



05CS601 MOBILE COMPUTING



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Unit – I

Wireless Communication Fundamentals

Wireless Communication-Introduction:

Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or very long (thousands or even millions of kilometers for radio communications). When the context is clear the term is often simply shortened to "wireless".

Wireless communications is generally considered to be a branch of telecommunications. Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or the entire communication path.

Example:

Cellular phones and pagers: provide connectivity for portable and mobile applications, both personal and business. Global Positioning System (GPS): allows drivers of cars and trucks, captains of boats and ships, and pilots of aircraft to ascertain their location anywhere on earth.

History of Mobile Communication

What is Cell phone?

A cellular phone is a portable telephone that does not use a wired connection. It connects to a wireless carrier network using radio waves. A cellular phone network uses a number of short-range radio transmitter-receivers to communicate simultaneously with many cellphones over a large area. The wireless network is connected to the public telephone system, another wireless carrier network or the Internet for completing calls to another phone or to a computer.

To use a cell phone, need to buy a handset (or mobile communications device) and sign up with a wireless service provider for a calling plan. Handsets are sold at retail outlets, electronics stores, wireless service dealers and Web-based retailers. Handsets come in a wide variety of styles, sizes, screens, keypads, software and capabilities. Most cell phones have a color screen for easier navigation and use. Most cell phones can exchange text

messages with other mobile devices or e-mail addresses. More advanced phones play games, take digital photographs, access the Internet, have personal digital assistant (PDA) functions, and play music.

History of cellular mobile communication:

The history of wireless follows following hierarchy. After the second world war many national and International projects in the area of wireless communications were triggered off.

- In ancient times the light was modulated either ON or OFF pattern used for wireless communication. Flags were used to signal code words. Smoke signals were used in wireless communication as early as 150 BC.
- In 206 BC Radio transmission was introduced.
- In 1794, Claude Chappe invented Optical Telegraph for long distance wireless communication
- In 1834 – 1874 Philip Reis discovered the Telephone Principle.
- In 1886, Heinrich Hertz demonstrate the wave character of electrical transmission through space.
- In 1906, vacuum tube were invented by Robert Von Lieben.
- In 1937, Guglielmo Marconi gave the wireless telegraphy. The first network in Germany was , analog A.Netz – in 1958 with 160MHz carrier frequency.
- In 1972 ,the B.Netz followed in Germany using the same 160MHz, here the current location of the mobile receiver should be known.
- In 1981, Nordic Mobile Telephone System(NMT) has been developed with 450MHz carrier.
- In 1982, Inmarsat A satellite has been launched.
- In 1984, Cordless Telephone(CT1) following its Predecessor the CT0 from 1980
- In 1987, CT2 was developed which uses the spectrum at 864MHz and offers a data channel at a rate of 32 Kb/Sec.
- In 1991, ETSI adopted the standard Digital European Cordless Telephone(DECT) for digital cordless telephony with a spectrum of 1880 – 1900 MHz. Now it is renamed

as Digital enhanced cordless telecommunications. At that time Code Division Multiple Access (CDMA) also enhanced.

- During 1992, Global System for Mobile communication (GSM) was standardized.
- In 1994, GSM-1800 networks in Europe also known as DCS 1800 (Digital Cellular System) started with a better quality.
- In 1996, HiperLAN (High Performance Radio LAN) which is standardized by ETSI.
- In 1998, Universal Mobile Telecommunication Systems (UMTS) developed by Europeans.
- In 1999, the 802.11b ,Bluetooth was standardized.
- In 2000, General Packet Radio Service(GPRS) IEEE802.11a was developed.
- In 2001, International Mobile Telecommunications(IMT – d-2000) was standardized
- The year 2007, is the fourth generation the Internet based.

IMPORTANT TERMINOLOGIES

1. **Cell** : It is smallest geographical area considered for cellular mobile communication radio coverage and the shape of a cell is hexagon.
2. **Base station (BTS)** : Base station provides functionalities between mobile u and mobile switching centre (MSC). BTS is located in each cell.
3. **Cell splitting** : In high cellular traffic regions, a larger cell is divided smaller cells to have complete radio coverage.
4. **Hand off**: When mobile unit moves from one cell to another cell, the cell in progress will be handed over from one base transceiver to the base transceiver of the new cell where the mobile unit enters so that the cell in progress is not disturbed and continues smoothly. This process is called as “Hand off”.
5. **Cell sectoring** : A cell can be divided in to many sectors for example 3 sectors to 6 sectors in each hexagonal cell. Also the directional antenna should focus on each sector
6. **Umbrella cell pattern** : A single large cell (Macro cell) consists of many small (micro cell) cells and there will be interaction between micro and macro cells.
7. **Control channel**: They are used for necessary exchange of information related to setting up and establishing cell base stations and the mobile units
8. **Traffic channels**: They are used for carrying data or voice connections between different users.

- 9. Frequency reuse:** It is a concept followed in cellular communication for efficient spectrum utilization. The same carrier frequency is reused by many cells in a cellular cluster and it is known as 'frequency reuse' scheme.
- 10. Fading :** Fading is an effect in mobile radio propagation. It is common in multipath mobile signalling environment
- 11. Mobile telecommunication switching office/mobile switching centre (MTSO/MSC):** It is the main unit that connects the base transceiver station and the public switched telephone network (PSTN) in mobile communication.
- 12. Page:** It is a brief message that is broadcast over a certain service area, generally in a simulcast type by many base stations at a time.

ForwardChannel

It is a radio channel used for transmission of information from base station to the mobile unit.

ReverseChannel

It is a radio channel used for transmission of information from mobile unit to the base station.

SimplexSystems

These are the communication systems that provide only one way communication. Subscriber A mobile phone user who pays subscription charges for using a cellular mobile communication system.

MobileStationMobile

station is mainly intended for use while in movement at any location. It can be hand-held personal units that is portable or installed in moving vehicles

FullDuplexSystems

The transmission and reception is typically on two different channels (FDD) even though new cordless systems are using TDD scheme. It is a communication system that allows two way communication simultaneously.

HalfDuplexSystems

The communication systems that allow two way communication by using same radio channel for both transmission and reception. The user can transmit or receive at any time.

Transceiver

It is a device used for both transmitting and receiving radio signals.

Roamer

It is a mobile station that operates in a service area other than the subscribed service area.

PSTN

It is the public switched telephone network to which the mobile telephone switching center

MOBILE COMPUTING ENVIRONMENT:

It is made over physical mobility of the user and it permits the user to perform a task from any distant area through mobile unit. It also known by different names according to its role such as

1. Virtual home environment
2. Nomadic computing
3. Wearable computing

1. Virtual home environment

Network supporting mobile users should provide them with the same computing environment on the road that they have their home or corporate computing environment. It is a concept for personal service environment (PSE) portability across network boundaries and between terminals.

2. Nomadic computing

It uses portability devices such as Laptop and handheld computers so the user can access the internet and data from their home or anywhere. People using such systems are referred to as technomads and the ability of using the system is nomadicity.

3. Wearable computing

It is a device that is always with the user and into which the user can enter commands and execute it.

