RS9116 n-Link Linux and Android

Technical Reference Manual

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Redpine Signals, Inc.
2107 North First Street, #540
San Jose, CA 95131.
Tel: (408) 748-3385
Fax: (408) 705-2019
Email: sales@redpinesignals.com
Website: www.redpinesignals.com

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About this Document

This document is a preliminary version of RS9116 n-Link Technical Reference Manual for Linux and Android, provided to customers under a Non-Disclosure Agreement (NDA).
src-23903865_Bluetoothhcitoolandhciconfig Usage-_Toc174878560

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1 Introduction to RS9116

The OneBox-Mobile(refers to single software providing combo of all the features supported) software supports the following modes. They are outlined below:

- Wi-Fi (Access Point, Client, Wi-Fi-Direct (P2P), Sniffer and Monitor modes)
- Bluetooth Classic
- Bluetooth Low Energy
- ZigBee (Coordinator, Router and End device modes).

The OneBox-Mobile Coexistence software supports the following combination of modes. They are as follows:

- WLAN STATION /WIFI-Direct/WLAN PER
- WLAN ACCESS POINT(including muliple APs on different vaps)
- WLAN ACCESS POINT + STATION MODE(on multiple vaps)
- WAKE ON WIRELESS(WOWLAN)
- BT CLASSIC MODE/BT CLASSIC PER MODE
- WLAN STATION + BT CLASSIC MODE
- WLAN ACCESS POINT + BT CLASSIC MODE
- BT LE MODE /BT LE PER MODE
- WLAN STATION + BT LE MODE
- BT CLASSIC + BT LE MODE
- WLAN STATION + BT CLASSIC MODE + BT LE MODE
- WLAN ACCESS POINT + BT CLASSIC MODE+ BT LE MODE
- ZIGBEE MODE/ ZIGBEE PER MODE
- WLAN STATION + ZIGBEE
- ZIGBEE COORDINATOR MODE
- ZIGBEE ROUTER MODE

The subsequent sections explain the use of OneBox-Mobile software . The installation and operation of the driver on specific representative processor platforms have been explained in the Appendix sections.

2 Getting Started with RS9116

This section lists the hardware and software requirements for the installation of the software and also describes the steps to be followed to initialize and run the software.

2.1 Hardware Requirements

The Hardware requirements are as follows:

- RS9116N n-Link® Module
- Laptop/PC with SDIO or USB interface or any embedded platform with Linux Board support package.

If the Laptop/PC does not have an SDIO slot, a SDHC/SD/MMC to CardBus Adapter like the one available at http://www.hwtools.net/cardreader/SDCBA_C01.html can be used.

2.2 Software Requirements

The Software requirements are as follows:

- Linux with kernel version from 2.6.38 to 4.18.5 – should enable the open source SDIO and USB stacks.
- DHCP Server (for Wi-Fi Access Point mode)
- Bluetooth supported commands bluetoothctl and bluetoothd must be present.
- Compatible Bluetooth Host Stack, e.g., the Open Source BlueZ Stack v4.101
- ncurses and ncurses-devel libraries

For kernel versions 3.13 and above, refer to the section on **Appendix A: Configuration of Kernels from 3.13 and above** to ensure correct kernel configuration.

2.3 Software Package Contents

The OneBox-Mobile Software is delivered as a tarball with a filename in the format: **RS9116.NXX.NL.GEN.LNX.x.y.z.tgz**, where the naming convention is as follows:
NXX – defines whether the package supports only Wi-Fi (N00) or Bluetooth Classic/Low Energy along with Wi-Fi (NB0) or ZigBee along with Wi-Fi (N0Z) or Bluetooth Classic/Low Energy and ZigBee along with Wi-Fi (NBZ).
x.y.z – identifies the software package.

Redpine driver comes in proprietary and open source form.The Linux driver package contains the following files/folders:

- Readme_nLink.txt
- Releasenotes_nLink.txt
- Documents
- Binary_files (optional)
- source (optional)

Based on the Software License Agreement, driver source code will be available for the users from "https://www.redpinenetworks.us/OpenKM/login.jsp"

3 Compiling the Driver

This section describes the steps to be followed in order to compile the OneBox-Mobile Linux software for different platforms. The steps are outlined below:

1. Save the required configuration of Driver using the **menuconfig utility**.

Following are the options available in menuconfig:

- Host Interface: SDIO or USB.
- Operating system: Linux or Android
- Nl80211 support
- Hostapd Support
- WIFI
- BLUETOOTH
- ZIGBEE

2. To open menuconfig utility, untar the tar ball, go to source->host folder & enter the given below command.

```
make menuconfig
```

The following images show the menuconfig utility options.

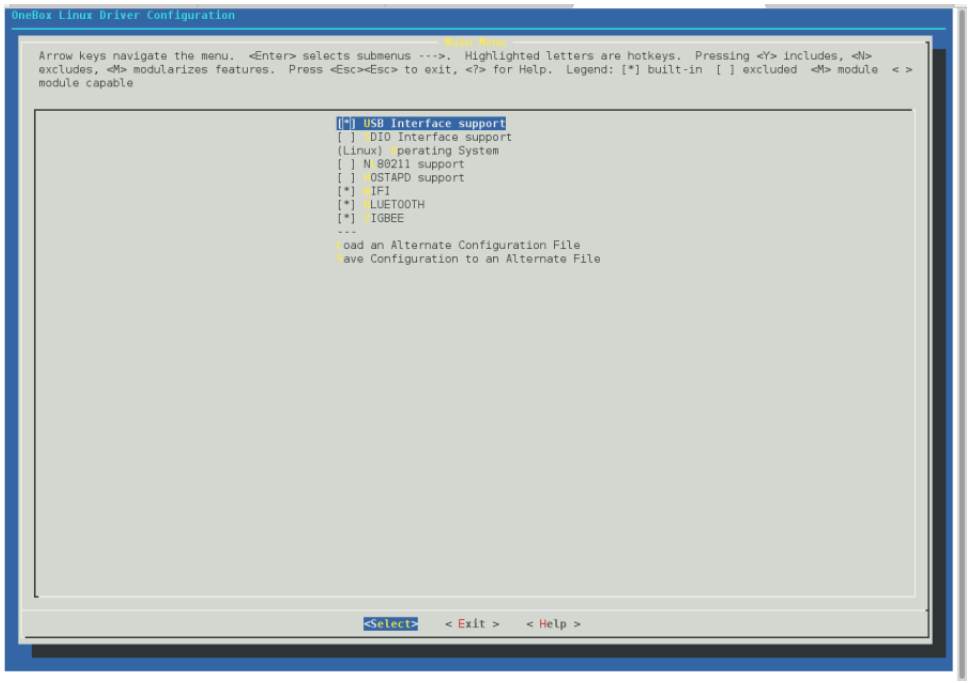


Figure 1: Main Page of menuconfig

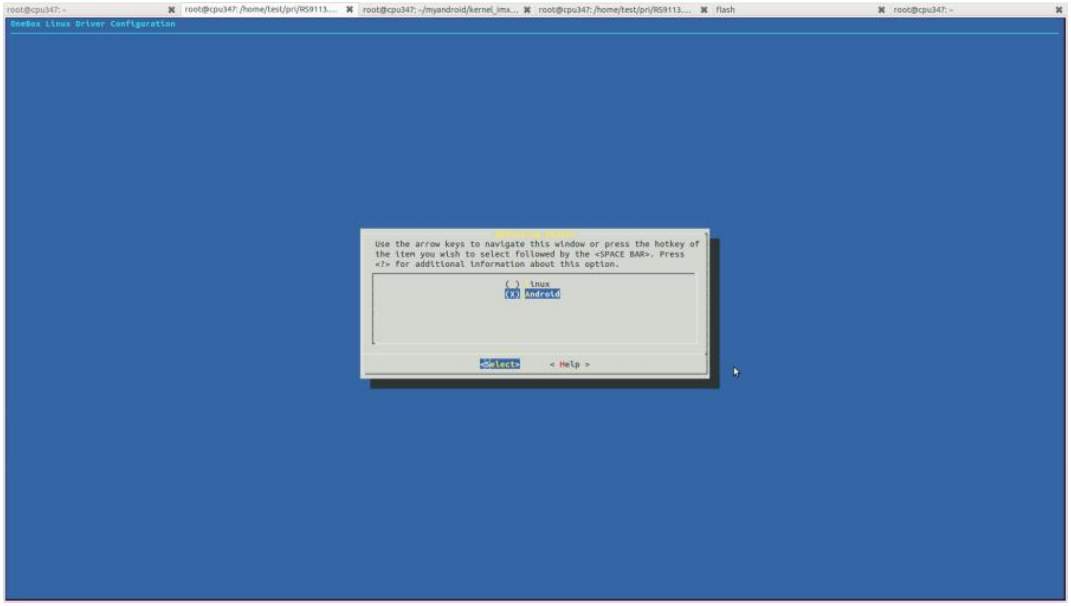


Figure 2: Selecting Operating System

By default, the driver package includes "BSD" support. In case the user needs "Nl80211" support for Access point and Station modes, select the **menuconfig** accordingly. For Nl80211, the **"Hostapd"** application is used as a configuration utility.

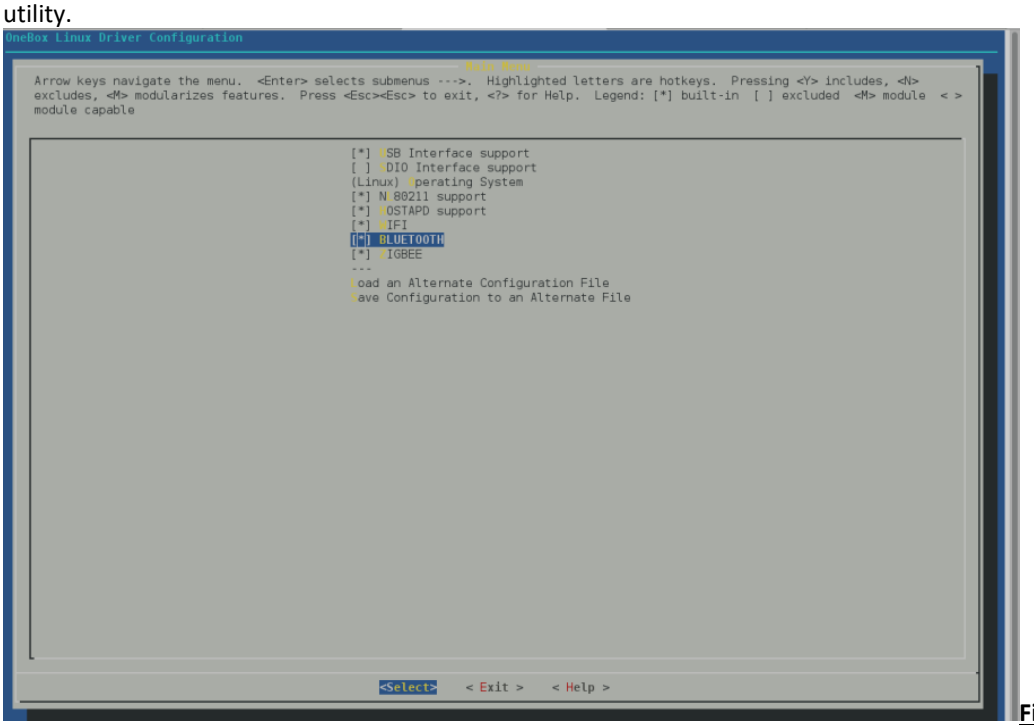


Figure 3: Selection of NL80211 and Hostapd Support

If NL80211 support is enabled in the driver, make sure that the following modules are loaded in the kernel before running the driver in order to avoid module dependencies. This can be verified by using the commands.

```
# lsmod | grep cfg80211
# lsmod | grep bluetooth
```

If they are not installed, can be installed by using the commands below :

```
# modprobe cfg80211
# modprobe bluetooth
```

By default the configuration is enabled with Wi-Fi, Bluetooth and ZigBee. If the user wants to compile the driver for a particular protocol, he can disable the unwanted protocols in **Menuconfig utility.** In case of coex mode, the Wi-Fi must always be enabled in conjunction with BT / ZigBee protocols, even if Wi-Fi will not be used.
For example, if the user wants to compile the driver only for Bluetooth only, the Wi-Fi and Bluetooth mode must be enabled. Refer to the following images of Menuconfig utility for more information:

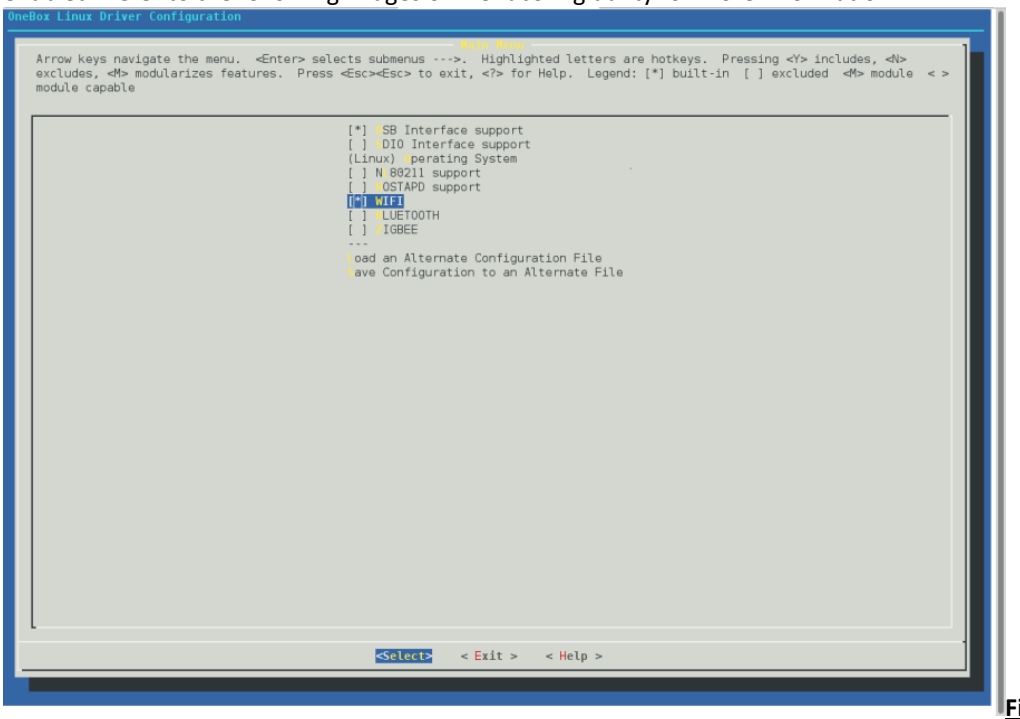


Figure 4: Selection of WIFI Only Mode

3. After selecting the configuration, exit the menuconfig and save the configuration. Please refer the given below image of saving the configuration.

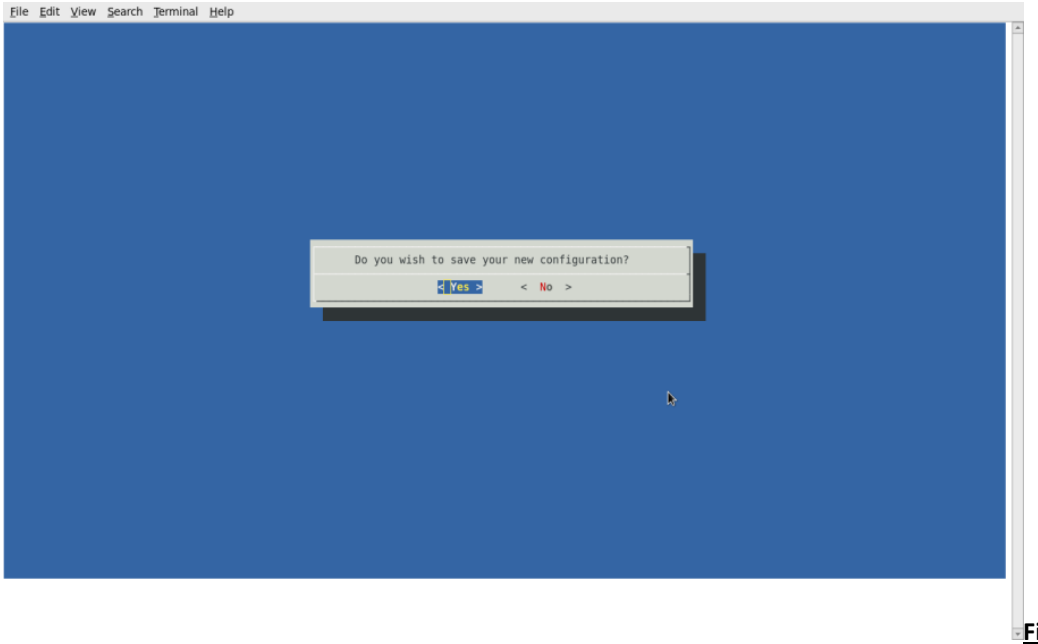


Figure 5: Save the changes before exiting

4. Now to compile the driver, enter the following command:

```
make
```

The code is compiled and the binaries are generated in the **source/host/release** folder**.** For embedded platforms, modify the path assigned to the **"DEF_KERNEL_DIR"** variable in the Makefile:

```
cd RS9116.NXX.NL.GEN.LNX.x.y.z/source/host
```

```
vim Makefile
```

The **DEF_KERNEL_DIR** variable has to be assigned along with the compiled kernel path. For an x86 based Linux platform, the path is usually ***"/lib/modules/<kernel_version>/build"*** and this is the path assigned in the **Makefile** provided in the package.

Example:

```
DEF_KERNEL_DIR:= /lib/modules/3.4.66/build
```

Next, use the **"make"** command to start compiling the driver. For embedded platforms, add the target platform and toolchain path as cross compilation option to the **"make"** command.

For example, if the target platform is ARM and tool chain path is ***"/opt/freescale/usr/local/gcc-4.4.4-glibc-2.11.1-multilib-1.0/arm-fsl-linux-gnueabi/bin/arm-none-linux-gnueabi-"***, then the command is issued as:
make ARCH=arm CROSS_COMPILE=/opt/freescale/usr/local/gcc-4.4.4-glibc-2.11.1-multilib-1.0/arm-fsl-linux-gnueabi/bin/arm-none-linux-gnueabi-

Before installing the Onebox RS9116 Driver modules, make sure that the RSI opensource modules are uninstalled. This has been taken care in the **onebox_insert.sh** script.

In order to un-install the RSI opensource driver, use the following commands:

```
# rmmod rsi_usb
# rmmod rsi_sdo
# rmmod rsi_91x
```

4 Installing the Driver

4.1 Installation of Modules

After completion of compilation, the driver generates the following modules in the release folder. They are outlined below:

- onebox_common_gpl.ko
- onebox_gpl.ko
- onebox_nongpl.ko
- onebox_wlan_gpl.ko
- onebox_wlan_nongpl.ko
- onebox_bt_gpl.ko
- onebox_bt_nongpl.ko
- onebox_zb_gpl.ko
- onebox_zb_nongpl.ko
- wlan.ko
- wlan_wep.ko
- wlan_ccmp.ko
- wlan_tkip.ko
- wlan_acl.ko
- wlan_scan_sta.ko
- wlan_xauth.ko

Load various modules in the following order:
Load onebox common gpl module

```
# insmod onebox_common_gpl.ko
```

Load protocol related Modules (Wi-Fi, BT, ZigBee)
Load common Hal Modules (onebox_nongpl.ko and onebox_gpl.ko).

4.2 Enabling a Protocol

Execute following command to enable required protocol(s):

```
# ./onebox_util rpine0 enable_protocol $protocol_value
```

Below are the possible values of protocol.

- 1 – Enables Wi-Fi only
- 2 – Enables Bluetooth only
- 4 – Enables ZigBee only
- 3 – Enables both Wi-Fi+Bluetooth
- 5 – Enables both Wi-Fi+ZigBee

Note:

- If user selects only **Wi-Fi** in Menuconfig during the compilation of Driver, use the command below :

sh wlan_enable.sh

- If user selects only **Bluetooth** in Menuconfig during the compilation of Driver, use the command below :

sh bt_enable.sh

- If user selects only **ZigBee** in Menuconfig during the compilation of Driver, use the command below:

sh zigb_enable.sh

- If user selects both **Wi-Fi** and **Bluetooth** in Menuconfig during the compilation of Driver, use the command below :

sh wlan_bt_insert.sh

- If user selects both **Wi-Fi** and **ZigBee** in Menuconfig during the compilation of Driver, use the command below :

sh wlan_zigb_insert.sh

- If user selects all the protocols in Menuconfig during the compilation of Driver, use the command below :

sh onebox_insert.sh

and need to run individual protocol enable scripts.

4.3 Disabling a Protocol

Execute he following command to disable required protocol(s):

```
# ./onebox_util rpine0 disable_protocol $protocol_value
```

- the possible values of protocol is same as mentioned in Enabling a Protocol.

Note:

- If user wants to disable only **WLAN**, use the command below :

sh wlan_disable.sh

- If user wants to disable only **Bluetooth**, use the command below :

sh bt_disable.sh

- If user wants to disable only **ZigBee**, use the command below :

sh zigb_disable.sh

- If user wants to disable both **WLAN** and **Bluetooth** or both **WLAN** and **ZigBee** , use the command below :

sh remove_all.sh

Disabling of protocol is not recommended when Wi-Fi is operating in AccessPoint mode.

4.4 OneBox-Mobile in Wi-Fi Only Mode

The steps for starting the Wi-Fi Only mode in Client, AccessPoint and Wi-Fi Direct modes are as follows:

1. Open the **common_insert.sh** file present in the **"release"** folder.
2. Ensure **DRIVER_MODE** and **COEX_MODE** are set as below:

- DRIVER_MODE = 1
- COEX_MODE = 1 (For Station Mode only/WIFI-Direct)
- COEX_MODE = 2 (For Access Point Mode)
- COEX_MODE = 3 (For Both Access Point and Station Modes)

For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel refer Appendix A: Configuration of Kernels from 3.13 and above section to install sdio stack modules .

4.4.1 Installation in Wi-Fi Client Mode (with BSD interface support)

The steps for installing OneBox-Mobile software in **Wi-Fi Client Mode** are as follows:

1. Edit the **"sta_settings.conf"** file in the **"release"** folder and enter the parameters of the Wi-Fi network as given below:

For Open (non-Secure) mode

```
network={
```

```
ssid="<SSID of Access Point>"
key_mgmt=NONE
}
```

For WPA-PSK (TKIP) mode

```
network={
ssid="<SSID of Access Point>"
key_mgmt=WPA-PSK
psk=<passphrase specified in the Access Point>
proto=WPA
pairwise=TKIP
group=TKIP
}
```

For WPA2-PSK (CCMP) mode

```
network={
ssid="<SSID of Access Point>"
key_mgmt=WPA-PSK
psk=<passphrase specified in the Access Point>
proto=WPA2
pairwise=CCMP
group=CCMP
}
```

For WEP-64 mode

```
network={
ssid="<SSID of Access Point>"
key_mgmt=NONE
wep_key0=XXXXXXXXXX
wep_tx_keyidx=X
}
```

The key can be input either in ASCII or Hexadecimal formats:
ASCII Format: wep_key0="12345"
Hexadecimal Format: wep_key0=1234567890
The key index can vary between 0 and 3.

For WEP-128 mode

```
network={
ssid="<SSID of Access Point>"
key_mgmt=NONE
```

```
wep_key0=XXXXXXXXXXXXXXXXXXXXXXXXXX
wep_tx_keyidx=X
}
```

The key can be input either in ASCII or Hexadecimal formats:
ASCII Format: wep_key0="1234567890123"
Hexadecimal Format: wep_key0=123456789012345678901234 56
The key index can vary between 0 and 3.

For WEP-Shared (64-bit) mode

```
network={
ssid="<SSID of Access Point>"
key_mgmt=NONE
wep_key0=XXXXXXXXXX
wep_tx_keyidx=X
auth_alg=SHARED
}
```

The key can be input either in ASCII or Hexadecimal formats:
ASCII Format: wep_key0="12345"
Hexadecimal Format: wep_key0=1234567890
The key index can vary between 0 and 3.
To connect to an Access Point whose SSID is not broadcast (Hidden), add the following line to the network block.

```
scan_ssid=1
```

For example

```
network={
ssid="<SSID of Access Point>"
scan_ssid=1
key_mgmt=NONE
}
```

Next, run the **"start_sta.sh"** script in the **"release"** folder to load the driver modules and the supplicant and also connect to the Access Point specified in the **"sta_settings.conf"** file.

```
sh start_sta.sh
```

User needs to make sure of the module detection w.r.t interface being used. If the module is not detected, user will end up with errors displayed on the console !

After issuing the above command, a virtual interface with the name **"wifi0"** will be created. You can view the list of interfaces by entering the following command:

```
ifconfig –a
```

You can check whether the connection to the Access Point is successful or not, by running the following command:

```
iwconfig wifi0
```

The sample output of this command is

```
wifi0     IEEE 802.11bgn  ESSID:"Range"  Nickname:""
          Mode:Managed  Frequency:2.412 GHz  Access Point: 38:A4:ED:DE:BB:06
          Bit Rate:39 Mb/s   Tx-Power=16 dBm   Sensitivity=1/0
          RTS thr:off   Fragment thr:off
          Encryption key:****-****   Security mode:restricted
          Power Management:off
          Link Quality=80/80  Signal level=-28 dBm  Noise level:0 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0
```

This command gives the status of the device. If the connection is successful, then the connected Access point SSID along with the MAC address is displayed. If it is not connected to an Access point, a message **"Not Associated"** is displayed.
To view the list of Access Points scanned in each channel, you can run the following command in the **"release"** folder.

```
./wpa_cli –i wifi0 scan_results
```

To obtain an IP address using DHCP, start the DHCP client by entering below commands. (1st command to remove entry for existing dhcp and 2nd to create a new entry).

```
$ dhclient -r wifi0
$ dhclient -v wifi0
```

The sample output of dhclient command is given below

```
Listening on LPF/wifi0/88:da:1a:1e:b2:58
Sending on   LPF/wifi0/88:da:1a:1e:b2:58
Sending on   Socket/fallback
DHCPDISCOVER on wifi0 to 255.255.255.255 port 67 interval 4 (xid=0x133cec16)
```

```
DHCPREQUEST on wifi0 to 255.255.255.255 port 67 (xid=0x133cec16)
DHCPOFFER from 192.168.43.1
DHCPACK from 192.168.43.1 (xid=0x133cec16)
bound to 192.168.43.167 -- renewal in 1783 seconds
```

4.4.2 Installation in Access Point Mode (with BSD interface support)

The steps for installing OneBox-Mobile software in **Access Point Mode** are as follows:

1. The **"start_ap.sh"** script present in the **"release"** folder needs to be run with the different configuration files present in the same folder in order to install an Access Point in different security modes.

```
# sh start_ap.sh <conf_file>
```

For example : sh start_ap.sh wpa_supplicant_open.conf
The different configuration files (.conf files) present in the **"release"** folder are as follows:
For Access Point in Open Mode, wpa_supplicant_open.conf configuration file is used, and this starts an Access Point with the following parameters:

- SSID: REDPINE_AP
- Channel 1 of 2.4GHz Band (2412 MHz)
- Open (non-Secure) mode

For Access Point in WEP-64 Mode, wpa_supplicant_wep64.conf configuration file is used, and this starts an Access Point with the following parameters:

- SSID: onebox_wep
- Channel 1 of 2.4GHz Band (2412 MHz)
- Security Mode: WEP-64
- WEP Key: 1234567890
- Key Index: 0

For Access Point in WEP-128 Mode, wpa_supplicant_wep128.conf configuration file is used, and this starts an Access Point with the following parameters:

- SSID: onebox_wep
- Channel 1 of 2.4GHz Band (2412 MHz)
- Security Mode: WEP-128
- WEP Key: 12345678901234567890123456
- Key Index: 0

For Access Point in WPA-PSK (TKIP) Mode, wpa_supplicant_tkip.conf configuration file is used, and this starts an Access Point with the following parameters:

- SSID: onebox_tkip
- Channel 1 of 2.4GHz Band (2412 MHz)
- Security Mode: WPA-PSK (TKIP)
- Passphrase: "12345678"

For Access Point in WPA2-PSK (CCMP) Mode, wpa_supplicant_ccmp.conf configuration file is used, and this starts an Access Point with the following parameters:

- SSID: onebox_ccmp
- Channel 1 of 2.4GHz Band (2412 MHz)
- Security Mode: WPA2-PSK (CCMP)
- Passphrase: "12345678"

All the above mentioned parameters can be modified in the respective configuration files by the user. The values provided in the above mentioned parameters are only for reference.

The Access Point does not support WEP-Shared algorithm in the current release.

2. After running the **"start_ap.sh"** script a virtual interface with the name **"wifi1"** will be created. You can view the list of interfaces using the following command:

```
ifconfig –a
```

You can check whether the Access Point has been started successfully or not, by running the following command:

```
iwconfig wifi1
```

The sample output of this command is

```
wifi1     IEEE 802.11bgn  ESSID:"test"  Nickname:""
          Mode:Master  Frequency:2.432 GHz  Access Point: 88:DA:1A:16:E5:5D
          Bit Rate:6 Mb/s   Tx-Power=30 dBm   Sensitivity=1/0
          RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:off
          Link Quality=80/80  Noise level:0 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0
```

This command gives the status of the device. It displays the Access Point's SSID along with the MAC address and channel frequency. If the Access Point does not start, a message saying **"Exiting: Driver Initialization not completed even after waiting for xxms"** is displayed.

