

B.E.
Sixth Semester Examination, 2010
Wireless Communication (EE-402-E)

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

Q. 1. (a) Explain wireless communication with block diagram.

Ans. Wireless Communication System : 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. In first generation cordless telephone systems, the portable unit communicates only to the dedicated base unit and only over distances of a few tens of meters. Early cordless telephones operate solely as extension telephone to a transceiver connected to a subscriber line on the PSTN and are primarily for in-home use.

Second generation cordless telephone have recently been introduced which allow subscribers to use their handsets at many outdoor locations within urban centers such as London or Hong Kong. Modern cordless telephones are sometimes combined with paging receivers so that a subscriber may first be paged and then respond to the page using the cordless telephone. Cordless telephone systems provide the user with limited range and mobility, as it is usually not possible to maintain a call if the user travels outside the range of the base station. Typical second generation base stations provide coverage ranges up to a few hundred meters. Figure illustrates a cordless telephone system.

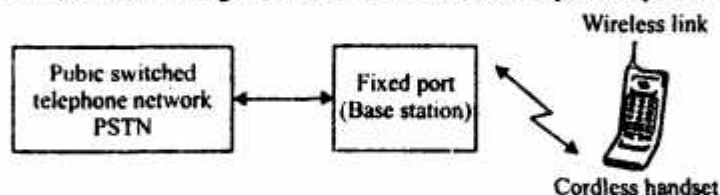


Fig. A wireless communication system

Q. 1. (b) Compare various wireless systems.

Ans. Table 1 and 2 illustrate the type of service, level of infrastructure, cost and complexity required for the subscriber segment and base station segment of each of the five mobile or portable radio system.

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	<100MHz	Transmitter
Paging System	High	High	Low	Low	<1GHz	Receiver
Cordless Phone	Low	Low	Moderate	Low	1-3GHz	Transceiver
Cellular Phone	High	High	High	Moderate	>2GHz	Transceiver

Table2 : Comparison of Mobile Communication Systems-Base Station :

Service	Coverage Range	Required Infrastructure	Complexity	Hardware Cost	Carrier Frequency	Functionality
TV Remote Control	Low	Low	Low	Low	Infrared	Receiver
Garage Door Opener	Low	Low	Low	Low	<100MHz	Receiver
Paging System	High	High	High	High	<1 GHz	Transmitter
Cordless Phone	Low	Low	Low	Moderate	1-3 GHz	Transceiver
Cellular Phone	High	High	High	High	>2 GHz	Transceiver

Q. 2. (a) What do you mean by WLL?

Ans. Wireless Local Loop (WLL) : The fast growth of internet has produce a large demand of broadband internet and computer access for the home and business point of view throughout the whole world.

The fixed wireless communication system has more advantage due to his well-defined, time invariant nature of the propagation channel between the fixed receiver and fixed transmitter.

The modern wireless system are allot the microwave and millimeter radio frequency are 28 GHz band and these frequency are ten time greater then the carrier frequency of 3G terrestrial cellular telephone network. The carrier frequency of fixed wireless access terminal is very high so sometime the radio channel behave like an optical channel. At very high frequency, the fixed wireless network are only viable where there are no obstructions, such in the rural setting or in relatively that suburban.

The microwave wireless can be used to provide a wireless local loop.

The local loop is from "last mile" of the telecommunication network that provide the connection between the control office and the individual homes and business as close as possible.

The WLL technology has an additional benefit that once the wireless equipment is paid for then there are no additional costs for transport between the customer premises equipment and (CO) central office.

The WLL system can be completed with copper wire based digital subscriber loop technologies.

Q. 2. (b) Explain the features of 3G wireless networks.

Ans. Third Generation (3G) Wireless Networks : 3G systems promise unparalleled wireless access in ways that have never been possible before. Multimegabit Internet access, communication using voice over Internet protocol, video and data services, unique network capacity and ubiquitous "always-on" are just some of the advantages being touted by 3G developers.

Companies developing 3G equipment envision users having the ability to receiver live music, conduct interactive web sessions, and have same time capability of voice and data access with multiple parties at the same time using a single mobile handset, whether driving, walking, or standing still in an office setting or in running condition.

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 primary 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 Telecommunications Service (UMTS). W-CDMA is identify by the network fundamentals of GSM, as well as the merged versions of GSM and IS-136 through EDGE technique.

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.

Countries throughout the world are currently define the new radio spectrum bands to accommodate the 3G networks that will likely be deployed in the 2004-05 time frame.

ITU's 2000 World Radio Conference to set and fixed the 2500-2690 MHz, 1710-1885 MHz and 806-960 MHz bands as candidates for 3G.

3G-W-CDMA (UMTS) : The Universal Mobile Telecommunications System is a visionary air interface standard that has developed since late 1996 under the auspices of the European Telecommunication Standards Institute (ETSI) organizations.