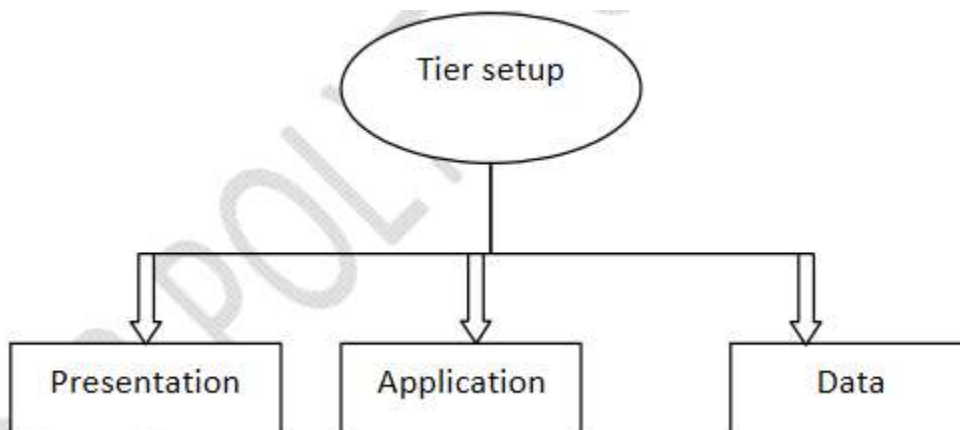
ARCHITECTURE OF MOBILE COMPUTING

Mobile computing architecture is made up of three-tier. The three tiers are:

1. Presentation (Tier-1)

2. Application (Tier-2)

3. Data (Tier-3)



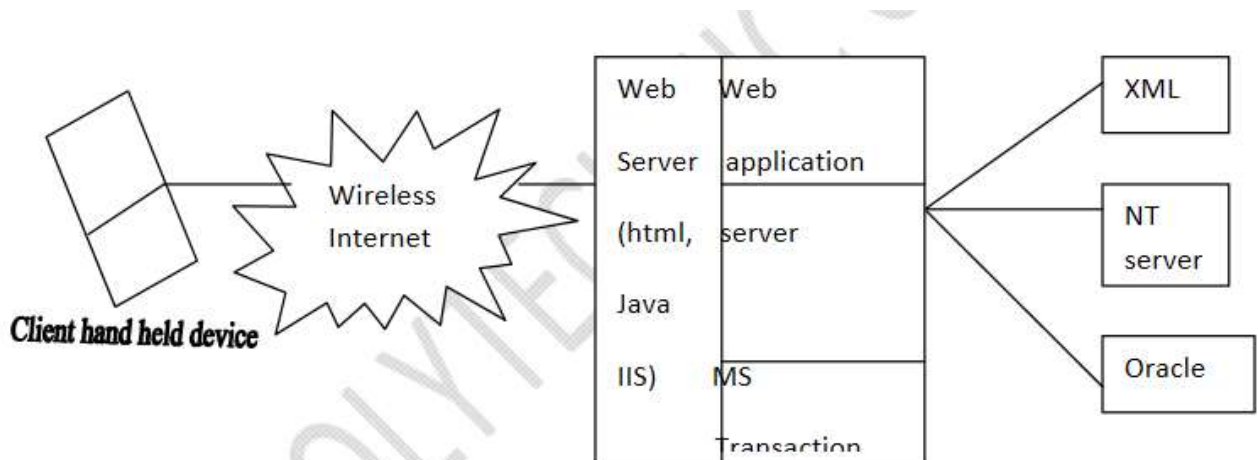
Presentation (Tier-1):

A thin client based on hand held device or PC where the user enter action takes place. Web browsers and customized client programs are included in this layer

Application (Tier -2):

It plays an important role in WLAN. It processes the user input, obtains the information and makes the decisions. It uses the technologies like .NET, Java, Zend. It acts as interface between the presentation layer and data layer.

Data (Tier -3): It includes database systems in which the processed data can be stored and retrieved.



Functions of Mobile computing

A computer environment is said to be mobile if it supports few of the characteristics mentioned below.

1. User mobility:

Though the user roams from one place to another he should be able to use the same service. This service may be a remote network or home network

2. Bearer mobility:

In this case the user may move from one bearer to another bearer but use the same service.

3. Host Mobility:

In host mobility the user device can be either a server or a client. If it is a host mobility the mobility of that IP should be given more care. But if it is server or host mobility, some complexities will change.

4. Service mobility:

Though the user change from one service to another service it should remain enabled and if a user is sending a mail and he refers some information in his PC stored file for adding in his mail he should be allowed to do so.

MULTIPLEXING

What is Multiplexing:-



Multiplexing is a technique for sending more than one information signal at a time down a single communication path(e.g. medium, circuit or channel). Multiplexing is sometimes loosely referred to as MANY into ONE

The multiplexed signal is transmitted over a communication channel, which may be a physical transmission medium. The multiplexing divides the capacity of the low-level communication channel into several higher-level logical channels, one for each message signal or data stream to be transferred. A reverse process, known as demultiplexing, can extract the original channels on the receiver side.

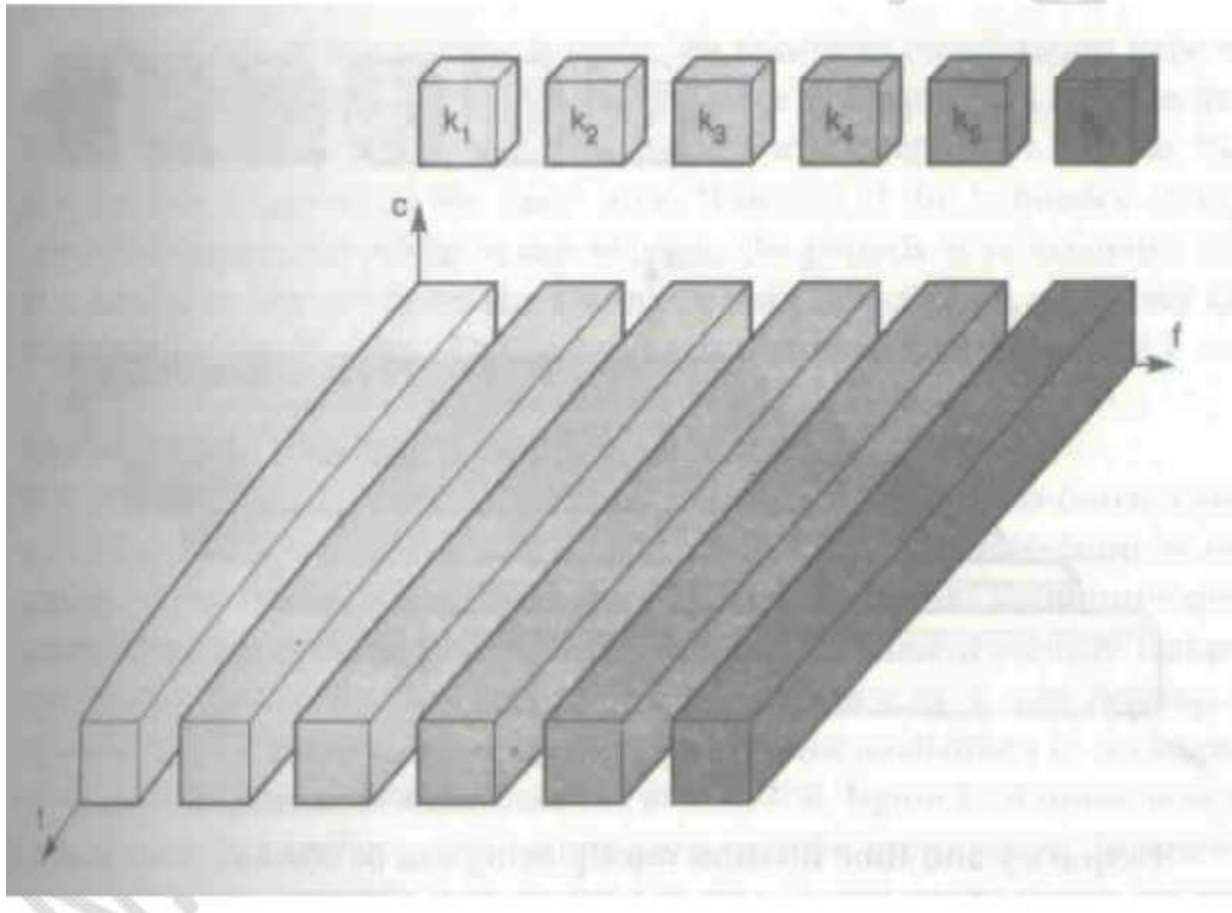
A device that performs the multiplexing is called a multiplexer (MUX), and a device that performs the reverse process is called a demultiplexer (DEMUX).

