Telit LN940 Module Linux Software User Guide

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APPLICABILITY TABLE (sample)

PRODUCT
LN940

SW Version
0.00.01

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Contents

1. Introduction

1.1. Scope

This user guide serves the following purpose:

- Provides details about Telit modems listed in the Applicability Table.
- Explains which Linux driver should be used for Telit modems listed in the Applicability Table.
- Describes how software developers can use Linux devices for typical use cases.

1.2. Audience

This document is intended for software developers who are integrating Telit modems listed in the applicability table in their Linux environment.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Document Organization

This document contains the following chapters (sample):

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "Chapter two" gives an overview of the features of the product.

"Chapter 3: "Chapter three" describes in details the characteristics of the product.

"Chapter 6: "Conformity Assessment Issues" provides some fundamental hints about the conformity assessment that the final application might need.

"Chapter 7: "Safety Recommendation" provides some safety recommendations that must be follow by the customer in the design of the application that makes use of the AA99-XXX.

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

AT Commands Reference Guide of Telit modems listed in the applicability table.

2. Operating System Setup (Linux)

2.1. Summary

Telit modems listed in the Applicability Table expose different kinds of devices according to the Product ID (PID) in use:

- Serial port
- Network adapter and device management, based on QMI custom protocol (GobiNet included)
- Network adapter and device management, following the CDC-MBIM standard
- ADB

Linux kernel supports these kinds of devices through the following drivers:

- option, for serial ports
- qmi_wwan, for QMI based network adapters and device management (GobiNet included)
- cdc_mbim for MBIM based network adapters and device management
- ADB devices do not need a driver.

Common Linux distributions already have these drivers included: if the devices are not recognized by the operating system, it is possible that the drivers are missing in the kernel. Please recompile the kernel including the above-mentioned drivers. Refer to your Linux vendor for instructions.

Some drivers can be found starting from a specific kernel version (e.g. cdc_mbim is present since 3.8). If the driver is not supported by the used kernel version please consider upgrading the kernel.

2.2. USB compositions

2.2.1. List of PIDs and related compositions

The table below highlights the suggested USB compositions for Linux (identified by the PID):

PID	Serial	Network adapter	Kernel drivers
0x1900	4 ports `/dev/ttyUSBx`	QMI based network adapter, `/dev/cdcwdmx` management device	option, qmi_wwan
0x1901	4 ports `/dev/ttyUSBx`	MBIM based network adapter, `/dev/cdcwdmx` management device	option, cdc_mbim

The number x associated with each Linux device depends on the current configuration of the operating system.

The name associated with the network adapter, if present, depends on the kernel version and on the driver: recent kernel usually shows the name wwanx.

Not all the ports exposed by a modem can be used for AT commands sending: please refer to the proper AT commands User Guide for port arrangement description.

Linux tool lsusb can be used for retrieving the current modem PID.

2.2.2. Customizing the driver: option

If the serial ports are not available, it is possible that the modem PID should be added to the driver option.

Identify the kernel version in use, retrieve the source code and check in

```
/drivers/usb/serial/option
```

under the line

```
#define   TELIT_VENDOR_ID
```

if the PID in use is present.

To add a missing PID, consider as an example one of Telit already supported devices and replicate the same structure found in the source code.

For missing PIDs 0x1900, 0x1901, since also the QMI network adapter is involved, consider backporting Telit related changes found in kernel versions since 3.14.

For all the compositions that present a network adapter, before adding the serial ports make sure that the USB interfaces related to the network adapter are no caught by the option driver. After having modified the code, the kernel should be rebuilt.

It is possible to temporary modify option behavior for runtime serial ports recognition. With root privileges, type in a shell:

```
modprobe option
echo 1bc7 PID > /sys/bus/usb-serial/drivers/option1/new_id
```

where PID is the current pid of the modem.

For all the compositions that present a network adapter, before adding the serial ports make sure that the system has properly recognized the network adapter, otherwise it will not be recognized.

2.2.3. Customizing the driver: qmi_wwan

If the QMI based network adapter is not available, it is possible that the modem PID should be added to the driver qmi_wwan.

Identify the kernel version, retrieve the source code and check in

`drivers/net/usb/qmi_wwan.c` for the presence of the

related source code line according to the PID:

PID	Line
0x1900	`{QMI_FIXED_INTF(0x1bc7, 0x1900, 5)}`
0x1901	`{QMI_FIXED_INTF(0x1bc7, 0x1901, 5)}`

If missing, consider backporting Telit related changes found in kernel versions since 3.13.

