EC2x&EG2x&EG9x&EM05 Series

PPP Application Note

LTE Standard Module Series

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Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

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About the Document

History

Revision	Date	Author	Description
1.0	2017-12-08	Duke XIN/ Shirly WANG	Initial
1.1	2023-10-16	Mount ZHONG	1. Updated applicable modules: ● Updated EC20 R2.0 and EC20 R2.1 to EC20-CE and added EC20-CN ● Updated EC21 to EC21 Series, EC25 to EC25 Series, EG91 to EG91 Series and EG95 to EG95 Series ● Added applicable modules: EG2x. 2. Updated contents of PPP connection termination (Chapter 5). 3. Updated contents of PPP dial-up operation (Chapter 6).

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1 Introduction

This document gives a brief introduction on the PPP function of Quectel EC2x family, EG2x family, EG9x family and EM05 series modules, including application mode, procedures for PPP setup and termination, modes for PPP connection, and examples for PPP dial-up, etc.

This document is applicable to following Quectel modules.

1.1 Applicable Module

Table 1: Applicable Modules

Module Family	Module
EC2x	EC20-CE
	EC21 Series
	EC25 Series
EG2x	EG21-G
	EG25-G
	EG21-GL
	EG25-GL
EG9x	EG91 Series
	EG95 Series
-	EM05 Series

2 Application Mode

The usage of PPP (Point-to-Point Protocol) is illustrated in the figure below. Either UART or USB can be used for PPP connection. The module provides a PPP server for application, and the application side provides a PPP client for the module. Meanwhile, the application side has to provide protocols such as TCP/IP, HTTP(S), etc. When PPP connection has been set up, the IP packet flow from the application side will be transmitted to Internet through the module.

Most standard operating systems (e.g. Windows, Unix/Linux) include the PPP protocol stack. For other operating systems which do not have existing application to set up PPP connection, it is very important to develop applicable application software to accomplish PPP connection first.

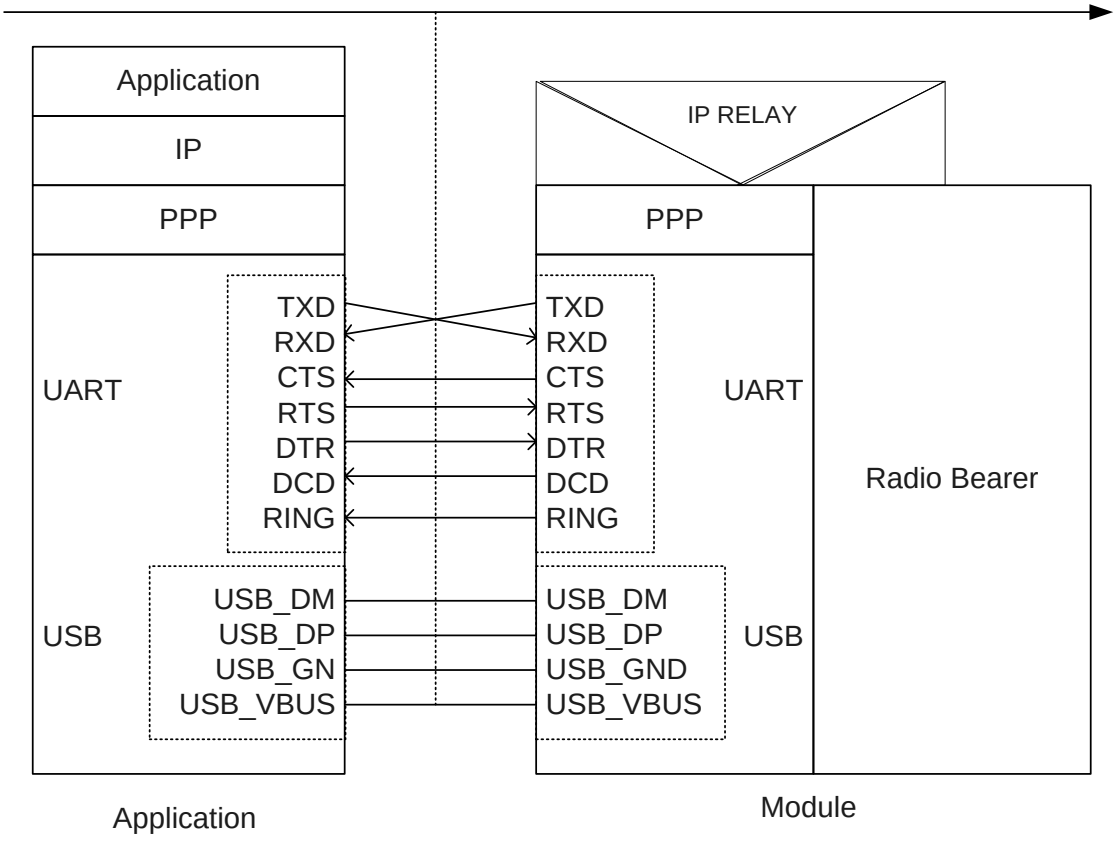

Figure 1: PPP Application Mode

3 Procedures for PPP Setup

3.1. General Procedures for PPP Setup

After the module has registered on GPRS network, please set APN for PPP by **AT+CGDCONT** and start PPP by **ATD*99#**. When **ATD*99#** is executed, the module enters into the procedure of PPP frame interaction which is carried out on the basis of standard Point-to-Point Protocol. Description about the module's packet interaction is included in the figure below. Please get more details about standard Point-to-Point Protocol from *RFC 1661*.

