Caterpillar

USB Wireless Adapter

User Guide

Version 1.1 ● 02/21/2019

Revision History

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Version	Date	Notes	Author(s)
V1.0	12 Dec 2018	Initial Release	Josh Reed
V1.1	21 Feb 2019	Added clarifications about software throughout	Josh Reed

Reference Documentation

Please see the following documents for more information:

Reference No.	Version	Name	Author(s)

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1 CHAPTER 1 GETTING STARTED

1.1 LINUX DRIVER INSTALLATION

1.1.1 BEFORE YOU BEGIN

It is required that the user obtain and install the appropriate Linux driver to support the USB Wireless Adapter. The Linux driver details are for informational purposes and only the Caterpillar D6:Cx Display is configured to utilize the Adapter. The drivers are hardcoded into the Display software and that software is programmed into the Display at the manufacturer. This software is not able to be accessed or downloaded from any external source.

1.1.2 COPY DRIVER MODULES

Copy the driver modules to proper directory, /lib/modules/marvell. The following kernel modules have been created during the build process and must be copied to this directory.

1. usb8997.ko
2. mlan_usb.ko
3. usbfwdnld.ko
4. bt8xxx_usb.ko

1.1.3 COPY MARVELL USB FIRMWARE IMAGE

Marvell provides firmware for the 8997 that is loaded onto the USB adapter. Copy the firmware image to the following directory. **Note the exact location for this file is specified via driver module options that are provided during the kernel module installation process. Also, be aware that the version of the file may affect the naming convention applied to the file by Marvell.**

Copy the firmware image, usbusb8997_combo_v4.bin, to /lib/firmware/mrvl/

1.1.4 CONFIGURE LINUX KERNEL LOAD KERNEL MODULES DURING SYSTEM BOOT

Depending on your Linux distribution, configure your kernel to load the Marvell kernel modules using the insmod command. Each module requires certain module options to be present when the modules are loaded.

1. usb8997.ko
    - options: drv_mode=3 cfg80211_wext=12 fw_name=mrvl/usbusb8997_combo_v4.bin init_cfg=mrvl/bt_init_cfg.conf
2. mlan_usb.ko

3. usbfwdnld.ko
    - options: fw_name=mrvl/usbusb8997_combo_v4.bin req_fw_nowait=1
4. bt8xxx_usb
    - drv_mode=3 cal_cfg=mrvl/bt_cal_data.conf init_cfg=mrvl/bt_init_cfg.conf

1.1.5 BUILD AND CONFIGURE BLUEZ 5.42

1. Visit bluez.org to get instructions on downloading the source code
2. Update tools/btgatt-server.c with our 1.0 released version
3. Update tools/bgatt-client.c with our 1.0 released version
4. Update tools/hcitool.c with our 1.0 released version
5. Configure with the following options: --host=arm --prefix= PKG_CONFIG_PATH=/path/to/fsl_bsp/build/tmp/sysroots/imx6qsabrelite/usr/lib/pkgconfig PKG_CONFIG_LIBDIR=/path/to/fsl_bsp/build/tmp/sysroots/imx6qsabrelite/usr/lib --enable-shared --disable-udev --disable-systemd --disable-cups --disable-obex --enable-experimental --enable-test

   Note: --host can be either x86 or arm and the package config locations should be updated per your particular build environment.
6. Build it (and any dependencies) according to the instructions at bluez.org

2 LINUX WIRELESS CONFIGURATION

2.1 CONNECT TO ACCESS POINT

The following is an example bash script that can be used to configure the wireless adapter to connect to an access point. **Note the script must be executed within a shell environment with root privileges.**

```
#!/bin/bash

# Script to configure mlan_usb0 according paramters specified in wpa_supplicant.conf file.

# Bring up wpa_supplicant

/sbin/wpa_supplicant -dd -B -imlan_usb0 -c/etc/wpa_supplicant/wpa_supplicant.conf -u

# Configure IP addressing via dhclient

dhclient -nw mlan_usb0
```

The following is an example supplicant configuration script that is to be located in the following directory: /etc/wpa_supplicant.

```
ctrl_interface=/var/run/wpa_supplicant

ap_scan=1

network={

        ssid="wifi2"

        scan_ssid=1

        psk="Trymeout90210"

        key_mgmt=WPA-PSK

}
```

2.2 CONFIGURE WIRELESS ADAPTER AS ACCESS POINT

The following is a bash script that will configure the wireless adapter to perform as a wireless access point. **Note the script must be executed within a shell environment with root privileges.**

```
#!/bin/bash

ifconfig uap_usb0 192.168.1.1

ifconfig uap_usb0 netmask 255.255.255.0

hostapd -B -dd  /etc/hostapd/uap_usb0_hostapd.conf

udhcpd  /etc/uap_usb0_udhcpd.conf
```

