

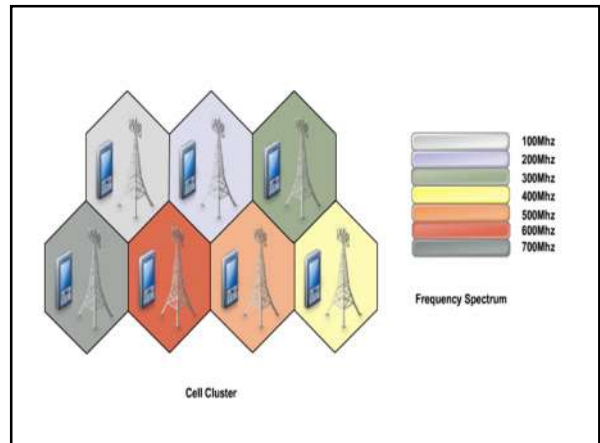
Cellular Communication

Cellular Communication

- Cellular communication is designed to provide communications between **two moving units**, or between **one mobile unit and one stationary phone or land unit (PSTN)**.

Network Cell and Cluster

- The entire network coverage area is divided into cells based on the principle of frequency reuse
- A Cell** -basic geographical unit of a cellular network; is **the area around an antenna** where a specific frequency range is used;
- Cell is represented graphically as a **hexagonal shape**, but in reality it is irregular in shape.
- A cluster** is a group of adjacent cells, **usually 7 cells**; no frequency reuse is done within a cluster
- In heavy traffic zones cells are smaller, while in isolated zones cells are larger.



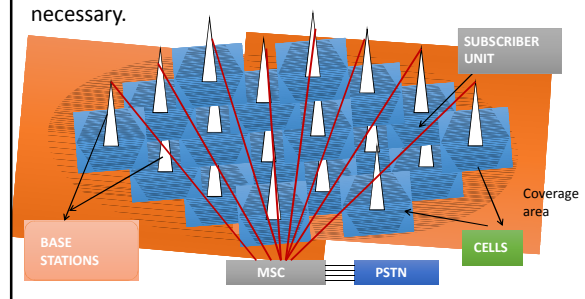
Frequency Reuse

- Base stations in adjacent cells are assigned channel groups which contain completely different channels than neighbouring cells.
- The base station antennas are designed to achieve the desired coverage within the particular cell.



Cellular system basic concept

By systematically spacing base stations and the channel groups may be reuse as many number of times as necessary.



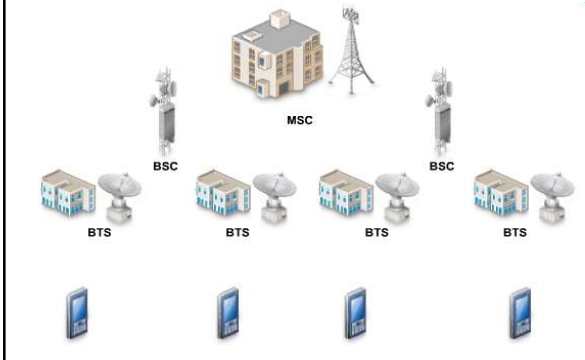
Cellular network components

- **BTS (Base Transceiver Station)** –
 - main component of a cell and it connects the subscribers to the cellular network;
 - for transmission/reception of information it uses several antennas spread across the cell
- **BSC (Basic Station Controller)** –
 - it is an interface between BTSs and it is linked to BTSs by cable or microwave links;
 - it routes calls between BTSs; it is also connected to the MSC
- **MSC (Mobile Switching Center)** –
 - the coordinator of a cellular network, it is connected to several BSCs, it routes calls between BSCs;
 - links the cellular network with other networks like PSTN through fiber optics, microwave or copper cable

Components of a cellular phone (MSU – Mobile Subscriber Unit)

- **radio transceiver** – low power radio transmitter and receiver
- **antenna**, usually located inside the phone
- **control circuitry** – formats the data sent to and from the BTS; controls signal transmission and reception
- **man-machine interface** – consists from a keypad and a display;
- **Subscriber Identity Module (SIM)** – integrated circuit card that stores the identity information of subscriber
- **battery**, usually Li-ion, the power unit of the phone

Cellular network components



Bands in Mobile Communication

- **Analog transmission** is used for cellular telephony.
- **Frequency modulation** is used for communication between the **mobile phone and cell office**.
- Two frequency bands are allocated for this purpose.
- One band of them is for the communication that is initiated by mobile phone & the other band for the land phone.
- Each uplink and downlink frequency bands is further split up as **Control Channel** (used to set up and manage calls) and **Traffic Channel** (used to carry voice)

Bands in Mobile Communication

- GSM uses FDMA and TDMA to transmit voice and data
- The **uplink channel** - between the cell phone and the BTS uses FDMA
- The **downlink channel**- between the BTS and the cell phone uses a TDMA technique
- uplink and downlink channels have a bandwidth of 25 MHz

GSM Frequency band	Uplink/BTS Transmit	Downlink/BTS Receive
900 MHz	935-960 MHz	890-915 MHz
1800 MHz	1805-1880 MHz	1710-1785 MHz
1900 MHz	1930-1990 MHz	1850-1910 MHz

Setting up a call process

- When powered on, the phone does not have a frequency/time slot assigned to it yet; so it scans for the control channel of the BTS and picks the strongest signal.
- Then it sends a message (including its identification number) to the BTS to indicate its presence.
- The BTS sends an acknowledgement message back to the cell phone
- The phone then registers with the BTS and informs the BTS of its exact location
- After the phone is registered to the BTS, the BTS assigns a channel to the phone and the phone is ready to receive or make calls

Making a call process

- The subscriber dials the receiver's number and sends it to the BTS.
- The BTS sends to its BSC the **ID, location and number of the caller** and also the number of the receiver
- The BSC forwards this information to its MSC
- The MSC routes the call to the receiver's MSC which is then sent to the receiver's BSC and then to its BTS.
- The communication with the receiver's cell phone is established.

