System Information/Layer 3 Messages

- **SYSTEM INFORMATION IN DETAIL**
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- **DISTRIBUTION OF SYSTEM INFORMATION MESSAGES**

INTRODUCTION

System information is data about the network that the MS needs in order to communicate with the network. System information messages are continuously sent on the BCCH and SACCH by the BTS to all idle (BCCH) and active (SACCH) mobiles in a cell.

There are different types of system information messages. They are numbered from 1 to 8. Types 2 and 5 have some variants, called 2 bis, 2 ter, 5 bis and 5 ter. This yields a total of twelve different system information types. System information message types 2 to 4 and optionally types 1, 2 bis, 2 ter, 7 and 8 are regularly sent by the network on the BCCH to idle mobiles. Types 5, 6 and optionally 5 bis and 5 ter are sent on the SACCH to mobiles in active mode.

System Information

1. Cell channel description, RACH control parameters

2. Neighbor cells description, NCC permitted ,RACH control parameters

2bis. Neighbor cells description (extension),RACH control parameters

2ter. Additional multiband information , Neighbor cells description (other bands)

3. Location area identification, Cell identity , Control channel description , Cell options , Cell selection parameters , RACH control parameters , SI 3 rest octets

4. Location area identification ,Cell selection parameters , RACH control parameters , CBCH channel description, CBCH mobile allocation ,SI 4 rest octets

5. Neighbor cells description

5bis. Neighbor cells description (extension)

5ter. Additional multiband information ,Neighbor cells description (other bands)

6. Location area identification , Cell identity Cell options ,NCC permitted

TYPE 1

When frequency hopping is used on the SDCCH in a cell or for cells with Immediate Assignment on traffic channel and frequency hopping, the MS needs to know which frequency band to use and which frequencies within the band it should use during frequency hopping. This information is provided in the cell channel description information element sent in system information type 1.

Cell Channel Description

The MS is informed about the frequencies that are used in the cell. The format of the cell channel description information element in GSM 900 is different from that used in GSM 1800/GSM 1900.

GSM 900

- A format called "bit map 0" is used where the information element is divided into two parts:

- **CA-NO**

  The cell allocation number shows which band is used. The CANO can have the value 0, 1 or 2. CA-NO=0 denotes GSM 900 while CA-NO=1 means E-GSM and CA-NO=2 GSM 1800.

- **CA ARFCN**

  The Absolute Radio Frequency Channel Numbers for all frequencies used in the cell. A 124 bits bit map is used. A bit set to 1 indicates that the frequency with that number is used in the cell.

RACH Control Parameters

ACC, EC

The access control class is described using a bit map with 16 bits. All MSs are spread out on ACC 0-9. Priority group MSs use ACC 11-15. A bit set to 1 indicates that the class is barred for access.

Bit 10 is used to indicate if emergency calls are permitted. EC=0 means that all MSs are allowed to make emergency calls, while EC=1 means that only MSs belonging to priority classes 11-15 are allowed to make emergency calls.

CB

Cell barred for access is denoted by using one bit only (yes/no).

RE

Call re-establishment allowed is also denoted by using one bit (yes/no). Re-establishment allowed means that if an MS using a TCH looses contact with the network, it is allowed to attempt to re-establish the contact using the old TCH, provided the attempt is made during some defined interval.

MAXRET (Max retransmissions)

This is the maximum number of channel request message retransmissions allowed when an MS attempts to access the system. MAXRET can have the value 1, 2, 4 or 7.

TX

This is the number of slots to spread random access retransmissions over when an MS attempts to access the system. The values TX can have are 3-12 in increments of one, 14, 16, 20, 25, 32 and 50.

TYPE 2

System information type 2 contains a list of BCCH frequencies used in neighboring cells. The MS needs this information because it must listen to the system information in the neighboring cells occasionally. The MS also uses this list of frequencies when measuring the signal strength of neighboring cells.

The MS is also receives information about which PLMN Network Color Codes (NCC) it may monitor.

Neighbor Cells Description

The neighbor cells description information element denotes the frequencies of the BCCH carriers to be monitored by the MSs in the cell.

This information element also occurs in system information types 2 bis, 2 ter, 5, 5 bis and 5 ter. What is described here concerning format of information elements is true for types 2 bis, 2 ter, 5, 5 bis and 5 ter as well.

GSM 900

BA-NO

This is a BCCH allocation number. BA-NO=0 means GSM 900.

BA-IND

This is a BCCH allocation sequence number indication. BAIND can have the value 0 or 1. When the operator changes the frequency list, the BA-IND changes from 1 to 0 or vice versa.

