

UM11442

NXP Wi-Fi and Bluetooth Demo Applications User Guide
for i.MX RT Platforms

Rev. 12 – 27 July 2023

User Manual

Document information

Information	Content
Keywords	i.MX RT crossover MCU, i.MX RT products, MX RT1060 EVK board, MCUXpresso SDK, 88W8801-based wireless module, IW416- based wireless module, 88W8987-based wireless module, RTOS image,
Abstract	Provides step-by-step guidance to configure, compile, debug, flash and run the Wi-Fi and Bluetooth sample applications available in the MCUXpresso SDK. It also covers IDE configurations and required tool set up



Revision history

Rev	Date	Description
v.1	20200717	Initial version
v.2	20210110	<p>Modifications:</p> <ul style="list-style-type: none"> Extended the scope to IW416-based modules Table 3: updated Section 1 "About this Document": updated Section 2 "Tool Setup": updated Section 3 "Wi-Fi Sample Applications": updated Section 4 "Useful Wi-Fi APIs": updated Section 3.5 "wifi_test_mode Sample Application": added Section 3.6 "wifi_cert Sample Application": added Section 5 "Bluetooth Classic/Low Energy Application": added Section 6 "Acronyms and abbreviations": added
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v.12	20230727	<p>Modifications:</p> <ul style="list-style-type: none"> • Section 2.3 “IPerf Remote Host Setup”: Updated iPerf version • Table 5: Added macro for IW612, updated SDK version, added foot note for IW612 • Section 3.1.1 “Run a Demo with MCUXpresso IDE”: Updated version • Section 3.1.2 “Run a demo using ARM® GCC”: Updated version

		<ul style="list-style-type: none">• Section 3.1.3 "Run a demo with IAR IDE": Updated version• Section 3.1.4 "Run a demo using Keil MDK/μVision": Updated version• Section 3.1.5.1 "Start-up logs": updated logs• Section 3.1.5.2 "Help command": updated logs• Section 3.1.5.4 "Scan command": updated logs and added new command wlan-scan-channel-gap• Section 3.1.5.6 "Station mode (connect to AP)": new command wlan-get-signal• Section 3.1.5.7 "Start Soft AP": Added new command wlan-set-uap-hidden-ssid• Section 3.1.5.10 "Wi-Fi Host sleep/wowlan": Updated logs• Section 3.1.5.11 "Wi-Fi Cloud Keep Alive": Added new• Section 3.1.5.15 "Roaming based on RSSI event": Added new• Section 3.7 "wifi_wpa_supplicant Sample Application": Added new• Section 4.2 "Enable Host based WPA supplicant Feature for Wi-Fi application": Added new• Table 20: Added macro for IW612• Section 6 "802.15.4 Sample Application": Added new
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1 About this Document

1.1 Purpose and Scope

This document provides the steps to configure, compile, debug, flash and run the Wi-Fi and Bluetooth sample applications available in the MCUXpresso SDK. It also covers IDE configurations and required tool set up.

1.2 Considerations

The i.MX RT is powered by FreeRTOS and the RTOS drivers are added to support the 88W8801, IW416, and 88W8987 NXP-based wireless modules. This document does not include NXP-based wireless modules information, i.MX RT product information, hardware interconnection, board settings, bring-up, IDE setup, SDK download, as these are covered in the [UM11441](#). The user must have i.MX RT platform related IDE and tools installed before going through the given demo process.

1.3 References

Table 1: Reference Documents

Reference Type	Description
User manual	NXP – MCUXSDKGSUG - Getting Started with MCUXpresso SDK (link)
Web page	NXP - Getting Started with Wi-Fi on i.MX RT platforms (link)
User manual	NXP – UM11441 - Getting Started with NXP-based Wireless Modules and i.MX RT Platform Running on RTOS <i>SDK Documents available at SDK_<version>_EVK-<RT-Platform>\docs\wireless</i>
User manual	NXP - MCUXpresso_SDK_WLAN_Driver_Reference_Manual.pdf SDK Documents available at <i>SDK_<version>_EVK-<RT-Platform>\docs\wireless\Wi-Fi</i>
User manual	NXP - Hardware Rework Guide for MIMXRT1060-EVK and AW-AM457-uSD.pdf SDK Documents available at <i>SDK_<version>_EVK-<RT-Platform>\docs\wireless\Wi-Fi.</i>
User manual	SIG - Core Specification (link)
App note	NXP - AN13296 Embedded Wi-Fi Subsystem API Specification v16 - Host driver firmware interface (link)
App note	NXP - AN13612 Overview of 88W8801 Coexistence with External Radios (link)
Android Application	NXP – AwsMusicControl.apk SDK Source: <i>SDK_<PATH>\boards\evkmimxrt1060\edgefast_bluetooth_examples\audio_profile\android_app.</i>
Configuration file	NXP - aws_clientcredential.h SDK Source: <i>SDK_<PATH>\rtos\freertos\demos\include.</i>
Configuration file	NXP - CertificateConfigurator.html SDK Source: <i>SDK_<PATH>\rtos\freertos\tools\certificate_configuration.</i>
Mobile application	NXP - IoT Toolbox Android (IoT Toolbox on Google Play) IoT Toolbox on the APP Store)

2 Tool Setup

2.1 Serial Console Tool Setup

The serial console tool is used to read out the demo application's logs on the computer connected to i.MX RT EVK board.

- Download and install the terminal emulator software such as minicom (Linux or Mac OS) or Tera Term (Windows)
- Use a micro-USB to USB cable to connect i.MX RT1060 EVK board to the host computer running on Linux, Mac OS or Windows.
- Open a terminal emulator program like minicom or Tera term.
- For minicom use following command and configure the below settings for serial console access:

```
# minicom -s

Serial Port Setup:
- /dev/ttyACMX serial port
- 115200 baud rate
- 8 data bits
- No parity
- One stop bit
- No flow control
```

Prior to running the Bluetooth demo application, update the serial console configuration so there is no extra spacing.

For Tera Term:

- Go to Setup > Terminal
- Look for the new line section
- Set the **Receive** to **Auto**

For minicom:

Press **Ctrl + A** and then press **Z** key to open the Help menu

Press the **U** key to add a carriage return

2.2 Wireshark Tool Setup

The Wireshark tool is required to analyze the Wi-Fi sniffer logs. Download and install Wireshark tool for Windows and Mac OS from [here](#).

Steps to install Wireshark tool on a computer running Linux Ubuntu:

```
sudo add-apt-repository ppa:wireshark-dev/stable
sudo apt update
sudo apt install wireshark
```

2.3 IPerf Remote Host Setup

Remote host setup for OS-Linux:

Perform the following steps to complete the setup:

- Download package of IPerf 2.1.9 for Ubuntu 16.04 from [here](#)
- Extract the package

```
$ tar -xzf iperf-2.1.9.tar.gz
```

- Install the package using below commands

```
$ cd iperf-2.1.9
$ ./configure
$ make
$ sudo make install
```

NOTE: Iperf 2.1.9 is used for the demonstration.

- Run the suitable command from the following table.

Table 2: iPerf Commands for Linux Remote Host

Functionality	Command
TCP server	iperf -s -i 1
UDP server	iperf -s -u -i 1
TCP client	iperf -c <server_ip> -i 1 -t 60
UDP client	iperf -c <server_ip> -u -i 1 -t 60

Remote host setup for mobile phone:

Perform the following steps to run the iPerf:

- Download the iPerf application like Magic iPerf, HE.NET Network Tools etc.
- Open the application and select the iperf2. Run the suitable from the following table.

Table 3: iPerf Commands for Mobile Phone Remote Host

Functionality	Command
TCP server	-s -i 1
UDP server	-s -u -i 1
TCP client	-c <server_ip> -i 1 -t 60
UDP client	-c <server_ip> -u -i 1 -t 60

2.4 IPv4/6 Tool Setup

Remote host setup:

- ncat - Recommended tool. Supports both IPv4 and IPv6. It is part of nmap tools. It can be found at <https://nmap.org/download.html>.
- nc (netcat) - Basically, the same as ncat, but a lot of antivirus consider this a virus.
- echotool - Supports only IPv4 and only for Windows. It can be obtained from <https://github.com/PavelBansky/EchoTool>

Zone Index:

- On Windows, the zone index is a number. You can get it from the output of the ipconfig command.
- On Linux, the zone index is an interface name.
- To connect to board with address FE80::12:13FF:FE10:1511,
 - over interface 21 on your Windows machine specify address as FE80::12:13FF:FE10:1511%21
 - over interface eth on your Linux or Mac machine specify address as FE80::12:13FF:FE10:1511%eth0

NOTE: The demo has only a single interface, so do not append zone ID to any address typed to the demo terminal.

3 Wi-Fi Sample Applications

This chapter describes the Wi-Fi example applications that are available in the SDK, and the steps to configure, compile, debug, flash, and execute these examples.

These Wi-Fi examples can be configured based on the Wi-Fi modules used with the help of Wi-Fi module-specific macros.

Table 4 lists the Wi-Fi module specific macros that are common to all Wi-Fi examples. Macros are available in the file `evk<RT-Platform>_wifi_cli\source\app_config.h`

Table 4: Macros for Wi-Fi Modules

Module	Chipset	Macro
AzureWave AW-NM191NF	88W8801	WIFI_88W8801_BOARD_AW_NM191_USD WIFI_88W8801_BOARD_AW_NM191MA
AzureWave AW-AM457	IW416	WIFI_IW416_BOARD_AW_AM457_USD WIFI_IW416_BOARD_AW_AM457MA
AzureWave AW-AM510	IW416	WIFI_IW416_BOARD_AW_AM510_USD WIFI_IW416_BOARD_AW_AM510MA
AzureWave AW-CM358	88W8987	WIFI_88W8987_BOARD_AW_CM358_USD WIFI_88W8987_BOARD_AW_CM358MA
Murata Type 2DS	88W8801	WIFI_88W8801_BOARD_MURATA_2DS_USD ^[1] WIFI_88W8801_BOARD_MURATA_2DS_M2 ^[1]
Murata Type 1XK	IW416	WIFI_IW416_BOARD_MURATA_1XK_USD ^[1] WIFI_IW416_BOARD_MURATA_1XK_M2 ^[1]
Murata 1ZM	88W8987	WIFI_88W8987_BOARD_MURATA_1ZM_USD ^[1] WIFI_88W8987_BOARD_MURATA_1ZM_M2 ^[1]
Murata Type 2EL	IW612	WIFI_IW61x_BOARD_MURATA_2EL_USD ^[2]
EVK-LILY-W131	88W8801	WIFI_88W8801_BOARD_UBX_LILY_W1_USD
EVK-MAYA-W1	IW416	WIFI_IW416_BOARD_UBX_MAYA_W1_USD
EVK-JODY-W2	88W8987	WIFI_88W8987_BOARD_UBX_JODY_W2_USD

[1] The module operation was tested during 2.14.0 release process.

[2] The module operation support is available in the i.MX RT1170 EVKB for the 2.13.2 SDK version only
USD=microSD interface
M2=M.2 interface

3.1 wifi_cli Sample Application

This section describes the *wifi_cli* application to demonstrate the CLI support to handle and enable Wi-Fi configuration for the features including scan the visible access points, create and configure the access point, connection with the access point and Throughput performance check using iPerf measurement tool. The CLI module in the application allows users to add CLIs in the application. In this sample application Wi-Fi connection manager CLIs are available.

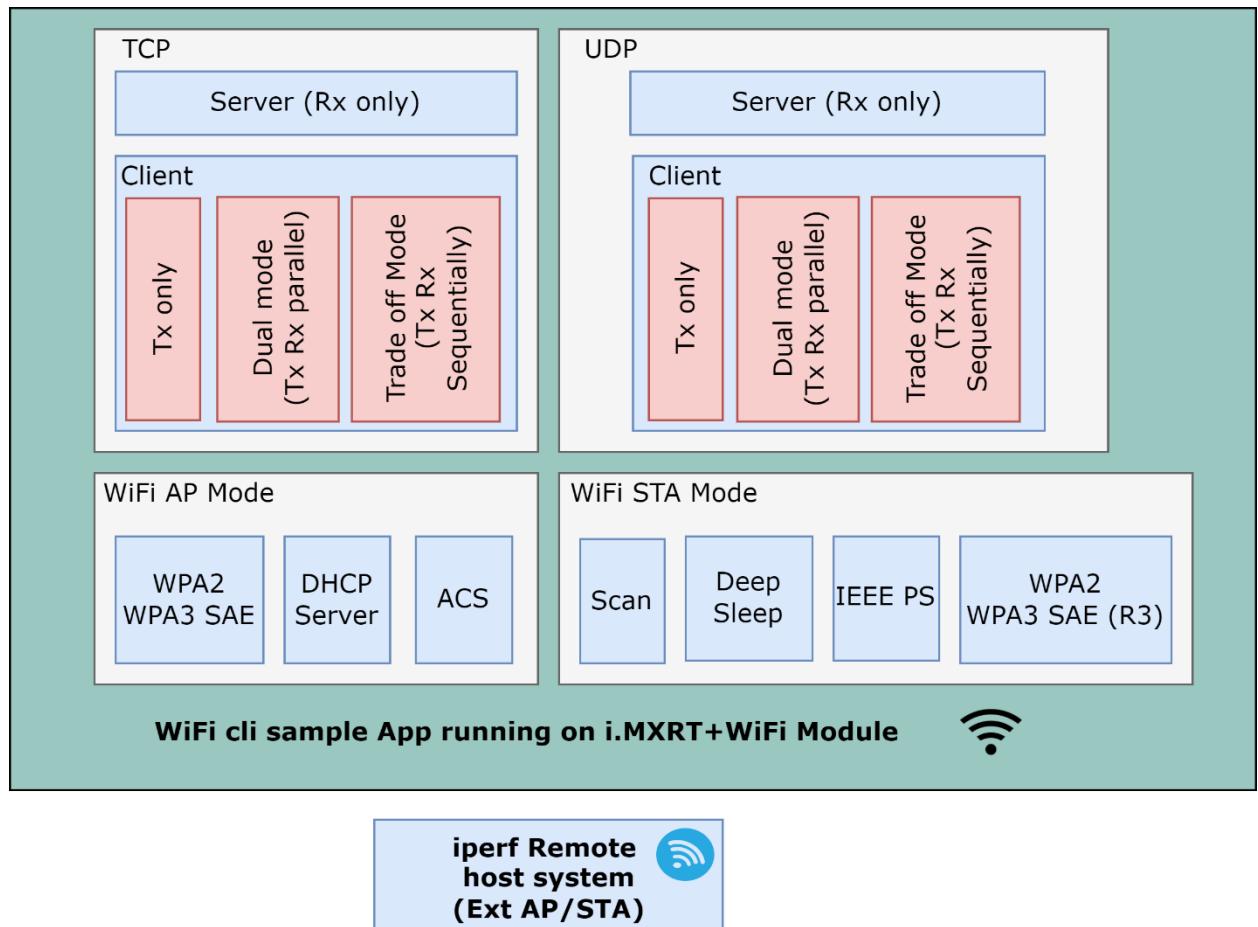


Figure 1: wifi_cli Sample Application Components

Wi-Fi and iPerf Features:

Table 5: Sample Application Features

Features	Details
Wi-Fi	Wi-Fi Soft AP mode Wi-Fi Station mode Wi-Fi Scan Wi-Fi IEEEPS power saving mode Wi-Fi deep-sleep power saving mode Wi-Fi host sleep/wowlan Wi-Fi RF Calibration Wi-Fi coexistence with external radios (for 88W8801) Wi-Fi 11r roaming Wi-Fi Cloud keep alive Wi-Fi Turbo mode
iPerf	TCP Client and Server TCP Client dual mode (Tx and Rx in simultaneous) TCP Client trade-off mode (Tx and Rx individual) UDP Client and Server UDP Client dual mode (Tx and Rx in simultaneous) UDP Client trade-off mode (Tx and Rx individual)

3.1.1 Run a Demo with MCUXpresso IDE

This section describes the steps to import, configure, build, debug and run the demo example through MCUXpresso IDE. MCUXpresso IDE version v11.8.0 is used for the following demo steps.

3.1.1.1 Project Import**Step 1: SDK Installation**

- Open MCUXpresso IDE.
- Locate the **Installed SDKs** tab at the bottom of the following image.
- Drag and drop the SDK into the **Installed SDKs** tab. Once done click “OK” on the pop-up window.

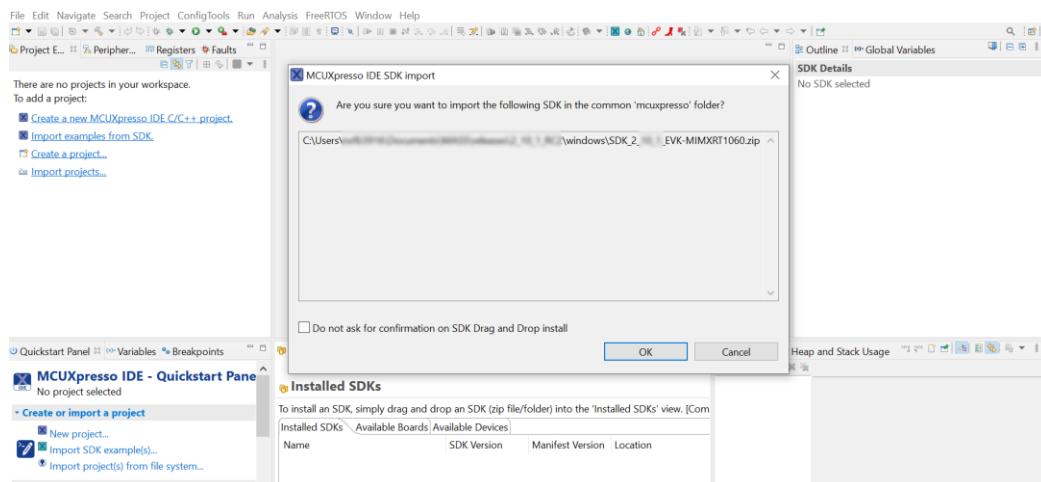


Figure 2: SDK Drag and Drop in MCUXpresso

Step 2: Import an example

- Go to the **Quickstart** panel and select the option **Import SDK example(s)**.



Figure 3: SDK Import Example in MCUXpresso

Step 3: Select EVK board.

- Select the evaluation board.

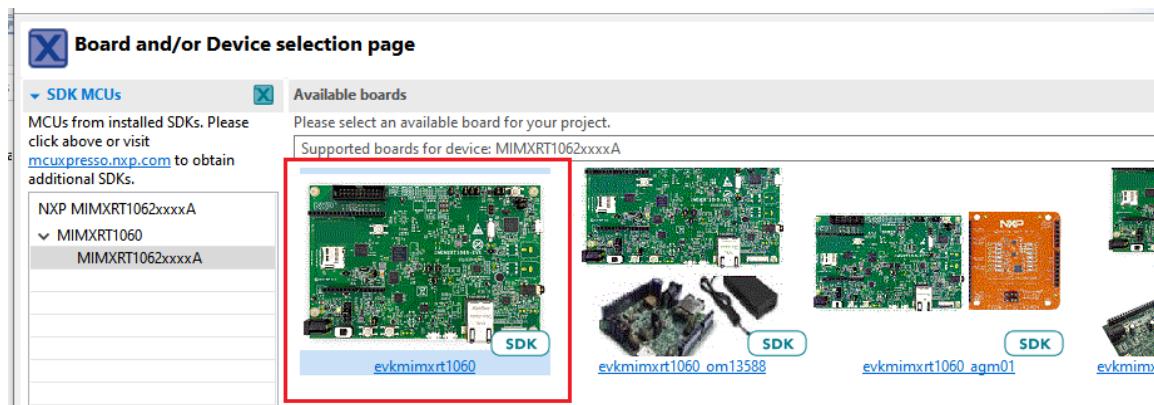


Figure 3: Device/EVK Selection in MCUXpresso

Step 4: Select any Wi-Fi or Bluetooth example and verify default Project Options.

- For example, select wifi_examples > wifi_cli and press **Finish** button to import the selected example into the workspace.

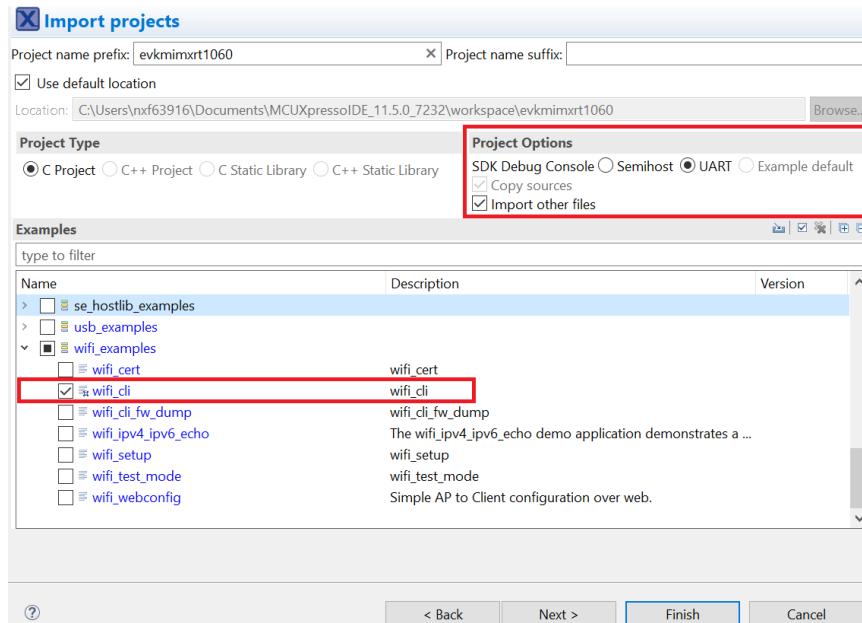


Figure 4: Sample App Selection in MCUXpresso

3.1.1.2 Project Settings

- By default, the project is configured to use the **WIFI_IW416_BOARD_MURATA_1XK_USD** Wi-Fi module based on IW416 chipset. Modify the value to match the module on your setup to include and compile the desired driver, components and application(s).
- The file "**app_config.h**" from the source folder is used for the macro definitions.
- Refer to Table 4 for the list of macros for Wi-Fi modules.



```

Project... × Regis... Faults Perip...
evkmimxrt1060_wifi_cli <Debug>
  Project Settings
  Includes
  CMSIS
  board
  component
  device
  drivers
  freertos
  linkscripts
  lwip
  sdmmc
  source
    app_config.h
    FreeRTOSConfig.h
    lwipopts.h
    lwipools.h
main.c × app_config.h ×
All rights reserved.
4 *
5 * SPDX-License-Identifier: BSD-3-Clause
6 */
7
8 */
9 * Supported Wi-Fi boards (modules):
10 * WIFI_88W8801_BOARD_AW_NM191_USD
11 * WIFI_IW416_BOARD_AW_AM457_USD
12 * WIFI_IW416_BOARD_AW_AM518_USD
13 * WIFI_88W8987_BOARD_AW_CM358_USD
14 * WIFI_88W8801_BOARD_MURATA_2DS_USD
15 * WIFI_IW416_BOARD_MURATA_1XK_USD
16 * WIFI_88W8987_BOARD_MURATA_1ZM_USD
17 * WIFI_88W8801_BOARD_UBX_LILY_W1_USD
18 * WIFI_88W8987_BOARD_UBX_JODY_W2_USD
19 * WIFI_IW416_BOARD_UBX_MAYA_W1_USD
20 */
21 /* @TEST_ANCHOR */
22 #define WIFI_IW416_BOARD_MURATA_1XK_USD
23 /* @END_TEST_ANCHOR */
24

```

Figure 5: Wi-Fi Module Selection in MCUXpresso

3.1.1.3 Build the Application

- To build the application, go to the **Quickstart** panel and select **Build**, or select the **Build** icon in the main toolbar.

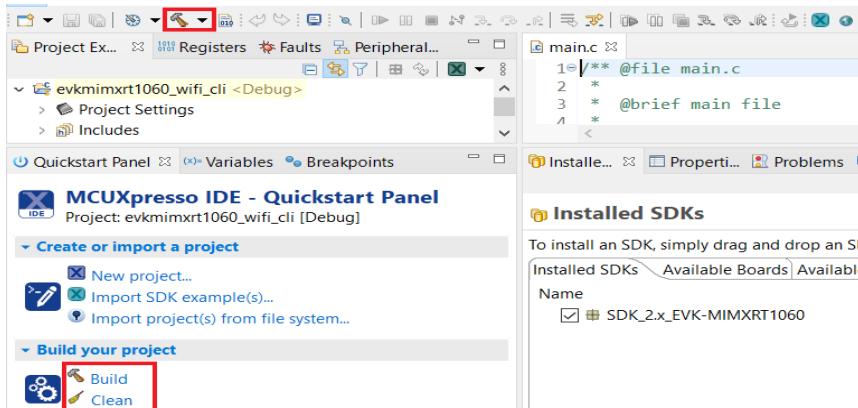
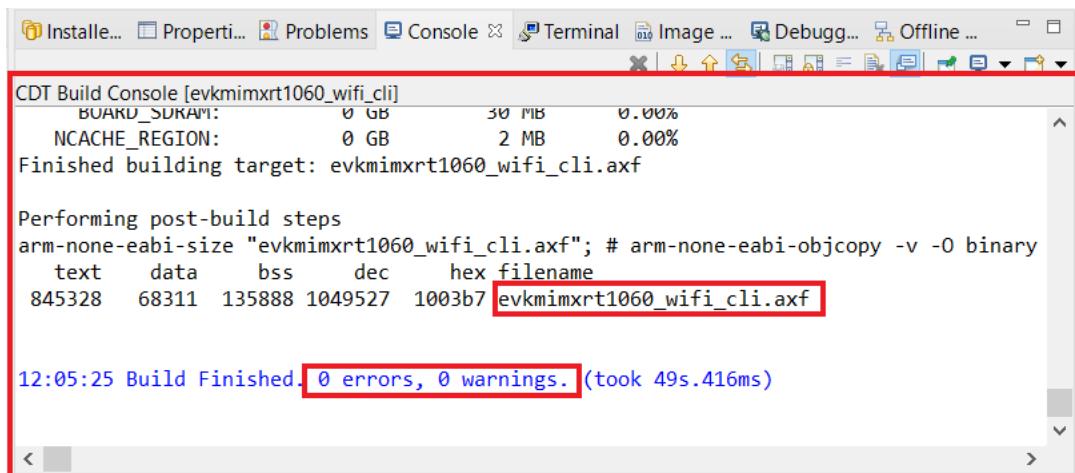


Figure 6: Application Build in MCUXpresso

- Verify the build result (success or fail) on the console window.



```

CDT Build Console [evkmimxrt1060_wifi_cli]
BOARD_SDRAM: 0 GB 30 MB 0.00%
NCACHE_REGION: 0 GB 2 MB 0.00%
Finished building target: evkmimxrt1060_wifi_cli.axf

Performing post-build steps
arm-none-eabi-size "evkmimxrt1060_wifi_cli.axf"; # arm-none-eabi-objcopy -v -O binary
text data bss dec hex filename
845328 68311 135888 1049527 1003b7 evkmimxrt1060_wifi_cli.axf

12:05:25 Build Finished. 0 errors, 0 warnings. (took 49s.416ms)

```

Figure 7: Build Messages in MCUXpresso

3.1.1.4 Run the Application in Debug Mode

Please follow these steps to run the application in debug mode.

- Initiate the application debug using the debug icon in the toolbar or go to the **Quickstart** panel and select **Debug**.

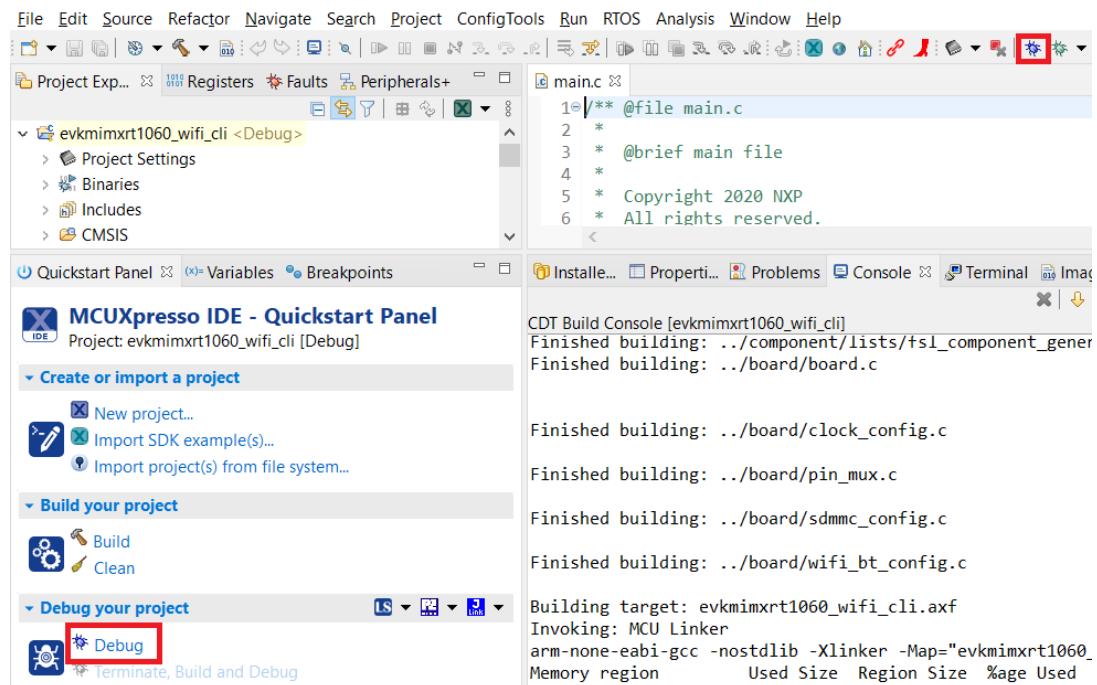


Figure 8: Initiate Debug in MCUXpresso

- Select the associated emulator probe for the first time as illustrated below and press **OK**.

Connect to target: MIMXRT1062xxxxA

1 probe found. Select the probe to use:

Available attached probes

Name	Serial number / ID / Nickname	Type	Manufacturer	IDE Debug Mode
LS CMSIS-DAP	02290000129469d90000000000...	LinkServer	ARM	Non-Stop

Supported Probes (tick/uncheck to enable/disable)

- MCUXpresso IDE LinkServer (inc. CMSIS-DAP) probes
- P&E Micro probes
- SEGGER J-Link probes

Probe search options

 Remember my selection (for this Launch configuration)

OK

Cancel

Figure 9: Emulator Probe Selection in MCUXpresso

- Upon selecting the probe, the application is downloaded on the board and the program execution starts with the program counter set at the main() function. Press **Resume** to start the application. To debug the application, use the **step into**, **step over** and **step return** buttons. To end the debugging session, use the **Terminate** button.

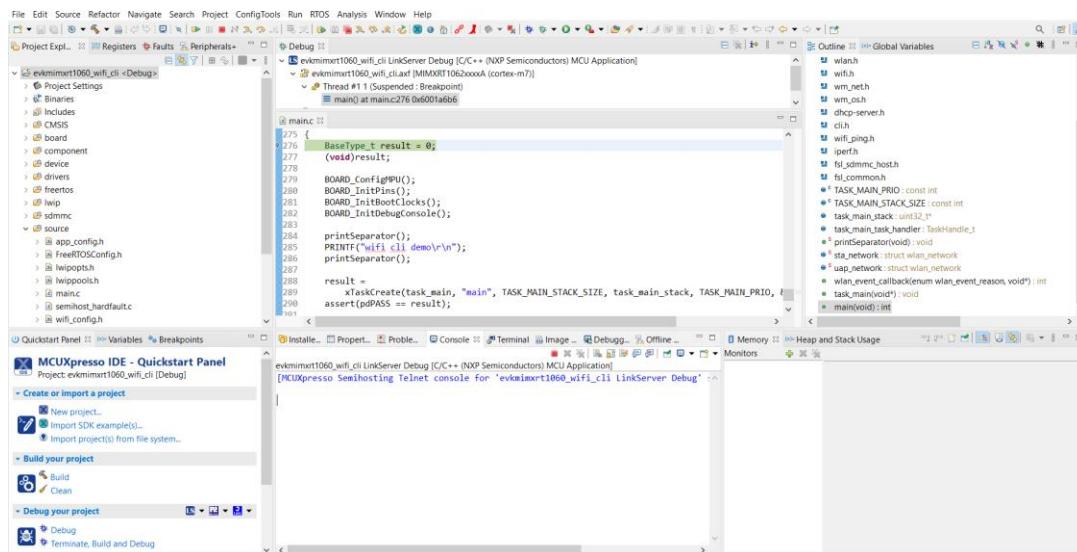


Figure 10: Application Debugging in MCUXpresso

3.1.1.5 Flash the Application Program (no debugging)

Please use the following steps to flash the application program.

To flash the required binaries, select the **GUI Flash Tool icon** in the toolbar as shown in the figure below. The GUI Flash Tool can be used to flash pre-build binary or locally compiled binary with *.axf or *.bin format. The path to the locally compiled binary is the following.

`${workspace_loc}\evkmimxrt1060_wifi_cli\Debug\evkmimxrt1060_wifi_cli.axf`

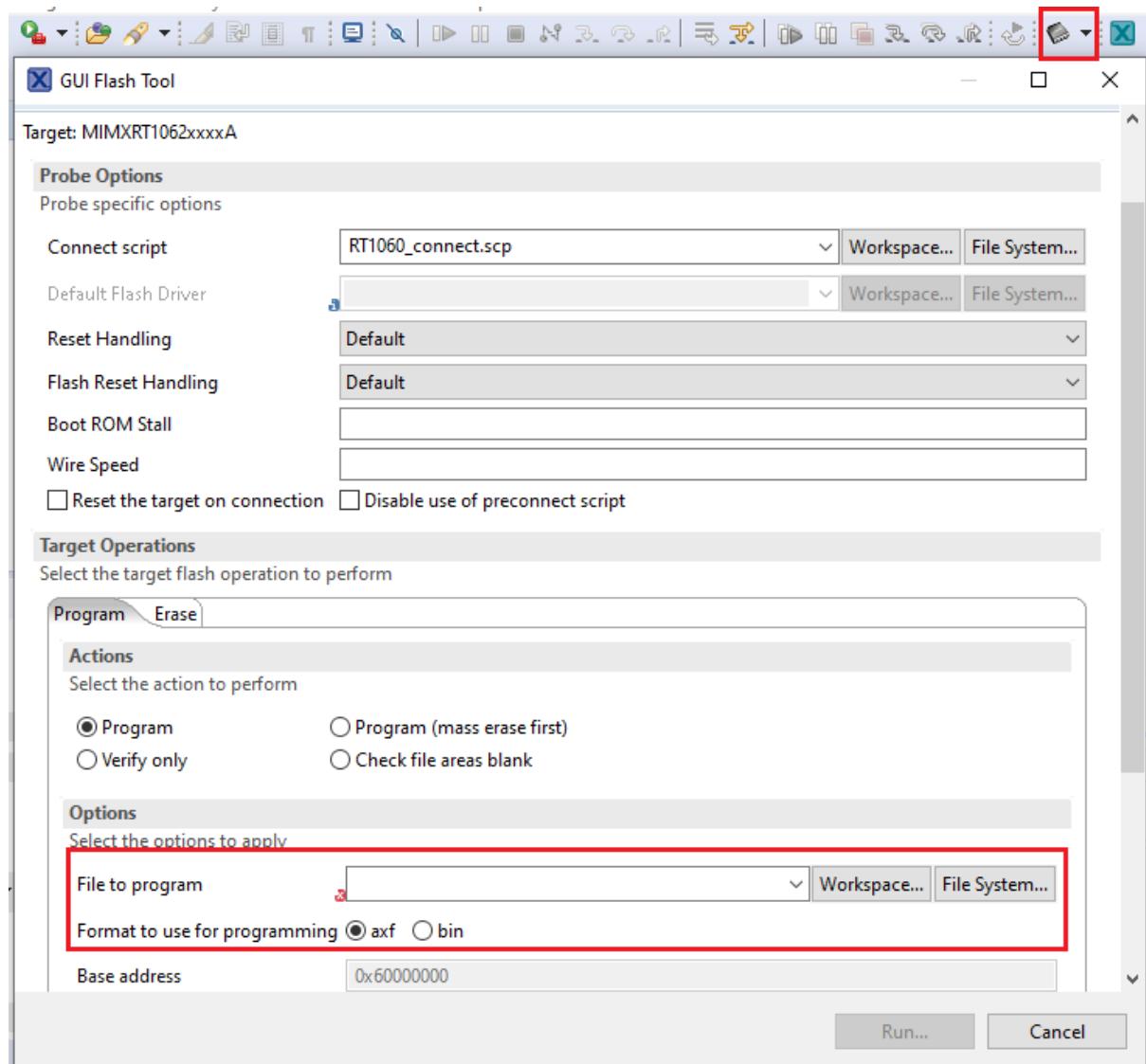


Figure 11: Binary Flashing in MCUXpresso

NOTE: Please refer to section 3.1.5 to view the output on the console once the application is executed.

3.1.2 Run a demo using ARM® GCC

This section describes the steps to configure the command line ARM® GCC tools to build and run demo applications. The wifi_cli application is used as an example, yet the same steps apply to any other example application available with the MCUXpresso SDK. The example uses Linux, one of the operating systems that ARM GCC tools support. Please refer to [MCUXSDKGSUG](#) for more details on ARM GCC toolchain setup.

3.1.2.1 Install ARM® GCC toolchain

In this section, the following steps are given to install toolchain:

- Download the toolchain for Linux x86_64 system from the [Link](#) (package *Linux x86_64 tarball*).
- Create a directory at the location of your choice:

```
$ mkdir toolchain-dir
```

- Copy the downloaded toolchain package to the created directory and extract the downloaded toolchain.

```
$ cp <download_path>/arm-gnu-toolchain-12.2.rel1-x86_64-arm-none-eabi.tar.xz  
toolchain-dir/  
$ cd toolchain-dir/  
$ tar -xvf arm-gnu-toolchain-12.2.rel1-x86_64-arm-none-eabi.tar.xz
```

- Export the ARMGCC_DIR variable using the following command:

```
$ export ARMGCC_DIR=<absolute-path>/toolchain-dir/ arm-gnu-toolchain-12.2.rel1-  
x86_64-arm-none-eabi/
```

- Add the toolchain path to the **PATH** environment variable using the command:

```
$ export PATH=$PATH:<absolute-path>/toolchain-dir/arm-gnu-toolchain-12.2.rel1-  
x86_64-arm-none-eabi /bin/
```

- Download and install *cmake* (source and binary distribution) using the [Link](#) for Linux system.
- Extract the source distribution and copy it to the */usr/share*/directory

```
$ tar -zxf cmake-3.25.1.tar.gz  
$ sudo cp -rf cmake-3.25.1 /usr/share/cmake-3.25  
• Extract the binary distribution and copy the binaries to the /usr/bin/directory
```

```
$ tar -zxf cmake-3.25.1-Linux-x86_64.tar.gz  
$ sudo cp cmake-3.25.1-Linux-x86_64/bin/* /usr/bin/
```

3.1.2.2 Build the application

This section provides the steps to build the application using the ARM GCC toolchain:

- Go to the `armgcc` directory of the application

```
$ cd <SDK-top-dir>/boards/evkmimxrt1060/wifi_examples/wifi_cli/armgcc/
```

Modify the configuration for a wireless module

- By default, the project is configured to use the `WIFI_IW416_BOARD_MURATA_1XK_USD` Wi-Fi module based on IW416 chipset. Modify the value in the file “`<SDK_EXAMPLE_PATH>/source/app_config.h`” to match the module on your setup to include and compile the desired driver, components and application(s).
- Build the binary

```
$ sh build_flexspi_nor_debug.sh
[100%] Linking C executable flexspi_nor_debug/wifi_cli.elf
[100%] Built target wifi_cli.elf
```

- Generate `wifi_cli.bin` using following command

```
arm-none-eabi-objcopy flexspi_nor_debug/wifi_cli.elf -O binary
flexspi_nor_debug/wifi_cli.bin
```

NOTE: Please refer to [MCUXSDKGSUG](#) for more details to debug the application using GDB.

3.1.2.3 Flash the application program (no debugging)

This section provides the steps to flash the binary on the i.MX RT board:

- Connect the board to the Linux host system. The board shows as a Mass storage device in the Linux host system.
- Copy the application binary (`wifi_cli.bin`) to the Mass storage device and wait for the start of the binary download on the board.

```
$ sudo cp flexspi_nor_debug/wifi_cli.bin /media/<user>/RT1060-EVK/
```

- The board stops showing as Mass storage device and appears again once the flash process has completed. If any error occurs during the flashing, the `FAIL.txt` file is generated and stored in the Mass storage device.
- To access the device using the serial console please refer to section 2.1.

```
=====
wifi cli demo
=====
Initialize CLI
=====
Initialize WLAN Driver
=====
MAC Address: 00:13:43:7F:9C:9F
[net] Initialized TCP/IP networking stack
=====
app_cb: WLAN: received event 10
=====
app_cb: WLAN initialized
=====
WLAN CLIs are initialized
=====
```

NOTE: Please refer to section 3.1.5 to view the actual output on the console once the application is executed.

3.1.3 Run a demo with IAR IDE

This section provides the steps to open, configure, build, debug and run the demo example using IAR Embedded Workbench IDE. The instructions and illustrations refer to IAR version 9.40.1.

3.1.3.1 Open the project workspace

To open the wifi_cli project available in the SDK, double-click the project workspace file named *wifi_cli.eww* stored at the following location.

<install_dir>\boards\evkmimxrt1060\wifi_examples\wifi_cli\iar\wifi_cli.eww

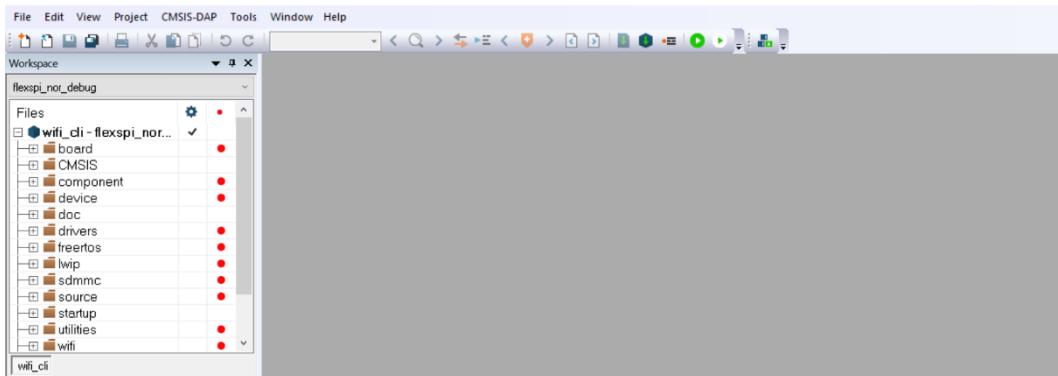


Figure 12: Open Project in IAR

3.1.3.2 Project Settings

- By default, the project is configured to use the ***WIFI_IW416_BOARD_MURATA_1XK_USD*** Wi-Fi module based on IW416 chipset. Modify the value to match the module on your setup to include and compile the desired driver, components and application(s).
- The file "***app_config.h***" from the source folder is used for the macro definitions
- Refer to Table 4 for the list of macros for Wi-Fi modules.

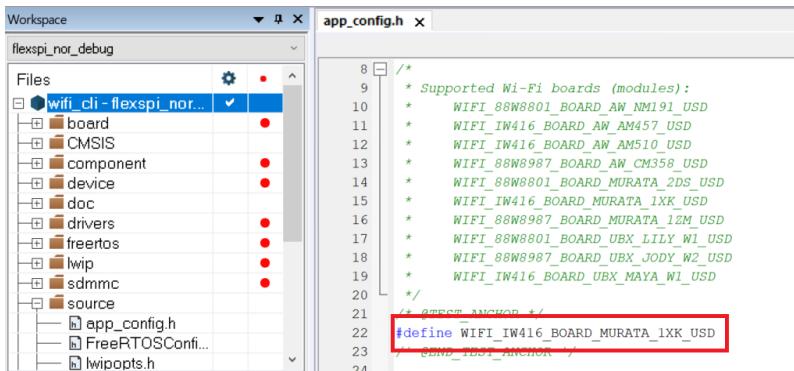


Figure 13: Wi-Fi Module Selection in IAR

3.1.3.3 Build the application

- To build the *wifi_cli* application, press the **Make** icon as illustrated below.

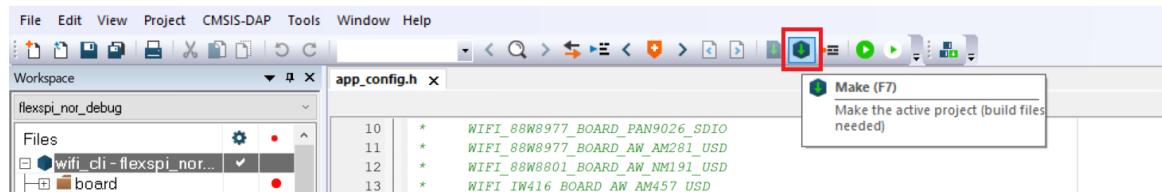


Figure 14: Application Build in IAR

- The details of the Build procedure are displayed in the **Messages** window of the **Build** tab.

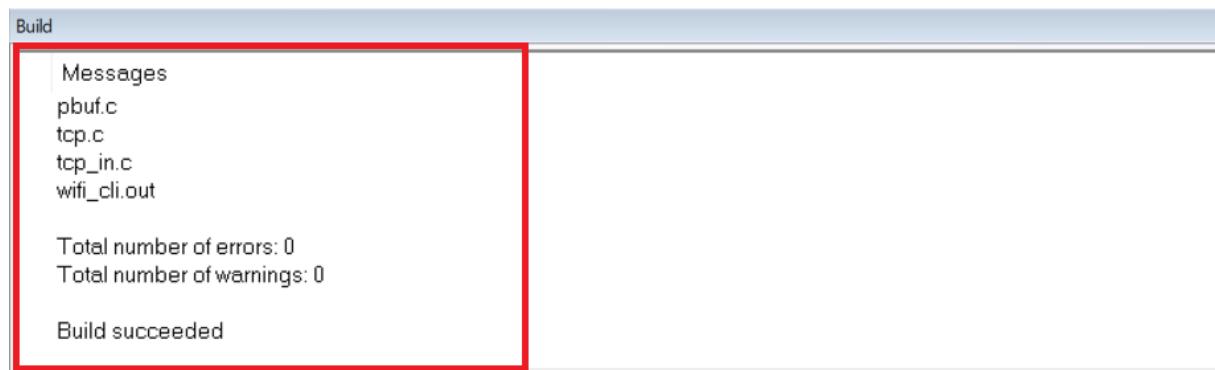


Figure 15: Build Message in IAR

3.1.3.4 Run the application in debug mode

The following steps describe how to run the application in debug mode.

The default debugger is **CMSIS-DAP**. However, if **CMSIS-DAP** is not selected, use the drop-down list to select it and press **OK**.

The selection of the debugger is a one-time configuration step that is not required for incremental debug.