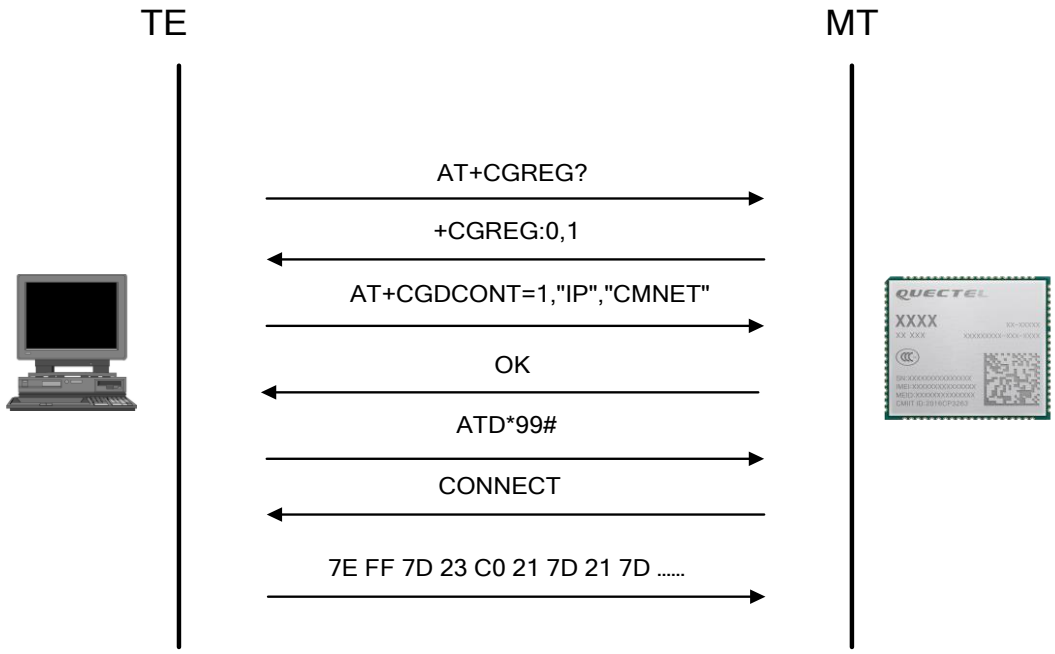

Figure 2: General Procedures for PPP Setup

3.2. Recommended Procedures for PPP Setup

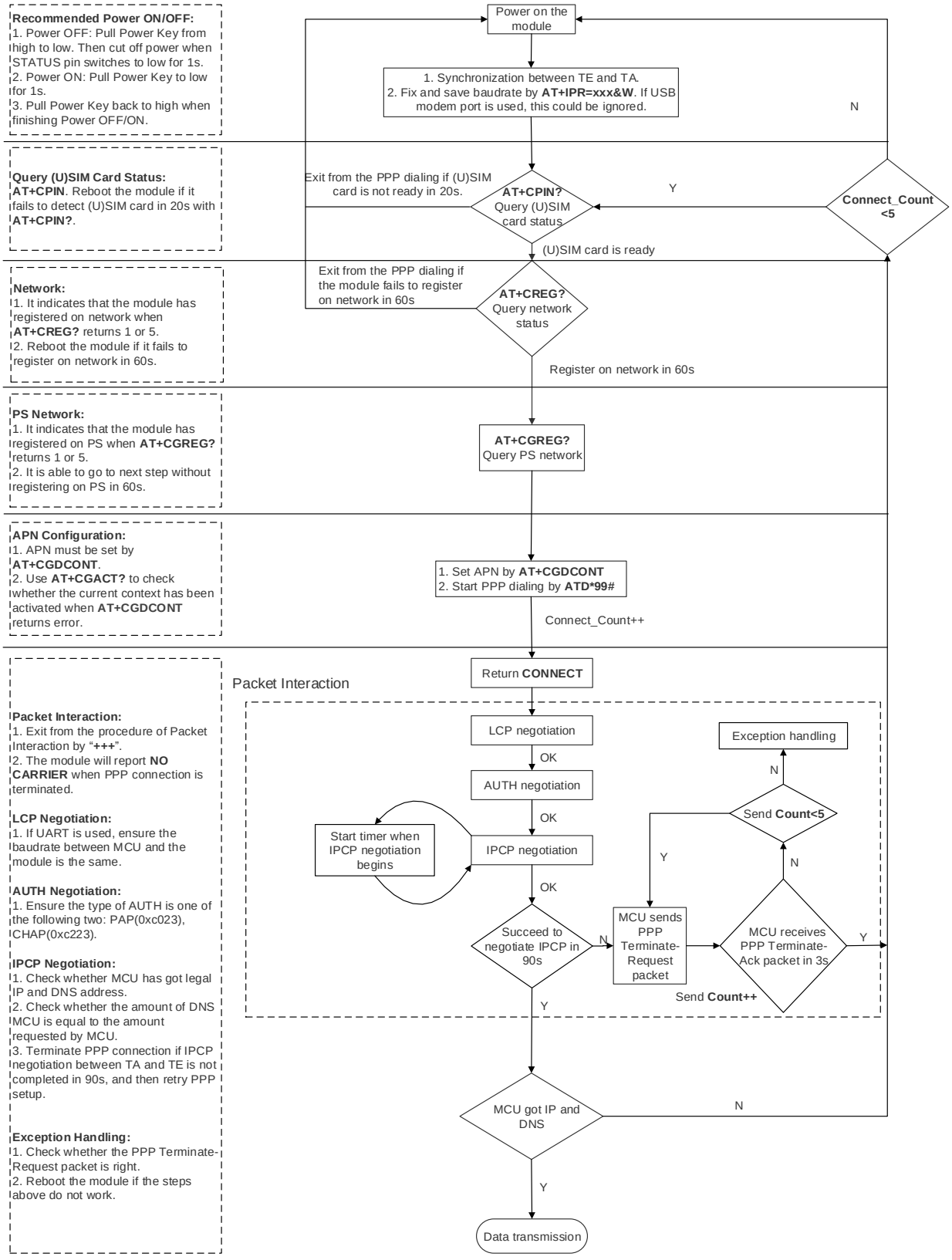

Figure 3: Flowchart of Recommended Procedures for PPP Setup

When the module is powered on, if the main UART is used, baud rate of the UART should be set by **AT+IPR=xxx;&W**. Before using **ATD*99#** to set up PPP, the status of (U)SIM card must be checked via **AT+CPIN?**. When (U)SIM card is ready, please check the network registration status periodically via **AT+CREG?** and **AT+CGREG?** until the network condition is prepared.

NOTES

1. Please ensure MCU and the module are synchronized successfully after rebooting the module. MCU sends **AT<CR><LF>** to the module every 100 ms until **OK** is received from the module. If the UART is used, MCU sets and saves baud rate via **AT+IPR=xxx;&W** after successful synchronization.
2. Please note that MCU has to wait for the response (for example **OK**, **CME error**, **CMS error**) to the previous AT command before inputting the next AT command. The module can be rebooted if there is no response in 60s.
3. It is strongly recommended that do NOT power on/off the module frequently. If the dial-up retry is failed for 3 times continuously, the module could be powered off/on (reset) immediately for the fourth time. After that, if the fourth dial-up retry still fails, reset the module for the fifth time after 10 minutes, the sixth time after 30 minutes, and the seventh time after one hour.
4. If MCU fails to transmit data to network after PPP connection has been set up, please check the configuration of PPP and the state of network, and then reboot the module.
5. If the module has registered on CDMA network, please do NOT use **ATD#777** command to set up PPP. **ATD*99#** command should be used.

4 Modes for PPP Connection

4.1. Data Mode and Command Mode

The module communicates information (including AT commands and data) with application via USB/UART port. There are two working modes for the two ports: data mode and command mode.

The ports are in command mode before PPP is set up, and the module can execute AT commands in this state. When PPP negotiation is started, the ports will enter into data mode, and will keep in this mode when PPP connection is set up. If the PPP connection is not set up successfully, the ports will enter into command mode. In data mode, the module cannot execute AT commands.

Quectel EC2x family, EG9x family, EG2x family and EM05 family modules provide convenient methods to switch between the two modes.

4.1.1. Switch from Data Mode to Command Mode

4.1.1.1. Change DTR Level to Switch from Data Mode to Command Mode

When PPP connection is already existed and the USB/UART port is in data mode, the ports can be switched to command mode by changing DTR level from low to high (**AT&D1** should be executed first). The module will return **OK** when switched to command mode successfully.

4.1.1.2. Use Sequence +++ to Switch from Data Mode to Command Mode

The other way to switch USB/UART port from data mode to command mode is using sequence "**+++**" when PPP connection has been set up successfully. To prevent the "**+++**" escape sequence from being misinterpreted as data, the following sequence should be followed:

1) Do not input any character within 1s or longer before inputting "**+++**".
2) Input "**+++**" within 1s, and no other characters can be inputted during the time.
3) Do not input any character within 1s after "**+++**" has been inputted.

When such particular sequence "**+++**" is received, the USB/UART port will switch from data mode to

command mode, and the module will return **OK** for the operation.

NOTE

Please make sure the above operations are performed after completion of PPP negotiation. If not, above operations will terminate the PPP negotiation and make USB/UART port quit from data mode. When USB/UART port is switched to command mode after accomplishing PPP negotiation, the data will be treated as AT command and the module still remains PPP connection.

4.1.2. Switch from Command Mode to Data Mode

4.1.2.1. Use ATO to Switch from Command Mode to Data Mode

When the PPP connection exists, the USB or UART port is in command mode. Execute **ATO** to enter data mode.

Example

```
//When PPP connection exists, and USB/UART port is in command mode.
ATO
CONNECT                    //Indicates that TA has entered into data mode, and all data
                           inputted from USB/UART port will be treated as PPP frames.
```

4.2. Handle URC in Data Mode

The URC for incoming calls and short messages will not be reported to the PPP dial-up port in data mode during PPP connection. But module's RI pin level will change from high to low for 120ms as an indication. According to the RI pin status, MCU can switch the port to command mode to process the call or short message. After switching to command mode, the URC will be reported to the port if the incoming call or short message still exists.

4.3. Data Carrier Detection (DCD) Mode

DCD mode is determined by **AT&C**. If **AT&C0** is set, the DCD pin will not be used to indicate the data carrier status. If **AT&C1** is set, the DCD pin will be used to indicate the data carrier status. The pin will keep at low level when data carrier exists or PPP negotiation begins, otherwise it will keep at high level.

NOTE

When switching module's USB/UART port from data mode to command mode (using "+++"), the DCD state does not change.

5 PPP Connection Termination

There are two methods to terminate the PPP dial-up connection:

1. Terminating the PPP connection through the LCP Terminate-Request message, which is recommended.

2. Terminating the PPP connection by changing the DTR level. Set the DTR function with **AT&D2**, change the DTR level from low to high, and the data connection will be automatically terminated. Once the PPP connection is terminated, the USB/UART port will enter the command mode.

Example

```
//USB/UART port is in command mode before PPP connection is established.
AT&D2
OK
```

NOTE

1. PPP connection termination procedures must be performed in data mode.
2. PPP connection termination procedures can be performed at any time during the PPP setting or connecting process.

6 PPP Dial-up Operation

This chapter mainly introduces how to establish PPP dial-up in Windows 10 and Linux system.

6.1. Preparation

It is necessary to finish the following steps before establishing a PPP dial-up connection in Windows.

1. Connect the module to PC and enter the PIN code if the (U)SIM card PIN is locked.
2. Make sure the (U)SIM card can successfully register on GPRS network.

6.2. PPP Dial-up in Windows 10

6.2.1. Modem Configuration

6.2.1.1. Add New Modem

If the **Standard 19200 bps Modem** is not installed, add a new standard modem to the modem section of the control panel.