Multiplexing can be achieved in a number of ways. The following three will be covered in this class:

- 1.Space Division Multiplexing
- 2.Frequency Division Multiplexing
- 3.Time Division Multiplexing 4.Code division multiplexing.

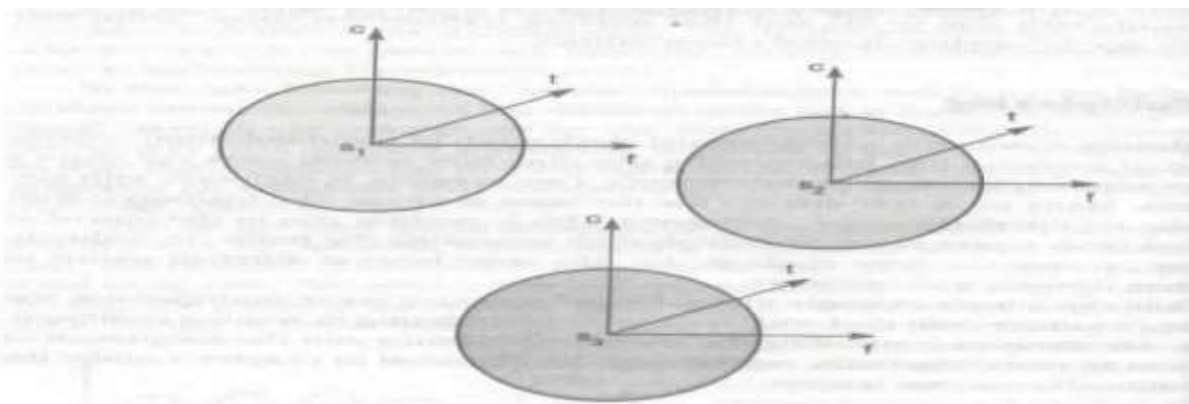
Frequency Division Multiplexing

- Frequency domain is subdivided into several non-overlapping frequency bands
- Each channel is assigned its own frequency band (with guard spaces in between)



Space Division Multiplexing

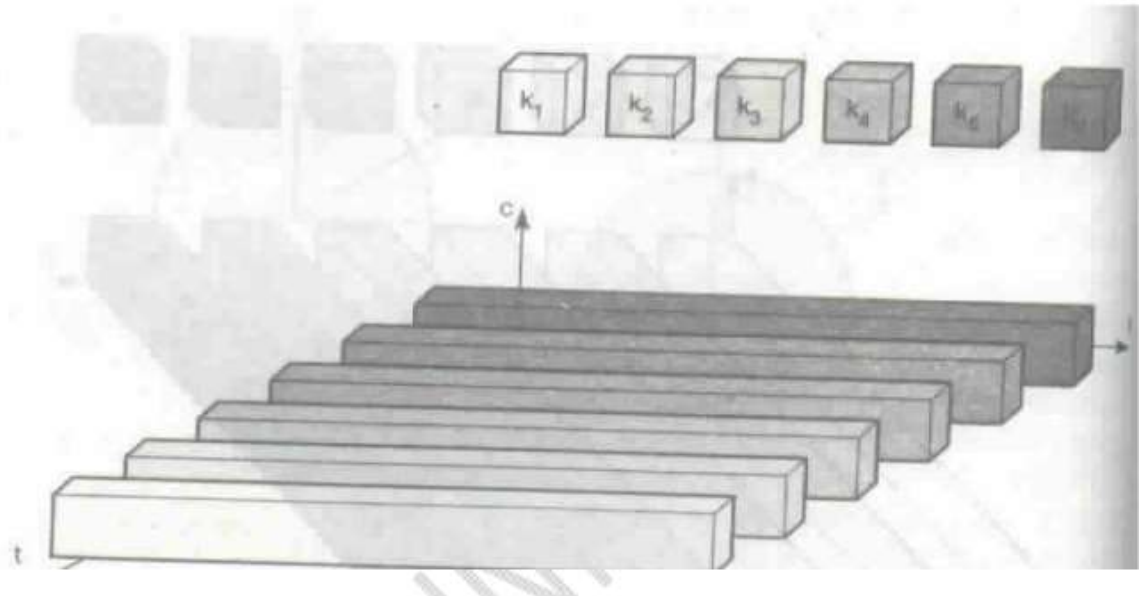
- Channels are assigned on the basis of “space” (but operate on same frequency)
- The assignment makes sure that the transmission do not interfere with each (with a guard band in between)



Time Division Multiplexing

- A channel is given the whole bandwidth for a certain amount of time –All senders use the same frequency, but at different point of time

Figure 2.18
Time division
multiplexing (TDM)



Two ways of implementing TDM are:

- 1.Synchronous TDM
- 2.Asynchronous TDM

Synchronous Multiplexing:

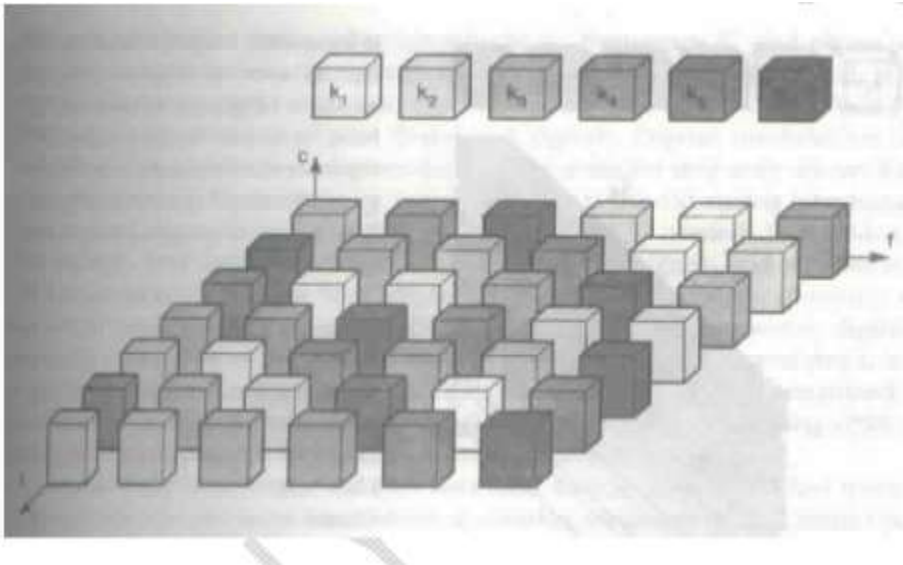
Synchronous TDM works by the multiplexor giving exactly the same amount of time to each device connected to it. This time slice is allocated even if a device has nothing to transmit. This is wasteful in that there will be many times when allocated time slots are not being used. Therefore, the use of Synchronous TDM does not guarantee maximum line usage and efficiency. Synchronous TDM is used in T1 and E1 connections.