BA ARFCN

These are absolute RF channels on which the MSs should perform signal strength measurements. A bit map with 124 bits is used to indicate what neighboring frequencies exist. Bit positions corresponding to neighboring frequencies on are set to

one and all other bits are set to zero.

GSM 1800 and GSM 1900

Different formats can be used to indicate which BCCH carrier frequencies to monitor.

FORMAT-ID

This denotes the format of the information element. For example, range 256 format.

EXT-IND

Extension indication is described using one bit only. If the information element in system information type 2 (5) is not enough for all frequency channel numbers, the rest are located in a 2 bis and/or 2 ter (5 bis and/or 5 ter) message. The extra information element has the same format as the first neighbor cells description information element. If received in system information type 2 or 2 bis (5 or 5 bis), the EXT-IND parameter coding is:

0 -- this information element carries the complete frequency list

1 --this information element carries part of the frequency list only and a complementary information element is located in another message

This bit is considered spare if it is received in a type 2-ter (5-ter) message.

BA-IND

See GSM 900.

The bits in the remaining part of the information element represent the frequencies using special encoding schemes.

NCC Permitted

NCCPERM

The MS gets information about which NCCs of the BCCH carriers it is allowed to monitor for handover purposes. To describe which NCCs are allowed, a bitmap of 8 bits is used: when bit *n = 1 it means, that frequency with Network Color* Code *n - 1 is allowed.*

RACH Control Parameters
Refer to parameters described in system
information type 1.

TYPE 2 BIS
System information type 2 bis is sent optionally on
the BCCH.
It contains information about control of RACH and
the
extension of BCCH allocation in neighboring cells.
Neighbor Cells Description (Extension)
See the neighbor cells description information
element in
system information type 2.
RACH Control Parameters
Refer to parameters described in system
information type 1.

TYPE 2 TER
System information type 2 ter is sent optionally on the BCCH. It contains information about the BCCH allocation of the other bands in the neighboring cells.

Additional Multiband Information
MULTIBAND REPORTING
This parameter is used to inform the MS how cells from other bands are to be handled in measurement reporting. One possible setting for this parameter orders the 6 strongest neighbors to be reported irrespective of the band used in the neighboring cells. Another setting means that at least the strongest identified neighbor in each band is to be reported.

Neighbor Cells Description (Other Bands)
See the neighbor cells description information element
in
system information type 2.
RACH Control Parameters
Refer to parameters described in system information
type 1.

TYPE 3

The MS must know the current location area's identity because a change in location area means that the MS must update the network. The MS gets the cell identity as well.

In order to calculate its paging group, the MS needs specific parameters contained in the control channel description. The description also informs the MS about periodic registration and it informs the MS if it should inform the system when it is about to enter idle mode.

There is information for the MS in the cell options which is aimed at achieving good performance in the cell. When the MS is in idle mode, it alone decides which cell to camp on.

Information needed by the MS for cell selection and reselection is also broadcast in system information type 3.

Location Area Identification (LAI)

MCC Mobile Country Code (3 digits)

MNC Mobile Network Code (2-3 digits)

LAC Location Area Code (2 octets: 0-65535 different LACs)

Cell Identity (CI)

Two octets (16 bits) identifying a cell within a location area.

Control Channel Description

ATT

Attach/Detach allowed flag: this tells whether or not the MS is

to perform IMSI Attach and IMSI Detach procedures (ATT=1)

or (ATT=0).

CCCH_CONF

This is the number of Basic Physical Channels used for the CCCH. (1-4 BPCs when not combined with SDCCH, 1 BPC if combined).

AGBLK (BS_AG_BLKS_RES)

This is the number of CCCH blocks reserved for the AGCH, CBCH or BCCH Extended. The range of this parameter is 0-2 if CCCH is combined with SDCCH and 0-7 for non-combined CCCH.

MFRMS (BS_PA_MFRMS)

This is the number of 51 multiframe periods for transmission of
Paging Request messages in the same paging group (2-9).

Cell options

DTX

Discontinuous transmission indicator (may, must or must not).

PWRC

The power control indicator equal to 1 means set and equal to 0
means not set. If frequency hopping is used in the cell and one of the frequencies in the hopping set is the BCCH carrier, there is a problem regarding the downlink signal strength value the MS writes to the measurement report. The BCCH carrier is always transmitted on fixed power because of measurements performed by MSs in neighboring cells.

An active MS reports the average downlink signal strength value for the serving cell and for neighboring cells every SACCH period. The average is calculated on all frequencies used for hopping.

