

Location Update (GSM Location Update Procedure)										
Highway		Virginia			GSM	Maryland			EventHelix.com/EventStudio 2.5	
GSM Mobiles		Virginia Location Area	Virginia GSM Equipment		GSM Databases	Maryland Location Area		Maryland GSM Equipment		
Other GSM Mobile	GSM Mobile	Vienna Cell	Virginia BSC	Virginia MSC VLR	HLR	Rockville Cell	Bethesda Cell	Maryland MSC VLR	31-Aug-04 22:04 (Page 1)	

Have you ever wondered how your cellular provider is able to route calls to you virtually anywhere? How does the cellular provider know where you are?

The short answer to these questions is that your cell phone keeps the cellular operator informed about your location. This sequence diagram we will examine how a mobile phones keep selecting the best cell to service your call and also keeps the cellular provider informed about your location.

We will be tracing the journey of a mobile phone from Rockville, Maryland to Vienna, Virginia. The path taken by the mobile phone is described in the following article:

http://www.EventHelix.com/RealtimeMantra/Telecom/GSM_network_example.htm

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Before we go any further, let us discuss a few important terms.

Location Area (LA)

A GSM network is divided into cells. A group of cells is considered a location area. A mobile phone in motion keeps the network informed about changes in the location area. If the mobile moves from a cell in one location area to a cell in another location area, the mobile phone should perform a location area update to inform the network about the exact location of the mobile phone.

Home Location Register (HLR)

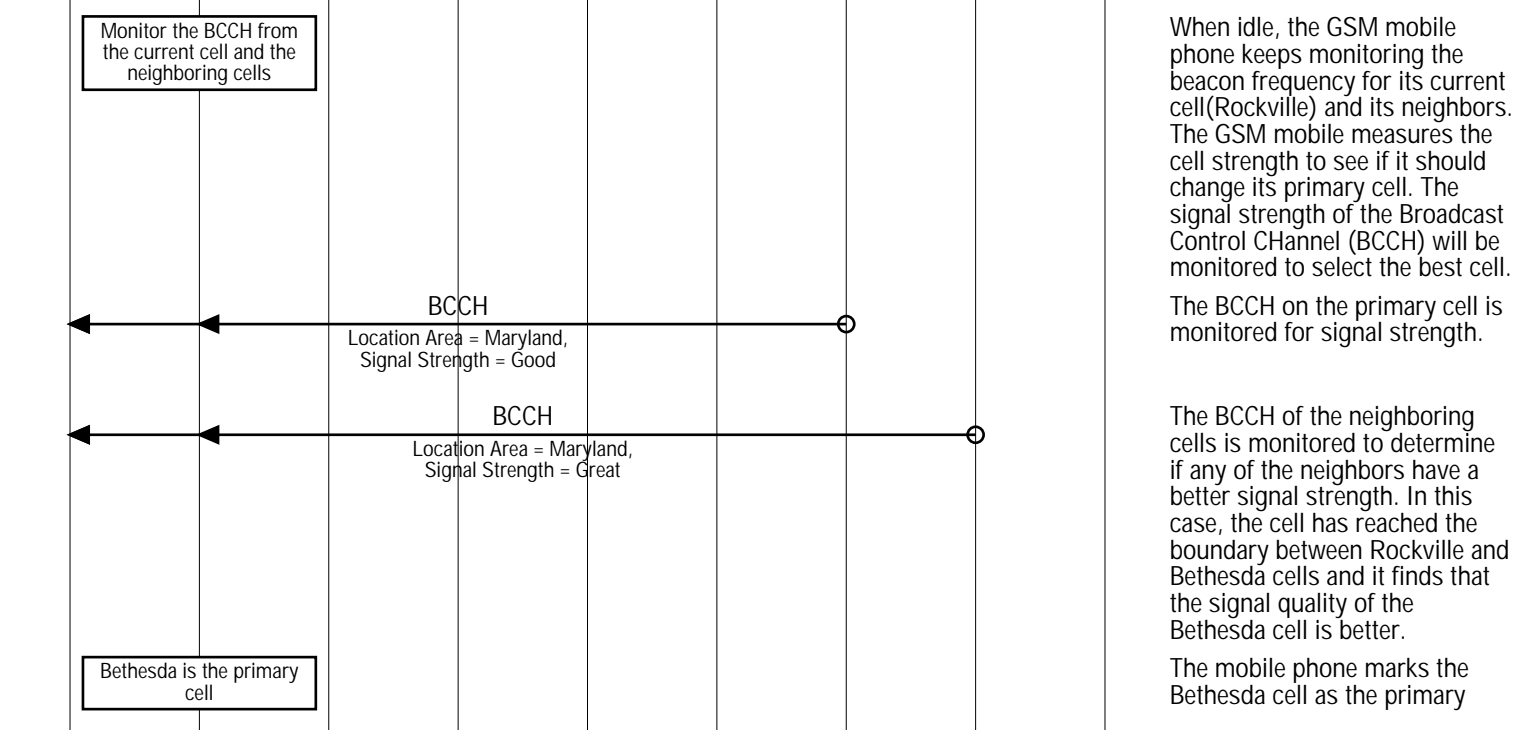
The HLR maintains a database for the mobile subscribers. At any point of time, the HLR knows the address of the MSC VLR that control the current location area of the mobile. The HLR is informed about a location area update only if the location area change has resulted in a change of the MSC VLR.