Asynchronous Multiplexing:

Asynchronous TDM is a more flexible method of TDM. With Asynchronous TDM the length of time allocated is not fixed for each device but time is given to devices that have data to transmit. This version of TDM works by tagging each frame with an identification number to note which device it belongs to. This may require more processing by the multiplexor and take longer, however, the time saved by efficient and effective bandwidth utilization makes it worthwhile. Asynchronous TDM allows more devices than there is physical bandwidth for. This type of TDM is used in Asynchronous Transfer Mode (ATM) networks

Frequency and time division multiplexing

- A channel use a certain frequency for a certain amount of time and then uses a different frequency at some other time –Used in GSM systems

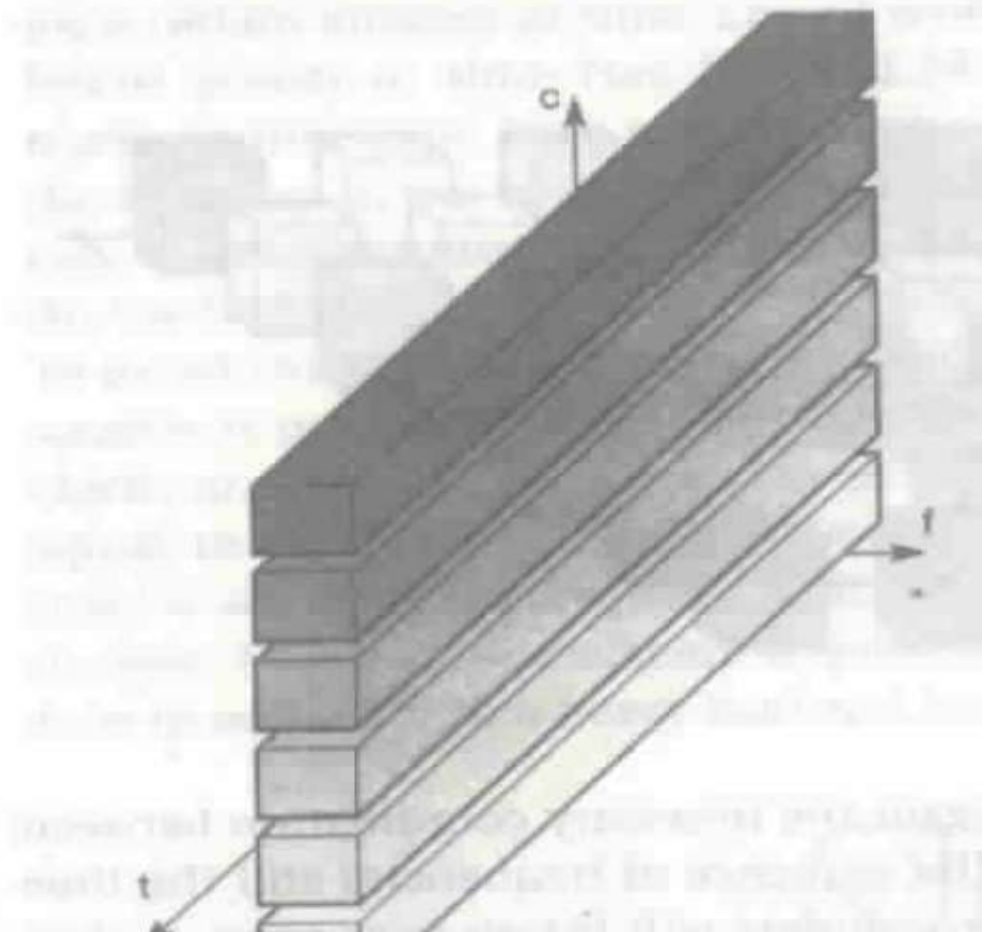


Code division multiplexing

- separation of channels achieved by assigning each channel its own code
- guard spaces are realized by having distance in code space (e.g. orthogonal codes)
- transmitter can transmit in the same frequency band at the same time, but have to use different code

- Provides good protection against interference and tapping but the receivers have relatively high complexity –has to know the code and must separate the channel with user data from the noise composed of other transmission –has to be synchronized with the transmitter

Figure 2.20
Code division
multiplexing (CDM)

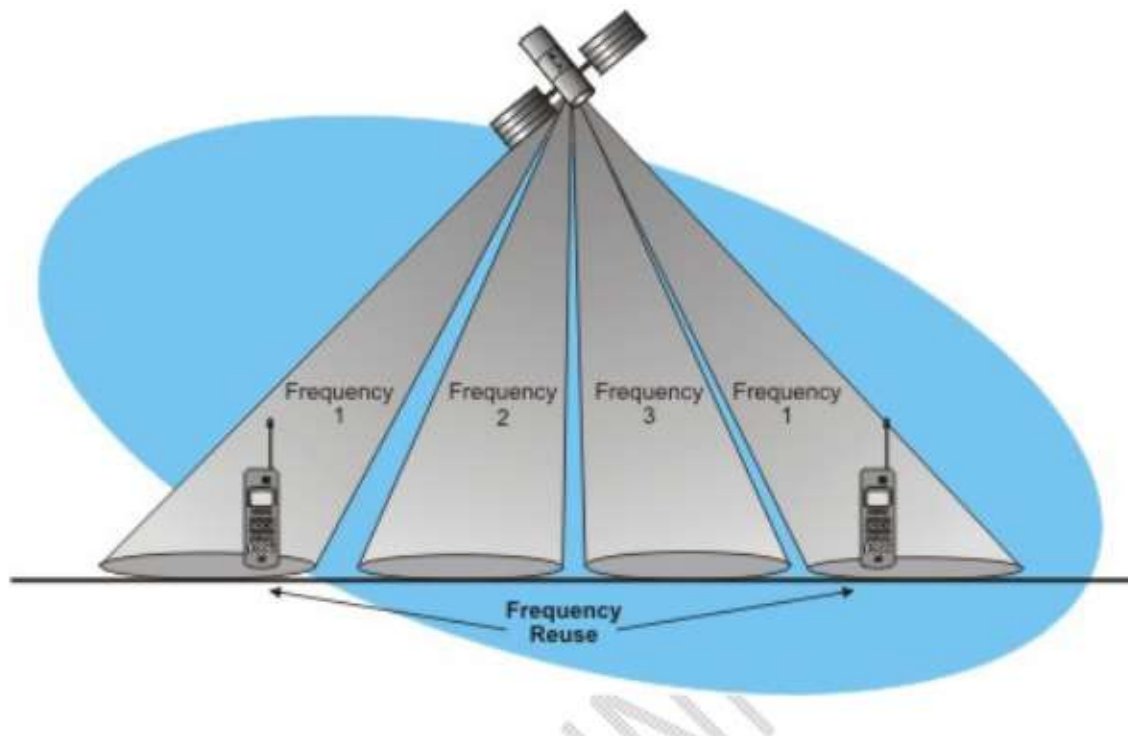


Medium Access Control

SDMA (Space Division Multiple Access)

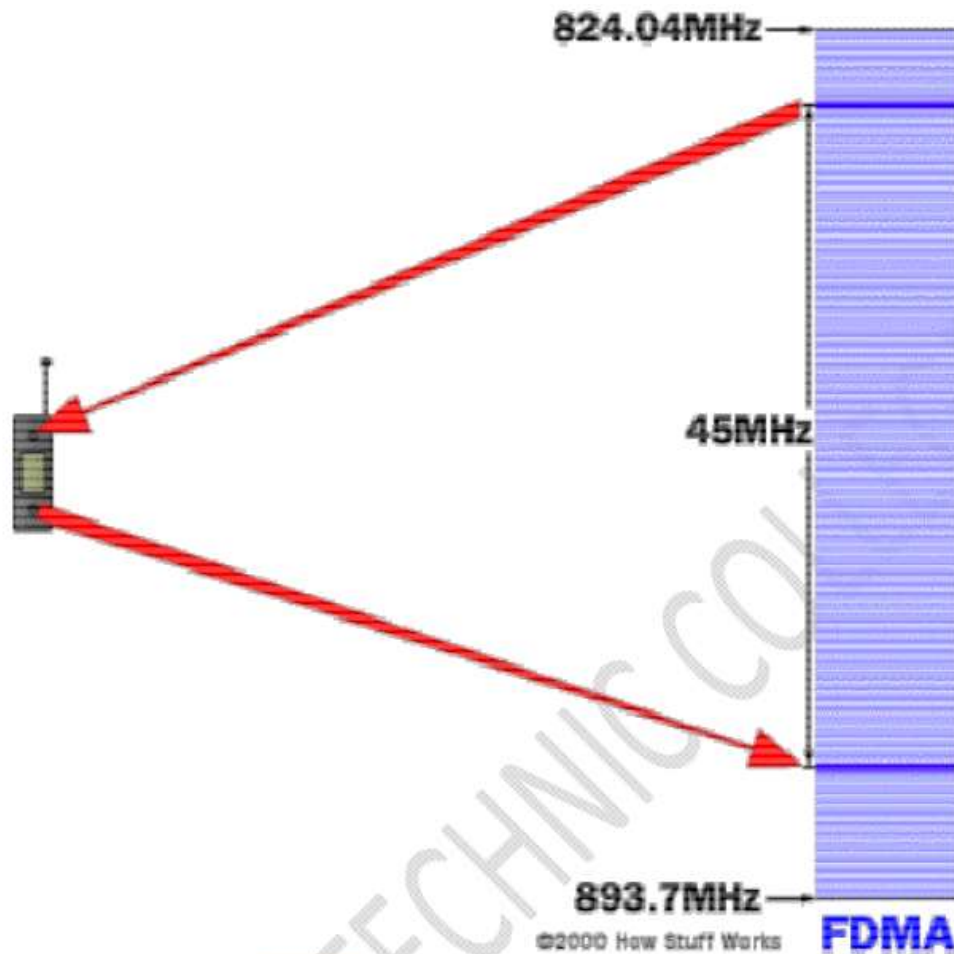
SDMA (Space-Division Multiple Access or Spatial Division Multiple Access) is a MIMO (Multiple-Input and Multiple-Output, a multiple antenna schematic architecture)-based

