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ST67W611
Wi-Fi 6 + Bluetooth® LE + Thread

Santa Clara Wireless Team

Agenda

- # **X-Cube- ST67W61 Package**
- # **How to use X-CUBE-ST67W61 within STM32CubeMX (Walk-through)**
- # **Device Setup and Flashing**
- # **Walk through of the MQTT application**
- # **Introduction to MLC**
- # **Demo: MLC Workflow in MEMS Studio**
- # **MQTT Hands-On**
  Integrating MLC into ST67 MQTT Demo
- # **Documentation**

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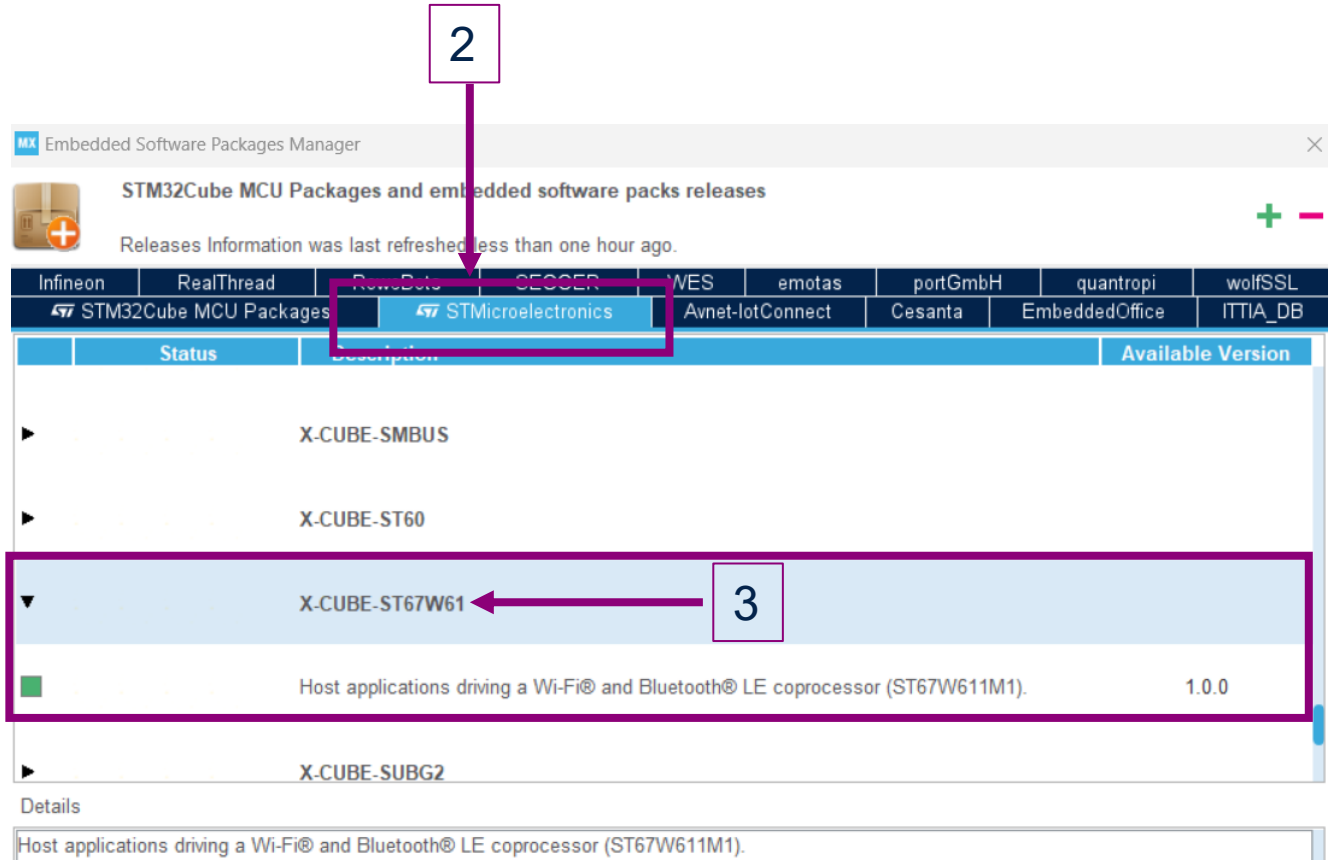
Prerequisites

- X_CUBE_ST67W61_V1.0.0
- STM32CubeIDE v1.16.1+
- STM32CubeProgrammer v2.18.0+
- STM32CubeMX_v6.14.1+
- HyperTerminal – TeraTerm v.5.4.0
- Python v.3.12.7+
- STBLE Toolbox
- IoT MQTT Panel App

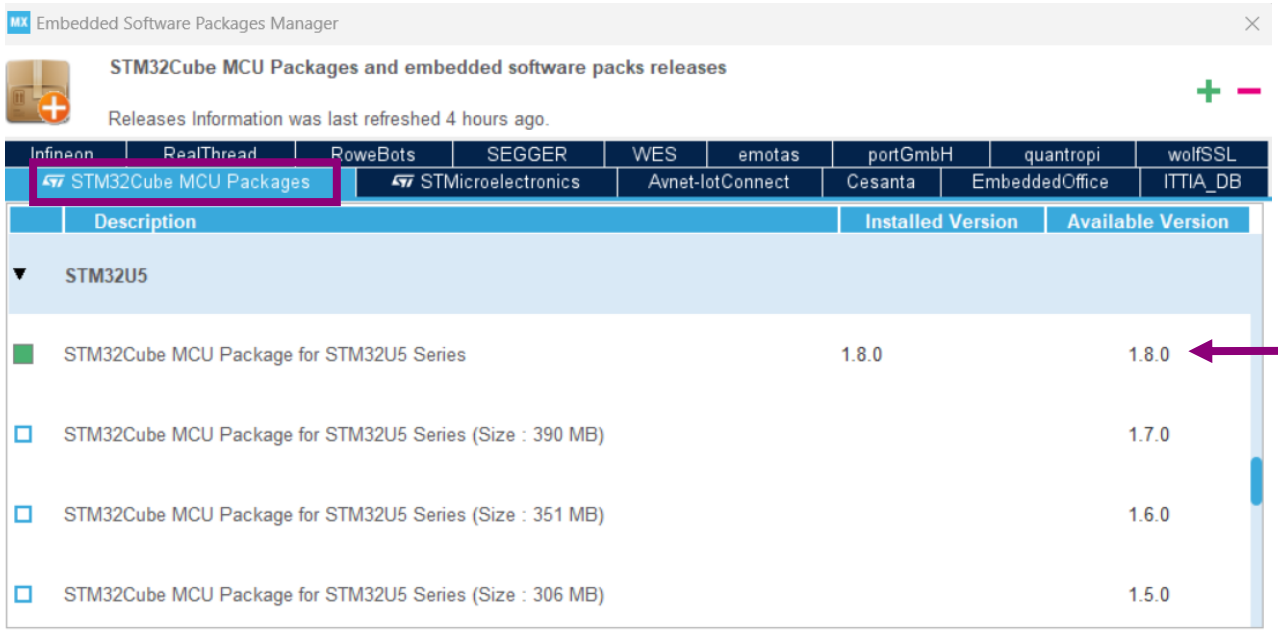
Installing X-CUBE-ST67W61

Open STM32CubeMX with admin rights

1. Go to “Install/Remove” software packages
2. Under STMicroelectronics tab
3. Install the X-CUBE-ST67W61

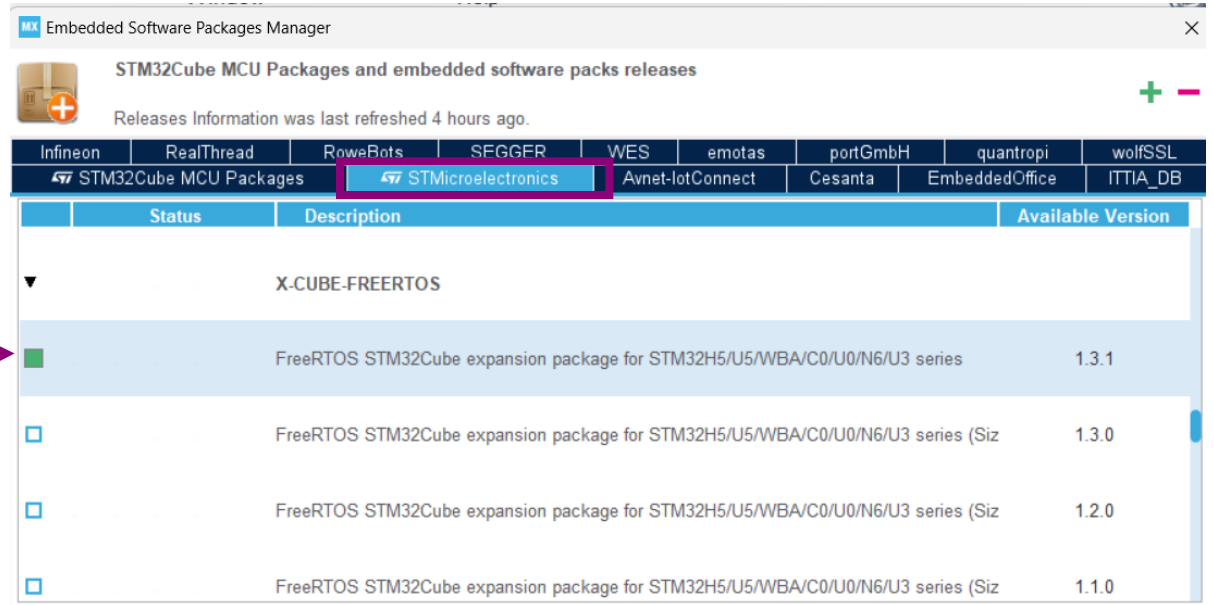


STM32U5 and X-CUBE-FREERTOS



Download latest STM32U5

Download latest X-CUBE-FREERTOS



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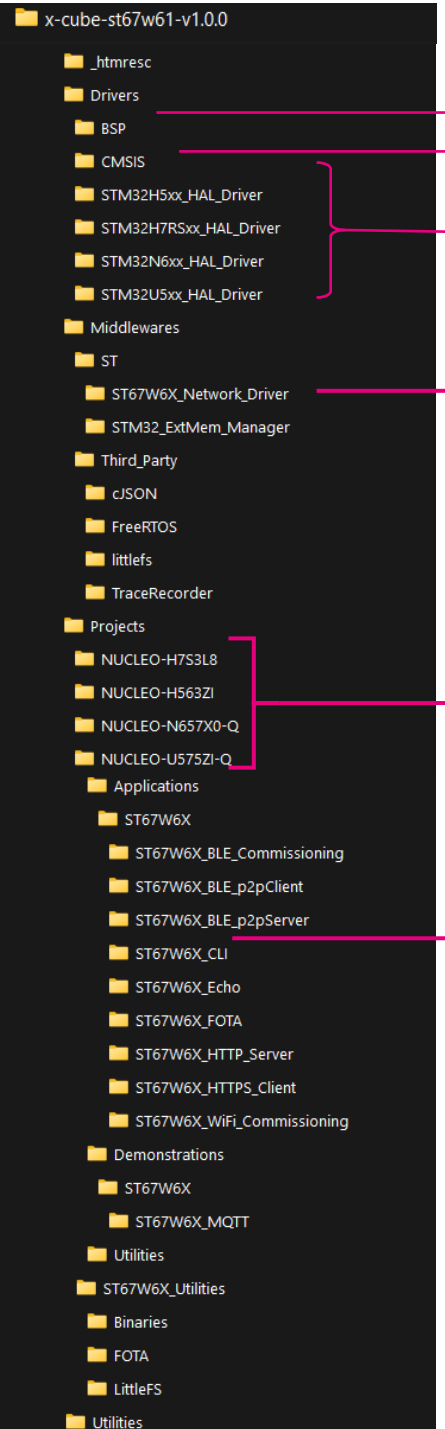
X-Cube-ST67W61

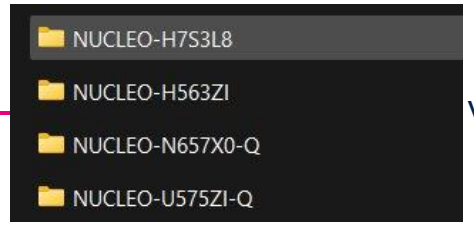
X-CUBE-ST67W61 package overview



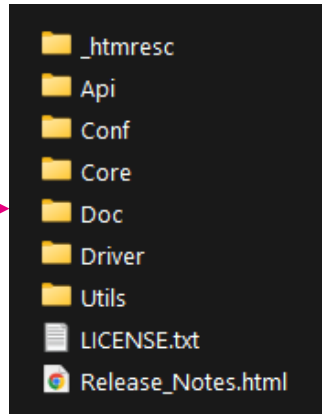
Board support package

CMSIS libraries

Device HAL drivers



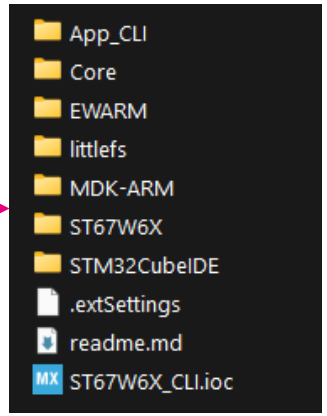
Variety of **Nucleo** hosts



APIs include files
Templates for middleware and driver config files
Integration between generic API and driver

W61 driver
- AT commands / responses
- SPI driver

UART Output logs
Memory usage statistics
CLI Console



STM32CubeIDE and **EWARM** Project Files

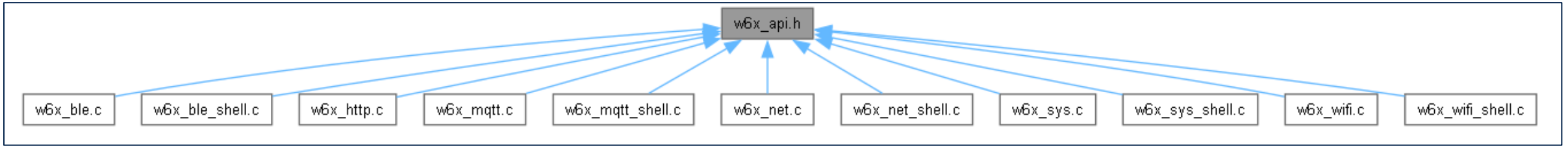
X-CUBE-ST67W61 Overview - stm32mcu

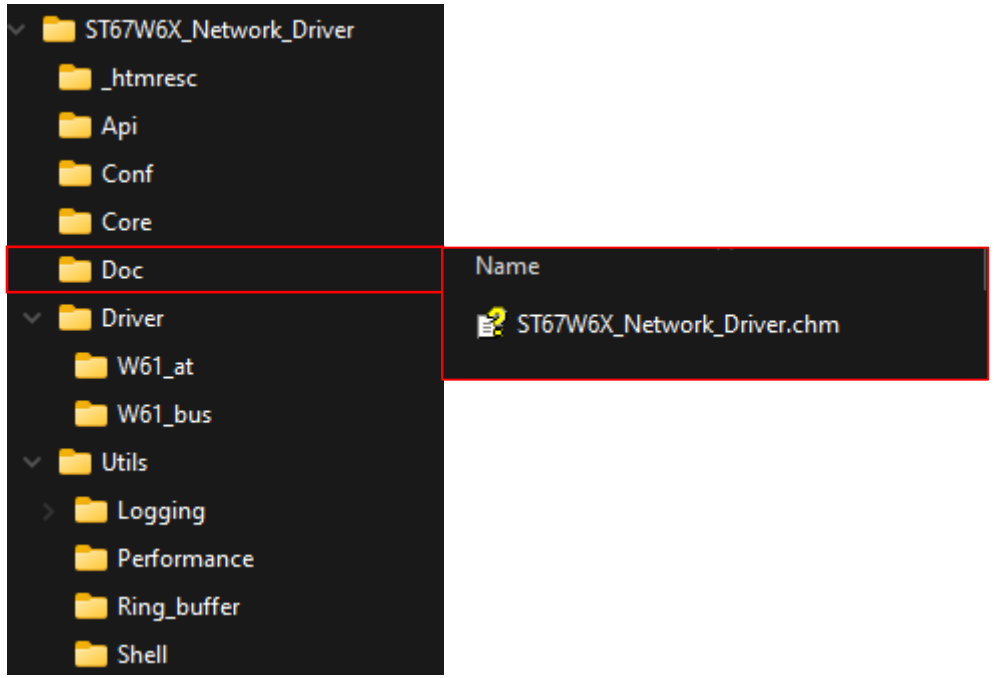
X-CUBE-ST67W1 middleware

	Scope / description
W61_bus	This is the SPI driver for communication between the host and the ST67W61.
W61_at	It does the formatting of the AT commands to be sent and it implements a receive tasks to decode the received messages from the W61 and dispatch them to the correspondent module.
W6x service API	The Core directory implements an adaptation layer between the W61 AT driver and the API proposed to the application. The APIs are "Zephyr-like" for the Wi-Fi® and socket API for the network operations.
Utils	Console handling, debug, trace, performance measurements.