Mobile Switching Center - Visitor Location Register (MSC VLR)

The MSC VLR is responsible to switching voice calls and it also keeps track of the exact location area where the mobile user is present. Note that a typical MSC VLR will service several location areas.



GSM Mobile reaches Rockville Cell-Bethesda Cell boundary

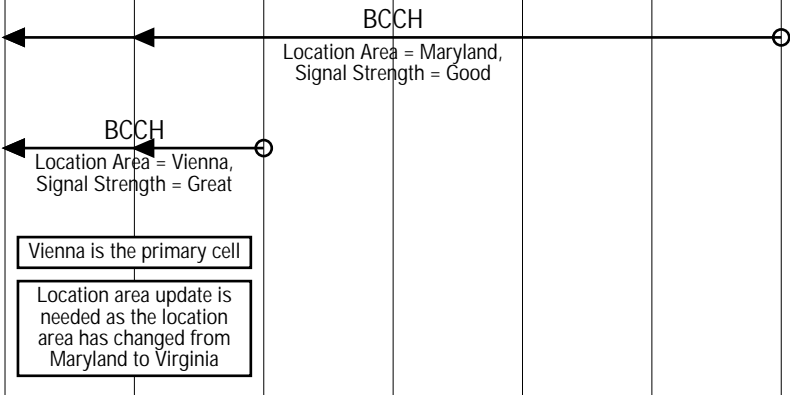


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Skip Location update as the location area for the old cell (Rockville) and the new cell (Bethesda) is the same (Maryland)

cell.
Whenever the primary cell changes, the mobile checks if the Location area of the old cell and the new cell are different. In this case, the mobile finds that the location areas are same so no location area update is needed.

GSM Mobile reaches Bethesda Cell-Vienna Cell boundary

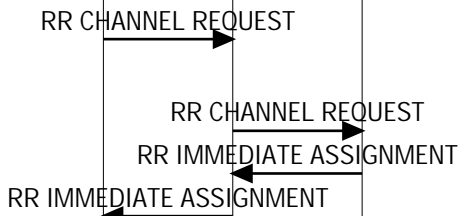


The BCCH on the beacon frequencies is monitored.

Now the Vienna cell is being received with better signal strength, so cell will be picked as primary.

This time, the old and new location areas are different. The mobile initiates the Location Area Update procedure.

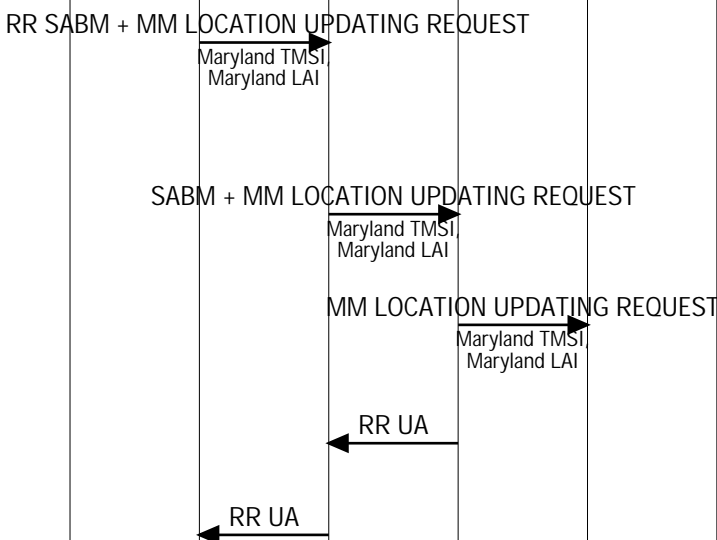
RR Connection Setup



The mobile establishes a RR connection to send the location update to the network.

A radio channel has been assigned to the GSM mobile.

GSM Location Update Procedure



The mobile tunes to the assigned radio channel and sends the SABM to initiate the radio connection. The location update is also piggybacked on the message.

The BSC receives the location update with the SABM.

