Technical Document - Confidential

GSM PROTOCOL STACK

MESSAGE SEQUENCE CHARTS

ALR

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1.2 Abbreviations

AGCH	Access Grant Channel
BCCH	Broadcast Control Channel
BS	Base Station
BSIC	Base Station Identification Code
CBCH	Cell Broadcast Channel
CBQ	Cell Bar Qualify
CC	Call Control
CCCH	Common Control Channel
CCD	Condat Coder Decoder
CKSN	Ciphering Key Sequence Number
C/R	Command / Response
C1	Path Loss Criterion
C2	Reselection Criterion

DCCH	Dedicated Control Channel
DISC	Disconnect Frame
DL	Data Link Layer
DM	Disconnected Mode Frame
EA	Extension Bit Address Field
EL	Extension Bit Length Field
EMMI	Electrical Man Machine Interface
F	Final Bit
FACCH	Fast Associated Control Channel
FHO	Forced Handover
GP	Guard Period
GSM	Global System for Mobile Communication
HPLMN	Home Public Land Mobile Network
I	Information Frame
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
Kc	Authentication Key
L	Length Indicator
LAI	Location Area Information
LPD	Link Protocol Discriminator
M	More Data Bit
MCC	Mobile Country Code
MM	Mobility Management
MMI	Man Machine Interface
MNC	Mobile Network Code
MS	Mobile Station
NCC	National Colour Code
NECI	New Establishment Causes included
N(R)	Receive Number
N(S)	Send Number
OTD	Observed Time Difference
P	Poll Bit
PCH	Paging Channel
PDU	Protocol Description Unit
P/F	Poll / Final Bit
PL	Physical Layer
PLMN	Public Land Mobile Network
RACH	Random Access Channel
REJ	Reject Frame
RNR	Receive Not Ready Frame
RR	Radio Resource Management
RR	Receive Ready Frame
RTD	Real Time Difference
SABM	Set Asynchronous Balanced Mode
SACCH	Slow Associated Control Channel
SAP	Service Access Point
SAPI	Service Access Point Identifier
SDCCH	Slow Dedicated Control Channel
SIM	Subscriber Identity Module
SMS	Short Message Service
SMSCB	Short Message Service Cell Broadcast
SS	Supplementary Services
TCH	Traffic Channel
TCH/F	Traffic Channel Full Rate
TCH/H	Traffic Channel Half Rate
TDMA	Time Division Multiple Access
TMSI	Temporary Mobile Subscriber Identity
UA	Unnumbered Acknowledgement Frame
UI	Unnumbered Information Frame

VPLMN Visiting Public Land Mobile Network
V(A) Acknowledgement State Variable
V(R) Receive State Variable
V(S) Send State Variable

1.3 Terms

Entity:	Program which executes the functions of a layer
Message:	A message is a data unit which is transferred between the entities of the same layer (peer-to-peer) of the mobile and infrastructure side. Message is used as a synonym to protocol data unit (PDU). A message may contain several information elements.
Primitive:	A primitive is a data unit which is transferred between layers on one component (mobile station or infrastructure). The primitive has an operation code which identifies the primitive and its parameters.
Service Access Point:	A Service Access Point is a data interface between two layers on one component (mobile station or infrastructure).

2 Overview

The Protocol Stacks are used to define the functionality of the GSM protocols for interfaces. The GSM specifications are normative when used to describe the functionality of interfaces, but the stacks and the subdivision of protocol layers does not imply or restrict any implementation.

The base of the Protocol Stack rests on the physical layer.

The Data Link Layer (DL) is used to handle an acknowledged connection between mobile and base station. The LAPDm protocol is used.

Radio Resource (RR) manages the resources of the air-interface. That means configuration of physical layer, cell selection and cell reselection, data transfer, RR-Connection handling.

Mobility Management (MM) handles registration aspects for the mobile station. It detects changes of location areas and updates a mobile station in the new location area.

Call Control (CC) provides the call functionality. This includes call establishment, call maintenance procedures like Hold, Retrieve or Modify, and call disconnection.

Supplementary Services (SS) handles all call independent supplementary services like call forwarding or call barring.

Short Message Services (SMS) is used for sending and receiving point-to-point short messages. Additionally the reception of cell broadcast short messages is included.

The man machine interface (MMI) is the interface to the user. Normally it is connected with a keypad as input device and a display as output device.

Between the several entities data interfaces are defined. These data interfaces are called Service Access Points (SAPs), indicating that an upper layer uses the services of a lower layer.

This document describes the services needed for integration of TI layer 1 and Condat protocol stack.

3 General Aspects

Condat Protocol Stack

3.1 Frequency Bands

The protocol stack supports different frequency bands:

- GSM 900
- DCS 1800
- PCS 1900
- Dualband GSM 900 / DCS 1800
- Dualband GSM 900 / E-GSM / DCS 1800

XXX
The different frequency ranges need some different algorithms and different storing of channel lists. Therefore a global variable std is introduced which is initialized in the PCM driver module. The value of this variable defines the supported frequency range. The following dependency exists:

Frequency Range	Std
GSM 900	1
E-GSM	2
PCS 1900	3
DCS 1800	4
Dualband GSM 900 / DCS 1800	5
Dualband GSM 900 / E-GSM / DCS 1800	6

GSM 900
channels 1 to 124 = 124 channels

radio_freq coding	channel

0	not defined
1	1
...	...
124	124
>124	not defined

E-GSM 900
channels 1 to 124 and 975 to 1023 and 0 = 174 channels

radio_freq coding	channel
0	not defined
1	1
...	...
124	124
125	975
...	...
173	1023
174	0
>174	not defined

DCS 1800
channels 512 to 885 = 374 channels

radio_freq coding	channel
0	not defined
...	not defined
512	512
...	...
885	885
>885	not defined

PCS 1900
channels 512 to 810 = 299 channels

radio_freq coding	channel
0	not definde
...	not defined
512	512
810	810
>810	not defined

Dualband GSM 900 / DCS 1800
channels 1 to 124 and 512 to 885 = 498 channels

radio_freq coding	channel
0	not defined
1	1
...	...
124	124
125	512
...	...
498	885
>498	not defined

Dualband GSM 900 / E-GSM / DCS 1800
channels 1 to 124 and 975 to 1023 and 0 and 512 to 885 = 548 channels

radio_freq coding	channel
0	not defined

1	1
...	...
124	124
125	975
...	...
173	1023
174	0
175	512
...	...
548	885
>548	not defined

3.2 Mobile Station Configuration

The protocol stack components read several records of the permanent memory configuration to get the actual configuration. The following records are read:

- IMEI the international mobile equipment identity of the mobile station
- MSCAP the mobile station capabilities
- CLASS2 the mobile station classmark 2 element
- CLASS3 the mobile station classmark 3 element.

Additionally records will be introduced with the MMI. The exact content is described in the PCM Driver Specification.

3.2.1 Default Settings

The following default settings are used in the current implementation:

Parameter	Frequency Range	PC-Version	Target-Version
MSCAP	GSM 900	fullrate, no data capabilities	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax
	DCS 1800	fullrate, halfrate, NT-Async	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax
	PCS 1900	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax
	Dualband	fullrate, enhanced fullrate T Async, T fax	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax
	Dualband Extended	fullrate, enhanced fullrate T Async, T fax, 14.4	fullrate, halfrate, enhanced fullrate, NT Async, T Async, T fax

Parameter	Frequency Range	PC-Version	Target-Version
CLASS2	GSM 900	class 2, A5/1 available early classmark sending phase 2 MS SMS, Pseudo-Sync Handover, no E-GSM No add info in class 3, no other cipher algorithm	class 4, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM No add info in class 3, no other cipher algorithm
	DCS 1800	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM noadd info in class 3, no other cipher	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM No add info in class 3, no other cipher

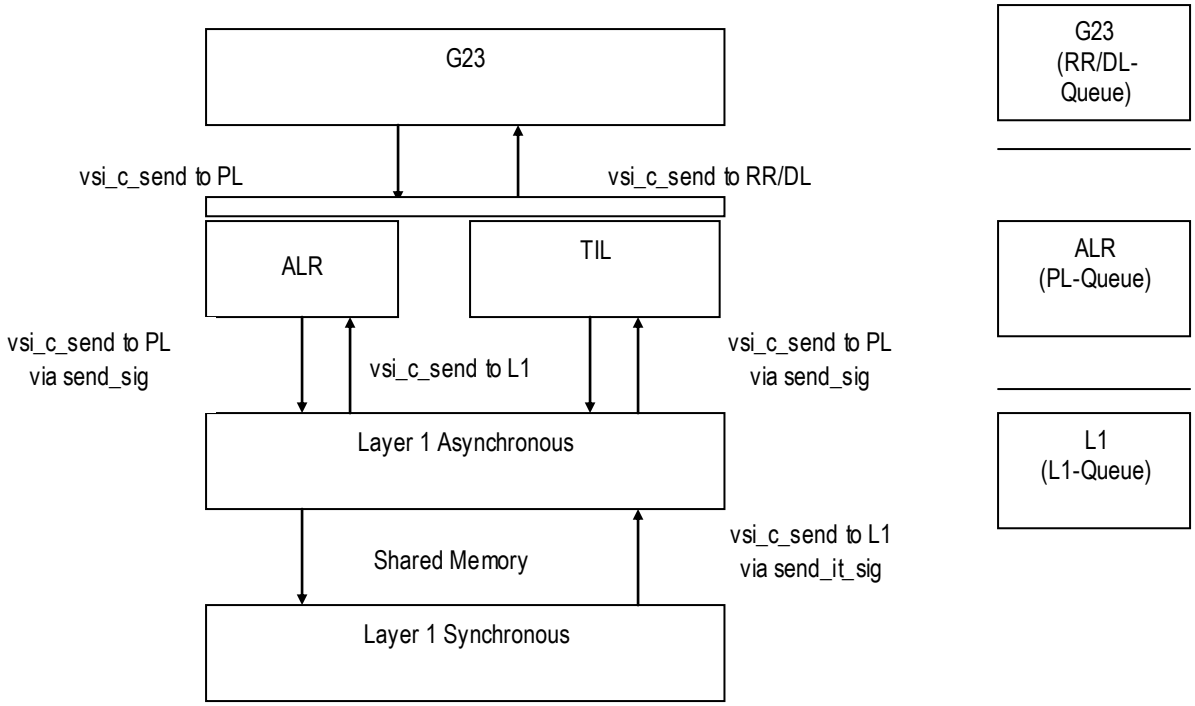
		algorithm	algorithm
	PCS 1900	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM No add info in class 3, no other cipher algorithm	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM No add info in class 3, no other cipher algorithm
	Dualband	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM add info in class 3, no other cipher algorithm	Class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, no E-GSM Add info in class 3, no other cipher algorithm
	Dualband Extended	class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, E-GSM add info in class 3, no other cipher algorithm	Class 1, A5/1 available early classmark sending phase 2 MS SMS, no Pseudo-Sync Handover, E-GSM add info in class 3, no other cipher algorithm
CLASS3	GSM 900	no information	no information
	DCS 1800	no information	no information
	PCS 1900	no information	no information
	Dualband	GSM 900 and DCS 1800 supported Class 2 DCS, Class 3 GSM	GSM 900 and DCS 1800 supported Class 1 DCS, Class 4 GSM
	Dualband Extended	GSM 900, E-GSM, DCS 1800 supp. Class 2 DCS, Class 3 GSM	GSM 900, E-GSM, DCS 1800 supp. Class 1 DCS, Class 4 GSM

3.3 Integration of Layer 1 and TIL and ALR

Three scenarios are defined for the Layer 1 / ALR integration.

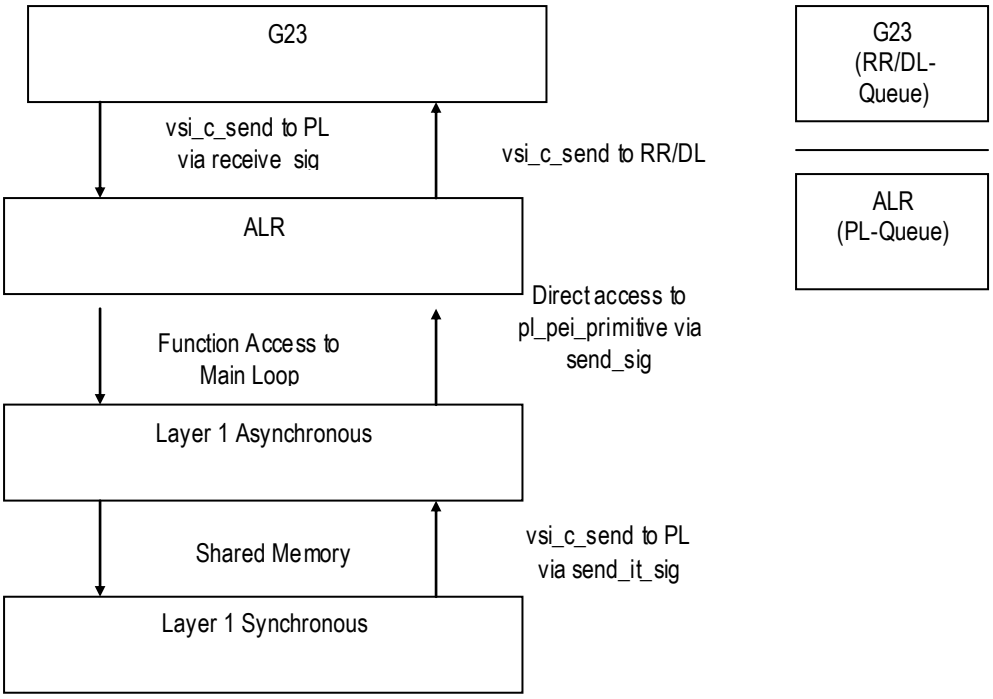
3.3.1 Layer 1 / TIL/ ALR not combined

G23, ALR and Layer 1 are separate threads. They communicate via primitives and queues. This is the actual solution. The following picture shows the communication pathes:



3.3.2 Layer 1 / ALR combined

TIL and Layer 1 are combined to one thread. They communicate via primitives and queues. This combination saves power and RAM.



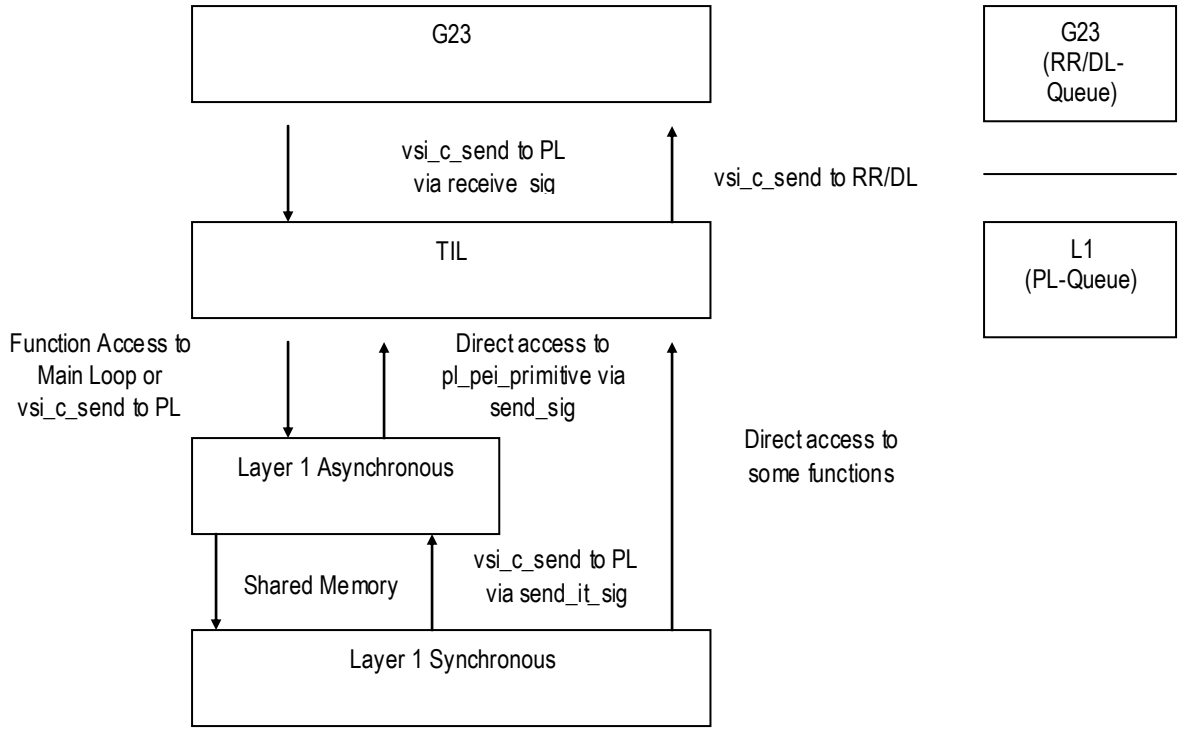
For this scenario the compile switch OPT_COMB must be set (ALRL Sources and DL1_MEM.C). The module DL1_PEI.C is not needed, the functionality is replaced by TIL_PEI.C.
The header pf_ent.h must be modified. TIL (named PL) must be used as ACTIVE BODY, the stack size must be increased and the layer 1 entity (named L1) must be removed.

```
/*
 * defines wich entities are a part of the Protocol stack
 * and wich of them are active components.
 * Last entry must be NULL, NULL, 0L, 0, 0, PASSIVE_BODY
 */

/*  name,  pei_createfunc,  stacksize, queueentries, priority, behaviour*/
/*-------------------------------------------------------------------------*/
   "MMI", mmi_pei_create, 1436L,    10,         10,      PASSIVE_BODY,
   "CC",  cc_pei_create,   924L,    10,          9,      PASSIVE_BODY,
   "SIM", sim_pei_create, 1180L,    10,          8,      PASSIVE_BODY,
   "SS",  ss_pei_create,   924L,    10,         11,      PASSIVE_BODY,
   "SMS", sms_pei_create, 1624L,    10,         12,      PASSIVE_BODY,
   "MM",  mm_pei_create,  1180L,    10,          6,      PASSIVE_BODY,
   "RR",  rr_pei_create,  1436L,    10,          5,      PASSIVE_BODY,
   "DL",  dl_pei_create,   924L,    10,          4,      PASSIVE_BODY,
   "PL",  pl_pei_create,  2436L,    10,          3,      ACTIVE_BODY,
   NULL,  NULL,             0L,     0,          0,      PASSIVE_BODY
```

3.3.3 Layer 1 / TIL combined with Access from Layer 1 Synchronous

TIL and Layer 1 are combined to one thread. Some services of TIL are requested directly by layer 1 synchronous. This combination saves power and RAM.



For this scenario the compile switch OPT_COMB and OPT_SYNC must be set (ALRL Sources and DL1_MEM.C). The module DL1_PEI.C is not needed, the functionality is replaced by TIL_PEI.C.
The header pf_ent.h must be modified. TIL (named PL) must be used as ACTIVE BODY, the stack size must be increased and the layer 1 entity (named L1) must be removed.

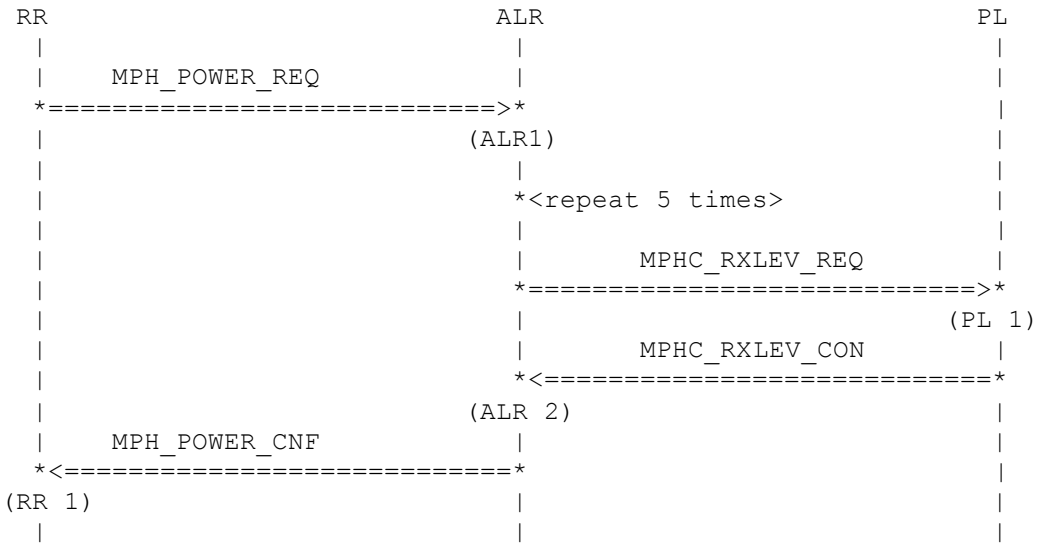
```
/*
 * defines wich entities are a part of the Protocol stack
 * and wich of them are active components.
 * Last entry must be NULL, NULL, 0L, 0, 0, PASSIVE_BODY
 */

/*  name,  pei_createfunc,  stacksize, queueentries, priority, behaviour*/
/*--------------------------------------------------------------------------*/
   "MMI", mmi_pei_create,  1436L,    10,         10,      PASSIVE_BODY,
   "CC",  cc_pei_create,   924L,     10,         9,       PASSIVE_BODY,
   "SIM", sim_pei_create,  1180L,    10,         8,       PASSIVE_BODY,
   "SS",  ss_pei_create,   924L,     10,         11,      PASSIVE_BODY,
   "SMS", sms_pei_create,  1624L,    10,         12,      PASSIVE_BODY,
   "MM",  mm_pei_create,   1180L,    10,         6,       PASSIVE_BODY,
   "RR",  rr_pei_create,   1436L,    10,         5,       PASSIVE_BODY,
   "DL",  dl_pei_create,   924L,     10,         4,       PASSIVE_BODY,
   "PL",  pl_pei_create,   2436L,    10,         3,       ACTIVE_BODY,
   NULL,  NULL,            0L,      0,          0,       PASSIVE_BODY
```

4 Cell Selection

The cell selection is splitted into two parts. The power measurements and the BCCH detection phase.

4.1 Power Measurements



(ALR 1)

The power measurements are initiated by RR. XXX All other activities of other parts like idle control etc. are stopped. The repeat counter for fieldstrength measurements is cleared. The power measurements are started.
The MPHC_RXLEV_REQ uses a shared memory area(ALR and PL) for storing and accumulating the fieldstrength values.

(PL 1)

Power measurement is requested to the physical layer.

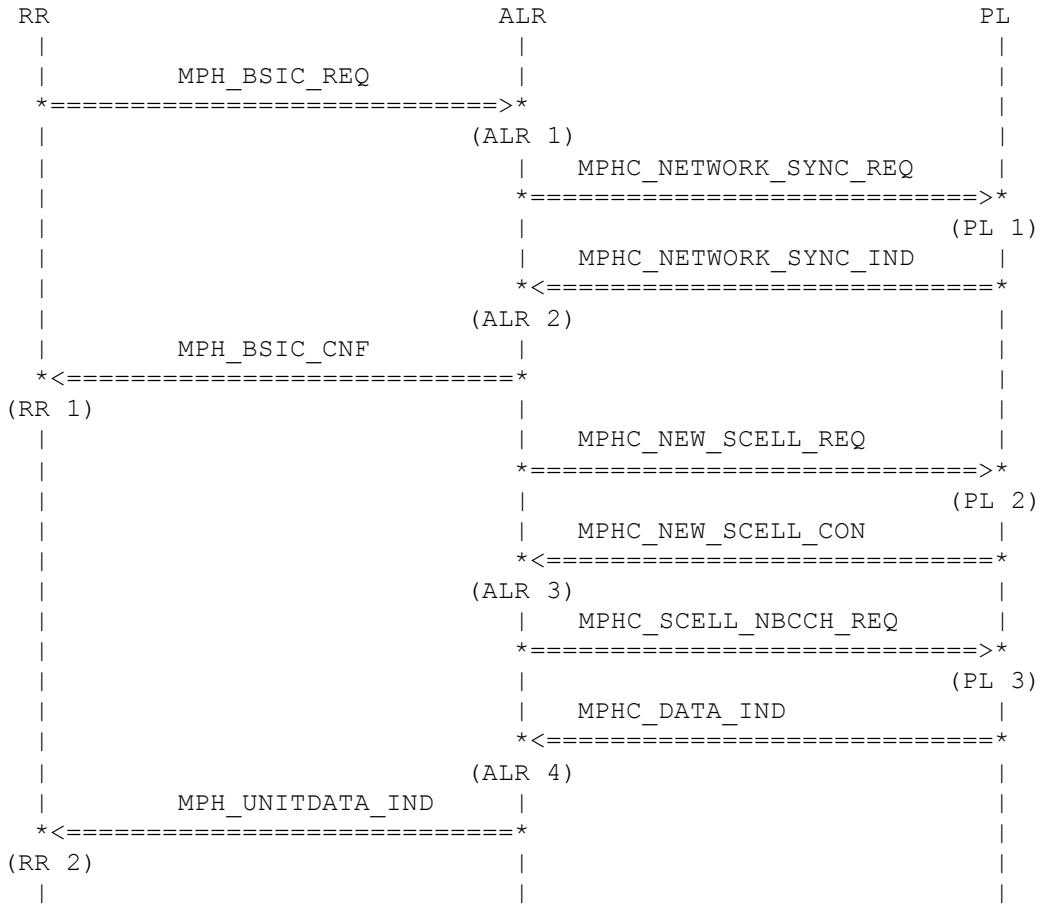
(ALR 2)

The result is received from PL. The repeat counter is incremented. If the maximum is not reached the next measurement is triggered by a MPHC_RXLEV_REQ primitive.

(RR 1)

A list in decreasing fieldstrength order is created by ALR. A maximum of channels for each frequency band is selected. The resulting list is forwarded to RR to trigger the BCCH detection phase. A threshold value is introduced to check only channels with a minimum fieldstrength.

4.2 BCCH Detection



(ALR 1)

RR requests BCCH detection for a channel. Typically this will be the channel with the highest fieldstrength from the previous power measurements.

(PL 1)

ALR requests synchronisation to frequency correction burst and synchron burst.

(ALR 2)

PL has read the frequency correction burst and the synchron burst (indicated by the error_flag in the MPHC_NETWORK_SYNC_IND primitive). The bsic is stored for this channel.

(RR 1)

RR is informed about the BCCH carrier. Therefore a MPH_BSIC_CNF with the channel number and the bsic is sent to RR. The cause is set to CS_NO_ERROR. The cell selection process starts reading the BCCH.

(PL 2)

ALR selects the channel as serving cell

(ALR 3)

PL acknowledges serving cell

(PL 3)

ALR requests full reading of the normal BCCH(modulus=1,relative_position=0).

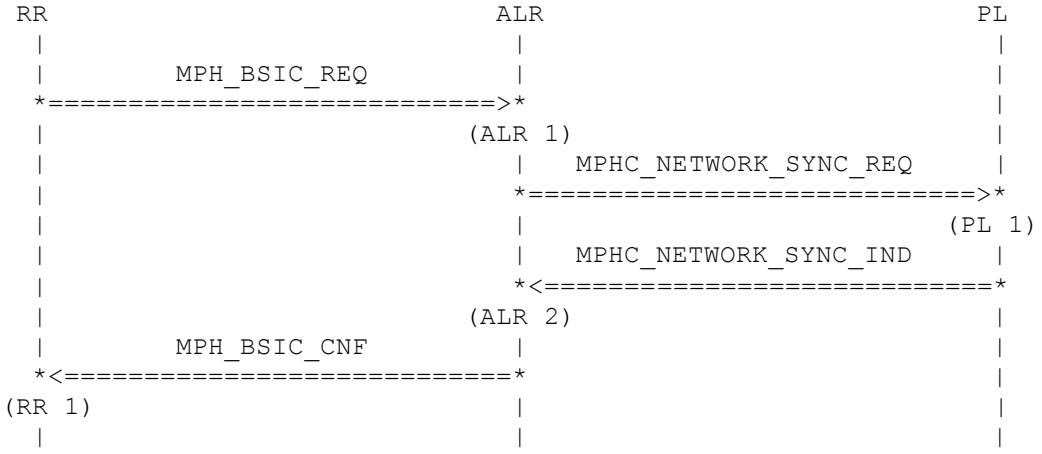
(ALR 4)

Layer 1 forwards subsequent received data blocks on BCCH. The content is valid.

(RR 2)

The content of the BCCH data block (stored in parameter l2_frame of the MPHC_DATA_IND) is forwarded directly to RR.

4.3 BCCH carrier synchronization failed



(ALR 1)

RR requests BCCH detection for a channel. Typically this will be the channel with the highest fieldstrength from the previous power measurements.

(PL 1)

ALR requests synchronisation to frequency correction burst and synchron burst.

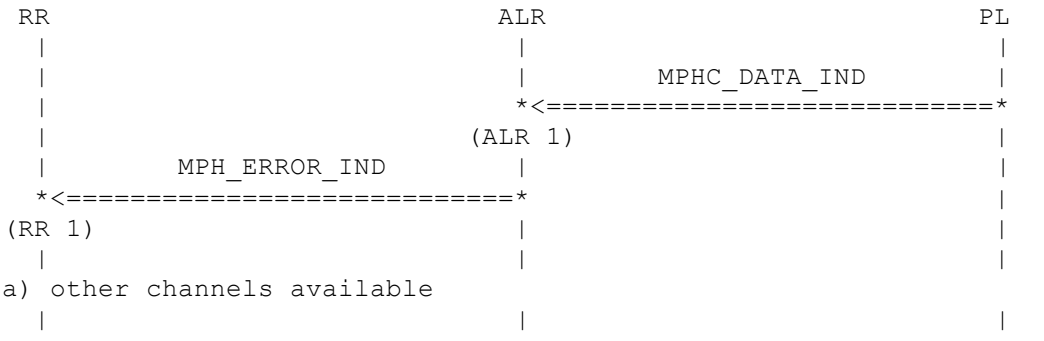
(ALR 2)

The error_flag in the MPHC_NETWORK_SYNC_IND primitive indicates that synchronisation to the frequency correction burst or the synchron burst has failed.

(RR 1)

RR is informed about the result. Therefore a MPH_BSIC_CNF with the channel number and the cause equal to CS_NO_BCCH_AVAIL is send to RR.

4.4 Reading of BCCH messages failed



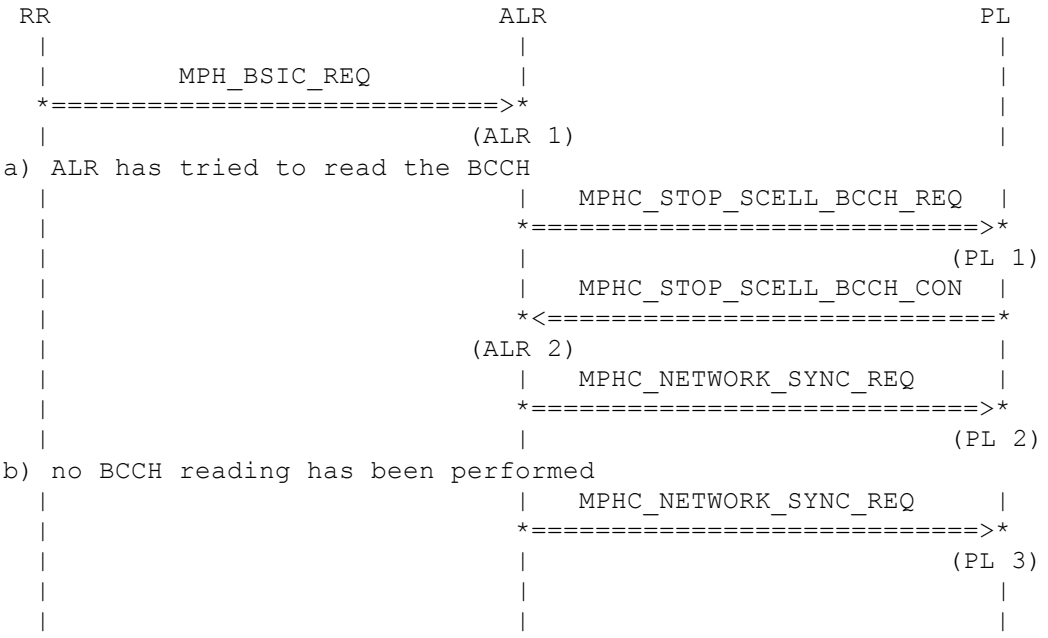
(ALR 1)

The error_cause in the MPHC_DATA_IND primitive indicates that reading of the BCCH data has failed.

(RR 1)

RR is informed with the MPH_ERROR_IND primitive and the cause BCCH read error. The numbers of read errors may used by RR to decide rejection of the BCCH carrier.

4.5 RR rejects BCCH carrier



(ALR 1)

RR rejects a BCCH carrier (cell barred, C1 <= 0, wrong plmn or too many read errors etc.) and requests BCCH detection for the next channel number. A channel number equal to 0xFFFF indicates that ALR shall stop the BCCH reading of the previous channel and shall not start a new BCCH detection.

