GSM TCPIP Recommended Process

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## 0. Revision history

<table>
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<th>Date</th>
<th>Author</th>
<th>Description of change</th>
</tr>
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<tr>
<td>1.0</td>
<td>2011-03-14</td>
<td>Colin HU</td>
<td>Initial</td>
</tr>
<tr>
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<td>2012-07-05</td>
<td>Jean HU</td>
<td>Added flow chart of TCPIP recommended process</td>
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<td>1.2</td>
<td>2012-04-08</td>
<td>Chris PENG</td>
<td>Added applicable modules</td>
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1. Introduction

This document introduces the simple process on how to use the embedded TCPIP services and gives some recommendations for handling the abnormalities.

This document is applicable to all Quectel GSM modules.

Please refer to [1] Mxx_ATC for AT commands description in Table 1. And refer to [2] GSM_TCPIP_AN for the details about TCPIP.

1.1. Reference

Table 1: Reference

<table>
<thead>
<tr>
<th>SN</th>
<th>Document name</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2]</td>
<td>GSM_TCPIP_AN_V1.01.pdf</td>
<td>GSM TCPIP application notes</td>
</tr>
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1.2. Terms and abbreviations

Table 2: Terms and abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APN</td>
<td>Access Point Network</td>
</tr>
<tr>
<td>CSD</td>
<td>Circuit Switched Data</td>
</tr>
<tr>
<td>FGCNT</td>
<td>Foreground Context. The internal TCP/IP stack supports to activate two GPRS PDP contexts at the same time and Foreground context is the context controlled by the UART at present.</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>MUXIP</td>
<td>The function to visit several servers or listen to multiple clients based on the same GPRS/CSD context</td>
</tr>
<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver/Transmitter</td>
</tr>
</tbody>
</table>
2. Initialization

AT+IPR=115200&W  // Fixed band rate as 115200bps.
OK
AT+CPIN?  // Make sure the SIM PIN is unlocked.
+CPIN:READY  // It shows SIM PIN is unlocked and ready
OK
AT+CREG?  // Make sure the network is registered successfully
+CREG: 0,1  // It shows it is successful to register to the network. If it is failed, execute command AT+CREG? continuously.
Here we can also set AT+CREG=1 to enable the network registration unsolicited result code at the beginning. And then just wait the automatic report +CREG: 1 or +CREG: 5.
OK
AT+QIFGCNT=0  // Set the Context 0 as the foreground context. Then all the following operations are aimed at Context 0.
OK
AT+QICSGP=1,"CMNET"  // Set APN for the current context.
Here set GPRS as the bearer for TCPIP connection, and set APN as "CMNET". It is the default setting. If the operator of SIM card is China Mobile or China Unicom, and use GPRS as the bearer, this command can be omitted.
OK

Other options:
A. **Set server address format.** By default, the module will adopt a dotted decimal IP address. If the server address is a domain name, user should execute command "AT+QIDNSIP=1" to change it to the domain name server format.

B. **Set the mode to handle the received data.** Currently the module supports two modes to handle the received TCP/IP data: Output all the received data through UART directly (default); or Output a notification statement "+QIRD: &lt;data&gt;", not output them directly when receiving data, then user need to retrieve the data by command AT+QIRD. If the latter is used, please execute the following command.
AT+QINDI=1 //Set mode: when receiving the data, output the notification: "+QIRDI:<id>,<sc>,<sid>". Then retrieve data by command " AT+QIRD=<id>,<sc>,<sid>,<len>"

OK

C. Set display format for received data. When users select to output the received data through UART directly, following commands can be used to set the display format for the received data. User can select the different configurations according to actual needs.

AT+QIHEAD=1 //Add head information "IPD<len>:" before the received data
OK

AT+QISHOWRA=1 // Display the IP address and port of the sender:
RECV FROM:<IP ADDRESS>:<PORT>
OK

AT+QISHOWPT=1 // Show the transmission layer protocol type, TCP or UDP. This application is rare.
OK

D. Set the session mode. The default mode is non-transparent mode, and the following section from Chapter 3 to Chapter 7 is the introduction of creating connection, sending and receiving data in this mode. Execute the following commands to set transparent mode and refer to Chapter 8 for the specific applied example in this mode.