To start a DHCP server, use the commands below.

```
sh dhcp_server.sh wifi1
```

Note: If DHCP server is not present , we can also assign IP statically by using following command. Also it should be noted that dhclient at connected clients will not work as dhcp server is not started at AP. We should assign IP statically at client side also.

```
ifconfig <interface> <IP>
Example : ifconfig wifi1 192.168.2.1
```

4.4.3 Installation in Wi-Fi Client Mode (with NL80211 support)

The steps for installing Wi-Fi Only mode in Client are as follows:

1. Open the **common_insert.sh** file present in the "release" folder.
2. Ensure that the DRIVER_MODE and COEX_MODE are set as below:

- DRIVER_MODE = 1
- COEX_MODE = 1 (For Station Mode only/WIFI-Direct)

or

- COEX_MODE = 3 (For Both Access Point and Station Modes)

For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel refer Appendix A: Configuration of Kernels from 3.13 and above section to install sdio stack modules .

Ensure that in menuconfig, NL80211 support is enabled as mentioned in Figure 4.

3. Compile the driver.

Make sure the following parameters are enabled in the supplicant configuration file (wlan/supplicant/linux/wpa_supplicant/.config)
CONFIG_DRIVER_NL80211=y
CONFIG_LIBNL32=y

```
$ make
```

4. Go to the release folder and start the device in station mode.

```
$ cd release

$ sh wlan_enable.sh
```

5. Issue the following command to get physical interfaces on which we can add wifi0 interface

```
$iw phy | grep phy
```

The output of the command will be phyX (X can be 1,2,3,… eg:phy1,phy2 etc)

In case of multiple phy's to identify the appropriate phy on which to run the command, enter the following command.

```
iw dev
```

The sample output of this command is

```
phy#3
          Interface wlp0s26u1u2
```

```
                          ifindex 10
                          wdev 0x300000001
                          addr 00:23:a7:65:2a:ac
                          type managed
phy#0
          Interface wlo1
                         ifindex 3
                         wdev 0x1
                         addr a4:17:31:a7:82:a3
                         type managed
```

In the above example "Phy3" is Redpine's interface.
Assuming the physical interface is detected as phy1, refer the below steps to create a virtual interface.
6. Add the wireless interface to the phy.

```
$service NetworkManager stop

$iw phy phy1 interface add wifi0 type managed
```

Instead of following the above 2 steps i.e. step 5 and step 6, we can directly create vap by using "onebox_util" binary present in the release folder.

```
cd release

./onebox_util rpine0 create_vap wifi0 sta sw_bmiss
```

Run the supplicant after configuring sta_settings.conf with required AP settings as mentioned in the section **Installation in Wi-Fi Client Mode (with BSD interface support)**
In the sta_settings.conf file, in addition to the above all configurations as mentioned for BSD case, NL80211 mode required country input in the global fields which need to be set as specified below.

```
country=US
```

Now run supplicant as given below.

```
$ ./wpa_supplicant -i wifi0 -D nl802ll -c sta_settings.conf -ddddt > log &
```

4.4.4 Installation in Wi-Fi AP mode (with NL80211 support)

The steps for installing Wi-Fi Only mode in AP are as follows:
1. Open the **common_insert.sh** file present in the **"release"** folder.
2. Ensure that the DRIVER_MODE and COEX_MODE are set as below

- DRIVER_MODE = 1
- COEX_MODE = 2 (For Access Point Mode)

(Or)

- COEX_MODE = 3 (For Both Access Point and Station Modes)

3. Ensure that in menuconfig, NL80211 and HOSTAPD support is enabled.
4. Compile the driver.

Make sure the following parameters are enabled in the hostapd configuration file (wlan/hostapd-2.4/hostapd/.config)
CONFIG_LIBNL32=y

```
$ make
```

Compilation of NL80211 requires libnl library files. Please refer to page Appendix F: Installation of Missing Generic Netlink Libraries for configuration of hoapd.conf file for libnl and installing libnl drivers if they are not available.

5. Go to the release folder and start the device in Access Point mode.

```
$ cd release

$ sh wlan_enable.sh
```

6. Issue the following command to get physical interfaces on which we can add wifi0 interface

```
$iw phy | grep phy
```

The output of the command will be phyX (X can be 1,2,3,… eg:phy1,phy2 etc)

- Now add wifi0 interface to phyX.
- $service NetworkManager stop
- $iw phy phy1 interface add wifi0 type __ap

Instead of following the above steps in step 6, we can directly create vap by using "onebox_util" binary present in the release folder

```
$ ./onebox_util rpine0 create_vap wifi0 ap
```

Configure the SSID Settings of the AP in the hostapd_open.conf file (say if you are starting AP in open mode).
In order to start AP in a particular band and channels, configure variables hw_mode, channel and country in hostapd_open.conf (present in release folder) file as follows :

- hw_mode=a ('a'-5GHz and 'g'-2.4GHz)
- channel=36
- country_code=US

Note:
Channel selection in the **hostapd_open.conf** file should be appropriate as per the band selected.

Make sure in **hostapd_open.conf** file, the AP netdevice name is set to wifi0 or wifi1 according to the interface obtained by following the above steps.
For eg:

- Interface = wifi0

Note: Refer section Appendix G: Considerations need to be made during hostapd usage for description of other configurable parameters of hostapd.conf file(s).
7. Run hostapd with following command

```
$ ./hostapd hostapd_open.conf -ddddt> log &
```

In the same way, we can also configure required SSID and Passphrase and key management settings in hostapd_ccmp.conf, hostapd_wep.conf, hostapd_tkip.conf files accordingly.
If you want to use Auto Channel Selection using hostapd refer ACS with Hostapd section.

4.4.5 Installation in Wi-Fi Direct Mode (With BSD Interface Support)

The steps for installing OneBox-Mobile software in Wi-Fi Direct Mode are as follows:
The **"start_p2p.sh"** script present in the **"release"** folder needs to be run in order to start the supplicant and also for installing the Wi-Fi Direct mode. The configurable parameters in the **p2p.conf** file are outlined below:

- listen channel
- operating channel
- GO Intent

After starting the supplicant, the p2p_commands mentioned below should be executed.

- To find other P2P networks
- #. /wpa_cli –i wifi0 p2p_find
- To find other P2P devices in range
- #. /wpa_cli –i wifi0 p2p_peers
- To connect to a P2P network
- #. /wpa_cli –i wifi0 p2p_connect <BSS ID> pbc go_intent=<intent value>

Here the intent value range is between 0 and 15 (Putting intent value to 0 makes p2p device as client and 15 makes p2p device as group owner).

4.4.5.1 Autonomous GO Mode

The given below command is used to start the device in Autonomous GO mode:

```
# ./wpa_cli –i wifi0 p2p_group_add freq=<channel_freq>
```

The **"channel_freq"** input mentioned in the above command is the center frequency of the Wi-Fi channel in which the GO needs to be started The OneBox-Mobile software supports DFS slave mode. However, DFS Channels need to be avoided till the module is certified for DFS.. If this parameter is not provided, then the GO will start in the channel specified in the p2p.conf file.
Legacy Wi-Fi clients (non P2P clients) need a passphrase to connect to the p2p group. The command given below generates the passphrase for legacy Wi-Fi clients.

```
#. /wpa_cli –i wifi0 p2p_get_passphrase
```

4.4.6 Installation in Wi-Fi Direct Mode (With NL80211 Support only for Kernel v3.8 or higher)

The steps for installing OneBox-Mobile software in Wi-Fi Direct Mode are as follows:
The **"start_p2p_nl80211.sh"** script present in the **"release"** folder needs to be run in order to start the supplicant and also for installing the Wi-Fi Direct mode. The configurable parameters in the **p2p_nl80211.conf** file are outlined below:

- listen channel
- operating channel
- GO Intent

wpa_supplicant version used should be latest one (2.6 or higher). Please check the start_p2p_nl80211.sh script for better understanding and update it accordingly.
After starting the supplicant, the p2p_commands mentioned below should be executed.

- To find other P2P networks

```
#. /wpa_cli –i wifi0 p2p_find
```

- To find other P2P devices in range

```
#. /wpa_cli –i wifi0 p2p_peers
```

- To connect to a P2P network

```
#. /wpa_cli –i wifi0 p2p_connect <BSS ID> pbc go_intent=<intent value>
```

Here the intent value range is between 0 and 15 (Putting intent value to 0 makes p2p device as client and 15 makes p2p device as group owner). If you are becoming GO, dhcp server should be running on GO Interface.

4.4.6.1 Autonomous GO Mode

The steps for installing OneBox-Mobile software in Wi-Fi Direct Mode are as follows:
The **"start_p2pgo.sh"** script present in the **"release"** folder needs to be run in order to start the supplicant and also for installing the Wi-Fi Direct mode. The configurable parameters in the **p2p_nl80211.conf** file are outlined below:

- listen channel
- operating channel
- GO Intent

wpa_supplicant version used should be latest one (2.6 or higher). Please check the start_p2pgo.sh script for better understanding and update it accordingly.
The given below command is used to start the device in Autonomous GO mode:

```
# ./wpa_cli –i wifi0 p2p_group_add freq=<channel_freq>
```

The **"channel_freq"** input mentioned in the above command is the center frequency of the Wi-Fi channel in which the GO needs to be started The OneBox-Mobile software supports DFS slave mode. However, DFS Channels need to be avoided till the module is certified for DFS.. If this parameter is not provided, then the GO will start in the channel specified in the p2p_nl80211.conf file.

- P2P Devices can scan this Group Owner and can connect directly. Run following command to start receiving connect calls from P2P devices

#. /wpa_cli –i wifi0
- > wps_pbc

You will start getting ENROLEE detect calls from other P2P Devices in the vicinity. You can see the running logs on wpa_cli prompt for the device getting connected.

- Legacy Wi-Fi clients (non P2P clients) need a passphrase to connect to the p2p group. The command given below generates the passphrase for legacy Wi-Fi clients.

#. /wpa_cli –i wifi0 p2p_get_passphrase

- Run DHCP Server on GO Interface before connecting P2P or Legacy devices.

4.5 OneBox-Mobile in Wi-Fi + Bluetooth Classic Coexistence Mode

This section explains about the installation of Wi-Fi and BT Classic modes. Please note that in case of using Coexistence mode, each protocol should be loaded individually one after the other.

- Open the **common_insert.sh** file present in the **"release"** folder.
- Ensure that the DRIVER_MODE and COEX_MODE are set as below:

- DRIVER_MODE = 1
- COEX_MODE = 5(For WLAN Station and BT Classic Mode)
- COEX_MODE = 6 (For WLAN Access Point and BT Classic Mode)

For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel refer Appendix A: Configuration of Kernels from 3.13 and above section to install sdio stack modules .

1. Follow the instructions mentioned in the section **4.4.1 Installation in Wi-Fi Client Mode** inorder to install the Wi-Fi Client mode.
2. Run the **"bt_enable.sh"** or **wlan_bt_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions given in the **Installing the Driver** in order to start the Bluetooth Classic mode. This script inserts Bluetooth modules and common HAL modules, provided if it is not already inserted.
3. You can check whether the BT Classic mode has been started successfully or not, by running the following command:

```
hciconfig
```

If the driver is loaded correctly, the above command displays a network adaptor named **"hciX"**. An example output is given below:

```
hci0:Type: BR/EDR Bus: SDIO
BD Address: 00:23:A7:00:05:68 ACL MTU: 1021:8 SCO MTU: 30:8
UP RUNNING PSCAN
RX bytes:478 acl:0 sco:0 events:20 errors:0
TX bytes:331 acl:0 sco:0 commands:19 errors:0
```

4. After the device is up, we can pair it with the other devices using the Bluetooth Manager application. The files can also be sent and received using Bluetooth Manager. Instead of Bluetooth Manager, the device can be configured using **"hcitool"** or **"hciconfig"**. The procedure for using Bluetooth Manager is explained in the section **Appendix C: Using the Bluetooth Manager**

4.6 OneBox-Mobile in Wi-Fi + Bluetooth LE Coexistence Mode

This section describes the installation of Wi-Fi and Bluetooth LE (BLE) modes. Please note that in case of using Coexistence mode, each protocol should be loaded individually one after the other.

- Open the common_insert.sh file present in "release" folder.
- Ensure that the DRIVER_MODE and COEX_MODE as set as below

- DRIVER_MODE = 1
- COEX_MODE = 9 (For WLAN Station and BT LE)

Note:
For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel refer Appendix A: Configuration of Kernels from 3.13 and above section to install sdio stack modules .

1. Follow the instructions in section 4.4.1 Installation in Wi-Fi Client Mode, inorder to install the Wi-Fi Client mode.
2. Run the **bt_enable.sh** or **wlan_bt_insert.sh** or **onebox_insert.sh** script present in the "release" folder as per the instructions present in the section 4.1 inorder to start the Bluetooth LE mode. This script inserts Bluetooth modules as well as common HAL modules, provided if it is not inserted initially.
3. You can check whether the BLE mode has been started successfully or not, by running the following command:

```
# hciconfig
```

If the driver is loaded correctly, the above command displays a network adaptor named "hciX". An example output is given below:

```
hci0:Type: BR/EDR Bus: SDIO
BD Address: 00:23:A7:00:05:68 ACL MTU: 1021:8 SCO MTU: 30:8
UP RUNNING PSCAN
RX bytes:478 acl:0 sco:0 events:20 errors:0
TX bytes:331 acl:0 sco:0 commands:19 errors:0
```

4. After the device is up, we can Advertise, Scan and Connect with other BLE devices. The device can be configured using hcitool or hciconfig.

4.6.1 Advertise, Scan, Connect Commands

The commands for Advertise, Scan and Connect are as follows:

- Enable Advertise

```
# hciconfig –a <hciX> leadv
```

- Disable Advertise

```
# hciconfig –a <hciX> noleadv
```

- Initiate Scan

```
# hcitool -i <hciX> lescan
```

The above command displays the scan responses and advertising information.

- Master Mode Connected State

Ensure that the remote device is in Advertise mode and then issue the command given below:

```
# hcitool -i <hciX> lecc <remote_MAC_Addr>
```

The **"remote_MAC_Addr"** parameter mentioned above is the MAC address of the remote device, e.g., 00:23:AC:01:02:03.

- Slave Mode Connected State

Ensure that our device is in Advertise mode and then issue the command given below:

```
# hcitool -i <hciX> lecc <device_MAC_Addr>
```

The "device_MAC_Addr" parameter mentioned above is the MAC address of the Redpine module, e.g., 00:23:AC:01:02:03.

4.7 OneBox-Mobile in Wi-Fi + Bluetooth Classic + Bluetooth LE Coexistence Mode

This section explains about the installation of Wi-Fi +Bluetooth Classic and Bluetooth LE modes.
Please note that in case of using Coexistence mode, each protocol should be loaded individually one after the other.

- Open the **common_insert.sh** file present in the **"release"** folder.
- Ensure that the DRIVER_MODE and COEX_MODE are set as below:

- DRIVER_MODE = 1
- COEX_MODE = 14(For WLAN Access Point, BT Classic and BT LE)
- COEX_MODE = 13(For WLAN Station, BT Classic and BT LE)

1. Follow the instructions mentioned in the section **Installation in Access Point Mode (with BSD interface support)**, in order to install the Wi-Fi Access Point mode.
2. Run the **bt_enable.sh** or **wlan_bt_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions mentioned in **Installation of Modules** to start the Bluetooth LE mode. This script inserts Wi-Fi, Bluetooth modules as well as common HAL modules, provided if it is not inserted initially.
3. To check whether the Bluetooth Classic and Bluetooth LE mode has been started successfully or not, run the given below command.

```
# hciconfig
```

If the driver has been installed successfully, the above mentioned command displays a network adapter named "hciX". An example output is given below:

```
hci0:Type: BR/EDR Bus: SDIO
BD Address: 00:23:A7:xx:xx:xx ACL MTU: 1021:8 SCO MTU: 30:8
UP RUNNING PSCAN
RX bytes:478 acl:0 sco:0 events:20 errors:0
TX bytes:331 acl:0 sco:0 commands:19 errors:0
```

4. After the device is up, we can Advertise, Inquiry, Scan and Connect with other BT Classic and BLE devices. The device can be configured using hcitool or hciconfig applications.
5. After the device is up, we can pair it with the other devices or from other devices using the Bluetooth Manager application. The files can also be sent and received using Bluetooth Manager. Instead of Bluetooth Manager, the device can be configured using **"hcitool"** or **"hciconfig"**. The procedure for using Bluetooth Manager is explained in the section **Appendix C: Using the Bluetooth Manager**.

NOTE: To know the device type for BT i.e., device is supporting LE or BR/EDR
By giving command: **hciconfig -a hcix features**

Example1:For LE Opermode i.e., DRIVER_MODE = 1 & COEX_MODE = 8
Command:hciconfig -a hci1 features
hci1: Type: Primary Bus: USB
BD Address: 88:DA:1A:16:E4:4F ACL MTU: 251:10 SCO MTU: 0:0
Features page 0: 0xbf 0xfe 0x0d 0xbe 0xfb 0xff 0x41 0x85
<3-slot packets> <5-slot packets> <encryption> <slot offset>
<timing accuracy> <role switch> <sniff mode> <RSSI>
<channel quality> <SCO link> <HV2 packets> <HV3 packets>
<u-law log> <A-law log> <CVSD> <power control>
<transparent SCO> <EDR ACL 2 Mbps> <EDR ACL 3 Mbps>
<enhanced iscan> <interlaced iscan> <interlaced pscan>
<extended SCO> <EV4 packets> <EV5 packets> <AFH cap. slave>
<AFH class. slave> **<BR/EDR not supp.> <LE support>**
<3-slot EDR ACL> <5-slot EDR ACL> <sniff subrating>
<pause encryption> <AFH cap. master> <AFH class. master>
<EDR eSCO 2 Mbps> <EDR eSCO 3 Mbps> <3-slot EDR eSCO>
<extended inquiry> <non-flush flag> <LSTO> <EPC>
<extended features>
Features page 1: 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Example2: For Classic(BT BR/EDR) Only i.e DRIVER_MODE = 1 & COEX_MODE = 4
Command:hciconfig -a hci1 features
hci1: Type: Primary Bus: USB
BD Address: 88:DA:1A:16:E4:4F ACL MTU: 1021:3 SCO MTU: 64:3
Features page 0: 0xbf 0xfe 0x0d 0xfe 0x9b 0xff 0x59 0x87
<3-slot packets> <5-slot packets> <encryption> <slot offset>
<timing accuracy> <role switch> <sniff mode> <RSSI>
<channel quality> <SCO link> <HV2 packets> <HV3 packets>
<u-law log> <A-law log> <CVSD> <power control>
<transparent SCO> <EDR ACL 2 Mbps> <EDR ACL 3 Mbps>
<enhanced iscan> <interlaced iscan> <interlaced pscan>
<inquiry with RSSI> <extended SCO> <EV4 packets> <EV5 packets>
<AFH cap. slave> <AFH class. slave> <3-slot EDR ACL>
<5-slot EDR ACL> <sniff subrating> <pause encryption>
<AFH cap. master> <AFH class. master> <EDR eSCO 2 Mbps>
<EDR eSCO 3 Mbps> <3-slot EDR eSCO> <extended inquiry>
<simple pairing> <encapsulated PDU> <non-flush flag> <LSTO>
<inquiry TX power> <EPC> <extended features>
Features page 1: 0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Example3: For the Classic and LE i.e DRIVER_MODE = 1 & COEX_MODE = 12
Command:hciconfig -a hci1 features

hci1: Type: Primary Bus: USB
BD Address: 88:DA:1A:16:E4:4F ACL MTU: 1021:3 SCO MTU: 64:3
Features page 0: 0xbf 0xfe 0x0d 0xfe 0xdb 0xff 0x5b 0x87
<3-slot packets> <5-slot packets> <encryption> <slot offset>
<timing accuracy> <role switch> <sniff mode> <RSSI>
<channel quality> <SCO link> <HV2 packets> <HV3 packets>
<u-law log> <A-law log> <CVSD> <power control>
<transparent SCO> <EDR ACL 2 Mbps> <EDR ACL 3 Mbps>
<enhanced iscan> <interlaced iscan> <interlaced pscan>
<inquiry with RSSI> <extended SCO> <EV4 packets> <EV5 packets>
<AFH cap. slave> <AFH class. slave> <LE support>
<3-slot EDR ACL> <5-slot EDR ACL> <sniff subrating>
<pause encryption> <AFH cap. master> <AFH class. master>
<EDR eSCO 2 Mbps> <EDR eSCO 3 Mbps> <3-slot EDR eSCO>
<extended inquiry> **<LE and BR/EDR>** <simple pairing>
<encapsulated PDU> <non-flush flag> <LSTO> <inquiry TX power>
<EPC> <extended features>
Features page 1: 0x03 0x00 0x00 0x00 0x00 0x00 0x00 0x00
Features page 2: 0x30 0x00 0x00 0x00 0x00 0x00 0x00 0x00

4.8 OneBox-Mobile in Wi-Fi + ZigBee Coexistence Mode

This section explains about the installation of Wi-Fi and ZigBee (ZB) modes. Please note that in case of using Coexistence mode, each protocol should be loaded individually one after the other.

1. Open the **common_insert.sh** file present in **"release"** by using an editor like gvim.
2. Ensure that the DRIVER_MODE and COEX_MODE are set as given below

- DRIVER_MODE = 1
- COEX_MODE = 17 (For Wlan Station and ZigBee)

> For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel refer Appendix A: Configuration of Kernels from 3.13 and above section to install sdio stack modules .

3. Follow the instructions mentioned in the section **Installation in Wi-Fi Client Mode**, inorder to install the Wi-Fi Client mode.
4. Run the **"zigb_insert.sh"** script present in the **"release"** folder inorder to start the ZigBee mode. This script inserts ZigBee modules and common HAL modules, provided if it is not inserted initially.
5. You can check whether the ZigBee mode has been started successfully or not, by running the given below command:

```
# ifconfig –a
```

If the driver is loaded correctly, the above command displays a network adapter named **"zigb0"**.

4.8.1 Building and Running the Sample Home Automation Switch Application

To help in evaluating the ZigBee mode, a sample Home Automation switch application is made available with the release. You will need a 3rd party ZigBee Coordinator and ZigBee-enabled Light bulb which support the Home Automation Profile. Ensure that the Coordinator and Light bulb are switched on and are in connected state before proceeding further.

4.8.1.1 About the Sample Application

This is the ZigBee Home Automation-defined switch application using Host APIs. This application connects to the light parent and tries to match the simple descriptors by using Match Descriptor command.
After exchanging the simple descriptors, it will send the toggle command to the light continuously.

4.8.1.2 Host API Folder Structure

The folder structure for host API along with sample applications has been given below. This folder structure is available in the **"ZigBee/utils"** folder.
The folders in the ZigBee/utils folder are as follows:

- apis – contains the core APIs and sample application

- core – contains the host mode API implementation.
- ref_apps – contains the reference HA switch application.
- build - contains Makefile to compile core and ref_apps irrespective of reference project.

- reference_projects – contains code related to netlink sockets which is used to communicate with driver.

4.8.1.3 Building and Running the Home Automation Sample Application

The steps for building and running the home automation sample application are as follows:

1. Go to the folder **"ZigBee/utils/reference_projects/src"**
2. Clean the existing builds by entering the given below command

```
# make clean
```

3. Build the Home Automation Switch application by using the given below command

```
# make switch
```

4. Run the switch app by entering the given below command

```
# ./rsi_wsc_zigb_app
```

4.9 Driver Uninstallation Procedure

The driver can be uninstalled along with the different modules by using the scripts provided in the **"release"** folder.

1. remove_all.sh: Uninstall the complete driver and all the modules including the common HAL modules .

```
# sh remove_all.sh
```

4.10 Driver Information

4.10.1 Driver Statistics

Use the given below command inorder to view Wi-Fi driver statistics:

```
cat /proc/rpine<$id>/stats
```

<$id> Indicates Id of Wi-Fi device. For example if rpine0 is created for module then to view Wi-Fi related statistics related to module then Use the below command:

```
# cat /proc/rpine0/stats
```

When 2nd usb device is connected to same host then rpine1 will get created, In order to see the Wi-Fi related statistics related to 2nd usb module use the below command:

```
cat /proc/rpine1/stats
```

This command prints statistics related to the total management packets, total data packets with respect to a given access category sent to/from the driver, buffer full status as well as semi buffer full status, FSM states etc.

4.10.2 Disabling Driver Debug Prints

You may opt to disable the debug prints of the driver appearing on the console by using the given below command. Ensure that the driver is installed correctly before using this command for SDIO interface.

```
# echo 0x0 > /proc/onebox-hal/debug_zone
```

For USB interface, the proc name is onebox-mobile$devnum$busnum.

```
# echo 0x0 > /proc/onebox-hal<$devnum$busnum>/debug_zone
```

5 Wi-Fi ioctl Usage Guide

This section explains about the usage of various ioctl commands present in the OneBox-Mobile driver. The user has control over multiple settings such as device settings, radio, aggregation, fragmentation thresholds, power save configurations and so on.

5.1 Configuring using Wireless Extensions

iwconfig" is a generic Linux based wireless tool which is used for setting parameters for a wireless network interface. It may be used in lieu of the Wi-Fi supplicant provided as a part of the OneBox-Mobile software. However, care has to be taken to follow the correct sequence of commands while using **"iwconfig"**. The Redpine Signals recommends usage of the supplicant provided in the software package.
This section describes the usage of **"iwconfig"** in conjunction with the Onebox-Mobile driver. For a detailed description of the tool, refer to the relevant main pages in Linux.
"iwconfig" only works when the driver is operating in the 'BSD' mode.
The details of the Access Point for which the n-Link® is connected in the Client mode can be viewed by using the given below command.

```
# iwconfig <vap_name>
```

The table below describes the usage of the command in more detail.

Set Channel/Frequency (only in Monitor mode)	
Description	This command is used to set the Channel for the n-Link® module.
Default value	1
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Channel number
Output Parameter	None
Reset required	No
Usage	# iwconfig <vap_name> freq <channel_no> (OR) # iwconfig <vap_name> channel <channel_no>
Example	# iwconfig wifi0 freq 6 (OR) # iwconfig wifi0 channel 6
Set Data Transmit Rate	
Description	This command is used to set the data rate for transmission.
Default value	0 (Auto Rate)
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value as per the mapping below: Auto Rate – 0 1 Mbps – 2 2 Mbps – 4 5.5 Mbps – 11 11 Mbps – 22

Set Channel/Frequency (only in Monitor mode)	
	6 Mbps – 12 12 Mbps – 24 18 Mbps – 36 24 Mbps – 48 36 Mbps – 72 48 Mbps – 96 54 Mbps – 108 MCS0 – 13 MCS1 – 26 MCS2 – 39 MCS3 – 52 MCS4 – 78 MCS5 – 104 MCS6 – 117 MCS7 – 130
Output Parameter	None
Reset required	No
Usage	# iwconfig <vap_name> rate <rate_val> **Note:** For Access Point mode, this command has to be issued after the Set Mode command only if the VAP has started using “iwconfig” commands and not using the supplicant provided by Redpine Signals. For Client mode, the Set Mode command is not mandatory
Set RTS/CTS Threshold (only in Access Point mode)	
Description	This command is used to set the RTS/CTS threshold of the n-Link® Module.
Default Value	2346
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer between 256 and 2346
Output Parameter	None
Reset Required	No.
Usage	# iwconfig <vap_name> rts <payload_size>
Example	The command below sets the RTS/CTS threshold to 1008 bytes: # iwconfig wifi0 rts 1008
Set Transmit Power	
Description	This command is used to set the transmit power of the n-Link® Module **Note:** If the value of transmit power set in the above command exceeds the maximum allowable power supported by the channel specified by the regulatory domain, then the minimum of the two values shall be used
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value in dBm
Output Parameter	None
Reset	No

Set Channel/Frequency (only in Monitor mode)	
Required	
Usage	# iwconfig <vap_name> txpower <val_in_dBm>
Example	# iwconfig wifi0 txpower 10 **Note:** Txpower setting can be defined as the minimum value that can be picked from the max regulatory power settings, from any user defined value and also from the maximum values the radio can support. So it is not guaranteed that the user defined value gets effected when these settings is done.

Table 1: iwconfig Usage

5.2 Private (Driver-Specific) Commands for Access Point and Client Modes

The **"iwpriv"** command is used to set parameters specific to the OneBox-Mobile software. The table below lists the usage of the **"iwpriv"** command for setting and getting parameters common for the Access Point and Client modes.