(PL 1)

Stop of last BCCH reading is requested.

(ALR 2)

Stop of BCCH reading is confirmed.

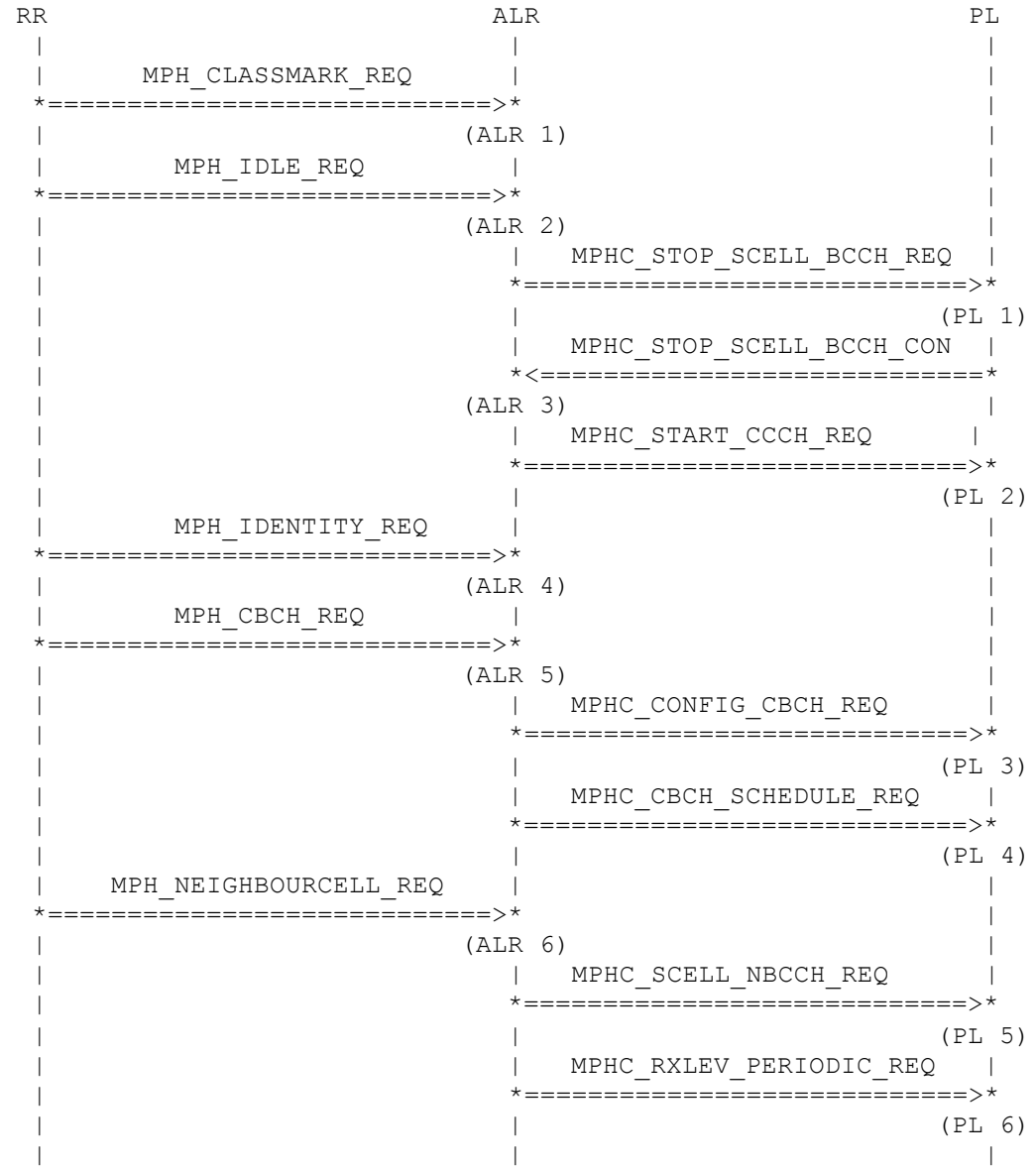
(PL 2)

ALR requests synchronisation to frequency correction burst and synchron burst.

(PL 3)

The BCCH has not been read before. Start directly to request synchronisation to frequency correction burst and synchron burst.

4.6 RR selects BCCH



(ALR 1)

If RR configures the idle mode typical four primitives are send to the lower layer. The first one is MPH_CLASSMARK_REQ containing the power class (or power classes for dualband) of the mobile station. This information is stored for the RACH control process and is not used by the cell selection process.

(ALR 2)

Configuration of the idle mode is carried out after receiving the MPH_IDLE_REQ from RR. The primitive contains the channel configuration and additional parameters to configure paging.

(PL 1)

Stop of BCCH reading is requested.

(ALR 3)

Stop of BCCH reading is confirmed.

(PL 2)

The layer 1 is configured for the idle mode. After configuration the cell selection process enters the idle mode and the idle control process is initiated. The layer 1 expects the MPHC_START_CCCH_REQ primitive. The primitive has the following parameters:

MPHC_START_CCCH_REQ	set from
bs_pa_mfrms	MPH_IDLE_REQ -> bs_pa_mfrms + 2
bs_ag_blks_res	MPH_IDLE_REQ -> bs_ag_blks_res
bcch_combined	MPH_IDLE_REQ -> comb_ccch
ccch_group	MPH_IDLE_REQ -> tn / 2
page_group	MPH_IDLE_REQ -> pg div PAG_BLOCKS_PER_MFR
page_block_index	MPH_IDLE_REQ -> pg mod PAG_BLOCKS_PER_MFR
page_mode	PGM_REORG

with PAG_BLOCKS_PER_MFR equal to the number of paging blocks during on multiframe according to the following rules (see also GSM 5.02, section 7 table 5):

Combined BCCH	PAG_BLOCKS_PER_MFR = MAX (1, 3-bs_ag_blks_res)
Not combined BCCH	PAG_BLOCKS_PER_MFR = 9-bs_ag_blks_res

(ALR 4)

RR sends the identities of the mobile (IMSI and TMSI) for the paging check in ALR. The mobile identities are forwarded to the paging sub-process of ALR.

(ALR 5)

RR configures the CBCH channel.

(PL 3)

The configuration is forwarded to layer 1. The cbch process is started.

(PL 4)

Request the full reading of the CBCH (schedule_length=0)

(ALR 6)

The neighbourcell description received with the system information messages on BCCH is forwarded to the lower layers. This channel list is the base for the measurements in idle mode. This information is stored and used by the idle control process and not used by the cell selection process.

(PL 5)

ALR configures periodic serving cell BCCH reading.The BCCH is read every thirty seconds:

The SCELL_NBCCH_REQ is configured with 8 schedules, one for each system info:

- modulus = 128 (128 multiframes are approx. 30 seconds)
- relative_position = TC from 0 to 7

(PL 6)

The neighbourcell list is forwarded to layer 1.

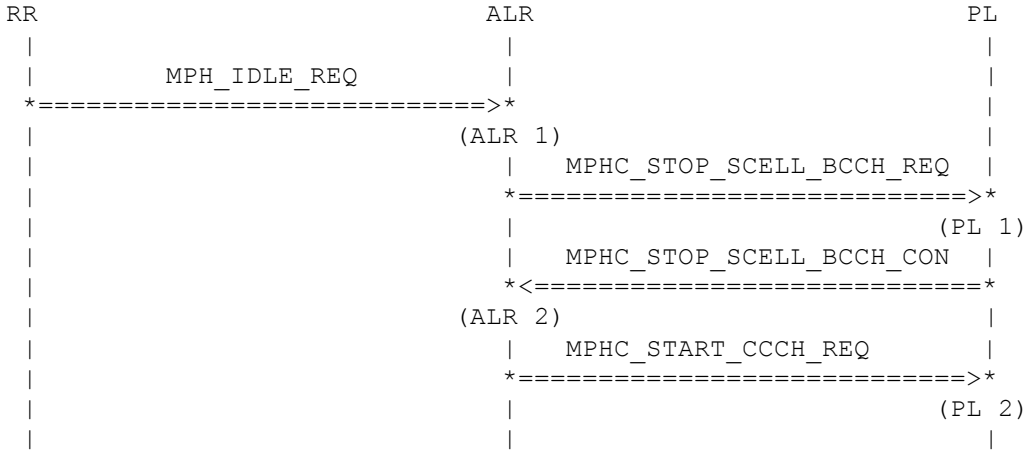
5 Idle Mode Serving Cell Procedures

After cell selection the mobile station is in idle mode. For the serving cell the following services supported by ALR:

- Initiation of idle mode
- Page mode change
- Measurement reporting
- BCCH reading
- Downlink failure detection

- Paging detection
- Stop idle mode

5.1 Initiation of Idle Mode

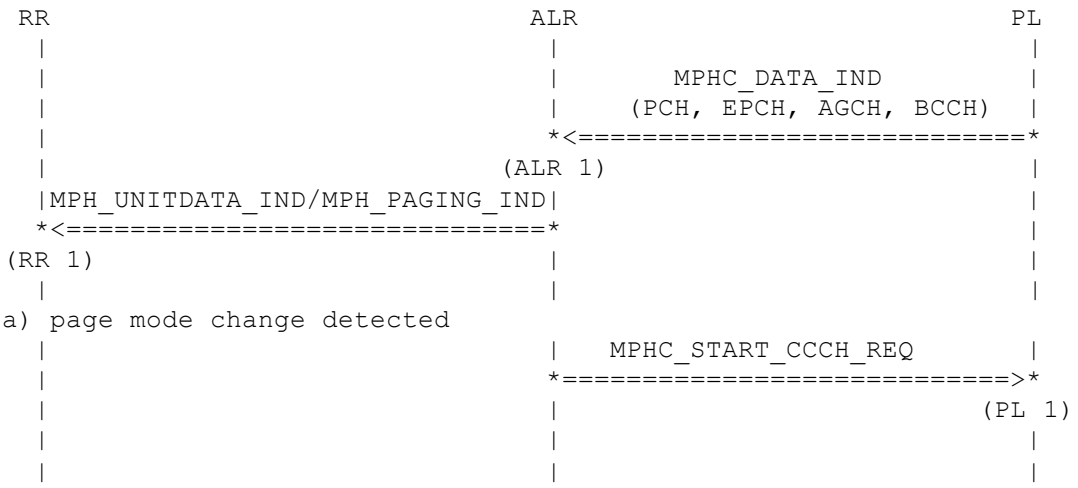


(ALR 1)

The initiation of idle mode process is carried out by the MPH_IDLE_REQ primitive from RR at the end of the cell selection process. This is described in detail in chapter 4.6.

Additional the downlink timeout value of the MPH_IDLE_REQ is send to the PCH control process to initialize the downlink failure detection.

5.2 Page Mode Change



(ALR 1)

Layer 1 listens to the unacknowledged channels BCCH and CCCH which is divided into AGCH and PCH. If the received data block is a PCH or extended PCH the result is forwarded to the PCH control process as input for downlink failure detection.

The page mode in the message is checked for CCCH messages. The following table shows the page mode change in detail:

old page mode	new page mode	Action
Paging reorganisation	normal paging extended paging paging reorganisation same as before	swap to normal paging None None None

normal paging	normal paging	None
	extended paging	swap to extended paging
	paging reorganisation	swap to paging reorganisation
	same as before	None
extended paging	normal paging	none
	extended paging	swap to extended paging ???
	paging reorganisation	swap to paging reorganisation
	same as before	swap to extended paging ???

(RR 1)

Valid data blocks may receive on the BCCH, AGCH or CCCH.

BCCH messages contain no page mode information. ALR removes the layer 2 pseudolength and forwards the message directly to RR, if the message content for a message has changed.

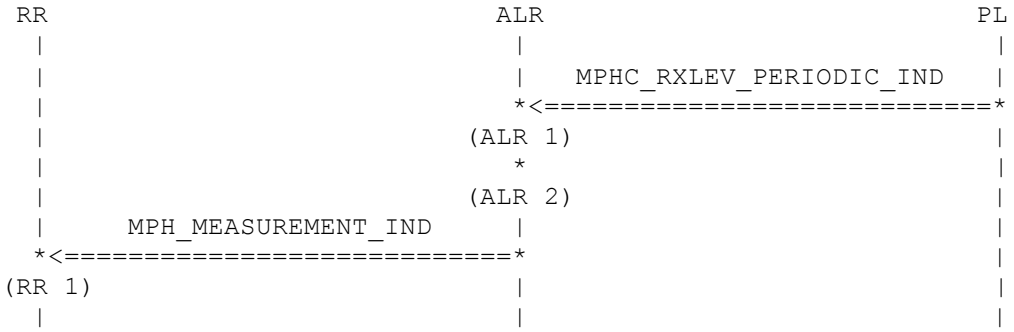
AGCH messages contain page mode information. ALR removes the layer 2 pseudolength and forwards the message directly to RR, if the mobile is in connection establishment phase.

PCH messages contain page mode information. ALR checks the content against the mobile identities and sends a paging information to RR, if the identities matches.

(PL 1)

Layer 1 changes the paging mode according to the above table.

5.3 Measurement Reporting



(ALR 1)

During listening to its own paging subchannel, layer 1 performs measurements of a set of cells. The results are forwarded to the upper layer. The values are „GSM encoded“ but with a four times better resolution.

(ALR 2)

The values are used to build an running average over at least five samples or a period of five seconds, whichever is the greater period.

(RR 1)

RR has the requirement to receive at least all five seconds a new measurement report from the lower layer after the initial period of five paging blocks or five seconds.

The periodic incoming MPHC_RXLEV_PERIODIC_IND primitives are used to determine the time for sending a measurement report to RR. The parameter fn_offset in the MPH_MEASUREMENT_IND is used to define the time between two measurement reports in TDMA frames. RR expects the fieldstrength values in the GSM range.

The first measurement report is send after receiving fieldstrength values from layer 1 for at least five seconds. The following measurement reports to RR are send for a time period just under five seconds. The following table shows the constants:

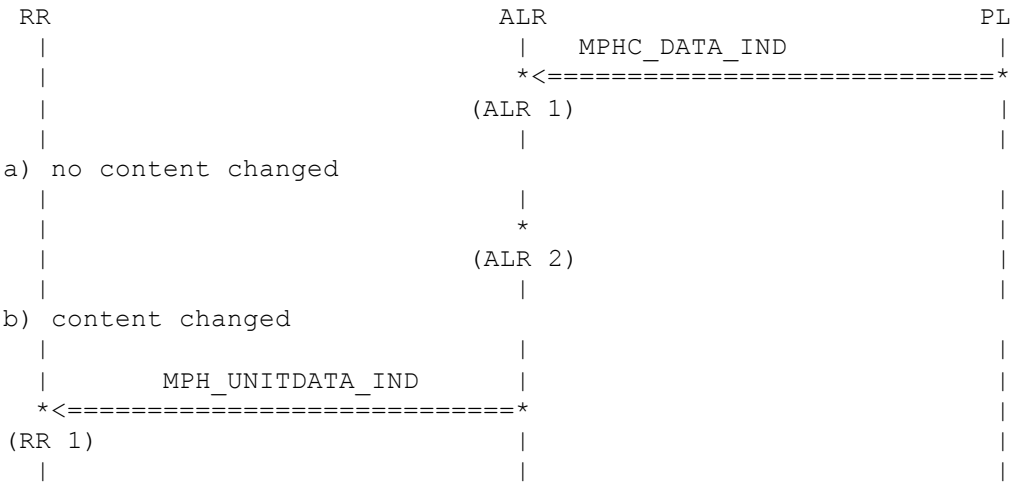
bs_pa_mfrms	initial number of reports	number of reports from layer 1 to send a measurement report	TDMA frames since last measurement report to RR

2	11	10	102
3	8	7	153
4	6	5	204
5	5	4	255
6	5	3	306
7	5	3	357
8	5	2	408
9	5	2	459

The measurement report contains only neighbourcells (up to 6) for which ALR has read the frequency correction burst and the synchron burst. The cells are ordered according to the multband parameter:

Multiband Parameter	Ordering of Neighbourcells
0	ordered by fieldstrength
1	one cell which is not on the serving cell band the rest is on the serving cell band and is ordered after fieldstrength
2	two cell which is not on the serving cell band the rest is on the serving cell band and is ordered after fieldstrength
3	three cell which is not on the serving cell band the rest is on the serving cell band and is ordered after fieldstrength

5.4 BCCH Reading



(ALR 1)

A BCCH data block is read by layer 1. The parameter tc in the received MPHC_DATA_IND primitive indicates the multiframe number modulo 8 in which the BCCH data block was read.

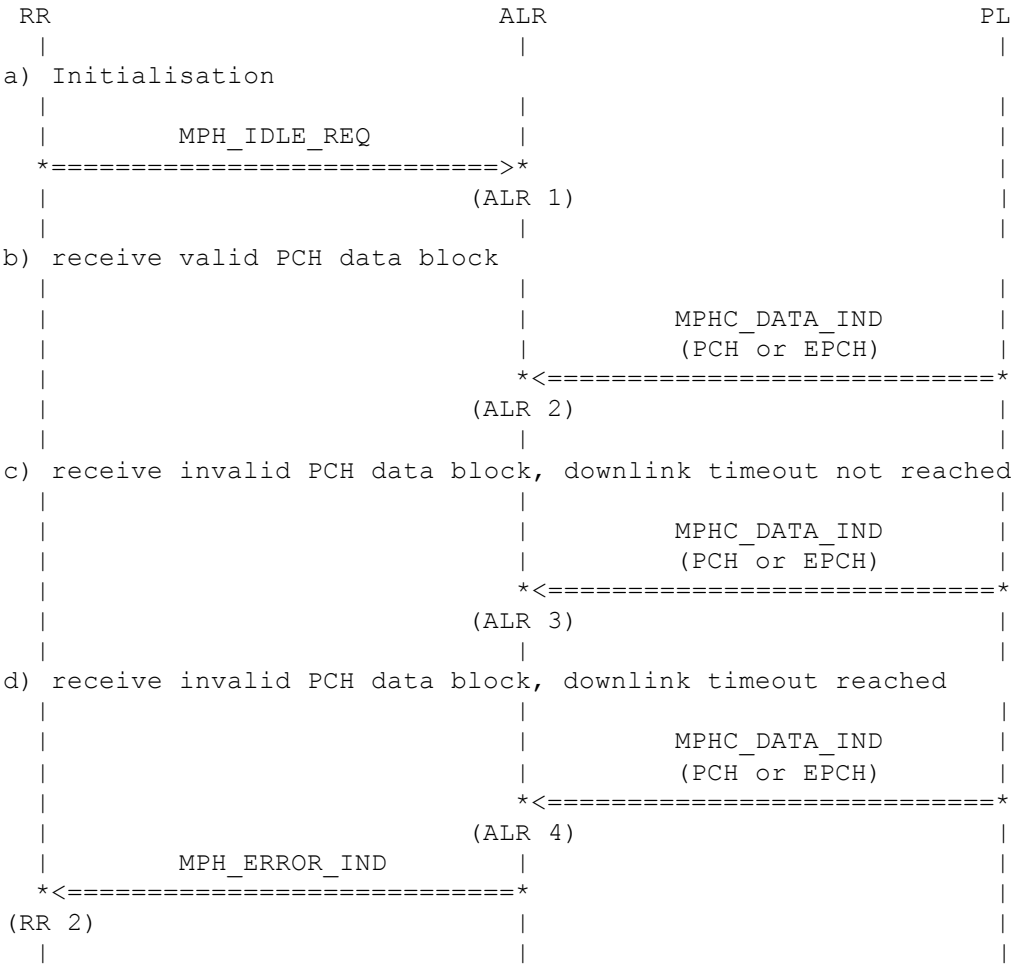
(ALR 2)

If the message content has not changed, the message is not forwarded.

(RR 1)

If the BCCH data block is a valid message and the contents has changed, ALR removes the layer 2 pseudolength and forwards the message to RR.

5.5 Downlink Failure Detection



(ALR 1)

During initialising the idle mode the downlink timeout counter is initialised by the MPH_IDLE_REQ primitive. This value is equal to the nearest integer of 90/bs_pa_mfrms and is calculated in RR.

(ALR 2)

If a valid PCH data block receives the counter is incremented by one up to the initial value.

(ALR 3)

If an invalid PCH data block receives the counter is decremented by four up to zero. The block is discharged.

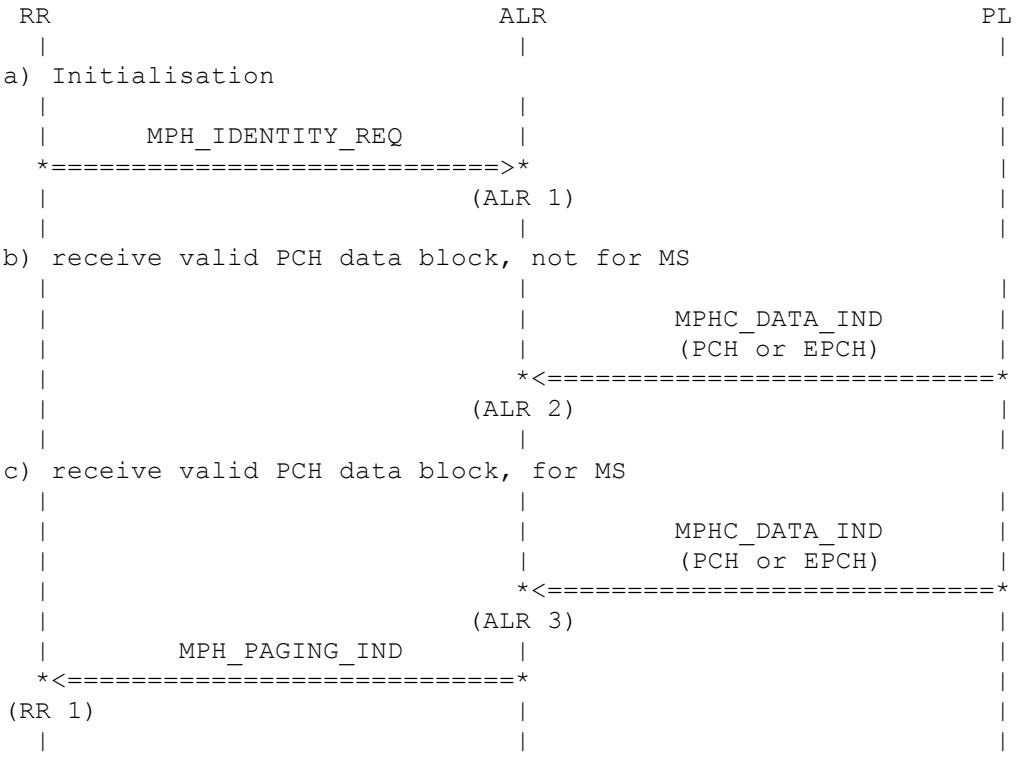
(ALR 4)

An invalid PCH data block received. The counter is decremented to zero. So the downlink failure criterion is met. The PCH data block is discharged.

(RR 2)

The downlink failure is signalled to RR. The downlink criterion counter is re-initialized.

5.6 Paging Detection



(ALR 1)

Whenever RR has new information about IMSI / TMSI, it sends a MPH_IDENTITY_REQ to ALR. ALR creates a pattern for the IMSI using the air-interface format and stores the TMSI.

(ALR 2)

A valid PCH data block receives containing a paging request type 1, 2 or 3 message. The compare fails and the message is not longer used.

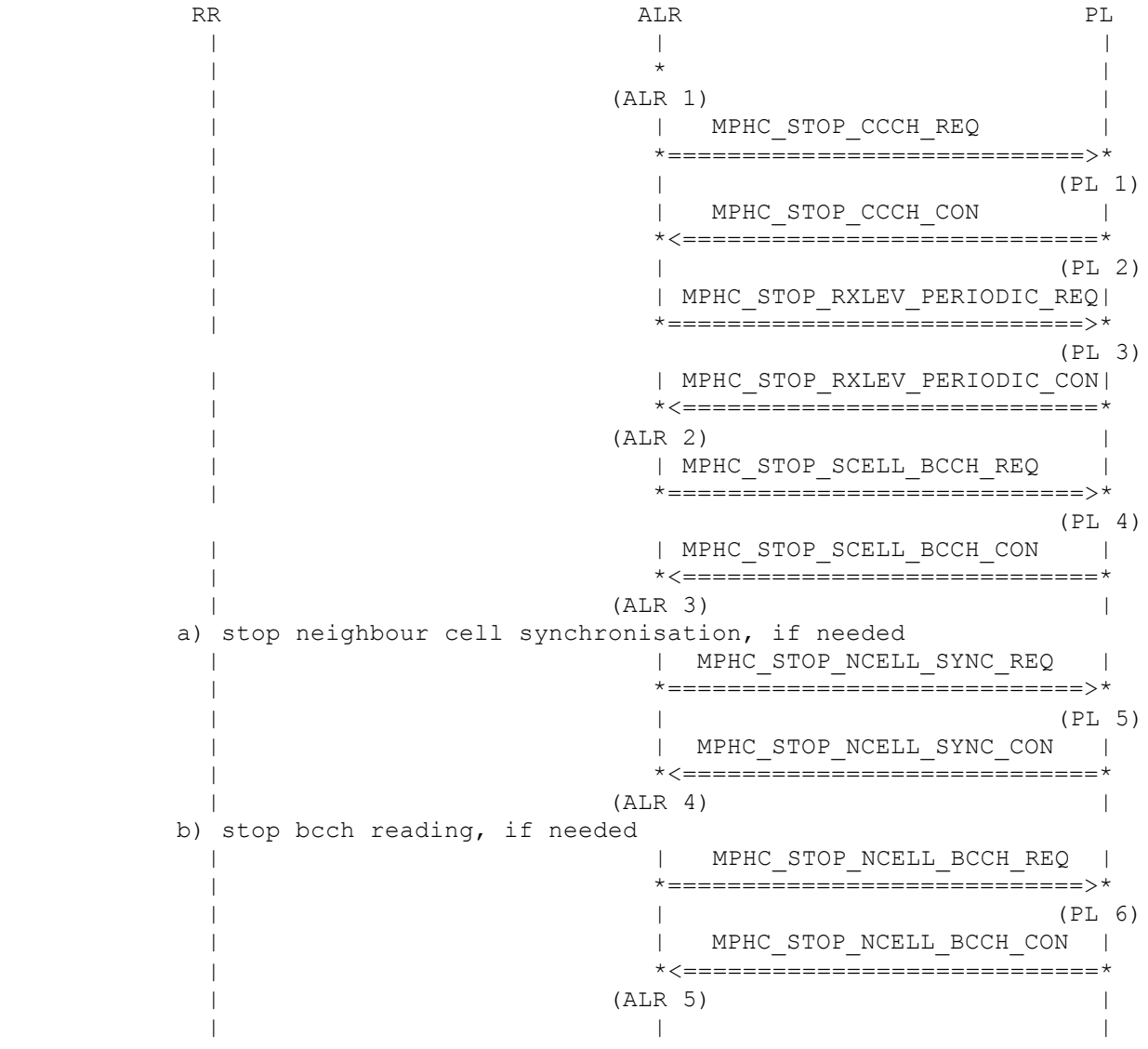
(ALR 3)

A valid PCH data block receives containing a paging request type 1, 2 or 3 message. The compare matches. ALR has calculated the mobile identity type which matches (IMSI or TMSI) and the needed channel depending on the position of the mobile identity in the paging request message.

(RR 1)

The paging indication is send to RR. RR starts mobile terminated connection establishment.

5.7 Stop Idle Mode



(ALR 1)

Various events may stop the idle mode:

- Start of Dedicated Mode
- Start of Cell Selection
- ...

(PL 1)

Stop paging.

(PL 2)

Confirm stop request.

(PL 3)

Stop power measurements.

(ALR 2)

Confirm stop request.

(PL 4)

Stop serving cell BCCH reading.

(ALR 3)

Confirm stop request.

(PL 5)

Stop outstanding neighbour cell synchronisation requests.

(ALR 4)

Confirm stop request.

(PL 6)

Stop neighbour cell BCCH reading if it is currently read.

(ALR 5)

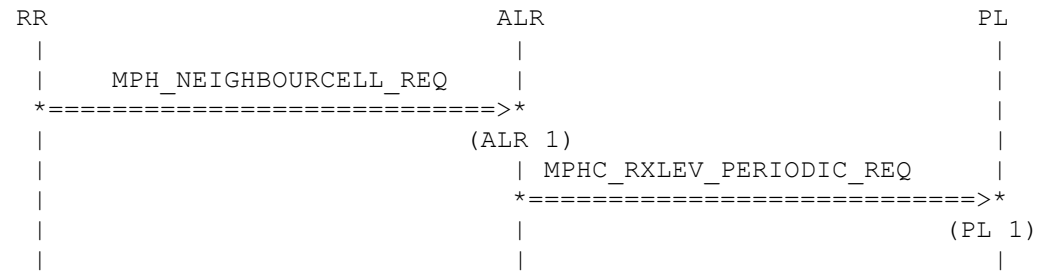
Confirm stop request.

6 Idle Mode Neighbour Cell Procedures

After cell selection the mobile station is in idle mode. For the neighbour cells the following services are requested by RR:

- Definition of BCCH allocation
- Fieldstrength measurements
- Synchronisation to neighbourcells
- Confirmation of synchronisation to neighbourcells
- BCCH reading for neighbourcells

6.1 Definition of BCCH Allocation



(ALR 1)

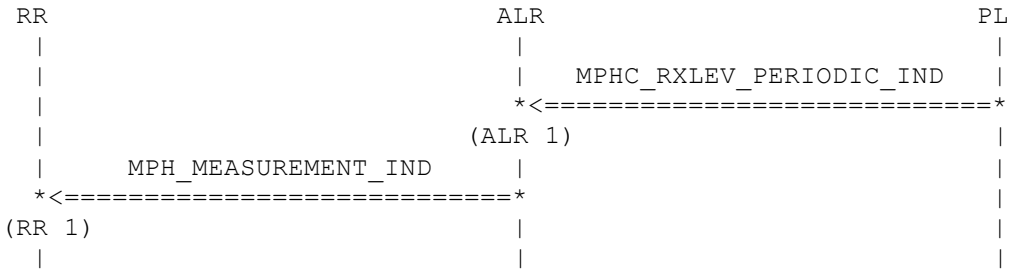
A new neighbour cell description list is forwarded from RR to the lower layer.

(PL 1)

The serving cell is added to the neighbour cell list. The BCCH allocation list in the neighbour cell process is updated. That means all channels in the old BCCH allocation list, which are not member of the new list are removed. All channels in the new list, which are not member of the old list are added to the BCCH allocation list in the neighbour cell process. These entries are initialised with status FB_SB_SYNC for the serving cell and IDLE for all other cells.

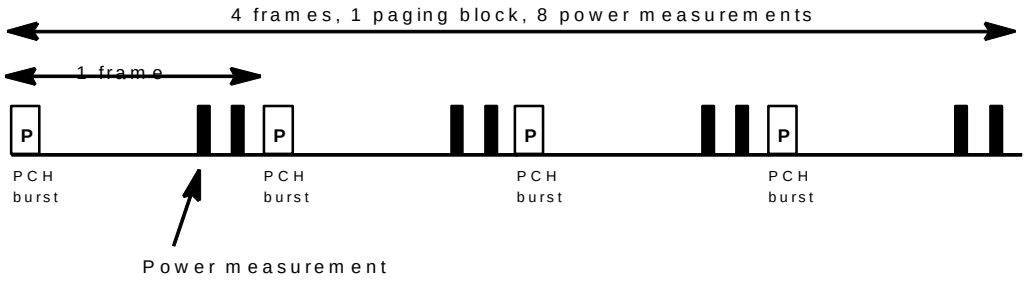
The new BCCH allocation list is forwarded to PL. The parameter ba_id is used to identify incoming fieldstrength samples.

6.2 Measurement Reporting



(ALR 1)

A single measurement report (MPHC_RXLEV_PERIODIC_IND) is returned to ALR after each PCH block monitor period. This report message contains a list of the 8 measurement results (arfcns measured with their corresponding power levels, in non clipped RXLEV format, i.e: 0 to 255). This list has a ba_id sequence number which matches the original MPHC_RXLEV_PERIOD_REQ request. If the BA list contains less than 8 arfcns, measurements shall be repeated during the PCH block (e.g: if the BA list contained 3 arfcns (1,2,3), the first measurement period would return results for arfcns 1, 2, 3, 1, 2, 3, 1, 2 the next measurement returned would be 3, 1, 2, 3, 1, 2, 3, 1). For any BA list length, the measurements shall be made on a wrap-around basis (e.g: if the BA list contained 10 arfcns, the first 8 would be measured in the first PCH block period, the next PCH block period would measure the remaining 2 arfcns and then re-measure the first 6 again).



The results are added in the rxlev parameter. If five measurement samples are collected an average is calculated in the rxlev_average parameter.

