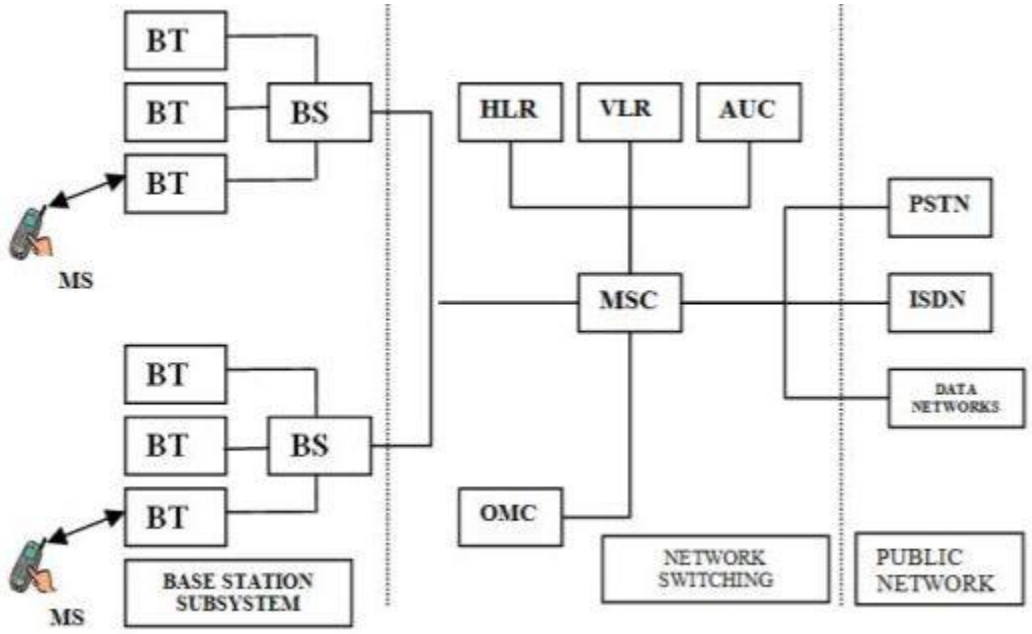
# Wireless Communication

## Mid Term Examination

## Semester Spring 2022

1. Explain with the neat diagram of GSM network

**Diagram:**




**Function:**

- A GSM network is composed of several functional entities, whose functions and interfaces are specified. Figure shows the layout of a generic GSM network. The GSM network can be divided into three broad parts.

1. The Mobile Station is carried by the subscriber.
2. The Base Station Subsystem controls the radio link with the Mobile Station.
3. 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.
- 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.

**Mobile Station**

- The mobile station (MS) consists of the mobile equipment (the terminal) and a smart card called the Subscriber Identity Module (SIM).
- The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

**Base Station Subsystem:**

The Base Station Subsystem is composed of two parts:

1. The Base Transceiver Station (BTS) and
2. The Base Station Controller (BSC).

These communicate across the standardized Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

**Network Subsystem:**

- The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber.
- The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call-routing and roaming capabilities of GSM.

