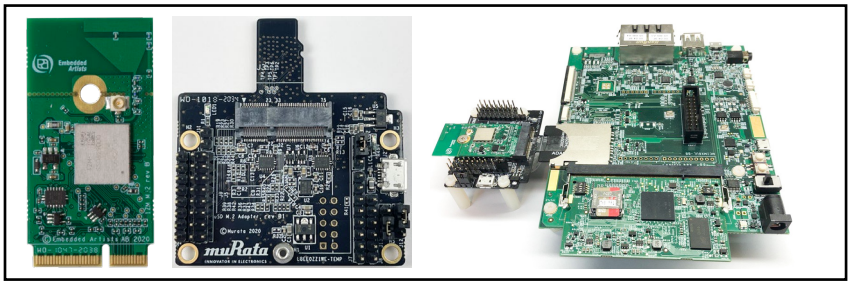
Murata Wi-Fi/BT (NXP) Solution for i.MX

Linux User Manual



Revision History

Revision	Date	Author	Change Description
1.0	Jan 29, 2021	TF	Initial Release

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1 Introduction

Murata has partnered with NXP Semiconductors N.V., and Embedded Artists AB to offer a complete Wi-Fi and Bluetooth connectivity environment for building world class Internet-connected products. The Murata Connectivity Modules enable developers to minimize the development time and effort for connectivity function implementation. All steps necessary to build Murata Wi-Fi/BT module-enabling software are documented here. Currently NXP i.MX Linux 5.4.47 BSP is supported.

Customized software images enabling NXP's i.MX 6 and i.MX 8 Reference Platforms is provided by Murata's "***meta-murata-wireless"*** Yocto solution. An automated build script makes image generation very simple.

Beyond validation of NXP i.MX platforms listed in **Table 1** below, the Murata software solution is easily applied to the complete i.MX 6/7/8 family. Users need only customize the Linux DTB (Device Tree Blob) which configures the kernel during boot.

This release also enables a custom evaluation release for Type 1YM (88W8997) module, allowing customers to interface the WLAN-SDIO instead of the default WLAN-PCIe bus.

Table 1: Current NXP i.MX Platforms Supported

NXP i.MX EVK Part number	NXP i.MX EVK	Murata Modules Supported	Inter-Connect
MCIMX8QXP-CPU	i.MX 8QXP MEK	1YM	M.2 (WLAN-PCIe)
MCIMX8M-EVKB	i.MX 8MQuad EVK	1YM	M.2 (WLAN-PCIe)
8MMINILPD4-EVK	i.MX 8M Mini EVK	1ZM,1YM	uSD-M.2 Adapter: 1ZM, 1YM M.2 (WLAN-PCIe): 1YM – WLAN Only
8MMINID4-EVK	i.MX 8M Mini EVK	1YM	M.2 (WLAN-PCIe) – WLAN Only
8MNANOD4-EVK	i.MX 8M Nano EVK	1ZM, 1YM	uSD-M.2 Adapter: 1ZM, 1YM M.2 (WLAN-PCIe): 1YM – WLAN Only
MCIMX6UL-EVKB	i.MX 6UL EVK	1ZM, 1YM	uSD-M.2 Adapter
MCIMX6ULL-EVK	i.MX 6ULL EVK	1ZM, 1YM	uSD-M.2 Adapter

Figure 1 illustrates a high-level connection diagram between NXP i.MX 6 EVK's and Murata module. This configuration is enabled with Murata's uSD-M.2 Adapter and Embedded Artists' Wi-Fi/BT M.2 EVB's. Note that there are limitations on this interconnect. Chief amongst them is fixed WLAN-SDIO VIO of 3.3V on certain i.MX 6 platforms, and a maximum WLAN-SDIO clock speed of 50 MHz. Please refer to the Linux User Guide, uSD-M.2 Adapter Datasheet, and Hardware User Manual for more details. Given that WLAN-SDIO VIO of Type 1ZM/1YM is 1.8V only, only NXP i.MX 6UL(L) EVK's work for this configuration.

Figure 1: Murata i.MX6 WLAN/BT Interconnect Block Diagram

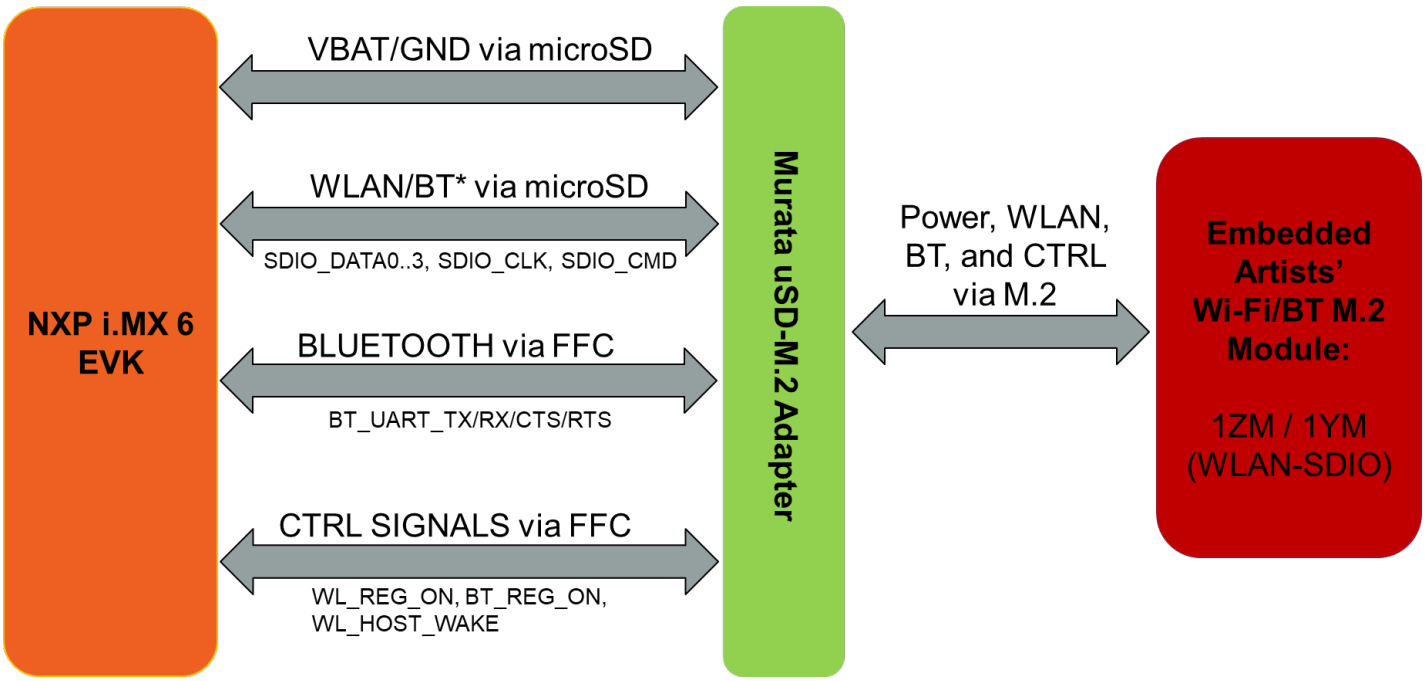


Figure 2 shows a simplified block diagram for the i.MX 8QXP MEK & i.MX 8MQuad EVK Wi-Fi/BT interconnect. Currently Type 1YM is supported with WLAN-PCIe interface. No adapter is needed for this interconnect as the M.2 EVBs can be connected directly to the i.MX 8 EVK.

Figure 2: i.MX 8QXP MEK & i.MX 8MQuad EVK WLAN/BT Interconnect Block Diagram

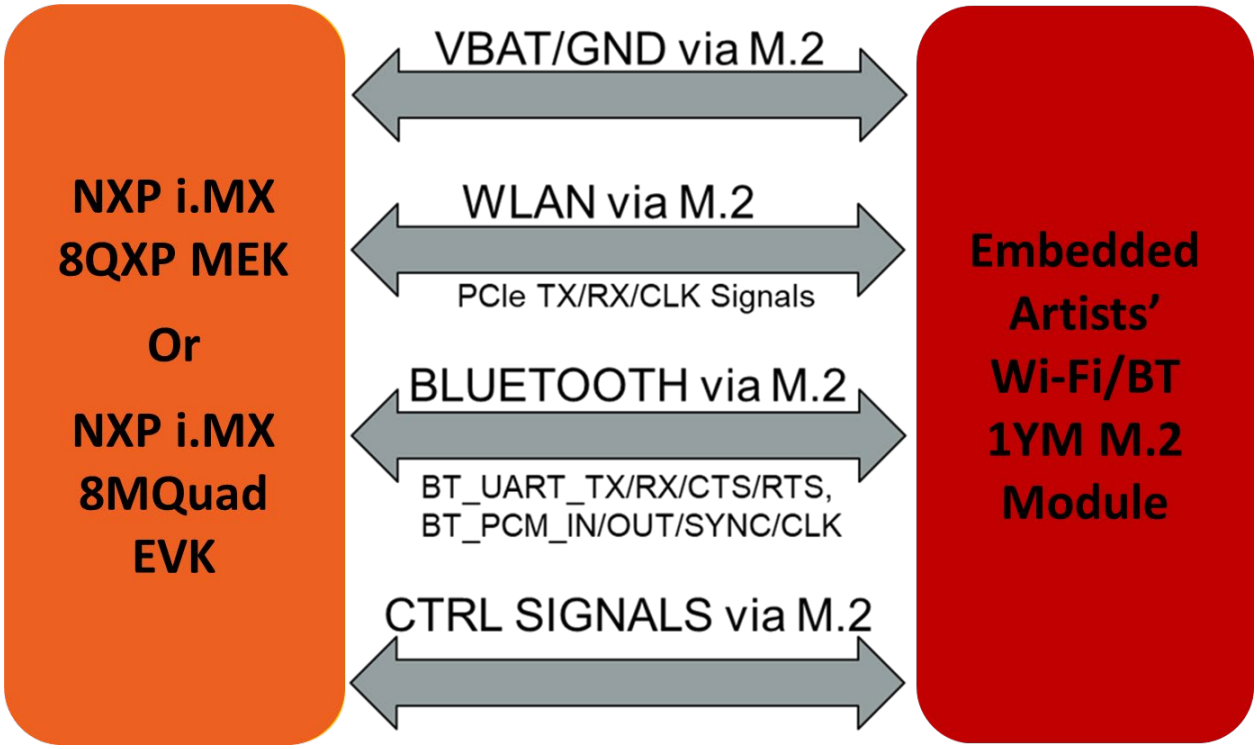


Figure 3 shows a simplified block diagram for the i.MX 8M Mini EVK WLAN interconnect with onboard M.2 EVB option. Currently Type 1YM is supported with WLAN-PCIe interface. Note that the NXP i.MX 8M Mini EVK **does not bring out** the Bluetooth signals to the M.2 connector – **WLAN only**.

Figure 3: i.MX 8M Mini EVK WLAN-PCIe Interconnect Block Diagram

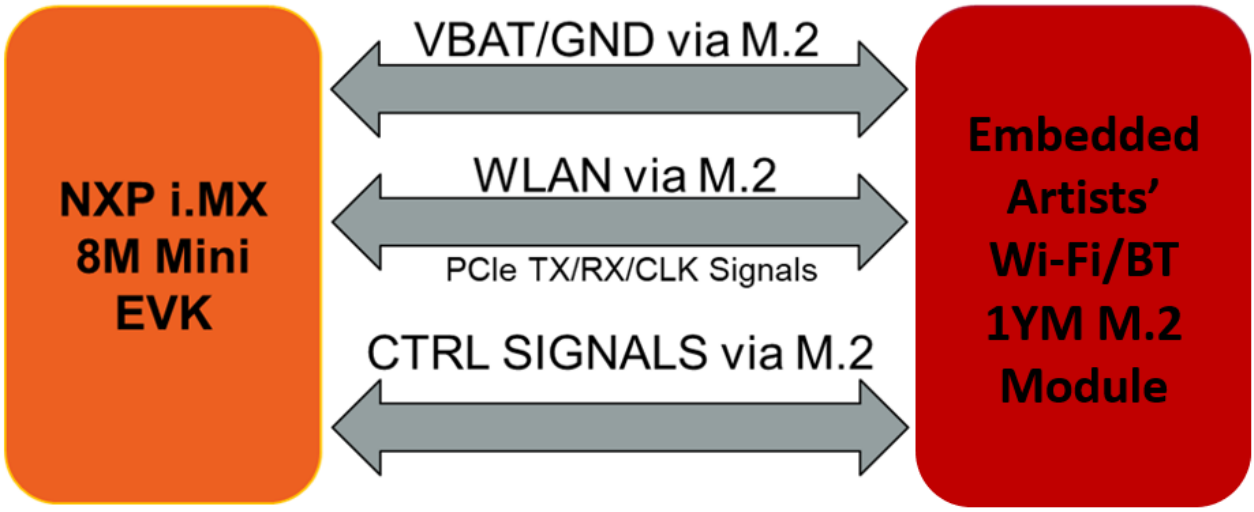
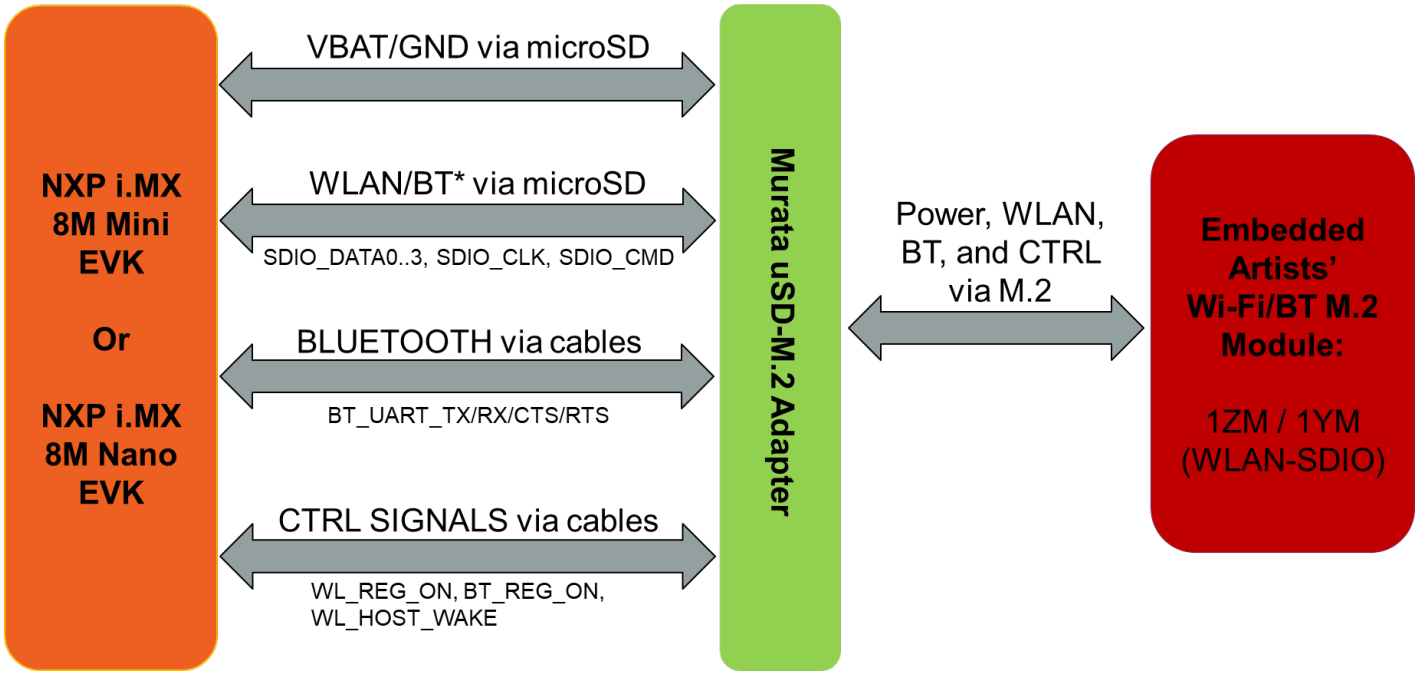


