Cellular Systems

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Introduction

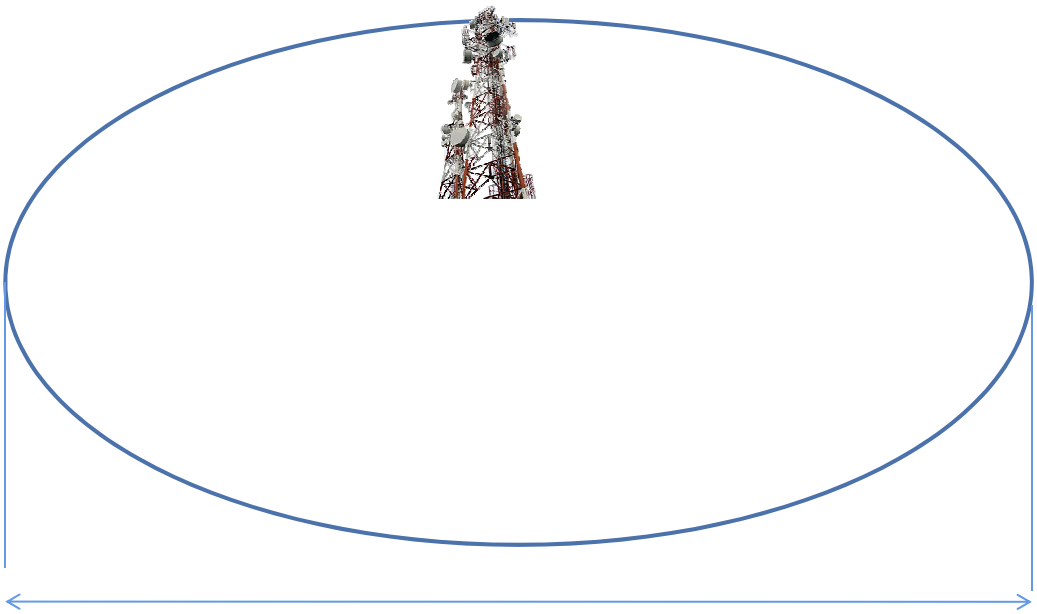
Many different technologies and protocols are used around the world to provide cellular coverage

In this module we will be introducing to:

- The Base Station
- The Cellular System Layout
- Cellular Technologies
- Cellular System Protocol Allocations, and
- Overview of Cellular Data

Base Tower Station (BTS)