3G CDMA 2000 : The CDMA 2000 vision, provides a seamless and evolutionary high data rate upgrade path for current users of 2G and 2.5G CDMA technology. With the help of a building block approach that centers on the original 2G CDMA channel bandwidth of 1.25 MHz per radio channel for transmission.

Examples of 3G Systems :

(i) HMT-2000

(ii) UMTS

(iii) MBMS

(iv) WLAN

Q. 3. (a) Describe the operation of cellular systems.

Ans: A cellular system is a radio network distributed over land areas called cells, each served by at least one fixed-location transceiver known as a cell site or base station. When joined together these cells provide radio coverage over a wide geographic area. This enables a large number of portable transceivers (e.g., mobile phones, pagers etc.) to communicate with each other and with fixed transceivers and telephones anywhere in the network, via base stations, even if some of the transceivers are moving through more than one cell during transmission.

Cellular networks offer a number of advantages over alternative solutions.

(i) Increased capacity (ii) Reduced power use

(iii) Larger coverage area

(iv) Reduced interference from other signals

(v) In a cellular radio system, a land area to be supplied with radio service is divided into regular shaped cells, which can be hexagonal, square, circular or some other irregular shape, although hexagonal cells are conventional. Each of these cells is assigned multiple frequencies ($f_1 - f_6$) which have corresponding radio base stations. The group of frequencies can be reused in other cells, provided that the same frequencies are not reused in adjacent neighbouring cells as that would cause co-channel interference.

(vi) The increased capacity in a cellular network, compared with a network with a single transmitter, comes from the fact that the same radio frequency can be reused in a different area for a completely different transmission. If there is a single plain transmitter, only one transmission can be used on any given frequency. Unfortunately, there is inevitably some level of interference from the signal from the other cells which use the same frequency. This means that, in a standard FDMA system, there must be at least a one cell gap between cells which reuse the same frequency.

Cell Signal Encoding : (i) To distinguish signals from several different transmitters, frequency division multiple access (FDMA) and code division multiple access (CDMA) were developed.

(ii) With FDMA, the transmitting and receiving frequencies used in each cell are different from the frequencies used in each neighbouring cell. In a simple taxi system, the taxi driver manually tuned to a frequency of a chosen cell to obtain a strong signal and to avoid interference from signals from other cells.

(iii) The principle of CDMA is more complex, but achieves the same result; the distributed transceivers can select one cell and listen to it.

(iv) Other available methods of multiplexing such as polarization division multiple access (PDMA) and time division multiple access (TDMA) cannot be used to separate signals from one cell to the next since the effects of both vary with position and this would make signal separation practically impossible. Time division multiple access, however, is used in combination with either FDMA or CDMA in a number of systems to give multiple channels within the coverage area of a single cell.

Q. 3. (b) Discuss features of Digital cellular systems.

Ans. Features of Digital Cellular System : The most common example of a cellular network is a mobile phone (cell phone) network. A mobile phone is a portable telephone which receives or makes calls through a cell site (base station), or transmitting tower. Radio waves are used to transfer signals to

and from the cell phone. Modern mobile phone networks use cells because radio frequencies are a limited, shared resource. Cell-sites and handsets change frequency under computer control and use low power transmitter so that a limited number of radio frequencies can be simultaneously used by many callers with less interference.

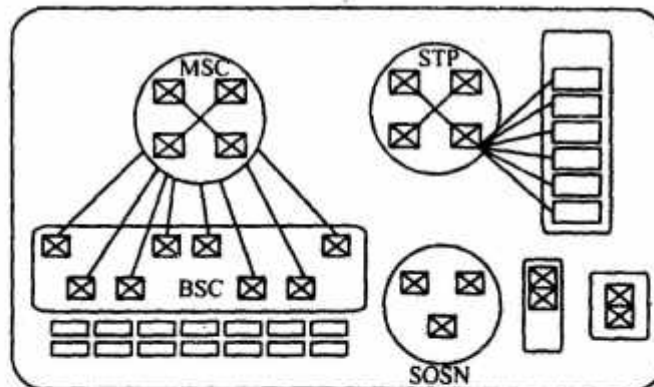
A cellular network is used by the mobile phone operator to achieve both coverage and capacity for their subscribers. Large geographic areas are split into smaller cells to avoid line-of-sight signal loss and to support a large number of active phones in that area. All of the cell sites are connected to telephone exchanges (or switches), which in turn connect to the public telephone network.

Since almost all mobile phones use cellular technology, including GSM, CDMA, and AMPS (analog), the term "cell phone" is in some regions, notably the US, used interchangeably with "mobile-phone". However, satellite phones are mobile phones that do not communicate directly with a ground-based cellular tower, but may do so indirectly by way of a satellite.