After having modified the code, the kernel should be rebuilt.

It is possible to temporary modify qmi_wwan behavior for runtime network adapter recognition. With root privileges, type in a shell:

```
modprobe qmi_wwan
echo 1bc7 PID > /sys/bus/usb/drivers/qmi_wwan/new_id
```

where PID is the current pid of the modem.

3. Modem Setup

3.1. Setting the USB Composition

For changing the modem USB composition, please refer to the proper AT command user guide.

4. Modem Usage

4.1. Using the Serial Ports

The devices `/dev/ttyUSBx` are normal Linux character devices and support most of the features implemented by the `tty` layer.

For sending AT commands, a terminal emulator like Minicom can be used.

When writing code for using the device please refer to the programming language API related to character devices. As an example, C applications can use the functions exported in the system header files `fcntl.h` and `unistd.h`. Please refer to the related man page for further details.

When an AT command is sent, for receiving the answer it is mandatory to have the DTR asserted

4.1.1. Data Connection

More recent Linux distributions have GUI tools for creating dial-up connections through serial ports.

If a ppp connection through command line is needed, the software pppd can be used. Please refer to the official website for further details and updated source code (https://ppp.samba.org/).

4.2. Using the Network Adapter

If the modem firmware supports a network adapter and the related driver is properly loaded, a network interface is created (usually called `wwanx` in recent kernel version).

Linux command `ifconfig` can be used for retrieving some network interface related info (please refer to the man page for further details).

4.2.1. Data Connection

For establishing a data connection through the network interface, follow the steps related to the PID in use:

PID	Line
0x1900 (QMI)	Standard NetworkManager and ModemManager can be used for setting up the data connection with the QMI network adapter. For command line data connection setup, the tool qmi-network from project libqmi can be used. Please refer to the libqmi documentation for further details.

0x1900
 	
(GobiNet)
	- Setup the context using `AT+CGDCONT` command
	- In a Linux root shell start a dhcp client on the network interface, for example:
	
	`dhclient <wwan network adapter name>`
	
	- Send the command for starting the data connection:
	
	`$ sudo bash -c "echo 1 > /sys/class/GobiQMI/qcqmi0/connect"`
	
	- When the dhcp client has finished, check the network adapter ip address with ifconfig
	
	Please refer to the AT commands User Guide for details.

0x1901	Standard NetworkManager and ModemManager can be used for setting up the data connection with the MBIM network adapter. For command line data connection setup, the tool mbim-network from project libmbim can be used. Please refer to the libmbim documentation for further details.

5. Installation for the Driver Package

5.1. Driver Package

Before installation, please refer to the driver package:
"Telit_LN940_Driver_Package_0.0.0.1.tar.gz".

5.2. Option.c

Check the Driver Package to find "drivers/0001-option-Add-Telit-LN940-support.patch" to patch "drivers/usb/serial/option.c" or refer to "drivers/option" to compile as kernel module).

If customer wants to utilize QMI library like libqmi-glib / ofono / uqmi ..., please use the module as "qmi_wwan".
If not, please use the module "GobiNet" for quick test.

5.3. Modem device as QMI

5.3.1. Patches for qmi_wwan after Qualcomm MDM9x30 generation

There are 2 patch files of Driver Package need to patch:

"drivers/0002-qmi_wwan-Add-rawIP-mode-support.patch"

"drivers/0003-qmi_wwan-Add-MDM9x30-quirk-setDTR-support.patch"

5.3.2. Check "drivers/0004-qmi_wwan-Add-Telit-LN940-support.patch" to patch

The "drivers/0004-qmi_wwan-Add-Telit-LN940-support.patch" is also located in the Driver Package.

"drivers/net/usb/qmi_wwan.c"

or refer "drivers/qmi_wwan" to compile as kernel moduler.

5.4. Modem device as GobiNet

Please check if `qmi_wwan` of your system supports Telit LN940 module or not at first. If it supports, please remove the `qmi_wwan` module.