Base Station Power : 10 – 100 W



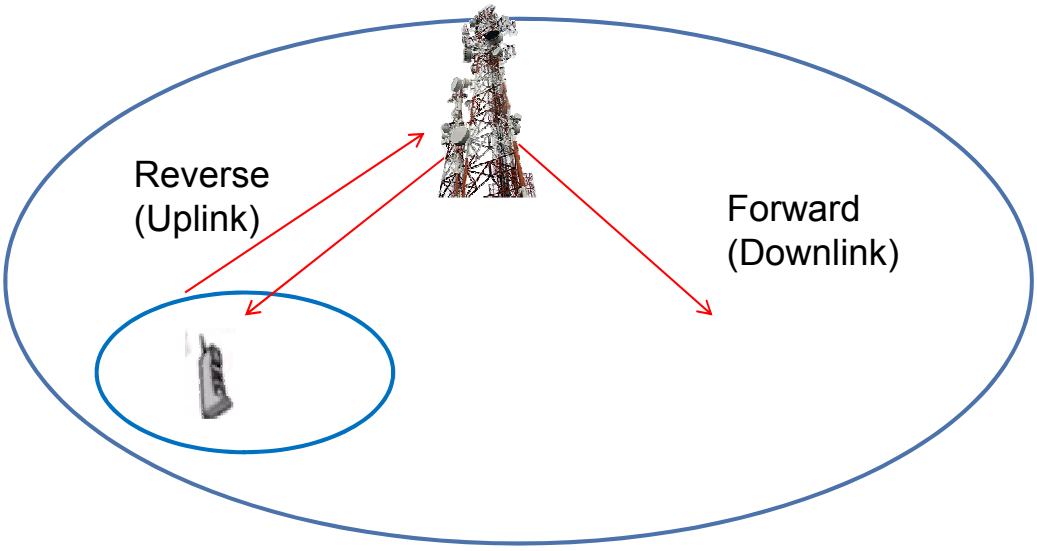
Rural 30 km

Urban 500 m

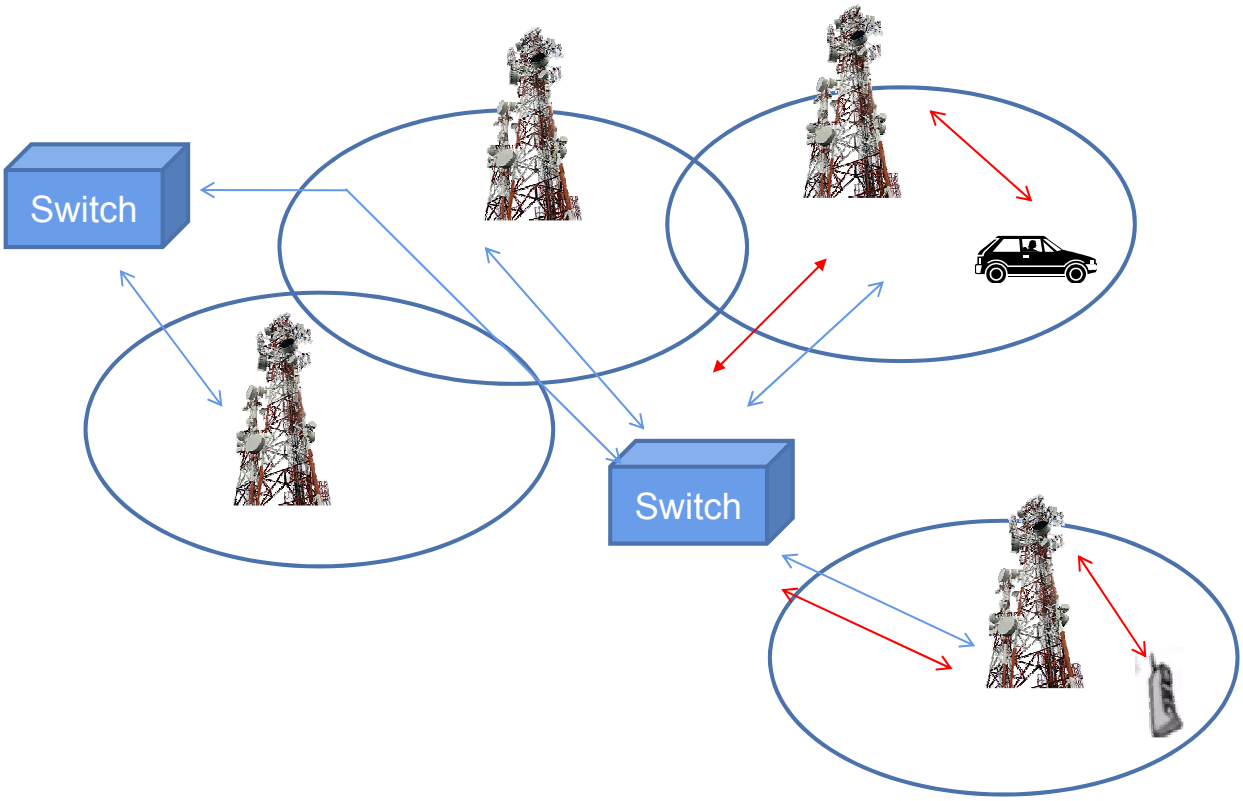
Base Tower Station (BTS)

