Traffic Cases

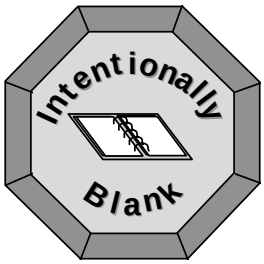
Chapter 3

This chapter is designed to provide the student with an overview of how different traffic cases are handled by the system.

OBJECTIVES:

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

- describe signaling during different types of location updating and when location updating is performed in the system.
- list nodes involved in setting up mobile originating calls.
- list nodes involved in setting up mobile terminating calls.
- describe signaling during handover.
- list nodes involved in the transfer of mobile originating short messages.
- list nodes involved in the transfer of mobile terminating short messages.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3 Traffic Cases

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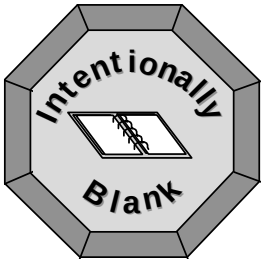
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INTRODUCTION

A MS can be in one of the following states:

- detached — MS is powered off or the SIM card is deactivated
- attached — MS power is on and the SIM card is activated

An attached MS can be:

- idle — MS has no dedicated channel allocated and listens to BCCH and PCH
- active (dedicated) — MS has a dedicated connection to the network

Changing from idle to active mode can be a result of location updating, call setup, short message transfer, or supplementary service procedure. Change of cells in active mode is called a handover.

This chapter describes most of the above mentioned traffic cases and does not discuss all parameters exchanged between the MS and the network. The mobile terminating call and location updating are described in chapter 13. The supplementary service procedure is described in chapter 14. More signaling details regarding other traffic cases are located in the GSM TS, especially parts 04.08, 08.08, 08.58 and 09.02.

LOCATION UPDATING

A mobile subscriber who is roaming moves freely within the network and the network knows where the MS is located. This makes it possible for the mobile subscriber to receive a call wherever he or she is. To keep the network up to date with the subscriber's location, the MS informs the system whenever it changes location area. This is called location updating.

There are three different types of location updating. They are:

- location updating type normal
- IMSI attach
- periodic registration

The MS also informs the network when it switches to detached mode.

LOCATION UPDATING, TYPE NORMAL

A location area is by definition the area, handled by one or more BTSs where the MS can move around without updating the system. A location area is controlled by one or more BSCs, but only by one MSC.

When the MS is idle, it listens to the system information on BCCH. This is how the MS gets the location area identity of the serving cell.

The main steps involved in location updating are shown in Figure 3-1. The numbers in the steps below refer to the numbers in the figure.

1. The MS listens to the system information, compares the Location Area Identity (LAI) to the one stored in the MS on the SIM card and detects whether it has entered a new location area or is still in the same location area. If the broadcast LAI differs from the one stored on the SIM card, the MS must perform a location update, type normal.

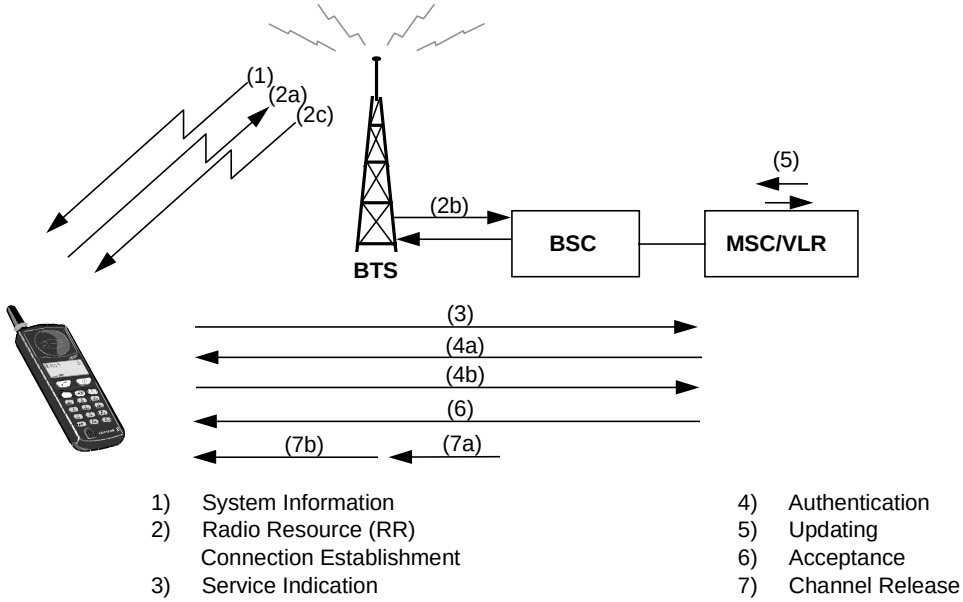


Figure 3-1 Location updating, type normal. MS already registered in VLR.

2a. The MS sends a channel request message including the reason for the access. Reasons other than location updating can be for example, answering a page or emergency call.

2b. The message received by the BTS is forwarded to the BSC. The BSC allocates a SDCCH, if there is one idle, and tells the BTS to activate it.

2c. The MS is now told to tune to the SDCCH.

The outcome of the procedure (2a, 2b, 2c) is that a radio resource connection is dedicated to the MS. The procedure is therefore called RR connection establishment.

3. The MS sends a location updating request message which contains the identity of the MS, the identity of the old location area and the type of updating.

4a. The authentication parameter is sent to the MS. In this case the MS is already registered in this MSC/VLR and the authentication parameter used is stored in the VLR.

If the MS is not already registered in this MSC/VLR the appropriate HLR or the previously used MSC/VLR must be contacted to retrieve MS subscriber data and authentication parameters (not shown here).

4b. MS sends an answer calculated using the received authentication parameter.

5. If the authentication is successful, the VLR is updated. If needed, the HLR and old VLR are also updated (new registration, not shown here).

6. The MS receives an acceptance of the location updating.

7a. The BTS is told to release the SDCCH.

7b. The MS is told to release the SDCCH and switches to idle mode.

In cases where the MS is busy when it changes location area, it receives the information about the new LAI on the SACCH. The location updating takes place after the call is released. The MS must set up a new connection and perform the procedures described in the previous case.

IMSI DETACH

The IMSI detach procedure may be used by the MS when it is powered off. The subscriber is marked as “detached” in the VLR and will not be paged. The system information, broadcast over the cell, informs the MS if IMSI attach and detach procedures are required or not.

The IMSI detach procedure is shown in Figure 3-2 and described below.

1. When the MS power is being turned off or the SIM card is taken out, the MS requests a SDCCH.
2. On the SDCCH the MS sends a message to inform the network that the MS is about to switch to detached mode. That is, the subscriber is no longer reachable.
3. The MSC marks the IMSI as detached in the VLR. The VLR sets an IMSI detached flag and rejects calls incoming to the MS. This procedure is not acknowledged nor is authentication performed.

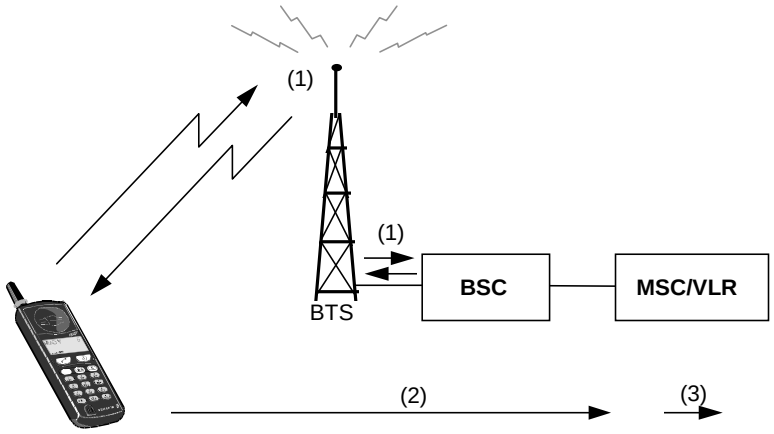


Figure 3-2 IMSI detach.

In Ericsson's GSM system, the detach information is stored in the VLR and no information is passed to the HLR. Optionally, the VLR can inform the HLR and the IMSI detached flag is set in the HLR.

LOCATION UPDATING, TYPE IMSI ATTACH

IMSI attach is a complement to the IMSI detach procedure and is used by the MS to notify the system that it was powered on, provided that it is in the same location area as it was when it entered the detached state. The system information informs the MS, if IMSI attach and detach is required or not.

This procedure is shown in Figure 3-3.

1. The MS requests a SDCCH.
2. The system receives the IMSI attach message from the MS.
3. The MSC sends the IMSI attach message to the VLR. The VLR removes the IMSI detached flag and resumes normal call handling for the MS.
4. The VLR returns the IMSI attach acknowledge message to the MSC.
5. The MS also receives an acknowledge message.

The procedure is to be used only when the IMSI detach flag is set in the VLR as is the case in Ericsson's GSM system. If the flag is set in the HLR, switching to active mode requires a normal location updating of the MS.