There are a number of different digital cellular technologies, including : Global System for Mobile Communications (GSM), General Packet Radio Service (GPRS), Code Division Multiple Access (CDMA), Evolution-Data Optimized (EV-DO), Enhanced Data Rates for GSM Evolution (EDGE), 3GSM, Digital Enhanced Cordless Telecommunications (DECT), Digital AMPS (IS-136/TDMA), and Integrated Digital Enhanced Network (IDEN).

Structure of the Mobile Phone Cellular Network

Main Article : GSM



Structure of a 2G cellular network

A simple view of the cellular mobile-radio network consists of the following :

- (i) A network of Radio base stations forming the base station subsystem.
- (ii) The core circuit switched network for handling voice calls and text
- (iii) A packet switched network for handling mobile data
- (iv) The public switched telephone network to connect subscribers to the wider telephony network

This network is the foundation of the GSM system network. There are many functions that are performed by this network in order to make sure customer get the desired service: including mobility management, registration, call set up, and handover.

Any phone connects to the network via an RBS in the corresponding cell which in turn connects to the MSC. The MSC allows the onward connection to the PSTN. The link from a phone to the RBS is called an uplink while the other way is termed downlink.

Radio channels effectively use the transmission medium through the use of the following multiplexing schemes : Frequency division multiplex (FDM), time division multiplex (TDM), code division multiple (CDM), and space division multiplex (SDM). Corresponding to these multiplexing schemes are the following access techniques: frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), and space division multiple access (SDMA).

Cellular Handover in Mobile Phone Networks :

Main Article : Handoff : As the phone user moves from one cell area to another cell whilst a call is in progress, the mobile station will search for a new channel to attach to in order not to drop the call. Once a new channel is found, the network will command the mobile unit to switch to the new channel and at the same time switch the call onto the new channel. With CDMA, multiple CDMA handsets share a specific radio channel. The signals are separated by using a pseudonoise code (PN code) specific to each phone. As the user moves from one cell to another, the handset sets up radio links with multiple cell sites (or sectors of the same site) simultaneously. This is known as "soft handoff" because, unlike with traditional cellular technology, there is no one defined point where the phone switches to the new cell. In IS-95 inter-frequency handovers and older analog systems such as NMT it will typically be impossible to test the target channel directly while communicating. In this case other techniques have to be used such as pilot beacons in IS-95. This means that there is almost always a brief break in the communication while searching for the new channel followed by the risk of an unexpected return to the old channel.

If there is no ongoing communication or the communication can be interrupted, it is possible for the mobile unit to spontaneously move from one cell to another and then notify the base station with the strongest signal.

Q. 4. (a) Explain frequency reuse concept in cellular communication.

Ans. Frequency Reuse : The cellular system are high capacity land mobile system in which assigned radio spectrum is divided into discrete channels which are assigned in groups to geographic cells covering cellular geographic region. The discrete channels are capable of being reused in different cells through a process known as frequency reused.

The design process of selecting and assigning the channels groups for all of the cellular base station within a system is called frequency reuse of frequency planning concept.

Each cellular base station is allocated a group of radio channels to be used within a small geographic region called a cell. Figure shows the concept of cellular frequency reuse, where cells adjacent with the same letter use the same group of channels.

The hexagonal cell shape shown in figure is conceptual and is a simplistic model of the radio coverage for each base station, but it has been universally embraced since the hexagon permits easy and manageable analysis of a cellular system. The actual radio coverage of a cell is called the foot print and is determined from field measurement or propagation prediction models.

Figure show the reuse concept ($N = 7$ reuse format). The explain the frequency reuse concept, consider a cellular system which has a total of S duplex channels available for use. If each cell is allocated a group of K channels ($K < S$) and if the S channels are split among N cells into unique and disjoint channel groups which each have the same number of channels, the total number of available radio channels can be expressed as the following equation

$$S = KN \quad (1)$$

The N -cells which collectively use the complete set of available or present frequencies is called a cluster.

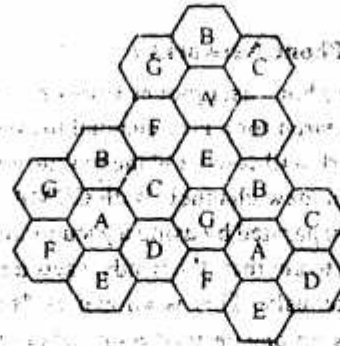


Fig. Illustration of the cellular frequency reuse concept

Cells with the same letter use the same of frequencies. A cell cluster is outlined in bold and replicated over the coverage area. In this example, the cluster size, N , is equal to seven, and the frequency reuse factor is $1/7$ since each cell contains one-seventh of the total number of available channels.

