Class: 4th

MOBILE COMMUNICATIONS

Lecture 3

Chapter Two

The Cellular Concept-System Design

By

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Lecture Outlines

2.1 Cellular Mobile Systems

2.2 Cellular system operation

2.3 RF Planning

2.4 Cell types

Teaching Tools:

- White Board, white board marker and eraser

Teaching Methods:

1. Method of lecture.
2. Method of discussion and dialogue.
3. Brain storming

2.1 Cellular Mobile Systems

GSM is a PLMN (Public Land Mobile Network)

- several providers setup mobile networks following the GSM standard within each country
- components
  - MS (mobile station)
  - BS (base station)
  - MSC (mobile switching center)
  - LR (location register)
- subsystems
  - RSS (radio subsystem): covers all radio aspects
  - NSS (network and switching subsystem): call forwarding, handover, switching
  - OSS (operation subsystem): management of the network

NSS is the main component of the public mobile network GSM

1- switching, mobility management, interconnection to other networks, system control
2- Components
   a. Mobile Services Switching Center (MSC) – high performance digital ISDN switches.
      controls all connections via a separated network to/from a mobile terminal within the domain of the MSC - several BSC can belong to a MSC
   b. Databases (important: scalability, high capacity, low delay)

i. Home Location Register (HLR)
central master database containing user data, permanent and semi-permanent data of all subscribers assigned to the HLR (one provider can have several HLRs)

ii. Visitor Location Register (VLR)
local database for a subset of user data, including data about all user currently in the domain of the VLR

The MSC (mobile switching center) plays a central role in GSM

- ❑ switching functions
- ❑ additional functions for mobility support
- ❑ management of network resources
- ❑ interworking functions via Gateway MSC (GMSC)
- ❑ integration of several databases

Functions of a MSC

1- Assigns the voice channel to each call.
2- Performs handoffs.
3- Monitors the call for billing information

Communication between the base station and the mobiles is defined by a standard common air interface (CAI) that specifies four different channels (2) voice channels, 2 control channels.