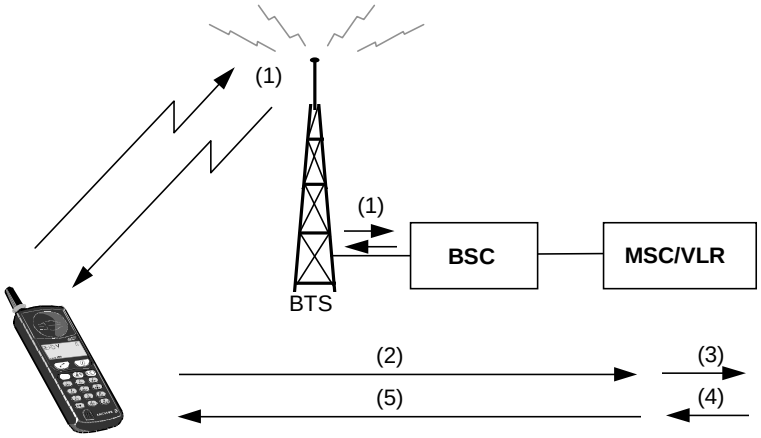


Figure 3-3 Location updating, type IMSI attach.

If the MS changes location area while detached, it must perform a normal location updating when switched on again.

The signaling for location updating, type IMSI attach is identical to normal location updating, except for some bits in the message Location Updating Request that indicate the type of updating. Authentication is optional in this case.

LOCATION UPDATING, TYPE PERIODIC REGISTRATION

Periodic registration is a type of location updating procedure that is used to avoid unnecessary paging of the mobile in cases where the MSC never receives the IMSI detach message and also to prevent damage in case of database failure. See Figure 3-4.

1. The MS is informed via the system information if periodic registration is used in the cell. If periodic registration is used, the MS is told how often it must register. The time is set by the operator and can have values from 0 to 255 deci-hours (a unit of six minutes). If the parameter is equal to zero, periodic registration is not used in this cell. If the parameter is set to ten, for example, the MS must register every hour.
2. The procedure is controlled by a timer both in the MS and in the MSC.

3a. When the timer in the MS expires, the MS performs a location updating, type periodic registration. The timers in MS and MSC restart.

3b. In the MSC there is a time scanning function for the MSs. If the MS does not register within the determined interval plus

a guard time, then the scanning function in MSC detects this and the MS is flagged as detached.

4. The MSC sends an acknowledgment to the MS.

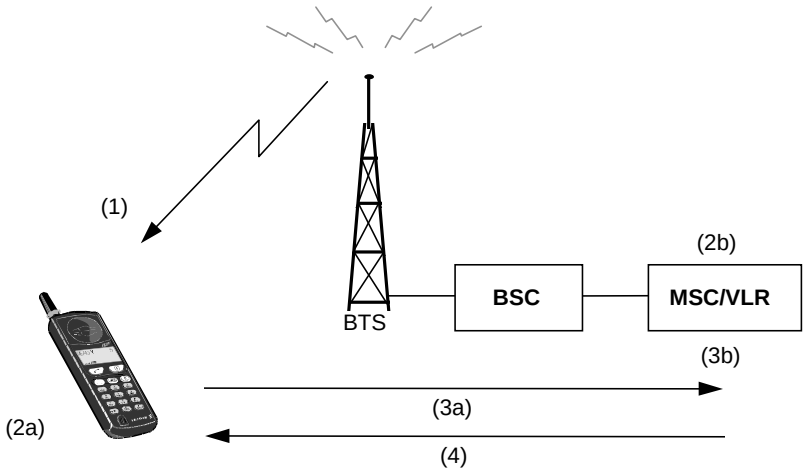


Figure 3-4 Location updating, type periodic registration.

If there is any other contact between the MS and the network the timers are reset.

MS PURGING

A subscriber who is registered in an MSC/VLR, may be deactivated by the MSC/VLR. This can be carried out in two ways:

- automatic deactivation - for example, when the MS does not have any radio contact during a certain period of time
- manual deactivation by command, in this case the IMSI-number is then specified in the command

If there is an incoming call for an MS that has been deactivated, the GMSC receives routing information from HLR and reroutes the call to the serving MSC/VLR. When the call arrives at the MSC/VLR, it fails because the subscriber information has been deleted from VLR.

Take for example a UK MS roaming in Australia and performing location updating in an Australian MSC. Later the MS travels back to UK by boat, not using the phone. Due to inactivity, the MSC/VLR deactivates the subscriber. If a caller in the UK then makes a call to the MS, the call is routed to Australia where the MSC/VLR says that the subscriber is not

available. The called subscriber is charged for an unnecessary roaming call forwarding leg.

To prevent this, the “purge MS” procedure allows the VLR to inform the HLR that the subscriber record will be removed, see Figure 3-5. The HLR then sets the MS purged flag and treats the subscriber as not reachable. In this case, if there is an incoming call for the MS, the HLR does not send a request for a roaming number to the Australian MSC/VLR and consequently, there will be no roaming leg and no unnecessary charge to the called MS.

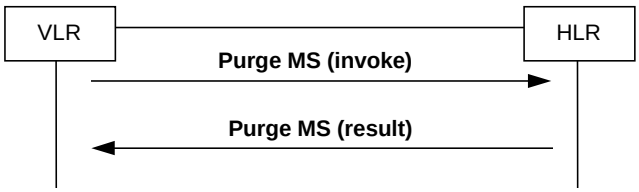


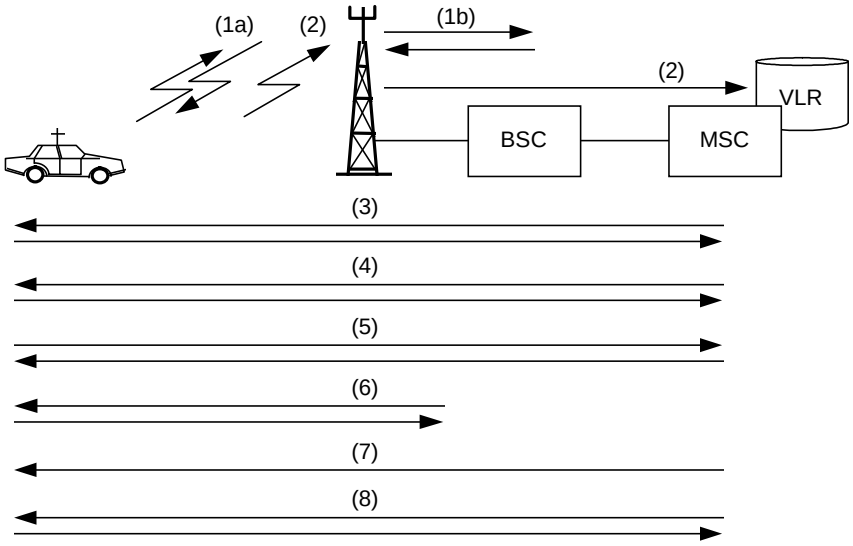
Figure 3-5 Purge MS.

CALLS

CALL FROM MS

Provided that the MS is listening to the system information in the cell and that it is registered in the MSC/VLR handling this cell, the MS can attempt to make a call. The procedures are shown in Figure 3-6.

1. The MS requests a SDCCH using the RACH.
2. The MS indicates that it wants to set up a call. The identity of the MS, IMSI, is analyzed and the MS is marked as busy in the VLR.
3. Authentication is performed as described for location updating.
4. Ciphering may be initiated.
5. The MSC receives a setup message from the MS. This information includes the kind of service the MS wants and the number (called the B number) dialed by the mobile subscriber. MSC checks that the MS does not have services like barring of outgoing calls activated. Barring can be activated either by the subscriber or by the operator. If the MS is not barred, the setup of the call proceeds.
6. Between the MSC and the BSC a link is established and a PCM TS is seized. The MSC sends a request to the BSC to assign a TCH. The BSC checks if there is an idle TCH, assigns it to the call and tells the BTS to activate the channel. The BTS sends an acknowledgment when the activation is complete and then the BSC orders the MS to transfer to the TCH. The BSC informs the MSC when the assignment is complete. The traffic control subsystem analyses the digits and sets up the connection to the called subscriber. The call is connected through in the group switch.
7. An alert message is sent to the MS indicating that a ringing tone has been generated on the other side. The ringing tone generated in the exchange on the B subscriber side is sent to the MS via the group switch in MSC. The ringing tone is sent over the air, not generated in the MS.
8. When the B subscriber answers, the network sends a connect message to the MS indicating that the call is accepted. The MS returns a connect acknowledgment, which completes the call set-up.



1a, b) RR connection establishment
2) Service request
3) Authentication
4) Ciphering mode setting
5) Call initiation
6) Assignment of a TCH
7) User alerting
8) Call accepted

Figure 3-6 Mobile originating call establishment.

Figure 3-7 shows the messages sent between the MS and the network during mobile originating call set-up.