Q. 4.(b) Explain various techniques for improving coverage and capacity.

Ans. Improving Coverage and Capacity in Cellular Systems : As the demand for wireless service increase, the number of channels allotted to a cell eventually becomes insufficient to support the required number of users. At this point, cellular design techniques are needed to allow more channels per unit coverage area.

The following techniques are used to increase the capacity of cellular systems:

- (i) Cell splitting
- (ii) Sectoring
- (iii) Coverage zone approaches
- (iv) Microcell zone concept

Comparison among cell splitting, cell sectoring, microcell zone concept increasing number of repeaters :

S. No.	Parameters	Cell Splitting	Microcell Zone Concept	Increasing Number of Repeater
(i) Process	Each cell is divided into smaller radius cells.	Each cell is divided into sectors of equal area having centred of equal mid of the main cell.	Each cell is formed using many zones.	Repeaters are used to cover more coverage area.

(ii) Base Station	Each smaller cell requires new base station.	No more base stations are required.	Each cell has only one base station.	Repeaters are required.
(iii) Interference	Interference gets increased due to nearer co-channel cells.	Co-channel interference is reduced.	Interference is reduced.	Interference is increased due to amplification.
(iv) System Capacity	System capacity increases due to increase in the number of cluster.	System capacity increased by increase in the signal to interference ratio (S/I).	System capacity increases without any degradation in trunking efficiency.	System capacity remains unchanged.
(v) Radius of Cell	Radius of cell decreases.	Radius of cell remains unchanged.	Radius of cell increases.	No effect at radius of cell.
(vi) Cost	Cost increase due to new base stations.	Cost increases due to more antennas.	Cost decreases due to less base station.	Increases due to repeaters.

Q. 5. (a) Explain the spread spectrum.

Ans. Spread Spectrum : "Spread spectrum" suggests this technique, supports spreading the bandwidth to transmit data with more security within a system.

Spread spectrum technique was developed for military applications to avoid jamming and interception because a signal spread over a wider bandwidth made jamming. More difficult to transmit via channel.

Advantage of spread spectrum technique over narrow band systems include the following.

- (i) Reduced interference with the other systems.
- (ii) Highly secure communication between two terminals.
- (iii) Low density power spectrum for signal hiding.
- (iv) Antijamming capability of the network.
- (v) Increased capacity of system.
- (vi) Low cost.
- (vii) Immunity to noise and multipath distortion.
- (viii) Several users can transmit the data simultaneously or at a time.

Spread spectrum techniques employ a transmission bandwidth that is several orders of magnitude greater than the minimum required signal bandwidth.

The spreading waveform is controlled pseudonoise (PN) sequence or pseudonoise code, which is a binary sequence that appears random but can be regenerate in a deterministic manner by intended receivers.

Spread spectrum signals are demodulated at receiver through cross-correlation with a locally-generated version of the pseudo-random carrier at the receiver to get the original information.

Q. 5. (b) What are features and drawbacks of TDMA?

Ans. Time Division Multiple Access (TDMA) : TDMA systems divide the radio spectrum into time slots, and in each slot only one user is allowed to either transmit or receiver, it can be seen from figure. That each user hold a cyclically repeating time slot so a channel may be thought of as a particular time slot reoccurs every frame, where N-time slots comprise a frame as shown in figure.

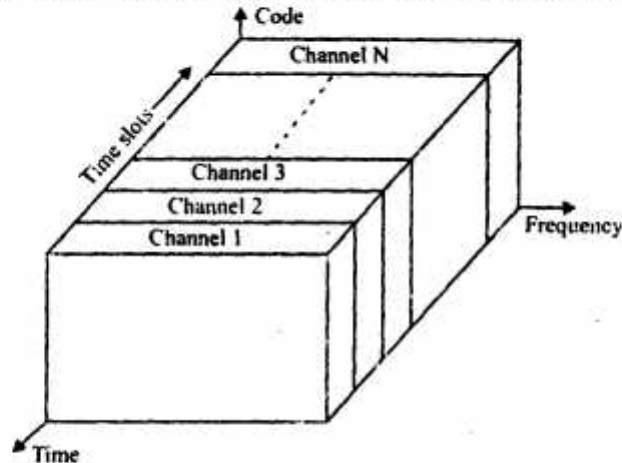


Fig. TDMA scheme where each channel occupies a cyclically repeating time slot

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 transmission 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. 6. (a) What do you mean by advanced intelligent networks ?

Ans. Advanced Intelligent Network (AIN) : The Advanced Intelligent Network (AIN) is a telephone network architecture that separates service logic from switching equipment, allowing new services to be added without having to redesign switches to support new services. It encourages competition among service providers since it makes it easier for a provider to add services and it offers customers more service choices.

The Advanced Intelligent Network (AIN) is recognized as an industry standard in North America, replacing the legacy IN. AIN has three key components :

Signal Control Points (SCP) : Computers with databases containing customer specific information used by the network to route calls in stored.