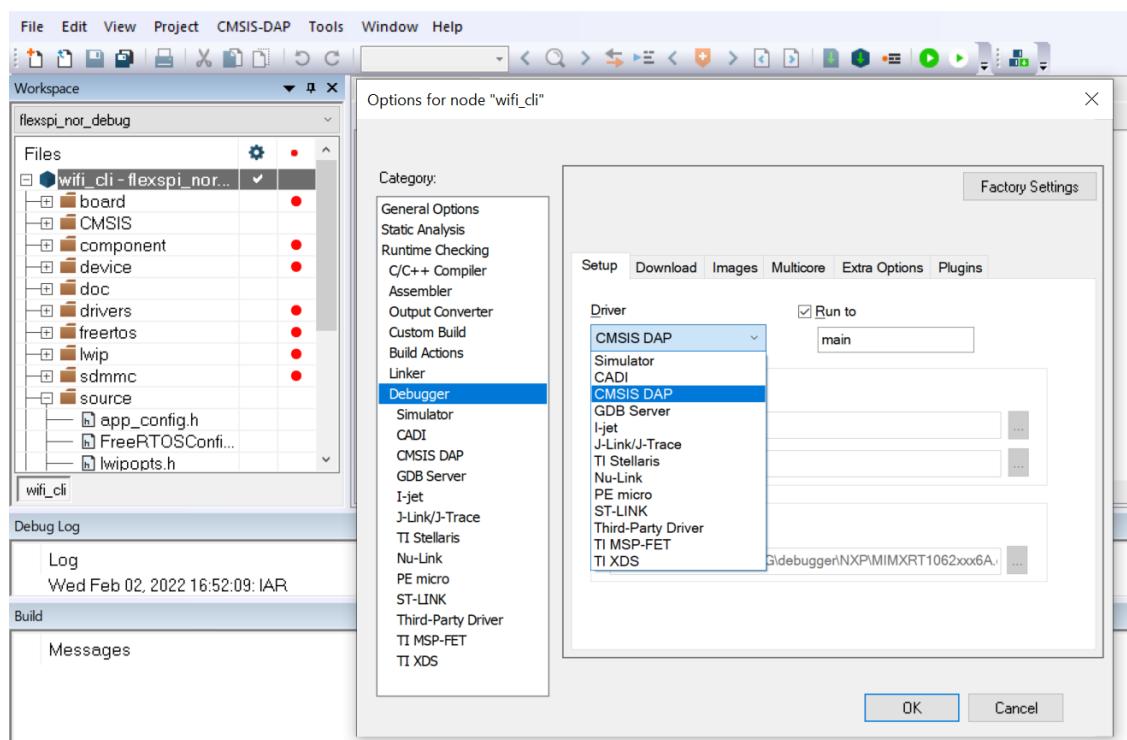


Figure 16: Debugger Selection in IAR

- To initiate the application debug, press the **Download and Debug** icon on the toolbar.



Figure 17: Initiate Debug in IAR

- The **Download and Debug** button is used to download the application to the target and set the program counter to the main() function of the application. Press **Go** to start the application. To debug the application, use the **Step Into**, **Step over** and **Step return** icons. To stop the debugging session, press the **Stop Debugging** icon.



Figure 18: Application Debugging in IAR

3.1.3.5 Flash the application program (no debugging)

Please use the following steps to flash the application program.

- Go to **Project > Download** to flash the binary file. The **Download** menu provides the commands to flash the pre-built binary file and to erase the memory.

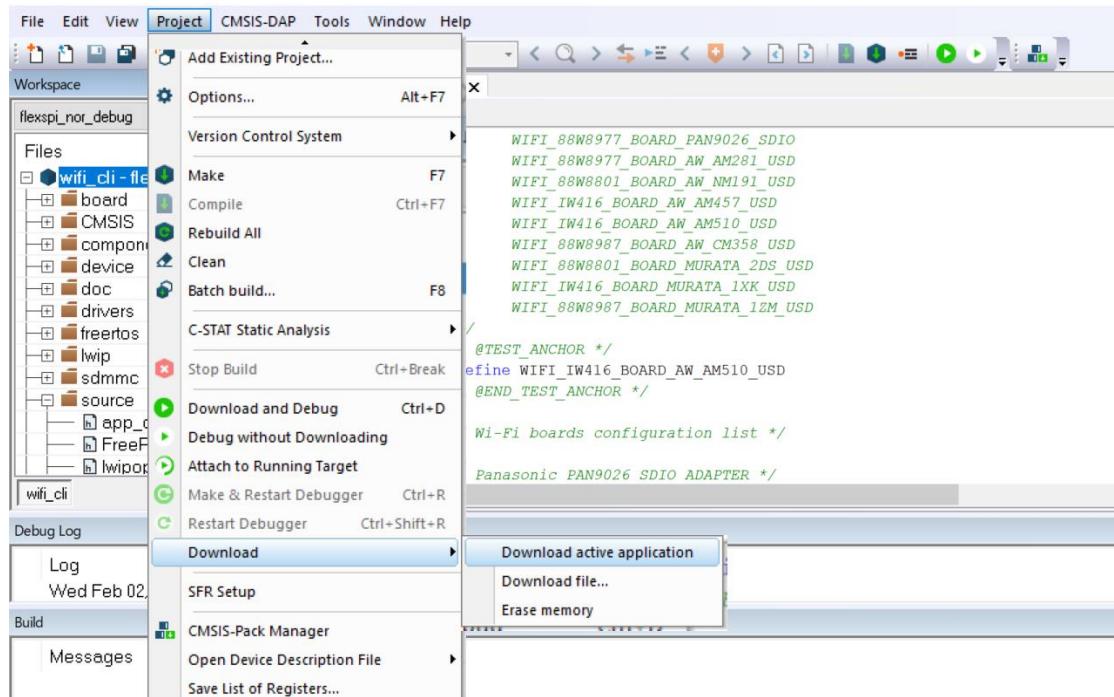


Figure 19: Binary Flashing in IAR

NOTE: Refer to section 3.1.5 to view the output on the console once the application is executed.

3.1.4 Run a demo using Keil MDK/μVision

This section details the steps to open, configure, build, debug and run demo example through Keil IDE. The Keil version used in the following instructions is V5.38.0.0.

NOTE: For Bluetooth demo applications Keil MDK/ μVision IDE is not supported.

3.1.4.1 Install CMSIS device pack

Following the installation of the MDK tools, install the CMSIS device packs so you can use the debug functionality on your device. The CMSIS device packs include the memory map information, register definitions and flash programming algorithms. The following steps install the MIMXRT106x CMSIS pack.

- Click on the **Pack Installer** icon in the toolbar, look for **iMXRT1060_MWP** in the **Packs** tab. Press **Install** in the **Action** column.

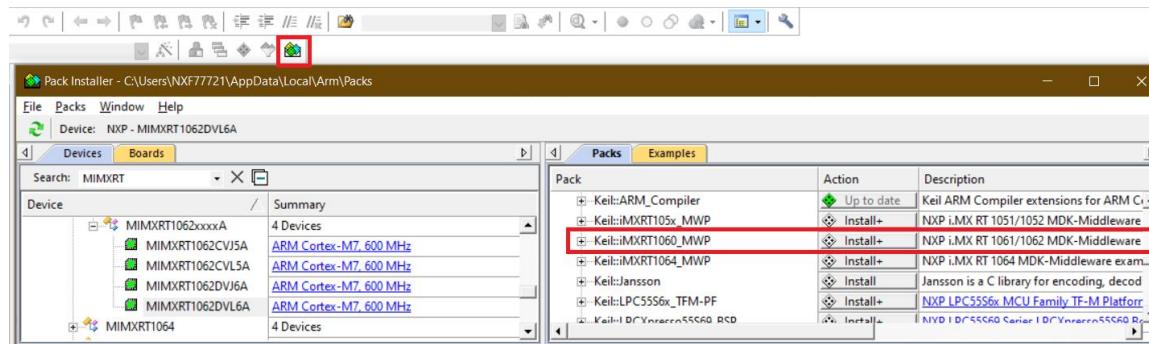


Figure 20: Install Packages using Pack Installer in Keil

- When the installation is complete, **Up to date** is displayed in the **Action** column. Verify that the **Board Support Pack** (BSP) and **Device Family Pack** (DFP) are both listed in the **Device > Packs** tab.

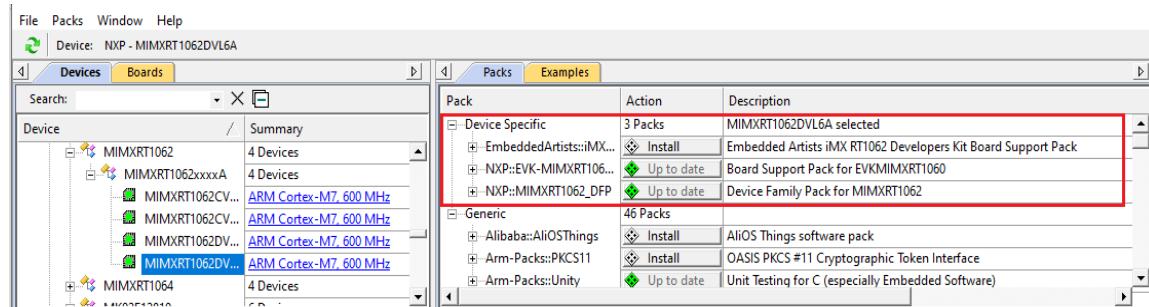


Figure 21: DFP Verification in Pack Installer in Keil

3.1.4.2 Open the project workspace

To open the `wifi_cli` project: double-click the project workspace file `wifi_cli.uvprojx` located at the following path: `<install_dir>\boards\evkmmimxrt1060\wifi_examples\wifi_cli\mdk\wifi_cli.uvprojx`

NOTE: For a multi-project, use `wifi_cli.uvmpw` instead of `wifi_cli.uvprojx`.

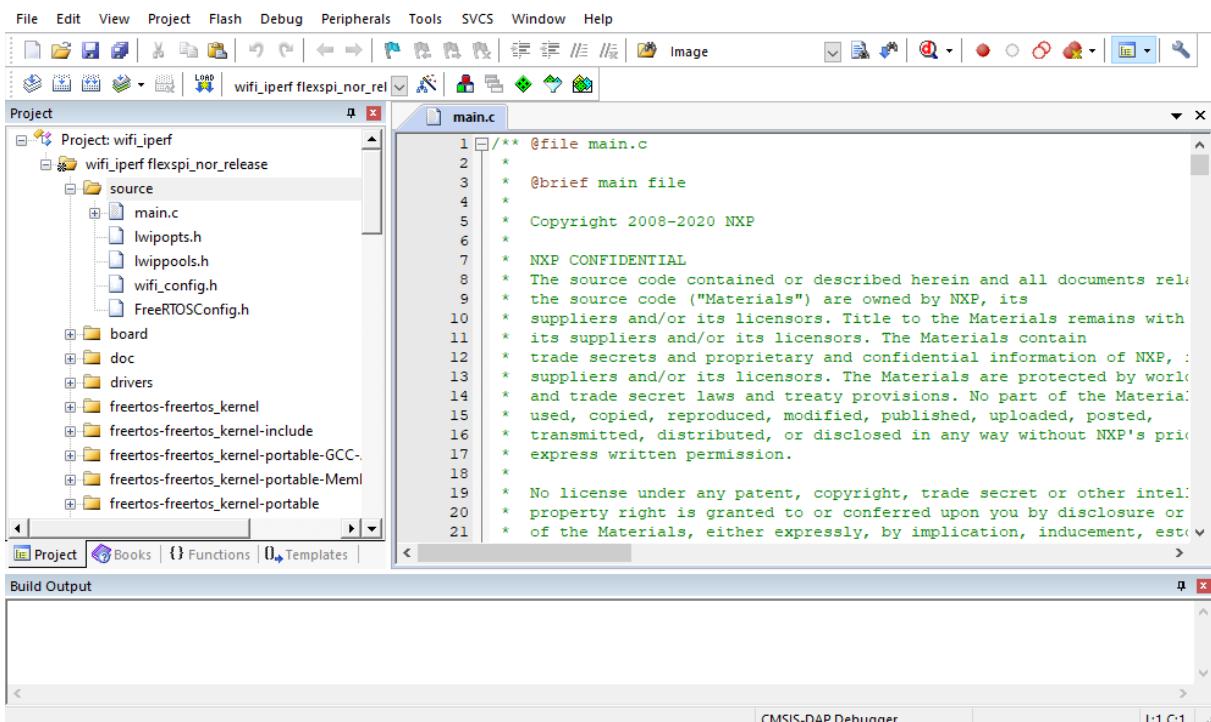


Figure 22: Open Project in Keil

3.1.4.3 Project Settings

- By default, the project is configured to use the `WIFI_IW416_BOARD_MURATA_1XK_USD` Wi-Fi module based on IW416 chipset. Modify the value to match the module on your setup to include and compile the desired driver, components and application(s).
- The file "`app_config.h`" from the source folder is used for the macro definitions
- Refer to Table 4 for the list of macros for Wi-Fi modules.

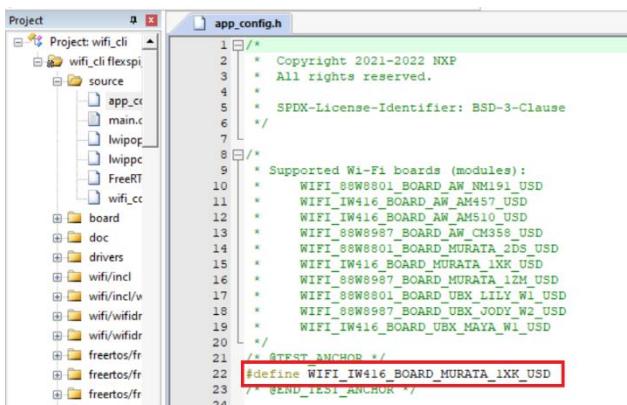


Figure 23: Wi-Fi Module Selection in Keil

3.1.4.4 Build the application

- To build the *wifi_cli* application, press the **Build** or **Rebuild** icons.

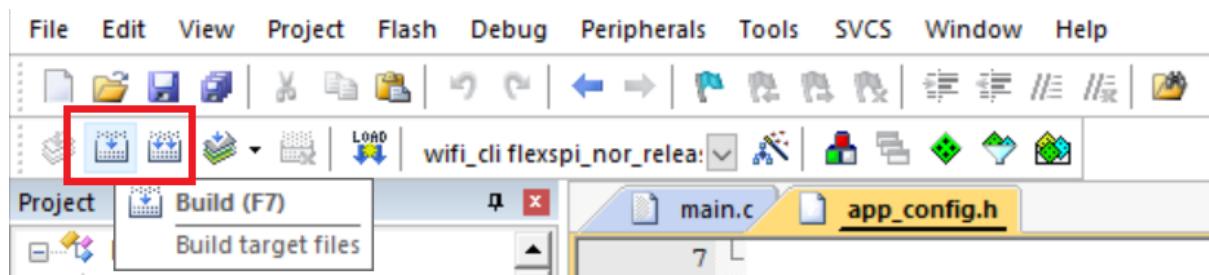


Figure 24: Application Build in Keil

- Verify the build progress in the **Build Output** window.

```
Build Output
compiling fsl_sdmmc_osa.c...
compiling firmware_dnld.c...
compiling fsl_os_abstraction_free_rtos.c...
compiling os.c...
linking...
Program Size: Code=176242 RO-data=527898 RW-data=67804 ZI-data=720808
"flexspi_nor_release\wifi_cli.out" - 0 Error(s), 0 Warning(s).
Build Time Elapsed: 00:00:31
```

Figure 25: Build Message in Keil

3.1.4.5 Run the application in debug mode

Please refer to following steps to run the application in debug mode.

The default debugger is **CMSIS-DAP**. However, if **CMSIS-DAP** is not selected, use the **Options** icon in the toolbar and open the **Debug** tab, select the debugger in the drop-down list and press **OK**.

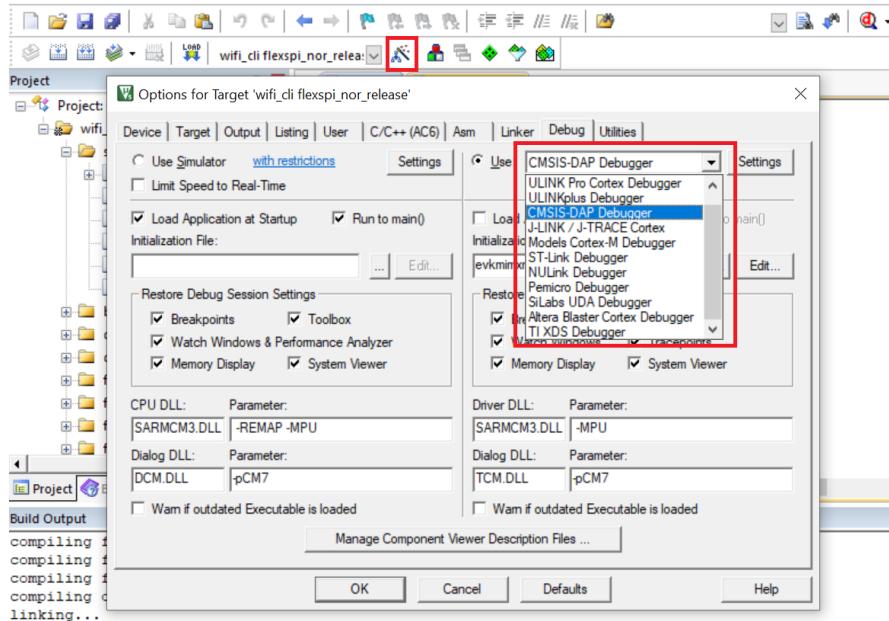


Figure 26: Debugger Selection in Keil

- To start the application debug, click on the **LOAD** icon to download the application on the board then click on the **Start/Stop Debug Session** icon in the toolbar.

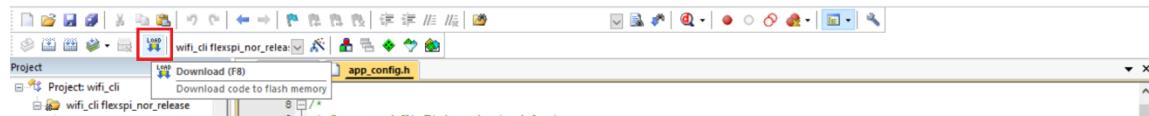


Figure 27: Load the application

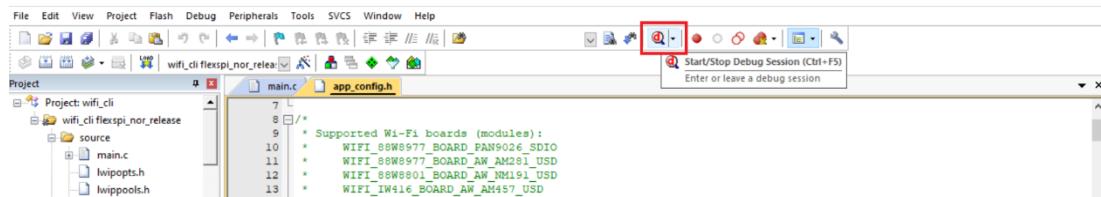


Figure 28: Initiate Debug in Keil

- Click on the **Start/Stop Debug Session** icon to set the program counter to the main() function of the application.

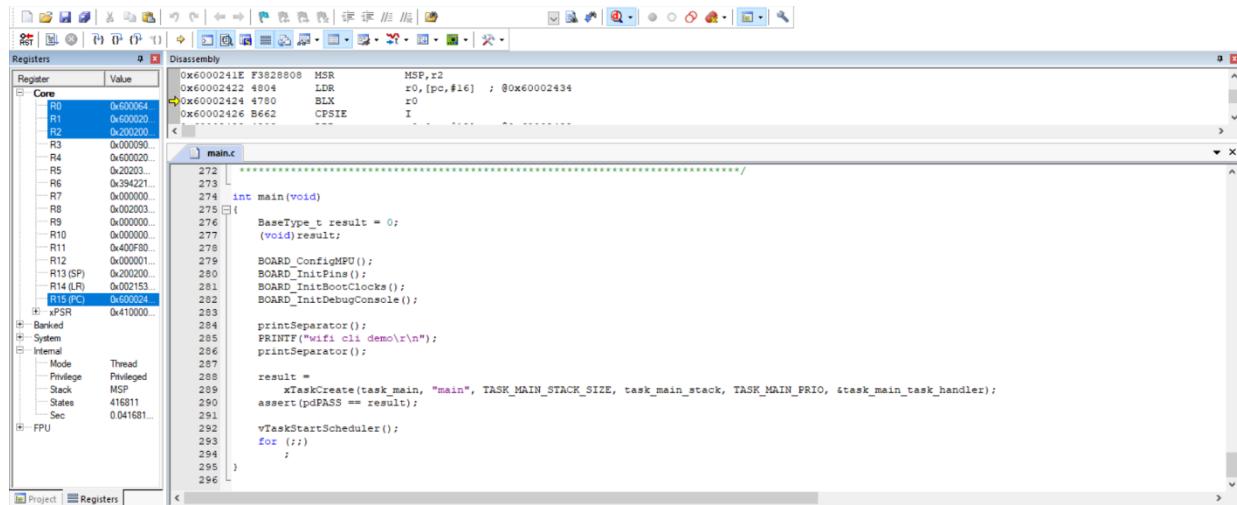


Figure 29: Application Debugging in Keil

- Press **Run** to start the application. Use **Step**, **Step Over**, **Step Out** and **Run to Cursor Line** icons in the toolbar to debug the application. To end the debugging session, click the **Stop** icon.



Figure 30: Application Debugging Features in Keil

3.1.4.6 Flash the application program (no debugging)

Please refer following steps to flash the application program.

- Click on the **Download** icon in the toolbar to flash the required binary file.

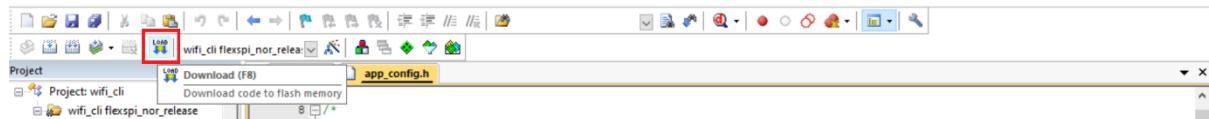


Figure 31: Binary Flashing in Keil

NOTE: Please refer to section 3.1.5 to view the output on the console once the application is executed.

3.1.5 *wifi_cli* Application Execution

3.1.5.1 Start-up logs

The following logs can be observed on the console once the devices (i.MX RT1060 EVK board and NXP-based Wireless module) are up and running and it shows that Wi-Fi module is ready for the operations. This section describes the available Wi-Fi commands, press Enter for the command prompt.

```
=====
wifi cli demo
=====
Initialize CLI
=====
Initialize WLAN Driver
=====
Setting up new cal data
MAC Address: 20:4E:F6:EC:1F:27
=====
app_cb: WLAN: received event 11
=====
app_cb: WLAN initialized
=====
WLAN CLIs are initialized
=====
CLIs Available:
=====

help
wlan-reset
wlan-version
wlan-mac
wlan-thread-info
wlan-set-mac <MAC_Address>
wlan-scan
wlan-scan-opt ssid <ssid> bssid ...
wlan-add <profile_name> ssid <ssid> bssid...
wlan-remove <profile_name>
wlan-list
wlan-connect <profile_name>
wlan-start-network <profile_name>
wlan-stop-network
wlan-disconnect
wlan-stat
wlan-info
wlan-address
wlan-get-uap-channel
wlan-get-uap-sta-list
wlan-ieee-ps <0/1>
wlan-deep-sleep-ps <0/1>
wlan-host-11k-enable <0/1>
wlan-host-11k-neighbor-req [ssid <ssid>]
wlan-host-11v-bss-trans-query <0..16>
wlan-roaming <0/1>
wlan-host-sleep <0/1> wowlan <wake_up_conds>
wlan-send-hostcmd
wlan-set-uap-bandwidth <1/2> 1:20 MHz 2:40MHz
wlan-set-uap-hidden-ssid <0/1/2>
wlan-ft-roam <bssid> <channel>
wlan-set-antcfg <ant mode> [evaluate_time]
wlan-get-antcfg
wlan-scan-channel-gap <channel_gap_value>
wlan-set-regioncode <region-code>
wlan-get-regioncode
```

```
wlan-rssi-low-threshold <threshold_value>
wlan-get-signal
wlan-cloud-keep-alive <start/stop/reset>
ping [-s <packet_size>] [-c <packet_count>] [-W <timeout in sec>] <ipv4/ipv6
address>
iperf [-s|-c <host>|-a|-h] [options]
dhcp-stat
=====
=====
```

3.1.5.2 Help command

The help command is used to get the list of commands available in the *wifi_cli* sample application.

```
# help

help
wlan-reset
wlan-version
wlan-mac
wlan-thread-info
wlan-set-mac <MAC_Address>
wlan-scan
wlan-scan-opt ssid <ssid> bssid ...
wlan-add <profile_name> ssid <ssid> bssid...
wlan-remove <profile_name>
wlan-list
wlan-connect <profile_name>
wlan-start-network <profile_name>
wlan-stop-network
wlan-disconnect
wlan-stat
wlan-info
wlan-address
wlan-get-uap-channel
wlan-get-uap-sta-list
wlan-ieee-ps <0/1>
wlan-deep-sleep-ps <0/1>
wlan-host-11k-enable <0/1>
wlan-host-11k-neighbor-req [ssid <ssid>]
wlan-host-11v-bss-trans-query <0..16>
wlan-roaming <0/1>
wlan-host-sleep <0/1> wowlan <wake_up_conds>
wlan-send-hostcmd
.
.
.
```

3.1.5.3 Reset Wi-Fi module

The reset command is used to reset and re-initialize the Wi-Fi module.

```
# wlan-reset
MAC Address: 70:66:55:7B:AC:84

# =====
app_cb: WLAN: received event 11
=====
app_cb: WLAN initialized
=====
WLAN CLIs are initialized
=====
CLIs Available:
.
.
.
```

3.1.5.4 Scan command

The scan command is used to scan the visible access points.

```
# wlan-scan
Scan scheduled...

# 1 network found:
38:E6:0A:C6:1A:EC "nxp" Infra
    channel: 11
    rssi: -57 dBm
    security: WPA2
    WMM: YES
    802.11V: YES
    802.11W: NA
```

```
# wlan-scan-opt ssid nxp
Scan for ssid "nxp" scheduled...

# 1 network found:
38:E6:0A:C6:1A:EC "nxp" Infra
    channel: 11
    rssi: -54 dBm
    security: WPA2
    WMM: YES
    802.11V: YES
    802.11W: NA
```

Set time gap between two consecutive channels scan

Command usage:

```
# wlan-scan-channel-gap
Invalid arguments
Usage:
wlan-scan-channel-gap <scan_gap_value>
scan_gap_value: [2,500]
```

Set time gap to 5 sec

```
# wlan-scan-channel-gap 5
```

3.1.5.5 Add network profile

Before adding a network profile for Soft AP and Station mode, please check command usage.

```
# wlan-add
Usage:
For Station interface
    For DHCP IP Address assignment:
        wlan-add <profile_name> ssid <ssid> [wpa2 <secret>]
            If using WPA2 security, set the PMF configuration if required.
        wlan-add <profile_name> ssid <ssid> [wpa3 sae <secret> mfpc <1> mfpr <0/1>]
            If using WPA3 SAE security, always set the PMF configuration.
    For static IP address assignment:
        wlan-add <profile_name> ssid <ssid>
            ip:<ip_addr>,<gateway_ip>,<netmask>
            [bssid <bssid>] [channel <channel number>]
            [wpa2 <secret>]
For Micro-AP interface
    wlan-add <profile_name> ssid <ssid>
        ip:<ip_addr>,<gateway_ip>,<netmask>
        role uap [bssid <bssid>]
        [channel <channelnumber>]
        [wpa2/wpa2-sha256 <secret>] [wpa3 sae <secret> [pwe <0/1/2> tr <0/1>]]
        [mfpc <0/1>] [mfpr <0/1>]
        [capa <11n/legacy>]
```

```
If Set channel to 0, set acs_band to 0 1.
0: 2.4GHz channel 1: 5GHz channel Not support to select dual band
automatically.
Error: invalid number of arguments
Error: invalid number of arguments
```

3.1.5.6 Station mode (connect to AP)

WPA2 Security

Use the following command to add the network profile to configure the device in station mode. Provide any profile name as well as use your AP's SSID and Passphrase in argument shown below:

```
# wlan-add abc ssid nxp wpa2 12345678
Added "abc"
```

Connect to the AP network using the saved network profile:

```
# wlan-connect abc
Connecting to network...
Use 'wlan-stat' for current connection status.

# =====
app_cb: WLAN: received event 1
=====
app_cb: WLAN: authenticated to network
=====
app_cb: WLAN: received event 0
=====
app_cb: WLAN: connected to network
Connected to following BSS:
SSID = [nxp]
IPv4 Address: [192.168.43.35]
IPv6 Address: Link-Local : FE80::7266:55FF:FE7B:AD1A (Preferred)
IPv6 Address: Global : 2409:4041:E8A:AFD9:7266:55FF:FE7B:AD1A
(Preferred)
```

NOTE: Once connected to the AP the console output will show Client successfully connected to AP with ssid "nxp" and got ip address "192.168.43.35" from AP.

Get signal information of connected External AP

```
# wlan-get-signal
      BeaconLast    Beacon Average   Data Last      Data Average
RSSI    -32          -32           -33          -33
SNR     58           58            57           57
NF     -90          -90           -90          -90
```

WPA2 Station disconnection (from AP)

Disconnect from the AP network profile:

```
# wlan-disconnect
=====
app_cb: WLAN: received event 9
=====
app_cb: disconnected
```

Remove the saved network profile:

```
# wlan-remove abc
Removed "abc"
```

WPA3 Security

```
# wlan-add nxp_test_1 ssid WPA3_AP wpa3 sae 12345678 mfpc 1 mfpr 1
Added "nxp_test_1"
```

Connect to the AP network using the saved network profile:

```
# wlan-connect nxp_test_1
Connecting to network...
Use 'wlan-stat' for current connection status.
```

```
=====
app_cb: WLAN: received event 0
=====
app_cb: WLAN: connected to network
Connected to following BSS:
SSID = [WPA3_AP]
IPv4 Address: [192.168.10.2]
```

NOTE: Once connected to the AP the console output will show Client successfully connected to AP with ssid "WPA3_AP" and got ip address "192.168.10.2" from AP. For WPA3 R3, above configuration will also work.

WPA3 Station disconnection (from AP)

Disconnect from the AP network profile:

```
# wlan-disconnect
```

```
=====
app_cb: WLAN: received event 9
=====
app_cb: disconnected
```

Remove the saved network profile:

```
# wlan-remove nxp_test_1
Removed "nxp_test_1"
```

3.1.5.7 Start Soft AP

Use the following command to add the network profile to configure the device in AP mode. Use your AP's SSID, IP details, role, channel and security (Passphrase if applicable) in argument shown below.

WPA2

```
# wlan-add xyz ssid NXPAP ip:192.168.10.1,192.168.10.1,255.255.255.0 role uap
channel 6 wpa2 12345678
Added "xyz"
```

WPA3

```
wlan-add xyz ssid NXPAP ip:192.168.10.1,192.168.10.1,255.255.255.0 role uap
channel 6 wpa3 sae 12345678 mfpc 1 mfpr 1
```

WPA3 SAE (R3)

```
wlan-add xyz ssid NXPAP ip:192.168.10.1,192.168.10.1,255.255.255.0 role uap
channel 6 wpa3 sae 12345678 pwe 1 mfpc 1 mfpr 1
```

Usage for pwe and tr

```
SAE mechanism for PWE derivation
# 0 = hunting-and-pecking loop only (default without password identifier)
# 1 = hash-to-element only (default with password identifier)
# 2 = both hunting-and-pecking loop and hash-to-element enabled
```

Transition Disable indication

```
# 0 = transition mode (allow to connect WPA2-Personal)
# 1 = disable transition mode ((i.e., disable WPA2-Personal = WPA-PSK and only
allow SAE to be used))
```

Set Wi-Fi bandwidth

The following command is used to set Wi-Fi bandwidth (20MHz or 40MHz):

NOTE: Default bandwidth is set to 40MHz if not set by following command.

NOTE: For 88W8801, default bandwidth is set to 20MHz and following command is not available.

Command Usage:

```
# wlan-set-uap-bandwidth
Usage: wlan-set-uap-bandwidth <1/2>
Error: Specify 1 to set bandwidth 20MHz or 2 for 40MHz
```

Set bandwidth:

```
# wlan-set-uap-bandwidth 1
bandwidth set successfully
```

Start the AP using saved network profile:

```
# wlan-start-network xyz
[wlcm] Warn: NOTE: uAP will automatically switch to the channel that station is
on.

=====
app_cb: WLAN: received event 14
=====
app_cb: WLAN: UAP Started
=====
Soft AP "NXPAP" started successfully
=====
DHCP Server started successfully
=====
```

Connect the wireless client to the AP just created, NXPAP. The logs below can be observed once the Client is associated successfully:

```
Client => 38:E6:0A:C6:1A:EC Associated with Soft AP
```

Get the associated clients list:

```
# wlan-get-uap-sta-list
Number of STA = 1

STA 1 information:
=====
MAC Address: 38:E6:0A:C6:1A:EC
Power mfg status: power save
Rssi : -58 dBm
```

Get the IP and MAC information for the associated clients:

```
# dhcp-stat
DHCP Server Lease Duration : 86400 seconds
Client IP      Client MAC
192.168.10.2   38:E6:0A:C6:1A:EC
```

SSID broadcast configuration

Command usage:

```
# wlan-set-uap-hidden-ssid
Usage: wlan-set-uap-hidden-ssid <0/1/2>
Error: 0: broadcast SSID in beacons.
1: send empty SSID (length=0) in beacons.
2: clear SSID (ACSI 0), but keep the original length
```

Set SSID broadcast control

```
# wlan-set-uap-hidden-ssid 1
SSID broadcast control set successfully
```

Stop Soft AP

```
# wlan-stop-network
=====
app_cb: WLAN: received event 19
=====
app_cb: WLAN: UAP Stopped
=====
Soft AP "NXPAP" stopped successfully
=====
DHCP Server stopped successfully
=====
```

3.1.5.8 IPerf Server/Client

The sample application implements the protocol used by iPerf performance measurement tool. The performance is measured between a single i.MX RT+NXP-based Wireless module and a computer running the iPerf tool. The instructions in this guide use an i.MX RT1060 EVK board. Yet the same steps apply to other i.MX RT products. The following figures show the setup overview to run the iPerf performance test.

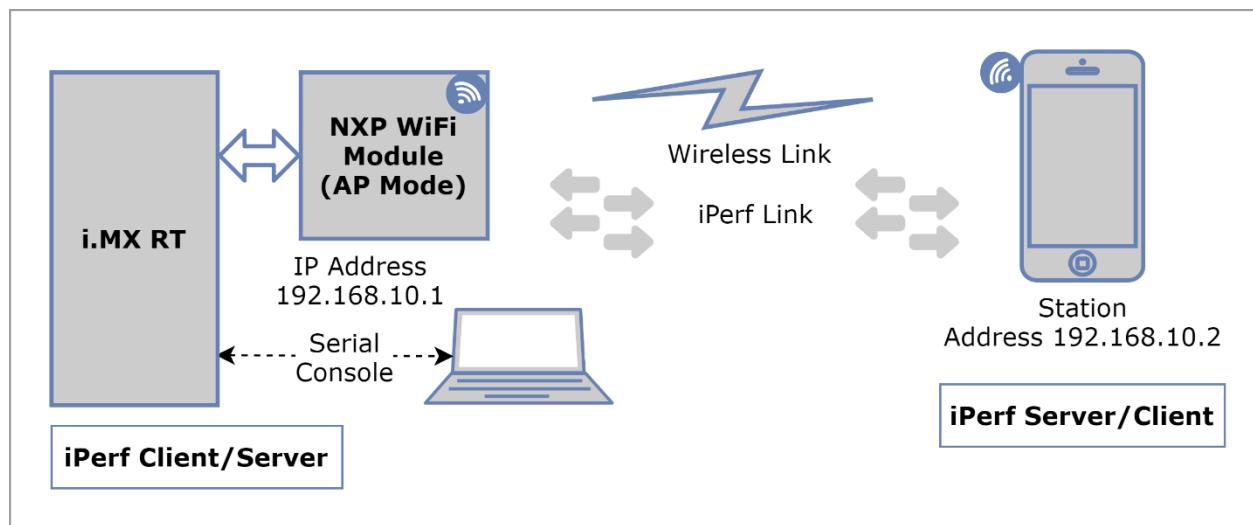


Figure 32: Hardware Setup for iPerf performance test with Soft AP Mode

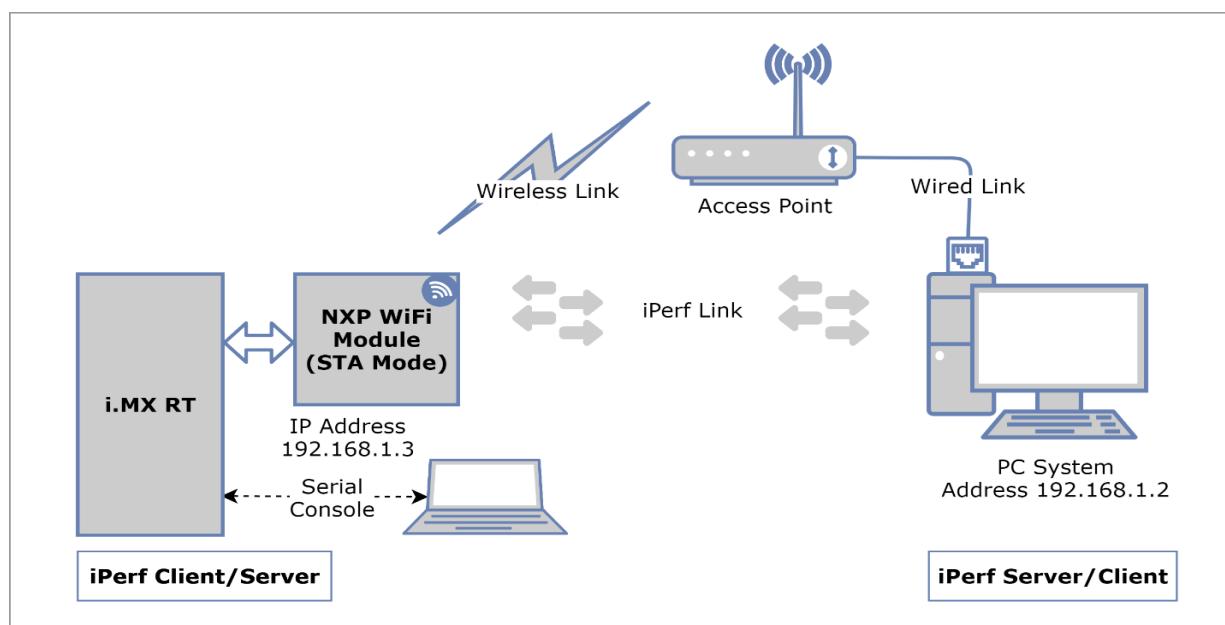


Figure 33: Hardware Setup for iPerf performance test with Station Mode

NOTE: Please refer to the section 2.3 for iperf remote host setup.

The following commands are used for IPerf Initialization:

IPerf Usage :

```
# iperf
Incorrect usage
Usage:
    iperf [-s|-c <host>|-a] [options]
    iperf [-h]

    Client/Server:
        -u          use UDP rather than TCP
        -B <host>   bind to <host> (including multicast address)
        -V          Set the domain to IPv6 (send packets over IPv6)
        -a          abort ongoing iperf session
        -p          server port to listen on/connect to

    Server specific:
        -s          run in server mode
        -D          Do a bidirectional UDP test simultaneously and with -
d from external iperf client
    Client specific:
        -c <host>   run in client mode, connecting to <host>
        -d          Do a bidirectional test simultaneously
        -r          Do a bidirectional test individually
        -t #        time in seconds to transmit for (default 10 secs)
        -b #        for UDP, bandwidth to send at in Mbps, default
100Mbps without the parameter
        -l          length of buffer in bytes to write (Defaults: v4
TCP=1460, v6 TCP=1440, v4 UDP=1470, v6 UDP=1450)
                                Note: Limit length is smaller than default
size.
```

NOTE: For iperf Linux and Mobile application commands refer Error! Reference source not found., Table 2 and Table 3 respectively from section 2.3

iPerf TCP

Start IPerf server:

```
# iperf -s
# IPERF initialization successful
New TCP client (settings flags 0x0)

-----
TCP_DONE_SERVER (RX)
Local address : 192.168.10.1 Port 5001
Remote address : 192.168.10.2 Port 36874
Bytes Transferred XXXX
Duration (ms) 10130
Bandwidth (Mbitpsec) XX
```

Start IPerf Client (Tx Only):

```
# iperf -c 192.168.10.2
# IPERF initialization successful

-----
TCP_DONE_CLIENT (TX)
Local address : 192.168.10.1 Port 49153
Remote address : 192.168.10.2 Port 5001
Bytes Transferred XXXX
Duration (ms) 10001
Bandwidth (Mbitpsec) XX
```

Start IPerf Client (Tx and Rx simultaneous):

```
# iperf -c 192.168.10.2 -d

IPERF initialization successful
New TCP client (settings flags 0x30313233)

-----
TCP_DONE_CLIENT (TX)
Local address : 192.168.10.1 Port 49154
Remote address : 192.168.10.2 Port 5001
Bytes Transferred XXXX
Duration (ms) 10001
Bandwidth (Mbitpsec) XX

-----
TCP_DONE_SERVER (RX)
Local address : 192.168.10.1 Port 5001
Remote address : 192.168.10.2 Port 36876
Bytes Transferred XXXX
Duration (ms) 10138
Bandwidth (Mbitpsec) XX
```

Start IPerf Client (Tx and Rx individual):

```
# iperf -c 192.168.10.2 -r

# IPERF initialization successful
-----
TCP_DONE_CLIENT (TX)
Local address : 192.168.10.1 Port 49155
Remote address : 192.168.10.2 Port 5001
Bytes Transferred XXXX
Duration (ms) 10001
Bandwidth (Mbitpsec) XX

New TCP client (settings flags 0x30313233)

-----
TCP_DONE_SERVER (RX)
Local address : 192.168.10.1 Port 5001
Remote address : 192.168.10.2 Port 36878
Bytes Transferred XXXX
Duration (ms) 10095
Bandwidth (Mbitpsec) XX
```

iPerf UDP

For UDP tests please specify local interface ip address using -B option

Start IPerf server:

```
# iperf -s -u -B 192.168.10.1

# IPERF initialization successful
New UDP client (settings flags 0x0)

-----
UDP_DONE_SERVER (RX)
Local address : 192.168.10.1 Port 5001
Remote address : 192.168.10.2 Port 54882
Bytes Transferred XXXX
Duration (ms) 10057
Bandwidth (Mbitpsec) XX
```

Start IPerf Client (Tx Only):

```
for UDP, bandwidth to send at in Mbps, default 100Mbps
# iperf -c 192.168.10.2 -u -B 192.168.10.1 -b 50

Ideal frame delay: 224 us

Send 4 frame(s) once per 1000 us

IPERF initialization successful

-----
UDP_DONE_CLIENT (TX)
Local address : 255.113.231.15 Port 49157
Remote address : 192.168.10.2 Port 5001
Bytes Transferred XXXX
Duration (ms) 10501
Bandwidth (Mbitpsec) XX
```

3.1.5.9 Wi-Fi Power Save

The following commands are used to save Wi-Fi power in different modes:

- IEEE Power Save

For IEEEPS mode Wi-Fi station should be connected with external AP and Soft AP should be de-activated.

IEEEPS Usage:

```
# wlan-ieee-ps
Usage: wlan-ieee-ps <0/1>
Error: Specify 0 to Disable or 1 to Enable
If <WNM> <sleep_interval> is specified, fw will enable WNM and use
sleep_interval
Example:
wlan-ieee-ps 1 WNM 5
```

NOTE: WNM is refer to Wireless Network Management sleep, if **CONFIG_WNM_PS** is enabled in **wifi_config.h** then **ieee-ps** command takes this extra argument of sleep duration, with this sleep duration can be extended.

Enable IEEEPS:

```
# wlan-ieee-ps 1
Turned on IEEE Power Save mode
```

Disable IEEEPS :

```
# wlan-ieee-ps 0
Turned off IEEE Power Save mode
• DeepSleep
```

Check Wi-Fi connection:

```
# wlan-stat
Station not connected
uAP not started
```

DepSleep Usage:

```
# wlan-deep-sleep-ps
Usage: wlan-deep-sleep-ps <0/1>
Error: Specify 0 to Disable or 1 to Enable
```

Enable DeepSleep:

```
# wlan-deep-sleep-ps 1
Turned on Deep Sleep Power Save mode
```

Disable DeepSleep:

```
# wlan-deep-sleep-ps 0
Turned off Deep Sleep Power Save mode
```

3.1.5.10 Wi-Fi Host sleep-wowlan

The following commands are used to put the Wi-Fi in the sleep mode and wake up based on the provided conditions.

NOTE: This command is only tested with i.MX RT1060 EVK

For this command execution Wi-Fi station should be connected with external AP.

Host sleep Usage:

```
# wlan-host-sleep
Error: invalid number of arguments
Usage:
    wlan-host-sleep <1/0> <wowlan [wake_up_conds]/mef>
        [wake_up_conds] -- value for host wakeup conditions
            bit 0: WAKE_ON_ALL_BROADCAST
            bit 1: WAKE_ON_UNICAST
            bit 2: WAKE_ON_MAC_EVENT
            bit 3: WAKE_ON_MULTICAST
            bit 4: WAKE_ON_ARP_BROADCAST
            bit 6: WAKE_ON_MGMT_FRAME
            All bit 0 discard and not wakeup host
            All bit 1 cancel host sleep configuration
    wlan-host-sleep <1/0> wowlan 0x1e
```

Reset Previous configured Host sleep configuration

```
# wlan-host-sleep 0
Cancel Previous configured Host sleep configuration
```

Enable host sleep with one of the conditions like, Broadcast or Unicast or Multicast or Mac event or ARP Broadcast or Management frame. For example, device will wake up on ping request.

```
# wlan-host-sleep 1 wowlan 2
Host sleep configuration successs with regular condition
```

Enable host sleep with no condition. Here device will not wake up based on any event/request like ping.

```
# wlan-host-sleep 1 wowlan 0
Host sleep configuration successs with regular condition
```

3.1.5.11 Wi-Fi Cloud Keep Alive

Note: This feature is only enabled in SDK 2.13.2 for IW612

The following commands are used to send TCP/IP keep-alive packets to the cloud server periodically when HOST goes to suspend mode and the cycle time for this can be configured.

Wi-Fi firmware will receive the ACK from cloud server on every keep-alive packet sent, if the firmware times out for 3 times continuously, it means keep alive failure.

When host wakes up, it should stop firmware from sending keep-alive packet. Since host will continue to send keep-alive packet by itself.

Cloud keep-alive Usage:

```
# wlan-cloud-keep-alive
Error: invalid number of arguments
Usage:
    wlan-cloud-keep-alive start dst_mac <dst_mac> dst_ip <dst_ip> dst_port
    <dst_port>
        <dst_mac> Destination MAC address
        <dst_ip> Destination IP
        <dst_port> Destination port
        Please specify dst_mac, dst_ip and dst_port
    wlan-cloud-keep-alive stop
    wlan-cloud-keep-alive reset
```

Here dst_mac is the mac address of the TCP server, dst_ip is the ip address of the TCP server, dst_port is port number of the TCP server.

Configure TCP/IP parameters

```
# wlan-cloud-keep-alive start dst_mac 4E:B9:85:60:E6:7F dst_ip 192.168.37.79
dst_port 9526
```

Refer to section [3.1.5.10](#) to put the DUT in sleep mode

Stop sending keep-alive packets

```
wlan-cloud-keep-alive stop
```

3.1.5.12 Set/Get Antenna Diversity Configuration

The following commands are used to set and get antenna diversity configuration:

NOTE: Make sure second antenna is connected before performing antenna configurations. Currently support is available for 88W8801 only.