All the above submodules make use of FreeRTOS™

API Documentation





Found in \Middlewares\ST\ST67W6X_Network_Driver**Doc**

- API Definitions
- Overview of API calls
- Correlated AT Commands

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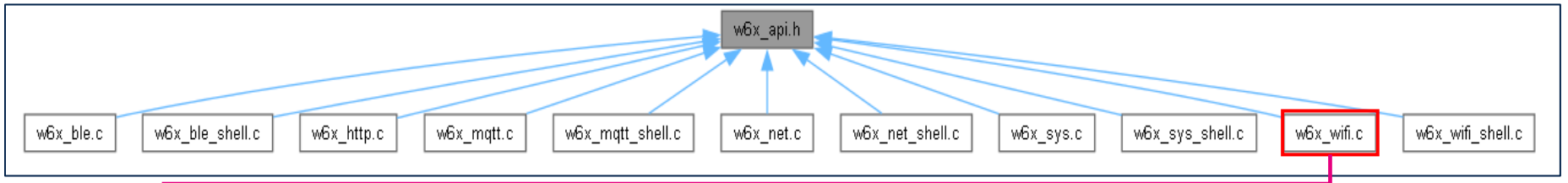
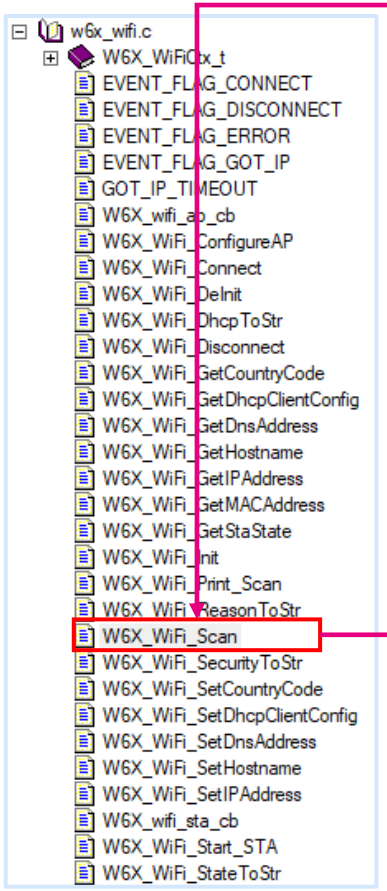
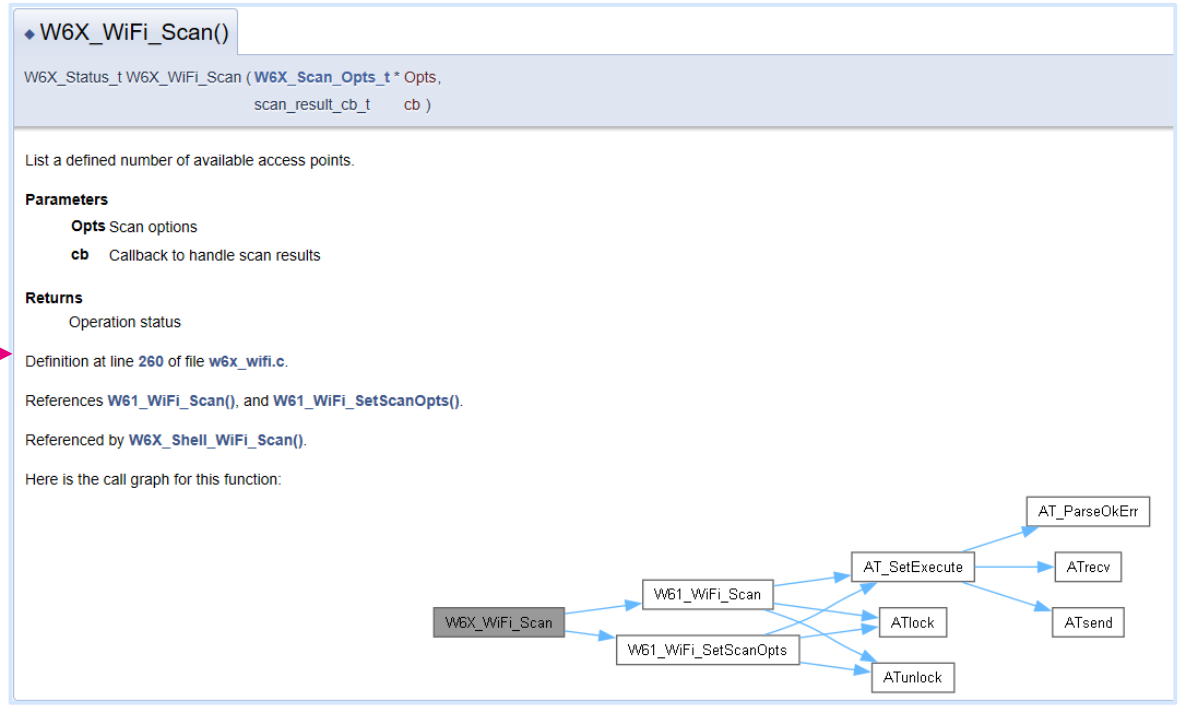
API Documentation cont…





Selecting **w6x_wifi.c** will provide the different API categories

Selecting the API, **W6X_WiFi_Scan(),** will provide information and the call graph



◆ W6X_WiFi_Scan()

W6X_Status_t W6X_WiFi_Scan (**W6X_Scan_Opts_t** * Opts,
scan_result_cb_t cb)

List a defined number of available access points.

Parameters

Opts Scan options

cb Callback to handle scan results

Returns

Operation status

Definition at line **260** of file **w6x_wifi.c**.

References **W61_WiFi_Scan()**, and **W61_WiFi_SetScanOpts()**.

Referenced by **W6X_Shell_WiFi_Scan()**.

Here is the call graph for this function:

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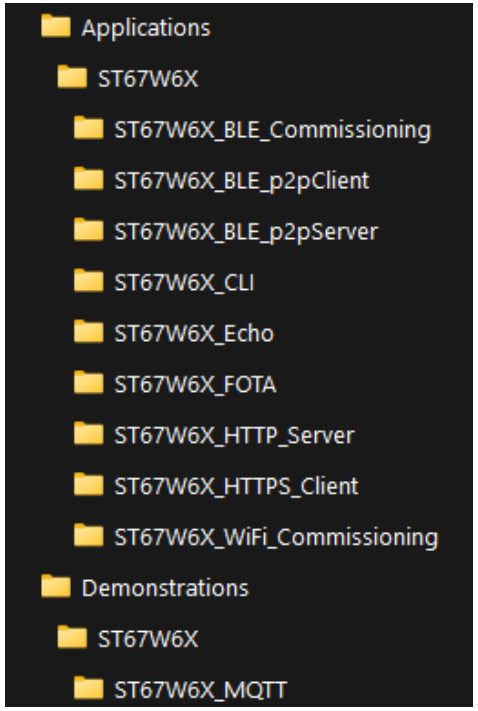
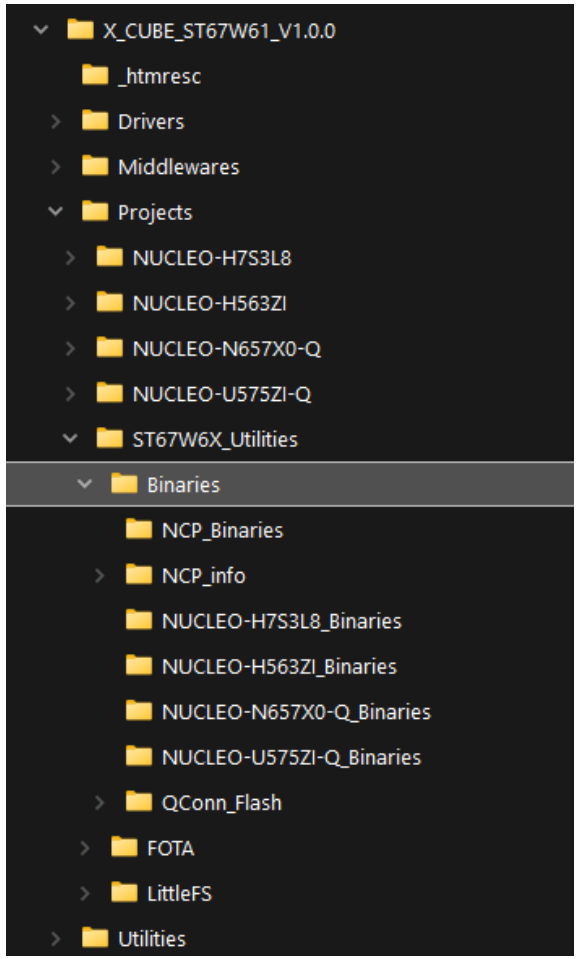
X-CUBE-ST67W61 applications



	Scope / description
Bluetooth® LE commissioning	Uses Bluetooth® LE to provide Wi-Fi® SSID and password after scanning available AP
Bluetooth® LE p2p client	Point-to-Point communication demo using Bluetooth® LE (GATT Client) Scan and connect to a p2pServer Write messages & receive notifications from the p2pServer
Bluetooth® LE p2p server	Point-to-Point communication demo using Bluetooth® LE (GATT server) Advertises and wait for a connection from either: - p2pClient app - *ST BLE Toolbox* smartphone application
Echo	TCP Echo feature over Wi-Fi - Good starting point for generic user development
CLI	ST67 evaluation via CLI and for WTS tests the Wi-Fi solution. - Wi-Fi API: scan, connect, disconnect, etc - NET socket API and iperf - Bluetooth® LE API
Echo FOTA	FOTA (firmware update over-the-air) feature demo over Wi-Fi - Using HTTP
HTTP server	HTTP server over Network API The server, running on the host board, has been validated with 1 client, using HTTP requests to send and receive data to and from the server.
HTTPS client	HTTPS Client over Network API demo - Basic GET requests to retrieve worldwide weather reports
Wi-Fi® commissioning	Wi-Fi® commissioning project using an HTTP server, hosted by a device configured as a soft access point (SoftAP) and station (STA).
MQTT Demo	Starting point for MQTT user development - Sends IKS sensor data to an MQTT broker

X-CUBE-ST67W1 NCP tools



Scripts for flashing the latest mission or manufacturing firmware:

..\x-cube-st67w61-v1.0.0\Projects\ST67W6X_Utilities\Binaries

Tool	Description
NCP_get_chip_info.bat	Script to retrieve ST67 MAC address and locking information even if no firmware is loaded onto the ST67 device.
NCP_update_mfg.bat	Script to flash the ST67 module with the manufacturing application.
NCP_update_mission_profile.bat	Script to flash the ST67 module with the mission profile application.

ST67W611M Security Overview

Two modes, each with a header containing a digital signature and versioning info

A. Mission mode:

- Bootloader binary
  - Authenticated by the ROM code during initial boot process
  - Versioning info to prevent rollback
- Mission profile binary
  - Wi-Fi® & Bluetooth® LE binary used for operational tasks
  - Authenticated by bootloader to ensure integrity & authenticity before execution

B. Manufacturing mode:

- Bootloader binary
  - Authenticated by the ROM code during initial boot process
  - Versioning info to prevent rollback
- MFG firmware binary
  - Used for test and production configuration
  - Authenticated by bootloader to ensure integrity & authenticity before execution

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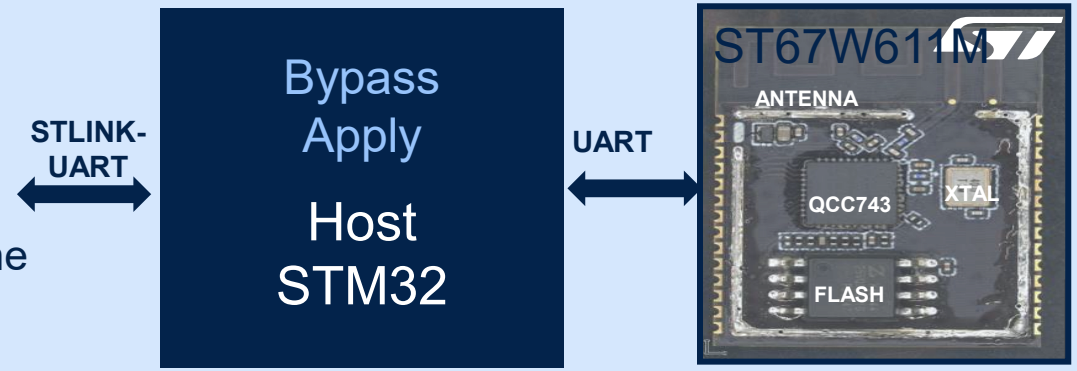
Flashing ST67 & Device Setup

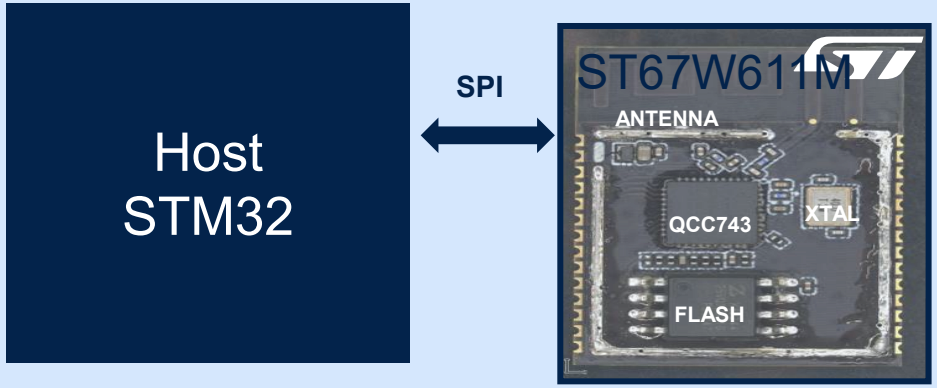
ST67W611M Modes of Operation

Manufacturing and Mission Modes

- **Manufacturing mode**
  - Host-less Application
  - Dedicated to RF performances monitoring and calibration.
  - QC provides graphical tools to control the device through the **UART** interface



- **Mission mode (Functional)**
  - Implementing the AT command for the different supported protocol (WIFI / BLE / MQTT /..) through the **SPI** interface.
  - The ROM boot loader loads and executes the program from SPI Flash to boot the system.



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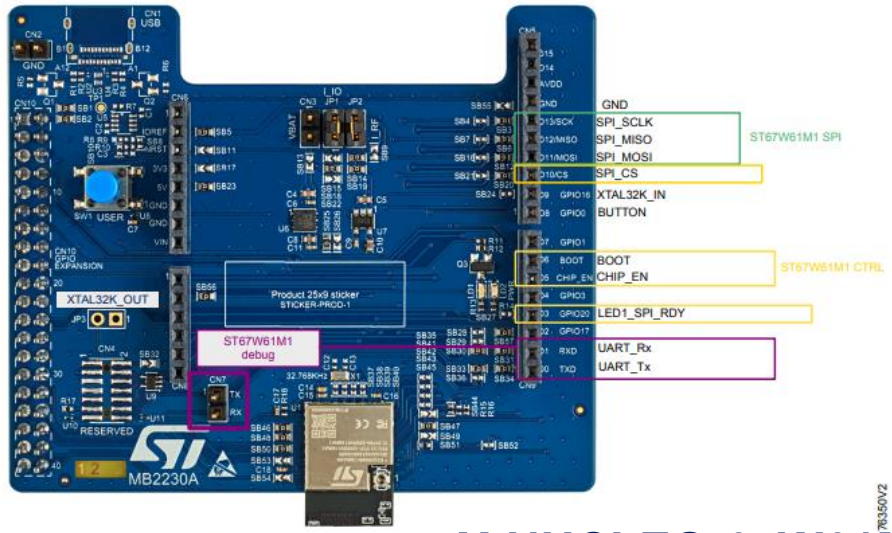
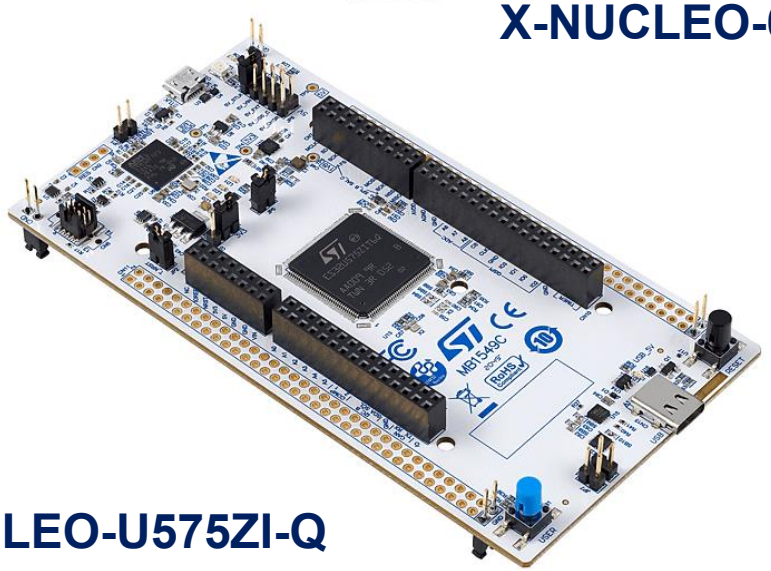
ST67W611M1 BOOT and bootstrap modes - stm32mcu

STM32U575 and ST67W611M configuration

- 1x NUCLEO-U575ZI-Q board
- 1x X-NUCLEO-67W61M1 board
- Boards connected through Arduino® connectors
  - Key signals: SPI (SCK, MISO,MOSI,CS), SPI_RDY, CHIP_EN, BOOT, UART_TX/RX
- Power: MicroUSB connection to NUCLEO-U575ZI-Q



X-NUCLEO-67W61M1



NUCLEO-U575ZI-Q

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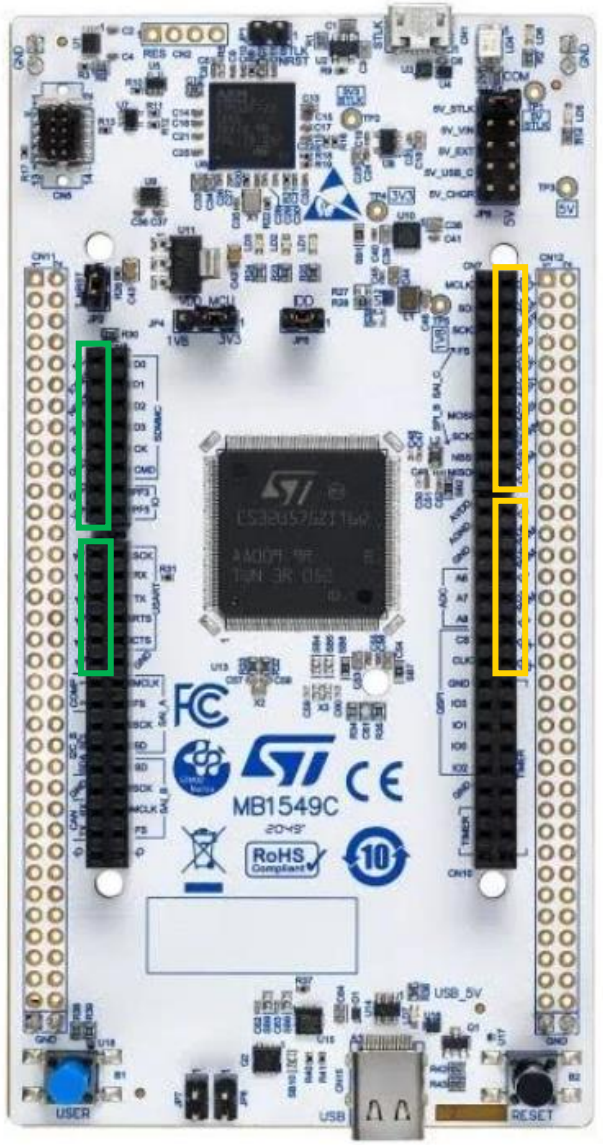
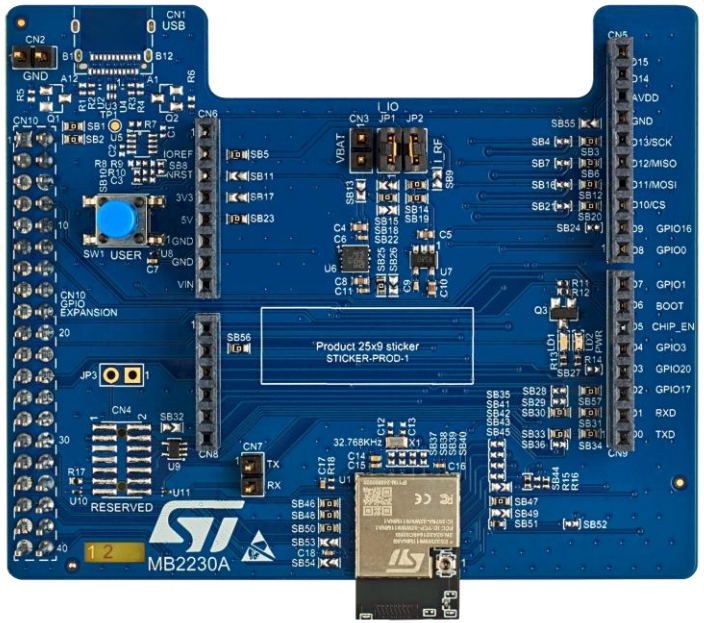
Nucleo-U575ZI and X-Nucleo-67W61M1 Configuration





When stacking the Nucleo and X-Nucleo boards the Arduino connectors must be aligned.