For all members of the BCCH allocation a status is defined. The following values are possible:

INACTIVE	No field strength average value available.
IDLE	Only fieldstrength of the member is known. The mobile station is not synchronized and has no knowledge about the BCCH.
READ_FB_SB	This state is entered if a neighbour cell is one of the six strongest channels and the mobile station is not synchronized yet. It indicates that the mobile station shall read frequency correction burst and synchron burst as soon as possible.
FB_SB_SYNC	The channel is one of the six strongest neighbour cells and the mobile station is synchronized to the neighbour cell. RR is informed about the channel.
FB_SB_SYNC_2	The channel is one of the six strongest neighbour cells and the mobile station is synchronized to the neighbour cell. RR is not yet informed about the channel.
READ_SB	The channel is one of the six strongest neighbour cells and the mobile station must read the synchron burst again as soon as possible.
READ_BCCH	The channel is one of the six strongest neighbour cells, the mobile is synchronized to the channel and the BCCH of this channel shall be read as soon as possible.
IDLE_SYNC	The mobile station is synchronized to the channel, but the channel is not longer one of the six strongest neighbour cells.
FB_SB_FAILED	The attempt for synchronization failed, but the channel is one of the six strongest.

FB_SB_FAILED2	The attempt for synchronization failed and the channel is not one of the six strongest.
EXCLUDED	After eight synchronization attempts the channel is excluded from further attempts.
READ_SB_BCCH	All five minutes the neighbour cell BCCH must be read. This is started with a synchronisation attempt to the synchron burst followed by reading of the BCCH. The synchronisation attempt is started as soon as possible.
READ_FB_SB_PENDING	The frequency correction and synchron burst is read for the channel. The response has not yet been received.
READ_SB_PENDING	The frequency correction and synchron burst is confirmed for the channel. The response has not yet been received.
READ_BCCH_PENDING	The BCCH is read for the channel. The response has not yet been received.
READ_SB_BCCH_PENDING	The frequency correction and synchron burst is confirmed for the channel. The response has not yet been received.

The status will be changed if a number of reports received from PL, or a primitive received from RR or the list of six strongest cells has changed. A counter is initialized to a value corresponding to the number of multiframes during the time period. After reception of a report from layer 1 the counter is decreased by BS_PA_MFRMS. If the value is less than BS_PA_MFRMS the time period has timed-out. This algorithm is independent from a change of BS_PA_MFRMS during the time period.

The neighbour cell process always checks the status of each neighbour cell, additionally it can start up to 6 procedures simultanously. The possible status changes after receiving a fieldstrength report from PL are listed in the following table:

old status	Condition	new status
INACTIVE	5 samples received	IDLE
IDLE	1 of 6 best channels	READ_FB_SB
READ_FB_SB	not 1 of 6 best channels	IDLE
FB_SB_SYNC	not 1 of 6 best channels	IDLE_SYNC
	more than 30 seconds	READ_SB
	more than five minutes	READ_SB_BCCH
FB_SB_SYNC_2	not 1 of 6 best channels	IDLE_SYNC
	more than 30 seconds	READ_SB
	more than five minutes	READ_SB_BCCH
READ_SB	not 1 of 6 best channels	IDLE
	more than five minutes	READ_SB_BCCH
READ_BCCH	Not 1 of 6 best channels	IDLE_SYNC
IDLE_SYNC	More than 30 seconds	IDLE
	1 of 6 best channels	FB_SB_SYNC
FB_SB_FAILED	1. to 4. Attempt, more than 10 seconds	READ_FB_SB
	5. to 8. Attempt, more than 20 seconds	READ_FB_SB
	More than 8. Attempt	EXCLUDED
	Not 1 of 6 best channels	FB_SB_FAILED2
	Reselection	ÎDLE
	Fieldstrength jump +6dBm	IDLE
FB_SB_FAILED2	1 of 6 best channels, less than 30 seconds	FB_SB_FAILED
	1 of 6 best channels, more than 30 seconds	FB_SB_FAILED
	Reselection	ÎDLE
	Fieldstrength jump +6dBm	IDLE

EXCLUDED	Reselection	ÎDLE
	Fieldstrength jump +6dBm	IDLE

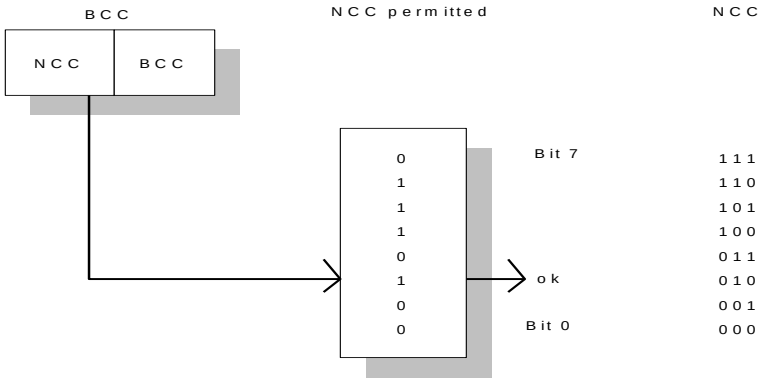
The conditions „more than 10/20/30 seconds“ are implemented by counters using BS_PA_MFRMS The criterion „1 of 6 best channels“ is calculated for all cells with a status unequal to INACTIVE. The calculation depends on the multi-band parameter in the dualband variant, else it depends on the fieldstrength.

(RR 1)

If a measurement report is send the neighbour cell process it adds all neighbour cells for which synchronisation was successful (status FB_SB_SYNC, READ_SB or READ_BCCH) and the NCC permitted check was successfull.

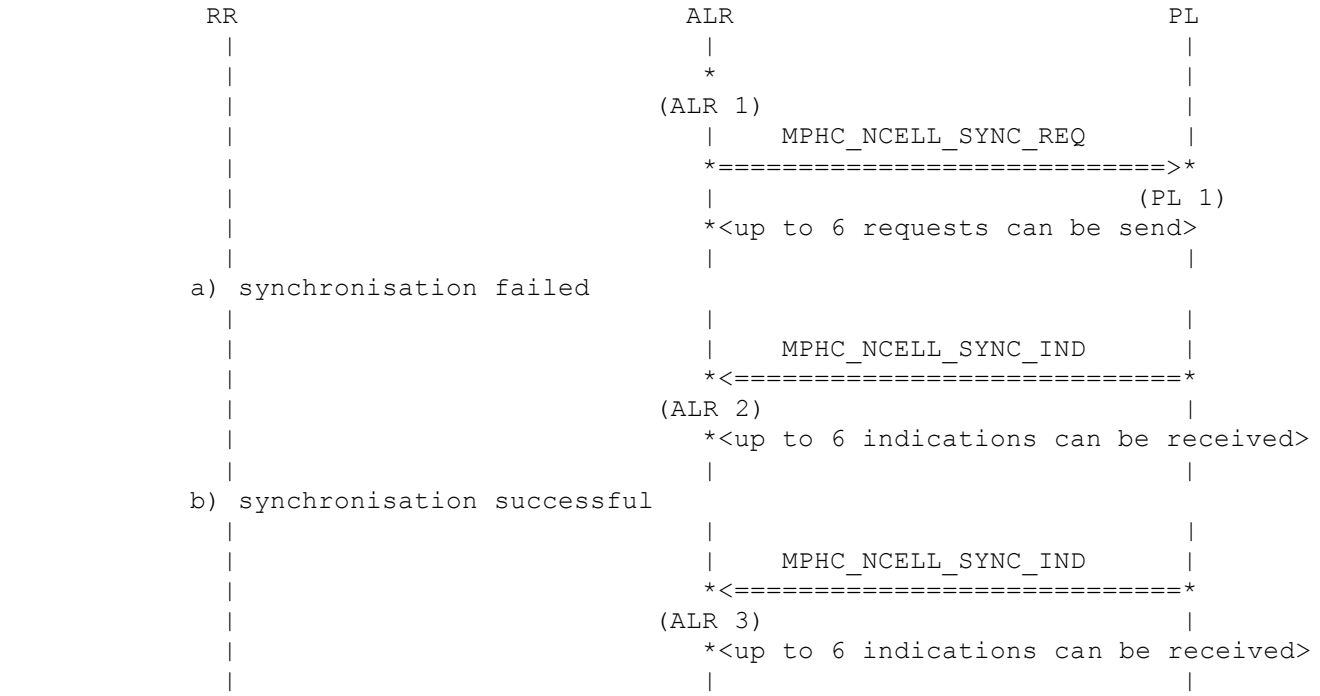
The measurement report contains only cells for which national colour code (NCC) is available in the NCC permitted field of the BCCH data.

The NCC is part of the BSIC. The NCC permitted field is a bitmap of allowed NCCs in the measurement report and will be received by RR with the SYSTEM INFORMATION TYPE 2 message. The following figure shows in which case an NCC is valid. If it is not valid, the cell is not included in the measurement report:



NCC Check

6.3 Synchronisation to Neighbour Cells



(ALR 1)

After processing a report from layer 1 or after receiving a MPHC_NCELL_SYNC_IND or a MPHC_NCELL_BCCH_REQ it is checked whether the following conditions are true:

- the „outstanding sync request counter“ is below 6 and
- at least one neighbour cell has the status READ_FB_SB, READ_SB, READ_SB_BCCH

If this is true then send the MPHC_NCELL_SYNC_REQ‘s.

(PL 1)

For up to 6 neighbour cells a synchronisation attempt is initiated with the primitive MPHC_NCELL_SYNC_REQ. The timing_validity parameter is set to TV_INVALID_TIMING_INFO, if the status of this cell is READ_FB_SB else the timing_validity parameter is set to TV_VALID_TIMING_INFO. The neighbour cell process increments the „outstanding sync request counter“ for each request send.

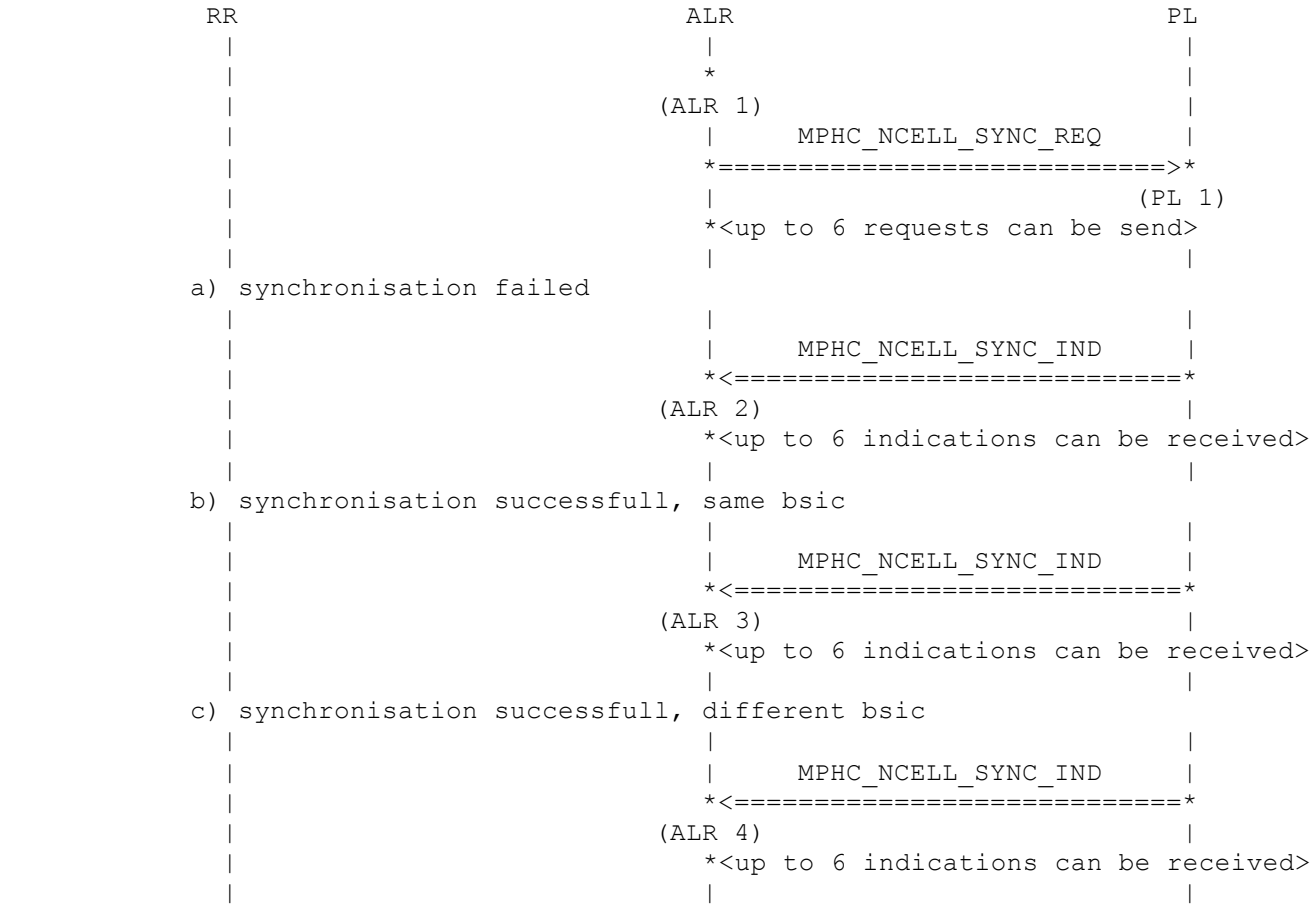
(ALR 2)

Layer 1 indicates a failed synchronisation attempt. The cell gets the status FB_SB_FAILED or EXCLUDED (depending on the attempt counter), the c_attempt counter is incremented and the c_report variable is initialised with 10 or 20 seconds. For this time no new attempt is carried out for this channel although it may have excellent fieldstrength values. The „outstanding sync request counter“ is decremented.

(ALR 3)

Layer 1 indicates a successful synchronisation. The cell gets the status FB_SB_SYNC. The c_report variable is set to 30 seconds and the attempt counter is cleared. The frame offset, the time alignment and the bsic are stored. The „outstanding sync request counter“ is decremented.

6.4 Confirmation of Synchronisation to Neighbour Cells



(ALR 1)

After processing a report from layer 1 or after returning from a specific procedure it is checked whether the following conditions are true:

- the „outstanding sync request counter(osrc)“ is below 6 and
- at least one cell has the status READ_SB, READ_BCCH or READ_SB_BCCH.

If this is true then send the MPHC_NCELL_SYNC_REQ's.

(PL 1)

The procedure is initiated by a MPHC_NCELL_SYNC_REQ primitive. The timing_validity parameter is set to TV_VALID_TIMING_INFO.

(ALR 2)

Layer 1 indicates a failed reading attempt. The cell gets the status FB_SB_FAILED and the c_report variable is set to a value depending on the failed attempt counter. For this time period no new attempt is carried out for this channel although it may have excellent fieldstrength values. The „outstanding sync request counter“ is decremented.

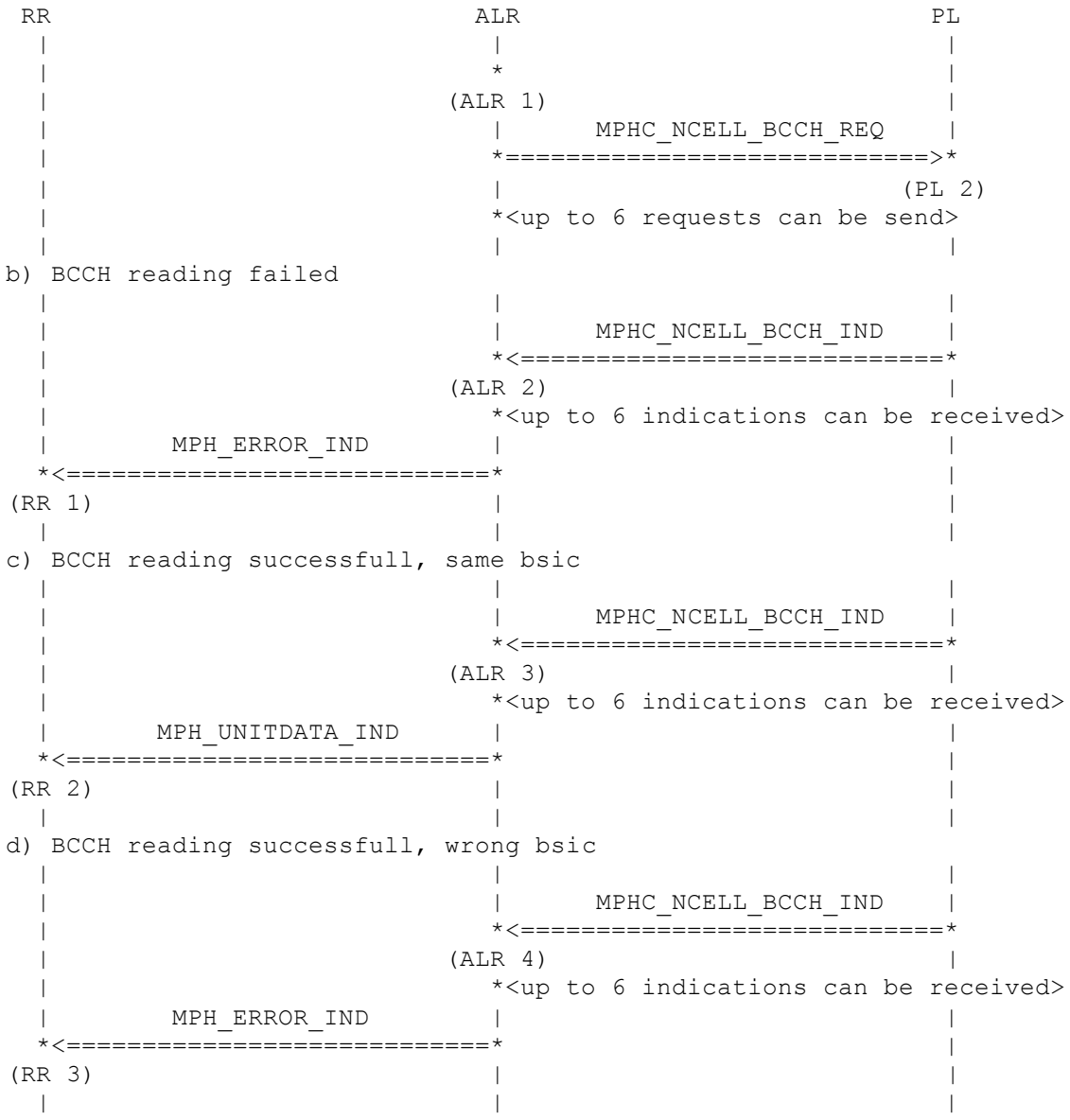
(ALR 3)

Layer 1 indicates a successful synchronisation with the same bsic. This indicates that the mobile station is synchronized to the same neighbour cell as the last time. The cell gets the status FB_SB_SYNC if the previous status was READ_SB. The c_report variable is set to 30 seconds. The frame offset and the time alignment are stored. The „outstanding sync request counter“ is decremented.

(ALR 4)

Layer 1 indicates a successful synchronisation with a different bsic. This indicates that the mobile station is synchronized to a different neighbour cell as the last time. The cell gets the status FB_SB_SYNC. The c_report variable is set to 30 seconds. The frame offset, the time alignment and the bsic are stored. The „outstanding sync request counter“ is decremented.

6.5 Reading of Neighbour Cell BCCH



(ALR 1)

After processing a report from layer 1 or after returning from a specific procedure it is checked whether the following conditions are true:

- the „outstanding bcch request counter“ is below 6 and
- at least one cell has the status READ_BCCH.

If this is true then send the MPHC_NCELL_BCCH_REQ's.

(PL 2)

The procedure is initiated by a MPHC_NCELL_BCCH_REQ primitive. The parameter bcch_blocks_required is set to reading system information type 3 / 4 / 7 / 8 messages.

(ALR 2)

The BCCH data block indicates that reading has failed. The data block is discarded. The cell gets the status FB_SB_SYNC. The „outstandind bcch request counter“ is decreased.

(RR 1)

An error indication is sent to RR with the cause BCCH decode error.

(ALR 3)

The BCCH data block indicates that reading was successful and the bsic is correct. Depending on the message type according the following table, BCCH reading is stopped or not. The cell gets the status FB_SB_SYNC. The c_report variable is resetted. The frame offset is stored. The „outstandind bcch request counter“ is decreased.

Message Type	
System Information Type 3	forward message and stop reading
System Information Type 4	forward message and stop reading, if message indicates no additional information necessary
System Information Type 7 / 8	forward message and stop reading if system information type 4 has indicated that additional information are necessary, else ignore.

(RR 2)

The BCCH data block is forwarded to RR.

(ALR 4)

The BCCH data block indicates that reading was successful but the bsic is wrong. The cell gets the status FB_SB_SYNC. The frame offset and the bsic are stored. The „outstanding bcch request counter“ is decreased.

(RR 3)

An error indication is sent to RR with the cause BCCH decode error.

6.6 REORGANIZATION mode vs. HPLNM search

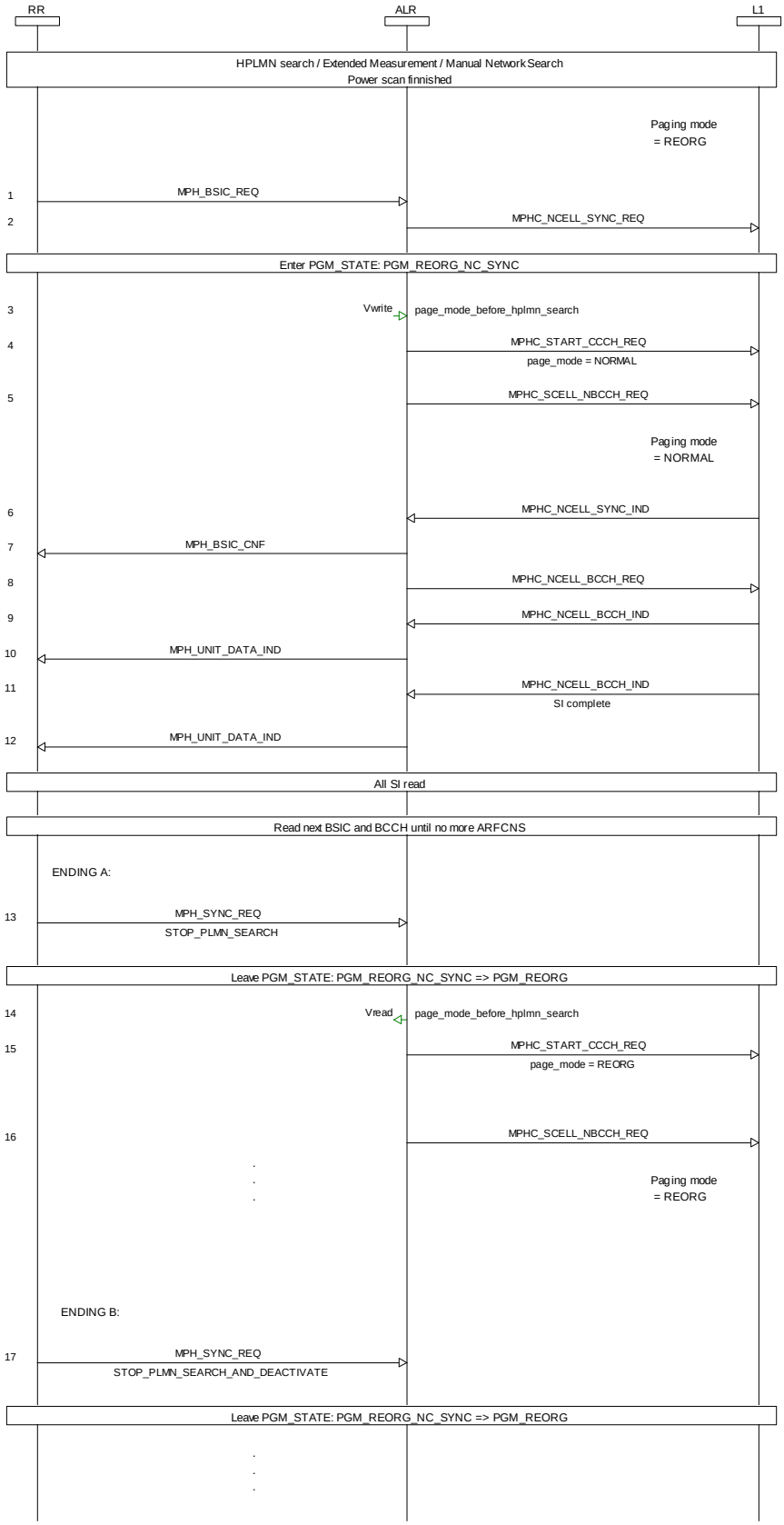
When the network configures reorganization as paging mode, a HPLMN search (or manual network search) is not done correctly. This happens because the mobile is too busy with listening to the CCCH and BCCH of the SC and can’t synchronize to the BCCH of any other carrier.

The mobile is listening only to pagings of own paging group during HPLMN search procedure. Also the BCCH is just read occasionally. After finishing the neighbor cell synchronization a MPH_SYNC_REQ primitive is received with the cause STOP_PLMN_SEARCH or STOP_PLMN_SEARCH_AND_DEACTIVATE . Then paging reorganization is continued and the BCCH is listened completely again to find a possible new page mode configuration.

If a BCCH configuration is read with normal paging during HPLMN search procedure, normal paging is configured and the mobile don’t reestablish reorganization after finishing the HPLMN search procedure.

HPLMN search is finished after ~1,5sec (for synchronization and SI reading) * number_of_requested_carriers.

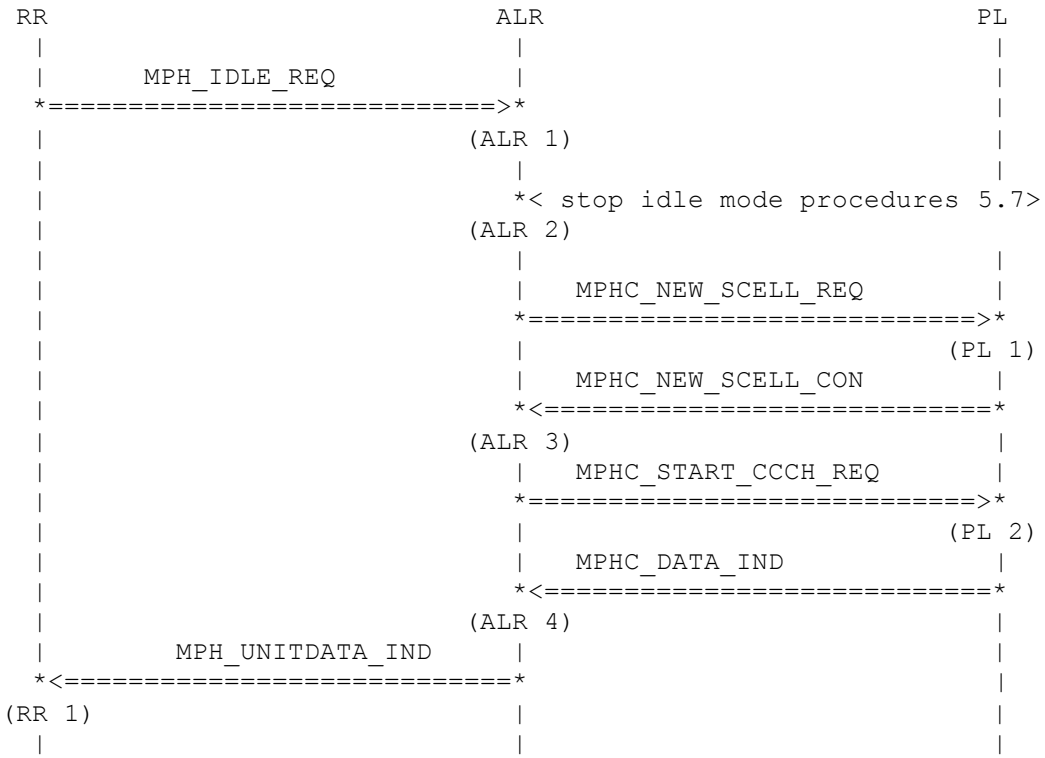
The number of lost pagings depends of the configuration. In the worst-case 79/80 of all paging possibilities are lost during this time.
There are configurations possible to reduce this number (e.g. with bs_pa_mfrms = 2), but that could mean not to listen to own paging group.


RR
ALR
L1
HPLMN search / Extended Measurement / Manual Network Search
Power scan finnished
Paging mode
= REORG
1
MPH_BSIC_REQ
2
MPHC_NCELL_SYNC_REQ
Enter PGM_STATE: PGM_REORG_NC_SYNC
3
Vwrite
page_mode_before_hplmn_search
4
MPHC_START_CCCH_REQ
page_mode = NORMAL
5
MPHC_SCELL_NBCCH_REQ
Paging mode
= NORMAL
6
MPHC_NCELL_SYNC_IND
7
MPH_BSIC_CNF
8
MPHC_NCELL_BCCH_REQ
9
MPHC_NCELL_BCCH_IND
10
MPH_UNIT_DATA_IND
11
MPHC_NCELL_BCCH_IND
SI complete
12
MPH_UNIT_DATA_IND
All SI read
Read next BSIC and BCCH until no more ARFCNS
ENDING A:
13
MPH_SYNC_REQ
STOP_PLMN_SEARCH
Leave PGM_STATE: PGM_REORG_NC_SYNC => PGM_REORG
14
Vread
page_mode_before_hplmn_search
15
MPHC_START_CCCH_REQ
page_mode = REORG
16
MPHC_SCELL_NBCCH_REQ
Paging mode
= REORG
ENDING B:
17
MPH_SYNC_REQ
STOP_PLMN_SEARCH_AND_DEACTIVATE
Leave PGM_STATE: PGM_REORG_NC_SYNC => PGM_REORG

7 Cell Reselection

Cell Reselection is the change of the serving cell in idle mode. The decision is made by RR depending on the fieldstrength measurements of the lower layer.

7.1 Cell reselection is requested



(ALR 1)

RR starts a cell reselection. The new channel description is send to ALR. One flag in the primitive indicates start of cell reselection.

(ALR 2)

All running idle mode procedures are stopped.

(PL 1)

Reselection is started in layer 1. Time alignment and frame offset are set by ALR.

(ALR 3)

Layer 1 is synchronized to the new cell.

(PL 2)

The MS switches to paging reorganization.

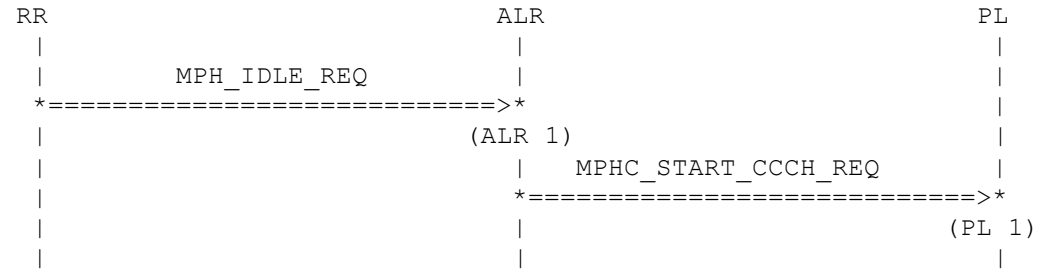
(ALR 4)

The BCCH data of the neighbour cell are read by layer 1. This is carried out for all BCCH blocks defined in the previous request.

(RR 1)

The valid BCCH blocks are send to RR.

7.2 End of Cell Reselection, cell is suitable



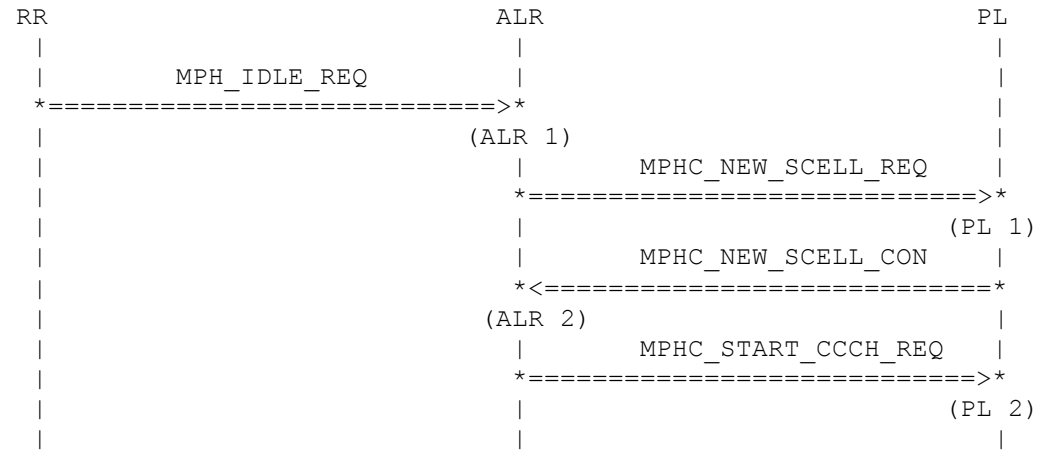
(ALR 1)

RR has decided that the neighbourcell is suitable. It forwards the new paging parameter to ALR.