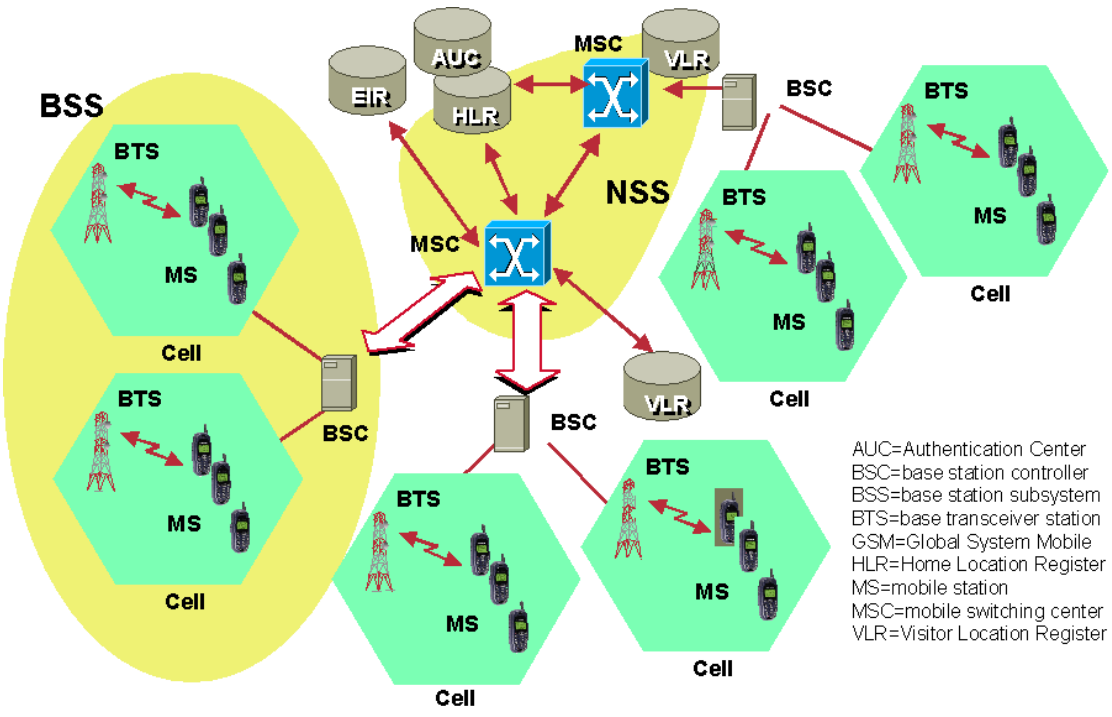
a. *Voice channels (Traffic channels):*

The channels used for voice transmission from the base station to mobiles are called forward voice channels (FVC), and the channels used for voice transmission from mobiles to the base station are called reverse voice channels (RVC).

b. *Control channels (setup channels)*

The two channels responsible for initiating mobile calls are the forward control channels (FCC) and reverse control channels (RCC). Control channels transmit and receive data messages that carry call initiation and service requests, and are monitored by mobiles when they do not have a call in progress.

2.2 Cellular system operation



According to the diagram above, it can be understood simply by:

- Mobile device is connected to BTS (Antenna).
- BTS is connected to the Switching system called BSC.
- BSC is connected to the main switching system called MSC.
- MSC contains its own VLR (VLR: is a temporary database which stores the information of the visitors under its coverage area. VLR stands for Visitor Location register. When you roam in a different place VLR stores your user information.).
- MSC's are connected to GMSC which is connected to HLR. (HLR stands for Home location register, it is the main database where the documents or information of user is stored. all the documents that you give during purchase of a SIM card is stored in this HLR.
- VLR Takes your information from HLR when you Roam in other state or region.).
- HLR also provides authentication by AuC. AuC is connected with HLR. If you initiate a call HLR and AuC will see if you are a genuine Mobile user with valid IMEI number and Plan.and then the call is set up from source to the destination device.

