Cellular System

- **A cellphone network**. Often spanning an entire country, a cellular system comprises a core network that connects to base stations with antennas on towers that span up to 20 miles in diameter. GSM and CDMA are the two major cellular technologies.
- Each transmitter typically called a base station, covers a certain area a Cell.
- Cell radii can vary from tens of meter in buildings, and hundreds of meter in cities, up to tens of kilometers in the country.
- The shape of cells are never perfect circles or hexagons but depends on the environment(buildings, mountains, valleys) on weather conditions and sometimes even on system load.

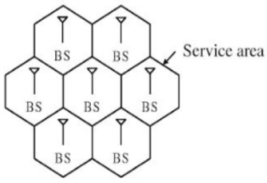


Fig: Cellular system: small zone

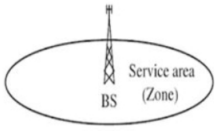
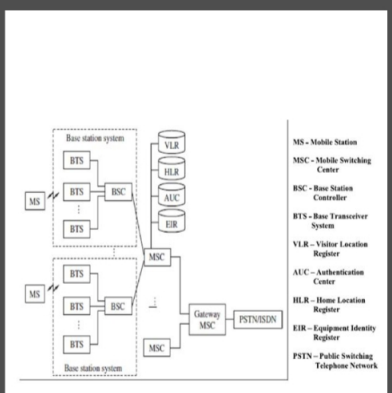


Fig: Early wireless system: large zone

- Wireless devices need to be supported for different types of services, the wireless device could be a wireless telephone laptop with wireless card, personal digital assistant (PDA), or web enabled phone. For simplicity, it could be called an MS.
- In a cellular structure, a MS (mobile station) needs to communicate with the BS of the cell where the MS is currently located and the BS acts as a gateway to the rest of the world. Therefore, to provide a link, the MS needs to be in the area of one of the cells (and hence a BS) so that mobility of the MS can be supported. Several base stations are connected through hard-wires and are controlled by a BS controller (BSC), which in turn is connected to a mobile switching center (MSC).
- Several mobile switching centers are interconnected to a PSTN (public switched telephone network) and the ATM (asynchronous transfer mode) backbone. To provide a better perspective of wireless communication technology,



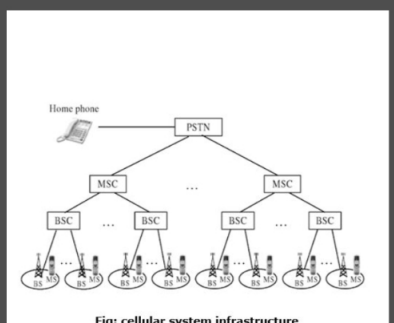
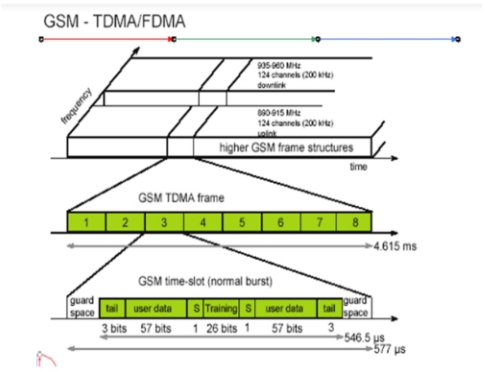


Fig: cellular system infrastructure

a home which contains all data like your ID proof, which plan you are taking, which caller tune you are using etc.

- **OMC :** OMC stands for Operation Maintenance Center. OMC monitor and maintain the performance of each MS, BSC and MSC within a GSM system.
- **AUC :** AUC stands for Authentication Center. AUC authenticates the mobile subscriber that wants to connect in the network.
- **EIR :** EIR stands for Equipment Identity Register. EIR is a database that keeps the record of all allowed or banned in the network. If you are banned in the network them you can't enter the network, and you can't make the calls.
- **PSTN :** PSTN stands for Public Switched Telephone Network. PSTN connects with MSC. PSTN originally a network of fixed line analog telephone systems. Now almost entirely digital in its core network and includes mobile and other networks as well as fixed telephones. The earlier landline phones which places at our home is nothing but PSTN.

Radio Interface

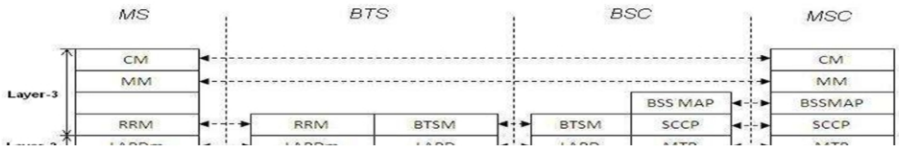


- The most interesting interface in a GSM system is U_m, the radio interface, as it comprises various multiplexing and media access mechanisms. GSM implements SDMA using cells with BTS and assigns an MS to a BTS.