1. Search for “**Phone**” in the main interface, and then click "**Phone and Modem**" option:

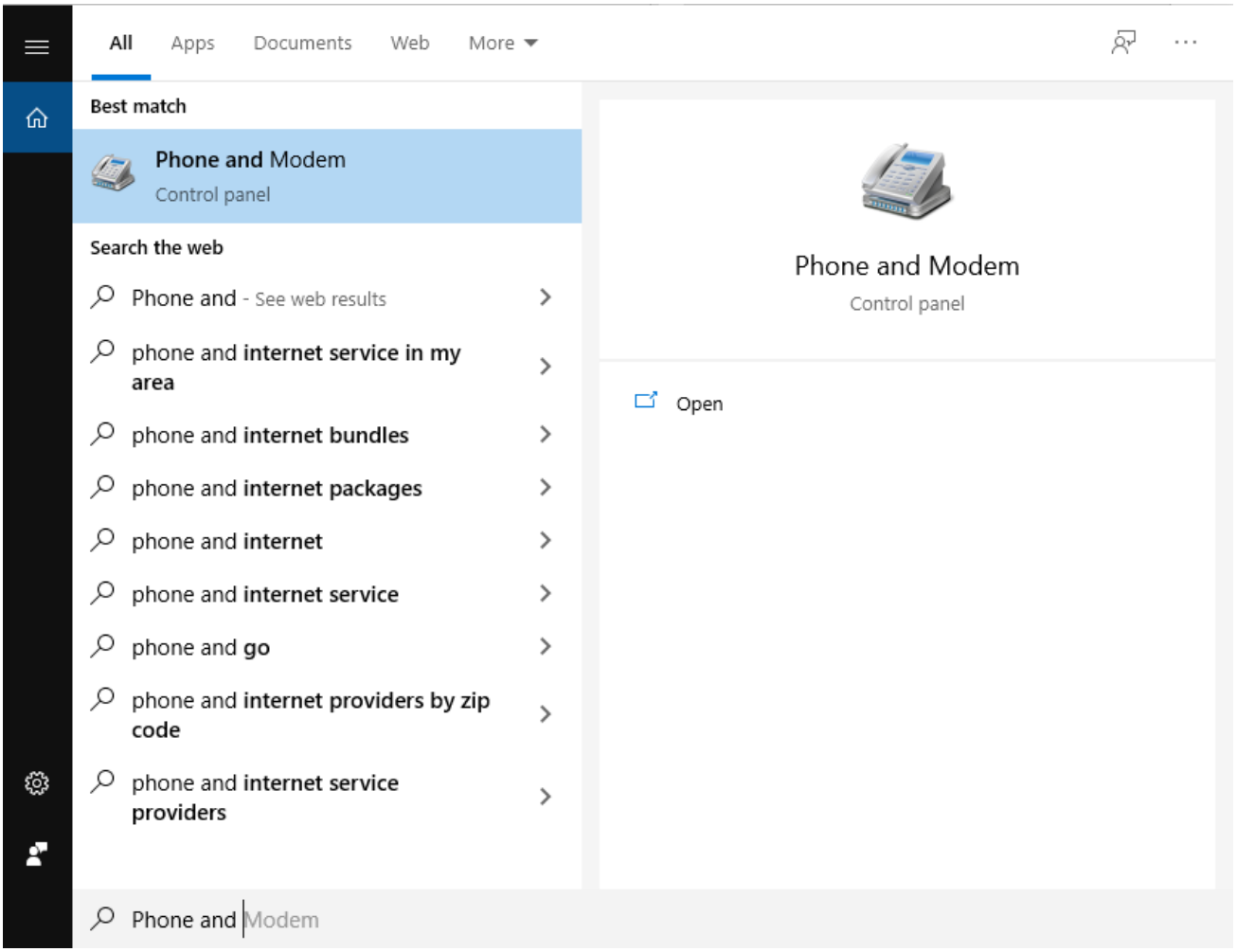

Figure 4: Search for "Phone and Modem" in Control Panel (Windows 10)

2. Double-click the "**Phone and Modem**", and select "**Modems**" → "**Add…**" to add a new modem.

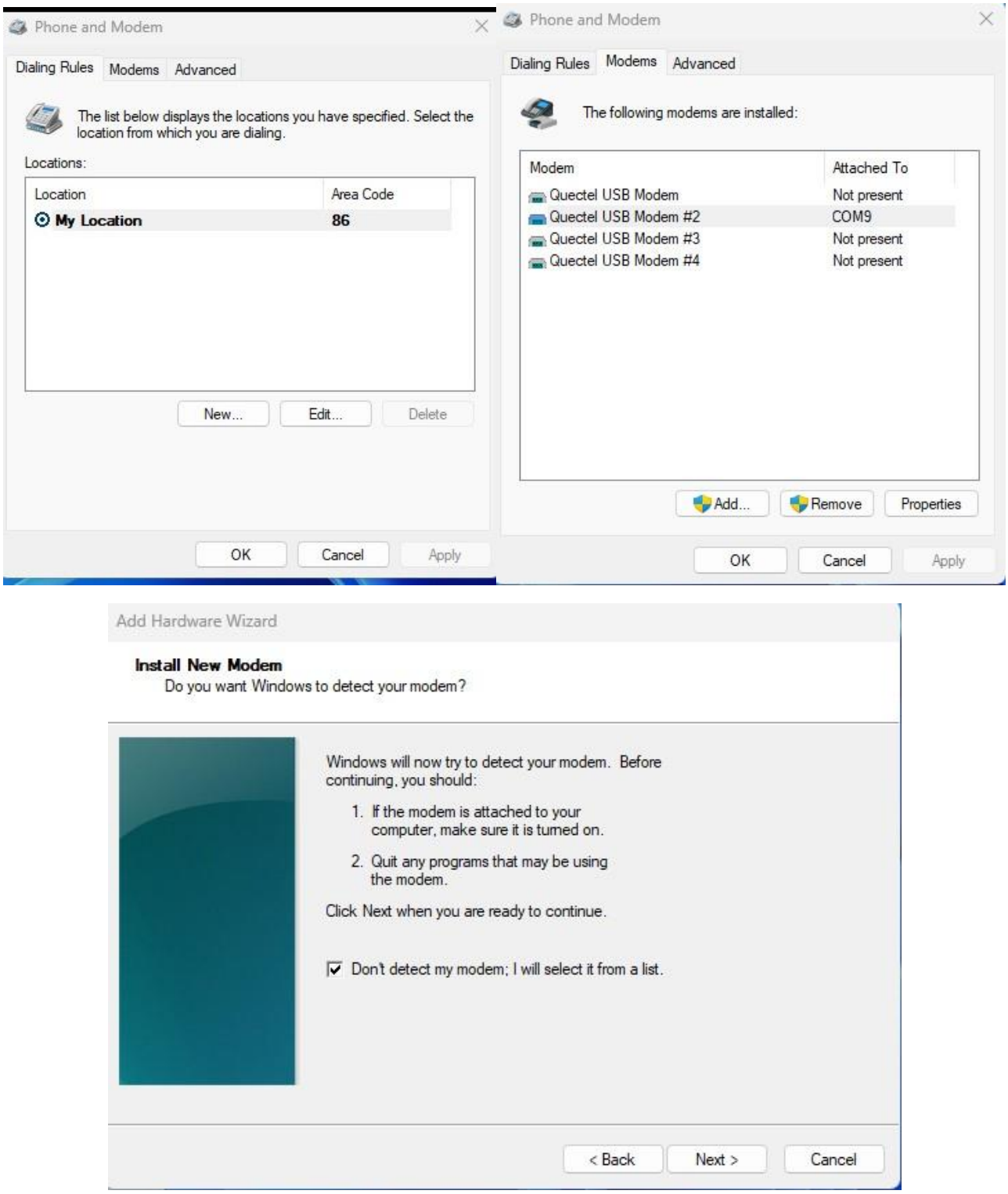

Figure 5: Add New Modem (Windows 10)

3. Follow the instructions on the screen to install the new modem:

   - select "**Standard 19200 bps Modem**" and then the port (such as "**COM10**") to be installed;
   - click "**Next**" button until the configuration is complete. For details, see the figures below.

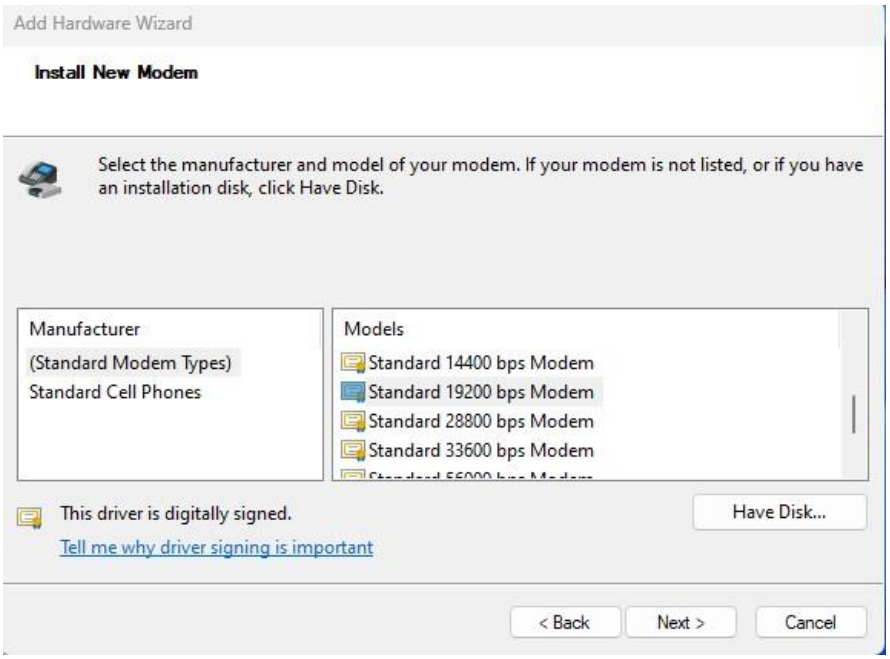

Figure 6: Select Modem Model (Windows 10)

