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4.2 Paging and Access Control Parameters

4.2.1 Number of Access Grant Reserved Blocks (BS_AG_BLK_RES or AG)

I. Definition

The common control channel consists of access grant channel (AGCH) and paging channel (PCH).

For different CCCHs, each BCCH multiframe (including 51 frames) contains CCCH message blocks different number. The CCCH is shared by AGCH and PCH. According g to regulations, partial message blocks on CCCH are especially reserved for AGCH. This avoids that the AGCH messages are blocked when the PCH traffic is great.

The number of parameter access grant reserved blocks (AG) refers to the number of message blocks reserved for AGCH on CCCH in each BCCH multiframe.

II. Format

The AG ranges from 0 to 2 when CCCH shares physical channel (CCCH_CONF = 1) with stand-alone dedicated control channel (SDCCH).

The AG ranges from 0 to 5 when CCCH does not share physical channel (CCCH_CONF=0) with stand-alone dedicated control channel (SDCCH).

III. Configuration and Influence

When the channel combination of the cell is fixed, the parameter AG adjusts the ratio of AGCH and PCH in CCCH. When the PCH is idle, it can send immediate assignment messages. The AGCH does not transmit paging messages. Equipment operators can balance AGCH and PCH by adjusting AG, with the following principles.

The principle for AG value is that based on no overload of AGCH, you must reduce the parameter to shorten the time for MS to respond to paging, and to improve system service performance. When the immediate assignment messages are superior to paging messages to be sent, configure AG to 0.

The value of AG is recommended as follows:

- AG is 1 when the CCCH and SDCCH share a physical channel.
- AG is 2 or 3 in other situations.

In network operation, take statistics of overload situations of AGCH and adjust AG accordingly. By default the immediate assignment messages are superior to paging messages to be sent in the network, so you need not reserve a channel for immediate assignment messages. In this situation, configure AG to 0.

4.2.2 Frame Number Coding Between Identical Paging

Frame number coding between identical paging is BS_PA_MFRMS (MFR for short).

I. Definition

According to GSM regulations, each MS (corresponding to an IMSI) belongs to a paging group (for calculation of paging groups, see GSM regulation 05.02). Each paging group in a cell corresponds to a paging subchannel. According to its IMSI, the MS calculates the paging group that it belongs to, and then calculates the location of paging subchannel that belongs to the paging group. The MS only receives the signals of the paging subchannel that it belongs to, and neglects that of other paging subchannels. In addition, the MS even powers off some hardware of itself during other paging subchannel to lower power cost of itself.

The number of paging channel multiframe (MFR) is the number of multiframes used in a period of paging subchannel. The MFR determines the number of paging subchannels that the cell PCH is divided into.

II. Format

The MFR ranges from 2 to 9, which respectively means that the same paging group cycles in a period of 2 to 9 multiframes.

III. Configuration and Influence

According to the definition of CCCH, AG, and MFT, you can calculate the number of paging channel in each cell.

- When the CCCH and SDCCH share a physical channel, there is (3 - AG) MFRs.
- When the CCCH and SDCCH share a physical channel, there is (9 - AG) MFRs.

According to the previous analysis, the greater the MFR is, the more the paging channels of the cell are (see the calculation of paging groups in GSM regulation 05.02).

Theoretically, the capacity of paging channels does not increase with the increase of MFR. The number of buffers for buffering paging messages on each base transceiver station (BTS) increases. The paging messages are sent more evenly both in time and space, so it seldom occurs that the paging messages overflow in the buffers so call lost occurs (related to functions by equipment providers).

However, to enjoy the previous advantages, you will have a longer delay of paging messages on the radio channels. The greater the MFR is, the greater the delay of paging messages in the space is, and the lower the average service performance of the system is. Therefore, the MFR is an important parameter in network optimization.

The following principle caters for configuring MFR:

The configured strategy for buffers of each equipment provider is different, so you must select the MFR properly so that the paging messages do not overflow on PCH. Based on this, configure the parameter as small as possible. In addition, you must measurement the overflow situations of PCH periodically while the network is running, and adjust MFR accordingly.

IV. Precautions

Any paging message of the same location area must be sent to all cells in the location areas at the same time, so the PCH capacity of each cell in the location area must be equivalent or close to each other. Otherwise, you must consider smaller PCH capacity as the evidence for designing location area.

4.2.3 Common Control Channel Configuration (CCCH-CONF)

I. Definition

The CCCH includes AGCH and PCH. It sends immediate assignment messages and paging messages. In each cell, all traffic channels (TCHs) share CCCH. According to the TCH configuration and traffic model of the cell, the CCCH can be one or more physical channels. In addition, the CCCH and SDCCH share a physical channel. The combination methods for CCH are determined by CCCH parameter CCCH_CONF.