The MicroUSB port is used when programming the STM32U575 or ST67W611M1.

The MicroUSB port is also used to read the UART messages from the STM32U575 in a serial terminal.

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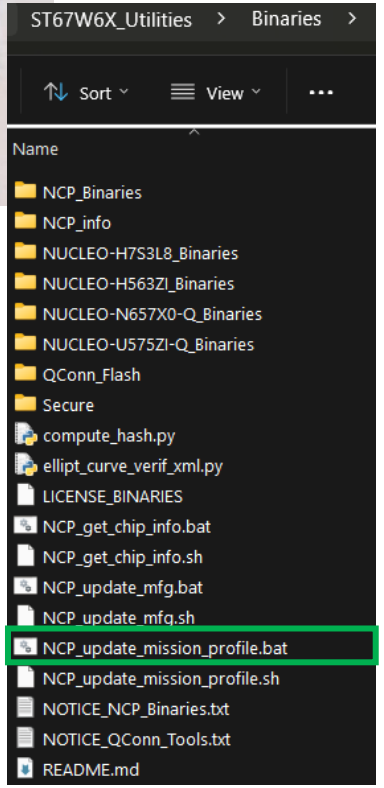
Flashing ST67W611M1
Mission Mode (Functional Mode) Setup

Prerequisites:

- Installed STM32CubeProgrammer
  - Installed in default directory (C:\Program Files\STMicroelectronics\STM32Cube\STM32CubeProgrammer
- Installed X-CUBE-ST67W61
  - Installed on C: drive (C:\x-cube-st67w61-v1.0.0)**



Using batch scripts located:
C:\ x-cube-st67w61-v1.0.0\Projects\ST67W6X_Utilities\Binaries

1. Nucleo-U575ZI-Q and X-Nucleo-67W61M1 stacked together

2. USB cable connected to microUSB port on Nucleo-U575ZI-Q and Windows PC.

3. Double-click the batch files to execute
   1. NCP_update_mission_profile.bat will flash the ST67W61M with the spi_wifi binary and the host processor with CLI application.

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***Note: Path length limits and paths with spaces in them for the x-cube-st67w61-v1.0.0 may cause issues. Saving on C: drive will prevent these issues.*

Flashing ST67W611M1

Mission Mode (Functional Mode) Process

```
"#########################################################"
"# You are about to load a signed binary to the NCP."
"# This will lock the ST67W61M if not yet locked."
"#########################################################"
Are you sure to proceed? (Y/N)
Press Y to continue or N to abort:
```

1. When executing NCP_update_mission_profile.bat the script will prompt the user with a warning message about locking the NCP. This is expected, and all devices have previously been locked with older firmware at manufacturing. Please press “Y” to continue.

```
Opening and parsing file: Bootloader.bin


Memory Programming ...
  File          : Bootloader.bin
  Size          : 8.96 KB
  Address       : 0x08000000


Erasing memory corresponding to segment 0:
Erasing internal memory sectors [0 1]
Download in Progress:
                                                  100%

File download complete
Time elapsed during download operation: 00:00:00.168
```

```
[11:54:50.657] - Load efuse 0
[11:54:50.657] - Load efuse 1
[11:54:50.657] - Load efuse remainder
[11:54:50.657] - Finished
[11:54:50.657] - All time cost(ms): 16587.53369140625
[11:54:50.767] - close interface
[11:54:50.767] - [All Success]
```

```
Opening and parsing file: ST67W6X_CLI.bin


Memory Programming ...
  File          : ST67W6X_CLI.bin
  Size          : 186.91 KB
  Address       : 0x08000000


Erasing memory corresponding to segment 0:
Erasing internal memory sectors [0 23]
Download in Progress:
                                                  100%

File download complete
Time elapsed during download operation: 00:00:02.186
```

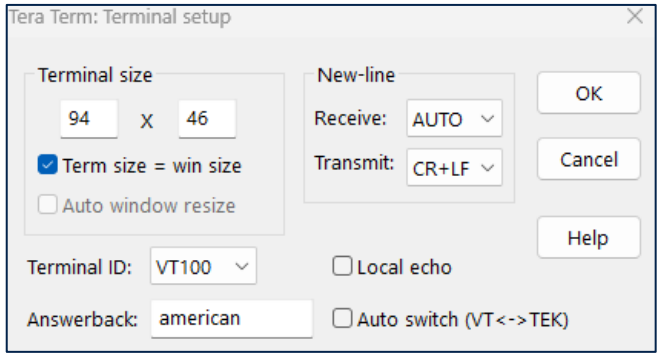
2. The NCP_update_mission_profile.bat will have 3 sequential flashing stages. The script will flash the STM32U5 with Bootloader.bin, then the ST67 with the signed mission mode binary, and the STM32U5 with ST67W6X_CLI.bin. Please verify success of all 3 flashing stages.

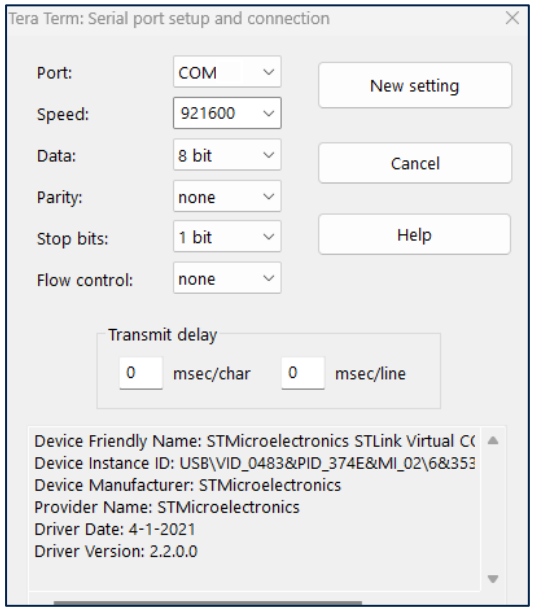
Flashing ST67W611M1

Mission Mode (Functional Mode) Verification

Flashing success can be verified by connecting to the Nucleo-U575ZI-Q with a serial terminal.

Configure the serial terminal with the following parameters and connect to the corresponding COM port for the Nucleo-U575ZI-Q.





With the serial terminal program configured, press the reset button the Nucleo-U575ZI-Q and verify application and SDK version.

```
    >#### Welcome to ST67W6X CLI Application #####
# build: 22:39:24 May 28 2025
--------------- Host info ---------------
Host FW Version:          1.0.0
-------------- ST67W6X info ------------
ST67W6X MW Version:       1.0.0
AT Version:               1.0.0.1
SDK Version:              2.0.75
MAC Version:              1.6.38
Build Date:               May 20 2025 23:01:38
Module ID:                C6AFDBD111400004
BOM ID:                   1
Manufacturing Year:       2024
Manufacturing Week:       47
Battery Voltage:          3.334 V
Trim Wi-Fi hp:            6,6,6,6,6,6,5,5,6,6,6,7,7,7
Trim Wi-Fi lp:            7,7,8,8,8,9,9,9,10,10,10,11,11,11
Trim BLE:                 5,4,5,6,7
Trim XTAL:                37
MAC Address:              40:82:7b:00:33:26
Anti-rollback Bootloader: 0
Anti-rollback App:        0
-----------------------------------------
mount success
Wi-Fi init is done
Net init is done
MQTT init is done
Starting FOTA task
ready
Application started from bank 1
```

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***Note: "Manufacturing Year" date may be incorrect and populated with the year "2000". This will have no effect on the functionality.*

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How to use X-CUBE-ST67W61 within STM32CubeMX

Software Development Tools

“STM32CubeIDE”
development environment

“STM32CubeMX”
initialization code generator

“X-CUBE-ST67W61”
application code and drivers for Wi-Fi

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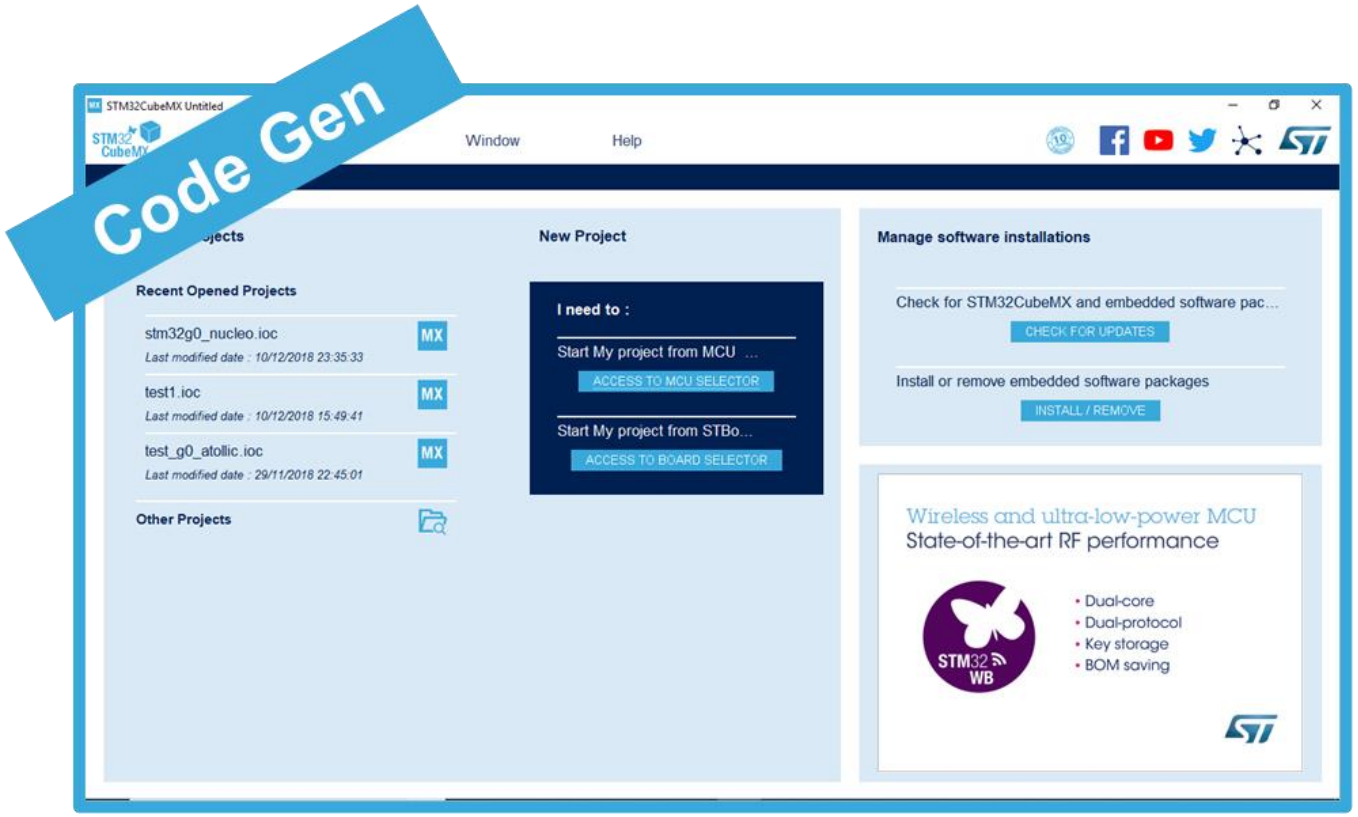
STM32CubeMX
an All-in-1 Development Tool



Very powerful configuration and code generation

Support all STM32 MCU and MPU, with integrated powerful Finder

Pinouts, clock tree, peripherals and middleware configuration.

Expandable to support wireless connectivity, sensors and much more!

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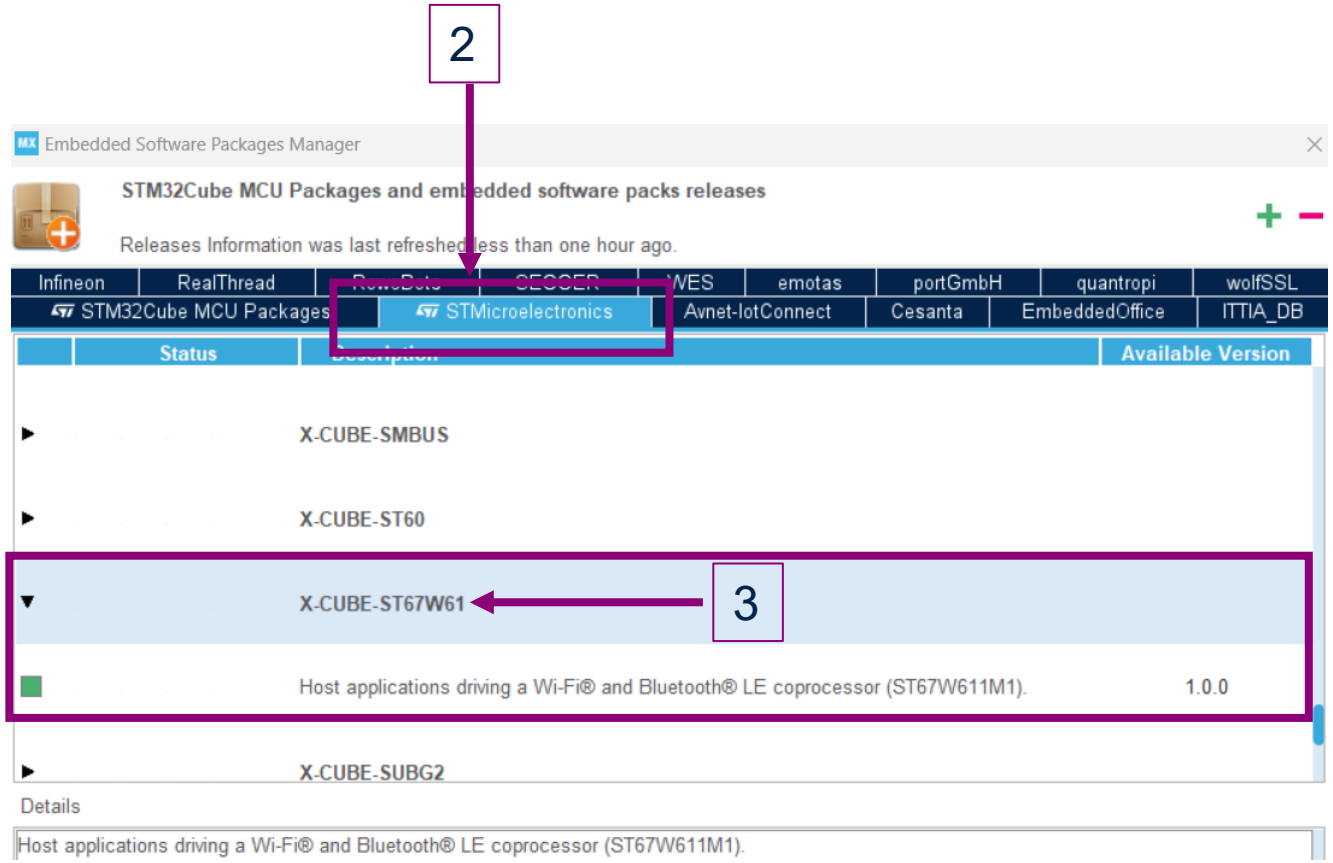
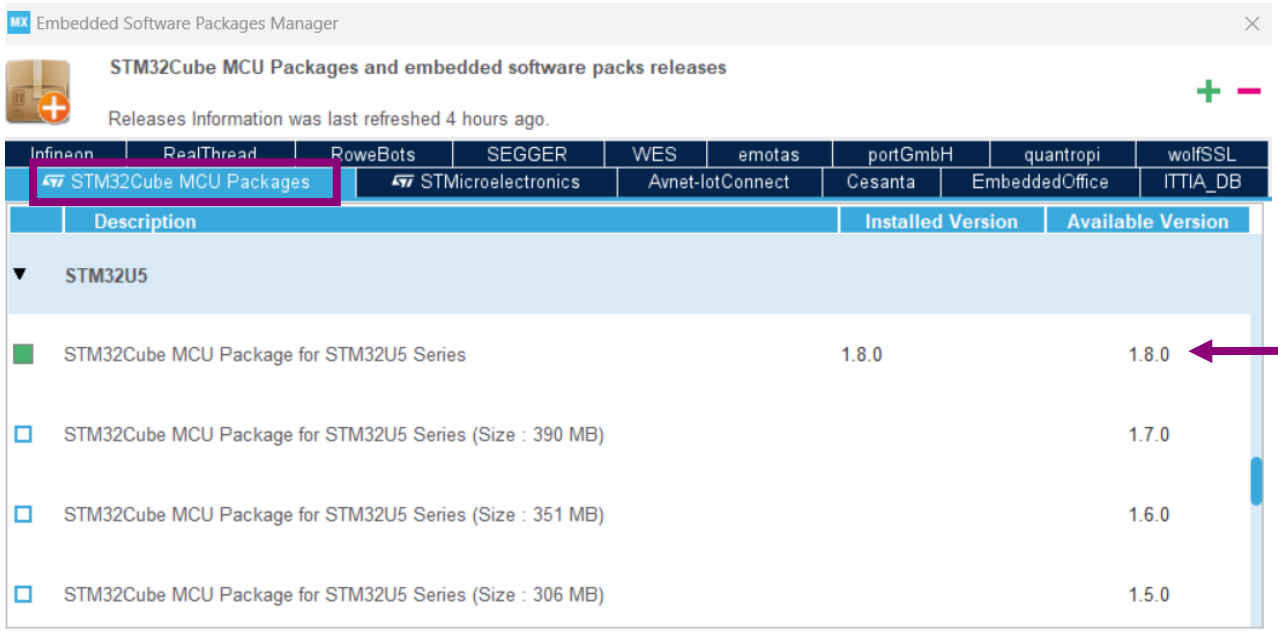
Installing X-CUBE-ST67W61

