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GSM BSS Network Performance PS KPI (Upload Rate) Optimization Manual

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Abstract and Abbreviations

Keyword

Upload rate

Abstract

The GPRS network is mainly used for data transmission. Like in download, the high layer desires wide bandwidth and short delay in upload. The only difference between upload and download is that the uplink and downlink bandwidth is different. In upload, the FTP is used to transmit the uplink data, and the TCP ACK is used to transmit the downlink data. In download, the FTP is used to transmit the downlink data, and the TCP ACK is used to transmit the uplink data. Therefore, in upload optimization, the principles for download optimization are followed, and the difference is considered.

Abbreviations

Abbreviation	Full Spelling
GPRS	General Packet Radio Service
EGPRS	Enhanced GPRS
MS	Mobile Station
CQT	Call Quality Test
DT	Drive Test
PCU	Packet Control Unit
BSS	Base Station System
BSC	Base Station Control
BTS	Base Transceiver Station
TBF	Temporary Block Flow
RLC	Radio Link Control
MAC	Media Access Control
MCS	Modulation and Coding Scheme



References

- [1] *TCP/IP Detail Volume 1* written by W.Richard Stevens published in April 2008
- [2] *GPRS Network Technology* prepared by Motorola Engineering Institute published on June 1, 2005
- [3] *GSM PS Wireless Performance Baseline (field version)* prepared by the GSM Solution Testing Department released on September 3, 2008
- [4] *3GPP TS 45.002 V7.5.0* released in August 2007

1 Introduction

This document explains the similarities and differences between upload and download. The assessment of the upload performance surely involves the download performance. The similarities between upload and download are not mentioned in this document. This document focuses on the differences. The readers are advised to read the *GSM BSS Network Performance PS KPI (Download Rate) Optimization Manual*.

In this document, the following tools are used to locate faults: TEMS, Ethereal/Wireshark, and the information tracking and browsing tools of each network element.

The prerequisite of the optimization means described in this document is that no download fault, such as channel fault and packet loss at the interface, exists.

1.1 Similarities and Differences between Upload and Download

A GPRS network can be regarded as the transmission medium at the bottom layer in upload and download. Thus, many similarities exist between upload and download. Air interface, Gabis interface, network elements above the PCU, and transmission are the same for download and upload. Like those mentioned in the *GSM BSS PS KPI (Download Rate) Optimization Manual*, attention should be given to loss of synchronization on the channel, bit error rate on the Gabis interface, packet loss ratio on the interface, subscription information of the MS, neighboring area configuration, and cell reselection parameters.

Differences between upload and download are as follows:

- The uplink bandwidth and downlink bandwidth of a GPRS/EGPRS network are different.
- During multiplexing of multiple MSs, the network can know which MSs have downlink data but cannot know which ones have uplink data, In uplink extension TBF mode, or due to the system delay, the PCU fails to receive wireless blocks

sent by the MS.

- The uplink coding scheme is adjusted by the MS that is controlled by the network. But certain MSs, for example, certain Sony Ericsson MSs, have compatibility issues. The network instructs the MS to change the coding scheme in the **Uplink ACK** message, but the MS does not adjust the coding scheme accordingly.
- The current PS system provides uplink power control but no downlink power control.

1.2 Factors Affecting the Upload Rate

Suppose that the factors that are the same as those affecting the download rate do not exist. The upload rate depends on the following factors:

- Uplink bandwidth
 - Multislot capacity of the MS (including whether EDA is enabled)
 - Whether the uplink channel number assigned can meet the uplink multislot capacity of the MS
 - Number of TBFs in uplink multiplexing
 - Proportion of the uplink signaling traffic
- Uplink coding scheme
 - Level and quality of uplink signals
 - Code adjustment algorithm
- Whether the ACK message of downlink RLC blocks is returned in time
- Whether the ACK packet of downlink TCP blocks is returned in time
- Whether the establishment and release flows of TBFs are normal, and whether they can be optimized

2 Analysis and Optimization Methods

2.1 Uplink Bandwidth

The following table lists several multislot classes of common test MSs. For more multislot classes, see reference [4].

