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Nokia BSC/TCSM S11.5 Product Documentation

Basic Call

Contents

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Summary of changes

Summary of changes

Changes between document issues are cumulative. Therefore, the latest document issue contains all changes made to previous issues.

Changes made between issues 12 and 11

In Section 2.1 added information about *channel needed* information element.

In Section 2.4 *CHANNEL ACTIVATION message* added a bullet about optional encryption information.

In Section 2.6 *SCCP connection establishment procedure* added information about the contents of CONNECTION CONFIRM message.

In Section 2.9 *TCH channel activation* added a bullet about optional channel identification information.

In Section 2.10 *Channel release procedure* added a note about GPRS resumption IE.

The document has been revised throughout to comply with the latest documentation standards.

Changes made between issues 11 and 10–1

The document has been revised throughout to comply with the latest documentation standards.

Changes made between issues 10–1 and 10

Layout corrections.

1 Overview of Basic Call

Basic Call provides speech or data services to the mobile subscriber by offering the means for establishing speech or data calls with half or full rate.

Basic Call requires parameters for radio configurations. The radio parameters, which are input from the Nokia NetAct network service and management system or the MMI, are necessary for call establishment.

The use of the cell identifier is also determined with a parameter.

This document describes the procedures related to normal call establishment in the GSM, involving the BSC. It also describes the differences between establishing mobile originating calls and mobile terminating calls.

Related topics

For a detailed description of the procedures, see *Procedures in Basic Call.*

2 Procedures in Basic Call

The procedures of the Basic Call are described in the following sections.

For an overview, see *Overview of Basic Call.*

2.1 Paging procedure

The paging procedure offers the network the means to start the establishment of a mobile terminating call with a given MS.

The BSC is able to handle all cell identifier types within the PAGING message.

The BSC requires parameters for calculating the paging group.

The paging procedure is presented in the following figures.

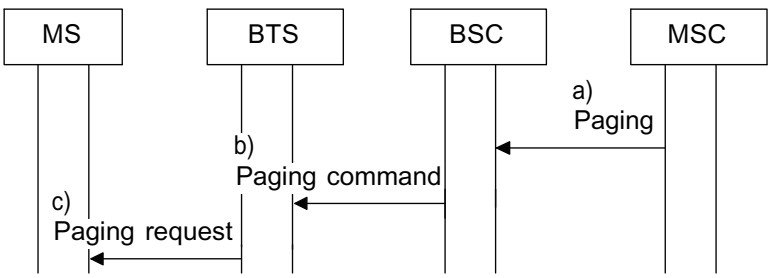

Figure 1. Paging procedure when paging comes from MSC

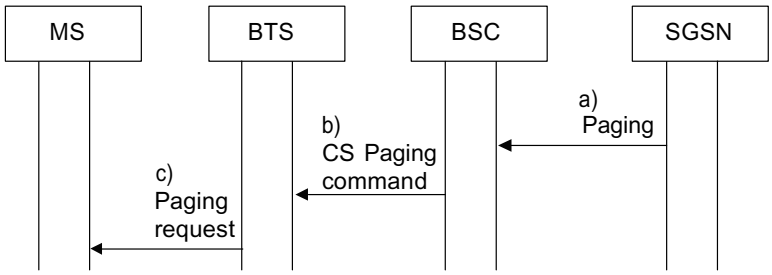

Figure 2. Paging procedure when paging comes from SGSN

In networks with GPRS capability, the PAGING message can also be routed through the SGSN. GPRS-related paging is used when paging an MS for a Circuit Switched or a Packet Switched call on a paging subchannel. The paging subgroup is calculated by the BTS. When the BSC receives paging from the SGSN, the BSC sends a CS-PAGING COMMAND or a PS-PAGING COMMAND (for packet data) to the BTS. For more information, see *(E)GPRS in BSC*.

If the BTS does not support GPRS, the BSC sends a PAGING COMMAND to the BTS. The BTS builds paging request messages and sends them on the radio path.

If the MS does not answer within a given time limit, the MSC repeats the PAGING COMMAND message.

PAGING message

If the BSC receives the PAGING message from the MSC (a), the PAGING message includes the following data:

- message type
- MS identity IE (IMSI)
- temporary MS identity (TMSI) (optional)
- cell identifier list (optional)
- channel needed (optional).

The cell identifier list identifies the cells where the PAGING message is sent. The BSC is able to handle all cell identifier types. If no cell identifier is included, the BSC pages the mobile in all cells it controls.

The Channel Needed information element is used to indicate to the mobile station which channel will be needed for the transaction linked to the paging procedure. The inclusion of the *channel needed* element depends on the MSC.

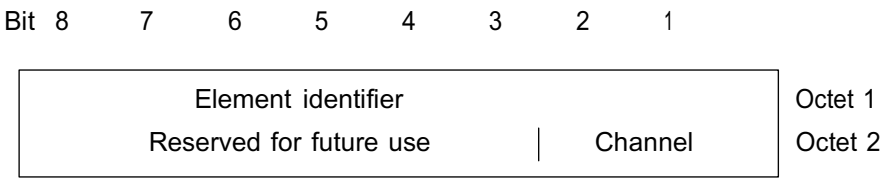

Figure 3. Channel needed information element

The Channel Field (bits 1-2 of octet 2) indicates the further combination of channel which will be needed. It is coded as follows:

Value	Channel Needed
00	Any Channel
01	SDCCH
10	TCH/F (Full rate)
11	TCH/F or TCH/H (Dual rate)

Figure 4. Values of Channel Field bits

PAGING COMMAND message

The PAGING COMMAND message includes the following data:

- message header
- paging group
- MS identity
- channel needed (optional).

The BSC uses the IMSI value received in the PAGING message to calculate the mobile's paging group and sends the PAGING COMMAND (b) message to the BTS. Consequently, the BTS uses the *paging group* element included in the PAGING COMMAND message to calculate which DRX paging block to use to transmit the paging request message (c) to the MS.

The CCCH has two alternative configurations that are described below. The CCCH configuration affects the value of the *paging group* information element that is included in the PAGING COMMAND message. The maximum value of the *paging group* element is 81.

i BCCH + CCCH in a 51-frame multiframe 9 CCCH block

ii BCCH + CCCH + 4 SDCCH (stand-alone dedicated control channel) 4 in a 51-frame multiframe 3 CCCH block

Paging Gp= ((IMSI mod 1000) mod (BS_CC_CHANSx N)) mod N

N= number of paging blocks available in one 51-frame multiframe on one CCCH x BS_PA_MFRMS

BS_PA_MFRMS=
number of multiframes

BS_CC_CHANS=
number of CCCH channels in a TRX

BS_AG_BLKS_RES=
number of blocks reserved for access grant, ranges from 0-7 in configuration (i), 0-2 in configuration (ii)

N= (9-BS_AG_BLKS_RES)*BS_PA_MFRS, if CCCH_CONF=0 configuration (i)

N= (3-BS_AG_BLKS_RES)*BS_PA_MFRS, if CCCH_CONF=1 configuration (ii)

The value of the `BS_CC_CHANS` parameter varies according to the value of the `CCCH_CONF` parameter, as shown in the following figure.

