UMTS_LTE_5G Linux USB Driver User Guide

UMTS/HSPA+/LTE/5G Module Series

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About the Document

Revision History

Version	Date	Author	Description
1.0	2015-02-27	Joe WANG	Initial
1.1	2015-3-25	Carl YIN	Updated supported products
1.2	2015-3-30	Kent XU	Added Zero Packet feature in Section 3.2.2 and 3.3.2
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1.4	2015-12-16		1. Deleted Auto-Connect of GobiNet and QMI WWAN 2. Updated the usage of quectel-CM
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1.6	2016-08-23	Kent XU	Added EC20 R2.0 in supported modules
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			5. Added FAQs in Chapter 6.
3.0	2022-03-18	Carl YIN	1. Added applicable modules. 2. Updated the overview of Linux USB driver (Chapter 2). 3. Updated the steps of integrating USB serial option driver into the Linux operating system (Chapter 3.2). 4. Updated the kernel configuration modification of GobiNet driver (Chapter 3.3.2). 5. Updated the kernel configuration modification of QMI_WWAN_Q (Chapter 3.4.2). 6. Added the description of ACM/ECM/RNDIS/NCM/MBIM drivers (Chapter 3.5). 7. Updated the information about how to configure the kernel to support PPP (Chapter 3.6). 8. Added the steps of how to configure the kernel (Chapter 3.7). 9. Updated AT command testing (Chapter 4.1). 10. Removed the description of quectel-CM (Chapter 4.3). 11. Added the information about how to test ECM/RNDIS/NCM/MBIM drivers (Chapter 4.6). 12. Updated the example (Chapter 6.1).

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1 Introduction

This document introduces how to port the supported USB drivers for Quectel UMTS&LTE&5G modules into the Linux operating system, and how to test the module after the USB driver is integrated successfully. The USB driver includes the USB serial drivers like option and ACM, USBNet drivers like GobiNet, qmi_wwan_q, MBIM, NCM, RNDIS and ECM.

2 Overview of Linux USB Driver

Quectel UMTS&LTE&5G modules are USB composite devices containing multiple USB interfaces. Each USB interface supports different functionalities, which are implemented by loading different USB interface drivers. After a driver is loaded successfully, the corresponding device node is generated, which can be used by Linux system to implement the module functionalities.

The following table describes the USB interface information of different modules in the Linux system, including USB driver, interface number, device name and interface function.

You can obtain the VID, PID and interface information corresponding to the module according to the model, and then port the USB interface driver listed in the following table.

Table 1: Applicable Modules and USB Interface Information

Module's VID and PID	USB Drivers	Interface Number	Device Names	Functions
EC20-CE/ EC25 series/ EG25-G/ EM05 series: VID: 0x2c7c PID: 0x0125	USB serial option	0	/dev/ttyUSB0	DIAG
EC21 series/ EG21-G: VID: 0x2c7c PID: 0x0121		1	/dev/ttyUSB1	GNSS
EG91 series: VID: 0x2c7c PID: 0x0191 **EG95 series:**		2	/dev/ttyUSB2	AT command

VID: 0x2c7c PID: 0x0195 **BG96:** VID: 0x2c7c PID: 0x0296		3	/dev/ttyUSB3	Modem
AG35 series: VID: 0x2c7c PID: 0x0435 **AG520R series:** VID: 0x2c7c PID: 0x0452	GobiNet	4	usb0 /dev/qcqmi0	USB network adapter Configure the network card type interface as RmNet by **AT+QCFG="usbnet",0**.
AG550Q series: VID: 0x2c7c PID: 0x0455 **EG06/EP06/EM06:** VID: 0x2c7c PID: 0x0306	qmi_wwan_q	4	wwan0 /dev/cdc-wdm0	USB network adapter Configure the network card type interface as RmNet by **AT+QCFG="usbnet",0**.
EG065K series/ **EG060K-EA/** **EG120K series:** VID: 0x2c7c PID: 0x030b		4		
EG12 series/ **EM12-G/** **EG18 series:** VID: 0x2c7c PID: 0x0512 **EG512R-EA:** **EM160R-GL:** **EM120R-GL:** **EM121R-GL:** VID: 0x2c7c PID: 0x0620 **RG500Q series/** **RM500Q series/**	MBIM	5	wwan0 /dev/cdc-wdm0	USB network adapter Configure the network card type interface as MBIM by **AT+QCFG="usbnet",2**.

RG501Q-EU/ RG502Q series/ RM502Q-AE/ RM505Q-AE/ RM510Q-GL: VID: 0x2c7c PID: 0x0800				
BG95 series/ BG77/ BG600L-M3: VID: 0x2c7c PID: 0x0700	USB serial option	0	/dev/ttyUSB0	DIAG
		1	/dev/ttyUSB1	GNSS
		2	/dev/ttyUSB2	Modem
		4	/dev/ttyUSB3	Configure USB composition as modem interface mode by **AT+QCFGEXT="usbnet","modem"**. Correspond to Modem USB combination: USB DIAG + GNSS + Modem + Modem.
	ECM	3	usb0	Configure USB composition as ECM interface mode by **AT+QCFGEXT="usbnet","ecm"**. Correspond to ECM USB combination: USB DIAG + GNSS + Modem + ECM.
		4		
EC200S series/ EG915N-EU: VID: 0x2c7c PID: 0x6002 **EC200T series:** VID: 0x2c7c PID: 0x6026 **UC200T series:** VID: 0x02c7c PID: 0x6120 **EC200A series:** VID: 0x02c7c PID: 0x6005 **UC200A-GL:** VID: 0x02c7c	ECM/ RNDIS	0	usb0	Configure the network card type interface as ECM by **AT+QCFG="usbnet",1**. Configure the network card type interface as RNDIS by **AT+QCFG="usbnet",3**.
		1		
	USB serial option	2	/dev/ttyUSB0	DIAG
		3	/dev/ttyUSB1	AT command
		4	/dev/ttyUSB2	Modem

PID: 0x6006 **EG912Y series:** VID: 0x02c7c PID: 0x6001				
	ECM/ RNDIS	0	usb0	Configure the network card type interface as ECM by **AT+QCFG="usbnet",1**. Configure the network card type interface as RNDIS by **AT+QCFG="usbnet",3**.
		1		
EC200U series/ EG915U series: VID: 0x2c7c PID: 0x0901	USB serial option	2	/dev/ttyUSB0	AT command
		3	/dev/ttyUSB1	DIAG
		4	/dev/ttyUSB2	MOS
		5	/dev/ttyUSB3	CP log
		6	/dev/ttyUSB4	AP log
		7	/dev/ttyUSB5	Modem
		8	/dev/ttyUSB6	GNSS

NOTE

1. GobiNet and qmi_wwan_q can be ported simultaneously for Linux operating system, but only one of them can work at a time. i.e. if GobiNet is loaded, qmi_wwan_q cannot be loaded and vice versa.
2. The device name of current module is not fixed. If no other USB serial device is connected to user's system, the device name of current module starts from /dev/ttyUSB0 as shown above; If another USB serial device is connected to the user's system, the device name of current module is determined by the number of device nodes generated by the USB serial device. For example, if an USB serial device is connected to user's system and generates one device node, /dev/ttyUSB0 is occupied by USB serial device, then the device name of current module starts from /dev/ttyUSB1.
3. For detailed information of **AT+QCFG**, see ***document [2]***.
4. For detailed information of **AT+QCFGEXT**, see ***document [3]***.