- Each of the 248 channels is additionally separated in time via a **GSM TDMA frame**, i.e., each 200 kHz carrier is subdivided into frames that are repeated continuously.
- The duration of a frame is 4.615 ms.A frame is again subdivided into 8 **GSM time slots**, where each slot represents a physical TDM channel and lasts for 577 μs.
- Each TDM channel occupies the 200 kHz carrier for 577 μs every 4.615 ms.
- Data is transmitted in small portions, called **bursts**.
- The following figure shows a so called **normal burst** as used for data transmission inside a time slot.
- The burst is only 546.5 μs long and contains 148 bits. The remaining 30.5 μs are used as **guard space** to avoid overlapping with other bursts due to different path delays and to give the transmitter time to turn on and off.

GSM Protocol

- GSM architecture is a layered model that is designed to allow communications between two different systems. The lower layers assure the services of the upper-layer protocols. Each layer passes suitable notifications to ensure the transmitted data has been formatted, transmitted, and received accurately.



GSM Mobile Service

- GSM stands for **Global System for Mobile Communication.**
- GSM is an open and digital cellular technology used for mobile communication.
- It uses 4 different frequency bands of 850 MHz, 900 MHz, 1800 MHz and 1900 MHz . It uses the combination of FDMA and TDMA.
- **GSM is having 4 different sizes of cells are used in GSM :**
- Macro : In this size of cell, Base Station antenna is installed.
- Micro : In this size of cell, antenna height is less than the average roof level.
- Pico : Small cells' diameter of few meters.
- Umbrella : It covers the shadowed (Fill the gaps between cells) regions.

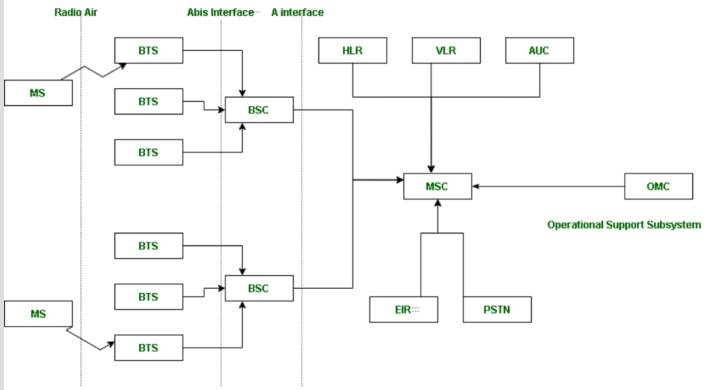
Continue....

BSS : BSS stands for Base Station Subsystem. BSS handles traffic and signaling between a mobile phone and the network switching subsystem. BSS having two components **BTS** and **BSC.**

NSS : NSS stands for Network and Switching Subsystem. NSS is the core network of GSM. That carried out call and mobility management functions for mobile phone present in network. NSS have different components like **VLR, HLR** and **EIR.**

OSS : OSS stands for Operating Subsystem. OSS is a functional entity which the network operator monitor and control the system. **OMC** is the part of OSS. Purpose of OSS is to offer the customer cost-effective support for all GSM related maintenance services.

Suppose there are 3 Mobile stations which are connected with the tower and that tower is connected to BTS through TRX, then further connected to BSC and MSC. Let's understand the functionality of different components.



- **1. MS :** MS stands for Mobile System. MS comprises user equipment and software needed for communication with a mobile network. Mobile Station (MS) = Mobile Equipment(ME) + Subscriber Identity Module (SIM). Now, these mobile stations are connected to tower and that tower connected with BTS through TRX. TRX is a transceiver which comprises transmitter and receiver. Transceiver has two performance of sending and receiving.
- **2. BTS :** BTS stands for Base Transceiver Station which facilitates wireless communication between user equipment and a network. Every tower has BTS.
- **3. BSC :** BSC stands for Base Station Controller. BSC has multiple BTS. You can consider the BSC as a local exchange of your area which has multiple towers and multiple towers have BTS.
- **4. MSC :** MSC stands for Mobile Switching Center. MSC is associated with communication switching functions such as call setup, call release and routing. Call tracing, call forwarding all functions are performed at the MSC level. MSC is having further components like VLR, HLR, AUC, EIR and PSTN.