(PL 1)

The layer 1 is configured for the idle mode and normal paging. See chapter for 4.6 details.

7.3 BCCH of Neighbour Cell is not suitable, next cell



(ALR 1)

RR has checked the incoming BCCH data for the neighbour cell. The cell is not suitable but there is another candidate for cell reselection.

(PL 1)

Reselection is started in layer 1. Time alignment and frame offset are set by ALR.

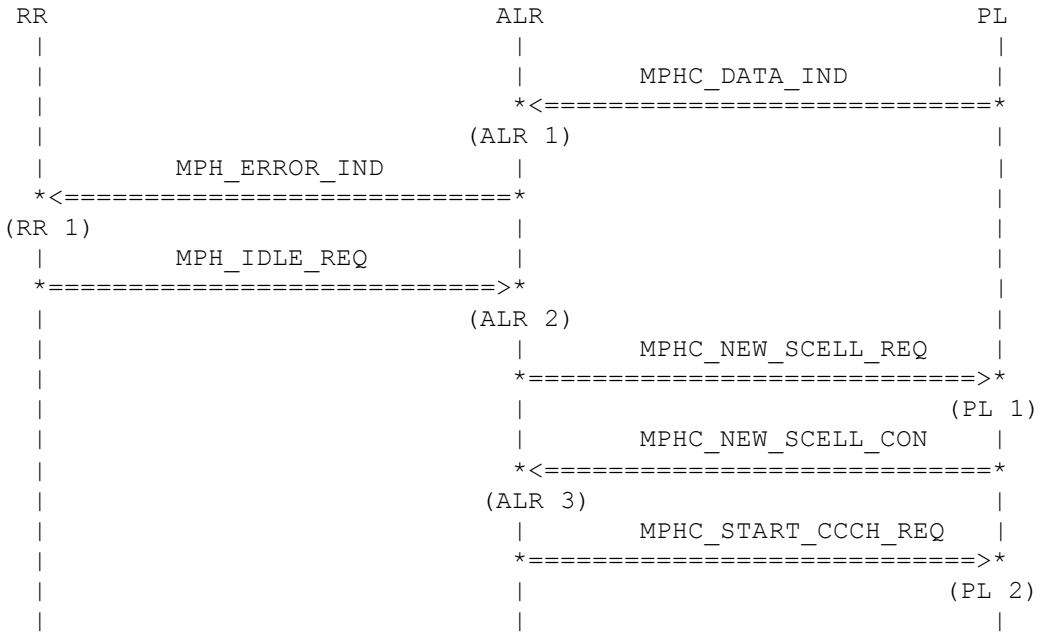
(ALR 2)

Layer 1 is synchronized to the new cell.

(PL 2)

The MS switches to paging reorganization.

7.4 BCCH of Neighbour Cell is not readable, next cell



(ALR 1)

The BCCH data of the neighbour cell are read by layer 1.

(RR 1)

An invalid BCCH block is detected and an error is forwarded to RR.

(ALR 2)

The cell is not suitable but there is another candidate for cell reselection.

(PL 1)

The next attempt is started. The time alignment and frame offset for this neighbour cell are send to layer 1.

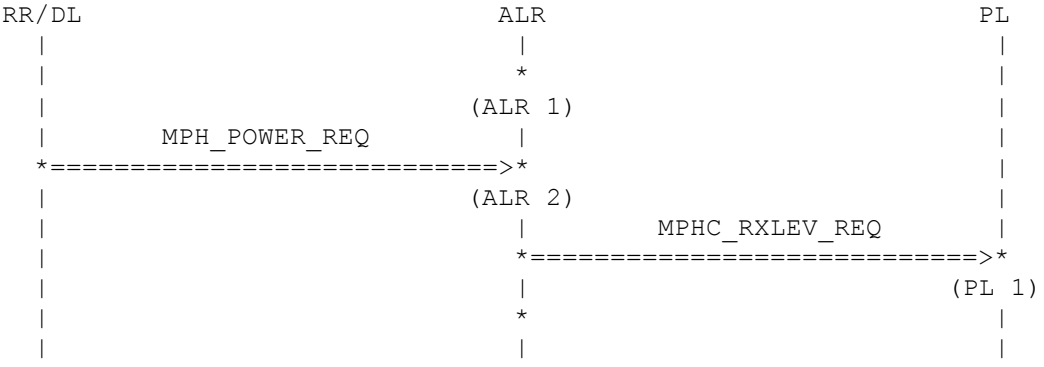
(ALR3)

Layer 1 is synchronized to the new cell.

(PL 2)

The MS switches to paging reorganization.

7.5 BCCH Error, no further cell available



(ALR 1)

A previous cell reselection attempt has failed.

(ALR 2)

If RR has no further candidate for cell reselection and the old serving cell is not available (e.g. cell is barred) a Cell Selection is initiated by RR.

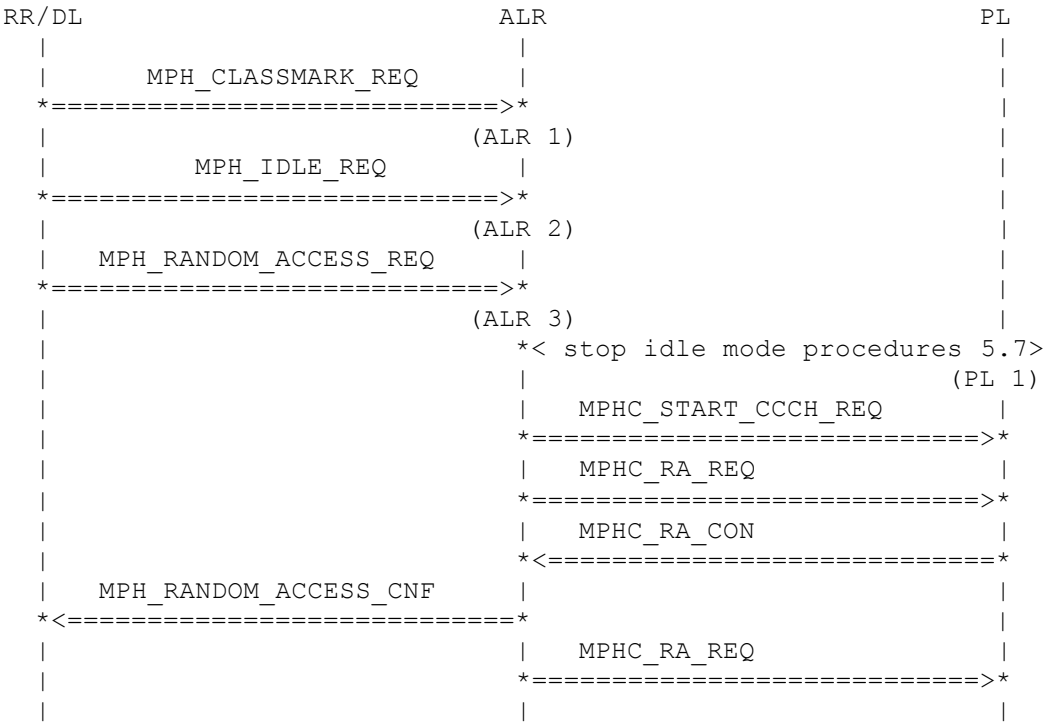
(PL 1)

Reading of fieldstrength values in layer 1 is triggered.

8 Connection Establishment

The mobile station is in idle mode and starts connection establishment. This is possible for the mobile originated call by initiation of mobility management or for the mobile terminated call after reception of a paging message for the mobile station.

8.1 Start of Connection Establishment



(ALR 1)

During cell selection RR has send classmark information to the lower layer. The power class (or two power classes for dual-band) of the mobile station is stored in the RACH control process. Note that the coding is different (RR 0 .. 4, PL 1 .. 5).

(ALR 2)

During configuring the idle mode the MAX_TX_PWR_CCCH value from the system information messages is send to the lower layer. The value is stored in the RACH control process.

(ALR 3)

The RACH control process is in state RA_NULL. RR starts the connection establishment. The primitive contains the number of random bursts (equal max_retrans + 1 from system information), the delta between to random bursts as multiple of TDMA frames and the channel request messages itself. The content of the primitive is stored.

(PL 1)

The idle mode is stopped.

(PL 2)

The access link is started by sending a MPHC_START_ACCESS_LINK primitive to PL. That means that in downlink direction the mobile station will send random burst on request and in uplink direction the full CCCH is listened. Therefore the RACH control process enters state RA_ACTIVE.

The first random burst is send.

(ALR 2)

Sending of the random burst is confirmed by layer 1. The primitive contains the absolute frame number. The short frame number FN = absolute frame number modulo 42432 is calculated. This frame number is splitted into the variables T1, T2 and T3:

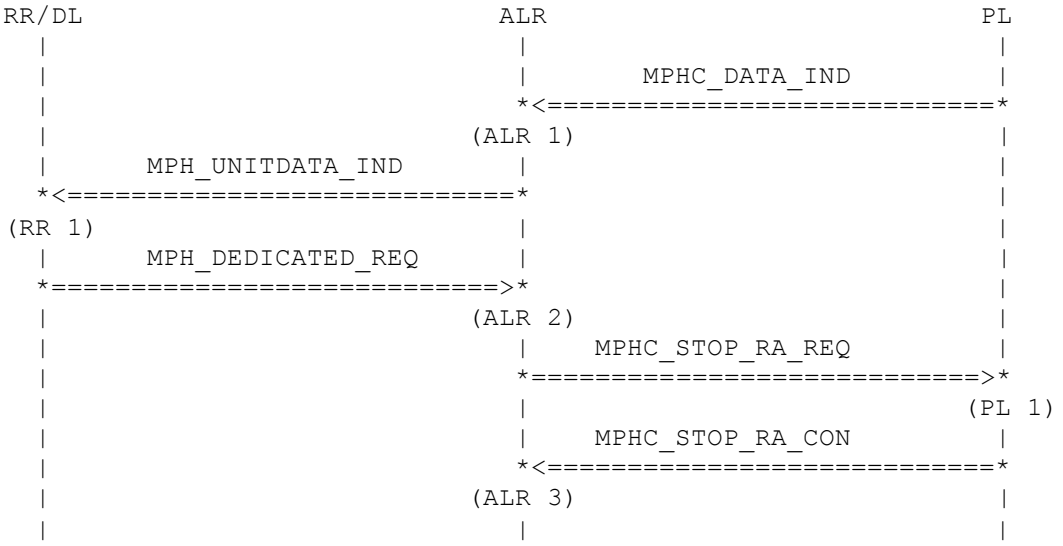
- T1 = (FN div 1326) mod 32
- T2 = FN mod 26
- T3 = FN mod 51.

(RR 1)

The calculated values are forwarded to the upper layer.

This procedure is carried out for all channel request messages. After the last confirmation the RACH control process enters the state RA_LISTEN_TO_CCCH.

8.2 Immediate Assignment Message for MS



(ALR 1)

After starting the access link, layer 1 listens to the downlink CCCH. All data blocks are forwarded to the upper layer.

(RR 1)

If the block is valid it will be forwarded to the upper layer.

(ALR 2)

If it is a immediate assignment or immediate assignment extended message, RR checks whether the random reference and the frame number in this message is equal to one of the three last send random bursts of the mobile station. If this matches, RR configures the dedicated mode for SDCCH or FACCH depending on the assigned channel configuration. Handling of this is carried out by the SDCCH or FACCH control process.

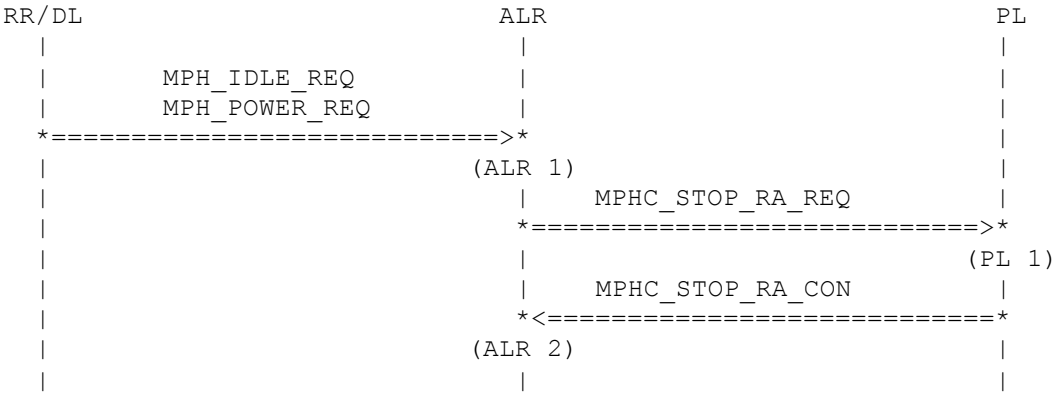
(PL 1)

Configuration of dedicated mode means on the other hand the end of the RACH control process. Layer 1 is informed and the RACH control process enters state RA_NULL.

(ALR 3)

Stop of RA is confirmed

8.3 T3126 Expiry in RR



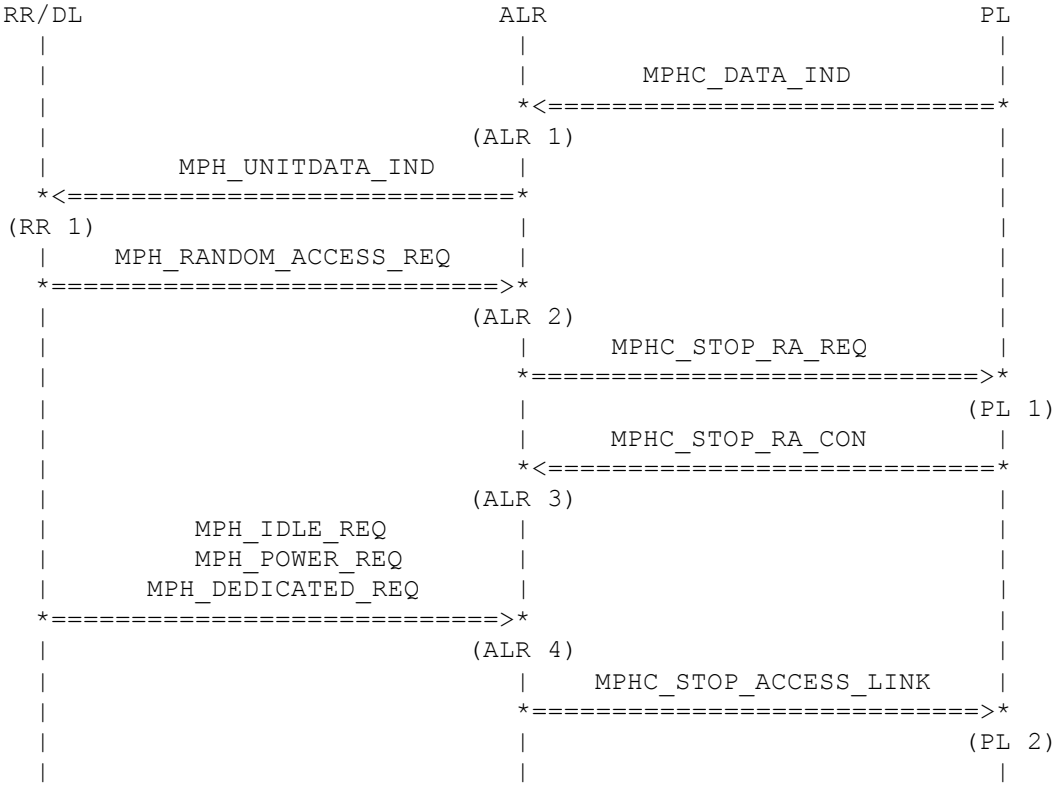
(ALR 1)

If all channel request messages are sent RR starts the timer T3126 defining the time in which an immediate assignment message may send from the infrastructure. After timeout RR goes back to idle mode (normally by MPH_IDLE_REQ). If no suitable cell is available a cell selection is started by power measurements with MPH_POWER_REQ.

(PL 1)

Going back to the idle mode or starting cell selection meas on the other hand the end of the RACH control process. Layer 1 is informed and the RACH control process enters state RA_NULL.

8.4 Immediate Assignment Reject Message for MS



(ALR 1)

After starting the access link, layer 1 listens to the downlink CCCH. All data blocks are forwarded to the upper layer.

(RR 1)

If the block is valid it will be forwarded to the upper layer.

(ALR 2)

If it is a immediate assignment reject message, RR checks whether the random reference and the frame number in this message is equal to one of the three last sended random bursts of the mobile station. If this matches RR stops sending of random burst if not all bursts are send. It starts T3126 and listens to the incoming CCCH messages.

(PL 1)

Sending of the remaining bursts is stopped and the RACH control process enters the state RA_LISTEN_TO_CCCH.

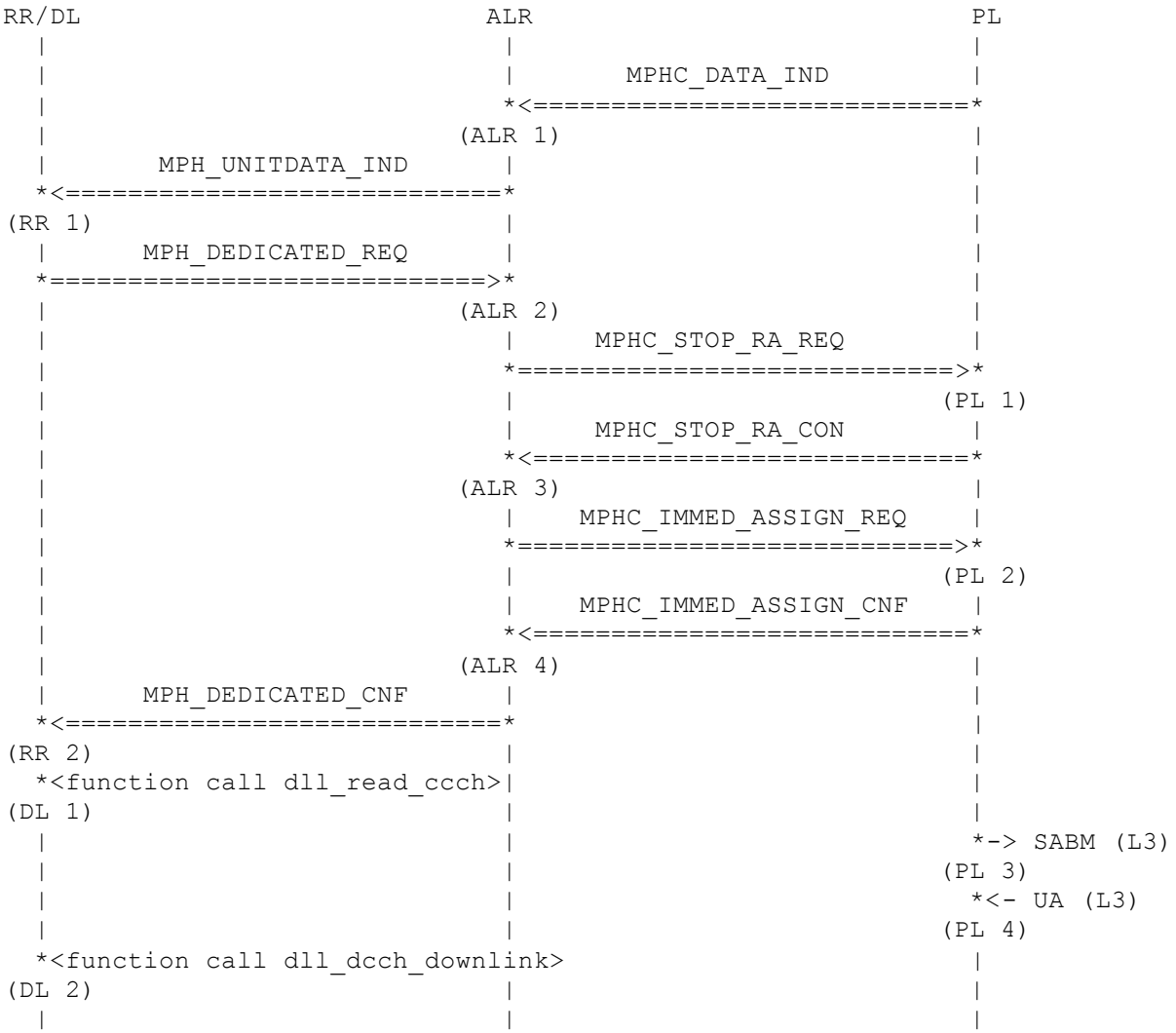
(ALR 4)

After timeout of T3126 RR goes back to idle mode (normally by MPH_IDLE_REQ). If no suitable cell is available a cell selection is started with power measurements.

(PL 2)

Going back to the idle mode or starting cell selection means on the other hand the end of the RACH control process. Layer 1 is informed and the RACH control process enters state RA_NULL.

9 Immediate Assignment



(ALR 1)

After starting the access link, layer 1 listens to the downlink CCCH. All data blocks are forwarded to the upper layer.

(RR 1)

The incoming CCCH data block is an immediate assignment or immediate assignment extended message. The request reference inside the message matches to one of three last bursts send by the mobile station.

(ALR 2)

The content of the immediate assignment (extended) message is forwarded to ALR).

(PL 1)

Sending of channel request bursts in uplink direction and listening to the CCCH in downlink direction is stopped.

(PL 2)

The new dedicated channel is set up in layer 1.

(ALR 4)

Layer 1 signals that the dedicated channel is configured.

(RR 2)

The confirmation is forwarded to RR. RR starts establishment of the layer 2 connection. That means it sends a DL_ESTABLISH_REQ primitive to DL containing the initial layer 3 message (CM_SERVICE_REQ or PAGING_RESPONSE).

(DL 1)

Layer 1 starts transmission on SDCCH or FACCH in uplink direction. This is carried out by a function call to avoid timing problems. DL prepares a layer 2 frame with a SABM command including the layer 3 message.

(PL 3)

The SABM command for service access point 0 including the layer 3 message is send to the base station.

(PL 4)

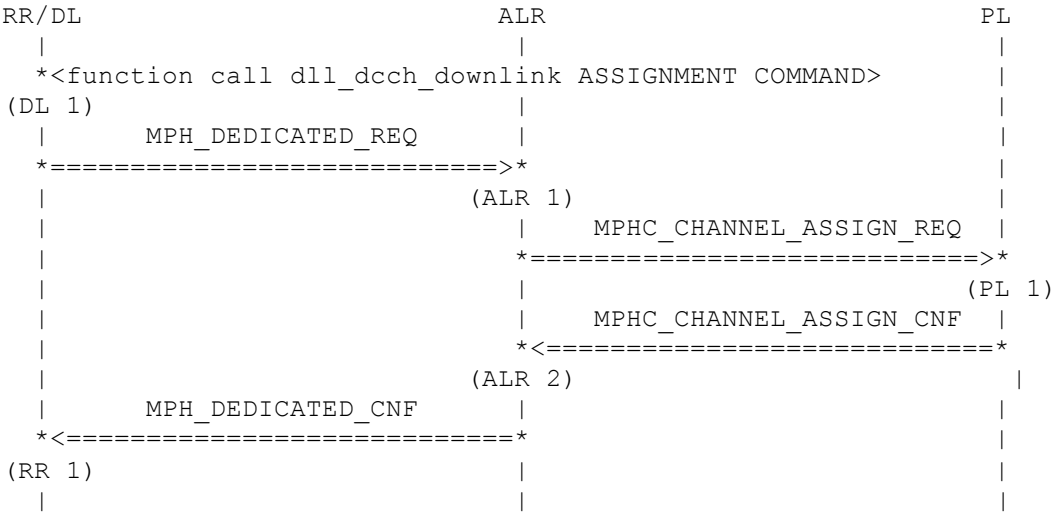
The answer of the base station is received by layer 1. In the successfull case this will be an UA response for SAPI 0 including the layer 3 message previously send.

(DL 2)

The incoming frame is forwarded directly to DL via a function call to avoid timing problems. DL signals to RR the establishment of the layer 2 connection.

10 Channel Assignment

10.1 Initiation



(DL 1)

DL receives an ASSIGNMENT COMMAND message. This message is forwarded to RR. RR checks the information elements of the message.

If a failure is detected by RR typical an ASSIGNMENT FAILURE message is sent to the network and the procedure is not started.

If the ASSIGNMENT COMMAND message is accepted, RR starts a local end release for the established connection. That means DL changes from multiple frame established state to the idle state.

(ALR 1)

With the information from the ASSIGNMENT COMMAND message RR builds a MPH_DEDICATED_REQ and sends this to ALR.

(PL 1)

The incoming information is converted to the MPHC_CHANNEL_ASSIGN_REQ primitive to layer 1. The following table show the conversions and calculations from the ASSIGNMENT COMMAND to the layer 1 primitive.

ASSIGNMENT COMMAND	MPH_DEDICATED_REQ	MPHC_CHANNEL_ASSIGN_REQ	Remark
Channel Description 1 after time	ch_type	channel_desc_1	
Power Command	tr_para.power	txpwr	
Frequency List after time	ch_type.ma	frequency_list	* 1)
Cell Channel Description	----	----	* 1)
Channel Mode 1	tr_para.mode	channel_mode_1	* 4)
Channel Description 2 after time	----	channel_desc_2	* 2)
Channel Mode 2	----	channel_mode_2	* 2)
Mobile Allocation after time	----	----	* 1)
Starting Time	start	starting_time	
Frequency List before time	ch_type2.ma	frequency_list_ _bef_sti	*3)
Channel Description 1 before time	ch_type2	channel_desc_1_ _bef_sti	* 3)
Channel Description 2 before time	----	channel_desc_2_ _bef_sti	* 2)
Frequency Channel Sequence before time	----	----	* 3)
Mobile Allocation before time	----	----	* 3)
Cipher Mode Setting	ciph	cipher_mode a5_algorithm cipher_key	

*1) Only one frequency list is build by RR from the

Frequency List after time or
Cell Channel Description together with Mobile Allocation after time.

*2) The protocol stack supports only one connection at one time.

*3) Only one frequency list is build by RR from the
Frequency List before time or
Frequency Channel Sequence befor time or
Cell Channel Description together with Mobile Allocation before time.

Information elements for before the starting time are only valid if the starting time is present.

*4) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate) 2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate) 5 (halfrate)
Data 3.6	19	6 (fullrate) 7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

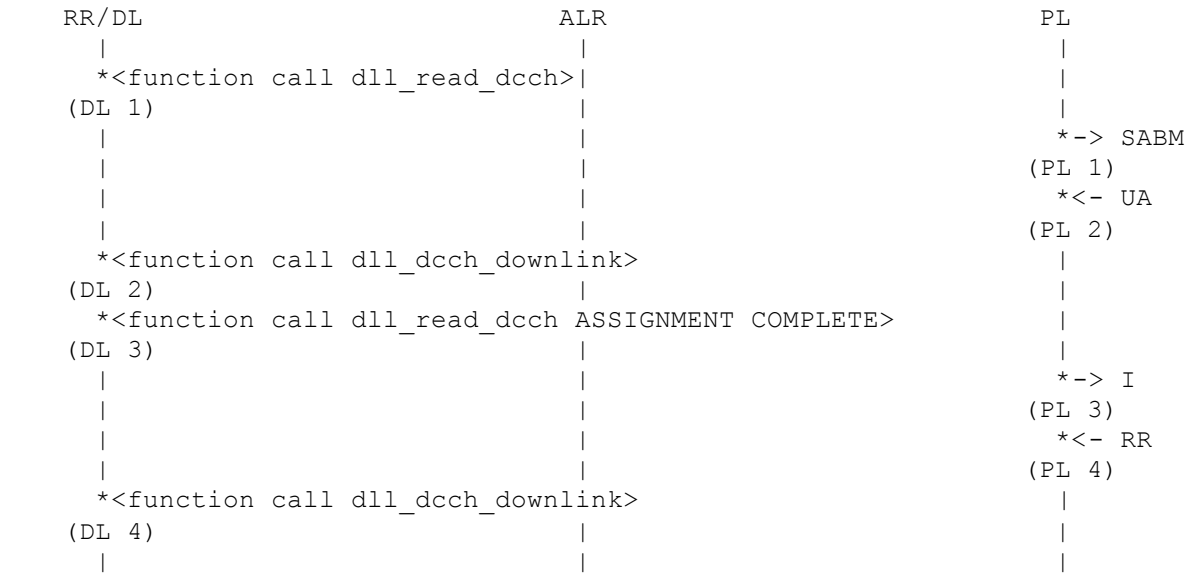
(ALR 2)

Layer 1 confirms the configuration of the dedicated channel.

(RR 1)

RR is informed about the configuration of the dedicated channel and starts resumption of the layer 2 connection to the network.

10.2 Successfull Resumption



(DL 1)

Resumption of the layer 2 connection is started by RR with the primitive DL_RESUME_REQ to DL including the ASSIGNMENT COMPLETE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

The base station answers with an UA response frame.

(DL 2)

DL receives this message directly with a function call dll_dcch_downlink from layer 1.

(DL 3)

If the next sending slot is received layer 1 calls DL with the dll_read_dcch function and DL sends the ASSIGNMENT COMPLETE message with an I command. RR is informed about the successfull resumption of the layer 2 connection.

(PL 3)

The I command is sent to the base station.

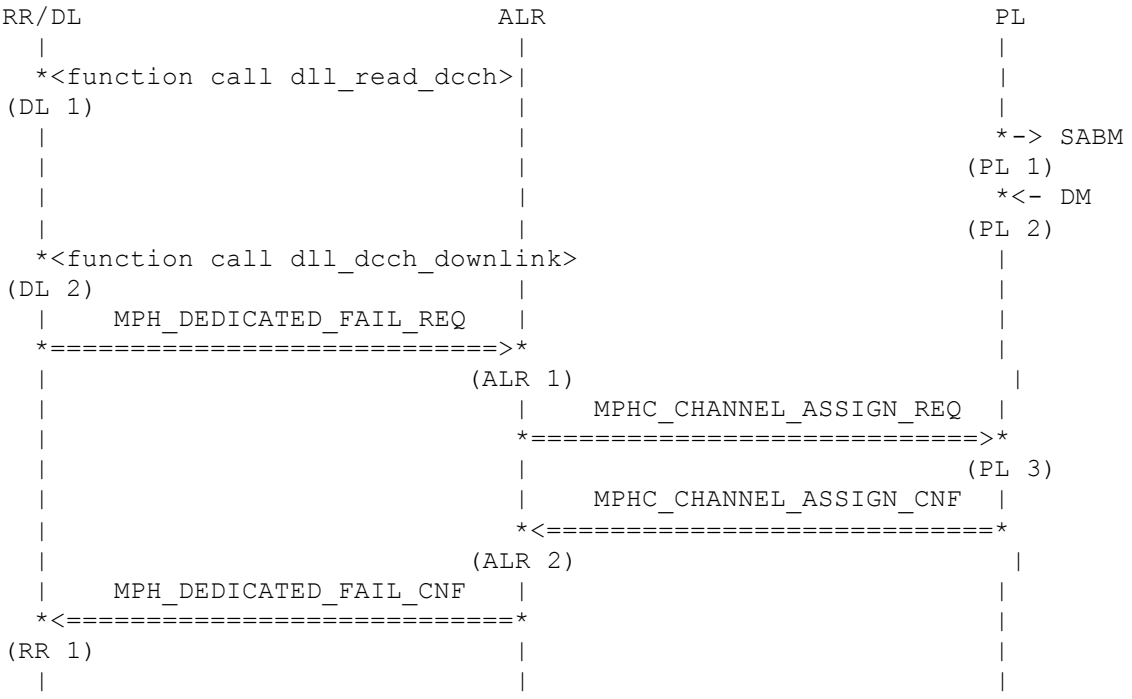
(PL 4)

The base station answers with a RR response frame.

(DL 4)

DL receives the RR response frame from layer 1.

10.3 Resumption fails



(DL 1)

Resumption of the layer 2 connection is started by RR with the primitive DL_RESUME_REQ to DL including the ASSIGNMENT COMPLETE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

An error situation occurs. E.g. the base station answers with a DM frame or there is no answer in the T200 time of DL.

(DL 2)

DL detects that resumption of the layer 2 connection fails and sends a DL_RELEASE_IND primitive to RR.

(ALR 1)

RR starts switching back to the old channel and sends a MPH_DEDICATED_FAIL_REQ to ALR.

(PL 3)

ALR configures the old channel for layer 1.