Table 1.1 Multislot classes of common test MSs

Multislot Class	Maximum Number of Slots			Minimum Number of Slots				Type
	Rx	Tx	Sum	T _{ta}	T _{tb}	T _{ra}	T _{rb}	
10	4	2	5	3	1	2	1	1
11	4	3	5	3	1	2	1	1
12	4	4	5	2	1	2	1	1

Rx indicates the maximum number of receiving timeslots. **Tx** indicates the maximum number of transmitting timeslots. **Sum** indicates the maximum number of timeslots assigned for the uplink and downlink if they exist at the same time. **Tta** indicates the number of timeslots needed between the receiving timeslot and the transmitting timeslot of the MS. The MS measures the adjacent area level and switches from receiving to transmitting mode. **Tta** is used with **Trb**. **Ttb** is the same as **Tta**. But it is not required to measure the adjacent area level. **Ttb** is used with **Tra** to measure the adjacent area level within the timeslot interval of **Tra**. **Tra** indicates the number of timeslots needed between the transmitting timeslot and the receiving timeslot of the MS. **Trb** and **Tra** are the same. **Type 1** indicates that the MS is not required to support receiving and transmission at the same time.

The multislot capacity and EDA support of an MS and can be obtained through the attach request of the MS or **Packet Resource Request**. The following figure shows

the MS and RA capacity resolved by the TEMS.

Figure 1.1 RA capacity of an MS

```

MS radio access 2 capability
MS RA capability value part structs :
[0 ] :
  Access Technology Type : (3) GSM 1800
  Access capabilities
  RF Power Capability : 1
  ES IND : (1) "Controlled Early Classmark Sending" option is implemented in the MS
  PS : (0) PS capability not present
  VGCS : (0) No VGCS capability or no notifications wanted
  VBS : (0) No VBS capability or no notifications wanted
  Multislot capability
  GPRS Multislot Class : 10
  GPRS Extended Dynamic Allocation Capability : (0) Extended Dynamic Allocation Capability for GPRS is not implemented
  EGPRS Multislot Class : 10
  EGPRS Extended Dynamic Allocation Capability : (0) Extended Dynamic Allocation Capability for EGPRS is not implemented
  8PSK Power Capability : (2) Power class E2
  COMPACT Interference Measurement Capability : (0) COMPACT Interference Measurement Capability is not implemented
  Revision Level Indicator : (1) The ME is Release '99 onwards
  UMTS FDD Radio Access Technology Capability : (0) UMTS FDD not supported
  UMTS 3.84 Mcps TDD Radio Access Technology Capability : (0) UMTS 3.84 Mcps TDD not supported
  CDMA 2000 Radio Access Technology Capability : (0) CDMA2000 not supported
  UMTS 1.28 Mcps TDD radio access technology capability : (0) UMTS 1.28 Mcps TDD not supported
  GERAN feature package 1 : (1) GERAN feature package 1 supported
  Modulation based multislot class support : (0) 'Modulation based multislot class' not supported
  GERAN Tu mode supported : (0) GERAN Tu mode not supported
  GMSK multislot power profile : 0
  8-PSK multislot power profile : 0
  Multiple TBF Capability : (0) Multiple TBF procedures in A/Gb mode not supported
  Downlink Advanced Receiver Performance : (0) Downlink Advanced Receiver Performance not supported
  Extended RLC/MAC Control Message Segmentation Capability : (0) Extended RLC/MAC control message segmentation not supported
  DTM Enhancement Capability : (0) The mobile station does not support enhanced DTM CS establishment and enhanced DTM CS release
  PS Handover Capability : (0) The mobile station does not support the PS Handover
[1 ] :
  Access Technology Type : (15) Indicates the presence of a list of Additional access technologies
  Additional Access Capabilities
  Additional Access Technologies :
  [0 ] :
    Access Technology Type : (1) GSM E
    GMSK Power Class : 4
  