- **VLR :** VLR stands for Visitor Location Register. VLR is a database which contains the exact location of all mobile subscribers currently present in the service area of MSC. If you are going from one state to another state then your entry is marked into the database of VLR.
- **HLR :** HLR stands for Home Location Register. HLR is a database containing pertinent data regarding subscribers authorized to use a GSM network.. If you purchase SIM card from in the HLR. HLR is like a home which contains all data like your ID proof, which plan you are taking, which caller tune you are using etc.
- **OMC :** OMC stands for Operation Maintenance Center. OMC monitor and maintain the performance of each MS, BSC and MSC within a GSM system.
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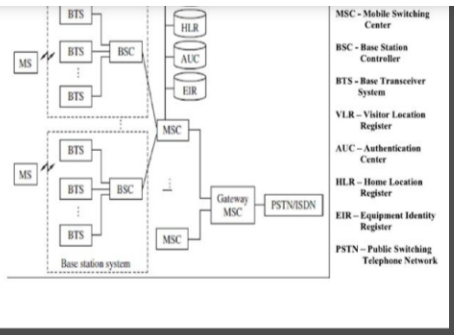


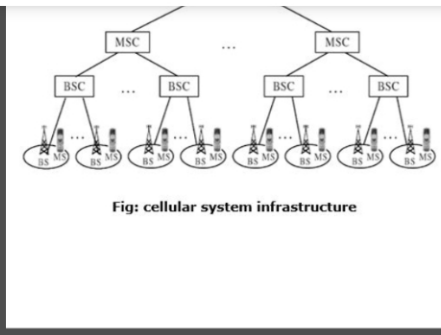


Fig: cellular system infrastructure

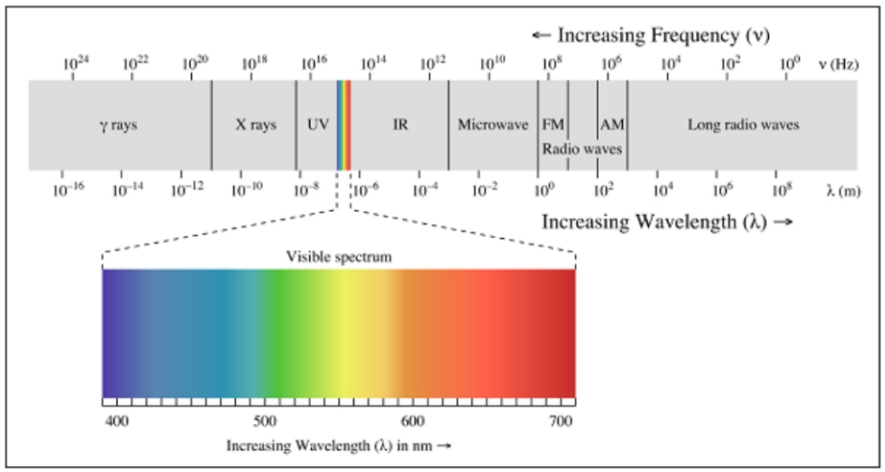
Electromagnetic Spectrum

Electromagnetic energy travels in waves and spans a broad spectrum from very long radio waves to very short gamma rays.

The human eye can only detect only a small portion of this spectrum called visible light.

A radio detects a different portion of the spectrum, and an x-ray machine uses yet another portion.

NASA's scientific instruments use the full range of the electromagnetic spectrum to study the Earth, the solar system, and the universe beyond.



Our Protective Atmosphere

- Our Sun is a source of energy across the full spectrum, and its electromagnetic radiation bombards our atmosphere constantly.
- However, the Earth's atmosphere protects us from

Telecommunication Generations

- he first-ever consumer mobile phone which has been released for commercial purposes has been launched in 1983.
- Since then mobile technology has seen a lot of changes and improvements in its features.
- Most of this progress can be attributed to improved engineering.
- This technology has been proven to be stable, accurate, cheap to manufacture, and easy to maintain.
- Let us discuss in detail the different generations that have been released and used for commercial purposes.

First Generation (1G) Technology

- In this generation of technology, mobile communication is done only through an analog signal that has been used to transmit the user data.
- The wireless industry has gone through a phase of digitization in which many of the devices that users today use with a wired PC connect to the Internet.
- 1G technology was primarily used and designed for voice communication purposes.
- The US Army began using VoIP (Voice over IP) technology in the late 1980s to create a new way of communication for soldiers in wartime, and this first generation of VOIP systems could be considered a breakthrough in the field of communications.
- It is an analog voice communication system consisting of two microphones, an amplifier, and a signal generator/modulator, called Voice Over Internet Protocol

Second Generation (2G) Technology

- The first time the digital signal was used in mobile telephony to transmit signals was in the second generation era of mobile communication. Mobile phones in this generation were capable of transmitting audio and video. The technology was used in more than 60 countries and is already well established in North America and Europe. 2G in a way revolutionized the mobile communication industry although the network speed is limited to 64kbps lots of digital information was being shared.
- GPRS technology was introduced it became very useful in transmitting more data through email and other web services that use slightly more network speed.
- The text message SMS feature in 2G technology was widely used and extremely popular at that time and it allowed many users to occupy a frequency band which made it more efficient.

Third Generation (3G) Technology

- In this technology true revolution took place where the network speed was increased up to 2Mpbs which made high-speed browsing, gaming, email, and other web services possible to a vast segment of the population.
- 3G technology has made a scenario where new mobile phones are developed and sold with major advertising capabilities.
- This makes the users a core demographic and is very important for the mobile service provider.
- all the existing mobile networks now have to run the latest operating systems and hardware, the number of mobile phones has increased from about 600 million in 1998 to nearly 10 billion today.