- Example in Ubuntu,

a. appends blacklist "qmi_wwan" to blacklist "/etc/modprobe.d/blacklist-modem.conf" file

b. or uses below command to remove kernel module

$ sudo rm /lib/modules/`uname -r`/kernel/drivers/net/usb/qmi_wwan.ko

$ sudo depmod

Uses below command to build the module "GobiNet" in "drivers/gobiusbnet"

$ sudo make install

5.5. Use GobiNet for Network Connection

5.5.1. Connection in Detail

- Make sure the modem already registers to the cellular network

AT+CPIN?

AT+CREG?

AT+COPS?

AT+CSQ

AT+CGDCONT=1,"IP","<apn>"

- Start connect

$ sudo bash -c "echo 1 > /sys/class/GobiQMI/qcqmi0/connect"

- Get network info

$ cat /sys/class/GobiQMI/qcqmi0/netinfo

IPv4 Addr : 10.136.7.153

Mask : 255.255.255.252

Gateway : 10.136.7.154

Primary DNS : 172.24.9.33

Secondary DNS : 172.24.9.22

- Configure static ip address

$ sudo ifconfig wwan0 <ip> netmask <netmask>

$ sudo route add default gw <gateway>

$ sudo echo "nameserver <dns1>" > /etc/resolv.conf

$ sudo echo "nameserver <dns2>" >> /etc/resolv.conf

<P.S> If you want to use DHCP, please check **chapter 5.6** for detail.

5.5.2. Disconnection

$ sudo bash -c "echo 0 > /sys/class/GobiQMI/qcqmi0/connect"

5.6. Modify Driver Code to Support DHCP under rawIP Interface

5.6.1. ISC DHCP - dhclient

Check "utilities/0001-dhclient-Add-DHCPDISCOVER-on-rawIP-network-interface.patch" of the Driver Package to patch ISC DHCP 4.3.5

$ sudo ./client/dhclient -d -4 wwan0

Internet Systems Consortium DHCP Client 4.3.5

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For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/wwan0/

Sending on LPF/wwan0/

Sending on Socket/fallback

DHCPDISCOVER on wwan0 to 255.255.255.255 port 67 interval 7

Attempt to assemble hw header for pure IP

Attempt to decode hw header for Pure IP

Received DHCPv4 packet without client-id option and empty hlen field.

DHCPREQUEST on wwan0 to 255.255.255.255 port 67

Attempt to assemble hw header for pure IP

DHCPOFFER from 10.136.7.154

Attempt to decode hw header for Pure IP

Received DHCPv4 packet without client-id option and empty hlen field.

DHCPACK from 10.136.7.154

bound to 10.136.7.153 -- renewal in 2935 seconds.h"

5.6.2. udhcpc - BusyBox

If kernel version <= 4.4 need to modify module "usbnet" to allow mini-drivers to consume L2 headers. Please check "utilities/0002-usbnet-Allow-mini-drivers-to-consume-L2-headers.patch" in Driver Package for detail information.

$ sudo udhcpc -i wwan0

udhcpc (v1.21.1) started

Sending discover...

Sending select for 10.146.209.214...

Lease of 10.146.209.214 obtained, lease time 7200

/etc/udhcpc/default.script: Resetting default routes

SIOCDELRT: No such process

/etc/udhcpc/default.script: Adding DNS 172.24.9.33

/etc/udhcpc/default.script: Adding DNS 172.24.9.22

6. Upgrade Firmware Image with Fastboot Method

6.1. Scope

Use fastboot method to upgrade image, the steps as the following:

1. Switch module from normal-mode to Fastboot-mode.
2. Use fastboot command to upgrade image, after firmware image update finished, reboot module from Fastboot-mode switch to normal-mode.
3. Active the MCFG via QMI PDC.

6.2. Enter to Fastboot-mode

Switch module from normal mode to Fastboot-mode via the following AT command.

```
at^fastboot
OK
```

6.3. Download image by fastboot command

After we switch to Fastboot-mode, use the following fastboot commands to upgrade firmware image, after firmware image update finished, reboot module from fastboot mode switch to normal mode.

```
fastboot -i '0x1bc7' devices (to check if LN940 available)
fastboot -i '0x1bc7' mibib partition.mbn
fastboot -i '0x1bc7' vendor vendor.img
fastboot -i '0x1bc7' sbl sbl1.mbn
fastboot -i '0x1bc7' tz tz.mbn
fastboot -i '0x1bc7' rpm rpm.mbn
fastboot -i '0x1bc7' aboot appsboot.mbn
fastboot -i '0x1bc7' mdm9640-boot.img
fastboot -i '0x1bc7' system mdm9640-sysfs.ubi
fastboot -i '0x1bc7' modem NON-HLOS.ubi
fastboot -i '0x1bc7' efs2
fastboot -i '0x1bc7' reboot
```

Note: After you successfully used fastboot and downloaded a firmware image, then you can start to use fastboot to download another firmware image again. To determine an image which is downloaded successfully, you can check the character “finished” whether is returned by fastboot.

