Call Set-up and Location Updating

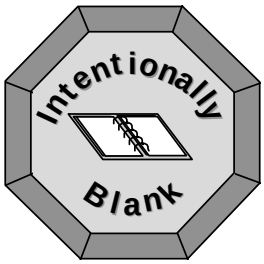
Chapter 13

This chapter is designed to provide the student with an overview of call set-up and location updating procedures.

OBJECTIVES:

Upon completion of this chapter the student will be able to:

- thoroughly describe what messages are sent on each interface and what the messages contain during call set-up.
- thoroughly describe what messages are sent on each interface and what the messages contain during location updating.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13 Call Set-up and Location Updating

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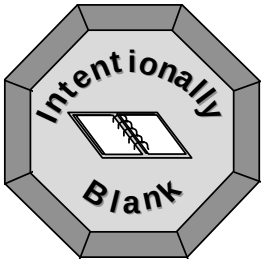
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CALL SET-UP, MOBILE TERMINATING CALL

INTRODUCTION

Call set-up within GSM consists of the following main steps:

- RR connection establishment
- Service request
- Authentication
- Ciphering mode setting
- TMSI-Reallocation
- IMEI Check
- Call initiation
- Assignment of a traffic channel
- User alerting
- Call accepted

The above steps are taken for both mobile originating and mobile terminating calls. However, for mobile terminating call they must be preceded by an interrogation phase.

INTERROGATION PHASE

When setting up a mobile terminating call an additional initial stage is required. Before a call can be routed to a mobile subscriber, the system must first find out where the subscriber is located at that moment. This is called the interrogation phase. During this phase, the GMSC interrogates the subscriber's HLR to find out where he/she is located.

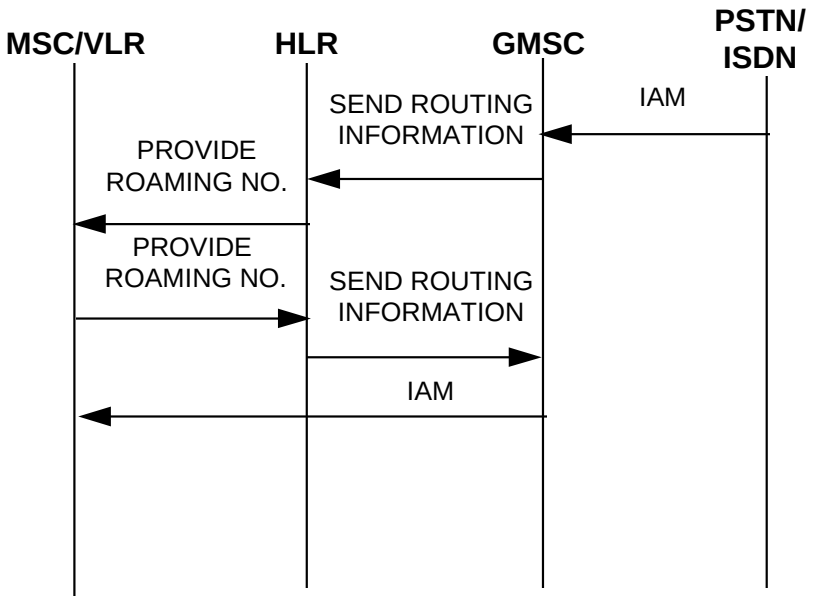


Figure 13-1 HLR interrogation.

The GMSC uses the information it receives in the Initial Address Message (IAM) from a fixed exchange to determine which HLR should be interrogated. (Part of the MSISDN is used to determine which HLR should be interrogated.)

In Ericsson's GSM system, the GMSC can contact the Flexible Numbering Register (FNR) node and the SCCP address used in the Send Routing Information will be changed from the MSISDN to MGT as defined in the FNR database. After this the request is sent further on to the HLR. This allows more flexible assignment and changes of the MSISDN numbers independent of the IMSI number of the subscriber.

In Ericsson GSM system the subscriber data can be simultaneously kept and updated in two HLRs. This feature is called HLR Redundancy and makes it possible to have a successful mobile-terminating call setup in case of HLR or signaling failure.

The contacted HLR should come back with an answer: a number that can be used to route the call from GMSC to MSC/VLR. That can either be a C-number if Call Forwarding Unconditional service is activated, or, most often, the MSRN. As the Roaming Number is not part of the information stored in the HLR, it must be retrieved from the appropriate MSC/VLR.

Call routing between the GMSC and MSC/VLR is performed using the Initial Address Message. This is one of the few possible situations in which two GSM nodes use non-GSM

specific protocols (e.g. ISUP or TUP) to communicate with each other instead of using MAP to communicate.

CALL SET-UP WITHIN GSM, OVERVIEW

After the interrogation phase the call is routed to the MSC/VLR. The rest of call set-up is performed according to the steps described earlier in this chapter. See Figure 13-2.

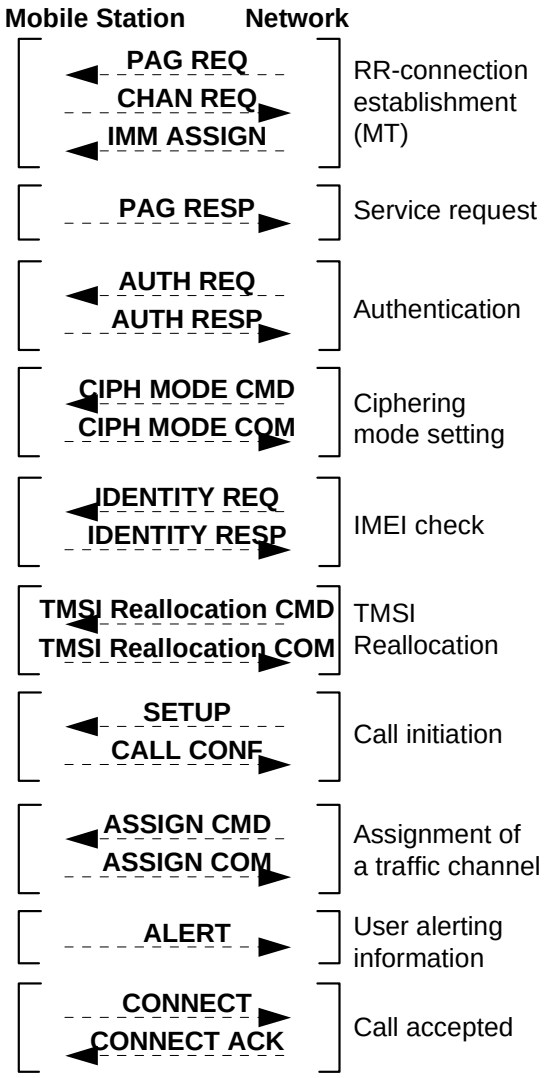


Figure 13-2 Call set-up overview, MT.

The following sections describe signaling in detail, with emphasis on the layer 3 messages.

References:

- Um L3: GSM (04.08)
- Abis L3: GSM (08.58)
- A L3: GSM (08.08)

RR CONNECTION ESTABLISHMENT

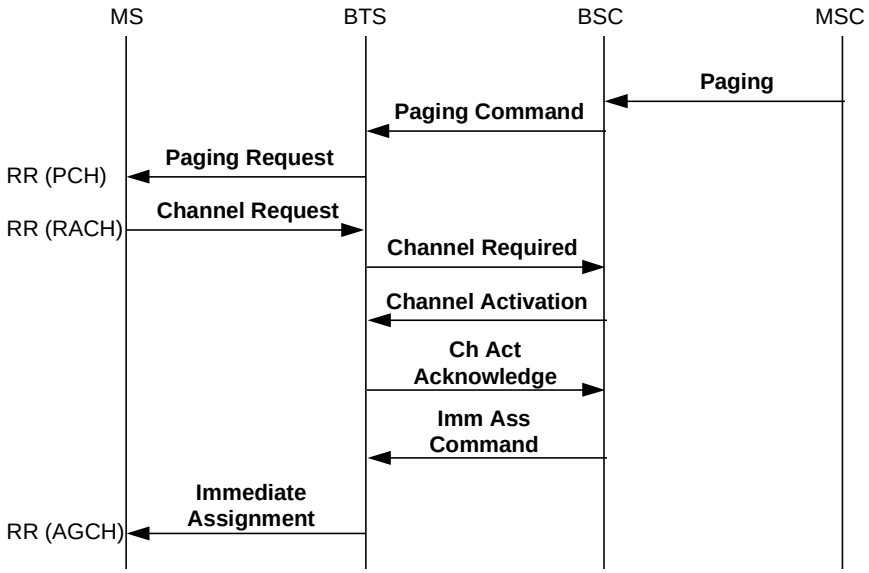


Figure 13-3 RR connection establishment.

MSC/VLR initiates the call set-up procedure by sending the Paging message to the relevant BSCs (see Figure 13-3)

The actual information contained in the Paging message depends on whether IMSI or TMSI is used in the Paging Request message. The IMSI is, however, always sent because the BSC needs the IMSI to calculate the correct paging group. The MS can be paged in all cells of a specific location area or globally in all cells in the MSC/VLR Service Area depending on how the appropriate exchange property (exchange properties are exchange parameters set by the operator) is defined in MSC. If the BSC does not have the information about which cells belong to which LAs, the MSC must provide the specific CGI. Otherwise it is enough to provide the LAI. This is the case in Ericsson's GSM system since the BSC has a conversion table to convert LAI to CGI. Note that only one MS can be paged in one message on the A-interface.

The BSC detects the Paging message and translates the LAI into a Cell Global Identity (CGI) if the cell has not been provided in the paging message. The BSC sends the Paging Command message to the relevant BTSs. This message contains the IMSI or TMSI, channel number (channel type and time slot number), and paging group. In this case, the channel type is downlink CCCH (PCH). The paging group is determined by the IMSI and two other parameters defined in BSC and broadcast as system information.