Open STM32CubeMX with admin rights

1. Go to “Install/Remove” software packages
2. Under STMicroelectronics tab
3. Install the X-CUBE-ST67W61

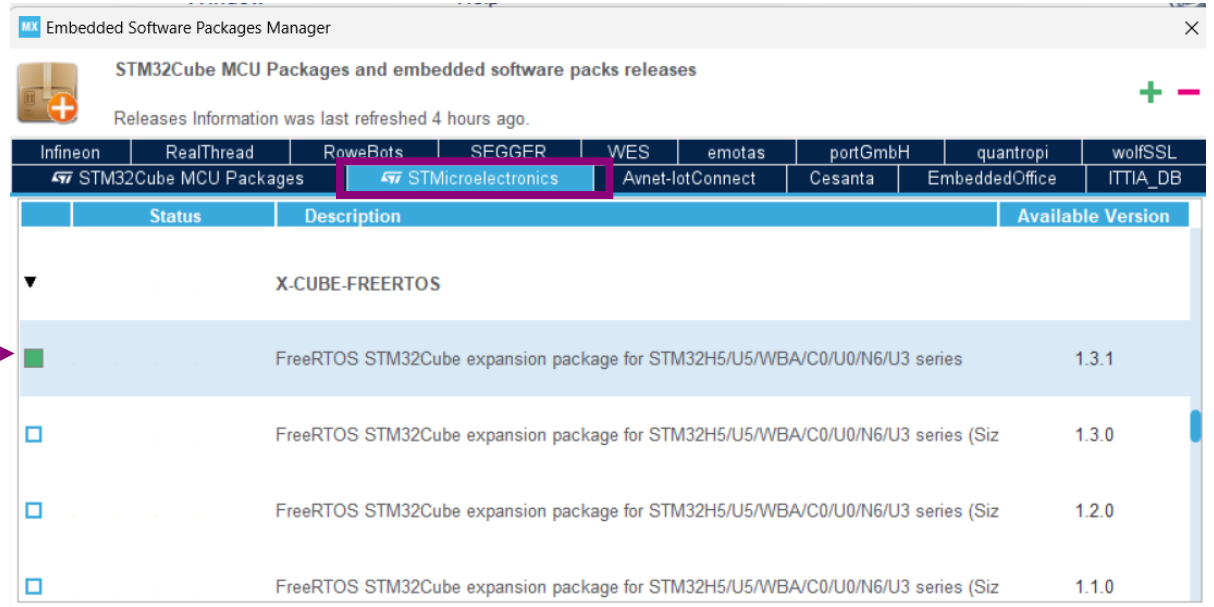


STM32U5 and X-CUBE-FREERTOS



Download
latest STM32U5

Download latest X-CUBE-FREERTOS



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Three possible cases to generate the code from the Cube MX:

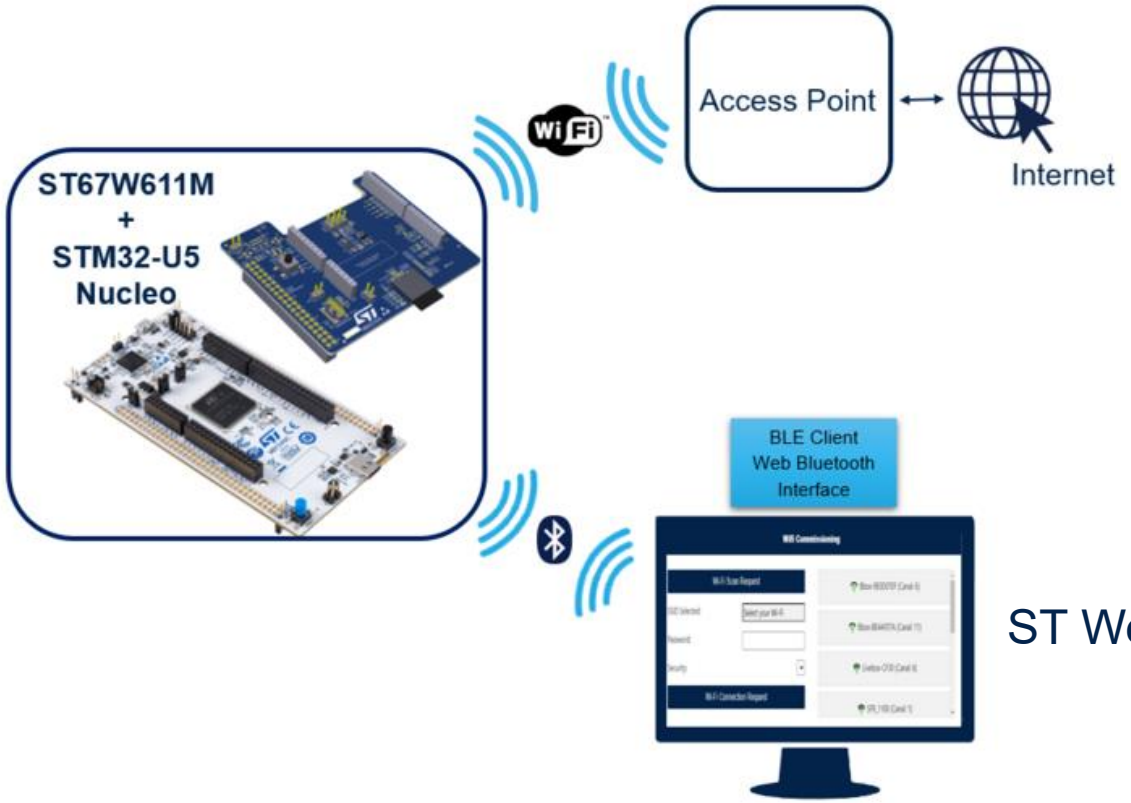
- **Case 1**: How to generate a project starting from an existing .ioc
- **Case 2**: How to export a project to a pinout compatible MCU
- **Case 3**: How to generate a project starting from scratch

In this section: We would be walking through to generate **BLE Commissioning** code using the following:

- Case 1 with NUCLEO-U575ZI-Q as host processor
- Case 3 with NUCLEO-G0B1RE as host processor

BLE Commissioning App

- This application aims to demonstrate **how to provision Wi-Fi credentials via Bluetooth® LE** to establish a Wi-Fi connection to an access point.



ST Web Page/ ST BLE Toolbox

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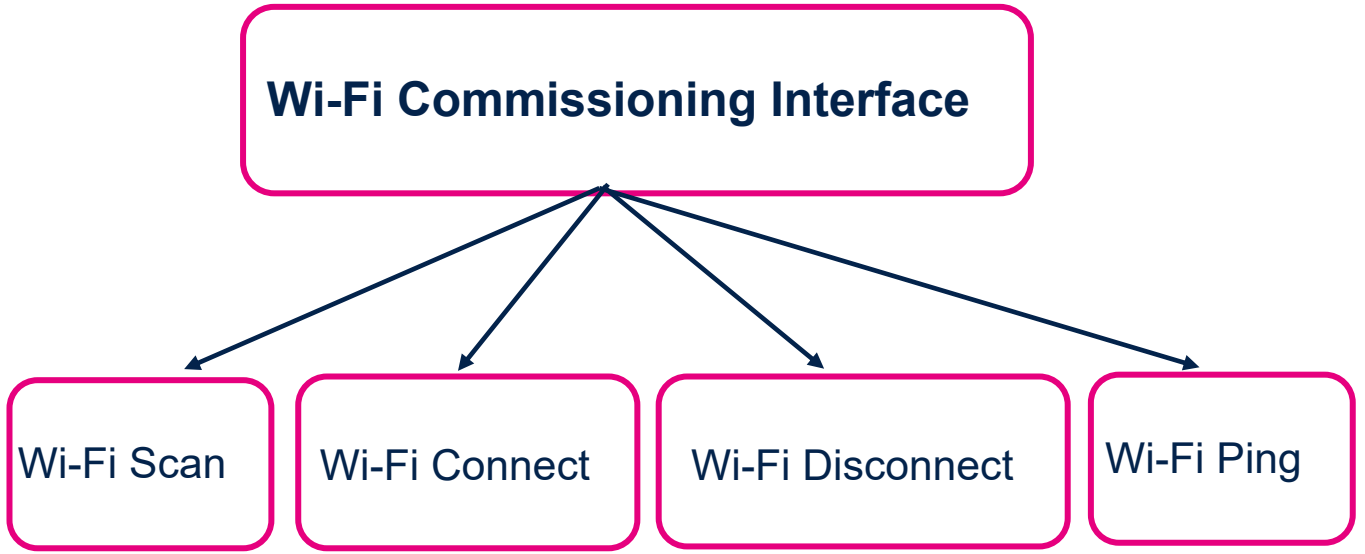
BLE Commissioning App cont..

The application acts as a peripheral device embedding the commissioning profile and its four characteristics.

At startup, the application starts to advertise.

ST Web Bluetooth® Interface must be used to scan and connect to the commissioning application: (Web-Interface available from the browser) / ST BLE Toolbox (Mobile Application)

Once connected, a Wi-Fi commissioning interface is available on web Bluetooth® page/ ST BLE Toolbox



Commissioning profile overview

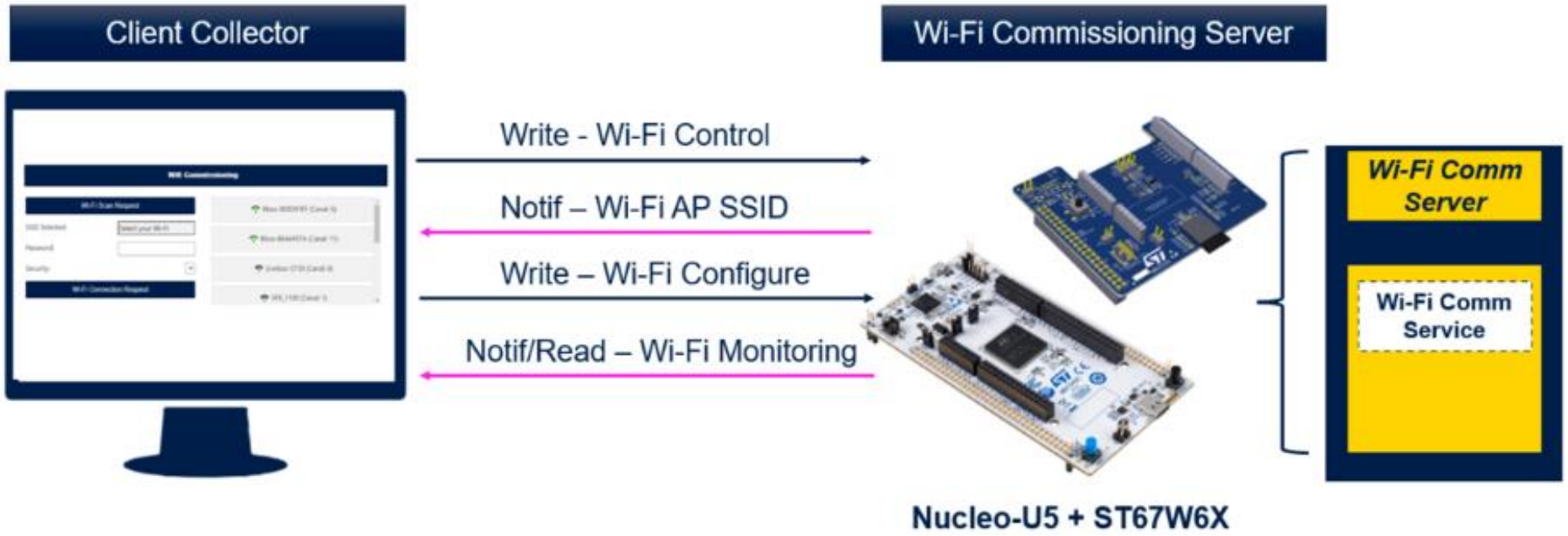
The Wi-Fi commissioning application demonstrates point to point communication using proprietary service and characteristics. It acts as a Peripheral device with one GATT service and four characteristics.

Wi-Fi commissioning server:

- Contains the Wi-Fi commissioning service, which exposes four characteristics: **Wi-Fi Control (write), Wi-Fi Configure (write), Wi-Fi Access Point List (notification), Monitoring (Notification)** to control and monitor a Wi-Fi connection.
- Is the GATT server

Client Collector: (STBLE Toolbox/ ST Web Bluetooth page)

- Accesses the information exposed by the Wi-Fi commissioning application, **configures and controls the Wi-Fi connection** with the write characteristics, **monitors the Wi-Fi connection status** by receiving notifications from it
- Is the GATT client



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The table below describes the structure of the commissioning service:

Bluetooth® LE commissioning service specification

Service	Characteristic	Mode
Wi-Fi commissioning		
	Wi-Fi Control	Write with Response/Read
	Wi-Fi Configure	Write with Response/Read
	Wi-Fi AP List	Notify
	Monitoring	Notify

Wi-Fi commissioning - Wi-Fi control

Byte Index	0
Name	Action
Value	0x01: Wi-Fi Start Scan 0x03: Wi-Fi Connect 0x04: Wi-Fi Disconnect 0x05: Wi-Fi Ping

Wi-Fi control characteristic:
Used to drive the Wi-Fi by launching scans, connecting or disconnecting from a network

Wi-Fi commissioning - Wi-Fi configure

Byte Index	0	1
Name	Type	Data[ ]
Value	0x01: AP-SSID 0x02: PWD	"ASCII" "ASCII"

Wi-Fi configure characteristic:
Used to setup the Wi-Fi parameters before establishing a connection

Wi-Fi Commissioning - Wi-Fi AP List

Byte Index	0	1	2 to 3	4 to 7	8 to 40
Name	SSID Length	Channel	Signal level	Security Flag	SSID
Value	0x00 ... 0x20	0x00 ... 0xFF	0x00 ... 0xFFFF	Security_Flag[ ]	Data[ ]

Wi-Fi access point list characteristic:
Used to notify information about scanned access points

Wi-Fi commissioning - Wi-Fi monitoring

Byte Index	0	1 up to 239
Name	Type	Data[ ]
Value	0x03: Connecting 0x04: Connection established 0x05: Ping response 0x06: Error	X SSID Refer to **table below** 0x01: Connection Timeout

Monitoring characteristic:
Used to notify information about Wi-Fi network.

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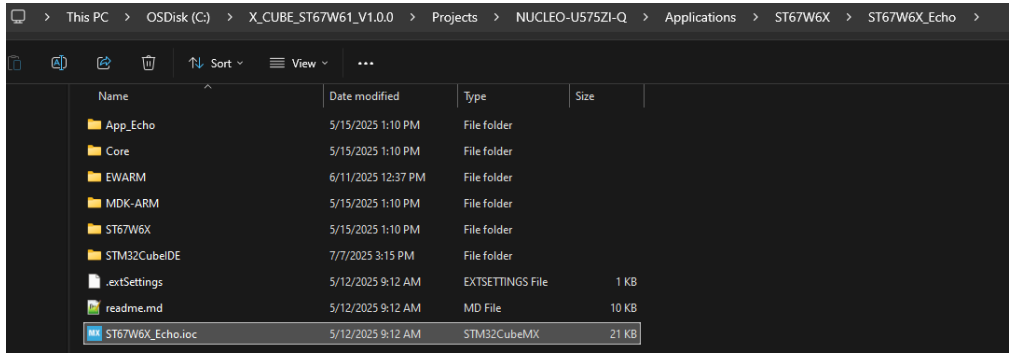
Generating BLE Commissioning app using NUCLEO-U575ZI-Q as host processor (Hands-on)

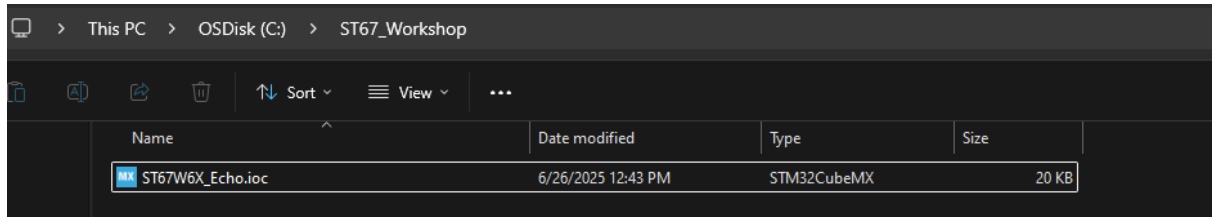
Case 1: Generating BLE Commissioning app using NUCLEO-U575ZI-Q as host processor

We would start with the ST67W6X_Echo.ioc file as a starting point and change the configuration to generate the BLE Commissioning application from the STM32CubeMX.