II. Format

The CCCH_CONF consists of three bits, with the coding methods listed in Table:

CCCH configuration coding

CCCH_CONF	Meaning	Number of CCCH message blocks in a BCCH multiframe
000	One physical channel for used for CCCH, not shared with SDCCH	9
001	One physical channel for used for CCCH, shared with SDCCH	3
010	Two physical channels for used for CCCH, not shared with SDCCH	18
100	Three physical channels for used for CCCH, not shared with SDCCH	27
110	Four physical channels for used for CCCH, not shared with SDCCH	36

III. Configuration and Influence

When the CCCH and SDCCH share one physical channel, the CCCH has the minimum channel capacity. When the CCCH and SDCCH do not share a physical channel, the more physical channels that the CCCH uses, the greater the capacity is.

The CCCH_CONF is determined by the operators based on combination of cell traffic model and paging capacity of the location area where a cell belongs to. It is determined in system design, and adjusted in network expansion. According to experiences, when the paging capacity in the location area is not high and cell has one or two carriers, it is recommended that the CCCH uses one physical channel and share it with SDCCH (in combination CCCH methods). This spares a physical channel for paging. Otherwise, the method that CCCH and SDCCH do not share one physical channel is used.

When the cell TRX exceeds 6 and CCCH OVERLOAD occurs in the cell, it is recommended that the CCCH uses two or more basic physical channel and does not share them with SDCCH.

IV. Precautions

The CCCH_CONF must be consistent with the actual configuration of cell CCCH. In addition, you must consider the influence on the access grant reserved blocks.

4.2.4 Extended Transmission Slots (TX_INTEGER)

I. Definition

In a GSM network, a random access channel (RACH) is an ALOH. To reduce the conflicting times on RACH when an MS accesses the network, and to increase RACH

efficiency, GSM regulations (sections 3.3.1.2 of 04.08) prescribe the compulsory access algorithm for MS. The algorithm defines three parameters as follows:

- Extended transmission slots T
- Maximum retransmission times RET
- T

It is the number of slots between two sending when the MS keeps sending multiple channel request messages.

- S

It is related to channel combination, and is an intermediate variable of access algorithm. It is determined by T and CCCH configuration.

II. Format

The value of T is from 3 to 12, 14, 16, 20, 25, 32, and 50.

The value of S ranges as listed in Table:

Values of S

T	S in different CCCH combination methods	
	The CCCH and SDCCH does not share a physical channel	The CCCH and SDCCH share a physical channel
3, 8, 14, 50	55	41
4, 9, 16	76	52
5, 10, 20	109	58
6, 11, 25	163	86
7, 12, 32	217	115

III. Configuration and Influence

To access the network, the MS must originate an immediate assignment process. To begin the process, the MS sends (RET + 1) channel request messages on RACH. To reduce conflicts on RACH, the time for MS to send channel request messages must meet the following requirements:

- The number of slots (not including slots for sending messages) between originating immediate assignment process by MS and sending the first channel request messages is random. Its range is {0, 1, …, MAX (T, 8) - 1}. When the MS originates the immediate assignment process, it takes a value from the range according to even distribution probability.
- The number of slots (not including slots for sending messages) between a channel request message and the next is from {S, S + 1, …, S + T - 1} according to even distribution probability.

According to previous analysis, the greater the T is, the larger the range of intervals between one channel request message and the next, and the less the RACH conflicting times is. The greater the S is, the greater the interval between one channel request message and the next, the less the RACH conflicting times is, and the more efficiently the SDCCH is used. However, the increase of T and S leads to longer time for MS to access the network, so the access performance of the whole network declines. Therefore you must configure T and S properly.

S is calculated by MS according to T and combination of CCH. You can configure T freely and sends it to MS by system information. Usually, you need configure T properly to make T + S as small as possible (to reduce the time for MS to access the network); meanwhile you must ensure an effective assignment of SDCCH to avoid overload (for all random access requests, the system does not distinguish whether they are from the same MS, but assigns a SDCCH). In operation, you can adjust the value according to traffic measurement of cell immediate assignment.

4.2.5 Minimum Access Level of RACH

I. Definition

The minimum access level of RACH is the level threshold for the system to judge whether there is a random access request.

II. Format

The minimum access level of RACH ranges from 0 to 63 (corresponding to –110 dBm to –47 dBm).

The unit is level grade value.

III. Configuration and Influence

When the access burst level of RACH is greater than the threshold, the BTS judges that there is an access request. The BTS, together with the parameter random access error threshold, determines whether the random access burst is valid. To configure the parameter properly, you must combine actual sensitivity of the base station and the parameter **minimum received level permitted for MS to access**. This prevents the MS from failing in calling though there are signals. The access burst level of RACH affects call drop rate and access range (coverage), so you must pay attention to the influence on access of MS.