**Q2 Explain the difference between 1G 2G and 3G?**

| Sno. | Basic Terms | 1G | 2G | 2.5G | 3G | 4G |
|---|---|---|---|---|---|---|
| 1 | Full Form | First Generation | Second Generation | Second and a Half Generation | Third Generation | Fourth Generation |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Year | 1980s | 1990s (1991) | 2001 through 2003 | 2005 | released in 2008 working Fully upto 2009 |
| 3 | Support | voice only | SMS, picture messages, and MMS. | WAP, MMS, SMS mobile games, and search and directory. | digital, supported data, GPS, Video Conferencing, Video on demand. | Voice , Video Call ,Mail VOIP INTERNET, Video Streaming etc |
| 4 | Speed | 2.4kbps | (GPRS) in 40-50kbps (EDGE) in 500kbps – 1 Mbps | (GPRS) 20 to 40 Kbps (EDGE) 236.8 kbps to 384 | 2 Mbps for non-moving devices and 384 Kbps in moving vehicles. | 50Mps-100Mbps |
| 5 | Dropped calls | Yes | Yes | Yes | Improvements | Much better. |
| 6 | Security | Little | Text Encryption | Encryption | Infrastructure Security, end-to-end security | end-to-end encryption |
| 7 | Voice | Yes | Yes | Yes | Yes | Yes |
| 8 | Video | No | No | No | Yes | Yes |
| 9 | Signals | Analog | Digital | Digital | Digital | Digital |
| 10 | Technologies | AMPS, NMT, TACS | GSM | TDMA,CDMA | W-CDMA UMTS, EDGE | LTE , LTE Advanced |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | Multiple Address/Access system | FDMA | TDMA, CDMA | TDMA, CDMA | CDMA | CDMA |
| 12 | Switching type | Circuit switching | Circuit switching for Voice and Packet switching for Data | Circuit switching for Voice and Packet switching for Data | Packet switching except for Air Interface | Packet switching |
| 13 | Internet service | No Internet | Narrowband | Narrowband | Broadband | Ultra Broadband |
| 14 | Bandwidth | Analog | 25 MHz | 25 MHz | 25 MHz | 100 MHz |
| 15 | Special Characteristic | First wireless communication | Digital version of 1G technology | Upgrade version of 2G technology | Digital broadband, speed increments | Very high speeds, All IP |

**Q3 Explain the classification of logical channel and explain the logical function of this logical channel**

A logical channel is defined by the type of information it carries and is generally classified as a control channel, used for transmission of control and configuration information necessary for operating an LTE system, or as a traffic channel, used for the user data.

**Logical channels and their functions**

As shown in the figure there are two main types of channels in the GSM. Traffic channels and control channels. Different bursts are mapped to these channels uniquely as per GSM TECHNICAL SPECIFICATION 05.02.

Traffic channels carry speech or data. There are two main categories here, Full rate (13 kpbs) and Half rate.

Control channels used to for control/command/signaling. Control channels are divided into three categories.

**Category 1: Broadcast channels**

As the name suggests they are point-to-multipoint and downlink only channels.

**FCCH:** Frequency correction control channel, this is transmitted by BTS to MS. This helps MS tune its local oscillator to exact RF carrier frequency of the BTS cell. All zero sequences are transmitted here which will produce fixed tone at the output of GMSK modulator. The frequency value will be about 67.7075 KHz.

**SCH:**synchronization channel, this carry BSIC(Base transceiver station identity code) and Frame number which helps MS tune to specific (Frequency,Ts) physical slot on TDMA frame in GSM network.

**BCCH:** Broadcast control channel, carry CGI,MNC,MCC which is received by MS. It is compared with SIM information, once verified OK connection is established with the network.

**Category 2: Common Control channels**

They are point-to-multipoint and downlink only channels except RACH which is used in uplink.

**PCH:**Paging channel, When someone is calling mobile phone, this channel sent information on downlink to alert called mobile phone. This is known as mobile phone terminated call.

**RACH:** Random Access channel, used in mobile originated call. When mobile wants to call some other mobile phone, control information is sent on this channel.

**AGCH:**Access Grant Channel, transmitted by BTS to MS once network approves request of mobile by RACH.

**CBCH:**Cell Broadcast channel, Used to carry the short message service cell broadcast.

**Category 3: Dedicated Control channels**

They are bidirectional and point-to-point Channels.

**SDCCH:** Stand alone dedicated control channel, used for call setup.

**SACCH:** Slow associated control channel, is used for control and supervisory signals associated with the traffic channels.

**FACCH:** Fast associated control channel, is used for control requirements such as handoff/handovers.

**Q4 Explain the common wireless cellular network components with a block diagram**

This chapter discusses the concept of cellular communications and different types of wireless technologies available. Cellular communications systems are wireless mobile communications systems that divide a large geographic area into smaller sections or cells, each with a low-power wireless transmitter, for the purpose of optimising the use of a limited number of frequencies. The basic geographic unit of a cellular system is a cell that conceptually has a hexagonal shape. A cellular communication system consists of four major components—namely, a public switched telephone network (PSTN), a mobile telephone switching office (MTSO), cell sites with antenna systems, and mobile subscriber units (MSU). Cellular digital packet data (CDPD), also known as "wireless IP," is a robust and secure data transmission technology for use on analog cellular phone frequencies General packet radio service (GPRS) is a data service that supplements circuit switch data (CSD) and short message service (SMS) on GSM networks. High data rate (HDR)—also referred to as l x EV—is a wireless Internet access technology that provides up to 2.4 Mbps in a standard bandwidth 1.25 MHz channel for fixed, portable, and mobile applications.

