

9 Location Updating

Objectives

After this chapter the student will:

- be able to define the concepts of roaming and location updating.
- be able to name the different types of location updating and why they are used.

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9.1 Introduction

When the MS is in idle mode it is said to be “Roaming”. When roaming, the MS is able to make and receive calls and use other services of the network. In idle mode the MS decides itself which BTS to listen to. The MS always searches for the best C_0 and selects that carrier. The C_0 is the carrier, in each BTS, where the broadcast information, BCCH, is found. The cell with the selected C_0 is called “serving cell”. On the C_0 in the serving cell the MS will get the “system information” on the BCCH. The system information includes among other information, which neighbour C_0 to listen to. When a neighbour C_0 becomes better, the MS chooses that cell as the serving cell.

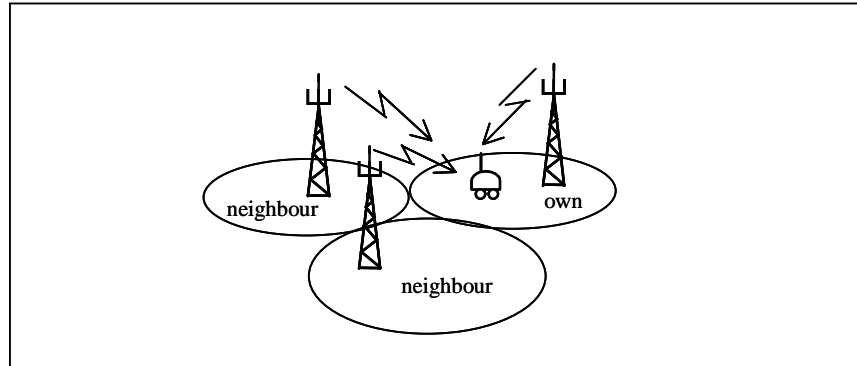
The MS always has to inform the system in which LA (Location Area) it is present. That is done with the procedure “Location Updating”. By location updating the MS updates its position in the VLR, which stores the LAI (Location Area Identity). In a LA a subscriber can be paged on incoming calls and other services. Due to the paging procedure, it is mandatory for the MS to register when entering a cell belonging to a new LA. A paging message will be sent in all cells, belonging to the LA, where the MS last registered. The operator can also request the location updating when the MS powers on as well as with a certain periodicity. The operator controls this by setting parameters in the system information sent on the BCCH on the C_0 .

9.2 Roaming

The first time the MS is powered on, it starts to listen to the system. It scans the frequency band for the strongest carriers. Among the ones strong enough, the MS makes a random choice and tries to detect the FCCH (Frequency Correction CHannel) of that one. The main purpose of FCCH, which provides a pure sine wave, is orientation. If the FCCH is found, the MS knows that this is a C_0 where also the BCCH (Broadcast Control CHannel) is found. Once the FCCH is found the MS must synchronise with the TDMA structure of this BTS to be able to find the BCCH. The current TDMA frame number is sent on the SCH (Synchronisation Channel).

On the BCCH the MS will get the important “System Information”. It informs the MS if this is the correct network for the MS to listen to and if the cell is allowed for the MS to choose. If that is the case the MS will continue to listen to get more information. The MS will carry out a Location Updating procedure if necessary. On the BCCH the MS will receive a list of C_0 of neighbour base stations to monitor. The MS will also monitor the PCH for paging messages.

The MS will measure the signal strength of the BTS in the cell where it is located, as well as those of the neighbouring cells. Based on these measurements, and on cell selection parameters in the system information, the MS makes decisions about which cell is the best.



Roaming MS

If a neighbouring cell is considered better, the MS will change to that cell. This means tuning in to another C_0 and monitoring the neighbours of that new cell. The changing of cell, in idle mode is called "Roaming". While roaming within an LA the MS does not need to inform the system about which specific cell it belongs to. A LA is the smallest area where an MS can be paged so it does not matter where in the LA the MS is located.

9.3 Location Updating

There exist three different reasons for the MS to start the Location Updating procedure. Type "normal" is required when the MS change LA. It is mandatory since it is essential for system to know where to page the MS. Type "IMSI attach" can be required when the MS is powered on or the SIM card is put in. Type "periodic" can be used to inform the system that the MS is still attached. Type IMSI attach and type periodic are set by parameters. The operator sets the parameters in the system information on the BCCH and the MS will read and apply them.

All the types are handled by the same Location Updating procedure. The operator can, however, choose which security procedures, e.g. authentication and ciphering, to go through before accepting the registration. The choice might be different depending on the type of location updating.

