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FIBOCOM NL668 Application Guide_PPP Dial-up in Linux

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Applicability type

No.	Product model	Description
1	NL668	NA
2	NL652	NA

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Versions

Version	Author	Assessor	Approver	Update Date	Description
V1.0.0				2018-05-13	Initial version
V1.0.1				2018-12-17	Standardized format
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Contents

1 Introduction

The Point-to-Point Protocol (PPP) is a link layer protocol designed for simple links that transport packets between peer units. This kind of links provide full-duplex operations and transfers packets in order. The purpose of it is to establish point-to-point connections for data transmission through dial-up or dedicated line, making it a common solution for simple connections between hosts, bridges and routers. This document mainly describes the PPP dial-up in Linux.

2 USB Port Information

Port Number	Port Information
17	Diag+Modem+AT+Pipe+RMNET+ADB
18	Diag+Modem+AT+Pipe+ECM+ADB
19	Diag+Modem+Pipe+RMNET
20	Modem
21	Modem+AT
22	Modem+AT+RMNET
23	Modem+AT+ECM
24	RNDIS+Modem+Diag+ADB

Table 2-1

Description:

The module's USB supports multiple modes. When using PPP dial-up, it must include AT port or Modem port. Send AT+GTUSBMODE? to the module,If it returns +GTUSBMODE: 17 (default), GTUSBMODE is 17 already contains AT port or Modem port, so it can be used for PPP dial-up. If you need to set to ECM dial-up, the setting command is AT+GTUSBMODE=18 or 23. After the module returns OK, set the power-down save and the restart will take effect.

[1] If a device with the same name already exists before module enumeration, then the port number of the module will auto-increment. Some systems may modify the device name by default.

3 USB Enumeration Mode Confirmation

For PPP dial-up, you need to use AT port or Modem port, as long as there is an AT port or Modem port in the enumeration, you can perform PPP dial-up.

4 USB Serial Port Driver Integration

4.1 System Components for Adding USB Serial Port Driver

The adding of USB serial port driver requires the configuration of Linux kernel, and the configuration method is as follows:

```
cd kernel
make menuconfig
device drivers->usb support->usb serial converter support
```

Select the following components:

```
USB driver for GSM and CDMA modems
```

Save the configuration.

4.2 Adding Device Support

1: Open the kernel source file option.c (the path is generally drivers/usb/serial/option.c). Find the option_ids array in the source codes, and add the VID(0x1508) and PID(0x1001) of NL668 product to the array;

```
static const struct usb_device_id option_ids[] = {
… …
#if 1
{ USB_DEVICE(0x1508, 0x1001) },
#endif
… …
```

2: Filter NDIS interface in USB serial port driver. USB serial port and NDIS are non-standard CDC devices, therefore, it is necessary to prevent NDIS port from being loaded by USB serial port driver, which causes that NDIS port driver cannot be loaded normally. There are three solutions:

A: For new kernel versions (3.8 or above), add a blacklist to option_ids in option.c. When loading, the driver will automatically skip the interfaces specified in the blacklist. Set interface 4 to not load option driver, the codes are as follows:

```
#if 1
static const struct option_blacklist_info fibocom_blacklist = {
    .reserved = BIT(4),
};
```

```
#endif
```

Add a blacklist to the option_ids array, the codes are as follows:

```
#if 1
{ USB_DEVICE(0x1508, 0x1001),
      .driver_info = (kernel_ulong_t)fibocom_blacklist
}
#endif
```

B: (Recommended) For previous kernel versions, it is not supported to set a blacklist in the option_ids array. It requires adding the PID/VID of NL668 series first, the codes are as follows:

```
static const struct usb_device_id option_ids[] = {
#if 1
{ USB_DEVICE(0x1508, 0x1001)}
#endif
```

And, judge the current interface num in the probe function for filtering, the codes are as follows:

```
#if 1
      if (serial->dev->descriptor.idVendor == cpu_to_le16(0x1508) &&
      serial->dev->descriptor.idProduct == cpu_to_le16(0x1001) &&
      serial->interface->cur_altsetting->desc.bInterfaceNumber >3) {
      printk(KERN_INFO “Discover the 4th interface for fibocom\n”);
      return –ENODEV;
}
#endif
```