CCCH_CONF	BS_CC_CHANS
000	1
001	1
010	2
100	3
101	4

Figure 5. Relation of BC_CC_CHANS and CCCH_CONF values

If the PAGING message includes both a TMSI and IMSI, the TMSI is used. The TMSI is a locally used number inside one Location Area which replaces the IMSI number in call setup. The TMSI improves security and ensures that any significant subscriber information, such as the IMSI, cannot be discovered during call setup.

The *channel needed* element is optional: if the *channel needed* element is not present, its value is assumed to be 00 (any channel).

CS-PAGING COMMAND message

The CS-PAGING COMMAND message includes the following data:

- message header
- MS identity
- DRX parameter (optional)
- temporary MS identity (optional)
- channel needed (optional).

MS identity IE (IMSI) is a mandatory element. The DRX parameter and the temporary MS identity (TMSI) elements are optional. The *channel needed* element is also optional: its inclusion depends on the MSC. If the *channel needed* element is not present, its value is assumed to be 00 (any channel).

PS-PAGING COMMAND message

The PS-PAGING COMMAND message includes the following data:

- message header
- MS identity
- DRX parameter (optional)
- (temporary) MS identity (optional).

2.2 Channel required procedure

The channel required procedure offers the MS the means to start the establishment of a mobile originating call or to answer the PAGING REQUEST message.

The channel required procedure is presented in the following figure.

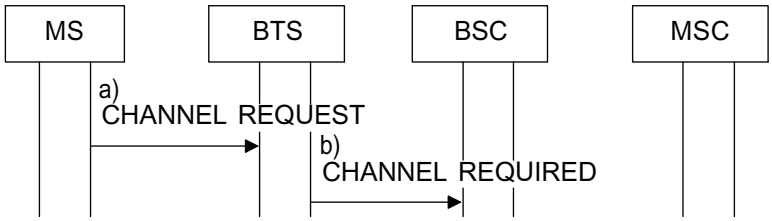

Figure 6. Channel required procedure

CHANNEL REQUEST message

The MS uses the CHANNEL REQUEST message to request for a dedicated signalling channel SDCCH. It sends the CHANNEL REQUEST message (a) to the BTS on the RACH . The message is sent in random mode and it consists of two different information elements that are coded as follows:

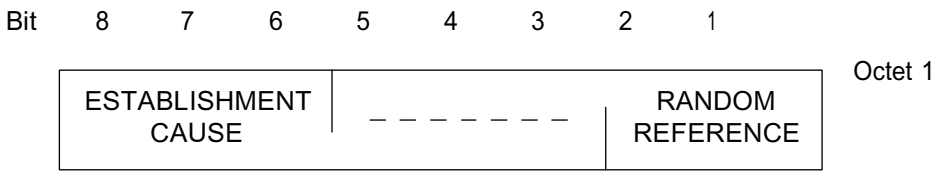

Figure 7. CHANNEL REQUEST message, only one octet long

The *establisment cause* information field indicates the reason for requesting the establishment of a connection. This field has a variable length (from 3 bits up to 6 bits). The *random reference* is an unformatted field with variable length (from 5 bits down to 2 bits). The *establisment cause* information field length is 3 when the MS is GSM phase 1 level or when the MS is GSM phase 2 level and the NECI (New establishment causes support) parameter is set to OFF.

The following establishment causes are supported (the *random reference* field is marked with *x* s):

MESSAGE 8 1	MEANING OF ESTABLISHMENT CAUSE
000xxxxx	Other procedures. (SDCCH)
100xxxxx	Answer to paging. (SDCCH)
101xxxxx	Emergency call. (SDCCH)
110xxxxx	Call re-establishment. (SDCCH)
111xxxxx	Originating call. (SDCCH)
0010xxxx	Answer to paging. Dual rate MS and TCH/F is requested. (TCH/F or SDCCH)
011xxxx	Answer to paging. Dual rate MS and TCH/H or TCH/F is requested. (TCH/H, TCH/F or SDCCH)

Figure 8. NECI parameter is set to OFF

MESSAGE 8 1	MEANING OF ESTABLISHMENT CAUSE
0000xxxx	Location updating. (SDCCH needed)
0001xxxx	Other procedures which can be completed with an SDCCH.
100xxxxx	Answer to paging. (SDCCH or TCH/F)
101xxxxx	Emergency call. (SDCCH or TCH/F)
110xxxxx	Call re-establishment. (SDCCH or TCH/F)
111xxxxx	Originating call. (SDCCH or TCH/F)
0010xxxx	Answer to paging. Dual rate MS and TCH/F is requested. (TCH/F or SDCCH)
0011xxxx	Answer to paging. Dual rate MS and TCH/H or TCH/F is requested. (TCH/H, TCH/F or SDCCH)
0100xxxx	Originating speech call from dual rate MS when TCH/H is sufficient. (TCH/H, TCH/F or SDCCH)
0101xxxx	Originating data call from dual rate MS when TCH/H is sufficient. (TCH/H, TCH/F or SDCCH)
011010xx	Call re-establishment; TCH/H was in use and the network sets NECI bit to 1. (TCH/H, TCH/F or SDCCH)

Figure 9. NECI parameter is set to ON

The network uses the random reference and the MS access slot number to identify and to address the MS.

The MS starts the GSM timer T3120 and waits for its access acceptance, which is an IMMEDIATE ASSIGNMENT message on the AGCH.

If the MS access is not granted within the time limit defined by T3120, the MS makes a second attempt and sends another CHANNEL REQUEST message with a new random reference on the next time slot. A new value of the GSM timer T3120 is computed and used. The MS repeats this procedure either until it is granted access or until the number of repetitions reaches the set maximum.

CHANNEL REQUIRED message

When the MS requests a dedicated resource by sending a random access, the BSC verifies that the distance between the MS and the BTS is not too long. By verifying this distance the BSC can detect some random accesses which are caused by white noise or co-channel interference, and therefore the BSC can also reject these accesses. This is a general functionality in the BSC.

After receiving the proper CHANNEL REQUIRED message (b) from the BTS, the BSC starts to allocate an SDCCH channel.

The CHANNEL REQUIRED message includes the following data:

- message discriminator: common channel management
- message type: channel required
- channel number: uplink CCCH (RACH)
- request reference: establishment cause, random reference received in the access request and the frame number on which it was received
- access delay: delay of the access burst as measured by the BTS.

2.3 Channel reservation procedure

After receiving the CHANNEL REQUIRED message from the BTS or the ASSIGNMENT REQUEST message from the MSC, the BSC starts searching for a relevant channel:

- After receiving the CHANNEL REQUIRED message, the BSC starts to search for a dedicated channel. If a channel is available in the cell where the original access came from, the BSC reserves it and starts the immediate assignment procedure. In a normal instance of a Basic Call the target channel is the SDCCH.
- After receiving the ASSIGNMENT REQUEST message from the MSC, the BSC starts to search for a TCH channel. If one is available in the cell comprising the SDCCH connection, the BSC reserves it and starts the assignment procedure. If no TCH channels are available, the TCH channel request is queued and when any one of the TCH channels in this cell is released, the BSC reserves it for the assignment procedure.

The BSC can allocate SDCCH or TCH channels as follows. The number of the TCH and SDCCH channels depends on the radio configuration.