wireless communication network architecture, primarily suitable for mobile ad-hoc networks, which enables access to a communication channel by identifying the user location and establishing a one-to-one mapping between the network bandwidth division and the identified spatial location. SDMA architecture can be configured and deployed for most of the well-known mobile communication architectures such as CDMA (Code division Multiple Access), TDMA (Time Division Multiple Access) and FDMA (Frequency Division Multiple Access)



FDMA

Analog transmission is considered an "older" cellular phone technology. Analog technology was built in the early 1980's. Analog allows a cellular phone to transmit signals by sending voice, video, and data that are always changing, and so does the network systems. Analog is considered an older method of modulating voice or data information radio signals

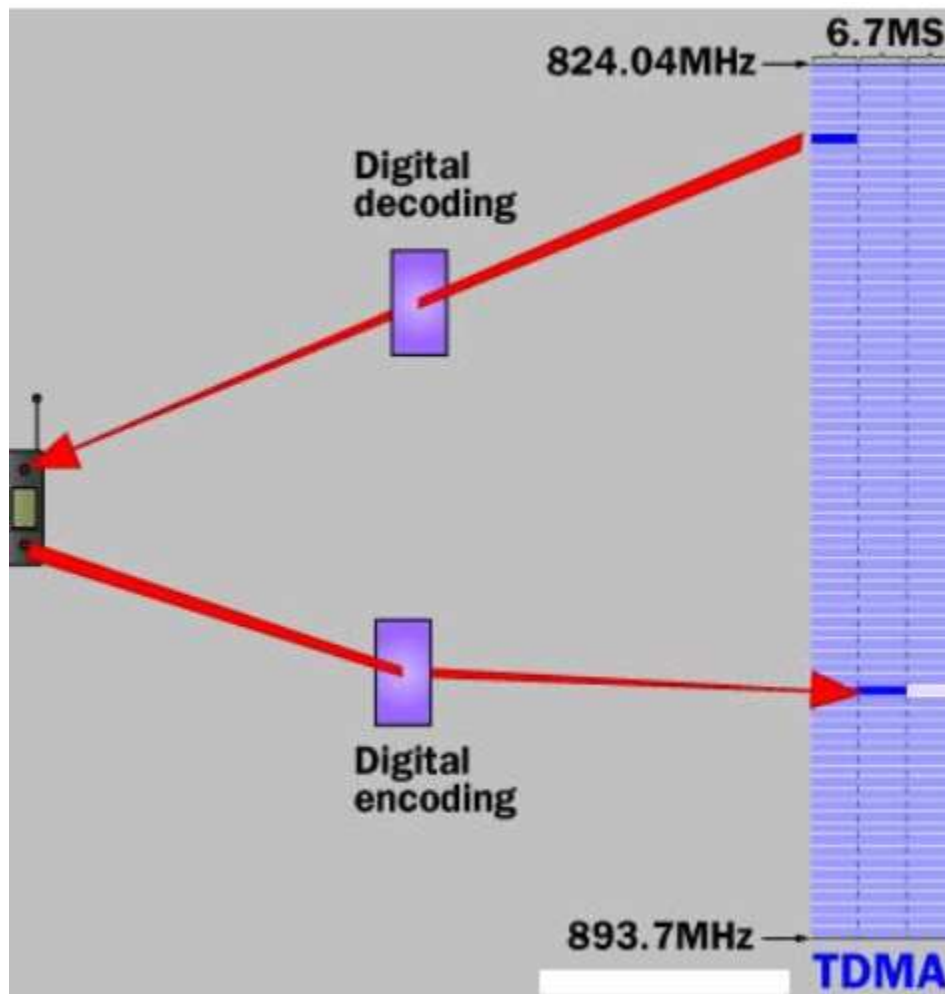


TDMA

Time Division Multiple Access (TDMA) improves spectrum capacity by splitting each frequency into time slots. TDMA allows each user to access the entire radio frequency channel for the short period of a call. Other users share this same frequency channel at different time slots. The base station continually switches from user to user on the channel. TDMA is the dominant technology for the second generation mobile cellular networks. Networks using TDMA assign 6 timeslots for each frequency channel.

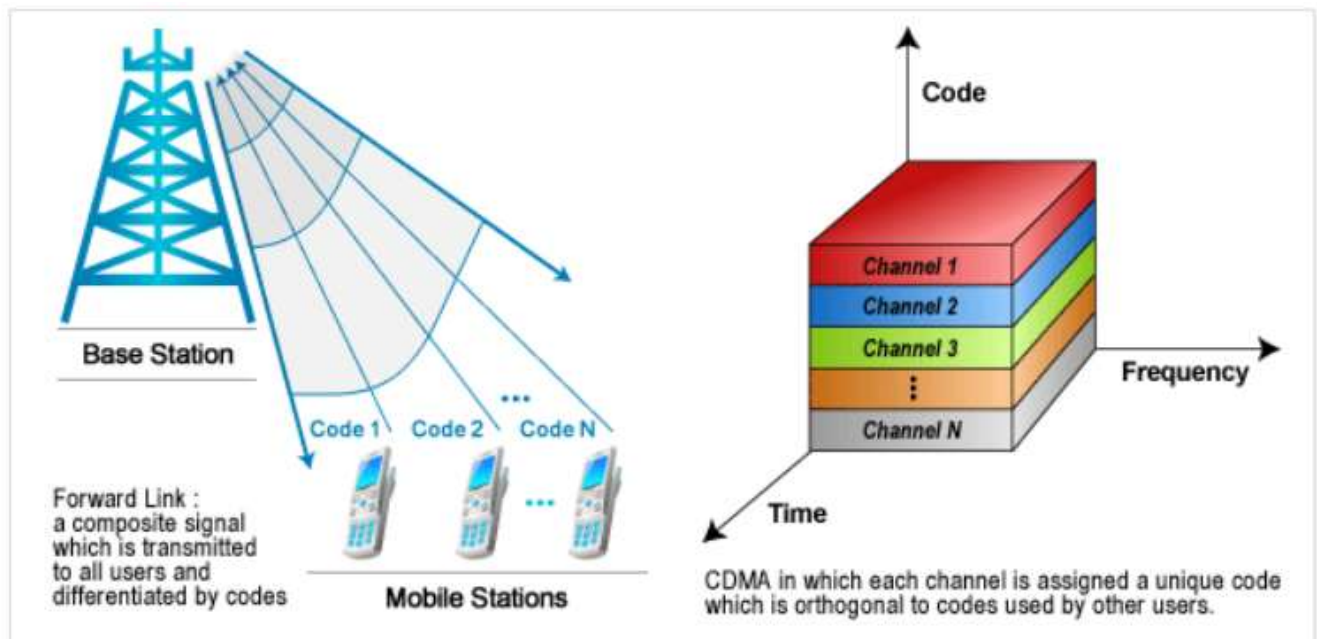
Devices using the wireless network send bursts of information that are reassembled at the receiving end. TDMA builds on FDMA (Frequency Division Multiple Access) by dividing conversations by frequency and time. Since digital compression allows voice to be sent under 10 kilobits per second (equivalent to 10 kHz), TDMA can fit three digital conversations into a FDMA/Analog channel (which is 30 kHz). By sampling a person's voice for, say 30 milliseconds, then transmitting it in 10 milliseconds; the system is able to offer

3 timeslots per channel in a round-robin fashion. This technique allows compatibility with FDMA while enabling digital services and easily



CDMA

CDMA is the latest, greatest cellular technology.