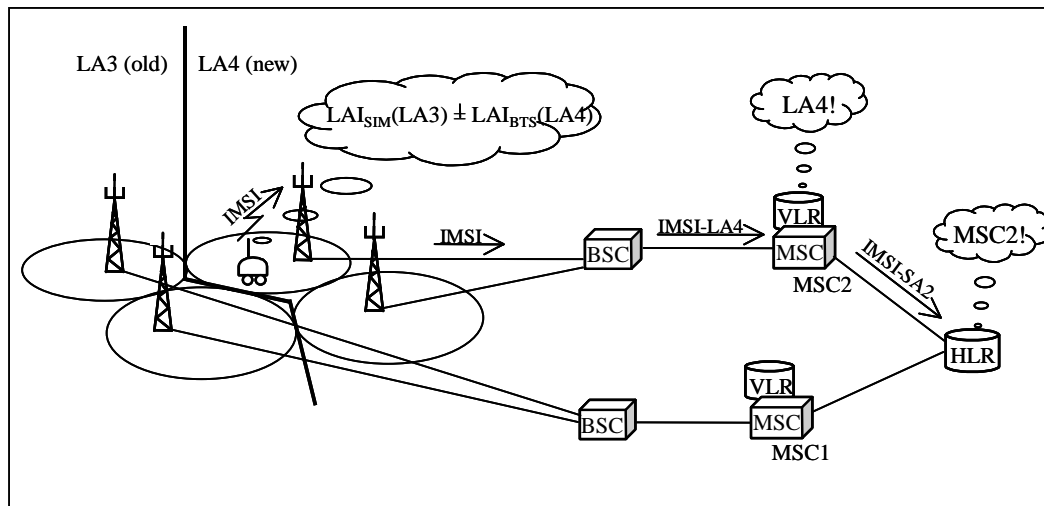
Type Normal

The Location Updating, type “normal” is initiated when the MS detects a change of location area. As soon as the MS changes to a new cell it compares the LAI (Location Area Identity) sent on the BCCH with the one stored on the SIM-card. If the two differ the MS is forced to register and inform the system. This is to ensure that the information in the VLR is valid so that the MS will be paged in the correct location area.

To perform the registration the MS needs a signalling channel. The MS sends a “channel request” on RACH and receives information about an assigned channel combination (SDCCH and SACCH) on AGCH. The channels have been allocated by the BSC, which also has activated the channels in the BTS. The SDCCH will be used for the signalling between the MS and the MSC/VLR. The SACCH will be used for system information from the system to the MS and for measurement reports from the MS to the system.

The MS now leaves idle mode for a while and goes to the assigned SDCCH where it sends a location updating request to the MSC/VLR. It identifies itself with either TMSI or IMSI. The security procedures, i.e. authentication, start ciphering, identification and new TMSI, is now carried out. The operator has defined which of them the MSC/VLR shall carry out for this type of location updating. After a successful security check the location updating is accepted and the new LAI is stored on the SIM card. New information is also stored in the VLR, along with other specific information about the subscription, fetched from the HLR. The MSC/VLR will then initiate the release of the channel and the MS will return to idle mode procedures, measuring and evaluating BTSs.

The MS is now registered and considered "attached" to the system. This means that the MS is ready to make and receive calls in this new LA. It will now start to listen to paging messages.



MS performs Location Updating

Type IMSI attach

If the MS is turned off or the SIM card is taken out it will, before powering down, request an SDCCH on which it sends "IMSI detach". This is to inform the network that the MS is no longer reachable. This will be marked in the VLR by setting a flag but the rest of the information about the specific MS will be unchanged. When the MS is powered on again or the SIM is inserted, still in the same location area (i.e. the LAI stored on the SIM-card), the MS will perform a location updating, type "IMSI attach".

It is operator dependent if it shall be required by the MS to make location updating type "IMSI attach". In a cell covering e.g. an ice hockey stadium type "IMSI attach" might not be required. It may download the system too much when the mobile owners, during a brake, turn on their mobiles almost at the same time. Not using location updating type IMSI attach can in itself be a problem. Possible solutions will not be discussed here.

Type Periodic Registration

The "IMSI detach" message is not acknowledged by the system! If this message is lost or if the MS was out of coverage when trying to send it, the network will still consider the MS attached. Subsequently the system will try to page the MS on incoming calls. To avoid this unnecessary paging, the MS may be asked to perform a location updating "type periodic registration". This means that the MS must register periodically. If it does not, the detach-flag will be set in the VLR. The interval between the registrations is determined by a parameter set by the operator and sent to the MS on the BCCH. The parameter could be set in the interval 1-255 decihours (6 min- 25.5 h).