4.2.6 Random Access Error Threshold

I. Definition

GSM protocols prescribe that by relativity of judgment training sequence (41 bits) the system can judge whether the received signals are the random access signals of MS.

II. Format

The value ranges from 0 to 255. The recommended value is 180.

III. Configuration and Influence

The random access error threshold defines the relativity of training sequence. If the smaller it is, the more errors of random access signals permitted by the network are, the easily the MS randomly accesses the network, and the greater the report error rate is. If the greater the random access error threshold is, the smaller the report error rate is, and the more difficult the access to the network is when signals are weak. See protocol 0408, 0502.

The system requires the random access error threshold transferred by current bit of 41 bit training sequence.

90–100	33
101–120	34
121–140	35
141–160	36
161–175	37
176–195	38
196–221	39
222–243	40
244–250	41
0–89 or 251–255	38

The two parameters random access error threshold and minimum access level of RACH determine the validity of random access burst.

4.2.7 Access Control Class (ACC)

I. Definition

GSM regulations (02.11) prescribe that each GSM user (common user) corresponds to an access class, ranging from class 0 to class 9. The access class is stored in SIM of mobile users. For special users, GSM regulations reserves five special access classes, ranging from class 11 to class 15. Theses classes are prior to other classes in accessing. Special users might have one or more access classes (between 11 and 15), which are also stored in user SIM. Users of class 11 to 15 are prior to that of class 0 to 9. However, the class between 0 and 9 or between 11 and 15 does not mean priority.

The access class is distributed as follows:

- Class 0–9: common users
- Class 11: users for PLMN management
- Class 12: users for security departments
- Class 13: common business departments (in charge of water, gas)
- Class 14: emergency services
- Class 15: PLMN staff

Users of class 0–9 have its access rights catering for home PLMN and visited PLMN. Users of class 11 and 15 have its access rights catering for visited PLMN only. Users of class 12, 13, and 14 have its access rights catering for in the country where home PLMN belongs to.

II. Format

The access control class consists of two parts:

- Common access control class
  Value range: a check option, including class 0 disabled, …, class 9 disabled.
  Recommended value: all 0.
- Special access control class
  Value range: a check option, including class 11 disabled, …, class 15 disabled.
  Recommended value: all 0.

If a class is configured to 1, it means that access is forbidden. For example, a common access class is configured to 1000000000; common users excluding class 0 users can access the network.

III. Configuration and Influence

C0–C15 (excluding C10) are set by equipment room operators. Usually these bits are configured to 1. Proper configuration contributes to network optimization as follow:

- When installing a base station, starting a base station, or maintaining and testing in some cells, configure C0–C15 (excluding C10) to 1. In this way, different users are prevented from accessing the network, so the installing and maintenance is less influenced.

- During busy hours of cells with high traffic, congestion occurs, RACH conflicting time increase, AGCH traffic overloads, and Abis interface traffic overloads. When you configure class of some users to 1, you can reduce the traffic of the cell.

4.2.8 Maximum Retransmission Times (RET)

I. Definition

See GSM regulation 04.08. When an MS originates an immediate assignment process, it sends a channel request message to the network on RACH. The RACH is an ALOH, so the MS can send multiple channel request messages before receiving immediate assignment messages, to increase access success rate of MS. The maximum retransmission times M (RET) is determined by equipment room operators, and sent to MS by SI.

II. Format

The maximum retransmission times consists of two bits, with the meanings listed in Table:

Coding of maximum transmission times M

M	maximum transmission times
00	1
01	2
10	4
11	7

III. Configuration and Influence

The greater the M is, the higher the success rate of call attempt is, and the higher the connection rate is, but the load of RACH, CCCH, and SDCCH increase. In cell with high traffic, if the RET is over great, overload of radio channels and congestion occur, so the connection rate and radio resource utilization declines sharply. If the RET is over small, the call attempt times of MS reduces, success rate reduces, so the connection rate reduces. Therefore, proper configuration of RET for each cell help utilize network radio resources and improve connection rate.

For configuration of RET M, refer to the following methods:

- For areas with low traffic, such as in suburban or rural areas, configure RET to 7 to increase the access success rate of MS.
- For areas with average traffic, such as common urban areas, configure RET to 4.

For microcell with high traffic and of apparent congestion, configure RET to 1.

4.2.9 Control Class of MS Maximum Transmit Power (MS-TXPWR-MAX-CCH)

I. Definition

MS-TXPWR-MAX-CCH is sent in BCCH SIs. It affects behavior of MS in idle mode. It is also used in calculating C1 and C2, and determines cell selection and reselection.