Set Short GI	
Description	This command is used to set the Short GI mode of the n-Link® Module.
Default Value	0 (Short GI disabled for both 20 MHz and 40 Mhz Bandwidth)
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 0 –Disable Short GI 1 –Enable Short GI for 20MHz Bandwidth 2 –Enable Short GI for 40MHz Bandwidth 3 –Enable Short GI for 20MHz and 40MHz Bandwidths
Output Parameter	None
Reset Required	Yes. Refer to the example for the reset process
Usage	# iwpriv <vap_name> short_gi <value>
Example	The commands given below set the Short GI for 20MHz bandwidth and then reset the adapter for the command to take effect: # iwpriv wifi0 short_gi 1 # ./onebox_util rpine0 reset_adapter **Note:** Issue this ioctl before starting the supplicant.
Get Short GI	
Description	This command is used to get the value programmed for Short GI mode of the n-Link® Module
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.)
Output Parameter	The integer value mapping has been shown below: 0 – Disable Short GI 32 – Enable Short GI for 20MHz Bandwidth 64 – Enable Short GI for 40MHz Bandwidth 96 – Enable Short GI for 20MHz and 40MHz Bandwidths
Reset Required	No
Usage	# iwpriv <vap_name> get_short_gi
Example	The command given below explains about getting the Short GI programmed in the module:

Set Short GI	
	# iwpriv wifi0 get_short_gi
Get Privacy	
Description	This command is used to get the Privacy bit of the n-Link® Module
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.)
Output Parameter	The integer value mapping has been shown below: 0 – Privacy is disabled 1 – Privacy is enabled
Reset Required	No
Usage	# iwpriv <vap_name> get_privacy
Example	The command given below tells about like how to get the Privacy information in the module: # iwpriv wifi0 get_privacy
Set WMM (only in Access Point mode)	
Description	This command is used to enable the WMM (QoS) feature of the n-Link® Module
Default Value	1 (Enabled)
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 0 – Disable 1 – Enable
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> wmm <value>
Example	The command below sets the WMM mode for the module: # iwpriv wifi0 wmm 1 **Note:** Issue this command before starting the supplicant in Access Point Mode.
Set AMPDU	
Description	This command is used to enable AMPDU Aggregation in the n-Link® Module
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 0 – Disable AMPDU Aggregation 1 – Enable AMPDU Aggregation for Transmit, disable for Receive 2 – Enable AMPDU Aggregation for Receive, disable for Transmit
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> ampdu_set <value>
Example	The command given below disables A-MPDU aggregation: # iwpriv wifi0 ampdu_set 0 The command given below enables A-MPDU aggregation for Transmit: # iwpriv wifi0 ampdu_set 1
Set Bandwidth	

Set Short GI	
Description	This command is used to enable or disable 20/40 MHz Bandwidths in the n-Link® Module.
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 1- Enable only 20MHz 2- Enable only 40MHz 3 – Enable both 20 and 40MHz
Output Parameter	None
Reset Required	Yes. Refer to the example for the reset process for Client and Access Point modes
Usage	# iwpriv <vap_name> set_htconf <value>
Example	The commands given below is used to delete and create the VAP to set the bandwidth in Access Point mode: # ./onebox_util rpine0 delete_vap wifi0 # ./onebox_util rpine0 create_vap wifi0 ap # iwpriv wifi0 set_htconf $value # ./wpa_supplicant –i wifi0 wpa_supplicant_open.conf & **Note:** Issue this ioctl before starting the supplicant. The commands given below is used to set the 20MHz bandwidth in Client mode and reset the Client for the command to take effect: # iwpriv wifi0 set_htconf 1 # ./onebox_util rpine0 reset_adapter.
Set Debug Zone	
Description	This command is used to select the debug zone for Wifi.
Default Value	0x4000
Input Parameters	Zone value. The integer value mapping has been shown below: 0 – Disable zone. 0x4000 – Error Zone.
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap name> set_dbg_zone <zone_value>
Example	The following command disables debug zone level. # iwpriv wifi0 set_dbg_zone 0

Table 2: iwpriv Usage for Access Point and Client Modes

5.3 Private (Driver- Specific) Commands for Access Point Mode

The table below describes the usage of the **"iwpriv"** command for setting and getting parameters common for the Access Point Mode.

Set DTIM Period	
Description	This command is used to set the DTIM period in the n-Link® Module. Issue this command before starting the supplicant.

Set DTIM Period	
Default Value	1
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value between 1 and 15
Output Parameter	None
Reset Required	Yes. In order to set the DTIM period, the virtual interface has to be reset.
Usage	1. iwpriv <vap_name> dtim_period <value>
Example	The commands given below is used to reset the VAP and set the DTIM period: #sh remove_all.sh #sh wlan_enable.sh (or) wlan_bt_insert.sh (or) wlan_zigb_insert.sh (or) onebox_insert.sh script present in the "release" folder as per the instructions in Section 4.1 #./onebox_util rpine0 create_vap wifi1 ap #iwpriv wifi1 dtim_period $value #./wpa_supplicant –I wifi1 –D bsd –c wpa_supplicant_open.conf –ddddt > log & **Note:** Issue this ioctl before starting the supplicant in Access Point.
Get DTIM Period	
Description	This command is used to get the DTIM period in the n-Link® Module.
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.)
Output Parameter	Integer value renges between 1 and 15
Reset Required	No.
Usage	iwpriv <vap_name> get_dtim_period
Example	The command given below is used to get the DTIM period programmed in the module: #iwpriv wifi0 get_dtim_period
Get Beacon Interval	
Description	This command is used to get the Beacon Interval programmed in the n-Link® Module
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.)
Output Parameter	Integer value
Reset Required	No
Usage	# iwpriv <vap_name> get_bintval
Example	The command given below is used to get the Beacon interval programmed in the module: #iwpriv wifi0 get_bintval
MAC Command	
Description	This command is used to set the Access Policy based on MAC address. The Access Policy can be disabled or can be used to allow or deny traffic from the MAC address.[1] Note: All the acl policy commands need to be issued before starting the wpa_supplicant.
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 0 – Disable Access Policy 1 – Enable Access Policy and Allow traffic 2 – Enable Access Policy and Deny traffic

Set DTIM Period	
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> maccmd <value>
Example	The command given below enables the ACL Policy and allows traffic: # iwpriv wifi0 maccmd 1 The command given below enables the ACL Policy and denies traffic: # iwpriv wifi0 maccmd 2
Add MAC Address for Access Policy	
Description	This command is used to add a MAC address for the Access Policy in the n-Link® Module.
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) 48-bit MAC Address in hexadecimal format with colon separation. e.g., 00:23:A7:01:02:03
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> addmac <mac_addr>
Example	The command given below adds a MAC Address (10:10:A9:12:13:14) to the ACL Policy: # iwpriv wifi0 addmac 10:10:a9:12:13:14 **Note:** Issue this command before a Station connects to the module.
Delete MAC Address from Access Policy list	
Description	This command is used to delete a MAC address from the Access Policy described in the n-Link® Module
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) 48-bit MAC Address in hexadecimal format with colon separation. e.g., 00:23:A7:01:02:03
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> delmac <mac_addr>
Example	The command given below is used to delete a MAC Address (10:10:A9:12:13:14) from the ACL Policy: # iwpriv wifi0 delmac 10:10:a9:12:13:14
Set Hidden SSID	
Description	This command is used to stop broadcasting of the SSID of the Access Point in the n-Link® Module's beacons and probe responses.
Default Value	0 (Hidden SSID Disabled)
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) The integer value mapping has been shown below: 0 – Disable Hidden SSID (SSID is broadcast) 1 – Enable Hidden SSID (SSID is not broadcast)
Output Parameter	None
Reset Required	Yes. In order to move from/to Hidden SSID mode, the virtual interface has to be reset.

Set DTIM Period	
Usage	# iwpriv <vap_name> hide_ssid <value>
Example	The command given below is used to start the Access Point in hidden mode: # ./onebox_util rpine0 create_vap wifi0 ap # iwpriv wifi0 hide_ssid 1 # ./wpa_supplicant –i wifi0 –D bsd –c wpa.conf & **Note:** Issue this ioctl before starting the supplicant.
Set DFS channel to switch to	
Description	This command is used to select a channel to switch to in case of Radar Detection in Access Point mode. This is used only when the bsd driver is used.
Default Value	Disabled (A channel gets picked at random)
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Frequency of the channel to switch to in case of radar detection.
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap name> dfs_chan_switch <frequency>
Example	The following command sets the channel 36 as the channel for switching to. # iwpriv wifi0 dfs_chan_switch 5180
Set Mgmt Rate	
Description	This command is used to set the mgmt rate
Default Value	0
Input Parameters	value*2
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap name> mgmt_rate <value*2>
Example	The Following command sets the mgmt rate to 5.5Mbps #iwpriv wifi0 mgmt_rate 11 To disable the mgmt_rate use the below command: #iwpriv wifi0 mgmt_rate 0
Set Keep Alive Period in AP mode	
Description	This command is used to set the Keep Alive period in the n-Link® Module. It is recommended that this command is given after the VAP is created and before wpa_supplicant/hostapd is started
Default Value	240 seconds
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value ranges between 15 and 12000 (seconds). Integer value should be a multiple of 15, if the value is not a multiple of 15, it will rounded off to nearst multiple of 15.
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> keep_alive <value>
Example	The command given below sets the Keep Alive period to 30 seconds, after rounding off 35 to the

Set DTIM Period	
	nearest multiple of 15. # iwpriv wifi0 keep_alive 35

Table 3: iwpriv Usage for Access Point Mode

5.4 Private (Driver- Specific) Commands for Client Mode

The table below lists the usage of the **"iwpriv"** command for setting and getting parameters common for the Client Mode.

De authenticate while Roaming	
Description	This command is used to de authenticate the n-Link® Module from "old" Access Point while roaming.
Default Value	NULL Data
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value - 0 or 1 0 – Inform Access Point that the module is going to be in power save mode. 1 – De authenticate from the previous Access Point during Roaming.
Output Parameter	None
Reset Required	No
Usage	iwpriv <vap_name> setparam 12 The value 12 is used for setting Roaming related parameters for the setparam command. <value>
Example	The command below sends de authentication during roaming. iwpriv wifi0 setparam 12 1
Set Keep Alive Period	
Description	This command is used to set the Keep Alive period in the n-Link® Module.
Default Value	90 seconds
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) Integer value ranges between 15 and 12000 (seconds)
Output Parameter	None
Reset Required	No
Usage	# iwpriv <vap_name> keep_alive <value>
Example	The command given below sets the Keep Alive period to 100 seconds: # iwpriv wifi0 keep_alive 100

Table 4: iwpriv Usage for Client Mode

5.5 Configuring Using onebox_util

The **"onebox_util"** program is provided to configure the n-Link® module for parameters which are not specific to a virtual interface (VAP). The table below describes the usage of the **"onebox_util"** command for setting and getting the parameters.

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Description	This command is used to create a virtual interface (VAP) in the operating mode specified. **Note:** The OneBox-Mobile software allows creation of 4 VAPs
Default Value	-

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Input Parameters	Base Interface (string like rpine0) VAP Name (string like wifi0, wifi1, etc.) Operating Mode (string): ap – Access Point Mode sta – Station/Client Mode p2p – P2P Mode mon – Monitor Mode Refer to the section **Monitor Mode** for more details. Beacon Filtering after connecting to an Access Point (only for Client mode). Valid inputs are: sw_bmiss – Beacon filtering disabled. All beacons of connected Access Point provided to Host driver. hw_bmiss – Beacon filtering is enabled. The Beacon is provided to Host driver when there is a change in the Beacon from the connected Access Point. This feature also programs the device to indicate to the Host driver when 20 consecutive beacons are not received by the device.
Output Parameter	None
Reset Required	No
Usage	./onebox_util <base_interface> create_vap <vap_name> <op_mode>
Example	The command given below creates a virtual interface named wifi0 in the Client mode with Beacon filtering disabled. /onebox_util rpine0 create_vap wifi0 sta sw_bm
Delete a VAP	
Description	This command is used to delete an existing virtual interface (VAP).
Default Value	-
Input Parameters	Base Interface (string like rpine0) VAP Name (string like wifi0, wifi1, etc.)
Output Parameter	None
Reset Required	No
Usage	# ./onebox_util <base_interface> delete_vap <vap_name>
Example	The command given below deletes a virtual interface named wifi0. # ./onebox_util rpine0 delete_vap wifi0
Print VAP Statistics	
Description	This command is used to print the statistics of the transmitted and received packets of an existing virtual interface (VAP).
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) [-v] – Get description of the fields in the statistics Filename (string) to which the statistics will be written
Output Parameter	Statistics like: 1) Number of Beacons transmitted (for Access Point/P2P GO modes) 2) Number of Beacons received (for Client/P2P Client modes) 3) Number of Management packets received 4) Number of packets received from a different BSS etc.

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Reset Required	No
Usage	# ./onebox_util <vap_name> print_vap_stats [-v] [-f filename]
Example	The command given below prints the statistics of the transmitted and received packets of the interface wifi0 into the file “stats”. # ./onebox_util wifi0 print_vap_stats -v -f stats
Print Station Statistics (only in Access Point mode)	
Description	This command is used to print the statistics of the packets exchanged between the Access Point and a Station.
Default Value	-
Input Parameters	VAP Name (string like wifi0, wifi1, etc.) 48-bit MAC Address in hexadecimal format with colon separation. e.g., 00:23:A7:01:02:03 [-v] – Get description of the fields in the statistics Filename (string) to which the statistics will be written
Output Parameter	Statistics like: 1) Number of Beacons received 2) Number of Management packets transmitted/received 3) Number of Unicast/Multicast packets transmitted/received 4) Number of data packets transmitted/received 5) Number of Probe Request/Response packets transmitted/received etc.
Usage	# ./onebox_util <vap_name> print_station_stats <mac_addr> [-v] [-f filename]
Example	The command below logs the statistics of the packets exchanged between the Access Point (wifi0) and a Station with MAC address 00:1C:2b:10:19:1a into the file named “stats”. #./onebox_util wifi0 print_station_stats 00:1C:2b:10:19:1a -v -f stats
Select Antenna	
Description	This command is used to select one of the two RF ports connecting to antennas. For the modules without integrated antenna, it is used to select between pins RF_OUT_1 and RF_OUT_2. For the modules with integrated antenna and U.FL connector, it is used to select between the two. In case **Antenna Diversity** feature is enabled, this ioctl will not have any effect. The Antenna selection will happen automatically at the firmware level. **Note:** This ioctl is redundant. Refer to Section 16 for futher details. The functionality of the ioclt is intact. However it might be removed in the future to reduce redundancy.
Default Value	2
Input Parameters	Base Interface (string like rpine0) The integer value mapping has been shown below: 2 – Select RF_OUT_2/Integrated Antenna 3 – Select RF_OUT_1/U.FL Connector
Output Parameter	None
Reset Required	No
Usage	# ./onebox_util <base_interface> ant_sel <value>
Example	The command given below selects the U.FL connector in case of modules with integrated antenna

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
	and will select RF_OUT_1 pin in the case of the module without an integrated antenna. # ./onebox_util rpine0 ant_sel 3
Enable Background Scan and Set Parameters (only in Client mode)	
Description	This command is used to enable background scan and set the relevant parameters. Refer to the section on **Background Scan Parameters** for more details on each parameter.
Default Value	2
Input Parameters	Base Interface (string like rpine0) Background Scan Threshold RSSI Tolerance Threshold Periodicity Active Scan Duration Passive Scan Duration Two Probe Enable Number of Background Scan Channels Channels to Scan **Note:** The OneBox-Mobile software supports DFS slave mode. However, DFS Channels need to be avoided till the module is certified for DFS.
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <base_interface> set_bgscan_params <bgscan_threshold> <rssi_tolerance_threshold> <periodicity> <active_scan_duration> <passive_scan_duration> <two_probe_enable> <num_of_bgscan_channels> <channels_to_scan>
Example	The command given below enables Background Scan with a scan threshold of 10, RSSI tolerance threshold of 10, periodicity of 3 seconds, active scan duration of 20 milliseconds, passive scan duration of 100 milliseconds, two-probe enabled and the channels 36, 40 and 44. # ./onebox_util rpine0 set_bgscan_params 10 10 3 20 100 1 3 36 40 44
Note	In order to select 11J channels 8, 12, 16, enter the channel number as 8J, 12J, 16J respectively. Remaining 11J channels can be selected with their channel numbers. Example: # ./onebox_util rpine0 set_bgscan_params 10 10 3 20 100 1 4 36 40 44 8J
Host-Triggered Background Scan (only in Client mode)	
Description	This command is used to trigger background scan without waiting for the periodicity mentioned in bgscan_parameters.
Default Value	-
Input Parameters	-
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <base_interface> do_bgscan

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Example	The command given below triggers background scan without waiting for periodicity timeout. # ./onebox_util rpine0 do_bgscan **Note:** The do_bgscan command has to be followed by set_bgscan_params command.
Set SSID for Background Scan (only in Client mode)	
Description	This command is used to set the SSID of the Hidden Access Point (SSID not being broadcast) during Background Scan.
Default Value	-
Input Parameters	Base Interface (string like rpine0) SSID (max. 32 characters)
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <base_interface> bgscan_ssid <ssid>
Example	The command below sets the SSID of a Hidden Access Point during Background Scan. # ./onebox_util rpine0 bgscan_ssid REDPINE_AP **Note:** The bgscan_ssid command has to be followed by the set_bgscan_params or do_bgscan command in order for the Probe Request to be sent with the SSID requested in the bgscan_ssid command.
Enable Power Save and Set Parameters (only in Client mode)	
Description	This command is used to enable/disable power save modes and set the required power save mode for the n-Link® module. Refer to the section **Power save Modes, Profiles and Parameters** for more details on each parameter and their usage.
Default Value	-
Input Parameters	Base Interface (string like rpine0) Power Save Enable/Disable Sleep Type Transmit Threshold Receive Threshold Transmit Hysteresis Receive Hysteresis Monitor Interval Sleep Duration Listen Interval Duration Number of Beacons per Listen Interval DTIM Interval Duration Number of DTIMs Per Sleep Duration
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <base_interface> set_ps_params <ps_en> <sleep_type> <tx_threshold> <rx_threshold> <tx_hysteresis> <rx_hysteresis> <monitor_interval> <sleep_duration>

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
	<listen_interval_duration> <num_beacons_per_listen_interval> <dtim_interval_duration> <num_dtims_per_sleep>
Example	The command below enables ULP Power Save Mode for a duration of 100 ms and with a listen_interval_duration of 100ms. # ./onebox_util rpine0 set_ps_params 1 2 0 0 0 0 0 100 100 0 0 1
Enable UAPSD (Normal and Mimic modes) and Set Parameters	
Description	This command is used to enable the UAPSD mode and set the relevant parameters. If the Access Point does not support UAPSD, the module tries to mimic this mode. Refer to the section **Power save Modes, Profiles and Parameters** for more details.[1]
Default Value	-
Input Parameters	Base Interface (string like rpine0) UAPSD Wakeup Period in milliseconds – 0 for Transmit Based UAPSD and between 10 and 100 for Periodic UAPSD. UAPSD Service Period Length- This field indicates number of packets delivered by AP to station after receiving one trigger frame. This filed value ranges between 0-3 as described below. 0-All buffered packets will be delivered. 1-Two buffered packets will be delivered. 2-four buffered packets will be delivered. 3-six buffered packets will be delivered.
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <base_interface> set_uapsd_params 0xF <sp_len> <uapsd_wakeup_period>
Example	The command enables UAPSD mode and sets the wakeup period as 100ms. # ./onebox_util rpine0 set_uapsd_params 0xF 0 100 **Note:** The set_uapsd_params command needs to be followed by the command given below for the values to take effect. # ./onebox_util <base_interface> reset_adapter
Reset Adapter (only in Client mode)	
Description	This command is used to reset the Client mode virtual interface. This command can be used to change certain configurations of the Client mode and reset the VAP for the configurations to take effect.
Default Value	-
Input Parameters	Base Interface (string like rpine0) – the base interface input ensures that the Client mode VAP is reset irrespective of the actual VAP name.
Output Parameter	-
Reset Required	-
Usage	/onebox_util <base_interface> reset_adapter
Example	/onebox_util rpine0 reset_adapter

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Set Beacon Interval (only in Access Point mode)	
Description	This command is used to set the Beacon Interval in milliseconds. It is recommended that this command is given before the VAP is created.
Default Value	200
Input Parameters	Base Interface (string like rpine0) Integer value between 50 and 1000 (other values will result in default value being assigned).
Output Parameter	None
Reset Required	Yes. In order to set the beacon interval, the virtual interface has to be reset.
Usage	# ./onebox_util <base_interface> set_beacon_intvl <beacon_intvl>
Example	The commands given below are used to reset the Access Point and set the beacon interval to 100ms. # sh remove_all.sh # sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh script present in the "release" folder as per the instructions in Installation of Modules # ./onebox_util rpine0 set_beacon_intvl 100 # ./onebox_util rpine0 create_vap wifi0 ap # ./wpa_supplicant –i wifi0 -D bsd –c wpa.conf -ddddt & **Note:** Issue this command before creating any virtual Access Point interfaces.
Set WMM Parameters (only in Access Point mode)	
Description	This command is used to set the WMM parameters for specific queues. **Note:** This ioctl is redundant, refer to the Section 16 for further details. The functionality of the ioclt is intact, however it might be removed in the future inorder to reduce redundancy.
Default Value	**Access Point:**

	AIFSN	Cwmin	Cwmax	TxOp
AC_BE	3	4	6	0
AC_BG	7	4	10	0
AC_VI	1	3	4	94
AC_VO	1	2	3	47

Station:

	AIFSN	Cwmin	Cwmax	TxOp
AC_BE	3	4	6	0
AC_BG	7	4	10	0
AC_VI	4	3	4	94
AC_VO	4	2	3	47

Input Parameters	VAP Name (string like wifi0, wifi1, etc.) WMM Parameter Name (string like aifs, cwmin, cwmax, txop, acm) Integer value. The allowed values are as follows:

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
	AIFSN – 1 to 15 Cwmin – 2^n-1, where 'n' is between 1 and 4 for BE_Q and BK_Q and between 1 and 3 for VI_Q and VO_Q. Cwmax – 2^n-1, where 'n' is between 1 and 6 for BE_Q, between 1 and 10 for BK_Q and between 1 and 4 for VI_Q and VO_Q. TxOp – 0 for BE_Q, BK_Q, 94 for VI_Q and 47 for VO_Q Access Category (string, as mapped below): 1) VO_Q – Voice data packets queue 2) VI_Q – Video data packets queue 3) BK_Q – Background data packets queue 4) BE_Q – Best effort data packets queue Self or Broadcast selection (Self is for the module's Access Point VAP, Broadcast is for Clients connected to the Access Point) Update Params (integer value mapped as below): 0 – To set more WMM Parameters 1 – To update current WMM Parameters
Output Parameter	None
Reset Required	No.
Usage	# ./onebox_util <vap_name> setwmmparams <wmm_param_name> <value> <access_category> <self/broadcast> <update_params>
Example	The command given below updates the AIFSN value for BE Access category for connected Clients. # ./onebox_util wifi0 setwmmparams aifsn 2 BE_Q broadcast 1
Set Country	
Description	This command is used to set the country for the n-Link® Module.
Default Value	-
Input Parameters	Integer (country code) mapped as below:

REGION	COUNTRY_CODE	COUNTRY_NAME
FCC	**840**	UNITED STATES
	124	CANADA
	484	MEXICO
ETSI	**250**	FRANCE
	56	BELGIUM
	276	GERMANY
	380	ITALY
JAPAN	**392**	JAPAN
WORLD	**36**	AUSTRALIA
	356	INDIA
	364	IRAN
	458	MALAYSIA
	554	NEWZEALAND

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs		
	643	RUSSIA
	702	SINGAPORE
	710	SOUTH AFRICA
Output Parameter	None	
Reset Required	Yes. In order to change the country code, the virtual interface has to be reset.	
Usage	# ./onebox_util <base_interface> set_country <country_code>	
Example	The commands below reset the VAP and set the country to Singapore in Station mode. # sh remove_all.sh # sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh script present in the “release” folder as per the instructions in Section 4.1 # ./onebox_util rpine0 set_country 702 # ./onebox_util rpine0 create_vap wifi0 sta sw_bmiss **Note:** Issue this command before creating any interfaces.	
Set External Antenna Gain		
Description	This command is used to program the gain of the external antenna for the module without antenna. The gain values are used by the module to attenuate the output transmit power so that regulatory requirements like FCC, ETSI, etc., are not violated. This command needs to be given before creating the VAP in the normal mode and before the “./transmit” command in the **Wi-Fi Performance Test** mode. In the Wi-Fi Performance Test mode, the transmission has to be stopped each time before the antenna gain values are programmed.	
Default Value	0	
Input Parameters	Base Interface (string like rpine0) Integer value for Antenna gain for 2.4 GHz band in dBm Integer value for Antenna gain for 5 GHz band in dBm	
Output Parameters	None	
Reset Required	No	
Usage	# ./onebox_util <base_interface> set_ext_ant_gain <gain_2g> <gain_5g>	
Example	The commands below set the Antenna gain values for 2.4 GHz and 5 GHz bands to 3 dBm and 5 dBm, respectively. # sh remove_all.sh # sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh script present in the “release” folder as per the instructions mentioned in the section Installation of Modules. # ./onebox_util rpine0 set_ext_ant_gain 3 5 # ./onebox_util rpine0 create_vap wifi0 sta	
Set Antenna Type		
Description	This command is used to configure the antenna, based on its type and its mounted path. The configuration values are used by the module to attenuate the output transmit power based on the selected antenna type for the corresponding path so that the regulatory requirements like FCC, ETSI, etc., are not violated. This command needs to be given before creating the VAP in the normal mode and before the "./transmit" command in the "Wi-Fi Performance Test ioctl usage" as mentioned in the section **Wi-Fi Performance Test ioctl usage**.	

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Default Value	ant_path: 1 ant_type: 1 **For ant_path** • If value is 1, then it is considered as RF_OUT_2/Integrated Antenna • If value is 2, then it is considered as RF_OUT_1/U.FL Connector. **For ant_type** • If value is 1, then it is considered as Type 1 antenna. • If value is 2, then it is considered as Type 2 antenna. If value is 3, then it is considered as Type 3 antenna.
Input Parameters	Use the following table to configure antenna type based on 2G and 5G gain values

2G Gain range	5G Gain range	Antenna Type
0 < Gain <= 0.99	0 < Gain <= 4.42	Type 1
0.99 < Gain <= 1.8	4.42< Gain <= 4.6	Type 2
1.8 < Gain <= 3	4.6 < Gain <= 4.9	Type 3

Output Parameters	None
Reset Required	No
Usage	./onebox_util rpine0 ant_type ant_path ant_type
Example	# ./onebox_util rpine0 ant_type 1 2
Set Wake-On-Wireless LAN Parameters (only in Client Mode)	
Description	This command is used to set the Wake-On-Wireless LAN (WoWLAN) parameters in the device. The Host has to give this command each time when it enters and exits sleep state. Refer to the section **Wake-On-Wireless LAN Parameters** for more details. GPIO_2 is used as a Host Wakeup Interrupt for this purpose.
Default Value	-
Input Parameters	Base Interface (string like rpine0) 48-bit Source MAC Address in hexadecimal format with colon separation. e.g., 00:23:A7:01:02:03 (valid when Unicast packet filtering from specific MAC address is enabled) Host Sleep Status WoWLAN Flags
Output Parameters	None
Reset Required	No
Usage	# ./onebox_util <base_interface> wowlan <src_mac_addr> <host_sleep_status> <wowlan_flags>
Example	# ./onebox_util rpine0 wowlan 00:23:a7:0c:bb:aa 1 3
Set RF Power Mode	
Description	This command is used to program the RF power mode to High, Medium and Low profiles. It has to be issued before creating the VAP. The performance of the RF is best in the High power mode.
Default Value	0 - High

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
Input Parameters	The integer value mapping has been shown below: 0 – High power mode 1 – Medium power mode 2 – Low power mode
Output Parameters	None
Reset Required	No
Usage	# ./onebox_util <base_interface> set_rf_tx_rx_pwr_mode tx_value rx_value
Example	./onebox_util rpine0 set_rf_tx_rx_pwr_mode 0 1
Set scan type	
Description	This command is used to select the band in which the user wants to perform the scan. Using this command the user can either test in 2.4Ghz or 5Ghz bands.
Default Value	Both 2.4Ghz and 5Ghz bands are enabled by default. List of possible values 1 – To scan 2.4Ghz only band 2 – To scan 5Ghz only band
Input Prameters	Integer value
Output Parameters	None
Reset Required	No
Usage	# ./onebox_util <base_interface> set_scan_type value
Example	./onebox_util rpine0 set_scan_type 1 The above command performs scan only in 2.4Ghz band. **Note:** Issue this command before creating station virtual interface.
Set Beacon Filter (Only in AP mode)	
Description	This command is used to enable beacon filtering in the firmware. All the third party beacons will be filtered at the firmware after applying beacon filter Ioctl.
Default Value	0-Disabled by default
Input Parameters	The integer value mapping has been shown below: 0-Disabled beacon filtering 1-Enabled beacon filtering
Output Parameter	None
Reset Required	No
Usage	# ./onebox_util <base_interface> set_rx_filter 0 0 0 0 <value> 0 0
Example	./onebox_util rpine0 set_rx_filter 0 0 0 0 1 0 0 The above command does not allow beacons to be received from firmware to driver in AP mode. **Note:** In the above command BIT (0, 1, 2, 3, 5, 6) are reserved for future use. Only BIT (4) is used for beacon filtering.
Get Tx-Power	
Description	This command is used to get current value of transmit power from firmware and updates it in

Create a VAP The OneBox-Mobile software allows creation of 4 VAPs	
	iwconfig command.
Default Value	-
Input Parameters	-
Output Parameter	None
Reset Required	No
Usage	# ./onebox_util <base_interface> get_txpwr
Example	./onebox_util rpine0 get_txpwr
Useonly rates	
Description	This command is used set the supported rates in AP mode. This will be helpfull to control the transmit data rates of the clients connected.
Default Value	All rates supported as per regulatory domain.
Input Prameters	Integer value as per the mapping below: 1 Mbps – 2 2 Mbps – 4 5.5 Mbps – 11 11 Mbps – 22 6 Mbps – 12 12 Mbps – 24
Output Parameters	None
Reset Required	No
Usage	# ./onebox_util <base_interface> useonly_rates <rate_val> <rate_val> <rate_val>
Example	./onebox_util rpine0 useonly_rates 2 11 12

Table 5: Usage of onebox util

5.5.1 WPS Configuration

Wi-Fi Protected Setup (WPS) is a standard for easy and secure wireless network setup and connections. The Onebox-Mobile supports the following configuration methods:

- Push Button Method
- PIN Method – Enter and Generate

A WPS Configuration file is used for setting up a connection with a remote Access Point or Station. A sample WPS configuration file is given below for reference.

```
ctrl_interface=/var/run/wpa_supplicant
update_config=1
uuid=12345678-9abc-def0-1234-56789abcdef0
device_name=RSI_P2P_DEVICE
manufacturer=Redpine Signals, Inc.
model_name=M2MCombo
model_number=9113
serial_number=03
device_type=1-0050F204-1
os_version=01020300
config_methods=display push_button keypad
```

The sections below list down the steps for configuring WPS and setting up a connection in Access Point and Client modes using the methods listed above.