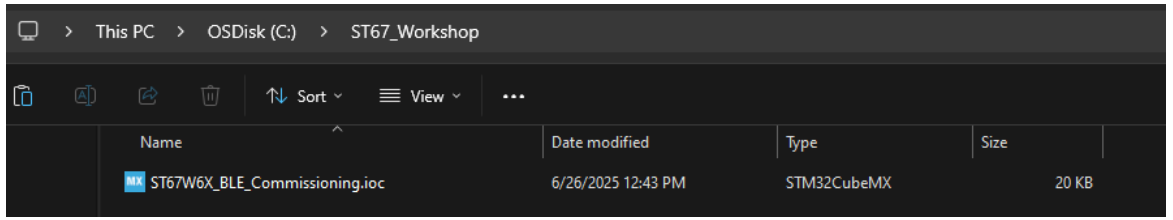
1. Browse through C:\X_CUBE_ST67W61_V1.0.0\Projects\NUCLEO-U575ZI Q\Applications\ST67W6X\ST67W6X_Echo
2. Copy ST67W6X_Echo.ioc
3. Create a new directory C:\ST67_Workshop
4. Paste and rename to ST67W6X_BLE_Commissioning.ioc



Copy & Paste



Rename



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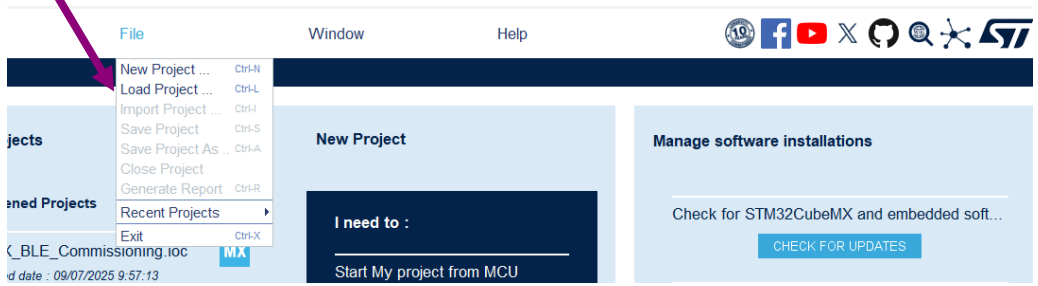
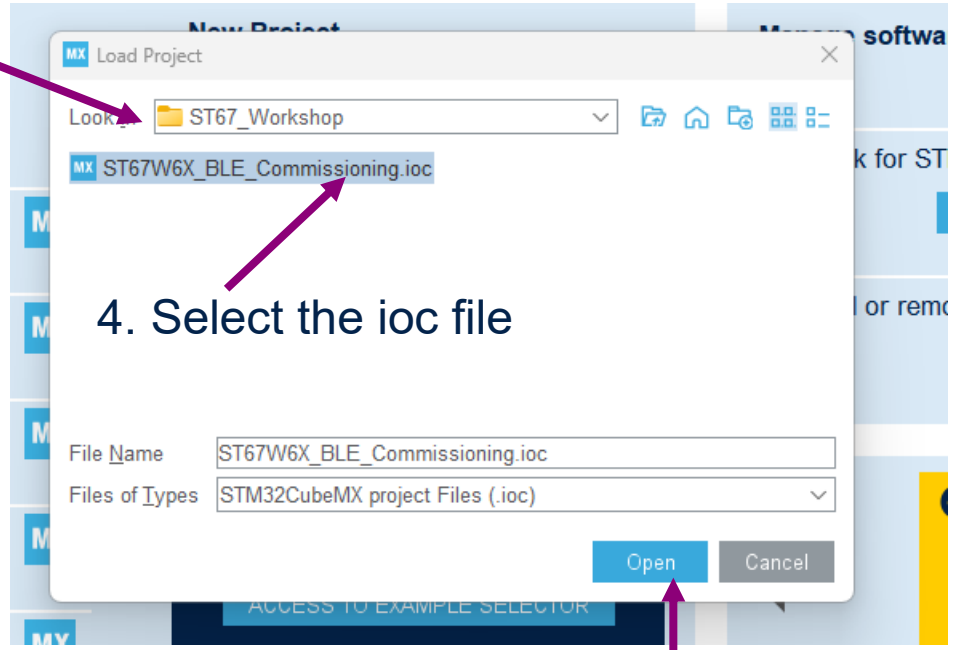
Loading ioc file in STM32CubeMX

1. Run STM32CubeMX with **admin rights**

2. Load Project

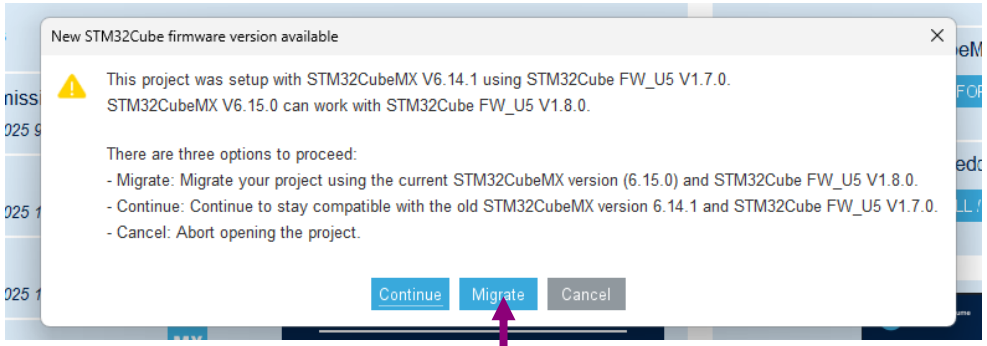


3. Go the ST67_Workshop

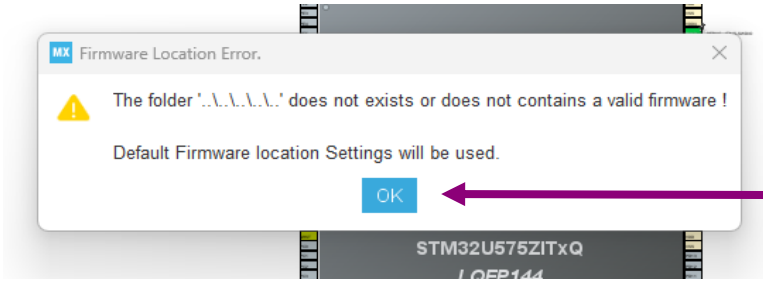


4. Select the ioc file

5. Click open



6. Migrate (If you get the warning)



7. Click Ok

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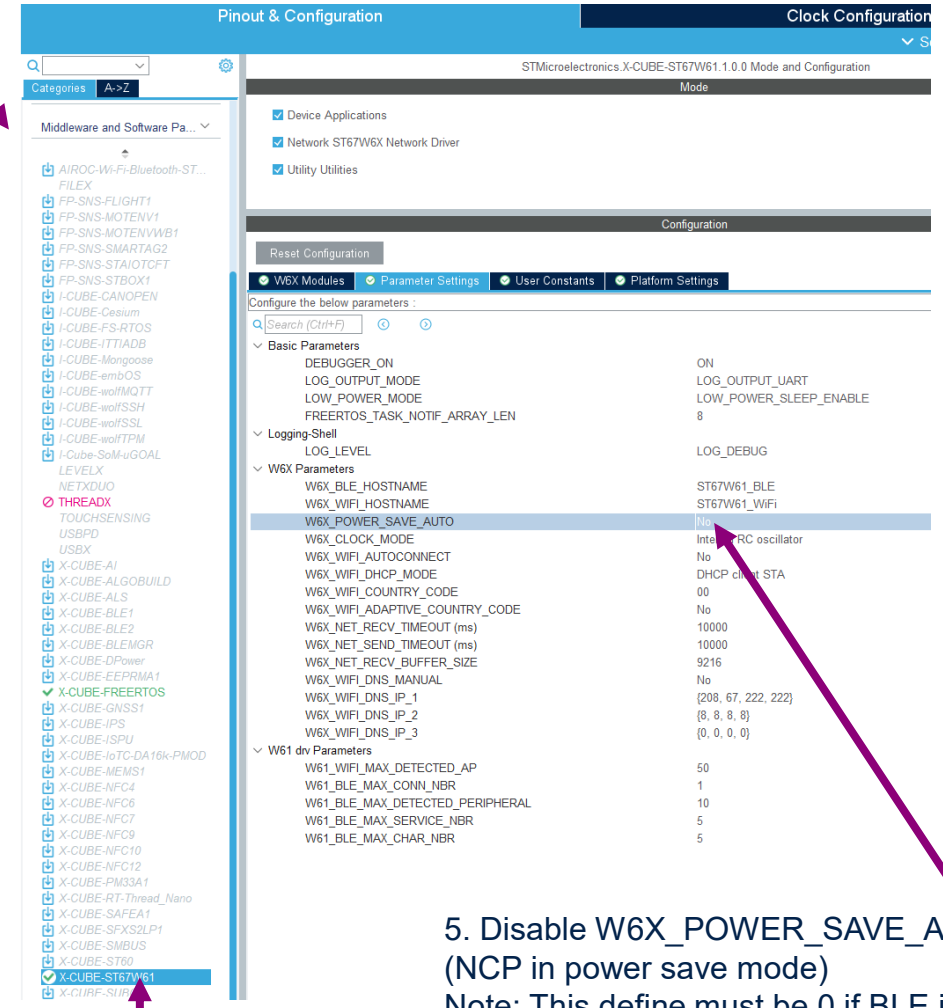
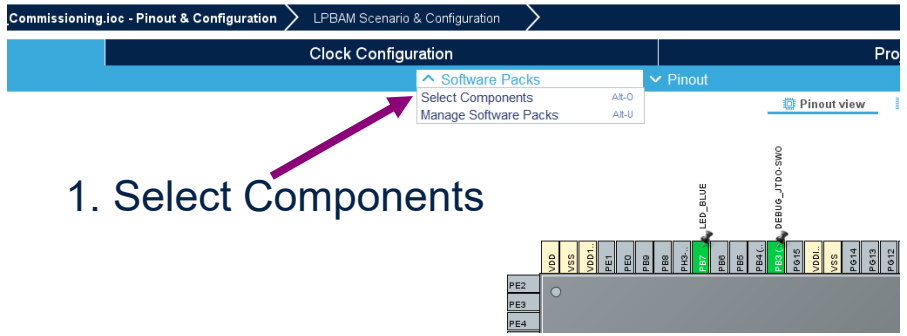
Configuration

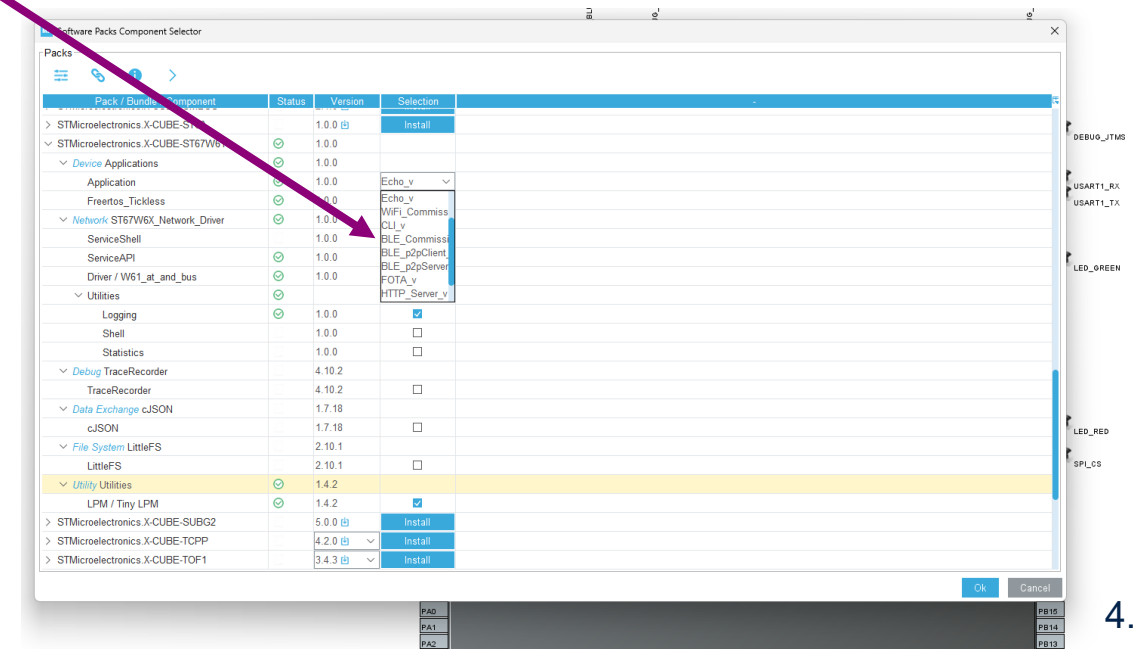
3. Under Middleware and Software Packs





1. Select Components

2. Select BLE Commissioning app



4. Select X-CUBE-ST67W61

5. Disable W6X_POWER_SAVE_AUTO (NCP in power save mode)
Note: This define must be 0 if BLE is enabled

Bluetooth Low Energy connection with NCP in Power save mode requires accurate external low-frequency clock. To setup and use external clock, SW and HW settings must be modified.
Refer to [Wiki Bluetooth LE with low-power setup](https://wiki.st.com/stm32mcu/wiki/Connectivity:How_to_measure_ST67W611M_current_consumption#Bluetooth-C2-AE_LE_with_low-power_setup) page to be informed about required changes.

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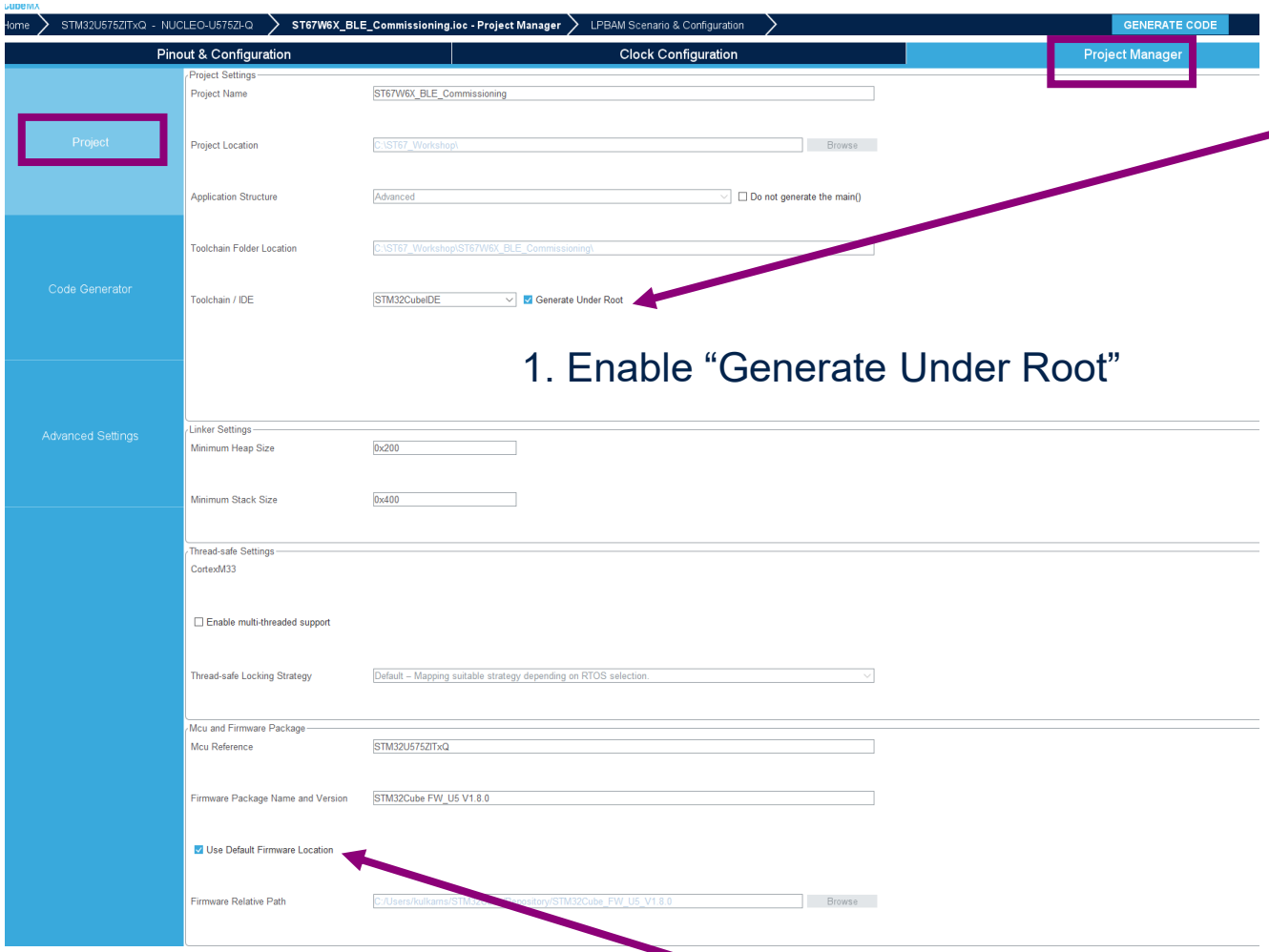
Project Settings



1. Enable “Generate Under Root”

2. Enable “ Use Default Firmware Location”

Here, we are enabling the Flat directory structure: (i.e. Driver and MW directories copied into your project directory)

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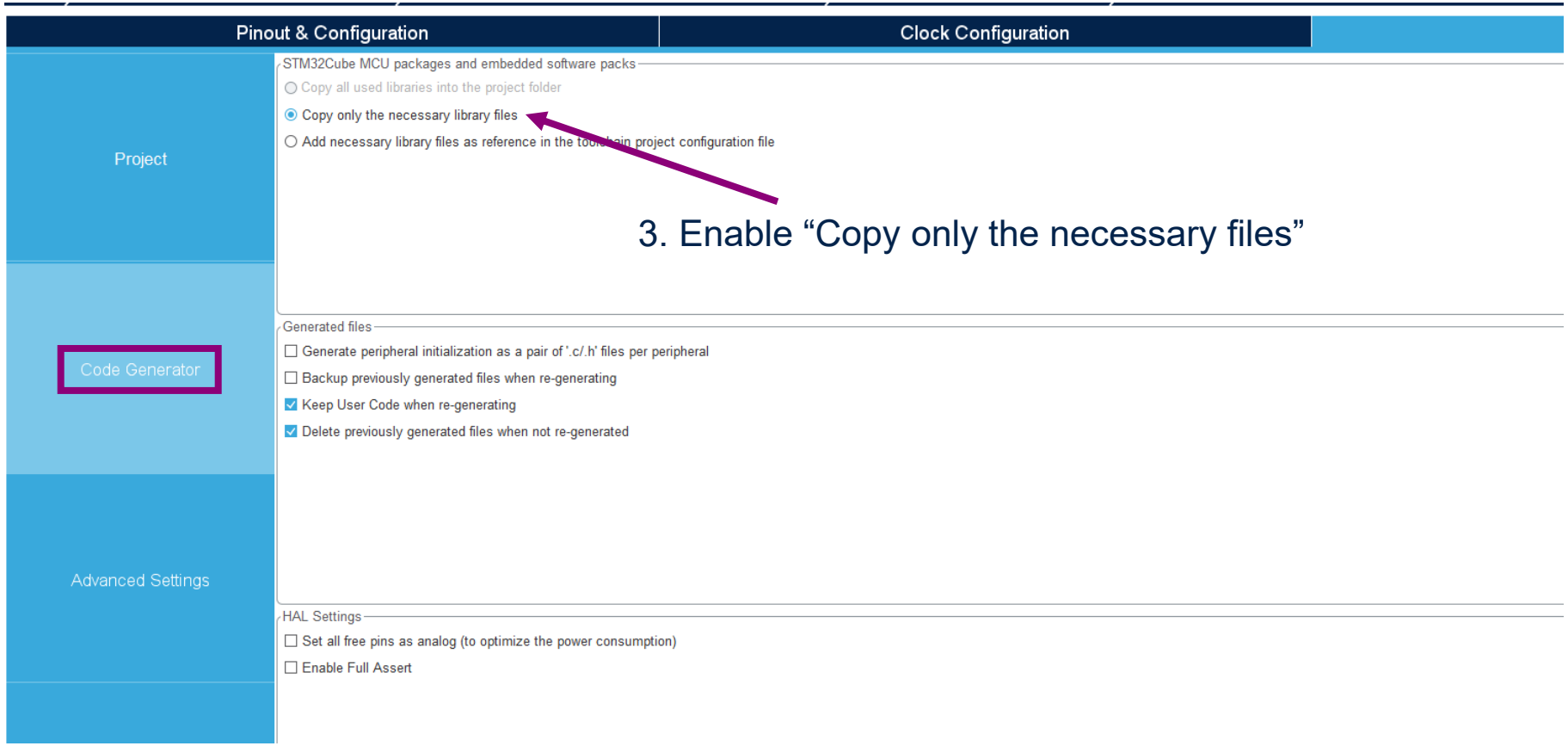
Project Settings cont..