- SDCCH, TCH/F or TCH/H channel in case of a CHANNEL REQUIRED message. For more information, see *Half Rate in BSC*.
- TCH/F or TCH/H channel in case of an ASSIGNMENT REQUEST message.
- SDCCH, TCH/F or TCH/H channel in case of a handover.
- Up to four TCH/F channels in case of a high speed circuit switched data call. For more information, see *HSCSD and 14.4 kbit/s Data Services in BSC*.

2.4 Channel activation procedure

After a successful reservation of a new SDCCH channel, the BSC activates it by sending the CHANNEL ACTIVATION message to the BTS. The GSM timer T9103 is used to supervise the channel activation procedure.

The BTS acknowledges a successful channel activation with the CHANNEL ACTIVATION ACK message. If the BTS refuses to activate the new channel, it sends a CHANNEL ACTIVATION NACK message to the BSC, including the reason for the failure.

If the BSC does not receive a CHANNEL ACTIVATION ACK or CHANNEL ACTIVATION NACK message within the time limit defined by the GSM timer T9103, it releases the dedicated radio channel by sending a RF CHANNEL RELEASE message to the BTS. The same applies also when the BSC receives the CHANNEL ACTIVATION NACK.

The channel activation procedure is presented in the following figure.

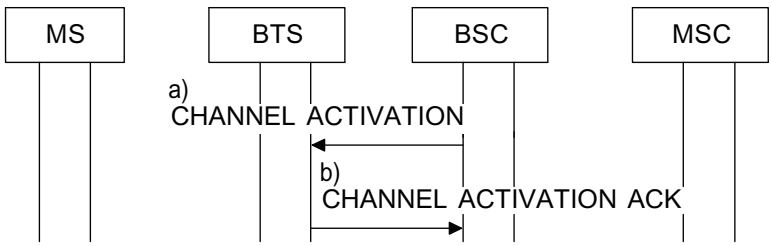

Figure 10. Channel activation procedure

CHANNEL ACTIVATION message

The BSC sends the CHANNEL ACTIVATION message to the BTS in order to activate the new SDCCH channel.

The CHANNEL ACTIVATION message includes the following data:

- message discriminator: dedicated channel management
- message type: channel activation
- channel number
- activation type
- channel mode: DTX control and channel type
- BS power: maximum BS power level authorised in the cell (optional)
- MS power: maximum MS power level authorised in the cell (optional)
- timing advance to be used by MS in subsequent communications (optional)
- SACCH information (optional).

The SACCH information is used in dual band cell or when IMSI Based Handover is enabled in the BSC. The other optional elements are always present. For more information, see *Dual Band Network Operation* or *IMSI-Based Handover*.

CHANNEL ACTIVATION ACK message

The BTS acknowledges a successful channel activation with the CHANNEL ACTIVATION ACK message. The BTS starts the transmission and reception on the associated SACCH using the power levels and the timing advance received in the CHANNEL ACTIVATION message.

The BTS acknowledges a failure with the CHANNEL ACTIVATION NACK message. The possible causes for a failure are listed below:

- radio resource not available
- radio channel already activated/allocated
- protocol error and subclause, such as mandatory information error
- O & M intervention in cases when the channel cannot be used for O & M reasons
- ciphering algorithm not supported
- equipment failure

- service or option not available
- not implemented unspecified
- mandatory IE error
- general IE error.

For more information, see *ETS 300 596 Digital cellular telecommunications system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 3 specification.*

2.5 Immediate assignment procedure

The IMMEDIATE ASSIGN message facilitates the assignment of the MS onto an SDCCH channel. Correspondingly, the IMMEDIATE ASSIGN REJECT message facilitates the refusal of the access: if the SDCCH channel reservation or activation fails, the BSC sends the IMMEDIATE ASSIGN REJECT message to the MS. The GSM timer T3101 supervises the immediate assignment procedure.

The immediate assignment procedure is presented in the following figure:

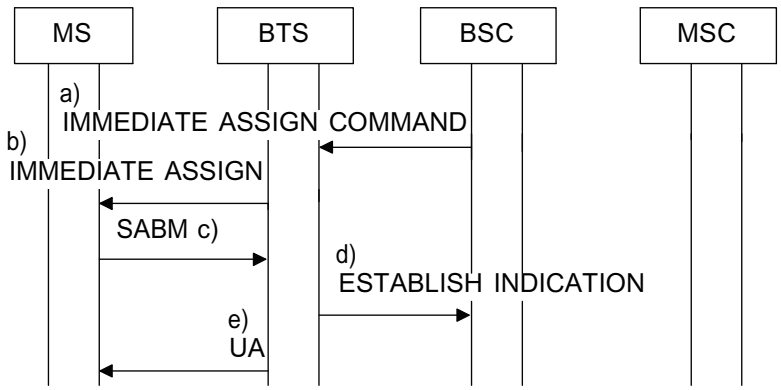

Figure 11. Immediate assignment procedure

IMMEDIATE ASSIGN COMMAND message

After a successful SDCCH channel activation, the BSC sends the IMMEDIATE ASSIGN COMMAND message (a) to the BTS. This message contains the IMMEDIATE ASSIGN message which the BTS sends to the MS.

The IMMEDIATE ASSIGN COMMAND message includes the following data:

- message header
- message type
- channel number
- immediate assign information.

The immediate assign information contains the complete IMMEDIATE ASSIGN message:

- pseudo length
- message header
- page mode: normal paging
- channel description of the allocated SDCCH, the associated SACCH and hopping frequency
- request reference as sent by the MS in the channel request
- initial timing advance
- mobile allocation, if frequency hopping is used
- rest octet.

IMMEDIATE ASSIGN message, SABM, UA frame

After receiving the IMMEDIATE ASSIGN message, the MS tunes to the assigned SDCCH and starts to establish the signalling link across the network. The MS sends the layer 2 SABM to the BTS on the SDCCH. The SABM (c) contains a layer 3 service request message. The MS specifies the required service type to the network with the service request message.

The service request message includes one of the following:

1. CM SERVICE REQUEST - for mobile originated calls and mobile originated SMSs - contains:
   - header
   - CM service type: MO call/SMS/SS/ emergency call
   - ciphering key sequence number
   - MS classmark 2
   - mobile identity.
2. LOCATION UPDATING REQUEST
3. IMSI DETACH

4. PAGING RESPONSE - for mobile terminated calls and mobile terminated SMSs - contains:
   - header
   - ciphering key sequence number
   - MS classmark 2
   - mobile identity.
5. CM RE-ESTABLISHMENT REQUEST
6. Emergency setup

The BTS acknowledges the SABM by sending the UA frame (e) to the MS. The MS expects this acknowledgement within time T; otherwise it acts as described in *I-ETS 300 022-1 European digital cellular telecommunications system (Phase 1); Mobile radio interface layer 3 specification.*

ESTABLISH INDICATION message

The BTS forwards the MS service request to the BSC in the ESTABLISH INDICATION message (d), which includes the following data:

- message discriminator: radio link layer management
- message type: establishment indication
- channel number: SDCCH + AGCH
- link identifier: main signalling channel SDCCH
- L3 Information: complete L3 service request as received from the MS.

Having received the ESTABLISH INDICATION message, the BSC starts the handover algorithm for SDCCH and starts to initiate the network connection for the MS.