The paging group, which is described in greater detail in chapter 2 “Channel concept”, is a way to spread out the paging over a certain number of frames. When the MS receives the system information and knows its IMSI, it calculates when its paging group will occur and listens for paging only when it is expected to.

Finally, the BTS sends the Paging Request message to the MS. It is sent on the PCH, and it occupies four bursts. By using TMSI instead of IMSI, up to four MSs can be paged in one Paging message as shown in Figure 13-4.

Message	Number of mobiles using IMSI	Number of mobiles using TMSI	Total
Paging Request type 1	0, 1, 2	0, 1, 2	≤ 2
Paging Request type 2	0, 1	2, 3	3
Paging Request type 3	0	4	4

Figure 13-4 Paging Request, type 1-3.

When the paged MS receives a Paging Request message it responds by sending a Channel Request message, thereby requesting a signaling channel for call set-up. The Channel Request message is sent on the Random Access Channel (RACH) and consists of 8 information bits: a random number (5 bits) and an establish cause (3 bits). In GSM specifications phase 2, the number of bits used to establish cause can be 3 through 6. Accordingly, the random number will be described using 5 down to 2 bits. The random access procedure is also described in Chapter 6 “Um interface”. The establish cause can be:

- Answer to page
- Originating call

- Location updating
- Emergency call
- Others, for example IMSI detach, SMS, supplementary services management

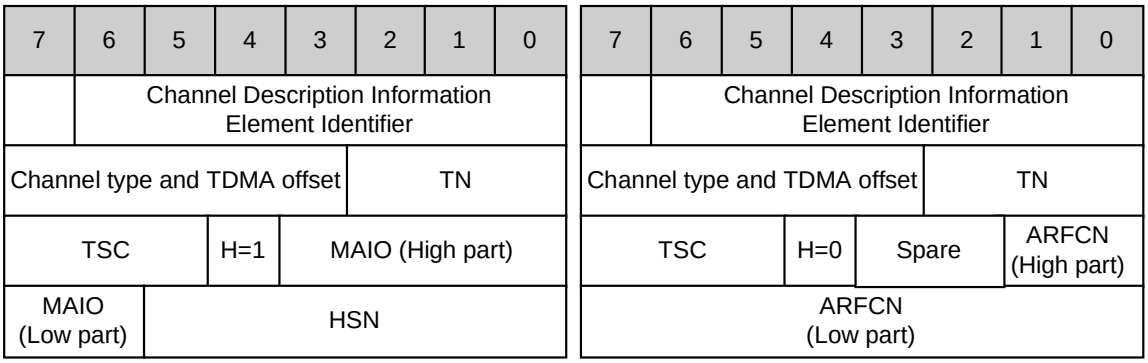
The establish cause can be used to set priority if there are numerous requests. Emergency calls can for example, have priority over answer to page, which in its turn has priority over mobile originating calls.

When the BTS detects an access burst, it sends a Channel Required message to the BSC to request a signaling channel for the MS. This message contains the access delay of the access burst and the request reference parameter. This parameter contains the eight bits from the access burst (random number and establish cause) and the TDMA frame number when the access burst was detected.

BSC compares the access delay value with the maximum permitted timing advance parameter value. The timing advance parameter is defined for each cell in BSC to ensure that the MS is within the allowed range. BSC then determines which channel to use and sends the identity of this channel to the BTS in the Channel Activation message. The contents of this message are:

- reason for allocation
- a complete description of the channel containing the channel description information element, according to Figure 13-5
- DTX applied or not
- MS power
- BS power
- Timing Advance (TA)

The BTS then activates the channel and confirms this by sending the Channel Activation Acknowledge message.



Channel type and TDMA offset:

Bits

7 6 5 4 3
0 0 0 0 1 Bm + ACCHs
0 0 0 1 T Lm + ACCHs
0 0 1 T T SDCCH/4 + SACCH/4 + or CBCH (SDCCH/4)
0 1 T T T SDCCH/8 + SACCH/8 + or CBCH (SDCCH/8)
T = Indicates subchannel number

ARFCN Absolute Radio Frequency Channel Number

TN Timeslot number 0 - 7

TSC Training Sequence Code

MAIO Mobile Allocation Index Offset. When configuring a Hopping Group using n frequencies, the channels are allocated MAIO of 0 to n-1, used in the selection process mentioned under HSN to separate the channels. Range: 0 - 63.

HSN Hopping Sequence Number. A number from 0 to 63, identifying a “pseudo random generator” used by the MS and the network, to select next frequency to hop to. HSN = 0 gives cyclic hopping i.e. the Hopping Frequency Set (HFS), which is the set of frequencies among which a channel shall hop, is repeatedly traversed in ascending order of frequency number. Range: 0 - 63.

Figure 13-5 Channel description information element.

The BSC then sends the Immediate Assignment command message containing an Immediate Assign message to the mobile station. The message tells the MS to switch to the allocated signaling channel (SDCCH+SACCH). The message contains:

- the channel description information element shown in Figure 13-5

- the frame number when the Channel Required message was detected
- the random reference from the access burst
- the TA that the MS will use

The MS compares the random reference and the frame number with those stored in the MS. If they correspond, the MS goes to the service request step.

In the following sections, only layer 2 messages which do not carry layer 3 messages as a primary function (dotted arrow) and the layer 3 messages (filled arrows) are discussed.

When the information field in such a layer 2 message includes a layer 3 message, that is, when piggybacking is used, the layer 3 message is depicted in brackets.

SERVICE REQUEST

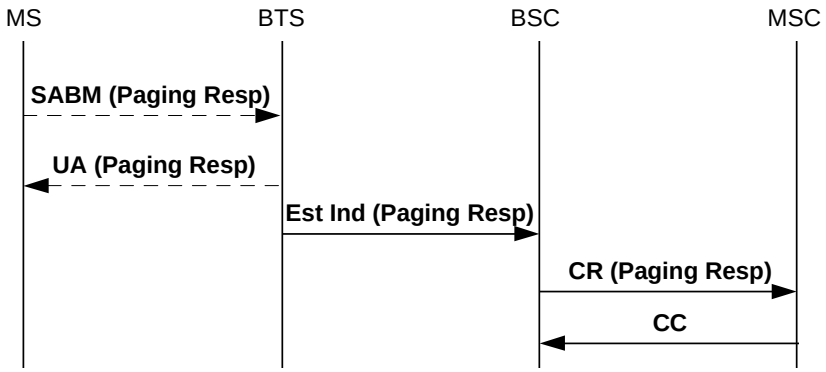


Figure 13-6 Service request.

The layer 2 message Set Asynchronous Balanced Mode (SABM) is sent to the BTS as soon as the MS has tuned to the new channel see Figure 13-7. SABM may contain a layer 3 service request message. In this case, the information field in SABM contains the Paging Response message.

The SABM message is used to start the acknowledged mode on the SDCCH channel. In practice, this means that the counters for send and receive sequence numbers are reset to zero.

The Paging Response message received from the MS contains the following information:

- MS identity (IMSI or TMSI and possibly IMEI)

- the ciphering key sequence number (CKSN)
- the mobile station classmark 2, that is, the type of MS station being used

The CKSN can be used by the MSC to start ciphering without authentication. (described later in the "Ciphering mode setting" section).

When the Paging Response arrives at the BTS, it is forwarded to the BSC in an Establish Indication message. This message tells the BSC that a change to acknowledged mode has been made. BSC activates radio connection quality supervision in the Transceiver Handler (TRH) which starts the locating function on SDCCH. It also initiates the power control algorithm for dynamic MS power control.

Paging Response is an Initial MS message which means that it was initially meant to be sent transparently to the MSC. However, the BSC adds CGI before forwarding the Paging Response to the MSC as a Complete L3 message.

The Paging Response is also looped back to the MS in a Unnumbered Acknowledgment (UA) frame. This confirms that only one MS is using the signaling channel. If the paging response is not returned the following case might occur:

Two MSs access the system at the very same frame number, with the same establish cause and the same random reference (there are only 32). If both MSs are strong, they must send another access burst in accordance with the Aloha procedure, which is a way to spread out random accesses in order to avoid consecutive collisions. However, if one of the MSs is weak, the signal does not reach the BTS. Unaware of this, the MS receives the reply sent to the other MS a short while after its own access attempt. The MS tunes to the signaling channel, sends the Paging Response message and then listens for the Paging Response to be looped back. Now the MS hears that the MS identity given is not its own and leaves the channel.

The BSC sets up a logical SCCP connection towards the MSC by sending the Connection Request message (GSM (08.06)) including a complete Layer 3 information - the Paging Response message piggybacked. The SCCP Connection Confirm message (GSM(08.06)) is returned to the BSC which means that the connection oriented signaling is established on the A interface.

Timers for RR Connection Establishment and Service Request (ALOHA)

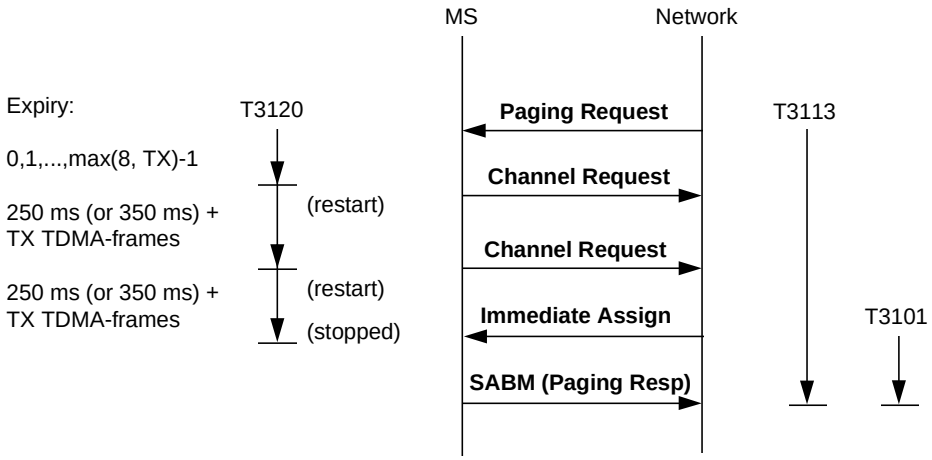


Figure 13-7 Timers for RR connection establishment

To avoid collisions in the BTS when more than one mobile attempts to access the system, for example when they are paged in one message; the Aloha procedure is used to spread out the accesses. This procedure makes use of timer T3120 in the MS.

