# 2. Services and Operations

## 2.1 Introduction

This section covers some of the main services and operations within the GSM network. Areas covered include:

- Subscriber services offered by GSM
- Network areas
- Roaming
- Activities and operations in the network

# 2.2 GSM Subscriber Services



## GSM Subscriber Services

- Two types of basic service can be offered to the end user:
  - Teleservices - service completely defined including terminal equipment functions - telephony and various data services
  - Bearer services - basic data transmission capabilities - protocols and functions not defined
- There are also supplementary services which support and complement both the telephony and data services

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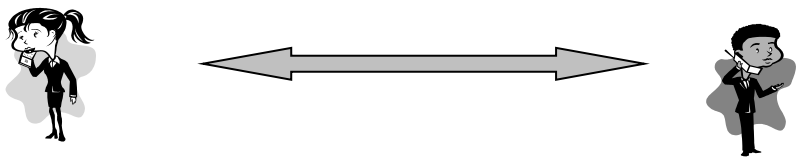
## Telephony Services

- Two types of telephony:
  - Basic speech telephony
  - Emergency calls
- Speech Telephony:
  - Transmission of speech information and fixed network signalling tones
  - Transmission can be mobile originated as well as mobile terminated



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# Emergency Calls

- Provides standard access to the emergency services irrespective of the country in which the call is made
- Mandatory in GSM networks
- May be initiated from a mobile without a SIM
- Emergency calls can override any locked state the phone may be in
- Uses a standard access to the emergency call (112) as well as the national emergency call code
- If the national emergency code is used the SIM must be present

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# Other Teleservices

Some services supported by GSM:

- DTMF - Dual Tone Multi-Frequency - used for control purposes - remote control of answering machine, selection of options
- FAX - GSM connected fax can communicate with analog machines
- SMS - short message service - Text
- Cell Broadcast - short text messages sent by the operator to all users in an area, e.g. to warn of road traffic problems, accidents
- Voice Mail - answering machine in the network, controlled by subscriber
- Fax Mail - fax messages stored - subscriber can direct message to any fax machine by using a security code

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# GSM Bearer Services

- Some data transfer bearer services offered by GSM are:
  - Asynchronous data
  - Synchronous data
  - Packet switched assembler/disassembler access
  - Alternate speech and data

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# Supplementary Services

Additional support services include:

- Call forwarding - forward incoming calls to another number
- Bar outgoing calls
- Bar incoming calls - all calls, calls when roaming outside home PLMN
- Advice of charge - estimates of billing data
- Call hold - interrupting a call - normal telephony only
- Call waiting - notification of new incoming call during another call
- Multi-party service - simultaneous conversation between 3 - 6 subscribers
- Calling line identification - presentation of callers ISDN number - caller can override this
- Closed user groups - group of users who can only call each other and certain specified numbers

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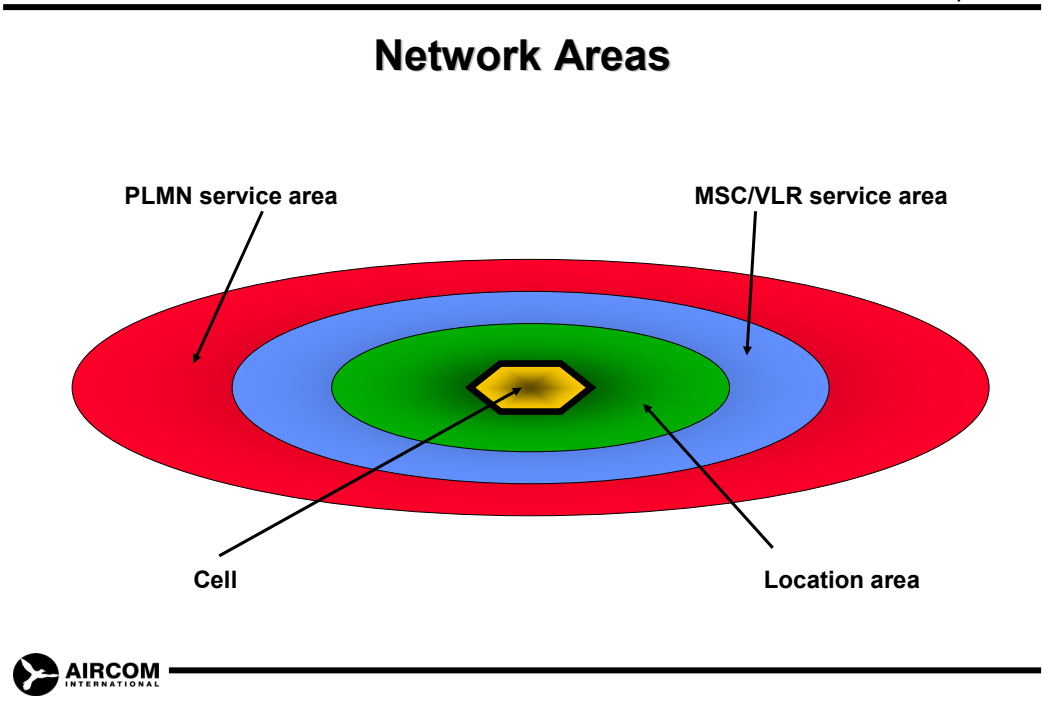
## 2.3 Network Areas