3 System Setup

This chapter describes the general structure of the USB stack in Linux and how to use, compile and load the USB drivers.

3.1. Linux USB Driver Structure

USB is a kind of hierarchical bus structure. The data transmission between USB devices and the host is realized by the USB controller. The following figure illustrates the structure of the Linux USB driver. Linux USB host driver comprises three parts: USB host controller driver, USB core and USB device drivers.

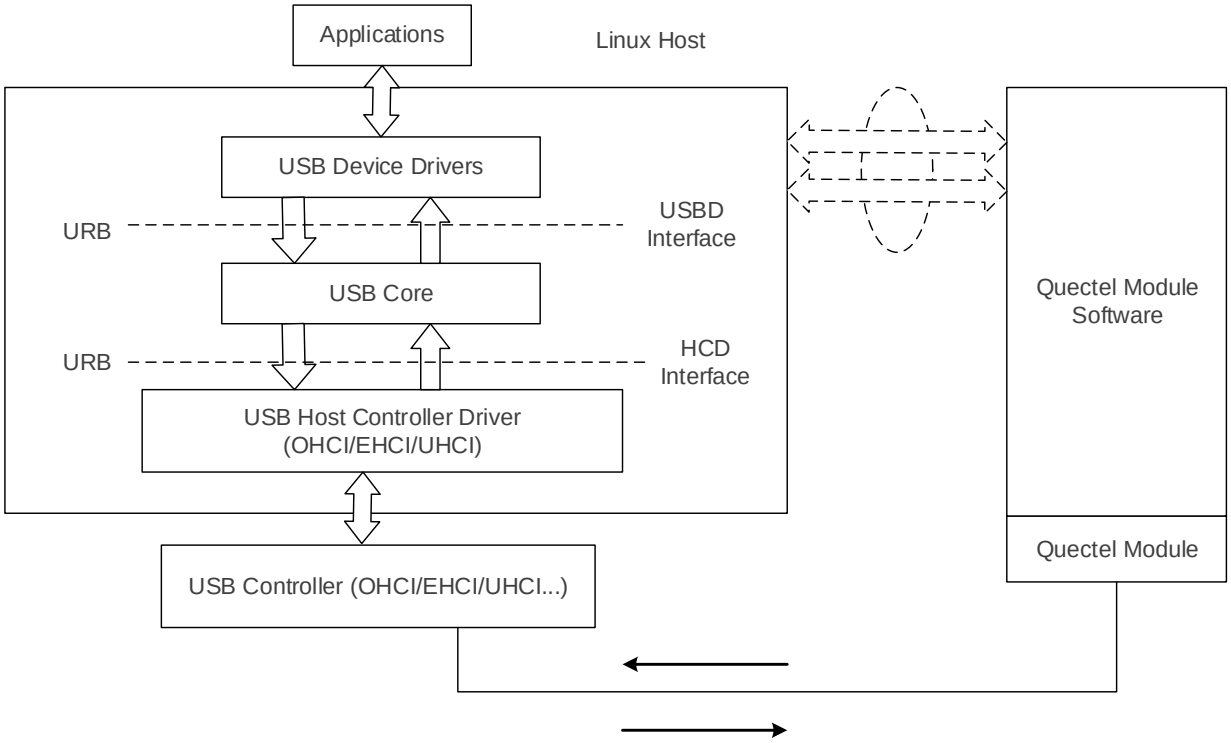

Figure 1: Linux USB Driver Structure

USB host controller driver, the bottom of the hierarchical structure, is a USB driver which interacts directly with the hardware.

USB core, the core of the whole USB host driver, is used for the management of USB bus, USB bus devices, and USB bus bandwidth; it provides the interfaces for USB device drivers, through which the applications can access the USB system files.

USB device drivers interact with the applications and provide the interfaces for accessing the specific USB devices.

3.2. USB Serial Option Driver

When the USB serial option driver has been installed in the module, the device files named as *ttyUSB0, ttyUSB1, ttyUSB2* and so on are created in directory */dev*.

The following chapters show how to port USB serial option driver into the Linux operating system.

3.2.1. Add VID and PID

In order to recognize the module, add the module's VID and PID information as below to the file *[KERNEL]/drivers/usb/serial/option.c* and the corresponding VID and PID can be obtained in ***Table 1***.

Taking EC25 series as an example:

```
static const struct usb_device_id option_ids[] = {
#if 1 //Added by Quectel
    { USB_DEVICE(0x2C7C, 0x0125) },
#endif
```

3.2.2. Use USBNet Driver

The configuration in ***Chapter 3.2.1*** makes all the USB interfaces of the module attach to USB serial option driver, which causes the USBNet driver interfaces cannot work. You can add the following statements to prevent USBNet driver interfaces attaching to USB serial option driver.

- For Linux kernel version higher than 2.6.30, you can add the following statements to the file *[KERNEL]/drivers/usb/serial/option.c*.

```
static int option_probe(struct usb_serial *serial, const struct usb_device_id *id) {
    struct usb_wwan_intf_private *data;
    ……
#if 1   //Added by Quectel
        if (serial->dev->descriptor.idVendor == cpu_to_le16(0x2C7C)) {
                __u16 idProduct = le16_to_cpu(serial->dev->descriptor.idProduct);
```

```
                struct usb_interface_descriptor *intf = &serial->interface->cur_altsetting->desc;

                if (intf->bInterfaceClass != 0xFF || intf->bInterfaceSubClass == 0x42) {
                        //ECM, RNDIS, NCM, MBIM, ACM, UAC, ADB
                        return -ENODEV;
                }

                if ((idProduct&0xF000) == 0x0000) {
                        //MDM interface 4 is QMI
                        if (intf->bInterfaceNumber == 4 && intf->bNumEndpoints == 3
                                && intf->bInterfaceSubClass == 0xFF && intf->bInterfaceProtocol
== 0xFF)
                                return -ENODEV;
                }
        }
#endif
    /* Store device id so we can use it during attach. */
    usb_set_serial_data(serial, (void *)id);
    return 0;
}
```