Signal Switching Points (SSP) : Digital telephone switches which talk to SCP and request them for customer specific instructions as to how the call should be completed.

Signal Transfer Points (STP) : Packet switches that shuttle messages between SSP and SCPs.

The Typical Working Flow of AIN Systems : A telephone caller dials a number that is received by a switch at the telephone company central office.

The switch-known as the Service Switching Point (SSP)—forwards the call over a Signaling System 7 (SS7) network to a Service Control Point (SCP) where the service logic is located. The Service Control Point identifies the service requested from part of the number that was dialed and returns information about how to handle the call to the Service Switching Point. Examples of services that the SCP might provide include area number calling service, disaster recovery service, do not disturb service, and 5-digit extension dialing service.

In some cases, the call can be handled more quickly by an Intelligent Peripheral (IP) that is attached to the Service Switching Point over a high-speed connection. For example, a customized voice announcement can be delivered in response to the dialed number or a voice call can be analyzed and recognized.

In addition, an "adjunct" facility can be added directly to the service switching point for high-speed connection to additional, undefined services.

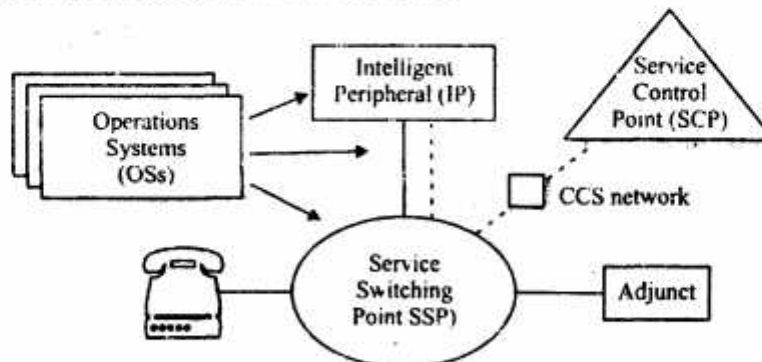


Fig. Intelligent Network (IN) and Advanced Intelligent Network (AIN)

Q. 6. (b) Difference between circuit switching and packet switching.

Ans. Circuit Switching : Circuit switching establishes a dedicated connection for the whole duration of a call.

A mobile user may handoff to different base stations, there is always a dedicated radio channel to arrange service to the user and the MSC dedicates a fixed, full duplex phone connection to the PSTN. Wireless data networks are not supported by circuit switching, due to their short, bursty transmissions which are often followed by periods of inactivity. Often, the time required to establish a circuit exceeds the duration of the data transmission.

Circuit switching is best suited for dedicated voice only traffic, or for instance where data is continuously sent over long periods of time.

Packet Switching : Packet switching is the most common technique used to implement connectionless services and allows a large number of data users to remain virtually connected to the same physical channel in the network.

All users may access the network randomly and at will; call setup procedures are not needed to dedicate specific circuits when a particular user requires to send data.

Packet switching breaks each message into smaller units for transmission and recovery for information.

When a message is broken into packets, a certain amount of control information is added to each packet to provide source and destination identification, as well as error recovery provisions from information.

Figure represents the sequential format of a packet transmission and packet consists of header information, the user data, and a trailer. The header specifies the beginning of a new packet and contains the source address, packet sequence number and other routing and billing information. User data have the information which is generally protected with error control coding. Trailer contains a cyclic redundancy check sum which is used for error detection at the receiver.



Fig. Packet data format

The packet switching is better than circuit switching for the PCS/PCN and the packet switching is affected by the following factor :

- (i) PCN will allow large population of infrequent users so the economic viability is depend on bandwidth sharing and infrastructural.
- (ii) The relatively unreliable channel is more suited for packet switching than the circuit switching.
- (iii) PCN will need a high capacity switching infrastructure for routing traffic between cells.
- (iv) PCN will need a wide range of services including voice, data email and digital video.

Q. 7. (a) Explain applications of intelligent micro cell system.

Ans. In the cellular industry, system capacity is a great issue. As demand for cellular service grows, system operators try to find ways to increase system capacity. Capacity can be increased by reducing the cell sizes. This is called the conventional microcell approach, but it does not provide intelligence. When the cell size becomes smaller, the control of interference among the cells becomes harder. Also, the handoff time from the beginning of the initiation to the action completion sometimes may take around 15s. If a mobile station is moving at a speed of 25 km/h (7 m/s), then the mobile station will travel 105 m in 15s; at a speed of 30 km/h, the mobile station travels 205m in 15s. Because within a microcell of 0.5-km radius the overlapped region for a handoff is very small, then the mobile station is in the overlapped region short a time for the handoff action to be complete. As a result, the call drops. In a conventional microcell system, interference is hard to control and the handoffs may not have enough time to complete.