5.5.1.1 Access Point Mode

The steps for configuring WPS in Access Point Mode are as follows:

1. Start the driver in Access Point mode.
2. Start the supplicant by entering the following command.

```
#. /wpa_supplicant –i <vap_name> -D bsd –c <wps_conf_file> -ddddt
```

3. For Push Button method:

- Push the button on the STA
- Enter the command below for the n-Link® Access Point
- # ./wpa_cli –i <vap_name> wps_pbc <sta_mac_addr>

This is the 3rd party Station's MAC address. If all the MAC addresses need to be allowed, the input parameter is the string "any".

4. Wait for the STA to parse all the WPS Access Points.
5. For Enter PIN method

- Click on "Generate PIN" on the STA. A 4/8-digit numeric WPS PIN is generated.
- Enter the command below for the n-Link® Access Point

```
#. /wpa_cli –i <vap_name> wps_pin <sta_mac_addr> <wps_pin>
```

- Wait for the STA to parse all the WPS Access Points.

6. For Generate PIN method

- Enter the command below for the n-Link® Access Point

```
#. /wpa_cli –i <vap_name> wps_pin <sta_mac_addr>
```

This will generate a 4/8-digit numeric WPS PIN.

7. Enter the PIN on the STA.
8. Wait for the STA to parse all the WPS Access Points.

Note:

1. WPS_PIN and passphrase are different.
2. WPS connection timeout is 120 seconds
3. 3rd party Stations usually try to connect to all scanned WPS Access Points until they succeed in connecting to one of them.
4. WPS can be used along with any of the Secure modes (except WEP) and also with Open mode.

5.5.1.2 Client Mode

The steps for configuring WPS in Client mode are as follows:

1. Start the driver in Client mode.
2. Start the supplicant by entering the following command.

```
# ./wpa_supplicant –i <vap_name> -D bsd –c <wps_conf_file> -ddddt
```

3. For Push Button method:

- Push the button on the Access Point
- Enter the command below for the n-Link® STA

```
# ./wpa_cli –i <vap_name> wps_pbc <bssid>
```

Note:
This is the Access Point's MAC address. If the BSSID is not known, the input parameter will be the string named "any".

- Wait for the STA to parse all the WPS Access Points.

4. For Enter PIN method,

- Click on **"Generate PIN"** on the Access Point. A 4/8-digit numeric WPS PIN is generated.
- Enter the command below for the n-Link® STA

```
# ./wpa_cli –i <vap_name> wps_pin <bssid> <wps_pin>
```

1. Wait for the STA to parse all the WPS Access Points.

5. For Generate PIN method,

- Enter the command below for the n-Link® STA

```
#. /wpa_cli –i <vap_name> wps_pin <bssid>
```

- This will generate an 8-digit numeric WPS PIN.
- Enter the PIN on the Access Point
- Wait for the STA to parse all the WPS Access Points.

6 Configuration Using CFG80211

This section explains about the usage of various IOCTL commands, which can be issued to the Onebox-Mobile™ driver operating in CFG80211 mode from the user space.

6.1 Using iw Wireless Tool

'iw' is a new nl80211 based CLI configuration utility for wireless devices. It is used to set/get various parameters of a wireless network interface. This section covers the usage of 'iw' when used with the Onebox-Mobile ™ driver. For a detailed description of 'iw' tool, please refer to the relevant man pages on Linux system. The list of supported commands via "iw" tool are listed below.

Creating a virtual Interface	
Description	This command is used to create a virtual interface in the specific mode requested by user
Default Value	-
Input Parameters	<phy name > – Phy name can be obtained by using the following command $ iw phy In case of multiple wireless interfaces are present, please refer to the NOTE given below on how to determine the phy name. <interface name> – name of the virtual interface to be created <operating mode> – operating mode of the virtual interface that can be either 'managed' for station mode or '__ap' for access point mode.
Output Parameter	-
Reset Required	No
Usage	iw phy <phy name> interface add <interface name> type <operating mode>

Example	To create a virtual interface in Access Point mode, use the command given below:
	$ iw phy phy0 interface add wifi0 type __ap
	To create a virtual interface in Station mode use the command below:
	$ iw phy phy0 interface add wifi0 type managed

Scan	
Description	This command is used to scan for the Access points nearby our device.
Default Value	-
Input Parameters	Interface name on which scan has to be performed
Output Parameter	List of AP's scanned
Reset Required	No
Usage	The following command initiates a scan and displays the list of AP's scanned. $ iw dev $interface_name scan
Example	$ iw dev wifi0 scan
Connect	
Description	This command is used to connect devices to the Access points in open or WEP security mode.
Default Value	-
Input Parameters	SSID, BSSID, key_index, key of AP.
Output Parameter	None
Reset Required	No
Usage	Open mode: $ iw dev $interface_name connect $SSID_NAME $BSSID. WEP Security:

Creating a virtual Interface	
	$ iw dev $interface_name $ssid_name $bssid keyid:$key_index:$key

Example	$ iw dev wifi0 connect REDPINE_AP 00:23:a7:00:05:55
	The above command connects to REDPINE_AP access point in open mode
	$ iw dev wifi0 REDPINE_AP 00:23:a7:00:05:55 keys d:1:234567890
	The above command instructs our device to connect to the REDPINE_AP in wep64 mode with the key index 1 and key '234567890'.

Disconnect	
Description	This command is used to disconnect our device from the connected network.
Default Value	-
Input Parameters	Interface name
Output Parameter	-
Reset Required	No
Usage	iw dev $interface_name disconnect
Example	$ iw dev wifi0 disconnect The above command disconnects our device from the connected Access point.
Link Status	
Description	This command is used to get the connection status of our device.
Default Value	-
Input Parameters	Interface name.
Output Parameter	Connection status.
Reset Required	No
Usage	iw dev $interface_name link
Example	iw dev wifi0 link
Interface Info	
Description	This command is used to get information about the device .
Default Value	-
Input Parameters	Interface name.
Output Parameter	Interface mac address, type, operating mode etc.
Reset Required	No
Usage	iw dev $interface_name info
Example	iw dev wifi0 info
Station Dump	
Description	This command is used to station statistic information such as the amount of tx/rx bytes, the last TX bitrate (including MCS rate)
Default Value	-
Input Parameters	Interface name.
Output Parameter	Connected Stations/AP mac address,tx bytes, rx bytes, signal level etc,. will be displayed.
Reset Required	No
Usage	iw dev $interface_name station dump
Example	iw dev wifi0 station dump
Set Power save mode	

Creating a virtual Interface	
Description	This command is used to set power save mode on/off in station mode.
Default Value	-
Input Parameters	Interface name.
Output Parameter	No
Reset Required	No
Usage	iw dev $interface_name set power_save <on | off>
Example	iw dev wifi0 set power_save <on | off>
Get Power save mode	
Description	This command is used to get power save mode on/off in station mode.
Default Value	-
Input Parameters	Interface name.
Output Parameter	Shows whether power save mode is on | off in station mode
Reset Required	No
Usage	iw dev $interface_name get power_save
Example	iw dev wifi0 get power_save

Note:
If there are multiple phys, i.e there are several instances of cfg80211 being used by different modules, then to determine the correct phy, run the following commands:
$ cat /sys/class/ieee80211/

This will give a list of all the phy's that are currently active.
$ cat /sys/class/ieee80211/phyX/macaddress
where 'X' is the number of the phys which are obtained from the previous command. The redpine module MAC address (xx:xx:xx:xx:xx:xx) has to be used in the field 'macaddress'.
Generic iw commands listed below are also supported. Please refer to the man page of the utility for further information on their usage.
$ iw phy <phyname> info
$ iw dev <devname> del
$ iw reg get
$ iw reg set <ISO/IEC 3166-1 alpha2>
$ iw dev <devname> scan dump [-u]
$ iw phy <phyname> set name <new name>
The commands that are supported only in the Access Point mode are as follows:
$ iw dev <devname> set channel <channel> [HT20|HT40+|HT40-]
$ iw dev <devname> set freq <freq> [HT20|HT40+|HT40-]
$ iw dev <devname> station del <MAC address>
$ iw dev <devname> station get <MAC address>

Limitation:

- In STA alone mode, after connection iw reg set command is not expected. If this command is given then whatever country code is given in command will be applicable. In this case it may possible that STA may disconnect from connected AP. e.g. STA is connected to AP in JP (Japan region) on channel 14. If user is giving command iw reg set US then channels will be limited to 1-11 and STA will disconnect from AP and will be looking for AP in those channels only by running scan.

7 Enterprise security using CFG80211

7.1 Installation and configuration of FREERADIUS Server

The following packages are required to install the freeradius server 3.09:

- libtalloc-devel
- openssl-devel

The steps for downloading as well as installing the freeradius tar ball are as follows:

```
$ tar zxvf freeradius-server-3.0.9.tar.gz

$ cd freeradius_3.09

$ ./configure

$ make

$ make install
```

Configure the freeradius server as per the given steps below:

Edit users file, which will contain the **“identity”** and **“password”**.

```
$ vim /usr/local/etc/raddb/users
```

- Add the following line at the starting in the users file

test Cleartext-Password := "password"

2. As an example, “user1” is an identity and “test123” is the password that has to be entered at client side i.e. in the sta_settings.conf file.

3. Now we need to edit “eap” file which contains the paths consisting of certificates and information about the EAP-Methods supported

```
$ vim  /usr/local/etc/raddb/mods-enabled/eap
```

If Free-radius version is below 3.x “eap”, it will be located in raddb folder and will be named as **“eap.conf”**.

In tls-config tls-common section, changes are made to point to our certificates which are placed in /etc/certs folder

```
tls-config tls-common {

#private_key_password = whatever

private_key_password = Wi-Fi

#private_key_file = ${certdir}/server.pem
```

```
private_key_file = /etc/certs/wifiuser.pem

#certificate_file = ${certdir}/server.pem

certificate_file = /etc/certs/wifiuser.pem

#ca_file = ${cadir}/ca.pem

ca_file = /etc/certs/wifiuser.pem

#dh_file = ${certdir}/dh

dh_file = /etc/certs/dh

}
```

To start the Radius server, run the flowing command in the terminal:

```
$ radiusd -X
```

For openssl versions of range 1.0.2 release - 1.0.2h release (or) in range `1.0.1 - 1.0.1t release (or) in range 1.1.0 - 1.1.0a release`
edit radiusd.conf file

```
$vim /usr/local/etc/raddb/radiusd.conf
```

and change '`allow_vulnerable_openssl`' to yes or CVE-2016-6304

```
allow_vulnerable_openssl =yes
(or)
allow_vulnerable_openssl ='CVE-2016-6304'
```

(here CVE-2016-6304 is openssl vulnerability ID which radius server will allow)

7.2 Configuration of AP and RADIUS server to use EAP methods

Hostapd is used as the RADIUS Server. The AP and the server are co-located (in the same system).
The following packages which have to be installed are as follows:

- libnl-devel
- libsqlite3x-devel
- openssl-devel

7.2.1 Configuration of the AP

Go to driver source folder and compile it with the following options enabled:

```
[*] NL80211 support

[*] HOSTAPD support
```

```
$ make
```

To start the device in AP mode, go to the release folder and run the following commands:

```
$ cd release

$ sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh
script present in the “release” folder as per the instructions mentioned in Section
4.1.

$ iw phy phyX interface add wifi1 type __ap

where 'X' represents phy number.
```

It can be obtained by the following command:

```
$ iw list | grep phy
```

Before starting the device in AP mode, ensure that in hostapd_eap.conf the following entities are enabled:

```
ieee8021x=1

own_ip_addr=192.168.2.1 /* IP address of AP */

/* RADIUS authentication server */

auth_server_addr=127.0.0.1

auth_server_port=1812

auth_server_shared_secret=testing123 /* shared secret must be the same as in
/etc/hostapd.radius_clients file */
```

Run the following command to start the device in the AP mode:

```
$. /hostapd hostapd_eap.conf -ddddt  >log &

$ sh dhcp_server.sh  wifi1 , where wifi1 is the interface name
```

7.2.2 Configuring hostapd as RADIUS server

The steps for configuring hostapd as RADIUS server are as follows:
Copy the certs folder in /etc location, which will contain the certificates, hostapd.radius_clients, hostapd.eap_user and dh files.
Go to driver folder and copy the certs folder to the /etc location in your system

```
  $ cp -rvf certs /etc/
```

Now go to wlan/hostapd-2.4/hostapd folder in the driver folder.

```
 $ cd wlan/hostapd-2.4/hostapd
```

Compile it

```
   $ make clean

   $ make
```

Check whether the interface in hostapd.conf is same or not as the name of AP interface name.
Example

```
$ vim hostapd.conf
```

interface = wifi1 ,so that RADIUS server will listen on that interface name.
Start the RADIUS server after AP had started in a new terminal.

```
$./hostapd hostapd.conf -ddddd
```

All the Credentials will be in /etc/certs/hostapd.eap_user file. A sample hostapd.eap_user file is present in the certs.tgz in the release folder.
The /etc/certs/hostapd.radius_clients file contains the IP required to communicate the shared secret between AP and RADIUS server. Here it is co-located, hence it is the loop-back address.

7.2.3 Configuring Station to connect to an EAP enabled AP.

Go to Driver Folder and copy the certs folder to /etc/ in your system, as it contains all the certificates required.

```
$ cp -rvf certs /etc/
```

Go to the driver folder and compile it, ensuring that the below options are enabled in wpa_supplicant.conf file.

```
$ vim wlan/supplicant/linux/wpa_supplicant/.config
```

```
CONFIG_DRIVER_NL80211=y
CONFIG_IEEE8021X_EAPOL=y
CONFIG_EAP_MSCHAPV2=y
CONFIG_EAP_TLS=y
CONFIG_EAP_PEAP=y
CONFIG_EAP_TTLS=y
CONFIG_EAP_FAST=y
CONFIG_EAP_LEAP=y
CONFIG_PKCS12=y
CONFIG_TLS=internal
```

Ensure that in menuconfig, NL80211 support is enabled.
Compile the driver.

```
$ make
```

Go to the release folder and start the device in station mode.

```
$ cd release
$ sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh
script present in the "release" folder as per the instructions in Section 4.1
$ service NetworkManager stop
$ iw phy phyX interface add wifi0 type managed
```

X is the phy number it will vary to get it type $ iw list |grep phy.

Run the supplicant after configuring sta_settings.conf according to the required EAP method. The network blocks listed below can be used as a reference.

```
$ ./wpa_supplicant -i wifi0 -D nl80211 -c sta_settings.conf -ddddt > log &
```

To connect using EAP-PEAP method, sta_settings.conf should be described as below:

```
network={
ssid="Redpine_Signals"
key_mgmt=WPA-EAP
eap=PEAP
anonymous_identity="peapuser"
identity="test"
password="password"
}
```

To connect using EAP-TTLS method, sta_settings.conf should be described as below:

```
network={
ssid="Redpine_Signals"
key_mgmt=WPA-EAP
eap=TTLS
anonymous_identity="ttlsuser"
identity="test"
password="password"
}
```

To connect using EAP-TLS method, sta_settings.conf should be described as below:

```
network={
ssid="Redpine_Signals"
key_mgmt=WPA-EAP
eap=TLS
anonymous_identity="tlsuser"
identity="test"
password="password"
ca_cert="/etc/certs/wifiuser.pem"
client_cert="/etc/certs/wifiuser.pem"
private_key_passwd="Wi-Fi"
private_key="/etc/certs/wifiuser.key"
}
```

To connect using EAP-FAST method, sta_settings.conf should be described as below:

```
network={
```

```
ssid="Redpine_Signals"
key_mgmt=WPA-EAP
eap=FAST
anonymous_identity="fastuser"
identity="test"
password="password"
phase1="fast_provisioning=1"
pac_file="/etc/p1.pac"
phase2="auth=mschapv2"
ca_cert="/etc/certs/wifiuser.pem"
private_key_passwd="wifi"
}
```

EAP-LEAP has been used when Freeradius is the RADIUS Server. This has been verified with only Cisco AP.
To connect using EAP-LEAP method, **sta_settings.conf** should be described as below:

```
network={
ssid="Redpine_Signals"
key_mgmt=WPA-EAP
eap=LEAP
identity="user1"
password="test123"
}
```

To connect using EAP-LEAP for CCX, **sta_settings.conf** should be described as below:

```
network={
ssid="Redpine_Signals"
key_mgmt=WPA-CCKM
eap=LEAP
identity="user1"
password="test123"
pairwise=TKIP
group=TKIP
proto= WPA2 WPA
scan_ssid=1
priority=2
}
```

```
$ radiusd -X
```

8 HOSTAPD and Wi-Fi Protected Setup (WPS)

This section describes how the WPS implementation in hostapd can be configured and how an external component on an AP is used to enable enrollment of client devices.
WPS uses the following terms to describe the entities participating in the network setup:
Access Point: WLAN access point
Registrar: A device that controls a network and can authorize addition of new devices. This may be either in the AP ("internal Registrar") or in an external device, e.g., a laptop, ("external Registrar")
Enrollee: A device that is being authorized to use the network
It should also be noted that the AP and a client device may change roles (i.e., AP acts as an Enrollee and client device as a Registrar) when WPS is used to configure the access point.)

8.1 Hostapd Configuration before Compilation

WPS component needs to be enabled in hostapd build configuration (.config)
i.e: vim host/wlan/hostapd-2.3/hostapd/.config
Ensure that the below mentioned entities are enabled in .config file

```
CONFIG_WPS=y

CONFIG_WPS2=y

CONFIG_WPS_UPNP=y
```

8.2 Configuration in hostapd_ccmp.conf

```
driver=nl80211

interface=wifi1; wifi1 is the name of the interface

# WPA2-Personal configuration for the AP

ssid=wps-test

wpa=2

wpa_key_mgmt=WPA-PSK

wpa_pairwise=CCMP

# Default WPA passphrase for legacy (non-WPS) clients

wpa_passphrase=12345678

# Enable random per-device PSK generation for WPS clients

wpa_psk_file=/etc/hostapd.wpa_psk
```

Check if the hostapd.wpa_psk file present in /etc/, if not, then create a new empty file naming hostapd.wpa_psk in location (/etc/).

```
# Enable control interface for PBC/PIN entry

ctrl_interface=/var/run/hostapd

# Enable internal EAP server for EAP-WSC (part of Wi-Fi Protected Setup)

eap_server=1

wps_state=2

ap_pin=12345670

wps_pin_requests=/var/run/hostapd_wps_pin_requests
```

8.3 WPS

8.3.1 AP-mode for WPS -push button method

$ sh wlan_enable.sh or **wlan_bt_insert.sh** or **wlan_zigb_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions mentioned in Section 4.1

```
$ is phi ; it will give phyX number

$ iw phy phyX  interface add wifi1 type __ap

$ ./hostapd hostapd_ccmp.conf -ddddddt>log &

$ sh dhcp_server.sh wifi1

$ ./hostapd_cli wps_pbc
```

Now push wps button on station side.
At this point, the client has two minutes to complete WPS negotiation

8.3.2 AP-mode for WPS Enter-pin method

$ sh wlan_enable.sh or **wlan_bt_insert.sh** or **wlan_zigb_insert.sh** or **onebox_insert.sh** scripts present in the **"release"** folder as per the instructions mentioned in Section 4.1

```
$ iw phy ; it will give phyXX number

$ iw phy phyXX  interface add wifi1 type __ap

$ /hostapd hostapd_ccmp.conf -ddddddt>log &

$ sh dhcp_server.sh wifi1

./hostapd_cli wps_pin any [wps-pin-of station]

$ ./hostapd_cli wps_pin any 12345670
```

8.3.3 AP-mode for WPS-Generate pin- method

$ sh wlan_enable.sh or **wlan_bt_insert.sh** or **wlan_zigb_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions mentioned in **section 4.1**

```
$  iw phy ; it will give phyXX number

$ iw phy phyXX  interface add wifi1 type __ap

$ ./hostapd hostapd_ccmp.conf -ddddddt>log &

$ sh dhcp_server.sh wifi1

$ hostapd_cli wps_ap_pin random [timeout]
```

The above command generates a random AP pin number. If the optional timeout parameter is given then the AP pin will be enabled for the specified number of seconds.

```
$ ./hostapd_cli wps_ap_pin random 300
```

The above command generates a 8digit random pin which needs to be entered at the station side using the procedure mentioned below.
Here AP acts as an Enrolee and client device as a Registrar, so ensure that the below mentioned entities are enable at the STATION side.
PATH: host/wlan/supplicant/linux/wpa_supplicant/.config

```
CONFIG_DRIVER_NL80211=y

CONFIG_WPS=y

CONFIG_WPS2=y

CONFIG_WPS_ER=y
```

8.3.4 Disable AP pin

To disable AP Pin, enter the command given below:

```
$ hostapd_cli wps_ap_pin disable
```

The command disables AP PIN (i.e., it does not allow external Registrars to use it inorder to learn the current AP settings or to reconfigure the AP).

8.3.5 Get the AP pin

To fetch the current AP pin enter the command given below:

```
$ hostapd_cli wps_ap_pin get
```

8.3.6 Set the AP pin

```
$ hostapd_cli wps_ap_pin set <PIN> [timeout]
```

Sets the AP PIN and enables it.
If the optional timeout parameter is given, the AP PIN will be enabled for the specified number of seconds.

8.3.7 Get the current configuration

```
$ hostapd_cli get_config
```

The above command displays the current configuration of the AP mode

9 ACS with Hostapd

Following steps should be followed for Auto Channel Selection using Hostapd:

1. **Compilation Steps:**
    a. Enable **CONFIG_ACS** in Driver Makefile
    b. Enable Hostapd and NL80211 in 'make menuconfig'
    c. Enable **CONFIG_ACS** in hostapd .config file. (wlan/hostapd/hostapd-2.4/hostapd/.config)
    d. Compile the driver using 'make' command
2. **Hostapd Conf File changes required for ACS**:

Set the correct interface and driver in hostapd.conf file (driver will be nl80211 for this)

```
interface=wlan0
driver=nl80211
```

Set SSID you want to configure

```
ssid="REDPINE"
```

Set hw_mode to 'g' for 2.4 GHz or 'a' for 5Ghz

```
hw_mode=g/a
```

Set channel=0 (For ACS this value should be zero. Hostapd will pick a channel depending upon survey dump from driver)

```
channel=0
```

Select the number of scans to be performed to trigger survey data commands. Hostapd will call this much times for new survey data

```
acs_num_scans=5 (Default Value)
```

Steps for Setting AP

1. Insert the driver and create AP interface using wlan_enable.sh and post_vap.sh
2. Up the ap interface created
3. Run the following command to run hostapd:

```
./hostapd hostapd.conf -ddd > log_file_name &
```

10 Antenna Diversity

10.1 Introduction

Antenna diversity is a feature which enables the automatic selection of the antennas which is needed to be use. The antenna on which the packets with better RSSI values are received is selected. The RSSI monitoring happens continuously. Once it is enabled, this feature will persist for the entire duration of operation.

10.2 Configuration

The steps described in this section are used to start the antenna diversity feature in Client mode only. Once it is enabled, the antenna selection happens automatically:

1. Open the **common_insert.sh** file present in the **"release"** folder.
2. Ensure that the variable **RSI_ANTENNA_DIVERSITY** is set as given below:

```
RSI_ANTENNA_DIVERSITY=1
```

When Antenna Diversity is enabled, User has to make sure that external antenna is connected to the module. Without connecting the external antenna the behavior may be unspecified

11 Sniffer Mode

The Steps for operating the device in Sniffer Mode are outlined below.
Ensure that the **common_insert.sh** present in the release folder has valid driver mode and coexistence mode.

```
DRIVER_MODE=7 (Sniffer mode)

COEX_MODE = 1 (Wi-Fi station/ Wi-Fi-Direct/Wlan-Per/Sniffer)
```

Go to the release folder and start the driver modules by using the given below command

```
# sh wlan_enable.sh
```

Create the virtual interface in monitor mode.

```
# ./onebox_util <base_interface>  create_vap wifi0 mon
```

To select the channel, use the given below command.

```
# iwconfig <interface_name(wifi0)> freq <channel_number>
```

Use tcpdump or wireshark tools to observe the packets being captured by the device.

12 Monitor Mode

The Monitor Mode is one of the operating modes that can be set while creating a VAP. It enables capturing of packets which is transferred over a single or multiple VAPs and are operating in either Access Point or Client or P2P modes.
The order of the VAPs' creation does not matter. Once it is created, the **"tcpdump"** command can be used to display the packets which are being transferred.

Monitor mode VAP should be enabled after enabling all other VAP's.

Example Scenario 1: Create a Client mode VAP and a Monitor mode VAP and display packets which are being transferred to/from the Client

```
./onebox_util rpine0 create_vap wifi0 sta sw_bmiss

./onebox_util rpine0 create_vap wifi1 mon

ifconfig wifi0 up

ifconfig wifi1 up

tcpdump –i wifi1
```

Example Scenario 2: Create an Access Point mode VAP, a Client mode VAP and a Monitor mode VAP and display the packets which are being transferred to/from the Access Point and Client.

```
./onebox_util rpine0 create_vap wifi0 ap

./onebox_util rpine0 create_vap wifi1 sta sw_bmiss

./onebox_util rpine0 create_vap wifi2 mon

ifconfig wifi0 up

ifconfig wifi1 up

ifconfig wifi2 up
tcpdump –i wifi2
```

The difference between Sniffer and Monitor modes is explained below:
Monitor mode displays the packets which are being transferred to/from the device and are configured in different operating modes like Access_point, Client and so on.
Where as,
Sniffer mode displays all the packets on air depending on the channel and band width configured and displays them using wire shark tool.

