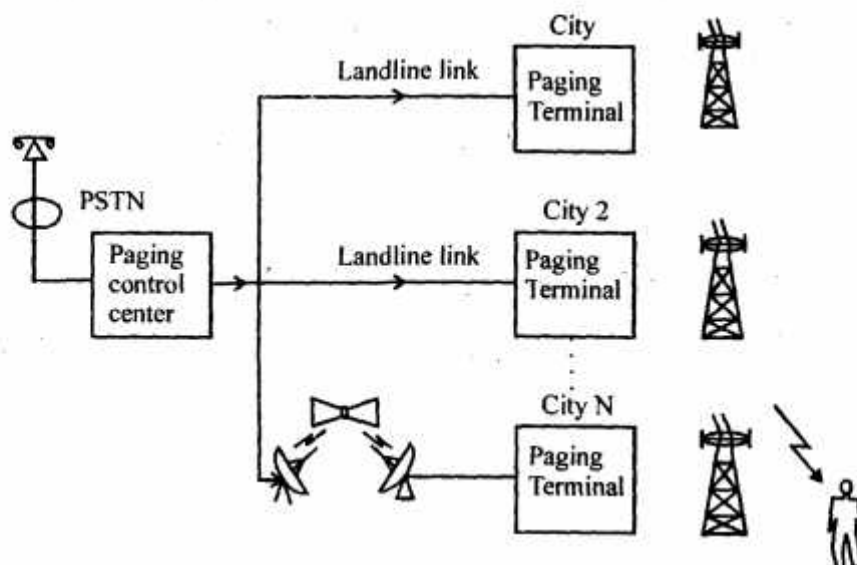
Sixth Semester Examination, Dec.-2009

Wireless Communication (EE402E)

Note : Attempt any five questions. All questions carry equal marks.

Q. 1. (a) Explain paging systems.

Ans. Paging Systems : Paging systems are communication systems that send brief messages to a subscriber. Depending on the type of service, the message may be either a numeric message, an alphanumeric message, one a voice message. Paging systems are typically used to notify a subscriber 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 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 stations which broadcast the page on a radio carrier.



A wide area paging system

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. Wide area paging systems consists of a network of telephone lines, many base station transmitters and large radio towers that simultaneously broadcast a page from each base station.

Q. 1. (b) Explain in brief examples of wireless communication systems.

Ans. Examples of Wireless Communication Systems : Most people are familiar with a number of mobile radio communication systems used in everyday life. Garage door openers, remote controllers for home entertainment equipment, cordless telephones, hand-hold walkie-talkie, pagers and cellular telephones are all examples of mobile radio communication systems.

The term mobile has historically been used to classify any radio terminal that could be moved during operation.

More recently, the term mobile is used to describe a radio terminal that is attached to a high speed mobile platform. Whereas the term portable describes a radio terminal that can be hand-held and used by someone at walking speed.

The mobile communicate to fixed base stations which are connected to a commercial power source and a fixed backbone network. 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.

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. A pair of simplex channels with a fixed and known frequency separation is used to define a specific radio channel in the system.

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.

Q. 2. (a) Explain advantages of 3G over 2G.

Ans. Advantages of 3G Over 2G :

3G systems promise unparalleled wireless access in ways that have never been possible before multi-megabit. Internet access, communications using voice over Internet Protocol (VoIP), voice-activated calls, unparalleled network capacity and ubiquitous "always on" access are just some of the advantages being touted by 3G developers. Companies developing 3G equipment envision users having the ability to receive line music, conduct interactive web sessions and have simultaneous voice and data access with multiple parties at the same time using a single mobile handset, whether drinking, walking or standing still in an office setting.

The International Telecommunications Union (ITU) formulated a plan to implement a global frequency band in the 2000 MHz range that would support a single, ubiquitous wireless communication standard for all countries throughout the world. This plan, called International Mobile Telephone 2000 (IMT-2000) has been successful in helping to cultivate active debate and technical analysis for new high speed mobile telephone solutions when compared to 2G.