The location updating request is forwarded to the MSC in the "BSSMAP COMPLETE LAYER 3 INFORMATION" message.

The RR connection setup is completed by responding with UA for the received SABM.

LEG: Inter MSC-VLR location update

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Compare the old location area with the new location area

MAP/G SEND PARAMETERS
Maryland TMSI

MAP/G SEND PARAMETERS RESULT
IMSI

MAP/D UPDATE LOCATION

Update the currently serving MSC address to the new MSC

MAP/D INSERT SUBSCRIBER DATA
Kc, RAND, SRES

Create a record for the new visiting subscriber and store the (Kc, RAND, SRES) tuples

MAP/D INSERT SUBSCRIBER DATA RESULT

MAP/D CANCEL LOCATION

Delete the record for the old subscriber.

MAP/D CANCEL LOCATION RESULT

MAP/D UPDATE LOCATION RESULT

The MSC finds that the old location area was handled by a different MSC. Thus the MSC needs to contact the HLR.

The Virginia MSC VLR does not find the TMSI in its database. It uses the old Location Area Indicator (LAI) to obtain the address of the old MSC VLR. A request is sent to the old MSC VLR, requesting the IMSI (International Mobile Subscriber Identity) of the subscriber.

The Maryland MSC VLR provides the IMSI corresponding to the TMSI. Note that the IMSI could have been obtained from the mobile. That is not a preferred option as the Location Updating Request is sent in clear so it could be used to determine the association between the IMSI and TMSI.

The MSC sends an update location message to the MSC. This message is needed for two reasons: (1) The HLR needs to update its record to point to the new MSC when queried for location. (2) The new MSC does not have information about this subscriber.

At this point, the HLR updates its records to indicate that the subscriber is now present in a location area served by the Virginia MSC VLR.

Pass information about the new subscriber to the new MSC. The message contains the a 64-bit ciphering key used as a Session Key (Kc), a 128-bit random challenge (RAND) and a 32-bit Signed Response (SRES). These parameters will be used in the authentication process.

Subscriber information is updated in the new MSC.

The new MSC replies back.

Ask the Old MSC to delete the record for this subscriber.

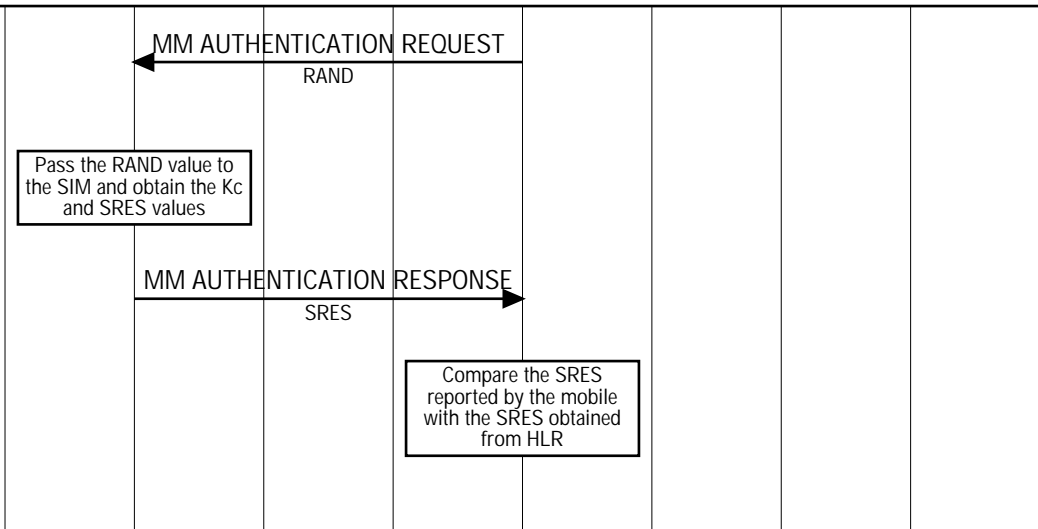
The old subscriber's record is deleted. The TMSI assigned to the mobile is also released.

The Old MSC replies back to the HLR.

The HLR has updated all records, so it replies back to the new MSC.