Command Usage:

```
# wlan-set-antcfg
```

Usage:

```
wlan-set-antcfg <ant mode> [evaluate_time]
```

<ant mode>:

Bit 0 -- Tx/Rx antenna 1

Bit 1 -- Tx/Rx antenna 2

0xFFFF -- Tx/Rx antenna diversity

[evaluate_time]:

if ant mode = 0xFFFF, SAD evaluate time interval,

default value is 6s(0x1770)

3.1.5.13 Set/Get Region Code

The following commands are used to set and get region code:

Command Usage:

```
# wlan-set-regioncode
```

Usage:

```
wlan-set-regioncode <region-code>
```

where, region code =

0xAA : World Wide Safe Mode

0x10 : US FCC, Singapore

0x20 : IC Canada

0x30 : ETSI, Australia, Republic of Korea

0x32 : France

0x40 : Japan

0x41 : Japan

0x50 : China

0xFE : Japan Special

Set region code:

```
# wlan-set-regioncode 0xAA
```

Region code: 0xaa set

Get region code:

```
# wlan-get-regioncode
```

Region code: 0xaa

3.1.5.14 Set RSSI low threshold

The following commands are used to set RSSI low threshold

Command Usage:

```
# wlan-rssi-low-threshold
```

Usage: wlan-rssi-low-threshold <rssi threshold value>

Error: Default value is 70. Specify the value you want to set as threshold.

Set RSSI threshold to -71

```
# wlan-rssi-low-threshold -71
```

rssi threshold set successfully.

3.1.5.15 Roaming based on RSSI event

Note: This feature is only enabled for IW612, and IW612 support is enabled in i.MX RT1170 EVKB for SDK 2.13.2 version only.

Command Usage:

```
# wlan-roaming  
Usage:  
      wlan-roaming <0/1>  
Example:  
      wlan-roaming 1  
Error: invalid number of arguments
```

Enable client to roam based on RSSI values

```
# wlan-roaming 1
```

3.1.5.16 Roaming with 802.11k, 802.11r, and 802.11v

The following commands are used for client roaming using Wi-Fi network standards:

- 802.11K

The 802.11k standard helps devices search quickly for nearby APs that are available as roaming targets by creating an optimized list of channels. When the signal strength of the current AP weakens, STADUT will scan for target APs from this list.

Note: For roaming, Ext.AP should be capable of 11k, 11v and 11r.

Command Usage:

```
# wlan-host-11k-enable  
Usage: wlan-host-11k-enable <0/1> < 0--disable host 11k; 1---enable host 11k>
```

Enable 11k:

```
# wlan-host-11k-enable 1
```

Send neighbor request and get nearby Aps list

Command Usage:

```
# wlan-host-11k-neighbor-req [ssid <ssid>]
```

Send neighbor request:

```
# wlan-host-11k-neighbor-req
```

- 802.11r

When STADUT roams from one AP to another on the same network, 802.11r uses a feature called Fast Basic Service Set Transition (FT) to authenticate more quickly.

Command Usage:

```
# wlan-ft-roam  
Usage:  
Roam to new AP using FT:  
      wlan-ft-roam <bssid> <channel>  
Error: invalid number of arguments
```

Roam through bssid and channel

```
wlan-ft-roam 00:e9:3a:b9:e0:35 1
```

- 802.11v

Trigger the bss transition query with specified status code from 0 to 16.

Command Usage:

```
# wlan-host-11v-bss-trans-query  
Usage: wlan-host-11v-bss-trans-query <query_reason[0..16]>
```

3.1.5.17 Other useful CLI commands

Use the other commands to get the Wi-Fi information, driver version, firmware version, list of the networks and other information.

Get the Wi-Fi information:

```
# wlan-info
Station connected to:
"abc"
    SSID: nxp
    BSSID: 38:E6:0A:C6:1A:EC
    channel: 11
    role: Infra
    security: WPA2

    IPv4 Address
    address: DHCP
        IP:          192.168.43.156
        gateway:     192.168.43.233
        netmask:     255.255.255.0
        dns1:        192.168.43.233
        dns2:        0.0.0.0

    IPv6 Addresses
    Link-Local   : FE80::2E9:3AFF:FE89:E035 (Preferred)
    Global       : 2409:40C1:33:DCD:2E9:3AFF:FE89:E035 (Preferred)

uAP started as:
"xyz"
    SSID: NXPAP
    BSSID: 00:13:43:6A:5A:ED
    channel: 11
    role: uAP
    security: WPA2

    IPv4 Address
    address: STATIC
        IP:          192.168.10.1
        gateway:     192.168.10.1
        netmask:     255.255.255.0
        dns1:        192.168.43.233
        dns2:        0.0.0.0

    IPv6 Addresses
    Link-Local   : FE80::2E9:3AFF:FE89:E035 (Tentative)
```

Get the Wi-Fi driver and firmware version:

```
# wlan-version
WLAN Driver Version   : vX.X.rXX.pX
WLAN Firmware Version : IW416-V0, RF878X, FP91, 16.91.21.p91.4, WPA2_CVE_FIX_1,
PVE_FIX_1
```

Get the Wi-Fi MAC address:

```
# wlan-mac
MAC address
00:13:43:6A:5A:ED
```

Get the list of Wi-Fi networks:

```
# wlan-list
2 networks:
"xyz"
    SSID: NXPAP
    BSSID: 00:00:00:00:00:00
    channel: 6
    role: uAP
    security: WPA2

    IPv4 Address
    address: STATIC
        IP:          192.168.10.1
        gateway:    192.168.10.1
        netmask:    255.255.255.0
        dns1:       192.168.43.1
        dns2:       0.0.0.0

"abc"
    SSID: nxp
    BSSID: 00:00:00:00:00:00
    channel: (Auto)
    role: Infra
    security: WPA2

    IPv4 Address
    address: DHCP
        IP:          0.0.0.0
        gateway:    0.0.0.0
        netmask:    0.0.0.0
        dns1:       0.0.0.0
        dns2:       0.0.0.0
```

Get the Wi-Fi stats:

```
# wlan-stat
Station connected (Active)
uAP started (Active)
```

Get the AP channel:

```
# wlan-get-uap-channel
uAP channel: 6
```

Ping the IP address:

```
# ping
Incorrect usage
Usage:
    ping [-s <packet_size>] [-c <packet_count>] [-W <timeout in sec>]
<ip_address>
Default values:
    packet_size: 56
    packet_count: 10
    timeout: 2 sec
# ping -s 56 -c 2 -W 2 192.168.43.1
PING 192.168.43.1 (192.168.43.1) 56(84) bytes of data
64 bytes from 192.168.43.1: icmp_req=1 ttl=64 time=196 ms
64 bytes from 192.168.43.1: icmp_req=2 ttl=64 time=95 ms
```

Send RF Calibration host command:

```
# wlan-send-hostcmd
Hostcmd success, response is e0 80 18 0 29 0 0 0 1 0 0 0 38 2 8 0 5 1
```

This cli hardcodes a specific command and demonstrates usage of **wlan_send_hostcmd** API. This command can be changed to any other hostcmd, formed in the format mentioned here.

First 8 bytes of cmd_buf should have Command Header.

```
* 2 bytes : Command.
* 2 bytes : Size.
* 2 bytes : Sequence number.
* 2 bytes : Result.
* Rest of buffer length is Command/Response Body
```

Default structure for hostcmd defined in **wlan_tests.c** cmd_buf[] = {0xe0, 0, 0x18, 0, 0x29, 0, 0, 0, 0x01, 0, 0, 0x38, 0x02, 0x08, 0, 0x05, 0, 0x01, 0, 0x02, 0x01, 0, 0x01}; and differentiated as below.

```
cmd_buf[] = {
Command: 0xe0, 0,
Size: <2 bytes of size of entire data>,
Sequence number: 0, 0,
Result: 0, 0,
Set/Get: (for set 0x1 0x0, for get 0x0 0x0)
Revision: <Cal data format revision, 2 bytes>
Cal Data len: <length of cal data, 2 bytes>
Cal Data: <cal data byte array>
};
```

Please refer to [AN13296](#) for more details about RF calibration Data commands.

Get the heap utilization

```
# heap-stat

Heap size ----- : 32968
Largest Free Block size ----- : 32968
Smallest Free Block size ----- : 32968
Number of Free Blocks ----- : 1
Total successful allocations --- : 49
Total successful frees ----- : 0
Min Free since system boot ---- : 32968
```

NOTE: Add **CONFIG_HEAP_STAT** in **wifi_config.h** to include in cli option.

Coexistence with External Radios for 88W8801

88W8801 Wi-Fi subsystem supports the packet traffic arbiter (PTA) protocol for coexistence with external radios (BT/802.15.4). The CLI command **wlan-8801-enable-ext-coex** is used to configure coexistence according to the external radio capabilities. Please refer to [AN13612](#) for more details *about the Wi-Fi driver APIs*.

```
# wlan-8801-enable-ext-coex
8801 External Coex Config set successfully
```

Get External Radio Coex statistics

```
# wlan-8801-get-ext-coex-stats
BLE_EIP: 1, BLE_PRI: 1, WLAN_EIP: 1
```

Data encryption and decryption

wlan-eu-crypto command is used to encrypt and decrypt data based on FIPS (Federal Information Processing Standards). FIPS is the standard for the protection of sensitive or valuable data.

Usage:

```
# wlan-eu-crypto-aes-wrap
Usage:
Algorithm AES-WRAP encryption and decryption verification
wlan-eu-crypto-aes-wrap <EncDec>
EncDec: 0-Decrypt, 1-Encrypt
Error: invalid number of arguments
```

Encrypt Data:

```
# wlan-eu-crypto-aes-wrap 1
Raw Data:
***** Dump @ 2020C1B4 Len: 16 *****
12 34 56 78 90 12 34 56 78 90 12 34 56 78 90 12

***** End Dump *****
Encrypted Data:
***** Dump @ 2020C1D8 Len: 24 *****
fa da 96 53 30 97 4b 61 77 c6 d4 3c d2 0e 1f 6d
43 8a 0a 1c 4f 6a 1a d7
***** End Dump *****
```

Decrypt Data:

```
# wlan-eu-crypto-aes-wrap 0
Raw Data:
***** Dump @ 2020C19C Len: 24 *****
fa da 96 53 30 97 4b 61 77 c6 d4 3c d2 0e 1f 6d
43 8a 0a 1c 4f 6a 1a d7
***** End Dump *****
Decrypted Data:
***** Dump @ 2020C1D8 Len: 16 *****
12 34 56 78 90 12 34 56 78 90 12 34 56 78 90 12

***** End Dump *****
```

List of useful crypto commands

```
wlan-eu-crypto-rc4 <EncDec>
wlan-eu-crypto-aes-wrap <EncDec>
wlan-eu-crypto-aes-ecb <EncDec>
wlan-eu-crypto-ccmp-128 <EncDec>
wlan-eu-crypto-ccmp-256 <EncDec>
wlan-eu-crypto-gcmp-128 <EncDec>
wlan-eu-crypto-gcmp-256 <EncDec>
```

3.1.6 Add CLIs in wifi_cli Sample Application

APIs can be called using CLI wrappers with the appropriate arguments. The new CLI command can be added in the existing demo application by using the existing structure that defines the list of commands. Command line arguments can be passed based on the API requirement.

The following example shows how to add a new command with arguments in the CLI application.

Command structure modification:

File: wlan_tests.c or wlan_basic_cli.c

Structure elements: {"command-name", "help", handler}

```
{"wlan-command-name", "<argument1> <argument2> <argument3>...",  
handler_wlan_command},
```

Command Handler: void handler_wlan_command (int argc, char *argv[])

Store the input argv list and pass it to the relative APIs to be used by the driver/firmware.

Return value of API can be used to print the Error/Success message and command output.

```
void handler_wlan_command (int argc, char *argv[])  
{  
    /* argv contains pointer to the arguments and argc is the number of  
    arguments */  
    return_value = wlan_command_driver_API(argument1, argument2, argument3,...);  
    if (return_value == WM_SUCCESS) {  
        /* Print success message and command output */  
    } else {  
        /* Print failure message and error number */  
    }  
}
```

3.2 wifi_setup Sample Application

This section describes *wifi_setup* sample application and its configuration along with the application execution. The *wifi_setup* sample application is used to demonstrate a Wi-Fi Station mode that connects to AP and starts pinging the IP address provided by the user.

Wi-Fi Features:

Table 6: wifi_setup Application Features

Features	Details
Wi-Fi	Wi-Fi Scan Wi-Fi Station mode Ping

3.2.1 wifi_setup Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console tool setup.

3.2.1.1 Run the application

The following logs can be observed on the console once the devices (i.MX RT1060 EVK board and NXP-based wireless module) are up and running.

```
Starting wifi_setup DEMO
MAC Address: 20:4E:F6:EC:1F:27
[i] WPL_Init: Success
[i] WPL_Start: Success
```

Once Wi-Fi module is initialized it'll try to scan nearby networks.

Initiating scan...

```
NXP_V10
    BSSID      : 5C:DF:89:0F:32:78
    RSSI       : -61dBm
    Channel    : 1
NXP_V10
    BSSID      : 5C:DF:89:0F:32:7C
    RSSI       : -64dBm
    Channel    : 36
ASUS_5G
    BSSID      : 7C:10:C9:02:DA:4C
    RSSI       : -58dBm
    Channel    : 36
Avaya_5G
    BSSID      : DC:33:3D:AB:E9:F8
    RSSI       : -73dBm
    Channel    : 11
nxp_netgear_2GHz
    BSSID      : 9C:C9:EB:F8:1F:71
    RSSI       : -76dBm
    Channel    : 6
NETGEAR-Guest
    BSSID      : A2:C9:EB:F8:1F:71
    RSSI       : -75dBm
    Channel    : 6
                                BSSID      : DC:33:3D:AB:E9:FD
                                RSSI       : -71dBm
                                Channel   : 11
nxp_netgear_5G
    BSSID      : 9C:C9:EB:F8:1F:73
    RSSI       : -74dBm
    Channel    : 40
ASUS_2G
    BSSID      : 7C:10:C9:02:DA:48
    RSSI       : -58dBm
    Channel    : 11
nxp
    BSSID      : 22:49:3E:98:55:CF
    RSSI       : -52dBm
    Channel    : 11
```

It will ask details to connect preferred network

Please enter parameters of WLAN to connect

```
SSID:nxp
Password (for unsecured WLAN press Enter) : *****
```

Once the connection is established successfully, it will ask a valid IPv4 address to ping. It will continuously ping the IP and print the received response time in ms(millisecond).

Please enter a valid IPv4 address to test the connection

```
IP address: 8.8.8.8

Starting ping task...
ping: send
8.8.8.8

ping: send
8.8.8.8

ping: recv
8.8.8.8
278 ms

ping: send
8.8.8.8

ping: recv
8.8.8.8
173 ms

ping: send
8.8.8.8

...
```

3.3 wifi_webconfig Sample Application

This section describes *wifi_webconfig* sample application and its configuration along with the application execution. The *wifi_webconfig* sample application is used to demonstrate a commissioning procedure using the uAP with an HTTP server to configure client mode to connect to an AP.

A simple LED control is implemented to check the operational mode. LED is on if the device is in AP mode, and it turns off after device is set to client mode.

The website in AP mode shows the available networks using scan. The desired network can be chosen by clicking on the listed SSID. Once SSID and passphrase are entered and posted, the device attempts to connect to the chosen network with the given configuration.

The Wi-Fi credentials are stored in *mflash*, so the device can connect to the network after a reboot. Once the device comes up with the client mode, the AP mode goes down, and consequently the website closes.

The website allows the user to reset the device to AP mode.

The following figure shows the logical flow diagram of the *wifi_webconfig* sample application.

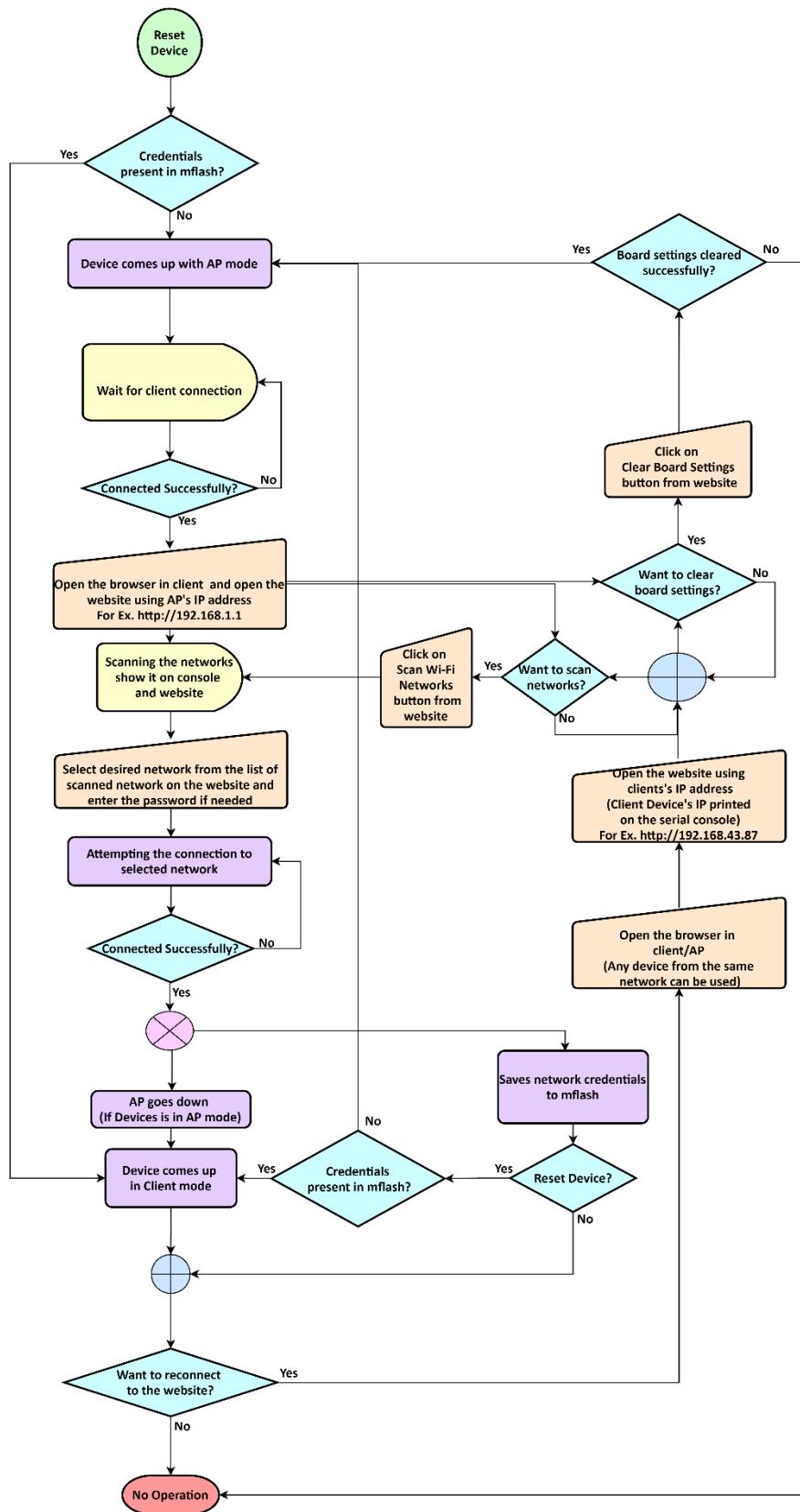


Figure 34: wifi_webconfig flow diagram

The *wifi_webconfig* application features are summarized in the table below.

Table 7: wifi_webconfig Sample Application Features

Features	Details
Wi-Fi and HTTP	Wi-Fi Soft AP mode Wi-Fi Station mode Wi-Fi Security (WPA2 by default for Soft AP) Desired Channel Selection for AP HTTP server (Request GET/POST) DHCP Server/Client

3.3.1 User Configurations

Some of the Wi-Fi features and feature related macros that user can configure based on requirement are listed in below table along with source file name.

Wi-Fi configurations

Table 8: wifi_webconfig Application Wi-Fi Configurations

Feature	Macro definition	Default value	File name	Details
Wi-Fi Soft AP	WIFI_SSID	“nxp_configuration_access_point”	webconfig.h	Default SSID and passphrase to start soft AP using the given sample application. It can be modified by changing the macro value. Default wpa2 security is used.
	WIFI_PASSWORD	“NXP0123456789”		
	WIFI_AP_CHANNEL	1		
	WIFI_AP_IP_ADDR	“192.168.1.1”		
	WIFI_AP_NET_MASK	“255.255.0.0”		

3.3.2 wifi_webconfig Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console setup.

3.3.2.1 Start-up logs

The following logs can be observed on the console once the devices (i.MX RT1060 EVK board and NXP-based wireless module) are up and running. The *Wi-Fi FW version log* shows that the Wi-Fi module is ready to operate.

```
Starting webconfig DEMO
[i] Trying to load data from mflash.
[i] Nothing stored yet
[i] Initializing Wi-Fi connection...
MAC Address: 20:4E:F6:EC:1F:27
[i] Successfully initialized Wi-Fi module
Starting Access Point: SSID: nxp_configuration_access_point, Chnl: 1
[wlcm] Warn: NOTE: uAP will automatically switch to the channel that station is
on.
Now join that network on your device and connect to this IP: 192.168.1.1
```

3.3.2.2 Connect the client to Soft AP

Connect the client to soft AP and observe the logs with the client mac address.

```
Client => 14:AB:C5:F4:C4:C3 Associated with Soft AP
```

3.3.2.3 Open the website in the client web browser

Use the AP IP-192.168.1.1 open website <http://192.168.1.1> in the client browser. Opening the website triggers the scan in the device and the available wireless networks are listed in the console and webpage. The current Wi-Fi mode AP is highlighted on the web page. See Figure 35.

```
Initiating scan...
```

```
Galaxy M210997
    BSSID      : 8A:A3:03:B3:09:97
    RSSI       : -86dBm
    Channel    : 2
nxp
    BSSID      : 38:E6:0A:C6:1A:EC
    RSSI       : -90dBm
    Channel    : 165
```

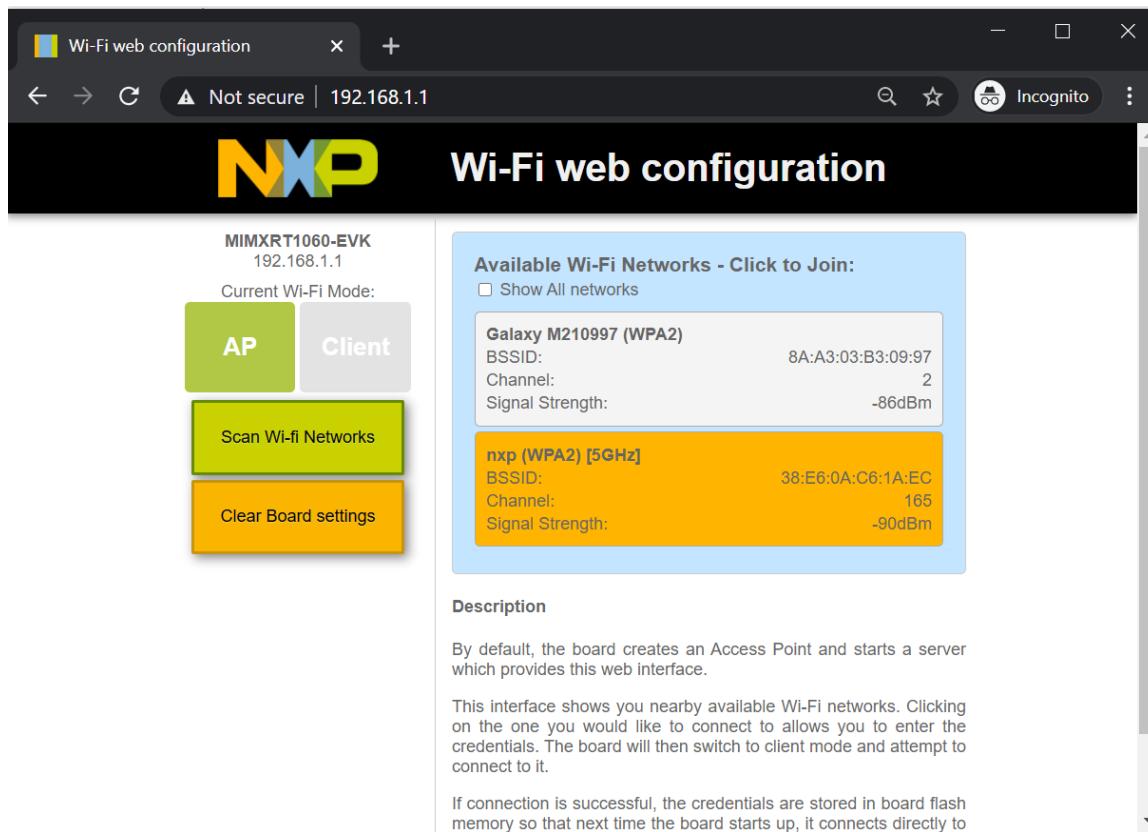


Figure 35: wifi_webconfig Website in AP Mode

3.3.2.4 Connect the device to the AP

Click on the desired SSID on the web page. If the AP uses Wi-Fi security, a dialog box opens and asks to enter a password. Once the credentials are posted, the device attempts the connection to the AP.

NOTE: This demo will not allow to connect with WPA3 SSID

```
[i] Chosen ssid: nxp
[i] Chosen passphrase: "12345678"
[i] Joining: nxp
Switch to channel 165 success!
[i] Successfully joined: nxp
Now join that network on your device and connect to this IP: 192.168.43.35
[i] mflash_save_file success
[i] Stopping AP!
```

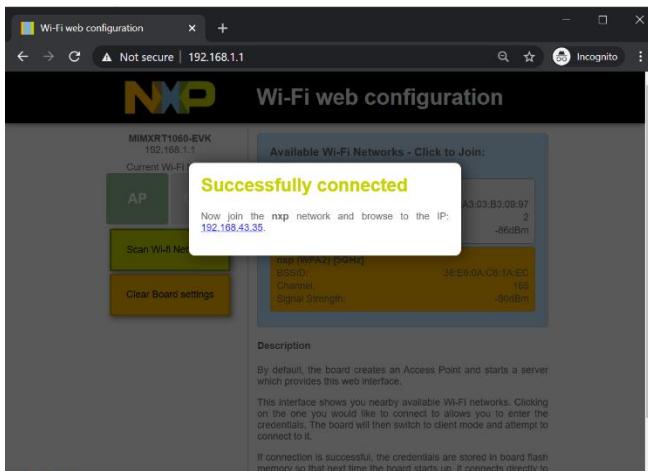
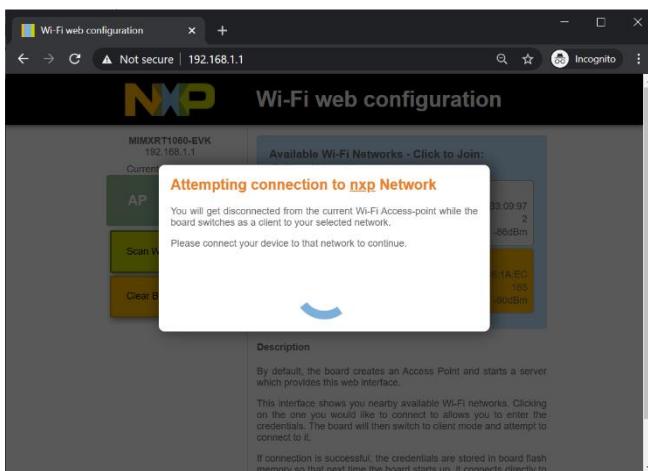
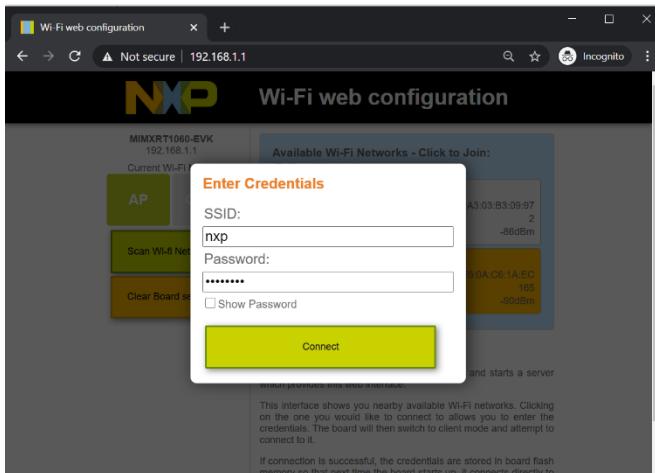


Figure 36: Connection Attempt to AP using wifi_webconfig Application

NOTE: Once the configurations are successfully received by the device, soft AP goes down and the device switches to the client mode. To reconnect to the website, switch to the AP network and use the device (client mode) IP (printed on the console) to open the website.

For example, Figure 37 shows <http://192.168.43.35> to reconnect to website.

The current Wi-Fi mode client is highlighted on the webpage captured in Figure 37.

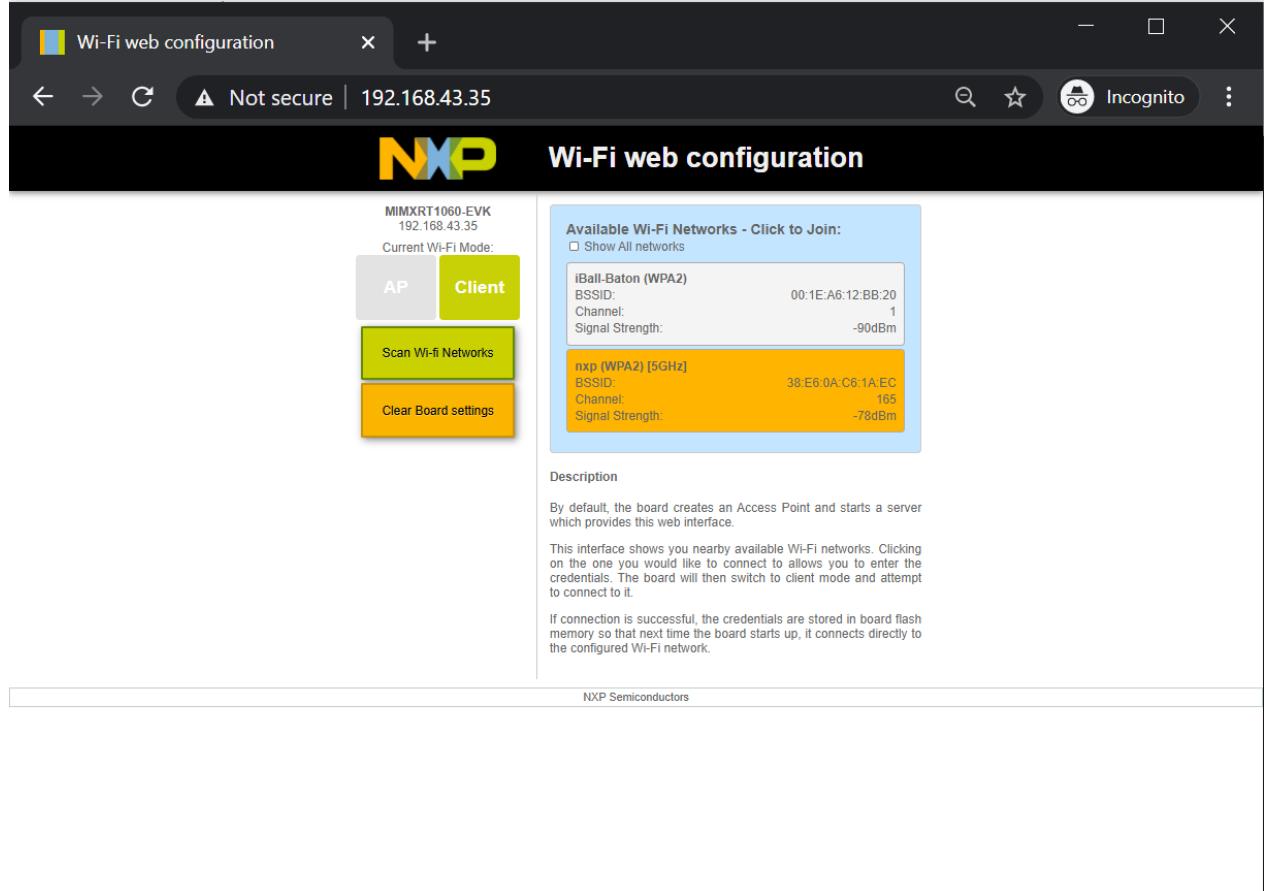


Figure 37: wifi_webconfig Website in Client Mode

3.3.2.5 Device reboot with the configurations stored in mflash

The following logs can be observed when the device has the client configuration saved in *mflash*. It reads the stored information and uses it to configure client mode after a reboot.

```
Starting webconfig DEMO
[i] Trying to load data from mflash.
[i] Saved SSID: nxp, Password: 12345678
[i] Initializing Wi-Fi connection...
MAC Address: 20:4E:F6:EC:1F:27
[i] Successfully initialized Wi-Fi module
Connecting as client to ssid: nxp with password 12345678
```

3.3.2.6 Clear the settings on the website

To clear the configurations saved in mflash, press the **Clear Board settings** button available on the webpage.

```
[i] mflash_save_file success
Starting Access Point: SSID: nxp_configuration_access_point, Chnl: 1
[wlcm] Warn: NOTE: uAP will automatically switch to the channel that station is
on.
Now join that network on your device and connect to this IP: 192.168.1.1
```



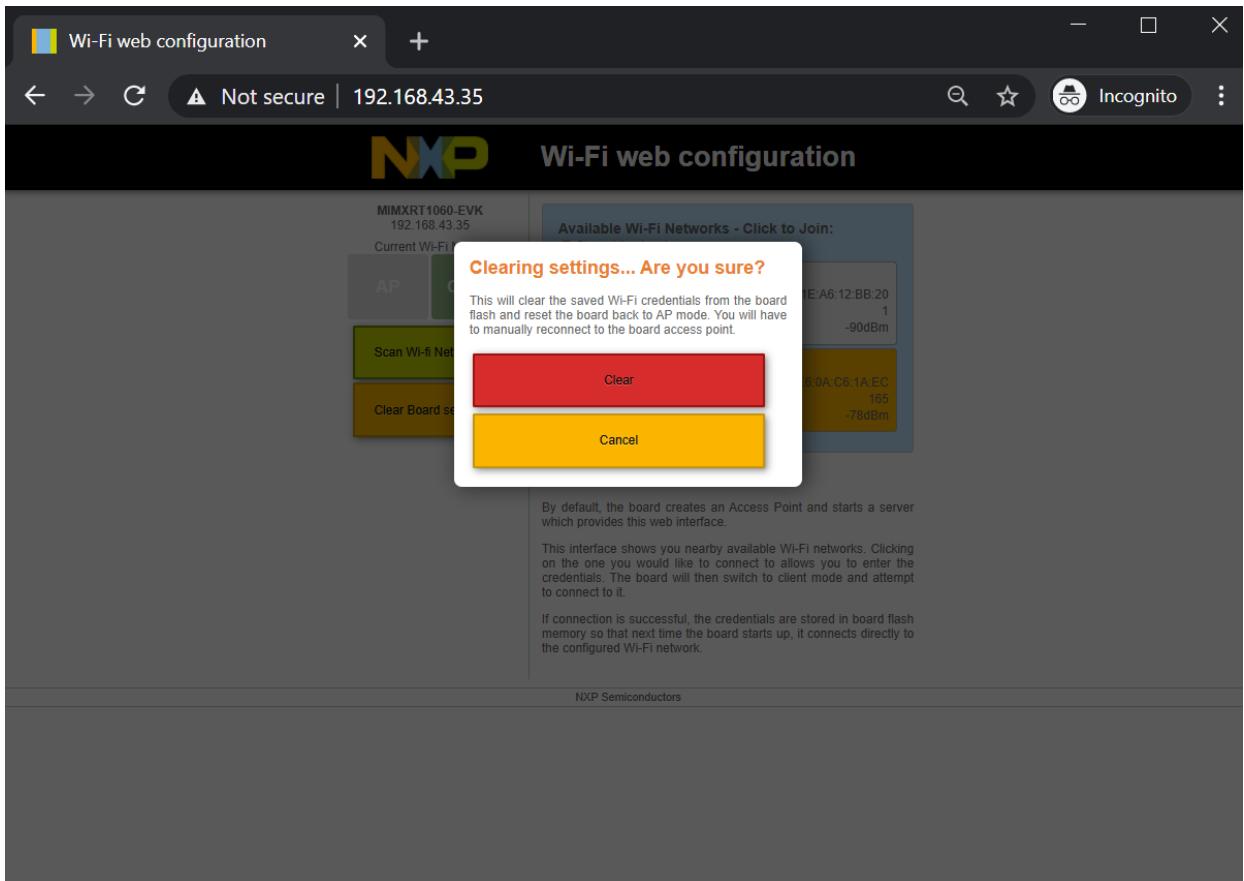


Figure 38: Clear Configurations saved in mflash using website (wifi_webconfig Application)

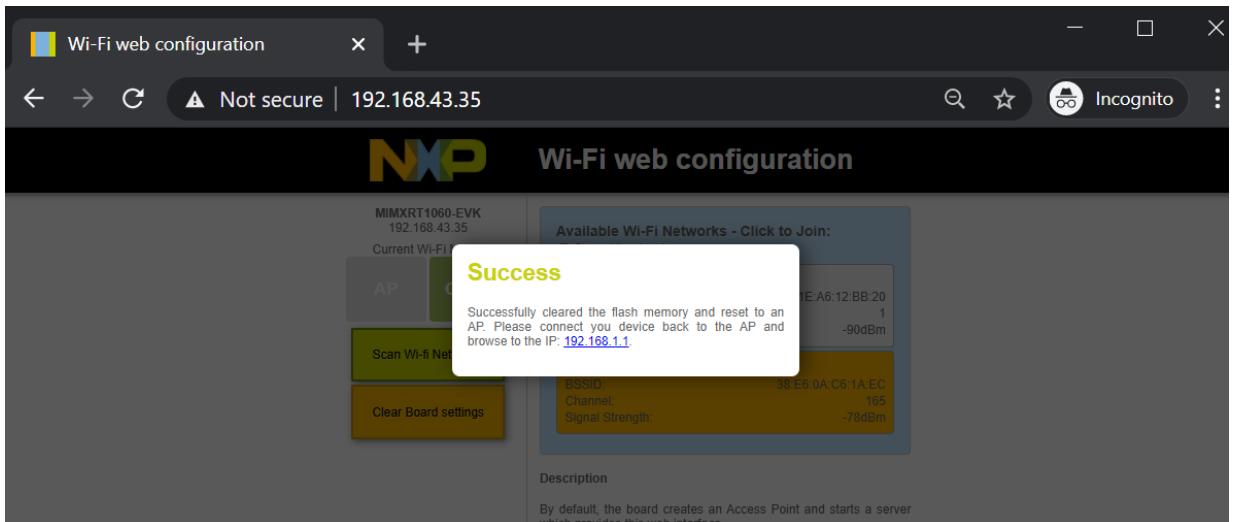


Figure 39: Clear Configuration Success Message in wifi_webconfig Application

3.4 wifi_test_mode Sample Application

This section describes the wifi_test_mode application to demonstrate the CLI support to enable the user to control the Wi-Fi device to run various RF and regulatory compliance tests. This application enables RF testing for the Wi-Fi module. It helps to Measure RF parameters such as transmit power for both 2.4GHz and 5GHz, display RF packet counts, RF antenna configuration and transmit standard 802.11 packets.

3.4.1 wifi_test_mode Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console setup.

3.4.1.1 Run the application

This section describes the available Wi-Fi commands. The application starts with the welcome message, press **Enter** for the command prompt.

```
=====
wifi test mode demo
=====
Initialize CLI
=====
Initialize WLAN Driver
=====
MAC Address: 00:13:43:7F:9C:9F
[net] Initialized TCP/IP networking stack
=====
app_cb: WLAN: received event 10
=====
app_cb: WLAN initialized
=====
WLAN Test Mode CLIs are initialized
=====
CLIs Available:
=====

help
wlan-version
wlan-mac
wlan-set-rf-test-mode
wlan-set-rf-tx-antenna <antenna>
wlan-get-rf-tx-antenna
wlan-set-rf-rx-antenna <antenna>
wlan-get-rf-rx-antenna
wlan-set-rf-band <band>
wlan-get-rf-band
wlan-set-rf-bandwidth <bandwidth>
wlan-get-rf-bandwidth
wlan-set-rf-channel <channel>
wlan-get-rf-channel
wlan-set-rf-tx-power <tx_power> <modulation> <path_id>
wlan-set-rf-tx-cont-mode <enable_tx> <cw_mode> <payload_pattern> <cs_mode>
<act_sub_ch> <tx_rate>
wlan-set-rf-tx-frame <start> <data_rate> <frame_pattern> <frame_len>
<adjust_burst_sifs> <burst_sifs_in_us> <short_preamble> <act_sub_ch> <short_gi>
<adv_coding> <tx_bf> <gf_mode> <stbc> <bssid>
wlan-get-and-reset-rf-per
=====
```

3.4.1.2 Prerequisite Commands

The following steps describe prerequisite commands to start Wi-Fi RF Test.

Wi-Fi RF test mode enable

The following command is used to set Wi-Fi mode to rf test mode:

```
# wlan-set-rf-test-mode  
RF Test Mode configuration successful
```

Wi-Fi RF band set and get

The following commands are used to set and get Wi-Fi band:

Command Usage:

```
# wlan-set-rf-band  
Usage:  
wlan-set-rf-band <band>  
band: 0=2.4G, 1=5G
```

Set and Get RF band:

```
# wlan-set-rf-band 1  
RF Band configuration successful
```

```
# wlan-get-rf-band  
Configured RF Band is: 5G
```

Wi-Fi RF channel set and get

The following commands are used to set and get Wi-Fi channel:

Command Usage:

```
# wlan-set-rf-channel  
Usage:  
wlan-set-rf-channel <channel>
```

Set and Get RF channel:

```
# wlan-set-rf-channel 132  
Channel configuration successful
```

```
# wlan-get-rf-channel  
Configured channel is: 132
```

Wi-Fi RF bandwidth set and get

The following commands are used to set and get Wi-Fi bandwidth:

NOTE: 88W8987 supports 11ac 80MHz support

Command Usage:

```
# wlan-set-rf-bandwidth  
Usage:  
wlan-set-bandwidth <bandwidth>  
  
<bandwidth>:  
    0: 20MHz  
    1: 40MHz  
    4: 80MHz
```

Set and Ge RF Bandwidth:

For 20MHz

```
# wlan-set-rf-bandwidth 0  
Bandwidth configuration successful
```

```
# wlan-get-rf-bandwidth  
Configured bandwidth is: 20MHz
```

For 80MHz

```
# wlan-set-rf-bandwidth 4
Bandwidth configuration successful
```

```
# wlan-get-rf-bandwidth
Configured bandwidth is: 80MHz
```

3.4.1.3 Display and Clear Received Wi-Fi Packet Count

The following command clear the received packet count and displays the received multi-cast and error packet counts.

```
# wlan-get-and-reset-rf-per
PER is as below:
Total Rx Packet Count : 20
Total Rx Multicast/Broadcast Packet Count: 20
Total Rx Packets with FCS error : 9
```

3.4.1.4 Wi-Fi Antenna Configuration

The following commands are used to set and get Wi-Fi Tx/Rx antenna configuration.

Command Usage:

```
# wlan-set-rf-tx-antenna
Usage:
wlan-set-rf-tx-antenna <antenna>
antenna: 1=Main, 2=Aux
```

Set and Get TX antenna configuration:

```
# wlan-set-rf-tx-antenna 1
Tx Antenna configuration successful
```

```
# wlan-get-rf-tx-antenna
Configured Tx Antenna is: Main
```

Command Usage:

```
# wlan-set-rf-rx-antenna
Usage:
wlan-set-rf-rx-antenna <antenna>
antenna: 1=Main, 2=Aux
```

Set and Get RX antenna configuration:

```
# wlan-set-rf-rx-antenna 2
Rx Antenna configuration successful
```

```
# wlan-get-rf-rx-antenna
Configured Rx Antenna is: Aux
```

3.4.1.5 Wi-Fi Tx Power configuration

The following command is used to set the transmitter output power at the antenna using stored calibration data. Power level is in dBm.

Command Usage:

```
# wlan-set-rf-tx-power
Usage:
wlan-set-rf-tx-power <tx_power> <modulation> <path_id>
Power      (0 to 24 dBm)
Modulation (0: CCK, 1:OFDM, 2:MCS)
Path ID    (0: PathA, 1:PathB, 2:PathA+B)
```

Set Tx Power:

```
# wlan-set-rf-tx-power 8 1 1
Tx Power configuration successful
Power      : 8 dBm
```

Modulation	:	OFDM
Path ID	:	PathB

3.4.1.6 Wi-Fi set transmitter in CW mode

The following command is used to set Wi-Fi transmitter to Continuous Wave (CW) mode.

Command Usage:

For different data rate values See Table 9bgn: Data rate parameter

```
# wlan-set-rf-tx-cont-mode
Usage:
wlan-set-rf-tx-cont-mode <enable_tx> <cw_mode> <payload_pattern> <cs_mode>
<act_sub_ch> <tx_rate>
Enable           (0:disable, 1:enable)
Continuous Wave Mode (0:disable, 1:enable)
Payload Pattern   (0 to 0xFFFFFFFF) (Enter hexadecimal value)
CS Mode          (Applicable only when continuous wave is disabled)
(0:disable, 1:enable)
Active SubChannel (0:low, 1:upper, 3:both)
Tx Data Rate      (Rate Index corresponding to legacy/HT/VHT rates)
```

To Disable:

```
wlan-set-rf-tx-cont-mode 0
```

Enable CW mode:

```
# wlan-set-rf-tx-cont-mode 1 1 B496DEB6 0 0 7
Tx continuous configuration successful
    Enable           : enable
    Continuous Wave Mode : enable
    Payload Pattern   : 0x7FFFFFFF
    CS Mode          : disable
    Active SubChannel : low
    Tx Data Rate     : 7
```

Disable CW mode:

```
# wlan-set-rf-tx-cont-mode 0
Tx continuous configuration successful
    Enable           : disable
    Continuous Wave Mode : disable
    Payload Pattern   : 0x00000000
    CS Mode          : disable
    Active SubChannel : low
    Tx Data Rate     : 0
```

NOTE: It is required to disable CW mode once test completed. CW mode test and TX frame test does not support parallel operation.

Table 9bgn: Data rate parameter

ID	Data rate
0	1Mbits/sec
1	2Mbits/sec
2	5.5Mbits/sec
3	11Mbits/sec
4	22Mbits/sec
5	6Mbits/sec
6	9Mbits/sec
7	12Mbits/sec
8	18Mbits/sec
9	24Mbits/sec
10	36Mbits/sec
11	48Mbits/sec
12	54Mbits/sec
13	72Mbits/sec
14	HT_MCS 0
15	HT_MCS 1
16	HT_MCS 2
17	HT_MCS 3
18	HT_MCS 4
19	HT_MCS 5
20	HT_MCS 6
21	HT_MCS 7
46	HT_MCS 32

Table 10: 11ac Data rate parameter

ID	Data rate
0	1Mbits/sec
1	2Mbits/sec
2	5.5Mbits/sec
3	11Mbits/sec
4	Reserved
5	6Mbits/sec
6	9Mbits/sec
7	12Mbits/sec
8	18Mbits/sec
9	24Mbits/sec
10	36Mbits/sec
11	48Mbits/sec

12	54Mbits/sec
13	Reserved
14	HT_MCS 0
15	HT_MCS 1
16	HT_MCS 2
17	HT_MCS 3
18	HT_MCS 4
19	HT_MCS 5
20	HT_MCS 6
21	HT_MCS 7
22	HT_MCS 8
23	HT_MCS 9
24	HT_MCS 10
25	HT_MCS 11
26	HT_MCS 12
27	HT_MCS 13
28	HT_MCS 14
29	HT_MCS 15
256	VHT_SS1_MCS0
257	VHT_SS1_MCS1
258	VHT_SS1_MCS2
259	VHT_SS1_MCS3
260	VHT_SS1_MCS4
261	VHT_SS1_MCS5
262	VHT_SS1_MCS6
263	VHT_SS1_MCS7
264	VHT_SS1_MCS8
265	VHT_SS1_MCS9

3.4.1.7 Transmit standard 802.11 packets

The following command is used to continuously transmit packets, with an adjustable time gap of 0 to 250 microseconds between packets.