CDMA stands for Code Division Multiple Access. For cellular phone users, it's a transparent interface for a wireless digital network. CDMA was originally developed by the military in the early 1960's. CDMA uses sequential code frequencies to funnel traffic channels within the same radio channels.

For a non-technical definition, CDMA channels the packets of voice and data over wireless radio frequencies so a cellular user can hear better, quicker and with more quality than ever before. CDMA cell phones are also more efficient as they use a channel's "band-width" efficiently.

A perfect analogy of CDMA wide-band technology and narrow-band analog would be the Internet. Picture CDMA technology as a Cable or DSL Line, and analog technology as a dial-up Internet connection. Since DSL or cable lines are thicker and wider than a thinner phone line, it's faster and quicker, in both directions. CDMA is faster in transmitting and receiving data over a cellular phone. CDMA was originally developed and enhanced by a US company named Qualcomm. Because the Company led the development of CDMA technology, it owns a significant amount of intellectual property, including patents,

patent applications and trade secrets. Qualcomm licenses these patents to customers and integrates them into its own products

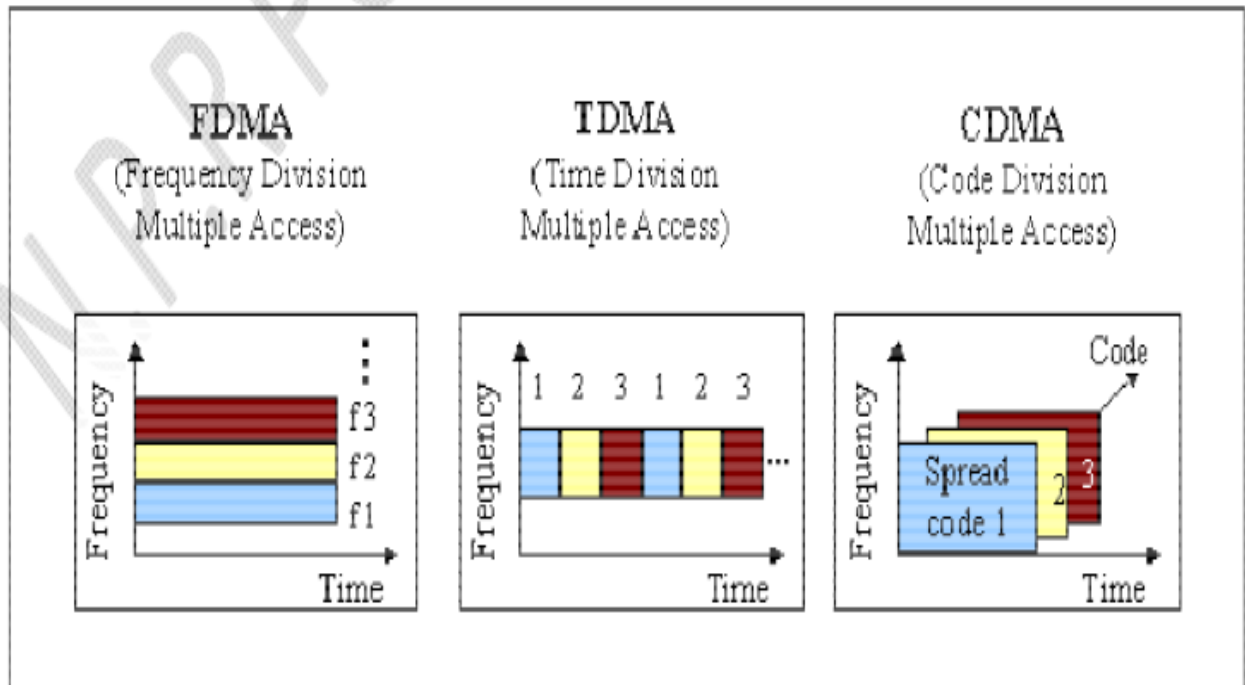
In 1993, CDMA went mainstream. That year, CDMA was certified by the TIA (Telecommunications Industry Association) and was adopted as the leading digital multiple access technique for cellular phones. Obviously, Qualcomm and other telecommunication service providers and manufacturers who use CDMA technology would like to push its growth.

A CDMA Development Group (CDG) was formed to produce products, platforms and services that use CDMA and helps to promote its adoption around the world. Since these manufacturers and telecommunications providers base designs, research and development budgets and plans on CDMA, there is much to gain or lose in its worldwide adoption. CDMA technology is based on a form of transmission known as Direct Sequence Spread Spectrum (DSSS). This form of transmission originally used for military and police communications because the transmissions were difficult to detect in many instances, and even if they were received they were very difficult to decipher without the correct codes. However the possibilities of using this technology to provide a multiple access scheme for mobile telecommunications and have now been exploited in a major way.

Advantages of CDMA:

There are several advantages to using code division multiple access CDMA. The main reason for its acceptance is that it enables more users to use a given amount of spectrum. Its use also enables adjacent base stations to operate on the same channel, allowing more efficient use of the spectrum and it provides for an easier handover

comparison of SDMA, FDMA, TDMA and CDMA techniques.



Telecommunication System

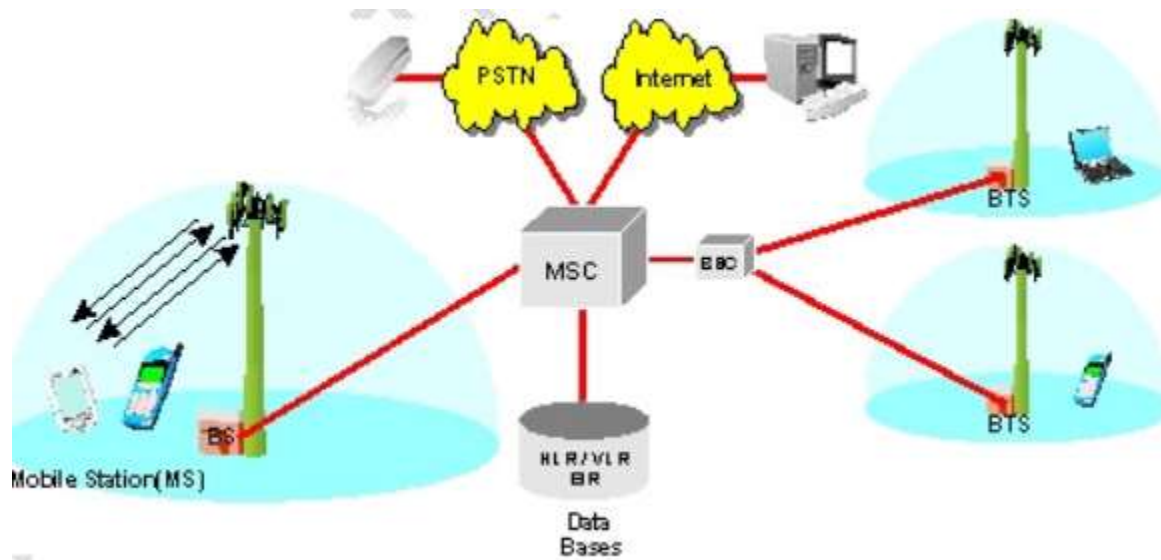
What is GSM?