13 Concurrent Mode

Concurrent mode is the mechanism in which Onebox-Mobile can be operated in AP and Client modes simultaneously.User can create a virtual interface as client mode on one interface and as AP mode on other interface.
Below are the Steps to operate the device in concurrent Mode.
Ensure that common_insert.sh present in the release folder has valid driver mode and coexistence mode.

```
DRIVER_MODE=1 (End to End mode)
COEX_MODE = 3 (AP + Station -on multiple vaps)
```

13.1 Installation Procedure

13.1.1 Creating VAP in Client Mode

Insert the driver using script wlan_insert.sh which is present in following folder.

```
cd /home/rsi/release
$ sh wlan_insert.sh
```

Create VAP in client mode using command.

```
$. /onebox_util rpine0 create_vap   <vap name>   sta sw_bmiss
```

For example: ./onebox_util rpine0 create_vap wifi0 sta sw_bmiss
After issuing the above command virtual interface with the specified interface name “wifi0” will be created. User can view the list of interfaces using the following command.

```
ifconfig -a
```

Make sure the appropriate settings are present in the sta_settings.conf file. Please refer the section 4.4.1 for the configuration details for different security modes.
After the configuration settings run the supplicant using the following command

```
$. /wpa_supplicant –i  <vap_name>  –Dbsd –c sta_settings.conf –ddddt >log&
```

Ex:./wpa_supplicant –i wifi0 –Dbsd –c sta_settings.conf –ddddt >log&
For example: If user creates the virtual interface with the name “wifi0” in client mode then the supplicant should be run on that interface only

13.1.2 Creating VAP in AP mode

Create VAP in AP mode using command:

```
$. /onebox_util   rpine0 create_vap   <vap_name>   ap
```

Ex:./onebox_util rpine0 create_vap wifi1 ap
After issuing the above command virtual interface with name “wifi1” will be created. User can view the list of interfaces using the following command.

```
ifconfig –a
```

User needs to enable the appropriate network block settings with the information about the Access point configuration. To configure the Access Point in different security modes use the configuration file settings. Please refer to the section on Security for the configuration files for different security modes
Here the virtual interface name is referred as wifi1. User can create the virtual interface with any name of his choice

The steps to be followed in order to recognize the expected concurrent mode operation are outlined below:

1. Boot the RPINE device in STA mode and wait for it to connect to the 3rd party AP.
2. Then start the AP mode, and connect a 3rd party station.
3. In case the 3rd party AP shuts off, or the RPINE STA for some reason is disconnected, the STA will NOT move into scan phase.
4. We can now scan for the 3rd party AP using the host based scan command,
   "./onebox_util rpine0 host_scan <periodicity> <active scan duration> <no of channels> <list of channels....>"
   a. Periodicity : This parameter specifies the interval between the scans. The unit of this field is seconds. Setting the value of this field as 0 will disable scans.
   b. Active scan duration : This parameter determines the duration of the active scan in each channel during the on-demand scan process. The recommended value for this parameter is 20ms for quicker scan operations and uninterrupted throughput. The maximum allowed value for this parameter is 255ms.
   c. No of channels : Specifies the no of channels to scan
   d. List of channels : The list of channels in which the scan is to be performed
   Example: ./onebox_util rpine0 host_scan 5 30 3 1 6 11.
   This commands enables host based scan, with a periodicity of 5 seconds, active scan duration of 30ms in the channels 1, 6 & 11.

1. Note, we do not have support for passive scan duration as of now.
2. When the STA is successfully able to connect to the AP, the user can stop the scan by setting the periodicity to "0".
3. Even if the user DOES NOT stop the scan after the RPINE STA is connected to the AP, use of the scan command on successive disconnections is a MUST.

The host_scan command should be issued only when the AP VAP is also UP.
It is also possible that STA can connect to the 3rd party AP without host_scan command and having AP VAP already UP. This case is possible due to the process that STA will continuously listen to beacons being received in the present channel. If any AP beacon matches with sta_settings, STA will start connection procedure. But for this to happen 3rd party AP should also be in the same channel in which RSI AP & RSI STA are UP.

In the case
The following command scans all the 2G channels, 1-14 with periodicity of 5 seconds and active scan duration of 30ms.

```
1. ./onebox_util rpine0 host_scan_2g 5 30
```

The following command stops the host based scan.

```
2. ./onebox_util rpine0 host_scan_stop
```

User can create the client mode first followed by AP mode or viceversa.If driver is unloaded in between the virtual interfaces created so far will be removed.For deleting particular virtual interface please follow th e below command.

```
$. /onebox_util  rpine0 delete_vap <vap_name>
```

Ex: ./onebox_util rpine0 delete_vap wifi0
You can create two VAPs at a time and then run corresponding supplicant command because supplicant command will be differentiated by using the interface name user has mentioned while creating VAP.

13.1.3 State of the Station

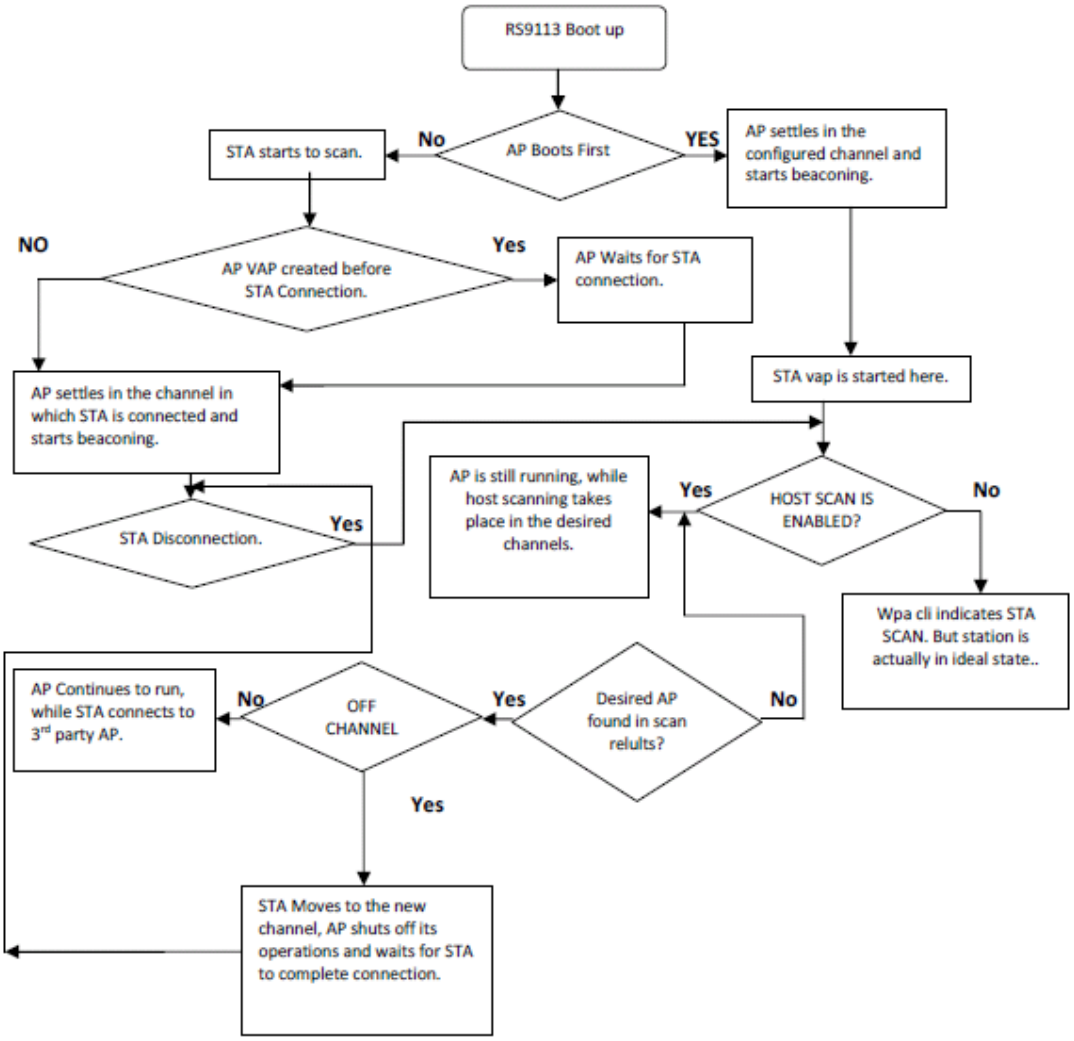
To check the Station state, Use the below command.

```
./onebox_util rpine0 check_sta_state
```

The possible outputs are,
1. INIT
2. SCAN
3. AUTH
4. ASSOC
5. RUN
6. DOWN
Error Msg:
In case the driver is unable to issue the ioctl, then the error message displayed
as : "ERROR! Unable to check STA State"
Description of output states,
1. INIT: This stage indicates, the STATION VAP is up, but it is not scanning. In case the station disconnects from the AP, by default it will move to the INIT state. The user is expected to give the host_scan command to initiate scanning.

2. SCAN: In This state the device performs scan and sends the scan results to the supplicant. In the STA alone mode, the scan request from the supplicant is sufficient for the STA to move to this state. In case AP is running and the STA is started, then the user has to give the host_scan command for the STA to move to this state.
3. AUTH: This is an intermediate state during connection. Once the STA collects the SCAN results and sends to the supplicant, if any desired BSS is found, then the STA moves to this state to complete authentication.
4. ASSOC: Once the AUTH is successful, the STA moves to the ASSOCIATION State.
5. RUN: Once the ASSOCIATION is successful, the STA moves to RUN state and the user can co-relate this to Connection Established. Once the STA enters into the RUN state, it automatically disables the host_scan command, i.e the device no longer performs the SCAN even if the user hasn't explicitly sent the scan stop command. If the user wishes to continue the SCAN he must initiate it again.
6. DOWN: If the STA VAP is not up, then the output is DOWN

Flow chart



Limitations

- AP will always operate in channel in which the client [corresponding to other VAP] connects. For eg: In case if client connects in ch6 then AP mode will get created in ch6 irrespective of the channel configured.Similarly if AP mode is

started first in the user configured channel and client mode is started later, then AP switches to the channel in which client is finally connected. However AP and client can operate in different security modes.

- If station disconnects then the AP mode would also not be operational [i.e the AP stops beaconing and disconnects all of the connected stations.
- Background scan(Bg-scan) and powersave features are not supported for the station mode vap in concurrent mode.
- In NL80211 mode, STA VAP has to be settled first (i.e. should be connected) to use proper country code. Whatever country of STA VAP's AP (third party AP to which STA is connected), that will be advertised in Beacons of AP VAPs. If AP VAPs were created first then also whatever country will be of 3rd party connected AP, that will be updated in our AP VAP's beacon.
- In NL80211 mode, If Multiple AP VAPs only created then all VAP should have same country code. In this case whichever AP will start first with country code, same will be use for others also.

14 Background Scan Parameters

This section describes the various parameters for the Background scan commands that can be sent to the n-Link Client using the onebox_util program.

- **<bgscan_threshold>:** The Background scan threshold is referred to as the RSSI Upper Threshold. At every background scan interval (configured via <periodicity>), the n-Link® module decides whether to initiate or not to initiate a background scan based on the connected Access Point's RSSI. The module initiates a background scan if the RSSI of the connected Access Point is below this threshold. The input value should be the absolute value in dBm.
- **<rssi_tolerance_threshold>:** If the difference between the current RSSI value of the connected Access Point and the RSSI value of the Access Point from the previous background scan is greater than the RSSI Tolerance Threshold, then the module performs a background scan. Assigning a large value to this field will eliminate this method of triggering background scans.
- **<periodicity>:** This parameter specifies the interval between the background scans. The unit of this field is seconds. Setting the value of this field as 0 will disable background scans.
- **<active_scan_duration>:** This parameter determines the duration of the active scan in each channel during the Background scan process. The recommended value for this parameter is 20ms for quicker Background scan operation and uninterrupted throughput. The maximum allowed value for this parameter is 255ms.
- **<passive_scan_duration>:** This parameter determines the duration of the passive scan in each DFS channel. If an active scan is enabled in a DFS channel and a beacon or probe response is received during that period, the module converts the passive scan into an active scan and waits through the duration specified by the <active_scan_duration> parameter. During a passive scan, if any beacon is recieved in a channel, then the recommended value for this parameter will be 100ms. The active scan in DFS channel can be enabled through Background scan probe request. Active scanning will be performed only if channel switch IE (Information Element) is not present in the received beacon or probe response packets. The maximum allowed value for this parameter is 255ms.
- **<two_probe_enable>:** If this feature is enabled, the Client sends two probe requests to the Access Point. This is useful when scanning is carried out in channels with high traffic. The valid values are

1. 0 – Disable
2. 1 – Enable

- **<num_of_bgscan_channels>:** Specifies the number of Background scan channels. The n-Link® module supports up to 24 channels.
- **<channels_to_scan>:** The list of channels in which Background scan has to be performed

15 Power save Modes, Profiles and Parameters

The Power save modes and parameters are valid only for the Client mode. By default, the module's power save is disabled.

15.1 Power save Modes

The module broadly supports two types of power save modes. They are outlined below:

- **Low Power (LP) Mode:** The PHY (RF and Baseband) and LMAC sections are powered off but the UMAC and Host Interface sections of the module are powered on and fed a low frequency clock. The module responds to commands/requests from the Host processor immediately in this mode.
- **Ultra-low Power (ULP) Mode:** A majority of the module is powered off except for a small section which has a timer and interrupts logic for waking up the module. The module cannot respond to the Host processor's commands/requests unless and until it gets wake up because of timeout or because of an interrupt asserted by Host processor. The sleep entry/exit procedures in this mode are indicated to the Host processor either through a packet based or signal based handshake. This mode is supported only for SDIO host interface.

15.2 Power save Profiles

For each of the above power save modes, the module supports multiple power save profiles. They are outlined below:

- **Deep Sleep:** The module is in deep sleep mode when it is not connected to an Access Point. The duration of the Deep Sleep is defined by the <sleep_duration> parameter of the set_ps_params command. For LP mode, a value of 0 for the <sleep_duration> parameter programs the module to be in Deep Sleep mode indefinitely till it is woken up by the Host processor via the host interface. The value of 0 is invalid for ULP mode and should not be used.
- **Connected Power Save**: In the connected state, the module can operate in Traffic Based Power Save Profile (PSP) or Fast PSP. These profiles are used by the module to decide when to enter and exit from power save modes on the fly. They have to be selected based on the performance and power consumption requirements of the end product.
- **Traffic Based PSP**: This profile is dependent on the <tx_threshold> and <rx_threshold> parameters, which indicate transmit and receive throughput thresholds beyond which the module exits power save mode and below which the module enters power save mode. The <tx_hysteresis> and <rx_hysteresis> parameters are also used in this profile. This profile is enabled when non-zero values are assigned to the <tx_threshold> and <rx_threshold> parameters along with the <monitor_interval> parameter.
- **Fast PSP**: This profile is a variant of the Traffic Based PSP which exits power save mode even for a single packet and enters the power save mode if no packet is transferred for the <monitor_interval> amount of duration. This profile is enabled independently for the Transmit and Receive directions if the <tx_threshold> and <rx_threshold> parameters are assigned zero, respectively, while assigning a non-zero value to the <monitor_interval> parameter.

15.3 Wakeup Procedures and Data Retrieval

When in power save mode, the module wakes up at periodic intervals or due to certain events (like pending transmit packets from the Host). At every wake up, the module has to poll the Access Point and check whether there are any pending Rx packets destined for the module. The module uses different protocols to retrieve data from the Access Point based on the protocol supported by the Access Point. These data retrieval methods (protocol-based) are used to further classify the power save profiles described in the previous section into Max PSP, Periodic UAPSD and Transmit based UAPSD.
The MAX PSP and UAPSD modes are explained below:

- **Max PSP:** In this mode, the module wakes up at the end of sleep period (Listen or DTIM interval) and retrieves pending Rx packets from the Access Point by sending a PS-POLL packet. It also transmits any packets received from the Host processor and then goes back to sleep. The parameters listed below are used by the module to decide the period of sleep during power save, in the same order of priority:

    a. <listen_interval_duration>
    b. <dtim_interval_duration>
    c. <num_beacons_per_listen_interval>

d. <num_dtims_per_sleep>

- **Periodic UAPSD:** This mode is enabled by the set_uapsd_params command only if the <uapsd_wakeup_period> parameter is assigned with a non-zero value. For this mode, the wakeup period can be assigned with a value ranging between 10 and 100 milliseconds. If it is supported by the Access Point, then in this mode, the module wakes up at the end of each sleep period and transmits pending data or a QoS Null packet in order to retrieve the data from the Access Point. The sleep period is governed by the parameter set which is using commands like set_ps_params command (see the list under Max PSP above) and also set_uapsd_params command. The sleep period has the minimum of the values programmed using the above two commands. If the Access Point does not support UAPSD, the module tries to mimic this mode by waking up at the end of the sleep period and transmits pending data and a PS_POLL packet to retrieve the data from the Access Point.
- **Transmit based UAPSD:** If <uapsd_wakeup_period> parameter is set to 0 in the set_uapsd_params command, the Transmit based UAPSD mode is enabled. In ULP mode, the Transmit based UAPSD mode can be used only when the signal-based handshake is enabled (and not in packet-based handshake mode). In this mode, the module wakes up from sleep when the Host sends a packet to be transmitted and then retrieves the pending packets from the Access Point by transmitting the packet. The module also wakes up if there is no packet transmitted for the sleep duration programmed in the set_ps_params command. If the Access Point does not support UAPSD, the module mimics this mode by waking up whenever there is a packet to be transmitted.
  It generally transmits the packet and then retrieves the pending data from the Access Point by sending a PS_POLL packet.

15.4 Power save Parameters

The input parameters of the set_ps_params command are explained below.

- **<ps_en>:** This parameter is used to enable (1) or disable (0) power save mode.
- **<sleep_type>:** This parameter is used to select the sleep mode between LP (1) and ULP (2) modes.
- **<tx_threshold>:** If a non-zero value is assigned, this parameter is used to set a threshold for the Transmit throughput computed during the <monitor_interval> period so that the module can decide to enter (throughput ≤ threshold) or exit (throughput > threshold) the power save mode. The value is in Mbps and minimum value is 0 Mbps.
- **<rx_threshold>:** If a non-zero value is assigned, this parameter is used to set a threshold for the Receive throughput computed during the <monitor_interval> period so that the module can decide to enter (throughput ≤ threshold) or exit (throughput > threshold) the power save mode. The value is in Mbps and minimum value is 0 Mbps.
- **<tx_hysteresis>:** The decision to enter or exit power save mode based on the Transmit throughput alone can result in frequent switching between the power save and non-power save modes. If this is not beneficial, the <tx_hysteresis> parameter can used to make the module re-enter the power save mode only when the throughput falls below the difference between the <tx_threshold> and <tx_hysteresis> values. The value is in Mbps and minimum value is 0 Mbps. This parameter should be assigned a value which is less than the value assigned to the <tx_threshold> parameter.
- **<rx_hysteresis>:** The decision to enter or exit power save mode based on the Receive throughput which alone can result in frequent switching between the power save and non-power save modes. If this is not beneficial, the <rx_hysteresis> parameter can be used to make the module re-enter the power save mode only when the throughput falls below the difference between the <rx_threshold> and <rx_hysteresis> values. The value is in Mbps and minimum value is 0 Mbps. This parameter should be assigned a value which is less than the value assigned to the <rx_threshold> parameter.
- **<monitor_interval>:** This parameter specifies the duration (in milliseconds) over which the Transmit and Receive throughputs are computed to compare with the <tx_threshold>, <rx_threshold>, <tx_hysteresis> and <rx_hysteresis> values. The maximum value of this parameter is 30000 ms (30 seconds).
- **<sleep_duration>:** This parameter specifies the duration (in milliseconds) for which the module sleeps in the Deep Sleep mode. For LP mode, a value of 0 for the <sleep_duration> parameter programs the module to be in Deep Sleep mode indefinitely till it is woken up by the Host processor via the host interface. The value of 0 is invalid for ULP mode and should not be used. The maximum value for this parameter can be 65535.
- **<listen_interval_duration>:** This parameter specifies the duration (in milliseconds) for which the module sleeps in the connected state power save modes. If a non-zero value is assigned to this parameter it takes precedence over the

other sleep duration parameters that follow (<num_beacons_per_listen_interval>, <dtim_interval_duration>, <num_dtims_per_sleep>). The maximum duration for which the device supports sleep is 4095 times the duration of the beacon interval considering the listen interval parameters of the access point. The maximum value for this parameter can be 65535, but the duration should be the deciding factor in the beacon interval of the access point. This parameter is considered only after the module is connected to the access point. For example, if the beacon interval of the AP is 100ms and listen interval of AP is 8 beacons, then the maximum time the device can sleep without any data loss is 800 ms (8 * 100). Hence, the listen_interval_duration can be up to 800ms.

- **<num_beacons_per_listen_interval>:** This parameter specifies the number of beacon intervals for which the module sleeps in the connected state power save modes. Here, the device will wake up for the nth beacon, where n is the listen interval value programmed by the user. If a non-zero value is assigned to this parameter it takes precedence over the other sleep duration parameters that follow (<dtim_interval_duration>, <num_dtims_per_sleep>). This parameter is used only when the above parameter is assigned to 0. The maximum value for this parameter is 4095. The value for this parameter also has to be chosen keeping in mind the listen interval of the access point. . This parameter is considered only after the module is connected to the access point.
- **<dtim_interval_duration>:** This parameter specifies the duration (in milliseconds) for which the module sleeps in the connected state power save modes. The device will wake up for the nearest DTIM beacon after the time which the user has programmed expires. This parameter can be used when DTIM information is not available. If a non-zero value is assigned to this parameter, then it takes precedence over the other sleep duration parameter that follows (<num_dtims_per_sleep>). This parameter is used only when the above parameters are assigned 0. The maximum value for this parameter can be 10000ms. This parameter is considered only after the module is connected to the access point.
- **<num_dtims_per_sleep>:** This parameter specifies the number of DTIM intervals for which the module sleeps in the connected state power save modes. This parameter has least priority compared to the ones above and is used only if the above parameters are assigned to 0. The maximum value for this parameter is 10. This parameter is considered only after the module is connected to the access point.

The LP and ULP Power Save modes are supported with SDIO interface. USB interface supports only LP Power Save mode

15.5 Procedure to enable device power save for USB interface

In order to enable power save for USB interface, following steps must be followed after enabling LP power save on USB interface.
Find where the RSI module got detected.
Eg: When RSI module is inserted, following prints are observed when dmesg is done.

```
usb 2-1: new high-speed USB device number 4 using ehci-pci

usb 2-1: New USB device found, idVendor=1618, idProduct=9113

usb 2-1: New USB device strings: Mfr=1, Product=2, SerialNumber=6

usb 2-1: Product: Wireless USB Network Module

usb 2-1: Manufacturer: Redpine Signals, Inc.

usb 2-1: SerialNumber: 000000000001
```

It means Redpine module is detected as 2-1 device. Please make a note of this.

Read the manufacturer of 2-1 device using following command.

```
#cat /sys/bus/usb/devices/2-1/manufacturer
```

The output of this command should be **Redpine Signals, Inc.**
Issue the following command to enable device power saves for RSI module in USB mode.

```
# echo 15 > /sys/bus/usb/devices/2-1/power/autosuspend_delay_ms
```

Recommended delay is 15msec.

16 Compliance and Certification

M15SB module is FCC/IC/CE certified. This section outlines the regulatory information for the M15SB module. This allows integrating the module in an end product without the need to obtain subsequent and separate approvals from these regulatory agencies. This is valid in the case no other intentional or un-intentional radiator components are incorporated into the product and no change in the module circuitry. Without these certifications, an end product cannot be marketed in the relevant regions.

☐ RF Testing Software is provided for any end product certification requirements.

16.1 Federal Communication Commission Statement

◆ Any changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

◆ Note: 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 or more 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.

16.1.1 Labeling and User Information

◆ 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.

◆ RF exposure statements

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body or nearby persons.

◆ For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: XF6-M15SB" or "Contains FCC ID: XF6-M15SB" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

16.2 Industry Canada / ISED Statement

This product meets the applicable Innovation, Science and Economic Development Canada technical specifications.

Ce produit repond aux specifications techniques applicables a l'innovation, Science et Developpement economique Canada.

◆ Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device complies with Industry Canada license-exempt RSSs. 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.

Le present appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisee aux deux conditions suivantes :

1) l'appareil ne doit pas produire de brouillage;

2) l'utilisateur de l'appareil doit accepter tout brouillage radioelectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.

◆ Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

16.2.1 Labeling and User Information

The M15SB module has been labeled with its own IC ID number (8407A-M15SB) and if the IC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use following wording: Contains Transmitter Module IC ID: 8407A-M15SB or Contains IC ID: 8407A-M15SB User manuals for license-exempt radio apparatus shall contain the above mentioned statement or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both

17 Wi-Fi Performance Test ioctl usage

The One Box-Mobile software provides applications to test Transmit and receive performances of the module. The Band of operation of the module needs to be configured before performing any tests.
Also open the **common_insert.sh** file present in the **"release"** folder using an editor like vim. Ensure that below parameters are set as specified.

```
DRIVER_MODE=2
POWER_SAVE_OPTION=0
STANDBY_ASSOC_CHAIN_SEL=0
LMAC_BEACON_DROP=0
```

Run the following command in order to install the Driver in Performance Test mode

```
sh wlan_enable.sh or wlan_bt_insert.sh or wlan_zigb_insert.sh or onebox_insert.sh
script
```

17.1 WiFi Transmit Tests

The **"transmit"** utility, present in the **"release"** folder allows the configuration of the following parameters in order to start the transmission of packets.

- Transmit Power
- Transmit Data Rate
- Packet Length
- Transmit Mode
- External PA Enable/Disable This is not supported in the current release.
- Rate Flags like Short GI, Greenfield, etc.
- Enable/Disable Aggregation
- Number of packets to be transmitted in Burst Mode
- Delay between packets in Burst Mode
- Regulatory Domain

17.1.1 Transmit Command Usage

The command usage is explained below

```
./transmit <base-interface> <tp> <r> <l> <m> <c> <p> <f> <a> <n> <d> <rd>
```

<base_interface>: This parameter specifies the Base Interface (string like rpine0).

<tp>: Transmit Power. To control transmit power in dBm units. To set the transmit power value; enter a value either between -7 and18. If a value of 127 is entered, the packet will be transmitted at the maximum power from the Transmit power table in the module.
<r>: Transmit Data Rate. To set the transmit data rate, select a value from 1, 2, 5.5, 11, 6, 9, 12, 18, 24, 36, 48, 54, mcs0,

mcs1, mcs2, mcs3, mcs4, mcs5, mcs6 and mcs7.
<l>: Transmit packet length in bytes. Enter a value between 24 and 1536 when aggregation is not enabled and between 24 and 30000 when aggregation is enabled.
<m>: Transmit mode. Enter 0 for Burst mode and 1 for Continuous mode.
<c>: Transmit channel number On-air testing in DFS, the channels should be avoided till the module is certified for DFS. Cabled tests can be run in these channels.. The following table maps the channel numbers to the center frequencies for 20MHz and 40MHz bandwidth modes in 2.4 GHz and 5 GHz bands.

Band (GHz)	Bandwidth (MHz)	Channel Number	Center Frequency (MHz)
2.4	20	1	2412
2.4	20	2	2417
2.4	20	3	2422
2.4	20	4	2427
2.4	20	5	2432
2.4	20	6	2437
2.4	20	7	2442
2.4	20	8	2447
2.4	20	9	2452
2.4	20	10	2457
2.4	20	11	2462
2.4	20	12	2467
2.4	20	13	2472
2.4	40	3	2422
2.4	40	4	2427
2.4	40	5	2432
2.4	40	6	2437
2.4	40	7	2442
2.4	40	8	2447
2.4	40	9	2452
2.4	40	10	2457
2.4	40	11	2462
4.9	20	184	4920
4.9	20	188	4940
4.9	20	192	4960
4.9	20	196	4980
5	20	8	5040
5	20	12	5060
5	20	16	5080
5	20	36	5180
5	20	40	5200
5	20	44	5220
5	20	48	5240
5	20	52	5260
5	20	56	5280

Band (GHz)	Bandwidth (MHz)	Channel Number	Center Frequency (MHz)
5	20	60	5300
5	20	64	5320
5	20	100	5500
5	20	104	5520
5	20	108	5540
5	20	112	5560
5	20	116	5580
5	20	120	5600
5	20	124	5620
5	20	128	5640
5	20	132	5660
5	20	136	5680
5	20	140	5700
5	20	149	5745
5	20	153	5765
5	20	157	5785
5	20	161	5805
5	20	165	5825
5	40	38	5190
5	40	42	5210
5	40	46	5230
5	40	50	5250
5	40	54	5270
5	40	58	5290
5	40	62	5310
5	40	102	5510
5	40	106	5530
5	40	110	5550
5	40	114	5570
5	40	118	5590
5	40	122	5610
5	40	126	5630
5	40	130	5650
5	40	134	5670
5	40	138	5690
5	40	151	5755
5	40	155	5775
5	40	159	5795
5	40	163	5815

<p>: Enable/Disable External PA. This parameter is not supported in the current release.
<f>: Rate Flags. This parameter is used to enable/disable Short GI and Greenfield and also to set the channel width of the

transmitted packets. The table below explains the flags that can be enabled and disabled. Multiple flags can be set at a time.

Bit	Description
0	Short GI 0 – Disable Short GI 1 – Enable Short GI
1	Greenfield transmission 0 – Disable Greenfield transmission 1 – Enable Greenfield transmission
[4:2]	Operating bandwidth of the channel (3 bits)]]></ac:plain-text-body></ac:structured-macro> 0 – 20MHz 2 (Bit 3 is set) – Upper 20MHz of 40MHz 4 (Bit 4 is set) – Lower 20MHz of 40MHz 6 (Bits 3 and 4 are set) – Full 40MHz
5	This bit has to be set when the user selects 11J channel.

<a>: Enable/Disable Aggregation. Enter 0 to disable aggregation and 1 to enable aggregation. The packet length is divided into chunks of size 1792 bytes and aggregated. This parameter applies only to the Burst mode transmission and is ignored in the case of Continuous mode of transmission.
<n>: Number of packets to be transmitted in Burst mode. The transmission stops after the number of packets specified by this parameter are transmitted in the Burst mode. If this value is 0, then the transmission will not stop until the user gives the **"./transmit 0"** command inorder to stop the transmissions. This parameter is ignored in the case of Continuous mode of transmission.
<d>: Delay between packets in Burst mode. This parameter is used to specify a delay between any two packets. The delay has to be specified in microseconds. If this value is 0, then the packets will be transmitted without any delay. This parameter is ignored in the case of Continuous mode of transmission.