If one of the frequencies is the BCCH carrier, the average value may be non-representative for the signal level received on the other frequencies since their output power may be a lot smaller than the BCCH power.

If the PWRC parameter is set, it means that the MS is not to include measurements on the BCCH carrier in the calculated average. If the parameter is not set, the BCCH measurements are included.

Radio Link Time-out

The time-out value for radio link failure (the parameter RLINKT) is used according to a procedure called "leaky bucket". A counter in the MS is set to RLINKT. This can be between 4 and 64. In Ericsson's GSM system, the recommended value is 16. Each time the MS succeeds in decoding the SACCH message, the counter is increased by 2.

It can not, however, exceed its initial value. If the message cannot be decoded, the counter is instead decreased by 1. If the counter reaches 0, it is detected as a layer 1 error and a radio link time-out is declared. All radio resources are released.

A complete SACCH message is received every 480 ms, thus implying that the counter is increased or decreased just as often. The SACCH reporting period can be 960 ms if the SACCH is also used for short messages.

The reason for having the radio link time-out is to enable the MS to re-establish or release the channel in a defined manner. The criteria for determining radio link failure on the *uplink* should be based upon either the error rate on the uplink SACCH or on RXLEV/RXQUAL measurements of the MS. The exact criteria to be employed are determined by the network operator.

Cell Selection Parameters
ACCMIN (RXLEV_ACCESS_MIN)

This is the minimum received signal level at the MS for which it is permitted to access the system. Range (0-63): -110 dBm up to -48 dBm. For the way ACCMIN is coded

ACCMIN value	Signal strength value
0	below -110 dBm
1	-110 dBm to -109 dBm
2	-109 dBm to -108 dBm
.	
.	
.	
62	-49 dBm to -48 dBm
63	greater than -48 dBm

CCHPWR (MS_TXPWR_MAX_CCH)

The CCHPWR field defines the maximum output power an MS is allowed to use when accessing the cell. What value corresponds to what power level for GSM 900 and GSM 1800

CCHPWR value	Signal strength value
0 - 2	39 dBm
3	37 dBm
4	35 dBm
. . .	. . .
18	7 dBm
19 - 31	5 dBm

CRH (CELL_RESELECT_HYSTERESIS)
This represents cell reselect hysteresis. The measured signal strength is decreased by CRH (range 0-14 dB) in increments of 2 dB if the cell belongs to a new LA.

ACS
This field defines the additional reselect parameters indicator and is spare in a system information type 3 message. It is set to 0.

NECI
This parameter is used for new establishment causes indication (0 or 1). It indicates whether the phase 2 establishment causes are supported by the system. The establishment cause is included in the channel request message on the RACH.

SI 3 Rest Octets

System information type 3 rest octets may contain parameters
that are used by a phase 2 MS for calculating the cell
reselection criterion C2. C2 is defined in the chapter
"Um interface". One bit indicates the presence of
system information type 2 ter message and another bit
indicates early classmark sending control.

2TI

This is system information type 2-ter indication (0 or 1). 2TI is

used by the MS to determine if the network broadcasts system
information type 2 ter.
2TI=0 means that system information type 2 ter is not available.
2TI=1 means that system information type 2 ter is available

ECSC

The setting of the early classmark sending control bit informs MSs with the "control early classmark sending" option whether early sending of additional classmark information is accepted or not accepted by the system. Early in this case means as soon as possible after access.

PI

Cell_reselect_param_ind can have the value 0 or 1. PI is used by the MS to determine if the C2 parameters are broadcast by the network in this message. C2 parameters include CBQ, CELL_RESELECT_OFFSET, TEMPORARY OFFSET AND PENALTY TIME.

PI=0 -- C2 parameters are not present

PI=1-- C2 parameters are present

If PI=1 then the four parameters described below are present

CBQ
Cell bar qualify (values: 0 or 1) is used by the network to control MS cell selection and re-selection. The use and coding of the CBQ parameter is described in the chapter "Um interface".

CELL_RESELECT_OFFSET
A system information value used by the MS to apply a positive or negative offset to the value of C2. Range is 0-63, which corresponds to 0-126 dB in 2 dB steps.

TEMPORARY_OFFSET
A system information value used by the MS to apply a negative offset to the value of C2 for the duration of PENALTY_TIME. Range is 0-7, where 0-6 corresponds to 0-60 dB in 10 dB steps and the value 7 means infinity.

PENALTY_TIME
This parameter defines the length of time for which TEMPORARY_OFFSET is active. Range is 0-31, where 0-30 corresponds to 20 to 620 seconds in 20 second increments and 31 is used to indicate that TEMPORARY_OFFSET is to be ignored.