Command Usage:

For different data rate values See Table 9bgn: Data rate parameter

```
# wlan-set-rf-tx-frame
Usage:
wlan-set-rf-tx-frame <start> <data_rate> <frame_pattern> <frame_len>
<adjust_burst_sifs> <burst_sifs_in_us> <short_preamble> <act_sub_ch> <short_gi>
<adv_coding> <tx_bf> <gf_mode> <stbc> <bssid>
Enable          (0:disable, 1:enable)
Tx Data Rate    (Rate Index corresponding to legacy/HT/VHT rates)
Payload Pattern (0 to 0xFFFFFFFF) (Enter hexadecimal value)
Payload Length  (1 to 0x400) (Enter hexadecimal value)
Adjust Burst SIFS3 Gap (0:disable, 1:enable)
Burst SIFS in us (0 to 255us)
Short Preamble   (0:disable, 1:enable)
```

Active SubChannel	(0:low, 1:upper, 3:both)
Short GI	(0:disable, 1:enable)
Adv Coding	(0:disable, 1:enable)
Beamforming	(0:disable, 1:enable)
GreenField Mode	(0:disable, 1:enable)
STBC	(0:disable, 1:enable)
BSSID	(xx:xx:xx:xx:xx:xx)

To Disable:

```
wlan-set-rf-tx-frame 0
```

Enable Tx Frame:

```
# wlan-set-rf-tx-frame 1 7 2730 256 0 0 0 0 0 0 0 0 0 0 0 0 38:E6:0A:C6:1A:EC  
Tx Frame configuration successful
```

```
Enable : enable
Tx Data Rate : 7
Payload Pattern : 0x000002730
Payload Length : 0x00000256
Adjust Burst SIFS3 Gap : disable
Burst SIFS in us : 0 us
Short Preamble : disable
Active SubChannel : low
Short GI : disable
Adv Coding : disable
Beamforming : disable
GreenField Mode : disable
STBC : disable
BSSID : 38:E6:0A:C6:1A:EC
```

Packet Capture:

Please refer section 2.2 for the Wireshark tool setup and start capturing packets for configured channel and bandwidth.

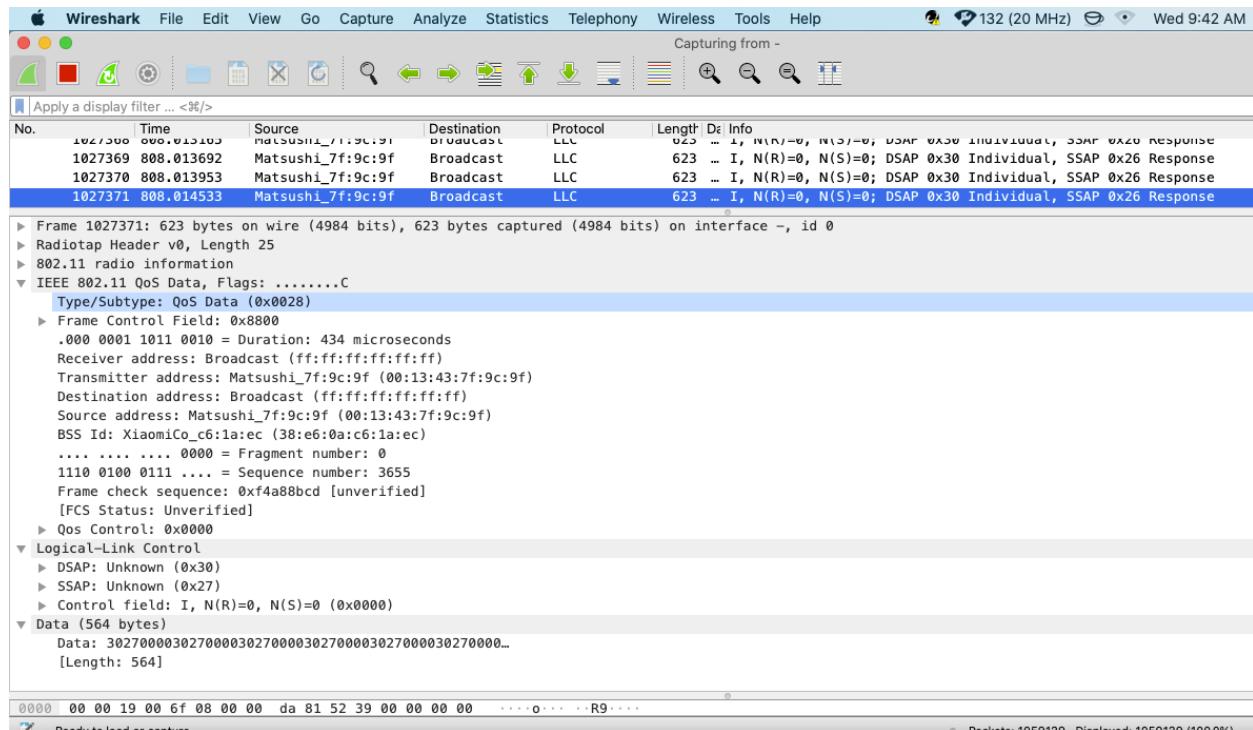


Figure 40: TX Frame Packet Capture

Disable TX Frame

```
# wlan-set-rf-tx-frame 0
```

```

Tx Frame configuration successful
  Enable          : disable
  Tx Data Rate    : 0
  Payload Pattern : 0x00000000
  Payload Length  : 0x00000001
  Adjust Burst SIFS3 Gap : disable
  Burst SIFS in us : 0 us
  Short Preamble   : disable
  Active SubChannel : low
  Short GI          : disable
  Adv Coding         : disable
  Beamforming        : disable
  GreenField Mode   : disable
  STBC              : disable
  BSSID             : 00:00:00:00:00:00

```

3.4.1.8 Other useful CLI commands

Use the other commands to get the Wi-Fi information, driver version and firmware version.

Get the Wi-Fi driver and firmware version:

```

# wlan-version
WLAN Driver Version   : vX.X.rXX.pX
WLAN Firmware Version : IW416-V0, RF878X, FP91, 16.91.21.p91.4, WPA2_CVE_FIX_1,
PVE_FIX_1

```

Get the Wi-Fi MAC address:

```

MAC address
00:13:43:7F:9C:9F

```

3.4.1.9 Example command sequences for adjusting Tx power in 2.4GHz

The radio is configured as shown below.

- 2.4 GHz band
- Channel 6
- 20 MHz bandwidth
- 6 Mbps legacy data rate
- Test pattern transmitted is 0x00000AAA
- Output power set to +15 dBm. then adjusted to +14 dBm
- For different data rate values See Table 9bgn: Data rate parameter

Table 11: Tx power command sequences for 2.4GHz

Step	Operation	Command
1	Set RF test mode	# wlan-set-rf-test-mode rf_test_mode set successfully
2	Set RF band	# wlan-set-rf-band 0 RF Band configuration successful
3	Set RF bandwidth (switched order with step 4)	# wlan-set-rf-bandwidth 0 Bandwidth configuration successful
4	Set RF channel	# wlan-set-rf-channel 6 Channel configuration successful
5	Set Tx antenna	# wlan-set-rf-tx-antenna 1 Tx antenna configuration successful
6	Get settings (optional)	# wlan-get-rf-band Configured RF band is: 2.4 G # wlan-get-rf-channel Configured channel is: 6

		# wlan-get-rf-bandwidth Configured bandwidth is: 20MHz
7	Set output power to +15 dBm	# wlan-set-rf-tx-power 15 1 0 Tx Power configuration successful Power : 15 dBm Modulation : OFDM Path ID : PathA
8	Set continuous transmit mode	# wlan-set-rf-tx-cont-mode 1 0 0xAAA 0 3 5 Tx continuous mode successful Enable : enable CW mode : disable Payload pattern : 0x00000AAA CS mode : disable Active SubChannel : both Tx Data Rate : 5
9	Stop transmission	# wlan-set-rf-tx-cont-mode 0
10	Set output power to +14 dBm	# wlan-set-rf-tx-power 14 1 0 Tx Power configuration successful Power : 14 dBm Modulation : OFDM Path ID : PathA
11	Restart transmission	# wlan-set-rf-tx-cont-mode 1 0 0xAAA 0 3 5 Tx continuous mode successful Enable : enable CW mode : disable Payload pattern : 0x00000AAA CS mode : disable Active SubChannel : both Tx Data Rate : 5
12	Stop transmission	# wlan-set-rf-tx-cont-mode 0

3.4.1.10 Example command sequences for adjusting Tx power in 5GHz

The radio is configured as shown below.

- 5 GHz band
- Channel 44/48
- 40 MHz bandwidth
- MCS0 HT data rate
- Test pattern transmitted is 0x00BBBAAA
- Output power set to +9 dBm, then adjusted to +8 dBm.
- For different data rate values See Table 9bgn: Data rate parameter

Table 12: Tx power command sequences for 5GHz

Step	Operation	Command
1	Set RF test mode	# wlan-set-rf-test-mode RF Test Mode configuration successful
2	Set RF band	# wlan-set-rf-band 1

		RF Band configuration successful
3	Set RF bandwidth (switched order with step 4)	# wlan-set-rf-bandwidth 1 Bandwidth configuration successful
4	Set RF channel	# wlan-set-rf-channel 48 Channel configuration successful
5	Set Tx antenna	# wlan-set-rf-tx-antenna 1 Tx antenna configuration successful
6	Get settings (optional)	# wlan-get-rf-band Configured RF band is: 5 G # wlan-get-rf-channel Configured channel is: 48 # wlan-get-rf-bandwidth Configured bandwidth is: 40MHz
7	Set output power to +10 dBm	# wlan-set-rf-tx-power 10 1 0 Tx Power configuration successful Power : 10 dBm Modulation : OFDM Path ID : PathA
8	Set continuous transmit mode	# wlan-set-rf-tx-cont-mode 1 0 0xBAA 0 3 14 Tx continous mode successful Enable : enable CW mode : disable Payload pattern : 0x00BBBAAA CS mode : disable Active SubChannel : both Tx Data Rate : 14
9	Stop transmission	# wlan-set-rf-tx-cont-mode 0
10	Set output power to +9 dBm	# wlan-set-rf-tx-power 9 1 0 Tx Power configuration successful Power : 9 dBm Modulation : OFDM Path ID : PathA
11	Restart transmission	# wlan-set-rf-tx-cont-mode 1 0 0xBAA 0 3 14 Tx continous mode successful Enable : enable CW mode : disable Payload pattern : 0x00BBBAAA CS mode : disable Active SubChannel : both Tx Data Rate : 14
12	Stop transmission	# wlan-set-rf-tx-cont-mode 0

13	Set output power to +8 dBm	# wlan-set-rf-tx-power 8 1 0 Tx Power configuration successful Power : 8 dBm Modulation : OFDM Path ID : PathA
14	Restart transmission	# wlan-set-rf-tx-cont-mode 1 0 0xBBBAAA 0 3 14 Tx continuous mode successful Enable : enable CW mode : disable Payload pattern : 0x00BBBAAA CS mode : disable Active SubChannel : both Tx Data Rate : 14
15	Stop transmission	# wlan-set-rf-tx-cont-mode 0

3.5 wifi_cert Sample Application

This section describes the *wifi_cert* application to demonstrate the CLI support to handle and enable Wi-Fi configuration for different features. This sample application includes commands related to the Wi-Fi certification process. In this sample application Wi-Fi connection manager CLIs are available.

NOTE: *Support for this application is available only for i.MX RT1060 EVK board.*

Table 13: wifi_cert Application Features

Features	Details
Wi-Fi	Wi-Fi Soft AP mode Wi-Fi Station mode Wi-Fi Scan Wi-Fi Tx Power Limit Wi-Fi Active/Passive Channel List Wi-Fi Tx Data Rate Wi-Fi Management Frame Protection Wi-Fi ED MAC Wi-Fi host sleep-wowlan Wi-Fi RF Calibration Wi-Fi coexistence with external radios (for 88W8801)
IPerf	TCP Client and Server TCP Client dual mode (Tx and Rx in simultaneous) TCP Client trade-off mode (Tx and Rx individual) UDP Client and Server UDP Client dual mode (Tx and Rx in simultaneous) UDP Client trade-off mode (Tx and Rx individual)

3.5.1 wifi_cert Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console setup.

3.5.1.1 Run the application

This section describes the available Wi-Fi commands. The application starts with the welcome message, press **Enter** for the command prompt.

```
=====
wifi cert demo
=====
Initialize CLI
=====
Initialize WLAN Driver
=====
MAC Address: 00:13:43:7F:9C:9F
[net] Initialized TCP/IP networking stack
=====
app_cb: WLAN: received event 10
=====
app_cb: WLAN initialized
=====
WLAN CLIs are initialized
=====
ENHANCED WLAN CLIs are initialized
=====
CLIs Available:
=====

help
wlan-version
wlan-mac
wlan-scan
wlan-scan-opt ssid <ssid> bssid ...
wlan-add <profile_name> ssid <ssid> bssid...
wlan-remove <profile_name>
wlan-list
wlan-connect <profile_name>
wlan-start-network <profile_name>
wlan-stop-network
wlan-disconnect
wlan-stat
wlan-info
wlan-address
wlan-get-uap-channel
wlan-get-uap-sta-list
wlan-ieee-ps <0/1>
wlan-deep-sleep-ps <0/1>
wlan-host-sleep <0/1> wowlan_test <0/1>
wlan-send-hostcmd
wlan-8801-enable-ext-coex
wlan-set-regioncode <region-code>
wlan-get-regioncode
wlan-get-txpwrlimit <subband>
wlan-set-txpwrlimit
wlan-set-chanlist-and-txpwrlimit
wlan-set-chanlist
wlan-get-chanlist
wlan-set-txratecfg <format> <index>
wlan-get-txratecfg
wlan-get-data-rate
wlan-set-pmfcfg <mfpc> <mfpr>
wlan-get-pmfcfg
wlan-set-antcfg <ant mode> [evaluate_time]
wlan-get-antcfg
wlan-set-ed-mac-mode <ed_ctrl_2g> <ed_offset_2g>
```

```
wlan-get-ed-mac-mode
ping [-s <packet_size>] [-c <packet_count>] [-W <timeout in sec>] <ipv4
address>
iperf [-s|-c <host>|-a|-h] [options]
dhcp-stat
=====
```

Note: Please refer sections 3.1.5.4 to 0 for basic Wi-Fi features like Wi-Fi Scan, Wi-Fi AP mode, Wi-Fi Station mode, IPerf etc.

3.5.1.2 Set/Get Region Code

The following commands are used to set and get region code:

Command Usage:

```
# wlan-set-regioncode
Usage:
wlan-set-regioncode <region-code>
where, region code =
0xAA : World Wide Safe Mode
0x10 : US FCC, Singapore
0x20 : IC Canada
0x30 : ETSI, Australia, Republic of Korea
0x32 : France
0x40 : Japan
0x41 : Japan
0x50 : China
0xFE : Japan
0xFF : Special
```

Set region code:

```
# wlan-set-regioncode 0xAA
Region code: 0xaa set
```

Get region code:

```
# wlan-get-regioncode
Region code: 0xaa
```

NOTE: We cannot set region code if the region code is programmed in the module's One Time Programmable (OTP) memory during production process of device.

3.5.1.3 Set/Get Tx Power Limit

The following commands are used to get and set tx power limit:

Command Usage:

```
# wlan-get-txpwrlimit
Usage:
wlan-get-txpwrlimit <subband>

Where subband is:
    0x00 2G subband (2.4G: channel 1-14)
    0x10 5G subband0 (5G: channel 36,40,44,48,
                      52,56,60,64)
    0x11 5G subband1 (5G: channel 100,104,108,112,
                      116,120,124,128,
                      132,136,140,144)
    0x12 5G subband2 (5G: channel 149,153,157,161,165,172)
    0x13 5G subband3 (5G: channel 183,184,185,187,188,
                      189, 192,196,
                      5G: channel 7,8,11,12,16,34)
```

Get Tx Power Limit:

```
# wlan-get-txpwrlimit 00
-----
```

```
Get txpwrlimit: sub_band=0
```

```
StartFreq: 2407
ChanWidth: 20
ChanNum: 1
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 2
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 3
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 4
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 5
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 6
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 7
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 8
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 9
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 10
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 11
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 12
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2414
ChanWidth: 20
ChanNum: 14
Pwr:0,0,1,0,2,0,3,0,4,0,5,0,6,0
```

Set Tx Power Limit:

NOTE: This command will first set tx power configurations for the band 2GHz or both 2GHz and 5GHz based on the Wi-Fi module selection and then prints saved tx power configurations of all the sub-bands on the console output.

```
# wlan-set-txpwrlimit
-----
-
StartFreq: 2407
ChanWidth: 20
ChanNum: 1
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 2
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 3
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 4
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 5
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 6
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 7
...
...
```

3.5.1.4 Set/Get Active/Passive Channel List

The following commands are used to set and get active and passive channel list.

Set Channel List:

```
# wlan-set-chanlist
-----
-
Number of channels configured: 39

ChanNum: 1      ChanFreq: 2412  Active
ChanNum: 2      ChanFreq: 2417  Active
ChanNum: 3      ChanFreq: 2422  Active
ChanNum: 4      ChanFreq: 2427  Active
ChanNum: 5      ChanFreq: 2432  Active
ChanNum: 6      ChanFreq: 2437  Active
ChanNum: 7      ChanFreq: 2442  Active
ChanNum: 8      ChanFreq: 2447  Active
ChanNum: 9      ChanFreq: 2452  Active
ChanNum: 10     ChanFreq: 2457  Active
ChanNum: 11     ChanFreq: 2462  Active
ChanNum: 12     ChanFreq: 2467  Passive
ChanNum: 13     ChanFreq: 2472  Passive
ChanNum: 14     ChanFreq: 2484  Passive
ChanNum: 36     ChanFreq: 5180  Active
...
...
```

Get Channel List:

```
# wlan-get-chanlist
-----
-
Number of channels configured: 39

ChanNum: 1      ChanFreq: 2412  Active
ChanNum: 2      ChanFreq: 2417  Active
ChanNum: 3      ChanFreq: 2422  Active
ChanNum: 4      ChanFreq: 2427  Active
ChanNum: 5      ChanFreq: 2432  Active
ChanNum: 6      ChanFreq: 2437  Active
ChanNum: 7      ChanFreq: 2442  Active
ChanNum: 8      ChanFreq: 2447  Active
ChanNum: 9      ChanFreq: 2452  Active
ChanNum: 10     ChanFreq: 2457  Active
ChanNum: 11     ChanFreq: 2462  Active
ChanNum: 12     ChanFreq: 2467  Passive
ChanNum: 13     ChanFreq: 2472  Passive
ChanNum: 14     ChanFreq: 2484  Passive
ChanNum: 36     ChanFreq: 5180  Active
...
```

3.5.1.5 Set Channel List and Tx Power Limit

The following command is used to set channel list as well as tx power limit.

NOTE: This command will first set defined configuration of channel list and tx power limit and then prints saved configuration on the console output.

```
# wlan-set-chanlist-and-txpwrlimit
-----
```

```
-
Get txpwrlimit: sub_band=0
StartFreq: 2407
ChanWidth: 20
ChanNum: 1
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 2
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 3
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 4
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 5
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 6
Pwr:0,8,1,8,2,8,3,8,4,8,5,8,6,8
StartFreq: 2407
ChanWidth: 20
ChanNum: 7
...
Number of channels configured: 39
```

```

ChanNum: 1      ChanFreq: 2412  Active
ChanNum: 2      ChanFreq: 2417  Active
ChanNum: 3      ChanFreq: 2422  Active
ChanNum: 4      ChanFreq: 2427  Active
ChanNum: 5      ChanFreq: 2432  Active
ChanNum: 6      ChanFreq: 2437  Active
ChanNum: 7      ChanFreq: 2442  Active
ChanNum: 8      ChanFreq: 2447  Active
ChanNum: 9      ChanFreq: 2452  Active
ChanNum: 10     ChanFreq: 2457  Active
ChanNum: 11     ChanFreq: 2462  Active
ChanNum: 12     ChanFreq: 2467  Passive
ChanNum: 13     ChanFreq: 2472  Passive
ChanNum: 14     ChanFreq: 2484  Passive
ChanNum: 36     ChanFreq: 5180  Active
...

```

3.5.1.6 Set/Get Tx Rate Configuration

The following commands are used to set and get tx rate.

Command Usage:

```

# wlan-set-txratecfg
Invalid arguments
Usage:
wlan-set-txratecfg <format> <index>
    Where
        <format> - This parameter specifies the data rate format used in this
command
            0:    LG
            1:    HT
            0xff: Auto
        <index> - This parameter specifies the rate or MCS index
If <format> is 0 (LG),
            0      1 Mbps
            1      2 Mbps
            2      5.5 Mbps
            3      11 Mbps
            4      6 Mbps
            5      9 Mbps
            6      12 Mbps
            7      18 Mbps
            8      24 Mbps
            9      36 Mbps
            10     48 Mbps
            11     54 Mbps
If <format> is 1 (HT),
            0      MCS0
            1      MCS1
            2      MCS2
            3      MCS3
            4      MCS4
            5      MCS5
            6      MCS6
            7      MCS7

```

Set Tx Rate:

```

# wlan-set-txratecfg ff 0
Configured txratecfg as below:
Tx Rate Configuration:
Type:          0 (LG)
Rate Index:   0 (1 Mbps)

```

Get Tx Rate:

```
# wlan-get-txratecfg
Tx Rate Configuration:
  Type:          0xFF (Auto)
  Rate Index:   0 (1 Mbps)
```

Get Data Rate:

```
# wlan-get-data-rate
Data Rate:
  TX:
    Type:  LG
    Rate: 1 Mbps
  RX:
    Type:  LG
    Rate: 1 Mbps
```

3.5.1.7 Set/Get Management Frame Protection Capability

The following commands are used to set and get MFP capability:

Command Usage:

```
# wlan-set-pmfcfg
```

Usage:

```
wlan-set-pmfcfg <mfpc> <mfpr>
```

<mfpc>: Management Frame Protection Capable (MFPC)

 1: Management Frame Protection Capable

 0: Management Frame Protection not Capable

<mfpr>: Management Frame Protection Required (MFPR)

 1: Management Frame Protection Required

 0: Management Frame Protection Optional

Default setting is PMF not capable.

mfpc = 0, mfpr = 1 is an invalid combination

Set MFP capability:

```
# wlan-set-pmfcfg 1 1
```

PMF configuration successful

Get MFP Capability:

```
# wlan-get-pmfcfg
```

Management Frame Protection Capability: Yes

Management Frame Protection: Required

3.5.1.8 Set/Get Antenna Diversity Configuration

The following commands are used to set and get antenna diversity configuration:

NOTE: Make sure second antenna is connected before performing antenna configurations.

Command Usage:

```
# wlan-set-antcfg
```

Usage:

```
wlan-set-antcfg <ant mode> [evaluate_time]
```

<ant mode>:

 Bit 0 -- Tx/Rx antenna 1

 Bit 1 -- Tx/Rx antenna 2

 0xFFFF -- Tx/Rx antenna diversity

```
[evaluate_time]:
if ant mode = 0xFFFF, SAD evaluate time interval,
default value is 6s(0x1770)
```

3.5.1.9 Set/Get ED MAC Feature

This feature enables the European Union (EU) adaptivity test as per the compliance requirements in the ETSI standard.

Depending on the device and front-end loss, the Energy Detection (ED) threshold offset (ed_ctrl_2g.offset and ed_ctrl_5g.offset) needs to be adjusted. The ED threshold offset can be adjusted in steps of 1 dB.

This section includes definitions of the commands and examples which shows how to adjust ED MAC. Below are the get and set commands for ED-MAC adjustment.

wlan-get-ed-mac-mode <interface>

#wlan-set-ed-mac-mode <ed_ctrl_2g> <ed_offset_2g> <ed_ctrl_5g> <ed_offset_5g>

Where:

Table 14: ED MAC Parameters

Parameter	Description
interface	0 = STA 1 = uAP
ed_ctrl_2_g	0 = disable ED MAC threshold for 2.4GHz band 1 = enable ED MAC threshold for 2.4GHz band
ed_offset_2_g	ED MAC threshold for 2.4 GHz band. Hexadecimal value in units of dB Range: 0x80 to 0x7F, (-128 to 127), 0 = default offset value
ed_ctrl_5_g	0 = disable ED MAC threshold for 5GHz band 1 = enable ED MAC threshold for 5GHz band
ed_offset_5_g	ED MAC threshold for 5 GHz band. Hexadecimal value in units of dB Range: 0x80 to 0x7F, (-128 to 127), 0 = default offset value

For 2.4GHz band:

In this example, the 2.4 GHz ED-MAC threshold is lowered by 1 dB.

Table 15: ED MAC 2.4 GHz Command Operations

Step	Operation	Command
1	Get ED-MAC status	#wlan-get-ed-mac-mode 0 EU adaptivity for 2.4GHz band : Enabled Energy Detect threshold offset : 0X9
2	Set ED-MAC threshold	#wlan-set-ed-mac-mode 0 1 0x8 ED MAC MODE settings configuration successful

For 5GHz band:

In this example, the 5 GHz ED-MAC threshold is lowered by 2 dB.

Table 16: ED MAC 5 GHz Command Operations

Step	Operation	Command
1	Get ED-MAC status	#wlan-get-ed-mac-mode 0 EU adaptivity for 2.4GHz band : Enabled Energy Detect threshold offset : 0X9 EU adaptivity for 5GHz band : Enabled Energy Detect threshold offset : 0Xc
2	Set ED-MAC threshold	#wlan-set-ed-mac-mode 0 1 0x9 1 0x3 ED MAC MODE settings configuration successful

3.6 wifi_ipv4_ipv6_echo Sample Application

The *wifi_ipv4_ipv6_echo* application demonstrates a TCP and UDP echo on the lwIP TCP/IP stack with FreeRTOS. The demo can use both TCP or UDP protocol over IPv4 or IPv6 and acts as an echo server. The application sends back the packets received from the PC, which can be used to test whether a TCP or UDP connection is available.

The demo generates a *IPv6* link-local address (the one from range FE80::/10) after the start. To send something to this (demo) address from the remote computer need to specify the interface over which the demo is reachable by appending % followed by zone index. Please refer to section [2.4](#) for more details about zone index.

3.6.1 wifi_ipv4_ipv6_echo Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console setup and section 2.4 for ipv4/6 tool setup.

3.6.1.1 Run the application

This section describes the available Wi-Fi commands. The application starts with the welcome message, press **Enter** for the command prompt.

```
=====
Initialize WLAN Driver
=====
MAC Address: 48:E7:DA:9A:CE:39
Initialize CLI
=====

Copyright 2020 NXP
```

3.6.1.2 Help command

```
SHELL>> help

"help": List all the registered commands

"exit": Exit program

"echo_tcp_client ip_addr port":
    Connects to specified server and sends back every received data.
Usage:
    ip_addr:      IPv6 or IPv4 server address
    port:         TCP port number

"echo_tcp_server port":
    Listens for incoming connection and sends back every received data.
Usage:
    port:         TCP port number

"echo_udp port":
    Waits for datagrams and sends them back.
Usage:
    port:         UDP port number

"end": Ends echo_* command.

"print_ip_cfg": Prints IP configuration.

"wlan_scan": Scans networks.

"wlan_connect ssid":
    Connects to the specified network without password.
Usage:
    ssid:        network SSID or BSSID

"wlan_connect_with_password ssid password":
    Connects to the specified network with password.
Usage:
    ssid:        network SSID or BSSID
    password:   password
SHELL>>
```

3.6.1.3 Scan command

The scan command is used to scan the visible access points.

```
SHELL>> wlan_scan
Scanning
SHELL>>
Initiating scan...
NXP_V10
    BSSID       : 5C:DF:89:0F:32:78
    RSSI        : -67dBm
    Channel     : 1
nxp
    BSSID       : 8E:36:15:52:42:0C
    RSSI        : -51dBm
    Channel     : 11
...
```

3.6.1.4 Connect to found access point

Connect to the network using one of the following commands:

```
wlan_connect <(b) ssid>
```

```
wlan_connect_with_password <(b) ssid> <password>
```

NOTE: SSID (the name of the network) or BSSID (it's mac)

```
wlan_connect_with_password nxp 12345678
```

```
Joining: nxp
```

```
Network joined
```

3.6.1.5 Print IP Configuration

This command will print IPv4 and IPv6 address of the board received from the external access point

```
SHELL>> print_ip_cfg
```

```
*****
```

```
IPv4 Address : 192.168.148.150
```

```
IPv4 Subnet mask : 255.255.255.0
```

```
IPv4 Gateway : 192.168.148.93
```

```
IPv6 Address0 : FE80::224E:F6FF:FECC:1F27
```

```
IPv6 Address1 : 2409:40C1:4E:7AFA:224E:F6FF:FECC:1F27
```

```
IPv6 Address2 : -
```

```
*****
```

NOTE: It is necessary to have installed tools capable of sending and receiving data over TCP or UDP to interact with the demo. Please refer to the section [2.4](#) for tool setup.

3.6.1.6 TCP client echo

Run ncat on Remote host computer.

```
C:\Users\nxp>ncat -v -l -p 10001
Ncat: Version 7.92 ( https://nmap.org/ncat )
Ncat: Listening on :::10001
Ncat: Listening on 0.0.0.0:10001
```

IPv4

Run the command echo_tcp_client <Remote host PC IPv4 addr> 10001 in demo shell.

```
SHELL>> echo_tcp_client 192.168.148.80 10001
```

```
Creating new socket.
```

```
Connecting...
```

```
Connected.
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
C:\Users\nxp>
Ncat: Connection from 192.168.148.150.
Ncat: Connection from 192.168.148.150:49153.
```

```
hello
```

```
hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
Echoing data. Use end command to return...
```

```
ECHO_TCP_CLIENT>>
```

```
6B sent back.
```

IPv6

Run the command echo_tcp_client <Remote host PC IPv6 addr> 10001 in demo shell.

```
SHELL>> echo_tcp_client fe80::8f3d:b4b4:b64f:764d 10001
```

```
Creating new socket.
```

```
Connecting...
```

```
Connected.
```

```
Echoing data. Use end command to return...
```

```
ECHO_TCP_CLIENT>>
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
C:\Users\nxp>
Ncat: Connection from fe80::224e:f6ff:feec:1f27.
Ncat: Connection from fe80::224e:f6ff:feec:1f27:49153.

hello
hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
Echoing data. Use end command to return...
ECHO_TCP_CLIENT>>
6B sent back.
```

Terminate remote host connection by pressing ctrl+c and for demo shell type end.

3.6.1.7 TCP server echo

Run the command echo_tcp_server 10001 in demo shell.

```
SHELL>> echo_tcp_server 10001

Creating new socket.
Waiting for incoming connection. Use end command to return...
```

IPv4

Run the command ncat -v <Demo IPv4 addr> 10001 on Remote host PC to connect with TCP server

```
C:\Users\nxp>ncat -v 192.168.148.150 10001
Ncat: Version 7.92 ( https://nmap.org/ncat )
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
C:\Users\nxp>
Ncat: Connected to 192.168.148.150:10001.

hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
ECHO_TCP_SERVER>>
Accepted connection
Echoing data. Use end command to return...

ECHO_TCP_SERVER>>
6B sent back.
```

IPv6

Run the command ncat -v <Demo IPv6 addr *FE80::****>> 10001 on Remote host PC to connect with TCP server

```
C:\Users\nxp>ncat -v FE80::224E:F6FF:FEEC:1F27 10001
Ncat: Version 7.92 ( https://nmap.org/ncat )
Ncat: Connected to FE80::224E:F6FF:FEEC:1F27:10001.
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
C:\Users\nxp>
Ncat: Version 7.92 ( https://nmap.org/ncat )
Ncat: Connected to FE80::224E:F6FF:FEEC:1F27:10001.

hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
ECHO_TCP_SERVER>>
Accepted connection
Echoing data. Use end command to return...
ECHO_TCP_SERVER>>
6B sent back.
```

Terminate remote host connection by pressing ctrl+c and for demo shell type end.

3.6.1.8 UDP echo

Run the command `echo_udp 10001` in demo shell.

```
SHELL>> echo_udp 10001  
  
Creating new socket.  
Waiting for datagrams  
Use end command to return...
```

IPV4

Run the command `ncat -v -u <Demo IPv4 addr> 10001` on Remote host PC to connect with UDP server

```
C:\Users\nxp>ncat -v -u 192.168.148.150 10001  
Ncat: Version 7.92 ( https://nmap.org/ncat )
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
Ncat: Connected to 192.168.148.150:10001.
```

```
hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
ECHO_UDP>> Datagram carrying 6B sent back.
```

IPV6

Run the command `ncat -v -u <Demo IPv6 addr FE80::***> 10001` on Remote host PC to connect with UDP server

```
C:\Users\nxp>ncat -v -u FE80::224E:F6FF:FE0C:1F27 10001  
Ncat: Version 7.92 ( https://nmap.org/ncat )
```

Verify connection from Remote host console. Type some text and hit enter, the demo will send line back.

```
Ncat: Connected to FE80::224E:F6FF:FE0C:1F27:10001.
```

```
hello
```

Check console logs which shows number of bytes sent back to Remote Host PC

```
ECHO_UDP>> Datagram carrying 6B sent back.
```

Terminate remote host connection by pressing `ctrl+c` and for demo shell type `end`.

3.7 wifi_wpa_supplicant Sample Application

The *wifi_wpa_supplicant* application demonstrates CLI support usage using wpa supplicant (host based). This application includes similar commands to *wifi_cli* application, some new commands/features which related to host based supplicant are covered in this section i.e WPA Enterprise, WPS.

Wi-Fi and iPerf Features:

Table 17: Sample Application Features

Features	Details
Wi-Fi	Wi-Fi Host based supplicant Wi-Fi Soft AP mode Wi-Fi Station mode Wi-Fi Scan Wi-Fi IEEEPS power saving mode Wi-Fi deep-sleep power saving mode Wi-Fi host sleep/wowlan Wi-Fi RF Calibration Wi-Fi coexistence with external radios (for 88W8801) WPA Enterprise WPS Wi-Fi 11r roaming Wi-Fi Cloud keep alive Wi-Fi Turbo mode
iPerf	TCP Client and Server TCP Client dual mode (Tx and Rx in simultaneous) TCP Client trade-off mode (Tx and Rx individual) UDP Client and Server UDP Client dual mode (Tx and Rx in simultaneous) UDP Client trade-off mode (Tx and Rx individual)

3.7.1 wifi_wpa_supplicant Application Execution

Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console tool setup.

3.7.1.1 Start-up logs

The following logs can be observed on the console once the devices (*i.MX RT1060 EVK board and NXP-based Wireless module*) are up and running and it shows that Wi-Fi module is ready for the operations. This section describes the available Wi-Fi commands, press Enter for the command prompt.

```
=====
wifi wpa supplicant demo
=====
Initialize CLI
=====
Initialize WLAN Driver
=====
Setting up new cal data
MAC Address: 20:4E:F6:EC:1F:27
Info: supplicant_main_task: 241 Starting wpa_supplicant thread with debug
level: 3

Info: Successfully initialized wpa_supplicant
Info: iface_cb: iface ml1 ifindex 2 20:4e:f6:ec:1f:27
```

```
Info: Using interface m11
Info: Initializing interface 0: m11
=====
app_cb: WLAN: received event 11
=====
app_cb: WLAN initialized
=====
WLAN CLIs are initialized
=====
CLIs Available:
=====

help
wlan-reset
wlan-version
wlan-mac
wlan-set-mac <MAC_Address>
wlan-scan
wlan-scan-opt ssid <ssid> bssid ...
wlan-add <profile_name> ssid <ssid> bssid...
wlan-remove <profile_name>
wlan-list
wlan-connect <profile_name>
wlan-start-network <profile_name>
wlan-stop-network
wlan-disconnect
wlan-stat
wlan-info
wlan-address
wlan-get-uap-channel
wlan-get-uap-sta-list
wlan-ieee-ps <0/1>
wlan-deep-sleep-ps <0/1>
wlan-host-11k-enable <0/1>
wlan-host-11k-neighbor-req [ssid <ssid>]
wlan-host-11v-bss-trans-query <0..16>
wlan-pmksa-list
wlan-pmksa-flush
wlan-set-scan-interval <scan_int: in seconds>
wlan-roaming <0/1>
wlan-host-sleep <0/1> wowlan <wake_up_conds>
wlan-send-hostcmd
wlan-set-uap-bandwidth <1/2> 1:20 MHz 2:40MHz
wlan-set-uap-hidden-ssid <0/1/2>
wlan-ft-roam <bssid> <channel>
wlan-set-antcfg <ant mode> [evaluate_time]
wlan-get-antcfg
wlan-scan-channel-gap <channel_gap_value>
wlan-set-regioncode <region-code>
wlan-get-regioncode
wlan-rssi-low-threshold <threshold_value>
wlan-generate-wps-pin
wlan-start-wps-pbc
wlan-start-wps-pin <8 digit pin>
wlan-wps-cancel
wlan-start-ap-wps-pbc
wlan-start-ap-wps-pin <8 digit pin>
wlan-wps-ap-cancel
wlan-get-signal
wlan-cloud-keep-alive <start/stop/reset>
```

```
ping [-s <packet_size>] [-c <packet_count>] [-W <timeout in sec>] <ipv4/ipv6
address>
iperf [-s|-c <host>|-a|-h] [options]
dhcp-stat
=====
```

3.7.1.2 Add network profile

Before adding a network profile for Soft AP and Station mode, please check command usage for different EAP methods.

```
Usage:
For Station interface
    For DHCP IP Address assignment:
        wlan-add <profile_name> ssid <ssid> [wpa2/wpa2-sha256/wpa2-ft <secret>]
        [mfpc <1> mfpr <0/1>]
            If using WPA2 security, set the PMF configuration if required.
        If using specific ciphers, set the group, pairwise and group mgmt using gc, pc
        and gmc options.
        supported ciphers: ccmp=0x10, gcmp=0x40, gcmp_256=0x100, ccmp_256=0x200
        supported group mgmt ciphers: aes_128_cmac=0x20, bip_gmac_128=0x800,
        bip_gmac_256=0x1000, bip_cmac_256=0x2000
            wlan-add <profile_name> ssid <ssid> [wpa3-sb/wpa3-sb-192] [eap-wild/eap-
            tls/eap-tls-sha256/eap-tls-ft/eap-tls-ft-sha384 id <identity> [key_passwd
            <client_key_passwd>]]
            wlan-add <profile_name> ssid <ssid> [wpa3-sb/wpa3-sb-192] [eap-ttls aid
            <anonymous identity> [key2_passwd <client_key2_passwd>]] [mfpc <1> mfpr <0/1>]
            wlan-add <profile_name> ssid <ssid> [wpa3-sb/wpa3-sb-192] [eap-ttls-
            mschapv2 aid <anonymous identity> id <identity> pass <password> [key_passwd
            <client_key_passwd>]] []
            wlan-add <profile_name> ssid <ssid> [wpa3-sb/wpa3-sb-192] [eap-peap-
            mschapv2/eap-peap-tls/eap-peap-gtc [ver 0/1] id <identity> pass <password>
            [key_passwd <client_key>]
            wlan-add <profile_name> ssid <ssid> [wpa3-sb/wpa3-sb-192] [eap-fast-
            mschapv2/eap-fast-gtc aid <anonymous identity> id <identity> pass <password>
            [key_passwd <client_ke>]
            wlan-add <profile_name> ssid <ssid> [eap-sim id <identity> pass <password>]
            If using WPA2/WPA3 Enterprise security, set the PMF configuration as
            required.
            wlan-add <profile_name> ssid <ssid> [owe_only] mfpc 1 mfpr 1
                If using OWE only security, always set the PMF configuration.
            wlan-add <profile_name> ssid <ssid> [wpa3_sae/sae-ft <secret> mfpc <1> mfpr
            <0/1>]
                If using WPA3 SAE security, always set the PMF configuration.
        For static IP address assignment:
            wlan-add <profile_name> ssid <ssid>
            ip:<ip_addr>,<gateway_ip>,<netmask>
            [bssid <bssid>] [channel <channel number>]
            [wpa2/wpa2-sha256/wpa2-ft <secret>] [wpa3-sb/wpa3-sb-192] [eap-tls/eap-tls-
            sha256/eap-tls-ft/eap-tls-ft-sha384] [owe_only] [wpa3_sae/sae-ft <secret>]
            [mfpc <0/1> mfpr ]
        For Micro-AP interface
            wlan-add <profile_name> ssid <ssid>
            ip:<ip_addr>,<gateway_ip>,<netmask>
            role uap [bssid <bssid>]
            [channel <channelnumber>]
            [wpa2/wpa2-sha256 <secret>] [wpa3_sae <secret> [pwe <0/1/2>] [tr
            <0/1/2/4/8>]]
            [wpa2-ft <secret>] [wpa3_sae-ft <secret>]
            [wpa3-sb/wpa3-sb-192] [eap-tls/eap-tls-sha256/eap-tls-mschapv2/eap-peap-
            mschapv2/eap-peap-tls/eap-peap-gtc/eap-fast-mschapv2/eap-fast-gtc]
            [eap-tls-ft/eap-tls-ft-sha384]
            [owe_only]
```

```
[mfpc <0/1>] [mfpr <0/1>]

[capa <11n/legacy>]
If Set channel to 0, set acs_band to 0 1.
0: 2.4GHz channel 1: 5GHz channel Not support to select dual band
automatically.
Error: invalid number of arguments
```

3.7.1.3 Station mode (connect to External AP)

This section demonstrate how to connect to External AP with Enterprise security.

Note: Here we make another RT as an External AP on which radius server is running. To generate own certificates please refer to the section [3.7.1.5](#).

WPA2 Enterprise Security

Use the following command to add the network profile to configure the device in station mode using **EAP-TLS** method. Provide any profile name, external AP's SSID, User ID and Password to authenticate with the server in argument shown below:

```
# wlan-add EapNet ssid EapNet_AP eap-tls id client1 key_passwd whatever
Added "abc"
```

Connect to the AP network using the saved network profile:

```
# wlan-connect EapNet
Connecting to network...
Use 'wlan-stat' for current connection status.

# Info: m11: SME: Trying to authenticate with d8:c0:a6:0f:d6:89
(SSID='EapNet_AP' freq=2437 MHz)
Info: m11: Trying to associate with d8:c0:a6:0f:d6:89 (SSID='EapNet_AP'
freq=2437 MHz)
Info: m11: Associated with d8:c0:a6:0f:d6:89
Info: m11: CTRL-EVENT-SUBNET-STATUS-UPDATE status=0
Info: m11: CTRL-EVENT-EAP-STARTED EAP authentication started
Info: m11: CTRL-EVENT-EAP-PROPOSED-METHOD vendor=0 method=13
Info: m11: CTRL-EVENT-EAP-METHOD EAP vendor 0 method 13 (TLS) selected
Info: m11: CTRL-EVENT-EAP-PEER-CERT depth=1 subject='C=IN, ST=MH, L=PUNE,
O=NXP, CN=CA, emailAddress=ca@nxp.com'
hash=4f7f0a703ca723e3f0e5c7d11f7f5e0ec5d68975791370354f2a006f0100d4d2
Info: m11: CTRL-EVENT-EAP-PEER-CERT depth=0 subject='C=IN, ST=MH, L=PUNE,
O=NXP, CN=SERVER, emailAddress=server@nxp.com'
hash=86f7f32f4450980966beac9df4695df908d532c0c1116e52d2ba07fef41cc764
Info: m11: CTRL-EVENT-EAP-SUCCESS EAP authentication completed successfully
Info: m11: PMKSA-CACHE-ADDED d8:c0:a6:0f:d6:89 0
=====
app_cb: WLAN: received event 1
=====
app_cb: WLAN: authenticated to network
Info: m11: WPA: Key negotiation completed with d8:c0:a6:0f:d6:89 [PTK=CCMP
GTK=CCMP]
Info: m11: CTRL-EVENT-CONNECTED - Connection to d8:c0:a6:0f:d6:89 completed
[id=0 id_str=]
=====
app_cb: WLAN: received event 0
=====
app_cb: WLAN: connected to network
Connected to following BSS:
SSID = [EapNet_AP]
IPv4 Address: [192.168.10.2]
```

NOTE: Once connected to the AP the console output will show Client successfully connected to AP with ssid "EapNet_AP" and got ip address "192.168.10.2" from AP.

Get signal information of connected External AP

```
# wlan-get-signal
      BeaconLast      Beacon Average   Data Last      Data Average
RSSI    -32           -32            -33          -33
SNR     58            58            57            57
NF     -90           -90           -90           -90
```

Get PMKSA list

```
# wlan-pmksa-list
PMKSA list
Index / AA / PMKID / expiration (in seconds) / opportunistic
1 d8:c0:a6:0f:d6:89 9ca541d20dcc1cbc3ae0834d54c816b4 43187 0
```

To flush the PMKSA entries

```
# wlan-pmksa-flush
Info: m11: PMKSA-CACHE-REMOVED d8:c0:a6:0f:d6:89 0
Info: m11: CTRL-EVENT-DISCONNECTED bssid=d8:c0:a6:0f:d6:89 reason=1
locally_generated=1
Info: m11: CTRL-EVENT-DSCP-POLICY clear_all
Flushed PMKSA cache
```

WPA2 Station disconnection (from AP)**Disconnect from the AP network profile:**

```
# wlan-disconnect
```

```
=====
app_cb: WLAN: received event 9
=====
app_cb: disconnected
```

Remove the saved network profile:

```
# wlan-remove EapNet
Info: m11: PMKSA-CACHE-REMOVED d8:c0:a6:0f:d6:89 0
Removed "EapNet"
```

Other Security options:**OWE**

```
wlan-add oweNet ssid oweNet_AP owe_only mfpc 1 mfpr 1
```

WPA3-Enterprise

To use WPA3 Suite B or Suite B 192 bit enterprise security, add wpa3-sb or wpa3-sb-192 before EAP security type. Applicable for all EAP securities.

If AP's EAP security type not known, then use EAP wildcard security

```
wlan-add EapNet ssid EapNet_AP eap-wild aid <anonymous> id <identity> pass
<password> key_passwd whatever mfpc 1 mfpr 0
```

WPA3 EAP TLS (Suite B)

```
wlan-add EapNet ssid EapNet_AP wpa3-sb eap-tls id client2 key_passwd whatever
```

WPA3 EAP TLS (Suite B 192 bit)

```
wlan-add EapNet ssid EapNet_AP wpa3-sb-192 eap-tls id client4 key_passwd
whatever
```

WPS-PIN

```
# wlan-start-wps-pin 96288863
Start WPS PIN session with 96288863 pin
Info: m11: WPS-PIN-ACTIVE
```

WPS-PBC

```
# wlan-start-wps-pbc
Info: m11: WPS-PBC-ACTIVE
# Info: m11: SME: Trying to authenticate with d8:c0:a6:0f:d6:89 (SSID='NXPPAP'
freq=2437 MHz)
Info: m11: Trying to associate with d8:c0:a6:0f:d6:89 (SSID='NXPPAP' freq=2437
MHz)
Info: m11: Associated with d8:c0:a6:0f:d6:89
```

3.7.1.4 Soft AP mode

Use the following command to add the network profile to configure the device in Enterprise AP mode. Use your AP's SSID, IP details, role, channel, security, user id and password in argument shown below.

Note: To generate own certificates please refer to the section [3.7.1.5](#).