When the MS receives a Paging message or when it decides to access the system for other reasons, the MS generates a random number between 0 and 8 and an integral value defined by the parameter called TX minus 1. Then it starts timer T3120 which expires after this random number of TDMA–frames. When the timer expires, the MS sends the random access burst with the Channel Request see Figure 13-8.

The MS restarts T3120 and waits for an order (Immediate Assignment) from the network to go to an SDCCH where the signaling can continue. According to GSM spec. phase 1, the MS waits 250 ms in the case of a non-combined SDCCH and 350 ms in the case of a combined CCCH/SDCCH, plus a new random number of TDMA–frames. The new random number is generated in the MS, this time ranging between 0 and TX. The parameter TX, which is broadcast on the BCCH, has a maximum value of 50. In GSM specification phase 2, the time that the MS must wait after the restart depends on the non-combined or combined SDCCH and the value of TX.

If the MS does not receive an Immediate Assignment from the network before T3120 expires, it sends a new random access burst with a channel request. The number of times the MS can

attempt to access the system is limited. The MS knows what the limit is from the system information read on the BCCH.

T3120 is stopped when the Immediate Assignment message is received.

On the network side there are two timers:

- T3113 which starts when Paging Request is sent and stops when Paging Response is received.
- T3101 which supervises the allocation of a channel and hence starts when the Immediate Assignment message is sent and stops when the SABM frame is received.

If T3113 expires before the Paging Response is received, the Paging Request message can be sent again according to an exchange parameter set by the operator. If T3101 expires however, the request is canceled and the channel released.

AUTHENTICATION

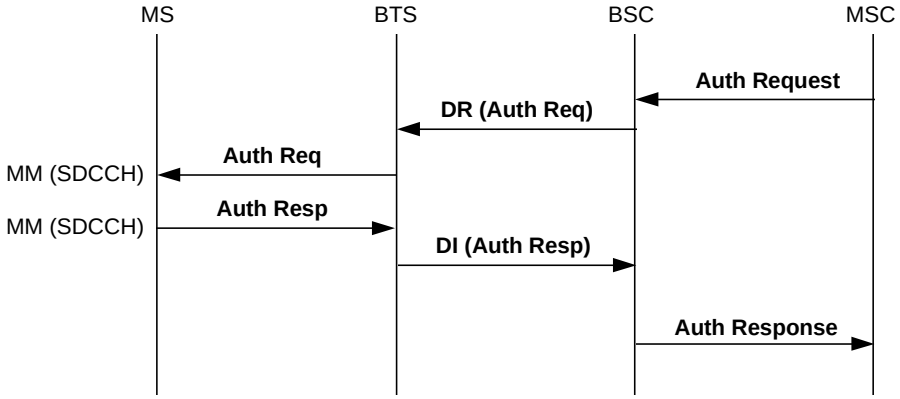


Figure 13-8 Authentication.

An exchange property in MSC/VLR defines whether authentication is to take place or not. An Authentication Request is sent transparently to the MS, see Figure 13-9. The parameters in the Auth. Req. message are the random (RAND) number, 128 bits, and CKSN, 3 bits.

When the MS receives the Auth. Req. message it stores the CKSN, which is to be sent in the next service request message. It then calculates the authentication parameter SRES by inserting K_i, the subscriber authentication key that is stored in the SIM card; and RAND in algorithm number A3 as well as Kc by inserting Ki and RAND in algorithm A8.

The SRES parameter is returned to MSC/VLR in the Authentication Response message.

The Data Indication (DI) frame is used to send a layer 3 message transparently in the direction from BTS to BSC. In the opposite direction, the Data Request (DR) frame is used.

Authentication is supervised by timer T3260 on the network side. It is set in the MSC when Auth. Req. is sent and stopped when Auth Resp is received. On the first expire Auth. Req. is sent again, but on the second expire the channel is released.

Unsuccessful Authentication

If authentication fails that is, SRES from the MS does not correspond with the SRES value stored in MSC/VLR; the network can distinguish between two different ways of identification used by the MS:

- TMSI
- IMSI

If TMSI is used, the network may initiate the identification procedure, where the MS is told to send its IMSI value. If the IMSI given by the MS differs from that which is stored in the network, the authentication is restarted using the correct parameters. If the IMSI provided is the expected one, the MSC should proceed as described below.

If the IMSI has been used or the network decides not to use the identification procedure, an Authentication Reject message is sent to the MS. All connections in progress are then released. The MS receiving the Auth. Rej. message deletes its TMSI, LAI, K_c, and CKSN and switches to the “IDLE no IMSI" state. In this state, the MS is only allowed to perform default cell selection, and only emergency calls are permitted.

This is a serious case because it means barring the SIM card from use. To prevent this from happening because of dues to bit errors or software errors, the GSM systems have an exchange parameter controlling unsuccessful authentication. If this parameter is set, then the MSC does not send the Authentication Reject message, but instead rejects the MS access to the system by sending one of the following messages depending on the establish cause (in brackets):

- “IMSI unknown in VLR" (Mobile originating call)

- No message, only disconnection (Mobile terminating call)
- “PLMN not allowed" (Location updating)
- “IMSI unknown in VLR" (Support services control operations)

CIPHERING MODE SETTING

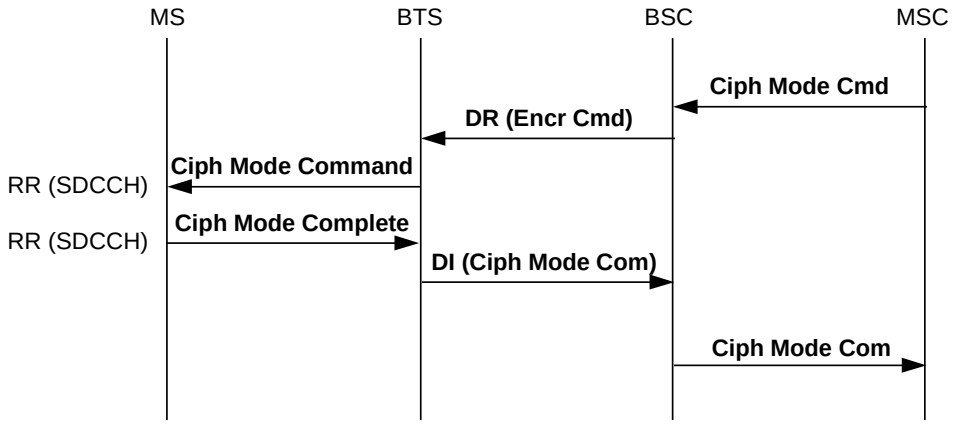


Figure 13-9 Ciphering mode setting.

If the authentication procedure is successfully performed, the ciphering mode setting procedure can be initiated by the MSC/VLR (depending on the exchange property setting in the MSC/VLR), which then sends the Ciphering Mode Command to the BSC (see Figure 13-9). This is a BSSMAP message which contains the K_c. K_c is forwarded by BSC to the BTS.

BTS stores K_c and tells the MS to start ciphering. BTS starts the deciphering. The Ciphering Mode Command message sent from BTS to MS is non-ciphered.

The MS inserts K_c and TDMA frame number into algorithm A5, which yields a ciphering sequence that is added to the message to be sent. The message is called Ciphering Mode Complete, and it does not have any parameters. It only tells the BTS that ciphering has started.

When the BTS receives the Ciphering Mode Complete message or any other correctly deciphered layer 2 frame, ciphering is started on the network side. Ciphering Mode Complete is then sent in a DI frame to the MSC.

Ciphering Key Sequence Number

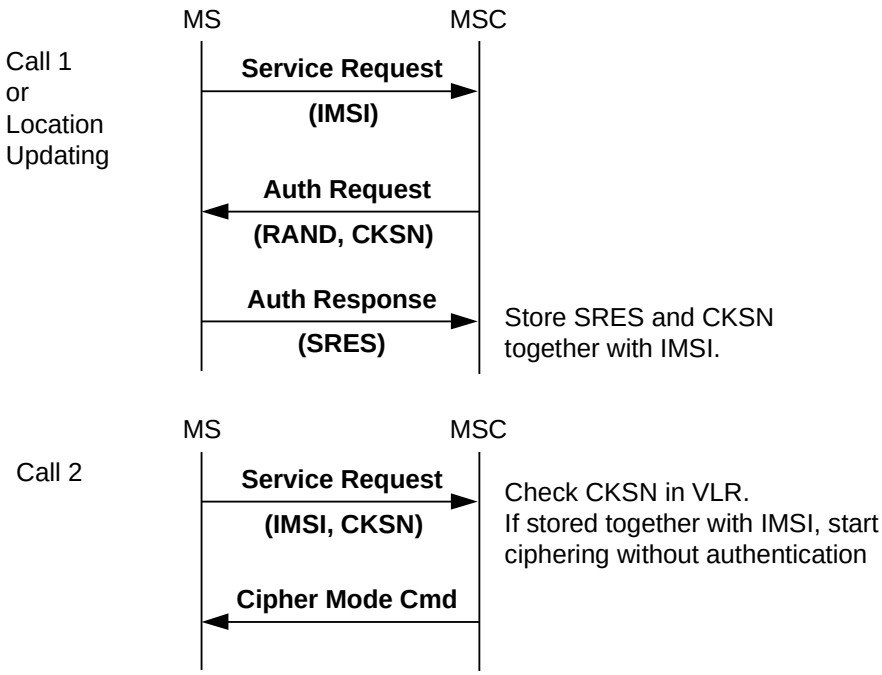


Figure 13-10 Use of CKSN.