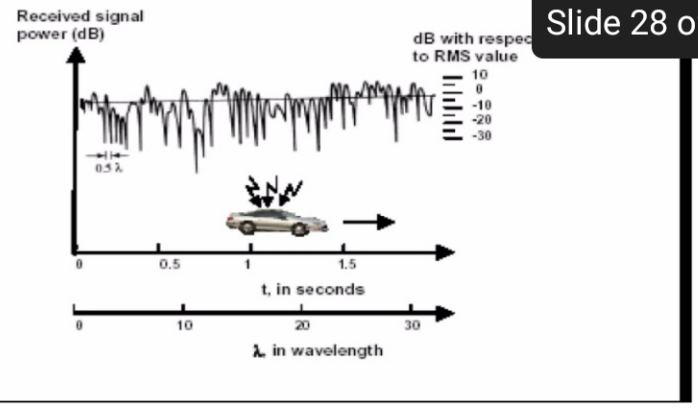
Fourth Generation (4G) Technology

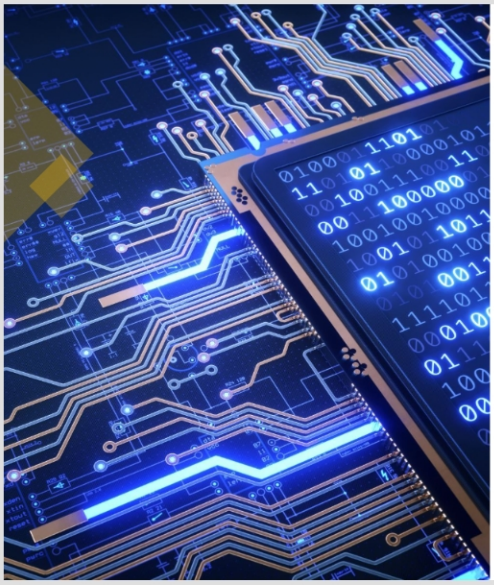
- The next evolution took place with the introduction of mobile broadband and mobile data in the year 2011 where 4G was introduced.
- 4G was one step higher than the 3G which was considered a revolution. With 4G, carriers can create a “super high speed” network so that even at 2G speeds it’ll be able to deliver fast, reliable downloads in just 30 seconds.
- The network speed in 4G has been increased up to 100Mpbs. This technology made possible some of the things such as high-speed gaming, High-definition Mobile Television, Digital Streaming, HD Television services, Cloud computing, etc.
- 4G offers faster data speeds at lower prices, in areas that are underserved by its competitors, and offers a wider variety of cellular networks.
- The development of Smartphones became very popular after the launching of 4G where all the devices manufactured post-2013 supported the 4G feature which made 4G technology reach a wider audience.

Fifth Generation (5G) Technology

- The wireless evolution of 5G is solving the problem of resource allocation by means of cooperation and coordination.
- Basically, 5G is the standard of wireless cellular technology, which was developed by 3GPP.
- The 5G is following footsteps of the 3G and 4G technologies. 5G network is based on the standards which was connecting wireless routers, smartphones, and other communication devices.
- 5G is delivering a good improvement in latency, transmission speed, and flexible deployment.
- 5G delivers additional capabilities as compared to the 4G wireless network. The below figure shows how revolution is done from 2G to 5G network.

Large-Scale & Small-Scale Fading





Multiplexing

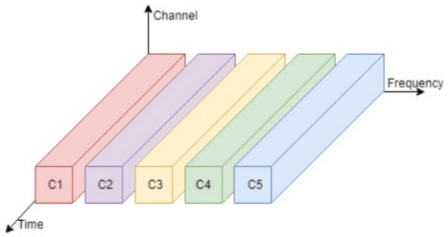
- Multiplexing is a technique used in the area of electronics and signal processing. In mobile computing, telecommunications and computer networks, Multiplexing is a method that can be used to combine multiple analog or digital signals into one signal over a shared medium. The main aim of using this method is to share a scarce resource.

Multiplexing can be classified into the following four types:

- Frequency Division Multiplexing (FDM)
- Time Division Multiplexing (TDM)
- Code Division Multiplexing (CDM)
- Space Division Multiplexing (SDM)

Frequency Division Multiplexing (FDM)

- in Frequency Division Multiplexing, the frequency dimension spectrum is split into smaller frequency bands. It combines several smaller distinct frequency ranges signals into one medium and sends them over a single medium. In FDM, the signals are electrical signals.
- **For example:** In cable TV, you can see that only one cable is reached to the customer's locality, but the service provider can send multiple television channels or signals simultaneously over that cable to all customers without any interference. The customers have to tune to the appropriate frequency (channel) to access the required signal.
- In FDM, several frequency bands can work simultaneously without any time constraint.
- It is used in Radio and television broadcasting stations, Cable TV etc.