Figure 4 shows a simplified block diagram for the i.MX 8M Mini/Nano EVK interconnect with Murata's uSD-M.2 Adapter option (with Embedded Artists' Wi-Fi/BT M.2 EVB). Only WLAN-SDIO based modules are supported in this configuration. To properly support this (WLAN-SDIO VIO @1.8V; BT-UART VIO @3.3V) interconnect, Rev B1 uSD-M.2 Adapter needs to be used given that it correctly level shifts the Bluetooth and WLAN/BT control signals between the M.2 EVB and the NXP i.MX 8M Mini/Nano EVK.

Figure 4: i.MX 8M Mini EVK Wi-Fi/BT SDIO Interconnect Block Diagram



1.1 Acronyms

Table 2: Acronyms used in Linux User Manual

Acronym	Meaning
1YM	AKA “1YM-PCIe”, indicates that M.2 EVB is strapped for WLAN-PCIe/BT-UART
1YM-SDIO	Type 1YM M.2 EVB strapped for WLAN-SDIO/BT-UART
1YM-SDIO*	Type 1YM M.2 EVB strapped for WLAN-SDIO/BT-SDIO
AP	Access Point
API	Application Programming Interface
BSP	Board Support Package
BT	Bluetooth
CTRL	Control
CTS	Clear to Send
DHCP	Dynamic Host Configuration Protocol
DTB	Device Tree Blob: Kernel reads in at boot time for configuration.
EA	Embedded Artists designs, manufactures and distributes current Wi-Fi/BT M.2 EVB’s (link here). EA also have enhanced i.MX developer kits which provide comprehensive support for Murata modules (link here).
EULA	End User License Agreement
EVB	Evaluation Board (Embedded Artists’ Wi-Fi/BT module)
EVK	Evaluation Kit (includes EVB + Adapter)
FFC	Flat Flex Cable
FW	Firmware
GPIO	General Purpose Input/Output
IRQ	Interrupt Request Line
MEK	Multisensory Enablement Kit
MIMO	Multiple Input Multiple Output
NVRAM	Non-Volatile Random-Access Memory
OOB	Out of Band
O/S	Operation System
PC	Personal Computer
PCIe	PCI Express
PCM	Pulse Code Modulation
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTS	Request to Send
SDIO	Secure Digital Input Output
STA	Station
SW	Software
UART	Universal Asynchronous Receiver/Transmitter
UHS	Ultra-High Speed
USB	Universal Serial Bus
uSD	Micro SD
uSD-M.2	Micro SD to M.2 Adapter
VBAT	Voltage of the Battery
VIO	Input Offset Voltage
WLAN	Wireless Local Area Network
WPA	Wi-Fi Protected Access

1.2 References

1.2.1 Murata's i.MX Wireless Solutions Landing Page

This website landing page provides latest/comprehensive information on Murata's i.MX Wireless solutions which use the uSD-M.2 Adapter as a key enabler so customers can easily evaluate Murata's modules on i.MX processors.

1.2.2 Murata uSD-M.2 Adapter Datasheet

This datasheet documents the current version of the Murata uSD-M.2 adapter hardware and its interfacing options.

1.2.3 Murata Wi-Fi/BT Solution for i.MX Hardware User Manual

This manual describes the Murata uSD-M.2 Adapter hardware. All interface signals to the NXP i.MX RT, 6, 7, and 8 EVK's are described. Specifics on interfacing each i.MX EVK to Murata uSD-M.2 Adapter are provided.

1.2.4 Murata Wi-Fi/BT (NXP) Solution for i.MX Linux User Guide

This User Guide details steps to get Murata Wi-Fi/BT NXP chipset-based solution up and running quickly on i.MX 6/7/8 EVK's.

1.2.5 Murata Wi-Fi/BT (NXP) Solution for i.MX Linux Quick Start Guide

This Quick Start Guide provides quick steps to get started with Murata Wi-Fi/BT NXP chipset-based solution with the help of an example.

1.2.6 Murata's Community Forum Support

Murata's Community provides online support for the Murata Wi-Fi/Bluetooth modules on various i.MX platforms running Linux. Refer to this link for the Forum's main Wi-Fi/Bluetooth landing page.

1.2.7 Embedded Artists' M.2 Modules Landing Page

This website landing page provides latest/comprehensive information on Embedded Artists' M.2 Evaluation Boards which enable Murata Wi-Fi/BT modules for easy evaluation.

1.2.8 NXP Reference Documentation

Some of the key NXP reference documentation for Linux includes the following:

- Yocto Project User's Guide: This document describes how to build an image for an NXP i.MX platform by using a Yocto Project build environment. It describes the NXP release layer and the NXP-specific usage.

- i.MX Linux User's Guide: This document explains how to build and install the NXP Linux O/S BSP on the i.MX platform. It also covers special NXP features and how to use them.

- i.MX Linux Reference Manual: This document supports porting the i.MX Linux O/S BSP to customer-specific products. Intended audience should have a working knowledge of Linux O/S kernel internals, driver models and i.MX processors.

- i.MX Linux Release Notes: This document contains important information about the package contents, supported features, known issues, and limitations in the release.

Table 3 provides the following information on all releases supported:

- Supported kernel release
- Documentation link(s)
- Corresponding Yocto release name

Table 3: NXP Reference Documentation Listing for Supported Releases

Kernel release	NXP documentation link	Yocto code name
5.4.47_2.2.0	Rev. L5.4.47_2.2.0_BSP	Zeus

NOTE: The releases mentioned in the above table are supported by Murata.

Each archive downloadable contains the following:

- i.MX_Yocto_Project_User's_Guide.pdf / IMXLXYOCTOUG
- i.MX_Linux_User's_Guide.pdf / IMXLUG
- i.MX_Linux_Reference_Manual.pdf / IMXLXRM
- i.MX_Linux_Release_Notes.pdf / IMXLXRN

2 Murata's Customized i.MX Yocto Image Explained

2.1 Overview

The default Linux 5.4.47 BSP for i.MX 6/7/8 has the WLAN driver supporting Type 1ZM (88W8987) integrated into the NXP baseline build. For Type 1YM (88W8997) only certain i.MX8 platforms have the default WLAN-PCIe driver integrated. Murata's customized "***meta-murata-wireless***" provides uniform Type 1ZM/1YM support on all i.MX 6/7/8 software builds.

Embedded Artists' Type 1YM M.2 EVB can be configured (via resistor strapping options – see Linux User Guide or Hardware User Manual) to support an additional evaluation mode of WLAN-SDIO/BT-SDIO (referenced as "**1YM-SDIO***" in this document). Eventual long-term software support for 1YM will support WLAN-PCIe/BT-UART and WLAN-SDIO/BT-UART only. The 1YM M.2 EVB (WLAN-SDIO/BT-UART) is denoted as "1YM-SDIO".

With Bluetooth already supported by integrated BlueZ stack, Murata's customized Yocto layer ***"meta-murata-wireless***" seamlessly integrates the WLAN drivers. More specifically it provides the **following enhancements/customizations:**

- Comprehensive support for 1ZM/1YM on all possible i.MX targets - hardware interconnect is the only limiting factor: see **Table 8.**
- Customized (evaluation-only) solution for Type 1YM configured in WLAN-SDIO/BT-SDIO mode. The eventual NXP release will integrate both WLAN-PCIe/BT-UART and WLAN-SDIO/BT-UART support for Type 1YM.
- Patches for DTB and Kernel for enabling Murata modules.
- Correct WPA-supplicant linking and configuration.
- 1.8V SDIO VIO configuration for WLAN interface on i.MX 6UL(L) EVK's.
- Customized Murata RF calibration files used to correctly configure/tune Murata's modules.

With hardware interconnect not a limiting factor, Murata's customized Yocto layer supports the following NXP i.MX EVK's as outlined in **Table 4**. ***"MACHINE=target"*** is a direct reference to Yocto build. The ***"target"*** string is the keyword used to select hardware configuration for the build.

Table 4: NXP i.MX EVK Part Number / Yocto (MACHINE) target / Kernel Version Matrix

i.MX EVK Part Number	MACHINE=target	Kernel Versions Supported	Interconnect
MCIMX8QXP-CPU	imx8qxpmek	5.4.47	M.2
MCIMX8M-EVKB	imx8mqevk	5.4.47	M.2
8MMINILPD4-EVK	imx8mmevk	5.4.47	M.2, uSD-M.2 Adapter
8MMINID4-EVK	imx8mmddr4evk	5.4.47	M.2
8MNANOD4-EVK	imx8mnddr4evk	5.4.47	uSD-M.2 Adapter
MCIMX6UL-EVK	imx6ulevk	5.4.47	uSD-M.2 Adapter
MCIMX6ULL-EVK	imx6ull14x14evk	5.4.47	uSD-M.2 Adapter

2.2 Murata GitHub: Cornerstone of NXP driver Implementation

*"The **cornerstone** is the first stone set in the construction of a masonry foundation, important since all other stones will be set in reference to this stone, thus determining the position of the entire structure."*

Murata GitHub is **the cornerstone** of the customized i.MX Yocto implementation for NXP wireless. Refer to **Table 5** for a complete listing of the Murata repositories currently used to build the i.MX Yocto image. For each repository, all available branch and release/tag names are included. All repositories are hosted at: https://github.com/murata-wireless. For "***meta-murata-wireless***" GIT repository, the following branch name is used:

- i.MX architecture, Linux kernel version (Yocto codename), and driver version release.

The release names follow the branch-naming convention. When deciding on using a branch versus release/tag, the user will want to consider the following points:

- Release/tag is strongly recommended for end users who want a stable/tested version of the customized release. Murata only "tags" a branch after having run through a testing cycle on the various i.MX/module configurations.

- If the user *just* needs to build a reference Linux image, then it is strongly recommended to use a release/tag.

- Branches are recommended for users who need the latest updates. Users can examine the latest git commits on GitHub for any given repository. The most up-to-date branch by default is ***"master"***. Note that Murata does limited testing on updates (new git commits) to a given branch. If the user runs into any unexpected difficulty, please post to Murata's Community Forum.

Table 5: Murata GitHub Repositories used in build

Murata GitHub Repository Name	Branch Names	Latest Release / Tag Names	Contents
"meta-murata-wireless"	"master" "imx-zeus-zigra" GitHub Listing	"imx-zeus-zigra_r1.0" GitHub Listing	***"meta-murata-wireless"*** customized recipe layer. It drops into existing Yocto build environment. "master" branch only contains build script utilities – key starting point for user wanting to generate an image.

Digging deeper into the Murata GitHub relevant repositories, ***"meta-murata-wireless"*** repository is the **"driver's seat"**. It determines which branches/releases of other branches are pulled into the Yocto build. This repository versions the Murata-customized Yocto layer which is copied into the Yocto ***"sources"*** sub-folder. In this Yocto build implementation, each i.MX/kernel implementation is independent. As such, there can be no single ***"master"*** branch that is the latest/greatest for all these

unique branches. However, the ***"master"*** branch does contain a unique sub-folder ***"script-utils"*** with Linux scripts for assisting the user on automatically building a customized i.MX image.

2.3 "*meta-murata-wireless*": Pulling it All Together

2.3.1 What does "*meta-murata-wireless*" do exactly?

Murata's customized Yocto layer ***"meta-murata-wireless***" provides the following enhancements / customizations:

- Comprehensive support for 1ZM/1YM on all possible i.MX targets - hardware interconnect is the only limiting factor: see **Table 8.**
- Customized (evaluation-only) solution for Type 1YM configured in WLAN-SDIO/BT-SDIO mode. The eventual NXP release will integrate both WLAN-PCIe/BT-UART and WLAN-SDIO/BT-UART support for Type 1YM.
- Patches for DTB and Kernel for enabling Murata modules.
- Correct WPA-supplicant linking and configuration.
- 1.8V SDIO VIO configuration for WLAN interface on i.MX 6UL(L) EVK's.
- Customized Murata RF calibration files used to correctly configure/tune Murata's modules.

For a Yocto primer, please refer to https://wiki.yoctoproject.org/wiki/Main_Page. For specifics on the i.MX Yocto implementation and their project user's guide, please refer to **Table 3.**

2.3.2 The Contents of "meta-murata-wireless"

"meta-murata-wireless" is a Murata-customized Yocto layer. Each Yocto layer resides in the "***sources***" sub-folder. Murata's implementation follows the Yocto "norm" with some minor exceptions due to required backport implementation. If you are planning on customizing or porting the Murata implementation, **please read** this section carefully. Refer to **Table 7** for a description of important folders/files in the ***"meta-murata-wireless"*** layer.