The intelligent cell can solve the two problems. The intelligent cell concept can be used not only in microcells but also in regular cells to bring extra capacity to the system.

There are two definitions to describe an intelligent cell. One definition of intelligent cells is that the cell is able to intelligently monitor where the mobile unit or portable unit is and find a way to deliver confined power to that mobile unit. The other definition of intelligent cell is that signals coexist comfortably and indestructibly with the interference in the cell. From the first definition, the intelligent cell is called the **power-delivery intelligent cell**, and from the second definition, it is called the **processing-gain intelligent cell**. The intelligent cell may be a large cell such as a macrocell or a small cell such as a microcell. The intelligent cell increases capacity and improves performance of voice and data transmission. Because personal communication service (PCS) needs vast capacity and high quality, the intelligent cell concept is well-suited to it. Actually, using any means intelligently in a cell to improve the performance of services is what the intelligent cell stands for.

The Philosophy of Implementing Power-Delivery Intelligent Cells : Many different wireless versions of an intelligent cell can be used as long as they can deliver power to the location of the mobile unit. The easiest explanation is the analogy of a person entering a house fig.

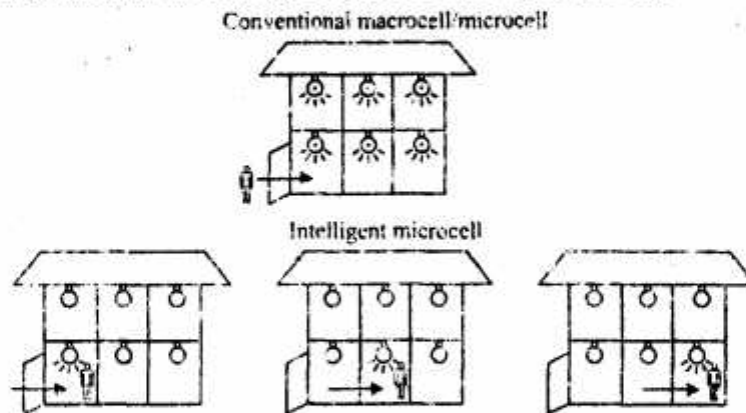


Fig. Microcell philosophy : energy follow the mobile analogy, light follows the person

In a conventional macrocell or microcell, when a mobile unit enters a cell or sector, the cell site will cover the power to the entire cell or sector. This is because the cell site does not know where the mobile unit is within the cell or sector. This is just like a house that turns on all the lights when a person enters it.

Delivering Power Intelligently : In an intelligent macrocell or microcell, when a mobile unit enters a cell or a sector, the cell site covers only a local area, which follows the mobile unit. This is just like a house that turns on only the light of the first room a person enters. When the person enters the second room, the light of the first room is turned off and the light of the second room is turned on. Therefore, the light of only one room is on at a time and not the lights in the whole house. When the lights of the entire house A and the lights of the entire house B are on, the two houses should be largely separated in order to avoid the light being seen from one house to the other. If the light of only one room of house A and house B is on, the light that can be seen from one house to the other house is relatively weak. Thus, the distance between the two houses can be much closer.

This same analogy can be applied to a cellular system. In a cellular system, the frequency reuse scheme is implemented for the purpose of increasing spectrum efficiency. If two cochannel cells (cells that use the same frequency) can be placed much closer, then the same frequency channel can be used more frequently in a given geographical area. Thus, the finite number of frequency channels can provide many more traffic channels, and both system capacity and spectrum efficiency can be further increased. In order to reduce the separation between two cochannel cells, the power of each cell should be reduced to cover merely one of numerous local areas in a cell if the cell operator is intelligent enough to know in which local area the mobile unit or handset is.

Therefore, there are two required conditions :

(i) The cell operator has to know where the mobile unit is located. Different resolution methods can be used to locate the mobile unit.

(ii) The cell operator has to be able to deliver power to that mobile unit. If the power transmitted from the cell site to the mobile unit can be confined in a small area (analogous to the light of a small room turning on when a person enters it), cochannel interference reduces, and the system capacity increases.

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

Ans. Intelligent Cell Concept : In the cellular industry, system capacity is a great issue. As demand for cellular service grows, system operators try to find ways to increase system capacity. Capacity can be increased by reducing the cell sizes. But it does not provide intelligence, because when the cell size becomes smaller, the control of interference among the cells becomes harder. The intelligent cell is able to intelligently monitor where the mobile unit or portable unit is and find a way to deliver confined power to that mobile unit. The intelligent cell increases capacity and improves performance of voice and data transmission. Because personal communication service (pcs) needs vast capacity and high quality, the intelligent cell concept is well-suited to it. Actually, using any means intelligently in a cell to improve the performance of services is what the intelligent cell stands for.