The eventual 3G evolution for 2G-CDMA systems leads to Cdma 2000. Several variants of CDMA 2000 are currently being developed, but they all are based on the fundamentals of IS-95 and IS-95B technologies. The eventual 3G evolution for GSM, IS-136 and PDC systems leads to wideband CDMA also called universal mobile telecommunication service. W-CDMA is based on the network fundamentals of GSM, as well as the merged versions of GSM and IS-136 through EDGE. It is fair to say that these two major 3G-technology camps, cdma 2000 and W-CDMA, will remain popular throughout the early part of the 21st century.

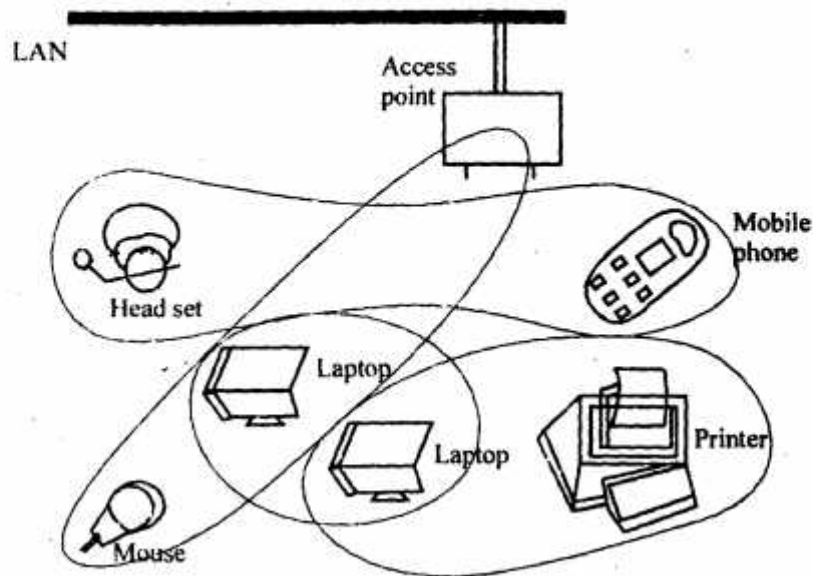
Q. 2. (b) Describe Personal area networks.

Ans. Personal Area Networks (PANs) and Bluetooth : PAN and bluetooth is an open standard that has been embraced by over 1000 manufacturers of electronic appliances. It provides an Ad-hoc approach for enabling various devices to communicate with one another within a nominal 10 meter range.

PANs operates in the 2.4 GHz ISM band (2400-2483.5 MHz) and uses a frequency hopping TDD scheme for each radio channel. Each PAN radio channel has a 1 MHz bandwidth and hops at a rate of approx. 1600 hops per second. Transmissions are performed in 625 μ sec slots with a single packet transmitted over a single slot.

For long data transmission, particular users may occupy multiple slots using the same transmission frequency, thus, slowing the instantaneous hopping rate to below 1600 hops/sec.

The frequency hopping scheme of each PANs user is determined from a cyclic code of length $2^{27} - 1$.



A personal Area Network (PAN)

and each user has a channel symbol rate of 1 Mbps using GFSK modulation to the internet in IEEE 802.11b. The IEEE 802.15 standards committee has been formed to provide an international forum for developing PANs.

Q. 3. (a) Describe drawback of analog cellular systems.

Ans. Drawback of Analog Cellular System :

- (i) The signal must be at least 18 dB above the co-channel interference to provide acceptable call quality.
- (ii) Analog channels of cellular systems support different users.
- (iii) Analog systems do not consider coding and multiplexing techniques.
- (iv) Analog systems do not give high quality voice transmission.
- (v) Analog cellular systems do not give right picture quality on the screen.
- (vi) It is not given the high range as the signal.