- ***"script-utils/latest/":*** contains "***Host_Setup_for_Yocto.sh***" and "***Murata_Wireless_Yocto_Build.sh***" script files. Refer to **Section 3.2** for more details on how these script files accelerate the Linux image build process.

- ***"add-murata-layer-script/add-murata-wirless.sh"***: This is the "hook". When run, it will insert necessary code into the current i.MX Yocto build to pull in ***"meta-murata-wireless"*** layer. This script is run after i.MX Yocto build environment setup and i.MX target/graphics selection. It **should only be run once** for any given/unique build directory.

- ***"conf/layer.conf"***: setting priorities for layers pulled into the Yocto build is **very important**. ***"meta-murata-wireless"*** is set to the highest priority (9) which guarantees that it's packages will be compiled in if there is any conflict. As a specific example, there is "competition" between two WPA supplicant packages. One is included in ***"meta-murata-wireless"*** and the other is "***meta***" (i.MX default version). "***meta***" layer priority is 5, so the WPA supplicant package it pulls in will not be part of the image (version 2.6). Rather, the ***"meta-murata-wireless"*** WPA supplicant package (Version 2.9).

- ***"freescale/<MACHINE>.conf":*** When compiling i.MX image for the following EVK's, these machine configuration files (**see Table 6**) are critical. It pulls in the necessary DTB files to the image – otherwise the resulting SD card image would not have the correct Device Tree Blob (DTB) file to configure the kernel when the platform boots.

Table 6: Config DTBs for EVKs

EVK Name	Machine File Name	Notes
i.MX6UL	imx6ulevk.conf	
i.MX6ULL	imx6ull14x14evk.conf	
i.MX 6SX SDB	imx6sxsabresd.conf	Not used for NXP wireless solutions due to VIO incompatibility
i.MX 6DualLite SDB	imx6dlsabresd.conf	Not used for NXP wireless solutions due to VIO incompatibility
i.MX 6QuadPlus SDB	imx6qpsabresd.conf	Not used for NXP wireless solutions due to VIO incompatibility
i.MX 6Quad SDB	imx6qsabresd.conf	Not used for NXP wireless solutions due to VIO incompatibility
i.MX 8M Mini EVK	imx8_all.conf, layer.conf	
i.MX 8M Nano EVK	imx8mnevk.conf, imx8mnddr4evk.conf, imx8mnlpddr4evk.conf	

- ***"recipes-connectivity/murata-binaries/murata-binaries_1.0.bb"***: This recipe installs the following files:
  - Calibration file for 1YM-PCIe.
  - switch_module.sh for switching between NXP wireless (1zm, 1ym-sdio and 1ym-pcie).

- ***"recipes-connectivity/murata-binaries/murata-binaries/switch_module.sh"***: This script file configures the WPA-Supplicant to point to default NXP ***wpa-supplicant*** and ensures automatic driver loading for 1ZM, 1YM-SDIO* and 1YM-PCIe chipsets. It is placed in the location, ***"/usr/sbin"***
  Usage: switch_module.sh <module>
  Where: <module> is one of (case insensitive):
  1zm, 1ym-sdio, 1ym-pcie

- ***"recipes-connectivity/wpa-supplicant/wpa_supplicant_%.bbappend"***: This folder contains the recipe file that configures the WPA Supplicant version (i.e. "***wpa_supplicant_2.9.bb***"). This file renames ***wpa supplicant*** executable to ***wpa_supplicant.nxp***.

- ***"recipes-kernel/linux/linux-imx_<Kernel Version>.bbappend"***: This file patches the i.MX kernel and makes any necessary changes to the kernel configuration file ("***.config***").

- ***"recipes-kernel/linux/linux-imx-<Kernel Version>/"***: This folder contains all the patches applied to the i.MX kernel. The "***linux-imx_<Kernel Version>.bbappend***" recipe selects which patches to apply.

Table 7: Important folders/files in "meta-murata-wireless"

"meta-murata-wireless" **folder/file**	**Notes**
script-utils/latest/	Murata automated script files for host setup and i.MX Yocto build.
add-murata-layer-script/ add-murata-wireless.sh	Script file which modifies "***bblayer.conf***" and "***local.conf***"; thereby enabling the Murata-customized implementation for current "***target***" build.
conf/layer.conf	Enable ***"meta-murata-wireless"*** bbappend files and set priority for ***"meta-murata-wireless"*** layer. **NOTE**: priority setting is important to avoid conflicts with multiple recipes in Yocto implementation such as WPA supplicant, Hostapd, etc.
freescale/imx6ulevk.conf freescale/imx6ull14x14evk.conf freescale/imx6sxsabresd.conf freescale/imx6dlsabresd.conf freescale/imx6qpsabresd.conf freescale/imx6qsabresd.conf freescale/imx8_all.conf freescale/imx8mnddr4evk.conf freescale/imx8mnevk.conf freescale/imx8mnlpddr4evk.conf freescale/layer.conf	Ensures that all necessary i.MX6UL(L), i.MX 8M Mini EVK and i.MX 8M Nano EVK Device Tree Blob (DTB) files are included in boot folder of generated i.MX image. The configuration files for i.MX 6SX, i.MX 6DualLite, i.MX 6QuadPlus and i.MX 6Quad are not used for NXP wireless solutions due to VIO incompatibility.
recipes-connectivity/ murata-binaries/murata-binaries_1.0.bb	Installs switch_module.sh script file and Calibration file for 1YM-PCIe.
recipes-connectivity/ murata-binaries/murata-binaries/switch_module.sh	Automatically switches WLAN driver loading for SDIO and PCIe NXP Wireless devices.
recipes-connectivity/ wpa-supplicant/wpa-supplicant_%.bbappend	Renames default WPA supplicant as NXP WPA supplicant (wpa_supplicant.nxp).
recipes-kernel/ linux/ linux-imx_<Kernel Version>.bbappend	Appends to the default i.MX recipe ***"meta-fsl-bsp-release/imx/meta-bsp/recipes-kernel/linux/linux-imx_<Kernel Version>.bb"***. This file patches the i.MX kernel and makes any necessary changes to the kernel configuration file ***(".config"***).

3 Finally… Building i.MX Yocto Linux!

3.1 i.MX Yocto Build: Overview

Certain Intellectual Property issues (for 3rd party drivers that are integrated into the baseline NXP i.MX image) prevents direct access to i.MX image binaries with built-in wireless driver release. Therefore, it is necessary for the end user to arrive at their own "SD card" image. There are two paths to arrive at the necessary image:

a) Execute Murata automated build script. This is intended to ease the "startup" phase. However, the user needs to install Ubuntu on a machine (PC or virtual environment). If selecting this (easier option) then please refer to **Section 3.2**.

b) Follow manually documented steps. Intended for users with reasonable familiarity of Linux and Yocto: refer to **Section 3.3**. For users familiar with "meta-murata-wireless" implementation, all the steps from **Section 3.3** are repeated in a condensed version as examples in **Section 3.4** and **Section 3.5**

3.2 i.MX Yocto Build: The Fast Track (In a Hurry or Linux Beginner?)

3.2.1 Install Ubuntu

First step is to install Ubuntu 14.04, 16.04 or 18.04 (Murata's build is verified on Ubuntu 16.04 and 18.04 64-bit installs) on the host - native PC or virtual environment like VMware. Host PC typically used has Ubuntu 18.04/16.04/14.04 installed with 50 GB free disk space (80 GB needed for i.MX8 build).

NOTE: Murata has verified these build steps using Ubuntu 16.04 and 18.04 (x64). For more information on the Ubuntu download, please refer to this link: https://www.ubuntu.com/download/desktop. The Ubuntu installation manual is provided here.

3.2.2 Download Murata's Script Files

With Ubuntu installed, we need to get the script files downloaded. There are a couple of quick options here:

a) Using "web browser" option to download "meta-murata-wireless" zip file and extract:

- Click on "Code" button at: https://github.com/murata-wireless/meta-murata-wireless.
- Now select "Download ZIP" option.
- Once the file is downloaded, extract it with "unzip" command or folder UI.
- Now go to the "meta-murata-wireless/script-utils/latest" folder where the necessary README and script files are contained.

OR:

b) Use "***wget***" command to pull specific files from Murata GitHub (**NOTE:** we need to set script files as executable afterwards with "***chmod a+x***" command because "wget" does not maintain the file permissions correctly):

```
wget --no-check-certificate --content-disposition https://github.com/murata-wireless/meta-murata-wireless/raw/master/script-utils/latest/README.txt

wget --no-check-certificate --content-disposition https://github.com/murata-wireless/meta-murata-wireless/raw/master/script-utils/latest/Host_Setup_for_Yocto.sh

wget --no-check-certificate --content-disposition https://github.com/murata-wireless/meta-murata-wireless/raw/master/script-utils/latest/Murata_Wireless_Yocto_Build.sh

chmod a+x *.sh
```

3.2.3 Configure Ubuntu for i.MX Yocto Build

Next step is configuring Ubuntu for Yocto build. Please run Murata's host setup script (should already be downloaded at this stage): "*Host_Setup_for_Yocto.sh*". To examine the plain ASCII text version, you can go to this link or just hit the "Raw" button. For more information (README file), just go to the main folder: https://github.com/murata-wireless/meta-murata-wireless/tree/master/script-utils/latest. The "latest" folder is used to maintain the most recent/up-to-date script.

Murata's script installs necessary additional packages required for the Yocto build. For additional information, refer to NXP Yocto Project User's Guide (part of NXP Reference Documents release). Murata's script will prompt user for password – as supervisory access is needed to install various packages. GIT is also configured so it can be used later during the build process. For more information on first-time GIT setup, you can refer to this link.

Running the script file is straightforward. Simply invoke at Ubuntu "terminal" prompt (folder location is not important):

```
./Host_Setup_for_Yocto.sh
```

The script goes through the following stages:

```
1) Verifying Host Environment
2) Verifying Host Script Version
3) Installing Essential Yocto host packages
4) GIT Configuration: verifying User name and email ID
```

For an example input/output sequence, refer to Appendix C.

3.2.3.1 Configure Ubuntu for bash

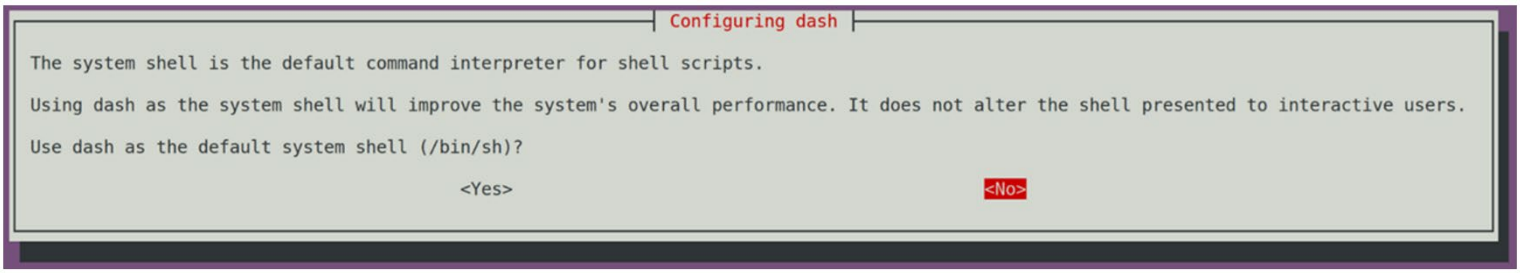
By default, Ubuntu sets the environment to use dash. It is mandatory that, User sets the default system shell to “No” when configuring dash. Follow the steps mentioned below for reconfiguring dash.

- Open “Terminal” App in Ubuntu 18.04 and enter the command, ***“sudo dpkg-reconfigure dash”***

```
sudo dpkg-reconfigure dash
```

- Enter the password.
- Select “No” when “Configuring dash” screen appears as shown in **Figure 5**.

Figure 5: Configuring dash



3.2.4 Murata’s i.MX Yocto Build Script

With Ubuntu installed and configured to build i.MX Yocto, please run the build script (should already be downloaded at this stage): “Murata_Wireless_Yocto_Build.sh”. For plain ASCII text version, you can go to this link or just hit the “Raw” button. For more information (README file), just go to the main folder: https://github.com/murata-wireless/meta-murata-wireless/tree/master/script-utils/latest. The “latest” folder is used to maintain the most recent/up-to-date script.

Prior to running Murata’s build script, make sure you have completed the following:

- Installed 64-bit version of Ubuntu 18.04 (preferred), 16.04, or 14.04.
- Ran Murata’s host setup script in **Section 3.2.3** to add necessary packages for Yocto build and configure GIT.
- Created a i.MX BSP folder ***specific*** to the desired i.MX Yocto Release. The i.MX Yocto distribution **cannot** build different versions of Yocto (Linux kernel) in the same folder. Currently the following Yocto releases are supported:
  - 5.4.47_2.2.0 GA

- Once the build script successfully completes, the i.MX BSP folder will contain:
  - Yocto “***sources***” and “***downloads***” folder.
  - “***meta-murata-wireless***” folder – is a sub-folder of “***sources***”.
  - One or more i.MX build folders.

NOTE: when creating a i.MX BSP folder (***$BSP_DIR*** or "***murata-imx-bsp***" used to reference this all-important folder later in this document), make sure that no parent folder contains a "***.repo***" folder.