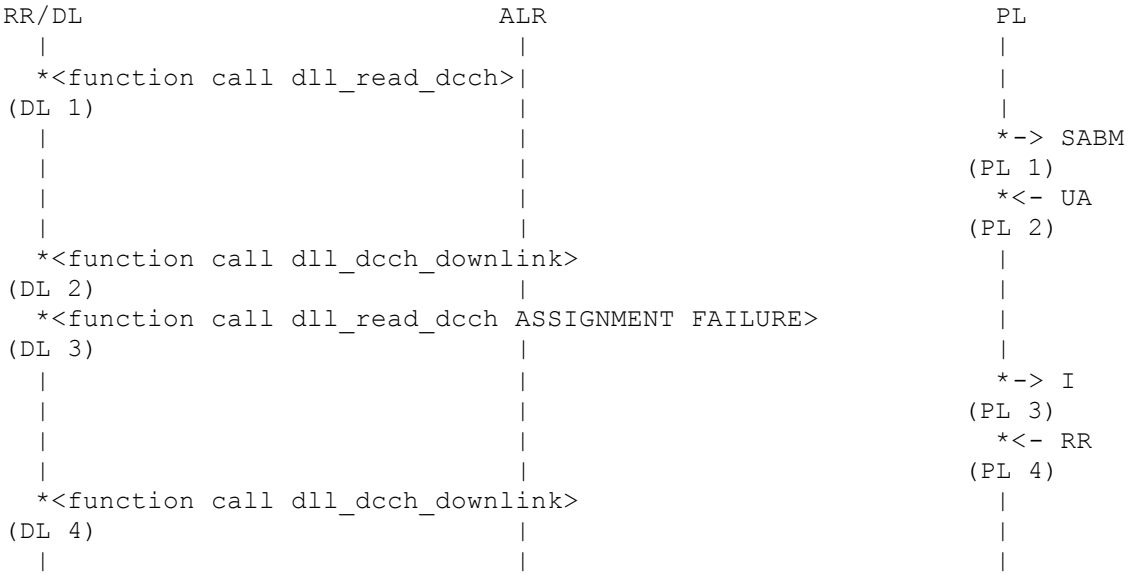
(ALR 2)

Layer 1 confirms the configuration of the old channel.

(RR 1)

The confirmation is forwarded to RR and RR starts the reconnection attempt for the layer 2 connection.

10.4 Successfull Reconnection



(DL 1)

Reconnection of the layer 2 connection is started by RR with the primitive DL_RECONNECT_REQ to DL including the ASSIGNMENT FAILURE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

The base station answers with an UA response frame.

(DL 2)

DL receives this message directly with a function call dll_dcch_downlink from layer 1.

(DL 3)

If the next sending slot is received layer 1 calls DL with the dll_read_dcch function and DL sends the ASSIGNMENT FAILURE message with an I command. RR is informed about the successfull reconnection of the layer 2 connection.

(PL 3)

The I command is sent to the base station.

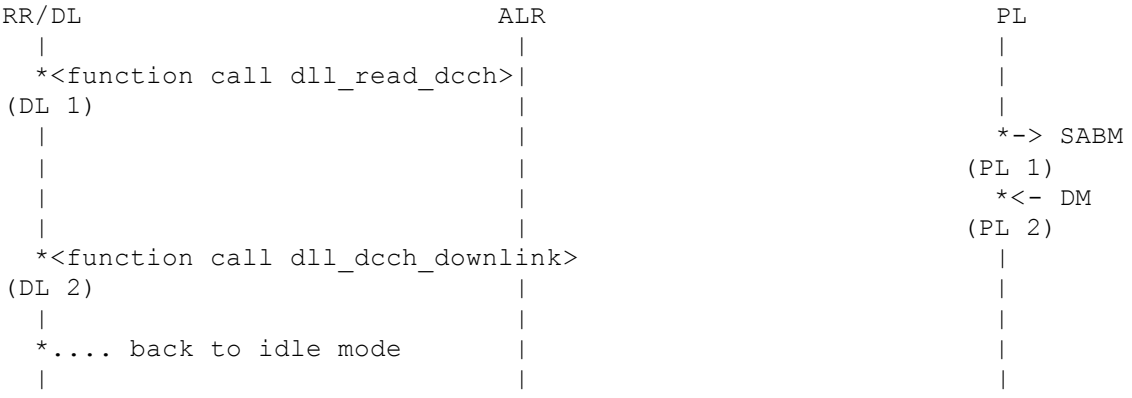
(PL 4)

The base station answers with a RR response frame.

(DL 4)

DL receives the RR response frame from layer 1.

10.5 Reconnection fails



(DL 1)

Reconnection of the layer 2 connection is started by RR with the primitive DL_RECONNECT_REQ to DL including the ASSIGNMENT FAILURE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

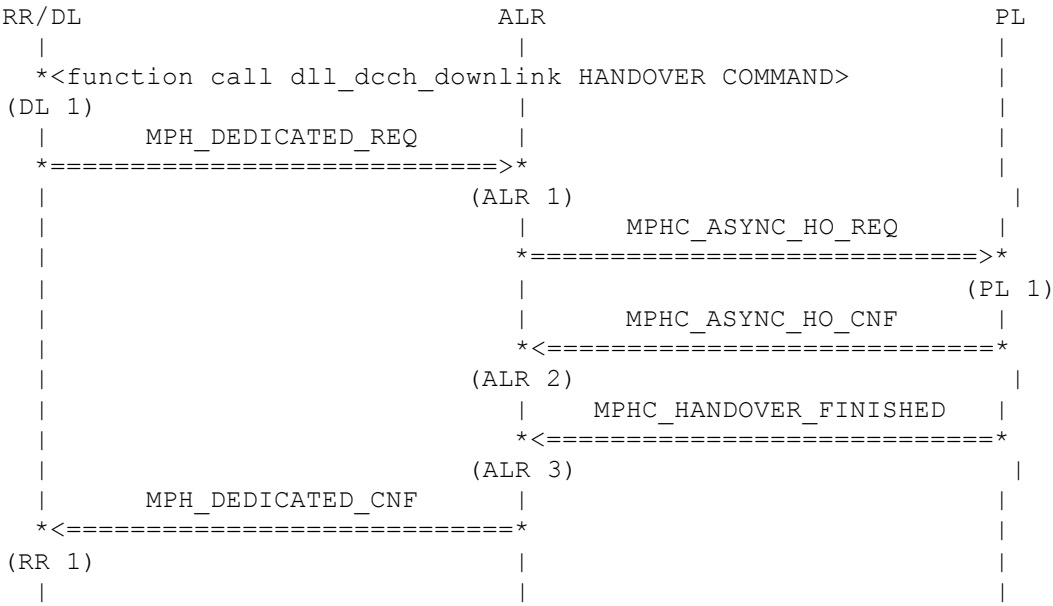
An error situation occurs. E.g. the base station answers with a DM frame or there is no answer in the T200 time of DL.

(DL 2)

DL detects that reconnection of the layer 2 connection fails and sends a DL_RELEASE_IND primitive to RR. This leads to an radio link failure situation and the mobile station comes back to idle mode.

11 Handover

11.1 Asynchronous Handover



(DL 1)

DL receives a HANDOVER COMMAND message. This message is forwarded to RR. RR checks the information elements of the message.

If a failure is detected by RR typical a HANDOVER FAILURE message is sent to the network and the procedure is not started.

(ALR 1)

With the information from the HANDOVER COMMAND message RR builds a MPH_DEDICATED_REQ and sends this to ALR.

(PL 1)

The handover type indicates an asynchronous handover.

The incoming information is converted to the MPHC_ASYNC_HO_REQ primitive to layer 1. The following table show the conversions and calculations from the HANDOVER COMMAND to the layer 1 primitive.

HANDOVER COMMAND	MPH_DEDICATED_REQ	MPHC_ASYNC_HO_REQ	Remark
Cell Description	bsic arfcn	handover_command. cell_description	
Channel Description 1 after time	ch_type	handover_command. channel_desc_1	
Handover Reference	ho_para.ho_ref	handover_command. ho_acc	
Power Command and Access Type	ho_para.ho_pow ho_para.ho_acc_type	handover_command. txpwr	*1)
Sychronization Indication	mode	----	*2)
Frequency Short List after time	ch_type.ma	handover_command. frequency_list	*4)
Frequency List after time	----	----	*4)
Cell Channel Description	----	----	*4)
Channel Mode 1	tr_para.mode	handover_command. channel_mode_1	*7)
Channel Description 2 after time	----	handover_command. channel_desc_2	*3)
Channel Mode 2	----	handover_command. channel_mode_2	*3)
Frequency Channel Sequence after time	----	----	*4)
Mobile Allocation after time	----	----	*4)
Starting Time	start	handover_command. starting_time	
Real Time Difference	----	----	*5)
Timing Advance	----	----	*5)
Frequency Short List before time	ch_type2.ma	handover_command. frequency_list_bef_sti	*6)
Frequency List before time	----	----	*6)
Channel Description 1 before time	ch_type2	handover_command. channel_desc_1_bef_sti	*6)
Channel Description 2 before time	----	handover_command. channel_desc_2_bef_sti	*3)
Frequency Channel Sequence before time	----	----	*6)
Mobile Allocation before time	----	----	*6)
Cipher Mode Setting	ciph	handover_command. cipher_mode handover_command. a5_algorithm cipher_key	

*1) Access Type is not supported from layer 1.

*2) The type of handover is defined by the primitive type.

*3) The protocol stack supports only one connection at one time.

*4) Only one frequency list is build by RR from the

Frequency Short List after time or
Frequency List after time or
Frequency Channel Sequence after time or
Cell Channel Description together with Mobile Allocation after time.

*5) For asynchronous handover no timing advance is available.

*6) Only one frequency list is build by RR from the
Frequency Short List before time or
Frequency List before time or
Frequency Channel Sequence befor time or
Cell Channel Description together with Mobile Allocation before time.

Information elements for before the starting time are only valid if the starting time is present.

*7) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate)
		2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate)
		5 (halfrate)
Data 3.6	19	6 (fullrate)
		7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

(ALR 2)

Layer 1 confirms the configuration of the dedicated channel. It starts sending continously HANDOVER ACCESS messages as random bursts on the dedicated channel. Timer T3124 is started.

(ALR 3)

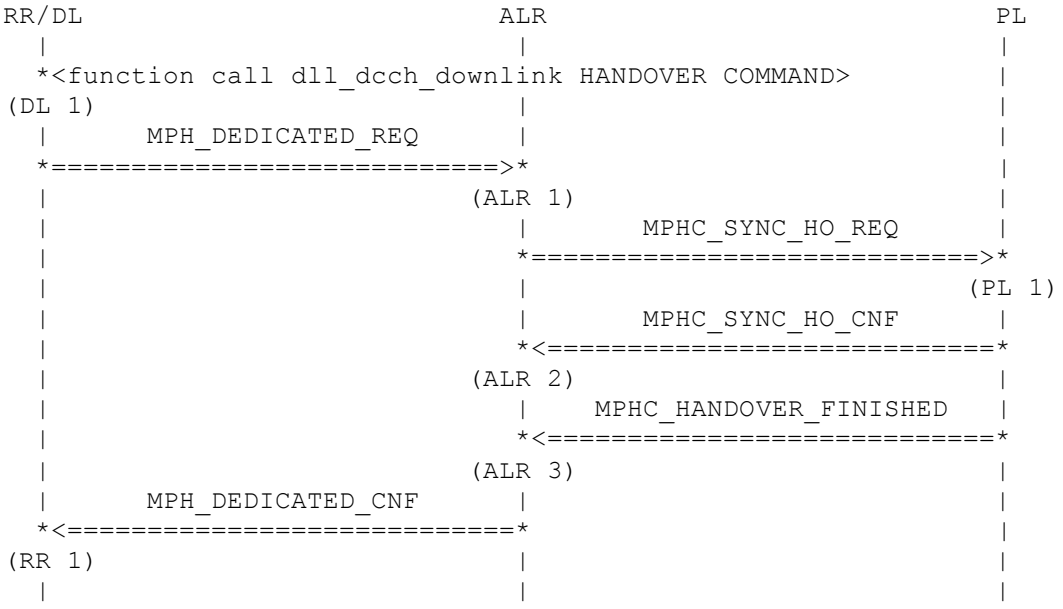
During T3124 is running the layer 1 listens on the downlink DCCH. After reception of the PHYSICAL INFORMATION message layer 1 stops T3214 and configures the received timing advance.

If the handover fails the same primitive is used with the error cause timeout.

(RR 1)

RR is informed about the successfull handover and starts resumption of the layer 2 connection to the network. If the handover fails RR is informed with the error cause timeout and reconnection is started.

11.2 Synchronous Handover



(DL 1)

DL receives a HANDOVER COMMAND message. This message is forwarded to RR. RR checks the information elements of the message.

If a failure is detected by RR typical a HANDOVER FAILURE message is sent to the network and the procedure is not started.

(ALR 1)

With the information from the HANDOVER COMMAND message RR builds a MPH_DEDICATED_REQ and sends this to ALR.

(PL 1)

The handover type indicates an synchronous handover.

The incoming information is converted to the MPHC_SYNC_HO_REQ primitive to layer 1. The following table show the conversions and calculations from the HANDOVER COMMAND to the layer 1 primitive.

HANDOVER COMMAND	MPH_DEDICATED_REQ	MPHC_ASYNC_HO_REQ	Remark
Cell Description	bsic arfcn	handover_command. cell_description	
Channel Description 1 after time	ch_type	handover_command. channel_desc_1	
Handover Reference	ho_para.ho_ref	handover_command. ho_acc	
Power Command and Access Type	ho_para.ho_pow ho_para.ho_acc_type	handover_command. txpwr	*1)
Sychronization Indication	mode ho_para.ho_nci	 nci	*2)
Frequency Short List after time	ch_type.ma	handover_command. frequency_list	*4)
Frequency List after time	----	----	*4)
Cell Channel Description	----	----	*4)
Channel Mode 1	tr_para.mode	handover_command. channel_mode_1	*7)

Channel Description 2 after time	----	handover_command. channel_desc_2	*3)
Channel Mode 2	----	handover_command. channel_mode_2	*3)
Frequency Channel Sequence after time	----	----	*4)
Mobile Allocation after time	----	----	*4)
Starting Time	start	handover_command. starting_time	
Real Time Difference	----	----	*5)
Timing Advance	----	----	*5)
Frequency Short List before time	ch_type2.ma	handover_command. frequency_list_bef_sti	*6)
Frequency List before time	----	----	*6)
Channel Description 1 before time	ch_type2	handover_command. channel_desc_1_bef_sti	*6)
Channel Description 2 before time	----	handover_command. channel_desc_2_bef_sti	*3)
Frequency Channel Sequence before time	----	----	*6)
Mobile Allocation before time	----	----	*6)
Cipher Mode Setting	ciph	handover_command. cipher_mode handover_command. a5_algorithm cipher_key	

*1) Access Type is not supported from layer 1.

*2) The type of handover is defined by the primitive type.

*3) The protocol stack supports only one connection at one time.

*4) Only one frequency list is build by RR from the

Frequency Short List after time or
Frequency List after time or
Frequency Channel Sequence after time or
Cell Channel Description together with Mobile Allocation after time.

*5) For synchronous handover no timing advance is available.

*6) Only one frequency list is build by RR from the
Frequency Short List before time or
Frequency List before time or
Frequency Channel Sequence befor time or
Cell Channel Description together with Mobile Allocation before time.

Information elements for before the starting time are only valid if the starting time is present.

*7) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate) 2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate) 5 (halfrate)
Data 3.6	19	6 (fullrate) 7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

(ALR 2)

Layer 1 confirms the configuration of the dedicated channel. It starts sending four HANDOVER ACCESS messages as random bursts on the dedicated channel.

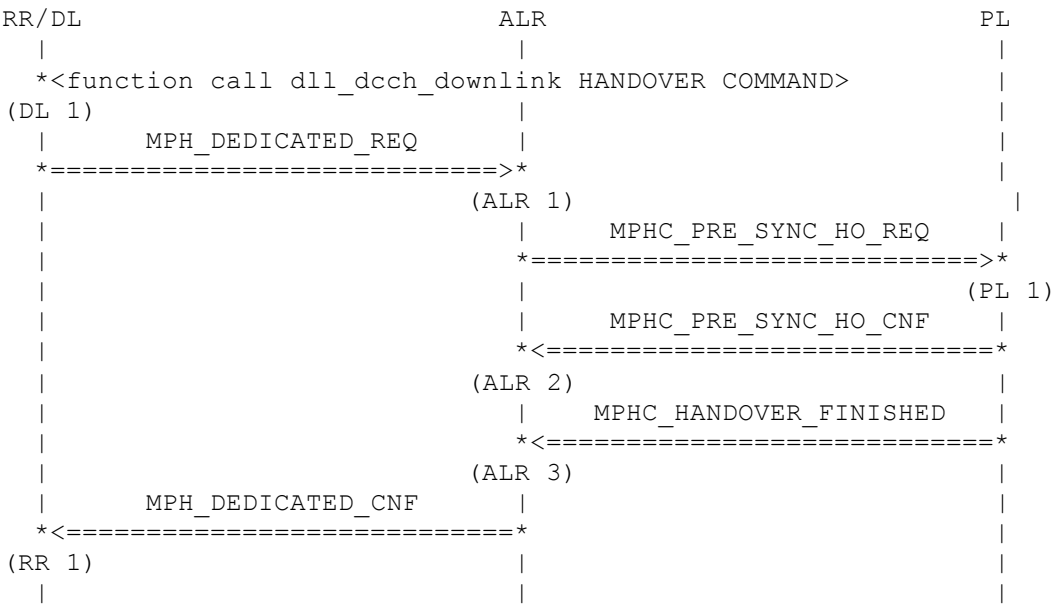
(ALR 3)

After sending the four handover access bursts the completion of the synchronous handover. If the layer 1 detects a timing advance out of range error this will be reported with the MPHC_TA_FAIL_IND primitve. In this case no bursts are send and no change to the new channel has occured.

(RR 1)

RR is informed about the successfull handover and starts resumption of the layer 2 connection to the network. If the handover fails RR is informed with the error cause TA out of range.

11.3 Pre-Synchronous Handover



(DL 1)

DL receives a HANDOVER COMMAND message. This message is forwarded to RR. RR checks the information elements of the message.

If a failure is detected by RR typical a HANDOVER FAILURE message is sent to the network and the procedure is not started.

(ALR 1)

With the information from the HANDOVER COMMAND message RR builds a MPH_DEDICATED_REQ and sends this to ALR.

(PL 1)

The handover type indicates an pre-synchronous handover.

The incoming information is converted to the MPHC_PRE_SYNC_HO_REQ primitive to layer 1. The following table show the conversions and calculations from the HANDOVER COMMAND to the layer 1 primitive.

HANDOVER COMMAND	MPH_DEDICATED_REQ	MPHC_ASYNC_HO_REQ	Remark
Cell Description	bsic arfcn	handover_command. cell_description	

Channel Description 1 after time	ch_type	handover_command. channel_desc_1	
Handover Reference	ho_para.ho_ref	handover_command. ho_acc	
Power Command and Access Type	ho_para.ho_pow ho_para.ho_acc_type	handover_command. txpwr	*1)
Sychronization Indication	mode ho_para.ho_nci	 nci	*2)
Frequency Short List after time	ch_type.ma	handover_command. frequency_list	*4)
Frequency List after time	----	----	*4)
Cell Channel Description	----	----	*4)
Channel Mode 1	tr_para.mode	handover_command. channel_mode_1	* 7)
Channel Description 2 after time	----	handover_command. channel_desc_2	*3)
Channel Mode 2	----	handover_command. channel_mode_2	*3)
Frequency Channel Sequence after time	----	----	*4)
Mobile Allocation after time	----	----	*4)
Starting Time	start	handover_command. starting_time	
Real Time Difference	----	----	*5)
Timing Advance	tr_para.tav	timing_advance_valid timing_advance	
Frequency Short List before time	ch_type2.ma	handover_command. frequency_list_bef_sti	*6)
Frequency List before time	----	----	*6)
Channel Description 1 before time	----	handover_command. channel_desc_1_bef_sti	*6)
Channel Description 2 before time	ch_type2	handover_command. channel_desc_2_bef_sti	*3)
Frequency Channel Sequence before time	----	----	*6)
Mobile Allocation before time	----	----	*6)
Cipher Mode Setting	ciph	handover_command. cipher_mode handover_command. a5_algorithm cipher_key	

*1) Access Type is not supported from layer 1.

*2) The type of handover is defined by the primitive type.

*3) The protocol stack supports only one connection at one time.

*4) Only one frequency list is build by RR from the

Frequency Short List after time or
Frequency List after time or
Frequency Channel Sequence after time or
Cell Channel Description together with Mobile Allocation after time.

*5) For pre-synchronous handover the timing advance is used from the HANDOVER COMMAND if available.

*6) Only one frequency list is build by RR from the
Frequency Short List before time or

Frequency List before time or
Frequency Channel Sequence befor time or
Cell Channel Description together with Mobile Allocation before time.

Information elements for before the starting time are only valid if the starting time is present.

*7) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate) 2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate) 5 (halfrate)
Data 3.6	19	6 (fullrate) 7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

(ALR 2)

Layer 1 confirms the configuration of the dedicated channel. It starts sending four HANDOVER ACCESS messages as random bursts on the dedicated channel.

(ALR 3)

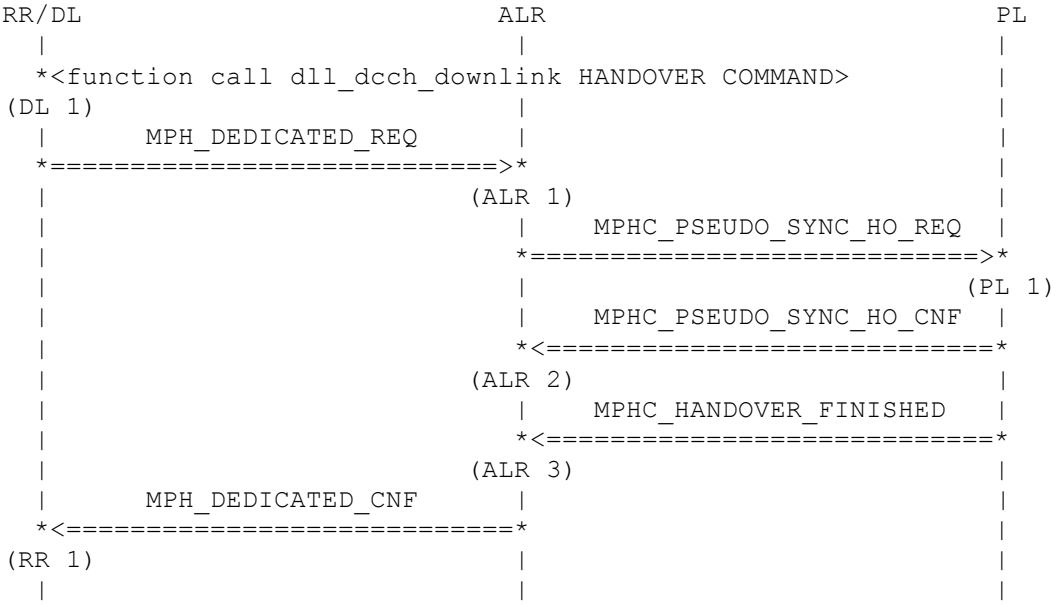
After sending the four handover access bursts the completion of the pre-synchronous handover. If the layer 1 detects a timing advance out of range error this will be reported with the MPHC_TA_FAIL_IND primitve. In this case no bursts are send and no change to the new channel has occured.

(RR 1)

RR is informed about the successfull handover and starts resumption of the layer 2 connection to the network. If the handover fails RR is informed with the error cause TA out of range.

11.4 Pseudo-Synchronous Handover

Pseudo-Synchronized Handover is not supported by layer 1.



(DL 1)

DL receives a HANDOVER COMMAND message. This message is forwarded to RR. RR checks the information elements of the message.

If a failure is detected by RR typical a HANDOVER FAILURE message is sent to the network and the procedure is not started.

(ALR 1)

With the information from the HANDOVER COMMAND message RR builds a MPH_DEDICATED_REQ and sends this to ALR.

(PL 1)

The handover type indicates a pseudo-synchronous handover.

The incoming information is converted to the MPHC_PSEUDO_SYNC_HO_REQ primitive to layer 1. The following table show the conversions and calculations from the HANDOVER COMMAND to the layer 1 primitive.

HANDOVER COMMAND	MPH_DEDICATED_REQ	MPHC_ASYNC_HO_REQ	Remark
Cell Description	bsic arfcn	handover_command. cell_description	
Channel Description 1 after time	ch_type	handover_command. channel_desc_1	
Handover Reference	ho_para.ho_ref	handover_command. ho_acc	
Power Command and Access Type	ho_para.ho_pow ho_para.ho_acc_type	handover_command. txpwr	*1)
Sychronization Indication	mode ho_para.ho_nci	 nci	*2)
Frequency Short List after time	ch_type.ma	handover_command. frequency_list	*4)
Frequency List after time	----	----	*4)
Cell Channel Description	----	----	*4)
Channel Mode 1	tr_para.mode	handover_command. channel_mode_1	*7)
Channel Description 2 after time	----	handover_command. channel_desc_2	*3)
Channel Mode 2	----	handover_command. channel_mode_2	*3)
Frequency Channel Sequence after time	----	----	*4)
Mobile Allocation after time	----	----	*4)
Starting Time	start	handover_command. starting_time	
Real Time Difference	tr_para.tav	real_time_difference	
Timing Advance	----	----	*5)
Frequency Short List before time	ch_type2.ma	handover_command. frequency_list_bef_sti	*6)
Frequency List before time	----	----	*6)
Channel Description 1 before time	ch_type2	handover_command. channel_desc_1_bef_sti	*6)
Channel Description 2 before time	----	handover_command. channel_desc_2_bef_sti	*3)
Frequency Channel Sequence before time	----	----	*6)
Mobile Allocation before time	----	----	*6)
Cipher Mode Setting	ciph	handover_command. cipher_mode	

		handover_command. a5_algorithm cipher_key	

*1) Access Type is not supported from layer 1.

*2) The type of handover is defined by the primitive type.

*3) The protocol stack supports only one connection at one time.

*4) Only one frequency list is build by RR from the

Frequency Short List after time or
Frequency List after time or
Frequency Channel Sequence after time or
Cell Channel Description together with Mobile Allocation after time.

*5) For pseudo-synchronous handover the real time difference is calculated by RR.

*6) Only one frequency list is build by RR from the
Frequency Short List before time or
Frequency List before time or
Frequency Channel Sequence befor time or
Cell Channel Description together with Mobile Allocation before time.

Information elements for before the starting time are only valid if the starting time is present.

*7) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate)
		2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate)
		5 (halfrate)
Data 3.6	19	6 (fullrate)
		7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

(ALR 2)

Layer 1 confirms the configuration of the dedicated channel. It starts sending four HANDOVER ACCESS messages as random bursts on the dedicated channel.

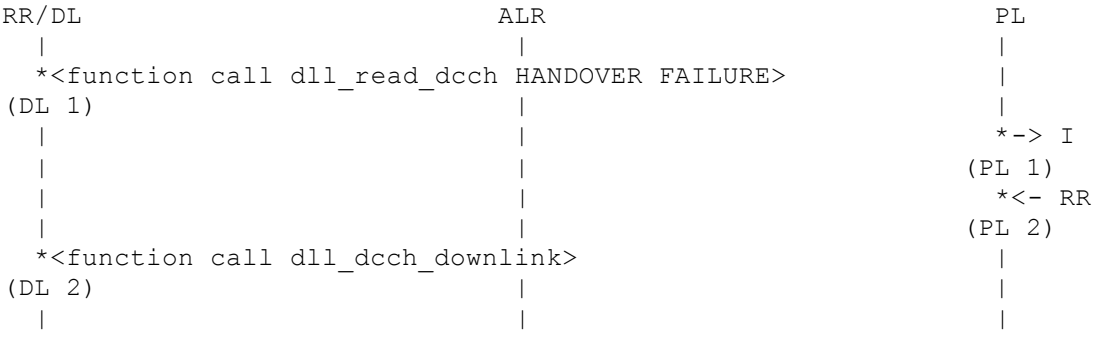
(ALR 3)

After sending the four handover access bursts the completion of the pseudo-synchronous handover. If the layer 1 detects a timing advance out of range error this will be reported with the MPHC_TA_FAIL_IND primitve. In this case no bursts are send and no change to the new channel has occured.

(RR 1)

RR is informed about the successfull handover and starts resumption of the layer 2 connection to the network. If the handover fails RR is informed with the error cause TA out of range.

11.5 Timing Advance out of Range



(DL 1)

If ALR has signalled a timing advance out of range problem, RR sends a HANDOVER FAILURE message to DL with the cause timing advance out of range.

If the next sending slot is received layer 1 calls DL with the dll_read_dcch function and DL sends the HANDOVER FAILURE message with an I command.

(PL 1)

The I command is sent to the base station.

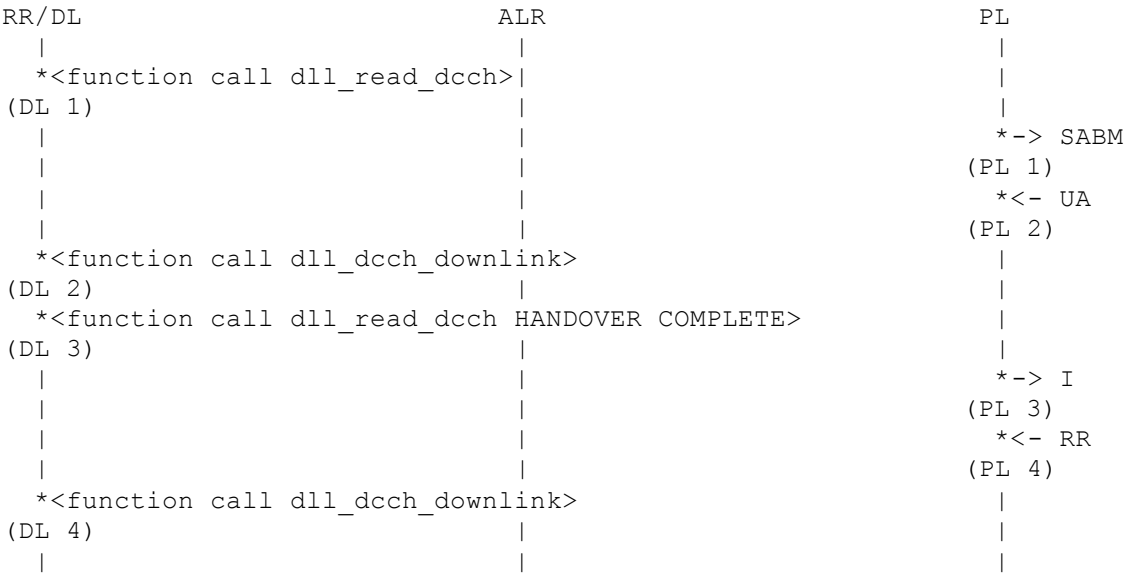
(PL 2)

The base station answers with a RR response frame.

(DL 2)

DL receives the RR response frame from layer 1.

11.6 Successfull Resumption



(DL 1)

RR starts a local end release for the old established connection. That means DL changes from multiple frame established state to the idle state.

Resumption of the layer 2 connection is started by RR with the primitive DL_RESUME_REQ to DL including the HANDOVER COMPLETE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

The base station answers with an UA response frame.

(DL 2)

DL receives this message directly with a function call dll_dcch_downlink from layer 1.

(DL 3)

If the next sending slot is received layer 1 calls DL with the dll_read_dcch function and DL sends the HANDOVER COMPLETE message with an I command. RR is informed about the successfull resumption of the layer 2 connection.

(PL 3)

The I command is sent to the base station.

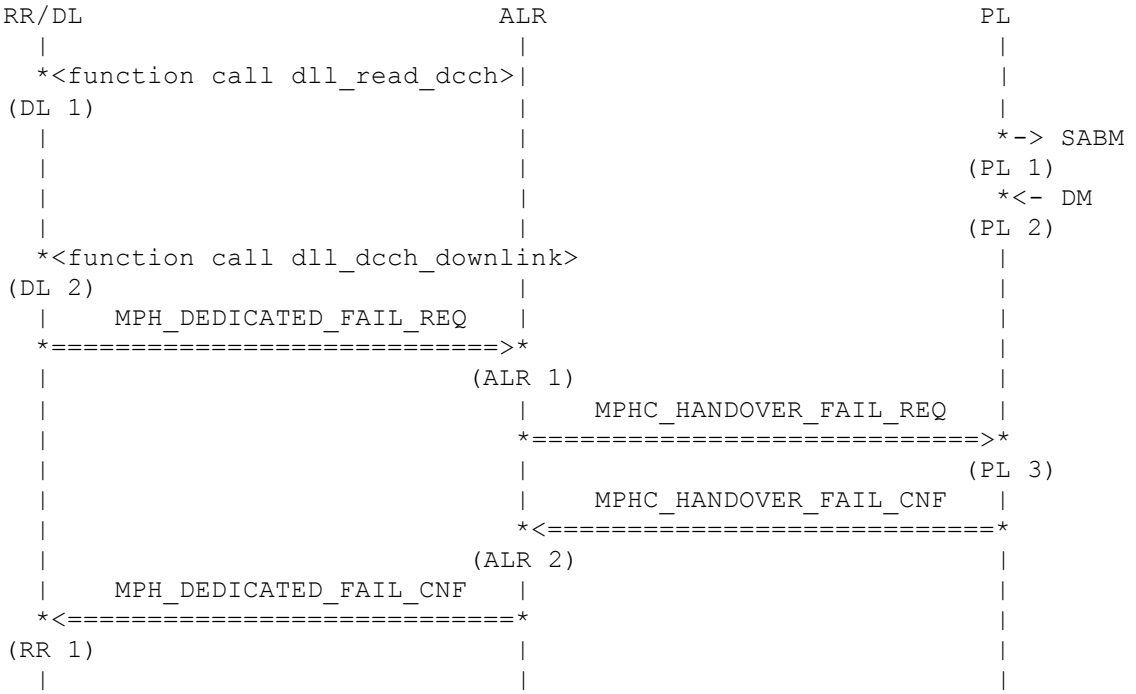
(PL 4)

The base station answers with a RR response frame.

