Archives

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1.8 Discontinuous Reception and Discontinuous Transmission

1.8.1 Discontinuous Reception and Paging Channel

In idle mode, if MS selects a cell as its service cell, it begins to receive the paging information from this cell. But in order to reduce power consumption, discontinuous reception (DRX) is introduced in GSM. Each user (IMSI) belongs to a paging group and each paging group corresponds to a paging subchannel. MS can calculate which group it belongs to based on the last three digits of its IMSI and the configuration of paging channel in this location area, and then locate the paging subchannel of this paging group. In fact, in idle mode, MS just listens to the paging information from the system on its subchannel (MS also monitors the Relev of BCCH carrier frequency in non-service area during this period of time) and ignores the information on other paging subchannels. Some of the hardware equipments are even switched off to save the power of MS. But MS must complete the required task of network information measurement within a specified time.

Through DRX, MS can receive the broadcast short messages that the users want to know with less power consumption, thus extending the service time. BSC has to send scheduling messages to support DRX at MS. One scheduling message contains lots of broadcast short messages to be sent soon. The time that all broadcast short messages of a scheduling information takes is a scheduling cycle. Scheduling information contains the description of all short messages to be broadcast in order and also indicates the position of the messages in scheduling cycle. Through scheduling messages, MS can find the broadcast short messages it wants quickly so as to reduce its power consumption.

The number of paging subchannels of each cell can be calculated based on the configuration type of CCCH, BS_AG_BLKS_RES (the number of blocks belonging to AGCH in 51 multiframe), and BS_PA_MFRMS (the number of 51 multiframes used as one paging subchannel cycle).

When there are three CCCHs in a 51 multiframe, the number of paging subchannels is (3-BS_AG_BLKS_RES) ×BS_PA_MFRMS

When there are nine CCCHs in a 51 multiframe, the number of paging subchannels is (9-BS_AG_BLKS_RES)×BS_PA_MFRMS

In addition, the configuration of CCCH parameters has the following principles:

The greater the parameter BS_PA_MFRMS, the more the paging subchannels, and the less the users of each paging subchannel, but the total capacity of the system remains the same, because the average delay of the paging information on radio channel increases. When the ratio of retransmission waiting is relatively high, BS_PA_MFRMS should be improved to increase the paging subchannels; when the ratio of retransmission waiting is relatively low, BS_PA_MFRMS should be reduced to shorten the paging delay.

The capacities of paging subchannels of all cells in a location area should be the same, because the paging message of a location area must be sent in all the cells of this location area at the same time.

The longer the cycle of paging channel, the less power the MS in this service area takes. For example, in cities, this cycle can be defined as 2, which means MS listens to paging messages once for every 102 frames. In rural areas, this cycle can be defined as 4 or 6. The MS with the paging channel cycle of 6 consumes 18% less power than the MS with the paging channel cycle of 2. After measuring the system information, MS enters the rest state and listens to the paging information in the specified paging blocks only and measures the Relev of BCCH of neighbor cells at the same time. After 30 s, MS will listen to system information again to judge the cell re-selection process.

In GSM, CCCH mainly includes AGCH and PCH. Its primary function is to transmit immediate assignment messages and paging messages. CCCH can be one or several physical channels and it can also share a physical channel with SDCCH. The combination mode of CCCH depends on the parameter CCCH_CONF. The configuration of CCCH_CONF must be consistent with the actual configuration. It is recommended that when there is only one TRX in a cell, the configuration of CCCH can be a physical channel shared with SDCCH (3 CCCH information blocks).

When the traffic volume is extremely large, in case one physical timeslot is not enough, GSM specification allows the configuration of multiple CCCH channels on the TRX besides BCCH, but these channels must be used in timeslot 0, 2, 4, and 6.

When CCCH_CONF is confirmed, parameter BS_AG_BLKS_RES actually decides the ratio of AGCH and PCH on CCCH. It is recommended that this parameter be configured as little as possible in order to reduce the response time of MS to paging.

1.8.2 DTX

I. DTX Overview

During communication, only 40% time is used for conversation; no useful information is transmitted during the rest 60% time. If all the information is transmitted to network, many of the system resources will be wasted, in addition, the interference will aggravate. In order to solve this problem, GSM adopts DTX technology to stop signal transmission when there is no voice signal. Therefore, the interference level is reduced and the system efficiency is improved.