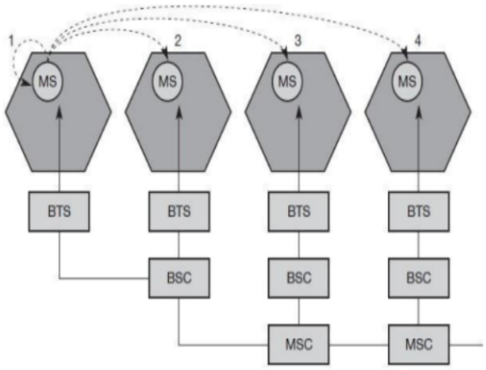
Time Division Multiplexing (TDM)

- The Time Division Multiplexing or (TDM) is a digital or analog technology (in rare cases) that uses time, instead of space or frequency, to separate the different data streams. It is used for a specific amount of time in which the whole spectrum is

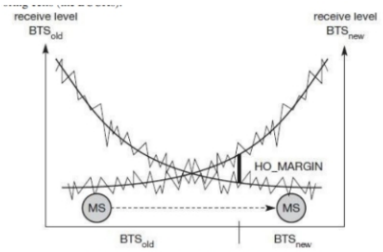
Handover

- Cellular systems require handover procedures, as single cells do not cover the whole service area. However, a handover should not cause a cut-off, also called call drop. GSM aims at maximum handover duration of 60 ms. There are two basic reasons for a handover:
- 1. The mobile station moves out of the range of a BTS, decreasing the received signal level increasing the error rate thereby diminishing the quality of the radio link.
- 2. Handover may be due to load balancing, when an MSC/BSC decides the traffic is too high in one cell and shifts some MS to other cells with a lower load.

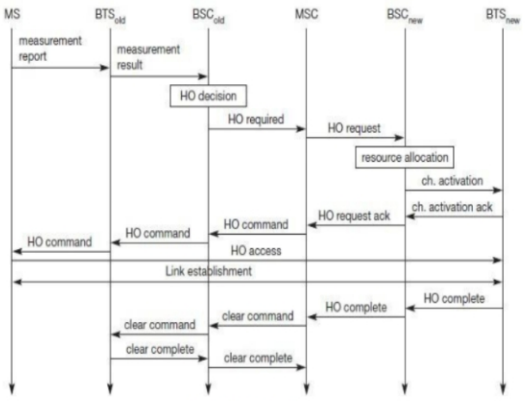
The four possible handover scenarios of GSM are shown below:



- **Intra-cell handover:** Within a cell, narrow-band interference could make transmission at a certain frequency impossible. The BSC could then decide to change the carrier frequency (scenario 1).
- **Inter-cell, intra-BSC handover:** This is a typical handover scenario. The mobile station moves from one cell to another, but stays within the control of the same BSC. The BSC then performs a handover, assigns a new radio channel in the new cell and releases the old one (scenario 2).
- **Inter-BSC, intra-MSC handover:** As a BSC only controls a limited number of cells; GSM also has to perform handovers between cells controlled by different BSCs. This handover then has to be controlled by the MSC (scenario 3).
- **Inter MSC handover:** A handover could be required between two cells belonging to different MSCs. Now both MSCs perform the handover together (scenario 4).



Handover decision depending on receive level



Intra-MSChandover

Security

- GSM offers several security services using confidential information stored in the AuC and in the individual SIM. The SIM stores personal, secret data and is protected with a PIN against unauthorized use. Three algorithms have been specified to provide security services in GSM. Algorithm A3 is used for authentication, A5 for encryption, and A8 for the generation of a cipher key. The various security services offered by GSM are:

There are Three types of GSM Security

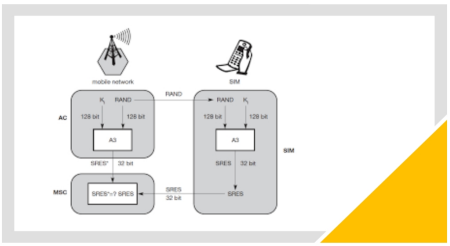
1. A3 Algorithm (It is used for Authentication)
2. A5 Algorithm (it is used for Encryption)
3. A8 Algorithm (it is used for generation of cipher key)

A3 Algorithm

- The first step includes the authentication of valid user for the SIM.
- The user needs a secret PIN to access the SIM.
- A3 and A8 are generally implemented together (known as A3/A8).
- An A3/A8 algorithm is implemented in Subscriber Identity Module (SIM) cards and in GSM network Authentication Centers.