- For Linux kernel version lower than 2.6.31, you can add the following statements to the file *[KERNEL]/drivers/usb/serial/option.c*.

```
static int option_startup(struct usb_serial *serial)
{
……
    dbg("%s", __func__);
#if 1   //Added by Quectel
        if (serial->dev->descriptor.idVendor == cpu_to_le16(0x2C7C)) {
                __u16 idProduct = le16_to_cpu(serial->dev->descriptor.idProduct);
                struct usb_interface_descriptor *intf = &serial->interface->cur_altsetting->desc;

                if (intf->bInterfaceClass != 0xFF || intf->bInterfaceSubClass == 0x42) {
                        //ECM, RNDIS, NCM, MBIM, ACM, UAC, ADB
                        return -ENODEV;
                }

                if ((idProduct&0xF000) == 0x0000) {
                        //MDM interface 4 is QMI
                        if (intf->bInterfaceNumber == 4 && intf->bNumEndpoints == 3
                                && intf->bInterfaceSubClass == 0xFF && intf->bInterfaceProtocol
== 0xFF)
                                return -ENODEV;
```

```
                }
        }
#endif
……
}
```

3.2.3. Modify Kernel Configuration

You need to enable the following configuration items. See ***Chapter 3.7*** for how to configure kernel.

```
CONFIG_USB_SERIAL
CONFIG_USB_SERIAL_WWAN
CONFIG_USB_SERIAL_OPTION
```

3.2.4. Add the Zero Packet Mechanism

As required by the USB protocol, the mechanism for processing zero packets needs to be added during bulk-out transmission by adding the following statements.

- For Linux kernel version higher than 2.6.34, you need to add the following statements to the file *[KERNEL]/drivers/usb/serial/usb_wwan.c*.

```
static struct urb *usb_wwan_setup_urb(struct usb_serial *serial, int endpoint,
                                      int dir, void *ctx, char *buf, int len,void (*callback) (struct urb *))
{
……
    usb_fill_bulk_urb(urb, serial->dev,
                      usb_sndbulkpipe(serial->dev, endpoint) | dir,
                      buf, len, callback, ctx);
    #if 1     //Added by Quectel for zero packet
    if (dir == USB_DIR_OUT) {
        struct usb_device_descriptor *desc = &serial->dev->descriptor;

        if (desc->idVendor == cpu_to_le16(0x2C7C))
            urb->transfer_flags |= URB_ZERO_PACKET;
    }
    #endif
    return urb;
}
```

- For Linux kernel version lower than 2.6.35, you need to add the following statements to the file *[KERNEL]/drivers/usb/serial/option.c*.

```
/* Helper functions used by option_setup_urbs */
static struct urb *option_setup_urb(struct usb_serial *serial, int endpoint,
            int dir, void *ctx, char *buf, int len,
            void (*callback)(struct urb *))
{
……
      usb_fill_bulk_urb(urb, serial->dev,
                  usb_sndbulkpipe(serial->dev, endpoint) | dir,
                  buf, len, callback, ctx);
      #if 1     //Added by Quectel for zero packet
      if (dir == USB_DIR_OUT) {
            struct usb_device_descriptor *desc = &serial->dev->descriptor;

            if (desc->idVendor == cpu_to_le16(0x2C7C))
                  urb->transfer_flags |= URB_ZERO_PACKET;
      #endif
      return urb;
}
```

3.2.5. Add Reset-resume Mechanism

If power loss or reset occurs to some USB host controllers/USB hubs when MCU enters the Suspend/Sleep mode, and they cannot be used for USB resume after MCU exits from the Suspend/Sleep mode. The reset-resume mechanism needs to be enabled by adding the following statements.

- For Linux kernel version higher than 3.4, you need to add the following statements to the file *[KERNEL]/drivers/usb/serial/option.c*.

```
static struct usb_serial_driver option_1port_device = {
……
#ifdef CONFIG_PM
      .suspend                = usb_wwan_suspend,
      .resume                 = usb_wwan_resume,
#if 1   //Added by Quectel
      .reset_resume     = usb_wwan_resume,
#endif
#endif
};
```

- For Linux kernel version lower than 3.5, you need to add the following statements to the file *[KERNEL]/drivers/usb/serial/usb-serial.c*.

```
/* Driver structure we register with the USB core */
static struct usb_driver usb_serial_driver = {
        .name =         "usbserial",
        .probe =        usb_serial_probe,
        .disconnect =   usb_serial_disconnect,
        .suspend =      usb_serial_suspend,
        .resume =       usb_serial_resume,
#if 1 //Added by Quectel
        .reset_resume = usb_serial_resume,
#endif
        .no_dynamic_id =        1,
        .supports_autosuspend = 1,
};
```

3.2.6. Increase the Quantity and Capacity of the Bulk Out URBs

For Linux kernel version lower than 2.6.29, the quantity and capacity of the bulk out URBs need to be increased to get faster uplink speed by adding the following statements to the file *[KERNEL]/drivers/usb/serial/option.c*.

```
#define N_IN_URB 4
#define N_OUT_URB 4             //Increase the quantity of the bulk out URBs to 4.
#define IN_BUFLEN 4096
#define OUT_BUFLEN 4096     //Increase the capacity of the bulk out URBs to 128.
```

3.3. GobiNet Driver

When the GobiNet driver has been installed in the module, a network device and a QMI channel are created. The network device is named as *ethX* (*usbX* if the kernel version is 2.6.39 or lower) and the QMI channel is */dev/qcqmiX*. The network device is used for data transmission, and QMI channel is used for QMI message interaction.

The following chapters explain how to port the GobiNet driver into the Linux operating system.

3.3.1. Modify Source Codes of the Driver

The GobiNet driver is provided by Quectel in the form of the source file containing source codes. The source file should be copied to *[KERNEL]/drivers/net/usb/* (or *[KERNEL]/drivers/usb/net/* if the kernel version is lower than 2.6.22).

3.3.2. Modify Kernel Configuration

You need to enable the following configuration item first. See ***Chapter 3.7*** for how to configure kernel.

```
CONFIG_USB_NET_DRIVERS
CONFIG_USB_USBNET
```

Then you can add the following statements to *[KERNEL]/drivers/net/usb/Makefile* (or *[KERNEL]/drivers/usb/net/Makefile* if the kernel version is lower than 2.6.22).

```
obj-y += GobiNet.o
GobiNet-objs := GobiUSBNet.o QMIDevice.o QMI.o
```

3.4. qmi_wwan_q Driver

When the qmi_wwan_q driver has been installed in the module, a network device and a QMI channel are created. The network device is named as *wwanX* and the QMI channel is */dev/cdc-wdmX*. The network device is used for data transmission, and QMI channel is used for QMI message interaction.