AT+QIMODE=1 //Set transparent mode
OK

AT+QITCFG=3,2,512,1 //Configure transparent transfer mode. Please focus on the two middle parameters. The second parameter 2 means to set wait interval as 200ms, which means system will wait for 200 ms before sending the data in the buffer when the data in the buffer is less than 512. The third parameter 512 means that once the length of the data in the buffer reaches 512, the 512 bytes data will be sent out.
OK
3. Establish TCP session

OK  //Format is right and current status is permitted to establish TCP session.

Analysis and treatment of other error response:
A. "ERROR", two reasons are possible:
   1. The command format is wrong. If all format are right here, verify if QIMUX is set as 0. Send command "AT+QIMUX?", if the response is 1, reset it as 0 by command AT+QIMUX=0.
   2. Current TCPIP connection status is not IP INITIAL, IP STATUS and IP CLOSE (Query by command AT+QISTAT). If current status is TCP CONNECTING, execute command AT+QICLOSE to close current failed TCP connection. If current status is others, execute command AT+QIDEACT to deactivate current failed GPRS context.
B. "ALREADY CONNECT", this means one TCP or UDP connection has been established. If new connection is required, send command AT+QICLOSE to close current connection.

CONNECT OK  // Successfully connect to the remote TCP server

Analysis and treatment of other error response:
A. "CONNECT FAIL", this shows the TCP connection is failed to be established. The correct processing method is to send command AT+QISTAT to query the current status at first.
   If current status is "TCP CONNECTING", it is recommended to close the failed connection by command AT+QICLOSE. In this way, GPRS is still active and there is no need to restart the GPRS context, so the program speed is improved.
   If current status is not "TCP CONNECTING", it is recommended to execute command AT+QIDEACT to deactivate GPRS context because these status are usually caused by the failure to activate GPRS context. More details about the treatment of response for AT+QIDEACT, please refer to the description in Chapter 7.
   The longest waiting time for this command, theoretically, is about 2.5 to 3.5 minutes. Customer can set timeout value which is less than 2 minutes in their own application according to their needs. If it is timeout, it is recommended to restart the module by EMERG_OFF pin. In the same way, the GPRS context is still not activated after repeating several times AT+QIDEACT and AT+QIOPEN, please restart the module by EMERG_OFF pin.

******************************************************************************/
/* Similarly, the module supports UDP mode. Just as TCP, it is needed to establish UDP session before using UDP as below. */

AT+QIOPEN="UDP","116.226.39.202","7007" //Visit the remote UDP server:

OK

CONNECT OK //Successfully connect to the remote UDP server.
In fact, UDP needs not establish a connection.
Here just configure the target IP address and port which the data will be sent to.
4. Send data

4.1. Send data in unfixed length

AT+QISEND
> TEST<Ctrl+Z>
  //Ready to send data

> TEST<Ctrl+Z>
  //Send data "TEST", <Ctrl+Z> is used to end the input and begin to send all input data.

  Please note that the maximum length of the data to input at one time is 1460. And some special characters can not be sent in this mode:
  0x08 (back space), when the module receives this character, it will delete the last input character.
  0x1A (<Ctrl+Z>), when the module receives this character, it will stop receiving the following input and begin to send all previously received data.
  0x1B (ESC), when the module receives this character, it will escape from the sending operation.

SEND OK
  //The data has been sent to TCP protocol layer successfully.

AT+QISACK
  // Check if data has been sent successfully by querying the data information.

+QISACK: 4, 4, 0
  //The former two parameters are total size and acknowledged data size. The last parameter is unacknowledged data size. If this size is 0, it means all data has been sent successfully. But this command is moot for UDP mode. Because UDP is connectionless, it will not confirm whether data has been sent successfully, thus the last parameter is always 0.

OK

**************************************************************************

Note:
A. The send buffer in the underlying socket is 7300. Therefore, it is not needed to wait all data has been acknowledged (that is the last parameter in the response of AT+QISACK is 0) and then send next package. Given that the maximum length of one TCP package is 1448, it is recommended to set a threshold value as 3000. If the unacknowledged data length (the last parameter in the response of AT+QISACK) is less than 3000, continue to send the next package by command AT+QISEND. Else if it exceeds 3000, stop sending data, and then query by AT+QISACK every 5 seconds until the last parameter is less than 3000. If the query time achieves a certain number (for example 20 times, equivalent to 100 seconds timeout) and the last parameter is always greater than 3000, it can be considered an anomaly.
occurred in the TCP connection. In this case close this connection, re-establish TCP connection, and then continue to send all previously unacknowledged data and next data package.