The following is the hostapd configuration file used to bring up the access point. Note this configuration has been tested and is functional with v2.4 of hostapd.

```
interface=uap_usb0
bssid=86:04:07:D2:1A:06
driver=nl80211
ssid=00_Ubuntu
hw_mode=g
wpa=2
wpa_passphrase=Trymeout90210
wpa_key_mgmt=WPA-PSK
channel=1
wme_enabled=1
macaddr_acl=0
auth_algs=1
ignore_broadcast_ssid=0
wpa_pairwise=TKIP
rsn_pairwise=CCMP
country_code=US
ieee80211d=1
ieee80211h=1
ieee80211n=1        # 802.11n support
wmm_enabled=1       # QoS support
ht_capab=[HT40][SHORT-GI-20][DSSS_CCK-40]
```

3 LINUX BLE CONFIGURATION

The provided Bluetooth software package allows the user to configure the system to communicate with up to 6 supported BLE peripherals, and 3 BLE centrals at one time. This is intended to be used to demonstrate the ability of the chipset on the USB Wireless Adapter to operate simultaneously as a peripheral and a central in order to demonstrate the ability to form a scatternet. The Linux configuration details are for informational purposes and only the Caterpillar D6:Cx Display is configured to utilize the Adapter. This configuration is hardcoded into the Display software and that software is installed at the manufacturer. This software is not able to be accesses or downloaded from any external source.

3.1 CONFIGURE THE SYSTEM

1. btsensor &

   This step configures the advertising data and configures the device to be connectable as a peripheral

2. packet_fwd &

   This step configures the packet forwarding mechanism to forward packets between connected peripherals and connected hosts to demonstrate a scatternet setup.

3. btgatt-server -f 0 &

   This step configures the gatt server to listen for incoming connections from a central on pipe 0.

4. btgatt-server -f 1 &

   This step configures the gatt server to listen for incoming connections from a central on pipe 1.

5. btgatt-server -f 2 &

   This step configures the gatt server to listen for incoming connections from a central on pipe 2.

3.2 CONNECT TO COMPATIBLE PERIPHERALS AUTOMATICALLY

./btgatt-client &

btgatt-client will perform a passive scan, looking for devices with a particular service UUID (8bf17940-841b-11e6-ae22-56b6b6499611). It will connect to the first 6 compatible devices it finds. It will filter out duplicates from the scan results. Next it will enable notifications by wring 0x0001 to the CCC attribute at handle 0x0010. Then notifications will be received and discarded if there is nowhere to send them (no connected centrals to forward the packets on to). There is a '-p' option that allows selection of the power level (0 – 4 dBm). For example, './btgatt-client -p 0' would set the transmit power level to 0 dBm.

3.3 CONNECT A CENTRAL (UP TO 3 AT A TIME)

Using an Android device or another device that supports BLE.

1. Connect to the device with the name "Caterpillar USB Wireless Adapter".

2. Enable notifications.
3. Observe the notifications coming in.

3.4 ALTERNATIVE TO 3.1 TO 3.3

An alternative to manually configuring this. The user may start this all by executing the provided script: cat_start_syvp_test.sh, cat_start_syvp_test_0dbm.sh, or cat_start_syvp_test_0dbm.sh. Executing these scripts will clean up BLE from the last run then re-initialize everything. The _0dbm.sh versions select a power level according to the name of the file. The cat_start_syvp_test.sh will rely on the default value of 4 dBm.

4 TROUBLESHOOTING

Logging data is printed on the console. This can be used to help determine the cause of any problem that may occur.

4.1 BLE

4.1.1 FAILURE TO CONNECT TO A UB1 PERIPHERAL ON THE ARRAY BOARD

1. Ensure the array board is functioning and the power jumpers are enabled for at least 6 of the peripherals on the board. A green LED will be illuminated for each module when it is powered. A red illuminated LED indicates a connection is established. A flashing blue LED indicates notifications being sent.
2. Ensure the board is in close proximity to the USB Wireless Adapter. The UB1 peripherals on the array board only transmit the advertising packet at their maximum transmit power of 0 dBm. This is not a limitation of the USB Wireless Adapter.

4.1.2 FAILURE TO CONNECT TO A CENTRAL

1. Verify btgatt-server is running by using the 'ps' command. If not, then executing it again. A central will not be able to connect completely without a GATT server running.
2. Verify the host is advertising and is connectable (if btsensor is running it should be)
    a. Execute - hciconfig hci0 leadv 0 – This will put the device into the proper mode again to advertise and be connectable.

4.1.3 INCORRECT OR MISSING ADVERTISING DATA

1. Verify that no other applications are attempting to change or disable advertising data. Some Linux systems, such as Ubuntu, have a Bluetooth manager that will attempt to change or disable advertising data.
2. Verify that bluetoothd is not running. This is unnecessary for executing the tests scripts.

5 Limitations And Known Issues

5.1 USB

5.1.1 Failure To Enumerate After A Host Reboot

If the host is rebooted without cycling power to the USB device, it will fail to re-enumerate and print logging messages similar to the following:

usb 1-1.2: device no response, device descriptor read/64, error -110

usb 1-1.2: device no response, device descriptor read/64, error -110

usb 1-1.2: new high-speed USB device number 4 using ci_hdrc

usb 1-1.2: device no response, device descriptor read/64, error -110

usb 1-1.2: device no response, device descriptor read/64, error -110

usb 1-1.2: new high-speed USB device number 5 using ci_hdrc

usb 1-1.2: device not accepting address 5, error -110

usb 1-1.2: new high-speed USB device number 6 using ci_hdrc

usb 1-1.2: device not accepting address 6, error -110

The workaround is to ensure that power is cycled off then on across a host reboot.