The CKSN is used in the following way:

The authentication message sent from the MSC/VLR contains the RAND number and the CKSN. CKSN is stored in VLR together with K_c. See Figure 13-10

When the MS receives the authentication message it calculates SRES and K_c, storing K_c together with the CKSN in the SIM card. The next time the MS wants to access the system, it sends the CKSN in the service request message. Now the MSC knows what K_c is stored in the MS, and therefore does not need to send the Authentication Request message containing the RAND. Instead, the MSC can go directly to the ciphering procedure. This is called selective authentication. It means that authentication does not take place every time. This function is defined by a number of exchange properties, set in the MSC/VLR, appropriate to different traffic cases and the frequency of repeating the authentication.

TMSI REALLOCATION

Exchange properties, as well as the result of the IMSI series analysis, defines whether TMSI is used for a particular traffic case and a particular IMSI. TMSI is allocated by MSC software and sent transparently to the MS as shown in Figure 13-11.

TMSI is stored in the SIM and TMSI Reallocation Complete message is returned by the MS.

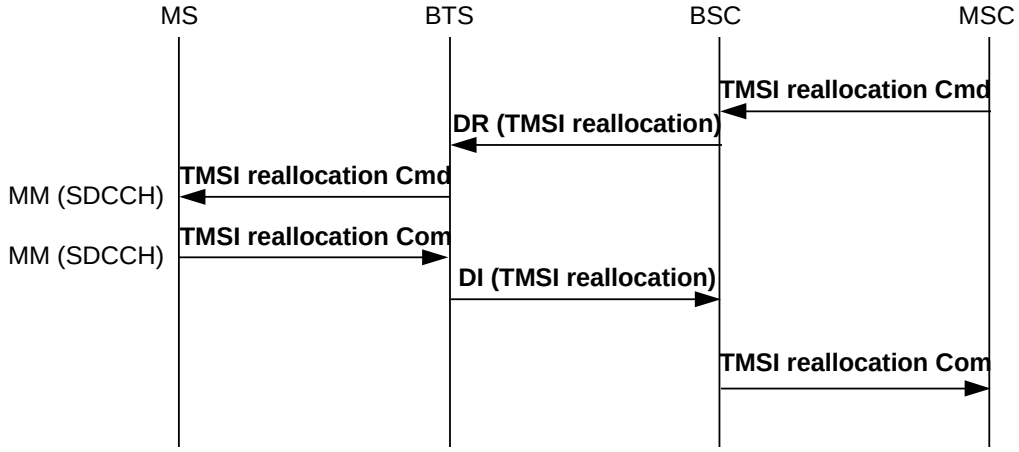


Figure 13-11 TMSI reallocation.

IMEI CHECK

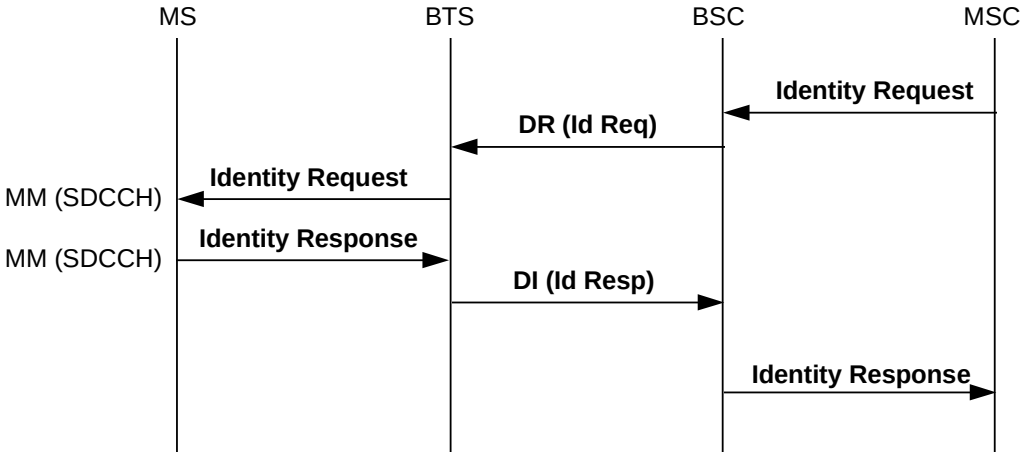


Figure 13-12 IMEI check

The exchange properties in the MSC/VLR define whether or not the IMEI check is performed. If it is, the MSC/VLR orders the mobile station to send its IMEI number. The downlink message, Identity Request, (see Figure 13-12) contains information about what the mobile should send back. In case of an IMEI check, the mobile receives a request to send back its IMEI number. The same Identity Request message can be used in other situations to order the mobile to send back its IMSI number.

The IMEI sent by the mobile is checked against information in the network's Equipment Identity Register (EIR). If the EIR returns the answer "white listed" the mobile is allowed to use

the network. If the mobile is “black listed” it will be rejected. The EIR can also return the answer “gray listed” or “unknown”. In these cases the operator can decide whether the mobile is permitted access the network.

CALL INITIATION

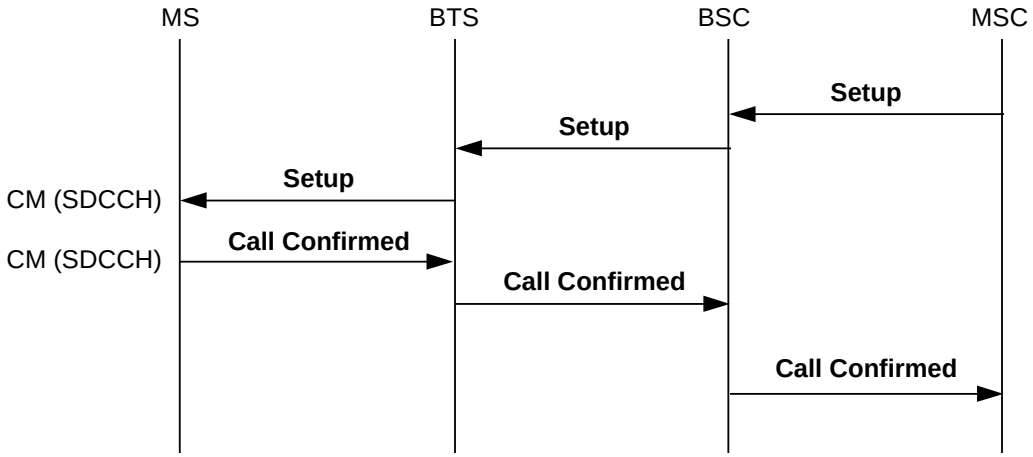


Figure 13-13 Call initiation.

Call initiation is started when the MSC sends the Setup message to the MS. See Figure 13-13. This message contains a request for bearer services (GSM - bearer capabilities). That is, speech, data, fax, bit rate, etc. If the MS can handle the required service, it sends a Call Confirmed message to the MSC. If the MS cannot handle the requested bearer services, it sends the release complete message to the MSC with reject cause No. 88, “Incompatible destination". The MSC then releases the connection to the MS and also releases the connection to the calling subscriber with cause number 88.

The call initiation procedure is supervised at the network side with the timer T303. This timer is set when the Setup message is sent and stopped when the Call Confirmed message is received. If the network does not receive the Call Confirmed message before timer T303 expires it releases the connection to the calling subscriber with cause No. 18, “No user responding". It also releases the connection to the MS. The Setup message is only sent once.

ASSIGNMENT OF A TRAFFIC CHANNEL

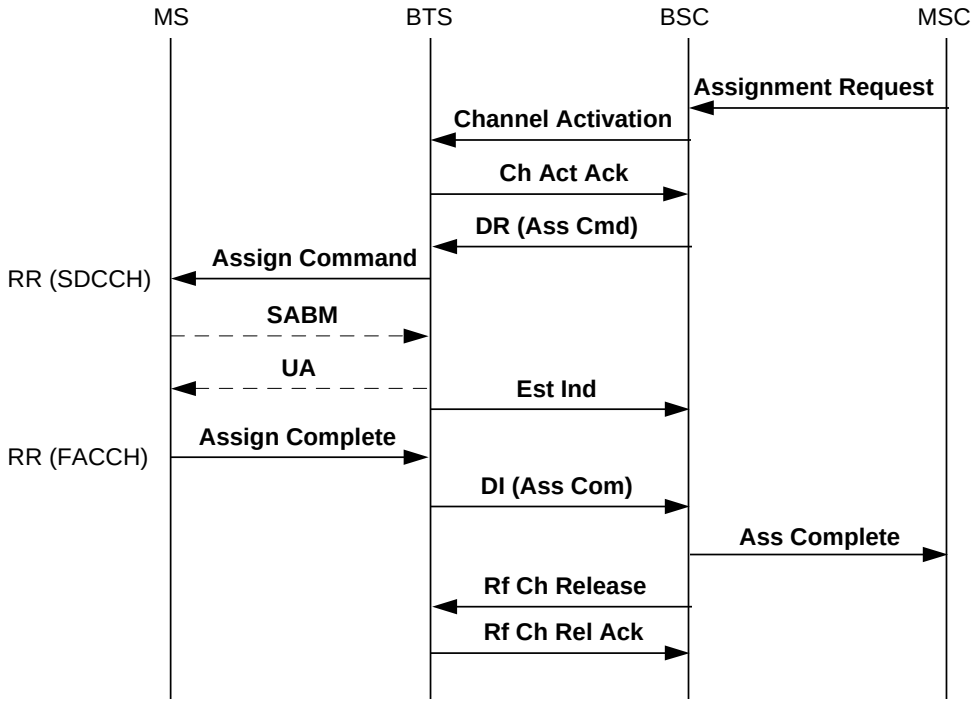


Figure 13-14 Assignment of a traffic channel.