Mobile Power =0,5 W

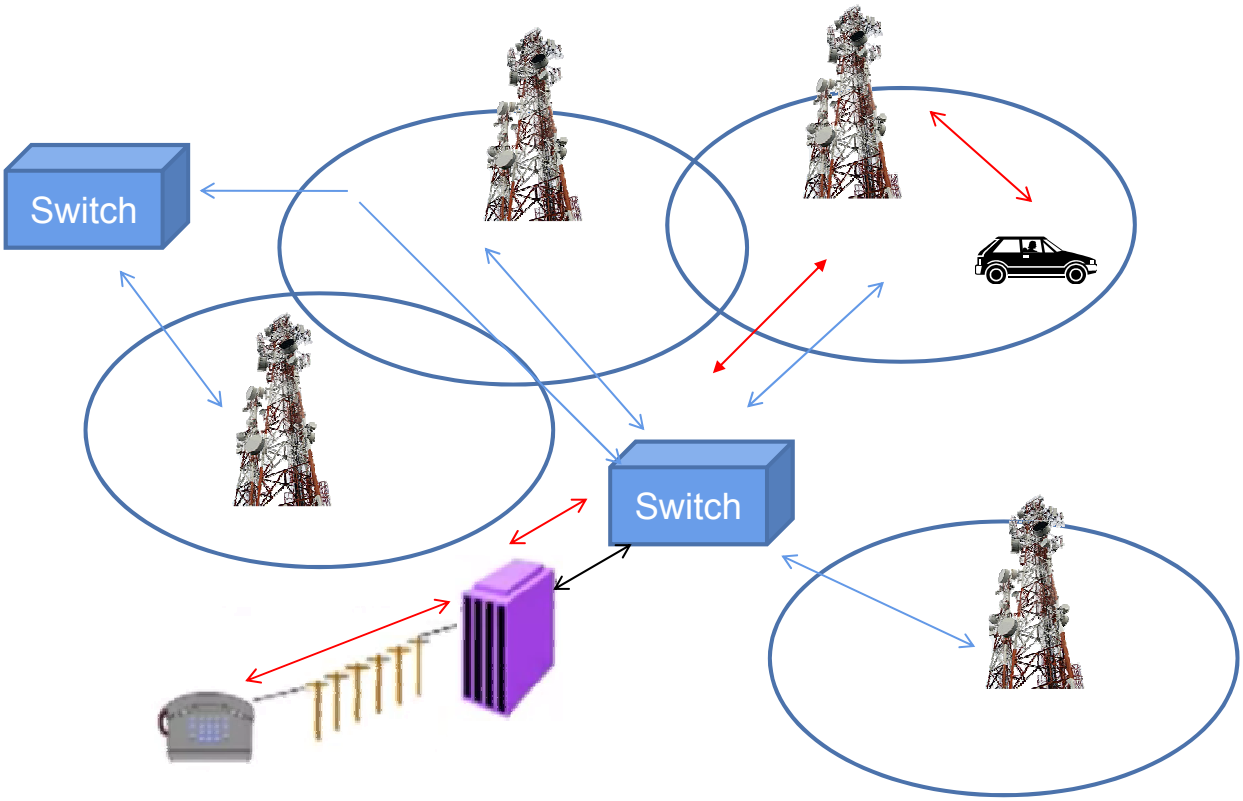
Base Station Power : 10 – 100 W



Cellular System Layout

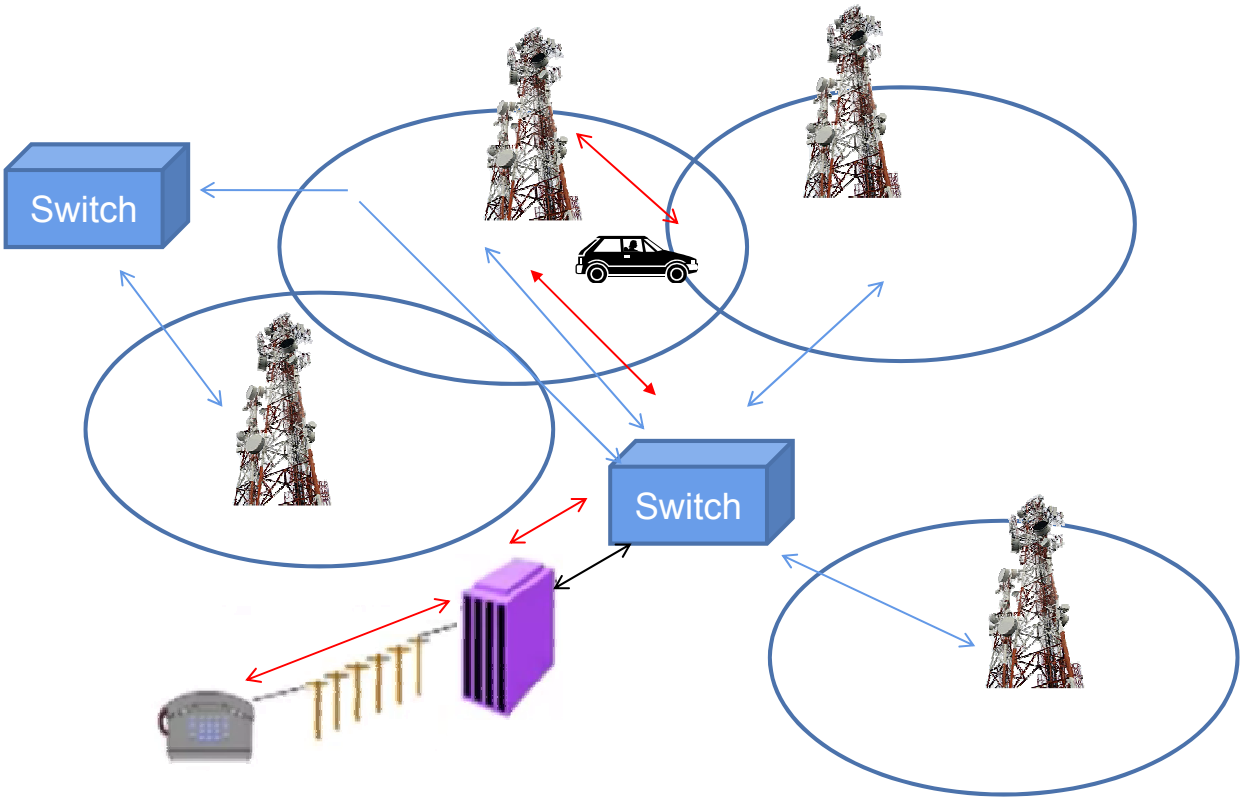


Cellular System Layout



PSTN – Telephone Exchange

Cellular System Layout

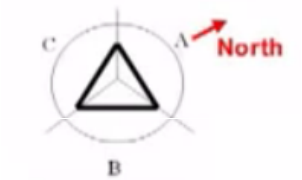


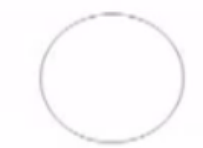
PSTN – Telephone Exchange

Celluar Tower Configurations

