
System Information

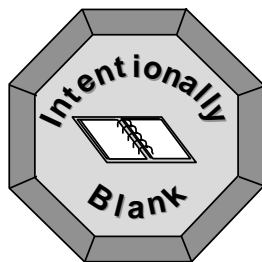
Chapter 5

This chapter is designed to provide the student with an overview of the system information messages.

OBJECTIVES:

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

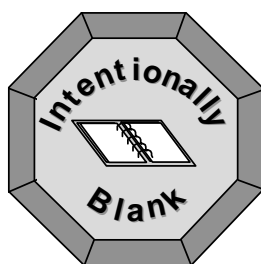
- describe the content of different types of system information messages.
- list which channels used to transmit the different messages.
- describe when system information messages are sent.



5 System Information

Table of Contents

Topic	Page
INTRODUCTION	85
SYSTEM INFORMATION IN DETAIL	88
TYPE 1	88
TYPE 2	89
TYPE 2 BIS	91
TYPE 2 TER	91
TYPE 4	98
TYPE 5	100
TYPE 5 BIS	101
TYPE 5 TER	101
TYPE 6	101
TYPE 7	102
TYPE 8	102
DISTRIBUTION OF SYSTEM INFORMATION MESSAGES	103



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. Figure 5-1 provides an introduction to the system information messages. Each will be explained in this chapter.

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
7. SI 7 rest octets
8. SI 8 rest octets

Figure 5-1 System information overview.

In order to facilitate the MS operation in idle mode, it is necessary to transmit the system information messages in defined 51-frame multiframes (BCCH multiframes). The messages are transmitted in a cyclic pattern reoccurring every eighth 51-frame multiframe as shown in Figure 5-2.

TC	7	0	1	2	3	4	5	6	7	0	1	2
multiframe	B	B	B	B	B	B	B	B	B	B	B	B
System Information Type												
GSM 900	4	1(3)*	2	3	4	3	2	3	4	1(3)	2	3
E-GSM, GSM 1800, GSM 1900	4	1(3)	2	3	4	3	2 bis	3	4	1(3)	2	3
Multi band	4	1(3)	2	3	4	3	2 ter	3	4	1(3)	2	3
Multi band	4	1(3)	2	3	4	2 ter	2 bis	3	4	1(3)	2	3

$$TC = (FN \text{ DIV}(51)) \text{ MOD } 8$$

* System Information Type 1 is mandatory only when frequency hopping is used

Figure 5-2 Multiplexing of phase 2 system information messages on BCCH norm. (TC is a sequence number for the 51-frame multiframe.)

According to the GSM specifications, what is sent when TC equals 4 or 5 is optional. System information type 1 only needs to be sent if frequency hopping is used. An MS should look for system information type 1 when TC=0. If it finds a system information message of another type there (type 3, see Figure 5-2), it will assume that frequency hopping is not used in the cell.

Types 7 and 8 are only sent if type 4 does not contain all information needed for cell re-selection. If used, type 7 and 8 are transmitted on BCCH extended when TC=7 and 3 respectively.

Definitions of BCCH normal and BCCH extended are provided in chapter 2 "Channel Concept".

There is no multiplexing on SACCH specified in the GSM specifications, except that system information types 5 and 6 are sent immediately after handover and whenever nothing else is being sent. Note that it is the downlink SACCH that is used for this purpose. The uplink SACCH normally carries measurement reports.

Parameters sent in system information messages are changeable via commands specified by the operator or controlled internally in the BSC. Each cell has its own set of parameters.

SYSTEM INFORMATION IN DETAIL

TYPE 1

When frequency hopping is used in a cell, 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. Information is also provided instructing the MS how to perform access to the system. This information is provided in the RACH control parameters information element and is sent in system information type 2, 2 bis, 3 and 4 as well.

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 CA-NO 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.

GSM 1800 and GSM 1900

Several different formats can be used to indicate the frequencies occurring in the cell. The information element here is also divided into two parts:

FORMAT-ID

This indicates the format of the information element.

The second part of the information element represents the frequencies through special encoding schemes described in GSM specifications 04.08 (10.5.2.1b).

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 a MS using a TCH loses 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 a 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. BA-IND 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 \Rightarrow this information element carries the complete frequency list

1 \Rightarrow 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 described in GSM specifications 04.08 (10.5.2.1b).

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.

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.

```
Time: 09:58:30.28
Lat: not valid Lon: not valid
Frame number: 1014196

Read from (ARFCN): 38
Cell Identity: 1089 (hex)
Location area identification
Mobile country code (MCC): 240
Mobile network code (MNC): 01
Location area code (LAC): 0bc4 (hex)
Control channel description
Attach/detach allowed (ATT): Yes
BS-AG-BLKS-RES: 1
CCCH-CONF: 1 basic physical channel, not combined with SDCCH's
BS-PA-MFRMS: 9 multiframe period
T3212 timeout value: 40
Cell options
Power control indicator (PWRC): Not set
DTX indicator: MS shall use discontinuous transmission
RADIO-LINK-TIMEOUT: 20
Cell selection parameters
CELL-RESELECT HYSTERESIS: 6 dB RXLEV
MS-TXPWR-MAX-CCH: 5
RXLEV-ACCESS-MIN: 0
RACH control parameters
Max retransmissions: 4
Tx-integer: 20
Cell bar access: Not barred
Call reestablishment (RE): Not allowed
Emergency call (EC) allowed: All MS
Not barred class(es) (ACC): 0 1 2 3 4 5 6 7
                        8 9 10 11 12 13 14 15

Message dump:
26 06 1b 10 89 42 f0 10 0b c4
48 07 28 14 65 00 b1 00 00
```

Figure 5-3 TEMS printout of 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_BLK_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).