Authentication

- The BTS authenticates the MS using a challenge-response scheme relying on a 128-bit shared secret Ki stored in the SIM card and the core network.
- MS ⟵ BTS : *Authentication Request* (128-bit RAND)
- MS ⟶ BTS : *Authentication Response* (32-bit SRES = A3(Ki, RAND))
- MS ⟵ BTS : *Authentication Reject* if SRES is incorrect



International Mobile Subscriber Identity (IMSI) number:

- A globally unique identifier allocated to each GSM subscriber.
- It is permanently stored both in the HLR of the user and in the SIM of the user terminal.
- Any GSM subscriber can be uniquely identified by its IMSI number.
- This International Mobile Subscriber Identity (IMSI) number is composed of the Mobile Country Code (MCC, three digits), the Mobile Network Code (MNC, two digits) and the Mobile Subscriber Identification Number (MSIN, ten digits).

Subscriber Authentication key (Ki):

- 128 bit shared key used for authentication of the subscriber by the network ·

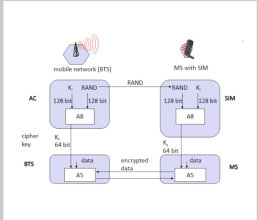
A3 and A8 Security algorithms:

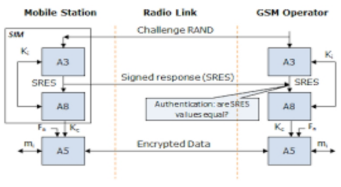
- Algorithms used for authentication and generation of cipher key.

A5 & A8 Algorithm

- A5 functions are the encryption algorithms.
- To ensure Privacy, all message containing user related information are encrypted in GSM over air interface.
- After authentication MS and BSS can start using encryption by applying the cipher key Kc.
- Kc is generated using the individual key Ki and a random value by applying the algorithm A8.
- MS and BTS can now encrypt and encrypt data using the algorithm A5 and cipher key Kc.
- Kc should be a 64 bit key- which is not very strong, but is at least a good protection against simple.

- All user related data is encrypted.
- After authentication BTS and MS apply encryption to voice data and signaling.
- This confidentiality exists only between MS and BTS but it does not exist end to end or within the whole fixed GSM network.





- The BSC uses a different set of protocols after receiving the data from the BTS. The Abis interface is used between the BTS and BSC. At this level, the radio resources at the lower portion of Layer 3 are changed from the RR to the Base Transceiver Station Management (BTSM). The BTS management layer is a relay function at the BTS to the BSC.
- The RR protocols are responsible for the allocation and reallocation of traffic channels between the MS and the BTS.

MSC Protocols

- At the MSC, starting from the BSC, the information is mapped across the A interface to the MTP Layers 1 through 3. Here, Base Station System Management Application Part (BSS MAP) is said to be the equivalent set of radio resources. The relay process is finished by the layers that are stacked on top of Layer 3 protocols, they are BSS MAP/DTAP, MM, and CM.

Localization and Calling

- The fundamental feature of the GSM system is the automatic, worldwide localization of users for which, the system performs periodic location updates.
- The HLR always contains information about the current location and the VLR currently responsible for the MS informs the HLR about the location changes.
- Changing VLRs with uninterrupted availability is called roaming. Roaming can take place within a network of one provider, between two providers in a country and also between different providers in different countries.

To locate and address an MS, several numbers are needed:

- **Mobile station international ISDN number (MSISDN):-** The only important number for a user of GSM is the phone number. This number consists of the country code (CC), the national destination code (NDC) and the subscriber number (SN).
- **International mobile subscriber identity (IMSI):** GSM uses the IMSI for internal unique identification of a subscriber. IMSI consists of a mobile country code (MCC), the mobile network code (MNC), and finally the mobile subscriber identification number (MSIN).
- **Temporary mobile subscriber identity (TMSI):** To hide the IMSI, which would give away the exact identity of the user signaling over the air interface, GSM uses the 4 byte TMSI for local subscriber identification.
- **Mobile station roaming number (MSRN):** Another temporary address that hides the identity and location of a subscriber is MSRN. The VLR generates this address on request from the MSC, and the address is also stored in the HLR. MSRN contains the current visitor country code (VCC), the visitor national destination code (VNDC), the identification of the current MSC together with the subscriber number. The MSRN helps the HLR to find a subscriber for an incoming call.

Mobile Originated Call

Antenna

- An Antenna is a transducer, which converts electrical power into electromagnetic waves and vice versa.
- An Antenna can be used either as a **transmitting antenna** or a **receiving antenna**.
- A **transmitting antenna** is one, which converts electrical signals into electromagnetic waves and radiates them.
- A **receiving antenna** is one, which converts electromagnetic waves from the received beam into electrical signals.
- In two-way communication, the same antenna can be used for both transmission and reception.
- if two people want to communicate who are at longer distances, then we have to convert these sound waves into **electromagnetic waves**. The device, which converts the required information signal into electromagnetic waves, is known as an **Antenna**.