3 sector (120 degree)

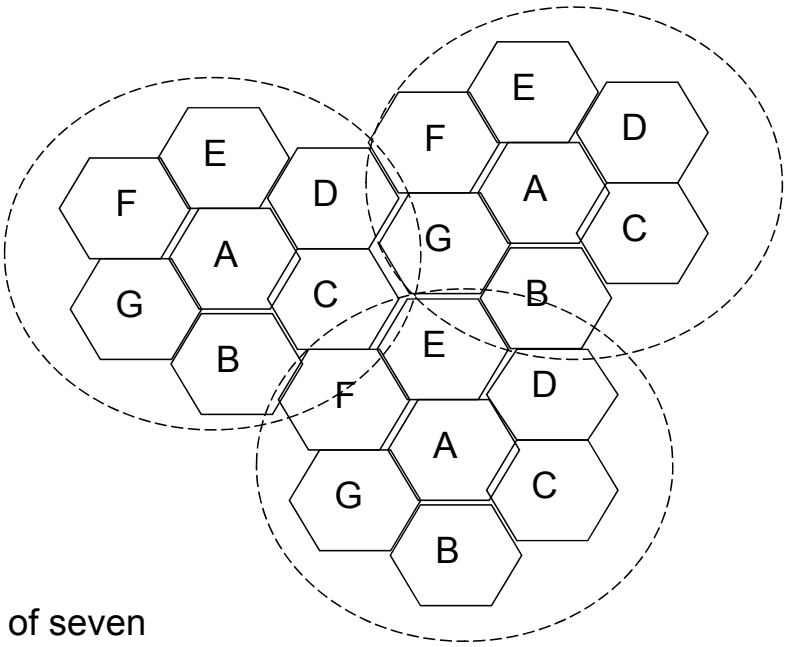
6 sector (50 degree)





Omni (360 degree)

Cell Design



•Cells grouped into a cluster of seven
•Letters indicate frequency use
•For each frequency, a buffer of two cells is used before reuse
•To add more users, smaller cells (microcells) are used
•Frequencies may not need to be different in CDMA (soft handoff)