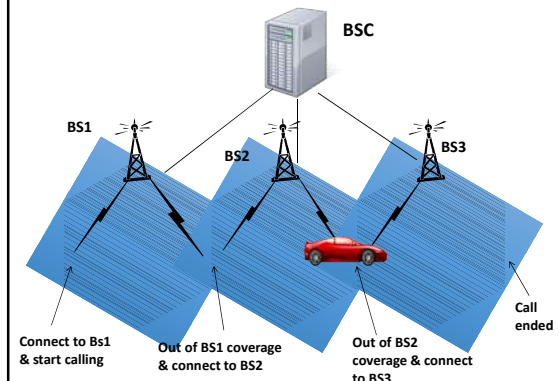
Receiving a call process

- When the receiver's phone is in an idle state **it listens for the control channel** of its BTS.
- If there is an incoming call the BSC and BTS sends a message to the cells in the area where the receiver's phone is located.
- The phone monitors its message and compares the number from the message with its own.
- If the numbers matches the cell phone sends an acknowledgement to the BTS.
- After authentication, the communication is established between the caller and the receiver.

Handover/ Handoffs

- When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station.
- This handoff operation involves
 - identifying a new base station,
 - also requires that the voice and control signals be allocated to channels associated with the new base station.
- Processing handoffs is an important task in any cellular radio system.

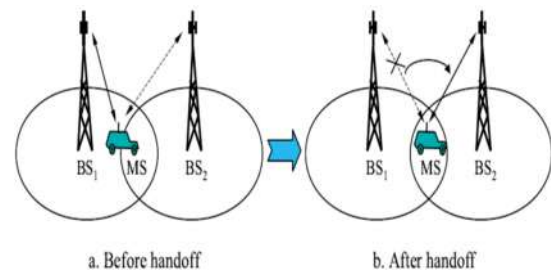
Handoff/ Handover



Hard Hand Off (Break before Make)

- In Hard Hand Off a mobile station only communicates with one base station.
- When the (mobile handset) MS moves from one cell to another, communication must **first be broken with the previous base station** before communication can be reestablished with the new one.
- This may create a rough transition.
- Hard hand off was used in earlier systems.
- There is generally a short break in transmission, this is normally short enough not to be noticed by the user.

Hard handoff between the MS and BSs.



Soft Hand Off (Make before break)

- In this case, a mobile station can communicate **with two base stations at the same time.**
- This means that, during Hand off a mobile station may continue with the new base station **before breaking off from the old one.**
- This is used in new systems.
- This provides seamless connectivity while roaming from one cell to another.

Roaming

- Roaming is a term used to describe the ability of phones to connect to the network of a different carrier, abroad or at home in.
- To offer users the same features they use while on their "home" network – making and receiving calls and text messages and surfing the web.

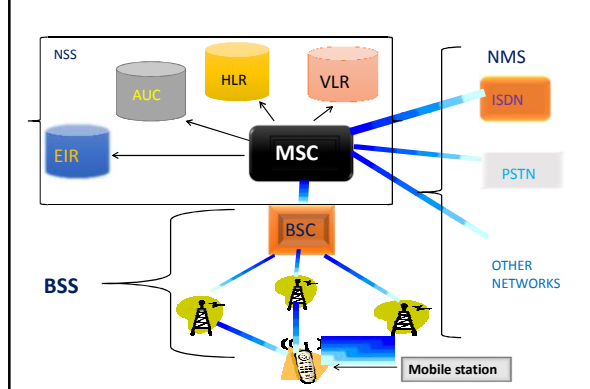
Roaming

- Roaming refers to a wireless network service extension in an area that differs from the registered home network location.
- Roaming enables a mobile device to access the Internet and other mobile services when out of its normal coverage area.
- It also gives a mobile device the ability to move from one access point to another.

What is GSM?

- **Global system for mobile communication** is a set of ETSI standards specifying the infrastructure for a digital cellular services.
- GSM networks are structured hierarchically it consist of one administrative region which is assigned to a **MSC**.
- Each administrative region is made up of at least one **location area (LA)**. LA is also called the visited area.
- An LA consists of several **cell groups**.
- Each cell group is assigned to a base station controller (**BSC**)

OPENED VIEW OF GSM ARCHITECTURE?



HLR, VLR and EIR registers

- **Home Location Register (HLR)** - is a database maintained by the service provider containing permanent data about each subscriber (i.e. **location, activity status, account status, call forwarding preference, caller identification preference**)
- **Visitor Location Register (VLR)** - database that stores temporary data about a subscriber; when the subscriber moves to a new area the new MSC requests this VLR from the HLR of the old MSC.
- **Equipment Identity Register (EIR)** - database located near the MSC and containing information identifying cell phones

Authentication Center (AuC)

- 1st level security mechanism for a GSM cellular network
- is a database that stores the **list of authorized subscribers** of a GSM network
- it is linked to the MSC and checks the identity of each user trying to connect
- also provides encryption parameters to secure a call made in the network

GSM Mobile Switching Center (MSC)

- is a switching center of the GSM network; coordinates BSCs linked to it