After the transmission starts, the following commands need to be given to stop the transmissions.

<rd>: Regulatory Domain. Refer the table below for the mapping of values to the regulatory domains.

Input Value	Regulatory Domain
0	US (FCC)
1	Europe (ETSI)
2	Japan(JP)
255	World Domain

Examples:

```
#. /transmit rpine0 2 5.5 750 1 11 0 1 0 0 0 0
```

The above command starts continuous transmission with the following configuration:
Transmit gain – 2dbm
Data rate – 5.5Mbps
Packet Length – 750 bytes
Transmit mode – 1 (continuous mode).
Channel number – 11
External PA – disabled
Rate flags – 1 (Short GI is enabled with 20MHz Channel width)
Aggregation – disabled (ignored in continuous mode)
Number of packets to be transmitted – 0 (ignored in continuous mode)
Delay between the packets – 0 (ignored in continuous mode)
#. /transmit 12 36 1000 0 6 0 25 0 1000 0 0
The above command starts burst mode transmission with the following configuration:
Transmit gain – 12dBm
Data rate – 36Mbps
Packet Length – 1000 bytes
Transmit mode – 0 (Burst mode).
Channel number – 6
External PA – disabled
Rate flags – 25 (Short GI with Full 40MHz Channel width)
Aggregation – disabled
Number of packets to be transmitted – 1000
Delay between the packets – 0

17.2 Wi-Fi Receive Tests

The **"receive"** utility present in the **"release"** folder can be invoked for displaying the following information.

- Total number of CRC PASS packets
- Total number of CRC FAIL packets and
- Total number of FALSE CCAs

17.2.1 Receive Command Usage

```
./receive <base-interface> <filename> <channel_number> <start/stop> <channel_width>
```

<base_interface>: This parameter specifies the Base Interface (string like rpine0).
<filename>: Name of the file into which the statistics will be logged, in addition to being displayed on the console.
<channel_number> On-air testing in DFS, the channels should be avoided till the module is certified for DFS. Cabled tests can be made run in these channels.: Channel number in which the statistics need to be logged.
<start/stop>: Parameter to start or stop logging the statistics. Enter 0 to start logging and 1 to stop logging.
<channel_width>: Operating bandwidth of the channel. Refer to the table below.

Value	Channel Width
0	20MHz
2	Upper 20MHz of 40MHz
4	Lower 20MHz of 40MHz
6	Full 40MHz
8	20Mhz mode for 11J channel

Table 10: Channel Width Values

Examples:

```
./receive rpine0 stats 6 0 0
```

The above command starts the receive utility and logs statistics with the following parameters.
Filename – stats
Channel number – 6
Channel Width – 20MHz
The test utility displays the following information:

- Total number of packets received with correct CRC.
- Total number of packets received with incorrect CRC.
- Total number of False CCA's received.

./receive stats 6 1 0
The above command will stop the receive application

17.3 Continuous Wave (CW) mode

The Continuous Wave mode is used to transmit a single tone – either a sine wave or a cosine wave.

17.3.1 Command Usage

```
./onebox_util <base_interface> cw_mode <channel> <start/stop> <type>
```

<base_interface>: This parameter specifies the Base Interface (string like rpine0)
<channel_number>: Channel number in which the transmission has to be done. Please refer to the **Table 7: Channel Numbers and Corresponding Center Frequencies** for a mapping between the channel numbers and the center frequencies.
<start/stop>: This parameter is used to start or stop the transmission. Enter 0 to start transmission and 2 to stop transmission. In order to start transmission for 11J 20MHz channels, enter 1.
<type>: This parameter is used to select among the different types of waves to be transmitted.
Enter 2 for Single Tone of 5MHz.
Enter 5 for DC tone.

1. The transmit power for the CW mode transmission is set using the **"transmit"** utility. The **"transmit"** command has to be issued first inorder to start the transmission at the required transmit power level and then it is called again to stop the transmission before giving the **"onebox_util"** command to start the CW transmission.
   The Antenna direction in CW mode will be in reverse direction.
   The user can select the appropriate antenna by using the following command.

- # ./onebox_util <base_interface> ant_sel <value>
- <value = 2> – Select RF_OUT_2/Integrated Antenna
- <value = 3 > – Select RF_OUT_1/U.FL Connector

Examples

```
#. /transmit rpine0 2 5.5 750 1 11 0 1 0 0 0 0
#. /transmit rpine0 0
#. /onebox_util rpine0 cw_mode 6 0 2
```

The above command starts continuous wave transmission with the following configuration.
Channel number – 6
Type – Single tone
Transmit Power – 2dBm
The command used for stopping continuous wave transmission is outlined below:

```
#. /onebox_util rpine0 cw_mode 6 2 2
```

The command used for starting transmission in 184(11J) channel is outlined below:

```
#. /onebox_util rpine0 cw_mode 184 1 2
```

The command used for stopping the transmission is outlined below:

```
#. /onebox_util rpine0 cw_mode 184 2 2
```

18 Wake-On-Wireless LAN

18.1 WoWLAN through onebox_util

The parameters listed below for the Wake-On-Wireless LAN are valid only in Client mode. The <hw_bmiss> parameter needs to be given as an input during VAP creation inorder to use the WoWLAN feature – refer to the section **Configuring Using onebox_util** for details on VAP creation.

- **<base_interface>:** Base Interface (string like rpine0)
- **<src_mac_addr>:** This parameter is the 48-bit Source MAC address in hexadecimal format with colon separation, which is used to filter the Unicast packets received by the device. This parameter is valid only when bit 2 of the <wowlan_flags> parameter is set to '1'.
- **<host_sleep_status>:** This parameter informs the device whether the Host is entering sleep state ("1") or exiting sleep state ("0"). The device will toggle the GPIO_2 (Host Wakeup Interrupt) only when the Host indicates that it is entering to sleep state.
- **<wowlan_flags>:** This parameter is a bitmap used to program the device to wake up the Host based on the type of packets received by it. It is a 16-bit value as explained in the table below. The Host can program multiple bits to "1" at the same time to enable wakeup on different types of events.

Bit [15:0]	Description
[15:4]	Reserved.
3	Wake up Host when EAPOL packets are received by the device
2	Wake up Host when Unicast packets from a specific MAC address (specified by <src_mac_addr> are received by the device
1	Wake up Host when Unicast packets are received by the device
0	Wake up Host for any packet received by the device

Table 11: WoWLAN Flags

The above configuration is used only when you have kept the device in transmit **burst mode** and has made random hopping as "enabled".
For more details in "Configuration of device in the transmit burst mode", please refer to the section **BT Transmit Tests**.

18.2 WoWLAN using Linux power state machine

Linux supports different power states to handle power management i.e. S3 (suspend), S4 (hibernate) and S5 (poweroff). WoWLAN can be verified through these power states which is the idle way. Presently only S3 is supported in N-Link Linux driver. Also WoWLAN configuration is allowed in NL80211 interface only. Enable ONEBOX_CONFIG_WOWLAN in Makefile to use this feature before building the driver. It supports kernel v3.11 or higher.

18.2.1 Overview

WoWLAN is a power saving technique where device goes to sleep until an explicit trigger is received through WLAN. For this feature to work station should be connected to an AP and the connection should retain while the system is in suspend. User shall configure WoWLAN trigger types like magic packet or pattern etc using which he wants to wake up the system. This trigger packet will be received by the WLAN device through AP. Device firmware shall process the trigger and check whether it is a valid trigger or not. If it is a valid trigger packet, it will trigger the GPIO of host wake-up. It is the vendor responsibility to map this GPIO to the platform's power module.
To verify WoWLAN below steps are needed:

- Configure WoWLAN
- Suspend the system

- Trigger wakeup

18.2.2 Configure WoWLAN

To configure WoWLAN, standard network tool 'iw' can be used. Issue below command in the terminal to configure WoWLAN.

```
# iw phy <phyX> wowlan enable <trigger_type>
```

phyX is the phy physical device number of the system for the device. It can be obtained by using the 'info' command. The command and its example output is shown below.

```
# iw dev <intf_name> info

Interface wlan0

ifindex 5

wdev 0x100000001

addr 00:23:a7:b9:ab:44

type managed

wiphy 1

channel 6 (2437 MHz), width: 20 MHz (no HT), center1: 2437 MHz
```

As can be seen, in this case, phy<X> is termed as phy1.

Trigger Type
These are the type of triggers currently available in linux. Possible triggers are:

```
[any] [disconnect] [magic-packet] [gtk-rekey-failure] [eap-identity-request] [4way-
handshake] [rfkill-release] [net-detect interval <in_msecs> [delay <in_secs>] [freqs
<freq>+] [matches [ssid <ssid>]+]] [active [ssid <ssid>]+|passive]
[randomise[=<addr>/<mask>]]] [tcp <config-file>] [patterns [offset1+]<pattern1> ...]
```

Triggers which are currently supported are:
<any> - To wake for any received packet
<disconnect> - To wake up for receival of disassociation or deauthentication from connected AP.
<magic-packet> - Receive of any magic packet generated through wowlan applications.

Note:
That host will be waked up if the connection is lost in any case (Like AP is powered off etc). Also host will be wakeup when GTK rekey packet is received. Hence before going to suspend, it is recommended to configure high GTK rekey timeout

18.3 Suspend system

Use below command to suspend the system.

```
#systemctl suspend
```

This step will suspend the system and system goes to power save mode.

18.4 Trigger wakeup

To initiate trigger packet, connect a PC or laptop to AP through LAN/WLAN. Get IP and check ping to AP is working or not. Copy WOWLAN applications 'wakeonlan' or 'etherwake' to this third party PC. Issue below command to issue trigger.

1. wakeonlan <MAC_addr_of_our_device>
   Or
2. etherwake <MAC_addr_or_our_device>
   For eatherwake application, please edit ether-wake.c and go to main() function, update the ifname with the interface name of our device. Compile the application using below command.
3. gcc ether-wake.c –o etherwake

Upon issuing this trigger, system should resume in 2 to 5 seconds.

19 PUF [Physical Unclonable Functions]

19.1 Introduction

PUF, is a technology which provides a secure method for storing a key, withstanding today's attack and even protecting against future potential attack. The purpose of PUF is to provide secure key storage without storing the key. Instead of storing the key a Key Code is generated which in combination with SRAM startup behavior is used to reconstruct keys.

19.2 Configuration

This feature is default disabled in Host Driver. To use this feature, ensure that driver is compiled with below define enabled in Makefile

```
EXTRA_CFLAGS += -DONEBOX_CONFIG_PUF
```

19.3 PUF Operations and IOCTL Usage

19.3.1 PUF Enroll

This operation enrolls PUF. After successful operation Activation code will be either saved in flash or it will be sent to host. The stored activation code shall be used for every further start operation on PUF.

```
./onebox_util rpine0 puf_req 0 1
```

19.3.2 PUF Start

This operation is used to start PUF. Once valid activation code is available PUF will be started. Start operation is must for any further operation with PUF.

```
./onebox_util rpine0 puf_req 1 1 puf_ac.txt
```

19.3.3 PUF Set Key

This operation is used for generating Key Code for the given key input.

```
./onebox_util rpine0 puf_req 2 0 0 abcdefghijklmnop
```

19.3.4 PUF Set Intrinsic Key

This operation is used for generating Key Code for internally generated intrinsic key.

```
./onebox_util rpine0 puf_req 3 0 0
```

19.3.5 PUF Get Key

This operation is used for generating key for the given key code input.

```
./onebox_util rpine0 puf_req 4 puf_keycode_0.txt
```

19.3.6 PUF Load Key

This operation is used for loading key to AES engine or key holder for the given key code input.

```
./onebox_util rpine0 puf_req 5 puf_keycode_0.txt
```

19.3.7 PUF AES Encryption

This operation is used for encrypting data inputted with Key provided or with key which is already loaded into AES by PUF. It also provides provision for encryption with AES engine for two modes (ECB, CBC). Parameters should be provided depending on mode of usage

```
./onebox_util rpine0 puf_req 6 0 0 0 0 128 plain_data.txt 0 0
```

For the above command, create a text file plain_data.txt that should have some data of length more than 128 bytes

19.3.8 PUF AES Decryption

This operation is used for decrypting data inputted with Key provided or with key which is already loaded into AES by PUF. It also provides provision for decryption with AES engine for two modes (ECB, CBC). Parameters should be provided depending on mode of usage

```
./onebox_util rpine0 puf_req 7 0 0 0 0 128 aes_enc_data.txt 0 0
```

19.3.9 PUF AES MAC Generation

This operation is used for generating Message authentication check (MAC) for the data inputted with provided key as well as Initialization Vector (IV). Parameters should be provided depending on mode of usage

```
./onebox_util rpine0 puf_req 8 1 0 0 0 128 plain_data.txt 0 abcdefghijklmnop
```

For the above command, create a text file plain_data.txt that should have some data of length more than 128 bytes

19.3.10 PUF Block Enroll

This operation is used for blocking further enroll operations.

```
./onebox_util rpine0 puf_req 9
```

19.3.11 PUF Block Set Key

This operation is used for blocking further Set Key operations.

```
./onebox_util rpine0 puf_req 10
```

19.3.12 PUF Block Get Key

This operation is used for blocking further Get Key operations.

```
./onebox_util rpine0 puf_req 11
```

Refer the page Features for all IOCTL commands in detail

20 GTK Offload

GTK Offload is a firmware feature that updates the Group Temporal Key (GTK) by processing EAPOL message within firmware instead of sending EAPOL messages to host driver.

20.1 Configuration

To use this feature, ensure that driver is compiled with below define enabled in Makefile

```
EXTRA_CFLAGS += -DONEBOX_CONFIG_GTK_OFFLOAD
```

To enable/disable this feature at run time, use the following ioctl

```
./onebox_util rpine0 gtk_offload 1/0
```

21 Steps to connect 802.11R client to AP

1. Use the following configuration in sta_settings.conf file to connect to 802.11R AP.
   `network={ssid="<SSID of Access Point>"key_mgmt=FT-PSKpsk=<passphrase specified in the Access Point>proto=WPA2pairwise=CCMPgroup=CCMP}`
2. Use following command to roam Over-The-DS for RSI 802.11R client:
   #./wpa_cli -i <interface_name> ft_ds <AP_MAC_ID>
   NOTE: Here AP_MAC_ID is obtained from scan results and given manually.

22 Steps to configure 802.11W

22.1 Configuring and Compiling Driver for PMF in client mode:

1. Enable CONFIG_11W in Driver Makefile
2. Enable CONFIG_IEEE80211W=y in wpa_supplicant .config
3. Enable WPA-PSK-SHA256 as key_mgmt in network block in supplicant sta_settings.conf
    a. pmf=1/2, PMF is enabled/required correspondingly .

```
pmf=2
network = {
 ssid="REDPINE_AP_MFP"
 pairwise=CCMP
 group=CCMP
 key_mgmt=WPA-PSK-SHA256
 psk="12345678"
 proto=WPA2
 priority=1
}
```

4. Configure AP as MFP Capable/Required.

22.2 Configuring and Compiling Driver for PMF in AP mode:

1. Enable CONFIG_11W in Driver Makefile
2. Enable CONFIG_IEEE80211W=y in hostapd .config
3. Enable WPA-PSK-SHA256 as key_mgmt in hostapd_ccmp.conf
    a. pmf=1/2, PMF is enabled/required correspondingly .

Make sure below options are enabled apart from your configuration.

```
# This field is a bit field that can be used to enable WPA (IEEE 802.11i/D3.0)
# and/or WPA2 (full IEEE 802.11i/RSN):
# bit0 = WPA
# bit1 = IEEE 802.11i/RSN (WPA2) (dot11RSNAEnabled)
wpa=2


# ieee80211w: Whether management frame protection (MFP) is enabled
# 0 = disabled (default)
# 1 = optional
# 2 = required
ieee80211w=2


wpa_key_mgmt =WPA-PSK-SHA256
group_mgmt_cipher=AES-128-CMAC
```

23 Bluetooth hcitool and hciconfig Usage

The hcitool and hciconfig commands are used to control and configure parameters for the Bluetooth interface. The HCI commands explained here are the most frequently used commands. For other HCI commands please refer to the Bluetooth specification, Volume 2 Part E, Chapter7 from **www.bluetooth.org.**

Reset	
Description	This command is used to issue a soft reset to the Bluetooth module
Default Value	-
Input Parameters	None
Output Parameter	None
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x03 0x03
Read Local Version Information	
Description	This command is used to read the local version information
Default Value	-
Input Parameters	None
Output Parameter	HCI version HCI revision LMP version Manufacturer name LMP subversion
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x04 0x01
Read Local Supported Commands	
Description	This command is used to read the local controller supported HCI commands.
Default Value	-
Input Parameters	None
Output Parameter	List of supported commands (64 bytes of bit field)
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x04 0x02
Get Local BD Address	
Description	This command is used to get the local BD Address
Default Value	-
Input Parameters	None
Output Parameter	6 Byte BD Address
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x04 0x09
Start Inquiry	
Description	This command is used to start the Inquiry process
Default Value	
Input Parameters	LAP (3 Bytes): (0x9E8B00 – 0x9E8B3F) Inquiry duration: (0x01 to 0x30 -> 1.28 to 61.44 Seconds) Number of responses: (0x01 – 0xFF)

Reset	
Output Parameter	None.
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x01 0x01 <LAP> <duration> <no_of_responses>
Write Local Name	
Description	This command is used to Set the local device name
Default Value	
Input Parameters	Name of the device.
Output Parameter	None.
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x03 0x13 <name>

Table 12: Bluetooth hcitool and hciconfig usage

23.1 Bluetooth Power Save Commands

The vendor-specific HCI Commands are used to configure the device in the power save mode. The module supports Low Power (LP) and Ultra-Low Power (ULP) modes. These are explained in more detail in the **Power Save Modes** section of WLAN ioctl Usage Guide. The LP and ULP modes are supported with the SDIO interface while only the LP mode is supported in USB mode.

Vendor Specific Power Save	
Description	This command is used to enable/disable the power save mode of the device and also set the sleep duration in Standby mode.
Default Value	-
Input Parameters	**Sleep Enable:** 0x01 - Sleep enable 0x00 - Sleep disable **Sleep Mode:** 0x01 – LP (Low Power) mode 0x02 – ULP (Ultra Low Power) mode Sleep Duration in Standby mode (in msec) : (Range 0x00 – 0xFF)
Output Parameter	None
Reset Required	No.
Usage	hcitool -i <hciX> cmd 0x3F 0x0003 <sleep enable/disable> <sleep mode> <sleep duration>

23.2 Bluetooth Performance Test ioctl Usage

The OneBox-Mobile software provides applications to test Transmit and Receive performance of the module.Open the common_insert.sh file present in the **"release"** folder using an editor like vim. Ensure that the DRIVER_MODE and COEX_MODE is set as below:

```
DRIVER_MODE = 2
COEX_MODE = 4(for BT Classic)
COEX_MODE = 8(for BT LE)
```

Ensure that only Bluetooth is selected in menuconfig.
Run the **onebox_insert.sh** script present in the **"release"** folder to install the Driver in Performance Test mode**.**
Next, follow the instructions below to run the Transmit and Receive tests.

23.3 BT CLASSIC Transmit

The **"transmit"** utility, present in the **"release"** folder requires configuring the following parameters to start transmitting packets.

- Device Address
- Packet Type
- Packet length
- Basic Rate/Enhanced rate indication
- Receive channel index
- Transmit_channel index
- link_type
- scrambler_seed
- no_of_packets
- payload_type
- Transmit power
- Transmitting mode
- hopping_type
- Antenna selection
- inter packet gap
- Pll_mode
- rf_type
- rf_chain

23.3.1 IOCTL

The following command can be given to start the transmission
/bt_br_edr_transmit <dev_addr> <pkt_type> <pkt_length> <br_edr_mode> <rx_channel_index> <tx_channel_index> <link_type> <scrambler_seed> <no_of_packets> <payload_type> <tx_power> <tx_mode> <hopping_type> <ant_sel> <inter_pkt_gap> <pll_mode> <rf_type> <rf_chain>
After the transmission starts, the following command can be given to stop the transmission.
. /bt_br_edr_transmit 0

1. Stop the Transmission first before starting of Transmission.
2. dev_addr need not be module's BD address, it can be any 48bit BD address. But it should be same for transmit and receive command.

23.3.2 Description

dev_addr: It is a 48-bit Device Address in hexadecimal format, e.g.,0023A7010203
pkt_type: Type of the packet to be transmitted, as per the Bluetooth standard.
pkt_length: Length of the packet, in bytes, to be transmitted.
br_edr_mode : basic rate - 1 enhanced_rate - 2 or 3
rx_channel_index - Receive channel index, as per the Bluetooth standard.i.e, 0 to 78
tx_channel_index - Transmit channel index, as per the Bluetooth standard. i.e, 0 to 78
link_type : sco - 0 acl - 1 esco - 2

scrambler_seed: Initial seed to be used for whitening. It should be set to '0' in order to disable whitening.In order to enable it he should give the scrambler seed value, which is used on the receive side.
no_of_packets: Number of packets to be transmitted. presently this option not valid.
payload_type: Type of payload to be transmitted. '0' – Payload consists of all zeros
'1' – Payload consists of all 0xFF's
'2' – Payload consists of all 0x55's
'3' – Payload consists of all 0xF0's
'4' – Payload consists of PN9 sequence.
tx_power: Transmit power value should be between 0 and 18
tx_mode: Burst mode - 0 Continuous mode - 1
hopping type : no hopping -0 fixed hopping - 1 random hopping - 2
ant_sel : onchip antenna - 2 u.f.l - 3
inter_pkt_gap : Number of slots to be skipped between two packets Each slot will be 625usec (At Always will happen at Tx slot).
pll_mode : PLL_MODE0 – 0 PLL_MODE1 – 1 PLL_MODE2 – 2
rf_type : External RF – 0 Internal RF – 1
rf_chain: WLAN_HP_CHAIN 0
WLAN_LP_CHAIN 1
BT_HP_CHAIN 2
BT_LP_CHAIN 3

23.3.3 Appendix

Frequencies and channel Numbers used for Bluetooth Classic Mode:

Bad(GHz)	Bandwidth(MHz)	Channel Number	Centre Freq(MHz)
2.4	1	0	2402
2.4	1	1	2403
2.4	1	2	2404
2.4	1	3	2405
2.4	1	4	2406
2.4	1	5	2407
2.4	1	6	2408
2.4	1	7	2409
2.4	1	8	2410
2.4	1	9	2411
2.4	1	10	2412
2.4	1	11	2413
2.4	1	12	2414
2.4	1	13	2415
2.4	1	14	2416
2.4	1	15	2417
2.4	1	16	2418
2.4	1	17	2419
2.4	1	18	2420
2.4	1	19	2421
2.4	1	20	2422
2.4	1	21	2423

Bad(GHz)	Bandwidth(MHz)	Channel Number	Centre Freq(MHz)
2.4	1	22	2424
2.4	1	23	2425
2.4	1	24	2426
2.4	1	25	2427
2.4	1	26	2428
2.4	1	27	2429
2.4	1	28	2430
2.4	1	29	2431
2.4	1	30	2432
2.4	1	31	2433
2.4	1	32	2434
2.4	1	33	2435
2.4	1	34	2436
2.4	1	35	2437
2.4	1	36	2438
2.4	1	37	2439
2.4	1	38	2440
2.4	1	39	2441
2.4	1	40	2442
2.4	1	41	2443
2.4	1	42	2444
2.4	1	43	2445
2.4	1	44	2446
2.4	1	45	2447
2.4	1	46	2448
2.4	1	47	2449
2.4	1	48	2450
2.4	1	49	2451
2.4	1	50	2452
2.4	1	51	2453
2.4	1	52	2454
2.4	1	53	2455
2.4	1	54	2456
2.4	1	55	2457
2.4	1	56	2458
2.4	1	57	2459
2.4	1	58	2460
2.4	1	59	2461
2.4	1	60	2462
2.4	1	61	2463

Bad(GHz)	Bandwidth(MHz)	Channel Number	Centre Freq(MHz)
2.4	1	62	2464
2.4	1	63	2465
2.4	1	64	2466
2.4	1	65	2467
2.4	1	66	2468
2.4	1	67	2469
2.4	1	68	2470
2.4	1	69	2471
2.4	1	70	2472
2.4	1	71	2473
2.4	1	72	2474
2.4	1	73	2475
2.4	1	74	2476
2.4	1	75	2477
2.4	1	76	2478
2.4	1	77	2479
2.4	1	78	2480

Packet Summary:

Packet	Type	br edr mode	Packet length	Link Type
DM1	3	1	0-17	1
DH1	4	1	0-27	1
DH3	11	1	0-183	1
DM3	10	1	0-121	1
DH5	15	1	0-339	1
DM5	14	1	0-224	1
2-DH1	4	2	0-54	1
2-DH3	10	2	0-367	1
2-DH5	14	2	0-679	1
3-DH1	8	3	0-83	1
3-DH3	11	3	0-552	1
3-DH5	15	3	0-1021	1
HV1	5	1	10	0
HV2	6	1	20	0
HV3	7	1	30	0
DV	8	1	10+(0-9)D	0
EV3	7	1	1-30	2
EV4	12	1	1-120 *	2
EV5	13	1	1-180 *	2

Packet	Type	br edr mode	Packet length	Link Type
2-EV3	6	2	1-60	2
2-EV5	12	2	1-360 *	2
3-EV3	7	3	1-90	2
3-EV5	13	3	1-540 *	2

'*' In eSCO (link type = 3), we have capability of maximum 90 bytes (Packet Length) only.

Examples:
For transmitting a DH5 packet of 339bytes length on Channel-10 and Device address of 111111111111 with the following parameters
scrambler_seed– 0
Number of packets to be transmitted – 0 (ignored in continuous mode)
Transmit Power – 10
Transmit mode – Continuous mode
hopping type – no hopping
ant_sel – External antenna
inter_pkt_gap – 0
pll_mode – PLL_MODE0
rf_type - Internal RF
rf_chain: BT_HP_CHAIN
IOCTL Command:
./bt_br_edr_transmit 111111111111 15 339 1 10 10 1 0 0 1 10 0 0 3 0 0 1 2

23.4 BT Classic Receive

23.4.1 Introduction

The **"receive"** utility, present in the **"release"** folder requires configuring the following parameters to start transmitting packets.

- Device Address
- Link type
- Packet type
- Packet length
- Scrambler_seed
- Br_edr_mode
- Receive channel index
- Transmit_channel index
- hopping_type
- Antenna selection
- loop_back_mode
- pll_mode
- rf_type
- rf_chain

23.4.2 IOCTL

The following command can be given to start the reception

./bt_br_edr_receive <dev_addr> <link_type> <pkt_type> <pkt_length> <scrambler_seed> <br_edr_mode> <rx_channel_index> <tx_channel_index> <hopping_type> <ant_sel> <loop_back_mode> <pll_mode> <rf_type> <rf_chain>
After the receive starts, the following command can be given to stop the reception.
. /bt_br_edr_receive 0

1. Stop the Reception first before starting of Receiving.
2. dev_addr need not be module's BD address, it can be any BD address. But it should be same for transmit and receive command.

23.4.3 Description

dev_addr: It is a 48-bit address in hexadecimal format, e.g.,000012345678
link_type : sco - 0 acl - 1 esco - 2
pkt_type: Type of the packet to be transmitted, as per the Bluetooth standard.
pkt_length: Length of the packet, in bytes, to be transmitted.
scrambler_seed: Initial seed to be used for whitening. It should be set to '0' in order to disable whitening.
br_edr_mode : basic rate - 1 enhanced_rate - 2
rx_channel_index - Receive channel index, as per the Bluetooth standard.i.e, 0 to 78
tx_channel_index - Transmit channel index, as per the Bluetooth standard. i.e, 0 to 78
hopping type : no hopping -0 fixed hopping - 1 random hopping - 2
ant_sel : onchip antenna - 2 u.f.l - 3
loop_back_mode : Disable - 0 Enable - 1
pll_mode : PLL_MODE0 – 0 PLL_MODE1 – 1 PLL_MODE2 – 2
rf_type : External RF - 0 Internal RF – 1
rf_chain: WLAN_HP_CHAIN 0
WLAN_LP_CHAIN 1
BT_HP_CHAIN 2
BT_LP_CHAIN 3

23.4.4 Appendix

Frequencies and channel numbers used for Bluetooth Classic mode and Packet Summary are same as BT classic TX case.

Examples:
For receiving a DH5 packet of 339bytes length on Channel-10 and Device address of 111111111111 with the following parameters
scrambler_seed– 0
rx_channel_freq – 2412MHz
tx_channel_freq – 2412MHz
hopping type – no hopping
Antenna Select – U.FL
loop_back_mode – disable
pll_mode – PLL_MODE0
rf_type – Internal RF
rf_chain: BT_HP_CHAIN

IOCTL Command:

./bt_br_edr_receive 111111111111 1 15 339 0 1 10 10 0 3 0 0 1 2

23.5 BLE/BLR Transmit

23.5.1 Introduction

The **"transmit"** utility, present in the **"release"** folder requires configuring the following parameters to start transmitting packets.