Cellular network is an underlying technology for mobile phones, personal communication systems, wireless networking etc. The technology is developed for mobile radio telephone to replace high power transmitter/receiver systems. Cellular networks use lower power, shorter range and more transmitters for data transmission.

# Features of Cellular Systems

Wireless Cellular Systems solves the problem of spectral congestion and increases user capacity. The features of cellular systems are as follows −

- Offer very high capacity in a limited spectrum.
- Reuse of radio channel in different cells.
- Enable a fixed number of channels to serve an arbitrarily large number of users by reusing the channel throughout the coverage region.
- Communication is always between mobile and base station (not directly between mobiles).
- Each cellular base station is allocated a group of radio channels within a small geographic area called a cell.
- Neighboring cells are assigned different channel groups.
- By limiting the coverage area to within the boundary of the cell, the channel groups may be reused to cover different cells.
- Keep interference levels within tolerable limits.
- Frequency reuse or frequency planning.
- Organization of Wireless Cellular Network.

Cellular network is organized into multiple low power transmitters each 100w or less.

# Shape of Cells

The coverage area of cellular networks are divided into **cells**, each cell having its own antenna for transmitting the signals. Each cell has its own frequencies. Data communication in cellular networks is served by its base station transmitter, receiver and its control unit.

The shape of cells can be either square or hexagon −

## Square

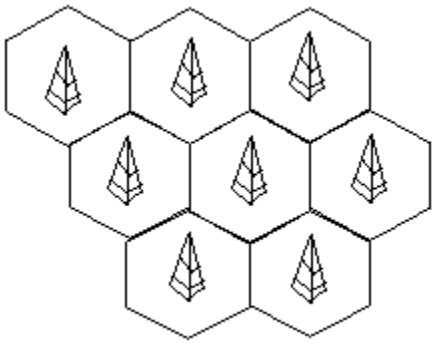
A square cell has four neighbors at distance **d** and four at distance Root **2 d**

- Better if all adjacent antennas equidistant
- Simplifies choosing and switching to new antenna

## Hexagon

A hexagon cell shape is highly recommended for its easy coverage and calculations. It offers the following advantages −

- Provides equidistant antennas
- Distance from center to vertex equals length of side



# Frequency Reuse

Frequency reusing is the concept of using the same radio frequencies within a given area, that are separated by considerable distance, with minimal interference, to establish communication.

Frequency reuse offers the following benefits −

- Allows communications within cell on a given frequency
- Limits escaping power to adjacent cells
- Allows re-use of frequencies in nearby cells
- Uses same frequency for multiple conversations
- 10 to 50 frequencies per cell

For example, when **N** cells are using the same number of frequencies and **K** be the total number of frequencies used in systems. Then each **cell frequency** is calculated by using the formulae **K/N**.

In Advanced Mobile Phone Services (AMPS) when K = 395 and N = 7, then frequencies per cell on an average will be 395/7 = 56. Here, **cell frequency** is 56.

## Q5 Describe the differences between WLAN and WPAN.

Wireless personal area networks (WPANs) are used to convey information over short distances among a private, intimate group of participant devices. Unlike a wireless local area network (WLAN), **a connection made through a WPAN involves little or no infrastructure or direct connectivity to the world outside the link**.

With **WPAN** think of its purposes like a personal-area networks join devices cellular phone joined with PC's to syncernize data and wireless earbuds to phones. With **WLAN** the purpose is to provide network connectivity throughout a facility, can also be more than one building within a small geographical area, with all the networking components connected via **LAN** (**l**ocal **a**rea **n**etwork) technologies

A **wireless local area network (WLAN)** is a wireless computer network that links two or more devices using a wireless distribution method within a limited area such as a home, school, computer laboratory, or office building. A **(WPAN) wireless personal area network** is a low range wireless network which covers an area of only a few dozens of meters[1]