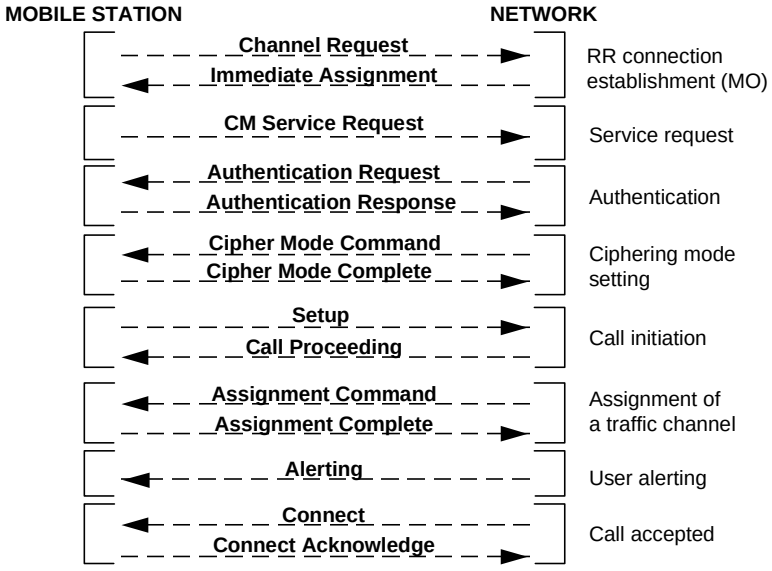


Figure 3-7 Mobile originating call establishment (early assignment).

CALL TO MS

A mobile terminated call is more complicated than a mobile originated call. This is due to the fact that the calling party does not know where the MS (called party) is located. The signaling is shown in Figure 3-8.

1. The number dialed by the calling part is called the Mobile Station ISDN number (MSISDN). In cases where a call is made from the fixed network, PSTN, the exchange analyses the number and determines that the call is for a GSM subscriber.
2. The call is routed to the GMSC in the home PLMN of the called MS.
3. By analyzing the MSISDN, the GMSC finds out which HLR the subscriber is registered in. GMSC asks the HLR for information so the call can be routed to the MSC/VLR where the MS is temporarily registered. Using the MSISDN the HLR finds the IMSI and the data record for the subscriber.

   International Mobile Subscriber Identity (IMSI) is a subscriber number (see Appendix), only used in the signaling network. The address to the serving VLR is received at registration and is stored together with IMSI in the HLR.
4. The HLR contacts the VLR to get a roaming number. This is an ordinary telephone number to the MSC/VLR. The VLR sends the roaming number to the HLR.
5. The HLR forwards the roaming number to the GMSC.

6a. With help of the roaming number, the GMSC can route the call to the appropriate MSC.

6b. The call is routed to the MSC.

   If the system has the feature ‘Call Dropback’, and this feature is supported by the national signaling scheme, the GMSC may drop the call ‘back’ to the previous node. The decision is based on the received roaming number and the capabilities of the incoming route. Then, the routes marked (2) and (6a) are released.

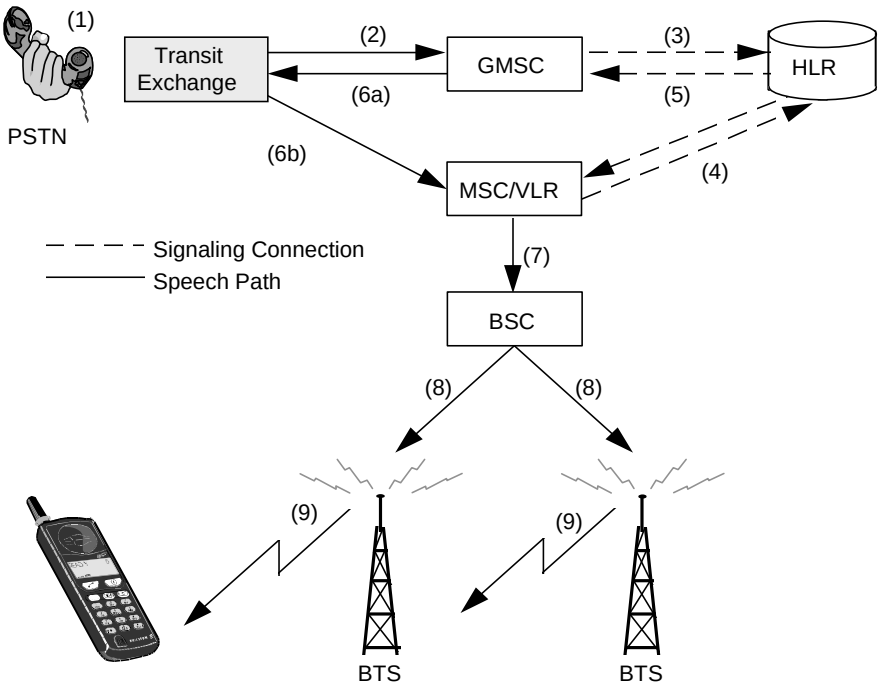


Figure 3-8 Call to MS from PSTN.

In some situations, PSTN may be used to reroute the call. In countries where there is a poorly functioning or very expensive PSTN, it might be better to build a separate network with connections between the MSCs and GMSCs.

7. The MSC knows which location area the MS is located in and sends a paging message to the BSCs handling this location area. In GSM, there are two places where information about which cells belong to the location area can be stored:

   - the MSC
   - the BSC

   In Ericsson's GSM system it is the BSC that stores this information. The MSC sends the identity of the location area and MS to the BSCs in the LA.

8. The BSC distributes the paging message to the BTSs in the LA.

9. The BTSs page the MS using IMSI or TMSI.

The MS sends a request for a SDCCH when it detects its identity in the paging message. See Figure 3-9. The MSC performs authentication and starts ciphering as described earlier. The MSC may send information to the MS about the requested services. These can for example be speech, data, fax.

The BSC orders the BTS to activate a TCH and to release the SDCCH. The MS is ordered to tune in to the frequency of the TCH. An Alerting message is sent from the MS indicating that a ringing tone has been generated in the MS. A ringing tone for the calling subscriber is generated in MSC. When the mobile subscriber answers, the MS sends a Connect message. The network completes the through connection path and sends a Connection acknowledgment to the MS. The duplex path for traffic is now open.

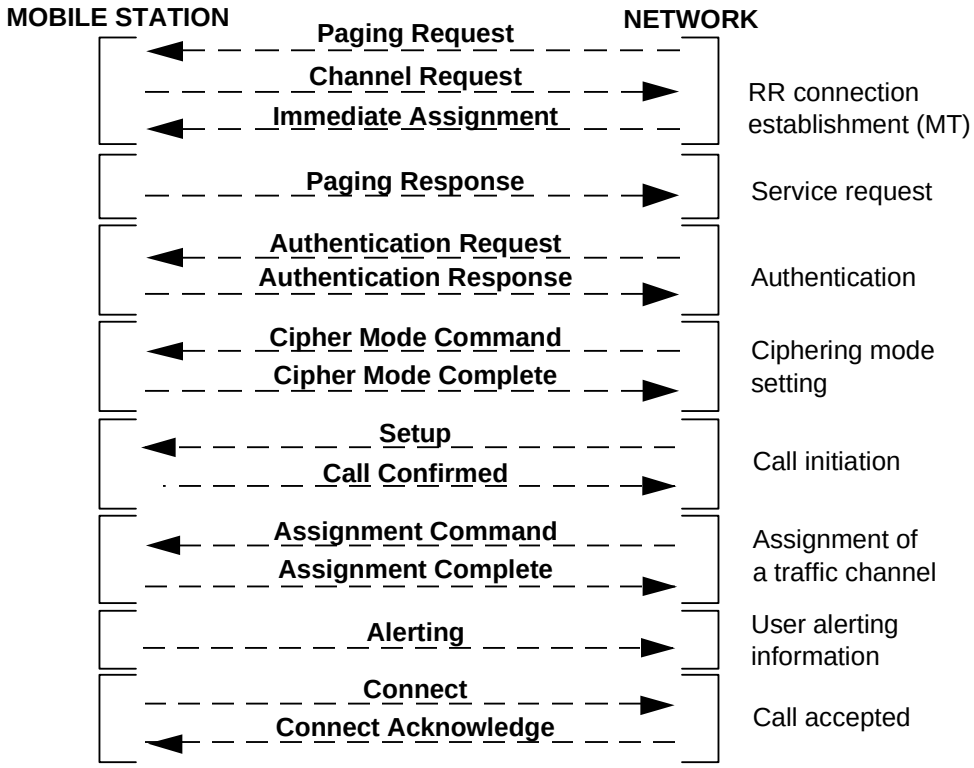


Figure 3-9 Mobile terminating call establishment.

Immediate Assignment on TCH

In the two previous traffic cases, the BSC assigns an SDCCH in the Immediate Assignment message, to be used by the MS for call set-up signaling. After call initiation the network allocates a TCH to the MS. This way of performing call set-up is called “early assignment” in the GSM specifications.

The “Immediate Assignment on TCH” function makes it possible to have more than one resource allocation strategy at call set-up. Using this function, the BSC can allocate a TCH using the Immediate Assignment message. This can be useful for example, when there is temporary congestion on the SDCCH. It allows call set-up signaling to be performed on the

TCH. When finished, the mode of the traffic channel is changed from signaling only to the mode necessary for traffic by employing a channel mode change procedure. See Figure 3-10. This means that the call set-up time can be slightly decreased, as no new channel is required.