Abnormal cases

If the SDCCH channel reservation or activation fails, the BSC sends the IMMEDIATE ASSIGN COMMAND message including an IMMEDIATE ASSIGNMENT REJECT message to the MS(s). The BSC can reject up to four mobiles with one IMMEDIATE ASSIGNMENT REJECT message assuming that the CHANNEL REQUEST messages have arrived within a fixed time limit.

The IMMEDIATE ASSIGN COMMAND message contains the complete IMMEDIATE ASSIGNMENT REJECT message:

- pseudo length
- message header
- page mode: normal paging
- request reference as sent by the MS in the channel request
- rest octet.

If the BTS is for some reason unable to send the IMMEDIATE ASSIGNMENT message to the MS, the BTS sends the DELETE INDICATION message to the BSC. The DELETE INDICATION message includes the following fields:

- message type
- channel number
- full immediate assign information.

After receiving the DELETE INDICATION message, the BSC releases the dedicated radio channel by sending the RF CHANNEL RELEASE message to the BTS.

If the ESTABLISH INDICATION message received during call setup is either empty or corrupted, the call attempt will be cleared and all resources released.

2.6 SCCP connection establishment procedure

The BSC starts to initiate the SCCP connection for the MS after receiving the ESTABLISH INDICATION message for the SDCCH establishment from the BTS. The GSM timer T9105 is used to supervise this procedure. If the SCCP link establishment fails, the BSC releases all resources related to this transaction.

The SCCP connection establishment procedure is presented in the following figure:

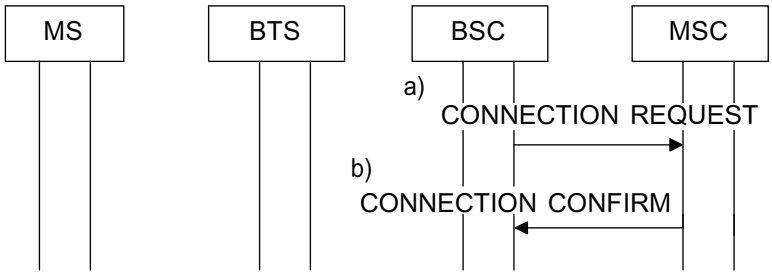

Figure 12. SCCP connection establishment procedure

The BSC transfers the L3 information received in the ESTABLISH INDICATION message transparently to the MSC in a CONNECTION REQUEST message (a). It starts the GSM timer T9105 to supervise the procedure.

The MSC acknowledges the CONNECTION REQUEST message with the CONNECTION CONFIRM message (b). This message can contain L3 information or COMMON ID information if IMSI Based Handover is enabled. In this case COMMON ID information contains IMSI information.

If the MSC refuses the CONNECTION REQUEST , it sends a CONNECTION REFUSE message to the BSC.

2.7 Transmission of transparent L3 messages procedure

Transparent messages are used in communication between the MS and the MSC. The BTS and the BSC forward the transparent messages.

The transmission of transparent messages is presented in the following figure:

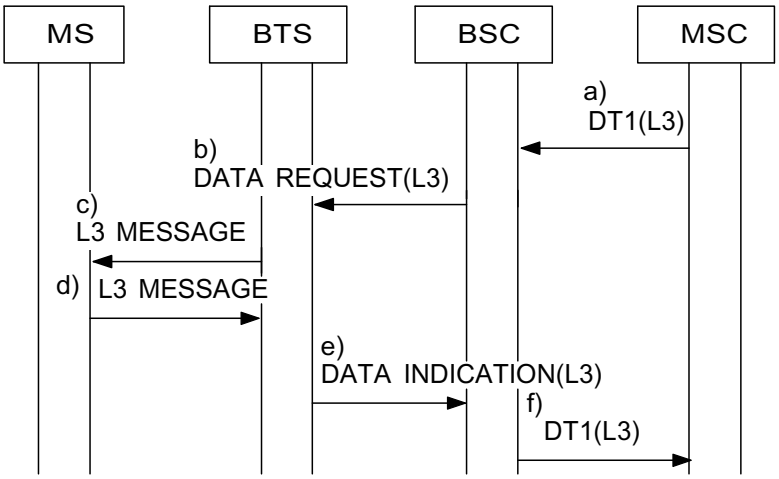

Figure 13. Transmission of transparent L3 messages

Transmission of transparent L3 messages from MSC to MS

The MSC sends the DATA FORM 1 (DT1) message (a) to the BSC. This message contains the complete layer 3 information message to be sent to the MS. If the transparent bit equals one, the BSC forwards the complete layer 3 information message to the BTS inside the DATA REQUEST message (b). For more information, see *ETS 300 589 European digital cellular telecommunications system (Phase 2); Signalling transport mechanism specification for the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface.* The BTS forwards the L3 information to the MS in a relevant message (c).

Transmission of transparent L3 messages from MS to MSC

The MS sends the L3 information message (d) to the BTS. The BTS forwards the L3 information inside the DATA INDICATION (e) message to the BSC. If the transparent bit equals one, the BSC forwards the L3 message to the MSC inside the DT1 message (f). For more information, see *ETS 300 589 European digital cellular telecommunications system (Phase 2); Signalling transport mechanism specification for the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface.*

2.8 Ciphering procedure

Ciphering is one of the security procedures designed to protect the subscriber identity and data. It is an optional procedure in GSM. When ciphering is active, all information exchanged between the mobile and the network on the dedicated radio channels is encrypted. The key previously set between the network and the MS is used to encipher and to decipher the encrypted information.

The authentication procedure checks the MS identity in order to prevent unauthorised use. During the procedure the ciphering key Kc is set between the network and the MS. Ciphering is initiated after the ciphering key is set on the dedicated signalling channel (SDCCH or FACCH).

The GSM uses stream ciphering, which means that the data flow transmitted on the SDCCH/TCH is the binary bit by bit addition of the user data flow to a ciphering bit stream. For more information, see *ETS 300 534 Digital cellular telecommunications system (Phase 2); Security related network functions.*

In an MSC-controlled handover, the MSC tells the new BSS whether encryption is required in the HANDOVER REQUEST.

In a BSC-controlled handover, the BSC passes the encryption information to the target BTS on the activation of the channels if the encryption information was received from the MSC.

The ciphering procedure is presented in the following figure:

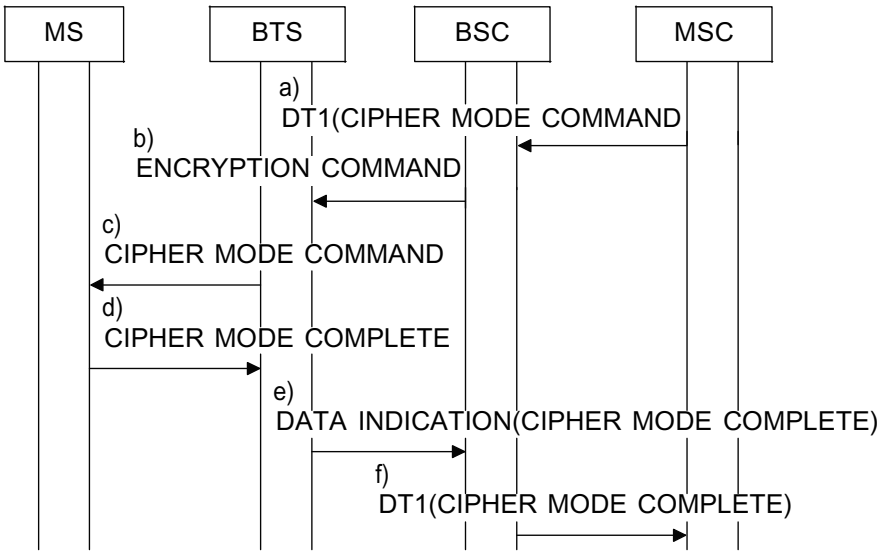

Figure 14. Ciphering procedure

CIPHER MODE COMMAND message

The MSC sends the CIPHER MODE COMMAND message (a) to the BSC to indicate whether ciphering is required and if so, to indicate the ciphering key.