C: (Not recommended) For usb-serial.ko drivers, you need to add the following judgment to the beginning of the usb_serial_probe() function in the usb-serial.c file to filter NDIS interface, the codes are as follows:

```
#if 1
      if (serial->cur_altsetting->desc.bInterfaceNumber >3) {
      printk(KERN_INFO “Discover the 4th interface for fibocom\n”);
      return –ENODEV;}
#endif
```

4.3 USB Serial Port Driver Loading Confirmation

Execute sudo modprobe option, use lsusb and ls /dev/ttyUSB* commands to check whether the loading succeeds, the codes are as follows:

```
root@ubuntu:/# lsusb
```

Bus 001 Device 005: ID 1508:1001

Bus 002 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse

Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub

Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub

Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub

Bus 002 Device 004: ID 0e0f:0008 VMware, Inc.

root@ubuntu:/# modprobe usbserial vendor=0x1508 product=0x1001

root@ubuntu:/# ls /dev/ttyUSB*

/dev/ttyUSB0 /dev/ttyUSB1 /dev/ttyUSB2 /dev/ttyUSB3

5 Linux Environment Confirmation

5.1 Check Whether pppd is Installed

Generally, Linux supports pppd by default, you can check it using the following method. If it is not installed, you can download the latest version from http://ppp.samba.org/.

[root@fedoral whl]# pppd --help

pppd version 2.4.2

Usage: pppd [options], where options are:

<device> Communicate over the named device

<speed> Set the baud rate to <speed>

<loc>:<rem> Set the local and/or remote interface IP addresses. Either one may be omitted.

asyncmap <n> Set the desired async map to hex <n>

auth Require authentication from peer

connect <p> Invoke shell command <p> to set up the serial line

crtscts Use hardware RTS/CTS flow control

defaultroute Add default route through interface

file <f> Take options from file <f>

modem Use modem control lines

mru <n> Set MRU value to <n> for negotiation

See pppd(8) for more options.

5.2 PPP dial-up script

Take wcdma as an example, the specific operations are as follows:

1: pppd connection option file /etc/ppp/peers/wcdma

Note that the punctuation marks such as double quotes are different between Windows and Linux;

```
# Usage: root>pppd call wcdma
/dev/ttyUSB1
115200
#noauth
nocrtscts
nocdtrcts
local
debug
nobsdcomp
nodeflate
nodetach
novj
defaultroute
noipdefault
usepeerdns
ipcp-accept-local
ipcp-accept-remote
mru 1280
mtu 1500
#lock
connect '/usr/sbin/chat -s -v -f /etc/ppp/chat/wcdma-connect-chat'
```

2: Connection establishment rule file /etc/ppp/chat/ wcdma-connect-chat

```
TIMEOUT 15
ABORT "DELAYED"
ABORT "BUSY"
ABORT "ERROR"
ABORT "NO DIALTONE"
ABORT "NO CARRIER"
TIMEOUT 40
"    \rAT
```

OK ATS0=0

OK ATE0V1

OK AT+CGDCONT=1,"IP","3gnet"

OK ATDT*99***1#

CONNECT ''

Description: Briefly explain the statement in the script wcdma-connect-chat AT+CGDCONT=1, "IP", "3gnet". If you want to set the pdp type to IPV4V6 or IPV6, just replace the IP with IPV4V6 or IPV6. If you want to change to the apn name, just replace 3gnet with the corresponding operator's apn (first consult the local operator or Fibocom FAE). If you replace it with mobile, you only need to replace 3gnet with cmnet.

5.3 PPP authentication method

In general, there are two ways to perform PPP authentication, one is PAP authentication and the other is CHAP authentication. The username and password required for authentication are stored in the pap-secrets and chap-secrets scripts. When authentication is required, the PPP module will be from pap-secrets and chap- by specifying the authentication method in the options script as PAP or CHAP-. The secret name script reads the user name and password, attaches it to the PPP authentication package, and sends it to the server for identity authentication.

5.3.1 PAP Authentication

The authentication file pap-secrets can be modified as needed. The corresponding directory is /etc/ppp/pap-secrets.

/etc/ppp # cat pap-secrets

Secrets for authentication using PAP

client server secret IP addresses

Myclient ISP-server mypassword *

The parameters have the following meanings:

Myclient --- The caller's PAP username.

ISP-server --- The name of the remote computer.

Mypassword --- The caller's PAP password.

* --- The IP address associated with the caller. Use an asterisk (*) to indicate any IP address.