- Access address
- packet length
- ble rate
- Receive channel index
- Transmit_channel index
- Scrambler seed
- no.of packets
- payload type
- le channel type
- tx power
- tx mode
- hopping_type
- antenna selection
- inter_pkt_gap
- pll_mode
- rf_type
- rf_chain

23.5.2 IOCTL

The following command can be given to start the transmission
./ble_transmit <Access_Addr> <pkt_length> <ble_rate> <rx_channel_index> <tx_channel_index> <scrambler_seed> <no_of_packets> <payload_type> <le_channel_type> <tx_power> <tx_mode> <hopping_type> <ant_sel> <inter_pkt_gap> <pll_mode> <rf_type> <rf_chain>
After the transmission starts, the following command can be given to stop the transmission.
. /ble_transmit 0

> Stop the Transmission first before starting of Transmission

23.5.3 Description

Access Address : It is a 32-bit address in hexadecimal format, e.g.,00112233
pkt_length : Length of the packet, in bytes, to be transmitted.
ble_rate : 1Mbps - 1 ,2Mbps - 2 , 125Kbps - 4, 500Kbps - 8
rx_channel_index : Receive channel index, as per the Bluetooth standard.i.e, 0 to 39
tx_channel_index : Transmit channel index, as per the Bluetooth standard. i.e, 0 to 39
scrambler_seed : Initial seed to be used for whitening. It should be set to '0' in order to disable whitening. In order to enable the whitening scrambler seed should be given, which is used on the receive side.
no_of_packets : Number of packets to be transmitted. It is valid only when the <tx_mode> is set to Burst mode.
payload_type : Type of payload to be transmitted
'0' – Payload consists of all zeros
'1' – Payload consists of all 0xFF's

'2' – Payload consists of all 0x55's
'3' – Payload consists of all 0xF0's
'4' – Payload consists of PN9 sequence.
le_channel_type : advertising channel - 0 data channel - 1
tx_power : Transmit power value should be between 0 and 18
tx_mode : Burst mode - 0 Continuous mode - 1
hopping_type: no hopping -0 fixed hopping - 1 random hopping - 2
ant_sel : onchip antenna - 2 u.f.l - 3
inter_pkt_gap : Number of slots to be skipped between two packets - Each slot will be 1250usec
pll_mode : PLL_MODE0 – 0 PLL_MODE1 – 1 PLL_MODE2 – 2
rf_type : External RF – 0 Internal RF – 1
rf_chain: WLAN_HP_CHAIN 0
WLAN_LP_CHAIN 1
BT_HP_CHAIN 2
BT_LP_CHAIN 3

23.5.4 Appendix

Frequencies and channel Numbers used for Bluetooth LE Mode:

Band(GHz)	Bandwidth (MHz)	Channel	Centre Freq (MHz)
2.4	2	0	2402
2.4	2	1	2404
2.4	2	2	2406
2.4	2	3	2408
2.4	2	4	2410
2.4	2	5	2412
2.4	2	6	2414
2.4	2	7	2416
2.4	2	8	2418
2.4	2	9	2420
2.4	2	10	2422
2.4	2	11	2424
2.4	2	12	2426
2.4	2	13	2428
2.4	2	14	2430
2.4	2	15	2432
2.4	2	16	2434
2.4	2	17	2436
2.4	2	18	2438
2.4	2	19	2440
2.4	2	20	2442
2.4	2	21	2444
2.4	2	22	2446
2.4	2	23	2448
2.4	2	24	2450

Band(GHz)	Bandwidth (MHz)	Channel	Centre Freq (MHz)
2.4	2	25	2452
2.4	2	26	2454
2.4	2	27	2456
2.4	2	28	2458
2.4	2	29	2460
2.4	2	30	2462
2.4	2	31	2464
2.4	2	32	2466
2.4	2	33	2468
2.4	2	34	2470
2.4	2	35	2472
2.4	2	36	2474
2.4	2	37	2476
2.4	2	38	2478
2.4	2	39	2480

Examples:
For transmitting a BLE-1Mbps Advertising packet with Access Address of 0x71764129 and packet length of 250bytes on 2478MHz with the following parameters
scrambler_seed– 0
Number of packets to be transmitted – 0 (ignored in continuous mode)
Transmit Power – 10
Transmit mode – Continuous mode
hopping_type – disabled
Antenna Select – U.Fl
inter_pkt_gap – 0

> Stop the Transmission first before starting of Transmission

pll_mode – PLL_MODE0
rf_type – Internal RF
rf_chain: BT_LP_CHAIN

IOCTL Command:
./ble_transmit 71764129 250 1 38 38 0 0 1 1 10 0 0 3 0 0 1 3

23.6 BLE/BLR Receive

23.6.1 Introduction

The **"receive"** utility, present in the **"release"** folder requires configuring the following parameters to start transmitting packets.

- Access Address
- Data Length indication
- Scrambler_seed

- ble_rate
- Receive channel index
- Transmit_channel index
- LE Channel type
- hopping type
- Antenna selection
- Loop_back_mode enable/disable
- pwrsave_options
- pll_mode
- rf_type
- rf_chain

23.6.2 IOCTL

The following command can be given to start the reception
./ble_receive <access_addr> <data_legth_indication> <scrambler_seed> <ble_rate> <rx_channel_index> <tx_channel_index> <le_channel_type> <hopping_type> <ant_sel> <loop_back_mode> <pwrsave_options> <pll_mode> <rf_type> <rf_chain>

After the receive starts, the following command can be given to stop the reception.
./ble_receive 0

> Stop the Reception first before starting of Receiving

23.6.3 Description

Access Address : It is a 32-bit address in hexadecimal format, e.g.,00112233
data_length_indication : 0 – Disable(37 Bytes) 1 – Enable(255 Bytes)
scrambler_seed : Initial seed to be used for whitening. It should be set to '0' in order to disable whitening.
ble_rate : 1Mbps - 1 ,2Mbps - 2 , Long Range(LR) - 4
rx_channel_index : Receive channel index, as per the Bluetooth standard.i.e, 0 to 39
tx_channel_index : Transmit channel index, as per the Bluetooth standard. i.e, 0 to 39
le_channel_type : advertising channel – 0 data channel – 1
hopping_type: no hopping -0 fixed hopping - 1 random hopping - 2
ant_sel : onchip antenna - 2 u.f.l – 3
loop_back_mode : Disable – 0 Enable – 1
pwrsave_options : Disable – 0 Enable – 1
pll_mode : PLL_MODE0 – 0 PLL_MODE1 – 1 PLL_MODE2 – 2
rf_type : External RF – 0 Internal RF – 1
rf_chain: WLAN_HP_CHAIN 0
WLAN_LP_CHAIN 1
BT_HP_CHAIN 2
BT_LP_CHAIN 3

23.6.4 Appendix

Frequencies and channel numbers used for Bluetooth LE Mode are same as BLE TX case.

Examples:

For receiving a BLE-1Mbps Advertising packet with Access Address of 0x71764129 and packet length of 250bytes on 2478MHz with the following parameters
scrambler_seed : 0
hopping_type: disable
ant_sel : u.f.l
loop_back_mode : Disabled
pwrsave_options : Disabled
pll_mode : PLL_MODE0
rf_type : Internal RF
rf_chain: BT_LP_CHAIN
IOCTL Command:
. /ble_receive 71764129 0 0 1 37 37 0 3 0 0 0 1 3

23.7 Hopping

23.7.1 Introduction

The “bt_util” command is used to configure the device in order to transmit packets in required channels when random hopping feature is enabled.

23.7.2 IOCTL

The parameters of "bt_util" command are as follows:
./bt_util afh_map <classic_le_mode> <channel_bit_map

23.7.3 Description

Classic_le_mode: 1 – BT_Classic 2 – BLE
channel_bit_map: It is bitmap to transmit in required channels. It is 10 bytes in length. Range:00000000000000000001 to 7FFFFFFFFFFFFFFFFFFF
Bit number is the channel number used.

23.7.4 Appendix

Note:-
The above configuration is used only when you have kept the device in transmit burst mode and has made random hopping as "enabled".
For more details in "Configuration of device in the transmit burst mode", please refer to the section **BT Classic Transmit Tests.**
111111111111
Examples:
. /bt_util afh_map 1 7FFFFFFFFFFFFFFFFFFF

Classic_le_mode – 1
channel_bit_map – **7FFFFFFFFFFFFFFFFFFF** (here all the bits of bit map are set. So, transmission happens in all the channels randomly)

. /bt_util afh_map 1 00000000000000000007

Classic_le_mode – 1
channel_bit_map – **00000000000000000007** (here only lower 3 bits of bit map are set. So, transmission happens in 0,1 & 2 channels randomly)

/bt_util afh_map 1 70000000000000000000

Classic_le_mode – 1
channel_bit_map –**70000000000000000000** (here only upper 4 bits of bit map are set. So, transmission happens in 76,77 & 78 channels randomly)

24 ZigBee Performance Test Application Usage

The steps for showing the usage of ZigBee Performance Test Application are as follows:
Open the **common_insert.sh** file present in the **"release"** folder. Ensure that the **DRIVER_MODE** and **COEX_MODE** are set as below:

```
DRIVER_MODE = 2

COEX_MODE = 16 (for ZigBee)
```

Run the following command in order to install the Driver in Performance Test mode:
 # sh zigb_enable.sh or **wlan_zigb_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions mentioned in the Section **4.1**.
Next, follow the instructions mentioned below in order to run the "Transmit" and "Receive" tests.

24.1 ZigBee Transmit Tests

The **"zb_transmit"** utility, present in the **"release"** folder, allows the configuration of the following parameters in order to start the transmission of packets.

- Transmit Power
- Packet Length
- Transmit Mode
- Channel Index
- Number of Packets
- Delay

Command Usage
The **"zb_transmit"** command usage is explained below:

```
/zb_transmit <tx_power> <pkt_length> <tx_mode> <channel_index> <no_of_packets> <delay>
```

Where,
<tx_power>: This is the transmit power (in dBm) to be used by the module. The value should be between 0 and 18.
<pkt_length>: This is the length of the packet (in bytes), to be transmitted. Valid range for packet length is [6-127]
<tx_mode>: This parameter is used to choose between Burst and Continuous modes of transmission.
'0' – Burst mode
'1' – Continuous mode
<channel_index>: This parameter indicates the channel index as per the ZigBee standard.
<no_of_packets>: This is the number of packets to be transmitted. This is valid only when the <tx_mode> is set to Burst Mode (0).
<delay>[1]: Specifies the delay time between the packets in Burst mode. This parameter is used to introduce a delay time between any two packets. The delay has to be specified in microseconds. If this value is 0, then the packets will be transmitted without any delay. This parameter is ignored in the case of Continuous mode of transmission.

24.2 Receive Tests

In order to stop the transmit, the user must issue the following command:

```
/zb_transmit 0
```

The **"zb_util"** utility present in the **"release"** folder allows the configuration of the channel and also does the collection of the received statistics in that particular channel.

Command Usage

The **"zb_util"** command usage is explained below. It has to be issued twice – first to set the channel and then to start/stop the collection of statistics. The statistics are reported once in every second.

./zb_util set_channel <channel_index>

./zb_util zb_stats <filename>

<channel_index>: This parameter indicates the channel index as per the ZigBee standard.

<filename>: This parameter indicates the file to which the statistics are saved.

The following statistics are returned every second.

crc_pass: The number of packets received which are passed in the CRC check.

crc_fail: The number of packets received which are failed in the CRC check.

rssi: The RSSI value of the last received packet.

24.3 Continuous Wave Transmit Mode

The **"zb_util"** command is used to configure the device inorder to transmit a continuous wave. The following parameters can be configured.

- Channel Index
- Start/Stop
- Antenna Select

Command Usage

The command usage is explained below:

/zb_util cw_mode <channel_index> <start/stop> <ant_sel>

<channel_index>: Channel index as per the zigbee standard.

<start/stop>: To start or stop the Continuous Wave mode transmission.

- '0' – start the cw mode transmission
- '2' – stop the cw mode transmission

<ant_sel>: Select one of the two RF ports. They are outlined below:

Modules without integrated antenna - Used to select between pins RF_OUT_1 and RF_OUT_2.

- '2' – RF_OUT_1
- '3' – RF_OUT_2

Modules with integrated antenna and U.FL connector - Used to select between the two

- '2' –U.FL
- '3' –Antenna

Example

```
. /zb_util cw_mode 26 0 2
```

The above command starts continuous wave transmission with the following configuration:

```
Channel index - 26
```

```
0  - Start(starts the transmission)
Antennal Select - 2(RF_OUT_1/U.FL)
```

25 Android support for RS9116

Redpine Signlas also supports Android Operating System.
Currently supported variants in Android

- MarshMallow (6.0.1)
- Nougat (7.1)

Please contact sales@redpinesignals.com for further details.

26 Appendix A: Configuration of Kernels from 3.13 and above

To ensure that the OneBox-Mobile software works on kernel versions from 3.13 and above, some configuration changes might be needed. These are explained in this section. Super user permissions are needed to make these changes.
For SDIO mode, ensure that the SDIO stack related modules are already inserted in the kernel.
This can be verified by using the commands below :

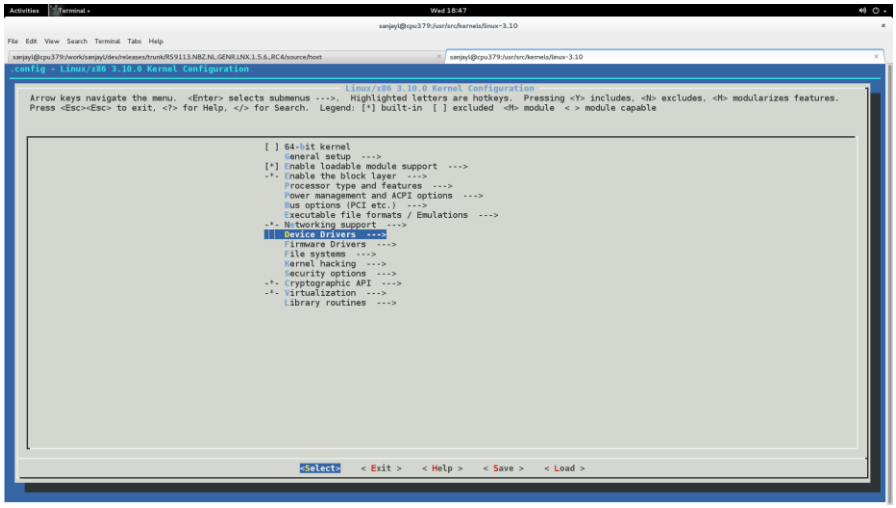
```
cd release

sh load_stack.sh

lsmod
```

Verify that the output of the **"lsmod"** command should describe **sdhci.ko**, **sdhci_pci.ko** (Specific for x86/PC, others should use their controller specific ko), **mmc_block.ko** as well as **mmc_core.ko** modules. This is a one-time process and need not be repeated unless the modules are explicitly removed by the user.

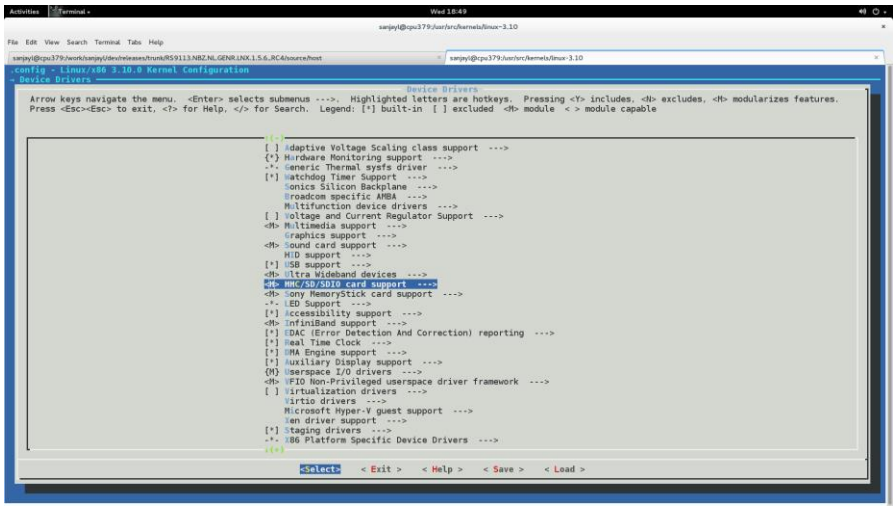
26.1 SDIO Stack Options

If SDIO is the interface to the Host processor, it has to be ensured that the SDIO stack related modules are compiled in the kernel. If the SDIO stack modules are not present, follow the steps below in order to enable SDIO support in the kernel.

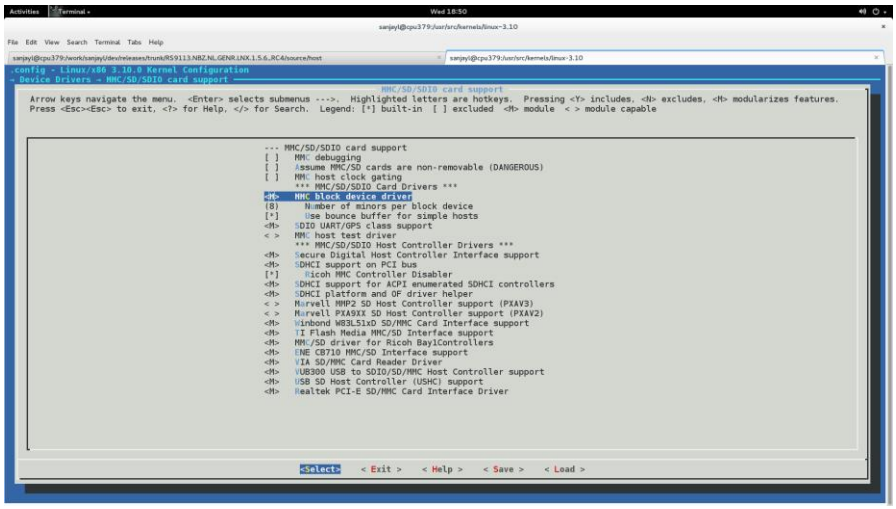
1. Navigate to the Linux kernel source folder. This is usually in /usr/src/kernels/Linux-<kernel-version>
2. Execute the **'make menuconfig'** command in order to open the Kernel Configuration menu.



3. Scroll down to the **"Device Drivers --->"** option and hit Enter.
4. In the new menu, scroll down to the **"MMC/SD/SDIO card support --->"** option and press **'M'** to modularize the **"MMC/SD/SDIO card support"** feature and hit Enter.



5. In the new menu, press **'M'** to modularize the following options:
    - MMC block device driver
    - Secure Digital Host Controller Interface support
    - SDHCI support on PCI bus



6. Hit the Tab key to select Exit and hit Enter. Repeat this till you are asked whether you want to save the configuration.
7. Select "Yes" and hit Enter. If the above options are already selected, the menuconfig screen will exit immediately

26.2 Wireless Extension Tools

Wireless Extension tools like **'iwconfig'** and **'iwpriv'** are required for configuring the OneBox-Mobile software. Make sure that the wireless extensions are enabled in the Linux kernel configuration file.
User needs to enable below options in kernel configuration file, re-compile the kernel and cross compile the driver.

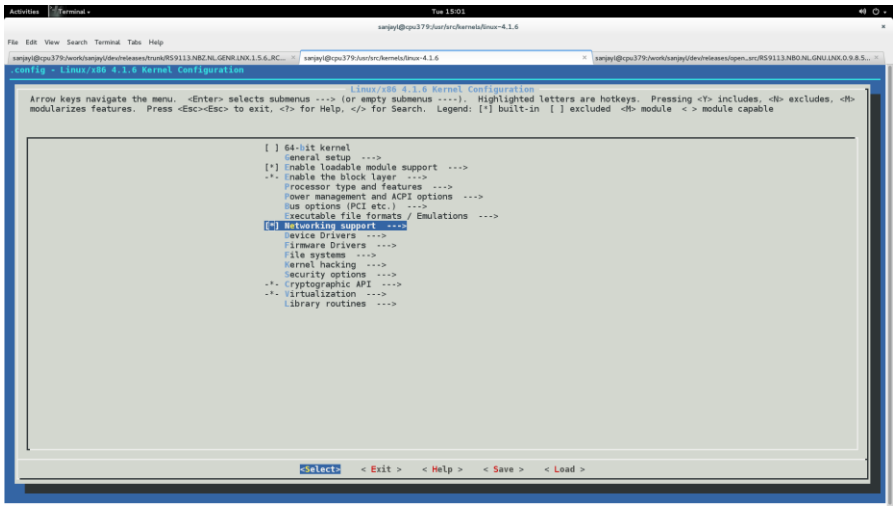
```
CONFIG_WIRELESS_EXT
```

```
CONFIG_WEXT_PRIV

CONFIG_WEXT_SPY
```

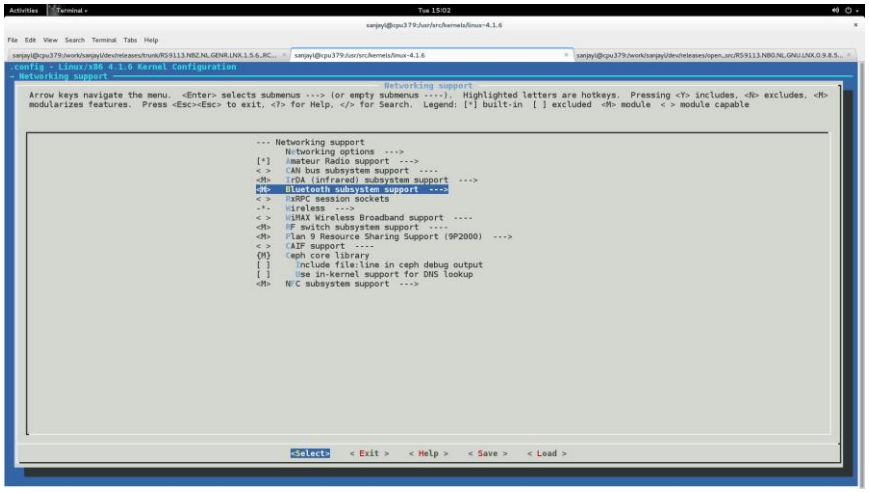
26.3 Bluetooth Stack Options

If Bluetooth is required, it has to be ensured that the Bluetooth modules are compiled in the kernel. If the Bluetooth modules are not present, follow the steps below to enable Bluetooth support in the kernel.

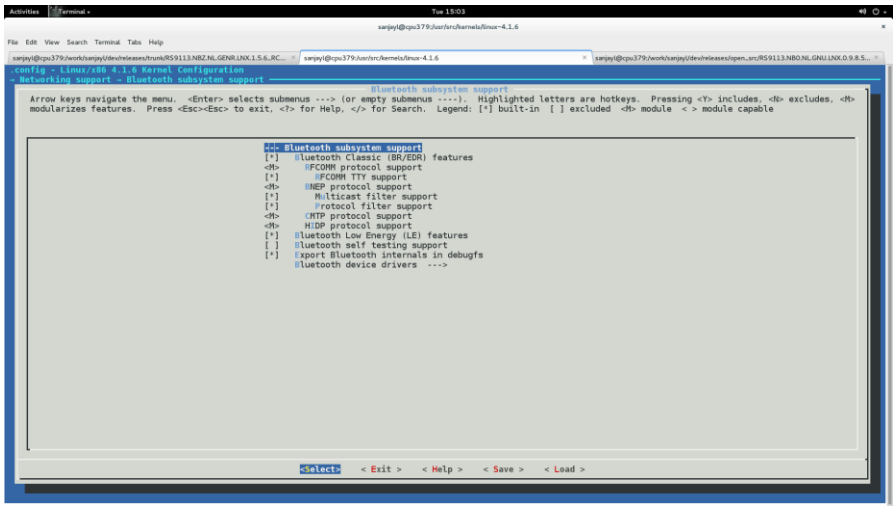
1. Navigate to the Linux kernel source folder. This is usually in /usr/src/kernels/linux-<kernel-version>
2. Execute the **'make menuconfig'** command in order to open the Kernel Configuration menu.
3. Scroll down to **"Networking support --->"** and hit Enter.



4. In the new menu, scroll down to the **"Bluetooth subsystem support --->"** option and press **'M'** to modularize the **"Bluetooth subsystem support"** feature and hit Enter.



5. In the new menu, press **'M'** to modularize the following options:



- RFCOMM Protocol support (enable the "RFCOMM TTY support" feature under this).
- BNEP Protocol support (enable the "Multicast filter support" and "Broadcast filter support" features under this).
- CMTP Protocol support
- HIDP Protocol support

6. Hit the Tab key to select Exit and hit Enter. Repeat this till you are asked whether you want to save the configuration.
7. Select "Yes" and hit Enter. If the above options are already selected, the menuconfig screen will exit immediately.

26.4 Kernel Compilation

The steps used for Kernel Compilation are as follows:

1. Navigate to the kernel source folder.
2. Execute the **"make"** command.
3. Execute the **"make modules_install"** command.
4. Execute the **"make install"** command. This ensures that the customized kernel is installed and the boot loader is updated appropriately.
5. Reboot the system in order to boot up with the customized kernel.

27 Appendix B: Binary Files for Embedded Platforms

Redpine offers pre-built binary files of the OneBox-Mobile software in order to enable customers to evaluate the software on specific embedded processor platforms. The platforms supported for the current release are listed below:

- Freescale i.MX6
- Atmel ATSAM9G45 and AT91SAM9M10

27.1 Common Hardware Requirements for Embedded Platforms

- RS9116 Evaluation Kit. The contents are as follows:
- RS9116 Module Evaluation Board
- USB-to-microUSB Cable
- SDIO Adaptor Cable
- SPI Adaptor Cable
- USB Pen Drive

The sections below explain about the usage of the binaries on these platforms and also describes like how to generate the binaries in case of the OneBox-Mobile software source is available.

27.2 Freescale i.MX6

27.2.1 Hardware Requirements

- i.MX 6SoloLite Evaluation Kit. The kit contents are as follows:

1. Board: MCIMX6SLEVK
2. Cables: Micro USB-B-2-USB-Type A male, V2.0
3. Power supply: 100/240 V input, 5 V, 2.4 A output W/AC adaptor
4. Two SD cards: Programmed Android™
5. Linux PC with Serial-to-USB drivers installed – Used to communicate with the i.MX6 platform.

27.2.2 Software Requirements

- Toolchain, BSP and Ubuntu Linux OS package for i.MX6 - Kernel version 3.0.35.
- OneBox-Mobile Software Release package.

27.2.3 Hardware Setup

The steps for Hardware Setup are as follows:

1. Connect the i.MX6 board to the Linux PC by using the USB-to-microUSB cable – the cable has to be connected to port J26 (microUSB) of the board.
2. Connect the Redpine Evaluation Board (EVB) to the i.MX6 board by using the SDIO adaptor or USB-to-microUSB cable (both are included in the Redpine Evaluation Kit), depending on which Host Interface is needed.

- i.MX6 + Redpine EVB with USB: Connect USB cable to J10 (USB) port of i.MX6
- i.MX6 + Redpine EVB with SDIO: Connect SDIO Adapter to SD3 port of i.MX6

1. Preparing the MMC Card: It is an SD/MMC memory card which is required to transfer the bootloader and kernel images for initializing the partition table and copy the root file system. This is included in the i.MX6 Evaluation Kit but it is programmed for Android OS.

Refer to the i.MX_6SoloLite_EVK_Linux_User's_Guide.pdf document provided by Freescale as a part of the **L3.0.35_4.1.0_LINUX_MMDOCS** documentation package in order to prepare the SD/MMC card for Linux OS with kernel version 3.0.35.

27.2.4 Cross Compile and Copy OneBox-Mobile Software

If the OneBox-Mobile software's source is available, follow the steps mentioned in the **Compiling the Driver** section in order to cross compile the OneBox-Mobile software for i.MX6.
Assign the DEF_KERNEL_DIR variable in the Makefile as follows (assuming the kernel source is available in the "/lib/modules" folder):

DEF_KERNEL_DIR:= /lib/modules/linux-3.0.35_SOLOLITE_hw
The **"make"** command for the i.MX6 is as follows, assuming the toolchain is present in the **"/toolchain/opt/freescale"** folder:

```
make ARCH=arm
CROSS_COMPILE=/toolchain/opt/freescale/FWIOCUA0R1M1P1/TOOLS/cross/bin/arm-mv5sft-
linux-gnueabi-
```

Next, plugin the SD/MMC card to the PC and copy the pre-built binaries or the binaries generated above to the SD/MMC card.
Plugin the SD/MMC card into the i.MX6 board and follow the boot procedure. Once the bootup and login are completed, go to the **release** folder and follow the procedure explained in the **Installing the Driver** section.