The assignment procedure is initiated by the MSC which sends the Assignment Request message to BSC. See Figure 13-14. This message contains:

- priority (a value between 1 and 14)
- CIC for trunk select to carry the traffic (speech or data) between MSC and BSC
- a DTX flag indicating whether DTX should be used on the downlink
- optionally, radio channel identity

By using this parameter the MSC can force the BSC to choose one particular radio channel for O&M reasons.

The BSC can then, with the message Physical Context Request, ask the BTS for physical information. That is, BS power, MS power and timing advance. The Physical Context Request is however not used in Ericsson's GSM system.

The list from the locating function is then evaluated in BSC and depending on the result, one of the following assignment procedures is started:

- Assignment to serving cell
- Assignment to another cell in the same BSC
- Assignment to an external cell

Only assignment to serving cell is described below. The BSC software reads the value of the timing advance and calculates MS power level from the locating function, selects an idle traffic channel and sends the Channel Activation to the BTS. Channel Activation is the same type of the message that is used for assigning the SDDCH + SACCH in the RR connection establishment (see Figure 13-5). But in this case the channel type is set to Bm + ACCH meaning full rate TCH + SACCH + FACCH. The BTS acknowledges the allocation of the speech channel by sending a Channel Activation Acknowledge message.

The BSC then sets up a path through the group switch, and ensures that there will be no disconnection due to missing Measurement Reports from the MS when the MS disappears from the old channel. The BSC sends the Assignment Command towards the MS, telling the mobile station to switch to the new channel (TCH + SACCH + FACCH). This message is sent on the SDCCH, and it consists of a complete channel description.

The MS tunes to the new physical channel and sends SABM (on FACCH) to indicate that the channel is correctly seized and that SACCH is then started in acknowledged mode. As the BTS receives this message, it returns UA to the MS and sends an Establish Indication message to the BSC.

The MS then sends an Assignment Complete message to the MSC indicating that the traffic channel is up and running.

Finally, the BSC tells the BTS that the signaling channel is no longer needed by sending the RF Channel Release message. This message is acknowledged as soon as the connection is released.

CALL CONFIRMATION AND CALL ACCEPTED

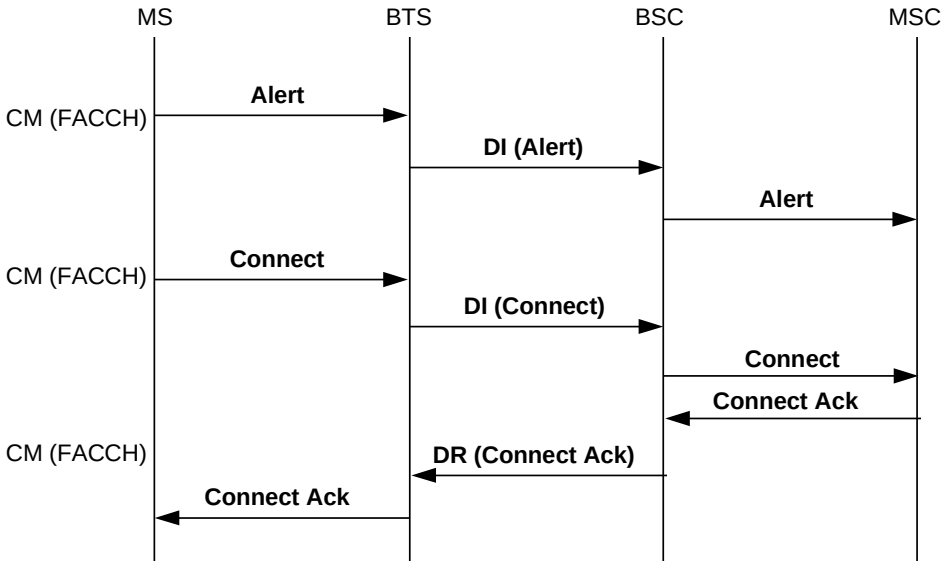


Figure 13-15 Call confirmation and call accepted.

The call confirmation procedure starts as the MS sends the Alerting message to the MSC. This message indicates that a ringing tone has been generated in the MS and it can be used for user-to-user signaling or for invocation of supplementary services. The message is sent transparently. When the Alerting message is received, the MSC/VLR sends the TUP Address Complete (ACM) message to the calling subscriber, who can now hear the ringing tone generated in the MSC.

When the MS user answers, the Connect message is sent to the MSC. This message contains facility, user-user signaling and a progress indicator. When the message is received at the MSC, a Connect Acknowledgment is sent back to the MS, and the originating exchange is informed by means of a TUP or ISUP Answering message and also charging information.

CALL RELEASE

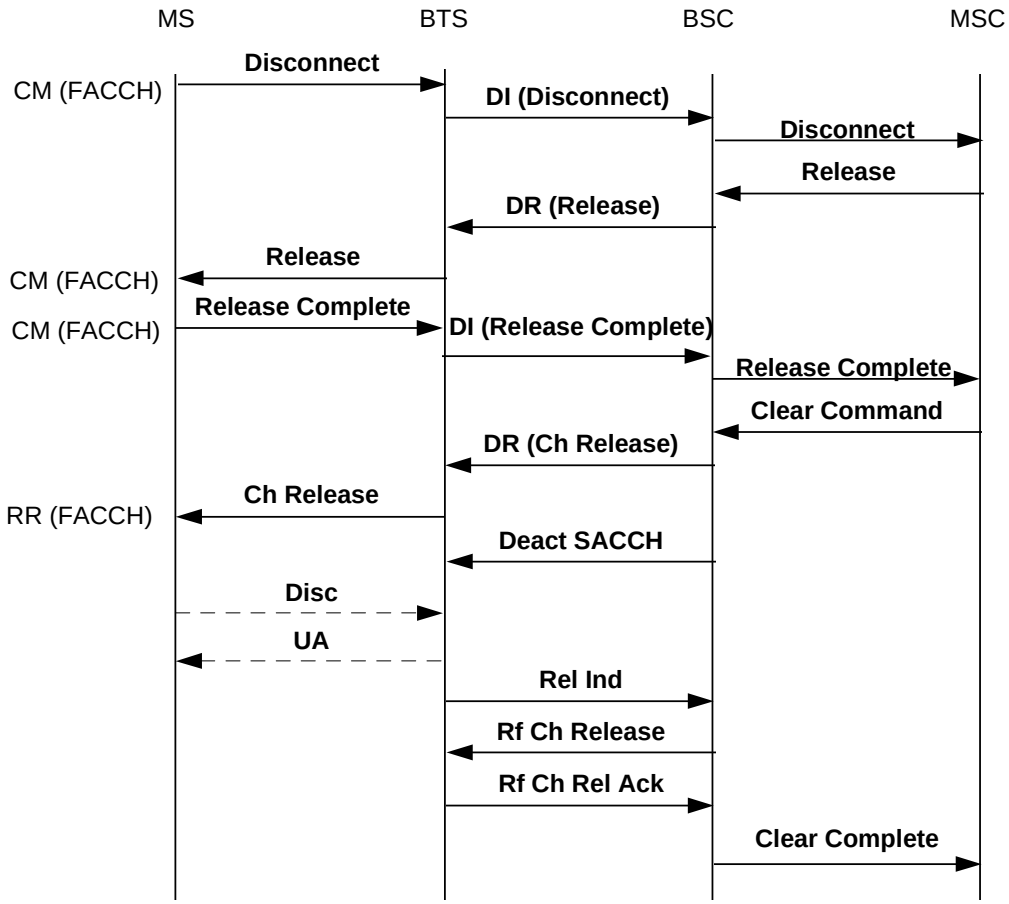


Figure 13-16 Call release.

Figure 13-16 shows the messages at the end of the call. In this case the call was ended by the mobile subscriber.

When MSC receives a Disconnect message it initiates the release of the CM connection. This is done with a Release message which is acknowledged by the Release Complete message from the MS. If there were no other connections on the CM level (e.g., held calls, SMSs, etc.) the network initiates a release on the RR level.

The network initiates the channel release by sending a Clear Command message to the BSC, including the cause for the release. The BSC then sends the Channel Release message transparently to the MS. The BTS has so far no knowledge about the release.

The BSC then sends the Deactivate SACCH message to the BTS, telling the base station to stop sending messages every 480 ms on the Slow Associated Control Channel.

When the MS gets the Channel Release message, it disconnects the main signaling link (here TCH) and sends the LAPDm Disconnect frame. This message indicates that the link is no longer in the acknowledged mode. This message is acknowledged by a UA frame.

When the main signaling link has been disconnected, that is, when the BTS receives the Disc frame, it sends the Release Indication message to the BSC. Now the link is disconnected, but the radio channel is still in use. To halt transmission on the radio frequency, the BSC sends the Rf Channel Release message to the BTS, which is acknowledged as soon as the BTS has stopped transmission on the radio channel. The timer T3111 is started when the Rf Channel Release message is sent.

LOCATION UPDATING

INTRODUCTION

There are three different types of Location updating. The difference in signaling between these three types is a parameter in the Location Updating Request Message. The three types are:

- Normal: used when an MS reaches a new location area; also called Forced Registration
- Periodic: used to prevent mobiles from becoming accidentally detached from the system
- Attach: used when a mobile is switched on

The main steps in the signaling scheme for location updating looks very much the same as for call set-up. The steps involve RR connection establishment, service request, authentication (except for periodic registration), ciphering mode setting, location updating and RR connection release.