For each traffic case indicated by the MS in the channel request message, the operator can control the allocation strategy via commands in the BSC. A choice of detail level can be made from one BSC down to individual cells.

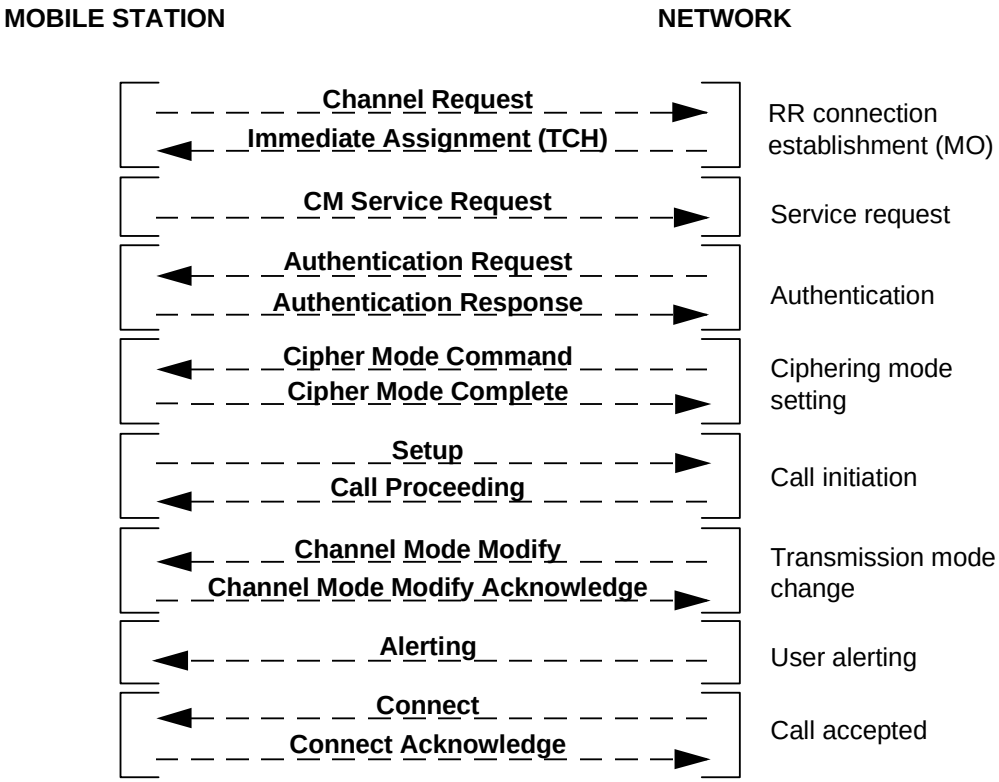


Figure 3-10 Immediate Assignment on TCH, MO call.

In the specifications, this procedure is called “very early assignment”.

INTERNATIONAL CALL TO MS

In Figure 3-11 an example of what happens when a PSTN subscriber makes an international call to a MS in the current system is shown.

1. José in Spain dials the number to his Swedish manager. He does not know that his manager is visiting Seville for an international exhibition.

2. The local exchange analyzes part of the number, determines that this is an international call and sends it further to the international exchange.
3. The international exchange analyzes the B number to find out which country to route the call to. The call is routed to an international exchange in Sweden.
4. After a new analysis the call is routed to the closest GMSC of the B subscriber's home PLMN because it is a call to a GSM telephone.
5. The GMSC, which has interrogation capability, analyzes the number to find the HLR of the MS. The GMSC interrogates the HLR for roaming number.
6. The HLR contacts the VLR where the Swedish manager is currently registered to get the roaming number, MSRN.
7. The MSRN is sent to the HLR.
8. The MSRN is passed to the GMSC.
9. The GMSC reroutes the call to the international exchange.
10. After analysis it is routed back to the international exchange in Spain.
11. The call is routed to the serving MSC/VLR.
12. The paging message is distributed to the appropriate BSCs handling the location area where the MS is registered.
13. The MS is paged.

To summarize, the call is routed from Spain to Sweden and then back again to Spain. This means unnecessary delays and costs.

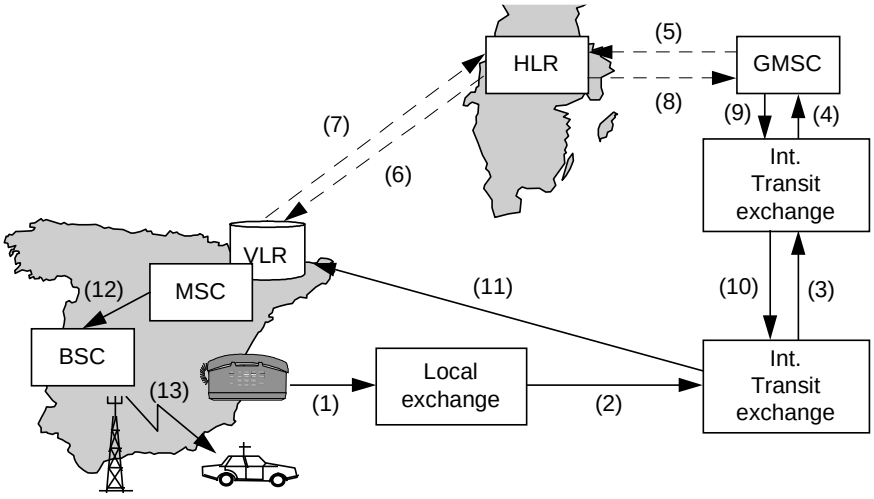


Figure 3-11 Making an international call today.

INTERNATIONAL CALL TO MS IN THE FUTURE

As illustrated in Figure 3-12 a procedure can be implemented in any exchange to determine if the B number is to a GSM subscriber. The interrogation and rerouting function can be implemented in the local exchange. The interrogation of the HLR is then carried out by the local exchange thus avoiding the unnecessary routing shown in Figure 3-11.

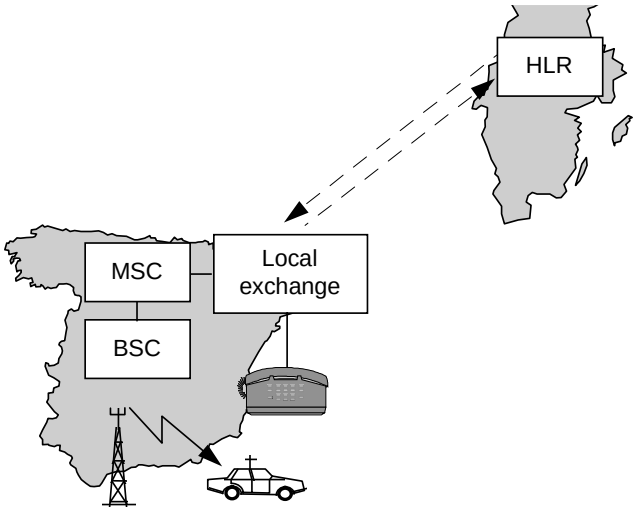


Figure 3-12 Interrogation and routing possibilities in a local exchange.

DATA CALLS

Demand for data transfer is growing rapidly. People around the world have an increasing need for communicating via fax, computer files, e-mail and for using Internet and Intranet access. Any modern telecommunication system must support these services as well as support services for traditional speech calls.

In GSM, transmission on the air interface is realized by using a digital transmission. In case of speech calls, the information must therefore be converted from analog to digital (A/D) before being sent and from digital to analog (D/A) before presenting it to the receiver. For data calls, the information to be transferred is already in digital form, so no A/D or D/A conversion is needed within the BSS.

But GSM is an access network, which means the data may have to leave the GSM environment to be transported by some other network, like PSTN or ISDN. Before leaving GSM the data must be converted into a format that can travel the accessed network. This conversion takes place in an Interworking Unit

(IWU), which can be a GSM Interworking Unit (GIWU) or Data Transmission Interface (DTI).

Accessing PSTN

Public Switched Telephony Network (PSTN) transports information in analog form. Therefore, on the GSM-PSTN border a modem is needed. Modems reside in the IWU.