For example: cmnet * cmnet * (configured according to the actual network username and password)

5.3.2 CHAP Authentication

The authentication file chap-secrets can be modified as needed, and the corresponding directory is /etc/ppp/chap-secrets

/etc/ppp # cat chap-secrets

Secrets for authentication using CHAP

client server secret IP addresses

Myclient ISP-server secret5748 *

The parameters have the following meanings:

Myclient --- The CHAP user of the caller.

ISP-server --- The name of the remote computer.

Secret5748 --- Caller's CHAP secret

* --- The IP address associated with the caller. Use an asterisk (*) to indicate any IP address.

Note：

It can be dialed if the authentication mode is not set, but if it is set, it can not be dialed. Solution: When setting PAP authentication mode, add the corresponding user name password to pap-secrets, and add auth and user card to the / etc/ppp/peers/wcdma file of pppd. similarly, in the chap authentication mode, add the corresponding username and password in chap-secrets, and add noauth and user card to pppd's /etc/ppp/peers/wcdma file. The corresponding chap-secrets and pap-secrets scripts are placed in the same directory. The parameters in the corresponding wcdma script can be explained in the options script (in the same directory). The script in the document is only a part of the reference function. The specific configuration can be configured by referring to the parameter description in the options script.

6 PPP Dial-up

Enter pppd call wcdma on the terminal

Note that the dial-up and the switching of user command su is only possible after getting the root privileges.

When the dial-up is successful, you can query the log through command cat /var/log/message. The normal situation is as follows:

Nov 15 20:56:10 fedoral kernel: [1022.8440048] PPP generic driver version 2.4.2

Nov 15 20:56:10 fedoral pppd[2699]: pppd 2.4.5 started by whl, uid 0

Nov 15 20:56:10 fedoral chat[2700]: abort on (BUSY)

Nov 15 20:56:10 fedoral chat[2700]: abort on (NO CARRIER)

Nov 15 20:56:10 fedoral chat[2700]: abort on (ERROR)

Nov 15 20:56:10 fedoral chat[2700]: abort on (+CME ERROR: 100)

Nov 15 20:56:10 fedoral chat[2700]: send (AT^M)

Nov 15 20:56:10 fedoral chat[2700]: expect (OK)

Nov 15 20:56:10 fedoral chat[2700]: AT^M^M

Nov 15 20:56:10 fedoral chat[2700]: OK

Nov 15 20:56:10 fedoral chat[2700]: -- got it

Nov 15 20:56:10 fedoral chat[2700]: send (AT+CGDCONT=1,”IP”,”CMNET”^M)

Nov 15 20:56:11 fedoral chat[2700]: expect (OK)

Nov 15 20:56:11 fedoral chat[2700]: ^M

Nov 15 20:56:11 fedoral chat[2700]: AT+CGDCONT=1,”IP”,”CMNET”^M^M

Nov 15 20:56:11 fedoral chat[2700]: OK

Nov 15 20:56:11 fedoral chat[2700]: -- got it

Nov 15 20:56:11 fedoral chat[2700]: send (AT^M)

Nov 15 20:56:11 fedoral chat[2700]: expect (OK)

Nov 15 20:56:11 fedoral chat[2700]: ^M

Nov 15 20:56:11 fedoral chat[2700]: AT^M^M

Nov 15 20:56:11 fedoral chat[2700]: OK

Nov 15 20:56:11 fedoral chat[2700]: -- got it

Nov 15 20:56:11 fedoral chat[2700]: send (ATDT*99***1#^M)

Nov 15 20:56:11 fedoral chat[2700]: expect (CONNECT)

Nov 15 20:56:11 fedoral chat[2700]: ^M

Nov 15 20:56:11 fedoral chat[2700]: ATDT*99***1#^M^M

Nov 15 20:56:11 fedoral chat[2700]: CONNECT

Nov 15 20:56:11 fedoral chat[2700]: -- got it

Nov 15 20:56:11 fedoral pppd[2699]: Serial connection established

Nov 15 20:56:11 fedoral pppd[2699]: Using interface ppp0

Nov 15 20:56:11 fedoral pppd[2699]: not replacing existing default route via 192.168.40.2