The following chapters explain how to port the qmi_wwan_q driver into the Linux operating system.

3.4.1. Modify Source Codes of the Driver

The source file containing source codes of qmi_wwan_q driver is *[KERNEL]/drivers/net/usb/qmi_wwan.c*. To use the qmi_wwan_q driver along with the Quectel module, the source file needs to be modified.

To simplify works, Quectel provides the source file *qmi_wwan_q.c*, which can coexist with *qmi_wwan.c* and only be used for Quectel's modules. The source file *qmi_wwan_q.c* should be copied to *[KERNEL]/drivers/net/usb/*.

3.4.2. Modify Kernel Configuration

Enable the following configuration items first. See ***Chapter 3.7*** for how to configure kernel.

```
CONFIG_USB_NET_DRIVERS
CONFIG_USB_USBNET
CONFIG_USB_NET_QMI_WWAN
CONFIG_USB_WDM
```

Then add the following statements to *[KERNEL]/drivers/net/usb/Makefile.*

```
# must insert qmi_wwan_q.o before qmi_wwan.o
obj-${CONFIG_USB_NET_QMI_WWAN} += qmi_wwan_q.o
obj-${CONFIG_USB_NET_QMI_WWAN} += qmi_wwan.o
```

3.5. ACM/ECM/RNDIS/NCM/MBIM Driver

ACM, ECM, RNDIS, NCM and MBIM drivers are USB interface class drivers. That is, the Linux system automatically attaches to the corresponding diver according to the interface's class, sub class and protocol. And these drivers are available in the upstream Linux releases if you use Linux distribution such as Ubuntu and Fedora. The drivers are automatically loaded when when the module is connected to the Linux PC through the USB interface. If you use an embedded system, you just need to enable the corresponding configuration items.

The configuration items to be enabled for each driver are as follows:

Table 2: Configuration Items for USB Class Drivers

USB Drivers	Configuration Items	Source Files
ACM	CONFIG_USB_ACM	*[KERNEL]/drivers/net/usb/cdc-acm.c*
ECM	CONFIG_USB_NET_DRIVERS CONFIG_USB_USBNET CONFIG_USB_NET_CDCETHER	*[KERNEL]/drivers/net/usb/cdc_ether.c*
RNDIS	CONFIG_USB_NET_DRIVERS CONFIG_USB_USBNET CONFIG_USB_NET_RNDIS_HOST	*[KERNEL]/drivers/net/usb/rndis_host.c*
NCM	CONFIG_USB_NET_DRIVERS CONFIG_USB_USBNET CONFIG_USB_NET_CDC_NCM	*[KERNEL]/drivers/net/usb/cdc_ncm.c*
MBIM	CONFIG_USB_NET_DRIVERS CONFIG_USB_USBNET CONFIG_USB_NET_CDC_MBIM	*[KERNEL]*/drivers/net/usb/cdc_mbim.c

3.6. How to Support PPP

If PPP function is used, you need to enable the following configuration items first to configure the kernel to support PPP. See ***Chapter 3.7*** for how to configure kernel.

```
CONFIG_PPP
CONFIG_PPP_ASYNC
CONFIG_PPP_SYNC_TTY
CONFIG_PPP_DEFLATE
```

3.7. Configure Kernel

Please follow the steps and the corresponding commands below to configure the kernel.

Step 1: Execute the following command to switch to kernel directory:

```
cd <your kernel directory>
```

Step 2: Execute the following command to set environment variables and import the board's "defconfig" file (taking Raspeberry Pi board for example).

```
export ARCH=arm
export CROSS_COMPILE=arm-none-linux-gnueabi-
make bcmrpi_defconfig
```

Step 3: Execute the following command to compile the kernel.

```
make menuconfig
```

Step 4: Enable the configuration item.

Selecting <*> means to build the driver to kernel image.

Selecting <M> means to build the driver as module.

Taking USB serial option as an example, you can enable CONFIG_USB_SERIAL_OPTION with the options below.

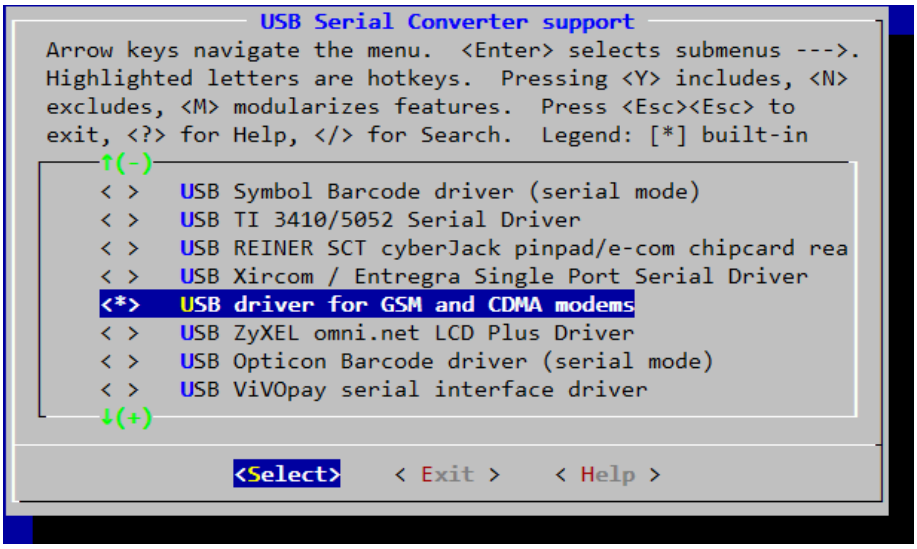

Figure 2: Configure USB Serial in Kernel

3.8. Install and Load Driver as a Kernel Module for PC in Linux

For developers requiring to test Quectel modules on PC with Linux operating system like Ubuntu, Quectel can provide source files of USB serial option/GobiNet/qmi_wwan_q drivers. These USB drivers can be installed and used by using the following commands and then rebooting the PC.