T3212

This is the time-out value for MS periodic location updating. T3212 has values from 0 to 255. T3212 equal to 0 means no periodic location updating is required in the cell while any other value means periodic location updating is to be performed after T3212 times 6 minutes. Periodic location updating is only required if no other action has taken place between the MS and network.

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.

In Ericsson's GSM system PWRC always equals 0. This means that the MS includes the BCCH value in the calculated average. Instead of using the PWRC parameter, special formulas in the locating algorithm are designed to compensate for the included BCCH signal strength value.

RLINKT (RADIO_LINK_TIMEOUT)

Radio link time-out means the maximum value of the radio link counter. RLINKT can have a value between 4 and 64 in increments of four. The use of RLINKT is described below and in Figure 5-4.

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.

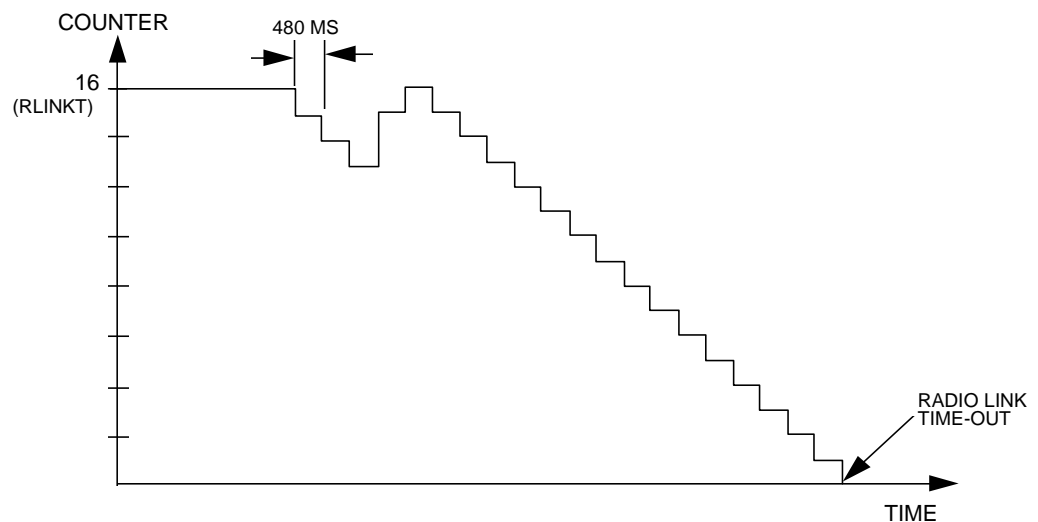


Figure 5-4 Radio link time-out, downlink.

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 is 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 to -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 is described in the GSM TS 05.05 (4.1).

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.

RACH Control Parameters

Refer to parameters described in system information type 1.

SI 3 Rest Octets

System information type 3 rest octets may contain parameters which 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 system information type 2 ter is broadcast by the network.

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 \Rightarrow C2 parameters are not present

PI=1 \Rightarrow 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 in this 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 \Rightarrow the system information type 4 rest octets, if present, are used to derive the PI value and any existing C2 parameters.
- 1 \Rightarrow the PI value and any existing C2 parameters in system information type 7 and 8 message are to be used.

RACH Control Parameters

Refer to parameters described in system information type 1.

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 \Rightarrow the channel selector field consists of the absolute RF channel number

H=1 \Rightarrow 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.

Neighbor Cells Description (Extension)

See system information type 2 and 2 bis.

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.

Additional Multiband Information System Information

See system information type 2 ter.

Neighbor Cells Description (Other Bands)

See system information type 2 ter.

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.

Location Area Identity

As described in system information type 3.

Cell Identity

As described in system information type 3.

Cell options

As described in system information type 3.

NCC permitted

As described in system information type 2.

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.

DISTRIBUTION OF SYSTEM INFORMATION MESSAGES

A cell in operation is in the active state.

The cell may also be halted, which means that the cell is not in operation. No channels are available in the cell, which means the BCCH is not transmitting.

When the cell state is changed from halted to active, all system information types are distributed to the BTS.

When parameters sent in the system information messages are changed while the cell is in active state, system information messages containing the changed parameters are distributed to the BTS.

When BTS equipment supporting the BCCH or SACCHs is taken into service in a cell in the active state, the BTS is updated with system information messages.

To prevent major disturbances to the system caused by lost messages or inaccurate messages arriving at the BTS, all system information messages are regularly distributed to the BTS in every cell where BCCH is transmitted.