Murata's build script performs the following tasks:

- Verifies host environment (i.e. Ubuntu 14.04/16.04/18.04).
- Check to make sure script being run is latest version.
- Prompts user to select release type:
  - "**Stable**" corresponds to "***meta-murata-wireless***" release/tag (rather than branch). Murata tests wireless functionality on i.MX platforms for each release/tag. This release type is recommended for baseline image builds or initial bring-up testing.
  - "**Developer**" corresponds to a branch which can be a "moving target". When performing the automated build, the script file pulls the latest branch contents – as opposed to a specific GIT commit on that branch. If the user wants the latest fixes, then this is the best option to go with. **NOTE**: Murata only runs "spot" tests before submitting fixes/enhancements to the branch.
- Select the i.MX Yocto release. As already pointed out the current i.MX BSP folder (from which script is being executed) can only support **one** i.MX Yocto release. If you need to test/evaluate different Yocto/kernel versions, then **you have to** create additional folders.
- Select the wireless solution. For newer kernel releases, Murata provides Wi-Fi support for both NXP and Cypress based modules. For older kernels, this option is not provided as only Cypress based modules are supported.
- Prompts to perform optional step for NXP **"1YM-SDIO*"**
  - Log into NXP website using the following link. **NOTE:** this may require special access granted by NXP. https://www.nxp.com/webapp/sps/download/license.jsp?colCode=SD-WLAN-SD-BT-8997-U16-MMC-W16-68-10-p56-16-26-10&appType=file2&DOWNLOAD_ID=null
  - Download the Software package (SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip).
  - Copy the file into BSP folder (the place where you are executing the script).
  - Ensure that copied file has the same software package name with **".zip"** extension. i.e SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip
- Select i.MX target: refer to **Table 9** for more details.
- Select the "DISTRO and image". This configures the graphical driver and Yocto image. For more details, reference the Yocto documentation. It is recommended to go with Murata defaults on this step – Murata has tested/validated with these images.
- Name desired build target folder name. If re-running the Murata build script, this folder name must be unique.
- Review final configuration and accept before moving forward.
- Accept the NXP/Freescale End User's License Agreement (EULA). There is 3rd party IP included in the i.MX Yocto build. This step addresses the sub-licensing issue. During this step the user must review a fair bit of legal documentation (by repeatedly entering space bar) or if already familiar with the EULA language, enter 'q' to bypass displaying the complete agreement. The final step of this EULA step prompts the user to enter "y" to accept.
- Last and final step is to confirm that user want to kick off final build process (invoke "***bitbake* <image>**" command).

Running the script file is straightforward. Simply invoke from your i.MX BSP folder (**$BSP_DIR** or "**murata-imx-bsp**"):

```
./Murata_Wireless_Yocto_Build.sh
```

The script goes through the following stages:

```
1) Verifying Host Environment
2) Verifying Script Version
3) Select Release Type:
    a) Stable: Murata tested/verified release tag. Stable is the recommended default.
    b) Developer: Includes latest fixes on branch. May change at any time.
4) Select "Linux Kernel"
5) Select wireless solution (if multiple solutions are supported for the kernel)
6) Optional Step for NXP "1YM-SDIO"
7) Select Target
8) Select DISTRO & Image
9) Creation of Build directory
10) Verify your selection
11) Acceptance of End User License Agreement (EULA)
12) Starting Build Now. NOTE: depending on machine type, build may take 1-7 hours to complete.
```

For an example input/output sequence, refer to Appendix D.

3.3 i.MX Yocto Build: Manual Steps (for Advanced Users)

The user should be very familiar with the NXP Yocto Project User's Guide (part of NXP Reference Documents release). We are only emphasizing some important steps in this section.

Before starting the manual build process, we need to understand which targets, kernel versions, and wireless options are supported. **Section 3.3.1** gives a quick overview of targets, associated supporting kernel versions, and what wireless interconnect is supported.

3.3.1 NXP i.MX versus Murata Module Interconnect

To figure out the Murata wireless modules supported on a given NXP i.MX Platform and kernel version, refer to **Table 8: NXP i.MX EVK Part Number / Murata Module Interconnect** and **Table 9: NXP i.MX EVK / Yocto (MACHINE) target / Kernel Version Matrix**.

Refer to **Table 10: i.MX6/8 Targets supported by Murata** for the supported targets: hardware interconnect, DTB file, and interrupt configuration. Refer to the Linux User Guide and Hardware User Manual for more details on hardware interconnect.

Table 8 provides an overview of i.MX Reference versus Murata module matrix. An additional column is included to provide a quick NXP chipset lookup. For a given i.MX platform and Murata module, you can quickly look up the compatibility. Providing more details on the terminology used in the table:

- "**NC**" means "No Connect". This is due to one or both of the following reasons:
  - VIO incompatible: Wi-Fi/BT M.2 Module requires VIO voltage level that the NXP i.MX Hardware cannot provide.
  - Physical bus (i.e. SDIO, PCIe, UART) and/or WLAN/Bluetooth control line interconnect is not available.
- "**uSD-M.2**": Murata's uSD-M.2 Adapter provides interconnect to the Embedded Artists' Wi-Fi/BT M.2 Module. NXP i.MX Host WLAN SDIO is configured for 1.8V VIO default. The Bluetooth UART, and WLAN/BT control signals from i.MX Host are configured at 3.3V VIO (hardware limitation due to fixed voltage rails). Rev B1 Adapter level shifts the BT UART and some of the WLAN/BT control signals.
- "**uSD-M.2^{+}**": Murata's uSD-M.2 Adapter (Rev B1) provides interconnect to the Embedded Artists' Wi-Fi/BT M.2 Module. However, additional cabling to connect Bluetooth UART and WLAN/BT control signals is required for NXP i.MX 8M Mini EVK and 8M Nano EVK. The cable (Jumper Wire F/F 6") is easily obtained through Distribution channel (example Digi-Key part numbers 1568-1644-ND or 1568-1513-ND. For this configuration, Type 1ZM M.2 EVB requires BT-UART and WLAN/BT control signal connection whereas Type 1YM M.2 EVB only requires WLAN/BT control signal connection.
- "**M.2**": Only Embedded Artists' Wi-Fi/BT M.2 EVB is required. Then NXP i.MX EVK has a M.2 connector. Currently only WLAN-PCIe, BT-UART, and WLAN/BT CTRL signals are brought out on the M.2 connectors for these specific NXP i.MX EVK's. As such, ***only*** Wi-Fi/BT M.2 EVB's which support WLAN-PCIe (i.e. Type 1YM) can be used.
- "**M.2^{W}**": Only Embedded Artists' Wi-Fi/BT M.2 EVB is required. Then NXP i.MX EVK has a M.2 connector. Currently only WLAN-PCIe, and WLAN CTRL signals are brought out on the M.2 connectors for these specific NXP i.MX EVK's. As such, there is no Bluetooth support – only WLAN.
- Again, the default hardware strapping option for EA's Type 1YM M.2 EVB (EAR00370) is WLAN-PCIe/BT-UART. In **Table 8**, we refer to this default configuration as "**1YM-PCIe**". It is otherwise referred to as "**1YM**". The non-default (WLAN-SDIO/BT-SDIO) strapping option is referred to as "**1YM-SDIO***". The 1YM (WLAN-SDIO/BT-UART) M.2 configuration is referenced as "**1YM-SDIO**".

NOTE: When using uSD-M2 adapter, there are limitations on maximum SDIO clock frequency (particularly on NXP i.MX 6UL(L) EVK's). For UHS mode support and for comprehensive signal support, ***Murata recommends*** the Embedded Artists' i.MX Developer Kits.

Table 8: NXP i.MX EVK Part Number / Murata Module Interconnect

NXP i.MX EVK Part Number	1ZM	1YM-SDIO*	1YM-PCIe
	NXP 88W8987	NXP 88W8997	NXP 88W8997
MCIMX8QXP-CPU	NC	NC	M.2
MCIMX8M-EVKB	NC	NC	M.2
8MMINILPD4-EVK	uSD-M.2+	uSD-M.2+	M.2W
8MMINID4-EVK	NC	NC	M.2W
8MNANOD4-EVK	uSD-M.2+	uSD-M.2+	NC
MCIMX6UL-EVKB	uSD-M.2	uSD-M.2	NC
MCIMX6ULL-EVK	uSD-M.2	uSD-M.2	NC

uSD-M.2 = works with uSD-M.2 Adapter configured for 1.8V default

uSD-M.2+ = works with uSD-M.2 Adapter (Rev B1) with additional cabling

M.2 = Wi-Fi/BT M.2 EVB plugs directly into M.2 connector

M.2W = Wi-Fi/BT M.2 EVB plugs directly into M.2 connector; but only WLAN is functional

NC = No Connection options available

Table 9: NXP i.MX EVK / Yocto (MACHINE) target / Kernel Version Matrix

NXP i.MX EVK Part Number	NXP i.MX EVK	MACHINE=target	Kernel 5.4.47
MCIMX8QXP-CPU	i.MX 8QuadXPlus MEK	imx8qxpmek	Y
MCIMX8M-EVKB	i.MX 8MQuad EVK	imx8mqevk	Y
8MMINILPD4-EVK	i.MX 8M Mini EVK	imx8mmevk	Y
8MMINID4-EVK	i.MX 8M Mini EVK	imx8mmddr4evk	Y
8MNANOD4-EVK	I.MX 8M Nano EVK	imx8mnddr4evk	Y
MCIMX6UL-EVKB	i.MX 6UL EVK	imx6ulevk	Y
MCIMX6ULL-EVK	i.MX 6ULL EVK	imx6ull14x14evk	Y

Table 10: i.MX6/8 Targets supported by Murata

Target (MACHINE)	Hardware Config	i.MX DTB File	Interrupt Config
imx8qxpmek	M.2	fsl-imx8qxp-mek.dtb	N/A
imx8mqevk	M.2	fsl-imx8mq-evk-pcie1-m2.dtb	N/A
imx8mmevk	M.2^{w}	imx8mm-evk.dtb	N/A
imx8mmevk	uSD-M.2^{+}	imx8mm-evk-usd-m2.dtb	SDIO
imx8mmddr4evk	M.2^{w}	imx8mm-ddr4-evk.dtb	N/A
imx8mnddr4evk	uSD-M.2^{+}	imx8mn-evk-usd-m2.dtb	SDIO
imx6ulevk	uSD-M.2	imx6ul-14x14-evk-btwifi-m2.dtb	SDIO
imx6ull14x14evk	uSD-M.2	imx6ull-14x14-evk-btwifi-m2.dtb	SDIO

uSD-M.2 = works with uSD-M.2 Adapter configured for 1.8V VIO default

uSD-M.2^{+} = works with uSD-M.2 Adapter (Rev B1) with additional cabling

M.2 = Wi-Fi/BT M.2 EVB plugs directly into M.2 connector

M.2^{w} = Wi-Fi/BT M.2 EVB plugs directly into M.2 connector; but only WLAN is functional

3.3.2 Host PC Preparation

First step is to install Ubuntu 18.04, 16.04 or 14.04 (Murata's build is verified on Ubuntu 16.04 and 18.04 64-bit installs) on the host - native PC or virtual environment like VMware. Host PC typically used has Ubuntu 18.04/16.04/14.04 installed with 50 GB free disk space (80 GB needed for i.MX8 build).
NOTE: Murata has verified these build steps using Ubuntu 18.04 (x64).

Next step is configuring Ubuntu for Yocto build. Refer to Yocto Project User's Guide (Section 3 "Host Setup"). When following NXP's Yocto Project User's Guide, make sure that GIT is setup properly with the commands below:

```
git config --global user.name "Your Name"
git config --global user.email "Your Email"
git config --list
```

3.3.3 Yocto Project Setup

The NXP Yocto Project BSP Release directory contains a "sources" directory, which contains the recipes used to build, one or more build directories, and a set of scripts used to set up the environment. The recipes used to build the project come from both the community and NXP. The Yocto Project layers are downloaded to the source directory. This sets up the recipes that are used to build the project. The following example shows how to download the NXP Yocto Project Community BSP recipe layers. Rather than use a specific folder name, we use the variable "**BSP_DIR**" name to represent the base directory for Yocto Build.

Create a build directory and setup "**BSP_DIR**":

```
cd ~
mkdir murata-imx-bsp
cd murata-imx-bsp
export BSP_DIR=`pwd`
```

➔Now we are ready to download the Freescale Yocto Project Community BSP recipe layers.

In this example, we are targeting Linux 5.4.47_2.2.0 release. Execute the following repo commands:

```
repo init -u https://source.codeaurora.org/external/imx/imx-manifest -b imx-linux-zeus -m imx-5.4.47-2.2.0.xml
repo sync
```

Once "***repo sync***" is completed, the source code is checked out into the directory "***$BSP_DIR/sources***". You can perform repo synchronization, with the command "***repo sync***", periodically to update to the latest code. If errors occur during repo initialization, try deleting the "***.repo***" directory and running the repo initialization command again. In **Section 3.3.4**, we add the customized ***"meta-murata-wireless"*** to "***$BSP_DIR/sources***".

To setup build directory for Linux 5.4.47_2.2.0, the following command syntax is used:

```
cd $BSP_DIR
DISTRO=<distro name> MACHINE=<machine name> source imx-setup-release.sh -b <build dir>
```

One example is to build fb frame buffer end for i.MX 6UltraLite EVK:

```
cd $BSP_DIR
DISTRO=fsl-imx-fb MACHINE=imx6ulevk source imx-setup-release.sh -b build-imx6ulevk-fb
```

NOTE: When specifying the build directory (**-b <build dir>**), it is better to specify a unique folder name (in this example "***build-imx6ulevk-fb***"). Otherwise the next time you configure a Yocto build from the same folder (i.e. invoke "***imx-setup-release.sh***" script from "***BSP_DIR***", it will delete your previous build.