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band.

GSM for Mobile Communication

The digital standard known as the Global System for Mobile (GSM) has captured a large share of the global cellular market. This book aims to bridge the gap between a reader's basic knowledge of telecommunications and the complexities of the 5000-page GSM

technical specification. It describes the system as a whole, covering all aspects of the standard, including mobile stations, switching equipment, the radio interface, infrastructure, transmission methods, and signaling protocols. System architects involved in the design of personal communications systems will find the book to be a complete description of the GSM communications system. It also may serve as a general introduction to digital cellular systems.



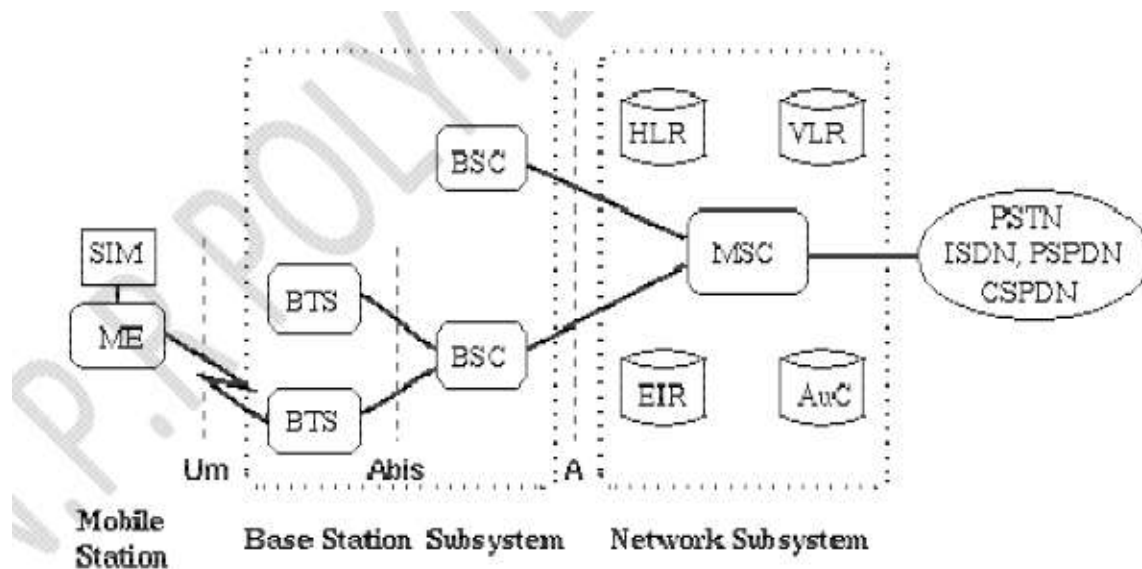
This figure shows an overview of a GSM radio system. This diagram shows that the GSM system includes mobile communication devices that communicate through base stations (BS) and a mobile switching center (MSC) to connect to other mobile telephones, public telephones, or to the Internet. This diagram shows that the MSC connects to databases of customers. This example shows that the GSM system mobile devices can include mobile telephones or data communication devices such as laptop computers.

GSM Technical Details:

The GSM network can be divided into three broad parts

- The subscriber carries the mobile station
- The base station subsystem controls the radio link with the mobile station The network subsystem performs the switching of calls between the mobile users and other mobile and fixed network users

Architecture of GSM network A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure 1 shows the layout of a generic GSM network. The GSM network can be divided into three broad parts. The Mobile Station is carried by the subscriber. The Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile services Switching Center (MSC), performs the switching of calls between the mobile users, and between mobile and fixed network users. The MSC also handles the mobility management operations. Not shown is the Operations and Maintenance Center, which oversees the proper operation and setup of the network. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link. The Base Station Subsystem communicates with the Mobile services Switching Center across the A interface.

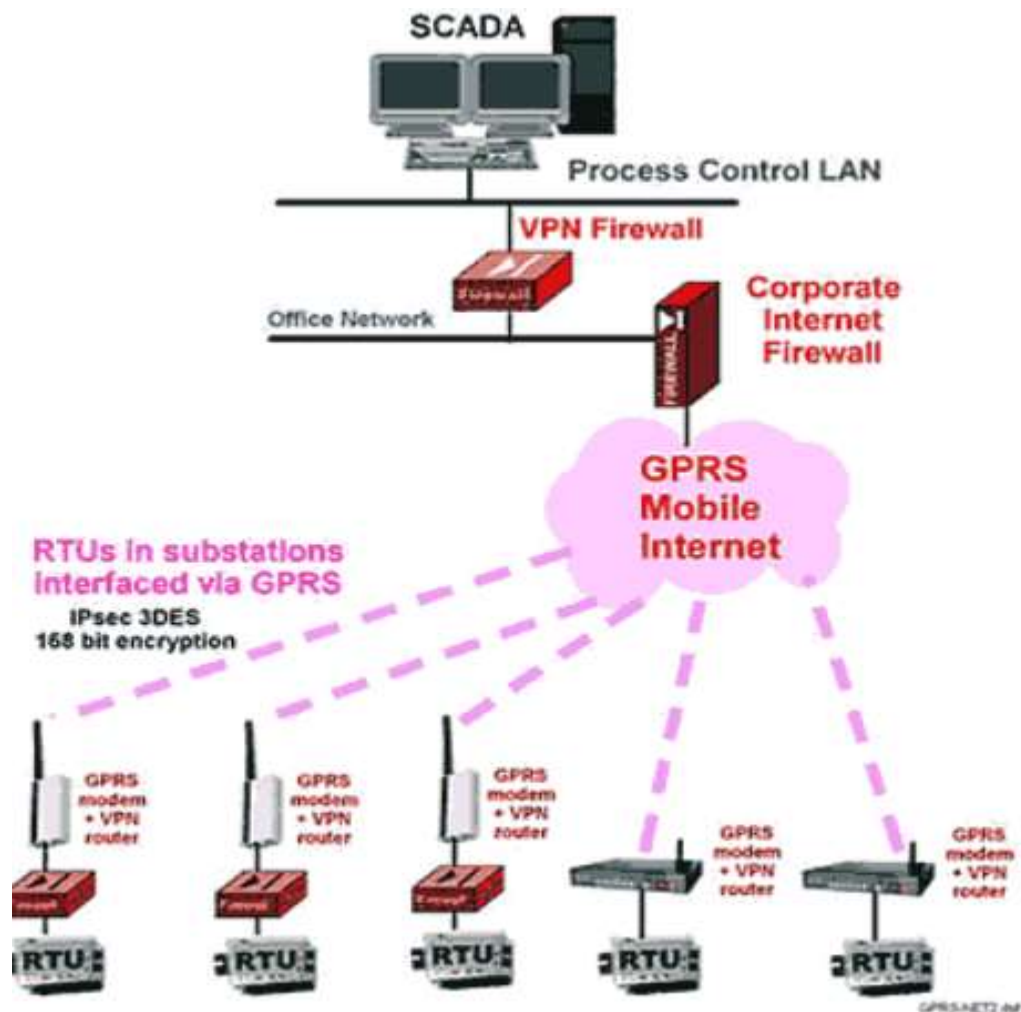


SIM Subscriber Identity Module	BSC Base Station Controller	MSC Mobile services Switching Center
ME Mobile Equipment	HLR Home Location Register	EIR Equipment Identity Register
BTS Base Transceiver Station	VLR Visitor Location Register	AuC Authentication Center

GPRS – Introduction

General Packet Radio Service (GPRS) is a Mobile Data Service available to users of Global System for Mobile Communications (GSM) and IS-136 mobile phones. GPRS data transfer is typically charged per megabyte of transferred data, while data communication via traditional circuit switching is billed per minute of connection time, independent of whether the user has actually transferred data or has been in an idle state. GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web access.