RR CONNECTION ESTABLISHMENT

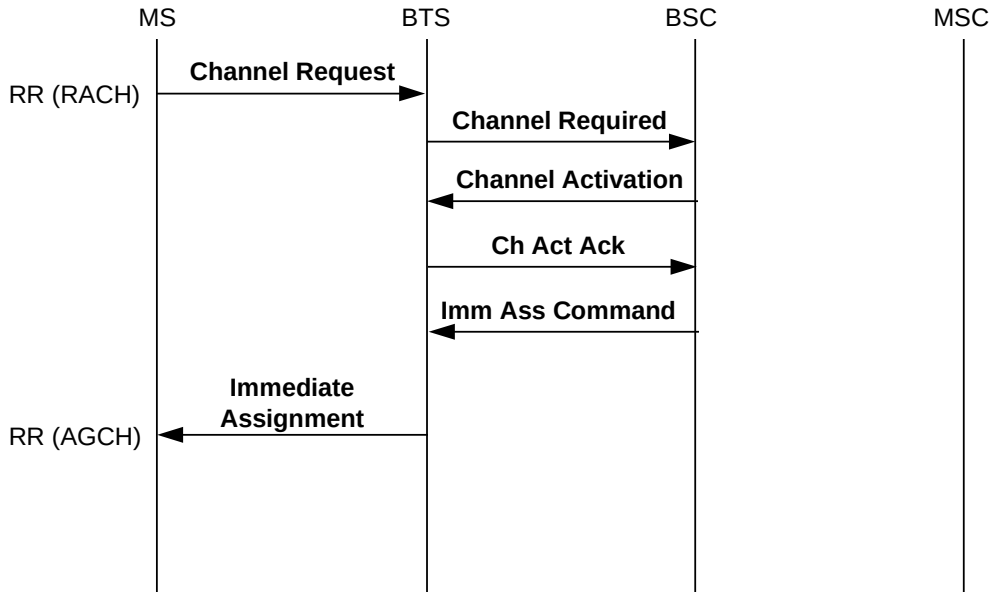


Figure 13-17 Location updating, RR connection establishment.

In the case of location updating, the procedure is started by the MS which sends the Channel Request message on the RACH.

The BTS then sends Channel Required to the BSC. This is shown in Figure 13-17.

If a free SDCCH is available, the BSC sends the Channel Activation message to the BTS.

When a channel has been activated, the BSC sends the Immediate Assignment message to the MS and starts timer T3101.

SERVICE REQUEST

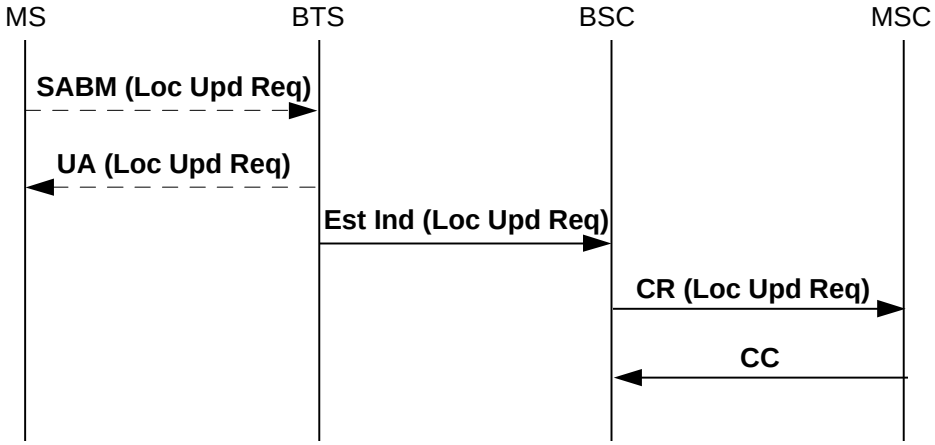


Figure 13-18 Location updating, service request.

As the MS receives the Immediate Assignment message it switches to the ordered channel and establishes the main signaling link by sending a SABM message including the Location Updating Request message. See Figure 13-18. The Location Updating Request message contains the type of location updating (normal, periodic or attach), the ciphering key sequence number, the old LAI stored in the MS, the mobile station classmark 1, either IMSI or TMSI and possibly IMEI.

When the Location Updating Request arrives in the BTS, it is looped back to the MS in a UA frame and forwarded to the BSC in an Establish Indication message.

When the Establish Indication is received at the BSC, the T3101 timer that was set when the Immediate Assignment message was sent is stopped. The BSC then establishes the SCCP connection to the MSC by sending the Connection Request message with the Location Updating Request included in the information field. This Location Updating Request message is somewhat modified because the BSC adds the new CGI, indicating where the mobile

is now. The MS itself identifies its previous location. The modified message is Complete Layer 3 information.

The MSC acknowledges the message by sending a Connection Confirmed frame.

AUTHENTICATION AND CIPHERING MODE SETTING

The MSC/VLR performs authentication in analogy with the call set up case. In Ericsson's GSM system, authentication is normally performed for new visitors.

The MSC/VLR checks the relevant exchange property and performs analysis on the IMSI series to establish whether or not authentication is to be performed. The same thing applies such things as call from or to MS, short messages and to supplementary services control operations.

Note that the authentication procedure might be delayed if the MSC/VLR must ask the HLR for parameters which is the case with new visitors.

If the CKSN sent from the MS in the Location Updating Request message is identical to the one that is stored in the MSC, authentication can be omitted (selective authentication) and ciphering may start immediately.

Ciphering must be activated if TMSI is to be reallocated. However, there are exchange properties defining when ciphering is to be used. Normally, when location updating is used for periodic registration or the network does not allocate a new TMSI, ciphering need not be activated.

UPDATE LOCATION

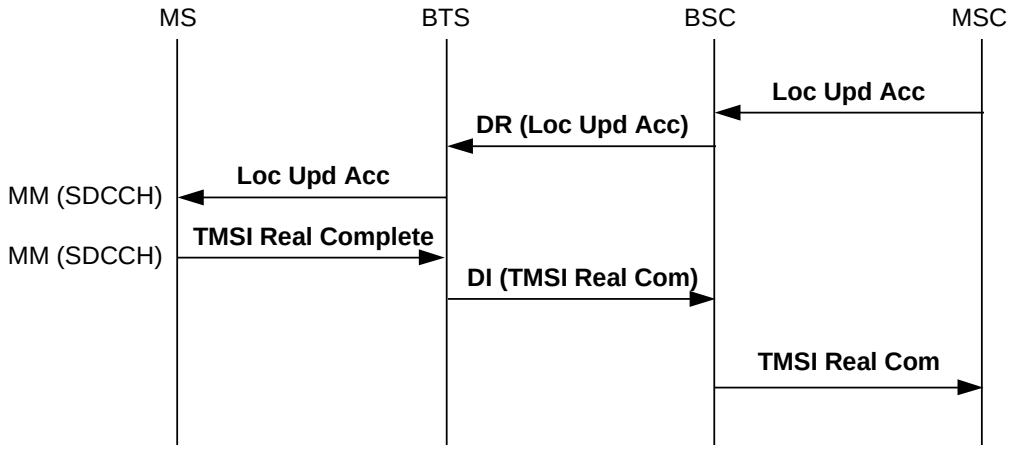


Figure 13-19 Location updating accepted.

If the MSC/VLR accepts location updating, the MSC/VLR now sends the Location Updating Accepted message to the MS. A new TMSI value may be included as in Figure 13-19. Timer T3250 is started in the MSC.

The TMSI can be sent to the MS at any time. This is performed in the TMSI Reallocation Command. When the MS has stored the new TMSI it sends a TMSI Reallocation Complete message back to the MSC.

If the Location Updating Accepted message received in the MS contains a new TMSI, the MS acknowledges the receipt of the TMSI by sending the TMSI Reallocation Complete message. When this message is received in the MSC, timer T3250 is stopped.

RR CONNECTION RELEASE

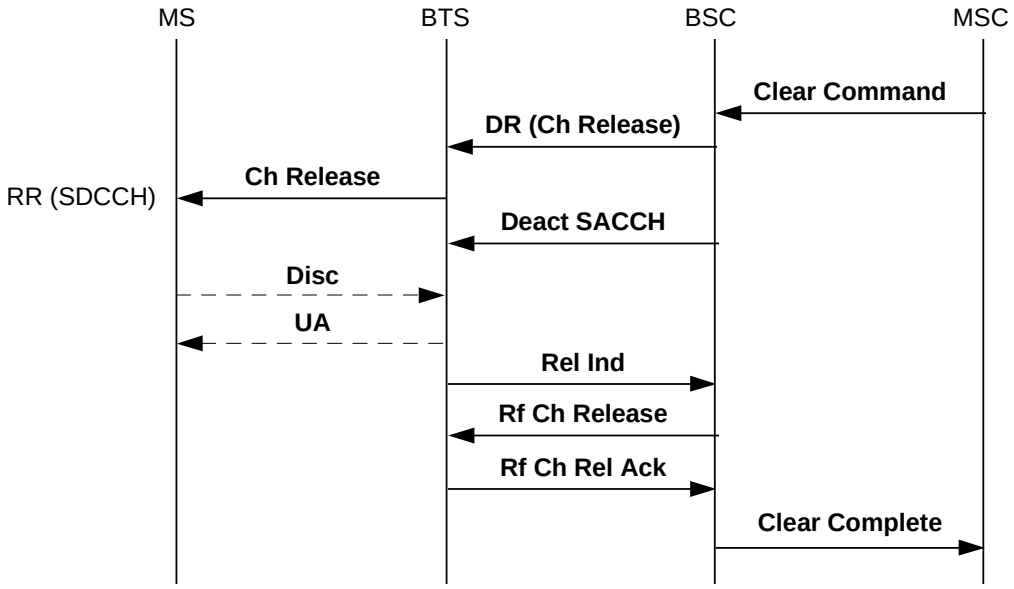


Figure 13-20 Connection release.

The network initiates the channel release by sending a Clear Command message to the BSC including the cause for the release. See Figure 13-20. The BSC then sends the Channel Release message transparently to the MS. The BTS has no knowledge about the release at this point.