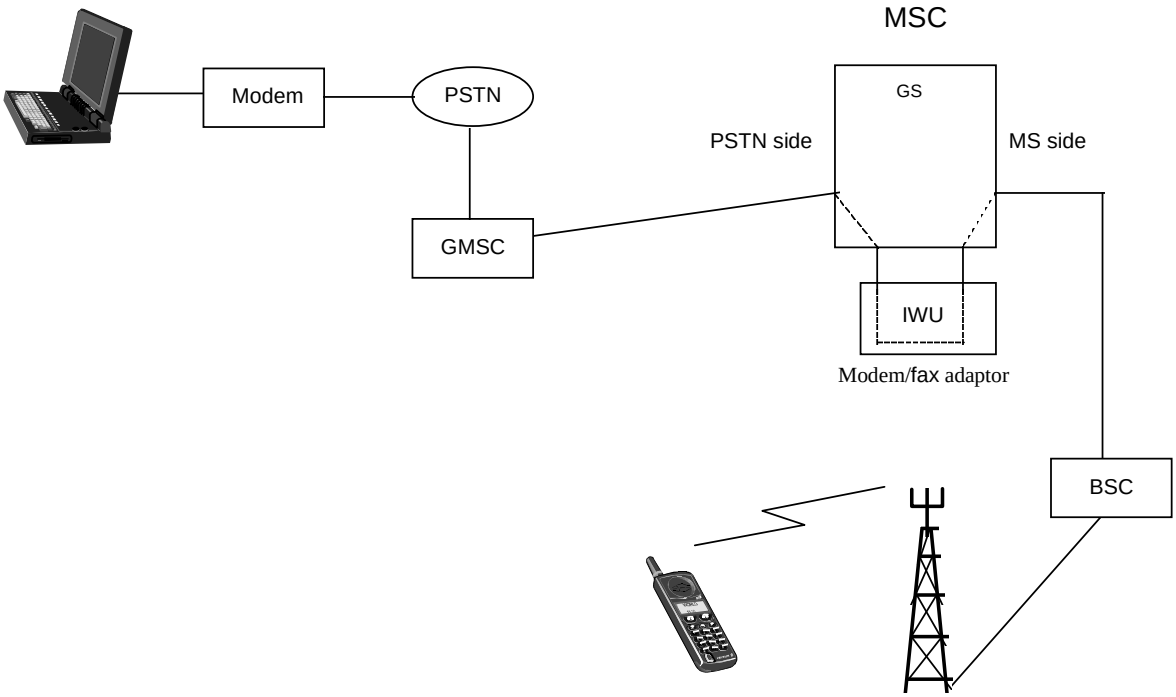


Figure 3-13 Mobile terminating data call, through PSTN

Accessing ISDN

Integrated Services Digital Network (ISDN) is a digital network. In this case no modems are needed at the GSM - ISDN border. The IWU contains functions to adapt the data to a suitable format (e.g. change the bit rate).

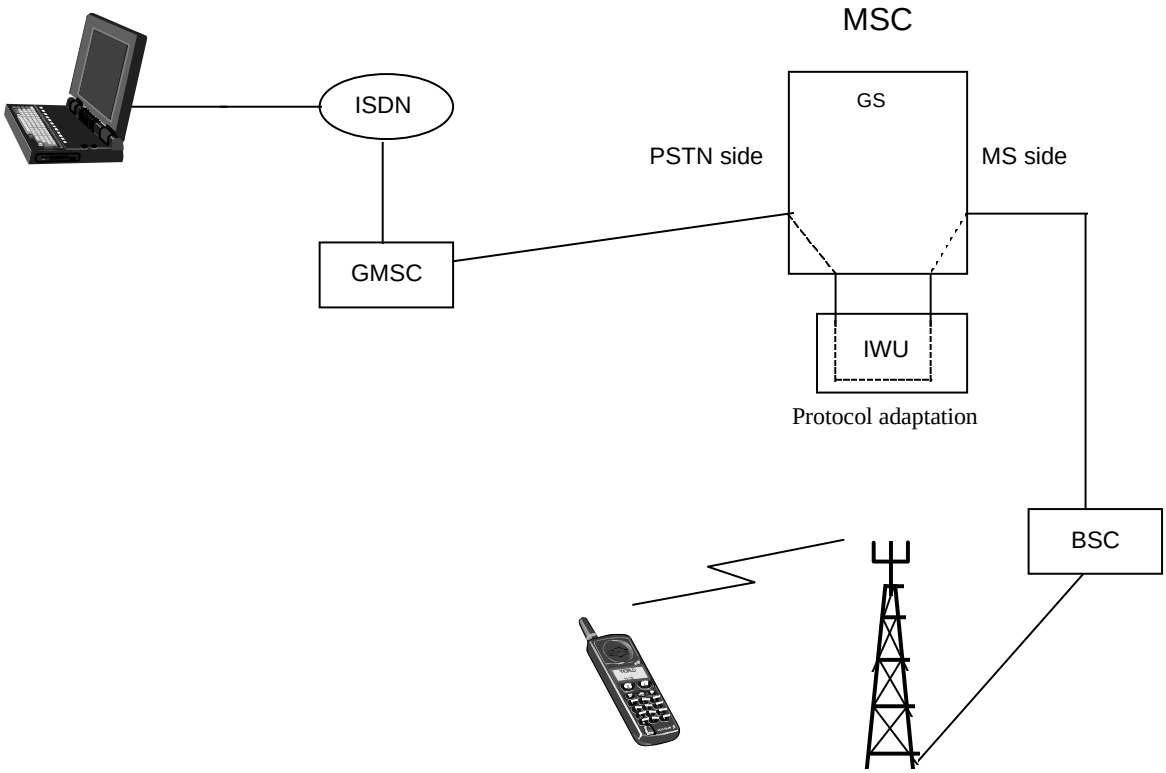


Figure 3-14 Mobile terminating data call, through ISDN

High Speed Circuit Switched Data (HSCSD)

This service enables the Mobile Station (MS) subscriber to establish a data connection with bit rates above 9.6 kbps. To achieve higher speeds, two or more timeslots in one radio channel are used, each timeslot being capable of carrying 9.6 kbps. The GSM specifications allow the subscriber to define how many channels he is willing to pay for in between 1-8. The Ericsson implementation supports a maximum of 4 timeslots, meaning a maximum of 38.4 kbps. If data compression is supported, access rates of up to 100 - 150 kbit/s can be achieved, depending on the type of user data. Throughout the call the subscriber can request a change of the number of channels he is allocated.

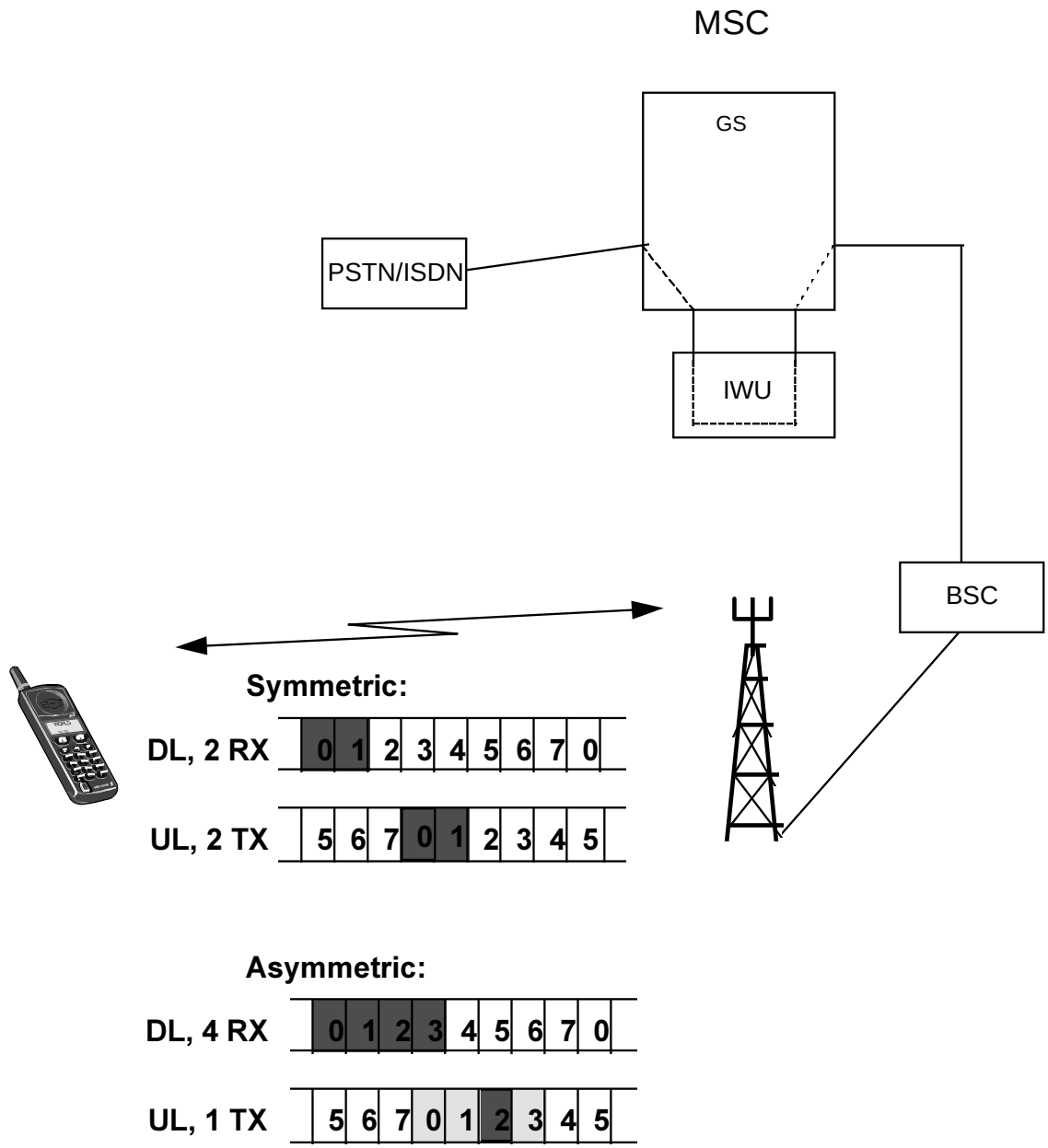


Figure 3-15 Multislot channel combination on Um for HSCSD

The HSCSD mobiles could be one of two kinds:

- symmetric, using the same number of timeslots on the uplink and the downlink, or
- asymmetric, using a different number of timeslots on the uplink and the downlink.