```

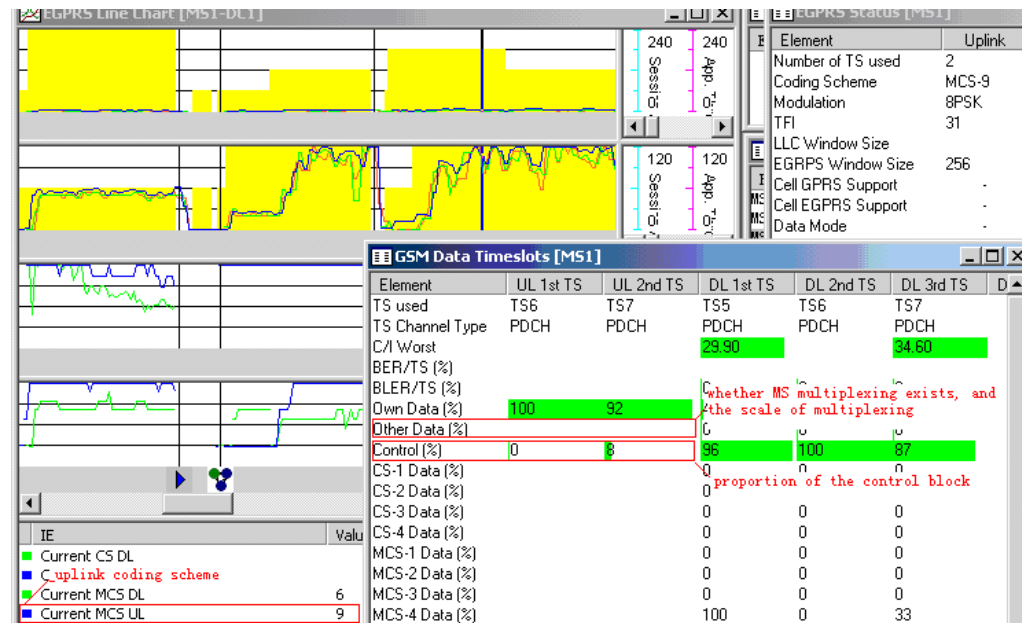
For an MS with the multislot capacity of class 11, the following timeslot assignment modes are available: 4+1, that is, four timeslots for the downlink and one for the uplink; 3+2, that is, three timeslots for the downlink and two for the uplink; 2+3, that is, two timeslots for the downlink and three for the uplink, when both the MS and network support EDA. For modes that do not support EDA, the 3+2 mode is used because the initial service type of the network is neutral. If the uplink does not support two timeslots, find out the fault by using the method described in the *GSM BSS Network Performance PS KPI (Download Rate) Optimization Manual*.

 **NOTE**

If EDA is not supported, the assigned channel must be downlink timeslots including uplink timeslots. If EDA is supported, the uplink timeslots include the downlink timeslots which are the first ones of the uplink timeslots.

The following figure shows the upload process of an MS recorded by TEMS. This figure shows whether the MSs are multiplexed or not, the number of MSs in multiplexing, the proportion of control blocks, and the uplink coding scheme.

Figure 1.2 Upload service process recorded by the TEMS



Compared with downlink multiplexing, uplink multiplexing has greater impact. Suppose that MSs A, B, and C are multiplexed. At the downlink, the three MSs send blocks in turns. But if MSs B and C have little data to send, the opportunities are given to MS A. But the situation is different in uplink multiplexing. The network does not know which MS has data to send due to delay or when the MSs become inactive. The MSs send data in turns only. Therefore, each MS has even opportunities no matter whether it has data to send or not. That is, uplink multiplexing has great impact on the upload service.

The purpose of reducing uplink multiplexing is to provide enough resources for MSs in upload. Therefore, perform the test in idle hours in the case of no special requirements. If it cannot be guaranteed, set **Uplink Multiplexing Threshold of Dynamic Channel Conversion** (log in to the LMT, click the cell. Choose **Cell Attributes > GPRS Attributes > Advanced<< > PS Channel Management Parameters**) to 1. When a TBF is multiplexed, the system applies for dynamic channel conversion in the case of a new TBF. If the rate is below the standard, set **PDCH Uplink Multiplex Threshold** (Choose **Cell Attributes > GPRS Attributes > Advanced<< > PS Channel Management Parameters**) to 1. As long as the MS can access the two assigned channels, other MSs cannot access this channel. But this may prevent the access by the MS. Therefore, it can be used only in a CQT.

During transmission, the signaling traffic at the uplink mainly consists of Packet Downlink ACK/NACK messages. The traffic volume is determined by the frequency of the RRBP. You can enlarge the frequency by changing the value of the parameter **RRBP Frequency for EGPRS Downlink TBF(Blocks)** (Enter the super user mode, click the cell, and then choose **BSC Attributes > Inner Software parameters**), for example, to 32. You need to enter into the super user mode. The impact of this part and the room for improvement through modification are small. For EDA, the room for improvement is greater, because the system dispatches all the uplink channels of the MS by using the signals of the minimum timeslot. If the RRBP is enabled, all channels except the control channel cannot be dispatched. In later product versions, the function

of automatic adjustment of RRB frequency in accordance with the service type of service will be supported.

 **NOTE**

Different from download, **Control %** in 1.1 indicates uplink signaling. This is because if no data is to be sent over the uplink, a Pack block is sent. That is, no blocks are confirmed by the network. If all the blocks have been confirmed and no data is to be sent, a Dummy block is sent.