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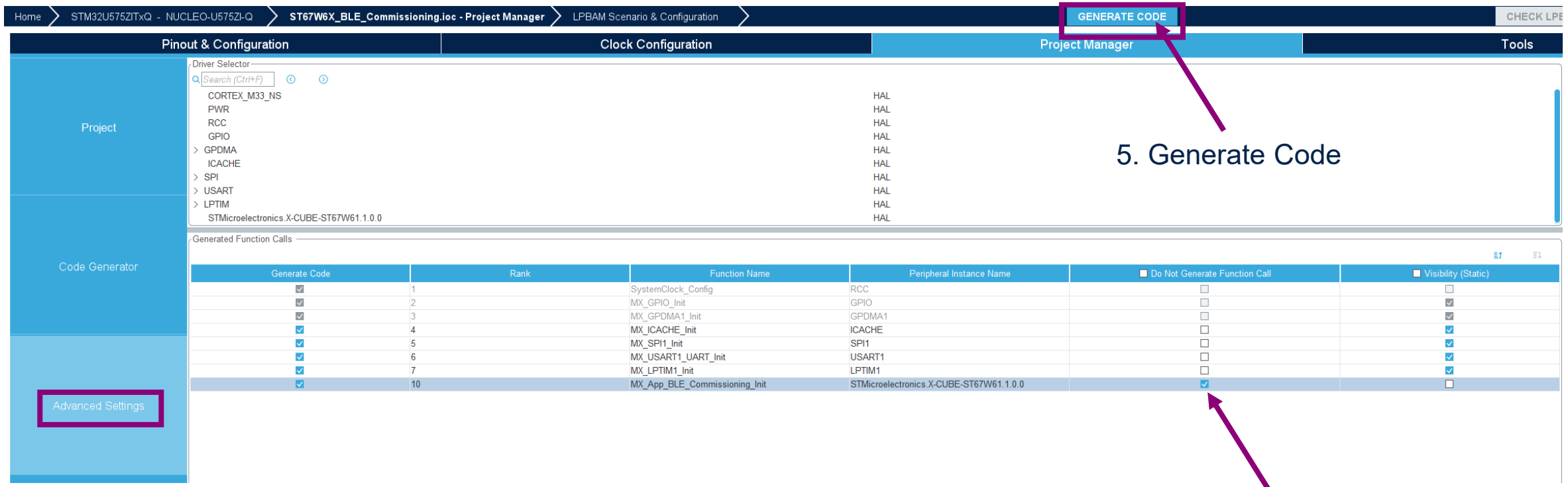
Generate Code



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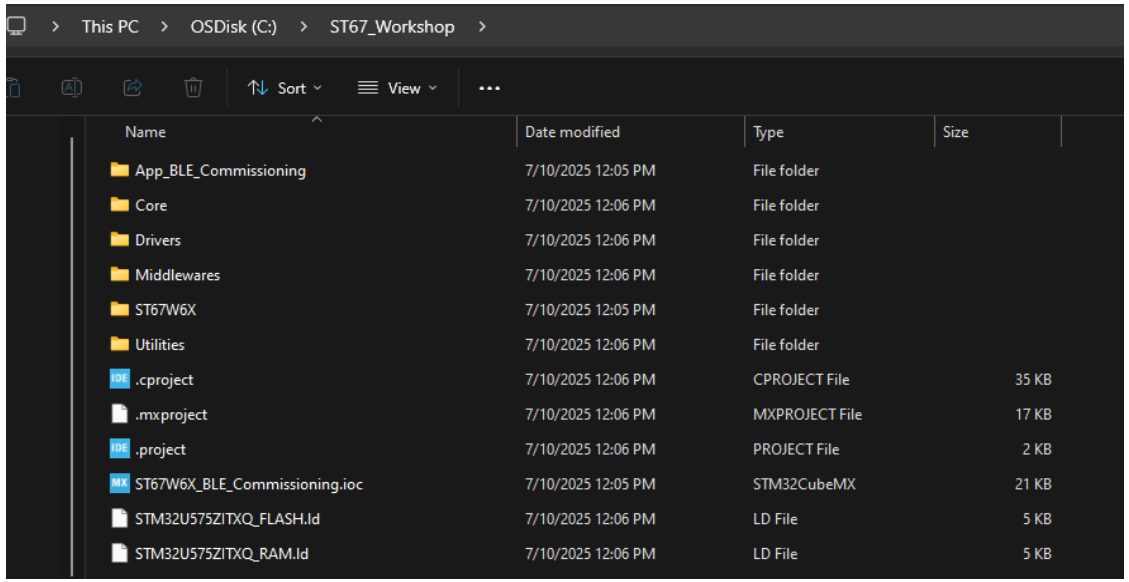
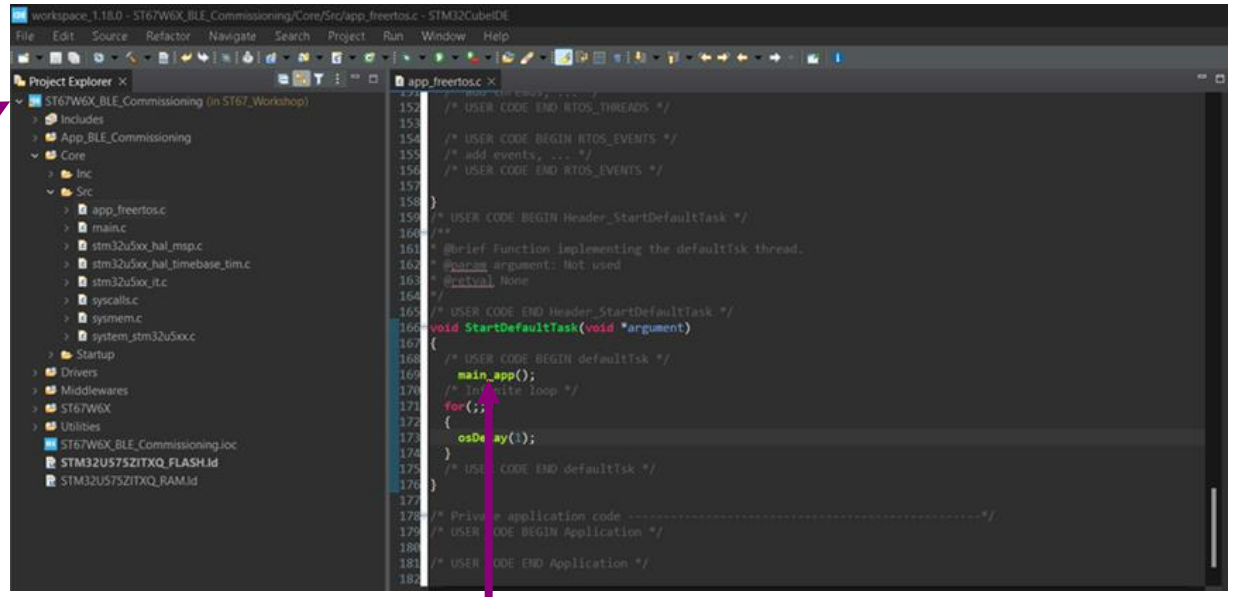
STM32CubeIDE



After, generating the code, you would view similar folder structure under ST67_Workshop

Load the project on the STM32CubeIDE



Call main_app() function under StartDefaultTask() in app_freertos.c file

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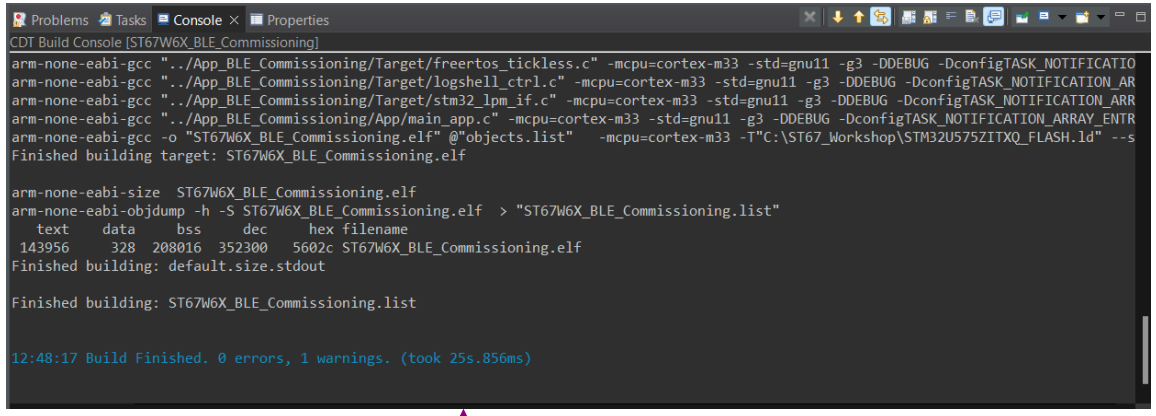
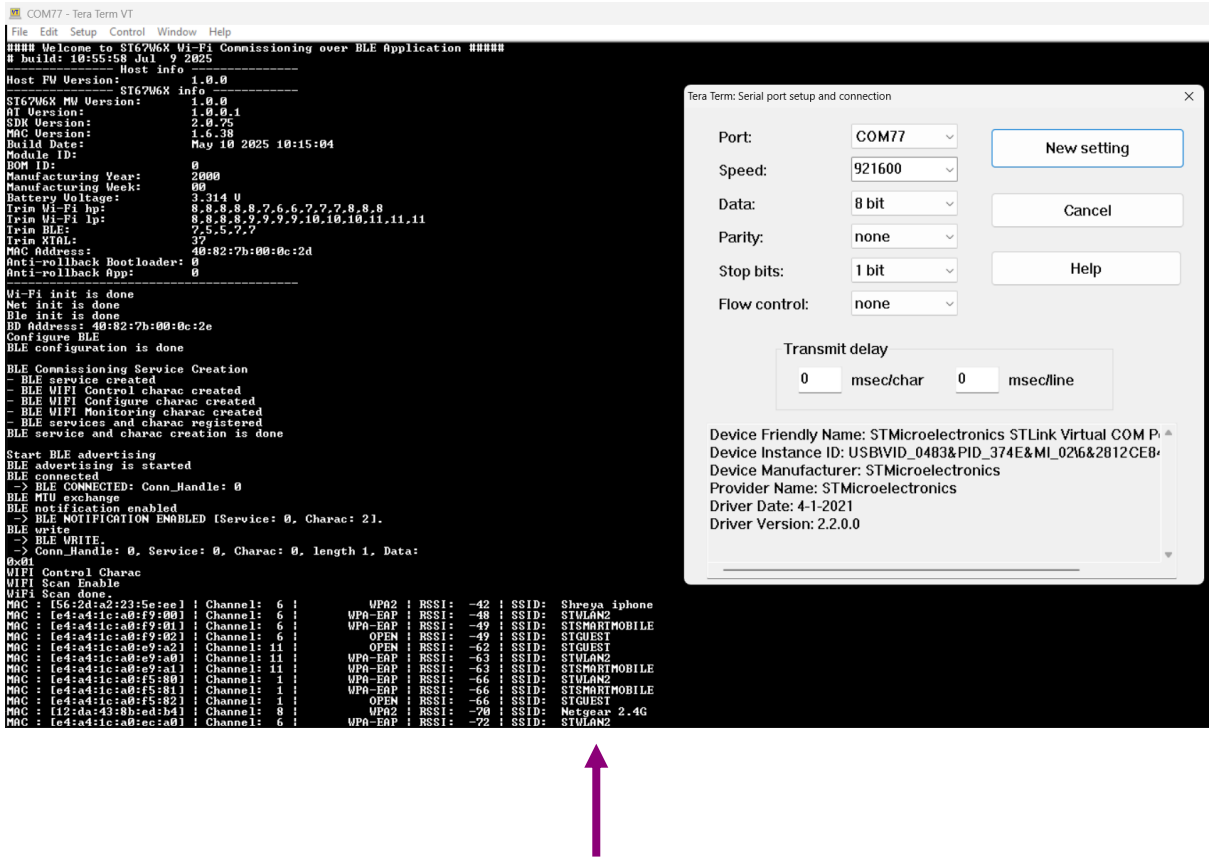
Time to build and flash



Console after building the application



Tera Term logs after flashing the BLE Commissioning application

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Porting to a new host processor using STM32CubeMX

Porting over new host processor(1/3)

1. **Select the Host MCU**

   Choose the target STM32 part number from the STM32CubeMX

2. **Check schematics of Host MCU and ST67**

   Review pin mappings for SPI, GPIO, USART

3. **Configure USART for Debugging**

   Used for debugging logs via STLink virtual port

4. **Configure the SPI Interface for Host MCU and ST67 communication**

   Set SPI pins, SPI mode

5. **Configure DMA Channels for SPI**

   Fast and reliable SPI data transfer, reducing CPU load during transmission

Porting over new host processor(2/3)

6. **Configure GPIO Pins** (CHIP_EN, SPI_RDY, SPI_CS, BOOT, User_Button)

   Set GPIO Mode, GPIO output level, GPIO Maximum Output speed

7. **Configure SYS** (Time base Source)
8. **Configure Clock**
9. **Enable FreeRTOS Middleware**

   Setup default task, heap size, stack size and required priorities

10. **Enable X-CUBE-ST67W61**

    Setup Application, W61 Drivers, Utilities

11. **Configure NVIC Interrupt Settings**

    SPI, DMA, USART, EXTI

Porting over new host processor(3/3)

12. Project Creation and Code Generation

Generate project files (STM32CubeIDE/IAR)

Open in IDE for application development

13. Application Entry: Call main_app()

Inside StartDefaultTask, invoke main_app()

This initializes ST67W6X Driver, ST67W6X Wi-Fi module, ST67W6X Network module, Application specific functions