The asymmetric mobiles, as they are cheaper, will probably be the more popular ones.

The following services towards the fixed network are supported:

- PSTN connections supporting V.34 modems (up to 28.8 kbps)
- ISDN connections using V.110 rate adaptation (up to 38.4 kbps).

Internet Access

Use of the Internet is now more popular than the exchange of data between users. It uses the general GSM facilities for transfer of data, but requires some specific features as well.

The best way to access an outside service like the Internet is to do it by means defined in that service. For that reason the GSM nodes receive functionalities defined in and typical for the services required. In the case of the Internet (or Intranet) access the functionality is called High level Data Link Control (HDLC) encapsulation and is added to the IWU.

Another idea to improve Internet access is to go directly to an Internet provider. Presently access to the Internet by phone, be it fixed or mobile, utilizes fixed networks, mostly PSTN. In Ericsson's GSM system, a feature has been implemented to bypass PSTN by using the Direct Access feature thus eliminating unnecessary analog/digital and digital/analog conversions. In this case there is a direct connection between GSM and the Internet Service Provider.

HANDOVER

Handover takes place when an active mobile changes cells. The BSC makes the decision to change cells based on the results calculated in the locating algorithm. This algorithm evaluates the signal strength in the mobile's own cells and neighboring cells reported in the measurement results to decide whether a change of cells should be performed.

There are different types of handovers. The type of handover performed depends on the relationship between the cell handing over the call and the cell intercepting the call. Types of handovers are discussed in this chapter. A flowchart in chapter 13 shows an inter MSC handover.

INTRA BSC HANDOVER

The main steps involved in an intra BSC handover are shown in Figure 3-16. During the call, the MS measures the signal strength and quality on its own TCH and the signal strength of the neighboring cells. The MS evaluates the average value for each of these.

1. Approximately two times per second the MS sends a measurement report to the BTS with measurements from the serving cell and the best neighboring cells.
2. The BTS adds its own measurements made on the TCH, uplink and forwards the report to the BSC. In the BSC the locating function determines if it is necessary to hand over the call to another cell because of poor quality or low signal strength in the serving cell.
3. If a handover is required, the BSC orders the BTS in the new cell to activate a TCH.
4. Once the new TCH is acknowledged the BSC sends a message to the MS via the old BTS with the information about the frequency, time slot and output power to change to.
5. The MS tunes to the new frequency and sends HandOver access (HO) bursts on the appropriate TS (FACCH). The MS does not use any timing advance. This is the reason why the HO burst is short, containing only 8 bits of information.
6. When the BTS detects the HO access burst it sends physical information containing the timing advance to the MS on the FACCH. The BTS also informs the BSC by sending a HO

detection message. The new path through the group switch is through connected.

7. The MS sends a Handover Complete message.
8. The old BTS is ordered to deactivate the old TCH and its associated signaling channel (SACCH).

In the intra BSC handover procedure, the BSC handles everything without any involvement from the MSC. However, to keep track of statistics the BSC informs the MSC when a handover is performed. This is not shown in Figure 3-16.

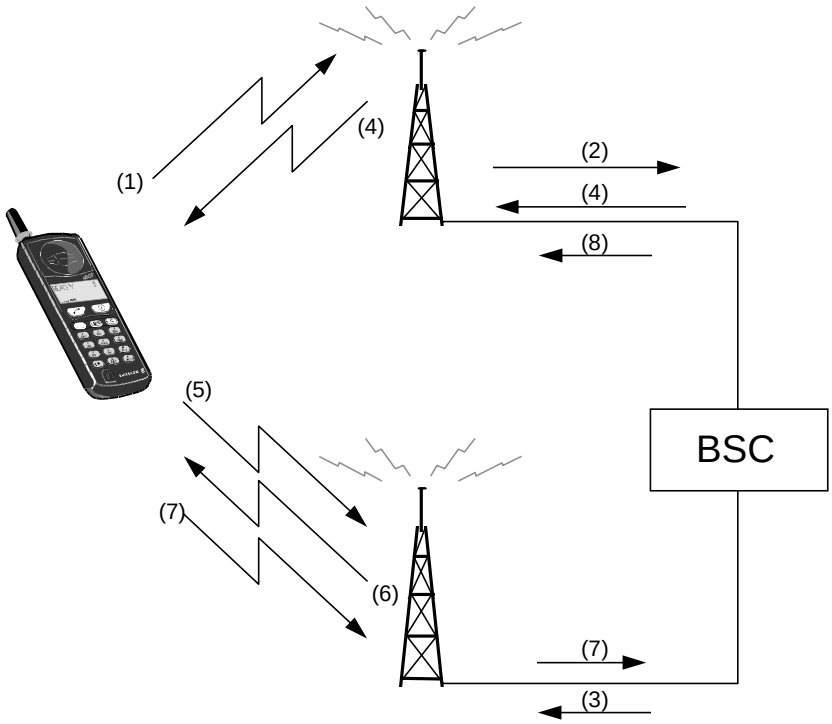


Figure 3-16 Intra BSC handover of a call.

INTER BSC HANDOVER

If the MS moves to an area covered by a cell belonging to another BSC and handover is required, an inter BSC handover takes place. See Figure 3-17.

The serving BSC decides from the measurement reports that the call must be handed over to a cell belonging to the new BSC.

1. The serving BSC sends a Handover Required message to the MSC together with the identity of the new cell. In Ericsson's GSM system, only one target cell is given to the MSC.

2. The MSC knows which BSC controls this BTS and sends a Handover Request to the new BSC.
3. The BSC orders the BTS to activate a TCH if there is one idle.
4. When the new BTS activates the TCH, the BSC sends information about the output power, TS, frequency and handover reference to the MSC.
5. The MSC passes this information to the old BSC.
6. The MS is told to change to the new TCH and also gets the handover reference in a Handover Command message.
7. The MS tunes to the new frequency and sends HO bursts, containing the handover reference, on the FACCH (new).
8. When the new BTS detects the HO access burst it sends physical information containing timing advance to the MS on the FACCH.
9. The new BTS also informs the new BSC by sending a HO detection message. The new BSC in turn informs the MSC. The new path through the group switch in the MSC is set up.
10. When the MS receives the physical information it sends a HO complete message.
11. The new BSC passes the HO complete information to the old BSC, via the MSC.
12. The old TCH and SACCH are deactivated by the BTS.

The MS gets information about the new cell on the SACCH associated with the new TCH. If the cell belongs to a new LA the MS performs a normal location updating after the call is released.

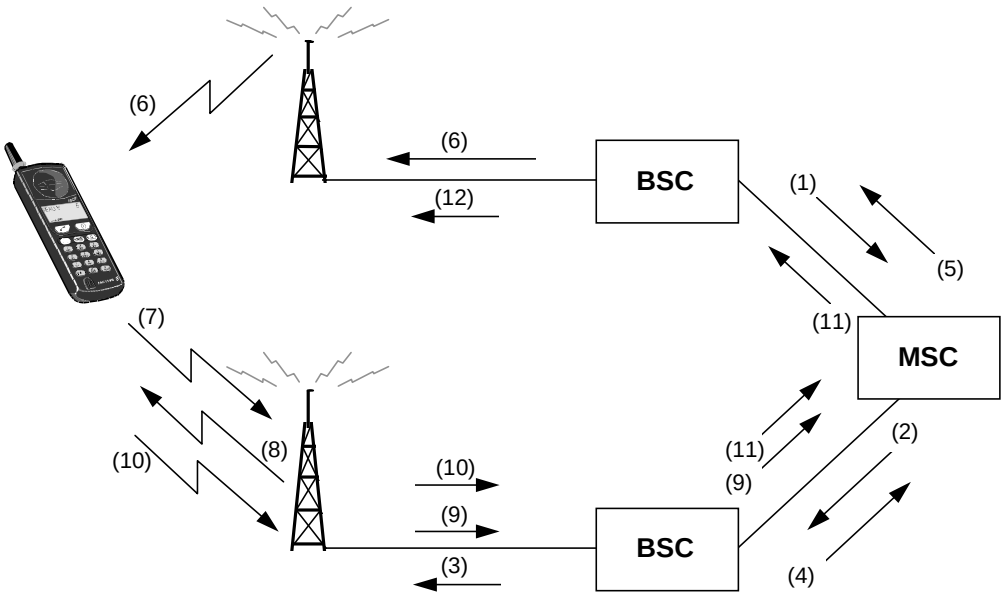


Figure 3-17 Inter BSC handover of a call.

INTER MSC HANDOVER

If, during a call, the serving BSC decides to perform a handover and the new cell belongs to another MSC, the traffic case becomes more complicated, compared to previously discussed handover cases. This is shown in Figure 3-18.