- Install qmi_wwan_q driver.

```
carl@carl-OptiPlex-7050:~/quectel/qmi_wwan$ sudo make install
```

- Install GobiNet driver.

```
carl@carl-OptiPlex-7050:~/quectel/ GobiNet$ sudo make install
```

- Install USB serial option driver.

```
# First use command `uanme –r` to query the current using kernel version
carl@carl-OptiPlex-7050:~/quectel/usb-serial-option$ uname   -r
4.4.0-31-generic
# Switch to the correspond kernel source directory
carl@carl-OptiPlex-7050:~/quectel/usb-serial-option$ cd 4.4.0/
carl@carl-OptiPlex-7050:~/quectel/usb-serial-option/4.4.0$ cp ../Makefile   ./
carl@carl-OptiPlex-7050:~/quectel/usb-serial-option/4.4.0$ sudo make install
```

4 Test the Module

Generally, AT and PPP functions are supported. If an USBNet driver has been installed, the USB network adapter function can also be used on the module. The following chapters explain how to test these functions.

4.1. Test AT Function

After the module is connected and the USB driver is loaded successfully, several device files are created in the directory */dev*.

The AT port is the ttyUSB port created by the USB serial option driver. See ***Table 1*** to view the device name corresponding to AT Command or Modem function.

Then UART port tools such as “minicom” or “busybox microcom” shown below can be used to test AT function.

```
root@cqh6:~# busybox  microcom /dev/ttyUSB2
at+cpin?;+csq;+cops?
+CPIN: READY

+csq: 26,99

+COPS: 0,0,"CHINA MOBILE CMCC",7

OK
```

Figure 3: AT Command Test Result

4.2. Test PPP Function

If the module supports any USBNet driver, it is recommended to use USBNet driver interface.

PPP dial-up is more complex than network card dial-up, and it causes higher current consumption of CPU, so it is not recommended to perform PPP dial-up.

To set up a PPP call, the following files are required. Please check if the following files exist in your product:

1. PPPD and chat programs. If the two programs do not exist, you can download the source codes of the two programs from https://ppp.samba.org/download.html and port them to the module.

2. One PPP script file named as */etc/ppp/ip-up*, which is used to set DNS. If there is no such file, please use *linux-ppp-scripts\ip-up* provided by Quectel.

3. Three scripts named as *quectel-ppp*, *quectel-chat-connect* and *quectel-chat-disconnect*. They are provided by Quectel in directory *linux-ppp-scripts*. You may need to make corresponding changes based on different modules. For more information, please refer to *linux-ppp-scripts\readme*.

Copy *quectel-ppp*, *quectel-chat-connect* and *quectel-chat-disconnect* to the directory */etc/ppp/peers*, then set up a PPP call by the following command:

```
# pppd call quectel-ppp &
```

The process of PPP calling setup is shown as below:

```
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)
AT^M^M
OK
  -- got it

send (ATD*99#^M)
expect (CONNECT)
^M
ATD*99#^M^M
CONNECT
  -- got it

Script chat -s -v -f /etc/ppp/peers/quectel-chat-connect finished (pid 2912), status = 0x0
Serial connection established.
using channel 1
Using interface ppp0
Connect: ppp0 <--> /dev/ttyUSB3
```

```
sent [LCP ConfReq id=0x1 <asyncmap 0x0> <magic 0x588fbf7f> <pcomp> <accomp>]
rcvd [LCP ConfReq id=0x0 <asyncmap 0x0> <auth chap MD5> <magic 0xea02c208> <pcomp> <accomp>]
sent [LCP ConfAck id=0x0 <asyncmap 0x0> <auth chap MD5> <magic 0xea02c208> <pcomp> <accomp>]
rcvd [LCP ConfAck id=0x1 <asyncmap 0x0> <magic 0x588fbf7f> <pcomp> <accomp>]
sent [LCP EchoReq id=0x0 magic=0x588fbf7f]
rcvd [LCP DiscReq id=0x1 magic=0xea02c208]
rcvd [CHAP Challenge id=0x1 <86b3d5669380a4bcfa502b8e92a4cc93>, name = "UMTS_CHAP_SRVR"]
sent [CHAP Response id=0x1 <9efc37eaf3dd8d819ac3e452d242e026>, name = "test"]
rcvd [LCP EchoRep id=0x0 magic=0xea02c208 58 8f bf 7f]
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>]
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=0x0]
sent [IPCP ConfNak id=0x0 <addr 0.0.0.0>]
rcvd [IPCP ConfNak id=0x1 <addr 10.187.151.143> <ms-dns1 202.102.213.68> <ms-dns2 61.132.163.68>]
sent [IPCP ConfReq id=0x2 <addr 10.187.151.143> <ms-dns1 202.102.213.68> <ms-dns2 61.132.163.68>]
rcvd [IPCP ConfReq id=0x1]
sent [IPCP ConfAck id=0x1]
rcvd [IPCP ConfAck id=0x2 <addr 10.187.151.143> <ms-dns1 202.102.213.68> <ms-dns2 61.132.163.68>]
Could not determine remote IP address: defaulting to 10.64.64.64
not replacing default route to eth0 [172.18.112.1]
local  IP address 10.187.151.143
remote IP address 10.64.64.64
primary     DNS address 202.102.213.68
secondary DNS address 61.132.163.68
Script /etc/ppp/ip-up started (pid 2924)
Script /etc/ppp/ip-up finished (pid 2924), status = 0x0
```

Now a PPP call is set up successfully.

Please use the following commands to check whether the information of IP, DNS and route in your system belongs to Quectel modules.

```
# ifconfig ppp0
ppp0          Link encap:Point-to-Point Protocol
              inet addr: 10.187.151.143    P-t-P:10.64.64.64    Mask:255.255.255.255
```

```
              UP POINTOPOINT RUNNING NOARP MULTICAST    MTU:1500    Metric:1
              RX packets:15 errors:0 dropped:0 overruns:0 frame:0
              TX packets:19 errors:0 dropped:0 overruns:0 carrier:0
              collisions:0 txqueuelen:3
              RX bytes:1057 (1.0 KiB)    TX bytes:1228 (1.1 KiB)

# cat /etc/resolv.conf
nameserver 61.132.163.68
nameserver 202.102.213.68

# route    -n
Kernel IP routing table
Destination        Gateway            Genmask             Flags Metric Ref      Use Iface
10.64.64.64        0.0.0.0            255.255.255.255 UH      0          0          0 ppp0
0.0.0.0            0.0.0.0            0.0.0.0             U       0          0          0 ppp0

# ping www.baidu.com
PING www.a.shifen.com (115.239.211.112) 56(84) bytes of data.
64 bytes from 115.239.211.112: icmp_seq=1 ttl=54 time=46.4ms
```

The following commands can be used to terminate the PPPD process to disconnect a PPP call:

```
# killall pppd
Terminating on signal 15
Connect time 0.4 minutes.
Sent 0 bytes, received 0 bytes.
```

NOTE

PPP dial-up is not recommended for Quectel LTE Cat 4 module series and not supported for Quectel 5G module series and LTE module series that data rates higher than Cat 4.