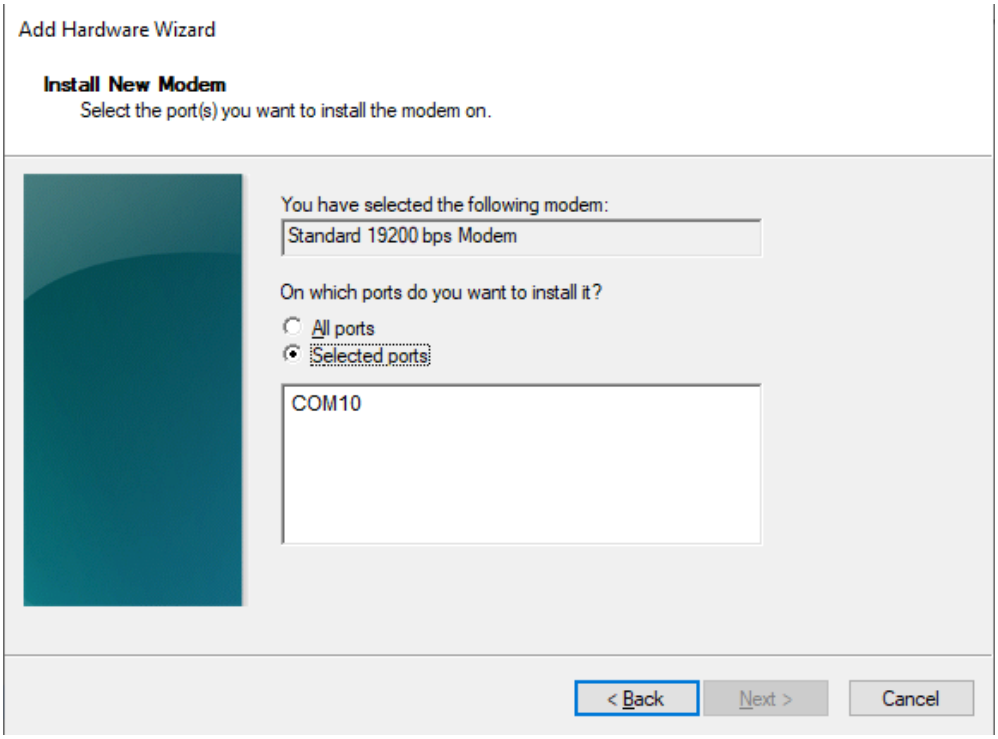

Figure 7: Select Port (Windows 10)

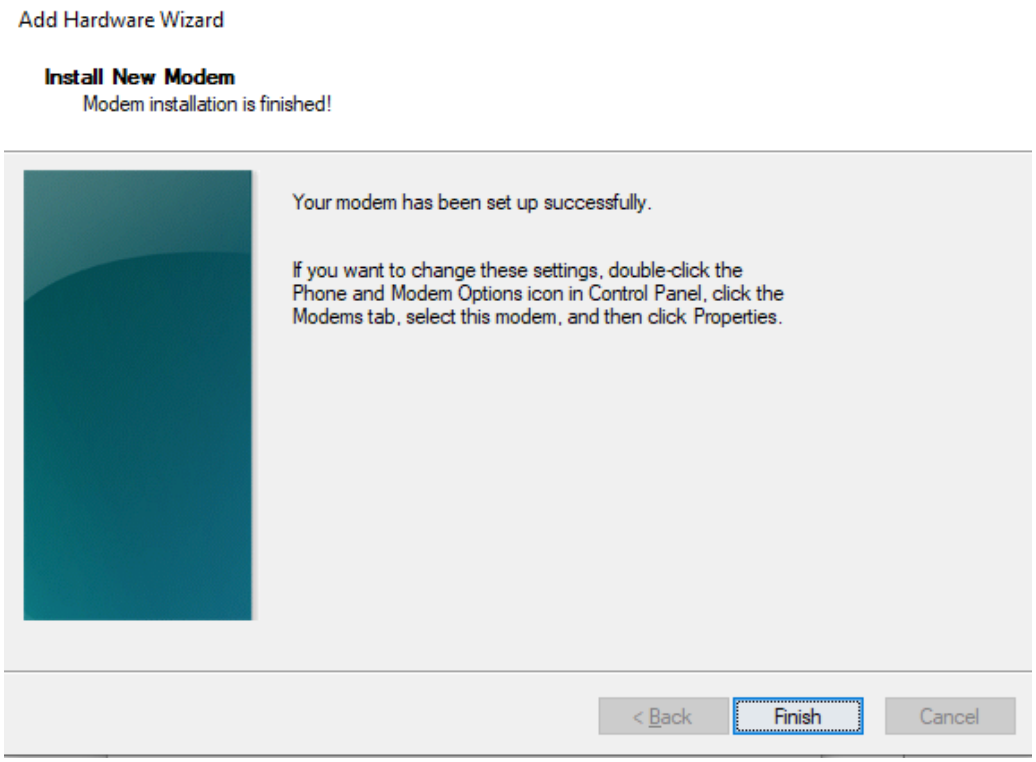

Figure 8: New Modem is Installed Successfully (Windows 10)

6.2.1.2. Configure Modem Driver

- Select the installed "**Standard 19200 bps Modem**" and click the "**Properties**" button.
- After entering the interface, select the "**Modems**" option and modify the "**Maximum Port Speed**" to "**115200**" (default value).
- Click the "**Advanced**" option, configure "**Extra Settings**" and input **AT+CGDCONT=1,"IP","CMNET"**.

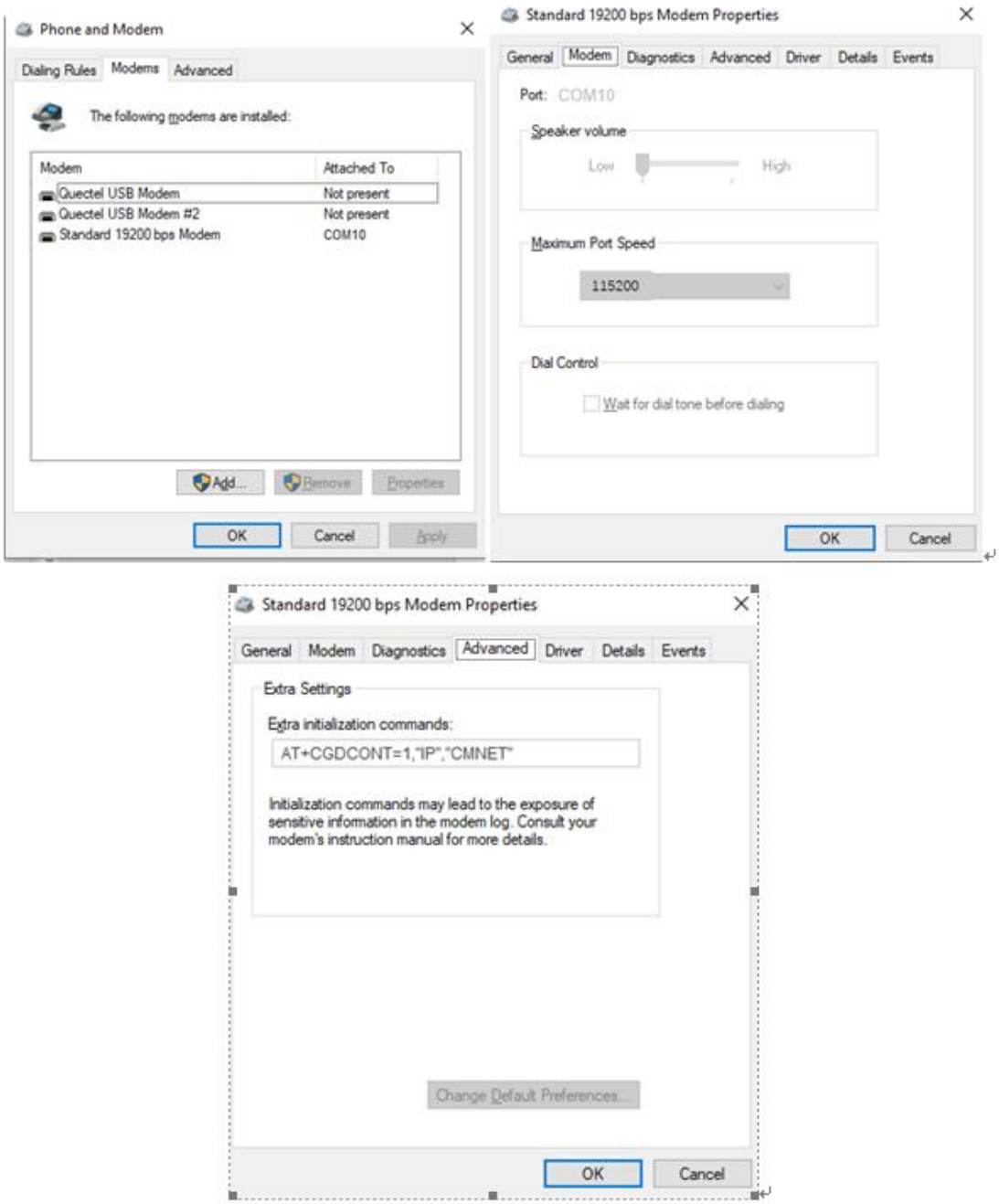

Figure 9: Configure Modem Driver (Windows 10)

NOTE

In the example above, AT+CGDCONT=1,“IP”,“CMNET” predefine a PDP context where CID=1, PDP type=IP and APN=CMNET. CMNET is the APN of the network operator China Mobile and it should be replaced with the value provided by the network operator.

6.2.2. Dial-up Network Configuration

6.2.2.1. Create a New Connection

1. Open “**Control Panel**”, click “**Network and Internet**”, “**Network and Sharing Center**” and finally “**Set up a new connection or network**”.