Q. 3. (b) What do you mean by near far effect?

Ans. Near-far-Effect : Packet radio multiple access techniques are based on contention within a channel. When used with FM or spread spectrum modulation, it is possible for the strongest user to successfully capture the intended receiver, even when many other users are also transmitting. Often, the closest transmitter is able to capture a receiver because of the small propagation path loss. This is called the near-far effect. The capture effect offers both advantages and disadvantages in practical systems. Because a particular transmitter may capture an intended receiver, many packets may survive despite collision on the channel.

A useful parameter in analyzing the capture effects in packet radio protocols is the minimum power ratio of an arriving packet, relative to the other colliding packets, such that it is received. This ratio is called the capture ratio and is dependent upon the receiver and the modulation used.

Packet radio techniques support mobile transmitters sending bursty traffic in the form of data packets using random access. In mobile system the CSMA protocols may fail to detect ongoing radio transmission of packets subject to deep fading on the reverse channel path utilization of an ALOHA channel can be improved by deliberately introducing differences between the transmit powers of multiple users competing for the base station receiver.

Q. 4. (a) Explain different types of handoff.

Ans. Handoff Strategies : When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station. In order to meet these requirements, system designers must specify an optimum signal level at which to initiate a handoff. Once a particular signal level is specified as the minimum usable signal for acceptable noise quality at the base station receiver a slightly stronger signal level is used as a threshold at which a handoff is made.

In Mobile Assisted Hand Off (MAHO), energy mobile station measures the received power from surrounding base stations and continuously reports the results of these measurements to the serving base station.

During the course of a call, if a mobile moves from one cellular system to a different cellular system controlled by a different MSC, an intersystem handoff becomes necessary.

An MSC engages in an intersystem handoff when a mobile signal becomes weak in a given cell and the MSC cannot find another cell within its system to which it can transfer the call in progress compatibility between the two MSC's must be determined before implementing an intersystem handoff.

Q. 4. (b) What are different channel assignment strategies?

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. Channel assignment strategies can be classified as either fixed or dynamic. In a fixed channel assignment strategy, each cell is allocated a predetermined set of voice channels. Any call attempt within the cell can only be served by the unused channels in that particular cell. If all the channels in that cell are occupied, the call is blocked and the subscriber does not receive service. The mobile switching center (MSC) supervises such borrowing procedures and ensures that the borrowing of a channel does not disrupt or interfere with any of the calls in progress in the donor cell.

In a dynamic channel assignment strategy, voice channels are not allocated to different cells permanently. Instead, each time a call request is made, the serving base station requests a channel from the MSC. The frequency of use of the candidate channel, the reuse distance of the channel and other cost functions.

Q. 5. (a) What is basic prerequisite for applying FDMA? How does this factor increase complexity compared to TDMA system.

Ans. FDMA : Frequency Division Multiple Access assigns individual channels to individual users. The users are assigned a channel as a pair of frequencies one frequency is used for the forward channel, while the other frequency is used for the reverse channel. Prerequisite for applying FDMA :

1. The FDMA channel carries only one plane circuit at a time.
2. In an FDMA channel is not in use.
3. The bandwidths of FDMA channels are relatively narrow (30 kHz in AMPS) as each channel supports only one circuit per carrier. That is, FDMA is usually implemented in narrow band systems.
4. FDMA requires tight RF filtering to minimize adjacent channel interference.

Factor Increase Complexity Compared to TDMA System :