4.3. Test GobiNet/qmi_wwan_q Driver

Please follow the steps below to test the GobiNet or qmi_wwan_q driver:

Step 1: Compile the Connect Manager program with the following commands. Quectel provides a Connect Manager program (“quectel-CM”) for you to set up data connection manually. The Connect Manager is provided in the form of source code in the directory *quectel-CM*.

- For PC Linux:

```
# make
```

- For embedded Linux:

```
# make CROSS-COMPILE=arm-none-linux-gnueabi-
```

Please replace *arm-none-linux-gnueabi-* by the cross compiler on the module.

Program “quectel-CM” will be output in this step.

Step 2: Prepare “busybox udhcpc” tool.

quectel-CM calls “busybox udhpc” to obtain IP and DNS, and “busybox udhpc” calls script file */usr/share/udhcpc/default.script* to set IP, DNS and routing table for Linux board.

You can download the source codes of “busybox udhpc” tool from https://busybox.net, then enable CONFIG_UDHCPC with the command below and copy the script file *[BUSYBOX]/examples/udhcp/simple.script* to Linux board (renamed as */usr/share/udhcpc/default.script*).

```
busybox menuconfig
```

Step 3: Use “quectel-CM” to set up a data call.

After the module is connected and the GobiNet or qmi_wwan_q driver is installed successfully, an USB network adapter and a QMI channel are created. The USB network adapter of the GobiNet driver is named as *ethX* (or *usbX* if the kernel version is 2.6.39 or lower), and the QMI channel is */dev/qcqmiX*. The USB network adapter of the qmi_wwan_q driver is named as *wwanX*, and the QMI channel is */dev/cdc-wdmX*.

quectel-CM sends QMI message to the module through QMI channel to set up a data connection. See ***document [1]*** for the usage of quectel-CM.

The working process of quectel-CM is shown as below (taking EM12 running qmi_wwan_q driver for example):

```
root@cqh6:~# ./quectel-CM/quectel-CM &
[07-03_06:56:28:172] WCDMA&LTE_QConnectManager_Linux&Android_V1.3.4
[07-03_06:56:28:172] ./quectel-CM/quectel-CM profile[1] = (null)/(null)/(null)/0, pincode = (null)
[07-03_06:56:28:174] Find /sys/bus/usb/devices/2-1.2 idVendor=2c7c idProduct=0512
[07-03_06:56:28:174] Find /sys/bus/usb/devices/2-1.2:1.4/net/wwan0
[07-03_06:56:28:174] Find usbnet_adapter = wwan0
```

```
[07-03_06:56:28:175] Find /sys/bus/usb/devices/2-1.2:1.4/usbmisc/cdc-wdm0
[07-03_06:56:28:175] Find qmichannel = /dev/cdc-wdm0
[07-03_06:56:28:197] cdc_wdm_fd = 7
[07-03_06:56:28:381] Get clientWDS = 18
[07-03_06:56:28:445] Get clientDMS = 1
[07-03_06:56:28:509] Get clientNAS = 2
[07-03_06:56:28:573] Get clientUIM = 2
[07-03_06:56:28:637] Get clientWDA = 1
[07-03_06:56:28:701] requestBaseBandVersion EM12GPAR01A06M4G
[07-03_06:56:28:957] requestGetSIMStatus SIMStatus: SIM_READY
[07-03_06:56:29:021] requestGetProfile[1] cmnet///0
[07-03_06:56:29:085] requestRegistrationState2 MCC: 460, MNC: 0, PS: Attached, DataCap: LTE
[07-03_06:56:29:149] requestQueryDataCall IPv4ConnectionStatus: DISCONNECTED
[07-03_06:56:29:277] requestRegistrationState2 MCC: 460, MNC: 0, PS: Attached, DataCap: LTE
[07-03_06:56:29:341] requestSetupDataCall WdsConnectionIPv4Handle: 0x127b42c0
[07-03_06:56:29:469] requestQueryDataCall IPv4ConnectionStatus: CONNECTED
[07-03_06:56:29:533] ifconfig wwan0 up
[07-03_06:56:29:543] busybox udhcpc -f -n -q -t 5 -i wwan0
udhcpc: started, v1.27.2
udhcpc: sending discover
udhcpc: sending select for 10.170.235.201
udhcpc: lease of 10.170.235.201 obtained, lease time 7200
[07-03_06:56:29:924] /etc/udhcpc/default.script: Resetting default routes
[07-03_06:56:29:936] /etc/udhcpc/default.script: Adding DNS 211.138.180.2
[07-03_06:56:29:936] /etc/udhcpc/default.script: Adding DNS 211.138.180.3
```

Step 4: Use the following commands to check the information about IP, DNS and route.

```
root@cqh6:~# ifconfig wwan0
wwan0: flags=4291<UP,BROADCAST,RUNNING,NOARP,MULTICAST>  mtu 1500
        inet 10.170.235.201  netmask 255.255.255.252  broadcast 10.170.235.203

root@cqh6:~# cat /etc/resolv.conf
nameserver 211.138.180.2
nameserver 211.138.180.3

root@cqh6:~# ip route show
default via 10.170.235.202 dev wwan0
10.170.235.200/30 dev wwan0 proto kernel scope link src 10.170.235.201
172.18.112.0/23 dev eth0 proto kernel scope link src 172.18.112.13

# ping www.baidu.com
PING www.a.shifen.com (115.239.211.112) 56(84) bytes of data.
64 bytes from 115.239.211.112: icmp_seq=1 ttl=53 time=24.8 ms
```

Step 5: Use the following command to terminate the quectel-CM process to disconnect the data connection:

```
root@cqh6:~# killall quectel-CM
[07-03_07:00:10:145] requestDeactivateDefaultPDP err = 0
[07-03_07:00:10:145] ifconfig wwan0 down
[07-03_07:00:10:152] ifconfig wwan0 0.0.0.0
[07-03_07:00:10:553] QmiWwanThread exit
[07-03_07:00:10:554] main exit
```

4.4. Test "AT$QCRMCALL" on GobiNet/ qmi_wwan_q Driver

This chapter mainly introduces how to use **AT$QCRMCALL** to set up a data call.

Although it is recommended to use QMI tools like quectel-CM/libqmi/uqmi to set up a data call, but **AT$QCRMCALL** is preferred for some developers.

And if your MCU's USB Host Controller does not fully support USB interrupt type endpoint, you need to use **AT$QCRMCALL** instead of QMI tools.

For GobiNet driver, in order to use **AT$QCRMCALL**, "qcrmcall_mode" in *GobiUSBNet.c* needs to be modified as "1". While for qmi_wwan_q driver, no extra modification is required.