WPA2 EAP-TLS

```
# wlan-add EapNet ssid EapNet_AP ip:192.168.10.1,192.168.10.1,255.255.255.0
role uap channel 6 eap-tls id client1 id client2 id client3 id client4
key_passwd whatever
```

```
Added "EapNet"
```

Set Wi-Fi bandwidth

The following command is used to set Wi-Fi bandwidth (20MHz or 40MHz):

NOTE: Default bandwidth is set to 40MHz if not set by following command.

NOTE: For 88W8801, default bandwidth is set to 20MHz and following command is not available.

Command Usage:

```
# wlan-set-uap-bandwidth
Usage: wlan-set-uap-bandwidth <1/2>
Error: Specify 1 to set bandwidth 20MHz or 2 for 40MHz
```

Set bandwidth:

```
# wlan-set-uap-bandwidth 1
bandwidth set successfully
```

Start the AP using saved network profile:

```
# wlan-start-network EapNet
[wlcm] Warn: NOTE: uAP will automatically switch to the channel that station is
on.
Info: ua2: interface state UNINITIALIZED->COUNTRY_UPDATE

# =====
app_cb: WLAN: received event 15
=====
app_cb: WLAN: UAP Started
=====
Soft AP "EapNet_AP" started successfully
=====
DHCP Server started successfully
=====
```

Check created network details

```
# wlan-info
Station not connected
uAP started as:
"EapNet"
    SSID: EapNet_AP
    BSSID: D8:C0:A6:0F:D6:89
    mode: 802.11AC
    channel: 6
    role: uAP
    security: WPA2 Enterprise EAP-TLS
    wifi capability: 11ac
    user configure: 11ac

    IPv4 Address
    address: STATIC
        IP:          192.168.10.1
        gateway:    192.168.10.1
        netmask:    255.255.255.0
        dns1:       0.0.0.0
        dns2:       0.0.0.0
```

```
IPv6 Addresses
Link-Local : FE80::DAC0:A6FF:FE0F:D689 (Tentative)
```

Connect the wireless client to the AP just created, EapNet_AP. The logs below can be observed once the Client is associated successfully:

```
# Info: ua2: STA 20:4e:f6:ec:1f:27 IEEE 802.11: associated (aid 1)
Info: : CTRL-EVENT-EAP-STARTED 20:4e:f6:ec:1f:27
Info: : CTRL-EVENT-EAP-PROPOSED-METHOD vendor=0 method=1
Info: : CTRL-EVENT-EAP-PROPOSED-METHOD vendor=0 method=13
Info: : CTRL-EVENT-EAP-RETRANSMIT 20:4e:f6:ec:1f:27
Info: m11: CTRL-EVENT-EAP-PEER-CERT depth=1 subject='C=IN, ST=MH, L=PUNE,
O=NXP, CN=CA, emailAddress=ca@nxp.com'
hash=4f7f0a703ca723e3f0e5c7d11f7f5e0ec5d68975791370354f2a02
Info: m11: CTRL-EVENT-EAP-PEER-CERT depth=0 subject='C=IN, ST=MH, L=PUNE,
O=NXP, CN=Client, emailAddress=client@nxp.com'
hash=8bb701aedec525fbcb4934c3a53a00adbcfb86f8c30750b
Info: : CTRL-EVENT-EAP-SUCCESS 20:4e:f6:ec:1f:27
Info: ua2: STA 20:4e:f6:ec:1f:27 WPA: pairwise key handshake completed (RSN)
Info: : EAPOL-4WAY-HS-COMPLETED 20:4e:f6:ec:1f:27
Info: : AP-STA-CONNECTED 20:4e:f6:ec:1f:27
=====
app_cb: WLAN: received event 16
=====
app_cb: WLAN: UAP a Client Associated
=====
Client => 20:4E:F6:EC:1F:27 Associated with Soft AP
=====
Info: ua2: STA 20:4e:f6:ec:1f:27 IEEE 802.1X: authenticated - EAP type: 0
(unknown)
```

Get the associated clients list:

```
# wlan-get-uap-sta-list
Number of STA = 1

STA 1 information:
=====
MAC Address: 20:4E:F6:EC:1F:27
Power mfg status: active
Rssi : -69 dBm
```

Get the IP and MAC information for the associated clients:

```
# dhcp-stat
DHCP Server Lease Duration : 86400 seconds
Client IP     Client MAC
192.168.10.2   20:4E:F6:EC:1F:27
```

Other Security options:

OWE

```
wlan-add oweNet ssid oweNet_AP ip:192.168.10.1,192.168.10.1,255.255.255.0 role
uap owe_only
```

WPA3 Enterprise

To use WPA3 Suite B or Suite B 192 bit enterprise security, add wpa3-sb or wpa3-sb-192 before EAP security type. Applicable for all EAP securities.

WPA3 EAP TLS (Suite B)

```
wlan-add EapNet ssid EapNet_AP ip:192.168.10.1,192.168.10.1,255.255.255.0 role
uap wpa3-sb eaptls id client1 id client2 id client3 id client4 key_passwd
whatever
```

WPA3 EAP TLS (Suite B 192 bit)

```
wlan-add EapNet ssid EapNet_AP ip:192.168.10.1,192.168.10.1,255.255.255.0 role
uap wpa3-sb-192 eap-tls id client1 id client2 id client3 id client4 key_passwd
whatever
```

WPS (Wi-Fi Protected Setup)

There are two primary approaches to network setup within Wi-Fi Protected Setup: push-button and PIN entry.

WPS-PIN

```
# wlan-add abc ssid NXPAP ip:192.168.81.100,192.168.81.100,255.255.255.0 role uap channel 6 wpa2 12345678  
Added "abc"
```

```
# wlan-start-network abc  
[wlcm] Warn: NOTE: uAP will automatically switch to the channel that station is on.  
Info: ua2: interface state UNINITIALIZED->COUNTRY_UPDATE  
  
# =====  
app_cb: WLAN: received event 15  
=====  
app_cb: WLAN: UAP Started  
=====  
Soft AP "NXPAP" started successfully  
=====  
DHCP Server started successfully  
=====  
Info: ua2: interface state COUNTRY_UPDATE->ENABLED  
Info: : AP-ENABLED
```

```
# wlan-generate-wps-pin  
WPS PIN is: 96288863
```

```
# wlan-start-ap-wps-pin 96288863  
Start AP WPS PIN session with 96288863 pin  
[uap] Warn: Overwriting previous configuration
```

WPS-PBC

```
wlan-add abc ssid NXPAP ip:192.168.81.100,192.168.81.100,255.255.255.0 role uap  
channel 6 wpa2 12345678
```

```
# wlan-start-ap-wps-pbc add  
[uap] Warn: Overwriting previous configuration  
Info: : WPS-PBC-ACTIVE
```

Stop Soft AP

```
# wlan-stop-network  
=====  
app_cb: WLAN: received event 19  
=====  
app_cb: WLAN: UAP Stopped  
=====  
Soft AP "EapNet_AP" stopped successfully  
=====  
DHCP Server stopped successfully  
=====
```

3.7.1.5 Certificates/Key configurations for WPA2/3 Enterprise

For enterprise security it is mandatory to have a radius server (hostapd radius server) and server/client certificates. This section describes how user can configure their own CA certificate, Client/Server certificate, Client/Server private key for WPA2/3 Enterprise.

RT SDK supports certificates in .h format and already configured server and client certificates available at the location `<SDK_PATH>/middleware/wifi_nxp/certs`. User need to replace ca-cert.h, client-cert.h and client-key.h files with newly created files.

Follow below steps for certificate conversion.

Note: Below commands should be executed from any Linux host where openssl and xxd are installed.

Convert PEM certificate to DER certificate:

```
openssl x509 -inform pem -in ca.pem -outform der -out ca-cert.der  
openssl x509 -inform pem -in client.pem -outform der -out client-cert.der  
openssl x509 -inform pem -in server.pem -outform der -out server-cert.der
```

convert a PEM private key to a DER private key:

```
openssl rsa -inform pem -in client.key -outform der -out client-key.der  
openssl rsa -inform pem -in server.key -outform der -out server-key.der
```

Convert DER certificates and privet key to Header files:

ca-cert

```
xxd -i ca-cert.der ca-cert.h
```

change array name and size inside .h as below:

```
const unsigned char ca_der[]  
unsigned int ca_der_len
```

client-cert

```
xxd -i client-cert.der client-cert.h
```

change array name and size inside .h as below:

```
const unsigned char client_der[]  
unsigned int client_der_len
```

client-key

```
xxd -i client-key.der client-key.h
```

change array name and size inside .h as below:

```
const unsigned char client_key_der[]  
unsigned int client_key_der_len
```

4 Useful Wi-Fi APIs

This section describes a few Wi-Fi driver APIs with their usage. These driver APIs can be called from the user application directly with the appropriate arguments to implement the required changes in the driver/firmware.

NOTE: Please refer to [wifi_cert](#) demo from section 3.5, which has support for these APIs. Please refer to [MCUXSDKGSUG](#) for more details about the Wi-Fi driver APIs.

4.1 Set/Get ED MAC Feature

This feature enables the European Union (EU) adaptivity test as per the compliance requirements in the ETSI standard.

Depending on the device and front-end loss, the Energy Detection (ED) threshold offset (ed_ctrl_2g.offset and ed_ctrl_5g.offset) needs to be adjusted. The ED threshold offset can be adjusted in steps of 1 dB.

4.1.1 wlan_set_ed_mac_mode()

This API is used to configure ED MAC mode in the Wireless Firmware.

Syntax: int wlan_set_ed_mac_mode(wlan_ed_mac_ctrl_t wlan_ed_mac_ctrl)

Where

Table 18: Set ED MAC API argument

Parameter	Description
[In] wlan_ed_mac_ctrl	A structure with parameters mentioned in section 4.1.3 to enable EU adaptivity.

Return Value:

WM_SUCCESS if the call is successful, -WM_FAIL if the call failed

4.1.2 wlan_get_ed_mac_mode()

This API can be used to get current ED MAC mode configuration.

Syntax: int wlan_get_ed_mac_mode(wlan_ed_mac_ctrl_t * wlan_ed_mac_ctrl)

Where

Table 19: Get ED MAC API argument

Parameter	Description
[Out] wlan_ed_mac_ctrl	A pointer to a structure with parameters mentioned in section 4.1.3 to get ED MAC mode configuration.

Return Value:

WM_SUCCESS if the call is successful, -WM_FAIL if the call failed

4.1.3 Usage and Output

This section includes the output console logs and code snippets for the reference and it can be used to add the feature-related commands in the user application.

To add new CLI command in the existing *wifi_cli* sample application, please refer to section 0.

Usage:

To add `set` command to the command list,

```
#ifdef CONFIG_5GHz_SUPPORT
    {"wlan-set-ed-mac-mode", "<ed_ctrl_2g> <ed_offset_2g> <ed_ctrl_5g>
<ed_offset_5g>", wlan_ed_mac_mode_set},
#else
    {"wlan-set-ed-mac-mode", "<ed_ctrl_2g>
<ed_offset_2g>", wlan_ed_mac_mode_set},
#endif
```

To print the usage regarding `set-ed-mac`

```
static void dump_wlan_set_ed_mac_mode_usage()
{
    PRINTF("Usage:\r\n");
#ifdef CONFIG_5GHz_SUPPORT
    PRINTF("wlan-set-ed-mac-mode <ed_ctrl_2g> <ed_offset_2g> <ed_ctrl_5g>
<ed_offset_5g>\r\n");
#else
    PRINTF("wlan-set-ed-mac-mode <ed_ctrl_2g> <ed_offset_2g>\r\n");
#endif
    PRINTF("\r\n");
    PRINTF("\ted_ctrl_2g \r\n");
    PRINTF("\t # 0      - disable EU adaptivity for 2.4GHz band\r\n");
    PRINTF("\t # 1      - enable EU adaptivity for 2.4GHz band\r\n");
    PRINTF("\ted_offset_2g \r\n");
    PRINTF("\t # 0      - Default Energy Detect threshold\r\n");
    PRINTF("\t #offset value range: 0x80 to 0x7F\r\n");
#endif
    PRINTF("\ted_ctrl_5g \r\n");
    PRINTF("\t # 0      - disable EU adaptivity for 5GHz band\r\n");
    PRINTF("\t # 1      - enable EU adaptivity for 5GHz band\r\n");
    PRINTF("\ted_offset_2g \r\n");
    PRINTF("\t # 0      - Default Energy Detect threshold\r\n");
    PRINTF("\t #offset value range: 0x80 to 0x7F\r\n");
#endif
}
```

To set ed mac mode using the structure parameter in driver (set) API:

```
static void wlan_ed_mac_mode_set(int argc, char *argv[])
{
    int ret;
    wlan_ed_mac_ctrl_t wlan_ed_mac_ctrl;

#ifndef CONFIG_5GHz_SUPPORT
    if (argc != 5)
#else
    if (argc != 3)
#endif
    {
        dump_wlan_set_ed_mac_mode_usage();
        return;
    }

    wlan_ed_mac_ctrl.ed_ctrl_2g    = strtol(argv[1], NULL, 16);
    wlan_ed_mac_ctrl.ed_offset_2g = strtol(argv[2], NULL, 16);
#ifndef CONFIG_5GHz_SUPPORT
    wlan_ed_mac_ctrl.ed_ctrl_5g    = strtol(argv[3], NULL, 16);
    wlan_ed_mac_ctrl.ed_offset_5g = strtol(argv[4], NULL, 16);
#endif

    if (wlan_ed_mac_ctrl.ed_ctrl_2g != 0 && wlan_ed_mac_ctrl.ed_ctrl_2g != 1)
    {
        dump_wlan_set_ed_mac_mode_usage();
        return;
    }
#ifndef CONFIG_5GHz_SUPPORT
    if (wlan_ed_mac_ctrl.ed_ctrl_5g != 0 && wlan_ed_mac_ctrl.ed_ctrl_5g != 1)
    {
        dump_wlan_set_ed_mac_mode_usage();
        return;
    }
#endif

    ret = wlan_set_ed_mac_mode(wlan_ed_mac_ctrl);
    if (ret == WM_SUCCESS)
    {
        PRINTF("ED MAC MODE settings configuration successful\r\n");
    }
    else
    {
        PRINTF("ED MAC MODE settings configuration failed\r\n");
        dump_wlan_set_ed_mac_mode_usage();
    }
}
```

To add get command to the command list,

```
{"wlan-get-ed-mac-mode", NULL, wlan_ed_mac_mode_get},
```

To print the usage regarding get-ed-mac

```
static void dump_wlan_get_ed_mac_mode_usage()
{
    PRINTF("Usage:\r\n");
    PRINTF("wlan-get-ed-mac-mode \r\n");
}
```

To get ed mac mode values filled address of wlan_ed_mac_ctrl structure passed as a parameter to the driver (get) API,

```
static void wlan_ed_mac_mode_get(int argc, char *argv[])
{
    int ret;
    wlan_ed_mac_ctrl_t wlan_ed_mac_ctrl;

    if (argc != 1)
    {
        dump_wlan_get_ed_mac_mode_usage();
        return;
    }

    ret = wlan_get_ed_mac_mode(&wlan_ed_mac_ctrl);
    if (ret == WM_SUCCESS)
    {
        PRINTF("EU adaptivity for 2.4GHz band : %s\r\n",
wlan_ed_mac_ctrl.ed_ctrl_2g == 1 ? "Enabled" : "Disabled");
        if (wlan_ed_mac_ctrl.ed_ctrl_2g)
            PRINTF("Energy Detect threshold offset : 0X%x\r\n",
wlan_ed_mac_ctrl.ed_offset_2g);
#ifdef CONFIG_5GHz_SUPPORT
        PRINTF("EU adaptivity for 5GHz band : %s\r\n",
wlan_ed_mac_ctrl.ed_ctrl_5g == 1 ? "Enabled" : "Disabled");
        if (wlan_ed_mac_ctrl.ed_ctrl_5g)
            PRINTF("Energy Detect threshold offset : 0X%x\r\n",
wlan_ed_mac_ctrl.ed_offset_5g);
#endif
        else
        {
            PRINTF("ED MAC MODE read failed\r\n");
            dump_wlan_get_ed_mac_mode_usage();
        }
    }
}
```

Console Output

```
# wlan-set-ed-mac-mode 1 0x9
ED MAC MODE settings configuration successful
```

```
# wlan-get-ed-mac-mode
EU adaptivity for 2.4GHz band : Enabled
Energy Detect threshold offset : 0x9
EU adaptivity for 5GHz band : Enabled
Energy Detect threshold offset : 0xc
```

4.2 Enable Host based WPA supplicant Feature for Wi-Fi application

This section describes changes required to enable host based wpa supplicant for Wi-Fi applications on i.MX RT1060 + IW416/88W8987/IW612 NXP-based wireless modules.

Host based supplicant is an open source software which requires increase in memory, mainly, HEAP (90~180 KB) and Increase number of clients store data in netif (LWIP).

To enable and support host based wpa supplicant Following files need updates.

Note: The file paths given in this section refers to application **wifi_setup**.

```
<SDK_PATH>/ boards/evkmimxrt1060/wifi_examples/wifi_setup/FreeRTOSConfig.h
<SDK_PATH>/ boards/evkmimxrt1060/wifi_examples/wifi_setup/lwipopts.h
<SDK_PATH>/ boards/evkmimxrt1060/wifi_examples/wifi_setup/wifi_config.h
```

4.2.1 FreeRTOSConfig.h

Increase Stack size:

In the following example stack is increased from 128 to 160 bytes.

```
- #define configMINIMAL_STACK_SIZE ((unsigned short)128)
+ #define configMINIMAL_STACK_SIZE ((unsigned short)160)
```

Increase heap size:

In following example, heap is increased from 60K to 120K bytes. 120KB is minimum required heap. If you enable CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE, then 180 KB of heap is required.

```
- #define configTOTAL_HEAP_SIZE ((size_t)(60 * 1024))
+ #define configTOTAL_HEAP_SIZE ((size_t)(120 * 1024))
```

Increase stack for software timer task

Following example is increasing stack and making it twice the earlier size.

```
- #define configTIMER_TASK_STACK_DEPTH (configMINIMAL_STACK_SIZE)
+ #define configTIMER_TASK_STACK_DEPTH (configMINIMAL_STACK_SIZE * 2U)
```

4.2.2 lwipopts.h

Add following definitions at the end of file before "#endif /* __LWIPOPTS_H__ */"

```
/**
 * LWIP_CHECKSUM_ON_COPY==1: Calculate checksum when copying data from
 * application buffers to pbufs.
 */
#define LWIP_CHECKSUM_ON_COPY 1

/**
 * LWIP_CHKSUM_ALGORITHM==3: Use the optimised checksum algorithm.
 */
#define LWIP_CHKSUM_ALGORITHM 3

#if (LWIP_DNS || LWIP_IGMP || LWIP_IPV6) && !defined(LWIP_RAND)
/* When using IGMP or IPv6, LWIP_RAND() needs to be defined to a random-
function returning an u32_t random value*/
#include "lwip/arch.h"
u32_t lwip_rand(void);
#define LWIP_RAND() lwip_rand()
#endif

#define LWIP_NETIF_TX_SINGLE_PBUF 1

#if (LWIP_NETIF_TX_SINGLE_PBUF)
#define PBUF_LINK_ENCAPSULATION_HLEN 26
#endif

#define LWIP_NUM_NETIF_CLIENT_DATA 2

/* ----- Core locking ----- */
```

4.2.3 wifi_config.h

Add following definitions to enable various WPA modes. Note that Enterprise mode is enabled only if needed.

```
/*
 * Config options for wpa supplicant
 */
#define CONFIG_WPA_SUPP 1

#ifndef CONFIG_WPA_SUPP
#define CONFIG_WPA_SUPP_WPS 1
#define CONFIG_WPA_SUPP_WPA3 1
//#define CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE 1
#endif
#endif/* 
 * wpa supplicant debug options
 */
#define CONFIG_WPA_SUPP_DEBUG_LEVEL 3
```

4.2.4 Adding components

For those users who are using zip package, following files need to be updated at board_MIMXRT1060-EVK/boards/evkbmimxrt1060/wifi_examples/wifi_<app name>/armgcc

Add dependent component needed for wpa supplicant, mbedtls and hardware drivers.

Update config.cmake and append following

```
set(CONFIG_USE_middleware_mbedtls true)
set(CONFIG_USE_middleware_wireless_wpa_supplicant_rtos true)
set(CONFIG_USE_mbedtls_port_kSDK true)
set(CONFIG_USE_mbedtls_template true)
set(CONFIG_USE_driver_dcp true)
set(CONFIG_USE_driver_trng true)
```

Update CMakeLists.txt and add following

```
if(CMAKE_BUILD_TYPE STREQUAL flexspi_nor_debug)
    target_compile_definitions(${MCUX_SDK_PROJECT_NAME} PRIVATE
MBEDTLS_CONFIG_FILE="wpa_supp_mbedtls_config.h")
endif(CMAKE_BUILD_TYPE STREQUAL flexspi_nor_debug)

if(CMAKE_BUILD_TYPE STREQUAL flexspi_nor_release)
    target_compile_definitions(${MCUX_SDK_PROJECT_NAME} PRIVATE
MBEDTLS_CONFIG_FILE="wpa_supp_mbedtls_config.h")
endif(CMAKE_BUILD_TYPE STREQUAL flexspi_nor_release)
```

4.2.5 Memory Overflow Issue Handling

It is observed that for certain RT boards such as RT1020, RT1040 and RT1050 with lower memory footprint, the memory overflow error occurs during compiling with certain compiler tool. Following is the solution to such issues.

Linker file update can help if we get memory overflow during linking stage for low end platforms on certain compilers.

For mcuxpresso projects

create bss.ldt file at location evkbmimxrt1060/wifi_examples/common/linkscripts/bss.ldt
and add following in bss.ldt

```
<#if memory.name=="SRAM_OC">
*(.bss*)
</#if>
```

For armgcc, iar and mdk, we need to move bss to m_data2. To do this update following files.

/wifi_examples/common/linker/MIMXRT1062xxxx_flexspi_nor.icf

```
-place in DATA_region { block ZI };
+place in DATA2_region { block ZI };
```

evkbmimxrt1060/wifi_examples/common/linker/MIMXRT1062xxxx_flexspi_nor.ld

In the .bss block, update '> m_data' to '> m_data2'. Do not change rest of the .bss block.

```
/* Uninitialized data section */
.bss :
{
    /* This is used by the startup in order to initialize the .bss section */
    . = ALIGN(4);
    __START_BSS = .;
    __bss_start__ = .;
    *(m_usb_dma_noninit_data)
    *(.bss)
    *(.bss*)
    *(COMMON)
    . = ALIGN(4);
    __bss_end__ = .;
    __END_BSS = .;
} > m_data
+} > m_data2
```

evkbmimxrt1060/wifi_examples/common/linker/MIMXRT1062xxxx_flexspi_nor.scf

```
- RW_m_ncache m_data2_start EMPTY 0 {
+ RW_m_data2 m_data2_start m_data2_size { ; RW data2
+     .ANY (+RW +ZI)
+ }
+ RW_m_ncache +0 EMPTY 0 {
}
- RW_m_ncache_unused +0 EMPTY m_data2_size-ImageLength(RW_m_ncache) { ; Empty
region added for MPU configuration
+ RW_m_ncache_unused +0 EMPTY m_data2_size-ImageLength(RW_m_data2)-
ImageLength(RW_m_ncache) { ; Empty region added for MPU configuration
```

5 Bluetooth Classic/Low Energy Applications

This chapter describes the Bluetooth Classic/Low Energy example applications that are available in the SDK, and the steps to configure, compile, debug, flash, and execute these examples.

The communication between the Host stack and the Link Layer (LL) is implemented via the standard HCI UART interface and PCM interface for voice.

Please refer to “*Hardware Rework Guide for EdgeFast BT PAL.pdf*” guide referenced in the Section 1.3 “References” for details to enable the UART and PCM interfaces.

The setup is done between the single i.MX RT+ IW416 NXP-based wireless module and remote Bluetooth devices. The instructions in this guide use an i.MXRT1060 EVK board. Yet the same steps apply to the other i.MX RT products.

The table lists the Bluetooth module specific preprocessor macro that is common to all Bluetooth examples.

Table 20: Preprocessor Macros for Bluetooth Modules

Module	Chipset	Macro
AzureWave AW-AM457-S-uSD	IW416	WIFI_IW416_BOARD_AW_AM457_USD
AzureWave AW-CM358-uSD	88W8987	WIFI_88W8987_BOARD_AW_CM358_USD
AzureWave AW-AM510-uSD	IW416	WIFI_IW416_BOARD_AW_AM510_USD
Murata Type 1XX	IW416	WIFI_IW416_BOARD_MURATA_1XX_USD WIFI_IW416_BOARD_MURATA_1XX_M2
Murata Type 1ZM	88W8987	WIFI_88W8987_BOARD_MURATA_1ZM_USD WIFI_88W8987_BOARD_MURATA_1ZM_M2
Murata Type 2EL	IW612	WIFI_IW61x_BOARD_MURATA_2EL_USD[1]

USD = microSD interface

M2 = M.2 interface

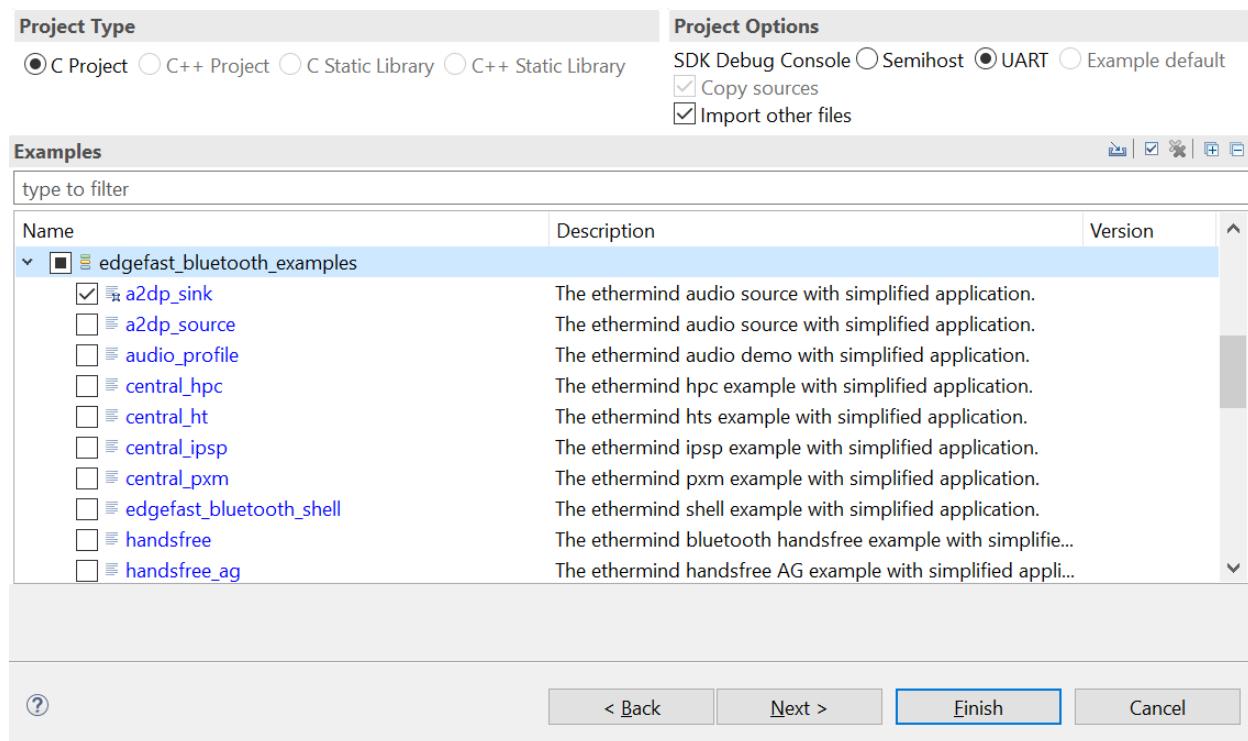
[1] The module operation support is available in 2.13.2 SDK version only

5.1 a2dp_sink Sample Application

This sample application section describes the steps to configure the i.MX RT1060 EVK board and IW416 wireless module as an A2DP Sink device.

5.1.1 a2dp_sink Application Execution

Please refer to the previous section 3.1.1 to run the demo using MCUXpresso IDE. Refer below image for selection of Bluetooth example.



Please refer to the previous sections 3.1.1-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.1.1.1 Run the Application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
BR/EDR set connectable and discoverable done
```

Discover the device “a2dp sink” from peer mobile phone and connect to it. The following logs should be displayed on the console.

```
Connected
Security changed: 7E:5A:23:AE:9E:C3 (0xed) level 2
a2dp connected success
a2dp configure sample rate 44100Hz
```

Now, user can play music from the cell phone connected and listen on the audio jack of the i.MX RT 1060 EVK board.

Following logs will appear on the console:

```
a2dp start playing
```

Stop playing music from the cell phone.

Following logs will appear on the console

```
a2dp stop playing  
Disconnect the device from peer cell phone.  
a2dp deconfigure  
Disconnected (reason 0x13)
```

5.2 a2dp_source Sample Application

This section describes the steps to configure the i.MX RT1060 EVK board and IW416 wireless module as an A2DP Source device.

5.2.1 a2dp_source Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.2.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
```

```
Copyright 2022 NXP
```

```
>>
```

Input "help" to show the available list of commands:

```
>>
```

```
help
```

```
"help": List all the registered commands
```

```
"exit": Exit program
```

```
"bt": BT related function
```

```
USAGE: bt [discover|connect|disconnect|delete]  
discover start to find BT devices  
connect connect to the device that is found, for example: bt  
connectdevice n (from 1)  
disconnect disconnect current connection.  
delete delete all devices. Ensure to disconnect the HCI link  
connection with the peer device before attempting to delete the bonding  
information.
```

```
>>
```

Input "bt discover" to scan connectable nearby Bluetooth devices.

```
>> bt discover
```

```
Discovery started. Please wait ...
```

```
>> BR/EDR discovery complete
```

```
[1]: 20:39:56:C6:6C:6C, RSSI -89 Nokia 6.1 Plus
```

```
[2]: B8:F6:53:E8:BF:B7, RSSI -84 JBL Flip 5
```

```
[3]: 70:F0:87:C0:FC:0E, RSSI -100
```

```
>>
```

Input "bt connect [index]" to create Bluetooth connection with the discovered device. The music starts playing on successful connection with the Bluetooth device.

```
>> bt connect 2
```

```
Connection pending
```

```
>> SDP discovery started
```

```
Connected
```

```
sdp success callback
```

```
A2DP Service found. Connecting ...
```

```
Security changed: 7E:5A:23:AE:9E:C3 (0xed) level 2
```

```
a2dp connected success
```

```
a2dp start playing  
Input "bt disconnect" to disconnect the current connection.  
>> bt disconnect  
>> a2dp disconnected  
Disconnected (reason 0x16)
```

Input "bt delete" to delete the bonding information of all the devices.

NOTE: Disconnect the HCI link connection with the peer device before attempting to delete the bonding information.

```
>> bt delete  
success  
>>
```

5.3 handsfree Sample Application

This section describes the steps to configure the i.MX RT1060 EVK board and IW416 wireless module as an HF Unit.

5.3.1 handsfree Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.3.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
BR/EDR set connectable and discoverable done  
  
Copyright 2022 NXP
```

Discover the device “edgefast hfp” from peer mobile phone and connect to it. The following logs should be displayed on the console.

```
HFP HF Connected!  
Wideband Config at Controller: Disabled  
Sending Vendor command 0028  
Sending Vendor command 0007 now  
Sending Vendor command 0029 now  
Sending Vendor command 001d now  
Sending Vendor command 0070 now  
Sending Vendor command 0073 with WBS disabled  
Service indicator value: 1  
Signal indicator value: 5
```

Make an incoming call to the mobile phone which is connected to the setup:

```
Call Setup indicator value: 1  
Incoming Call...  
Init Audio CODEC for RingTone
```

Type help command to check all calling options.

```
"help": List all the registered commands  
  
"exit": Exit program  
  
"bt": BT related function  
    USAGE: bt [dial|aincall|eincall]  
          dial      dial out call.  
          aincall   accept the incoming call.  
          eincall   end an incoming call.  
          svr      start voice recognition.
```

```

evr          stop voice recognition.
clip         enable CLIP notification.
disclip      disable CLIP notification.
ccwa         enable call waiting notification.
disccwa      disable call waiting notification.
micVolume    Update mic Volume.
speakerVolume Update Speaker Volume.
lastdial     call the last dial number.
voicetag     Get Voice-tag Phone Number (BINP).
multipcall   multiple call option.

```

Input "bt aincall" to answer the incoming call:

```

Setup for SCO audio: Success
Sending Vendor command 006f now
Call indicator value: 1
Call Setup indicator value: 0
Init Audio SCO SAI and CODEC samplingRate :8000 bitWidth:16
mic dummy

```

Input "bt eincall" to end the incoming call:

```

sco_audio_stop_pl: Sending Vendor command 0073 with WBS disabled
Call indicator value: 0

```

5.4 handsfree_ag Sample Application

This application demonstrates the HFP audio gateway basic functionality. Currently, the support simulates an incoming call, and the call could be answered and ended.

The HFP audio gateway can be connected to a HFP HF device like headphone or device running HFP HF device.

5.4.1 handsfree_ag Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.4.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
```

```
Copyright 2022 NXP
```

```
>>
```

Input "help" to show the available list of commands:

```
>> help
```

```
"help": List all the registered commands
```

```
"exit": Exit program
```

```
"bt": BT related function
```

```
USAGE: bt [discover|connect|disconnect|delete]
discover      start to find BT devices
connect       connect to the device that is found, for example: bt connect n
(from 1)
sincall      start an incoming call.
aincall       accept the incoming call.
eincall      end an incoming call.
disconnect   disconnect current connection.
```

```
delete      delete all devices. Ensure to disconnect the HCI link  
connection with the peer device before attempting to delete the bonding  
information.  
>>
```

Input "bt discover" to scan the nearby Bluetooth devices:

```
>> bt discover
Discovery started. Please wait ...
>> BR/EDR discovery complete
[1]: 50:82:D5:78:31:DA, RSSI -65 iPhone 6
[2]: 80:CE:B9:22:B3:FD, RSSI -79 Galaxy S8
[3]: BC:17:B8:74:2C:9F, RSSI -58 LAPTOP
[4]: 70:F0:87:C0:FC:0E, RSSI -66 iPhone
[5]: 00:00:AB:CD:87:D6, RSSI -38 Airdopes 441
[6]: C8:3D:D4:43:5A:14, RSSI -93 LAPTOP-NLHDBT0E
```

>>

Input "bt connect <number>" to connect to the peer device.

```
>> bt connect 5
Connection pending
>> SDP discovery started
Connected
Security changed: 7A:D6:2C:9B:F7:A3 (0x5e) level 2
HFP AG Connected!
```

Input "bt disconnect" to disconnect from the peer device.

```
>> bt disconnect
>> HFP AG Disconnected!
Disconnected (reason 0x16)
```

Input "bt delete" to delete the bonding information of all the devices.

Note: Disconnect the HCI link connection with the peer device before attempting to delete the bonding information.

```
>> bt delete
success
>>
```

5.5 spp Sample Application

This application demonstrates the Serial Port Profile on i.MX RT1060 EVK board and IW416 wireless module.

5.5.1 spp Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.5.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
BR/EDR set connectable and discoverable done

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>>
```

Input "help" to display the available options:

```
>> help
"help": List all the registered commands

"exit": Exit program

"bt": BT related function
    USAGE: bt <discover|connect|disconnect|delete>
```

```

bt conns          print all active bt connection
bt switch <index> switch a bt connection
bt discover       start to find BT devices
bt connect        connect to the device that is found, for example: bt
connectdevice n (from 1)
bt disconnect     disconnect current connection.
bt delete         delete all devices. Ensure to disconnect the HCI link
connection with the peer device before attempting to delete the bonding
information.

"spp": SPP related function
USAGE:
  spp handle          display active spp handle list
  spp switch <hanlde>
  spp register <cid>
  spp discover        discover spp server channel(cid)
  spp connect <cid>
  spp disconnect      disconnect current spp connection.
  spp send <1|2|3|4>
  spp get_port <s|c> <cid>
  spp set_port <s|c> <cid>
  spp set_pn <s|c> <cid>
  spp get_pn <s|c> <cid>
  spp send_rls
  spp send_msc
>>

```

5.5.1.2 Serial Port Profile Server Configuration

This section describes the steps to configure the i.MX RT1060 EVK board and IW416 wireless module as an SPP Server.

Register a SPP server channel.

```
>> spp register 5
SPP channel 5 register successfully, waiting for connected callback!
>>
```

Connect to the device “edgefast spp” from the smartphone Bluetooth pairing settings and enable the pairing.

Following logs will appear on console:

```
>> Connected
Security changed: 48:74:12:C2:F2:82 (0x6d) level 2
Disconnected (reason 0x13)
```

Now, open the “Serial Bluetooth Terminal” smartphone application and go to settings > devices.

Select the device “edgefast spp”. The connection will be established and following logs will appear on console:

```
BR connection with 48:74:12:C2:F2:82 is created successfully!
Security changed: 48:74:12:C2:F2:82 level 2
Security changed: 48:74:12:C2:F2:82 level 2
spp handle 0: server, channel = 5, connected with device 82:F2:C2:12:74:48.
SPP appl handle 0 is connected successfully and becomes current spp appl
handle!
```

Write data in the smartphone application and send:

```
SPP appl handle 0 received 31 data callback, dumped here:
-----CHAR DUMP-----
  h e l l o   f r o m   s m a r t p h o n e
° ä ö ÿ ÿ ÿ
-----
-----HEX DUMP-----
```

```
20 68 65 6C 6C 6F 20 66 72 6F 6D 20 73 6D 61 72 74 70 68 6F 6E 65 0D 0A B0 E3
F5 81 FF FF FF
-----
```

Input “spp send [n]” to send data to peer device.

```
>> spp send 1
SPP appl handle 0 send string successfully, waiting for data sent callback.
>>
SPP appl handle 0 sent 11 data callback, dumped here:
-----CHAR DUMP-----
A T + C I N D = ? \ r
-----
```

Input “spp disconnect” to disconnect with peer device.

```
>> spp disconnect
SPP appl handle 0 disconnect successfully, waiting for disconnected callback.
SPP appl handle 0 is disconnected successfully.
BR connection with 48:74:12:C2:F2:82 is disconnected (reason 0x13)
```

5.5.1.3 Serial Port Profile Client Configuration

This section describes the steps to configure the i.MX RT1060 EVK board and IW416 wireless module as an SPP Client. Here, another setup of i.MX RT1060 EVK board and IW416 wireless module is used as SPP Server.

Start SPP server first then follow the steps to configure SPP client.

Input “bt discover” to start find the nearby Bluetooth devices.

```
>> bt discover
Discovery started. Please wait ...
>> BR/EDR discovery complete
[1]: C8:3D:D4:43:5A:14, RSSI -86 LAPTOP-NLHDBT0E
[2]: 04:D1:3A:82:B5:FE, RSSI -65 LAPTOP-NLHDBT0F
[3]: 18:5E:0F:96:8C:31, RSSI -69 BUILD0
[4]: 20:4E:F6:EC:1F:26, RSSI -79 edgefast spp

>>
```

Input “bt connect <n>” to connect to the device that is found.

```
>> bt connect 4
Connection pending
>> Connected

>>
```

Input “spp discover” to discover the registered SPP server channel in peer device.

```
>> spp discover
>> Discover 1 SPP server channel from device 26:1F:EC:F6:4E:20!
0x0005

>>
```

Input “spp connect [channel]” to create SPP connection with peer SPP server channel.

```
>> spp connect 5
Connect SPP Successful!
>> Security changed: 84:17:25:08:64:F9 (0xef) level 2
SPP connection is created successfully!

>>
```

Input “spp send [1|2|3|4]” to send data over SPP.

```
>> spp send 1
>>
Status of SPP data sent callback: 0x0000.
```

```
Sent 11 data, dumped here:
```

```
-----CHAR DUMP-----  
A T + C I N D = ? \ r  
-----  
>>
```

```
Input "spp disconnect" to disconnect with peer device.
```

```
>> spp disconnect  
>> SPP connection is disconnected successfully!
```

5.6 peripheral_hps Sample Application

This application demonstrates the Bluetooth LE Peripheral role, except that this application specifically exposes the HTTP Proxy GATT Service.

5.6.1 peripheral_hps Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.6.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Advertising successfully started
```

The demo does not require user interaction.

The application will automatically start advertising the HTTP Proxy Service and it will accept the first connection request it receives. The application is then ready to process HTTP requests from the peer.

The application simulates processing of the HTTP request. It will always return HTTP Status Code 500 and preset values for HTTP Headers and HTTP Body.

```
Connected to peer: 70:E8:F5:6B:FA:96 (random)  
Passkey for 70:E8:F5:6B:FA:96 (random): 012896  
Security changed: 90:78:B2:B6:A7:6C (public) level 4 (error 0)
```

5.7 central_hpc Sample Application

This application demonstrates very basic Bluetooth LE Central role functionality on i.MX RT1060 EVK board and IW416 wireless module by scanning for other Bluetooth LE devices and establishing a connection to the first one with a strong enough signal.

Except that this application specifically looks for HPS Server and programs a set of characteristics that configures a Hyper Text Transfer Protocol (HTTP) request, initiate this request, and then read the response once connected.

Here, another setup of i.MX RT1060 EVK board and IW416 wireless module is used as *peripheral_hps*.

5.7.1 central_hpc Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.7.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Scanning started  
[DEVICE]: 20:4E:F6:25:F3:18 (public), AD evt type 0, AD data len 7, RSSI -71
```

The demo does not require user interaction.

The application will automatically start scanning and will connect to the first advertiser who is advertising the HTTP Proxy Service.

If the connection is successful, the application performs service discovery to find the characteristics of the HTTP Proxy Service. If discovery is successful, the application will perform a GET for the URI <http://nxp.com> by writing the URI and the Control Point characteristics of the HTTP Proxy Service.

The application will display the received response in the console after it gets notified through the HTTP Status Code characteristic.

```
Found device: Connected to peer: 20:4E:F6:25:F3:18 (public)
Starting service discovery
GATT Write successful
Subscribed to HTTP Status Code
GATT Write successful
Received HTTP Status 500
Reading Headers..
HTTP Headers: HTTPHEADER
Reading Body...
Unsubscribed
HTTP Body: HTTPBODY
```

5.8 peripheral_pxr Sample Application

This application demonstrates the BLE Peripheral role on i.MX RT1060 EVK board and IW416 wireless module. Except that this application specifically exposes the Proximity Reporter (including LLS, IAS, and TPS) GATT Service.

5.8.1 peripheral_pxr Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.8.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
Advertising successfully started
```

The demo does not require user interaction.

The application will automatically start advertising the Link Loss Service and it will accept the first connection request it receives. The application is then ready to process operations from the peer.

The application will initially set the default levels for the Link Loss Alert and the Immediate Alert.

```
Connected to peer: 20:4E:F6:25:F3:18 (public)
Locally setting Link Loss Alert Level to OFF
Locally setting Immediate Alert...
```

```
ALERT: OFF
```

The Proximity Monitor peer will trigger or stop the Immediate Alert on the application depending on the connection RSSI.

```
Monitor is setting Link Loss Alert Level to HIGH
Monitor is setting Immediate Alert...
ALERT: HIGH
Monitor is setting Immediate Alert...
ALERT: OFF
```

If the connection with the Proximity Monitor is timed out, the Link Loss Alert will be triggered with the level previously set by the Monitor.

```
Link Loss Alert Triggered...
ALERT: HIGH
```

5.9 central_pxm Sample Application

This application demonstrates very basic Bluetooth LE Central role functionality on i.MX RT1060 EVK board and IW416 wireless module by scanning for other Bluetooth LE devices and establishing a connection to the first one with a strong enough signal.

Except that this application specifically looks for Proximity Reporter.

Here, another setup of i.MX RT1060 EVK board and IW416 wireless module is used as *peripheral_pxr*.

5.9.1 central_pxm Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.9.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Scanning started
```

The application will automatically start scanning and will connect to the first advertiser who is advertising the Link Loss Service.

If the connection is successful, the application performs service discovery to find the characteristics of the Link Loss Service, as well as additional services and characteristics specified by the Proximity Profile, such as Immediate Alert and Tx Power services.

```
[DEVICE]: 20:4E:F6:25:F3:18 (public), AD evt type 0, AD data len 11, RSSI -83  
Found device: Connected to peer: 20:4E:F6:25:F3:18 (public)  
Starting service discovery  
GATT Write successful  
Connection RSSI: -81
```

If the Tx Power service and its characteristics have been discovered, the application will read the peer's Tx power and display it.

```
Read successful - Tx Power Level: 0
```

If the Immediate Alert service and its characteristics have been discovered, the application will continuously monitor the connection RSSI and will trigger or stop the Immediate Alert on the peer when the value is crossing a preset threshold in either direction.

```
Connection RSSI: -81  
Connection RSSI: -81  
Connection RSSI: -81  
Connection RSSI: -81  
Connection RSSI: -81
```

After the mandatory Link Loss service is discovered, the application will write the Link Loss Alert Level on the peer as HIGH_ALERT.

To trigger the Link Loss Alert on the peer, the connection will have to be timed out. The user can trigger this by simply resetting the board (press the RST button).

5.10 peripheral_ht Sample Application

This application demonstrates the BLE Peripheral role on i.MX RT1060 EVK board and IW416 wireless module. Except that this application specifically exposes the HT (Health Thermometer) GATT Service. Once a device connects it will generate dummy temperature values.

5.10.1 peripheral_ht Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.10.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board.

When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Advertising successfully started
```

The application does not require user interaction.

The application will automatically start advertising the Health Thermometer Service and it will accept the first connection request it receives. If the peer subscribes to receive temperature indications, these will be sent every 1 second.

The temperature readings are simulated with values between 20 and 25 degrees Celsius.

```
Connected to peer: 90:78:B2:B6:A7:6C (public)  
Passkey for 90:78:B2:B6:A7:6C (public): 413238  
Security changed: 90:78:B2:B6:A7:6C (public) level 4 (error 0)  
temperature is 21C  
Indication success  
temperature is 22C  
Indication success
```

5.11 central_ht Sample Application

This application demonstrates very basic Bluetooth LE Central role functionality on i.MX RT1060 EVK board and IW416 wireless module by scanning for other Bluetooth LE devices and establishing a connection to the first one with a strong enough signal.

Except that this application specifically looks for health thermometer sensor and reports the temperature readings once connected.

Here, another setup of i.MX RT1060 EVK board and IW416 wireless module is used as *peripheral_ht*.

5.11.1 central_ht Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.11.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Scanning started
```

The demo does not require user interaction.

The application will automatically start scanning and will connect to the first advertiser who is advertising the Health Thermometer Service. If the connection is successful, the application performs service discovery to find the characteristics of the Health Thermometer Service.

If discovery is successful, the application will subscribe to receive temperature indications from the peer.

The application will display the received indications in the console.

```
[DEVICE]: 20:4E:F6:25:F3:18 (public), AD evt type 0, AD data len 9, RSSI -84
Found device: Connected to peer: 20:4E:F6:25:F3:18 (public)
Starting service discovery
Subscribed to HTS
Temperature 21 degrees Celsius
Temperature 22 degrees Celsius
```

5.12 peripheral_ipsp Sample Application

This application demonstrates the BLE Peripheral role on i.MX RT1060 EVK board and IW416 wireless module. Except that this application specifically exposes the Internet Protocol Support GATT Service.

5.12.1 peripheral_ipsp Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.12.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board.

When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized
Advertising successfully started
IPSS Service ready
```

The demo does not require user interaction.

The application will automatically start advertising the IPSP Service and it will accept the first connection request it receives.