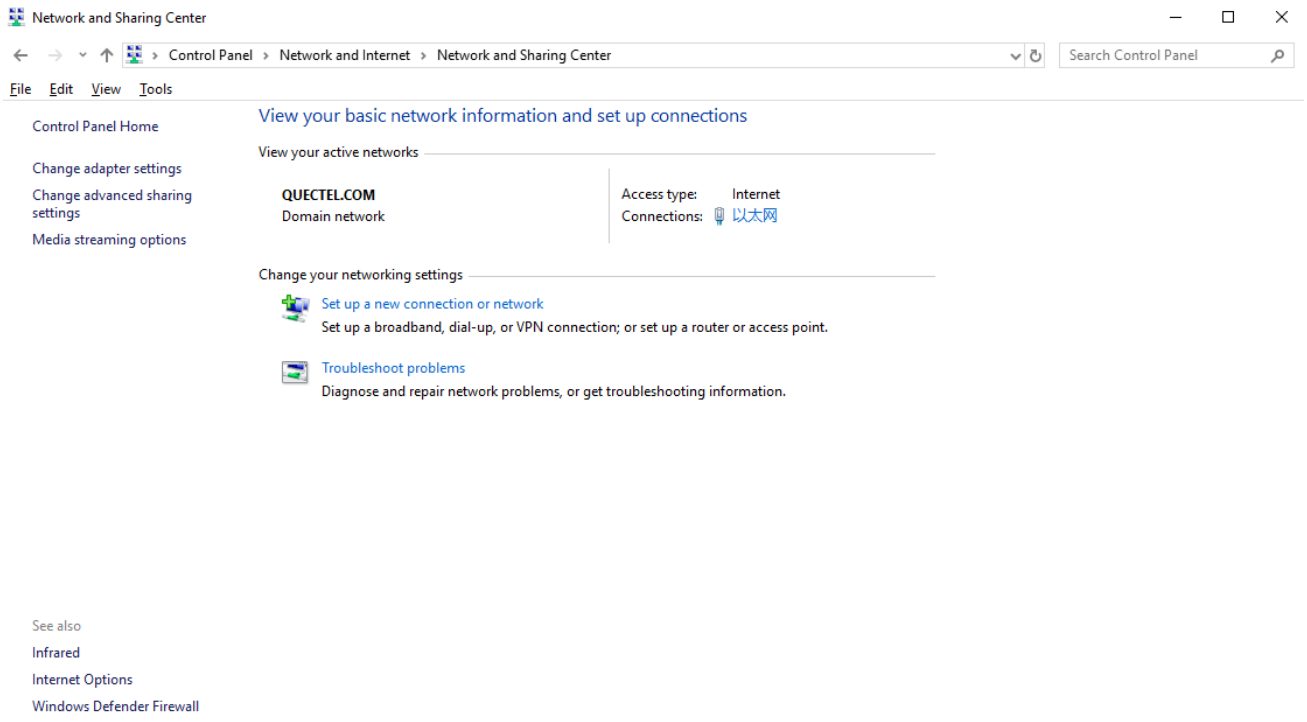

Figure 10: Create New Connection (Windows 10)

2. Select “**Connect to the Internet**”, click “**Next**”. Then click “**Set up a new connection anyway**” and “**Dial-up**” to connect.

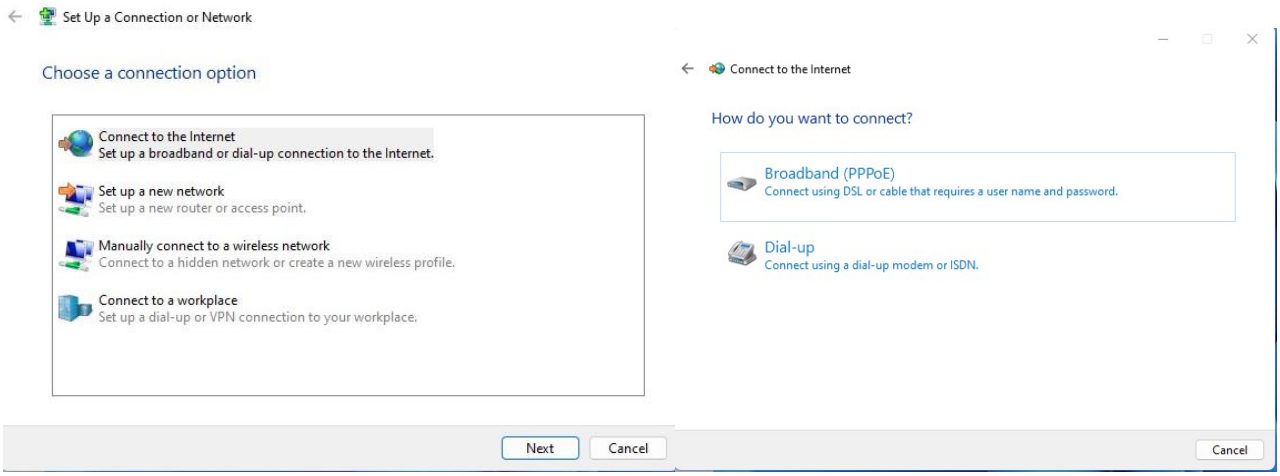

Figure 11: Set up New Connection (Windows 10)

6.2.2.2. Configure the Connection

Enter characters (such as "***99#**") in "**Dial-up phone number**" box, and then click "**Connect**" button.

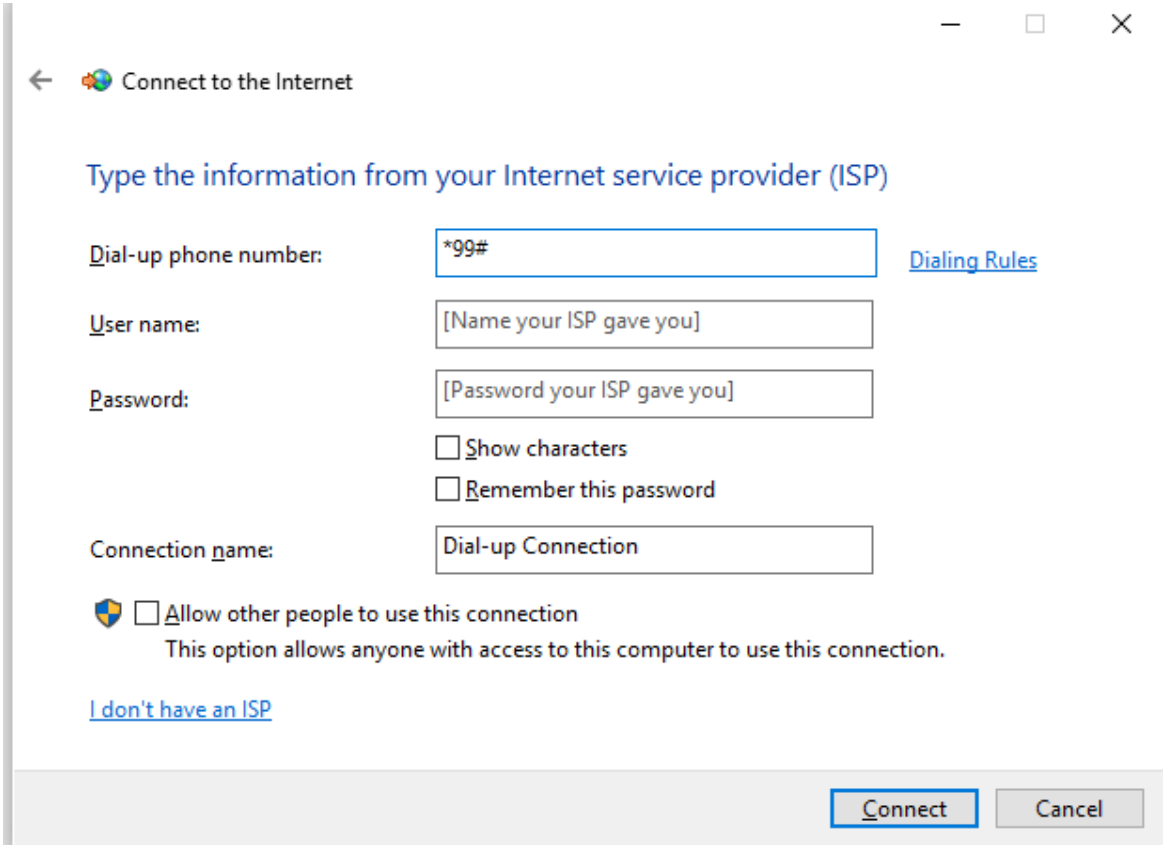

Figure 12: Configure Connection (Windows 10)

6.2.2.3. Configure the Dial-up Tool

- Enter characters (such as "***99#**") in "**Dial**" window.
- Click "**Properties**" button, and configure the "**Standard 19200 bps Modem (COM10)**".
- Select "**115200**" from the drop-down list of "**Maximum speed**".
- Click "**OK**" button to finish the configuration.
- Click "**Dial**" button to initiate the PPP connection.