B. If users want to send hexadecimal characters in non-transparent mode, especially 0x08, 0x1A, 0x1B, it is recommended to send data with fixed length, which described as below.

4.2. Send data in fixed length

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+QISEND=3</td>
<td>Specify the data length to be sent is 3.</td>
</tr>
<tr>
<td>&gt;0x080x1A0x1B</td>
<td>Send special characters 0x08, 0x1A, 0x1B in turn. When actually input the data, be sure to input these special data in hexadecimal format, other than input a string of “0x080x1A0x1B”. The example just gives a demonstration to let user see clearly.</td>
</tr>
</tbody>
</table>

SEND OK

AT+QISACK
+QISACK: 17, 17, 0

OK
5. Receive data

5.1. Output the data through UART directly

The received data from the server will be output through UART without any head information in the defaulting setting. In order to distinguish the received data from the responses of AT commands or any URC, it is allowed to add some information at the beginning of the received data controlled by some commands. The details have been described in Chapter 2.

It is better to set display format for the received data before the TCP connection has been established. Below is a sample of the received data.

```
RECV FROM:116.228.146.250:7070<CR><LF> //The module receives data from the remote server 116.228.146.250:7070. This line will not be displayed if not set AT+QISHOWRA=1 in the initialization phase.
IPD36TCP:1234567890abcdefghijklmnopqrstuvwxyz //Receive TCP data with the length of 36. These data is 36 characters after the colon symbol ":". The header "IPD36TCP:" will not be displayed if not set AT+QIHEAD=1. The header "TCP" will not be displayed if not set AT+QISHOWPT=1.
```

Note:
In this mode, the data will be output immediately once received, so it is unavoidable that the data appears in the middle of AT commands. In the current design we have done some timeout processing to avoid the received data from breaking AT command or its response (for example, separate AT command directly). But it is still unavoidable that the AT command is separated with its response.

5.2. Retrieve the received data by command

The module in this mode, compared with the above mode, outputs a URC “+QIRD:” to inform the user that TCP/UDP data has been received and user can retrieve the data by command AT+QIRD. This mode is not supported by default. Execute command AT+QINDI=1 to enable this mode before the TCP connection is established. An example when the module receives the data in this mode is shown as below.

/*Suppose the module receives the TCP data below from the remote end:
"1234567890abcdefghijklmnopqrstuvwxyz"*/

+QIRDI:0,1,0 //The module receives the data based on Context 0, and the module acts as the client.

/*Now retrieve data by the following command*/

AT+QIRD=0,1,0,1024 //Retrieve the data from the module’s socket buffer. The maximum length to retrieve is 1024. If the data length in the buffer is less than 1024, retrieve all the data from the buffer.
+QIRD:116.228.146.250:7070,TCP,36<CR><LF>1234567890abcdefghijklmnopqrstuvwxyz
6. TCP connection maintenance and detection

Most of the modules are connected to the Internet through GPRS gateway. GPRS gateway here has the similar functions as the router in LAN. Every time when the module tries to connect with one server in the internet, GPRS gateway should assign a port to the module. A problem will be caused when the connection between the module and the Internet is established via this port. Since the port resource of GPRS gateway is limited, so it will have some restrictions on these ports for the terminals within the GPRS network. If there is no data transmission on the TCP connection for a period of time, it will release the port to other connection to achieve a rational allocation of port resource. So the TCP connection between the module and the server may be disconnected by GPRS network without any notification.

There is no clear value at present about how long the resource will be released without data transmission. The test result in Shanghai is the port resource will not be released within 10 minutes.

In order to avoid the TCP connection from disconnection by GPRS gateway without any notification, it is recommended to periodically send a small data packet to the remote end through which the TCP connection can be maintained and detected.