2.2 Selection and Adjustment of Uplink Coding Schemes

The following options are available for uplink coding scheme adjustment:

- No adjustment
- Adjusting the uplink coding scheme according to the downlink coding scheme
- Adjusting the uplink IR/LA algorithm by entering into the super user mode and changing the value of the parameter **Support EGPRS Uplink MSC Dynamic Adjust** (Choose **BSC Attributes > Inner Software parameters**)

The ideal situation is high coding scheme and low block error rate. If the wireless conditions are good enough, that is, little channel damage, enough transmission power of the MS and no uplink interference, the MCS9 coding scheme is enough. This applies to the CQT. To adjust the uplink coding scheme according to the downlink coding scheme, ensure that the uplink and downlink are balanced, and no strong interferences exist at the uplink or downlink. You can refer to the measurement units **Uplink-and-Downlink Balance Measurement** and **Interference Band Measurement** for details. The uplink IR/LA algorithm helps rectify most faults in adjusting uplink coding scheme. This function is supported in C12.

If the power at the uplink is weak, and the fault cannot be rectified through means such as optimization of the RF terminal, you can modify the values of uplink power control parameters to obtain a greater transmitting power. When the IR/LA algorithm is used, you can properly modify the values of the power control parameters to obtain a better air interface C/I. That is, you must balance the level and interference. A great transmitting power of the MS brings a high level and strong interferences.

The following table lists the parameters related to power control.

Table 1.1 Power control parameters

Parameter	Description	Recommended Value
ALPHA	Alpha Parameter	1
T_AVG_W	Signal Strength Filter Period in Idle Mode	10
T_AVG_T	Signal Strength Filter Period in Transfer Mode	10

Parameter	Description	Recommended Value
N_AVG_I	Constant of Filtering the Collision Signal Strength for Power Control	2
GAMMA	Initial Power Level	Set a proper value according to the balance between uplink and downlink.
	Measured Receive Power Level Channel	BCCH

The transmitting power of MS is mainly improved by modifying GAMMA. The default value is 14. If it is degraded by one class, the transmitting power is increased by MS 2dB.

 **NOTE**

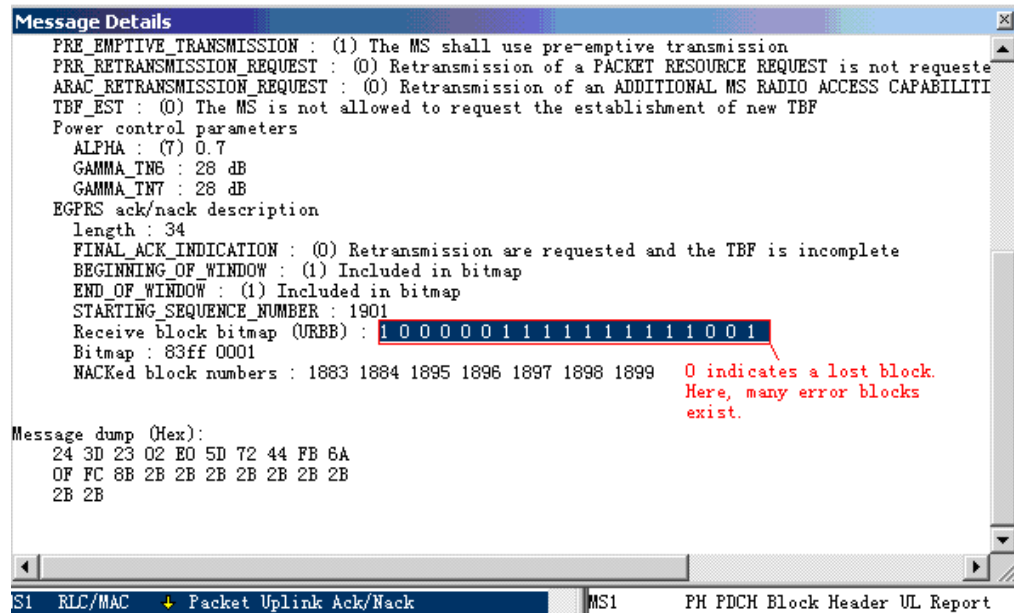
$$P_{CH} = \text{MIN}(G_0 - \text{GAMMA} - \text{ALPHA} * (C_{\text{VALUE}} + 48), P_{\text{MAX}})$$

Where P_{CH} is the transmitting power of the MS. $G_0 = 39$ dBm for GSM 400, GSM 700, GSM 850 and GSM900; = 36 dBm for DCS1 800 and PCS 1900. **P_{MAX}** is the level value of **MS_TXPWR_MAX_CCH** (Choose **Cell Attributes > Other Attributes > Advanced<< > Public Channel Control**).