After invoking the "***imx-release-setup.sh***" script, the EULA (End User License Agreement) will be presented to the user for agreement. Press "space" bar repeatedly (or "q" to skip reading entire EULA) until you reach the bottom of the agreement. Enter 'y' to accept the EULA agreement:

```
2.3. For NXP Licensed Software provided to you in source code

Do you accept the EULA you just read? (y/n) y

EULA has been accepted.
```

In this example, the final expected output is (after accepting license agreement):

```
Your build environment has been configured with:
MACHINE=imx6ulevk
SDKMACHINE=i686
DISTRO=fsl-imx-fb
EULA=
BSPDIR=
BUILD_DIR=.
meta-freescale directory found
<username>@ubuntu:~/murata-imx-bsp/build-imx6ulevk-fb$
```

To make code examples easier going forward, let's create a variable for the build directory:

```
$ export BUILD_DIR=`pwd`    ← in this example "~/murata-imx-bsp/build-imx6ulevk-fb"
```

3.3.4 Fetch "meta-murata-wireless" from GitHub and copy into "Sources"

Clone ***"meta-murata-wireless"*** git and checkout "***imx-zeus-zigra_r1.0***" release (Linux 5.4.47):

```
cd $BSP_DIR/sources
git clone  https://github.com/murata-wireless/meta-murata-wireless.git
cd meta-murata-wireless
git checkout imx-zeus-zigra_r1.0
```

"meta-murata-wireless" contains the following (refer to **Section 2.3.2** for more details):

- *"add-murata-layer-script"* folder
- *"conf"* folder
- *"freescale"* folder
- *"recipes-connectivity"* folder
- *"recipes-kernel"* folder
- files (*COPYING.MIT, README, README.md*)

3.3.5 Install Necessary "hooks" for "meta-murata-wireless"

To enable ***"meta-murata-wireless"*** into the selected i.MX target Yocto build, certain Yocto configuration files must be modified. Murata provides "***add-murata-wireless.sh***" script file:

```
cd $BSP_DIR
sh ./sources/meta-murata-wireless/add-murata-layer-script/add-murata-wireless.sh build-imx6ulevk-fb
```

NOTE: "***build-imx6ulevk-fb***" is just the build folder name and not the directory.

If successful, the output will look like:

```
Welcome to Freescale Community BSP

The Yocto Project has extensive documentation about OE including a
reference manual which can be found at:
   http://yoctoproject.org/documentation

For more information about OpenEmbedded see their website:
   http://www.openembedded.org/

You can now run 'bitbake <target>'

Common targets are:
   core-image-minimal
   meta-toolchain
   meta-toolchain-sdk
   adt-installer
   meta-ide-support

Your configuration files at build-imx6ulevk-fb have not been touched.  ← misleading statement[1]
BSPDIR=
BUILD_DIR=.
meta-freescale directory found

CORRECTION: Murata modified the following files  ← Additional Murata logging to clarify file modifications.
 - bblayers.conf present in <BUILD_DIR>/conf
 - local.conf present in <BUILD_DIR>/conf
 - imx6ulevk.conf present in sources/meta-freescale/conf/machine
 - imx6ull14x14evk.conf present in sources/meta-imx/meta-bsp/conf/machine
 - imx8mnevk.conf ./sources/meta-imx/meta-bsp/conf/machine
 - imx8_all.conf ./sources/meta-imx/meta-bsp/conf/machine
```

[1] "$BSP_DIR/sources/meta-fsl-bsp-release/imx/tools/fsl-setup-release.sh" generates the "have not been touched" message. Subsequently the "add-murata-wireless.sh" script modifies the "bblayer.conf" and "local.conf".

```
- imx8mnddr4evk.conf ./sources/meta-imx/meta-bsp/conf/machine
- imx8mnlpddr4evk.conf ./sources/meta-imx/meta-bsp/conf/machine
- layer.conf ./sources/meta-imx/meta-bsp/conf
```

Murata-Wireless setup complete. Create an image with:

```
$ bitbake fsl-image-validation-imx ← no errors logged and here is the bitbake command
```

To double check on correct script execution, you can check the content of two files in "***$BUILD_DIR/conf***" folder: "***bblayers.conf***" and "***local.conf***". Verify last line in "***$BUILD_DIR/conf/bblayers.conf***" is:

```
BBLAYERS += " ${BSPDIR}/sources/meta-murata-wireless "
```

Verify the last two lines in "***$BUILD_DIR/conf/local.conf***" are:

```
CORE_IMAGE_EXTRA_INSTALL += " hostap-conf hostap-utils hostapd murata-binaries iperf3 backporttool-linux kernel-modules-pcie8997 linux-firmware-pcie8997 kernel-modules-sdio8997 "
CORE_IMAGE_EXTRA_INSTALL += " bluez5 bluez5-noinst-tools bluez5-obex openobex obexftp glibc-gconv-utf-16 glibc-utils cyw-supplicant python3"
```

3.3.6 Build Murata-Customized Yocto Image for Specific i.MX Target

Now that the ***"meta-murata-wireless"*** layer is "hooked" into the i.MX BSP Yocto build, we can invoke "***bitbake***" to build the default (Murata-verified) "***fsl-image-validation-imx***" image:

```
cd $BUILD_DIR
bitbake fsl-image-validation-imx
```

Things to watch out for:

- If any necessary source file cannot be fetched, the build process terminates. In such a scenario, re-execute the command "***bitbake fsl-image-validation-imx***" again to see if the problem resolves itself. If the problem persists, report the error to whoever maintains the failing git repository.
- The "***bitbake***" step is expected to take at least **1-7 hours** to complete. This build process depends heavily on processor speed, RAM, hard drive access (i.e. SSD is optimal), and internet download speeds.
- Ensure that there is a minimum of 50 GB free disk space (80 GB needed for i.MX8 build).

3.4 i.MX Yocto Build: Manual Steps "Take 2" (Quick Recap)

This section is for users already familiar with the "***meta-murata-wireless***" implementation. It provides a condensed (i.e. repeat) version of **Section 3.3**. The following example sequence shows all the necessary steps to build the Murata customized i.MX image for the following configuration:

- i.MX6UL or i.MX6ULL EVK at 1.8V VIO (both WLAN and BT interfaces).
- Murata uSD-M.2 Adapter is used, install J12 in 1-2 position for 1.8V setting.
- SDIO in-band (default) and OOB IRQ (WL_HOST_WAKE) both supported in DTB files. However due to i.MX hardware limitation, OOB IRQ is not guaranteed to work – testing has shown that it does "work". To configure for OOB IRQ, choose the "***m2-oob***" version of DTB file.
- WLAN interface is initialized during kernel boot. To bring up interface just invoke "***ifconfig mlan0 up***" or configure WPA supplicant etc.
- Bluetooth UART is connected and is initialized by running "***hciattach***" command.
- Bluetooth PCM connection is not supported.

3.4.1 Initialize Linux i.MX Yocto Default Build Environment

```
cd ~
mkdir murata-imx-bsp
cd murata-imx-bsp
export BSP_DIR=`pwd`
repo init -u https://source.codeaurora.org/external/imx/imx-manifest -b imx-linux-zeus -m imx-5.4.47-2.2.0.xml
repo sync
```

3.4.2 Configuring the i.MX Target

```
cd $BSP_DIR   ← in this example "~/murata-imx-bsp"
DISTRO=fsl-imx-fb MACHINE=imx6ulevk source imx-setup-release.sh -b build-imx6ulevk-fb
```

This will bring the EULA (End User License Agreement). Press "space" bar repeatedly (or "q" to skip reading entire EULA) until you reach the bottom of the agreement. Enter 'y' to accept the EULA agreement:

```
2.3.            For NXP Licensed Software provided to you in source code
Do you accept the EULA you just read? (y/n) y
EULA has been accepted.
```

3.4.3 Add “meta-murata-wireless” Layer and Kick off the Build

```
export BUILD_DIR=`pwd`     ← in this example “~/murata-imx-bsp/build-imx6ulevk-fb”
cd $BSP_DIR/sources
git clone  https://github.com/murata-wireless/meta-murata-wireless.git
cd meta-murata-wireless
git checkout imx-zeus-zigra_r1.0
cd $BSP_DIR
sh ./sources/meta-murata-wireless/add-murata-layer-script/add-murata-wireless.sh build-imx6ulevk-fb

cd $BUILD_DIR
bitbake fsl-image-validation-imx
```

3.5 i.MX Yocto Build: Manual Steps “Take 2” for “5.4.47”

3.5.1 For i.MX8 platform

```
cd ~
mkdir murata-imx-bsp
cd murata-imx-bsp
export BSP_DIR=`pwd`
repo init -u https://source.codeaurora.org/external/imx/imx-manifest -b imx-linux-zeus -m imx-5.4.47-2.2.0.xml
repo sync

cd $BSP_DIR
DISTRO=fsl-imx-wayland MACHINE=imx8mqevk source imx-setup-release.sh -b build-imx8mqevk-wayland
export BUILD_DIR=`pwd`
cd $BSP_DIR/sources
git clone https://github.com/murata-wireless/meta-murata-wireless.git
cd meta-murata-wireless
git checkout imx-zeus-zigra_r1.0

cd $BSP_DIR
sh./sources/meta-murata-wireless/add-murata-layer-script/add-murata-wireless.sh build-imx8mqevk-wayland

cd $BSP_DIR/sources/meta-murata-wireless/recipes-kernel/linux
cp linux-imx_5.4.bbappend.8MQ linux-imx_5.4.bbappend
```

```
cd $BUILD_DIR
bitbake fsl-image-validation-imx
```

3.5.2 For i.MX6 platforms

```
cd ~
mkdir murata-imx-bsp
cd murata-imx-bsp
export BSP_DIR=`pwd`
repo init -u https://source.codeaurora.org/external/imx/imx-manifest -b imx-linux-zeus -m imx-5.4.47-2.2.0.xml
repo sync
cd $BSP_DIR
DISTRO=fsl-imx-wayland MACHINE=imx6ulevk source imx-setup-release.sh -b build-imx6ulevk-wayland
export BUILD_DIR=`pwd`
cd $BSP_DIR/sources
git clone https://github.com/murata-wireless/meta-murata-wireless.git
cd meta-murata-wireless
git checkout imx-zeus-zigra_v1.0

cd $BSP_DIR
sh ./sources/meta-murata-wireless/add-murata-layer-script/add-murata-wireless.sh build-imx6ulevk-wayland


cd $BUILD_DIR

bitbake core-image-base
```

3.6 1YM-SDIO* Support on NXP i.MX EVKs

By default, NXP build supports 1ZM and 1YM-PCIe. But, for 1YM-SDIO*, User must perform the following additional steps for getting the drivers built into the image. If you are performing manual build steps, then, before kicking off the final build:

- Log into NXP website using the following link. https://www.nxp.com/webapp/sps/download/license.jsp?colCode=SD-WLAN-SD-BT-8997-U16-MMC-W16-68-10-p56-16-26-10&appType=file2&DOWNLOAD_ID=null
- Download the Software package (SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip).
- Copy the file into BSP folder.
- Ensure that copied file has the same software package name with ".zip" extension. i.e SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip

3.6.1 Explanation of 1YM-SDIO* driver build

The name of the recipe file that builds 1YM-SDIO* driver is ***"kernel-modules-sd8997.bb"*** and is present in ***meta-murata-wireless/recipes-kernel/recipes-modules***

The recipe file contains 3 functions ***do_patch***, ***do_compile*** and ***do_install***. Each of the function is explained below in detail.

Input:

The input for the recipe file is the software package, ***SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip***. The function ***do_patch()*** performs the following.

- Ensures that, the md5sum and file size of the software package meets the expected value.
- Copies the software package SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip from BSP folder into yocto working folder.

  Ex: ***$build_dir/tmp/work/imx8mmevk-poky-linux/kernel-modules-sdio8997/1.0-r0***

- Unzips the software package and applies the necessary patches to the source files.
- After unzip, following folders can be found in the package,
  - wlan_src
  - mbtc_src
  - mbt_src

Output:

The function ***do_compile()*** sets the necessary environment variables depending on whether the support is for 32-bit or 64 bit i.MX platform. The environment variables are, ***ARCH*** and ***CROSS_COMPILE***.

For 64-bit, the values are,

- ARCH=arm64
- CROSS_COMPILE=aarch64-poky-linux-

For 32-bit, the values are,

- ARCH=arm
- CROSS_COMPILE=arm-poky-linux-gnueabi-

After setting the environment variables, it performs the compilation of the source code with the command "***oe_runmake build"*** for the following folders, ***wlan_src, mbtc_src*** and ***mbt_src***. The outputs generated are the following.

- ***mlan.ko***
- ***sd8997.ko***

Packaging:

The output files (mlan.ko and sd8997.ko) are packaged in the root file system with the help of the function, ***do_install***.
The files are placed in the following location,
/usr/share/nxp_wireless/bin_sd8997

3.6.2 Flashing build Image to Target

Refer to **Section 4** of **Murata Wi-Fi/BT (NXP) Solution for i.MX Linux User Guide** for flashing the built image to corresponding target.

3.6.3 Bringing Up 1YM-SDIO* Wi-Fi Interface

As i.MX kernel boots (and has been set up for the correct EVB type using the switch_module.sh script), the WLAN driver is loaded automatically. As part of driver loading sequence, the WLAN device is probed over the SDIO bus. As an example, we will bring up Wi-Fi when using following configuration:

- i.MX 8M-Mini EVK
- Type 1YM-SDIO* (88W8997) EVB

Expected output as kernel boots (can use "***dmesg***" later to display):

```
wlan: Loading MWLAN driver
vendor=0x02DF device=0x9141 class=0 function=1
SDIO: max_segs=128 max_seg_size=65535
rx_work=1 cpu_num=4
wlan: Enable TX SG mode
wlan: Enable RX SG mode
Request firmware: nxp/sdsd8997_combo_v4.bin
Wlan: FW download over, firmwarelen=626760 downloaded 626760
WLAN FW is active
fw_cap_info=0x18fcffa3, dev_cap_mask=0xffffffff
max_p2p_conn = 8, max_sta_conn = 8
wlan: version = SD8997-16.68.10.p56-C4X16C667-GPL-(FP68)
wlan: Driver loaded successfully
```

In addition to the documented log messages, there are highlighted sections:

- "***wlan***" string identifies driver log messages
- "***sdsd8997_combo_v4.bin***" indicates the WLAN+Bluetooth firmware file being loaded.
- "***version***" indicates specific version of firmware being loaded by the driver.