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Authenticate subscriber



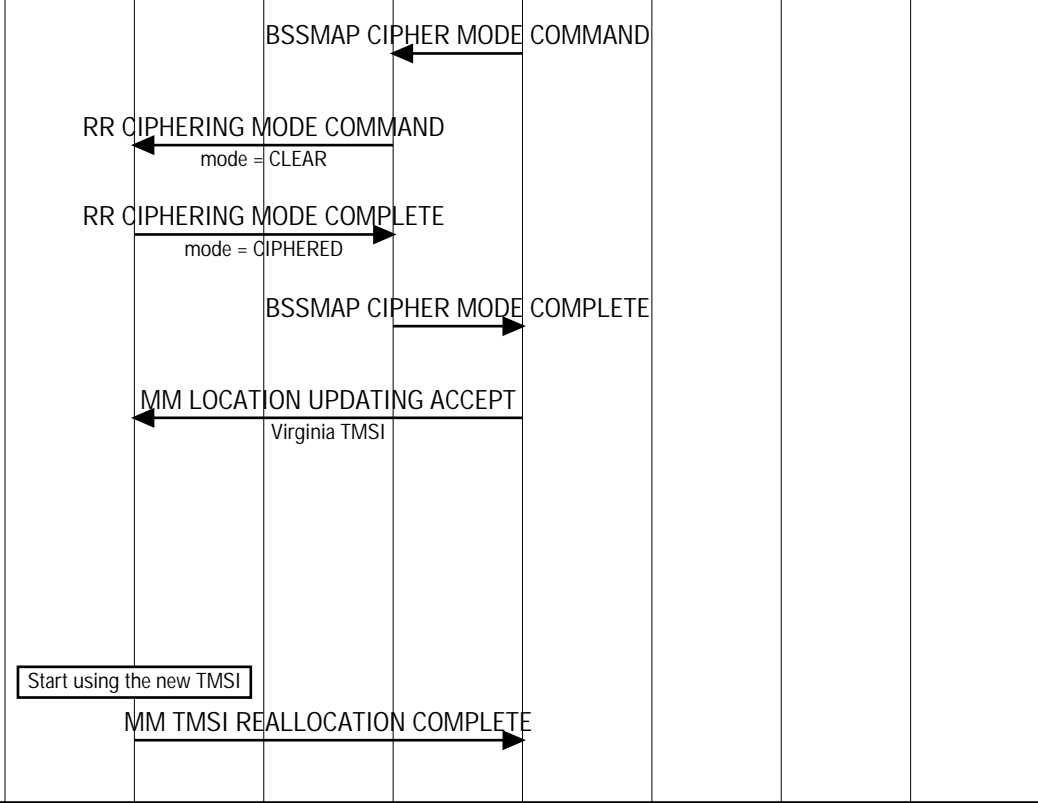
The MSC VLR decides to authenticate the subscriber. The RAND value received from the HLR is sent to the mobile.

The SIM applies secret GSM algorithms on the RAND and the secret key Ki to obtain the session key Kc and SRES.

The mobile passes the computed SRES value in the response.

If the SRES obtained from the mobile matches the SRES value obtained from the HLR, the subscriber authentication procedure completes successfully.

Enable Cipherng



The MSC initiates ciphering of the data being sent on the channel.

The BSC sends the CIPHERING MODE COMMAND to the mobile.

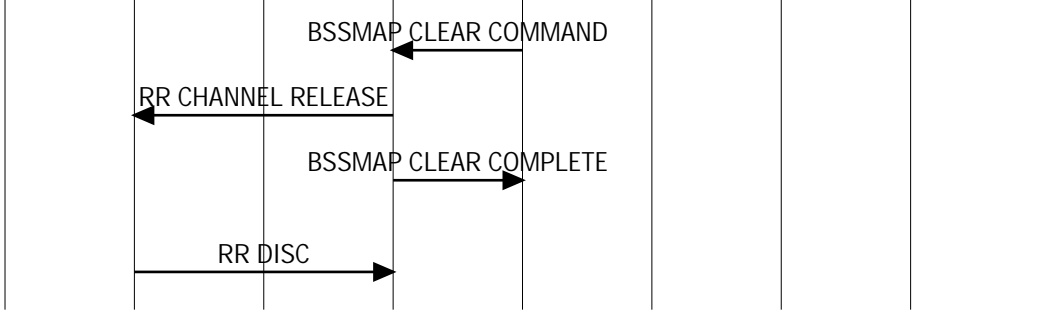
Ciphering has already been enabled, so this message is transmitted with ciphering.

The BSC replies back to the MSC, indicating that ciphering has been successfully enabled.

The new MSC replies back to the mobile via the Virginia BSC. The message also assigns a new Temporary Mobile Subscriber Id (TMSI) to the terminal. Since the TMSI assignment is being sent after ciphering is enabled, the relationship between TMSI and the subscriber cannot be obtained by unauthorized users.

The GSM mobile replies back indicating that the new TMSI allocation has been completed.

RR Connection Release



The RR connection is released by the MSC.

The BSC initiates RR release with the mobile.

The BSC informs the MSC that the RR connection has been released.

The mobile sends a disconnect message to release the LAPm

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RR UA

connection.
The BSC replies with an Unnumbered Acknowledge message.