In the cellular industry, system capacity is a great issue. As demand for cellular service grows, system operators try to find ways to increase system capacity. Capacity can be increased by reducing the cell sizes. This is called the *conventional microcell approach*, but it does not provide intelligence. When the cell size becomes smaller, the control of interference among the cells becomes harder. Also, the handoff time from the beginning of the initiation to the action completion sometimes may take around 15 s. If a mobile station is moving at a speed of 25 km/h (7m/s), then the mobile station will travel 105 m in 15 s; at a speed of 50 km/h, the mobile station travels 205 m in 15s. Because within a microcell of 0.5-km radius the overlapped region for a handoff is very small, then the mobile station is in the overlapped region too short a time for the handoff action to be complete. As a result, the call drops. In a conventional microcell system, interference is hard to control and the handoffs may not have enough time to complete.

The intelligent cell can solve the two problems. The intelligent cell concept can be used not only in microcells but also in regular cells to bring extra capacity to the system.

Q. 8. Write short note on :

(i) Cell sectoring

SDMA

(iii) ISDN

Ans. (i) Cell Sectoring : In the sectorization technique, neither more base stations are required nor cell division into microcell is done but each cell splitted into sectors with each sector directional antennas to increases the system capacity by increasing the signal to interference ratio or reduce the interference level. SIR is increased by using directional antennas.

As we know that directional antenna radiate in a particular direction in all directions as done by omnidirectional antennas. So the directional antenna reduces interference and therefore increase S/R. Here each cell is splitted into more then one sector having one directional antenna at each sector.

The factor by which co-channel interference is reduced depends on the amount of sectoring used.

Figure shows sectoring at different angles. One at 120° and second at 60° sectoring.

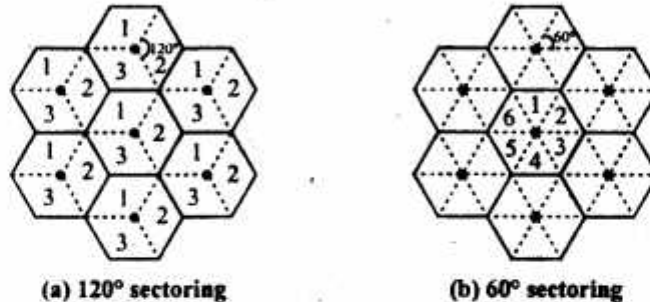


Fig. Sectoring at different angles

Sectoring technique uses more than one antenna per base station.

The available channels in the cells are subdivided and each division is dedicated to a particular antenna. For example, in 120 sectorization, each cell is subdivided into three sectors and each sector consists its own directional antenna and channel frequency.

Figure define the 120° sectoring reduces interference from co-channel cells.

Before sectoring, six co-channel cell interfere with the centre center cell but after sectoring only two co-channel cells are reserve to interfere.

Co-channel cell of cluster A and B gets interfere due to main cell after sectorization while interference because these are at anti side of sectorization and notice in the interference region of main cell.

In practice, the reduction in interference enables the designers to reduce the cluster size N and consequently a small value of N increases the capacity and therefore a small value of N increase the capacity and support an additional degree of freedom assigning channels.

Advantage of Sectoring :

- (i) Reduce co-channel interference within a system.
- (ii) Increases capacity by increasing signal to interference ratio.
- (iii) Cell radius gets unchanged.

Disadvantage of Sectoring :

- (i) Number of antennas per cell get increased.

(ii) Trunking efficiency decreases due to channel sectoring at the base station because available trunked channel pool is splitted into several smaller pools.

(iii) Sectoring makes handoff more typical because mobiles crossing the boundary of sector to another sector within the same cell demanded handoff.

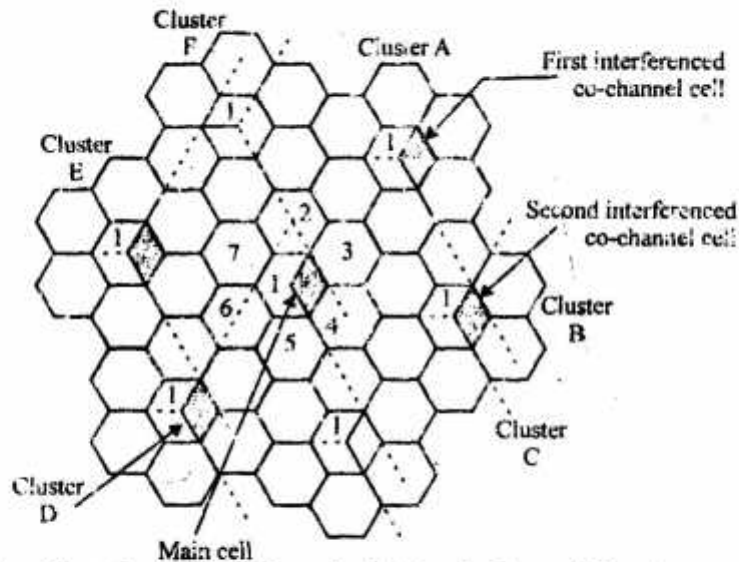


Fig. Reduced interference in co-channel cells (showing by no. 1) by using sectorization

(ii) **Space Division Multiple Access (SDMA)** : SDMA control the radiated energy for each user in space.