Now invoke "***ifconfig mlan0 up***" command to initialize the "***mlan0***" interface. Example output shown below:

```
$ ifconfig mlan0 up
$ ifconfig mlan0
mlan0     Link encap:Ethernet  HWaddr 2c:4c:c6:f4:52:1b        ← WLAN MAC Address
          UP BROADCAST MULTICAST  MTU:1500  Metric:1           ← "mlan0" interface is UP
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

4 Using NXP driver

This section is intended to provide the user with a quick "how to" when using NXP driver for the first time.

4.1 How-To on NXP driver

Here is a quick overview on expected output when platform is correctly configured for Murata-NXP WLAN solution. First off, let's go through a checklist:

- Murata-customized image correctly built and (micro) SD card flashed. Even without testing WLAN/BT, make sure your finished image allows the i.MX platform to boot correctly (use default i.MX "***dtb***" file).
- i.MX hardware correctly setup: i.e. for 1.8V VIO signaling image, make sure the uSD-M.2 Adapter is correctly configured.
- Select the correct "***dtb***" file by interrupting bootloader sequence. Refer to
- **Table** 10 for selecting the right "***dtb***" (Device Tree Blob) file.

4.1.1 Using Switch Modules Script File

The steps to load the correct drivers for the m.2 board are provided below.

- Boot into Linux by entering the command, ***"boot"***
- Login in as ***"root"*** at the prompt.
- Run the script with the module as parameter
  switch_module.sh <module-name>
  Where <module-name> can be 1zm, 1ym-sdio or 1ym-pcie.

```
switch_module.sh 1zm
reboot
```

Look for the following message after entering ***switch_module.sh <module-name>*** Command.

```
Setting up for 1ZM (NXP - SDIO)
```

- Reboot by entering the command, ***"reboot"***
- m.2 board should now have been detected and the correct kernel modules gets loaded.

4.1.2 Bringing Up Wi-Fi Interface

As i.MX kernel boots (and has been set up for the correct EVB type using the switch_module.sh script), the WLAN driver is loaded automatically. As part of driver loading sequence, the WLAN device is probed over the SDIO bus. As an example, we will bring up Wi-Fi when using following configuration:

- i.MX 6ULL EVK
- uSD-M.2 Adapter configured for 1.8V VIO (J12 jumper is set in position 1-2)
- Type 1ZM (88W8987) EVB

Expected output as kernel boots (can use "***dmesg***" later to display):

```
sdhci: Secure Digital Host Controller Interface driver
sdhci: Copyright(c) Pierre Ossman
sdhci-pltfm: SDHCI platform and OF driver helper
sdhci-esdhc-imx 2190000.usdhc: allocated mmc-pwrseq
mmc0: SDHCI controller on 2190000.usdhc [2190000.usdhc] using ADMA
mmc0: new high speed SDIO card at address 0001
…
cfg80211: Loading compiled-in X.509 certificates for regulatory database
cfg80211: Loaded X.509 cert 'sforshee: 00b28ddf47aef9cea7'
wlan: Loading MWLAN driver
vendor=0x02DF device=0x9149 class=0 function=1
Attach moal handle ops, card interface type: 0x105
SD8987: init module param from usr cfg
card_type: SD8987, config block: 0
cfg80211_wext=0xf
wfd_name=p2p
max_vir_bss=1
cal_data_cfg=none
drv_mode = 7
ps_mode = 2
auto_ds = 2
fw_name=nxp/sdiouart8987_combo_v0.bin
SDIO: max_segs=128 max_seg_size=65535
rx_work=0 cpu_num=1
Attach mlan adapter operations.card_type is 0x105.
wlan: Enable TX SG mode
wlan: Enable RX SG mode
Request firmware: nxp/sdiouart8987_combo_v0.bin
```

```
Wlan: FW download over, firmwarelen=526996 downloaded 526996
WLAN FW is active
on_time is 17660343376
fw_cap_info=0x181c3f03, dev_cap_mask=0xffffffff
max_p2p_conn = 8, max_sta_conn = 8
imx-sdma 20ec000.sdma: loaded firmware 3.5
wlan: version = SD8987---16.92.10.p207-MXM4X16186.p6-GPL-(FP92)
wlan: Driver loaded successfully
```

In addition to the documented log messages, there are highlighted sections:

- "***wlan***" string identifies driver log messages
- "***card_type: SD8987***" string identifies the chipset being 88W8987.
- "***sdiouart8987_combo_v0.bin***" indicates the WLAN+Bluetooth firmware file being loaded.
- "***version***" indicates specific version of firmware being loaded by the driver.

4.1.3 *"mlan0"* initialization

After the kernel boots, the "***mlan0***" interface can be initialized by one of the following methods.

- "***ifconfig***" command:

```
ifconfig mlan0 up
```

Now invoke "***ifconfig mlan0 up***" command to initialize the "***mlan0***" interface. Example output shown below:

```
$ ifconfig mlan0 up

$ ifconfig mlan0
mlan0     Link encap:Ethernet  HWaddr b8:d7:af:56:61:fc      ← WLAN MAC Address
          UP BROADCAST MULTICAST  MTU:1500  Metric:1         ← "mlan0" interface is UP
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

4.2 Using manual driver load

Following are the steps for manual loading of NXP drivers for 1ZM, 1YM-SDIO* and 1YM-PCIe.

4.2.1 1ZM – Manual load

After setting the correct DTB file for the corresponding platform, Enter the following commands at the prompt.

```
insmod /lib/modules/5.4.47-2.2.0+g5ec03d0/kernel/net/wireless/cfg80211.ko

modprobe moal mod_para=nxp/wifi_mod_para_sd8987.conf

ifconfig mlan0 up
```

4.2.2 1YM-SDIO* Manual load

```
insmod /lib/modules/5.4.47-2. 2.0+g5ec03d0/kernel/net/wireless/cfg80211.ko

cd /usr/share/nxp_wireless/bin_sd8997

insmod ./mlan.ko

insmod sd8997.ko fw_name=nxp/sdsd8997_combo_v4.bin
cal_data_cfg=nxp/WlanCalData_ext_DB_W8997_1YM_ES2_Rev_C.conf cfg80211_wext=0xf

ifconfig mlan0 up
```

4.2.3 1YM-PCIe Manual load

```
insmod /lib/modules/5.4.47-2.2.0+g5ec03d0/kernel/net/wireless/cfg80211.ko

cd /usr/share/nxp_wireless/bin_pcie8997

insmod ./mlan.ko

insmod ./pcie8997.ko drv_mode=3 ps_mode=2 auto_ds=2 cfg80211_wext=0xf
fw_name=nxp/pcieuart8997_combo_v4.bin
cal_data_cfg=nxp/WlanCalData_ext_DB_W8997_1YM_ES2_Rev_C.conf

ifconfig mlan0 up
```

4.3 Bluetooth Interface (Standard BT-UART)

Before initializing the Bluetooth interface, the WLAN interface (mlan0) must be brought up first. For the standard/default configuration of BT-UART interconnect (i.e. 1ZM or 1YM), we can verify the HCI UART connection by invoking "***hciattach***", bringing up the interface with "***hciconfig***" and then invoking "***hcitool scan***" to see what Bluetooth devices are visible. The Bluetooth test commands vary depending on which UART port is connected to Bluetooth. With the "***modem_reset***" construct in DTS file, the Bluetooth core should come up in the correct state to be initialized (i.e. as kernel boots, the Bluetooth core is reset and is taken out of reset). Here is the default command sequence to verify Bluetooth functionality:

```
hciattach /dev/ttymxc[UART# -1] any 115200 flow
hcitool -i hci0 cmd 0x3f 0x0009 0xc0 0xc6 0x2d 0x00
killall hciattach
hciattach /dev/ttymxc[UART# -1] any -s 3000000 3000000 flow
hciconfig hci0 up
hciconfig hci0 piscan
hciconfig hci0 noencrypt
hcitool scan
```

For more specifics on controlling the Bluetooth interface, refer to the Linux User Guide. Here is example output using i.MX 6ULL EVK with Type 1ZM module:

```
$ hciattach /dev/ttymxc1 any 115200 flow
Setting TTY to N_HCI line discipline
Device setup complete
$ hciconfig hci0 up
$ hcitool -i hci0 cmd 0x3f 0x0009 0xc0 0xc6 0x2d 0x00
< HCI Command: ogf 0x3f, ocf 0x0009, plen 4
  C0 C6 2D 00
> HCI Event: 0x0e plen 4
  01 09 FC 00
$ killall hciattach
[ 1669.277042] Bluetooth: hci0: sending frame failed (-49)      ← ignore this error
$ hciattach /dev/ttymxc1 any -s 3000000 3000000 flow
Setting TTY to N_HCI line discipline
Device setup complete
$ hciconfig hci0 up
$ hciconfig hci0 piscan
$ hciconfig hci0 noencrypt
$ hciconfig -a
$ hcitool scan
Scanning ...
        34:F3:9A:A6:00:53       SCOTTK-HPZBOOK
```

4.4 Bluetooth Interface (Evaluation 1YM-SDIO* BT-SDIO)

Different steps are required to initialize Bluetooth over SDIO interface on 1YM ("**1YM-SDIO***" or WLAN_SDIO/BT-SDIO configuration). Note this configuration is only for ***evaluation testing only***. Before initializing the Bluetooth interface, the WLAN interface (mlan0) must be brought up first. Enter the following commands for bringing up Bluetooth over SDIO interface.

```
$ cd /usr/share/nxp_wireless/bin_sd8997_bt
$ insmod bt8997.ko
$ hciconfig hci0 up
$ hcitool -i hci0 cmd 3f ee 01 XX
$ hcitool scan
```

Sample outputs after executing the above commands are provided below for reference.

```
$ cd /usr/share/nxp_wireless/bin_sd8997_bt
    $ insmod bt8997.ko
BT: Loading driver
BT FW is active(0)
BT: FW already downloaded!
BT: Driver loaded successfully

    $ hciconfig hci0 up
    $ hcitool -i hci0 cmd 3f ee 01 XX
        < HCI Command: ogf 0x3f, ocf 0x00ee, plen 2
          01 00
        > HCI Event: 0x0e plen 4
          01 EE FC 00
    $ hcitool scan
          Scanning ...
          EC:CE:D7:C2:C6:55      Work phone
```

5 Hierarchy of device tree source files for i.MX6/8 platforms

Device tree source files is a set of text files in the Linux kernel that describe the hardware of certain platform. For 32-bit platforms (i.MX 6UL/ULL), they are located in /arch/arm/boot/dts/. For 64-bit platforms (i.MX 8MMini/Nano) they are located in /arch/arm64/boot/dts/. Dts files come with two extensions, dtsi and dts. *.dtsi files are include files for device tree source. *.dts files are device tree source files. They can be used together to describe a target platform.

Since Murata launched uSD-M.2 Adapter, we also provide software support for this new hardware, which is done via new set of dtb files (a dtb file is the "compiled" binary version of a dts file; this is the file that is actually used by the kernel). In addition to the standard dtb files, you can find dtb files that end with btwifi-m2 in Murata's customized images. These dtb files are developed to work with uSD-M.2 Adapter and are verified on several platforms that support uSD-M.2 Adapter, i.e. imx6ulevk,

imx6ull14x14evk, imx8mmevk, imx8mnevk. The following figures shows how these dts files are organized in the hierarchy structures.

NOTE: dtb files that end with btwifi-m2-oob in Murata's customized images are not used for NXP wireless solutions. This is because OOB IRQ is not guaranteed to work due to i.MX hardware limitation.