Notice that a location area may involve more than one BSC.

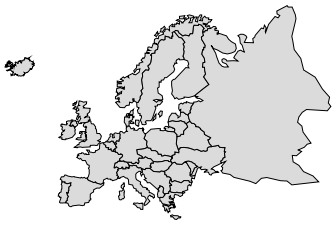
A subscriber outside of their PLMN may access their normal service with a roaming agreement.

# 2.4 Roaming



## Roaming

- Allows subscriber to travel to different network areas, different operator's networks, different countries - keeping the services and features they use at home
- Billing is done through home network operator, who pays any other serving operator involved
- Requires agreements between operators on charge rates, methods of payments etc.



- Clearing house companies carry out data validation on roamer data records, billing of home network operators and allocation of payments

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# 2.5 Activities and Operations

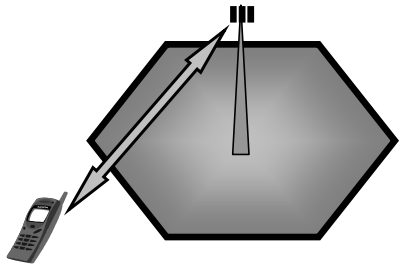


## Activities and Operations

- Main activities which the network must carry out are:
  - Switching mobile on (IMSI attach)
  - Switching mobile off (IMSI detach)
  - Location updating

  } Mobility Management

  - Making a call (mobile originated)
  - Receiving a call (mobile terminated)
  - Cell measurements and handover



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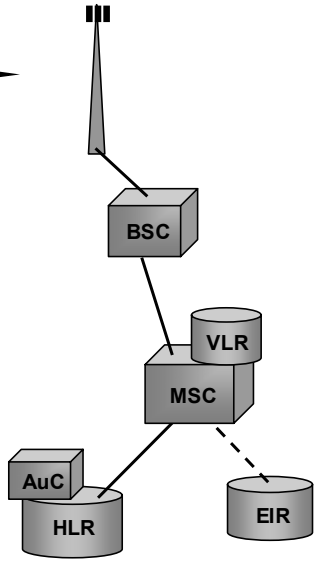
Mobility Management refers to the way in which the network keeps track of a mobile in idle mode, so that it can be located when there is an incoming call (mobile terminated).



## IMSI Attach (Switch on)

- Mobile camps on to best serving BTS
- Mobile sends IMSI to MSC
- MSC/VLR is updated in HLR
- Subscriber data including current location area is added to local VLR
- MSC and HLR carry out authentication check - challenge and response using $K_i$
- Optionally EIR checks for status of mobile (white/grey/black)