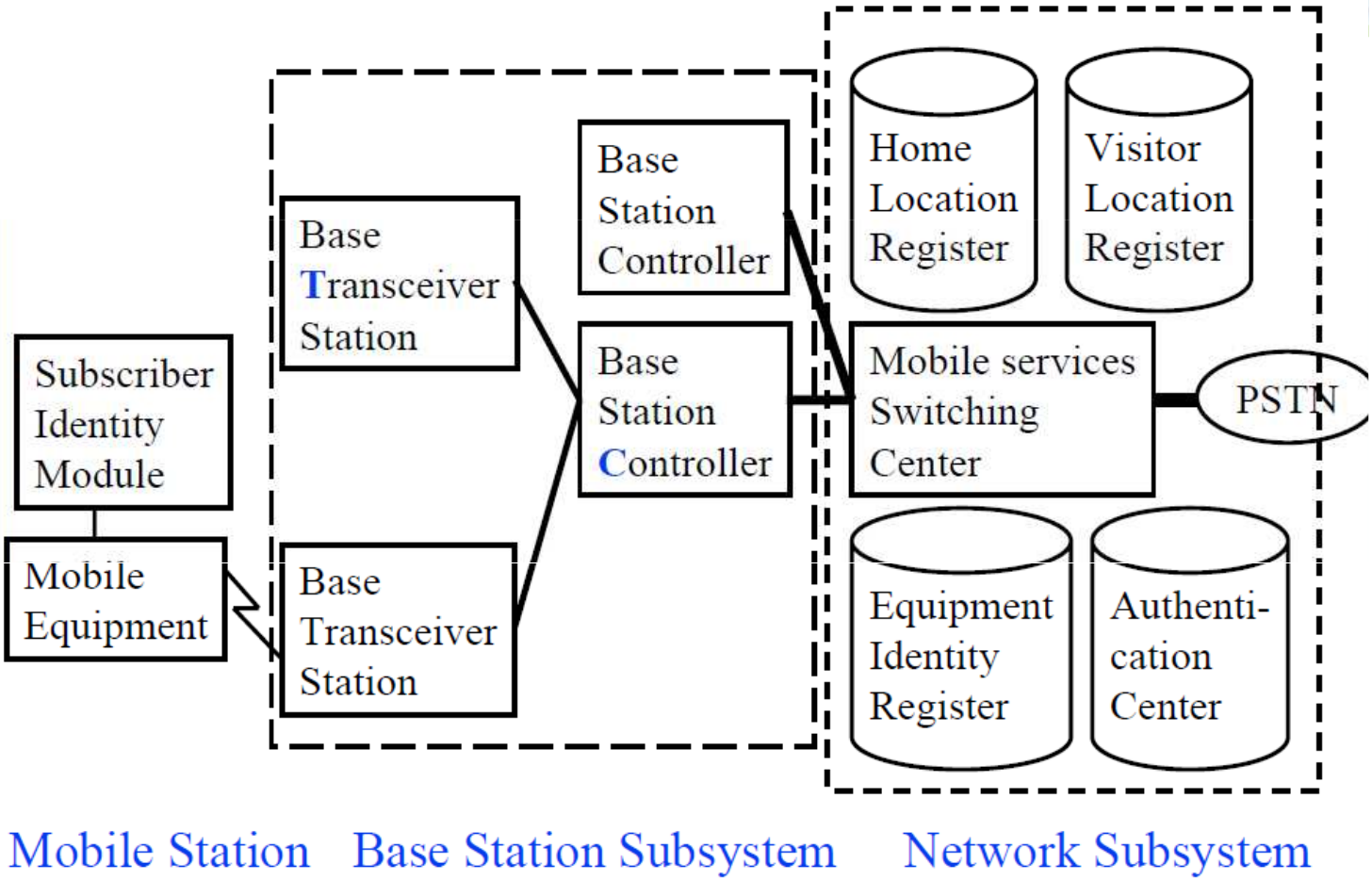
Cellular Network Organization

- Cell design (around 10 mile radius)
  - Served by base station consisting of transmitter, receiver, and control unit
  - Base station (BS) antenna is placed in high places (churches, high rise buildings) -
    - Operators pay around $500 per month for BS
  - 10 to 50 frequencies assigned to each cell
  - Cells set up such that antennas of all neighbors are equidistant (hexagonal pattern)
- In North America, two 25-MHz bands allocated to AMPS
  - One for transmission from base to mobile unit
  - One for transmission from mobile unit to base