The CIPHER MODE COMMAND message (from the MSC to the BSC) contains the following data:

- message type
- layer 3 header information
- encryption information: permitted algorithms and ciphering key
- cipher response mode.

The message contains the encryption instruction and the L3 header information for the MS.

When ciphering is required, the encryption information element contains information for the BTS to load the encryption device with the appropriate key.

ENCRYPTION COMMAND message

On receiving the CIPHER MODE COMMAND message, the BSC selects the algorithm to be used according to the list of permitted algorithms included in the message and the algorithms that are supported by that particular BSS. See *Support for different ciphering algorithms* for details.

Regardless of whether ciphering is to be activated, the BSC stores the encryption information, including the selected algorithm for possible subsequent handovers, and passes the encryption information to the BTS in the ENCRYPTION COMMAND message (b).

The ENCRYPTION COMMAND message contains the following data:

- message header
- encryption information: selected algorithm and ciphering key
- link identifier
- L3 ciphering mode command to MS
- message header
- cipher mode setting: no ciphering/start ciphering
- cipher response: the cipher response element is used if received from the MSC (optional).

The BTS analyses the ENCRYPTION COMMAND . If encryption is required, the BTS activates the demodulator to decipher. Regardless of whether ciphering is required, the BTS sends the CIPHER MODE COMMAND message (c) to the MS.

CIPHER MODE COMPLETE message

The MS starts to decipher and to encipher using its available ciphering key. It then returns to the BTS, in encrypted form, the CIPHER MODE COMPLETE message (d) or the next message it is due to send. The message includes the IMEI, if required by the MSC.

On receiving the CIPHER MODE COMPLETE message (or any correctly enciphered layer 2 frame), the BTS starts enciphering and forwards the message via the BSC to the MSC (f). For more information, see *I-ETS 300 022-1 European digital cellular telecommunications system (Phase 1); Mobile radio interface layer 3 specification.*

If the ciphering procedure fails, the MSC takes the appropriate action.

Support for different ciphering algorithms

The MSC may send a list of permitted ciphering algorithms to the BSC in the CIPHER MODE COMMAND message. The BSC selects the algorithm to be used from this list according to those algorithms that are supported by the BSS. If the BSS can support several algorithms, the BSC makes the selection according to the following preference:

1. A5/1
2. A5/2
3. A5/0 (no ciphering).

Algorithms other than those mentioned above cannot be used.

If the BSS cannot support any of the permitted algorithms, the BSC sends the CIPHER MODE REJECT message to the MSC. The MSC then decides on further action.

2.9 Assignment procedure

The assignment procedure is used to assign the MS to the correct TCH channel. The selection of the TCH channel is based on the information received from the MSC.

The assignment procedure is presented in the following figure:

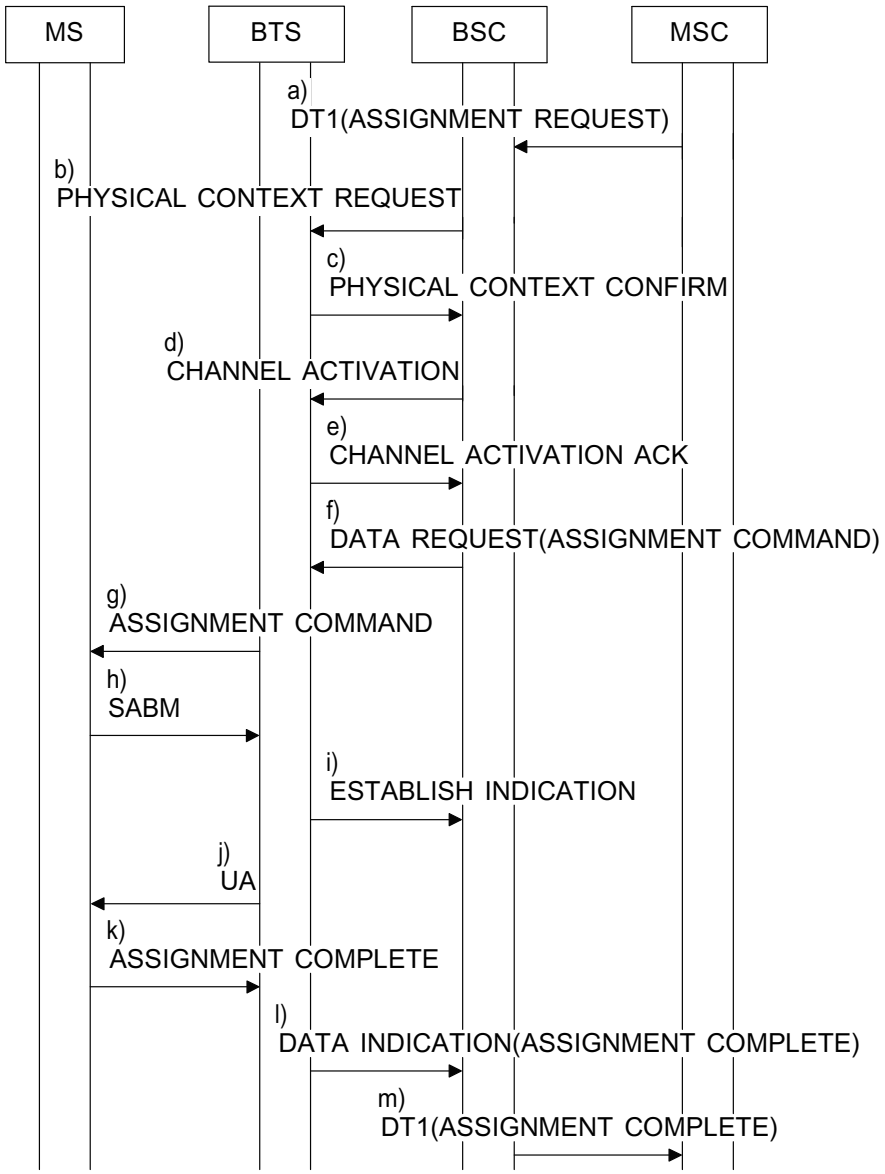

Figure 15. Assignment procedure

ASSIGNMENT REQUEST message

The MSC sends an ASSIGNMENT REQUEST (a) message to the BSC for the assignment of channels on the A interface and the radio interface. The MSC also runs a supervisory timer for the assignment procedure.