(DL 4)

DL receives the RR response frame from layer 1.

11.7 Resumption fails



(DL 1)

Resumption of the layer 2 connection is started by RR with the primitive DL_RESUME_REQ to DL including the HANDOVER COMPLETE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

An error situation occurs. E.g. the base station answers with a DM frame or there is no answer in the T200 time of DL.

(DL 2)

DL detects that resumption of the layer 2 connection fails and sends a DL_RELEASE_IND primitive to RR.

(ALR 1)

RR starts switching back to the old channel and sends a MPH_DEDICATED_FAIL_REQ to ALR.

(PL 3)

ALR forward the trigger to layer 1.

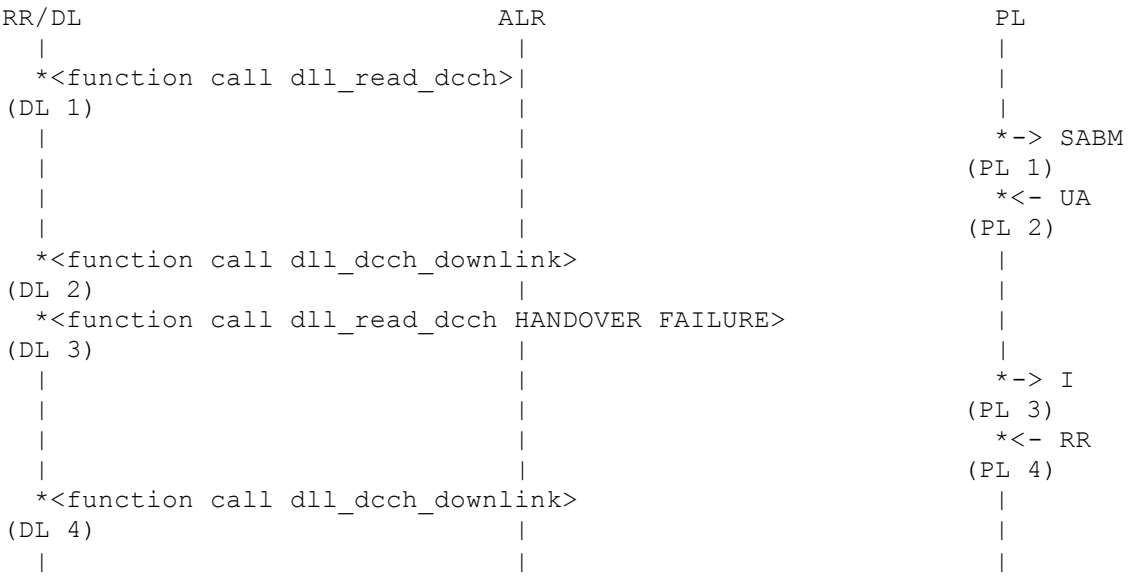
(ALR 2)

Layer 1 confirms the configuration of the old channel.

(RR 1)

The confirmation is forwarded to RR and RR starts the reconnection attempt for the layer 2 connection.

11.8 Successfull Reconnection



(DL 1)

Reconnection of the layer 2 connection is started by RR with the primitive DL_RECONNECT_REQ to DL including the HANDOVER FAILURE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

The base station answers with an UA response frame.

(DL 2)

DL receives this message directly with a function call dll_dcch_downlink from layer 1.

(DL 3)

If the next sending slot is received layer 1 calls DL with the dll_read_dcch function and DL sends the HANDOVER FAILURE message with an I command. RR is informed about the successfull reconnection of the layer 2 connection.

(PL 3)

The I command is sent to the base station.

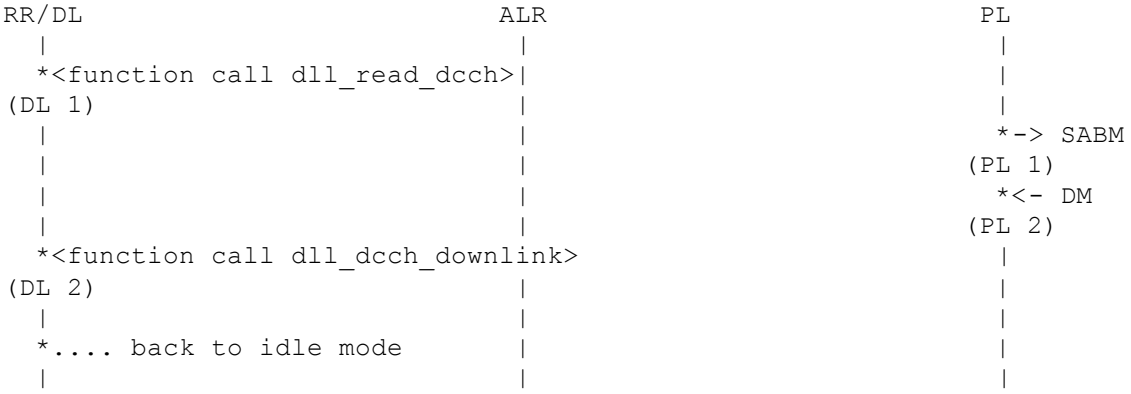
(PL 4)

The base station answers with a RR response frame.

(DL 4)

DL receives the RR response frame from layer 1.

11.9 Reconnection fails



(DL 1)

Reconnection of the layer 2 connection is started by RR with the primitive DL_RECONNECT_REQ to DL including the HANDOVER FAILURE message. Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. DL fills a layer 2 frame with the SABM command.

(PL 1)

Layer 1 sends the SABM command via the air interface to the base station. This SABM command includes no message.

(PL 2)

An error situation occurs. E.g. the base station answers with a DM frame or there is no answer in the T200 time of DL.

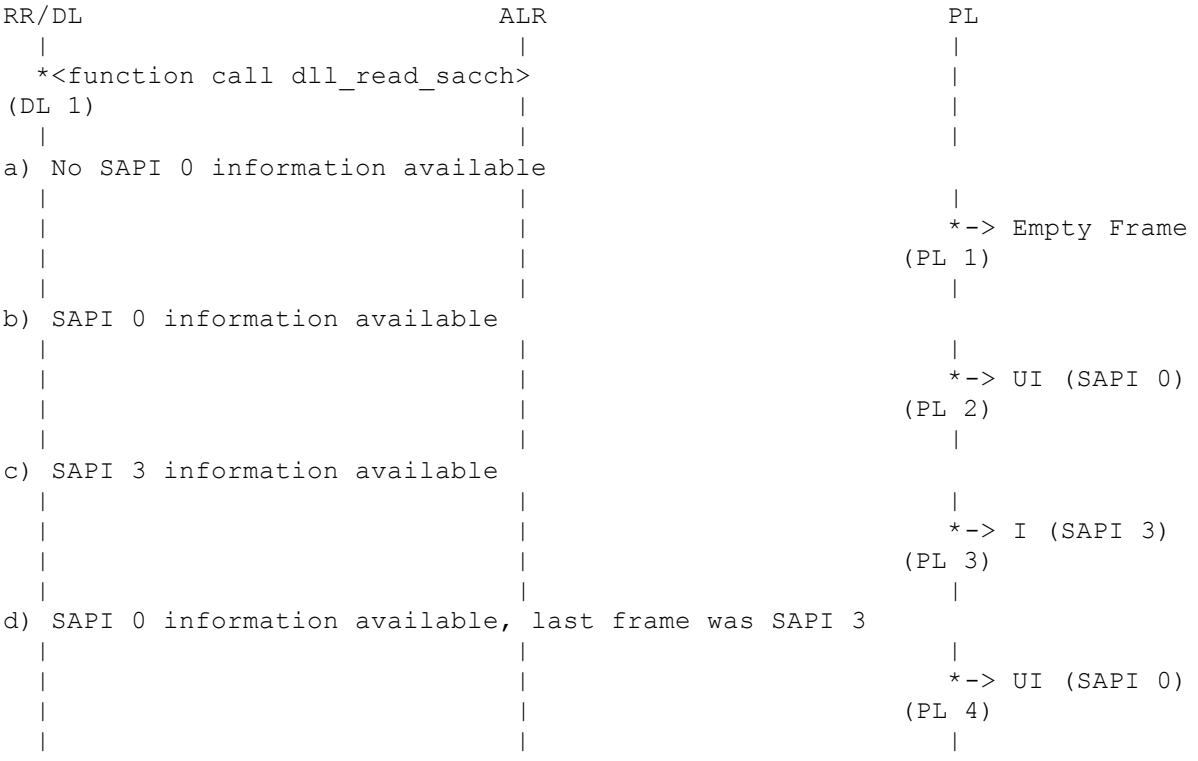
(DL 2)

DL detects that reconnection of the layer 2 connection fails and sends a DL_RELEASE_IND primitive to RR. This leads to an radio link failure situation and the mobile station comes back to idle mode.

12 Message Interfaces

The message interfaces are build not by primitives. Instead function calls used to fullfill the timing requirements. These function calls are initiated from an interrupt service routine in layer 1 . Therefore it is necessary to avoid trace outputs. Nevertheless for testing into a simulation variant a primitive interface is used as well for data link layer.

12.1 SACCH Uplink Interface



(DL 1)

Layer 1 indicates with the function call dll_read_sacch that it expects data for the SACCH. On SACCH uplink direction measurement reports as UI frames for SAPI 0 are send and short message service messages as I frames for SAPI 3 if the main dedicated channel is FACCH.

The prototype for the dll_read_sacch function is:

T_RADIO_FRAME * dll_read_sacch (T_CHANNEL_MODE chn_mode)

The structure T_RADIO_FRAME is an array of 23 bytes.

(PL 1)

If no information for SAPI 0 is availabe, layer 2 sends an empty frame to layer 1. This may happens in start phase of a connection if RR has not build a first measurement report message. A DL UNITDATA CNF primitive is given to RR to request sending of new measurement report data. An empty frame has the following structure:

```
0 0 0 0 0 0 0 1     Address field
0 0 0 0 0 0 1 1     Control field    (UI frame)
0 0 0 0 0 0 0 1     Length field     (0 bytes)
0 0 1 0 1 0 1 1
...
0 0 1 0 1 0 1 1
```

The length of empty frames is 21 bytes for SACCH and 23 bytes for SDCCH. Frames for SACCH starts at position 2, that means byte 0 and 1 are free for the layer 1 header.

(PL 2)

New measurement report data are send with a DL UNITDATA REQ primitive from RR to DL. DL builds with this data an unnumbered information frame for SAPI 0 and sends this by the return value of the function to layer 1. New measurement report data is requested from RR by sending a DL UNITDATA CNF primitive to RR.

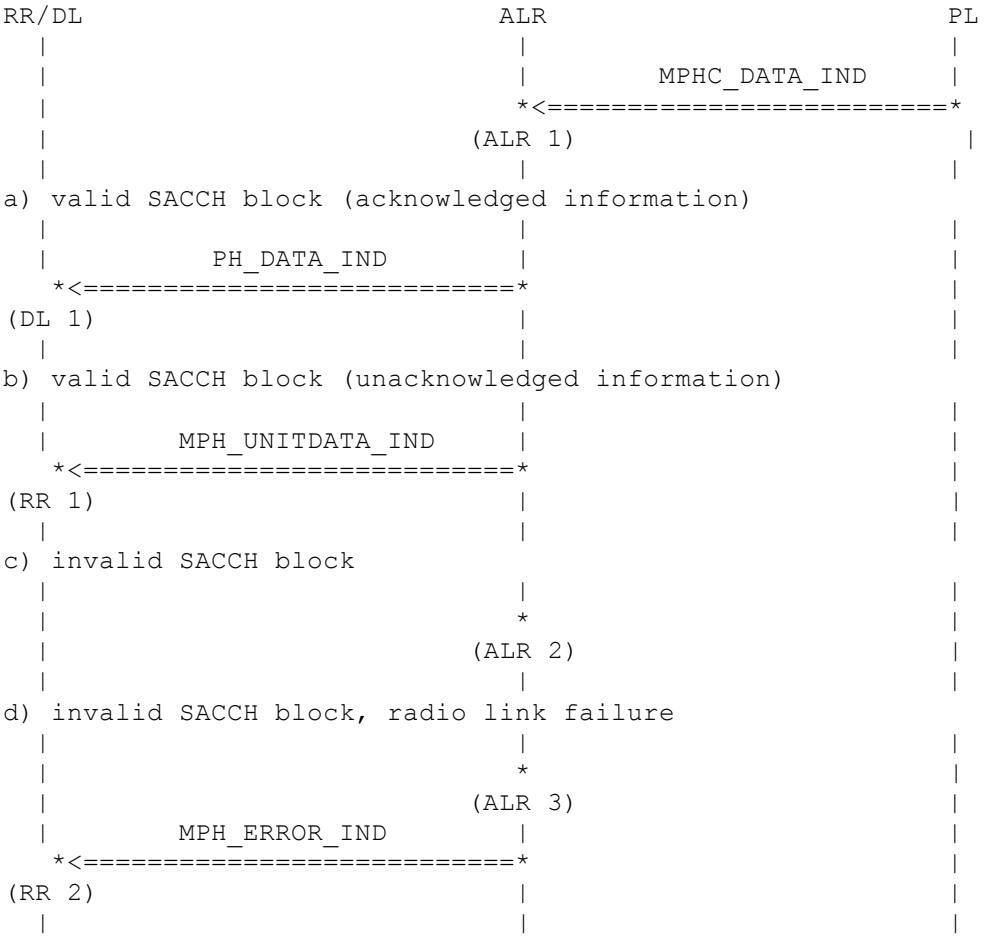
(PL 3)

If SAPI 3 information is available for SACCH, DL builds an I frame or a SABM frame during establishment of the layer 3 connection. This frame is given by the return value of the function to layer 1.

(PL 4)

If SAPI 3 information is available for SACCH and the last transmitted frame on SACCH was a SAPI 3 frame transmission of SAPI 0 data is processed. This is done to fullfill the requirement that at least each second frame must be a measurement report (equal SAPI 0 frames).

12.2 SACCH Downlink Interface



(ALR 1)

After reception of a SACCH downlink frame layer 1 sends this frame to ALR using the MPHC DATA IND primitive. On SACCH downlink the SYS INFO TYPE 5 and 6 and SMS layer 2 frames are send.

(DL 1)

If it is a valid block the radio link counter is incremented if it is less than the inital value. The frame is forwarded to DL with the primitive PH DATA IND in the windows environment and with a function call in the target system if it is an acknowledged frame (that means SMS layer 2 frame).

(RR 1)

If it is unacknowledged information the frame is forwarded to RR directly.

(ALR 2)

An invalid block has received. The block is discharged and the radio link failure counter is decreased. The radio link failure criterion is not reached.

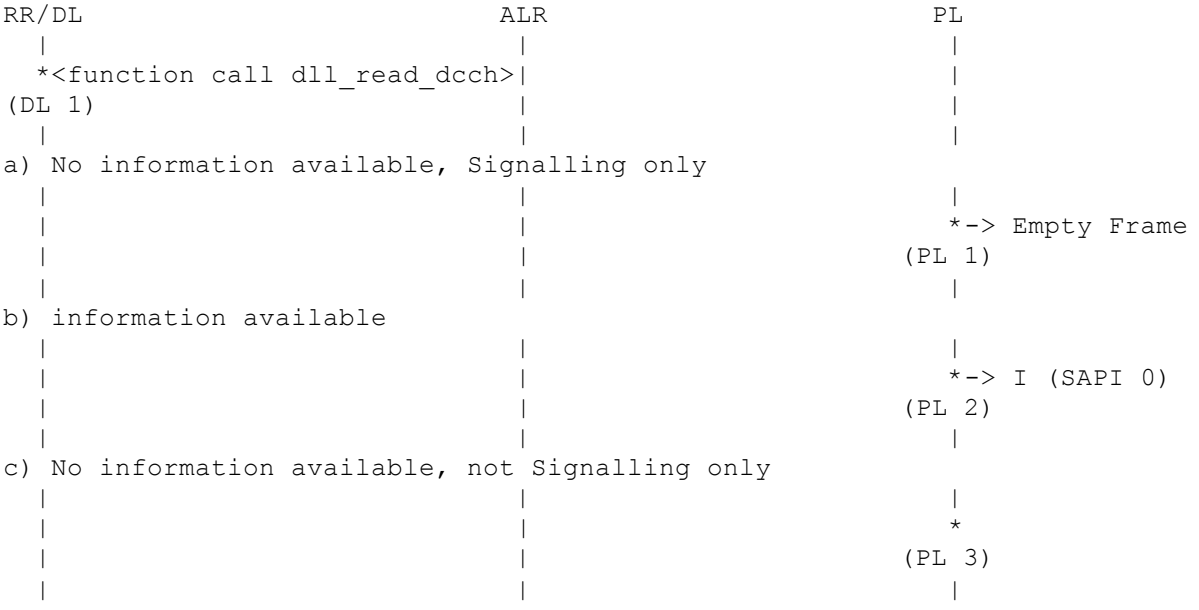
(ALR 3)

An invalid block has received. The block is discharged and the radio link failure counter is decreased. The radio link failure criterion is reached.

(RR 2)

An error indication is send to RR.

12.3 FACCH/SDCCH Uplink Interface



(DL 1)

Layer 1 indicates with the function call dll_read_dcch that it expects data for the FACCH or SDCCH. On FACCH and SDCCH layer 3 messages with SAPI 0 from RR, MM, CC and SS are send to the base station. If the channel is SDCCH additional SMS messages with SAPI 3 are send.

The prototype for the dll_read_dcch function is:

T_RADIO_FRAME * dll_read_dcch (T_CHANNEL_MODE chn_mode)

The structure T_RADIO_FRAME is an array of 23 bytes.

(PL 1)

The actual channel mode is signalling only. Layer 2 sends fillframes which are discharged on the network side. Therefore the frame structure of 23 bytes is filled with a fill byte pattern (0x2B) and forwarded with the return value to layer 1.

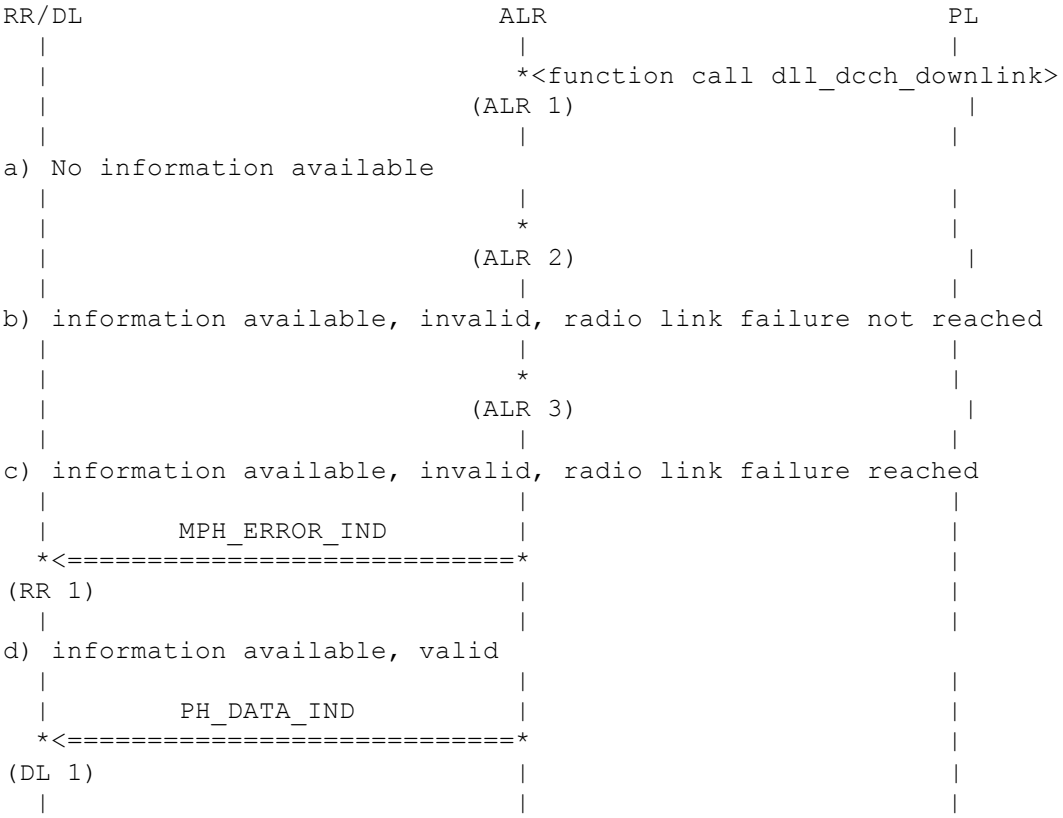
(PL 2)

DL has stored information for the base station. If fills the frame structure with the data and the appropriate layer 2 command (e.g. SABM or I or RR frame) and sends it by the return value of the function to layer 1.

(PL 3)

If the channel mode is unequal to signalling only and no data is available for transmission a NULL pointer is given back by the function. This indicates that the layer 1 has nothing to do.

12.4 FACCH/SDCCH Downlink Interface



(ALR 1)

Layer 1 indicates with the function call dll_dcch_downlink that it has read FACCH or SDCCH downlink. On FACCH and SDCCH layer 3 messages with SAPI 0 from RR, MM, CC and SS are send by the base station. If the channel is SDCCH additional SMS messages with SAPI 3 are send.

The prototype for the dll_dcch_downlink function is:

void dll_dcch_downlink (T_RADIO_FRAME * frame, BOOL valid)

The structure T_RADIO_FRAME is an array of 23 bytes.

(ALR 2)

If layer 1 has not received information the frame pointer is set to NULL. There is no reaction by the upper layer.

(ALR 3)

Layer 1 indicates reception of an invalid block. The frame is ignored and the radio link counter is decremented. The radio link error condition is not fullfilled.

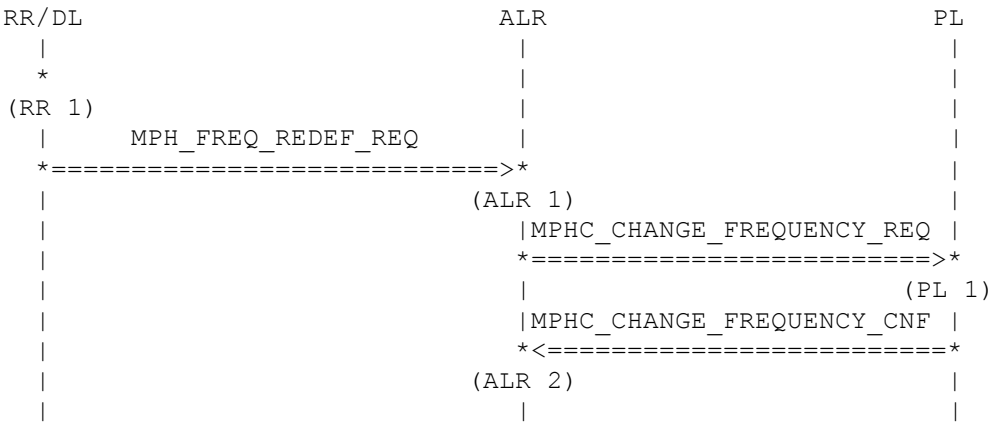
(RR 1)

Layer 1 indicates reception of an invalid block. The frame is ignored and the radio link counter is decremented. The radio link error condition is fullfilled and an error indication is send to RR.

(DL 1)

Layer 1 indicates reception of a valid block. The frame is forwarded to DL with the primitive PH DATA IND in the windows environment and with a function call in the target system..

13 Frequency Redefinition



(RR 1)

RR has received a frequency redefinition message. The new frequencies are calculated.

(ALR 1)

The new frequencies and a start time are forwarded to ALR. The parameters are converted according to the following table:

FREQUENCY REDEFINTION	MPH_FREQ_REDEF_REQ	MPHC_CHANNEL_FREQUENCY_REQ	Remark
Channel Description	chan_desc	channel_desc	
Mobile Allocation	chan_desc.ma	frequency_list	* 1)
Starting Time	start	starting_time	
Cell Channel Description	----	----	* 1)

*1) The frequency list is build from mobile allocation and cell channel description.

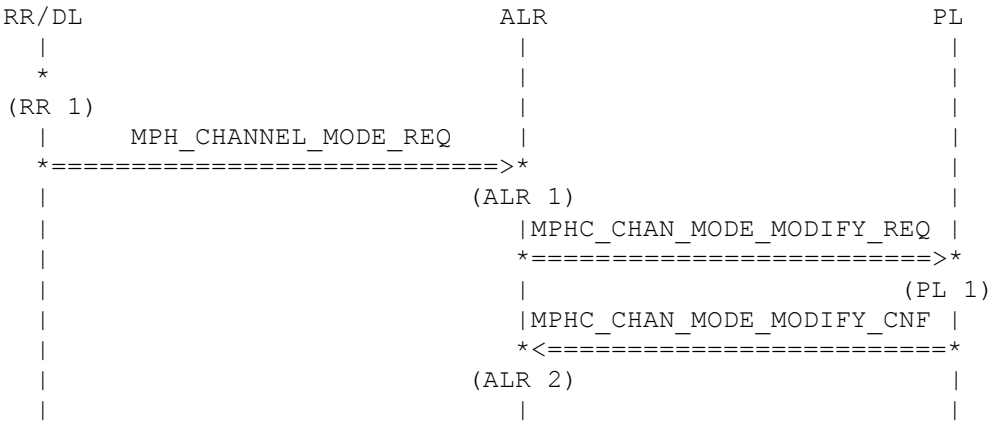
(PL 1)

Layer 1 receives the new frequency list and switches to the new dedicated channel.

(ALR 2)

A confirmation is send to ALR.

14 Channel Mode Modify



(RR 1)

RR has received a channel mode modify message.

(ALR 1)

The new channel mode is forwarded to ALR. The parameters are converted according to the following table:

CHANNEL MODE MODIFY	MPH_CHANNEL_MODE_REQ	MPHC_CHANNEL_MODE_MODIFY_REQ	Remark
Channel Description	----	subchannel	*1)
Channel Mode	mode	channel_mode	*2)

*1) The protocol stack supports only one channel.

*2) The channel mode must be converted according to the following rules:

channel mode	RR (Air-Interface)	Layer 1
Signalling Only	0	0
Speech	1	1 (fullrate) 2 (halfrate)
Data 12.0	3	3
Data 6.0	11	4 (fullrate) 5 (halfrate)
Data 3.6	19	6 (fullrate) 7 (halfrate)
Enhanced Fullrate	21	8
Data 14.5	15	9

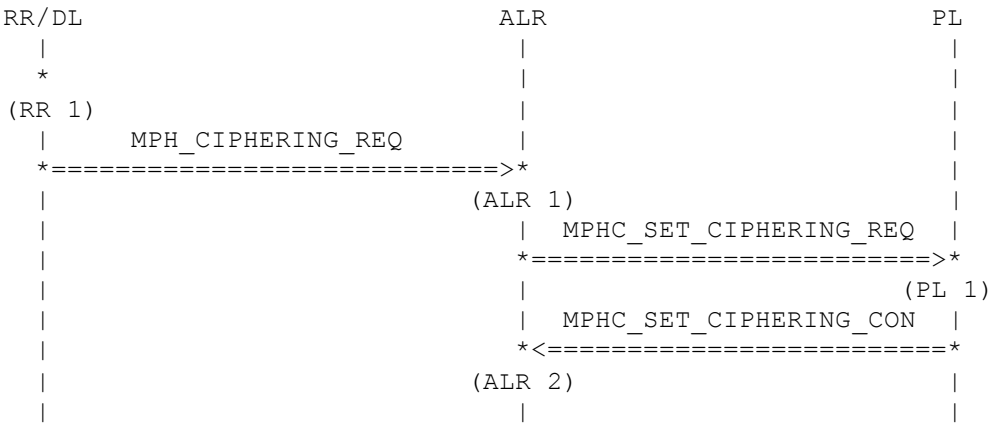
(PL 1)

Layer 1 receives the new channel mode.

(ALR 2)

A confirmation is send to ALR.

15 Cipher Mode Setting



(RR 1)

RR has received a cipher mode setting message.

(ALR 1)

The new cipher parameters are forwarded to ALR. The parameters are converted according to the following table:

CIPHER MODE SETTING	MPH_CIPHERING_REQ	MPHC_SET_CIPHERING_REQ	Remark
Cipher Mode Setting	stat algo kc	cipher_mode a5_algorithm new_ciph_param	

Cipher Response	---–	----–	*1)

*1) Cipher Response is carried out by RR.

(PL 1)

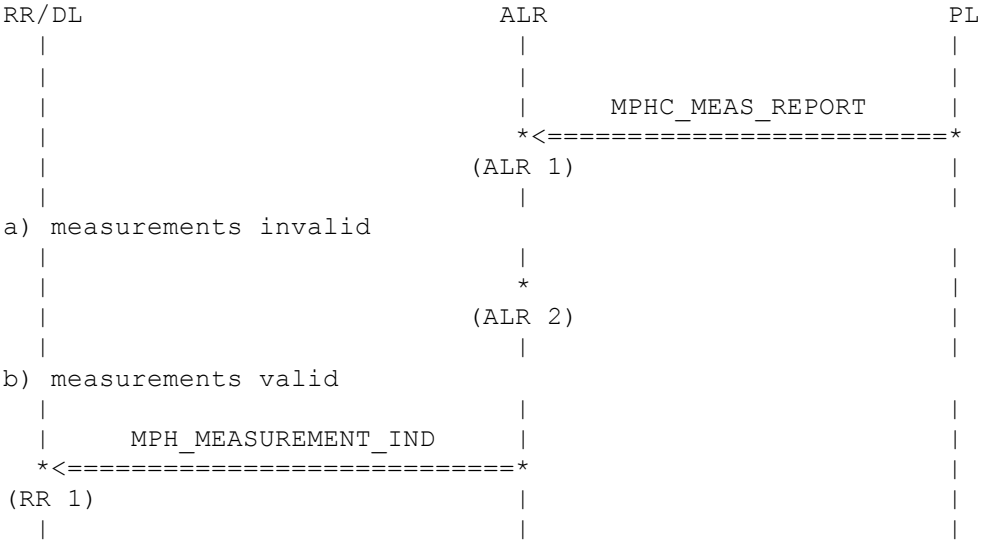
Layer 1 receives the new cipher parameters.

(ALR 2)

A confirmation is send to ALR.

16 Dedicated Mode Neighbour Cell Procedures

16.1 Measurement Reporting



(ALR 1)

Layer 1 sends measurement values to ALR.

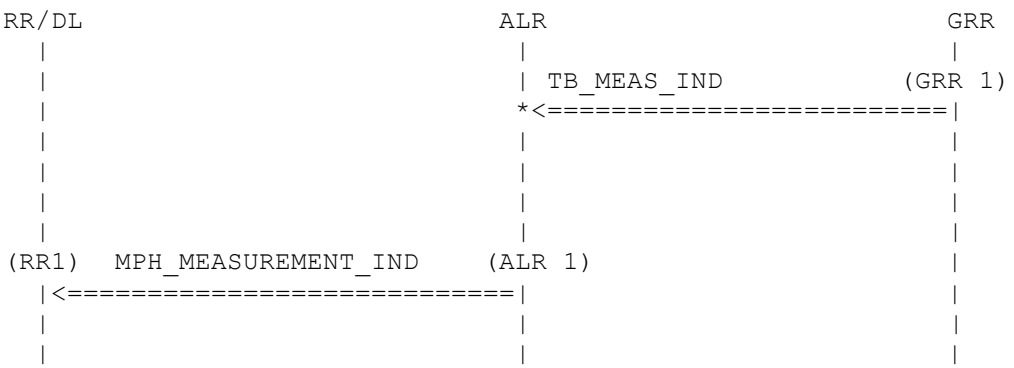
(ALR 2)

The valid flag in the measurement values indicates invalid data. ALR deletes the measurement values.

(RR 1)

If the measurement values are valid, ALR builds a MPH MEASUREMENT IND primitive and sends the data to RR.