Approaches to Increase Capacity

- Adding/reassigning channels - some channels are not used
- Frequency borrowing – frequencies are taken from adjacent cells by congested cells
- Cell splitting – cells in areas of high usage can be split into smaller cells
- Microcells – antennas move to buildings, hills, and lamp posts

Cellular Architecture

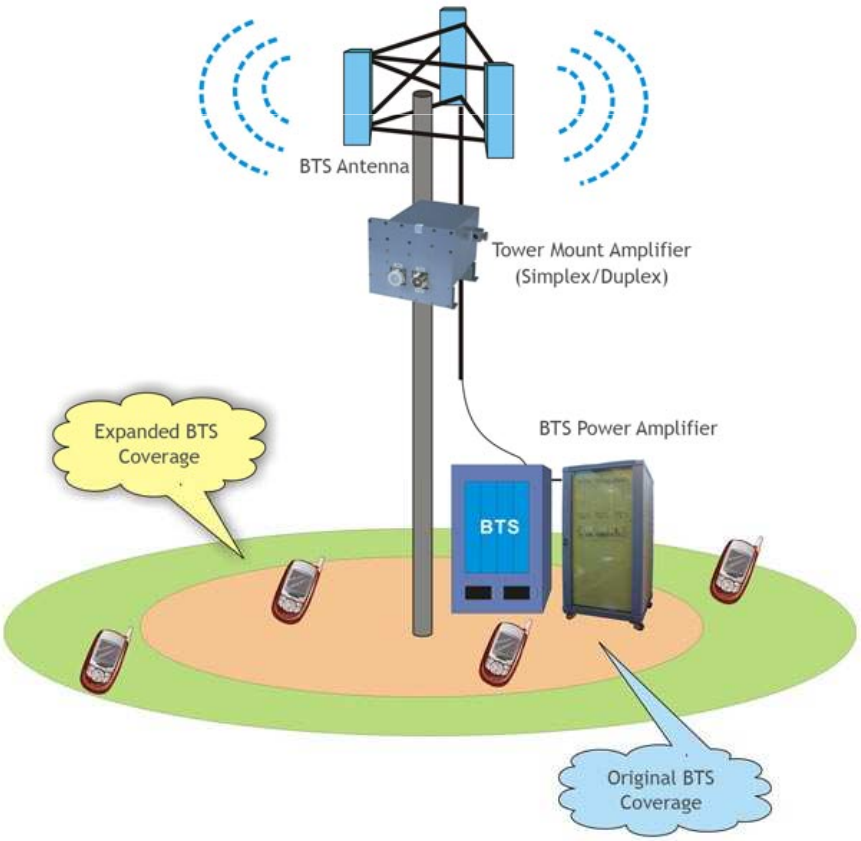


Cellular Architecture (Cont)

- Home Location Register (HLR) and Visitor Location Register (VLR) provide call routing and roaming
- VLR+HLR+MSC functions are generally in one equipment
- Equipment Identity Register (EIR) contains a list of all valid mobiles.
- Authentication Center (AuC) stores the secret keys of all SIM cards.
- Each handset has a International Mobile Equipment Identity (IMEI) number.

Cellular Architecture (Cont)

- Base station controller (BSC) and Base transceiver station (BTS)
- One BTS per cell.
- One BSC can control multiple BTS.
  - Allocates radio channels among BTSs.
  - Manages call handoffs between BTSs.
  - Controls handset power levels
- Mobile Switching Center (MSC) connects to PSTN and switches calls between BSCs. Provides mobile registration, location, authentication. Contains Equipment Identity Register.