1. The serving BSC sends Handover Required to the MSC as in the inter BSC handover case.
2. The old MSC asks the new MSC for help.
3. The new MSC allocates a handover number (ordinary telephone number) in order to reroute the call. A Handover Request is sent to the new BSC.
4. The new BSC, in cases where there is an idle TCH in the target cell, tells the new BTS to activate a TCH.
5. The new MSC receives the information about the new TCH and handover reference.
6. The TCH description and handover reference is passed on to the old MSC together with the handover number.
7. A link is set up from the old MSC to the new MSC.
8. A Handover Command message is sent to the MS with information about which frequency and time slot to use in

the new cell and what handover reference to use in the HO access burst.

9a. The MS tunes to the new frequency and sends HO access bursts on the FACCH.

9b. When the new BTS detects the HO access burst it sends physical information containing timing advance to the MS on the FACCH.

10. The old MSC is informed (via, the new BSC and the new MSC) about the detection of HO bursts. The new path through the group switch in the old MSC is set-up.

11. A Handover Complete message is sent from the MS. The new BSC and MSC informs the old MSC. The old MSC informs the old BSC and the old TCH is released.

The originating MSC retains the main control of the call until it is cleared. This MSC is called the anchor MSC.

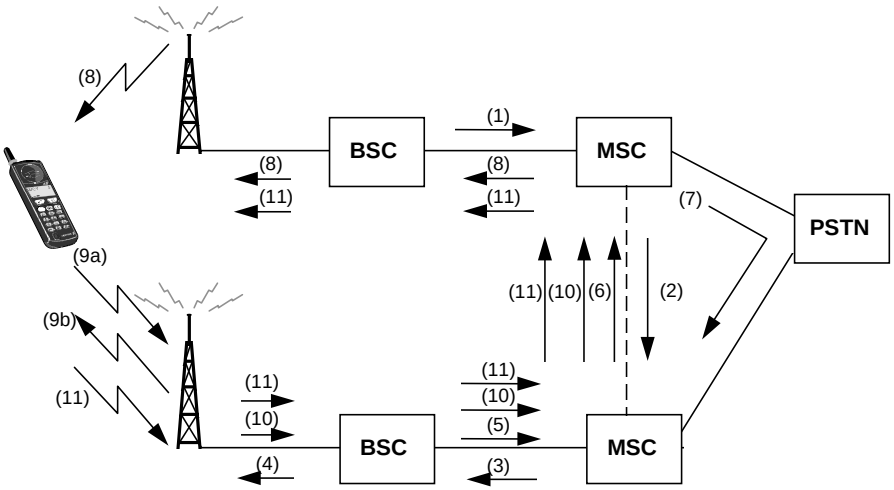


Figure 3-18 Inter MSC handover of a call.

Because the call entered a new LA the MS is required to perform a location updating when the call is released. During the location updating, the HLR is updated and sends a Cancel Location message to the old VLR telling it to delete all stored information about the subscriber.

INTRA CELL HANDOVER

The intra cell handover makes it possible to switch from one TCH to another within the same cell during a call. An intra cell handover is initiated when the channel quality is worse than expected from the signal strength level.

HANDOVER ON SDCCH

The different handover cases described here have dealt with change of TCHs. For the transfer of short messages to MSs in idle mode, a SDCCH is used.

Because SDCCH can be used for long periods, there must be a handover procedure for this case as well.

The handover procedure for the SDCCH is identical to the handover procedure used for the TCH. It can also be used during call set-up, where an SDCCH is used before the assignment of a TCH.

SHORT SPEECH INTERRUPTS AT HANDOVER

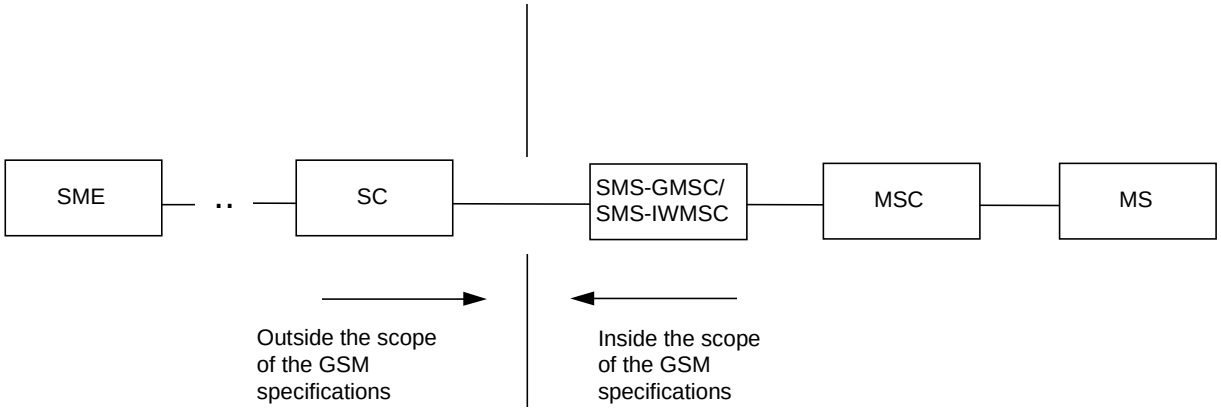
In Ericsson's GSM system the speech interrupt experienced at handover within one BSC is reduced by an optimized switching sequence in the group switch. In practice this means that there are two paths reserved for the call, BSC to old BTS and BSC to new BTS, during performance of the handover. When the handover is completed all resources associated with the old path are released.

HANDOVER POWER BOOST

In Ericsson's GSM system the number of dropped calls can be reduced. This increases the overall quality of the system by using the Handover Power Boost feature. When the BSC detects a drastic drop of signal strength (e.g. resulting from the subscriber turning a corner) it orders the BTS to send Handover Command with the maximum power allowed in the cell, thus increasing the chance for the MS to receive the message and perform a successful handover. The Handover Access Burst to the new BTS is sent by the MS with the maximum allowed uplink power.

SHORT MESSAGE SERVICE

Short Message Service (SMS) provides a means of sending text messages consisting of up to 160 alpha numeric characters from/to a GSM MS to/from a Short Message Entity (SME) via a Service Center (SC). The SME is an entity capable of sending and receiving short messages. It can for example, reside in a fixed network or in another MS. The SC acts as a store and forward center for short messages.



SME = Short Message Entity
SC = Service Center

Figure 3-19 Basic network architecture for SMS.

The functions of the SC and its interfaces are outside the scope of the GSM specifications (see Figure 3-19), but there is nothing in the specifications preventing an operator from operating a SC and including one in his network. Therefore, a GSM PLMN must support the transfer of short messages between SCs and MSs.

Two different point to point services have been defined:

- Mobile Originated (MO) SMSs are messages transported from an MS to the SC
- Mobile Terminated (MT) SMSs are messages transferred from the SC to a MS.

In the case of a MT SMS, the MSC interfacing with the SC is called SMS-GMSC. In case of a MO SMS, it is called SMS-IWMSC (InterWorking MSC). See Figure 3-19. The GMSC/IWMSC functionality can be implemented in any MSC.

Note: SMS should not be confused with cell broadcast service, which provides the ability to transfer textual messages point-to-multipoint from the BSC.

MOBILE ORIGINATED SMS

MO SMS provides the means to transfer a short message from an MS to a SMS SC. This can be done either when the MS is idle or when a connection, for example speech or fax, already exists. For both successful and unsuccessful deliveries, the MS receives a delivery report.

If the MS is in idle mode, it must first establish a signaling connection with the BSC. This is performed in the same way as during location updating or call set-up procedure. The MS sends a request for a SDCCH to the BSC which allocates an SDCCH and orders the MS to tune in to that channel.

Then the short message transfer takes place according to Figure 3-20.

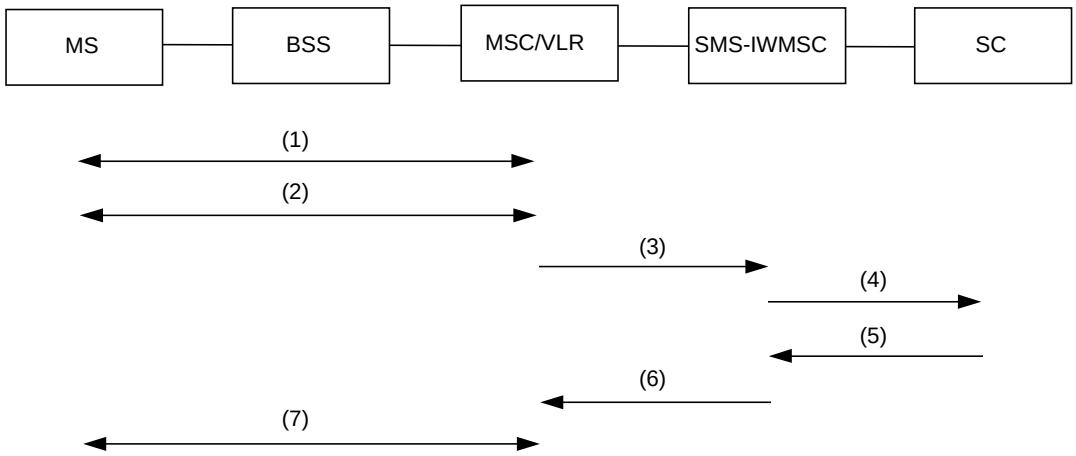


Figure 3-20 Mobile originated short message transfer.