The BSC then sends the Deactivate SACCH message to the BTS, telling the base station to stop sending messages every 480 ms on the Slow Associated Control Channel.

When the MS gets the Channel Release message, it disconnects the main signaling link (here SDCCH) and sends the layer 2 Disconnect message. This message indicates that the link is no longer in acknowledged mode. The Disc message is acknowledged by a UA frame.

When the main signaling link has been disconnected, that is, when the BTS receives the Disc frame; it sends the Release Indication message to the BSC. Now the link is disconnected, but the radio channel is still in use. To halt transmission on the radio frequency, the BSC sends the Rf Channel Release message to the BTS which is acknowledged as soon as the BTS has stopped transmission on the radio channel. The timer T3111 is started when the Rf Channel Release message is sent.

On expire of timer T3111 the BSC considers the released channel free for use and sends the Clear Complete message to MSC/VLR.

SCCP, CONNECTION ORIENTED, RELEASE

The SCCP Released (RLSD) message is sent by MSC to BSC to indicate that the SCCP wants to release the signaling connection and Release Complete is sent in response indicating that the appropriate procedure has been completed. This is shown in Figure 13-21.

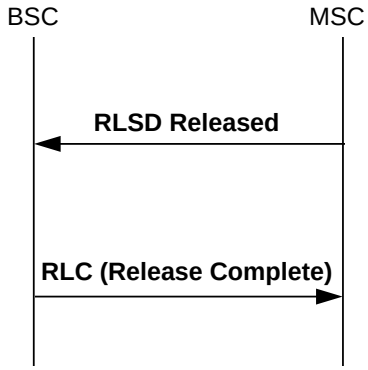


Figure 13-21 SCCP (CO) release.

Location Updating Reject

If location updating cannot be accepted, the network sends a Location Updating Reject message to the MS. This message contains the cause for rejection. For example, IMSI unknown in HLR, illegal MS, congestion, etc.

The RR connection is then released, and if the reject cause is either number 2 “IMSI unknown in HLR" or number 3 “Illegal MS", the MS deletes any TMSI, stored LAI, cipher key and ciphering key sequence number. The MS then enters the “IDLE no IMSI" state. In this state, the MS acts in the following way:

- No starting any normal location updating attempt
- No performing periodic updating
- No performing IMSI detach if powered down
- Only allows emergency calls
- No responding to paging

SIGNALING DIAGRAMS

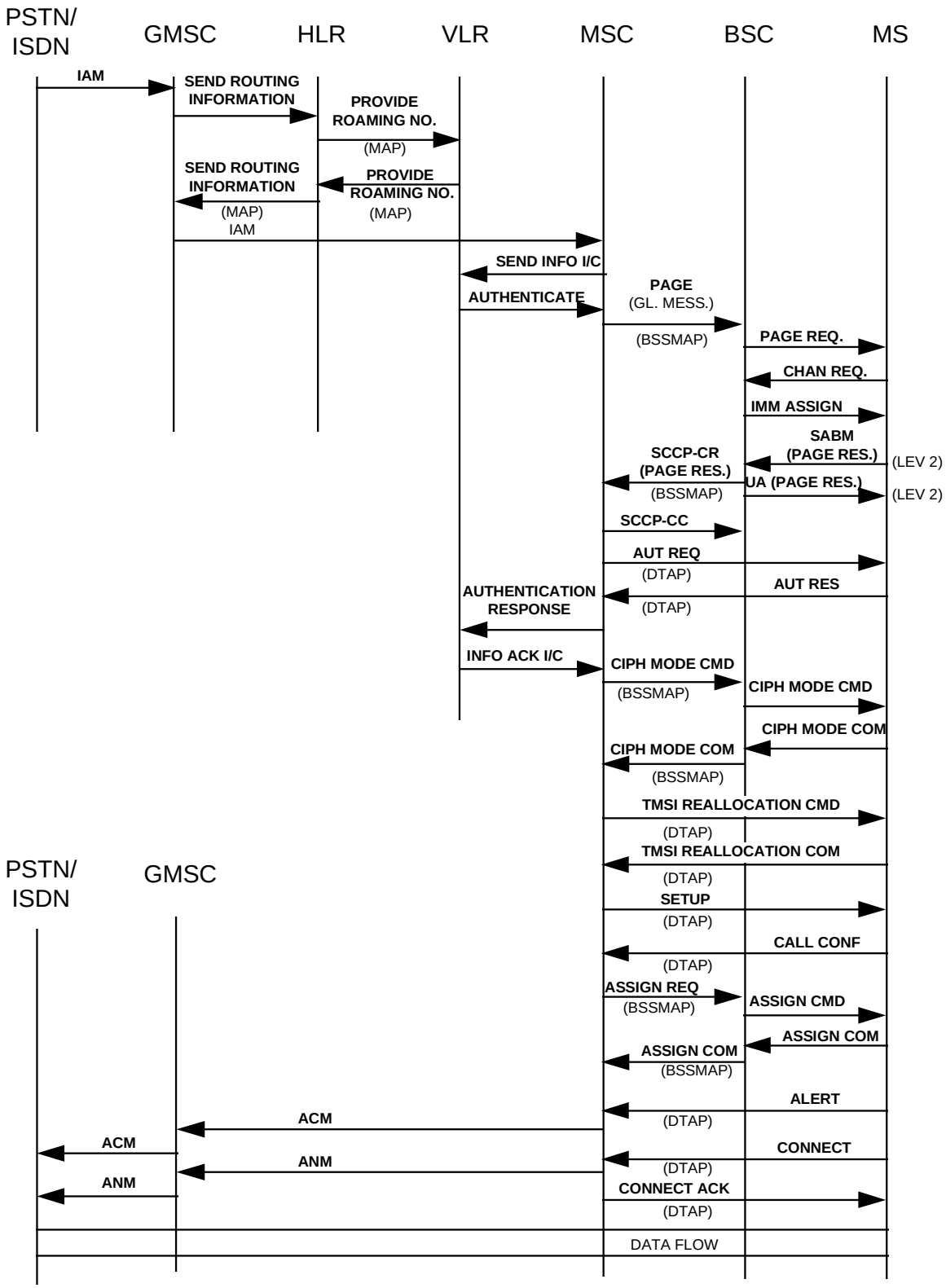


Figure 13-22 Mobile terminated call, flow chart.

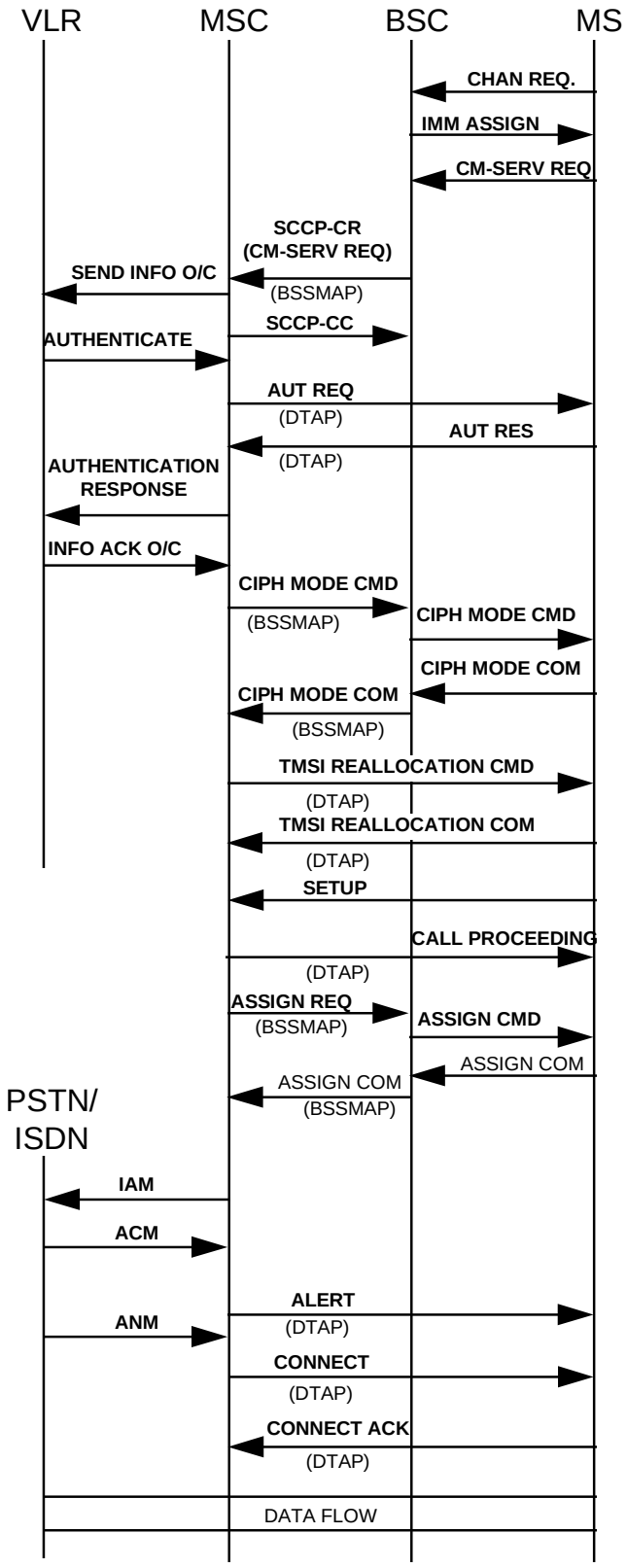


Figure 13-23 Mobile originated call, flow chart.