The following logs show how to use **AT$QCRMCALL** to set up a data call. For details, please contact Quectel Technical Supports.

```
root@imx6qdlsabresd:~# busybox microcom /dev/ttyUSB2
at+csq;+cgreg?;+cops?
+CSQ: 27,99
+CGREG: 0,1
+COPS: 0,0,"CHINA MOBILE",7
OK

AT$QCRMCALL=1,1
$QCRMCALL: 1,V4
OK

AT+QNETDEVSTATUS?
+QNETDEVSTATUS: 0,1,4,1
OK

root@imx6qdlsabresd:~# busybox udhcpc -fnq -i wwan0
```

```
udhcpc (v1.24.1) started
Sending discover...
Sending select for 10.166.47.120...
Lease of 10.166.47.120 obtained, lease time 7200
/etc/udhcpc.d/50default: Adding DNS 211.138.180.2
/etc/udhcpc.d/50default: Adding DNS 211.138.180.3
root@imx6qdlsabresd:~#
```

NOTE

AT$QCRMCALL is only supported for EC25 series, EG25-G, EC20-CE, EG95 series and EM05 series modules.

4.5. Test QMAP on GobiNet/qmi_wwan_q Driver

This chapter introduces how to test the QMAP (Qualcomm Multiplexing and Aggregation Protocol) on GobiNet or qmi_wwan_q driver, especially catering for developers using GobiNet or qmi_wwan_q driver and requiring QMAP.

When GobiNet or qmi_wwan_q driver being used, only one physical network card can be created by default, so only one PDN data call can be set up. However, through using the multiplexing protocol, multiple virtual network cards can be created over one physical network card, so multiple PDN data calls can be set up.

When GobiNet or qmi_wwan_q driver being used, only one IP Packet in one URB can be transferred, so if there are high throughput and frequent URB interrupts, the Host CPU is overloaded. However, the aggregation protocol can be used to transfer multiple IP Packets in one URB with increased throughput by reducing the number of URB interrupts.

If multiplexing or aggregation protocol is needed, please contact Quectel Technical Supports support@quectel.com.

4.6. Test ECM/RNDIS/NCM/MBIM Driver

For ECM/RNDIS/NCM/MBIM driver, you need to use the Quectel AT commands to set up a data call. Different modules have different ways to set up a data call. You can contact Quectel Technical Supports for details if needed.

For MBIM mode, MBIM tools like “mbimcli” and “umbim” can be used to set up a data call.
quectel-CM, which is provided by Quectel, can also be used to set up a data call. See ***document [1]*** for details.

5 Power Management

The USB system in Linux provides two advanced power management features: USB Auto Suspend and USB Remote Wakeup. This chapter introduces how to enable these features, particularly for developers in need.

When USB communication between the USB host and the USB devices is idle for some time (for example 3 seconds), the USB host can make the USB devices enter Suspend mode automatically. This feature is called USB Auto Suspend.

USB Remote Wakeup allows a suspended USB device to remotely wake up the USB host over the USB which may also be suspended (for example, deep sleep mode). The USB device, which has a remote wakeup capability, performs an activity to wake up the USB host, and then the USB host is woken up by the remote activity.

USB Auto Suspend and USB Remote Wakeup features of the drivers described in this document except USB serial option driver are enabled by default.

5.1. Enable USB Auto Suspend

For USB serial option driver, please add the following statements to *option_probe()* in the file *[KERNEL]/drivers/usb/serial/option.c* to enable USB Auto Suspend feature.

```
static int option_probe(struct usb_serial *serial, const struct usb_device_id *id) {
    struct usb_wwan_intf_private *data;
    ……
#if 1 //Added by Quectel
    //For USB Auto Suspend
    if (serial->dev->descriptor.idVendor == cpu_to_le16(0x2C7C)) {
        pm_runtime_set_autosuspend_delay(&serial->dev->dev, 3000);
        usb_enable_autosuspend(serial->dev);
    }
#endif
    /* Store device id so we can use it during attach. */
    usb_set_serial_data(serial, (void *)id);
    return 0;
}
```

5.2. Enable USB Remote Wakeup

For USB serial option driver, please add the following statements to *option_probe()* in the file *[KERNEL]/drivers/usb/serial/option.c* to enable USB Remote Wakeup feature.

```
static int option_probe(struct usb_serial *serial, const struct usb_device_id *id) {
	struct usb_wwan_intf_private *data;
	……
#if 1 //Added by Quectel
	//For USB Remote Wakeup
	if (serial->dev->descriptor.idVendor == cpu_to_le16(0x2C7C)) {
		device_init_wakeup(&serial->dev->dev, 1); //usb remote wakeup
	}
#endif
	/* Store device id so we can use it during attach. */
	usb_set_serial_data(serial, (void *)id);
	return 0;
}
```

6 FAQs and Kernel Log

6.1. How to Check Whether USB Driver Exists in the Module

The existence of the USB driver can be checked from the content of the directory */sys/bus/usb/drivers*. For example:

```
root@OpenWrt:~# ls /sys/bus/usb/drivers
GobiNet          cdc_wdm          rndis_host       usbfs
cdc_ether        hub              uas              usbserial
cdc_mbim         option           usb              usbserial_generic
cdc_ncm          qmi_wwan_q       usb-storage
```

If the USB serial option driver is required, please make sure *option* exists in the content of the directory */sys/bus/usb/drivers*.

Similarly, if GobiNet driver is required, make sure *GobiNet* exists.

If qmi_wwan_q driver is required, make sure *qmi_wwan_q* exists, and so forth.

6.2. How to Check Whether the Module Works Well with the Corresponding USB Driver

This chapter shows the kernel log about the module with the corresponding USB driver installed in the Linux operating system. If the module does not work well, please compare the kernel log in the module with that in this chapter to help with troubleshooting.