The application will perform the required setup for the L2CAP credit-based channel specified by the IPSP Profile. The application will display in console any message it receives from the peer through the L2CAP channel.

```
Connected to peer: 90:78:B2:B6:A7:6C (random)
Passkey for 90:78:B2:B6:A7:6C (random): 214634
Security changed: 90:78:B2:B6:A7:6C (public) level 4 (error 0)
Received message: hello
Received message: hello
```

5.13 central_ipsp Sample Application

This application demonstrates very basic BLE Central role functionality by scanning for other BLE devices and establishing a connection to the first one with a strong enough signal.

Except that this application specifically looks for IPSP Service and communicates between the devices that support IPSP is done using IPv6 packets over the Bluetooth Low Energy transport once connected.

Here, another setup of i.MX RT1060 EVK board and IW416 wireless module is used as *peripheral_ipsp*.

5.13.1 central_ipsp Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.13.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Bluetooth initialized  
Scanning started
```

The demo does not require user interaction.

The application will automatically start scanning and will connect to the first advertiser who is advertising the IPSP Service.

After the L2CAP credit-based channel specified by the IPSP Profile is established, the application will send a predefined test message every 5 seconds through the channel.

```
[DEVICE]: 20:4E:F6:25:F3:18 (public), AD evt type 0, AD data len 7, RSSI -82  
Found device: Connected  
Starting service discovery  
Sending message...  
Sending message...
```

5.14 Wireless UART Sample Application

The application implements a custom GATT based Wireless UART Profile that emulates UART over BLE. Central and peripheral role can be switched by user button (SW8). To test the service/profile the "IoT Toolbox" application can be used which is available for both Android and iOS. IoT Toolbox can be found on Apple App Store or Google Play Store.

5.14.1 wireless_uart Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode, and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.14.1.1 Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
BLE Wireless Uart demo start...  
Bluetooth initialized  
Advertising successfully started
```

The demo requires user interaction. The application will automatically start advertising the wireless uart Service after reset, the application can only accept 1 connection when configured as a peripheral.

The application will start scanning and connect to the wireless uart Service automatically.

Pressing the Button will switch from Peripheral mode to central mode and now it can connect to 8 devices. We can use "IoT Toolbox" or another wireless_uart example (use B to refer to) to test the current device.

peripheral role test:

Open "IoT Toolbox" application on an Android or iOS smartphone, select the "Wireless UART" option. A device named "NXP_WU" should appear. Connect to "NXP_WU" by selecting the device from the scan list. The Android/iOS device should receive a prompt for a Bluetooth Pairing Request. Please complete the pairing process by entering the passkey that is displayed on the debug terminal. Once pairing is completed, we can now transmit and receive data over the emulated UART interface.

```
BLE Wireless Uart demo start...
Bluetooth initialized
Advertising successfully started
Connected to 4B:6B:F0:B6:7C:F8 (random)
GATT MTU exchanged: 65
[ATTRIBUTE] handle 40
[ATTRIBUTE] handle 41
Passkey for 4B:6B:F0:B6:7C:F8 (random): 994660
Security changed: 20:39:56:C6:6C:6C (public) level 4 (error 0)
Data received (length 5): hello
```

central role test:

let B work as default state after reset.

short press the user button(SW8), the example will work as central can automatically connect to any discovered wireless uart example. Each time short press, the example will scan and connect to wireless uart service if new device is found.

```
BLE Wireless Uart demo start...
Bluetooth initialized
Advertising successfully started
Scanning successfully started
[DEVICE]: 24:FC:E5:9F:EE:EB (public), AD evt type 3, AD data len 28, RSSI -92
[DEVICE]: 64:86:7F:5A:7C:7F (random), AD evt type 0, AD data len 23, RSSI -81
[DEVICE]: 64:86:7F:5A:7C:7F (random), AD evt type 4, AD data len 0, RSSI -80
[DEVICE]: 65:F2:7E:9A:AF:C7 (random), AD evt type 0, AD data len 19, RSSI -89
[DEVICE]: 65:F2:7E:9A:AF:C7 (random), AD evt type 4, AD data len 0, RSSI -89
[DEVICE]: 63:F2:B1:6A:FC:3D (random), AD evt type 0, AD data len 18, RSSI -80
[DEVICE]: 63:F2:B1:6A:FC:3D (random), AD evt type 4, AD data len 0, RSSI -80
[DEVICE]: 78:B3:AA:89:78:3B (random), AD evt type 0, AD data len 18, RSSI -80
[DEVICE]: 78:B3:AA:89:78:3B (random), AD evt type 4, AD data len 0, RSSI -79
[DEVICE]: 80:D2:1D:E8:2B:7E (public), AD evt type 0, AD data len 21, RSSI -43
Connected to 80:D2:1D:E8:2B:7E (public)
GATT MTU exchanged: 65
[ATTRIBUTE] handle 25
[ATTRIBUTE] handle 26
Security changed: 80:D2:1D:E8:2B:7E (public) level 2 (error 0)
```

Note:

The device address, AD event type data len, and RSSI are variable, it depends on all the Bluetooth device in test environment.

Send data 12345 in B device's Serial port terminal, then current device will print the following log.

```
Data received (length 5): 12345
```

Send data 123 in current device's Serial port terminal, then B device will print the following log.

```
Data received (length 5): 123
```

5.15 Shell Sample Application

Application Demonstrating the Interactive Shell Mode of Bluetooth Commands and APIs. It provides users full control over the Bluetooth Interface. User can control the basic Bluetooth operations such as advertising/scanning , device discovery , connection and pairing as well as direct access to the HCI command interface.

5.15.1 Shell Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode, and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.15.1.1 Shell Run the application

Press the power reset button on i.MX RT1060 EVK board to run the demo application downloaded on the board. When the demo starts, the following message about the demo would appear on the console.

```
Edgefast Bluetooth PAL shell demo start...
```

```
SHELL build: Aug 9 2022  
Copyright 2020 NXP
```

```
@bt>
```

NOTE: The shell information "SHELL build: Aug 10 2021" may be different, which depends on the compile date.

The shell command list can be accessed by typing "help" in serial terminal. The demo can be configured to either "central" or "peripheral" by shell commands.

Here is an example of scan devices (the BLE host must be initialized before executing the scan command):

```
@bt> bt.init  
@bt> Bluetooth initialized  
Settings Loaded  
  
@bt> bt.scan on  
Bluetooth active scan enabled  
@bt> [DEVICE]: 44:6D:F5:85:DC:5F (random), AD evt type 0, RSSI -64 C:1 S:1 D:0  
SR:0 E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 44:6D:F5:85:DC:5F (random), AD evt type 4, RSSI -63 C:0 S:1 D:0 SR:1  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 6D:B3:D3:8E:ED:A2 (random), AD evt type 0, RSSI -77 C:1 S:1 D:0 SR:0  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 6D:B3:D3:8E:ED:A2 (random), AD evt type 4, RSSI -76 C:0 S:1 D:0 SR:1  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 3F:FB:95:F7:F9:14 (random), AD evt type 3, RSSI -75 C:0 S:0 D:0 SR:0  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 49:A3:4E:86:63:0C (random), AD evt type 0, RSSI -76 C:1 S:1 D:0 SR:0  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff  
[DEVICE]: 49:A3:4E:86:63:0C (random), AD evt type 4, RSSI -75 C:0 S:1 D:0 SR:1  
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff
```

```
[DEVICE]: 5C:28:50:F9:DD:57 (random), AD evt type 0, RSSI -82 C:1 S:1 D:0 SR:0
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff
[DEVICE]: 3B:95:00:4D:F3:EB (random), AD evt type 3, RSSI -82 C:0 S:0 D:0 SR:0
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff
[DEVICE]: 47:9D:D0:CB:5F:0D (random), AD evt type 0, RSSI -86 C:1 S:1 D:0 SR:0
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff
@bt> bt.scan off
Scan successfully stopped
@bt>
```

Here is an example of advertising (the BLE host must be initialized before):

```
@bt> bt.init
@bt> Bluetooth initialized

@bt> bt.advertise on
Advertising started
@bt> bt.advertise off
Advertising stopped
@bt>
```

RF Test Mode Operations

This section describes the commands to perform the RF test for Bluetooth Classic and Bluetooth Low Energy

NOTE : The mentioned "command complete event" can be found in HCI log, U-DISK should be connected to usb port to get HCI log capture. CONFIG_BT_SNOOP macro is used to enable stack to capture the HCI log.

Here is the log of rf_test_mode application:

```
>> help

@bt> help

+---"help": List all the registered commands
+---"exit": Exit program
+---"echo": Set echo(0 - disable, 1 - enable)
+---"bt": bt command entry
    +---"init": init [no-settings-load], [sync]
    +---"settings-load": settings-load [none]
    +---"id-create": id-create [addr]
    +---"id-reset": id-reset <id> [addr]
    +---"id-delete": id-delete <id>
    +---"id-show": id-show [none]
    +---"id-select": id-select <id>
    +---"name": name [name]
    +---"scan": scan <value: on, passive, off> [filter: dups, nodups] [fal]
    +---"scan-filter-set": scan-filter-set Scan filter set commands
        +---"name": name <name>
        +---"addr": addr <addr>
    +---"scan-filter-clear": scan-filter-clear Scan filter clear commands
        +---"all": all
        +---"name": name
        +---"addr": addr
    +---"advertise": advertise <type: off, on, scan, nconn> [mode: discov, non_discov] [filter-accept-list: fal, fal-scan, fal-conn] [identity] [no-name] [one-time] [name-ad] [disable-37] [disable-38] [disable-39]
        +---"directed-adv": directed-adv <address: XX:XX:XX:XX:XX:XX> <type: (public|random)> [mode: low] [identity] [dir-rpa]
        +---"connect": connect <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>
```

```

+---"disconnect": disconnect [none]
+---"select": select <address: XX:XX:XX:XX:XX> <type: (public|random)>
+---"info": info <address: XX:XX:XX:XX:XX> <type: (public|random)>
+---"conn-update": conn-update <min> <max> <latency> <timeout>
+---"data-len-update": data-len-update <tx_max_len> [tx_max_time]
+---"phy-update": phy-update <tx_phy> [rx_phy] [s2] [s8]
+---"channel-map": channel-map <channel-map: XXXXXXXXXXXX> (36-0)
+---"oob": oob [none]
+---"clear": clear <remote: addr, all>
+---"security": security <security level BR/EDR: 0 - 3, LE: 1 - 4> [force-pair]
+---"bondable": bondable <bondable: on, off>
+---"bonds": bonds [none]
+---"connections": connections [none]
+---"auth": auth <method: all, input, display, yesno, confirm, oob, status, none>
    +---"auth-cancel": auth-cancel [none]
    +---"auth-passkey": auth-passkey <passkey>
    +---"auth-passkey-confirm": auth-passkey-confirm [none]
    +---"auth-pairing-confirm": auth-pairing-confirm [none]
    +---"auth-oob-tk": auth-oob-tk <tk>
    +---"oob-remote": oob-remote <address: XX:XX:XX:XX:XX> <type: (public|random)> <oob rand> <oob confirm>
        +---"oob-clear": oob-clear [none]
    +---"fal-add": fal-add <address: XX:XX:XX:XX:XX> <type: (public|random)>
    +---"fal-rem": fal-rem <address: XX:XX:XX:XX:XX> <type: (public|random)>
    +---"fal-clear": fal-clear [none]
    +---"fal-connect": fal-connect <on, off>
+---"gatt": gatt Bluetooth GATT shell commands
    +---"discover": discover [UUID] [start handle] [end handle]
    +---"discover-characteristic": discover-characteristic [UUID] [start handle] [end handle]
        +---"discover-descriptor": discover-descriptor [UUID] [start handle] [end handle]
        +---"discover-include": discover-include [UUID] [start handle] [end handle]
        +---"discover-primary": discover-primary [UUID] [start handle] [end handle]
        +---"discover-secondary": discover-secondary [UUID] [start handle] [end handle]
    +---"exchange-mtu": exchange-mtu [none]
    +---"read": read <handle> [offset]
    +---"read-uuid": read-uuid <UUID> [start handle] [end handle]
    +---"read-multiple": read-multiple <handle 1> <handle 2> ...
    +---"signed-write": signed-write <handle> <data> [length] [repeat]
    +---"subscribe": subscribe <CCC handle> <value handle> [ind]
    +---"resubscribe": resubscribe <address: XX:XX:XX:XX:XX> <type: (public|random)> <CCC handle> <value handle> [ind]
    +---"write": write <handle> <offset> <data>
    +---"write-without-response": write-without-response <handle> <data> [length] [repeat]
        +---"write-without-response-cb": write-without-response-cb <handle> <data> [length] [repeat]
    +---"unsubscribe": unsubscribe [none]
    +---"get": get <start handle> [end handle]
    +---"set": set <handle> [data...]
    +---"show-db": show-db [uuid] [num_matches]
    +---"att_mtu": att_mtu Output ATT MTU size
    +---"metrics": metrics [value: on, off]
    +---"register": register register pre-predefined test service
    +---"unregister": unregister unregister pre-predefined test service
    +---"notify": notify [data]
+---"l2cap": l2cap Bluetooth L2CAP shell commands
    +---"connect": connect <psm> [sec_level]

```

```

+---"disconnect": disconnect [none]
+---"metrics": metrics <value on, off>
+---"recv": recv [delay (in milliseconds)]
+---"register": register <psm> [sec_level] [policy: allowlist, 16byte_key]
+---"send": send <number of packets>
+---"allowlist": allowlist [none]
    +---"add": add [none]
    +---"remove": remove [none]
+---"br": br Bluetooth BR/EDR shell commands
    +---"auth-pincode": auth-pincode <pincode>
    +---"connect": connect <address>
    +---"discovery": discovery <value: on, off> [length: 1-48] [mode: limited]
    +---"iscan": iscan <value: on, off>
    +---"l2cap-register": l2cap-register <psm>
    +---"l2cap-register-mode": l2cap-register-mode <psm> <mode:
        3. Enhanced Retransmission mode
        4. Streaming mode>
    +---"l2cap-connect": l2cap-connect <psm>
    +---"l2cap-disconnect": l2cap-disconnect [none]
    +---"l2cap-send": l2cap-send <number of packets>
    +---"oob": oob [none]
    +---"pscan": pscan <value: on, off>
    +---"sdp-find": sdp-find <HFPAG>
+---"rfcomm": rfcomm Bluetooth RFCOMM shell commands
    +---"register": register <channel>
    +---"connect": connect <channel>
    +---"disconnect": disconnect [none]
    +---"send": send <number of packets>

+---"a2dp": a2dp Bluetooth A2DP shell commands
    +---"register_sink_ep": register_sink_ep <select codec.
        1:SBC
        2:MPEG-1,2
        3:MPEG-2,4
        4:vendor
        5:sbc with delay report and content protection services
        6:sbc with all other services(don't support data
transfer yet)>
    +---"register_source_ep": register_source_ep <select codec.
        1:SBC
        2:MPEG-1,2
        3:MPEG-2,4
        4:vendor
        5:sbc with delay report and content protection services
        6:sbc with all other services(don't support data
transfer yet)>
    +---"connect": connect [none]
    +---"disconnect": disconnect [none]
    +---"configure": configure [none]
    +---"discover_peer_eps": discover_peer_eps [none]
    +---"get_registered_eps": get_registered_eps [none]
    +---"set_default_ep": set_default_ep <select endpoint>
    +---"configure_ep": configure_ep "configure the default selected ep"
    +---"deconfigure": deconfigure "de-configure the default selected ep"
    +---"start": start "start the default selected ep"
    +---"stop": stop "stop the default selected ep"
    +---"send_media": send_media <second> "send media data to the default
selected ep"

```

```

+---"send_delay_report": send_delay_report <delay> "a2dp sink send delay
report to default selected ep"

+---"avrcp": avrcp Bluetooth AVRCP shell commands
+---"init_ct": init_ct [none]
+---"init_tg": init_tg [none]
+---"ctl_connect": ctl_connect "create control connection"
+---"brow_connect": brow_connect "create browsing connection"
+---"ct_list_all_cases": ct_list_all_cases "display all the test cases"
+---"ct_test_case": ct_test_case <select one case to test>
+---"ct_test_all": ct_test_all "test all cases"
+---"ct_reg_ntf": ct_reg_ntf <Register Notification. select event:
    1. EVENT_PLAYBACK_STATUS_CHANGED
    2. EVENT_TRACK_CHANGED
    3. EVENT_TRACK_REACHED_END
    4. EVENT_TRACK_REACHED_START
    5. EVENT_PLAYBACK_POS_CHANGED
    6. EVENT_BATT_STATUS_CHANGED
    7. EVENT_SYSTEM_STATUS_CHANGED
    8. EVENT_PLAYER_APPLICATION_SETTING_CHANGED
    9. EVENT_NOW_PLAYING_CONTENT_CHANGED
        a. EVENT_AVAILABLE_PLAYERS_CHANGED
        b. EVENT_ADDRESSED_PLAYER_CHANGED
        c. EVENT_UIDS_CHANGED
        d. EVENT_VOLUME_CHANGED>
+---"tg_notify": tg_notify <Notify event. select event:
    1. EVENT_PLAYBACK_STATUS_CHANGED
    2. EVENT_TRACK_CHANGED
    3. EVENT_TRACK_REACHED_END
    4. EVENT_TRACK_REACHED_START
    5. EVENT_PLAYBACK_POS_CHANGED
    6. EVENT_BATT_STATUS_CHANGED
    7. EVENT_SYSTEM_STATUS_CHANGED
    8. EVENT_PLAYER_APPLICATION_SETTING_CHANGED
    9. EVENT_NOW_PLAYING_CONTENT_CHANGED
        a. EVENT_AVAILABLE_PLAYERS_CHANGED
        b. EVENT_ADDRESSED_PLAYER_CHANGED
        c. EVENT_UIDS_CHANGED
        d. EVENT_VOLUME_CHANGED>
+---"ca_init_i": ca_init_i "Init cover art initiator"
+---"ca_init_r": ca_init_r "Init cover art responder"
+---"ca_connect": ca_connect "create cover art connection"
+---"ca_test": ca_test "cover art test all cases"

+---"bt_test": bt_test Bluetooth BR/EDR test mode commands
+---"enter_test_mode": enter_test_mode Enable device under test mode
+---"tx_test": tx_test test_scenario[1] hopping_mode[1] tx_channel[1]
rx_channel[1] tx_test_interval[1] pkt_type[1] data_length[2] whitening[1]
num_pkt[4] tx_pwr[1]
+---"rx_test": rx_test test_scenario[1] tx_channel[1] rx_channel[1]
pkt_type[1] num_pkt[4] data_length[2] tx_addr[6] report_err_pkt[1]
+---"reset": reset Reset the HCI interface
+---"le_test": le_test Bluetooth BLE test mode commands
+---"set_tx_power": set_tx_power tx_power[1]
+---"tx_test": tx_test tx_channel[1] data_length[1] payload[1] phy[1]
+---"rx_test": rx_test rc_channel[1] phy[1] modulation[1]

```

```
+---"end_test": end_test end the le test
+---"hci": hci Bluetooth HCI Command interface
+---"generic_command": generic_command ogf[1] ocf[1] params....
```

```
@bt>
>>
>> bt.init
bt.init

>>
>> Bluetooth initialized
Settings Loaded

>>
```

Enable the device under test mode

This command puts the controller into the test mode

```
@bt> bt_test.enter_test_mode
```

```
Enable device under test mode
@bt> HCI Command Response : 00
```

Set the transmit test parameters for Bluetooth Classic

This command sets the transmit test parameters. An HCI reset command is required after this test to resume normal Bluetooth operation.

```
@bt> bt_test.tx_test 01 00 01 01 0D 03 0F 00 00 00 00 00 00 00 04
```

Command output example:

```
rx_on_start default set to=80
synt_on_start default set to=80
tx_on_start default set to=80
phd_off_start default set to=80
test_scenario= 1
hopping_mode= 0
tx_channel= 1
rx_channel= 1
tx_test_interval= d
pkt_type= 3
data_length= f 0
whitening= 0
num_pkt= 0 0 0 0
tx_pwr= 4
@bt> HCI Command Response : 00
```

Command Parameters :

Name	Length	Description
RxOnStart	1	These 4 parameters should be set to 0x80.
SyntOnStart	1	
TxOnStart	1	
PhdOffStart	1	
TestScenario	1	0x01 = PATTERN_00 (data pattern: 0x00) 0x02 = PATTERN_FF (data pattern: 0xFF) 0x03 = PATTERN_55 (data pattern: 0x55) 0x04 = PATTERN_PRBS (data pattern: 0xFE) 0x09 = PATTERN_OF (data pattern: 0x0F) 0xFF = exit test
HoppingMode	1	0x00 = fix frequency 0x01 = hopping set
TxChannel	1	Transmit Frequency = (2402+k) MHz, where k is the value of TxChannel
RxChannel	1	Receive Frequency = (2402+k) MHz, where k is the value of RxChannel
TxTestInterval	1	Poll interval in frames for the link (units, 1.25 ms)
PacketType	1	Transmit Packet Type 0x03 = DM1 0x04 = DH1 0x0A = DM3 0x0B = DH3 0x0E = DM5 0x0F = DH5 0x14 = 2-DH1 0x18 = 3-DH1 0x1A = 2-DH3 0x1B = 3-DH3 0x1E = 2-DH5 0x1F = 3-DH5
Length	2	Length of Test Data
Whitening	1	0x00 = disabled 0x01 = enabled
Number of Test Packets	4	0 = infinite (default)
Tx Power	1	Signed value of Tx power (dBm) Range = -20 dBm to 12 dBm (default = 4 dBm)

End transmitter test for Bluetooth Classic:

```
@bt> bt_test.tx_test FF 00 01 01 0D 03 0F 00 00 00 00 00 00 00 04
```

Observe the packet count in vendor-specific command complete event in HCI logs (Refer to the table below for Event details).

Event Name	Event Code	Event ID	Parameters

Tx Test Result	0xFF	0x19	<table border="1"> <thead> <tr> <th>Name</th><th>Length</th><th>Value</th></tr> </thead> <tbody> <tr> <td>Status</td><td>1</td><td>0x00 = completed 0x01 = aborted</td></tr> <tr> <td>Total Packets</td><td>4</td><td>(in hexadecimal)</td></tr> </tbody> </table>	Name	Length	Value	Status	1	0x00 = completed 0x01 = aborted	Total Packets	4	(in hexadecimal)
Name	Length	Value										
Status	1	0x00 = completed 0x01 = aborted										
Total Packets	4	(in hexadecimal)										

Set the Receive Test parameters for Bluetooth Classic

This command sets the receive test parameters. An HCI reset command is required after this test to resume normal Bluetooth operation.

```
@bt> bt_rx_test 01 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00
```

Command output example :

```
test_scenario= 1
tx_channel= 1
rx_channel= 1
pkt_type= 3
num_pkt= 10 0 0 0
data_length= f 0
tx_am_addr default set to= 1
tx_addr:
20
4e
f6
ec
1f
26
report_err_pkt= 0
@bt> HCI Command Response : 00
```

Command Parameters :

Name	Length	Description
TestScenario	1	Test Scenario 0x01 = receiver test, 0-pattern 0x02 = receiver test, 1-pattern 0x03 = receiver test, 1010-pattern 0x04 = receiver test, PRBS-pattern 0x09 = receiver test, 1111 0000-pattern 0xFF = abort test mode
TxFrequency	1	Transmit Frequency f = (2402+k) MHz
RxFrequency	1	Receive Frequency f = (2402+k) MHz

TestPacketType	1	Test Packet Type 0x03 = DM1 0x04 = DH1 0x0A = DM3 0x0B = DH3 0x0E = DM5 0x0F = DH5 0x14 = 2-DH1 0x18 = 3-DH1 0x1A = 2-DH3 0x1B = 3-DH3 0x1E = 2-DH5 0x1F = 3-DH5
Expected Number of Packets	4	--
Length of Test Data	2	Should not be bigger than the maximum size of the specified test packet type
Tx AM Address	1	Default = 0x01
Transmitter BD Address	6	This is used to derive the access code
Report Error Packets	1	Report Error Packets 0x00 = none (default) 0x01 to 0xFE = number of packets to report

End receiving test for Bluetooth Classic:

```
@bt> bt_test.rx_test FF 01 01 03 10 00 00 00 0F 00 20 4E F6 EC 1F 26 00
```

Observe the packet count in vendor-specific command complete event in HCI logs (Refer to the table below for Event details).

Event Name	EventCode	Event ID	Parameters

Receive Test Result	0xFF	0x01	Name	Length	Value
			Status	1	0x00 = completed 0x01 = aborted
			Total Packets (Expected)	4	(in hexadecimal)
			No Rx Count	4	(in hexadecimal)
			Successful Correlation Count	4	(in hexadecimal)
			HEC Match Count	4	(in hexadecimal)
			HEC Match CRC Packets Count	4	(in hexadecimal)
			Payload Hdr Error Count	4	(in hexadecimal)
			CRC Error Count	4	(in hexadecimal)
			Total Packet Received	4	(in hexadecimal)
			Packet OK Count	4	(in hexadecimal)
			Drop Packet Count	4	(in hexadecimal)
			Packet Error Rate (%)	4	(in hexadecimal)
			Total Number of Bits (Expected)	4	(in hexadecimal)
			Total Number of Bit Errors (Lost+Drop)	4	(in hexadecimal)
			Bit Error Rate	4	(in hexadecimal)
			Total Number of Bytes (Received)	4	(in hexadecimal)
			Total Number of Bit Errors (Received)	4	(in hexadecimal)
			Average RSSI	4	(in decimal)

Perform HCI reset

An HCI Reset command is required after this test to resume normal Bluetooth operations.

```
@bt> bt_test.reset
API returned success...
```

Bluetooth LE Set TX Power

This command sets the Bluetooth LE transmit power level.

```
bt> le_test.set_tx_power 4
tx_power= 4
@bt> HCI Command Response : 00
```

Parameter	Length	Definition
TX_POWER	1	Min value : 0xE2 (-30 dBm) Max value : 0x14 (20 dBm) Default value = 0x00

Bluetooth LE Transmitter test

To start a test where the DUT generates test reference packets at a fixed interval, use LE Transmitter Test[V2] command. For more details on the command please refer to Section 7.8.29 in [Bluetooth Core Specification v5.3 Vol 0 Part A](#).

```
@bt> le_test.tx_test 01 FF 00 01
```

Command output example :

```
tx_channel= 1
test_data_len= ff
pkt_payload= 0
phy= 1
@bt> HCI Command Response : 00
```

Observe the transmitter test packets over the air logs.

Bluetooth LE receiver test :

To start a test where the DUT receives test reference packets at a fixed interval, use LE Receiver Test[V2] command. For more details on the command please refer to Section 7.8.28 [Bluetooth Core Specification V5.3 Vol 0 Part A](#).

```
@bt> le_test.rx_test 01 01 00
```

Command output example :

```
rx_channel= 1
phy= 1
modulation_index= 0
@bt> HCI Command Response : 00
```

End Test for Bluetooth LE:

To end any test for Bluetooth LE use the below command

```
@bt> le_test.end_test
API returned success...
>>
```

Running a2dp

The commands are as follows:

```
+---"a2dp": a2dp Bluetooth A2DP shell commands
    +---"register_sink_ep": register_sink_ep <select codec.
1:SBC
2:MPEG-1,2
3:MPEG-2,4
4:vendor
5:sbc with delay report and content protection services
6:sbc with all other services(don't support data transfer yet)>
    +---"register_source_ep": register_source_ep <select codec.
1:SBC
2:MPEG-1,2
3:MPEG-2,4
4:vendor
5:sbc with delay report and content protection services
6:sbc with all other services(don't support data transfer yet)>
    +---"connect": connect [none]
    +---"disconnect": disconnect [none]
    +---"configure": configure [none]
    +---"discover_peer_eps": discover_peer_eps [none]
    +---"get_registered_eps": get_registered_eps [none]
    +---"set_default_ep": set_default_ep <select endpoint>
    +---"configure_ep": configure_ep "configure the default selected ep"
```

```
+---"deconfigure": deconfigure "de-configure the default selected ep"
+---"start": start "start the default selected ep"
+---"stop": stop "stop the default selected ep"
+---"send_media": send_media <second> "send media data to the default selected ep"
```

Test flow:

1. Create ACL connection between two devices (A and B).
2. In device B, input "a2dp.register_sink_ep x" to initialize sink endpoint.
3. In device A, input "a2dp.register_source_ep x" to initialize source endpoint.
4. In device A, input "a2dp.connect" to create a2dp connection with the default ACL connection.
5. In device A, input "a2dp.configure" to configure the a2dp connection.
6. In device A, input "a2dp.start" to start the a2dp media.
7. In device A, input "a2dp.send_media x" to send media data for x seconds.
8. For other commands:
 - i. "a2dp.disconnect" is used to disconnect the a2dp.
 - ii. "a2dp.discover_peer_eps" is used to discover peer device's endpoints.
 - iii. "a2dp.get_registered_eps" is used to get the local registered endpoints.
 - iv. "a2dp.set_default_ep" is used to set the default selected endpoint.
 - v. "a2dp.deconfigure" de-configure the endpoint, then it can be configured again.
 - vi. "a2dp.stop" stops media.
 - vii. "a2dp.send_delay_report" send delay report.

Running avrcp

The commands are as follows:

```
+---"avrcp": avrcp Bluetooth AVRCP shell commands
+---"init_ct": init_ct [none]
+---"init_tg": init_tg [none]
+---"ctl_connect": ctl_connect "create control connection"
+---"brow_connect": brow_connect "create browsing connection"
+---"ct_list_all_cases": ct_list_all_cases "display all the test cases"
+---"ct_test_case": ct_test_case <select one case to test>
+---"ct_test_all": ct_test_all "test all cases"
+---"ct_reg_ntf": ct_reg_ntf <Register Notification. select event:
  1. EVENT_PLAYBACK_STATUS_CHANGED
  2. EVENT_TRACK_CHANGED
  3. EVENT_TRACK_REACHED_END
  4. EVENT_TRACK_REACHED_START
  5. EVENT_PLAYBACK_POS_CHANGED
  6. EVENT_BATT_STATUS_CHANGED
  7. EVENT_SYSTEM_STATUS_CHANGED
  8. EVENT_PLAYER_APPLICATION_SETTING_CHANGED
  9. EVENT_NOW_PLAYING_CONTENT_CHANGED
  a. EVENT_AVAILABLE_PLAYERS_CHANGED
  b. EVENT_ADDRESSED_PLAYER_CHANGED
  c. EVENT_UIDS_CHANGED
  d. EVENT_VOLUME_CHANGED>
+---"tg_notify": tg_notify <Notify event. select event:
  1. EVENT_PLAYBACK_STATUS_CHANGED
  2. EVENT_TRACK_CHANGED
  3. EVENT_TRACK_REACHED_END
  4. EVENT_TRACK_REACHED_START
  5. EVENT_PLAYBACK_POS_CHANGED
  6. EVENT_BATT_STATUS_CHANGED
  7. EVENT_SYSTEM_STATUS_CHANGED
  8. EVENT_PLAYER_APPLICATION_SETTING_CHANGED
  9. EVENT_NOW_PLAYING_CONTENT_CHANGED
  a. EVENT_AVAILABLE_PLAYERS_CHANGED
  b. EVENT_ADDRESSED_PLAYER_CHANGED
```

```

c. EVENT_UIDS_CHANGED
d. EVENT_VOLUME_CHANGED>
+---"ca_init_i": ca_init_i "Init cover art initiator"
+---"ca_init_r": ca_init_r "Init cover art responder"
+---"ca_connect": ca_connect "create cover art connection"
+---"ca_test": ca_test "cover art test all cases"

```

Test flow:

1. Create ACL connection between two devices (A and B).
2. In device B, input "avrccp.init_tg" to initialize Target.
3. In device A, input "avrccp.init_ct" to initialize Controller.
4. In device B, input "avrccp.ca_init_r" to initialize Cover Art responder.
5. In device A, input "avrccp.ca_init_i" to initialize Cover Art Initiator.
6. In device A, input "avrccp.ctl_connect" to create AVRCP Control connection.
7. In device A, input "avrccp.brow_connect" to create AVRCP Browsing connection.
8. In device A, input "avrccp.ct_test_all" to test all the cases.
9. In device A, input "avrccp.ct_reg_ntf" to register notification.
10. In device B, input "avrccp.tg_notify" to notify.
11. In device A, input "avrccp.ca_test" to test all the cover art commands.
12. For other commands:
 - i. In device A, input "avrccp.ct_list_all_cases" to list all the test cases.
 - ii. In device A, input "avrccp.ct_test_case x" to test one selected case.

Running BR/EDR L2CAP

1. Create ACL connection between two devices (A and B).
2. In device A and B, input "br.l2cap-register <psm>" to register one psm (for example: br.l2cap-register 1001).
3. In device A, input "br.l2cap-connect <psm>" to create l2cap connection (for example: br.l2cap-connect 1001).
4. In device A, input "br.l2cap-send x" to send data.
5. In device A, input "br.l2cap-disconnect" to disconnect the l2cap connection.
6. In device A and B, input "br.l2cap-register-mode <psm>" to register one psm (for example: br.l2cap-register 1003).
7. In device A, input "br.l2cap-connect <psm>" to create l2cap connection (for example: br.l2cap-connect 1003).
8. In device A, input "br.l2cap-send x" to send data.
9. In device A, input "br.l2cap-disconnect" to disconnect the l2cap connection.

Example of BLE pairing and bonding

GATT peripheral role side

Initialize the Host.

```
@bt> bt.init
```

Start Advertising

```
@bt> bt.advertise on
```

After the connection is established, perform the pairing sequence, it could be started from peripheral side by "bt.security <level>", such as

```
@bt> bt.security 2
```

If the bondable is unsupported by peripheral role then enter the command below and repeat step 3.

```
@bt> bt.bondable off
```

GATT central role side

Initialize the Host

@bt> bt.init

Scan for Advertising Packets

@bt> bt.scan on

Stop the Scanning after few seconds

@bt> bt.scan off

Select the target board and create a new connection. If the target is not listed, repeat “scan on” and “scan off” then enter “*bt.connect <remote address: XX:XX:XX:XX:XX> <type: (public|random)>*”,
@bt> bt.connect 11:22:33:44:55:66 public

After the connection is established, perform the pairing sequence, it could be started from central side by “*bt.security <level>*”, such as

@bt> bt.security 2

If the bondable is unsupported by central role then enter the command below and repeat the previous step

@bt> bt.bondable off

After all the operations are performed , we can initiate a disconnection from the central device

@bt> bt.disconnect

Example of GATT data signing**GATT peripheral role side****Initialize the Host**

@bt> bt.init

Enable Advertising

@bt> bt.advertise on

After the connection is established, perform the pairing sequence, it could be started from peripheral side by “*bt.security <level>*”

@bt> bt.security 2

After the authentication is successfully, disconnect the connection, it could be started from peripheral side by

@bt> bt.disconnect

Reinitiate the advertising and wait for new connection. After the connection is established (LL encryption should be disabled), add new service “”

@bt> gatt.register

GATT central role side**Initialize the Host**

@bt> bt.init

Scanning advertising packets

@bt> bt.scan on

A few seconds later, stop the scanning

@bt> bt.scan off

Select the target board and create a new connection. If the target is not listed, then scan for the devices

@bt> "bt.connect <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>"

After the connection is established, perform the pairing sequence, it could be started from central side by “*bt.security <level>*”

@bt> bt.security 2

After the authentication is successfully, disconnect the connection, it could be started from central side by

@bt> bt.disconnect

Repeat the previous steps to start and stop scanning for few more seconds and Reinitiate the connection. After the connection is established (LL encryption should be disabled), perform the GATT data signing sequence , i.e., "gatt.signed-write <handle> <data> [length] [repeat]"

```
@bt> gatt.signed-write 22 AA 1
```

After all the operations are performed , we can initiate a disconnection from the central device

```
@bt> bt.disconnect
```

Example of GATT Service Changed Indication,

GATT peripheral role side,

Initialize the Host

```
@bt> bt.init
```

Advertising

```
@bt> bt.advertise on
```

After the connection is established. and waiting for the service changed indication is subscribed

Add new service

```
@bt> "gatt.register"
```

Wait for the Central device to finish performing the operations. After that Remove the added service

```
@bt> "gatt.unregister".
```

GATT central role side,

Initialize the Host

```
@bt> "bt.init"
```

Scanning advertising packets

```
@bt> "bt.scan on"
```

A few seconds later, stop the scanning

```
@bt> "bt.scan off"
```

Select the target board and create a new connection. If the target is not listed, repeat the previous steps to start and stop scanning for few more seconds

```
@bt> "bt.connect <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>"
```

After the connection is established, subscribe the GATT service changed indicator.

i.e. : "bt.subscribe <CCC handle> <value handle> [ind]"

```
@bt> gatt.subscribe f e ind
```

After all the operations are performed , we can initiate a disconnection from the central device

```
@bt> bt.disconnect
```

Example of GATT Service Dynamic Database Hash

GATT peripheral role side,

Initialize the Host

```
@bt> bt.init
```

Advertising

```
@bt> bt.advertise on
```

After the connection is established. and waiting for the service changed indication is subscribed,

Add new service

```
@bt> gatt.register
```

Wait for the Central device to perform the operations and then remove the added service

```
@bt> gatt.unregister
```

GATT central role side,

Initialize the Host

```
@bt> bt.init
      Scanning advertising packets
@bt> bt.scan on
      A few seconds later, stop the scanning
@bt> bt.scan off
      Select the target board and create a new connection. If the target is not listed, repeat the previous
      steps to start and stop scanning for few more seconds
@bt> bt.connect <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>
      After the connection is established, subscribe the GATT service changed indicator
@bt> bt.subscribe <CCC handle> <value handle> [ind]
      i.e : gatt.subscribe f e ind
      If the indication is indicated, read DB hash, i.e. : "gatt.read <handle> [offset]" or "gatt.read-uuid
      <UUID> [start handle] [end handle]"
@bt> gatt.read 13
Or
@bt> gatt.read-uuid 2b2a
      After all the operations are performed , we can initiate a disconnection from the central device
@bt> bt.disconnect
```

Example of PHY 1M/2M update.**GATT peripheral role side,**

```
Initialize the Host
@bt> bt.init
Enable Advertising
@bt> bt.advertise on
      After the connection is established. Send PHY update command such as
      "bt.phy-update <tx_phy><rx_phy>". tx_phy/rx_phy could be 1(1M) or 2(2M).
@bt> bt.phy-update 2 2
      The message "LE PHY updated: TX PHY LE 2M, RX PHY LE 2M" would be printed if the PHY is updated.
```

Note: If peer don't support PHY update, then this message will not be printed.

GATT central role side,

```
Initialize the Host
@bt> bt.init
      start scan
@bt> bt.scan on
      Bluetooth devices around your current Bluetooth will be list, for example,
      stop scan
@bt> bt.scan off
[DEVICE]: 72:78:C1:B5:0F:DA (random), AD evt type 4, RSSI -32 BLE Peripheral
C:0 S:1 D:0 SR:1 E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms),
SID: 0xff

[DEVICE]: C4:0D:02:55:5E:AD (random), AD evt type 0, RSSI -83 C:1 S:1 D:0 SR:0
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff

[DEVICE]: 66:8F:26:27:1F:52 (random), AD evt type 0, RSSI -82 C:1 S:1 D:0 SR:0
E:0 Prim: LE 1M, Secn: No packets, Interval: 0x0000 (0 ms), SID: 0xff
      connect target device
bt.connect <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>
@bt> bt.connect 72:78:C1:B5:0F:DA random
```

Send PHY update command

```
bt.phy-update <tx_phy> [rx_phy] [s2] [s8]", tx_phy/rx_phy could be 1(1M) or
2(2M).
such as "bt.phy-update 2 2/bt.phy-update 1 2". Note, the "s2" and "s8" are
unsupported.
@bt>
```

After all the operations are performed , we can initiate a disconnection from the central device

```
@bt> bt.disconnect
```

Note :The message "LE PHY updated: TX PHY LE 2M, RX PHY LE 2M" would be printed if the phy is updated. note, if peer don't support phy update, then this message will not be printed.

Example of Filter Accept List.

GATT peripheral role side

Initialize the Host

```
@bt> bt.init
```

Adding device to Filter Accept List

```
bt.fal-add <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>
@bt> bt.fal-add 11:22:33:44:55:66 public
```

Enable Advertising

```
@bt> bt.advertise on fal-conn
```

Only the device in Filter Accept List can connect to the current device or else no log will be printed.

Note: if device address is added after command bt.advertise on, then Filter Accept List will take effect after re-star advertise. the bt.advertise off and bt.advertise on can be used to re-start the advertise.

GATT central role side

Initialize the Host

```
@bt> bt.init
```

Adding device to Filter Accept List

```
"bt.fal-add <address: XX:XX:XX:XX:XX:XX> <type: (public|random)>"
@bt> bt.fal-add 80:D2:1D:E8:2B:7E public
```

Initiate connection with the Filter Accept Listed device with the command "bt.fal-connect on". The device will be connected with the following log.

```
@bt> Connected: 80:D2:1D:E8:2B:7E (public)
```

Initiate disconnection with the Filter Accept Listed "bt.disconnect". device will be disconnect.

```
@bt> Disconnected: 80:D2:1D:E8:2B:7E (public) (reason 0x16)
```

Remove the device from the Filter Accept List

```
@bt> bt.fal-rem 80:D2:1D:E8:2B:7E public
```

Running BR/EDR RFCOMM

Note: Only 1 rfcomm connection is supported in shell project.

RFCOMM Server Side

Initialize Bluetooth

```
@bt> bt.init
```

Turn on pscan

```
@bt> br.pscan on
```

Turn on iscan

```
@bt> br.iscan on  
Register rfcomm server channel 5  
@bt> rfcomm.register 5  
After rfcomm connection is created, To send data  
@bt> rfcomm.send <count of sending>  
After rfcomm connection is created, To disconnect with peer device  
@bt> rfcomm.disconnect
```

RFCOMM Client Side

```
Initialize Bluetooth  
@bt> bt.init  
Enable Discovery  
@bt> br.discovery on  
Create Connection , i.e "br.connect <remote device address>"  
@bt> br.connect 80:D2:1D:E8:2B:7E  
Create RFCOMM connection on channel 5  
@bt> rfcomm.connect 5  
After connection, Send Data , i.e : "rfcomm.send <count of sending>"  
@bt> rfcomm.send 3  
After finishing the test , disconnect the RFCOMM connection  
@bt> rfcomm.disconnect
```

Running Generic HCI Commands

This functionality allows execution of arbitrary command to the wireless controller.

The command format is as given below

hci.generic_command <ogf> <ocf> <n parameters>..

i.e. : Checking the firmware version with the vendor specific command

```
@bt> hci.generic_command 3f 0f  
We get the command response
```

```
HCI Command Response :  
@bt> 00 15 5B 10 40 00 00 02 04
```

5.16 peripheral_beacon Sample Application

Application demonstrating the BLE Peripheral role, This application implements types of beacon applications.

Beacon: A simple application demonstrating the BLE Broadcaster role functionality by advertising Company Identifier, Beacon Identifier, UUID, A, B, C, RSSI.

Eddystone : The Eddystone Configuration Service runs as a GATT service on the beacon while it is connectable and allows configuration of the advertised data, the broadcast power levels, and the advertising intervals.

iBeacon: This simple application demonstrates the BLE Broadcaster role functionality by advertising an Apple iBeacon.

5.16.1 peripheral_beacon Application Execution

Please refer to the previous sections 3.1.1-3.1.4 and 5.1.1 for instructions on importing a project, building an application, running an application in debug mode, and flashing an application program for a few IDEs. Please refer to section 2.1 for serial console tool setup.

5.16.1.1 peripheral_beacon Run the application

This application contains 3 Different type of Beacons configurations.

Beacon : A simple Application demonstrating the BLE Broadcaster role functionality

To configure the sample application, go to app_config.h and do the following changes to the macros.

Here we are enabling the Beacon app and disabling the other beacon configurations.

```
/* Select which beacon application to start */
#define BEACON_APP 1
#define IBEACON_APP 0
#define EDDYSTONE 0
```

After changing the macros , recompile the example and flash the application onto the board.

After the example is flashed successfully you will be able to see the following initialization logs on the terminal

```
Starting Beacon Demo
Bluetooth initialized
Beacon started, advertising as 00:E9:3A:B9:E0:24 (public)
```

On the BLE Scanner side our device should be visible as an advertiser.

Eddystone : The Eddystone Configuration Service runs as a GATT service on the beacon while it is connectable and allows configuration of the advertised data, the broadcast power levels, and the advertising intervals. It also forms part of the definition of how Eddystone-EID beacons are configured and registered with a trusted resolver.

To configure the sample application, go to app_config.h and do the following changes to the macros.

Here we are enabling the Eddystone and disabling the other beacon configurations.

```
/* Select which beacon application to start */
#define BEACON_APP 0
#define IBEACON_APP 0
```

```
#define EDDYSTONE 1
```

After changing the macros , recompile the example and flash the application onto the board.

After the example is flashed successfully you will be able to see the following initialization logs on the terminal

```
Bluetooth initialized  
Initial advertising as 00:E9:3A:B9:E0:24 (public)  
Configuration mode: waiting connections...
```

On the BLE Scanner side our device should be visible as an advertiser.

iBeacon : This is a simple application demonstrates the BLE Broadcaster role functionality by advertising an Apple iBeacon. The calibrated RSSI @ 1 meter distance can be set using an IBEACON_RSSI build variable (e.g., IBEACON_RSSI=0xc8 for -56 dBm RSSI), or by manually editing the default value in the ibeacon.c file.

To configure the sample application, go to app_config.h and do the following changes to the macros.

Here we are enabling the Eddystone and disabling the other beacon configurations.

```
/* Select which beacon application to start */  
#define BEACON_APP 0  
#define IBEACON_APP 1  
#define EDDYSTONE 0
```

After changing the macros , recompile the example and flash the application onto the board.

After the example is flashed successfully you will be able to see the following initialization logs on the terminal.

```
Starting iBeacon Demo  
Bluetooth initialized  
iBeacon started
```

On the BLE Scanner side our device should be visible as an advertiser

5.17 audio_profile Sample Application

There are five parts working in the demo: AWS cloud, Android app, audio demo (running on i.MX RT1060 EVK board), U-disk and Bluetooth headset.

- With an app running on the smart phone (Android phone), the end users can connect to AWS cloud and control the audio demo running on the i.MX RT1060 EVK board through AWS cloud. Some operations like play, play next, pause, etc. can be used to control the media play functionalities.
- Audio demo running on the RT1060 EVK board connects to the AWS through Wi-Fi, also a connection can be established between the i.MX RT1060 EVK board and a Bluetooth headset.
- To get the media resource (mp3 files) from the U-disk, an HS USB host is enabled, and a U-disk with mp3 files should be connected to i.MX RT1060 EVK board via the USB port.
- After that, the audio demo will search the root directory of U-disk for the audio files and upload the audio file list to AWS, then the list would be shown in the app running on the smart phone.
- Finally, the music can be played out via the Bluetooth headset once end user controls the app to play the mp3 file.

Prerequisites and Important details about this Demo :

- This demo can NOT function with the default setting provided in SDK package
- AWS Account is mandatory to run this demo. User must create their own AWS account and configure the IoT Thing.
- WiFi SSID , WiFi Password etc. must be updated.
- The music files names in U-disk need to be English.
- The volume of audio adjustment is not supported.

5.17.1 User Configurations

Some of the AWS Client Credentials related macros that user need to configure based on requirement are listed in below table along with source file name.

The *aws_clientcredential.h* file is available in the SDK source; path is given in section 1.3 “References”.