1. The MS sends the CM Service Request message to the MSC/VLR, with the service type information element indicating SMS. The MSC/VLR may perform authentication and initiate ciphering.
2. Several protocols are involved in the short message transfer between MS and MSC/VLR. One of them is called the Control Protocol (CP). A CP Data message carries the short message from the MS to the MSC/VLR. A CP acknowledge message is returned to MS.

3. In the VLR a check is performed to see whether the subscriber has an SMS subscription and whether operator barring or supplementary services call barring is activated. When the MS has passed all checks, the short message is transferred to SMS- IWMSC.
4. The short message is transferred to the SC.

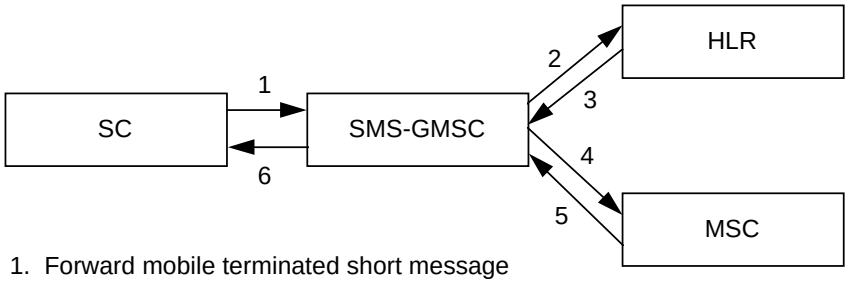
5-6. A delivery or failure report is sent back to serving MSC/VLR via SMS-IWMSC depending on whether the delivery of the short message was successful or not.

7. A CP data message carries the positive or negative acknowledgment back to MS and finally a CP acknowledgment message is returned to the MSC/VLR.

If the MS is already busy with a call when sending an SMS, the CM Service Request message (see step 1 above) is sent on the FACCH over the air. The MSC/VLR responds with a CM Service Accept message, also on FACCH. Then steps 2 through 7 are performed as in the previous case, but now SACCH is used to transfer the CP Data and Acknowledgment. messages over the air interface.

MOBILE TERMINATED SMS

The MT SMS has the capability to transfer a short message from the SMS SC to a MS. It also provides information about the delivery of the message via a delivery report or failure report. The delivery report confirms the delivery of the short message whereas the failure report informs the originator that the short message was not delivered. In the latter case, the reason for failure is included. A specific mechanism for later delivery is used at failure. The MT SMS may be input to the SMS SC by a variety of sources, for example speech, telex or facsimile or other MSs.



1. Forward mobile terminated short message
2. Send routing information for short message
3. Routing information
4. Forward short message
5. Result message
6. Result message

Figure 3-21 Successful mobile terminated short message transfer.

Figure 3-21 gives an overview of a mobile terminated short message transfer.

1. A short message to a mobile subscriber is always routed from the SC to the SMS-GMSC. This is done with the message Forward MT SMS.
2. The SMS-GMSC requests routing information from the HLR by means of the message Send Routing Information for SMS. The message contains the MSISDN of the called subscriber, the priority and the SC address.
3. The HLR looks for subscriber data, related to the received MSISDN number. Checks are performed. The result, sent back to SMS-GMSC, can either be an unsuccessful or successful event indication. Reasons for failure can be for example:

   a) Unknown subscriber, if the MSISDN is not allocated.

   b) Teleservices not provided, if SMS transfer is not provided for the mobile subscriber.

   c) Call barred, if status of the service 'Barring of incoming calls' is active (supplementary services- or operator determined barring).

   d) Absent subscriber, if location is unknown for the MS

If the short message is delivered successfully, the following routing information is sent back:

- MSC identity (a signaling address not a roaming number)
- IMSI

4. The MSC address received from the HLR is used for sending the message Forward Short Message to the MSC where the MS is currently located. In the MSC/VLR the identity of the MS is derived from the IMSI received in this message.

   Provided that the MS is registered in the MSC/VLR and not in detached state or busy, the BSS is ordered to page the MS. See Figure 3-22.

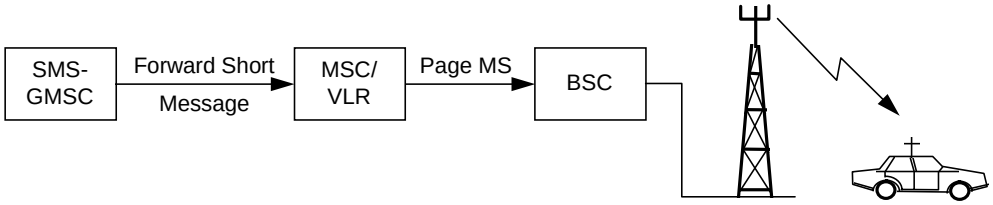


Figure 3-22 Short message transfer.

The MS is paged using the TMSI or the IMSI.

After the MS has responded to the paging, the procedures for security related functions are performed. These are for example, authentication, cipher mode setting and IMEI check are performed.

The short message is transferred to the MS on a SDCCH, if the MS is idle; and on the SACCH, if the MS is active. The transfer is made in a similar way as for MO SMS using a SAPI 3 connection, see chapter 6.

5. The successful delivery of a short message is returned to the SMS-GMSC as a result message. In case of failure, an error message is returned.
6. The delivery report is sent to the SMS SC.

Unsuccessful Mobile Terminated SMS Delivery

In cases where the MS is unreachable, i. e. there is no page response or the MS is detached; the message waiting flag is set in the MSC/VLR. An error message is then sent to the SMS-GMSC, see Figure 3-23.

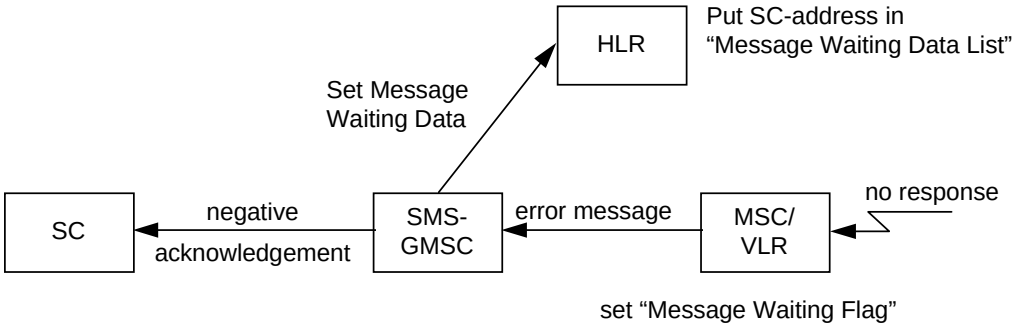


Figure 3-23 Unsuccessful SMS transfer.

When the SMS-GMSC receives the error message from MSC/VLR the message Set Message Waiting Data is sent to the HLR, requesting it to set the SC-address into the message waiting data list. The message contains the MSISDN of the called subscriber and the SC address.

If the MSISDN is known, and the message waiting data list is not full, HLR includes the SC address in the list.

After receiving the answer to the Set Message Waiting Data message, the SMS-GMSC sends a negative acknowledgment to the SC.

Note MS Present

When the MS is performing location updating and the message waiting flag in the MSC/VLR is set, the message Note MS Present is sent from MSC/VLR to the HLR. The message carries the IMSI of the MS. See Figure 3-24.

HLR looks for the subscriber data related to the IMSI number, the message waiting data list, and starts to alert the SC. This is done by sending the message Alert SC containing the SC address to SMS-IWMSC.

The SMS-IWMSC transfers the SC alert information to the SC. The reception of this information triggers a new attempt for the SMS delivery in the SC.

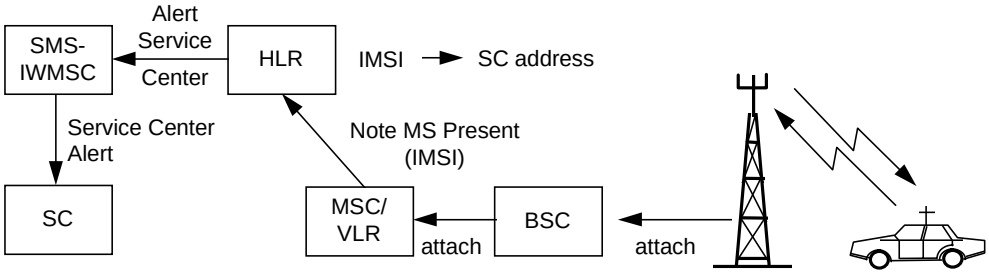
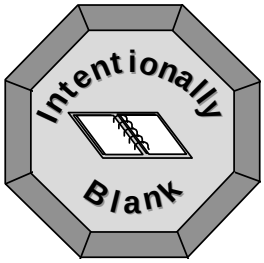


Figure 3-24 Note MS present.


Intentionally
Blank