- For USB serial option and GobiNet driver: Kernel logs of different modules are almost the same except for the VID&PID information (framed in red in the following figure). The example of USB serial option and GobiNet for RG502Q series module is as follows:

```
root@OpenWrt:/# dmesg
[  683.624602] usb 4-1: new SuperSpeed USB device number 5 using xhci-hcd
[  683.650397] usb 4-1: New USB device found, idVendor=2c7c, idProduct=0800
[  683.650425] usb 4-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[  683.656207] usb 4-1: Product: RG502Q-EA
[  683.663217] usb 4-1: Manufacturer: Quectel
[  683.666861] usb 4-1: SerialNumber: 39249701
[  683.674432] option 4-1:1.0: GSM modem (1-port) converter detected
[  683.675317] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB0
[  683.681796] option 4-1:1.1: GSM modem (1-port) converter detected
[  683.688537] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB1
[  683.694777] option 4-1:1.2: GSM modem (1-port) converter detected
[  683.701320] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB2
[  683.707574] option 4-1:1.3: GSM modem (1-port) converter detected
[  683.714186] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB3
[  683.737886] GobiNet 4-1:1.4 usb0: register 'GobiNet' at usb-xhci-hcd.1.auto-1, GobiNet Ethernet Device,
[  683.739546] creating qcqmi0
[  685.973561] GobiNet::QMIWDASetDataFormat qmap settings qmap_version=9, rx_size=31744, tx_size=4096
[  685.973598] GobiNet::QMIWDASetDataFormat qmap settings ul_data_aggregation_max_size=4096, ul_data_aggre
```

Figure 4: USB Serial Option and GobiNet for RG502Q Series Module

- For USB serial option and qmi_wwan_q driver: kernel logs of different modules are almost the same except for the VID&PID information (framed in red in the following figure). The example of USB serial option and qmi_wwan_q for RG502Q series module is as follows:

```
root@OpenWrt:/# dmesg
[  119.804631] usb 4-1: new SuperSpeed USB device number 3 using xhci-hcd
[  119.827695] usb 4-1: New USB device found, idVendor=2c7c, idProduct=0800
[  119.827723] usb 4-1: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[  119.833479] usb 4-1: Product: RG502Q-EA
[  119.840610] usb 4-1: Manufacturer: Quectel
[  119.844146] usb 4-1: SerialNumber: 39249701
[  119.874871] option 4-1:1.0: GSM modem (1-port) converter detected
[  119.875098] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB0
[  119.880477] option 4-1:1.1: GSM modem (1-port) converter detected
[  119.887234] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB1
[  119.893319] option 4-1:1.2: GSM modem (1-port) converter detected
[  119.899995] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB2
[  119.906211] option 4-1:1.3: GSM modem (1-port) converter detected
[  119.912818] usb 4-1: GSM modem (1-port) converter now attached to ttyUSB3
[  119.936455] qmi_wwan_q 4-1:1.4: cdc-wdm0: USB WDM device
[  119.936738] qmi_wwan_q 4-1:1.4: Quectel RG502Q-EA work on RawIP mode
[  119.941518] qmi_wwan_q 4-1:1.4: rx_urb_size = 31744
[  119.948090] qmi_wwan_q 4-1:1.4 wwan0: register 'qmi_wwan_q' at usb-xhci-hcd.1.auto-1,
```

Figure 5: USB Serial Option and qmi_wwan_q for RG502Q Series Module

6.3. How to Check Which USB Driver Has Been Installed

This chapter shows how to query which USB driver that the USB interface of the Quectel module is attached to. The USB driver's name is identified by the keyword "Driver=". If "Driver=none" is shown, the reason may be that the corresponding configuration item is not enabled in your kernel configuration, or the VID and PID of Quectel modules are not inserted to the corresponding USB driver source files. In such a case, please follow the steps mentioned in ***Chapter 2*** to check again.

The example of USB interface and driver for RG502Q series modules is as follows:

```
root@OpenWrt:/# mount -t debugfs none /sys/kernel/debug/
root@OpenWrt:/# cat /sys/kernel/debug/usb/devices
T:  Bus=04 Lev=01 Prnt=01 Port=00 Cnt=01 Dev#=  3 Spd=5000 MxCh= 0
D:  Ver= 3.20 Cls=00(>ifc ) Sub=00 Prot=00 MxPS= 9 #Cfgs=  1
P:  Vendor=2c7c ProdID=0800 Rev= 4.14
S:  Manufacturer=Quectel
S:  Product=RG502Q-EA
S:  SerialNumber=39249701
C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=896mA
I:* If#= 0 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=30 Driver=option
E:  Ad=81(I) Atr=02(Bulk) MxPS=1024 Ivl=0ms
E:  Ad=01(O) Atr=02(Bulk) MxPS=1024 Ivl=0ms
I:* If#= 1 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=00 Prot=00 Driver=option
E:  Ad=83(I) Atr=03(Int.) MxPS=  10 Ivl=32ms
E:  Ad=82(I) Atr=02(Bulk) MxPS=1024 Ivl=0ms
E:  Ad=02(O) Atr=02(Bulk) MxPS=1024 Ivl=0ms
I:* If#= 2 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=00 Prot=00 Driver=option
E:  Ad=85(I) Atr=03(Int.) MxPS=  10 Ivl=32ms
E:  Ad=84(I) Atr=02(Bulk) MxPS=1024 Ivl=0ms
E:  Ad=03(O) Atr=02(Bulk) MxPS=1024 Ivl=0ms
I:* If#= 3 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=00 Prot=00 Driver=option
E:  Ad=87(I) Atr=03(Int.) MxPS=  10 Ivl=32ms
E:  Ad=86(I) Atr=02(Bulk) MxPS=1024 Ivl=0ms
E:  Ad=04(O) Atr=02(Bulk) MxPS=1024 Ivl=0ms
I:* If#= 4 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=ff Prot=ff Driver=qmi_wwan_q
E:  Ad=88(I) Atr=03(Int.) MxPS=   8 Ivl=32ms
E:  Ad=8e(I) Atr=02(Bulk) MxPS=1024 Ivl=0ms
E:  Ad=0f(O) Atr=02(Bulk) MxPS=1024 Ivl=0ms
```

Figure 6: USB Interface and Driver for RG502Q Series Module

7 Appendix References

Table 3: Related Documents

Document Name
[1] Quectel_QConnectManager_Linux_User_Guide
[2] Quectel_EC2x&EG2x&EG9x&EM05_Series_QCFG_AT_Commands_Manual
[3] Quectel_BG95&BG77&BG600L_Series_QCFGEXT_AT_Commands_Manual

Table 4: Terms and Abbreviations

Abbreviations	Descriptions
ACM	Abstract Control Model
AP	Application Processor
APN	Access Point Name
CP	Coprocessor
CPU	Central Processing Unit
DNS	Domain Name System
ECM	Ethernet Control Model
EHCI	Enhanced Host Controller Interface
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HCD	Host Controller Driver
IP	Internet Protocol
MBIM	Mobile Interface Broadband Model

MCU	Microcontroller Unit
NCM	Network Control Model
NDIS	Network Driver Interface Specification
NMEA	National Marine Electronics Association
OHCI	Open Host Controller Interface
OS	Operating System
PC	Personal Computer
PDN	Packet Data Network
PID	Product ID
PPP	Point to Point Protocol
QMAP	Qualcomm Multiplexing and Aggregation Protocol
QMI	Qualcomm Messaging Interface
UHCI	Universal Host Controller Interface
URB	USB Request Block
USB	Universal Serial Bus
VID	Vendor ID