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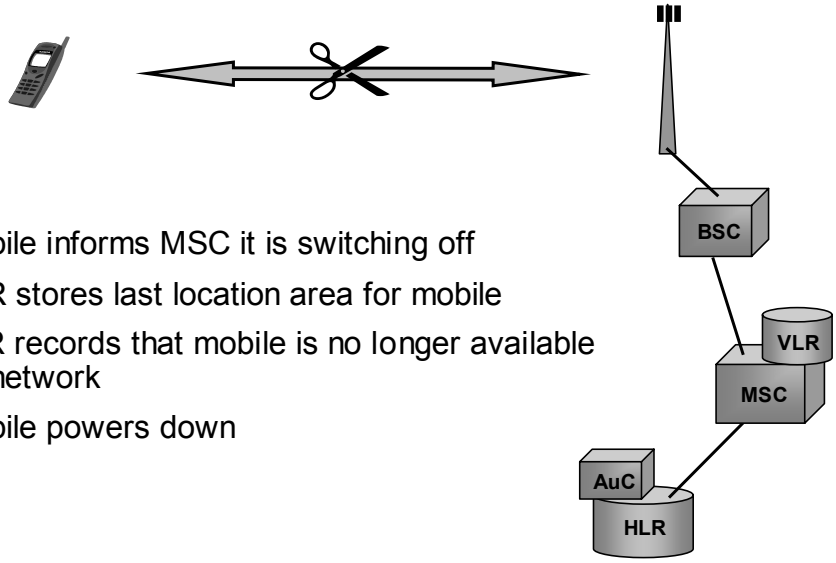
The process of camping on to the best BTS is cell selection which involves calculating a parameter C1 for each cell. Subsequent re-selections are based on a second parameter, C2. This is covered in detail in course G103.



## IMSI Detach (Switch off)




- Mobile informs MSC it is switching off
- HLR stores last location area for mobile
- VLR records that mobile is no longer available on network
- Mobile powers down

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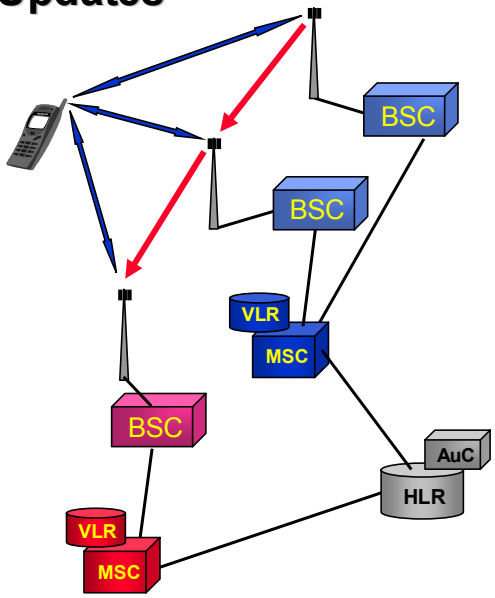
If the mobile is not powered down correctly, the network will lose track of it. Periodic Location Updates may be carried out to check the mobile is still in the network.



## Location Updates




- Automatic Location Update - when mobile moves to new location area
- Periodic Location Update - checks that mobile is still attached to network
- Updates location area in VLR
- If move is to a new MSC/ VLR then HLR is informed

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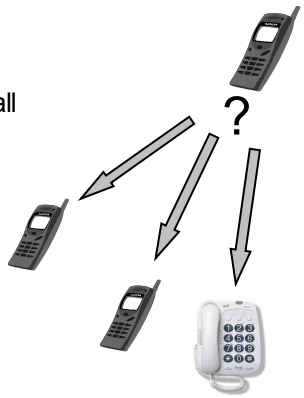
## Mobile Originated Call

- When the mobile requests access to the network to make a call:
- BSS determines the nature of the call - e.g. regular voice call, emergency call, supplementary service
  - Allocates radio resources to the mobile for the call
- NSS determines the destination of the call:
  - Mobile to mobile on same PLMN
  - Mobile to mobile on another PLMN
  - Mobile to fixed network (PSTN, ISDN)
  - MSC / GMSC routes the call appropriately and handles signalling

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If the call is for another network, the originating MSC will route it to the gateway (GMSC) where it will be passed to the other network's gateway.

For calls within the home network, the VLR and possibly the HLR must be interrogated to find the current location of the recipient. See the activity at the end of this section for more details.