Nov 15 20:56:11 fedoral pppd[2699]: local IP address 172.16.178.254

Nov 15 20:56:11 fedoral pppd[2699]: remote IP address 172.16.178.254

Nov 15 20:56:11 fedoral pppd[2699]: primary DNS address 210.21.196.6

Nov 15 20:56:11 fedoral pppd[2699]: secondary DNS address 221.5.88.88

In addition, you can also query the network interface by the command ifconfig. The normal situation is as follows, and the dial-up succeeds.

```
[root@fedoral whl]# ifconfig
eth0      Link encap:Ethernet  HWaddr 08:94:ef:0a:2d:f0
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:500
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:48351160 errors:0 dropped:0 overruns:0 frame:0
          TX packets:48351160 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:45562895173 (45.5 GB)  TX bytes:45562895173 (45.5 GB)
ppp0      Link encap:  Point-to-Point Protocol
          inet addr:172.16.178.254  P-t-P:172.16.178.254  Mask:255.255.255.255
          UP BROADCAST MULTICAST  MTU:1280  Metric:1
          RX packets:3 errors:0 dropped:0 overruns:0 frame:0
          TX packets:4 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
          RX bytes:54 (54.0 B)  TX bytes:76 (76.0 B)
```

7 Reference Flow Chart of PPP Dial-up

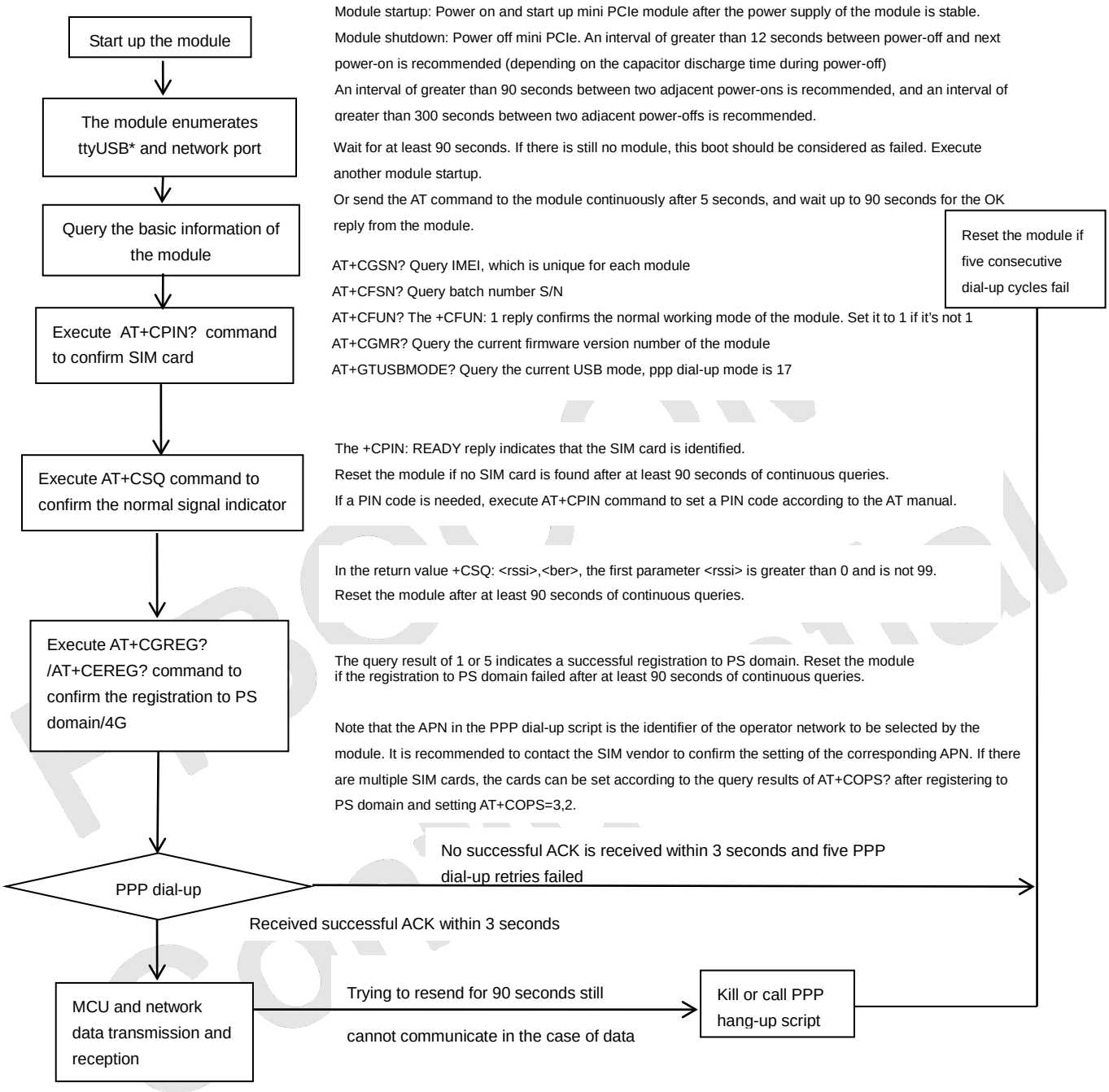

Figure 7-1

Note:

ttyUSB1 is adopted for PPP dial-up by default. After PPP dial-up, the port does not respond to common AT commands. The above AT commands are sent via ttyUSB2.

8 FAQ

8.1 How to mount the module from Windows to an Ubuntu virtual machine under Windows?

“Virtual Machine”------>“Removable Device”------>“Qualcomm Android”------>“Connect”

Conversely, select “Disconnect” to release from the virtual machine.

8.2 Why didn’t I see the PID 1508 and VID 1001 of the module after executing lsusb and dmesg? What is USB mode?

This may be because the USB mode of the module is not in RmNet mode, i.e., GTUSBMODE 17 mode. In fact, both GTUSBMODE 17 and 18 support PPP dial-up, and different modes correspond to different PIDs and VIDs.

(1) When the module GTUSBMODE is 19, as shown in Figures 8-1 and 8-2.

```