1. TDMA shares a single carrier frequency with several users. Where each user makes use of non-

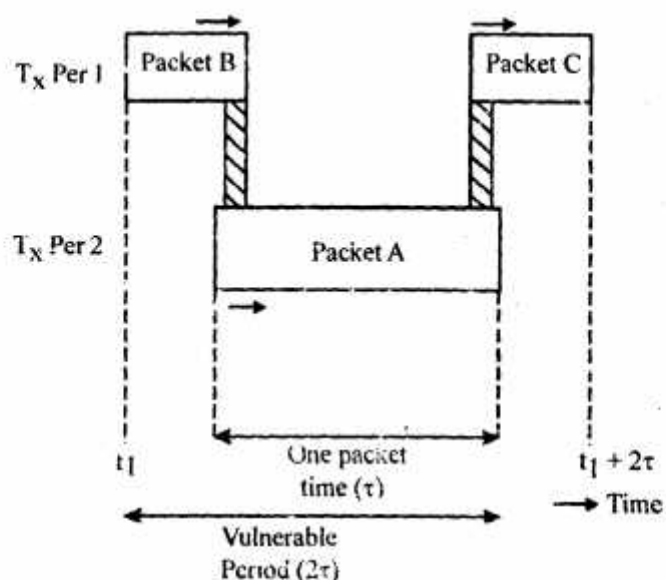
- overlapping time slots.
- 2. Data transmission for users of a TDMA system is not continuous, but occurs in burst.
- 3. TDMA uses different time slots for transmission and reception, thus, duplexers are not requested.
- 4. In TDMA, the guard time should be minimized.

Q. 5. (b) What is packet ratio?

Ans. Packet Radio : In PR access techniques, many subscribers attempt to access a single channel in an uncoordinated manner.

Packet radio multiple access is very easy to implement, but has low spectral efficiency and may include delays. The subscribers use a contention technique to transmit on a common channel. It is evaluated by the throughput (τ), which is defined as the average number of messages successfully transmitted per unit time and average delay (D) experienced by a typical message burst.

Packet Radio Protocols : It is important to vulnerable period V_p , which is defined as the time interval during which the packets are susceptible to collisions with transmissions from other users.



The packet A will suffer a collision if other terminals transmit packets during the period t_1 to $t_1 + 2\tau$. Even if only a small portion of packet A sustains a collision, the interference may render the message useless.

It is assumed that packet transmissions occur with a Poisson distribution having a mean arrival rate of λ packets per second. If τ is the packet duration in seconds, then the traffic occupancy or throughput R of a packet radio network is given by

$$R = \lambda \tau \quad \dots(i)$$

The normalized throughput is given as the total offered load times the probability of successful transmission, i.e.,

$$T = R P_r(\text{no collision}) = \lambda \tau P_r(\text{no collision}) \quad \dots(ii)$$

Where, P_r [no collision] is the probability of a user making a successful packet transmission, Poisson distributed.

$$P_r(n) = \frac{R^n e^{-R}}{n!}$$

The probability that zero packets are generated during this interval

$$P_r(0) = e^{-R}$$

Based on the type of access, contention protocols are categorized as random access, scheduled access and hybrid access.

Q. 6. (a) What are the advantages of packet switching technique over circuit switching technique?

Ans. Advantages of Packet Switching Technique Over Circuit Switching Technique : Packet switching technology will have more advantages for PCS/PCN than circuit switching. The factors that influence the use of packet switching include the following :

- (i) It is required to serve a wide range of services including voice, data, email, and digital video. Commercial grade voice over IP will catapult packet switched PCNs.
- (ii) Support large populations of infrequent users, so that economic viability will depend on the ability to effectively share the bandwidth and infrastructure equipment.
- (iii) The relatively unreliable channel is more suited for packet switching than for circuit switching. In addition, packet switching does not need a dedicated link at very low bit error rates and has the ability to compensate for lost or corrupt data through ARQ based transmission strategies.
- (iv) PCN will require a high-capacity switching infrastructure for routing of traffic between cells.

Q. 6. (b) Explain fixed network transmission hierarchy.

Ans. Fixed Network Transmission Hierarchy : Wireless networks rely heavily on a landline connection. For example, the MSC connects to the PSTN and SS7 networks using fiberoptic or copper cable or microwave links. Base stations within a cellular system are connected to the MSC using line-of-sight (LOS) microwave links or copper or fibre optic cables.

Several Standard Digital Signaling (DS) formats form a transmission hierarchy that allows high data rate digital networks which carry a large number of voice channels to be interconnected throughout the world. These DS formats use time division multiplexing (TDM). The digital transmission hierarchy is the T(N) designation, which is used to denote transmission line compatibility for a particular DS format.