Basic Types of Antennas

Antennas may be divided into various types depending upon –

- The physical structure of the antenna.
- The frequency ranges of operation.
- The mode of applications etc.

1. Physical structure

Following are the types of antennas according to the physical structure. You will learn about these antennas in later chapters.

- Wire antennas
- Aperture antennas
- Reflector antennas
- Lens antennas
- Micro strip antennas
- Array antennas

2. Frequency of operation

Following are the types of antennas according to the frequency of operation.

- Very Low Frequency (VLF)
- Low Frequency (LF)
- Medium Frequency (MF)
- High Frequency (HF)
- Very High Frequency (VHF)
- Ultra High Frequency (UHF)
- Super High Frequency (SHF)
- Micro wave
- Radio wave

3. Mode of Applications

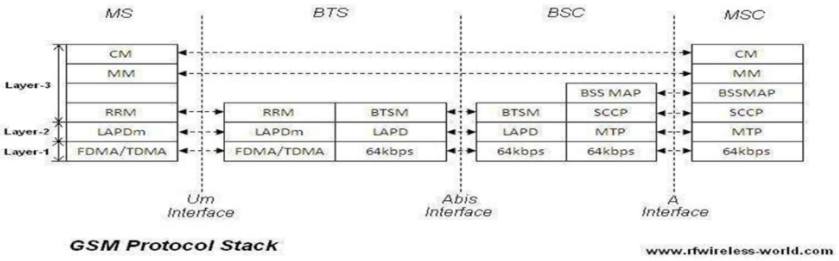
Following are the types of antennas according to the modes of applications –

- Point-to-point communications
- Broadcasting applications
- Radar communications
- Satellite communications

Band Name	Frequency	Wavelength	Applications
Extremely Low Frequency (ELF)	30 Hz to 300 Hz	10,000 to 1,000 KM	Power line frequencies
Voice Frequency (VF)	300 Hz to 3 KHz	1,000 to 100 KM	Telephone Communications
Very Low Frequency (VLF)	3 KHz to 30 KHz	100 to 10 KM	Marine Communications
Low Frequency (LF)	30 KHz to 300 KHz	10 to 1 KM	Marine Communications
Medium Frequency (MF)	300 KHz to 3 MHz	1000 to 100 m	AM Broadcasting
High Frequency (HF)	3 MHz to 30 MHz	100 to 10 m	Long distance aircraft/ship Communications
Very High Frequency(VHF)	30 MHz to 300 MHz	10 to 1 m	FM Broadcasting
Ultra High Frequency (UHF)	300 MHz to 3 GHz	100 to 10 cm	Cellular Telephone
Super High Frequency (SHF)	3 GHz to 30 GHz	10 to 1 cm	Satellite Communications, Microwave links
Extremely High Frequency (EHF)	30 GHz to 300 GHz	10 to 1 mm	Wireless local loop
Infrared	300 GHz to 400 THz	1 mm to 770 nm	Consumer Electronics
Visible Light	400 THz to 900 THz	770 nm to 330 nm	Optical Communications

GSM Protocol

- GSM architecture is a layered model that is designed to allow communications between two different systems. The lower layers assure the services of the upper-layer protocols. Each layer passes suitable notifications to ensure the transmitted data has been formatted, transmitted, and received accurately.



GSM Protocol Stack

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MS Protocols

Based on the interface, the GSM signaling protocol is assembled into three general layers –

- **Layer 1** – The physical layer. It uses the channel structures over the air interface.
- **Layer 2** – The data-link layer. Across the Um interface, the data-link layer is a modified version of the Link access protocol for the D channel (LAP-D) protocol used in ISDN, called Link access protocol on the Dm channel (LAP-Dm). Across the A interface, the Message Transfer Part (MTP), Layer 2 of SS7 is used.
- **Layer 3** – GSM signaling protocol's third layer is divided into three sublayers –
  - Radio Resource Management (RR).
  - Mobility Management (MM), and
  - Connection Management (CM).

MS to BTS Protocols

- The **RR layer** is the lower layer that manages a link, both radio and fixed, between the MS and the MSC. For this formation, the main components involved are the MS, BSS, and MSC. The responsibility of the RR layer is to manage the RR-session, the time when a mobile is in a dedicated mode
- The **MM layer** is stacked above the RR layer. It handles the functions that arise from the mobility of the subscriber, as well as the authentication and security aspects. Location management is concerned with the procedures that enable the system to know the current location of a powered-on MS so that incoming call routing can be completed.
- The **CM layer** is the topmost layer of the GSM protocol stack. This layer is responsible for Call Control, Supplementary Service Management, and Short Message Service Management.

BSC Protocols

- The BSC uses a different set of protocols after receiving the data from the BTS. The Abis interface is used between the BTS and BSC. At this level, the radio resources at the lower portion of Layer 3 are changed from the RR to the Base Transceiver Station Management (BTSM). The BTS management layer is a relay function at the BTS to the BSC.
- The RR protocols are responsible for the allocation and reallocation of traffic channels between the MS and the BTS.