The BSS responds by sending the MSC the ASSIGNMENT COMPLETE , ASSIGNMENT FAILURE or the QUEUEING INDICATION message. If the MSC fails to receive any of the messages within the time limit defined by the timer, it clears the call with a CLEAR COMMAND message. The BSS releases the MS connection with the channel release procedure.

The BSC expects to receive the following fields in the ASSIGNMENT REQUEST message:

- channel type: radio channel required for the call type
- L3 header info
- priority (optional)
- circuit identification code (CIC) indicating the channel to be used on the A interface
- downlink DTX flag (optional)
- radio channel identity (optional)
- interference band to be used (optional).

The MSC uses the priority element to define whether the request is allowed to be queued and, if so, to define the queueing priority level. If the priority element is not present, it is assumed that the request can be queued if it cannot be served immediately. Furthermore, if the priority is not indicated, the message is queued according to the priority associated with the request type, which is defined internally within the BSS. If the request is queued, a QUEUEING INDICATION message is returned to the MSC.

The downlink DTX flag is also optional: it is present only when the MSC controls the downlink DTX in a speech call.

If the BSC identifies any of the following situations on analysing the ASSIGNMENT REQUEST message, it rejects the request by sending the ASSIGNMENT FAILURE message to the MSC, without taking any action towards the BTS:

1. If the BSC is not able to use the A channel indicated in the CIC , due to its being in use for another call, the BSC rejects the request with the cause *requested terrestrial circuit already allocated.*
2. If the BSC is not able to use the A channel indicated in the CIC, due to its being marked as undefined, the BSC rejects the request with the cause *requested terrestrial resource unavailable.*

3. If the CIC is blocked, the BSC rejects the request with the cause *requested terrestrial resource unavailable* and sends a BLOCK message to the MSC. For reasons when a circuit is blocked by the BSC, see *ETS 300 590 Digital cellular telecommunications system (Phase 2); Mobile-services Switching Centre - Base Station System (MSC - BSS) interface Layer 3 specification.*

4. If there is no circuit pool on the A interface that is able to support the requested TCH type, the BSC rejects the request with the cause *requested transcoding/rate adaption not available.*

5. If there is a circuit pool on the A interface that is able to support the requested TCH type, but the pool implied by the CIC is totally contradictory with the required TCH type, the BSC rejects the request with the cause *circuit pool mismatch.*

6. If the circuit pool implied by the CIC is at least partially compliant with the requested TCH type, change of the circuit pool may be required. Reasons for the change include the actual traffic channel resource situation of the cell and the attempt to allocate the resources in the most optimal way. In this case the BSC rejects the request with the cause *switch circuit pool.*

7. If the requested speech coder versions are not supported, the BSC rejects the request with the cause *requested speech version unavailable.*

8. If the radio interface data rate requirement is totally contradictory with the requested TCH channel rate, the BSC rejects the request with the cause *invalid message contents.*

On receiving the ASSIGNMENT FAILURE message, the MSC can either issue a CLEAR COMMAND or retry.

If the MSC receives the ASSIGNMENT FAILURE message with a cause indicating a CIC problem, the MSC may send another ASSIGNMENT REQUEST for the same call using a different circuit.

TCH assignment procedure in the BSS

After the ASSIGNMENT REQUEST , the BSC proceeds to perform the TCH assignment procedure.

The BSC sends the PHYSICAL CONTEXT REQUEST message (b) to the BTS. In this message it requests for the timing advance of mobile transmission. The SDCCH sends the timing advance via the TCH and the BTS to the MS, which requires it when moving onto a new radio channel.

If the BSC fails to receive the PHYSICAL CONTEXT CONFIRM message (c) within the time limit defined by the GSM timer T9108, the BSC returns an ASSIGNMENT FAILURE message to the MSC with the cause *radio interface message failure.* This applies also when the PHYSICAL CONTEXT CONFIRM message does not contain all the information expected. The MSC either aborts with a CLEAR COMMAND or retries.

On receiving the PHYSICAL CONTEXT CONFIRM message, the BSC searches for the relevant TCH channel using the channel reservation procedure described in *Channel reservation procedure in Basic Call.*

If the request cannot be acted upon, the BSC returns an ASSIGNMENT FAILURE message with the cause *no radio resource available.* The reason for this is that all radio channels are reserved, the queue is full, the request has been in the queue for too long, or exceptional conditions such as restart or reset.

TCH channel activation

After a successful channel reservation, the BSC sends a CHANNEL ACTIVATION message to the BTS. In this message it tells the BTS to activate the radio channel required. The BSC also starts the GSM timer T9103.

The CHANNEL ACTIVATION message contains the following data:

- message type
- channel number: Lm/Bm + AGCH
- activation type: normal assignment
- channel mode: DTX indication and channel type. The channel type is either a speech or data channel. If it is a speech channel, the speech encoding algorithm is included; if it is a data channel, the transparent or the non-transparent mode is included. The data rate is also given.
- channel identification (optional)
- encryption information if received from the MSC (optional)
- BS power as received in the PHYSICAL CONTEXT CONFIRM (optional)
- MS power as received in the PHYSICAL CONTEXT CONFIRM (optional)
- timing advance as received in the PHYSICAL CONTEXT CONFIRM (optional)
- SACCH information (optional)
- multirate configuration (optional).

Channel identification information is included only when activating TCH channel under DFCA TRX. For more information, see *Dynamic Frequency and Channel Allocation in BSC.*

The SACCH information is used in dual band cell or when IMSI Based Handover is enabled in the BSC. For more information, see *Dual Band Network Operation, IMSI-Based Handover* and *Dynamic Frequency and Channel Allocation in BSC.* The multirate configuration element is present in calls using multirate speech codec. For more information, see *Enhanced Speech Codecs: AMR and EFR.* Other optional elements are always present.

The BTS returns the CHANNEL ACTIVATION NACK message in the following situations. The BSC indicates the failure to the MSC by sending the ASSIGNMENT FAILURE message with the relevant assignment failure cause value, which can be one of the following:

- *radio interface message failure,* due to a message format error
- *requested transcoding/rate adaption not available,* due to the requested service not being supported
- *radio resource not available,* due to radio channel problems
- *radio channel already activated;* the radio channel is already in use
- *equipment failure*
- *service or option not available*
- *not implemented unspecified*
- *mandatory IE error*
- *general IE error.*

For more details, see *ETS 300 596 Digital cellular telecommunications system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 3 specification.*

If no response is received from the BTS within the time limit defined by the GSM timer T9103, the BSC sends the MSC an ASSIGNMENT FAILURE message with the cause *equipment failure.* The MSC either aborts or retries.

When the BTS has successfully activated the radio TCH channel, it returns the CHANNEL ACTIVATION ACKNOWLEDGE message (containing the current frame number) to the BSC.

TCH radio channel assignment in the BSS

The BSC sends the ASSIGNMENT COMMAND message (f, g) to the MS and starts the GSM timer T3107. This command is transparent to the BTS and is transferred as the DATA REQUEST message over the Abis interface.

The ASSIGNMENT COMMAND gives the MS all the information necessary for it to change over to the TCH. The message consists of:

- header
- channel description
- power command: max. MS power
- frequency list (optional)
- cell channel description (optional)
- channel mode: speech full rate, half rate or data (optional)
- mobile allocation (optional)
- multirate configuration (optional).