Table 21: audio_profile Application Configurations

Feature	Macro definition	Value set for Example	File name	Details
AWS Client Credentials	clientcredentialMQTT_BR_OKER_ENDPOINT	“a2qkq6ssjggf7-ats.iot.us-east-1.amazonaws.com”	aws_clientcredential.h	These credentials are required to connect the correct end point of AWS IoT Thing.
	clientcredentialIOT_THIN_G_NAME	“MusicPlayer”		
	clientcredentialWIFI_SSID	“NXP_Demo”		
	clientcredentialWIFI_PASWORD	“123456789”		
	clientcredentialMQTT_BR_OKER_PORT	“8883”		

5.17.2 audio_profile Application Execution

Please refer to the previous section 3.1.1 to run the demo using MCUXpresso IDE. Refer below figures for importing Bluetooth example and selection of Bluetooth module.

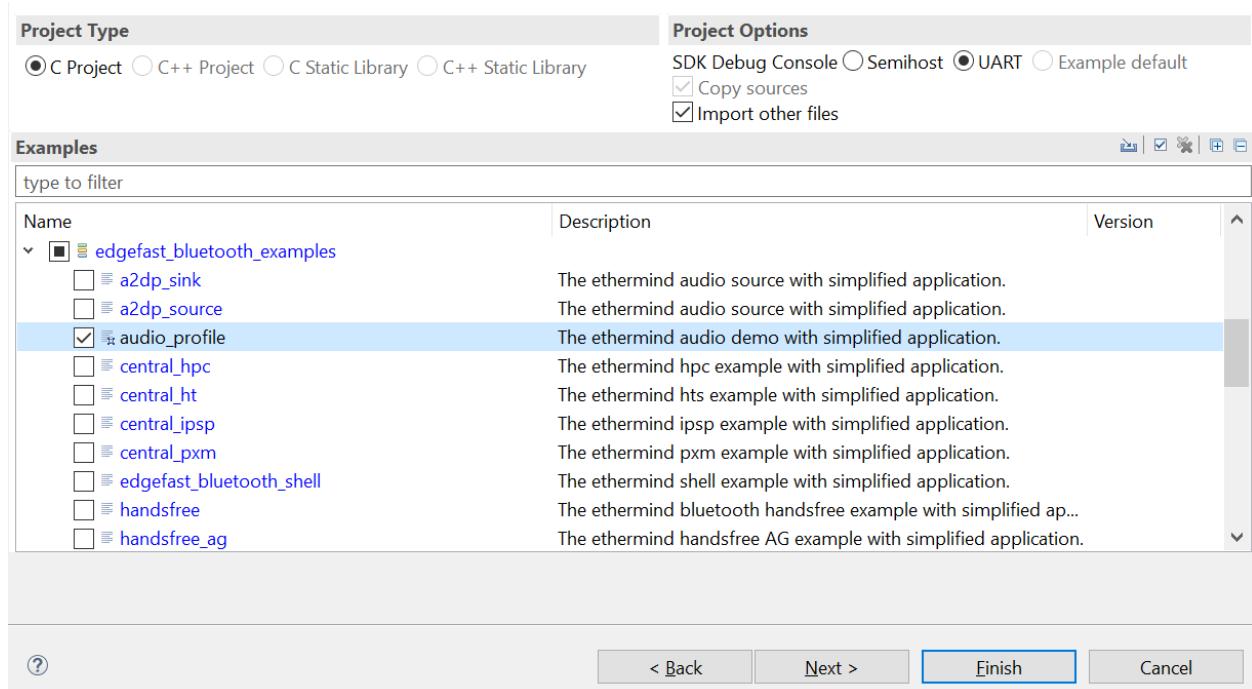


Figure 41 : Selection of audio_profile application in MCUXpresso IDE

Please refer to the previous sections 3.1.2-3.1.4 for instructions on importing a project, building an application, running an application in debug mode and flashing an application program for a few IDEs. Please refer to section 2.1 for information about the serial console setup.

5.17.2.1 Create and configure AWS Account

Follow the link to create a new AWS account:

<https://console.aws.amazon.com/console/home>

Follow the instructions to create a new AWS account:

<https://aws.amazon.com/premiumsupport/knowledge-center/create-and-activate-aws-account/>

5.17.2.2 Create an AWS IoT Policy

This section describes the steps to create a policy for AWS IoT.

Browse to the AWS IoT console

<https://console.aws.amazon.com/iotv2/>

Click "Policies" inside the "Secure" tab:

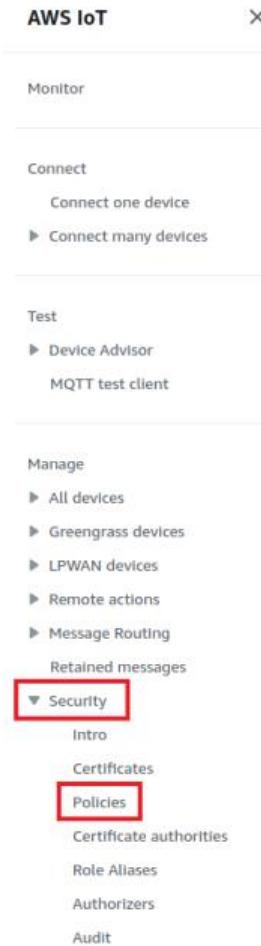


Figure 42: Creating a new policy

Create a new policy: Enter a name to identify a policy. For example, the policy name is "**MusicPlayerPolicy**".

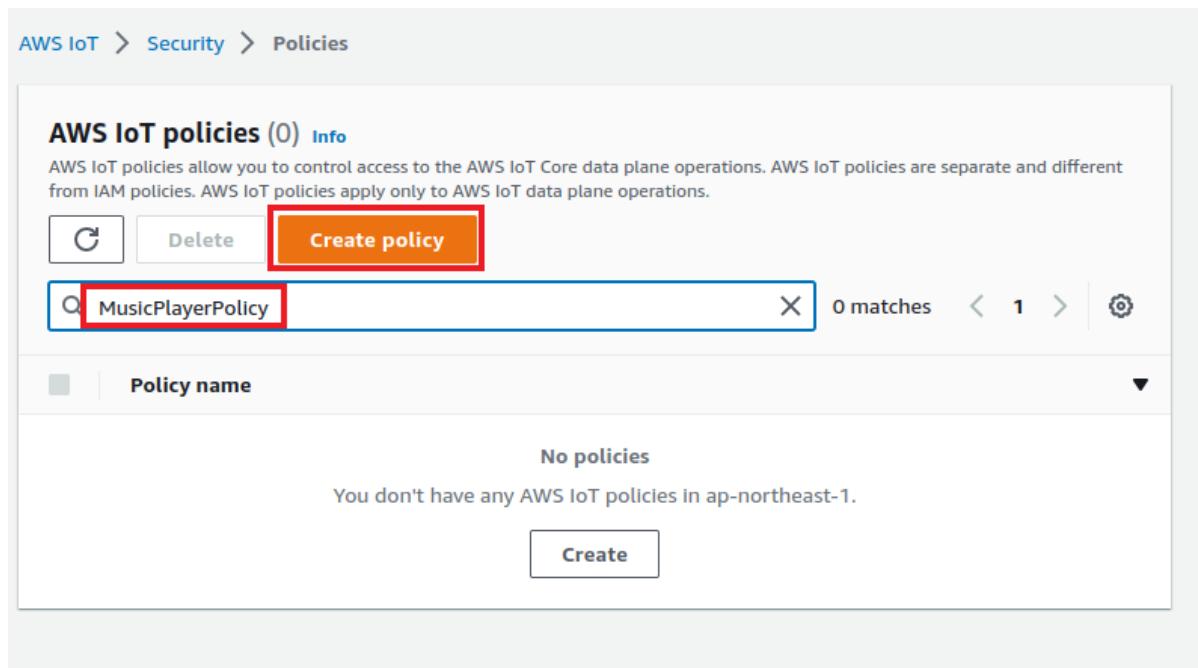


Figure 43: Policy Name

In the "Policy statements" section, click "JSON".

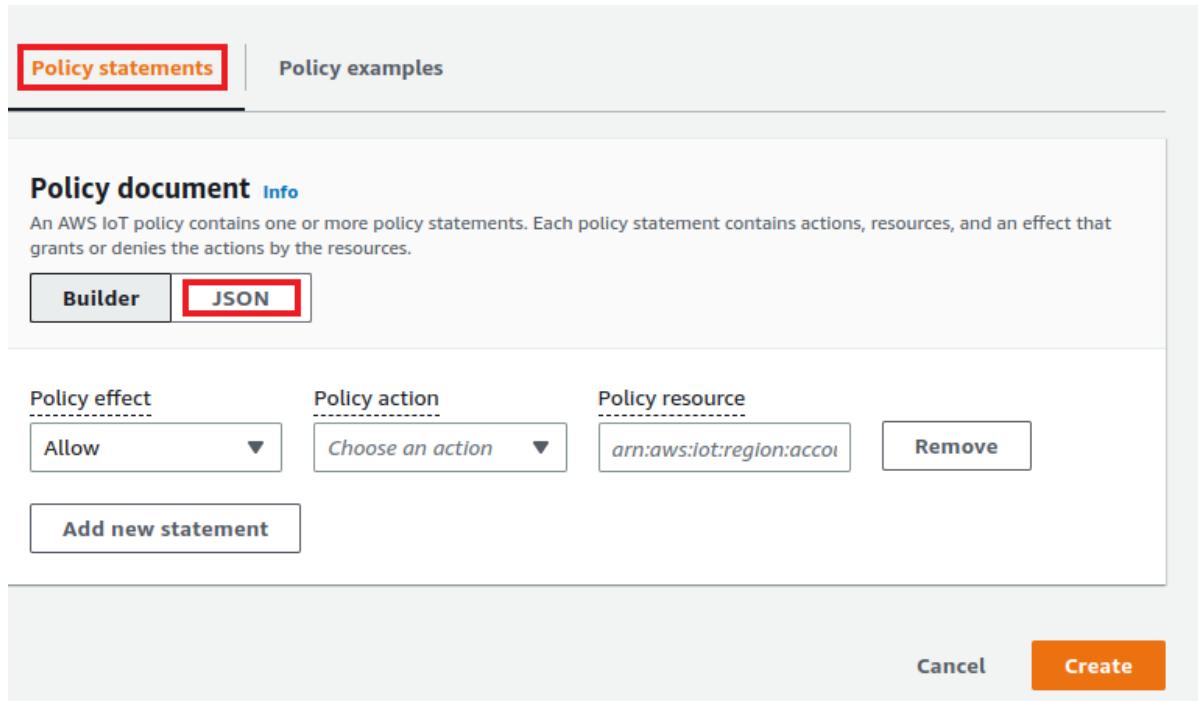


Figure 44: Policy statements

Add the JSON into the Policy editor window and create a policy.

```
{
  "Version": "2012-10-17",
```

```
"Statement": [
    {
        "Effect": "Allow",
        "Action": "iot:/*",
        "Resource": "*"
    }
]
```

Policy statements | Policy examples

Policy document Info

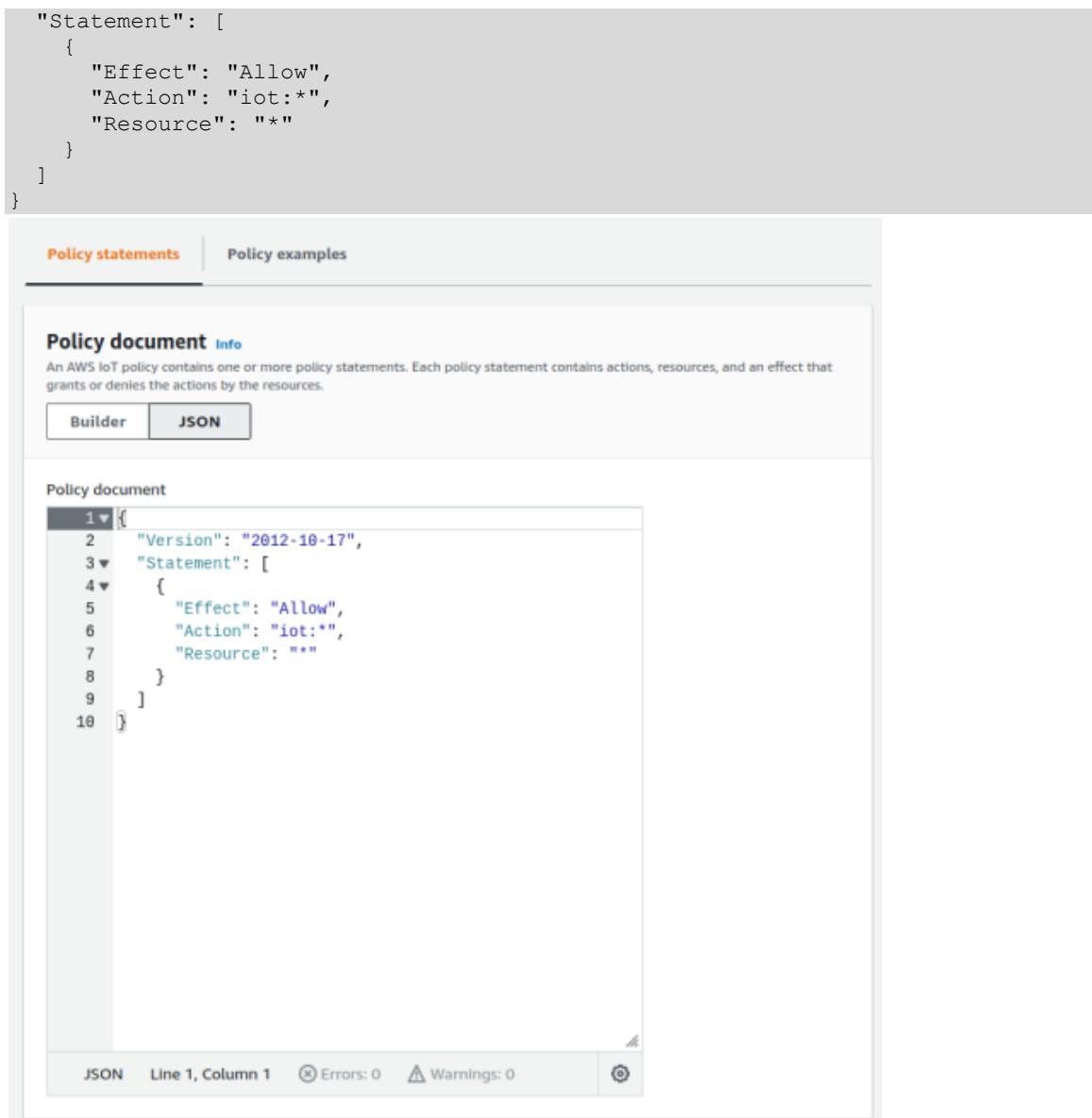
An AWS IoT policy contains one or more policy statements. Each policy statement contains actions, resources, and an effect that grants or denies the actions by the resources.

Builder JSON

Policy document

```
1 [{
2     "Version": "2012-10-17",
3     "Statement": [
4         {
5             "Effect": "Allow",
6             "Action": "iot:/*",
7             "Resource": "*"
8         }
9     ]
10}]
```

JSON Line 1, Column 1 Errors: 0 Warnings: 0

A screenshot of the AWS IoT Policy Editor interface. At the top, there's a code editor window containing a JSON policy document. The JSON is as follows:

```
"Statement": [
    {
        "Effect": "Allow",
        "Action": "iot:/*",
        "Resource": "*"
    }
]
```

Below the code editor, there are two tabs: "Policy statements" (which is selected) and "Policy examples". Under the "Policy document" heading, there's a brief description: "An AWS IoT policy contains one or more policy statements. Each policy statement contains actions, resources, and an effect that grants or denies the actions by the resources." Below this description are two buttons: "Builder" and "JSON". The "JSON" button is currently selected. The main area is titled "Policy document" and shows the JSON code with line numbers 1 through 10. At the bottom of the editor window, there are status indicators: "JSON", "Line 1, Column 1", "Errors: 0", "Warnings: 0", and a refresh icon.

Figure 45: Adding the required JSON into the policy editor window

Go back to the "Builder" and click on "Create"

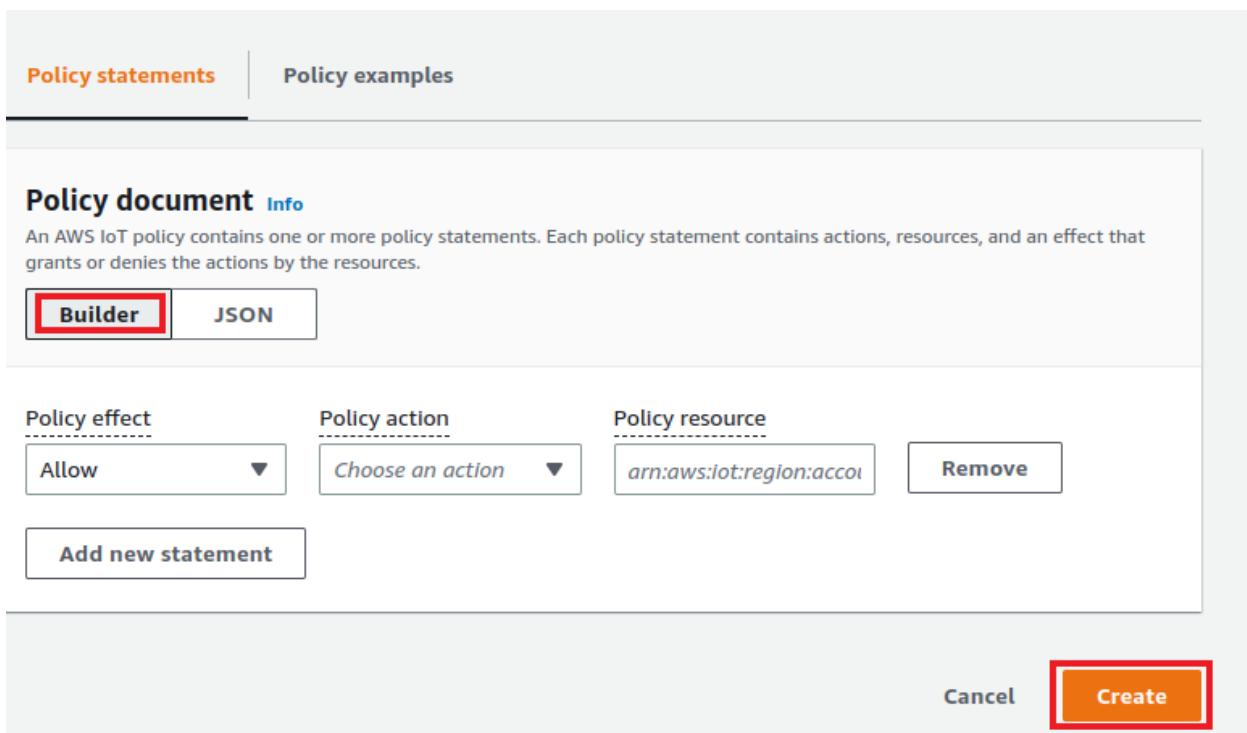


Figure 42: Create a policy with required JSON

Upon successful creation of Policy following screen will appear:

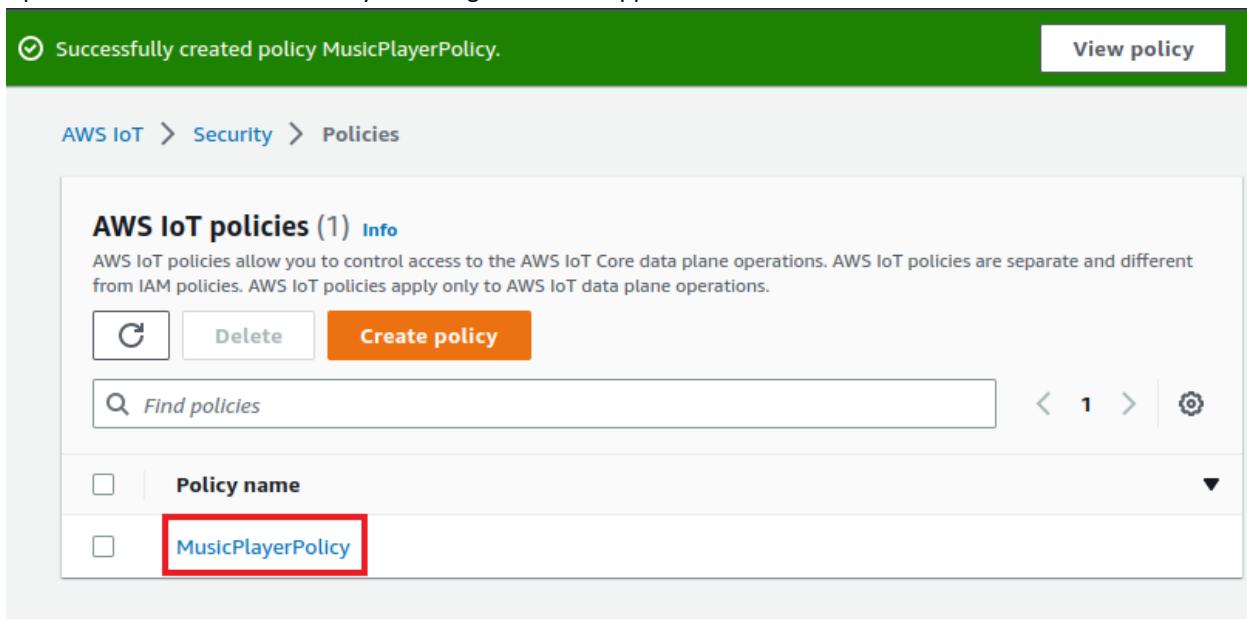


Figure 43: Showing the success of policy creation

5.17.2.3 Create IoT thing, private key, and certificate for device

Open the "AWS IoT console"

<https://console.aws.amazon.com/iot/>

From the navigation pane, click "Things" inside "All devices" tab.

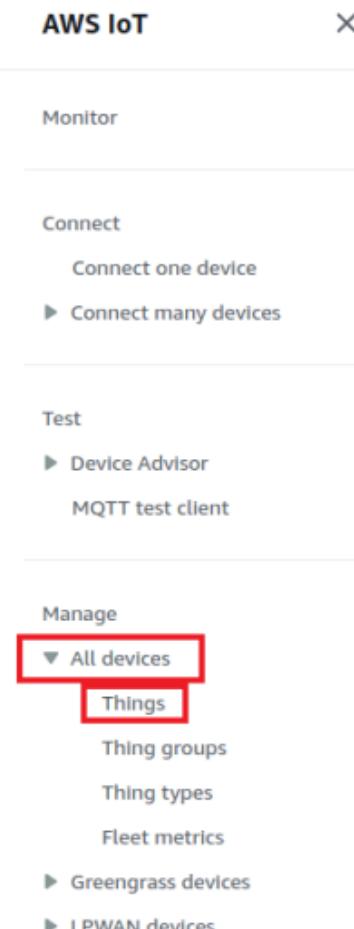


Figure 44: Selection of Things from AWS IoT tab

Click on "Create".

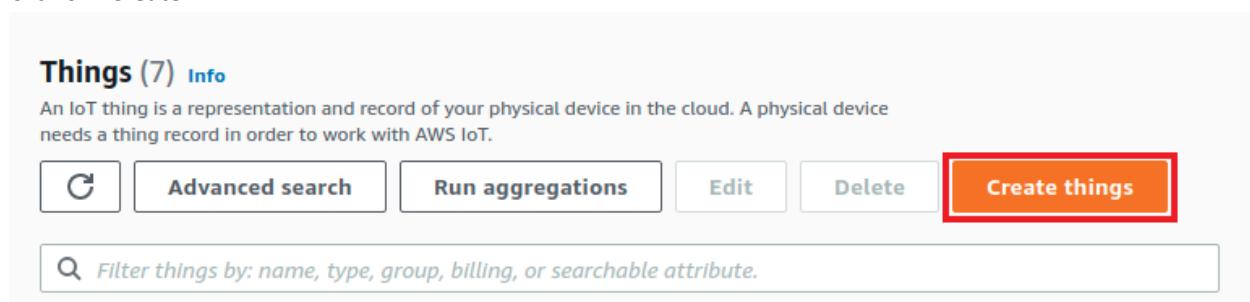


Figure 45: Creating a new Thing

Click "Create a single thing"

AWS IoT > Manage > Things > Create things

Create things Info

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

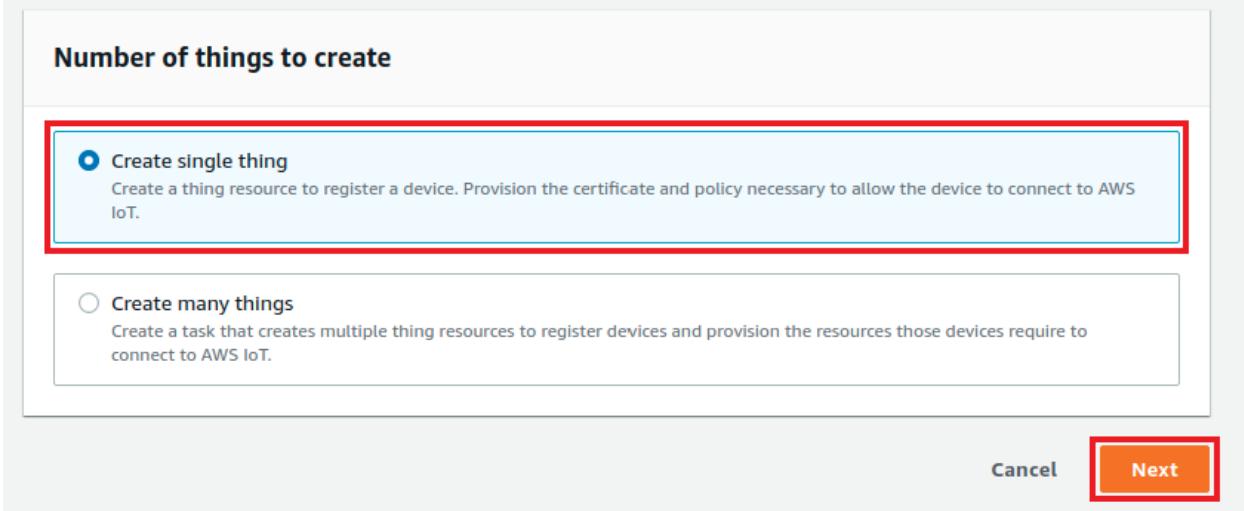


Figure 46: Creating a new Thing

Enter a name for your device, and then choose "Next". For example, the thing name is "MusicPlayer".

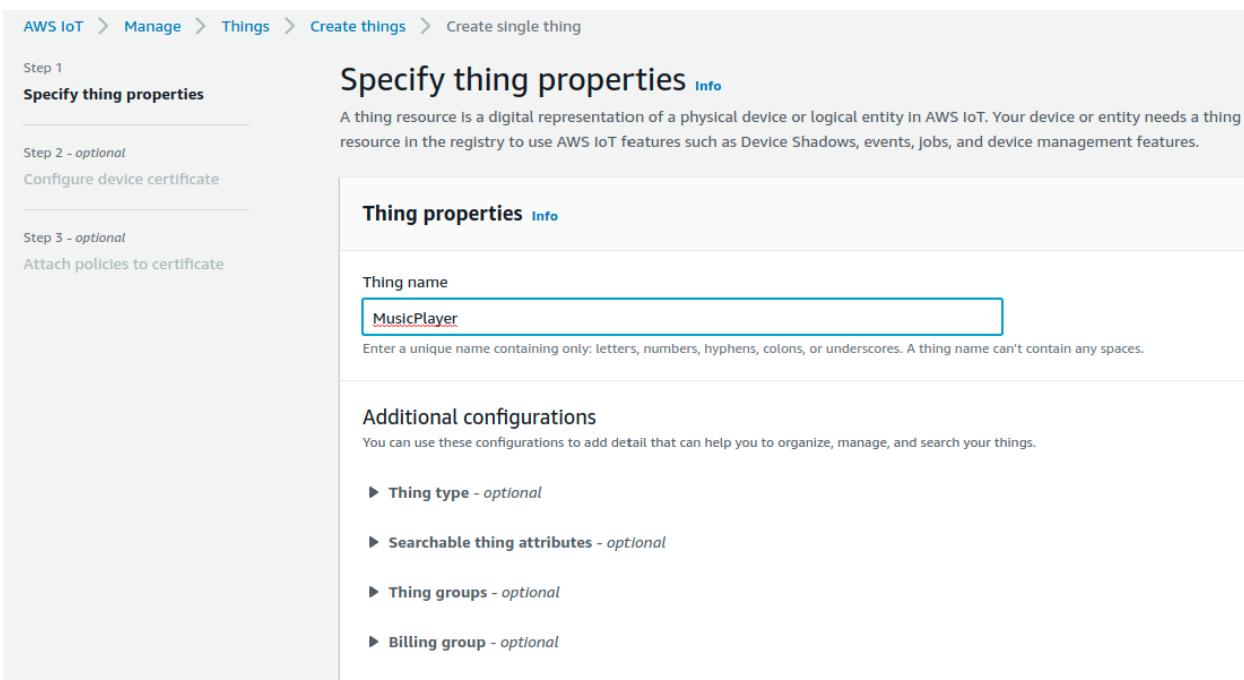


Figure 47: Giving name to a new thing

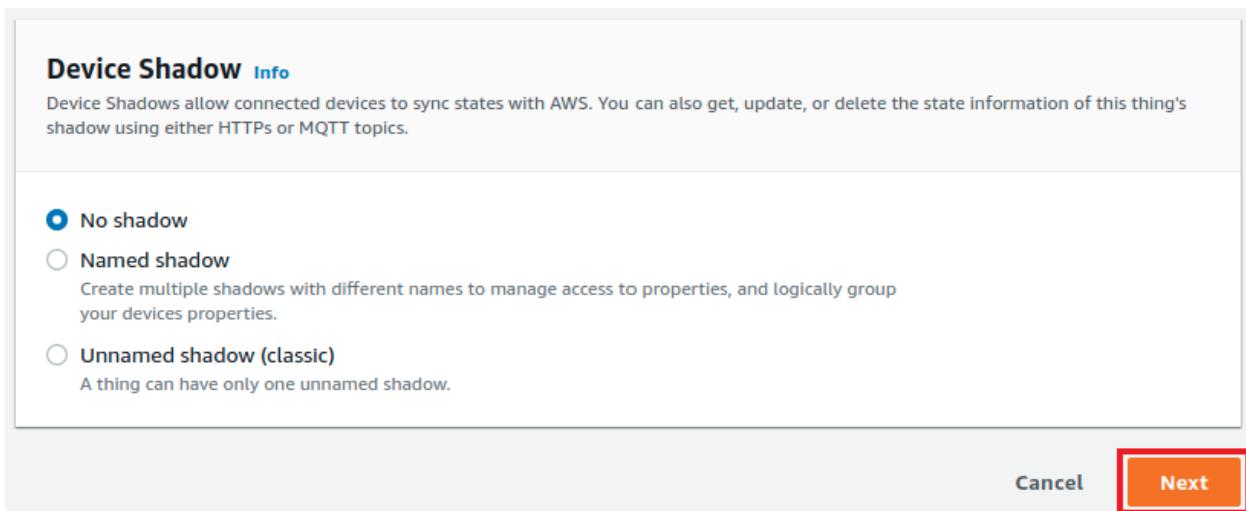


Figure 48: Click next to proceed for creating a new thing

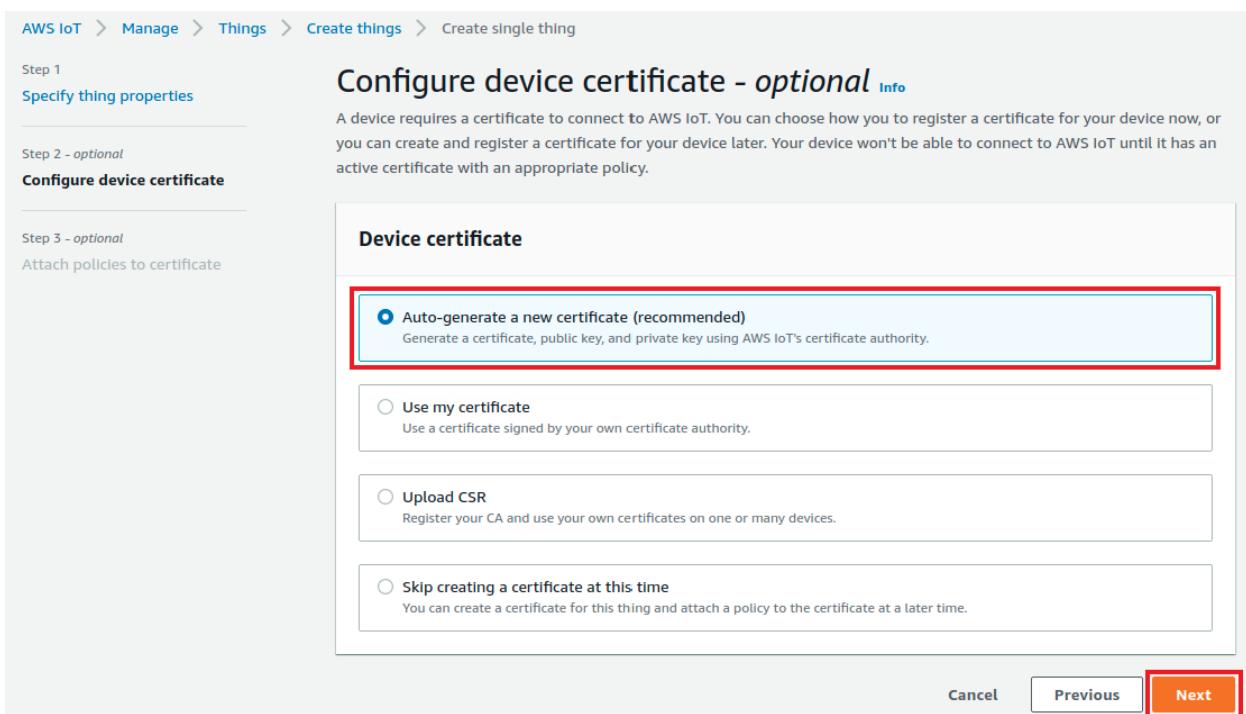
Click "Create certificate"

Figure 49: Selecting Device Certificate configuration for a new Thing

Select a policy to attach to your certificate that grants your device access to AWS IoT operations and click "Create Thing".

Step 1
Specify thing properties

Step 2 - optional
Configure device certificate

Step 3 - optional
Attach policies to certificate

Attach policies to certificate - optional Info

AWS IoT policies grant or deny access to AWS IoT resources. Attaching policies to the device certificate applies this access to the device.

Policies (1/7)
Select up to 10 policies to attach to this certificate.

Filter policies

Name
<input type="checkbox"/> test_aws_wifi_provisioning_policy
<input type="checkbox"/> myIoTPolicy
<input type="checkbox"/> aws_wifi_provisioning_policy
<input type="checkbox"/> TestMyMusic
<input type="checkbox"/> MyWifiPro
<input type="checkbox"/> MyMusic
<input checked="" type="checkbox"/> MusicPlayerPolicy

Cancel Previous Create thing

Figure 50: Attach a policy and create a Thing

Download the thing's certificate, public key, and private key.

Download certificates and keys



Download certificate and key files to install on your device so that it can connect to AWS.

Device certificate

You can activate the certificate now, or later. The certificate must be active for a device to connect to AWS IoT.

Device certificate

5ff36500294...te.pem.crt

[Deactivate certificate](#)

[Download](#)

Key files

The key files are unique to this certificate and can't be downloaded after you leave this page. Download them now and save them in a secure place.



This is the only time you can download the key files for this certificate.

Public key file

5ff36500294bace6e709df4...f13bfff-public.pem.key

[Download](#)

Private key file

5ff36500294bace6e709df4...13bfff-private.pem.key

[Download](#)

Figure 51: Downloading the certificate, public and private keys

Click the thing that you just created from the list.

The screenshot shows the AWS IoT Things list interface. At the top, there are several buttons: 'Advanced search', 'Run aggregations', 'Edit', 'Delete', and a prominent orange 'Create things' button. Below these is a search bar with the placeholder text 'Filter things by: name, type, group, billing, or searchable attribute.' A navigation bar with arrows and a gear icon follows. The main table lists one item:

<input type="checkbox"/>	Name	Thing type
<input type="checkbox"/>	MusicPlayer	-

Figure 52: Selecting the policy and Register Thing

Click "Interact" from your thing's page and open "View Settings".

The screenshot shows the 'MusicPlayer' thing details page. At the top, there are 'Edit' and 'Delete' buttons. Below is a section titled 'Thing details' containing fields for Name (MusicPlayer), Type (-), ARN (arn:aws:iot:us-east-1:533155200463:thing/MusicPlayer), and Billing group (-). The 'Interact' tab is highlighted with a red box. Below the tabs, two informational boxes are shown:

- The device data endpoint has moved to Settings.** Your device data endpoint can be found under **Settings**. HTTP prefixes for Device Shadow interactions that use this endpoint can be found on the **Device Shadows** tab. **View Settings** button (boxed).
- MQTT and HTTP prefixes have moved to Device Shadows.** MQTT topic prefixes and HTTP URLs are created for each Device Shadow and you can find them in the **Device Shadows** tab. **View Device Shadows tab** button (boxed).

Figure 53: Selecting Interact and opening View Settings to get Endpoint

Make a note of the AWS IoT REST API endpoint to use it for next sections.

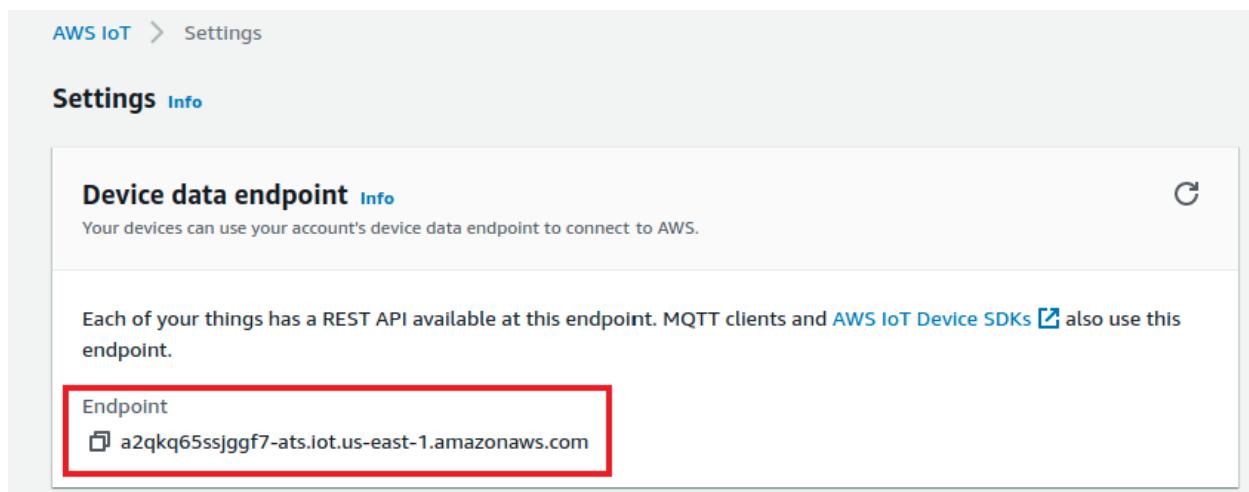


Figure 54: Copy the AWS IoT REST API endpoint

5.17.2.4 Configure the AWS IoT Certificate and Private Keys

FreeRTOS needs the AWS IoT certificate and private keys associated with your registered thing and its permissions policies to successfully communicate with AWS IoT on behalf of your device.

FreeRTOS is a C language project, and the certificate and private key must be specially formatted to be added to the project.

Get the PEM-to-C-stringp.py file from SDK (<MCUXpresso SDK>\middleware\aws_iot\amazon-freertos\tools\certificate_configuration)

Usage:

```
PEM-to-C-string.py [-h] [--private-key-file PRIVATE_KEY_FILE] [--cert-file CERT_FILE] [--root-ca-file ROOT_CA_FILE] [--pem-file PEM_FILE]
```

Execute this script with private-key.pem and certificate.pem file. This Python script will arrange the key in a format which is required for the project and print it on console.

For example:

```
PEM-to-C-string.py -h --private-key-file PRIVATE_KEY_FILE.key.pem --cert-file CERT_FILE.pem
```

```
root@satyamnimavat-desktop:/home/nimavat/Desktop/certificate_configurati
===== Formatted private.pem.key =====

#define keyCLIENT_PRIVATE_KEY_PEM \
"-----BEGIN RSA PRIVATE KEY-----\n" \
"MIIEpAIBAAKCAQE2V3bqVAbbp3Ne5snK6LjJufYf/apnrI8e9qBTeSBkmfJM5Fn\n" \
"LIQzJ1JJGjfFdUnLsv8j75PLI7RHfehEztTn4N5AcClJS+prz99V7cZ0S5CWXIE\n" \
"8NtcZGJDnY0TNQHnC9pQW/eulRn2sPxnr2RIriQvUmYsxMbyzcdrosIth9\n" \
"2HtLrgyd/DdT4vXVoFaWzrdA3tLj00ijCbkq2U8wECOpNOE/t7MsMw7wZ16Gqlq4P\n" \
"Wbvb8fnf6tf0jxVu4rIEy9CES1ya/j4nAhW7bZpCbH5rAy9asqu1f9dj4U5yYYoW\n" \
"rJdp/7bFEzHjYxxK4e28UK8LNTcBljPpJ1XBRQIDAQABAoIBAEJB+vhUV9hHH+DC\n" \
"vaDu1QFOAM+Y18F5ITi7tViSA/Elo831T5CKf01W0HnZwhzFmakJIXaJ80Zozl0t\n" \
"LRtYpTflcphXkb/5FGdIGiQHu0XpL05o98qbh0GinNmwrGa55zLzvhjmmeUat26od\n" \
"dlyBY+mnv0PN1gSFB8tr7Qyihx1l0I2RqlYB6FpgKN0xrPaWGoyZ7bgJsuaFx9YR\n" \
"ieLRAhko4TxTrmvyu8+dzyW7PjKrcCmbuG0dG3TmqQR4eTmxP4VEEO4rsLPn+b\n" \
"+e+x10D2t+i5QDRPUf6/gcHsgcuZTzEhjy5K4QNz9Z7P2WQt+6TcG/XqGITHl\n" \
"BAxsAQEcYEa+a09JujuJzlvhnEgut0h1q1v1CQjMKVQABV1xm9jsd8YaXjunZld\n" \
"kyOzdz+3tbRNMDG4mzvImun1oswjeBI4V8YnWPdLYPm+lBk7pxPvRvH91LSNK1P\n" \
"sxPgEG7ButyHwdviVNwFUU600oobAgBzCovPTKVibrKwBrLseRowrkECgYEAt9L\n" \
"DhEnogI0Q2QMM//fbTEARAGCHmUeff7qvhwAJsqt2+cYZq1QidBBzLufYohKQGwg\n" \
"57419N+d05ZIXB0qbNw+s9wRLmRDV88W09GjVcUe7veNksEj56CI59GV8D1gsvtV\n" \
"RgwwEIwzxwqX2axsxDJGDk0UWCiE4MpKS84/2gUcgYEakBv/dGA825/USIQVcyBi\n" \
"AiobkOQu144jtdkVH6LghSwGyCh/fISmsWOPVEKLttbbhzUw+z0zfOKTwvq0Qwb\n" \
"lZ21UZmCD2Y3Rp0oVjXGR127bpqEL9l07hTjuDhly3idH4nN6lMQUqzHEwAsXQta\n" \
"CB5j1VbPvLPptU095mxiesEcgyBJ1FJ6sG+BzU61dPtdEanvcnGvxErPhgjaoS+\n" \
"X0T6Cu9ZH27X5KX/YTvK5IRiD4Fbs89HtzFBTKo7aQdDaUhVk4g58bIVXJxjiqT\n" \
"tkiu6x3Zpd1CNjT8sBNqJ+Wx1c0IxvVypoqaYrdsqjgXY32ULFagON26boHGLxz7\n" \
"K7G/0QKBgqCu2jeUlGZ6NSD83VpTNTkezbGp9RmFeZj7leZeQ35R3W3EG2UZA5\n" \
"RSTyx0JUZZGII04T5EX1RdrDj5SJ+DWx43jC4wBvd5jY2NwAEZPwnjUoePcrN3r\n" \
"TBGVAKOAO2LE6jl11uEtyLuX1wzyL7FUSNipItvHoKUeRS3DE7sjA==\n"
"-----END RSA PRIVATE KEY-----\n"
=====
```

Figure 55: Certificates printed on console logs

Open aws_clientcredential_keys.h from the below mentioned SDK path.
SDK/boards/<board>/edgefast_bluetooth_examples/audio_profile.

Find keyCLIENT_CERTIFICATE_PEM and paste formatted certificate as a value.

```
/* @TEST_ANCHOR */
/* @brief PEM-encoded client certificate.
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the certificate that will be used for TLS client authentication.
 * @note Must include the PEM header and footer:
 * -----BEGIN CERTIFICATE-----\n"
 * ...base64 data...\n"
 * -----END CERTIFICATE-----\n"
 */
#ifndef keyCLIENT_CERTIFICATE_PEM |
#define keyCLIENT_CERTIFICATE_PEM NULL
#endif
/*
 * @brief PEM-encoded issuer certificate for AWS IoT Just In Time Registration (JITR).
 * @todo If you are using AWS IoT Just in Time Registration (JITR), set this to
 * the issuer (Certificate Authority) certificate of the client certificate above.
 */
```

Figure 56: Adding client certificate

Then find keyCLIENT_PRIVATE_KEY_PEM and paste formatted private-key as value.

```

/*
 * @brief PEM-encoded client private key.
 *
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the private key that will be used for TLS client authentication.
 * Please note pasting a key into the header file in this manner is for
 * convenience of demonstration only and should not be done in production.
 * Never paste a production private key here!. Production devices should
 * store keys securely, such as within a secure element. Additionally,
 * we provide the corePKCS library that further enhances security by
 * enabling keys to be used without exposing them to software.
 *
 * @note Must include the PEM header and footer:
 * "-----BEGIN RSA PRIVATE KEY-----\n"
 * "...base64 data...\n"
 * "-----END RSA PRIVATE KEY-----\n"
 */
#ifndef keyCLIENT_PRIVATE_KEY_PEM
#define keyCLIENT_PRIVATE_KEY_PEM NULL
#endif

#endif /* AWS_CLIENT_CREDENTIAL_KEYS_H */

```

Figure 57: Adding private key

NOTE: The certificate and private key are hard-coded for demonstration purposes only. Production-level applications should store these files in a secure location.

5.17.2.5 Configure the AWS IoT endpoint

User need to update FreeRTOS with your AWS IoT endpoint so the application running on the board can send requests to the correct endpoint.

Open “aws_clientcredential.h” file.

Set the “clientcredentialMQTT_BROKER_ENDPOINT” as per the Rest API Endpoint.

```
#define clientcredentialMQTT_BROKER_ENDPOINT      "a2qkq65ssjggf7-
ats.iot.us-east-1.amazonaws.com"
```

Set the “clientcredentialIOT_THING_NAME” as per the name of IoT Thing

```
#define clientcredentialIOT_THING_NAME          "MusicPlayer"
```

Set the “clientcredentialWIFI_SSID” as the connected Wi-Fi SSID

```
#define clientcredentialWIFI_SSID                "NXP_Demo"
```

Set the “clientcredentialWIFI_PASSWORD” as the connected Wi-Fi Password.

```
#define clientcredentialWIFI_PASSWORD           "123456789"
```

Set the “clientcredentialMQTT_BROKER_PORT” as 443

```
#define clientcredentialMQTT_BROKER_PORT        8883
```

Rebuild the application and flash it on the target board.

Either press the reset button on your board or launch the debugger in your IDE to begin running the demo.