Measurement reporting from GRR:



(GRR 1) forwards the cell re-selection measurement results during packet transfer mode to ALR.

(ALR 1) ALR checks if TB_MEAS_IND is received in MA_PTM, packet transfer mode. ALR updates the measurement indications values for those cells that are present in the BA list. ALR then sends an MPH_MEASUREMENT_IND to RR i.

(RR 1) The MPH_MEASUREMENT_IND are handled by RR as in previous case.

For all members of the BCCH allocation a status is defined. The status of idle mode is used as initial value for the dedicated mode. The status READ_BCCH is not possible in dedicated mode. It is handled like READ_SB. The neighbour cell process switches to state NCELL_DEDICATED. The following values are possible:

NULL	No field strength average value available.
IDLE	Only fieldstrength of the member is known. The mobile station is not synchronized and has no knowledge about the BCCH.
READ_FB_SB	This state is entered if a neighbour cell is one of the six strongest channels and the mobile station is not synchronized yet. It indicates that the mobile station shall read frequency correction burst and synchron burst as fast as possible.
FB_SB_SYNC	The channel is one of the six strongest neighbour cells and the mobile station is synchronized to the neighbour cell
READ_SB	The channel is one of the six strongest neighbour cells and the mobile station must read the synchron burst again as fast as possible.
IDLE_SYNC	The mobile station is synchronized to the channel, but the channel is not longer one of the six strongest neighbour cells.
FB_SB_FAILED	The attempt for synchronization failed

The status will be changed if a number of reports received from PL, or a primitive received from RR or the list of six strongest cells has changed. Cells which not passing the NCC permitted check are not member of the measurement report.

If the neighbour cell process is in state NC_DEDICATED the status will be changed and a procedure is started. In state NC_DEDICATED_ACTIVE a specific procedure is running and only the status will be changed.

The possible status changes after receiving a fieldstrength report from PL are listed in the following table:

old status	condition	new status
NULL	1 sample received	IDLE
IDLE	1 of 6 best channels	READ_FB_SB
READ_FB_SB	not 1 of 6 best channels	IDLE
FB_SB_SYNC	not 1 of 6 best channels	IDLE_SYNC
	more than 8 seconds	READ_SB
READ_SB	not 1 of 6 best channels	IDLE
IDLE_SYNC	more than 8 seconds	IDLE
	1 of 6 best channels	FB_SB_SYNC
FB_SB_FAILED	more than 8 seconds	IDLE

The condition „more than 8 seconds“ is implemented by counting the number of reports (Variable c_report). Layer 1 sends a each 104 TDMA frames (102 TDMA frames for SDCCH) one measurement report. The criterion „1 of 6 best channels“ is calculated for all cells with a status unequal to NULL. It depends on the fieldstrength of the cells and additionally on the multiband period in the dualband variant.

If a measurement report is send the neighbour cell process adds all neighbour cells for which synchronization was successfull (status FB_SB_SYNC, READ_SB or READ_BCCH).

MPHC_MEAS_REPORT	MPH_MEASUREMENT_IND	Relationship
---	arfcn	1)
---	fn_offset	2)

dtx_used	dtx	3)
meas_valid	---	
rxlev_full_acc	rxlev_full	4)
rxlev_full_nbr_meas	---	
rxlev_sub_acc	rxlev_sub	5)
rxlev_sub_nbr_meas	---	
rxqual_full_acc_errors	rxqual_full	6)
rxqual_full_nbr_bits	---	
rxqual_sub_acc_errors	rxqual_sub	7)
rxqual_sub_nbr_bits	---	
no_of_ncell_meas	ncells.no_of_ncells	8)
ncell_meas.A[33].bcch_freq	ncells.arfcn[6]	9)
ncell_meas.A[33]rxlev_acc	ncells.rxlev[6]	10)
---	ncells.bsic[6]	11)
---	ncells.tav[6]	12)
ncell_meas.A[33]rxlev_nbr_meas	---	
ba_id		
timing_advance	tav	13)
txpwr_used	---	

1) The channel number of the current serving cell is stored in the arfcn parameter.

2) The frame offset defines the number of TDMA frames since the last measurement report to RR. It is 104 for FACCH and 102 for SDCCH.

3) The Parameter dtx defines whether discontinous transmission was used or not. The value is taken directly from the layer 1 measurement report.

4) The Parameter rxlev_full is the receiving signal strength on the serving cell., measured on all slots. Layer 1 indicates a value with is the sum of n attempts. Each layer 1 value is in the range 0 to 255. So the value is divided by the number of attempts and 4.

5) The Parameter rxlev_sub is the receiving signal strength on the serving cell., measured on a subset of slots. Layer 1 indicates a value with is the sum of n attempts. Each layer 1 value is in the range 0 to 255. So the value is divided by the number of attempts and 4.

6) The Parameter rxqual_full is calculated from the values rxqual_full_acc and rxqual_full_nbr_bits. The number of detected error bits is multiplied with 500 and divided by the number of checked bits. This leads to the following table:

RX Quality	Bit Error Rate	Calculated Value
0	< 0.2 %	0
1	0.2 % .. < 0.4 %	1
2	0.4 % .. < 0.8 %	2-3
3	0.8 % .. < 1.6 %	4-7
4	1.6 % .. < 3.2 %	8-15
5	3.2 % .. < 6.4 %	16-31
6	6.4 % .. < 12.8 %	32-63
7	12.8 % ...	> 63

7.) The Parameter rxqual_sub is calculated from the values rxqual_sub_acc and rxqual_sub_nbr_bits. The number of detected error bits is multiplied with 500 and divided by the number of checked bits.

8.) The number of neighbourcells is filled with the number of synchronized neighbourcells up to the maximum of six strongest cells.

9.) The parameter defines the channel number of the neighbourcell.

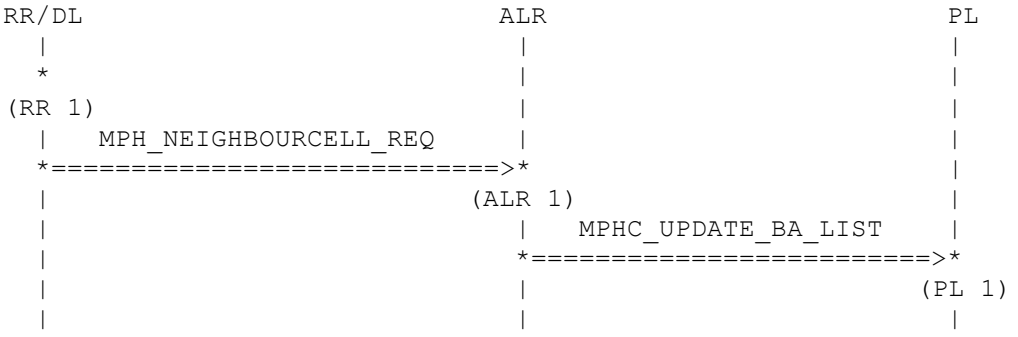
10.) The parameter defines the fieldstrength of the neighbourcell. It is the average of ncell_meas.A[cell].rxlev_acc calculated with ncell_meas.A[cell].rxlev_nbr_meas and divided by four to have the GSM range of 0 to 63.

11.) The BSIC of the neighbourcell is taken from the result of the synchronization attempt.

12.) The relative timing advance of the neighbourcell to the serving cell is taken from the result of the synchronization attempt.

13.) The timing advance of the serving cell is taken directly from the layer 1 report.

16.2 Update of Neighbour Cell List



(RR 1)

RR receives a System Information Type 5 message. It is a option for the base station to have different BCCH allocations in idle and in dedicated mode. If the System Information Type 5 message contains a neighbour cell description different from the BCCH allocation in idle mode, this will be detected by RR.

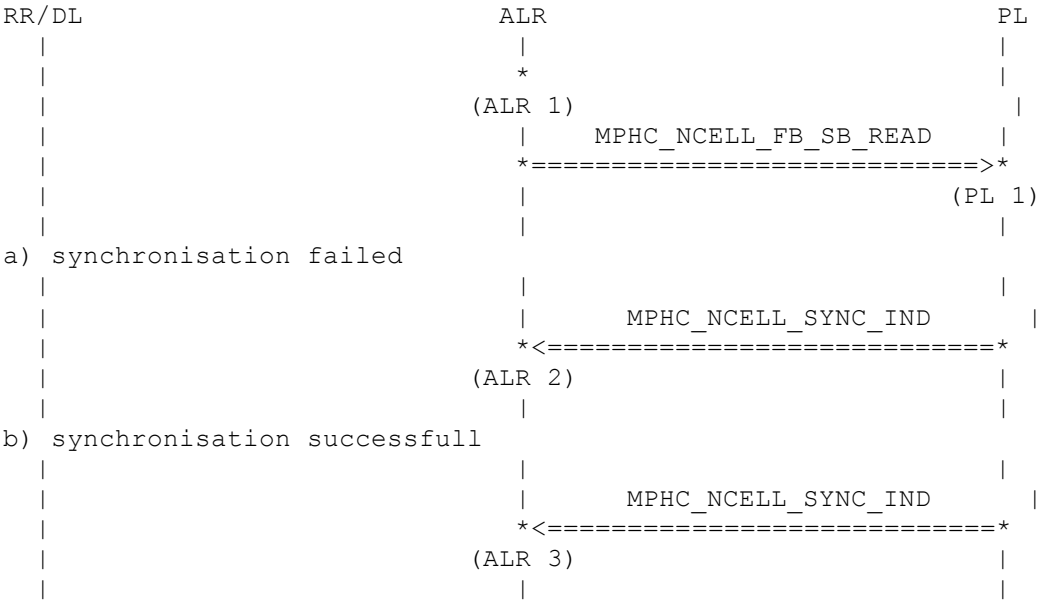
(ALR 1)

The updated neighbour cell list is forwarded to ALR. If the serving cell is not included yet, ALR includes it.

(PL 1)

The updated BCCH allocation is forwarded to layer 1. It will be used immediately. To avoid inconsistency the next measurement report to ALR is signed as invalid.

16.3 Synchronization to Neighbour Cells



(ALR 1)

If the neighbour cell process is in state NC_DEDICATED after processing a report of layer 1 or entering NC_DEDICATED after processing a specific procedure, it is checked whether the following conditions are true:

- At least one neighbour cell has the status READ_FB_SB and
- No neighbour cell has the status READ_SB or READ_BCCH

(PL 1)

For the first neighbour cell with the status READ_FB_SB an attempt is initiated with the primitive MPHC_NCELL_FB_SB_READ. The neighbour cell process enters the state NC_DEDICATED_ACTIVE.

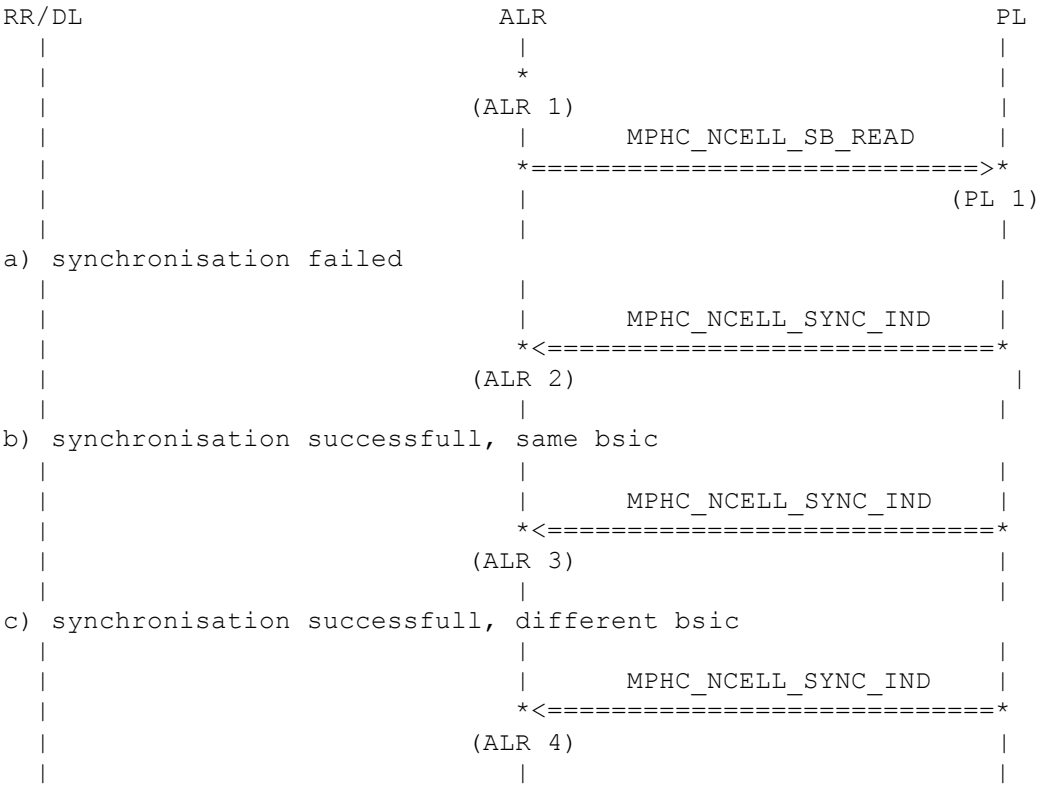
(ALR 2)

Layer 1 indicates a failed synchronisation attempt. The cell gets the status FB_SB_FAILED and the c_report variable is resetted. For the next eight seconds no new attempt is carried out for this channel although it may have excellent field-strength values. The neighbour cell process enters state NC_DEDICATED.

(ALR 3)

Layer 1 indicates a successfull synchronisation. The cell gets the status FB_SB_SYNC. The c_report variable is resetted. The frame offset, the time alignment and the bsic are stored. The neighbour cell process enters state NC_DEDICATED.

16.4 Confirmation of Synchronisation to Neighbour Cells



(ALR 1)

If the neighbour cell process is in state NC_DEDICATED after processing a report of layer 1 or entering NC_DEDICATED after processing a specific procedure, it is checked whether the following condition is true:

- From all cells with the status READ_SB or READ_BCCH has the cell with the highest c_report value the status READ_SB

(PL 1)

The procedure is initiated by a MPHC_NCELL_SB_READ primitive.

(ALR 2)

Layer 1 indicates a failed reading attempt. The cell gets the status FB_SB_FAILED and the c_report variable is resetted. For the next eight seconds no new attempt is carried out for this channel although it may have excellent fieldstrength values. The neighbour cell process enters state NC_DEDICATED.

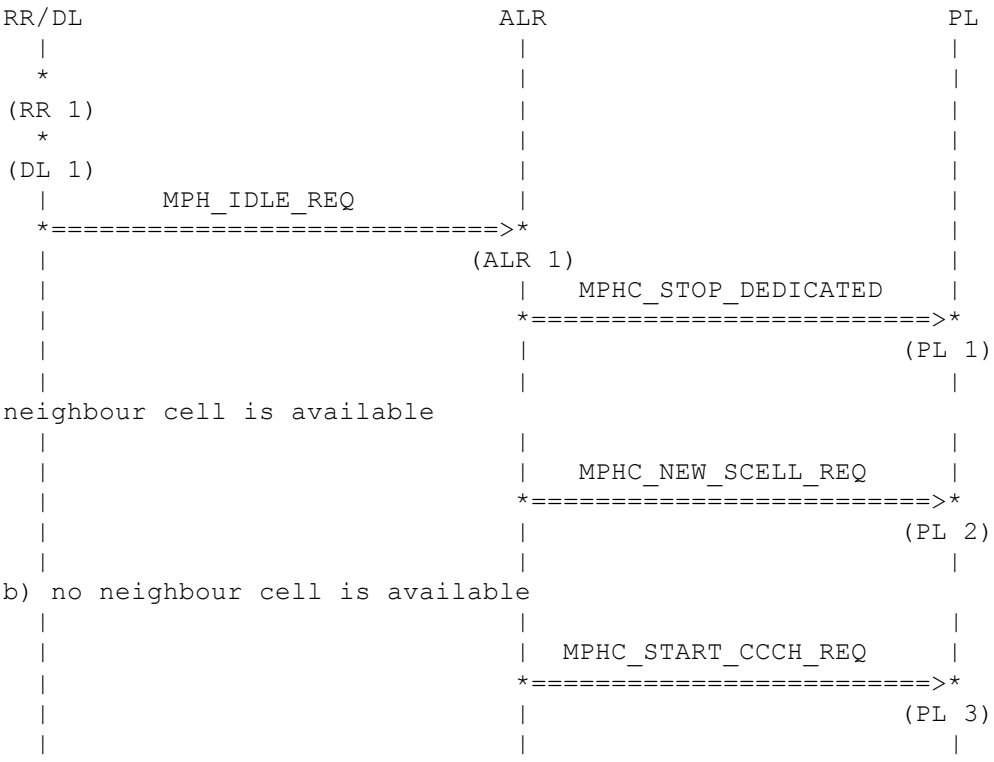
(ALR 3)

Layer 1 indicates a successful synchronisation with the same bsic. This indicates that the mobile station is synchronized to the same neighbour cell as the last time. The cell gets the status FB_SB_SYNC if the previous status was READ_SB. If RR has requested BCCH reading no status change occur. The c_report variable is resetted. The frame offset and the time alignment are stored. The neighbour cell process enters state NC_DEDICATED.

(ALR 4)

Layer 1 indicates a successfull synchronisation with a different bsic. This indicates that the mobile station is synchronized to a different neighbour cell as the last time. The cell gets the status FB_SB_SYNC. The c_report variable is resetted. The frame offset, the time alignment and the bsic are stored. The neighbour cell process enters state NC_DEDICATED.

17 Channel Release



(RR 1)

RR receives a Channel Release message.

(DL 1)

The layer 2 connection is disconnected.

(ALR 1)

RR returns to idle mode and configures the lower layer.

(PL 1)

The channel release is signalled to layer 1.

(PL 2)

A cell reselection is started.

(PL 3)

Normal paging is configured.

18 Short Message Cell Broadcast

The CBCH procedure is located in ALR. The following aspects are handled:

- Configuration of CBCH
- Collection of CBCH blocks
- Request of information (Message Id, Data Coding Scheme, Mode)
- Reading of CBCH Messages
- Suppression of multiple received CBCH messages
- Handling of Schedule Messages
- Handling of Null Message

CBCH-SMS messages may be received approximately every 2 seconds from the network. They are unacknowledged by the mobile. A CBCH channel occupies a SDCCH block and has a cycle of 8 multi frames a 51 TDMA frames. Only 4 multi frames contain CBCH information. This time is called a "CBCH slot".

The infrastructure may send schedule message. A schedule message includes information about a number of immediately following consecutive CB message, planned for a cell. The length of time covered by the CB messages referred to in a schedule message is called the "schedule period" of that message.

The schedule message contains a message description for each CB message to be broadcast during the scheduling period, in order of transmission. The position of a CB message is called the "message slot number" of the CB message, and it indicates the position of the CB message within the schedule period.

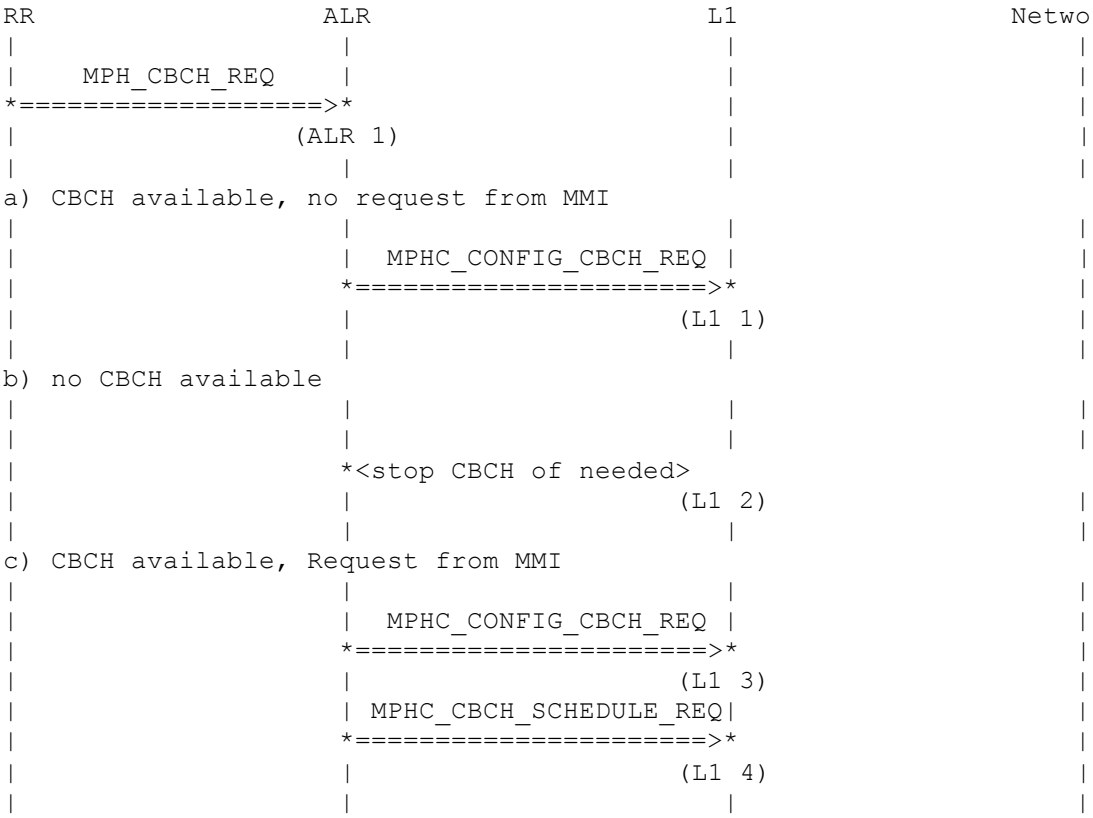
Each Message Description includes various information, including for SMSCB messages directly or indirectly all or part of their message identifier, and whether an occurrence is repetition or not.

Each Schedule message includes a begin slot number field and an end slot number field. The end slot number field indicates the length of the schedule period (i.e., specifically the number of CB message slots about which information is provided). In the case where the network uses schedule messages to describe all message slots in advance, the first schedule message of the next schedule period will be transmitted in the message slot pointed by end slot number plus 1.

The begin slot number is defined to allow the network to broadcast several scheduling message referring to the same schedule period. The begin slot number field indicates the message slot number of the CB message following the received schedule message.

The network may send unscheduled messages during empty message slots. The network need only update the begin slot number in an unscheduled schedule message to reflect the current offset within the schedule message of the next message to be transmitted.

18.1 Configuration of CBCH



(ALR 1)

As part of the idle mode configuration the CBCH is configured by RR.

(L1 1)

RR indicates that a CBCH is available. There was no request from MMI for reading CB message. ALR configures the CBCH process in layer 1.

(L1 2)

RR indicates that the current cell has no support of CBCH. It stops any older configuration of the CBCH process in layer 1 if needed.

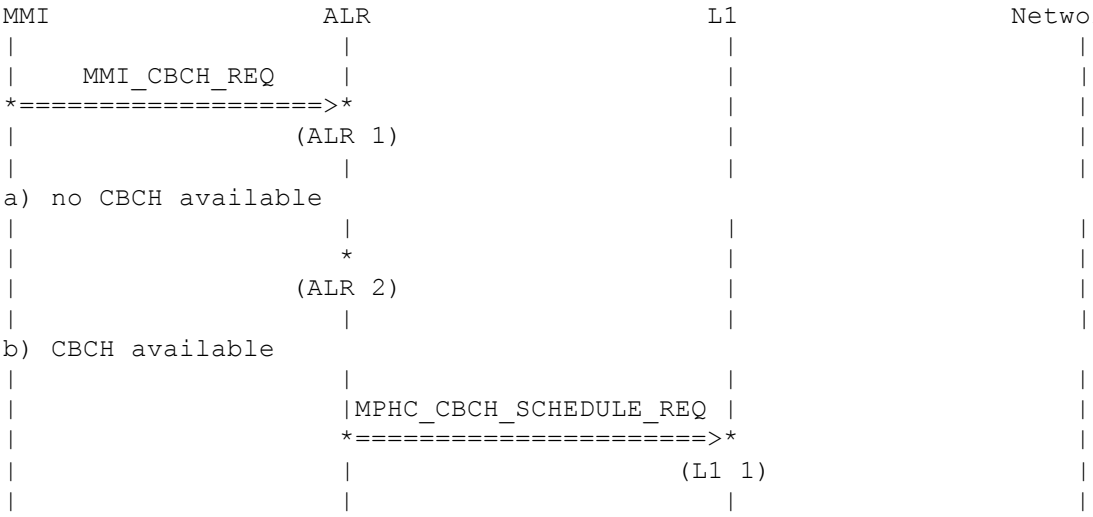
(L1 3)

ALR configures the CBCH process in layer 1.

(L1 4)

A previous request of CB message reading is stored in ALR. After configuration of the CBCH process in layer 1 reading of the first block of CB message is started. The parameter of the primitive to layer 1 is set to zero indicating that each first block shall be read.

18.2 Start Reading of CBCH



(ALR 1)

MMI requests reading of CB message. The primitive contains a list of message identifier ranges , a list of data coding scheme ranges and the used mode. Two subsequent values define the lower and the upper boundary of a range. The value 0xFFFF indicates the end of the list. The mode defines whether all CB message shall be read which are inside the ranges or outside.

An example: CB messages with message identifiers 2, 4-50 and 99 shall be read. This leads to the following primitive content:

- Message identifier 2,2
  4,50
  99,99
  0xFFFF, ...
- Data Coding Scheme 0xFFFF, ...
- Mode Inside the ranges

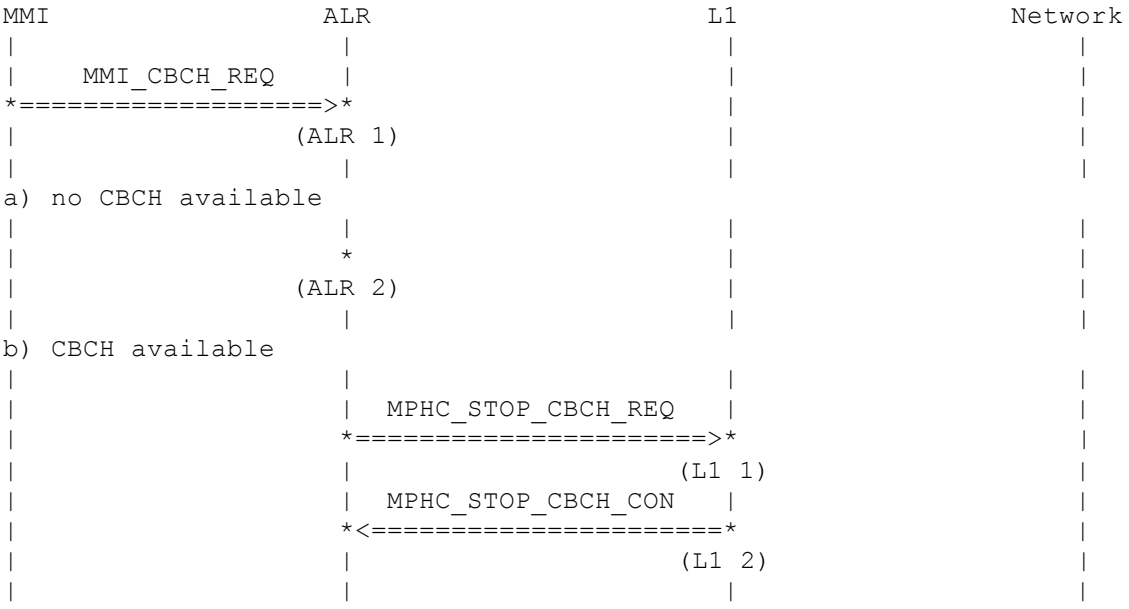
(ALR 2)

If no CBCH is available, the parameters are stored.

(L1 1)

Reading of all slots is requested by layer 1.

18.3 Stop Reading of CBCH



(ALR 1)

MMI stops CBCH reading with the mode set to 0xFF.

(ALR 2)

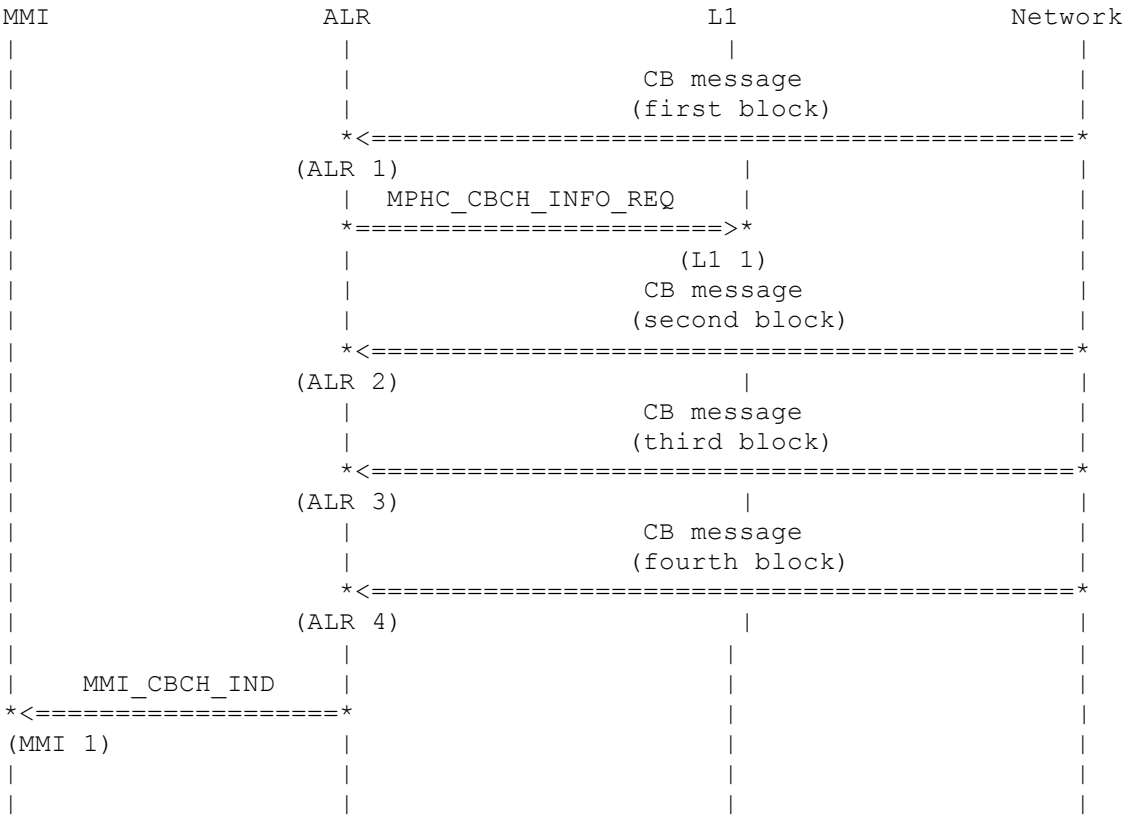
If no CBCH is available, previous stored parameters are cleared.

(L1 1)

If a CBCH is available, the CBCH process in layer 1 is stopped and all previous stored parameters are cleared.

18.4 Collection of CBCH Blocks

18.4.1 CBCH message, expected



(ALR 1)

ALR receives a CBCH block. The first byte has the following structure:

8	7 6	5	4 3 2 1
Spare 0	LPD 0 1	LB	Sequence Number

The sequence number indicates "first block" of a CBCH message. The following 22 bytes are the first quarter of the CBCH message.

The first block of a CBCH message has the following structure:

Octet No.	Meaning
1-2	Serial Number
3-4	Message Identifier
5	Data Coding Scheme
6	Page Parameter
7 ..	Content of Message

ALR checks whether the message identifier and the data coding scheme matches to the requested CBCH messages. An additional check is made for the serial number and the page parameter against already received messages.

(L1 1)

If both checks have the result that this is an expected not yet received message, the remaining three blocks of the message are requested.

(ALR 2)

The second block of the message receives. The block content is stored.

(ALR 3)

The third block of the message receives. The block content is stored.

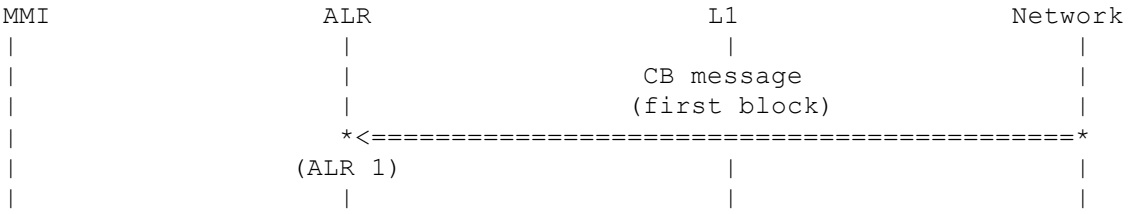
(ALR 4)

The fourth block of the message receives. The block content is stored.