2G cellular systems combined with GPRS is often described as "2.5G", that is, a technology between the second (2G) and third (3G) generations of mobile telephony. It provides moderate speed data transfer, by using unused Time division multiple access (TDMA) channels in for example the GSM system. Originally there was some thought to extend GPRS to cover other standards, but instead those networks are being converted to use the GSM standard, so that GSM is the only kind of network where GPRS is in use. GPRS is integrated into GSM Release 97 and newer releases. It was originally standardized by European Telecommunications Standards Institute (ETSI), but now by the 3rd Generation Partnership Project (3GPP)

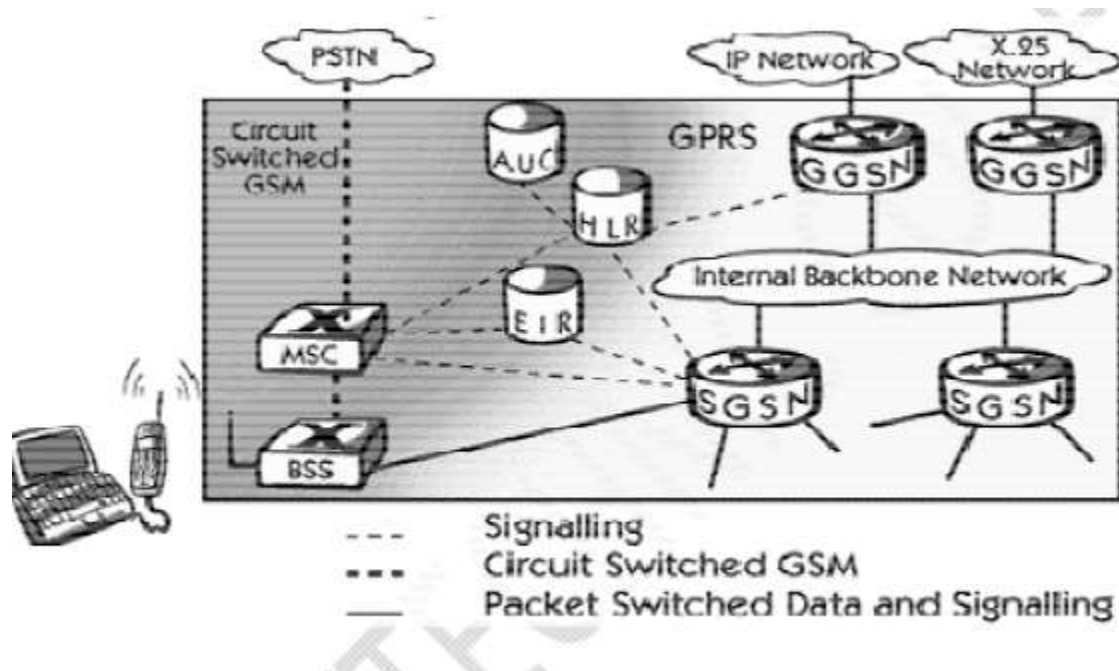


GPRS Applications:

GPRS enables a variety of new and unique services to the mobile wireless subscriber. These mobile services have unique characteristics that provide enhanced value to customers. These characteristics include the following:

- Mobility**—the ability to maintain constant voice and data communications while on the move
- Immediacy**—Allows subscribers to obtain connectivity when needed, regardless of location and without a lengthy login session
- Localization**—Allows subscribers to obtain information relevant to their current location

The combination of these characteristics provides a wide spectrum of possible applications that can be offered to mobile subscribers. The core network components offered by Cisco enable seamless access to these applications, whether they reside in the service provider's network or the public Internet.



Some limitations of GPRS:

Although GPRS will provide better data rates than is currently available, there are some limitations.

- Speeds of 177.2kbps would require a user to use all eight timeslots without any error protection - which simply won't happen. Initial terminals are likely to use only 1-3 timeslots anyway, limiting the available bandwidth to a GPRS user.
- When GPRS packets are sent to a destination they are sent in all different directions - allowing for the potential for one or some of those packets to be corrupted or even lost altogether during the data transmission over the radio link. This is inherent in wireless packet technologies so data integrity and retransmission strategies are incorporated - which in turn result in potential transit delays.

•Although available radio resource can be concurrently shared between several users, an increase in the numbers of users will slow data services down for each user.

CELLULAR WIRELESS NETWORK OVERVIEW OF CELLULAR SYSTEM:

Wireless communication technology in which several small exchanges (called cells) equipped with low-power radio antennas (strategically located over a wide geographical area) are interconnected through a central exchange. As a receiver (cell phone) moves from one place to the next, its identity, location, and radio frequency is handed-over by one cell to another without interrupting a call. Cellular networks offer a number of advantages over alternative solutions:

Increased capacity

- Reduced power
- Use larger coverage area
- Reduced interference from other signals

OPERATION OF CELLULAR SYSTEM

The heart of the cellular system is made up of individual radio coverage areas called cells. Each cell has a base station. When a call is made from a cell phone, radio signals are to the cell site, which alerts mobile telephone switching office thus MTSO provide connections for all calls between mobile units. The MTSO performs the central functions call processing, traffic management and transferring calls as a phone moves between cells. It assigns voice channel to each call i.e, channel assignment, call connection billing and hand off, then again the communication between base station and mobile is defined by common air interface (AI) Common air interface specified the following channels:

1.Traffic channel

2.Control channe

Step – 1 Mobile unit utilization

When a mobile is switched on it scans for control channel and selects the strongest signal from base station. An acknowledgement happens between mobile and MTSO through base station to identify and to register its location. It scans for signal periodically as long as the mobile unit is on this is to find the mobility of mobile station.

Step -2 Request for connection

Mobile station makes a call by sending mobile identification number. Receiver examines the information sent through forward control channel. If the channel is idle, then the receiver unit transmits the reply through reverse control channel. The base station then sends the request to the MTSO.

Step – 3 Paging

The connection to the called unit is attempted by the MTSO. MTSO sends a paging message to all base system in cellular system.

Step – 4 Call accepted

The called unit receives the paging message sent by the base station and it responds through RCC. Then it sends an acknowledgement. MTSO instructs the base station to move the call to an unused voice channel within cell

Step – 5 Ongoing call

The mobile units on both sides exchange data or voice through their BS and MTSO.

Step – 6 Hand off

During a call if the user moves in and out of the range of base station. MTSO adjusts the transmitted power and changes the channel of the mobile unit

DIVERSITY TECHNIQUE

It is the best technique applied to improve mobile links with lower cost. This technique has the concept of diverting each signal in an independent path that is uncorrelated with another signal path. When one signal path loses its strength in the propagation environment it is called fading.

Two types of fading:

1. Small scale fading
2. Large scale fading

1. Small scale fading:

It occurs due to fast amplitude fluctuations as the mobile unit moves away from the base station. This can be overcome by using microscoping diversity technique.

2. Large scale fading:

This effect is due to shadowing which occurs due to variations in surroundings. This can be reduced by using macroscopic diversity technique.

Types of diversity:

1. Space diversity
2. Frequency diversity
3. Time diversity
4. Polarization diversity
5. Angle diversity

Path diversity Improving coverage and capacity in cellular systems:

Due to increase in demand for various wireless services the numbers of channels allocated are insufficient to support all users.

To expand the capacity of cellular systems approaches like Cell splitting, Sectoring, and Coverage zone are used

CELL SPLITTING:

It 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.

It 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.

VERAGE ZONE APPROACHES:

It is the concept that distributes the coverage of a cell and extends the cell boundary to hard-to-reach places.