14. Build and Flash the application

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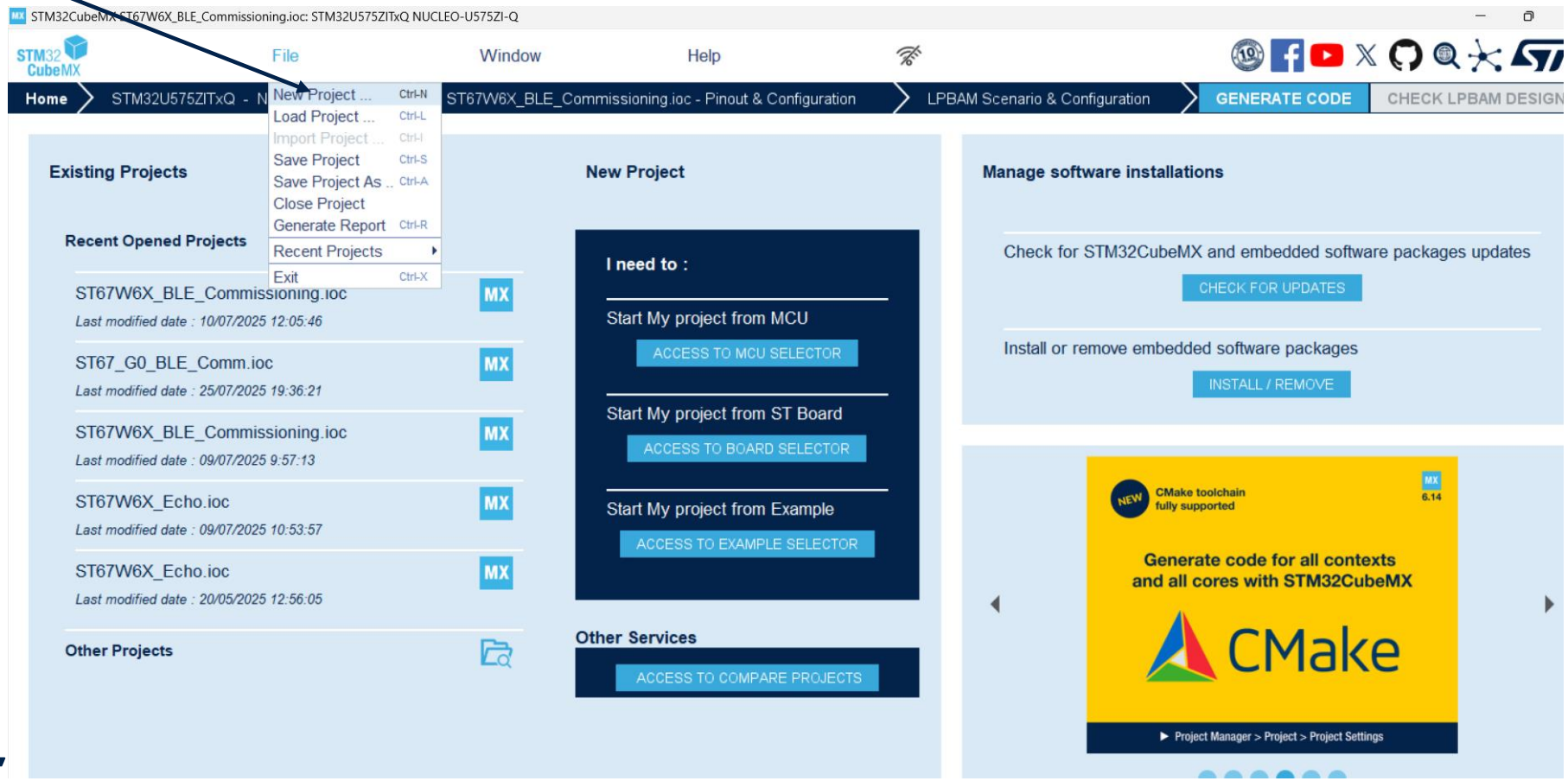
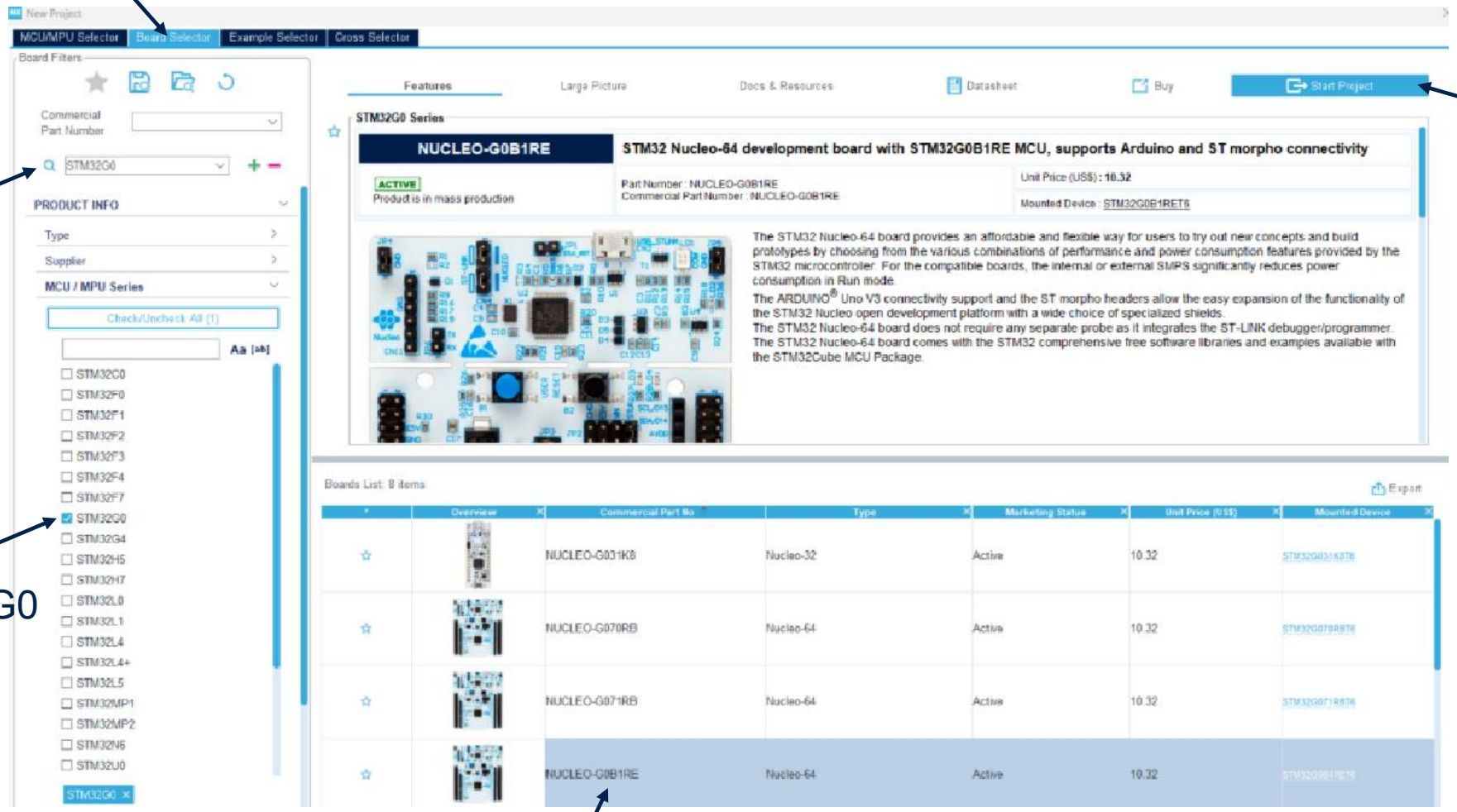
Generating BLE Commissioning app using NUCLEO-G0B1RE as host processor (Walk-through)

Case 3: Generating BLE Commissioning app using NUCLEO-G0B1RE as host processor

Open STM32CubeMX and create the new project.



Select the board selector



Type STM32G0

Start Project

Select STM32G0

Select NUCLEO-G0B1RE

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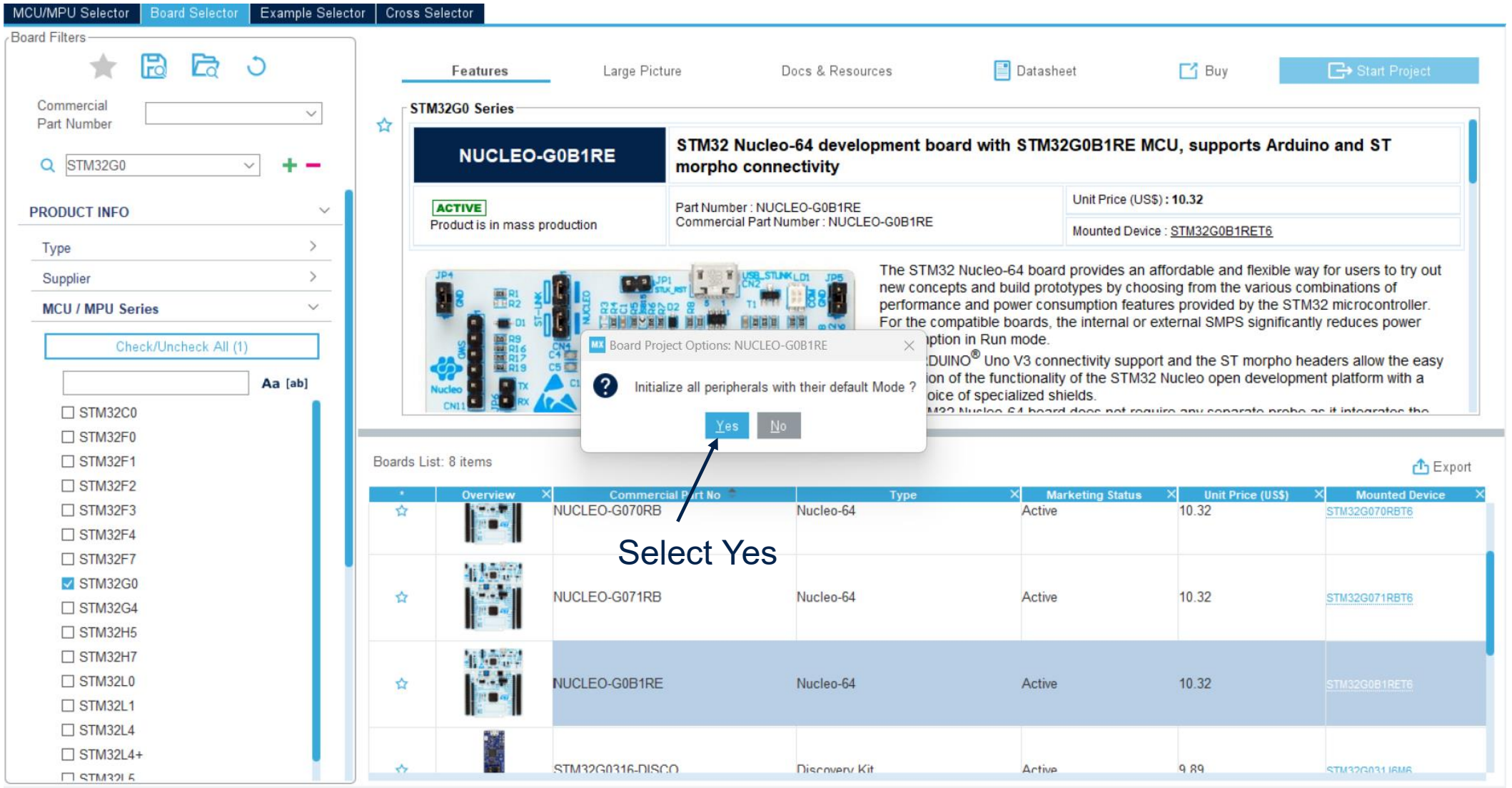

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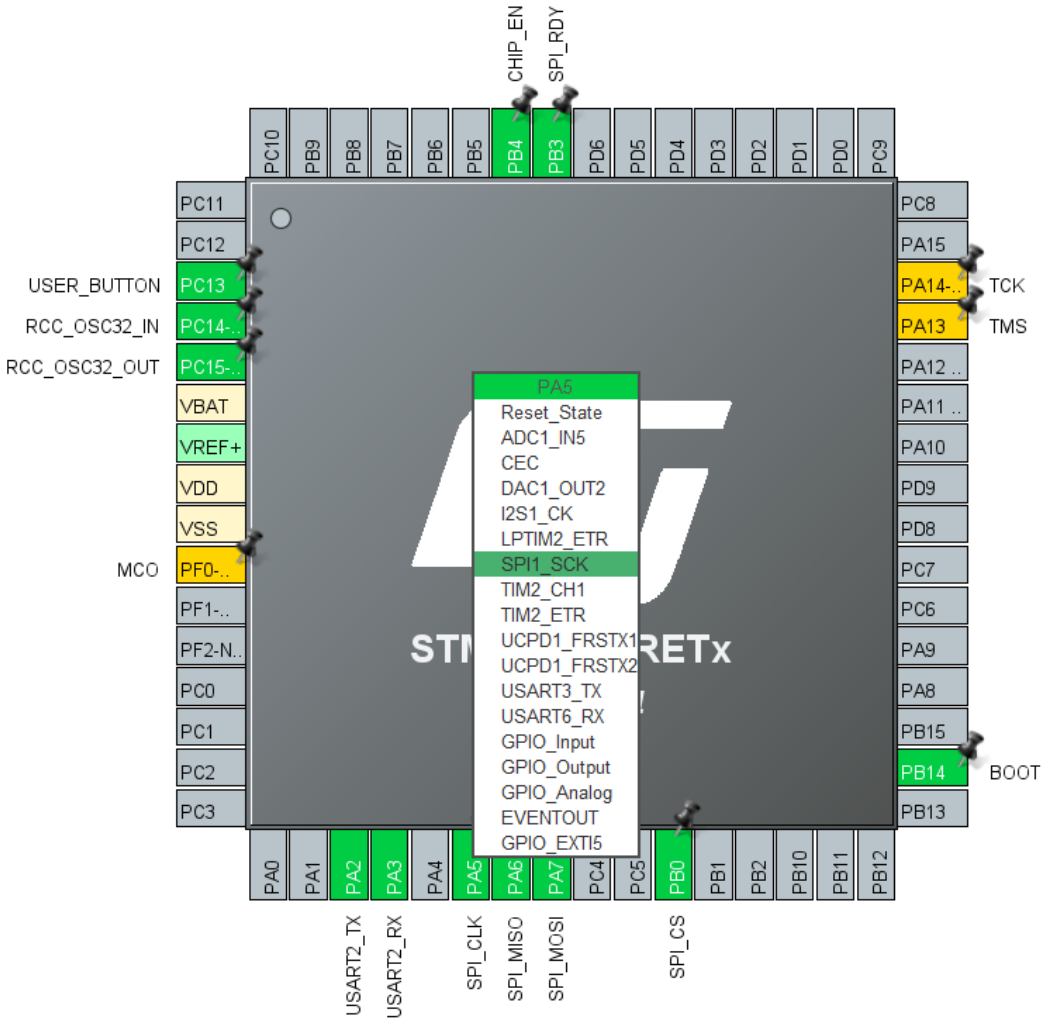
Pinout

When generating an application from scratch and if X-Nucleo-67W61M1 is used, the pinout must be set in accordance with the ST67W61M1 Arduino interfaces.

Pin function	Arduino Connector	STM32G0 Pin	GPIO mode	GPIO pull mode	GPIO speed
SPI_CLK	CN5.D13	PA5	AF PP	No Pull	Very high
SPI_MISO	CN5.D12	PA6	AF PP	No Pull	Very high
SPI_MOSI	CN5.D11	PA7	AF PP	No Pull	Very high
SPI_CS	CN5.D10	PB0	Output PP	No Pull	high
USER_BUTTON	-	PC13	EXTI Falling	Pull-up	N/A
CHIP_EN	CN9.D5	PB4	Output PP	No Pull	High
BOOT	CN9.D6	PB14	Output PP	No Pull	Low
SPI_RDY	CN9.D3	PB3	EXTI Falling/Rising	No Pull	N/A

Assigning functionality



For assigning, click on the pin and select functionality.
(e.g) PA5->SPI_SCK

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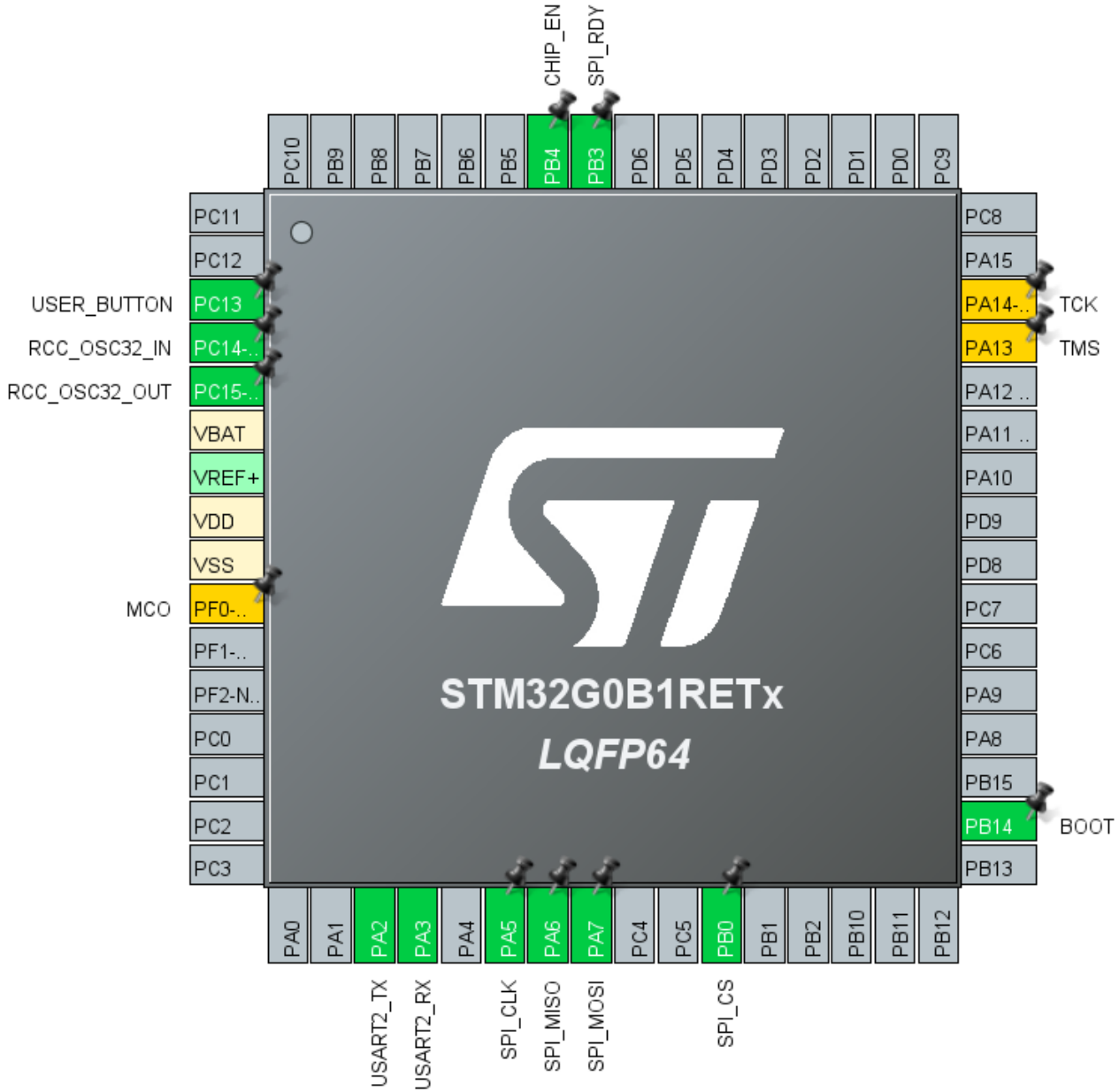
Pinout View