Figure 6: DTS hierarchy for imx6ulevk

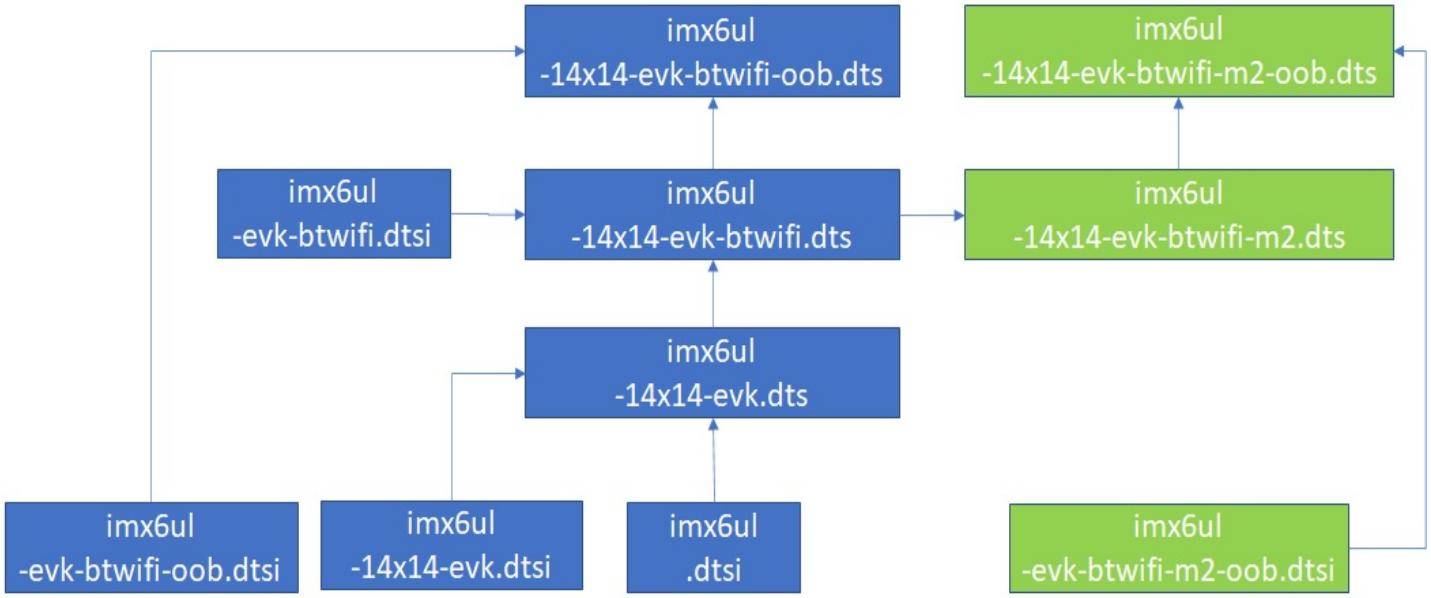


Figure 7: DTS hierarchy for imx6ull14x14evk

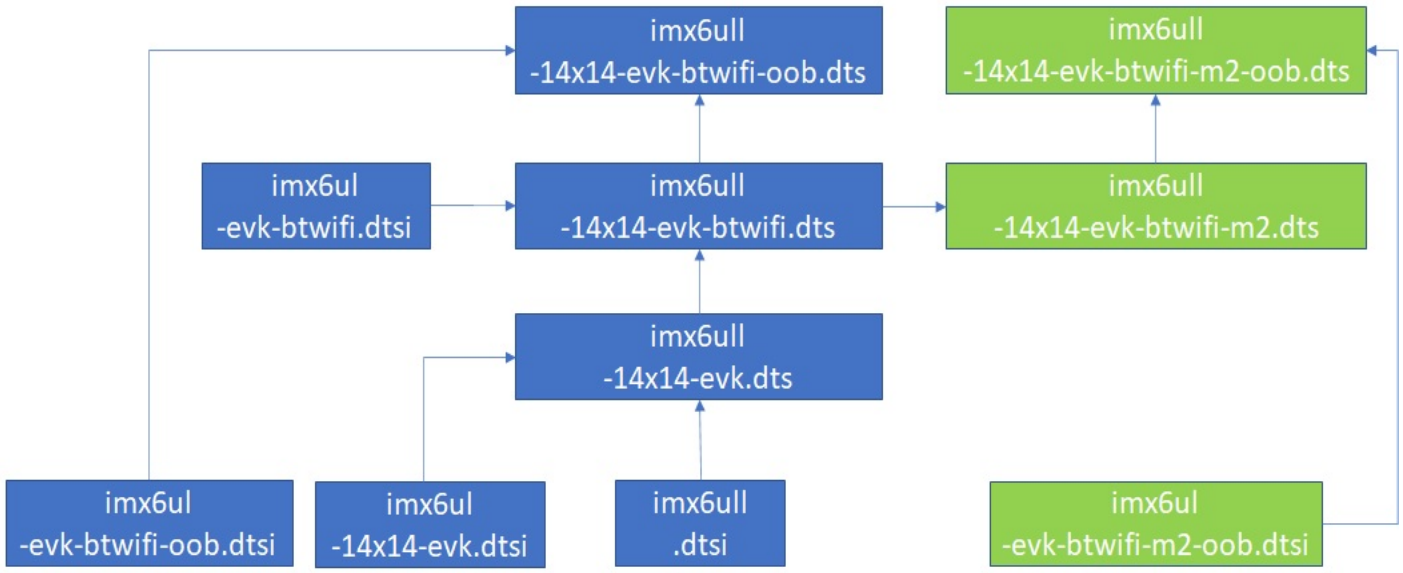


Figure 8: DTS hierarchy for imx8mmevk

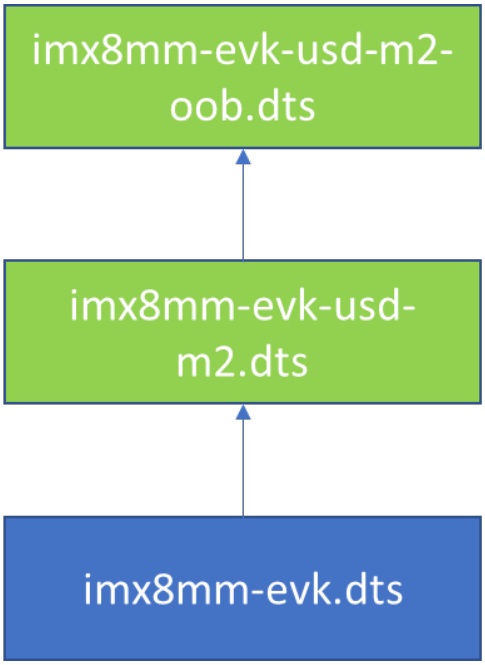
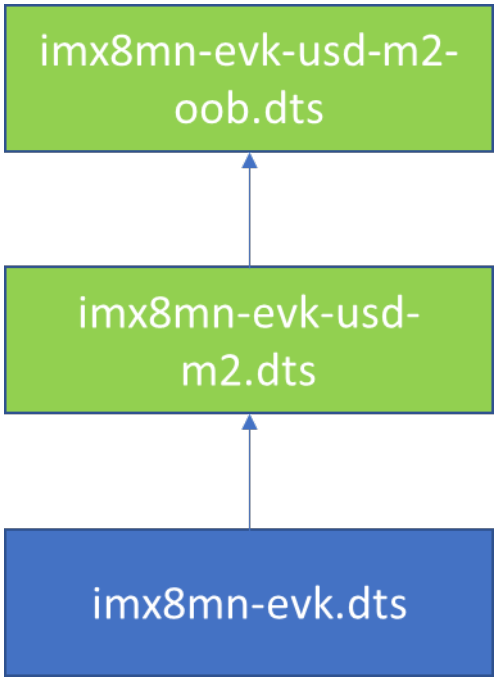


Figure 9: DTS hierarchy for imx8mnevk



6 Embedded Artists' Solution

Murata has partnered with Embedded Artists to provide an easier solution for evaluating Wi-Fi/BT IOT modules. This solution is composed of three parts: Carrier board, Computer on Module (COM) board, and M.2 Evaluation boards (EVB). **Figure 10** shows that the carrier board can work with a variety of NXP i.MX6/7/8 COM boards and two different Murata EVBs (1YM configured for both WLAN-PCIe and WLAN-SDIO). With this platform, users can ***more easily evaluate*** i.MX processors against Wi-Fi/BT M.2 EVBs to find the best combination for their product. Also, Embedded Artists brings out all the test points you need for trouble shooting. With this platform, no adapter/interconnection is needed, therefore you can achieve the real potential of Murata's Wi-Fi/BT modules. **Figure 10** shows how this platform work with COM board and M.2 Wi-Fi/BT EVBs.

Figure 10: Combine i.MX COM with Wi-Fi/BT M.2 EVB

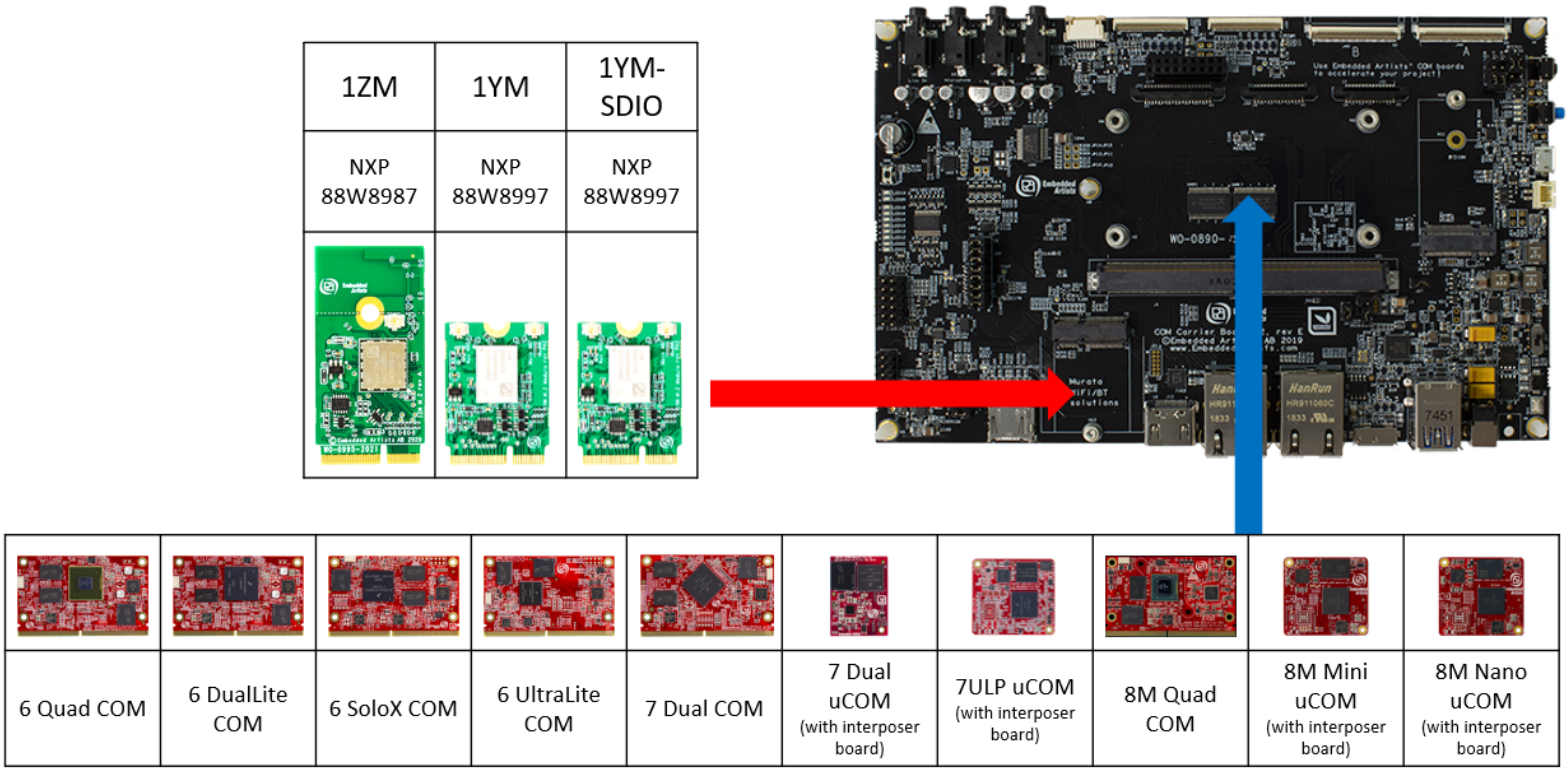


Table 11 provides an i.MX Reference Platform versus Murata module matrix. An additional column is included to provide a quick NXP chipset lookup. As the table clearly shows, the Embedded Artist's solution provides very comprehensive interconnect options.

As we will also see in **Section 6.1**, Embedded Artists provides not just a better hardware solution but an enhanced software solution as well. The software is well documented and easy to use.

Table 11: Embedded Artists' i.MX Interconnect

i.MX EVK	1ZM	1YM
	NXP 88W8987	NXP 88W8997
iMX8M Quad COM	M.2	M.2
iMX8M Mini uCOM	M.2	M.2
iMX8M Nano uCOM	M.2	M.2
iMX7 Dual COM	M.2	M.2
iMX7 Dual uCOM	M.2	M.2
iMX7ULP uCOM	M.2	M.2
iMX6 Quad COM	NC	M.2
iMX6 DualLite COM	NC	M.2
iMX6 SoloX COM	NC	M.2
iMX6 UltraLite COM	M.2	M.2
M.2 = Works with onboard M.2 slot NC = No Connection option (due to 1ZM/1YM-SDIO only supporting 1.8V SDIO VIO)		

6.1 Build Steps

Please refer to Embedded artists document, Getting-Started-with-M2-modules-and-iMX6_7_8-from-Linux-v5.4, Section 5 for detailed steps on building images.

6.1.1 Create Build Directory

Create a directory for the downloaded files (ea-bsp in the example below):

```
mkdir ea-bsp
cd ea-bsp
```

6.1.2 Initialize repo

Enter the command, “repo init” and “repo sync” for downloading the files:

```
repo init -u https://github.com/embeddedartists/ea-yocto-base -b <selected branch>
repo sync
```

Refer to **Table 12** for current branches supporting Murata’s modules based on NXP chipsets.

Table 12: Embedded Artists' supported branches

GitHub Repository	Branches	Description
ea-yocto-base	ea-5.4.47, ea-5.4.24	Linux image build
linux-imx	ea_5.4.47, ea_5.4.24	Linux Kernel
uboot-imx	ea_v2020.04	Bootloader

6.1.3 Optional Step for NXP: 1YM-SDIO*

By default, Embedded Artists build supports 1ZM and 1YM-PCIe. But, for 1YM-SDIO*, User has to perform the following additional steps for getting the drivers built into the image:

- Log into NXP website using the following link. https://www.nxp.com/webapp/sps/download/license.jsp?colCode=SD-WLAN-SD-BT-8997-U16-MMC-W16-68-10-p56-16-26-10&appType=file2&DOWNLOAD_ID=null
- Download the Software package (SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip). **Note**: NXP may have to grant access.
- Copy the file into BSP folder (“ea-bsp”).
- Ensure that copied file has the same software package name with ".zip" extension. i.e SD-WLAN-SD-BT-8997-U16-MMC-W16.68.10.p56-16.26.10.p56-C4X16667_V4-MGPL.zip

6.1.4 Select Machine Configuration and Distribution

A machine configuration must be specified before a build can be started. The **Table 13** below contains the machine configurations available for Embedded Artists boards. It is also possible to find the configuration files in the directory *~/ea-bsp/sources/meta-ea/conf/machine*

Table 13: Embedded Artists' Machine Configuration

i.MX EVK	Machine
iMX8M Quad COM	imx8mqea-com
iMX8M Mini uCOM	imx8mmea-ucom
iMX8M Nano uCOM	imx8mnea-ucom
iMX7 Dual COM	imx7dea-com
iMX7 Dual uCOM	imx7dea-ucom
iMX7ULP uCOM	imx7ulpea-ucom
iMX6 Quad COM	imx6qea-com
iMX6 DualLite COM	imx6dlea-com
iMX6 SoloX COM	imx6sxea-com
iMX6 UltraLite COM	imx6ulea-com

6.1.5 Initialize Build

Before starting the build, it must be initialized. In this step the build directory and local configuration files are created. A distribution must be selected when initializing the build, see iMX Working with Yocto for different alternatives. For headless setups (i.e. without a display) use fsl-imx-fb. Note that the i.MX8 boards do not support fsl-imx-fb so use fsl-imx-wayland instead.

In the example below the machine imx6sxea-com, the build directory build_dir and the fsl-imx-fb distribution (see iMX Working with Yocto for other distributions) is selected.

```
DISTRO=fsl-imx-fb MACHINE=imx6sxea-com source ea-setup-release.sh -b build_dir
```

6.1.6 Start Build

Invoke the command below to start the build. Please note that depending on the capabilities of your host computer building an image can take many hours.

```
bitbake ea-image-base
```

6.1.7 Deploy Image

Please refer to Embedded Artists document, Getting-Started-with-M2-modules-and-iMX6_7_8-from-Linux-v5.4, Section 5.3 for deploying images.

6.2 Documentation

Embedded Artists also provide every document you need on their website. **Table 14** provides the list of documents you might need during the evaluation process.