C_{VALUE} is obtained through measurement and filtering of the MS. The filtering is controlled through parameters **Signal Strength Filter Period In Idle Mode** and **Signal Strength Filter Period In Transfer Mode** ($2^{\wedge}(k/2)/6$ multiframe). In idle mode, measure the CCCH. In transmission mode, perform the channel measurement set in **Measured Receive Power Level Channel**.

In addition, when adjusting the uplink coding scheme according to the downlink coding scheme, if the power at the uplink is weak after power control, many error blocks are resulted. A large number of error blocks bring a greater negative gain than the situation when a low coding scheme is used. Therefore, the uplink coding scheme should be degraded properly. You can set the uplink coding scheme three classes lower than the downlink coding scheme by entering into the super user mode and enabling the fifth bit of **DSP Control Table 2** (Chose **BSC Attributes > Inner Software parameters**). The following figure shows the uplink error blocks checked from signaling.

Figure 1.3 Packet Uplink ACK/NACK indicating many error blocks



2.3 Timely Return of the ACK Message for Uplink RLC Blocks

When uplink RLC error blocks occur, the blocks are retransmitted only when the Packet Uplink ACK message indicates error blocks. The RLC blocks must be packed into LLC packet orderly. Otherwise, the boundaries of the LLC remain unknown. In the case of error blocks, the TCP packet starting from the error blocks cannot be packed. As a result, the delay of packets from MS to server RTT surges, affecting the bandwidth utilization rate.

The network controls the sending of Uplink ACK. You can set the ACK frequency by entering the super user mode and set the value of **ACK Frequency for EGPRS Uplink TBF(Blocks)** (Chose **BSC Attributes > Inner Software parameters**). The default value is **32**, which can be changed to **20**. Uplink ACK affects the signaling traffic at the downlink. In the case of uplink and downlink multiplexing, a higher frequency increases the signaling traffic at the downlink.

2.4 Timely Return of the ACK Message for Downlink TCP Blocks

If the ACK message of a downlink TCP packet is not returned in time, the application layer of the computer, which is connected with the MS, enters into the **congestion control** state. As a result, the air interface keeps sending the Pack blocks because no

new blocks are available. If no Pack blocks are available, the air interface sends Dummy control blocks. That is, the power at the downlink cannot be weak. You can check the downlink situation according to the methods described in the *GSM BSS Network Performance PS KPI (Download Rate) Optimization Manual*.

At the beginning of data transmission, the MS is in slow start state. You can quickly establish the TBF by setting **Support Advance Downlink TBF Establishment** (Chose **BSC Attributes > Inner Software parameters**) to **Optimize with all TLLI** after entering the super user mode. The RTT delay of the first packet is reduced, and the window of MS is opened as soon as possible.

During data transmission, because the TCP ACK packet is not a consistent data flow, when data transmission is complete, the downlink may be released. It is recommended that you enable the downlink delay release function by setting the value of **Release Delay of Downlink TBF(ms)** (Chose **Cell Attributes > GPRS Attributes > Advanced<< > PS Network Optimization Parameters**) to the recommended value 2400. During the test, if downlink is released while uplink exists, this value can be set as even larger. In addition, to avoid the slow downlink reestablishment, after downlink release, it is recommended that you enable the Quickly Set Up Downlink Function During Uplink and Quickly Set Up Downlink Function During Downlink by entering the super user mode and setting **Quick Start of Downlink TBF on Uplink** and **Quick Start of Downlink TBF on Downlink** (Chose **BSC Attributes > Inner Software parameters**) to **Yes**. This function makes it possible to send data directly to the MS without waiting for the MS to report the Ctrl ACK message. As a result, the delay of sending the downlink packet is reduced.

2.5 Establishment and Release Flow of a TBF

Avoid the release of a TBF when possible during data transmission. Enable the uplink extension function (the support of MS is needed) to avoid the normal release of a TBF during transmission. Set the Inactive Period of Extended Uplink TBF(ms) (Chose **Cell Attributes > GPRS Attributes > Advanced<< > PS Network Optimization Parameters**) to a proper value. The recommended value is **2400**. For the abnormal release flow, it depends on the actual situation. The one that have great impact on the performance is the release during the DT process, which causes constant access failure in a cell and then the access is reselected to other cells. This will cause long time interception, and the downlink TCP packet resending is not indicated by ACK for a long time, which eventually causes slow start. Check the cells that cannot be accessed. Carry out another CQT if needed. The analysis staff should be highly familiar with the establishment and release flow of uplink and downlink TBFs. This is also a basic requirement for the personnel in PS performance optimization.