27.3 Freescale i.MX53

27.3.1 Hardware Requirements

- IMX53QSB: i.MX53 Quick Start Board. The kit contents are as follows:

1. i.MX53-QUICK START Board
2. microSD Card preloaded with Ubuntu Demonstration Software
3. USB Cable (Standard-A to Micro-B connectors)
4. 5V/2.0A Power Supply
5. Quick Start Guide
6. Documentation DVD
7. Linux PC with Serial port – this will be used to communicate with the processor platform.
8. Serial RS232 Cable

27.3.2 Software Requirements

The software requirements Free scale i MX53 platform are as follows:

- Toolchain, BSP and Linux OS package for i.MX6 - Kernel version 2.6.35.
- OneBox-Mobile Software Release package
- minicom/GTKTerm on the Linux PC

27.3.3 Hardware Setup

The hardware setup is as follows:

1. Connect the i.MX53 board to the Linux PC using the Serial RS232 cable.
2. Connect the Redpine Evaluation Board (EVB) to the i.MX53 board using the SDIO adaptor or USB-to-microUSB cable (both included in the Redpine Evaluation Kit), depending on which the Host Interface is needed.
3. Open a serial terminal program like minicom or GTKTerm and configure it with the following settings:
    a. Baud Rate: 115200
    b. Data bits: 8
    c. Stop bits: 1
    d. Parity: None
    e. Flow Control:
4. Preparing the MMC Card: An SD/MMC memory card is required to transfer the bootloader and kernel images for initializing the partition table and copy the root file system. This is included in the i.MX53 Evaluation Kit. Refer to the i.MX53_EVK_Linux_BSP_UserGuide.pdf document provided by Freescale as a part of the **IMX53_1109_LINUXDOCS_BUNDLE** documentation package, in order to prepare the SD/MMC card for Linux OS with kernel version 2.6.35.

27.3.4 Cross Compile and Copy OneBox-Mobile Software

If the OneBox-Mobile software's source is available, follow the steps mentioned in the section **Compiling the Driver** in order to cross compile the OneBox-Mobile software for i.MX53.
Assign the **DEF_KERNEL_DIR** variable in the Makefile as follows (assuming the kernel source is available in the **"/lib/modules"** folder):
DEF_KERNEL_DIR := /lib/modules/linux-2.6.35.3
The **"make"** command for the i.MX53 is as follows:

```
make ARCH=arm CROSS_COMPILE=/toolchain/opt/freescale/usr/local/gcc-4.4.4-glibc-2.11.1-
multilib-1.0/arm-fsl-linux-gnueabi/bin/arm-none-linux-gnueabi-
```

Next, plugin the SD/MMC card to the PC and copy the pre-built binaries or the binaries generated above to the SD/MMC card.
Plugin the SD/MMC card into the i.MX53 board and follow the boot procedure. Once the bootup and login are completed, go to the **release** folder and follow the procedure explained in the section 4 **Installing the Driver**.

27.4 Atmel AT91SAM9G45 and AT91SAM9M10

The Linux kernel version used on the Atmel AT91SAM9G45/M10 is 2.6.30. This is used to verify only the Wi-Fi mode. Bluetooth and ZigBee drivers are not compatible with this kernel version.

27.4.1 Hardware Requirements

- SAM9M10-G45-EK - ARM926-based eMPU Eval Kit. The kit contents are as follows:

1. Board: SAM9M10-G45-EK
2. Cables: One micro A/B-type USB cable, One serial RS232 cable, One RJ45 crossed cable
3. Power supply: Universal input AC/DC power supply, One 3V Lithium Battery type CR1225
4. Linux PC with Serial port – Used to communicate with the processor platform

27.4.2 Software Requirements

The software requirements for Atmel AT91SAM9G45 and AT91SAM9M10 platform are as follows:

- Toolchain, BSP and Ubuntu Linux OS package for AT91SAM9G45 and AT91SAM9M10 - Kernel version 2.6.30
- OneBox-Mobile Software Release package
- minicom/GTKTerm on the Linux PC

27.4.3 Hardware Setup

The hardware setup is as follows:

1. Connect the Atmel board to the Linux PC using the Serial RS232 cable.
2. Connect the Redpine Evaluation Board (EVB) to the processor board using the SDIO adaptor or USB-to-microUSB cable (both included in the Redpine Evaluation Kit), depending on which Host Interface is needed.
3. Power on the processor board.
4. Open a serial terminal program like minicom or GTKTerm and configure it with the following settings:

- Baud Rate: 115200
- Data bits: 8
- Stop bits: 1
- Parity: None
- Flow Control:

1. Connect the RJ45 cable between the PC and the board.
2. Follow the instructions given at **http://www.at91.com/linux4sam/bin/view/Linux4SAM/GettingStarted** in order to setup the board with the Linux OS kernel version 2.6.30.

27.4.4 Cross Compile and Copy OneBox-Mobile Software

If the OneBox-Mobile software's source is available, follow the steps mentioned in the section **Compiling the Driver** in order to cross compile the OneBox-Mobile software for the Atmel processor.
Assign the **DEF_KERNEL_DIR** variable in the Makefile as follows (assuming the kernel source is available in the **"/lib/modules"** folder):
DEF_KERNEL_DIR := /lib/modules/linux-2.6.30

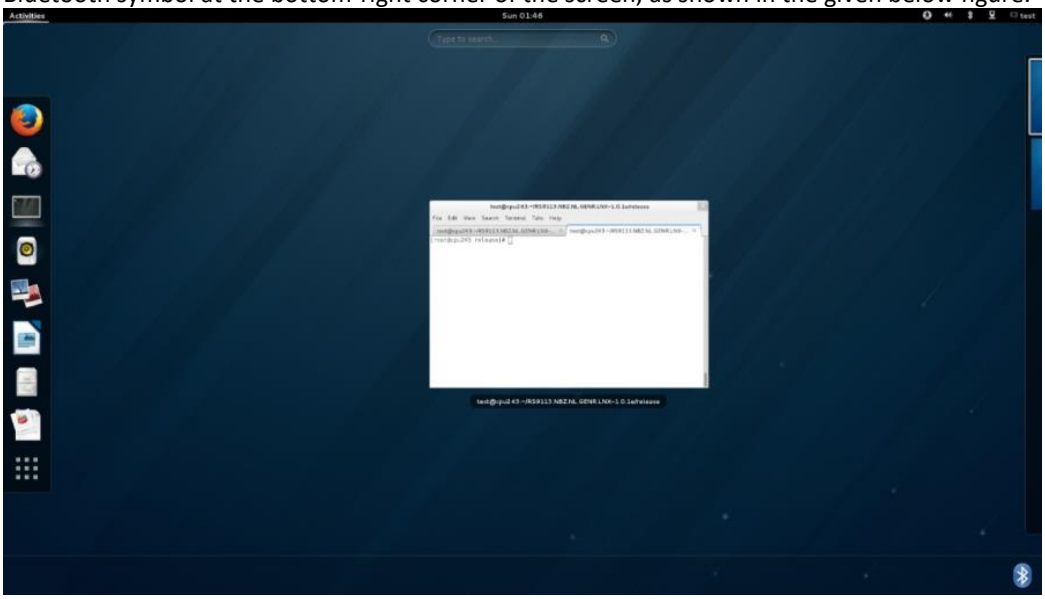
The **"make"** command for the **AT91SAM9G45/M10** is as follows, assuming the toolchain is present in the **"/toolchain/opt/atmel"** folder:

```
make ARCH=arm CROSS_COMPILE=/toolchain/opt/atmel/arm-2007q1/bin/arm-none-linux-
gnueabi-
The steps need to be followed inorder to copy the pre-built binaries or the binaries
generated above the Atmel processor platform are as follows:

Ensure that the Linux PC and the Atmel platform are in the same subnet. The IP of the
processor platform can be assigned using the minicom/GTKTerm terminal.

ifconfig <vap_name> <ip_address>
Example: ifconfig eth0 192.168.1.24

Power cycle the board.

Login as "root". There is no password required for the default credentials unless and
until some changes has been done by the user.

Create a folder called "rsi" in the "/home" folder.

Copy the OneBox-Mobile binaries by using the command below:

scp –r release/ root@192.168.1.24:/home/rsi
```

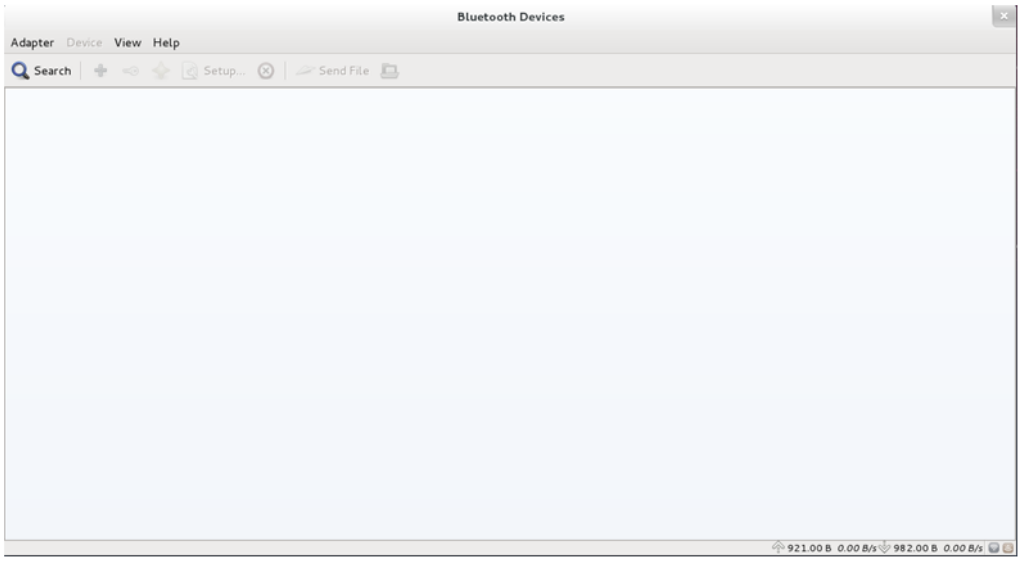
Follow the procedure explained in the section **Installing the Driver** in order to start using the OneBox-Mobile software.

28 Appendix C: Using the Bluetooth Manager

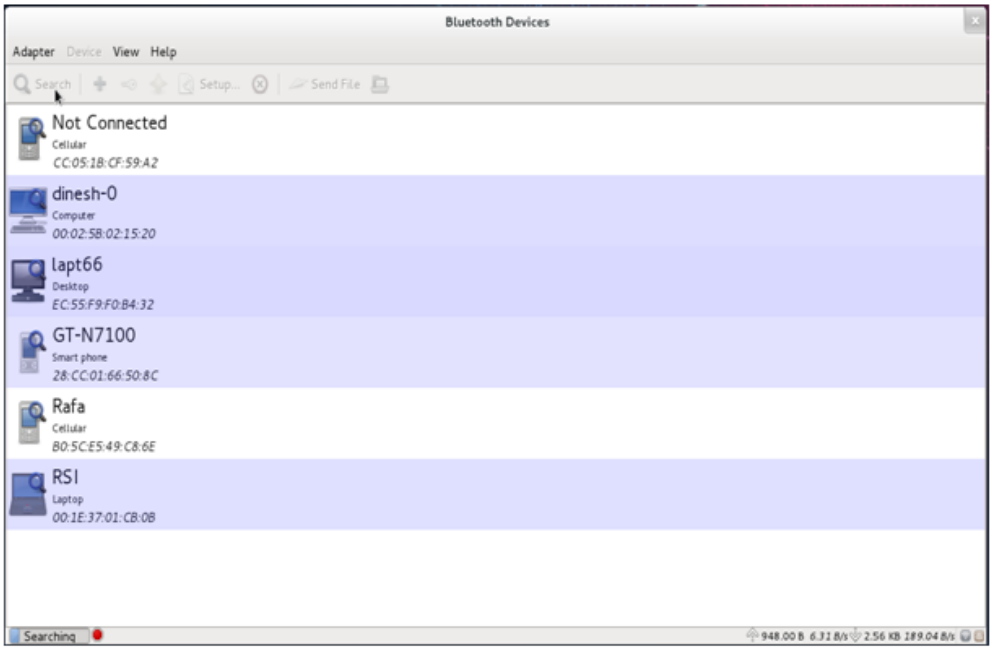
The steps given below explain about the usage of the Bluetooth Manager in Fedora Core 18 on an x86 platform for pairing Bluetooth devices and transferring files.
Once the Bluetooth modules have been installed using **wlan_bt_insert.sh** or **onebox_insert.sh** script present in the **"release"** folder as per the instructions mentioned in **Section 4.1,** hit the "Windows" button on the keyboard. You will see Bluetooth symbol at the bottom-right corner of the screen, as shown in the given below figure.



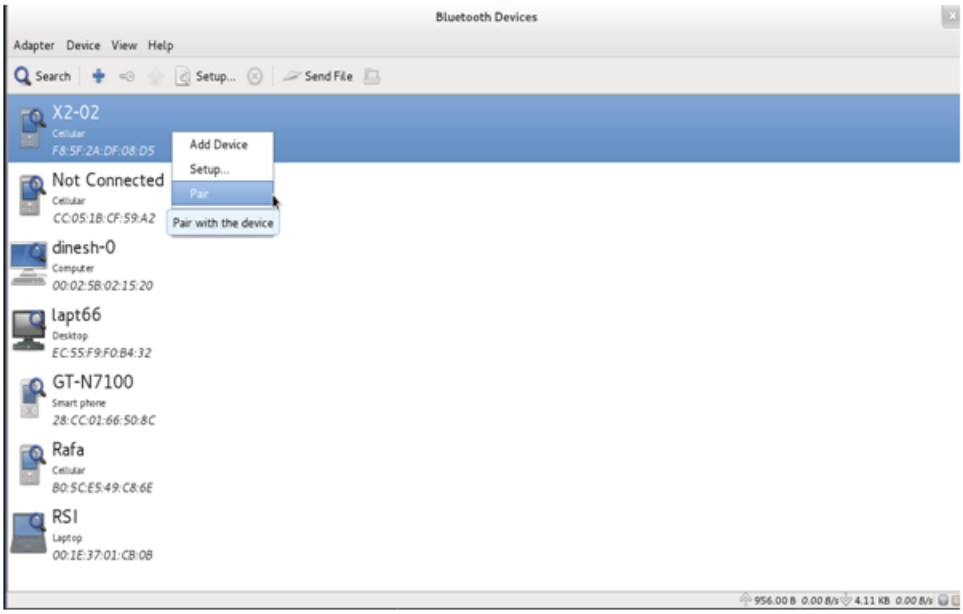
This will open the Bluetooth Manager as shown in the figure below:



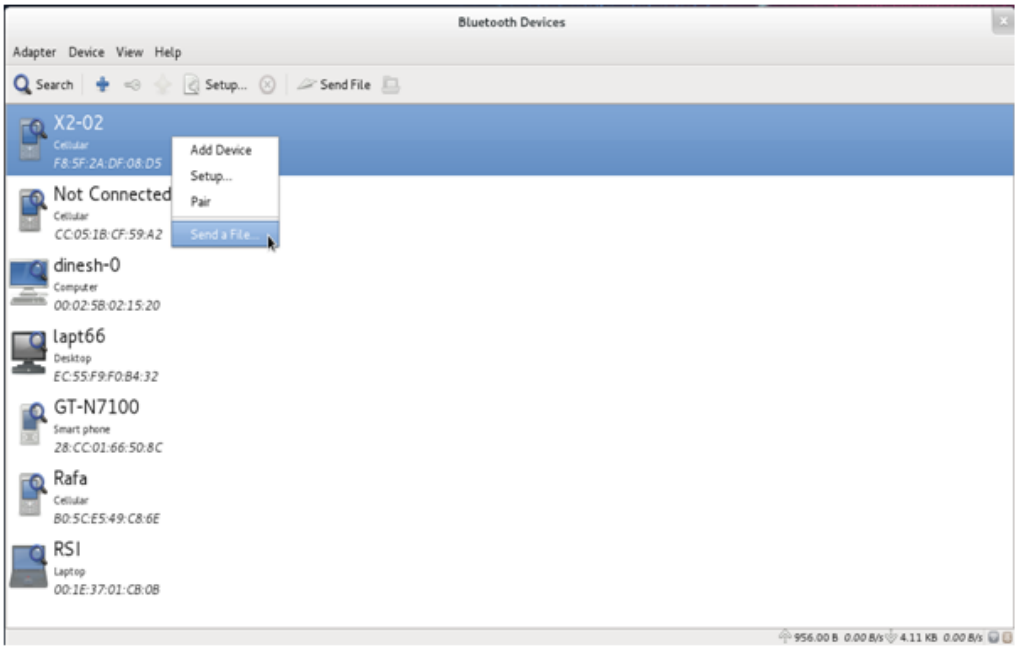
Click on **Search** in order to start inquiry.



Select the particular device, like your smartphone, right click and select **Pair** tab to pair with that device.



After successfully pairing with the device, right-click on the device and select **"Send a file"** button in order to send data to the device. You will be presented with a dialog box to select the file that you wish to send.


Bluetooth Devices
Adapter Device View Help
Search
Setup...
Send File
X2-02
Cellular
F8:5F:2A:DF:08:D5
Add Device
Setup...
Pair
Send a File...
Not Connected
Cellular
CC:05:1B:CF:59:A2
dinesh-0
Computer
00:02:5B:02:15:20
lapt66
Desktop
EC:55:F9:F0:B4:32
GT-N7100
Smart phone
28:CC:01:66:50:8C
Rafa
Cellular
B0:5C:E5:49:C8:6E
RSI
Laptop
00:1E:37:01:CB:0B
956.00 B 0.00 B/s 4.11 KB 0.00 B/s

29 Appendix D: Common Configuration Parameters

The common_insert.sh script is used to configure parameters at boot time. The parameters with their usage and input values are described below.

29.1 RF Power Mode parameter

The RF Power Mode parameter is used to set the power mode at which the RF operates. It is applicable for each protocol. By default, it is set to high power TX and high power RX. The following are the possible configurable values:

- 0x00 - For Both TX and RX High Power
- 0x11 - For Both TX and RX Medium Power
- 0x22 - For Both TX and RX LOW Power
- 0x10 - For High Power TX and Medium RX Power
- 0x20 - For High Power TX and LOW RX Power
- 0x01 - For Medium TX and RX High Power
- 0x21 - For Medium Power TX and LOW RX Power
- 0x02 - For Low Power TX and RX High Power
- 0x12 - For LOW Power TX and Medium RX Power

WLAN_RF_PWR_MODE is used to set the rf power mode for WLAN protocol.
BT_RF_PWR_MODE is used to set the rf power mode for Bluetooth protocol.
ZB_RF_PWR_MODE is used to set the rf power mode for Zigbee protocol.

Example:
WLAN_RF_PWR_MODE=0x00
The above sets high TX and high RX power for WLAN.
BT_RF_PWR_MODE=0x00
The above sets high TX and high RX power for Bluetooth.
ZIGB_RF_PWR_MODE=0x00
The above sets high TX and high RX power for Zigbee.

29.2 Country selection

This parameter is used to set the module in a specific country. This is set commonly across all protocols. The following country codes are applicable.

- 0 - World Domain
- 840 - US Domain Maps to US Region
- 276 - Germany Maps to EU Region
- 392 - Japan Maps to Japan Region

Example:
SET_COUNTRY_CODE=0
The above sets the module in the world domain.

In the NL80211 mode priority is given for the country code from "sta_settings /hostapd.conf / iw" than the country code from common_insert.sh. It is recommended to use same country code in all inputs to avoid confusion.

29.3 Antenna selection

This variable is used to select the antenna to be used. The following are the possible values:

- 2 – Select internal antenna
- 3 – Select external antenna

Example:
ANT_SEL_VALUE=2
The above line selects the internal antenna. The Operation starts on this antenna.

> If antenna diversity selection feature is also enabled, initial operation will start on the antenna selected. Antenna diversity operation will continue as expected.

29.3.1 COEX Mode selection

This variable is used to select the Coex mode in which the module has to operate. The following are the possible values:

- 1 - WLAN STATION /WIFI-Direct/WLAN PER
- 2 - WLAN ACCESS POINT (including multiple APs on different vaps)
- 3 - WLAN ACCESS POINT + STATION MODE (on multiple vaps)
- 4 - BT CLASSIC MODE/BT CLASSIC PER MODE
- 5 - WLAN STATION + BT CLASSIC MODE
- 6 - WLAN ACCESS POINT + BT CLASSIC MODE
- 8 - BT LE MODE /BT LE PER MODE
- 9 - WLAN STATION + BT LE MODE
- 12 - BT CLASSIC + BT LE MODE
- 13- WLAN STATION + BT CLASSIC MODE+ BT LE MODE
- 14 - WLAN ACCESS POINT + BT CLASSIC MODE+ BT LE MODE
- 16 - ZIGBEE MODE/ ZIGBEE PER MODE
- 17 - WLAN STATION + ZIGBEE
- 32 - ZIGBEE COORDINATOR
- 48 - ZIGBEE ROUTER

Example:
COEX_MODE=3
The above line sets the module to operate in WLAN AP + STA concurrent mode.

29.3.2 BT RF Type

This variable is used to select the BT RF TYPE which the module has to operate. The following are the possible values:
0 - EXTERNAL RF
1 - INTERNAL RF

Example:
BT_RF_TYPE=1
The above sets bt rf type to Internal RF.

29.3.3 BLE_TX_PWR_INX

This variable is used to select the BLE_TX _PWR index value.The following are the possible values.
Default Value for BLE Tx Power Index is 30
Range for the BLE Tx LP Chain Power Index is 1 - 63 (0, 32 are invalid)
Range for the BLE Tx HP Power Index is 64 to 76
BLE_TX_PWR_INX=0x1e

29.3.4 BLE_PWR_SAVE_OPTIONS

BLE_PWR_SAVE_OPTIONS=2
This variable is used to select the BLE_PWR_SAVE_OPTIONS mode value.The following are the possible values.
BLE_DUTY_CYCLING BIT(0)

BLR_DUTY_CYCLING BIT(1)
BLE_PWR_SAVE_4X_MODE BIT(2)

30 Appendix E: Installation of Missing Generic Netlink Libraries

libnl CFlags should be enabled with CONFIG_LIBNL32=y in supplicant and hostpad .config file \[The above configuration settings should be set to "y" in case NL80211 is used\]. Make sure that the NL80211 support and Hostapd support are enabled in the menuconfig during compilation.

Create a directory in the location where Tool chain and BSP are present

```
mkdir build
```

Download the libnl 3.2.xx.tar.gz\[Referring 3.2.27.tar.gz as an example here \] library and extract it in the build directory.

```
cd build

tar xvf 3.2.27.tar.gz
```

Configure the libnl library for target platfrom

```
CC=/path to the toochain/bin/arm-linux-gnueabihf-gcc
./configure --host=arm-linux-gnueabihf -prefix=/<complete path to build directory>/
```

Here headers will be installed in ${prefix}/include/libnl3.
Make and install the libraries in the destination directory or else they will be installed in /usr/local/lib and /usr/local/include/libnl folders of host machine by default.
Follow the example given below:

```
make DESTDIR=$(arm-cortex_a8-linux-gnueabihf-gcc -print -/<path to build
directory>/build/)
```

Exporting the path for build directory in the command line or add these flags in the supplicant and hostapd config files under CONFIG_DRIVER_NL80211= y variable.

```
#export LDFLAGS='-L/<path to build directory>/lib/libnl'
OR
CFLAGS += -I/<path to build directory>/include/libnl3
Ex: LIBS += -L/<path to build directory>/lib/libnl
LIBS : Contains a list of additional libraries to pass to the linker command.
```

31 Appendix F: Procedure to use latest supplicant with NL80211 interface

Follow the below steps to use latest supplicant with the NL80211 interface
Download the supplicant from https://w1.fi/wpa_supplicant/
Extract the supplicant using the following command

```
tar xvf wpa_supplicant-2.6.tar.gz

cd wpa_supplicant-2.6/wpa_supplicant

cp defconfig .config
```

Make sure the following parameters are enabled in the supplicant configuration file (.config)

```
CONFIG_DRIVER_NL80211=y CONFIG_BGSCAN_SIMPLE=y
NL80211_CMD_ROAM=y
CONFIG_LIBNL20=y
CONFIG_LIBNL32=y
CONFIG_WPS2=y
CONFIG_p2p=y
CONFIG_BGSCAN=y
```

Save the configuration file and exit
Compile the supplicant using "make" command in the following path

```
$ cd wpa_supplicant-2.6/wpa_supplicant
$ make clean
$ make
```

After successful compilation the supplicant executable will be found in the same path.Copy the supplicant executable to the driver release folder.

```
cp wpa_supplicant RS9116.NXX.NL.XXX.LNX.XXX/source/host/release.
```

31.1 Bgscan and Roaming

To enable Bgscan and Roaming add 'bgscan="simple:10:-45:100" ' in the sta_settings.conf.

31.1.1 Description

wpa_supplicant behavior for background scanning can be specified by configuring a bgscan module. These modules are responsible for requesting background scans for the purpose of roaming within an ESS (i.e., within a single network block with all the APs using the same SSID).
The bgscan parameter uses the below format:
"<bgscan module name>:<module parameters>"
bgscan="simple:<short bgscan interval in seconds>:<signal strength threshold>: <long interval>"

```
ctrl_interface=/var/run/wpa_supplicant
update_config=1
network={
     ssid="REDPINE_AP_CCMP"
     pairwise=CCMP TKIP
     group=CCMP TKIP
     key_mgmt=WPA-PSK
     psk="12345678"
    proto=WPA2 WPA
    bgscan="simple:10:-45:100"
     priority=1
}
```

31.1.2 Configure Connection quality monitoring (cqm) rssi and hysteresis using iw command

To know more about iw tool, refer to the section Configuration Using CFG80211.

```
 $iw dev <devname> cqm rssi <threshold|off> [<hysteresis>]
Set connection quality monitor RSSI threshold.

Example:
$iw dev wlan0 cqm rssi -45 4
```

When finished, execute the commands given in the chapter Wi-Fi ioctl Usage Guide-->>Enable Background Scan and Set Parameters (only in Client mode).
To know more about Background Scan and Set Parameters, refer to the section Background Scan Parameters.

32 Appendix G: Considerations need to be made during hostapd usage

32.1 Parameters updated from hostapd.conf file

The following are the parameters that **will be updated from *hostapd conf*** file instead of using onebox util ioctls.

- **Band Selection**:To enable 40MHz for onebox-mobile AP using hostapd following params must be enabled in hostap.conf file

```
ieee80211n=1
ht_capab=[HT40-] (or) ht_capab=[HT40+]
require_ht=1
wmm_enabled=1
```

Here ht_capab variable must be set as per the channel selected, description regarding this is available in hostap.conf file, set_htconf ioctl will not work in case of hostapd.

- **Hidden ssid**: To disable ssid broadcast in beacons for onebox-mobile AP using hostapd , use following variable in hostapd.conf file.

```
ignore_broadcast_ssid=0
```

Here hide_ssid ioctl will not work in case of hostapd.

- **DTIM Interval**: To set dtim interval in beacons for onebox-mobile AP using hostapd, use following variable in hostapd.conf file.

```
dtim_period=5
```

Here dtim_period iwprivioctl will not work in case of hostapd.

- **SHORT GI**: To enable Short GI using hostapd following params must be enabled in hostap.conf file.

```
ht_capab=[SHORT-GI-20][SHORT-GI-40]
```

Here SHORT-GI iwprivioctl will not work in case of hostapd.

32.2 Paramaeters that will not get updated from hostapd.conf file

- **beacon_int** : Beacon interval can not be set from hostapd.conf file. To change the default beacon interval, one should issue beacon_intvl ioctl before creating VAP itself.

33 RS9116 n-Link Software TRM Revision History

Revision No.	Version No.	Date	Changes
1	v1.0	October 2017	Preliminary version
2	v1.1	January 2018	Formatted the document as per Redpine document standard
3	v1.2	March 2018	Added information related to FW_LOAD_MODE configuration option
4	v1.3	March 2018	Added information related to BGSCAN and ROAMING for NL80211 Driver
5	v1.4	April 2018	1. Added Appendix I page regarding hostapd.conf file usage considerations 2. Added support for GTK offload feature 3. Added support for 802.11R roaming feature 4. Added support for PUF feature 5. Updated the hostapd configuration parameter info 6. Added new parameter(service period length) in uapsd power save params ioctl.
6	v1.5	June 2018	1. Modified AP set channel/frequency command usage in Wi-Fi ioctl Usage Guide section. 2. Updated PER transmit and receive commands in Wi-Fi Performance Test ioctl usage section. 3. Updated info note in Monitor Mode section. 4. Fixed documentation issues. 5. Added information of radius server usage in Enterprise security using CFG80211 section.
7	v1.6	October 2018	1. Added Notes in bgscan ioctl section 2. Added missing info notes in IOCTL section. 3. Added information regarding Country code update from supplicant in NL mode. 4. Fixed documentation issues. 5. Removed ESSID change and modified channel change commands in Wi-Fi ioctl Usage Guide section
8	v1.7	October 2018	1. Updated configuration parameters for WIFI PER mode in Wi-Fi Performance Test ioctl usage.
9	v1.8	October 2018	1. Added Steps to configure 802.11W.
10	V1.9	November 2018	1. Added labelling and statement information for regulatory.