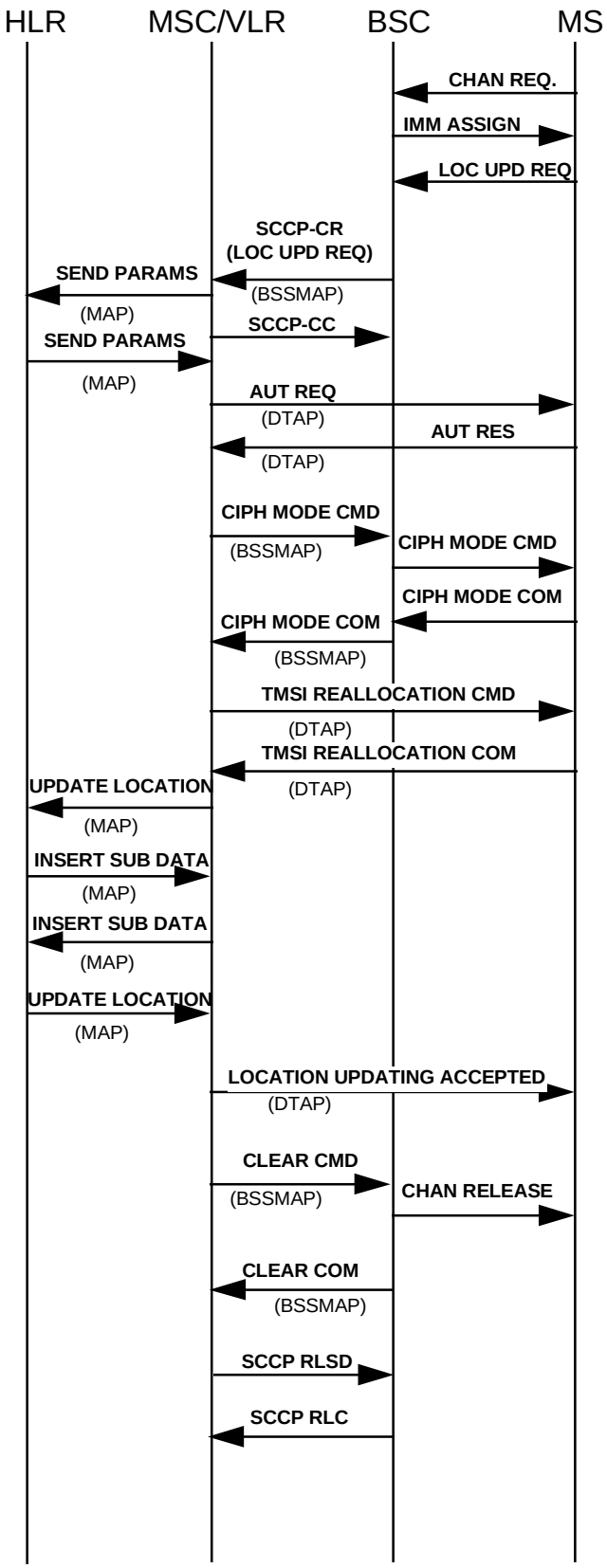


Figure 13-24 Location Updating, flow chart.

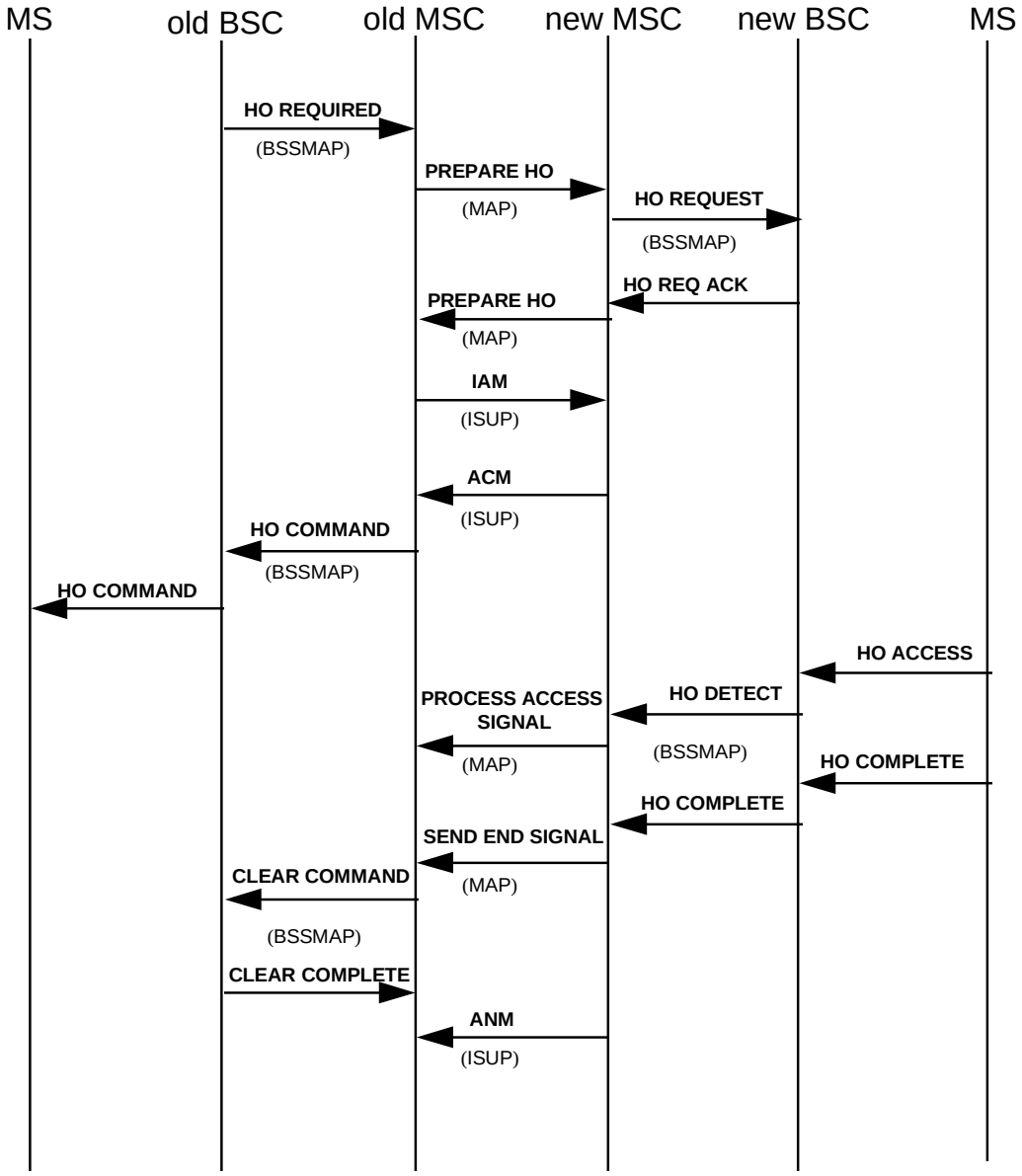


Figure 13-25 Handover, flow chart.

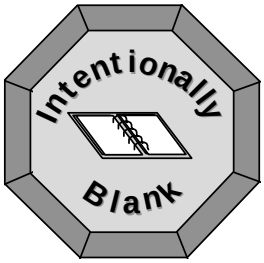
LIST OF ABBREVIATIONS

The abbreviations listed here are used primarily in the diagrams but may also occur in the text. They relate to messages and commands sent in order to perform call set-up and location updating. In some cases, more than one abbreviation exists for the same word. For instance, the word “Channel" may appear both as “Chan" and as “Ch". Such variants have been indicated in the list for a few of the words.

Abbreviation	Complete name	Interface
ACM	Address Complete Message	ISUP
ALERT	Alerting	Transparent
ANM	Answer Message	ISUP
ASS(IGN) CMD	Assignment Command	Abis RSL, Um RR
ASS(IGN) COM	Assignment Complete	Transparent
ASS REQ	Assignment Request	A BSSMAP
AUTH REJ	Authentication Reject	Transparent
AUTH REQ	Authentication Request	Transparent
AUTH RESP	Authentication Response	Transparent
CALL CONF	Call Confirmed	Transparent
CC	Connection Confirmed	A SCCP
CH(AN) ACT	Channel Activation	Abis RSL
CH(AN) ACT ACK	Channel Activation Acknowledge	Abis RSL
CH(AN) REQ	Channel Request	Um
CH(AN) RQD	Channel Required	Abis RSL
CIPH MOD(E) CMD	Cipher Mode Command	A RR
CIPH MOD(E) CMD	Ciphering Mode Command	Um RR
CIPH MOD(E) COM	Ciphering Mode Complete	Transparent
CONNECT	Connect	Transparent
CONNECT ACK	Connect Acknowledge	Transparent
CR	Connection Request	A SCCP

Abbreviation	Complete name	Interface
DEACT SACCH	Deactivate SACCH	Abis RSL
DI	Data Indication	Abis RSL
DISC	Disconnect	Um LAPDm
DR	Data Request	Abis RSL
ENCR CMD	Encryption Command	Abis RSL
EST IND	Establish Indication	Abis RSL
IAM	Initial Address Message	ISUP
IMM ASS CMD	Immediate Assignment Command	Abis RSL
LOC UPD ACC	Location Updating Accepted	Transparent
LOC UPD REQ	Location Updating Request	Transparent*
PAG(ING) CMD	Paging Command	Abis RSL
PAG(ING) REQ	Paging Request	Um
PAG(ING) RESP	Paging Response	Transparent*
(PHYS CONT CONF	Physical Context Confirm	Abis RSL)
(PHYS CONT REQ	Physical Context Request	Abis RSL)
REL IND	Release Indication	Abis RSL
RF CH REL	Radio Frequency Channel Release	Abis RSL
RF CH REL ACK	RF Channel Release Acknowledgment	Abis RSL
SABM	Set Asynchronous Balanced Mode	Um LAPDm
SETUP	Setup	Transparent
TMSI REAL COM	TMSI Reallocation Complete	Transparent
UA	Unnumbered Acknowledgment	Um LAPDm

*) Initial MS message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