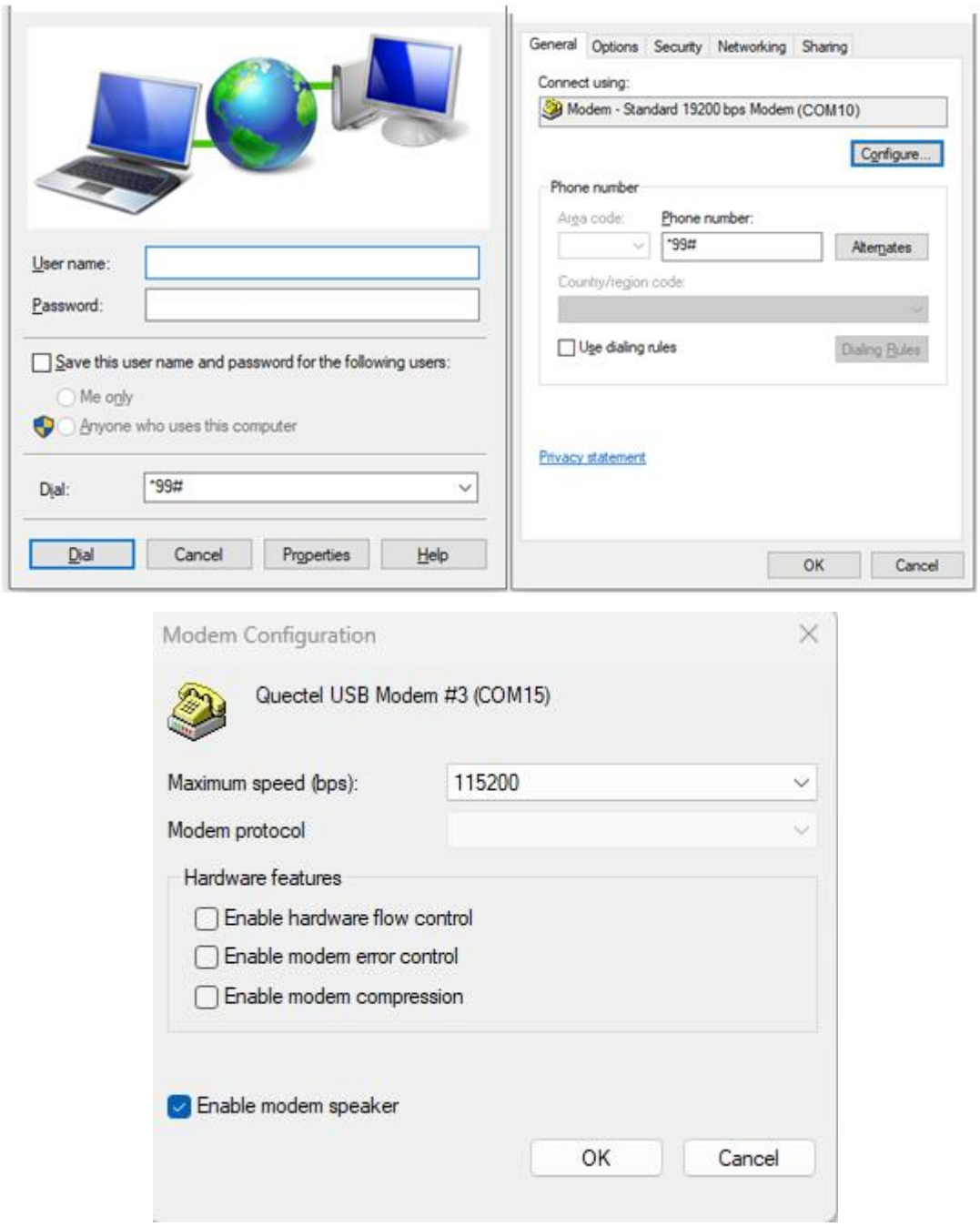

Figure 13: Configure Dial-up Tool (Windows 10)

6.2.2.4. Establish the Dial-up Connection

The interface will pop up a prompt box "**Verifying username and password**", and the pop-up box quickly pops up "**Connected**" to indicate a dial-up connection. See the following figures for details.

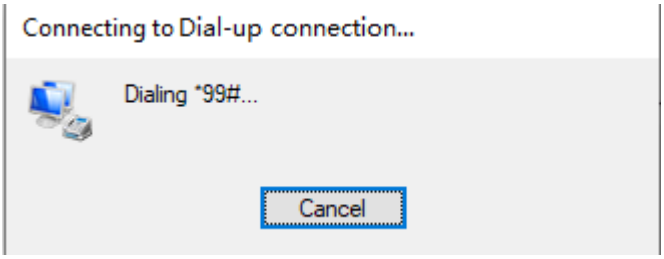

Figure 14: Connecting to Dial-up Connection (Windows 10)

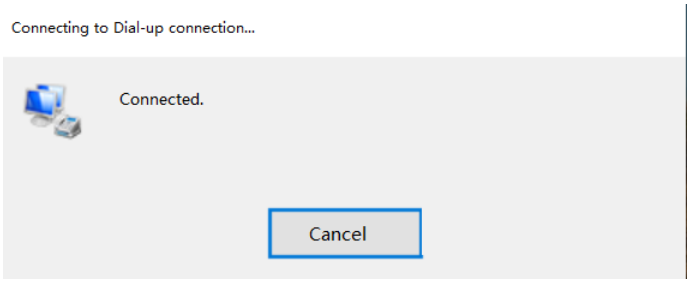

Figure 15: Establish Dial-up Connection Successfully (Windows 10)

6.3. PPP Dial-up in Linux

6.3.1. Basic Procedure for Dail-up in Linux

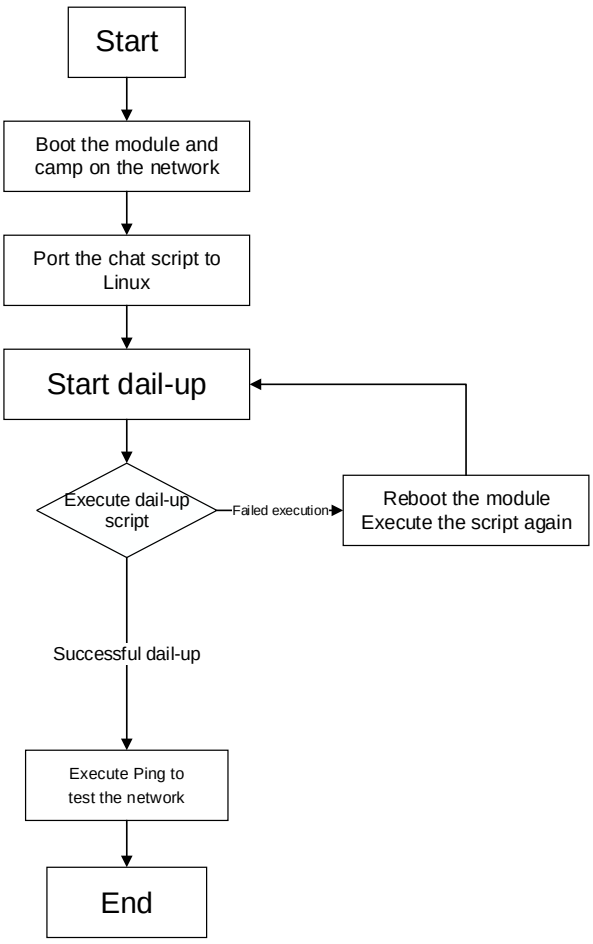

Figure 16: Dail-up Flowchart (Linux)

6.3.1.1. Dial-up Through pppd

The *chat* and *options* scripts are closely related to PPP connection. Among them, the *chat* script is used to make AT call and AT control with modules; the *options* script is used to configure PPP and set up the PPP connection.

Scripts provided by Quectel:

- The *chat* script: *quectel-chat-connect* and *quectel-chat-disconnect*
- The *options* script: *quectel-ppp*

1. Prepare the script:

```
~$ tar -zxvf xxxx.tar.gz
~$ cd /xxx/
~$ dos2unix *
```

2. Copy the PPP script to */etc/ppp/peers/*:

```
~$ cp quectel-chat-connect quectel-chat-disconnect quectel-ppp /etc/ppp/peers/
```

3. Modify the script file:

```
~$ vi quectel-ppp
# Modem path Modify it as /dev/ttyUSB3 115200
# user name and passwd Set it to the default value.
```