The multirate configuration element is present in calls using multirate speech codec. For more information, see *Enhanced Speech Codecs: AMR and EFR.*

On receiving the ASSIGNMENT COMMAND over the radio interface, the MS changes over from the SDCCH to the TCH it has been assigned to. The MS sends a layer 2 SABM (h) on the TCH. The BTS acknowledges the SABM with a UA frame (j) and sends the ESTABLISH INDICATION (i) message to the BSC. Synchronisation with the transcoder starts as described in ETR 111 Digital cellular telecommunications system (Phase 2); Interworking between Phase 1 infrastructure and Phase 2 Mobile Stations (MS). It is at this point that the BSC connects the Abis channel to the A channel and the speech path is switched through.

On receiving the UA frame (j), the MS indicates to the BSC with an ASSIGNMENT COMPLETE message (k) that it has successfully changed over to the TCH. This message is transparent to the BTS and is transferred over the Abis interface as a DATA INDICATION message (l). The BSC sends the information to the MSC in the DT1 (ASSIGNMENT COMPLETE) message (m) with the RR cause *normal release.*

After a successful assignment procedure, the BSC releases the SDCCH channel.

Failure Cases

Note

If the BSC receives a HANDOVER COMMAND message from the MSC between the ASSIGNMENT REQUEST and the ASSIGNMENT COMPLETE message, it ignores the HANDOVER COMMAND message.

The MS returns to its SDCCH and sends the ASSIGNMENT FAILURE message to the BSC if it fails to:

- receive the TCH ASSIGNMENT COMMAND
- move to the TCH
- receive the UA frame from the BTS when it is on the TCH.

The BSC sets the cause *radio interface failure, reversion to old channel.* On receiving this failure cause, the BSC sends the MSC the ASSIGNMENT FAILURE message over the A interface with the same cause. The MSC clears the connection or retries.

If the time limit defined by the GSM timer T3107 expires, the BSC returns an ASSIGNMENT FAILURE message to the MSC with the cause *radio interface message failure.* The MSC either aborts or retries.

2.10 Channel release procedure

The channel release procedure is used for releasing a dedicated radio channel. The channel release procedure is started either by the BSC or the MSC:

- if the MSC starts the channel release procedure, it sends the CLEAR COMMAND message to the BSC
- if the BSC starts the channel release procedure, it sends the CLEAR REQUEST message to the MSC, which then sends the CLEAR COMMAND message to the BSC.

The channel release procedure started by the MSC is presented in the following figure:

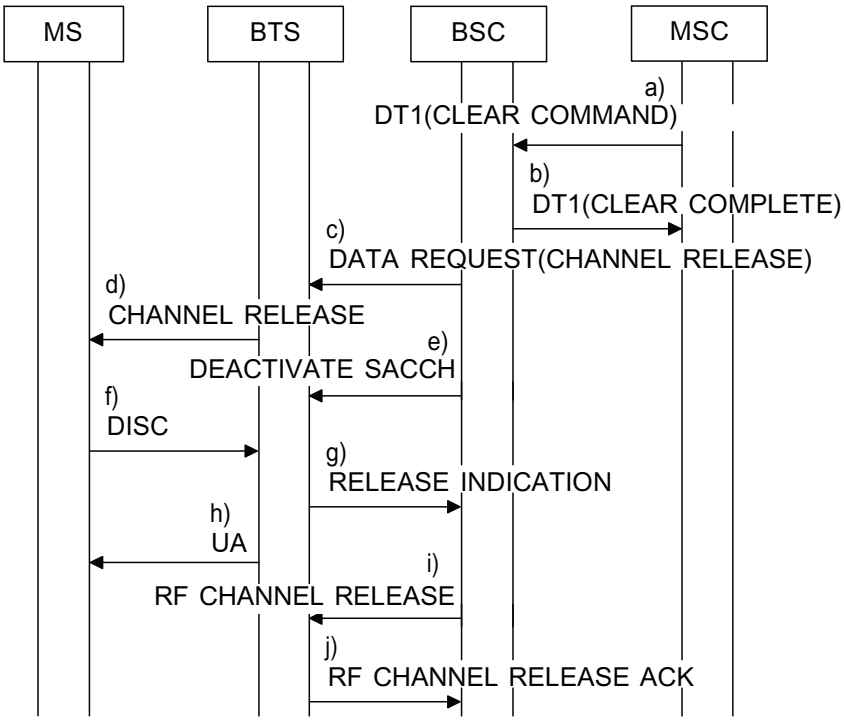

Figure 16. Channel release procedure

The MSC initiates the channel release procedure by sending the CLEAR COMMAND message (a) to the BSC. On receiving the CLEAR COMMAND message the BSC releases the A interface speech circuit and sends the CLEAR COMPLETE message (b) to the MSC. The MSC releases the SCCP connection.

After the release, the BSC sends a CHANNEL RELEASE message (c, d) with an RR cause value *Normal Release* to the MS and a DEACTIVATE SACCH message (e) to the BTS. The BSC also starts the GSM timer T3109 to supervise the procedure.When the BTS receives the DEACTIVATE SACCH message, the transmission of system information messages on the SACCH is forbidden.

Note

If the BSC has completed GPRS suspension for the MS, GPRS resume procedure is initiated when CLEAR COMMAND message (a) is received. CHANNEL RELEASE message contains GPRS resumption IE that indicates whether GPRS services were successfully resumed or not. From this information MS knows whether to do Routing Area Update in order to resume GPRS services or not. For more information, see *(E)GPRS in BSC*.

When the MS receives the CHANNEL RELEASE message (d), it disconnects the signalling link by sending the DISC frame (f). After receiving the DISC frame, the BTS sends a UA frame (h) to the MS and a RELEASE INDICATION message (g) to the BSC.

The BSC starts the GSM timer T3111 when it receives the RELEASE INDICATION message or when the time limit defined by the GSM timer T3109 expires. The BSC waits for the expiry of the time limit defined by T3111 before it sends the RF CHANNEL RELEASE message (i) to the BTS.

When the BTS receives the RF CHANNEL RELEASE message, it releases the dedicated radio channel and sends the RF CHANNEL RELEASE ACK message (j) to the BSC.

After receiving the RF CHANNEL RELEASE ACK message, the BSC releases the radio resource allocation.

Channel release started by the BSC

The channel release procedure started by the BSC is presented in the following figure.