MSC Protocols

- At the MSC, starting from the BSC, the information is mapped across the A interface to the MTP Layers 1 through 3. Here, Base Station System Management Application Part (BSS MAP) is said to be the equivalent set of radio resources. The relay process is finished by the layers that are stacked on top of Layer 3 protocols, they are BSS MAP/DTAP, MM, and CM.

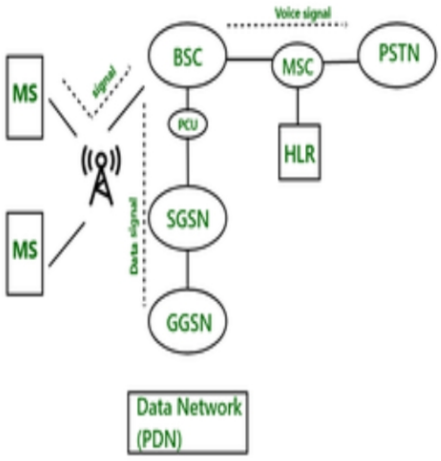
GPRS (General Packet Radio Service)

- **GPRS** stands for General Packet Radio Service.
- It is the modified version of GSM architecture service.
- In GSM architecture we can only transport the voice signal. But if signal consists of the data then only GSM architecture cannot use.
- For that there are two more software components are used, SGSN (Serving GPRS supporting Node) and GGSN (Gateway GPRS supporting Node).

1. SGSN (Serving GPRS supporting Node)
- Authentication of GPRS user.
- Data Compression
- Registration of mobile in N/W.
- Packet Delivery
- Mobility management
  apply/ sign off of terminals
  localization
- LLC (Logical Link Control) management
- billing

2. GGSN (Gateway GPRS supporting Node).
- Mediator between GPRS between backbone and external data networks.
- Saves current data for the SGSN address of the participant as well as their profile and data for authentication and invoice

3. PCU (Packet Control Unit)



- In GSM architecture there is one component called BSC. But in GPRS there is one component is added to BSC called PCU.
- PCU stands for Packet Control Unit. If signal comes to BSC and that signal contains data, then PCU routes to the SGSN.
- Interface is used between BSC and PCU is FRI interface. After signal comes to SGSN, it delivers the data packet to the GGSN.
- GGSN routes the data packet to the data network (PDN- Predefined Data Network).

UMTS /UTRAN/3G

- UMTS stand for Universal Mobile Telecommunication System.
- UTRANS stand for UMTS Terrestrial Radio Access Network.
- It is a third generation broadband mobile cellular system which is based on the GSM.
- It is used packet switch transmission or Circuit switch transmission.

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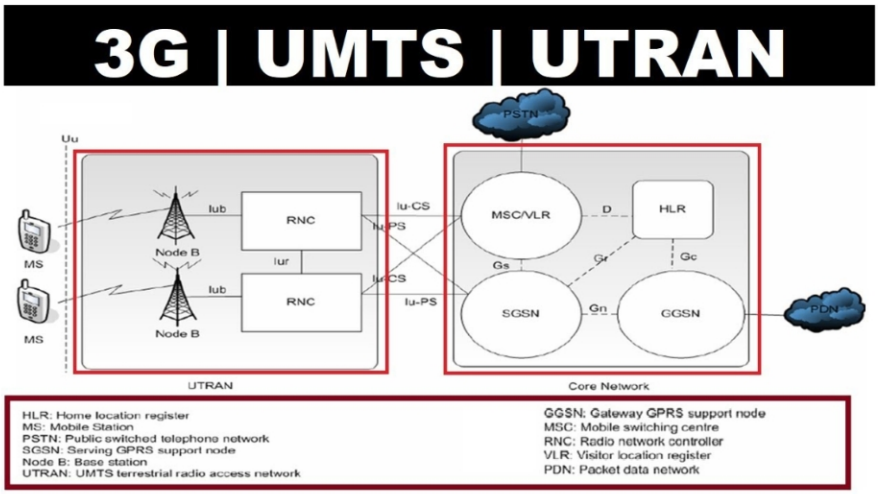

UE:- (User Equipment)

- ME (mobile equipment)
- USIM(User SIM)

So when ever a user insert SIM into his mobile. UE is connected to Node B

UTRAN: (UMTS Terrestrial Radio Access Network) it is brain of UMTS.

It has 2 components

1. Node B:- which is similar to BTS of GSM. It helps transfer and receiver data.
2. RNC:-(Radio Network Controller)

Many of the Node B are connected to one RNC. It just to control where to send.

So here we have two paths one for voice call and another for data transfer.

If user wants to call it is forwarded to PSTN network. Via MSC or GMSC.

If user want to connect to internet or transfer data is forwarded to PDN network via SGSN or GGSN.