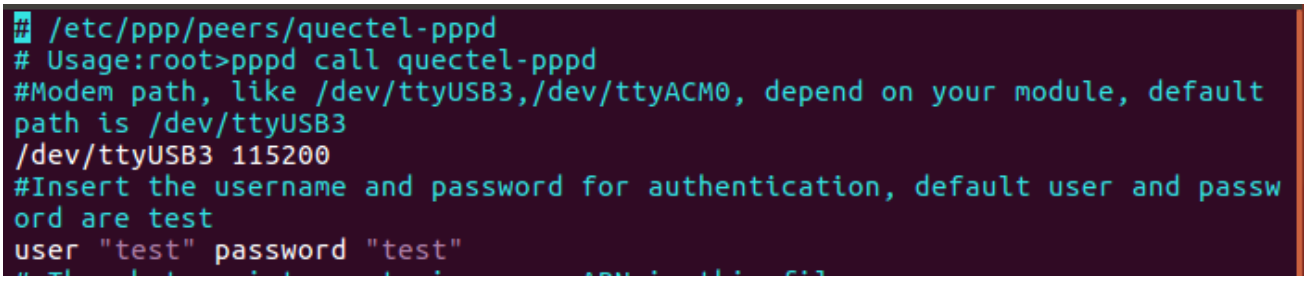

Figure 17: Modify the Profile

4. Modify APN:

```
~$ vi quectel-chat-connect
# Modify the APN information
```

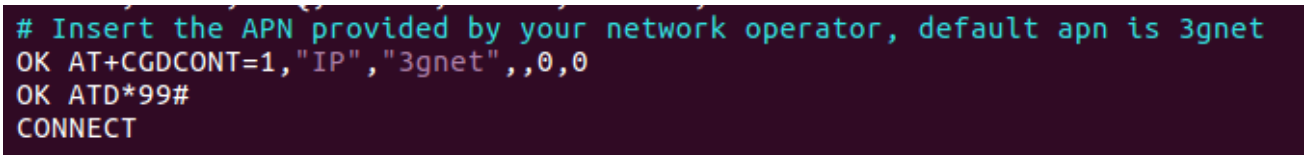

Figure 18: Modify APN

5. Start PPP dail-up:

```
~$ pppd call quectel-ppp &
```

```
gz@gz-VirtualBox:~$ pppd call quectel-ppp &
[1] 2256
gz@gz-VirtualBox:~$ pppd options in effect:
debug           # (from /etc/ppp/peers/quectel-ppp)
nodetach                # (from /etc/ppp/peers/quectel-ppp)
dump            # (from /etc/ppp/peers/quectel-ppp)
noauth          # (from /etc/ppp/peers/quectel-ppp)
user test               # (from /etc/ppp/peers/quectel-ppp)
password ??????         # (from /etc/ppp/peers/quectel-ppp)
remotename 3gppp                # (from /etc/ppp/peers/quectel-ppp)
/dev/ttyUSB3            # (from /etc/ppp/peers/quectel-ppp)
115200          # (from /etc/ppp/peers/quectel-ppp)
lock            # (from /etc/ppp/peers/quectel-ppp)
connect chat -s -v -f /etc/ppp/peers/quectel-chat-connect               # (from /etc/ppp/peers/quectel-ppp)
disconnect chat -s -v -f /etc/ppp/peers/quectel-chat-disconnect         # (from /etc/ppp/peers/quectel-ppp)
nocrtscts               # (from /etc/ppp/peers/quectel-ppp)
modem           # (from /etc/ppp/peers/quectel-ppp)
asyncmap 0              # (from /etc/ppp/options)
lcp-echo-failure 4              # (from /etc/ppp/options)
lcp-echo-interval 30            # (from /etc/ppp/options)
hide-password           # (from /etc/ppp/peers/quectel-ppp)
novj            # (from /etc/ppp/peers/quectel-ppp)
novjccomp               # (from /etc/ppp/peers/quectel-ppp)
ipcp-accept-local               # (from /etc/ppp/peers/quectel-ppp)
ipcp-accept-remote              # (from /etc/ppp/peers/quectel-ppp)
ipparam 3gppp           # (from /etc/ppp/peers/quectel-ppp)
noipdefault             # (from /etc/ppp/peers/quectel-ppp)
ipcp-max-failure 30             # (from /etc/ppp/peers/quectel-ppp)
defaultroute            # (from /etc/ppp/peers/quectel-ppp)
usepeerdns              # (from /etc/ppp/peers/quectel-ppp)
noccp           # (from /etc/ppp/peers/quectel-ppp)
noipx           # (from /etc/ppp/options)
abort on (BUSY)
abort on (NO CARRIER)
abort on (NO DIALTONE)
abort on (ERROR)
abort on (NO ANSWER)
timeout set to 30 seconds
send (AT^M)
expect (OK)
^M
OK
 -- got it

send (ATE0^M)
expect (OK)
^M
^M
OK
 -- got it

send (ATI;+CSUB;+CSQ;+CPIN?;+COPS?;+CGREG?;&D2^M)
expect (OK)
^M
^M
```

Figure 19: Start PPP Dail-up (1)

```
Script chat -s -v -f /etc/ppp/peers/quectel-chat-connect finished (pid 2276), status = 0x0
Serial connection established.
using channel 1
Using interface ppp0
Connect: ppp0 <--> /dev/ttyUSB3
sent [LCP ConfReq id=0x1 <asyncmap 0x0> <magic 0x47be6037> <pcomp> <accomp>]
rcvd [LCP ConfReq id=0x7 <asyncmap 0x0> <auth chap MD5> <magic 0xa32ab458> <pcomp> <accomp>]
sent [LCP ConfAck id=0x7 <asyncmap 0x0> <auth chap MD5> <magic 0xa32ab458> <pcomp> <accomp>]
rcvd [LCP ConfAck id=0x1 <asyncmap 0x0> <magic 0x47be6037> <pcomp> <accomp>]
sent [LCP EchoReq id=0x0 magic=0x47be6037]
rcvd [LCP DiscReq id=0x8 magic=0xa32ab458]
rcvd [CHAP Challenge id=0x1 <b9946c823305f5d193b40b8130c2cb74>, name = "UMTS_CHAP_SRVR"]
sent [CHAP Response id=0x1 <526cf8b5852c7f3119e10c2882b6487d>, name = "test"]
rcvd [LCP EchoRep id=0x0 magic=0xa32ab458 47 be 60 37]
rcvd [CHAP Success id=0x1 ""]
CHAP authentication succeeded
CHAP authentication succeeded
sent [IPCP ConfReq id=0x1 <addr 0.0.0.0> <ms-dns1 0.0.0.0> <ms-dns2 0.0.0.0>]
rcvd [IPCP ConfReq id=0x5]
sent [IPCP ConfNak id=0x5 <addr 0.0.0.0>]
rcvd [IPCP ConfNak id=0x1 <addr 10.60.79.174> <ms-dns1 202.103.224.68> <ms-dns2 202.103.225.68>]
sent [IPCP ConfReq id=0x2 <addr 10.60.79.174> <ms-dns1 202.103.224.68> <ms-dns2 202.103.225.68>]
rcvd [IPCP ConfReq id=0x6]
sent [IPCP ConfAck id=0x6]
rcvd [IPCP ConfAck id=0x2 <addr 10.60.79.174> <ms-dns1 202.103.224.68> <ms-dns2 202.103.225.68>]
Could not determine remote IP address: defaulting to 10.64.64.64
local  IP address 10.60.79.174
remote IP address 10.64.64.64
primary   DNS address 202.103.224.68
secondary DNS address 202.103.225.68
Script /etc/ppp/ip-up started (pid 2292)
Script /etc/ppp/ip-up finished (pid 2292), status = 0x0
```

Figure 20: Start PPP Dail-up (2)

6. Check the USBnet information:

```
~$ ifconfig ppp0
```

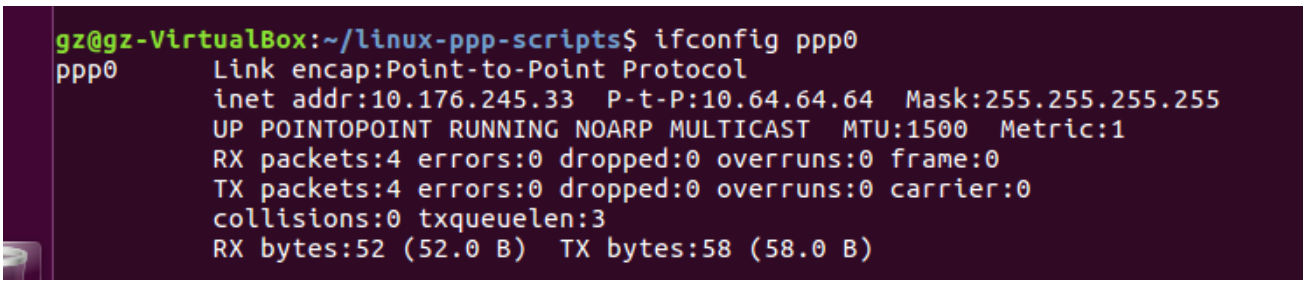

Figure 21: Check the USBnet Information

7. Check the route information:

```
~$ route -n
```

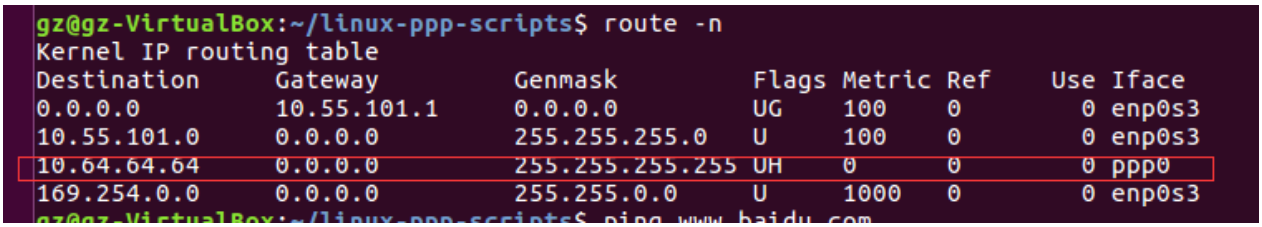

Figure 22: Check the Route Information

8. Check DNS information

```
~$ cat /etc/resolv.conf
```

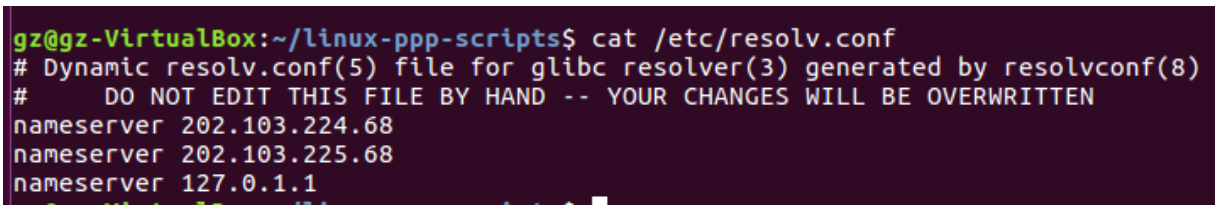

Figure 23: Check DNS Information

9. Check the network connection status:

```
~$ ping www.baidu.com
```

```
gz@gz-VirtualBox:~/linux-ppp-scripts$ ping www.baidu.com
PING www.a.shifen.com (14.215.177.38) 56(84) bytes of data.
64 bytes from 14.215.177.38: icmp_seq=1 ttl=52 time=23.2 ms
64 bytes from 14.215.177.38: icmp_seq=2 ttl=52 time=23.5 ms
64 bytes from 14.215.177.38: icmp_seq=3 ttl=52 time=23.9 ms
64 bytes from 14.215.177.38: icmp_seq=4 ttl=52 time=21.9 ms
64 bytes from 14.215.177.38: icmp_seq=5 ttl=52 time=24.5 ms
64 bytes from 14.215.177.38: icmp_seq=6 ttl=52 time=24.6 ms
64 bytes from 14.215.177.38: icmp_seq=7 ttl=52 time=23.8 ms
64 bytes from 14.215.177.38: icmp_seq=8 ttl=52 time=23.9 ms
64 bytes from 14.215.177.38: icmp_seq=9 ttl=52 time=21.7 ms
```