(MMI 1)

The message is forwarded to MMI. The CBCH message parameter (serial number, message identifier, data coding scheme and page parameter) are stored in the list of the already received CBCH messages.

18.4.2 CBCH message, not expected



(ALR 1)

ALR receives a CBCH block. The first byte has the following structure:

8	7 6	5	4 3 2 1
Spare 0	LPD 0 1	LB	Sequence Number

The sequence number indicates "first block" of a CBCH message. The following 22 bytes are the first quarter of the CBCH message.

The first block of a CBCH message has the following structure:

Octet No.	Meaning
1-2	Serial Number
3-4	Message Identifier
5	Data Coding Scheme
6	Page Parameter
7 ..	Content of Message

ALR checks whether the message identifier and the data coding scheme matches to the requested CBCH messages. An additional check is made for the serial number and the page parameter against already received messages.

18.4.3 Schedule message

(ALR 1)

TI ++ receives a schedule message. The first byte has the following structure:

8	7 6	5	4 3 2 1
Spare 0	LPD 0 1	LB	Sequence Number

The sequence number indicates "first schedule block" of a schedule message. The following 22 bytes are the first quarter of the schedule message.

The schedule message has the following structure:

Octet No.	Meaning
1	Begin Slot Number
2	End Slot Number
3-8	New CBSMS Message Bitmap
9 - 2m	New CBSMS Message Description
(2m+1)-n	Other Message Description

(L1 1)

ALR requests reading of the remaining three blocks of the schedule message.

(ALR 2)

ALR receives the second block of the schedule message. The message block is stored.

(ALR 3)

ALR receives the third block of the schedule message. The message block is stored.

(ALR 4)

ALR receives the fourth block of the schedule message. The message block is stored.

Now the forecast for the next scheduling period is calculated. The behaviour of ALR depends on the DRX mode of the CBCH process. There are three modes defined:

NO DRX

This is the mode before receiving the schedule message. In this mode all first blocks of the message slots are read and the remaining three blocks if the first block indicates that this is useful.

FIRST DRX

The MS has received a schedule message applicable to the next message slot. But either did not receive the first schedule message of the schedule period previous to the current one, or has not received all messages sent in that period (during that period or before).

SECOND DRX

The MS knows all the messages of interest sent in the schedule period previous to the current one, and has received the first schedule message of the current period.

The begin slot number indicates the begin of the scheduling period from the view of the incoming schedule message. If the begin slot number is 1, this is the first schedule message of that schedule period.

The end slot number indicates the length of the scheduling period.

The new CBSMS message bitmap indicates the new CBCH messages. The bitmap is valid from bit 1 to the bit with the number of the end slot number. All bits in this range with the value 1 are new CBCH messages or define free slots which must be read by the mobile.

All bits in this range with the value 0 are free slots, which must not be read by the mobile or which contains repetitions of the CBCH message, which were new in previous scheduling periods.

New CBCH message must be read in FIRST and SECOND DRX mode if the message identifier matches to the requested message identifiers.

Free Slots with bit set to 1 must be read in FIRST and SECOND DRX mode.

Old CBCH message must be read in FIRST DRX mode if the message identifier matches to the requested message identifiers.

Free Slots with bit set to 0 must not be read.

After the new CBSMS message bitmap message descriptions are defined for the messages with bit set to 1 in the bitmap. At least message descriptions for messages with bit set to 0 are added.

Using this informations ALR indicates to layer 1 which slots shall be read by layer 1. The parameter of the MPHC_START_CBCH_READING primitive has the following meanings:

0 Read all subsequent slots

1 Read the next slot and stop reading

2 Don´t read the next slot but the second slot and stop reading

and so on.

Four possible message descriptions are defined:

First transmission of an SMSCB within the Schedule Period

Octet 1	MDT 1	Message Identifier (high part)

Octet 2	Message Identifier (low part)

Retransmission Indication

Octet 1	MDT 0 0	Repeated Message Slot Number

Free Message Slot, reading optional

Octet 1	MDT 0 1	0

Free Message Slot, reading advised

Octet 1	MDT 0 1	1

An example:

MMI has requested reading of the CB messages with the message identifiers 3, 11 and 7. The infrastructure has defined a slot period of 19 slots. Depending on the DRX mode of the mobile different behaviour of ALR is implemented.

The infrastructure sends a schedule message in slot 0 and slot 10. Repeated (old) CB message are send in the slots 2 and 16. New CB messages are send in the slots 4 and 14. An unscheduled message is send in the slot 7 and 17.

If the mobile is in NO DRX mode it starts after configuration of CBCH at slot 5 (random slot number).

Read CBCH means reading of a CB message.

Read Schedule means reading of the schedule message.

Start with n=x means sending of the MPHC_START_CBCH_READING primitive with the parameter n as defined before.

Schedule (x,y) means schedule message with begin slot number x and end slot number y.

Old CBCH (x) means repeated CBCH message with message identifier x.

New CBCH (x) means new CBCH message with message identifier x.

Unscheduled CBCH (x) means CBCH message with message identifier x which was not indicated by the schedule message.

In slot 18 a repetition of the old CBCH message with message identifier 3 is send.

Slot No	CBCH activity	NO DRX	FIRST DRX	SECOND DRX
0	Schedule (0/18)	-	Read Schedule, Start with n = 2	Read Schedule, Start with n = 7
1	NULL	-	-	-
2	Old CBCH (3)	-	Read CBCH, Start with n= 5	-
3	NULL	-	-	-
4	New CBCH (5)	-	-	-
5	NULL	Start with n = 0	-	-
6	NULL	-	-	-
7	Unscheduled CBCH (11)	Read CBCH, Start with n = 0	Read CBCH, Start with n = 7	Read CBCH, Start with n = 7

8	NULL	-	-	-
9	NULL	-	-	-
10	Schedule (11 / 18)	Read Schedule, Start with n = 4	-	-
11	NULL	-	-	-
12	NULL	-	-	-
13	NULL	-	-	-
14	New CBCH (7)	Read CBCH, Start with n = 5	Read CBCH, Start with n = 3	Read CBCH, Start with n = 3
15	NULL	-	-	-
16	Old CBCH (8)	-	-	-
17	Unscheduled CBCH (14)	-	Start with n = 2	Start with n = 2
18	Old CBCH (3) Repeat	-	-	
Next DRX mode		FIRST DRX	SECOND DRX	SECOND DRX

The schedule message in slot 0 has the following layout.

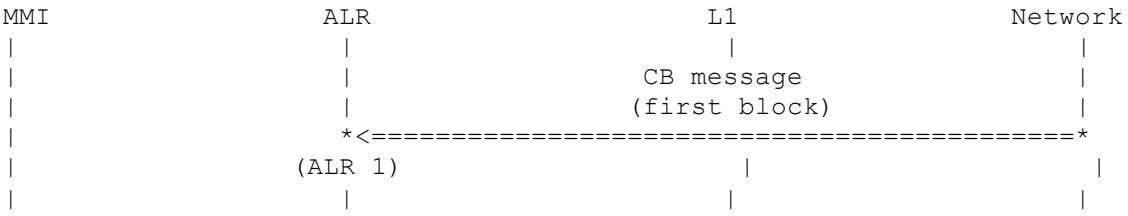
01 Begin Slot Number 1
12 End Slot Number 18
12 New CBSMS Message Bitmap (NM 4 and NM 7)
04 NM 14
80 NM 17
00
00
00
80 05 New Message Indication: Message Identifier 5 (NM 4 = 1)
41 Free Message Slot, reading advised (NM 7 = 1)
80 07 New Message Indication: Message Identifier 7 (NM 14 = 1)
41 Free Message Slot, reading advised (NM 17 = 1)
40 Free Message Slot, reading optional (NM 1 = 0)
80 03 Old Message Indication: Message Identifier 3 (NM 2 = 0)
40 Free Message Slot, reading optional (NM 3 = 0)
40 Free Message Slot, reading optional (NM 5 = 0)
40 Free Message Slot, reading optional (NM 6 = 0)
40 Free Message Slot, reading optional (NM 8 = 0)
40 Free Message Slot, reading optional (NM 9 = 0)
40 Free Message Slot, reading optional (NM 10 = 0)
40 Free Message Slot, reading optional (NM 11 = 0)
40 Free Message Slot, reading optional (NM 12 = 0)
40 Free Message Slot, reading optional (NM 13 = 0)
40 Free Message Slot, reading optional (NM 15 = 0)
80 08 Old Message Indication: Message Identifier 8 (NM 16 = 0)
02 Old Message Indication: Repeat Message Identifier 3 from Slot 2 (NM 18 = 0)

The unscheduled schedule message from slot 10 has the same layout, only the begin slot number is set to 11.

(L1 2)

ALR updates the scheduling parameter of Layer 1.

18.4.4 Null message



(ALR 1)

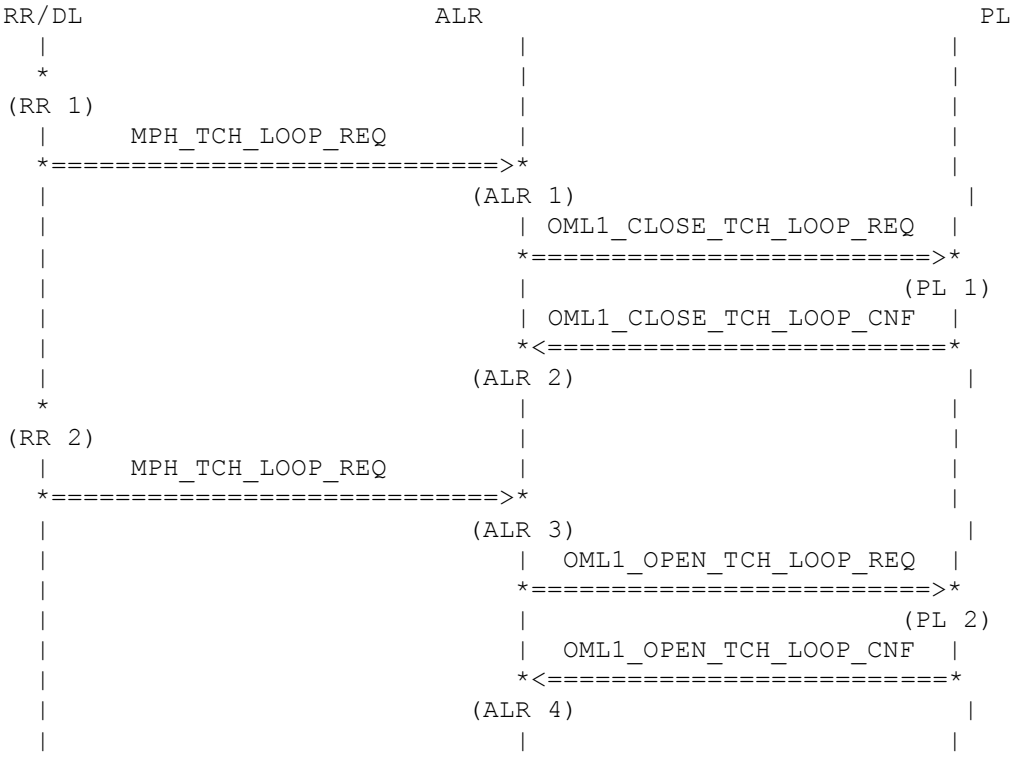
ALR receives a null message. The first byte has the following structure:

8	7 6	5	4 3 2 1
Spare 0	LPD 0 1	LB	Sequence Number

The sequence number indicates "null message". The message is ignored.

19 Special Testfeatures

19.1 TCH Loopback



(RR 1)

RR receives a Close TCH Loop Command message.

(ALR 1)

The parameter are forwarded to ALR if a test sim is available.

(PL 1)

Closing of the TCH loop is configured for layer 1.

(ALR 2)

A confirmation is given to ALR.

(RR 2)

RR receives an Open TCH Loop Command message.

(ALR 3)

The parameter are forwarded to ALR if a test sim is available.

(PL 2)

Opening of the TCH loop is configured for layer 1.

(ALR 4)

A confirmation is given to ALR.

19.2 DAI Testing

(RR 1)

RR receives a Test Interface message.

(ALR 1)

The parameter are forwarded to ALR if a test sim is available.

(PL 1)

Starting of DAI testing is configured for layer 1.

(ALR 2)

A confirmation is given to ALR.

(RR 2)

RR receives a Test Interface message indicating no further tests.

(ALR 3)

The parameter are forwarded to ALR if a test sim is available.

(PL 2)

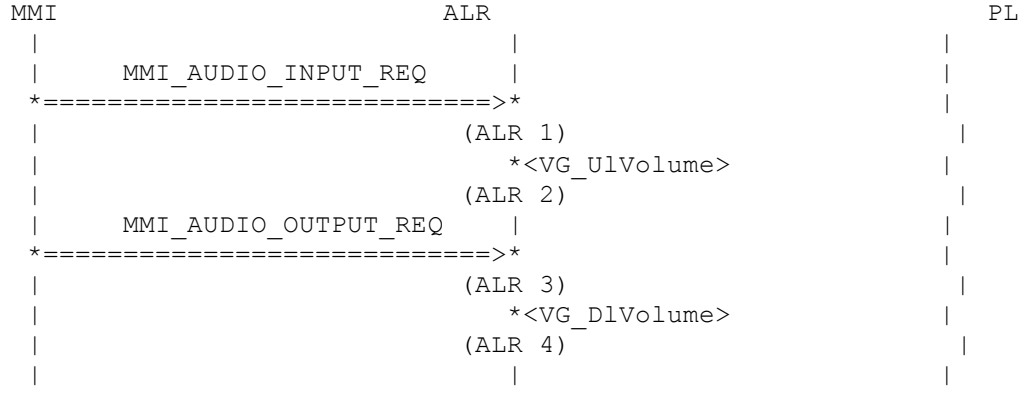
Stopping of DAI testing is configured for layer 1.

(ALR 4)

A confirmation is given to ALR.

20 Audio Control

20.1 Volume Initialization



(ALR 1)

After power-on the MMI reads the input volume and forwards it to ALR.

(ALR 2)

ALR forwards the uplink microphone volume to the hardware using the driver call VG_UlVolume.

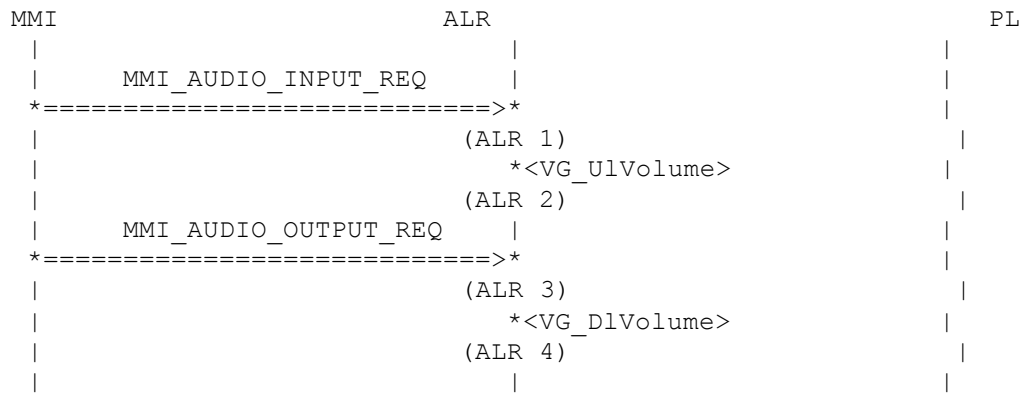
(ALR 3)

After power-on the MMI reads the out volume and forwards it to ALR.

(ALR 4)

ALR forwards the downlink speaker volume to the hardware using the driver call VG_DlVolume.

20.2 Volume Change



(ALR 1)

If the input volume changes, MMI forwards the new value to ALR.

(ALR 2)

ALR forwards the uplink microphone volume to the hardware using the driver call VG_UlVolume.

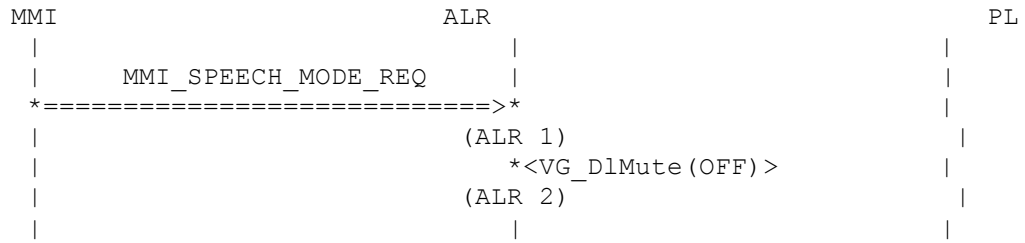
(ALR 3)

If the output volume changes, MMI forwards the new value to ALR.

(ALR 4)

ALR forwards the downlink speaker volume to the hardware using the driver call VG_DlVolume.

20.3 Speech On



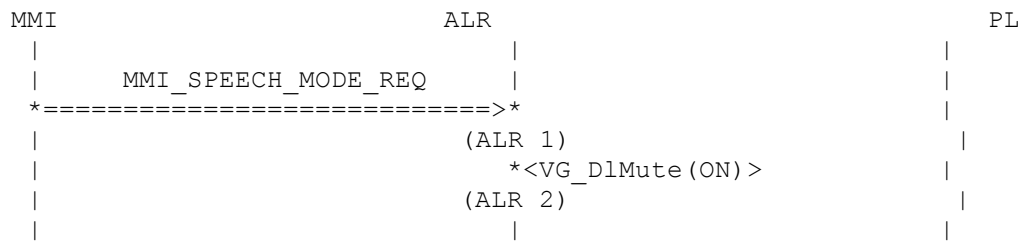
(ALR 1)

MMI requests switching on of the speech channel.

(ALR 2)

ALR uses the driver call VG_DlMute with the parameter set to OFF to disable muting of the speech channel.

20.4 Speech Off



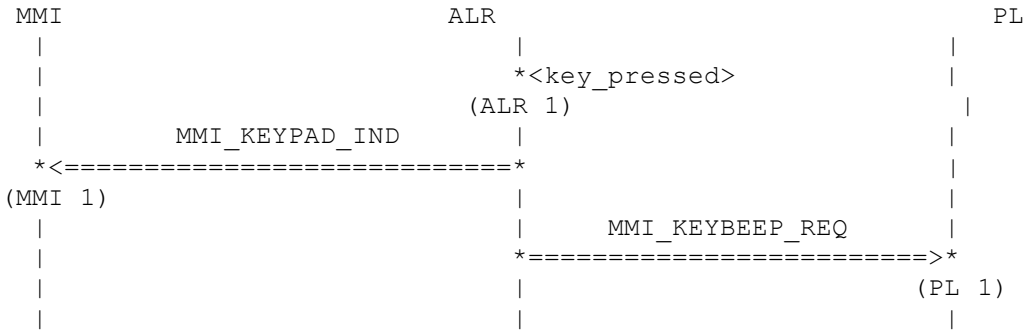
(ALR 1)

MMI requests switching off of the speech channel.

(ALR 2)

ALR uses the driver call VG_DlMute with the parameter set to ON to enable muting of the speech channel.

20.5 Keypad Feedback



(ALR 1)

A key is pressed on the keypad.

(MMI 1)

The pressed key is forwarded to MMI.

(PL 1)

If it is configured a keybeep is given to the user as a feedback to key pressing.

20.6 Tones

For each possible tone a describing data structure is defined. This data structure describes whether it is a tone created by the buzzer or imposed to the audio channel.
If it is a buzzer tone the tone itself is described in a list with the entries command and length. The following commands are possible:

0 the buzzer is switched off for the time length in TDMA frames.
> 0 the buzzer is switched on with the value (equal to frequency) for the time length in TDMA frames.
FFFE the buzzer is switched on continously.
FFFF end of list

Example:	Subscriber Busy	Command	Length	Comment
		425	108	500 ms On
		0	108	500 ms Off
		FFFF	0	end of list

If the tone is imposed to the Audio Channel, the tone is described by up to two frequencies and optional a silence time. The tone is described in a list with the entries command_1, command_2 and length. The following commands are possible:

0 the tone is switched off for the time length in 20 ms units.
> 0 the tone is switched on with the value (corresponding to a frequency and amplitude) for the time length
in 20 ms units.
FFFF end of list

Example:	DTMF Tone 1	Command_1	Command_2	Length	Comment
		F_697	F_1209	13	260 ms On
		FFFF	FFFF	0	end of list

If the tone is requested by MMI the options volume and mode are possible. The parameter volume defines the volume of the tone. The parameter mode has the following options:

- single tone the tone is created one time

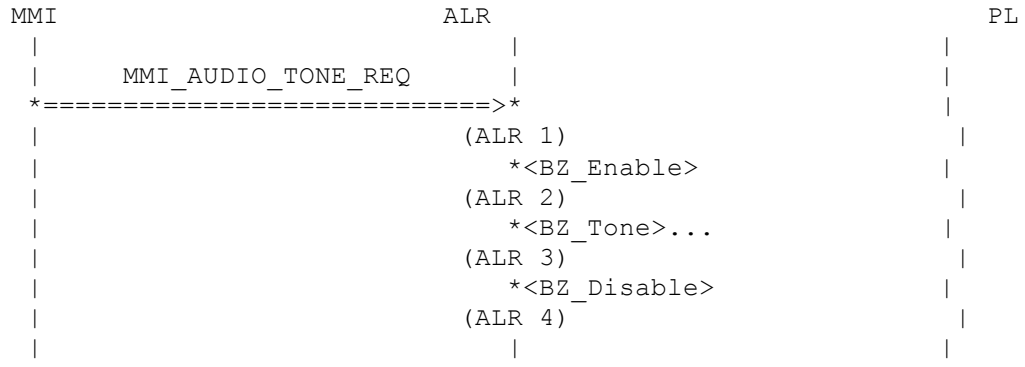
- repeated tone the tone is repeated
- silent tone the tone is not created.

20.6.1 Tones without Audio Channel

Tones without Audio Channel are produced with the buzzer. The following tones are defined according to
GSM 2.40:

Type	Tone	Silence
Ringing *1)	10 x (55 ms 800 Hz, 55 ms 900 Hz)	4000 ms
Normal Clearing	Continous 425 Hz	-
Subscriber Busy	500 ms 425 Hz	500 ms
Congestion	200 ms 425 Hz	200 ms
Radio Path Acknowledgement *2)	200 ms 425 Hz	-
Radio Path not available	3 periods with 200 ms 425 Hz	200 ms
Error/Special Information	tripple tone 330 ms 940 Hz 330 ms 1400 Hz 330 ms 1800 Hz	1000 ms

*1) Additional 15 custom specific ringing tones
*2) Optional



(ALR 1)

MMI requests to generate a buzzer tone.

(ALR 2)

The buzzer is enabled using the BS_Enable driver call.

(ALR 3)

According to the tone description list the frequency of the tone is configured using the driver call BZ_Tone. A timer is started to supervise the length of the tone.

(ALR 4)

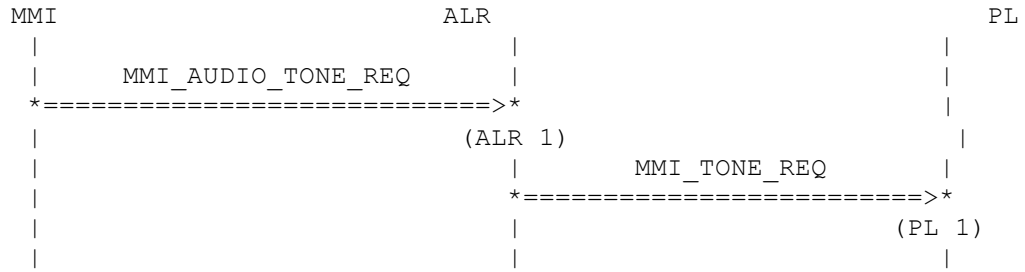
After timeout the next entry of the tone description list is used or if the list is finished the buzzer is disabled with the driver call BZ_Disable.

20.6.2 Tones with Audio Channel

Tones with Audio Channel are produced by layer1. The tone is mixed with the speech data. The following tones are defined according to GSM 2.40:

Type	Tone	Silence
Call Waiting Tone	200 ms 425 Hz	600 ms

	200 ms 425 Hz 200 ms 425 Hz 200 ms 425 Hz	3000 ms 600 ms
DTMF ´1´	260 ms 697 Hz / 1209 Hz	-
DTMF ´2´	260 ms 697 Hz / 1336 Hz	-
DTMF ´3´	260 ms 697 Hz / 1477 Hz	-
DTMF ´a´	260 ms 697 Hz / 1633 Hz	-
DTMF ´4´	260 ms 770 Hz / 1209 Hz	-
DTMF ´5´	260 ms 770 Hz / 1336 Hz	-
DTMF ´6´	260 ms 770 Hz / 1477 Hz	-
DTMF ´c´	260 ms 770 Hz / 1633 Hz	-
DTMF ´7´	260 ms 852 Hz / 1209 Hz	-
DTMF ´8´	260 ms 852 Hz / 1336 Hz	-
DTMF ´9´	260 ms 852 Hz / 1477 Hz	-
DTMF ´e´	260 ms 852 Hz / 1633 Hz	-
DTMF ´*´	260 ms 941 Hz / 1209 Hz	-
DTMF ´0´	260 ms 941 Hz / 1336 Hz	-
DTMF ´#´	260 ms 941 Hz / 1477 Hz	-
DTMF ´^´	260 ms 941 Hz / 1633 Hz	-



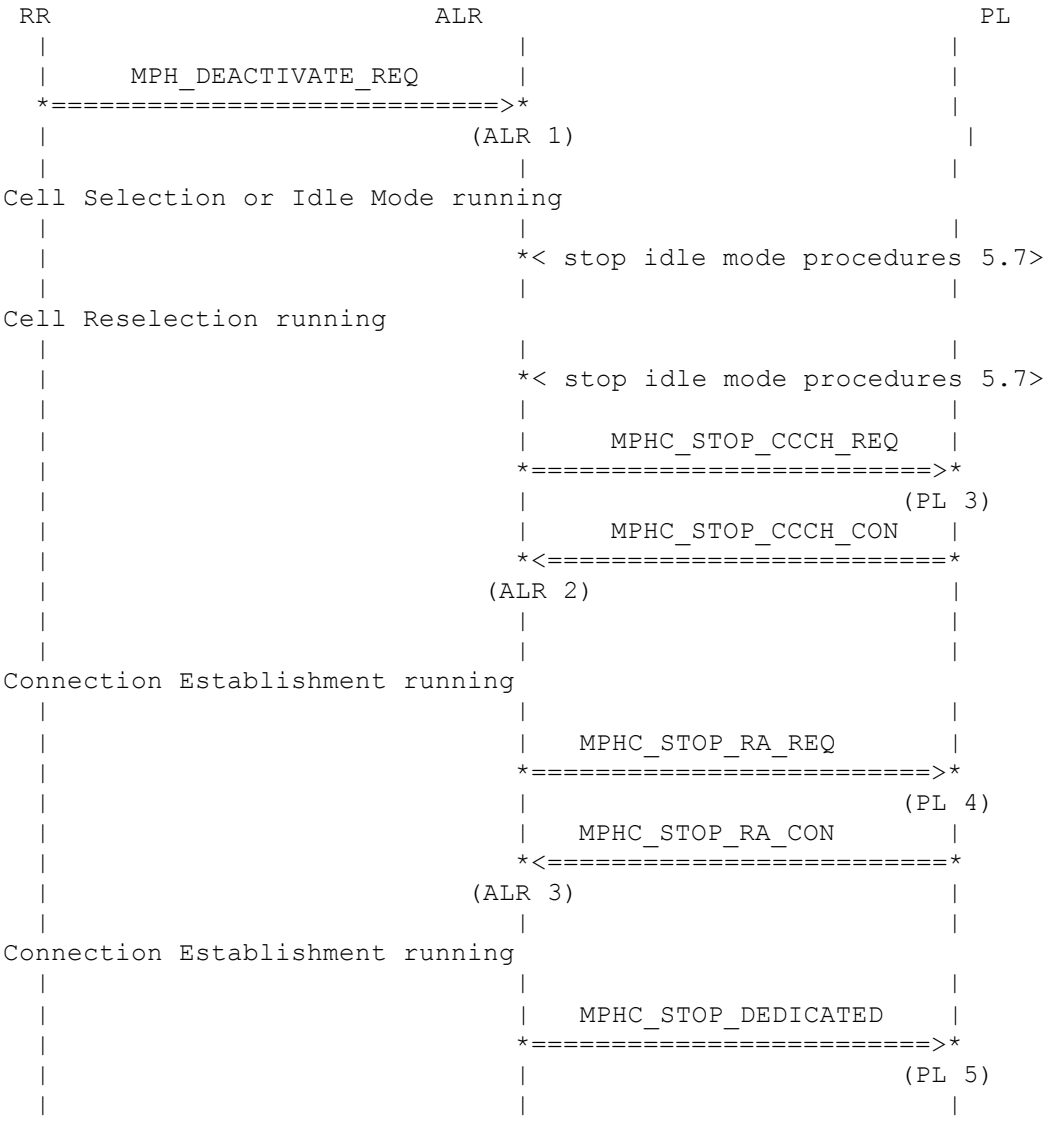
(ALR 1)

MMI requests generation of a tone imposed to the audio channel.

(PL 1)

The parameters are set and forwarded to layer 1. If it is necessary a timer is started for the next tone generation according to the tone description list.

21 Deactivation



(ALR 1)

After power-off the lower layer are deactivated.

(PL 1)

During cell selection or in idle mode the idle mode tasks in layer 1 are deactivated.

(PL 2)

During cell reselection the idle mode tasks are deactivated.

(PL 3)

The cell reselection process in layer 1 is stopped.

(PL 4)

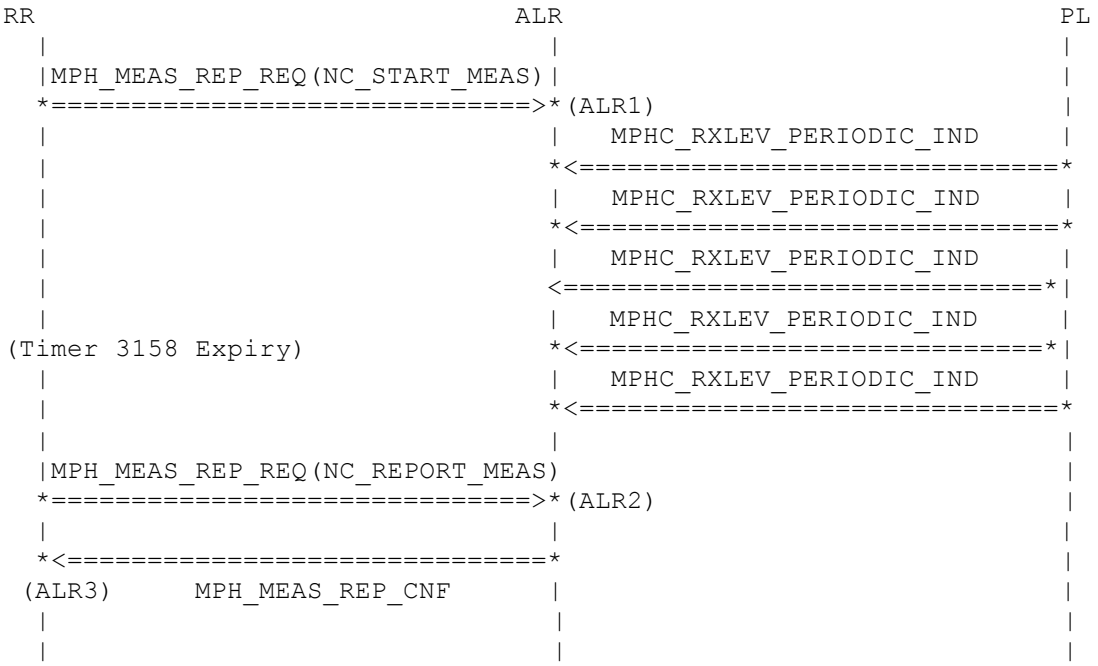
During connection establishment sending of random bursts and downlink listen to CCCH is stopped.

(PL 5)

During dedicated mode the dedicated mode tasks are stopped.

(Provide a short description of this document.)

22 Network control Measurement averaging for GPRS



(ALR1)

ALR Receives request from RR to start storing the measurement from L1.

(ALR2)

ALR Receives request from RR to report the average of stored measurements.

(ALR3)

ALR sends the average of measured values to RR.

Appendices

A. Acronyms

DS-WCDMA	Direct Sequence/Spread Wideband Code Division Multiple Access

B. Glossary

International Mobile Telecommunication 2000 (IMT-2000/ITU-2000)	Formerly referred to as FPLMTS (Future Public Land-Mobile Telephone System), this is the ITU's specification/family of standards for 3G. This initiative provides a global infrastructure through both satellite and terrestrial systems, for fixed and mobile phone users. The family of standards

is a framework comprising a mix/blend of systems providing global roaming. <URL: http://www.imt-2000.org/>