Example:
Set an interval of 10 minutes to send the heart beating package according to our test result.

```
AT+QISACK // Check the information of the sending data
+QISACK: 1448, 1448, 0 //Suppose 1448 bytes data has been sent to the server successfully.
OK
AT+QISEND //Send the normal data
> 1234567890abcdefghijklmnopqrstuvwxyz<0x1A> //Input the data to be sent, <0x1A> is used to end the input and require to send data
SEND OK //The data has been sent to TCP protocol layer successfully

认识不支持发送带头认包的包，所以要重新建立连接
```

Assuming no data is needed to be sent for a long time, it is recommended to send a heart beating small packet to maintain the TCP connection. Before sending the heart beating packet to maintain the TCP connection, confirm if the current TCP connection is normal by querying whether the current package has been sent successfully. If the package is still not acknowledges after two minutes (query every 5 seconds, 24 times in total), the TCP connection may be abnormal, execute AT+QICLOSE to close the current connection, and then execute AT+QIOPEN to re-establish the TCP connection. After the connection has been established successfully, resent the unacknowledged data.

******************************************************************************
Assuming no data is needed to be sent for a long time, it is recommended to send a heart beating small packet to maintain the TCP connection. Before sending the heart beating packet to maintain the TCP connection, confirm if the current TCP connection is normal by querying whether the current package has been sent successfully. If the package is still not acknowledges after two minutes (query every 5 seconds, 24 times in total), the TCP connection may be abnormal, execute AT+QICLOSE to close the current connection, and then execute AT+QIOPEN to re-establish the TCP connection. After the connection has been established successfully, resent the unacknowledged data.

******************************************************************************
### AT+QISACK

+QISACK: 1484,1448,36

//Check the information of the sending data
The total length of the data which has been sent is 1484, but only 1448 bytes has been acknowledged, and 36 bytes has not been acknowledged (can not confirm whether it has been sent successfully) yet. Check again after 5 seconds.

OK

......

AT+QISACK
+QISACK: 1484,1484,0

//Check the information of the sending data
All 1484 bytes data has been acknowledged to sent successfully. This means the TCP connection is normal until now.

OK

......

AT+QISEND
> Heart01<0x1A>

//Send a heart beating small packet to server
Send small packet Heart 01. It can be simpler. Any other data is OK, and users can define specific format to avoid server misunderstanding

SEND OK

......

AT+QISACK
+QISACK: 1491,1491,0

// Check the information of the sending data
The packet has been received successfully, the TCP connection is still OK, so stop the check operation. If the packet has not been acknowledged (the third parameter of the response of “AT+QISACK” is not 0), please wait for 5 seconds and check again. Repeat the former operation for several times until the packet has been acknowledged or the times of repeat reaches to a limitation (for example, 24 times, i.e. 2 minutes). If the time of repeat reaches to the limitation, the TCP connection may be abnormal, so it is suggested to re-establish the TCP connection.

OK
7. Close TCP session

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+QICLOSE</td>
<td>//Close the current TCP connection after all data has been sent.</td>
</tr>
<tr>
<td>CLOSE OK</td>
<td></td>
</tr>
<tr>
<td>AT+QIDEACT</td>
<td>//If the context will not be used in a long period (for example more than one hour), it is recommended to close this context by command AT+QIDEACT. Normally the responding time for this command is about 2-5 seconds. But when the network is very bad or in some abnormal conditions, the longest waiting time will achieve about 2.5 minutes. It is recommended to set timeout value which is less than 1 minute or less according to their application. If it is timeout, users have not received DEACT OK, user can restart the module by EMERG_OFF pin.</td>
</tr>
<tr>
<td>DEACT OK</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
Make sure to receive the corresponding response (or ERROR) and then execute the next command.
8. Transparent session mode

If AT+QIMODE=1 is executed in the initialization phase, the UART will enter data mode after the TCP/UDP session is established. In data mode, all the input data through UART is considered as the data needed to send to the remote server and all the output data through UART is received from the remote server except some special strings such as "CLOSED", "+PDP DEACT". An example of TCP transparent session is as below.

8.1. Example

OK //Format is right and current status is permitted to establish TCP session. Other error response here can be referred to the Chapter 3.

CONNECT // Successfully connect to the remote TCP server and the UART has entered the data mode. Other error response here can be referred to the Chapter 3.

…….. //User can send data now. For example, when “1234567890abcdefghijklmnopqrstuvwxyz”is input, these data will not be echoed by UART. Because the data length is less than 512, the module will wait 200ms to send the data (see configuration in Chapter 2).

abcdefghijklmnopqrstuvwxyz1234567890 //These data are received from the server.