root@ubuntu:/home/fae/Downloads# lsusb
Bus 001 Device 045: ID 05c6:9025 Qualcomm, Inc. Qualcomm HSUSB Device
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 004: ID 0e0f:0008 VMware, Inc.
Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 002 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
root@ubuntu:/home/fae/Downloads#
```

Figure 8-1

```
[ 2331.815550] usb 1-1: new high-speed USB device number 51 using ehci-pci
[ 2332.178801] usb 1-1: New USB device found, idVendor=05c6, idProduct=9025
[ 2332.178804] usb 1-1: New USB device strings: Mfr=1, Product=2, SerialNumber
=3
[ 2332.178806] usb 1-1: Product: Android
[ 2332.178807] usb 1-1: Manufacturer: Android
[ 2332.178808] usb 1-1: SerialNumber: 12345678
[ 2332.235284] qmi_wwan 1-1:1.4: cdc-wdm0: USB WDM device
[ 2332.235850] qmi_wwan 1-1:1.4 wwan0: register 'qmi_wwan' at usb-0000:02:03.0
-1, WWAN/QMI device, 7e:1d:77:81:f6:cc
[ 2332.238889] usb-storage 1-1:1.5: USB Mass Storage device detected
[ 2332.238946] scsi host82: usb-storage 1-1:1.5
[ 2333.243797] scsi 82:0:0:0: Direct-Access     Linux    File-CD Gadget   0310
 PQ: 0 ANSI: 2
[ 2333.247704] sd 82:0:0:0: Attached scsi generic sg3 type 0
[ 2333.263609] sd 82:0:0:0: [sdb] Attached SCSI removable disk
```

Figure 8-2

How to switch USB mode? Connect the USB interface of the module to the PC, and start up the module normally. After installing the USB driver of the module in Windows, the port and modem virtualized by the module can be seen via the device manager. Confirm the modem port according to the properties of modem, use the serial port assistant to select this port, and check “CTS”, “RTS” and baud rate 115200. If you need to switch to RmNet mode, the command is AT+GTUSBMODE=17, and the module replies OK. Set power-down data storage, and restart to take effect, as shown in Figure 8-3.

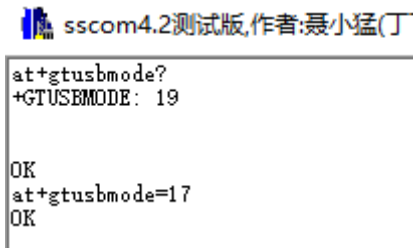

Figure 8-3

(2) When GTUSBMODE is 18

When the driver is not installed in Windows, the device manager prompts as shown in Figure 8-4.

Figure 8-4

Executing dmesg under Linux can be printed as shown in Figure 8-5.