Typically, coaxial or fibre optic cable or wideband microwave links are used to transmit data rates in excess of 10 Mbps, whereas inexpensive wire or coaxial cable may be used for slower data transfer. When connecting base stations to a MSC or distributing trunked voice channels throughout a wireless network,

T_1 (DS₁) or level 1 links are most commonly used and utilize common-twisted pair wiring. DS-3 and higher rate circuits are used to connect MSC and CDs to the PSTN.

Digital Transmission Hierarchy :			
Signal level	Digit bit Rate	Equivalent Voice Circuits	Carrier System
North American & Japan			
DS-0	64.0 kbps	1	
DS-1	1.544 Mbps	24	T-1
DS-1C	3.152 Mbps	48	T-1C
DS-2	6.312 Mbps	96	T-2
DS-3	44.736 Mbps	672	T-3
DS-4	274.176 Mbps	4032	T-4
CEPT (Europe and Most other PTTs)			
0	64.0 kbps	1	
1	2.048 Mbps	30	E-1
2	8.448 Mbps	120	E-1C
3	34.368 Mbps	480	E-2
4	139.264 Mbps	1920	E-3
5	565.148 Mbps	7680	E-4

Q. 7. (a) Explain CDMA cellular Radio network.

Ans. CDMA Cellular Radio Networks : The cellular radio network is interference limited. In a CDMA system, the link performance for each user increases as the number of users decreases.

For evaluating the capacity of a CDMA system, first consider a single cell system. The cellular network consists of a large number of mobile users communicating with a base station.

Let the number of users be N . Then, each demodulator at the cell site receives a composite waveform containing the desired signal of power S and $(N-1)$ interfering users, each of which has power S . Thus, the signal to noise ratio.

$$SNR = \frac{S}{(N-1)S} = \frac{1}{(N-1)} \quad \dots(i)$$

The SNR at the base station receiver can be represented in terms of E_b / N_0 .

$$\frac{E_b}{N_0} = \frac{S/R}{(N-1)(S/V)} = \frac{W/R}{N-1} \quad \dots(ii)$$

Equation (ii) does not take into account the back ground thermal noise, η , in the spread bandwidth.

$$\frac{E_b}{N_0} = \frac{W/R}{(N-1) + (\eta/S)} \quad \dots(iii)$$

The number of users can access the system,

$$N = 1 + \frac{W/R}{E_b/N_0} - (\eta/S) \quad \dots(iv)$$

W/R is called the processing gain.

Equating equation (ii) becomes $(N_s - 1)\alpha$, where N_s is the number of users per sector. With the use of these two techniques, the new average value of E_b/N_0 within a sector

$$\frac{E_b}{N_0} = \frac{W/R}{(N_s - 1)\alpha + (\eta/S)} \quad \dots(v)$$

The number of users,

$$N_s = 1 + \frac{1}{\alpha} \left[\frac{W/R}{\frac{E_b}{N_0}} \right] \quad \dots(vi)$$

If the voice activity factor is assumed to have a value of 3/8 and three sectors per cell site are used.

Q. 7. (b) What do you mean by intelligent cell concept.

Ans. Intelligent Cell Concept : Allows its users to have a single telephone number to be used for both wireless and wireline services. It contains databases for the storage of information about the network users. A large amount of signaling will be required for efficient working of these networks. It uses employ SS7 signaling. It required to serve a wide range of services including voice, data, email and digital video. It support large populations of inadequate users, so that economic viability will depend on the ability to effectively share the bandwidth and infrastructural equipment. It required a high capacity switching infrastructure for routing of traffic between cells.