Table 14: Embedded Artists' Landing Pages

Landing Pages	Notes
Embedded Artists' Website	The Art of Embedded Systems Development – made EASY™
i.MX 6/7/8 COM Boards	Listing of Computer-on-Module boards.
i.MX 6/7/8 COM Carrier Board V2	Main baseboard which all the COM boards plug into.
Getting Started with i.MX 6/7/8 Developer's Kit V2	How to bring up i.MX 6/7/8 Dev Kit (V2).
M.2 Module Family	Top level listing of 1ZM and 1YM M.2 EVB.
Application Development on an i.MX Developer's Kit	Description of C/C++, Python, Node.js, and Qt5 development.
Devices and Peripherals on an i.MX Kit	Description of how to work with peripherals and devices.

Table 15 includes the links to the datasheets and schematics of COM boards and the EVBs.

Table 15: Embedded Artists' Datasheets and Schematics

Datasheets and Schematics	Notes
i.MX 6/7/8 COM Carrier Board V2 Datasheet	Comprehensive definition of COM Carrier (baseboard).
i.MX6/7/8 COM Carrier Board V2 Schematics	Complete schematics including clear definition of uSD-M.2 Adapter.
M.2 SDIO Interface Schematic	Reference schematic for customers designing in WLAN-SDIO M.2 EVB.
M.2 PCIe Interface Schematic	Reference schematic for customers designing in WLAN-PCIe M.2 EVB.
EACOM Board Specification Guide	Comprehensive definition of Embedded Artists' Computer-On-Module's.
1ZM M.2 Module Datasheet	Comprehensive details on 1ZM Wi-Fi/BT M.2 Module.
1YM M.2 Module Datasheet	Comprehensive details on 1YM Wi-Fi/BT M.2 Module.

Table 16 provides the link to the required manual documents and the software.

Table 16: Embedded Artists' User Manuals and Software

User Manuals and Software	Notes
Getting Started With M.2 Modules and i.MX 6/7/8	Comprehensive document covering all major topics associated with using Wi-Fi/BT M.2 EVB's on EA's i.MX 6/7/8 Dev Kits.
i.MX Working with Yocto	Comprehensive guide on building Linux images using Yocto framework.
Linux i.MX Images Download	Pre-compiled images using "uuu" tool: allows users to easily flash i.MX platforms with latest Linux images with integrated Wi-Fi/BT support.
Wi-Fi/BT M.2 EVB Primer	Introduction and drill-down on M.2 interface.

7 Technical Support Resources

Table 17 lists all the support resources available for the Murata Wi-Fi/BT solution.

Table 17: List of Support Resources

Support Site	Notes
Murata Community Forum	**Primary support point for technical queries.** This is an open forum for all customers. Registration is required.
Murata i.MX Landing Page	No login credentials required. Murata documentation covering hardware, software, testing, etc. is provided here.
Murata uSD-M.2 Adapter Landing Page	Landing page for uSD-M.2 Adapter. In conjunction with Murata i.MX Landing Page, this should provide the user with comprehensive getting started documentation.
Murata Module Landing Page	No login credentials required. Murata documentation covering all Wi-Fi/BT modules is provided here.

8 Appendix A: Useful "*git*" commands

Git is a free and open source distributed version control system. It is important for the user to have a reasonable understanding of Git, because Murata's implementation relies heavily on GitHub (https://github.com/): a remote Git repository. Some people may be new to using "***git***" commands or to remote Git repositories such as GitHub. Here is a good primer on using "***git***". For more details, refer to the main Git page: https://git-scm.com/. Commonly used "***git***" commands are shown in **Table 18**.

Table 18: Useful "*git*" commands

"*git*" command	Description
git config --list	List Git identity: username and email address.
git config --global --unset-all user.name	Remove Git username setting.
git config --global --unset-all user.email	Remove Git user email address setting.
git config --global user.name "<User Name>"	Configure Git username. Is done as part of first-time Git setup. Example: ***git config --global user.name "Fred Jones"***
git config --global user.email "<User Email>"	Configure Git user email address. Is done as part of first-time Git setup. Example: ***git config --global user.email "fj@gmail.com"***
git clone <remote_URL>	Creates a local working copy of an existing remote repository.
git branch -a	Lists all available branches of current local repository.
git tag	Lists all the available release tags.
git checkout <branch_name>	Check out a specific branch or release/tag in local repository.
git status	Lists the current branch (which is checked out) in local repository.
git reset --hard	Reset current Git repository content to default branch settings. **NOTE:** there are two "-" characters before "hard" switch.
git log	Shows the chronological commit history for local repository.
git clean -fd	Will remove all untracked directories and the files within them. It will start at the current working directory and will iterate through all subdirectories.

Providing more details on certain "***git***" commands:

- "***git config***" commands: Git needs to be configured prior to using it. At a minimum the username and email address must be configured. For more details refer to: https://git-scm.com/book/en/v2/Getting-Started-First-Time-Git-Setup.

- "***git clone***": This command is one of the key steps in building the customized Murata i.MX Yocto image. After configuring the baseline i.MX Yocto environment, the user must install the "***meta-murata-wireless***" layer in the Yocto "***sources***" folder by invoking "***git clone*** https://github.com/murata-wireless/meta-murata-wireless.git".

- "***git branch -a***": This command is useful to see which branches are currently available. Once you have the correct spelling of a given branch, then you can invoke the "***git checkout***" command to pull your desired release.

- "***git tag***": For users who want to use formal configured/tested release. This command will list all the current release tags. Typically run only in "***meta-murata-wireless***" repository.

- "***git checkout***": This command checks out a given branch or release tag. It can only be run after a git repository is created. In the Murata-customized build flow, we are invoking "***git checkout***" after "***git clone***" which creates a local copy of the "***meta-murata-wireless***" repository. "***git clone/checkout***" are also useful to pull specific versions of files. "***git checkout***" can be used to easily switch branches in any given repository.

- "***git status***": This confirms which branch/release you are on. It also indicates if there have been any changes to the files: both tracked (files checked out as part of the current branch) and un-tracked (new files that you may have added).

- "***git reset --hard***": **NOTE:** The double "**-**" character entry before "***hard***" switch. This command resets the content of the current Git repository to the default for current "<branch_name>". This is a useful command if you implemented certain changes that you want to back out. You can also invoke "***git reset* <filename>**" to reset (restore) just that one file.

9 Appendix B: Useful “bitbake” commands

Quoting from the BitBake User Manual:

“*Fundamentally, BitBake is a generic task execution engine that allows shell and Python tasks to run efficiently and in parallel while working within complex inter-task dependency constraints. One of BitBake's main users, OpenEmbedded[2], takes this core and builds embedded Linux software stacks using a task-oriented approach.*”

Or to be more succinct, BitBake is ***the*** “Swiss Army Knife” when using Yocto or OpenEmbedded. **Table 19** provides a list of essential “***bitbake***” commands.

Table 19: Useful “*bitbake*” commands

Yocto commands	Description
bitbake -c devshell virtual/kernel	To access kernel source
bitbake <recipe> -c devshell	Open a new shell where necessary system values already defined for recipe
bitbake-layers show-layers	To see the layers and their priorities.
bitbake -e <recipe> | grep ^PV	To check which version got selected for the recipe.
bitbake -c fetch <recipe>	To fetch source code. Source code can be found in downloads folder.
bitbake -b <recipe.bb> -c compile -D	To force compilation of the selected recipe.
bitbake -b <recipe.bb>	To perform build on the selected recipe.
bitbake -b <recipe.bb> -c clean	To perform clean on the selected recipe.
bitbake fsl-image-validation-imx	To create SD card image.
bitbake virtual/kernel *-c menuconfig*	Interactive kernel configuration
bitbake <image > -g -u depexp	Show the package dependency for *image*.

NOTE: “***bitbake***” commands must be invoked from the Yocto build directory.

[2] OpenEmbedded and Yocto are similar embedded Linux distributions. “meta-murata-wireless” can be easily leveraged in OpenEmbedded as well.

10 Appendix C: Example of running Host Setup for Yocto Script

```
$ ./Host_Setup_for_Yocto.sh
Murata: setup script to check Ubuntu installation and install
        additional host packages necessary for Yocto build
================================================================================

1) Verifying Host Environment
-----------------------------
Murata: Verified Linux Distribution:  Ubuntu
Murata: Verified Ubuntu Release:      16.04

2) Verifying Host Script Version
--------------------------------
Fetching latest script from Murata Github.
Cloning "https://github.com/murata-wireless/meta-murata-wireless.git"
Creating "meta-murata-wireless" subfolder.
Latest:  06182018
Current: 06182018........PASS

3) Installing Essential Yocto host packages
-------------------------------------------

Murata: Installing Essential Yocto Project host packages.
        sudoers-priviledged user will be prompted for password...
[sudo] password for skerr:
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.1ubuntu2).
diffstat is already the newest version (1.61-1).
gawk is already the newest version (1:4.1.3+dfsg-0.1).
gcc-multilib is already the newest version (4:5.3.1-1ubuntu1).
unzip is already the newest version (6.0-20ubuntu1).
chrpath is already the newest version (0.16-1).
socat is already the newest version (1.7.3.1-1).
texinfo is already the newest version (6.1.0.dfsg.1-5).
git-core is already the newest version (1:2.7.4-0ubuntu1.9).
libsdl1.2-dev is already the newest version (1.2.15+dfsg1-3ubuntu0.1).
wget is already the newest version (1.17.1-1ubuntu1.5).
0 upgraded, 0 newly installed, 0 to remove and 342 not upgraded.
Murata: Installing i.MX layers host packages...
```

```
Reading package lists... Done
Building dependency tree
Reading state information... Done
autoconf is already the newest version (2.69-9).
automake is already the newest version (1:1.15-4ubuntu1).
g++ is already the newest version (4:5.3.1-1ubuntu1).
gcc is already the newest version (4:5.3.1-1ubuntu1).
libglu1-mesa-dev is already the newest version (9.0.0-2.1).
make is already the newest version (4.1-6).
sed is already the newest version (4.2.2-7).
xterm is already the newest version (322-1ubuntu1).
asciidoc is already the newest version (8.6.9-3).
docbook-utils is already the newest version (0.6.14-3ubuntu1).
groff is already the newest version (1.22.3-7).
help2man is already the newest version (1.47.3).
lzop is already the newest version (1.03-3.2).
python-pysqlite2 is already the newest version (2.7.0-1).
repo is already the newest version (1.12.32-2).
texi2html is already the newest version (1.82+dfsg1-5).
coreutils is already the newest version (8.25-2ubuntu3~16.04).
curl is already the newest version (7.47.0-1ubuntu2.15).
cvs is already the newest version (2:1.12.13+real-15ubuntu0.1).
desktop-file-utils is already the newest version (0.22-1ubuntu5.2).
libgl1-mesa-dev is already the newest version (18.0.5-0ubuntu0~16.04.1).
libsdl1.2-dev is already the newest version (1.2.15+dfsg1-3ubuntu0.1).
subversion is already the newest version (1.9.3-2ubuntu1.3).
mercurial is already the newest version (3.7.3-1ubuntu1.2).
0 upgraded, 0 newly installed, 0 to remove and 342 not upgraded.
Murata: Installing i.MX layers host packages for a Ubuntu 16.04 or 14.04 host setup only...
Reading package lists... Done
Building dependency tree
Reading state information... Done
u-boot-tools is already the newest version (2016.01+dfsg1-2ubuntu5).
0 upgraded, 0 newly installed, 0 to remove and 342 not upgraded.
Murata: Ubuntu Linux host environment verified, necessary host packages installed...

4) GIT Configuration:
---------------------

Scott Kerr
skerr@murata.com
```

```
user.name : Scott Kerr
user.email: skerr@murata.com

Do you want to proceed with user name and email ID? Y/n: Y

Murata: please verify git username and email address prior to running Yocto build.
Currently configured as...
user.name=Scott Kerr
user.email=skerr@murata.com

Murata: ready to build "meta-murata-wireless" customized i.MX Linux image!
```

11 Appendix D: Example of running Murata Wireless Build

The following shows the output of building an image for NXP i.MX 6ULL EVK with Murata Type 1ZM module, running 5.4.47 kernel release, using the Murata build script.

1. Start the build by running Murata's build script.

```
./Murata_Wireless_Yocto_Build.sh
```

2. Select Stable build.

```
Select Stable ( 'n'=Developer )? Y/n: Y
Stable release selected
```

3. Select Zeus Yocto release running Linux 5.4.47.

```
Select which entry? 0
Selected : 5.4.47
```

4. Select "NXP" for wireless solution (this configures image for 1ZM).

```
Select which entry? 0
Selected : NXP
```

5. Skip "Optional" Step for NXP 1YM-SDIO*.

6. Select i.MX 6ULL EVK as target platform.

```
Select your entry: 2
Selected target: imx6ull14x14evk
```

7. Proceed with the default distro and image selections.

```
Murata default DISTRO & Image pre-selected are:
DISTRO: fsl-imx-fb
Image:  core-image-base
```

```
Proceed with this configuration? Y/n: Y
Proceeding with Murata defaults.
```

8. Enter build-imx6ullevk as build directory name.

```
Enter build directory name: build-imx6ullevk
```

9. Verify selection and start the build.

```
i.MX Yocto Release              : 5.4.47_2.2.0 GA
Yocto branch                    : zeus
Wireless                        : NXP
1YM-SDIO Option                 : No
Target                          : imx6ull14x14evk
NXP i.MX EVK Part Number        : MCIMX6ULL-EVK
meta-murata-wireless Release Tag: imx-zeus-zigra_r1.0
DISTRO                          : fsl-imx-fb
Image                           : core-image-base
Build Directory                 : build-imx6ullevk

Please verify your selection
Do you accept selected configurations ? Y/n: Y
```

10. Accept the End User License Agreement (EULA).

```
Do you want to continue? Y/n: Y
```

11. Accept the third-party EULA (press ‘space’ to read next page, ‘q’ to quit reading).

```
Do you accept the EULA you just read? (y/n) y
EULA has been accepted.
```

12. Start the build. This will take a long time to complete. Ensure that there is a minimum of 50 GB free disk space.

```
Do you want to start the build ? Y/n: Y
```

13. Once the build is complete, the image will be available in **~/linux-imx/build-imx6ullevk/tmp/deploy/images/imx6ullevk/** folder. Look for the file with “.wic.bz2” extension.