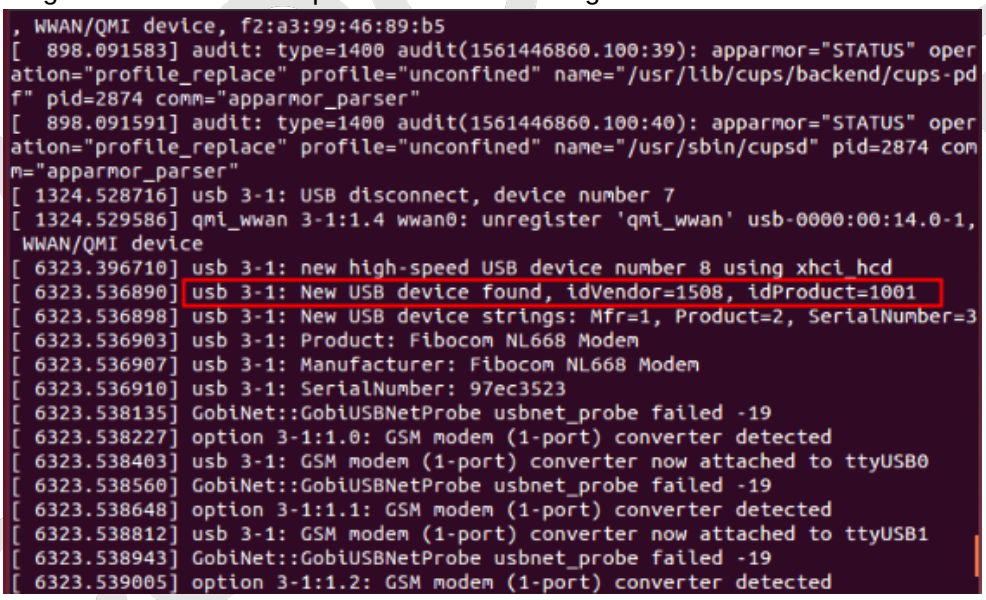

Figure 8-5

For Ubuntu, when the module is properly started up and USB is mounted in Ubuntu system, you can see the above PID and VID after executing dmesg.

Save the following codes as nl668.sh and then execute chmod 777 nl668.sh and ./nl668.sh, you can see the module port, as shown in Figure 8-6.

```
#!/bin/bash
KV=`uname -r`
echo "############ insmod NL668 drivers ########\r\n"
insmod /lib/modules/$KV/kernel/drivers/usb/serial/usbserial.ko
```

insmod /lib/modules/$KV/kernel/drivers/usb/serial/usb_wwan.ko

insmod /lib/modules/$KV/kernel/drivers/usb/serial/option.ko

echo "############ Load NL668 drivers ########\r\n"

echo "1508 1001 ff" > /sys/bus/usb-serial/drivers/option1/new_id

ls -al /dev/ttyUSB*

ls /sys/class/net

Ifconfig

```
root@haven-K45VD:/home/haven/share# ./nl668.sh
############ insmod NL668 drivers ########\r\n
insmod: ERROR: could not insert module /lib/modules/4.4.0-142-generic/kernel/dri
vers/usb/serial/usbserial.ko: File exists
insmod: ERROR: could not insert module /lib/modules/4.4.0-142-generic/kernel/dri
vers/usb/serial/usb_wwan.ko: File exists
insmod: ERROR: could not insert module /lib/modules/4.4.0-142-generic/kernel/dri
vers/usb/serial/option.ko: File exists
############ Load NL668 drivers ########\r\n
crw-rw---- 1 root dialout 188, 0  6月 25 16:45 /dev/ttyUSB0
crw-rw---- 1 root dialout 188, 1  6月 25 16:45 /dev/ttyUSB1
crw-rw---- 1 root dialout 188, 2  6月 25 16:44 /dev/ttyUSB2
crw-rw---- 1 root dialout 188, 3  6月 25 16:44 /dev/ttyUSB3
crw-rw---- 1 root dialout 188, 6  6月 25 16:45 /dev/ttyUSB6
eth0  lo  wlan0
eth0      Link encap:以太网  硬件地址 60:a4:4c:7b:0c:0b
          inet 地址:192.168.23.5  广播:192.168.23.255  掩码:255.255.252.0
```

Figure 8-6

(3) When AT+GTUSBMODE=17, as shown in Figures 8-7 and 8-8.