## Mobile Terminated Call

- A telephone user (within the mobile network or outside) tries to call a mobile subscriber - dials MS ISDN for subscriber
- For external caller:
  - ISDN routes call to GMSC
  - Current VLR is found from HLR
  - Mobile Subscriber Roaming Number sent to GMSC
  - GMSC routes call to correct MSC/VLR
- For internal caller: HLR supplies current MSC/VLR
- VLR supplies current location area
- BSS pages mobile within location area
- Mobile responds and radio resources are allocated by BSS

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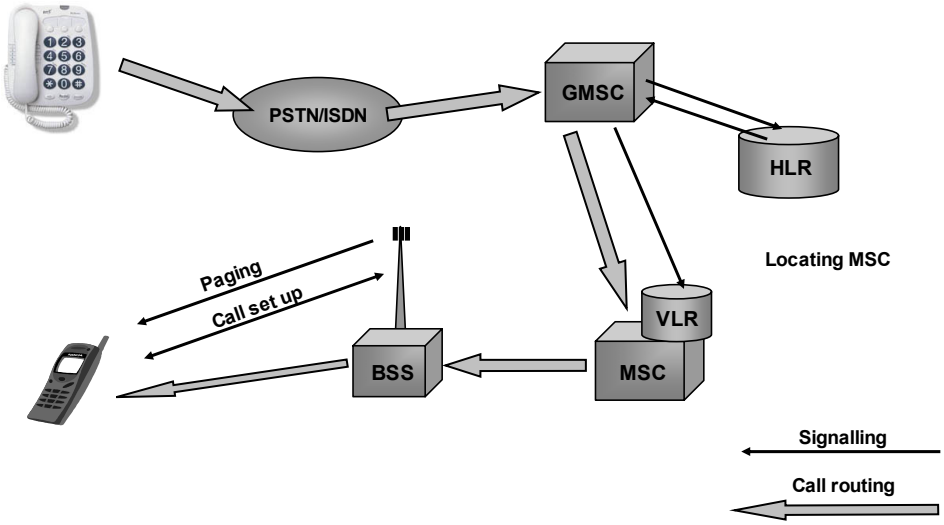
The HLR stores location information only to the level of the MSC/VLR of the subscriber.

Their VLR stores the Location Area within that MSC/VLR.



## Routing of External Call

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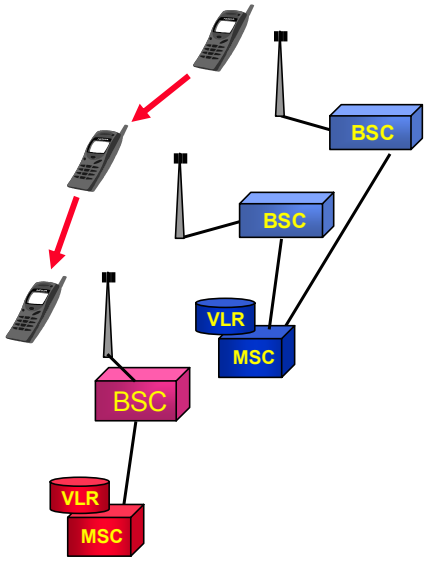
## Cell Measurements and Handover

- As mobile moves around it monitors signal strength and quality from up to 6 neighbour cells
- BSS determines when handover should occur, based on cell measurements and traffic loading on neighbour cells
- Handover may be to:
  - another channel in the same cell
  - new cell, same BSC
  - new cell, new BSC
  - new cell, new MSC/VLR
- GSM handover is 'hard' - mobile only communicates with one cell at a time

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The mobile remains under the control of the originating MSC throughout subsequent handovers.

Example of an Inter – MSC handover:

The call starts with MSC A and is handed over to MSC B. As the call continues it is necessary to handover to MSC C.

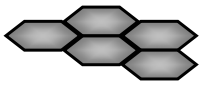
To do this, the call is first handed back to MSC A, which then hands it over to MSC C.

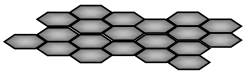
Intra-cell handovers (within the same cell) may occur if there is interference on a particular physical channel.



## Summary

- Subscriber services offered by GSM:
  tele-services (voice), bearer services (data), supplementary services
- Network areas: PLMN, MSN, LA, Cell
- Roaming: billing arrangements, clearing houses
- Activities and operations on the network:
  IMSI attach / detach, location updating,
  Calls: mobile originated / mobile terminated
  Cell measurements, handover





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# Section 2 Self-Assessment Exercises

## Exercise 2.1 – Mobile-Originated Calls

The following exercise re-visits the situation of a mobile originated call. You will need to consider how the network determines the location of the recipient in order to route the call correctly.

### Mobile Originated Calls

A subscriber is trying to call another user of the same network.

The other user may be in the same MSC as the caller (Location Area 1) or a different MSC (Location Area 2).

Add notes and arrows to the diagram below to show the call routing and signalling required to locate the user and set up the call