…….. //Input "+++" to quit the data mode

OK //The response for "+++". "OK" means the UART has switched to the command mode successfully. Then if user wants to close the TCP connection, please refer to the example in Chapter 7.

8.2. Treatment for abnormality

If the module receives "CLOSED" or "+PDP DEACT" in the data mode, it means TCP connection has been broken or some abnormalities have happened. But it is also possible these data are from the remote end. In this case, it is recommended to input “+++” to confirm if the
UART is still in the data mode. When input “+++”, OK is returned, which means the UART has switched to the command mode successfully and the previously received "CLOSED" or "+PDP DEACT" are TCP data from server. Otherwise, when input “+++”, just “+++” echoes (when echo mode is open) and “OK” is not returned, which means the module has already entered in command mode, that is, the previously received "CLOSED" or "+PDP DEACT" means the TCP session has been disconnected or GPRS context has been deactivated. In this case, the TCP session is needed to re-establish as the following steps. (Of course, if it is certain that the remote server will not send a string as "CLOSED" and "+PDP DEACT", re-establish the TCP session directly and not require to input “+++” to judge the current state.)

| AT+QIDEACT | //Deactivate the current GPRS context. The responding time for this command is normally about 2-5 seconds. But when the network is very bad or in some abnormal conditions, the longest waiting time will achieve about 2.5 minutes. It is recommended to set timeout value which is less than 1 minute or less according to their application. If it is timeout DEACT OK is still not received, user can restart the module by EMERG_OFF pin. |
| DEACT OK | |

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9. TCPIP Recommended Process Flow Chart

Following is the flow chart of TCPIP recommended process.

Recommended Power ON/OFF:
1. Power OFF: Pull Power Key to low in 1s, then cut off power after 12s.
2. Power ON: Pull Power Key to high then to low in 2s.

TCP/IP Configuration
AT+CGDCONT=1,"IP","IP Address";

SIM Card Status:
AT+CPIN?
Reboot the module if AT+CPIN? failed to find SIMCard in 10s.

GPS Network:
1. <status> of AT+CGREG: equals to 1/5 which means the module registered to GSM network.
2. Reboot the module if it failed to register to GSM network in 30s.

GPRS Network:
1. <status> of AT+CGREG: equals to 1/5 which means the module registered to GSM network.
2. Go to next step whether to GPRS network or not in 30s.

PDP context:
1. Activate PDP context:
   AT+QIREGAPP
   AT+QIActivate
   AT+QILOCIP

   NOTES:
   1. All above commands should be executed together in sequence.
   2. Reboot the module if there is no response for AT+QIActivate in 180s.
   3. Fail to DEACT PDP context for 3 times then reboot the module.

   DEACT PDP context:
   Reboot the module if there is no response for AT+QIDEACT in 90s.

   NOTE:
   1. DEACT PDP context and try again if failed to open connection for 5 times.
   2. Fail to get response for AT+QIOPEN in 90s then DEACT PDP context.

Open connection:
1. DEACT PDP context and try again if failed to open connection for 5 times.
2. Fail to get ACK for AT+QIOPEN in 90s then DEACT PDP context.

TCP connection maintenance and detection:
1. AT+QISEND - Send data
   It is recommended to periodically send a small data packet to the remote end through which the TCP connection can be maintained and detected.

2. AT+QISACK - Query ACK
   If the package is still not acknowledged after two minutes (query every 5 seconds, 24 times in total), the TCP connection may be abnormal, execute AT+QICLOSE to close the current connection, and then execute AT+QIOPEN to re-establish the TCP connection.

NOTES:
1. Ensure that TE and TA are correctly synchronized after rebooting the module. Send 15 AT commands continuously following the constraint that sleep 500ms after each AT command input, then fix and save bandrate configuration by AT+IPR=xxx&W after synchronized.
2. Please note that you need to wait for the final response (for example OK, CME error, CMS error) of the last AT command you entered before you enter the next AT command. You can reboot the module if the module failed to get response in 60s.
3. Reboot the module if the module has no response of AT+QIActivate in 180s or no response of AT+QICLOSE and AT+QIDEACT in 90s.
4. The module CAN NOT be rebooted frequently. You can reboot the module immediately at first, then reboot the module after 10 minutes, 30 minutes, 1 hour, etc if the module is repeatedly abnormal.