Figure 8-7

```
ght@ubuntu:~$ lsusb
Bus 001 Device 002: ID 1508:1001
Bus 002 Device 002: ID 0e0f:0003 VMware, Inc. Virtual Mouse
Bus 002 Device 003: ID 0e0f:0002 VMware, Inc. Virtual USB Hub
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
Bus 002 Device 004: ID 067b:2303 Prolific Technology, Inc. PL2303 Serial Port
ght@ubuntu:~$
```

Figure 8-8

8.3 How to view the USB port form of module, check SIM card, signal strength and dial-up situation when the Internet is inaccessible?

Assume that the USB mode of the current module is GTUSBMODE 18, and the enumerated ports are /dev/ttyUSB0, /dev/ttyUSB1, /dev/ttyUSB2, /dev/ttyUSB3, /dev/ttyUSB4 and network port USB0. Note that if a device with the same name already exists before module enumeration, then the port number of the module will auto-increment.

You can adopt echo mode to view the status via ttyUSB1 and ttyUSB2.

(1) Confirm SIM card, signal strength, registration network status and network type, as shown in Figures 8-9 and 8-10.

```
root@ubuntu:/home/fae/Downloads# echo -e "ATE0\r\n" > /dev/ttyUSB2
[1]   Done                    cat /dev/ttyUSB1
[2]-  Done                    cat /dev/ttyUSB1
[3]+  Done                    cat /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads# cat /dev/ttyUSB2 &
[1] 3349
root@ubuntu:/home/fae/Downloads# echo -e "ATE0\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+CPIN?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
+CPIN: READY

OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+CSQ\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
+CSQ: 27,99

OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+CREG?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
+CREG: 0,1

OK
```

Figure 8-9

```
root@ubuntu:/home/fae/Downloads# echo -e "AT+CGREG?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
+CGREG: 0,1

OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+COPS=3,2\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+COPS?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads#
+COPS: 0,2,"46001",7

OK
```

Figure 8-10

(2) When SIM card cannot be identified, as shown in Figures 8-11.

```
root@ubuntu:/home/fae/Downloads# echo -e "AT+CPIN?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads# AT+CPIN?
ERROR

root@ubuntu:/home/fae/Downloads# echo -e "AT+CMEE=2\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads# AT+CMEE=2
OK

root@ubuntu:/home/fae/Downloads# echo -e "AT+CPIN?\r\n" > /dev/ttyUSB2
root@ubuntu:/home/fae/Downloads# AT+CPIN?
+CME ERROR: SIM not inserted
```

Figure 8-11

(3) Check the routing table after executing pppd call wcdma & dial-up, as shown in Figures 8-12.

```
root@ubuntu:/home/fae/Downloads# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
default         *               0.0.0.0         U     0      0        0 ppp0
10.64.64.64     *               255.255.255.255 UH    0      0        0 ppp0
root@ubuntu:/home/fae/Downloads#
root@ubuntu:/home/fae/Downloads# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         0.0.0.0         0.0.0.0         U     0      0        0 ppp0
10.64.64.64     0.0.0.0         255.255.255.255 UH    0      0        0 ppp0
root@ubuntu:/home/fae/Downloads#
```

Figure 8-12

(4) Ping to check the connectivity, as shown in Figures 8-13.

```
root@ubuntu:/home/fae/Downloads# ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=248 time=28.7 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=248 time=25.7 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=248 time=34.0 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=248 time=32.9 ms
^C
--- 8.8.8.8 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3006ms
rtt min/avg/max/mdev = 25.773/30.379/34.027/3.323 ms
root@ubuntu:/home/fae/Downloads# ping www.baidu.com
PING www.baidu.com (163.177.151.109) 56(84) bytes of data.
64 bytes from 163.177.151.109: icmp_seq=1 ttl=54 time=28.4 ms
64 bytes from 163.177.151.109: icmp_seq=2 ttl=54 time=30.7 ms
64 bytes from 163.177.151.109: icmp_seq=3 ttl=54 time=37.7 ms
64 bytes from 163.177.151.109: icmp_seq=4 ttl=54 time=35.5 ms
64 bytes from 163.177.151.109: icmp_seq=5 ttl=54 time=33.5 ms
^C
--- www.baidu.com ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 8624ms
rtt min/avg/max/mdev = 28.491/33.218/37.742/3.303 ms
```

Figure 8-13