It can be seen figure that SDMA serves different users by using spot beam antennas. The distinct area covered by the antenna beam may be served by the same frequency or different frequency.

Sectorized antennas may be thought of a original application of SDMA. In future, adaptive antenna will likely be used to simultaneously steer energy in the direction of many users at once and appear to be best suited for TDMA and CDMA base station architectures.

The reverse link presents the most difficulty in cellular systems for several reasons.

First, the base station has complete control over the power of all the transmitted signals on the forward link. However because of different radio propagation paths between each user and the base station, the transmitted power from each subscriber unit must be dynamically controlled to prevent any single user from driving up the interference level for other users. Second transmit power is limited by battery consumption at the subscriber unit therefore there are limit on the degree to which power may be controlled on the reverse link.

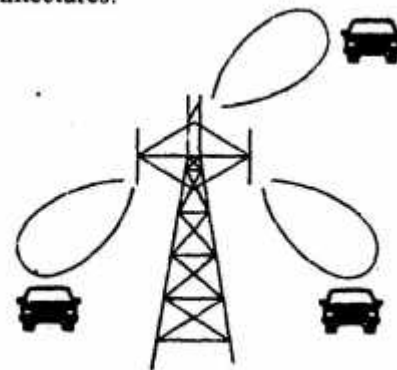


Fig. A spatially filtered base station antenna serving different users by using spot beams

If the base station antenna is made to spatially filter each desired user so that more energy is detected from each subscriber, then the reverse link for each user is improved and less power is required.

The basis of SDMA technology is formed by cells and sectorized antennas which constitute the infrastructure for SDMA technology. The sectorized antenna cover its area using spot beams. These different areas covered by the antennas beam may be served by the same frequency or different frequency.

(iii) Integrated Services Digital Network (ISDN): Integrated services digital network (ISDN) is a complete network framework designed around the concept of common channel signaling. While telephone users throughout the world rely on the PSTN to transmit conventional voice traffic, new end user data and signaling services can be provided with a parallel, dedicated signaling network.

ISDN describe the dedicated signaling network that has been created to complement the PSTN for more flexible and efficient network access and signaling and may be thought of as a parallel world-wide network for signaling traffic that can be used to either route voice traffic on the PSTN or to support new data services between network nodes and the end-users.

ISDN support two distinct kinds of signaling components to end-users in a telecommunications networks :

(i) The first component supports traffic between the end users and the network, and is known as access signaling. Access signaling defines how end-users obtain access to the PSTN and the ISDN for communications and is determine a suite a protocols known as the digital subscriber signaling system number (DSSN).

(ii) The second signaling component of ISDN is network signaling and is determine by the SSI suite of protocol.

As shown in figure, ISDN provides integrated end-user access to both circuit switched and packet-switched networks with digital end-to-end connectivity.

ISDN end-users may select between two different interfaces, the basic rate interface or the primary rate interface (PRI). The BRI is intended to serve small capacity terminals while the PRI is intended for large capacity terminals.

The B channels support 64 Kbps data for both the primary rate and 16 Kbps for the basic rate.

BRI provides two 64 Kbps bearer channels and one 16 Kbps signaling channel, whereas the PRI provide twenty three 64 Kbps bearer channels and one 64 Kbps signaling channel for North America and Japan.

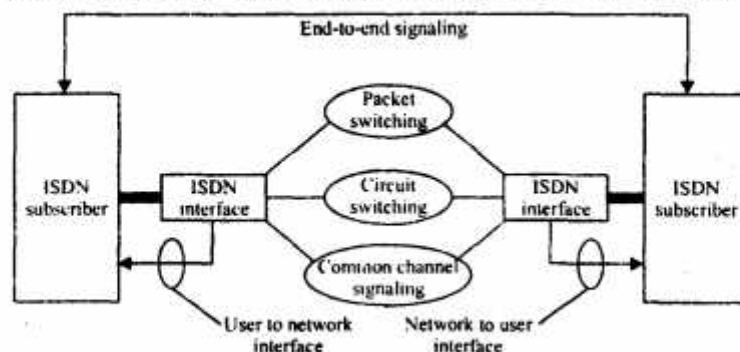


Fig. Block diagram of an ISDN