There are two kinds of transmission modes in GSM: normal mode and discontinuous transmission (DTX) mode. In normal mode, noise and voice have the same transmission quality. In DTX mode, the transmission of unuseful messages is prohibited. MS only sends man-made noise signals that are tolerable, which means this noise will not annoy the listeners nor affect the conversation. This kind of noise is called comfort noise. In DTX mode, 260-bit code is transmitted in every 480 ms; in normal mode, 260-bit code is transmitted in every 20 ms.

Whether the downlink DTX is adopted or not is controlled by network operators of the exchange part. This kind of control is based on BSC. The control information is transmitted to baseband processing part through dedicated signaling channel, and then arrives at TC through the inband signaling of TRAU frame to indicate whether downlink DTX is adopted. For some vendors, the downlink DTX can be configured on the basis of cell.

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Uplink DTX is configured by network operators of the radio part. The parameter DTX in system information consists of 2 bits.
Parameter DTX is contained in “cell option” of information unit and transmitted periodically in the system information of each cell broadcast. MS decides whether to start DTX function based on this information. DTX can be used for voice signal transmission and nontransparent data transmission. BCCH TRX does not use this technology. The benefits of DTX are listed below:
Uplink DTX can save MS batteries and reduce interference.
Downlink DTX can save BTS power consumption and reduce interference and intra-BTS intermodulation.
Uplink DTX and downlink DTX used together can improve the intra-frequency ratio of the system. This kind of improvement, when used in aggressive-frequency-reuse cell planning, especially when used with frequency hopping, can greatly expand the system capacity.

II. Voice Activity Detection

For voice activity detection (VAD), the source must indicate when the transmission is required. When DTX mode is activated, the encoder must detect the signal is voice or noise. Therefore, the VAD is required. VAD can differentiate voice from noise through calculating some signal parameters and threshold values. This kind of differentiation is based on an energy rule: the energy of noise is always lower than that of voice.
VAD generates a group of threshold value in every 20 ms to judge whether the next 20ms block is voice or noise. When the background noise is too loud, the noise signal will be regarded as voice signal to transmit.

III. Silence Indicator

The coding procedure of noise is the same as that of voice. After sampling and quantification, a noise block will be produce by encoder in every 20ms. Like voice block, the coded noise block also contains 260 bits, which forms a SID frame. The SID frame will go through channel coding, interleaving, encryption and modulation and finally be sent by eight continuous bursts.
On TCH, a complete SACCH information block has four 26 muliframe cycles (480 ms). In order to differentiate voice frame and SID frame, these eight continuous bursts are arranged at the beginning of the third multiframe. During other time of the 480 ms, no information is transmitted except SACCH timeslot. The SID frame made from the 20 ms noise block is interleaved with the preceding frame and the following frame; the first SID frame is interleaved with the preceding voice frame and the following SID frame.

IV. Measurement

Uplink DTX and downlink DTX are two irrelevant procedures that are activated by system parameters respectively. There are two kinds of measurement in GSM: full measurement and sub measurement. Global measurement is the average of the level and quality of the 104 timeslots in a measurement cycle (four 26 multiframes); local measurement is the average of level and quality of 12 timeslots, including eight continuous TCH bursts (for TCH/F, 0-103 TDMA frames as a cycle. The frame numbers of these eight bursts are 52, 53, 54, 55, 56, 57, 58, and 59. when no voice or signaling is transmitted, the descriptor of comfort noise they contain is called SID) and four SACCH bursts (0-103 TDMA frames as a cycle, for timeslot 0, the frame numbers of these four bursts are 12, 38, 64, and 90; for timeslot 1, the frame number is that of timeslot 0 plus 13. similarly, the frame numbers that the eight timeslots correspond to can be obtained in this way). In order to achieve uniformity, no matter the uplink DTX or downlink DTX is activated or not, BTS and MS must complete these two kinds of measurement. Each SACCH measurement report of BTS and MS indicates whether DTX is used in last measurement report time. BSC choose one of the two kinds of measurement based on this indication.

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