6.4. Active the MCFG via QMI PDC

Active the MCFG process as the following (Need to active the SKT MCFG under SK folder):

1. Load the MCFG into module:
   ```
   QMI: QMI_PDC_LOAD_CONFIG; MSG ID: 0x0026
   ```

2. Active the MCFG:
   ```
   QMI: QMI_PDC_LIST_CONFIGS; MSG ID: 0x0024
   QMI: QMI_PDC_SET_SELECTED_CONFIG; MSG ID: 0x0023
   QMI: QMI_PDC_ACTIVATE_CONFIG; MSG ID: 0x0027
   ```

3. Operate Steps:
   ```
   (1)  $ CROSS_COMPILE=/home/rudi/dev/fsl-community-
        bsp/build/tmp/sysroots/x86_64-
        linux/usr/bin/cortexa9hf-vfp-neon-poky-linux-
        gnueabi/arm-poky-linux-gnueabi- make
   (2)  cp
        Telit_T77W676.F0.0.0.2.1\ for\ SKT_linux\ image/Image/
        T77W676.F0.0.0.2.1/GC/MCFG.009/mcfg_sw.mbn ./
   (3)  sudo ./qmicli -d /dev/cdc-wdm0 --pdc-load
        config="mcfg_sw.mbn"
   [13 Jul 2017, 23:55:43] -Warning ** [/dev/cdc-wdm0] requested auto mode
   but no MBIM QMUX support available
   Uploaded 0  of 22376
   Loading next chunk (21352 bytes remaining)
   ***
   Loading next chunk (872 bytes remaining)
   Uploaded 21504  of 22376
   Finished loading

   (4)  cp
        Telit_T77W676.F0.0.0.2.1\ for\ SKT_linux\ image/Image/
        T77W676.F0.0.0.2.1/SK/MCFG.001/mcfg_sw.mbn ./
   (5)  sudo ./qmicli -d /dev/cdc-wdm0 --pdc-load-
        config="mcfg_sw.mbn"
   [13 Jul 2017, 23:55:57] -Warning ** [/dev/cdc-wdm0] requested auto mode
   but no MBIM QMUX support available
   Uploaded 0  of 22688
   Loading next chunk (21664 bytes remaining)
   ***
   Loading next chunk (160 bytes remaining)
   Uploaded 22528  of 22688
   Finished loading
   ```

(6) $ sudo ./qmicli -d /dev/cdc-wdm0 --pdc-list-configs=software

```
[13 Jul 2017, 23:56:03] -Warning ** [/dev/cdc-wdm0] requested auto mode
but no MBIM QMUX support available
Total configurations: 2
Configuration 1:
    Description: GCF
    Type:        software
    Size:        22376
    Status:      Inactive
    Version:     0x6010009
    ID:
7D:47:0A:8C:85:1E:D2:B7:5A:FB:F4:BD:A9:A3:06:6F:07:92:D4:74

Configuration 2:
    Description: SKT
    Type:        software
    Size:        22688
    Status:      Inactive
    Version:     0x6010001
    ID:
8D:D1:7F:13:65:13:59:9E:60:52:F6:EF:5E:FF:64:6A:28:03:11:DE
```

(7) $ sudo ./qmicli -d /dev/cdc-wdm0 --pdc-activate-config="software,7D470A8C851ED2B75AFBF4BDA9A3066F0792D474"

```
[13 Jul 2017, 23:56:55] -Warning ** [/dev/cdc-wdm0] requested auto mode
but no MBIM QMUX support available
```

The following is Qualcomm reference document for QMI detail information. Please refer to “80-NV400-38_A_QMI_PDC_MPSS_TH_1_0.pdf”.

7. Document History

Revision	Date	Changes
0	2017-06-26	First issue
1	2017-06-26	Add Chapter 6 for “Upgrade Firmware Image with Fastboot Method”