Mobile Terminated Call

1: calling a GSM subscriber

2: forwarding call to GMSC

3: signal call setup to HLR

4, 5: request MSRN from VLR

6: forward responsible MSC to GMSC

7: forward call to current MSC

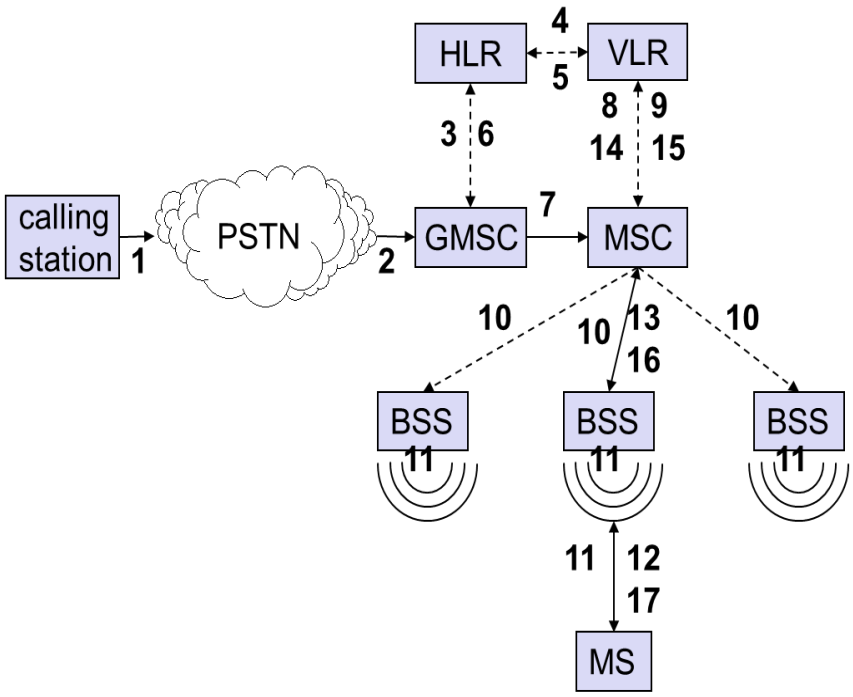
8, 9: get current status of MS

10, 11: paging of MS

12, 13: MS answers

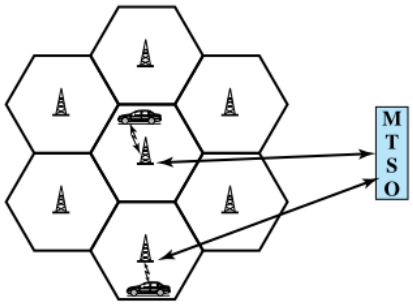
14, 15: security checks

16, 17: set up connection



Other functions performed by the system include the following:

- **Handoff (Handover):** If a mobile unit moves out of range of one cell and into the range of another during a connection, the traffic channel has to change to one assigned to the BS in the new cell. The system makes this change without either interrupting the call or alerting the user.



- **Call blocking:** During the mobile-initiated call stage, if all the traffic channels assigned to the nearest BS are busy, then the mobile unit makes a preconfigured number of repeated attempts. After a certain number of failed tries, a busy tone is returned to the user.
- **Call termination:** When one of the two users hangs up, the MTSO is informed and the traffic channels at the two BSs are released.
- **Call drop:** During a connection, because of interference or weak signal spots in certain areas, if the BS cannot maintain the minimum required signal strength for a certain period of time, the traffic channel to the user is dropped and the MTSO is informed.
- **Calls to/from fixed and remote mobile subscriber:** The MTSO connects to the public switched telephone network (PSTN). Thus, the MTSO can set up a connection between a mobile user in its area and a fixed subscriber via the telephone network.

2.3 RF Planning

RF Planning is the process of assigning frequencies, transmitter locations and parameters of a wireless communications system to provide sufficient coverage and capacity for the services required. The RF plan of a cellular communication system has two objectives: coverage and capacity.

a. Coverage relates to the geographical footprint within the system that has sufficient RF signal strength to provide for a call/data session.
b. Capacity relates to the capability of the system to sustain a given number of subscribers. Capacity and coverage are interrelated.

To improve coverage, capacity has to be sacrificed, while to improve capacity, coverage will have to be sacrificed. **It is necessary to restructure radiotelephone system to achieve high capacity with limited spectrum.**

1- **Increase the capacity of the system**: by using lower-power systems with shorter radius and to use numerous transmitters/receivers (Base stations). Thereby providing additional radio capacity with no additional increase in radio spectrum.
2- **Distributing the available channels throughout geographic region**: by systematically spacing base stations and their channel groups. The available channels can be reused as long as the interference between co-channel stations is kept below acceptable level.

2.4 Cell types

- Macro cell – their coverage is large (aprox. 6 miles in diameter); used in remote areas, high-power transmitters and receivers are used
- Micro cell – their coverage is small (half a mile in diameter) and are used in urban zones; low-powered transmitters and receivers are used to avoid interference with cells in another clusters
- Pico cell –is a small cellular system typically covering a small area, such as in-building (offices, shopping malls, train stations) . In cellular networks, picocells are typically used to extend coverage to indoor areas where outdoor signals do not reach well.
- Selective cells . located at the entrances of tunnels where a coverage of 360 degrees is not needed this case, a selective cell with a coverage of 120 degrees is used.

Decreasing the cell size gives:

- ❖ Increased user capacity
- ❖ Increased number of handovers per call
- ❖ Increased complexity in locating the subscriber
- ❖ Lower power consumption in mobile terminal: so it gives longer talk time, safer operation