5.2 BLE

5.2.1 BLE Range Issue

Certain units delivered in the first batch of hardware may have lower RF performance. This is resolved in the latest delivery of hardware.

6 PRODUCT OVERVIEW

The USB Wireless Adapter is a portable device that when installed in a machine, provides Wi-Fi and local Bluetooth connectivity within the vicinity of the vehicle/machine.

The Wi-Fi connectivity enables local basic diagnostic and service functionality. The customer or service technician can monitor the health of the machine over WiFi with a smart device such as a mobile phone or tablet.

The Bluetooth connectivity can be used for other sensing/detection activities as well providing authentication functions with other parts of the asset itself, other assets in the field, or vehicle operators.

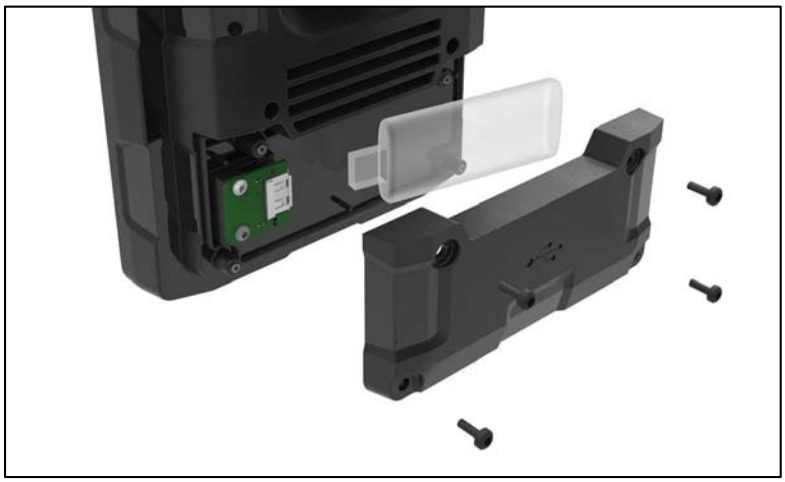
7 INSTALLATION PROCEDURE

The USB Wireless Adapter is designed to be installed into the USB port of a Caterpillar D6:Cx Display. Proper installation is crucial for desired operation and to provide adequate environmental protection.

7.1 D6:CX DISPLAY

The D6:Cx Display has a specially designed compartment for the USB Wireless Adapter. Follow the instructions below to ensure proper installation:

Step #1 – Remove cover from the compartment on the back of the D6:x Display



Step #2 - Remove protective cap from the end of the USB Wireless Adapter and insert into the mating connector as shown

8 GLOSSARY OF TERMS

Term	Meaning
BLE	Bluetooth Low Energy or Bluetooth SMART
BT	Bluetooth
RF	Radio Frequency
RX	Receive
SSID	Service Set Identifier
TBD	To be determined
TX	Transmit
USB	Universal Serial Bus
LED	Light Emitting Diode

9 COMPLIANCE STATEMENTS

This device is manufactured for the global market but when labeled for marketing in North America the one-time programmable (OTP) ROM is programmed at the factory to operate and actively scan only these specific channels:

Channels 1-11, 2412-2462MHz 802.11b mode
Channels 1-11, 2412-2462MHz 802.11g mode
Channels 1-11, 2412-2462MHz 802.11n mode (20MHz channel)
Channels 3-9, 2422-2452MHz 802.11n mode (40MHz channel)

The following channels will be programmed at the factory to passively scan and will only listen but cannot send a probe request to initiate communication on these specific channels. Ad-hoc mode is always disabled on these passive channels:

Channels 12 &13, 2467 & 2472MHz 802.11b mode
Channels 12 &13, 2467 & 2472MHz 802.11g mode
Channels 12 &13, 2467 & 2472MHz 802.11n mode (20/40MHz channel)

This information, when programmed into the OTP ROM, will not be accessible and cannot be modified by the host system.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

This portable transmitter with its antenna complies with FCC and Innovation Science and Economic Development Canada RF exposure limits for general population / uncontrolled exposure.

This Device complies with Innovation, Science and Economic Development Canada License-exempt RSS standard(s). Operation is subject to the following two conditions: 1) this device may not cause interference, and 2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet émetteur portable avec son antenne est conforme aux limites d'exposition RF de la FCC et d'Innovation Science et Développement économique Canada pour la population générale / exposition non contrôlée.

Cet appareil est conforme aux normes RSS exemptes de licence d'Innovation, Science et Développement économique Canada. Son fonctionnement est soumis aux deux conditions suivantes: 1) cet appareil ne doit pas provoquer d'interférences, et 2) cet appareil doit accepter toute interférence, y compris les interférences susceptibles de provoquer un fonctionnement indésirable de l'appareil.