Mobile Station and Base Station Subsystem (BSS)

Mobile station

- Mobile station communicates across Um interface (air interface) with base station transceiver in same cell as mobile unit
- Mobile equipment (ME) – physical terminal, such as a telephone or PCS
  - ME includes radio transceiver, digital signal processors and subscriber identity module (SIM)
- GSM subscriber units are generic until SIM is inserted
  - SIMs roam, not necessarily the subscriber devices

BSS

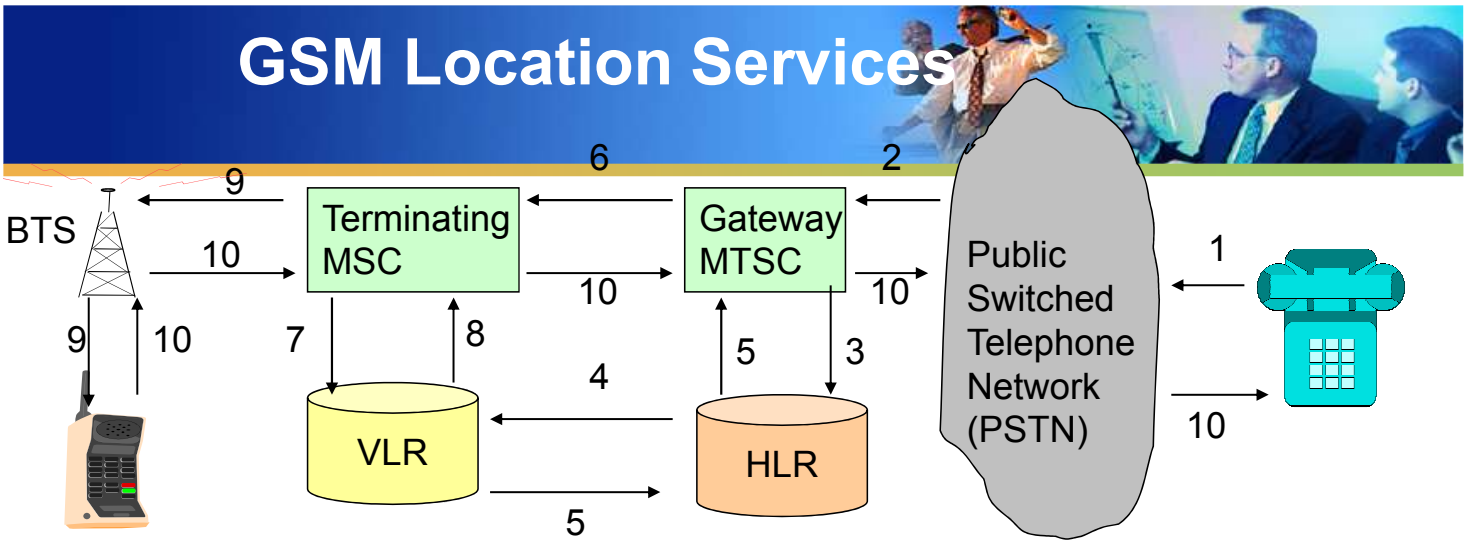
- BSS consists of base station controller and one or more base transceiver stations (BTS)
- BSC reserves radio frequencies, manages handoff of mobile unit from one cell to another within BSS, and controls paging

Network Subsystem Center

Mobile Switching Center (MSC) is at core; consists of several databases

- Home location register (HLR) database – stores information about each subscriber that belongs to it
- Visitor location register (VLR) database – maintains information about subscribers currently physically in the region
- Authentication center database (AuC) – used for authentication activities, holds encryption keys
- Equipment identity register database (EIR) – keeps track of the type of equipment that exists at the mobile station

GSM Location Services



1. Call made to mobile unit (cellular phone)
2. Telephone network recognizes number and gives to gateway MSC
3. MSC can't route further, interrogates user's HLR
4. Interrogates VLR currently serving user (roaming number request)
5. Routing number returned to HLR and then to gateway MSC
6. Call routed to terminating MSC
7. MSC asks VLR to correlate call to the subscriber
8. VLR complies
9. Mobile unit is paged
10. Mobile unit responds, MSCs convey information back to telephone

Legend: MTSC= Mobile Telephone Service Center, BTS = Base Transceiver Statior
HLR=Home Location Register, VLR=Visiting Location Register

Functions Provided by Protocols

- Protocols above the link layer of the GSM signaling protocol architecture provide specific functions:
  - Radio resource management: controls setup, termination and handoffs of radio channels
  - Mobility management: location and security (MTSO)
  - Connection management: connects end users
  - Mobile application part (MAP): between HLR,VLR
  - BTS management: management base system