TYPE 4

There is a function that allows the operator to broadcast short messages to all MSs in one or more cells. In system information type 4, MSs are informed if the cell broadcast function is used inthis cell and on what frequency the CBCH is found.

The LAI, the cell selection parameters, the RACH control parameters and rest octets are also included in the type 4 message.

Location Area Identification (LAI)

Refer to parameters described in system information type 3.

Cell Selection Parameters

Refer to parameters described in system information type 3. However, the coding of the ACS parameter is different. It is described below:

ACS

Additional reselect parameters indicator (0 or 1).

0 Þ the system information type 4 rest octets, if present, are used to derive the PI value and any existing C2 parameters.

1 -- the PI value and any existing C2 parameters in system information type 7 and 8 message are to be used.

CBCH Channel Description (Optional)
In this information element, the channel used for SMS cell broadcast is described.
CHANNEL TYPE
This is the channel combination and sub-channel used for CBCH. For example, SDCCH/4 + SACCH/C4 or CBCH, sub channel 2.
TN
This represents the time slot number

TSC
This is the training sequence code. BCC part of BSIC is recommended.

H
This is the hopping parameter, where H=0 means single RF channel and H=1 means RF hopping channel.

CHANNEL SELECTOR
H=0 --the channel selector field consists of the absolute RF channel number
H=1 -- the channel selector field consists of the mobile allocation index offset, MAIO, and the hopping sequence number HSN

CBCH Mobile Allocation (Conditional)
This information element must be present if the CBCH channel description information element indicates frequency hopping.
MAC
This is the mobile allocation RF channel. The frequencies used in the hopping sequence are described by referring to the cell channel description element in system information type 1.

SI 4 Rest Octets

System information type 4 rest octets may contain the

parameters needed for C2 calculations as described under SI

type 3 rest octets. These are PI, CBQ, CELL_RESELECT_OFFSET, TEMPORARY_OFFSET, and PENALTY_TIME.

TYPE 5

When the MS is in busy mode, it has a SACCH activated. On the uplink, the MS sends measurement reports, and on the downlink the network sends output power and TA for the MS to use. In addition, the MS receives information about the frequencies used as BCCH carriers in neighboring cells on SACCH. The signal strength of these frequencies are monitored and reported in the measurement report for handover purposes. The frequencies in the neighbor cells description given here may differ from those sent in system information type 2. In active mode, the MS measures on a reduced number of BCCH frequencies in order to improve the accuracy of the measurements. In idle mode, the MS measures on a greater number of frequencies to reduce the time required to establish contact with the network after power on. This time reduction occurs only if the idle BA list is stored at the previous power off.
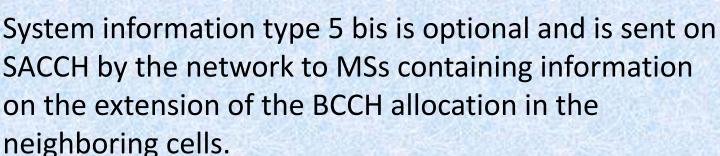
Neighbor Cells Description

The format of this information element is the same as in system information type 2. The frequencies may, however, be different.

As an example, consider the GSM 900 case, where the same parameter, BA ARFCN occurs in both system information types 2 and 5. The same format is used, namely a bitmap of 124 bits, where bit set to 0 means do not measure this frequency. A bit set to 1 means measure this frequency. The different lists are created by setting other bits to 1 in the system information type

5 bitmap than in system information type 2 bitmap. For example, the BA given in system information type 5 may contain umbrella cell frequencies

TYPE 5 BIS

System information type 5 bis is optional and is sent on SACCH by the network to MSs containing information on the extension of the BCCH allocation in the neighboring cells.

TYPE 5 TER

System information type 5 ter is optional and is sent on SACCH by the network to MSs containing information on the extension of the BCCH allocation in the neighboring cells.

TYPE 6

When in active mode, the MS needs to know if the LAI changes. In case the LAI changes the MS must perform location updating when the call is released

If the MS changes between cells (within the location area) where RLINKT or DTX conditions differ the new cell options must be reported to the MS. NCC permitted information element is also included.

TYPE 7

System information type 7 is optional and is sent on BCCH extended if system information type 4 does not contain all information needed for cell reselection

SI 7 Rest Octets

System information type 7 rest octets have the same format as the system information type 4 rest octets

TYPE 8

System information type 8 is optionally sent on BCCH extended if system information type 4 does not contain all information needed for cell reselection.

SI 8 Rest Octets

System information type 8 rest octets have the same format as the system information type 4 rest octets.