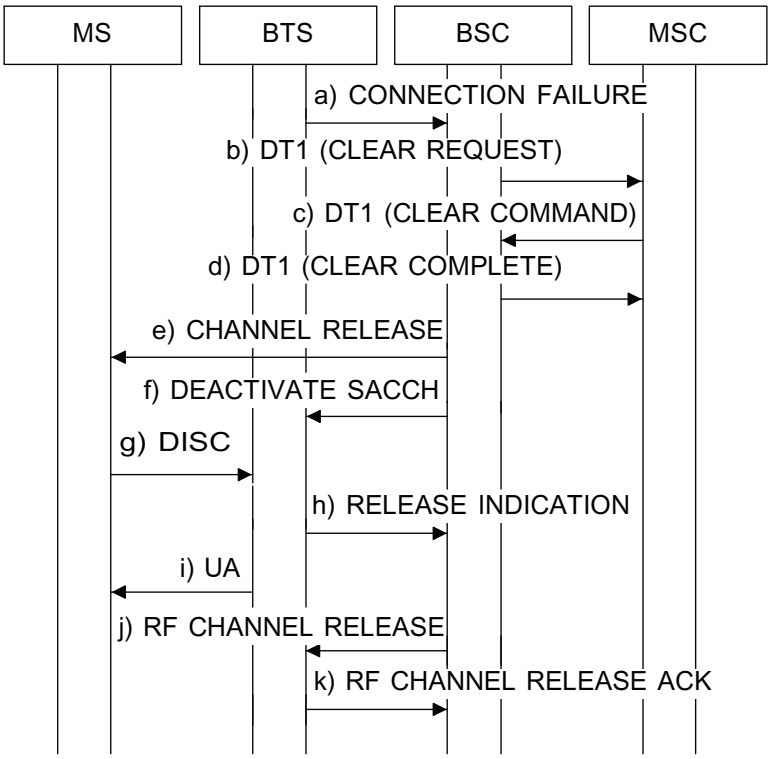

Figure 17. Channel release started by the BSC

If there is a BSS failure, for example, the BSC has received the CONNECTION FAILURE message (a) from the BTS, the BSC sends the CLEAR REQUEST message (b) to the MSC and starts the GSM timer T9101 to wait for the CLEAR COMMAND message (c).

When the BSC receives the CLEAR COMMAND message (c) from the MSC and the connection to the MS is lost, the BSC releases the A interface speech circuit and sends the CLEAR COMPLETE message (d) to the MSC. The BSC releases the dedicated radio channel by sending the CHANNEL RELEASE message (e) to the MS and the DEACTIVATE SACCH message (f) to the BTS.

The BSC starts the GSM timer T3109 to wait for the RELEASE INDICATION message (h). The MS sends the DISC frame (g) to the BTS which acknowledges it with the UA frame (i). When the BSC receives the RELEASE INDICATION message (h) from the BTS, it stops the GSM timer T3109 and starts the GSM timer T3111. The BSC sends the RF CHANNEL RELEASE message (j) to the BTS when the GSM timer T3111 expires. The BTS acknowledges it by sending the RF CHANNEL RELEASE ACK (k) message to the BSC.

After receiving the RF CHANNEL RELEASE ACK message (k) from the BTS, the BSC releases all radio resources related to it. After the reception of the CLEAR COMPLETE message (d) from the BSC, the MSC releases the SCCP connection.

Note

If the BSC receives the CONNECTION FAILURE message (a) with the RR cause value *Radio Link Failure* and re-establishment is allowed, the BSC does not send the CHANNEL RELEASE message (e) to the MS.

2.11 System information broadcasting procedure

The network broadcasts regularly the messages SYSTEM INFORMATION TYPE 1 to 4 and optionally TYPE 2bis on the BCCH .

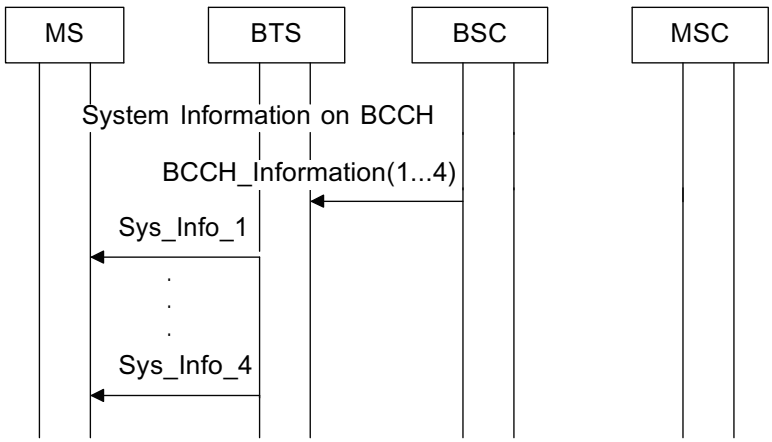

Figure 18. Sending of BCCH information

The MS uses this information to decide whether and how it may gain access to the system via the current cell. The SYSTEM INFORMATION TYPE 2bis message is sent if the extended neighbour cell description is in use. The TYPE 2 and TYPE 2bis messages indicate that each IE carries only a part of the BA (BCCH Allocation).

The network sends similar information in messages SYSTEM INFORMATION TYPE 5 and 6 , and optionally in 5bis , on the SACCH. The messages are sent directly after a handover, and whenever there is no other use of the channel. The SYSTEM INFORMATION TYPE 5bis message is sent if extended neighbour cell description is in use and the TYPE 5bis message indicates that each IE carries only a part of the BA.

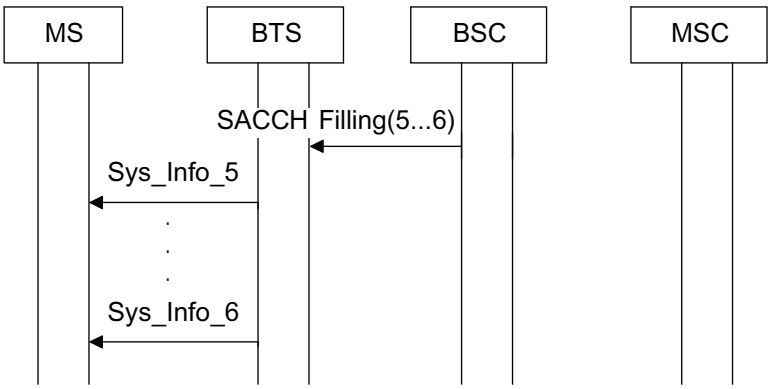

Figure 19. Sending of SACCH Filling

The information broadcast can be grouped in the following classes:

- information giving unique identification of the current network, location area and cell
- information used for cell selection and candidate cell measurements for handover procedures
- information describing the current control channel structure
- information controlling the random access channel utilisation
- information defining different options supported within the cell.

Purpose of C2 cell reselection

The purpose of C2 cell reselection is to control the cell reselection of MSs in idle status. The C2 cell reselection allows the operator to define other criteria for reselection in addition to the power level. The operator can define different reselection criteria for different kinds of cells, such as macro and micro cells.

The C2 reselection criteria also includes the so called penalty time, which allows the cell reselection to happen more slowly than the pure C1 criteria evaluated by the MS. This enables avoiding undesirable reselection of a micro cell in an environment where there is coverage by a micro cell and a macro cell.

Broadcasting C2 reselection parameters

The C2 reselection information is broadcasted to the MSs in System Information 3 and 4 frames. The parameters are included in SI X rest octets information element when the C2 reselection function is used. The BSC sends the System Information frames to the BTS on the Abis interfaces and the BTS sends them on the air. The MS evaluates the C2 reselection criteria according to the given parameters. For more information, see ETS 300 574 Digital cellular telecommunications system (Phase 2); Multiplexing and multiple access on the radio path.

The C2 reselection needs the following four parameters for each BTS:

- cell barred qualify
- cell reselect offset
- temporary offset
- penalty time.

The appearance of these parameters in System Information is controlled by the parameter PI (Parameter Index).