Figure 24: Check Network Connection Status

6.3.1.2. Dail-up Through quectel-pppd.sh

The dialing principle of the *shell* script is the same as that of the above dial-up through **pppd**, which sends AT command to the modem to perform PPP dial-up. The verification steps after successful dial-up are the same as that of the above dial-up through **pppd**.

Start dail-up:

```
~$ ./quectel-pppd.sh /dev/ttyUSB3 cmnet test test ATD*99***2#
```

```
gz@gz-VirtualBox:~/linux-ppp-scripts$ sudo ./quectel-pppd.sh /dev/ttyUSB3 cmnet test test ATD*99***2#
quectel-pppd options in effect:
devname   /dev/ttyUSB3    # (from command line)
apn       cmnet     # (from command line)
user      test   # (from command line)
password  test   # (from command line)
./quectel-pppd.sh: 42: [: IP: unexpected operator
./quectel-pppd.sh: 45: [: IP: unexpected operator
gz@gz-VirtualBox:~/linux-ppp-scripts$ pppd options in effect:
debug           # (from command line)
nodetach            # (from command line)
dump            # (from command line)
noauth          # (from command line)
user test           # (from command line)
password ??????         # (from command line)
/dev/ttyUSB3            # (from command line)
115200          # (from command line)
lock            # (from command line)
connect ''chat -s -v ABORT BUSY ABORT \"NO CARRIER\" ABORT \"NO DIALTONE\" ABORT ERROR ABORT \"NO ANSWER\" TIMEOUT 30 \"\" AT OK ATE0 OK ATI\\;+CSUB\\;+CSQ\\;+CPIN?\\;+COPS?\\;+CGREG?\\;\\&D2 OK AT+CGDCONT=1,\\\"IP\\\",\\\"cmnet\\\",,0,0 OK ATD*99***1# CO
            # (from command line)
```

Figure 25: Dail-up Through shell_PPP

```
#quectel-pppd devname apn user password
echo "quectel-pppd options in effect:"
QL_DEVNAME=/dev/ttyUSB3
QL_APN=3gnet
QL_USER=user
QL_PASSWORD=passwd
QL_PDP=1
QL_IP=IP #IP, IPV4, IPV6, IPV4V6
```

Figure 26: Parameters of the Shell Script

Among them, *QL_PDP*, *QL_IP* and *QL_APN* can be configured by **AT+CGDCONT=$QL_PDP,"$QL_IP","$QL_APN",,0,0** to modify or create a APN in PPP dail-up, and *QL_PDP* can be configured by **ATD*99***$QL_PDP** to specify the channel to be used for dial-up.

6.3.1.3. Hang Up PPP Dail-up

- Hang up through **pppd**:

```
~$ sudo killall pppd
```

- Hang up through executing the script:

```
~$ sudo ./quectel-ppp-kill
```

- Hang up through AT command:

```
~$ sudo minicom -D /dev/ttyUSB2

~$ AT&D2
```

The module should be rebooted after hanging up dail-up, otherwise the next dial-up will fail.

6.3.2. Process of PPP Dial-up through Scripts

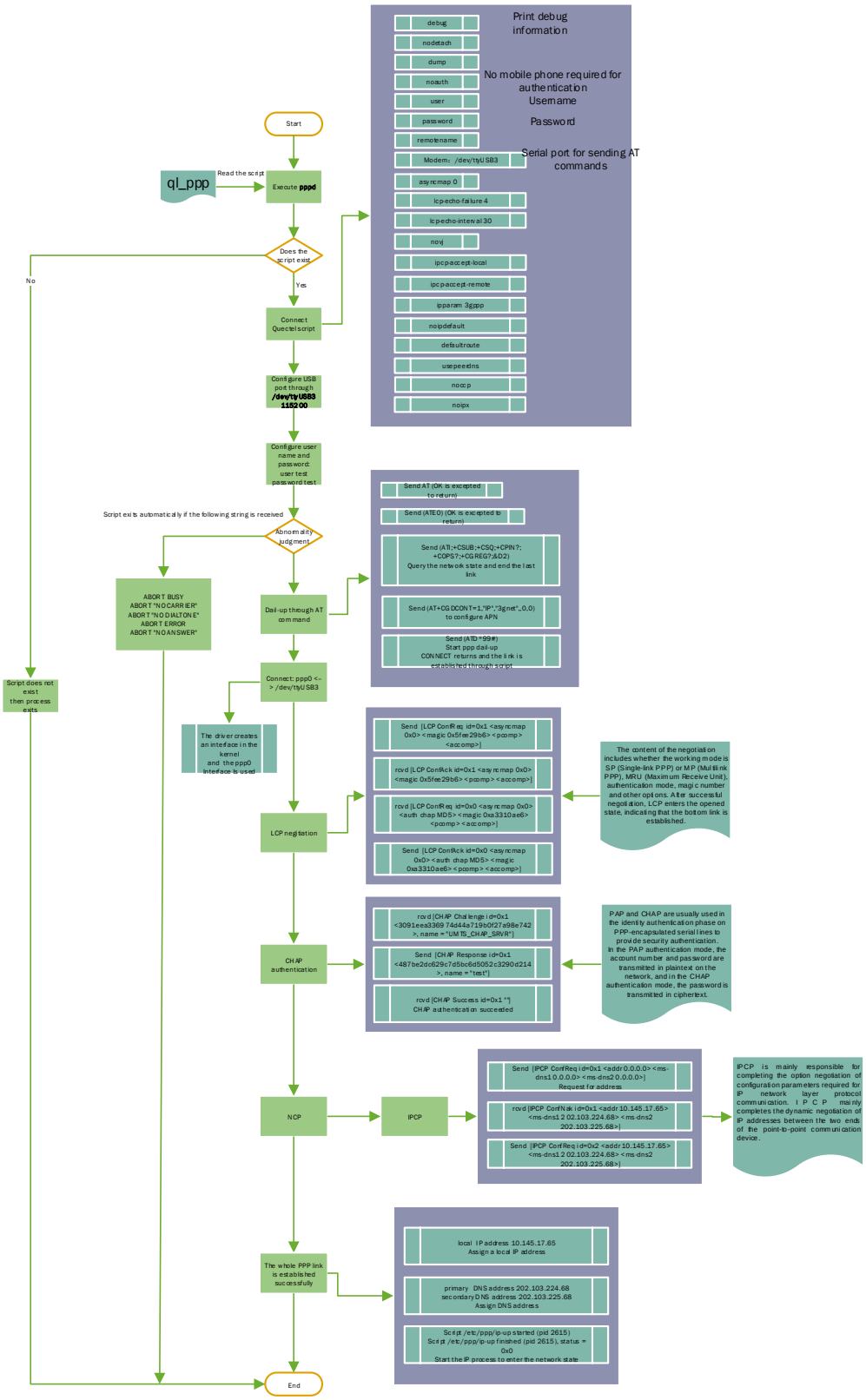

Figure 27: Process of PPP Dial-up Through Scripts

7 Appendix and References

Table 2: Terms and Abbreviations

Abbreviation	Description
APN	Access Point Name
CHAP	Challenge Handshake Authentication Protocol
DCD	Data Carrier Detection
DNS	Domain Name Server
DTR	Data Terminal Ready
GPRS	General Packet Radio Service
GSM	Global System of Mobile Communication
IP	Internet Protocol
IPCP	IP Control Protocol
LCP	Link Control Protocol
MCU	Micro Control Unit
MS	Mobile Station
PAP	Password Authentication Protocol
PDP	Packet Data Protocol
PIN	Personal Identification Number
PPP	Point-to-Point Protocol. The Point-to-Point Protocol is designed for simple links which transport packets between two ports. These links provide full-duplex simultaneous bi-directional operation, and are assumed to deliver packets in order. It is intended that PPP provides a common solution for easy connection of a wide variety of hosts, bridges and routers.
RI	Ring Indicator

TA	Terminal Adapter
TE	Terminal Equipment
UART	Universal Asynchronous Receiver Transmitter
(U)SIM	(Universal) Subscriber Identity Module