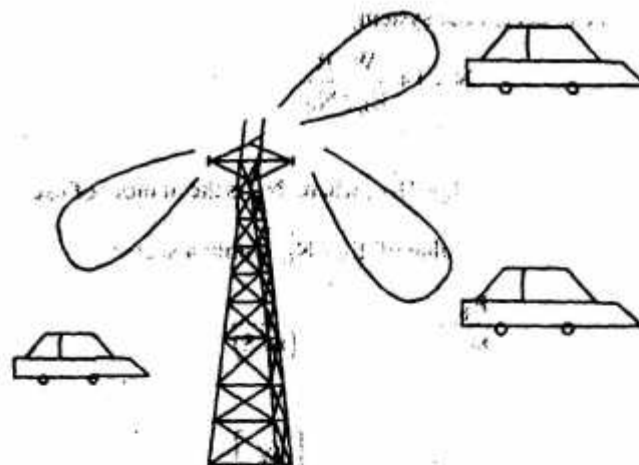
Q. 8. Write short notes on :

- (a) SDMA
- (b) Microcell zone concept
- (c) WLL

Ans. (a) SDMA . Space Division Multiple Access (SDMA) controls the radiated energy for each user in space.

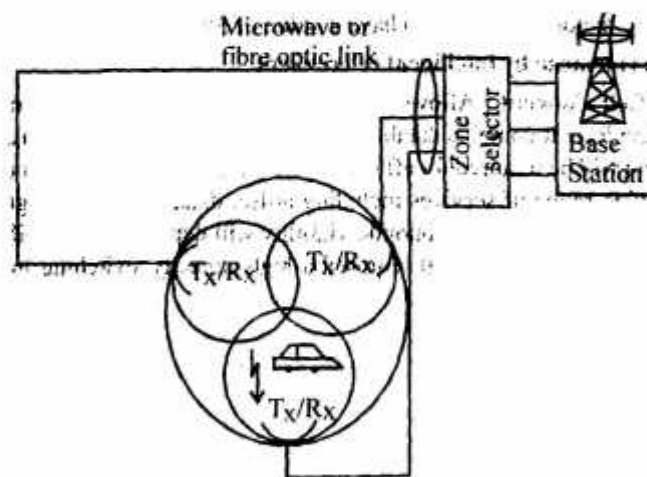
SDMA serves different users by using spot beam antennas. Sectorized antennas may be thought of as a primitive application of SDMA.

The base station has complete control over the power of all the transmitted signals on the forward link. Adaptive antennas used at the base station promise to mitigate some of the problems on the reverse link. In the limiting case of infinitesimal beam width and infinitely fast track ability, adaptive antennas implement optimal SDMA; thereby providing a unique channel that is free from the interference of all other users in the cell with SDMA, all users within the system would be able to communicate at the same time using the same channel. In addition, a perfect adaptive antenna system would be able to track individual multipath components for each user and combine them in an optimal manner to collect all of the available signal energy from each user. The perfect adaptive antenna system is not feasible since it requires infinitely large antennas.



A Spatially Filtered Base Station Antenna Serving Different Users by Using Spot Beams

(b) Microcell Zone Concept :



The Microcell Concept

The increased number of handoffs required when sectoring is employed results in an increased load on the switching and control link element of the mobile. Each of three zone sites are connected to a single base station and share the same radio equipment. The zones are connected by coaxial cable, fibreoptic cable, or microwave link to the base station. Multiple zones and a single base station make up a cell.

As a mobile travels from one zone to another with the cell, it retains the same channel. Thus, unlike in sectoring, a handoff is not required at the MSC when the mobile travels between zones within the cell. The advantage of the zone cell technique is that while the cell maintains a particular coverage radius, the co-channel interference in the cellular system is reduced since a large central base station is replaced by several lower powered transmitters on the edge of the cell.

(c) WLL : Wireless in local loop is a fixed wireless equipment is extremely well suited for rapidly deploying a broadband connection in many instances and this approach is steadily becoming more popular for providing "last mile" broadband local loop access, as well as for emergency or redundant point-to-point or point-to-point multipoint private networks.

~~Microwave wireless links can be used to create a wireless local loop (WLL) such as resides between the Central Office (CO) and the individual homes.~~

Benefits of WLL technology is that uses the wireless equipment is paid for, there are no additional costs for transport between the co and customer premises equipment (CPE), whereas buried cables often must be leased from a service provider or utility company, on a monthly basis.

It is possible that WLL systems could compete with copper-wire based digital subscriber (DSL) loop technologies that are rapidly proliferating.