Prepare the Android application

Open the Amazon Cognito console,

```
https://console.aws.amazon.com/cognito/home
```

Choose “Manage Identity Pools”

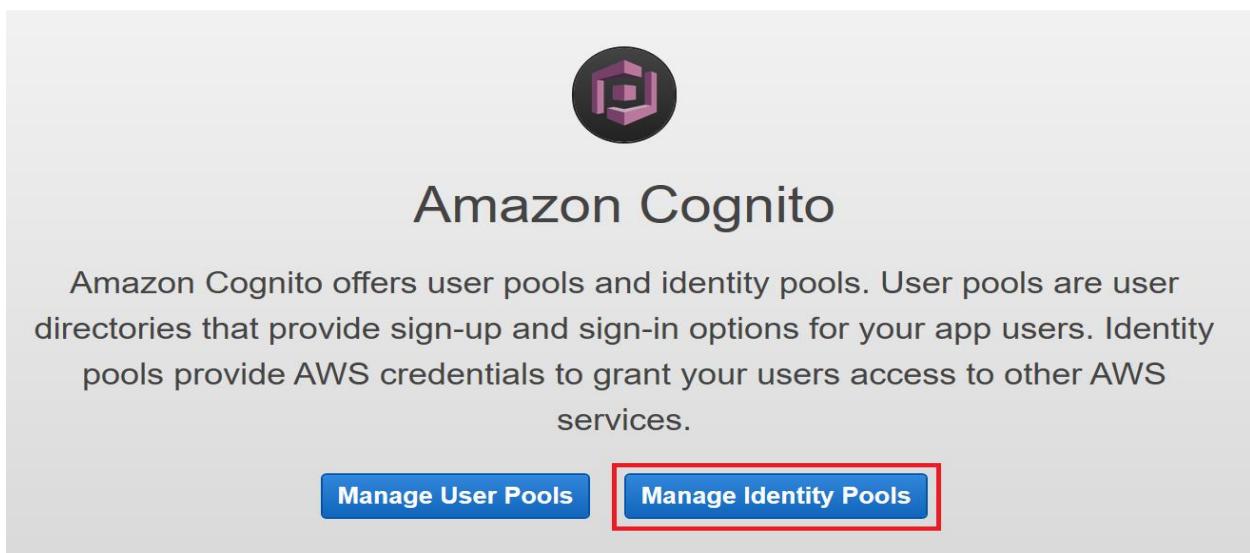


Figure 58: Manage Identity Pools
Click “Create new identity pool”.

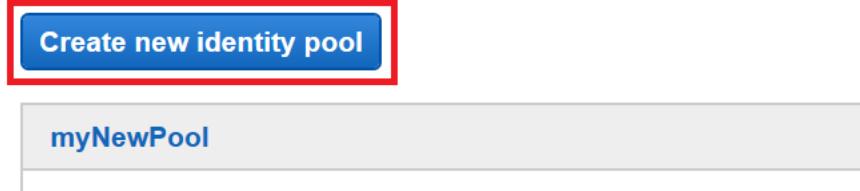


Figure 59: Create new identity pool
Enter a name for your identity pool. Such as the pool name is "MusicPlayerIdentity", enable unauthenticated access.

Create new identity pool

Identity pools are used to store end user identities. To declare a new identity pool, enter a unique name.

Identity pool name*

Example: My App Name

▼ Unauthenticated identities

Amazon Cognito can support unauthenticated identities by providing a unique identifier and AWS credentials for users who do not authenticate with an identity provider. If your application allows customers to use the application without logging in, you can enable access for unauthenticated identities. [Learn more about unauthenticated identities.](#)

[Enable access to unauthenticated identities](#)

Enabling this option means that anyone with internet access can be granted AWS credentials. Unauthenticated identities are typically users who do not log in to your application. Typically, the permissions that you assign for unauthenticated identities should be more restrictive than those for authenticated identities.

Figure 60: Identity pool name

Click "Create Pool".

▼ Authentication flow settings ⓘ

A user authenticating with Amazon Cognito will go through a multi-step process to bootstrap their credentials. Amazon Cognito has two different flows for authentication with public providers: enhanced and basic. Cognito recommends the use of enhanced authentication flow. However, if you still wish to use the basic flow, you can enable it here. [Learn more about authentication flows.](#)

Allow Basic (Classic) Flow

► Authentication providers ⓘ

* Required

Cancel

Create Pool

Figure 61: Create pool

Click “Allow” to create a pool

► View Details

Cancel

Allow

Figure 62: Allow to create a pool

Click “Services”

The screenshot shows the AWS Services menu. On the left, there's a sidebar with links like 'Identity pool', 'Dashboard', 'Sample code' (which is highlighted with an orange border), and 'Identity browser'. On the right, the main content area is titled 'Getting started with Amazon Cognito'. It includes a 'Platform' dropdown set to 'Android', a section for 'Download the AWS SDK', and a 'Developer Guide' link. A search bar at the top right says 'Search for services, features, marketplace products, and docs [Alt+S]'. The 'Services' dropdown button is also highlighted with a red box.

Figure 63: Open services menu

Click “IAM” inside “All Services”

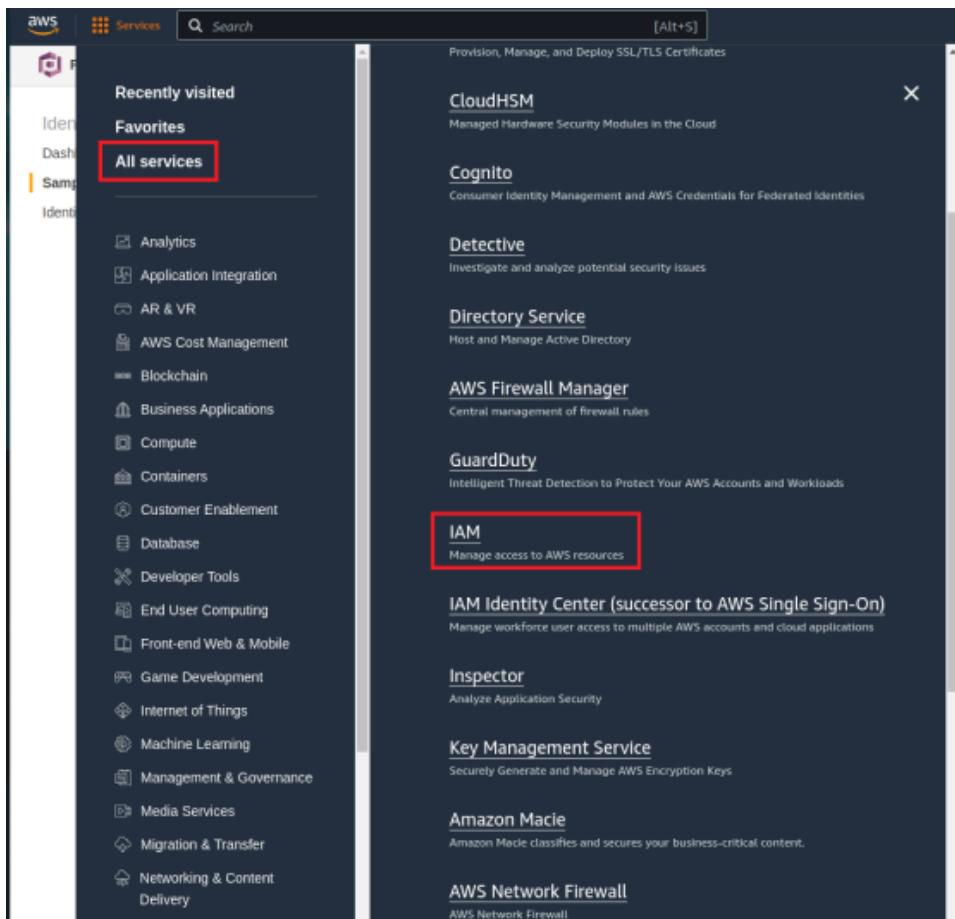


Figure 64: Open IAM

Click “Roles” from “IAM dashboard”.

IAM dashboard

Security recommendations 1

! Add MFA for root user

Enable multi-factor authentication (MFA) for the root user to improve security for this account.

[Add MFA](#)

✓ Root user has no active access keys

Using access keys attached to an IAM user instead of the root user improves security.

IAM resources

User groups	Users	Roles	Policies	Identity providers
0	0	19	2	0

Figure 65: Open available roles

Click “Cognito_MusicPlayerIdentityUnauth_Role”.

New! Securely access AWS services from your data center with IAM Roles Anywhere. [Learn more](#)

IAM > Roles

Roles (19) Info
An IAM role is an identity you can create that has specific permissions with credentials that are valid for short durations. Roles can be assumed by entities that trust you.

Role name	Trusted entities	Last activity
AWSServiceRoleForSupport	AWS Service: support (Service-Linked Role)	-
AWSServiceRoleForTrustedAdvisor	AWS Service: trustedadvisor (Service-Linked Role)	-
Cognito_aws_wifi_provisioning_identity_poolAuth_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_aws_wifi_provisioning_identity_poolUnauth_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_MusicPlayerIdentityAuthentication_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_MusicPlayerIdentityAuth_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_MusicPlayerIdentityUnauthentication_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_MusicPlayerIdentityUnauth_Role	Identity Provider: cognito-identity.amazonaws.com	-
Cognito_MyMusicAuth_Role	Identity Provider: cognito-identity.amazonaws.com	-

Figure 66: Selecting un-authentication role

Click the arrow as shown to edit the policy.

Permissions policies (1) Info
You can attach up to 10 managed policies.

Policy name	Type	Description
oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848	Customer inline	Customer ini...

Figure 67: Open policy content

Click "Edit".

Permissions policies (1) Info
You can attach up to 10 managed policies.

Policy name	Type	Description
oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848	Customer inline	Customer inline

```

1+ [
2+   {
3+     "Version": "2012-10-17",
4+     "Statement": [
5+       {
6+         "Effect": "Allow",
7+         "Action": [
8+           "iot:Connect"
9+         ],
10+        "Resource": [
11+          "*"
12+        ]
13+      }
14+    ]
15+  }
16+
17+ ]
  
```

Figure 68: Edit the policy

Click “JSON”

Edit oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848

1 2

A policy defines the AWS permissions that you can assign to a user, group, or role. You can create and edit a policy in the visual editor and using JSON. [Learn more](#)

Visual editor **JSON** Import managed policy

Expand all | Collapse all

Mobile Analytics (1 action) Clone Remove

Cognito Sync (All actions) Clone Remove

[Add additional permissions](#)

Character count: 130 of 10,240.
The current character count includes character for all inline policies in the role: Cognito_MusicPlayerIdentityUnauthentication_Role.

[Cancel](#) [Review policy](#)

Figure 69: Open JSON tab

Fill the below content to the policy.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "iot:Connect"
            ],
            "Resource": [
                "*"
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "iot:Publish"
            ],
            "Resource": [
                "*"
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "iot:Subscribe",
                "iot:Receive"
            ],
            "Resource": [
                "*"
            ]
        }
    ]
}
```

Click “Review Policy”

Edit oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848

1 2

A policy defines the AWS permissions that you can assign to a user, group, or role. You can create and edit a policy in the visual editor and using JSON. [Learn more](#)

```

1 * {
2     "Version": "2012-10-17",
3     "Statement": [
4         {
5             "Effect": "Allow",
6             "Action": [
7                 "iot:Connect"
8             ],
9             "Resource": [
10                 "*"
11             ]
12         }
13     ]
14 }
  
```

Character count: 237 of 10,240.
The current character count includes character for all inline policies in the role: Cognito_MusicPlayerIdentityUnauthentication_Role.

Cancel

Review policy

Figure 70: Review policy

Click “Save changes”

Edit oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848

1 2

Review policy

Review this policy before you save your changes.

Summary			
<input type="text"/> Filter			
Service	Access level	Resource	Request condition
Allow (1 of 258 services) Show remaining 257			
IoT	Limited: Write	All resources	None

* Required

Cancel

Previous

Save changes

Figure 71: Save changes for the role selected

The pool is created successfully.

Click “Trust relationships”

The screenshot shows the AWS IAM Trust relationships tab. At the top, there are tabs for Permissions, Trust relationships (which is highlighted with a red border), Tags, Access Advisor, and Revoke sessions. Below the tabs, a section titled "Permissions policies (1) Info" shows a single policy named "oneClick_Cognito_MusicPlayerIdentityUnauth_Role_1607781324848". A search bar and several buttons (Simulate, Remove, Add permissions) are also visible.

Figure 72: Open Trust relationships tab

Make a copy of the Identity pool ID to use for next section.

The screenshot shows the AWS IAM Trust relationships tab with the JSON policy document displayed. The policy document includes a condition where the "cognito-identity.amazonaws.com:aud" claim must be "us-east-1:408bb2c1-0728-4af8-97ce-c0f13c268a21". The highlighted part of the JSON code is: "StringEquals": ["us-east-1:408bb2c1-0728-4af8-97ce-c0f13c268a21"]

Figure 73: copy Identity pool ID

5.17.2.6 Prepare Configuration File for the Android Application

Prepare "AwsMusicControlPreferences.properties" file with yours AWS credentials.

Its structure looks like this:

```
customer_specific_endpoint=<REST API ENDPOINT>
cognito_pool_id=<COGNITO POOL ID>
thing_name=<THING NAME>
region=<REGION>
```

Where:

customer_specific_endpoint is the endpoint that is configured in *aws_clientcredential.h*

cognito_pool_id is the copied pool id in above step.

thing_name is the created Thing name.

region is the front part of the cognito pool id.

For Example:

```
customer_specific_endpoint=a2qkq65ssjggf7-ats.iot.us-east-1.amazonaws.com
cognito_pool_id=us-east-1:408bb2c1-0728-4af8-97ce-c0f13c268a21
thing_name=MusicPlayer
region=us-east-1
```

To run Android application,

Install and run pre-build *AwsRemoteControl.apk* on Android device, file path is referenced in section 1.3 “References”.

Then in both cases when asked to select *AwsMusicControlPreferences.properties* file with AWS IoT preferences. Then control the music.

NOTE: Application requires at least Android version 5.1 (Android SDK 22).

5.17.2.7 Run the application

The log below shows the output of the demo in the console window. The log can be different based on your Wi-Fi network configuration and based on the actions, which you have done in the Android application.

After the log "**Use mobile application to control the remote device.**", the shell command can be used to connect to Bluetooth headset.

```
usb host init done
mass storage device attached:pid=0x6387vid=0x58f address=1
usb msd device is ready
Available audio files:
demo-1-109869.mp3
demo-4-109870.mp3
ruling-planet-biab-demo-song-remix-117443.mp3
trance-eye-biab-demo-song-remix-117445.mp3
vlog-hip-hop-18447.mp3
0 197 [main_task] Warning: could not clean-up old crypto objects. 6
1 197 [main_task] Initializing Wi-Fi...
MAC Address: 00:E9:3A:B9:E0:35
2 3372 [main_task] Wi-Fi initialized successfully.
3 3374 [main_task] Connecting to: NXP_Demo
4 12982 [main_task] Wi-Fi connected
5 12983 [main_task] IP Address acquired: 192.168.131.241
6 12984 [MQTT] [INFO] Creating a TLS connection to a2nxzv2h17k05v.ats.iot.cn-north-1.amazonaws.com.cn:8883.
7 23840 [MQTT] [INFO] (Network connection 0x20257550) TLS handshake successful.
8 23841 [MQTT] [INFO] (Network connection 0x20257550) Connection to a2nxzv2h17k05v.ats.iot.cn-north-1.amazonaws.com.cn established.
9 23841 [MQTT] [INFO] Creating an MQTT connection to the broker.
10 24744 [MQTT] [INFO] MQTT connection established with the broker.
11 24744 [MQTT] [INFO] Successfully connected to MQTT broker.
12 24745 [SHADOW_DEV] [INFO] MQTT Agent is connected. Initializing shadow device task.
13 24745 [SHADOW_DEV] [INFO] Sending subscribe request to agent for shadow topics.
14 24761 [SHADOW_APP] [INFO] MQTT Agent is connected. Initializing shadow update task.
15 24761 [SHADOW_APP] [INFO] Sending subscribe request to agent for shadow topics.
16 25620 [SHADOW_APP] [INFO] Received subscribe ack for shadow update topics.
17 25620 [SHADOW_DEV] [INFO] Successfully subscribed to shadow update topics.
18 25621 [SHADOW_DEV] [INFO] Publishing to /get message using client token 25621.
19 25621 [MQTT] [INFO] Publishing message to $aws/things/MarkWangMusicPlayer/shadow/get.
20 25627 [SHADOW_APP] [INFO] Publishing to /update with following client token 25626.
```

```

21 25627 [MQTT] [INFO] Publishing message to
$aws/things/MarkWangMusicPlayer/shadow/update.

22 25634 [SHADOW_DEV] [INFO] Successfully sent a publish message to /get topic.
Bluetooth initialized

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>> 23 26418 [MQTT] [INFO] Ack packet deserialized with result: MQTTSuccess.
24 26419 [MQTT] [INFO] State record updated. New state=MQTTPublishDone.
25 26420 [MQTT] [INFO] Ack packet deserialized with result: MQTTSuccess.
26 26420 [MQTT] [INFO] State record updated. New state=MQTTPublishDone.
27 26478 [MQTT] [INFO] De-serialized incoming PUBLISH packet:
DeserializerResult=MQTTSuccess.
28 26478 [MQTT] [INFO] State record updated. New state=MQTTPubAckSend.
29 26488 [MQTT] [INFO] De-serialized incoming PUBLISH packet:
DeserializerResult=MQTTSuccess.
30 26489 [MQTT] [INFO] State record updated. New state=MQTTPubAckSend.
31 26490 [MQTT] [INFO] Received accepted response for update with token 25626.
32 26494 [SHADOW_DEV] [INFO] Received an accepted response for shadow GET
request.

```

Use command “**help**” to list the available options:

```
>> help
```

“**help**”: List all the registered commands

“**exit**”: Exit program

“**bt**”: BT related function

```

USAGE: bt [connectaddress|finddevice|connectdevice|disconnect|deletedevice]
      connectaddress connect to the device of the address parameter, for example:
bt connectaddress xx:xx:xx:xx:xx:xx. Address format(LSB-MSB): xx:xx:xx:xx:xx:xx
      finddevice      start to find BT devices
      connectdevice   connect to the device that is found, for example: bt
connectdevice n (from 1)
      disconnect      current connection
      deletedevice    delete all devices. Ensure to disconnect the HCI link
connection with the peer device before attempting to delete the bonding
information.
>>

```

Use command “**bt finddevice**” to scan nearby Bluetooth devices

```

>> bt finddevice
>> Discovery started. Please wait ...
BR/EDR discovery complete
[1]: 70:F0:87:C0:FC:0E, RSSI -65 iPhone
[2]: BC:17:B8:74:2C:9F, RSSI -52 Galaxy
[3]: 50:82:D5:78:31:DA, RSSI -78 iPhone 6
[4]: 00:00:AB:CD:87:D6, RSSI -38 Airdopes 441
[5]: 04:C8:07:25:29:73, RSSI -69 Mi A3

```

Use command “**bt connectdevice <number>**” to connect to remote Bluetooth device

Here, “**number**” value can be found from the logs of “**bt finddevice**” command used above.

```

>> bt connectdevice 4
>> Connection pending
SDP discovery started
Connected
sdp success callback
A2DP Service found. Connecting ...
Security changed: 7E:5E:2B:2E:9A:C3 (0xed) level 2

```

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```
33 114978 [SHADOW_APP] [INFO] Publishing to /update with following client token  
114977.  
34 114978 [MQTT] [INFO] Publishing message to  
$aws/things/MarkWangMusicPlayer/shadow/update.  
35 115685 [MQTT] [INFO] Ack packet deserialized with result: MQTTSuccess.  
36 115685 [MQTT] [INFO] State record updated. New state=MQTTPublishDone.  
37 115742 [MQTT] [INFO] De-serialized incoming PUBLISH packet:  
DeserializerResult=MQTTSuccess.  
38 115743 [MQTT] [INFO] State record updated. New state=MQTTPubAckSend.  
39 115745 [MQTT] [INFO] Received accepted response for update with token  
114977.
```

Open the android app and load the *AwsRemoteControlPreferences.properties*, wait for connection to get complete.

Use the smartphone application to play the music.

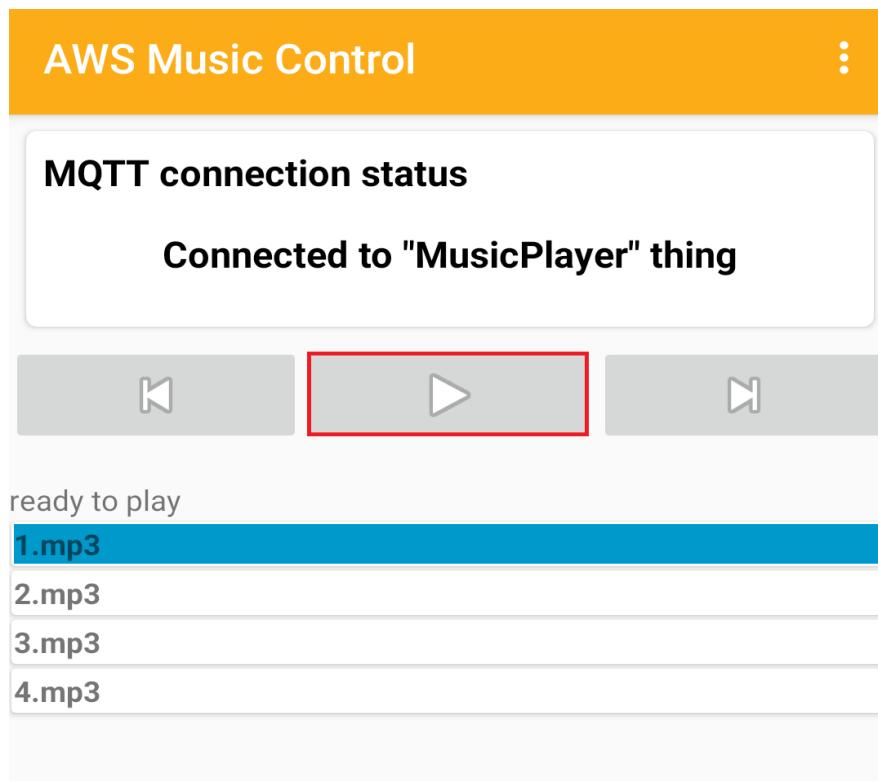


Figure 74: Play music using Android application

Following logs will be appear on the i.MX RT1060 EVK board console:

```
>> start play
[STREAMER] Message Task started
[STREAMER] start playback
Starting playback 0
47 118031 [AWS-RemoteCtrl] [INFO ] [MQTT] [lu] (MQTT connection 0x20230c48) MQTT
PUBLISH operation queued.
48 118045 [iot_thread] [WARN ] [Shadow] [lu] Received a Shadow UPDATE response
with no client token. This is possibly a response to a bad JSON document:
{"state":{"desired":{"playIndex":0,"playState":true}}, "metadata":{"desired":{"playIndex":{"timestamp":1649}}}
118045 [iot_thread] [WARN ] [Shadow] [lu] Shadow
UPDATE callback received an unknown operation.
50 118695 [iot_thread] [INFO ] [Shadow] [lu] Shadow UPDATE of MusicPlayer was
ACCEPTED.
51 118695 [AWS-RemoteCtrl] Successfully performed update.
STREAM_MSG_UPDATE_POSITION
  position: 1005 ms
STREAM_MSG_UPDATE_POSITION
  position: 2011 ms
STREAM_MSG_UPDATE_POSITION
  position: 3004 ms
```

Use the smartphone application to pause the music.

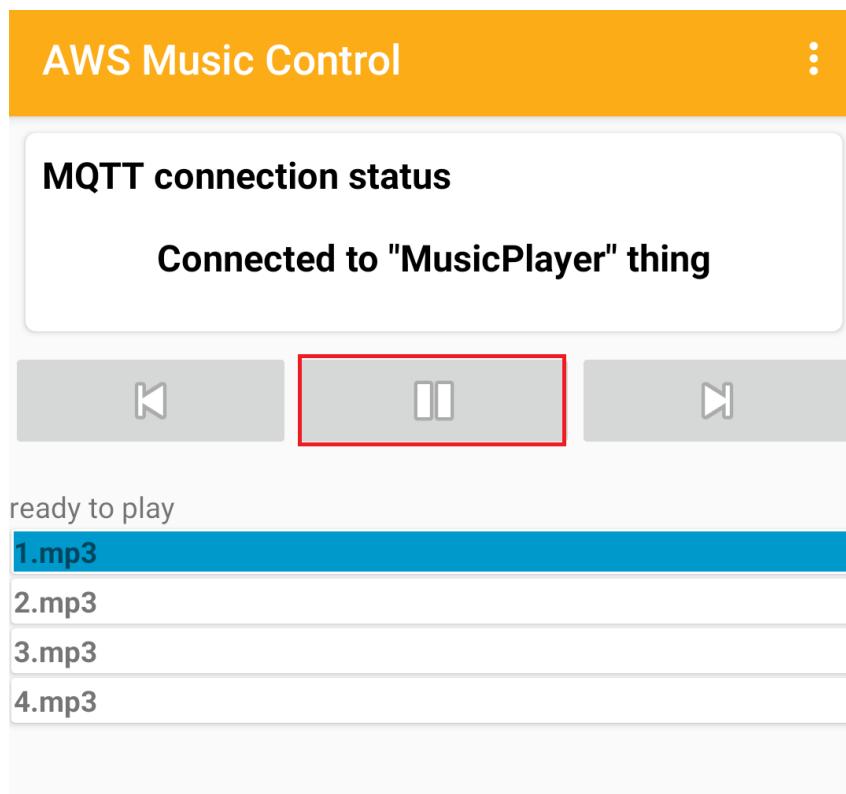


Figure 75: Pause music using Android application

Following logs will be appear on the i.MX RT1060 EVK board console:

```
stop play
52 214884 [AWS-RemoteCtrl] [INFO ] [MQTT] [lu] (MQTT connection 0x2022fdb0) MQTT
PUBLISH operation queued.
53 214885 [iot_thread] [WARN ] [Shadow] [lu] Received a Shadow UPDATE response
with no client token. This is possibly a response to a bad JSON document:
{"state":{"desired":{"playIndex":0,"playState":false}}, "metadata":{"desired":{{
playIndex":{"timestamp":154 214885 [iot_thread] [WARN ] [Shadow] [lu] Shadow
UPDATE callback received an unknown operation.
55 215504 [iot_thread] [INFO ] [Shadow] [lu] Shadow UPDATE of MusicPlayer was
ACCEPTED.
56 215504 [AWS-RemoteCtrl] Successfully performed update.
```

Use command “**bt disconnect**” to release the connection with Headset.

```
>> bt disconnect
>> 46 689546 [iot_thread] [ERROR] [NET] [lu] Error -27648 while sending data.
47 689547 [AWS-RemoteCtrl] [INFO ] [MQTT] [lu] (MQTT connection 0x20230c48) MQTT
PUBLISH operation queued.
Disconnected (reason 0x16)
58 249328 [iot_thread] [INFO ] [Shadow] [lu] Shadow UPDATE of MusicPlayer was
ACCEPTED.
59 249329 [AWS-RemoteCtrl] Successfully performed update.
```

Use command “**bt deletedevice**” to remove bound and authentication information of all the connected devices.

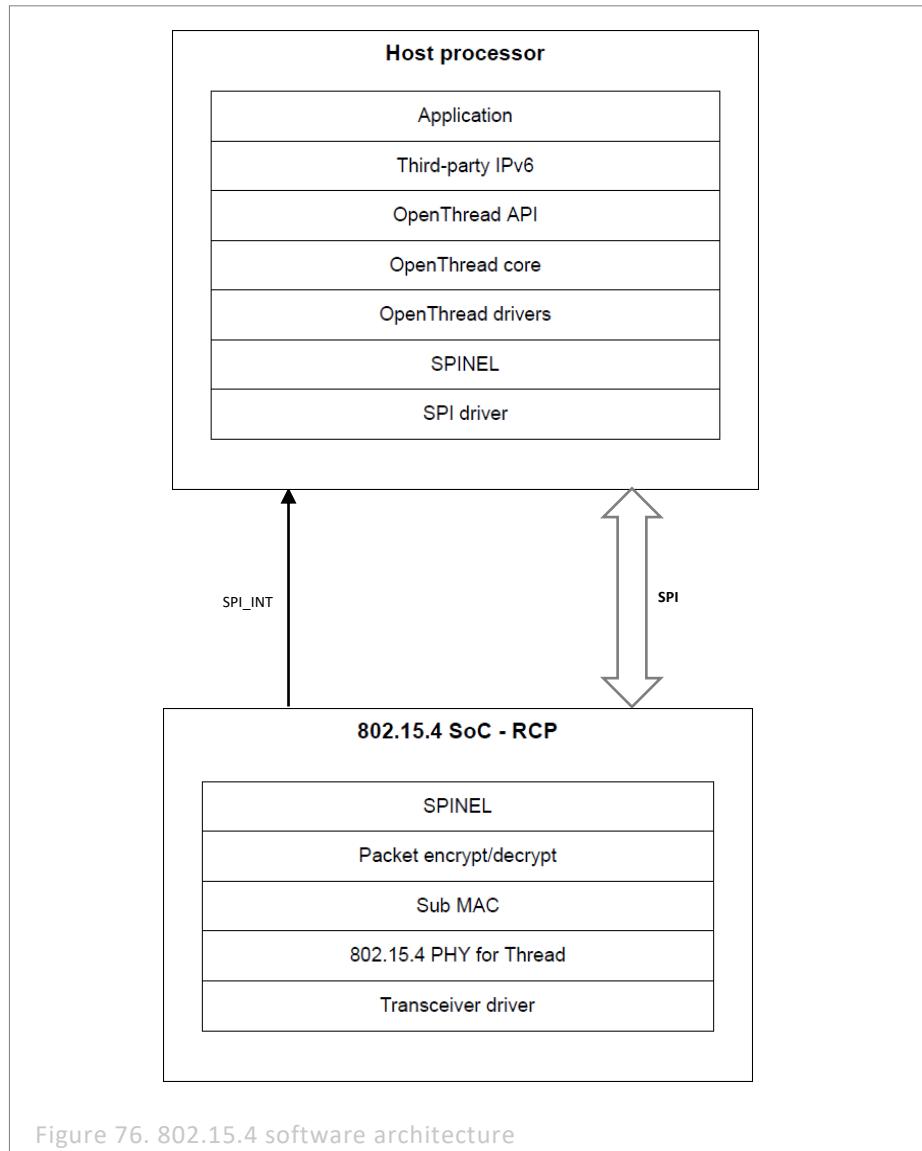
```
>> bt deletedevice
>>
```

6 802.15.4 Sample Application

This chapter describes the Thread example application that is available in the OpenThread repository, and the steps to configure, debug and execute this example.

Thread is an IPv6-based networking protocol designed for low-power Internet of Things devices in an IEEE802.15.4-2006 wireless mesh network. OpenThread released by Google is an open-source implementation of Thread.

The communication between the Open-thread RCP stack and the Link Layer (LL) is implemented via the SPI interface as shown on Figure 76.



The setup is done between an i.MX RT+ IW612 NXP-based wireless module. The instructions in this guide use an i.MXRT1170 EVK board. Please check the UM11823 - Getting Started with IW612 Evaluation Board and i.MX RT1170 Running RTOS for details of how to build the OpenThread CLI demo.

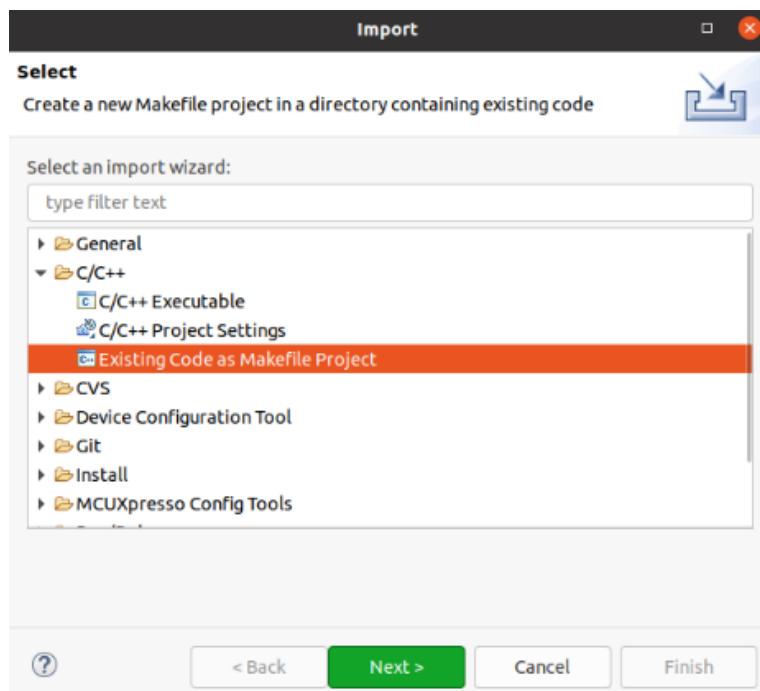
6.1 CLI Sample Application

This sample application section describes the steps to configure the i.MX RT1170 EVK board and IW612 wireless module to create/join a thread network and other useful commands using the command line. It is recommended to use a Linux PC to compile and debug this example.

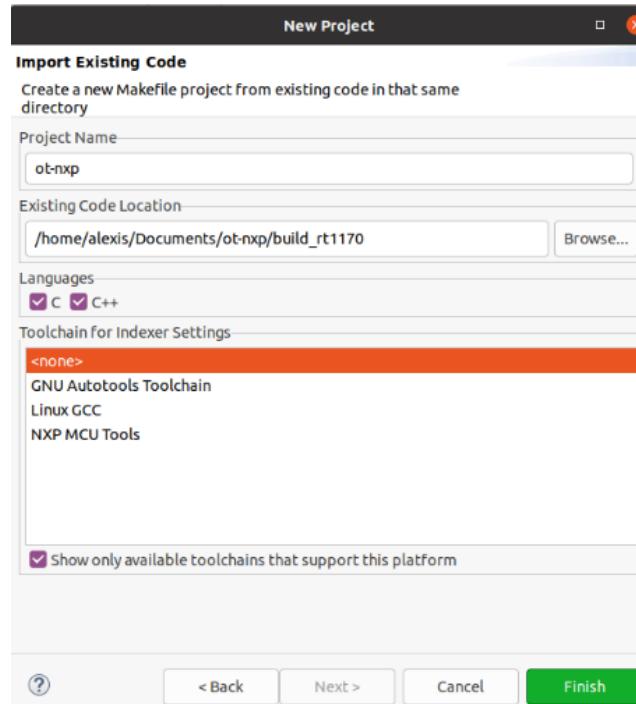
6.1.1 Create debug session

After following the steps from the Getting Started guide UM11441 section “Run a 802.15.4 demo application”, a folder “build_rt1170” with the executable would be created.

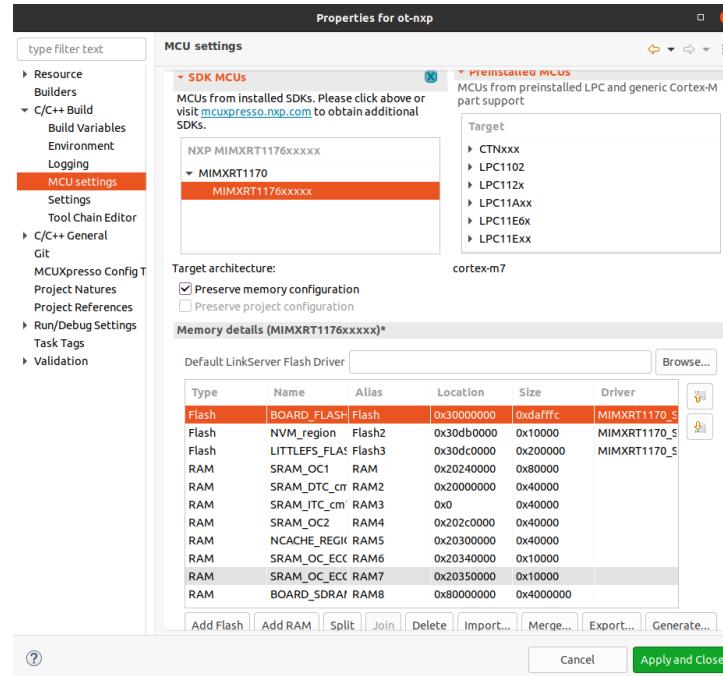
To create the debug session is needed to import to whole ot-nxp folder in MCUXpresso IDE as a “Makefile Project”:



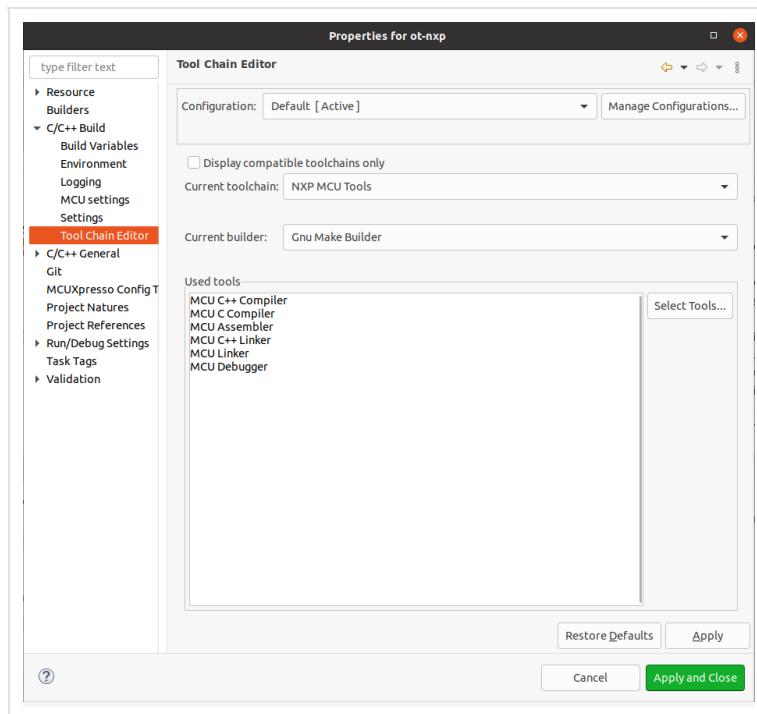
Use none as Toolchain for Indexer Settings:



Configure memory map to match the following picture. To open this window right click on the Project -> Properties -> C/C++ Build -> MCU Settings -> Select MIMXRT1170 -> Apply & Close:



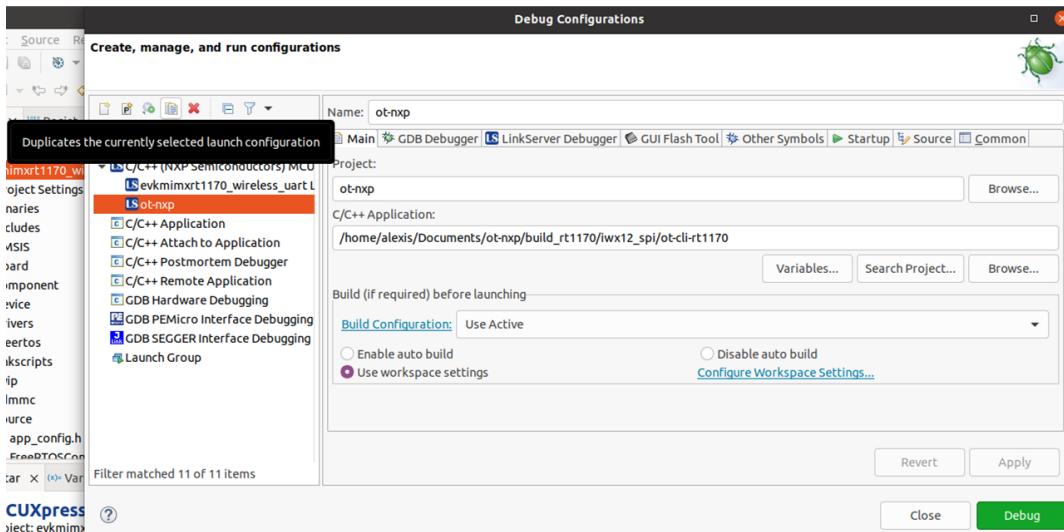
Configure the toolchain editor to NXP MCU Tools. To open this window right click on the Project -> C/C++ Build-> Tool Chain Editor -> NXP MCU Tools -> Apply & Close



To create the debug session, it's needed to duplicate a current debug session for the same chipset, in this case, it is used a Wi-Fi CLI debug session. In the drop-down menu on the “green bug” select the Debug configurations:



Click on the duplicate icon and update the project to point to the ot-nxp workspace project. Update C/C++ Applications to point to the ot-nxp executable generated on path ot-nxp/build_rt1170/iwx12_spi/ot-cli-rt1170:



After that, a debug session for the OpenThread project should be generated correctly.

6.1.2 ot-nxp Application Execution

6.1.2.1 Start-up logs

The following character can be observed on the console once the devices (i.MX RT1170 EVK board and IW612 module) are up and running and it shows that 802.15.4 module is ready for the operations.

>

6.1.2.2 Help Command

The help command is used to get the list of commands available in the *ot-nxp* sample application.

```
> help
bbr
bufferinfo
ccathreshold
ccm
channel
child
childip
childmax
childsupervision
childtimeout
coap
commissioner
contextreusedelay
counters
dataset
delaytimermin
discover
dns
domainname
eidcache
eui64
extaddr
extpanid
factoryreset
fake
fem
ifconfig
ipaddr
ipmaddr
joiner
joinerport
keysequence
leaderdata
leaderweight
log
mac
mliid
mlr
mode
multiradio
neighbor
netdata
netstat
networkdiagnostic
networkidtimeout
networkkey
networkname
panid
parent
parentpriority
```

```
partitionid
ping
pollperiod
preferrouterid
prefix
promiscuous
pskc
rcp
region
releaserouterid
reset
rloc16
route
router
routerdowngradethreshold
routereligible
routeridrange
routerselectionjitter
routerupgradethreshold
scan
service
singleton
state
tcp
thread
tvcheck
txpower
udp
unsecurereport
version
Done
```

6.1.2.3 Factory Reset 15.4 module

The `factoryreset` command is used to reset any change made on the current network and reset the device.

```
> factoryreset
Done
```

6.1.2.4 Scan command

The `scan` command is used to scan the visible thread devices.

```
> scan
| PAN | MAC Address | Ch | dBm | LQI |
+---+-----+---+---+---+
| 2233 | 2a702820dd853ea7 | 11 | -44 | 136 |
Done
```

6.1.2.5 Add leader network data

Before creating a network, we need to define certain parameters as the network key, network channel, PAN ID and network name.

```
> dataset init new
Done
> dataset channel 11
Done
> dataset networkkey 00112233445566778899AABBCCDDEE00
Done
> dataset panid 0x0123
Done
> dataset networkname ot-example
Done
> dataset commit active
```

```
Done
```

6.1.2.6 Start network

Using the data previously set, a network would be created.

```
> ifconfig up
Done
> thread start
Done
```

6.1.2.7 Enable commissioner

To enable other devices to join the network, it's needed to enable the commissioner role, this is used to authenticate a device onto the network.

```
> commissioner start
Commissioner: petitioning
Done
Commissioner: active
> commissioner joiner add * NXP123(pskd/pskc)
Done
> ~ Discovery Request from 2a702820dd853ea7: version=2,joiner=1
Commissioner: Joiner start 2a702820dd853ea7
Commissioner: Joiner connect 2a702820dd853ea7
Commissioner: Joiner finalize 2a702820dd853ea7
Commissioner: Joiner end 2a702820dd853ea7
```

6.1.2.8 Join network

For a device to be able to join it need to have the same network key and pskd/pskc. Also the device need to change to a joiner role to be able to send and receive the information to connect to the current network.

```
> dataset networkkey 00112233445566778899AABBCCDDEE00
Done
> dataset commit active
Done
> ifconfig up
Done
> joiner start NXP123 (pskd)
Done
Join success
> thread start
Done
```

6.1.2.9 Ping Devices

For a device to be able to ping another, it's needed the IPv6 of the target device. Use the ipaddr command on the target device to obtain the IPv6 on the target device.

```
> ipaddr
fd70:e262:f738:8d2e:0:ff:fe00:9001
fd70:e262:f738:8d2e:6c0d:de9c:7602:20ab
fe80:0:0:0:2cea:23a4:654:8c28
Done
```

After obtaining the IPv6 of the target device. The following command can be used to ping other devices.

```
> ping fe80:0:0:0:f4e7:f954:e813:7e4a
16 bytes from fe80:0:0:0:f4e7:f954:e813:7e4a: icmp_seq=1 hlim=64 time=35ms
1 packets transmitted, 1 packets received. Packet loss = 0.0%. Round-trip
min/avg/max = 35/35.0/35 ms.
Done
```

6.1.2.10 UDP Server/Client

The sample application implements a UDP protocol communication

To open a socket on the server:

```
> udp open
Done
> udp bind :: 1234
Done
```

To connect to the socket on the client side:

```
> udp open
Done
> udp connect fe80:0:0:0:f4e7:f954:e813:7e4a 1234
Done
```

Send a command from client to server:

```
> udp send hello
```

Output from server:

```
> 5 bytes from fe80:0:0:0:2cea:23a4:654:8c28 49154 hello
```

6.1.2.11 Other useful commands

Router

Print all the routers on the network, depending of the parameter is the information

Table

ID	RLOC16	Next Hop	Path Cost	LQ In	LQ Out	Age	Extended MAC
24	0x6000		63	0	0	0	2eea23a406548c28
36	0x9000		63	0	3	3	f6e7f954e8137e4a
1							

```
Done
```

List:

```
> router list
24 36
Done
```

Router ID:

```
> router 36
Alloc: 1
Router ID: 36
Rloc: 9000
Next Hop: fc00
Link: 0
Done
```

EUI64

Get the factory-assigned IEEE EUI-64

```
> eui64
ffffffffffff
Done
```

Router eligible

By default, the example sets the devices as a REED (Router Eligible Device). In case the devices needs to join the network only as an endpoint you can change this using the following command.

Disable router role:

```
> routereligible disable
Done
```

Enable router role:

```
> routereligible enable
Done
```

Get router role:

```
> routereligible  
Enabled  
Done
```

7 Acronyms and abbreviations

Table 22: Acronyms and Abbreviations

Terms	Definition
ACS	Auto Channel Selection
AP	Access Point
API	Application Program Interface
CLI	Command Line Interface
CMSIS	Cortex® Microcontroller Software Interface Standard
DFP	Device Family Pack
DHCP	Dynamic Host Configuration Protocol
DHCPD	DHCP daemon
ED	Energy Detection
EU	European Union
EVK	Evaluation Kit
Ext AP	External Access Point
Ext STA	External Station
FW	Firmware
IDE	Integrated Development Environment
IP	Internet Protocol
IwIP	Lightweight IP
NAT	Network Address Translation
PS	Power Save
Rx	Receive
SD	Secure Digital
SDK	Software Development Kit
SSID	Service Set Identifier
STA	Station/client
SW	Software
TCP	Transmission Control Protocol
TRPC	Transmit Rate-based Power Control
Tx	Transmit
UDP	User Datagram Protocol
WLAN	Wireless Local Area Network
WPA	Wi-Fi Protected Access
MFP	Management Frame Protection
OTP	One Time Programmable
ETSI	European Telecommunications Standards Institute
A2DP	Advanced Audio Distribution Profile
HFP	Hands-Free Profile
SPP	Serial Port Profile
BT	Bluetooth

BLE	Bluetooth Low Energy
PXR	Proximity Reporter
PXM	Proximity Monitor
HTS	Health Thermometer Service
IPSP	Internet Protocol Support Profile
HTTP	Hypertext Transfer Protocol
ACL	Asynchronous Connection-Less Link
AWS	Amazon Web Services
HCI	Host Controller Interface
UART	Universal Asynchronous Receiver Transmitter
PCM	Pulse-code Modulation
HS	High Speed
USB	Universal Serial Bus
EIP	Event in progress
PRI	Priority
PTA	Packet Traffic Arbiter

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