- C1 = RLA_C - RXLEV_ACCESS_MIN - MAX((MS_TXPWR_MAX_CCH - P), 0)
- RLA_C: average received level by MS
- RXLEV_ACCESS_MIN: minimum received level permitted for MS to access
- MS_TXPWR_MAX_CCH: maximum power level of control channel (control class of MS maximum transmit power)
- P: Maximum transmit power level of MS

II. Format

The range of MS-TXPWR-MAX-CCH is 0–31. For cells of GSM900 and GSM1800, the dBm values corresponding to the control class are different.

- In a GSM900 network, the 32 control class of maximum transmit power corresponding to 0–31 is as follows:
  {39, 39, 39, 37, 35, 33, 31, 29, 27, 25, 23, 21, 19, 17, 15, 13, 11, 9, 7, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5}
- In a GSM1800 network, the 32 control class of maximum transmit power corresponding to 0–31 is as follows:
  {30, 28, 26, 24, 22, 20, 18, 16, 14, 12, 10, 8, 6, 4, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 36, 34, 32}

Recommended values are 5 for GSM900 and 0 for GSM1800.

III. Configuration and Influence

MS-TXPWR-MAX-CCH determines the power class used before MS receives power control messages. For details, see *protocol 0508*.

The smaller it is, the greater the output power of MS is. The MS near the base station interferes with neighbor channels of the cell, so the access to the network by other MSs and communication quality are influenced. The greater it is, the smaller the output power of MS is, and the lower the access success rate of MS at cell borders is. You must configure MS-TXPWR-MAX-CCH properly according to the serving range of the cell.

4.2.10 Power Offset (POWEROFFSET)

I. Definition

When the MS accesses the network and before it receives the initial power control messages, all GSM900 MSs and type 1 and type 2 DCS1800 MSs use MS_TXPWR_MX_CCH of BCCH. If the MS_TXPWR_MX_CCH exceeds the maximum transmit power of MS, the MS uses the closest power.

The parameter POWEROFFSET is effective to type 3 DCS1800 MSs. When the type 3 DCS1800 MS accesses the network, it use total power of MS_TXPWR_MX_CCH + POWEROFFSET before receiving the initial power control message. See *protocol GSM0508*.

II. Format

The values of 0–3 correspond to 0 dB, 2 dB, 4 dB, and 6 dB.

The recommended value is 2.

III. Configuration and Influence

The greater the parameter is, the more easily the type 3 DCS1800 MS accesses the network. A great POWEROFFSET enables MS to access the network afar, but does not help control cross-cell interference, so the network quality is influenced.

4.2.11 IMSI Attach/Detach Allowed

I. Definition

The IMSI detach means that the MS informs the network of itself work state changing from working to non-working. Usually it refers to when the MS powers off or the SIM is taken off MS. After receiving the inform from MS, the network sets the IMSI as in non-working state.

The IMSI attach is opposite of IMSI detach. It means that MS informs the network of itself work state changing to working. Usually it refers to when the MS powers on or the SIM is put into MS again. After the MS turns to working state again, it detects whether the current location areas (LAI) is the same as that recorded in MS at last.

- If yes, the MS starts IMSI attach process (this is one of location updating).
- If no, the MS starts location updating process of cross location area.

After receiving the location updating message or IMSI message from MS, the network sets the IMSI as in working state.

The parameter IMSI attach/detach allowed (ATT) is used for informing MS of the IMSI attach/detach process.

II. Format

The value of ATT includes YES/NO. NO means that starting IMSI attach/detach process by MS is forbidden. YES means that starting IMSI attach/detach process by MS is compulsory.

III. Configuration and Influence

Usually configure ATT to YES so that the network will not process the proceeding of the MS after the MS powers off. This frees system resources (such as PCH).

IV. Precautions

The ATT of different cells in the same location area must be the same to avoid abnormalities while the MS is called. For example, in a cell with YES as the value of ATT, when the MS powers off, it starts IMSI detach process. Therefore the network records that the MS is in non-working state, so it does not page the MS. In a cell with No as the value of ATT and the cell being different from the one where the MS powers off, when the MS powers on again in the cell, the MS does not start IMSI attach process. In this situation, the MS cannot be called normally until it starts location updating process.

4.2.12 Direct Retry (DR)

I. Definition

During the assignment process of call setup, congestion might cause assignment failure. The assignment failure causes failure of the whole call. GSM networks has a function to avoid such failures, namely, DR. The DR is that the BSS directly assign MS to TCH of neighbor cells. The parameter is used by system to set whether to allow direct retry function.

II. Format

The value of DR includes YES and NO. YES means that the system allows directional retry. NO means that the system does not support direction retry function.

III. Configuration and Influence

DR improves call success rate. If conditions are ready, start DR. On the contrary, DR is that the BSS directly assign MS to TCH of neighbor cells when congestion occurs in the cell where the MS camps, so the MS can originates a call in the non-best cell with lowest received level, and extra interference might be brought about in frequency reuse networks. Therefore, you must use the function properly according to comprehensive network situations.

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