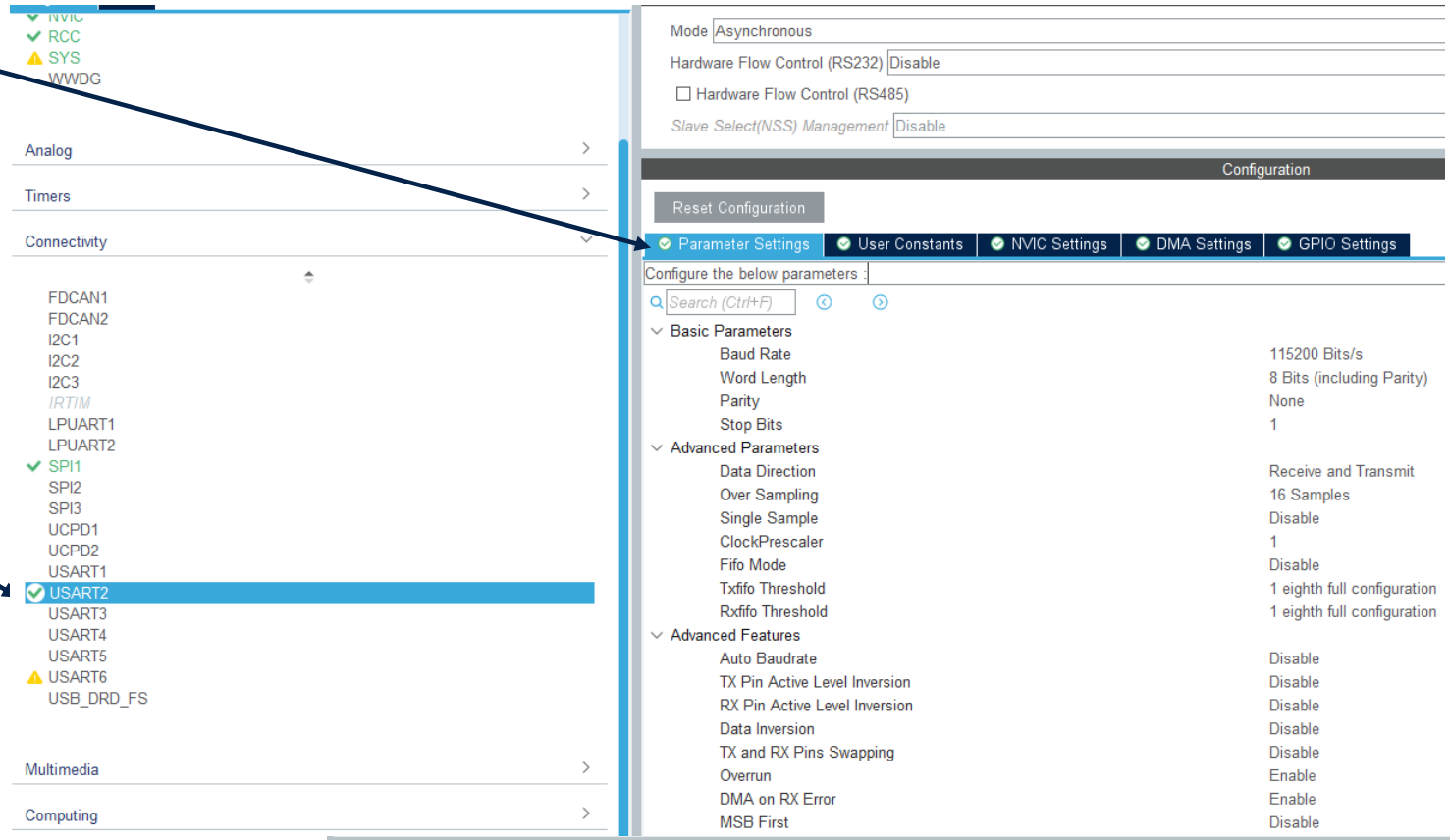


After, assigning all the pins mentioned from the pin out table, this would be overall pinout view

UART GPIO(USART 2)

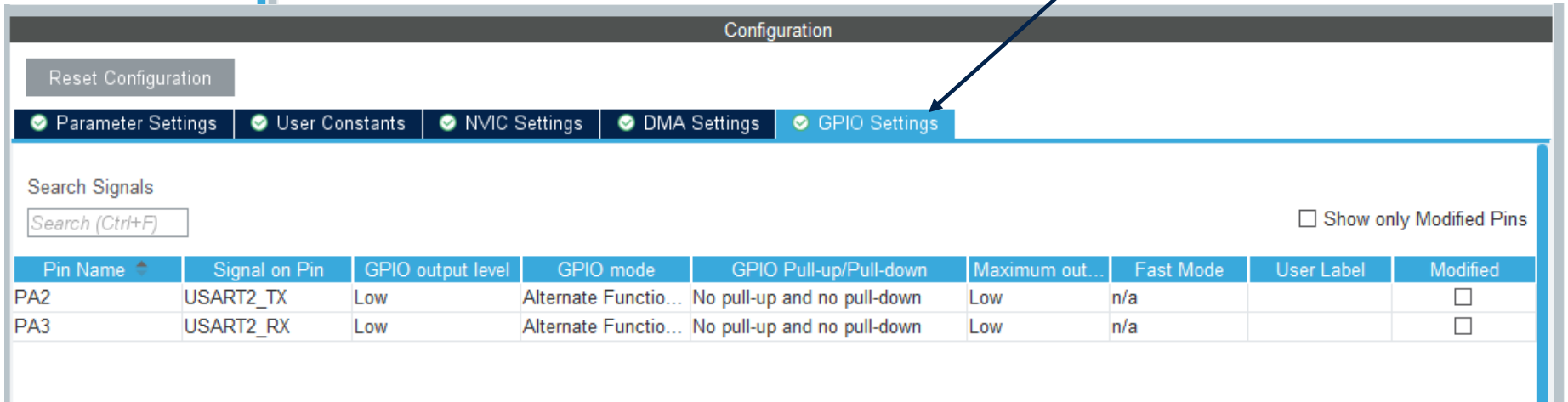
Parameter Settings

Select USART2



PA2: USART2_TX
PA3: USART2_RX

GPIO Settings



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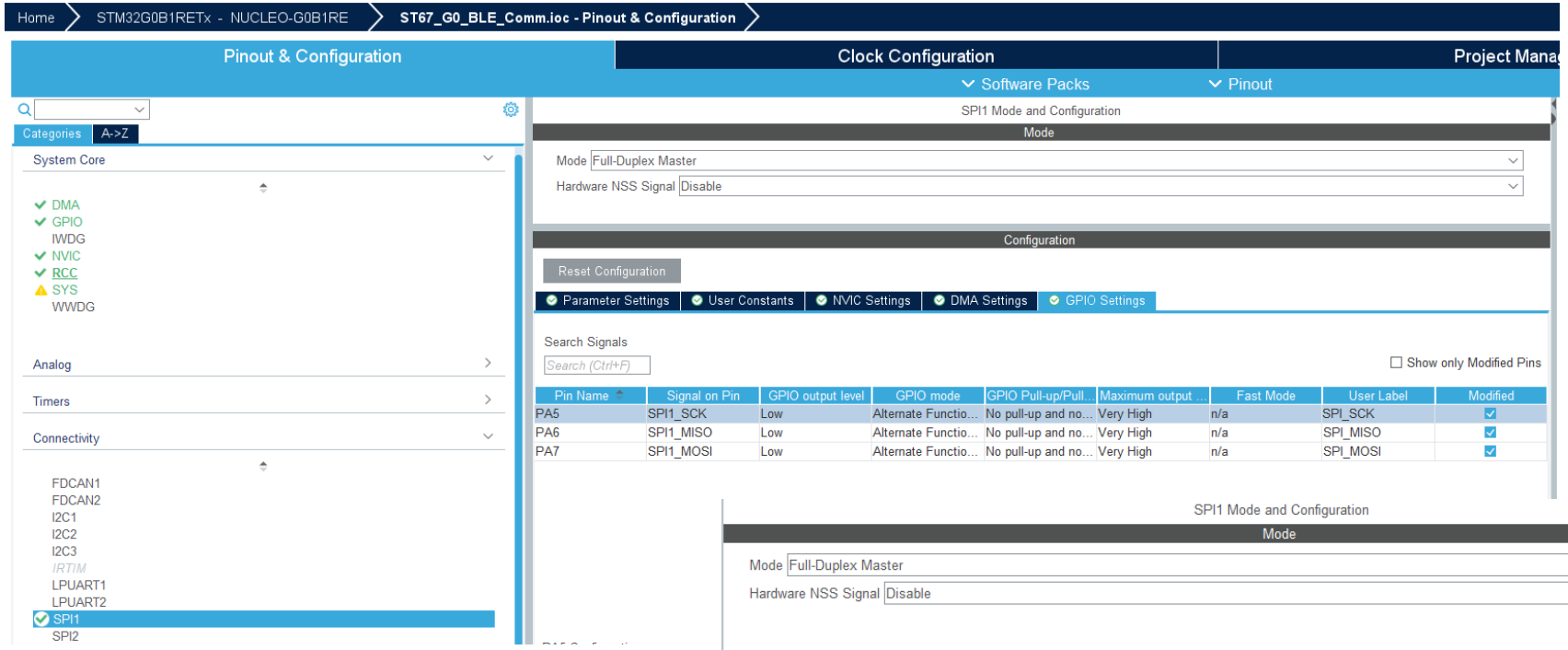
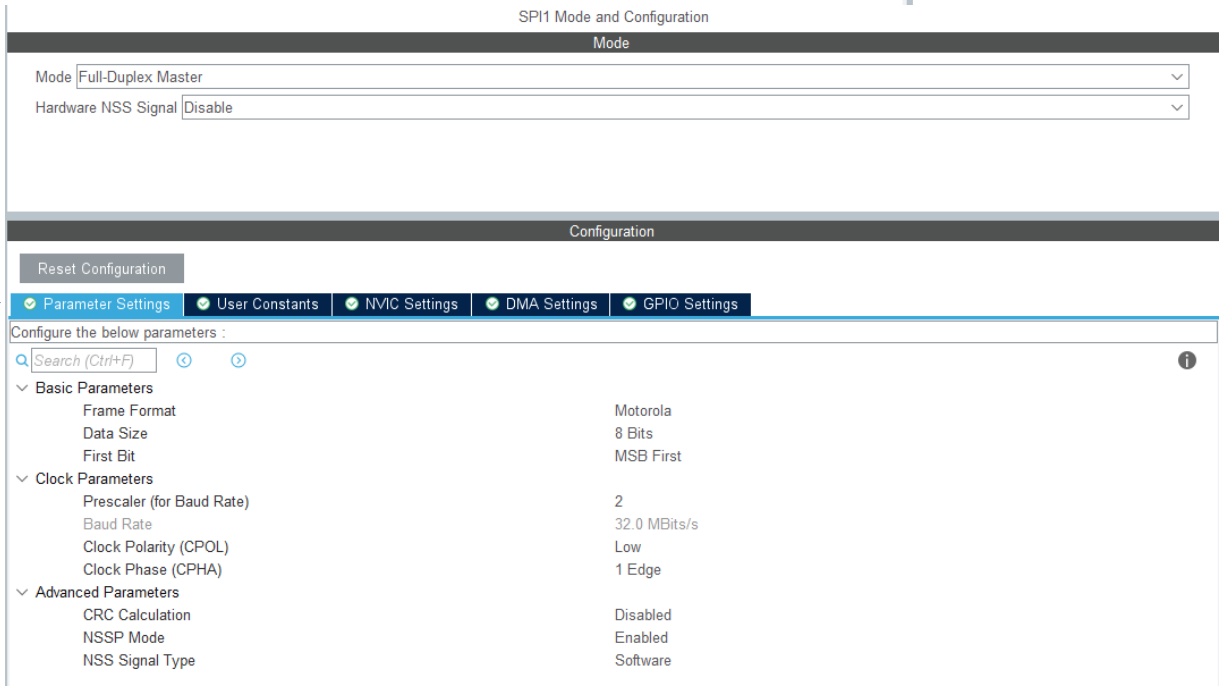
SPI GPIO(SPI1)

PA5: SPI_SCK
PA6: SPI_MISO
PA7: SPI_MOSI

Select SPI1





Parameter settings

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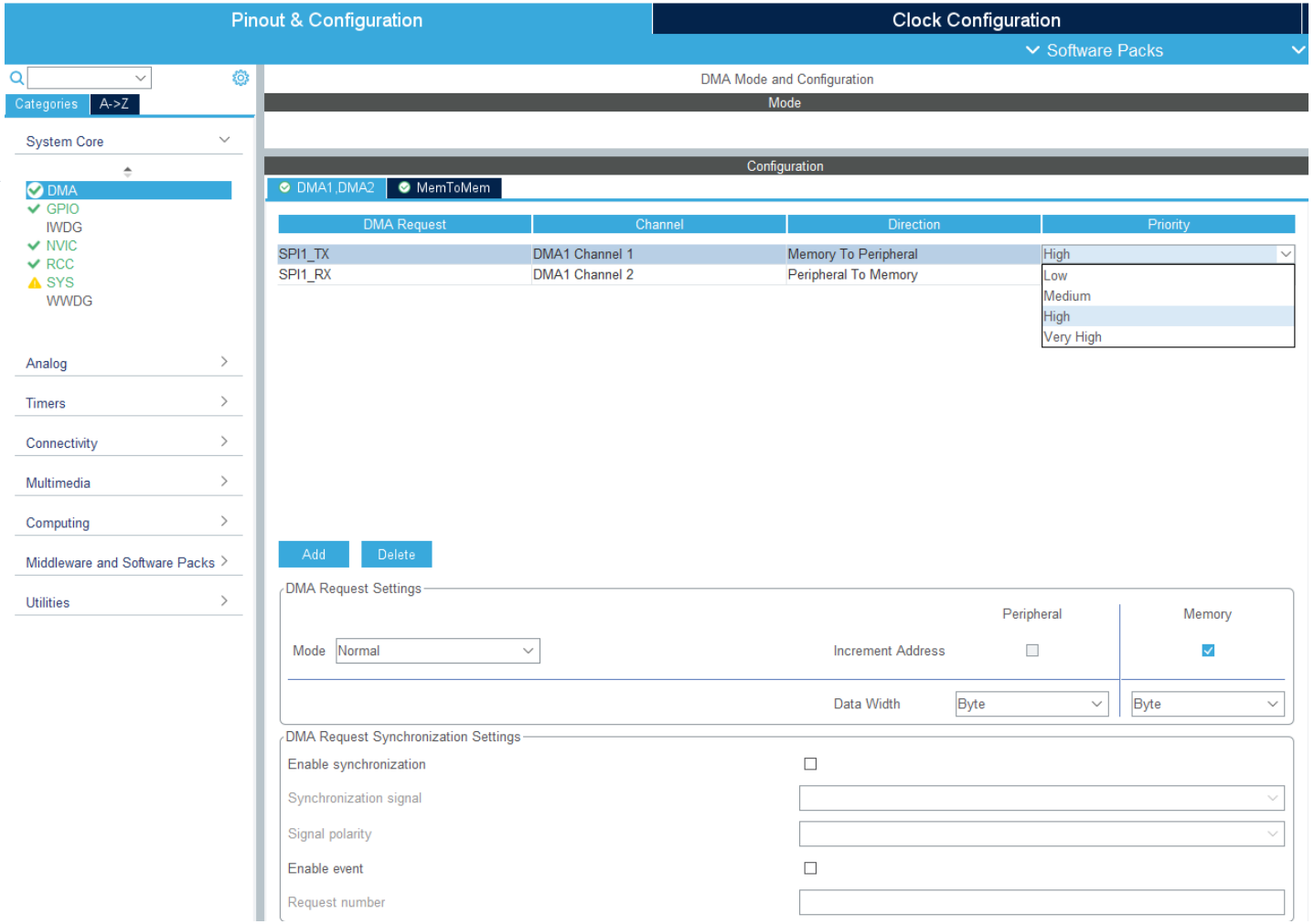
DMA Channels

Select DMA



SPI1_TX -> DMA1 CHANNEL 1->High
SPI1_RX -> DMA1 CHANNEL 2-> High

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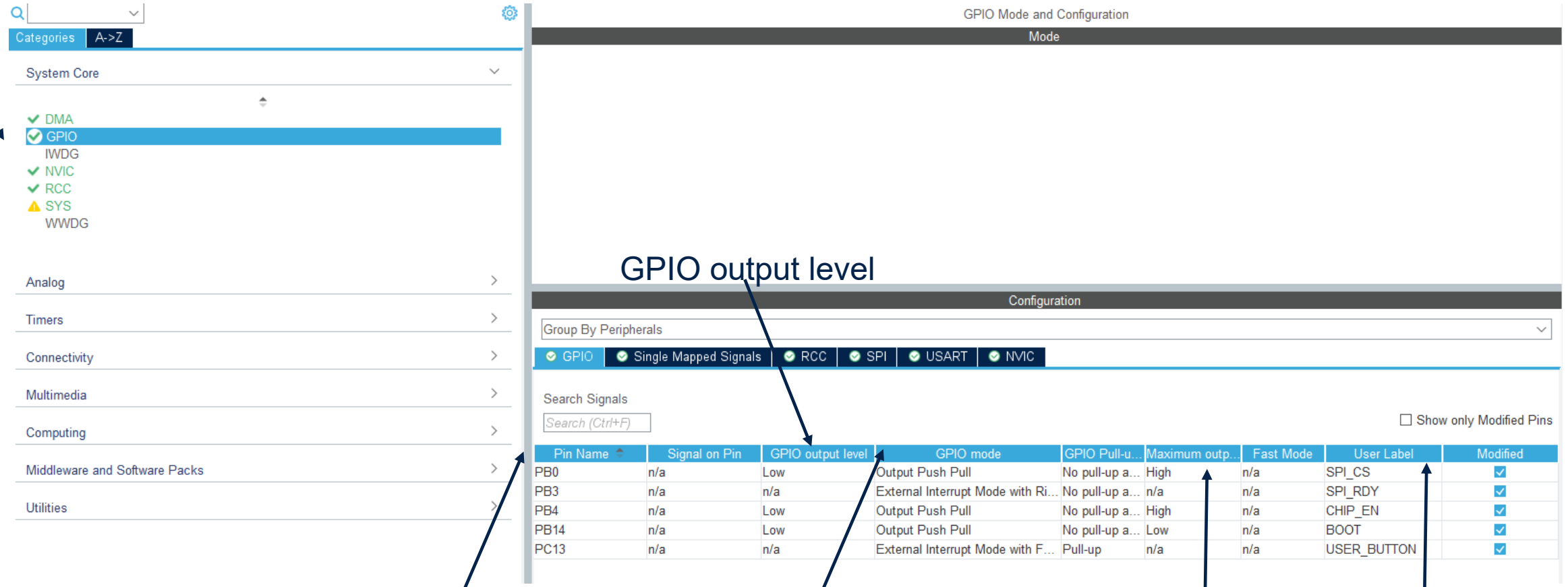
GPIO

Select GPIO



GPIO output level

GPIO pin names

GPIO mode

GPIO Maximum Output speed

GPIO User label

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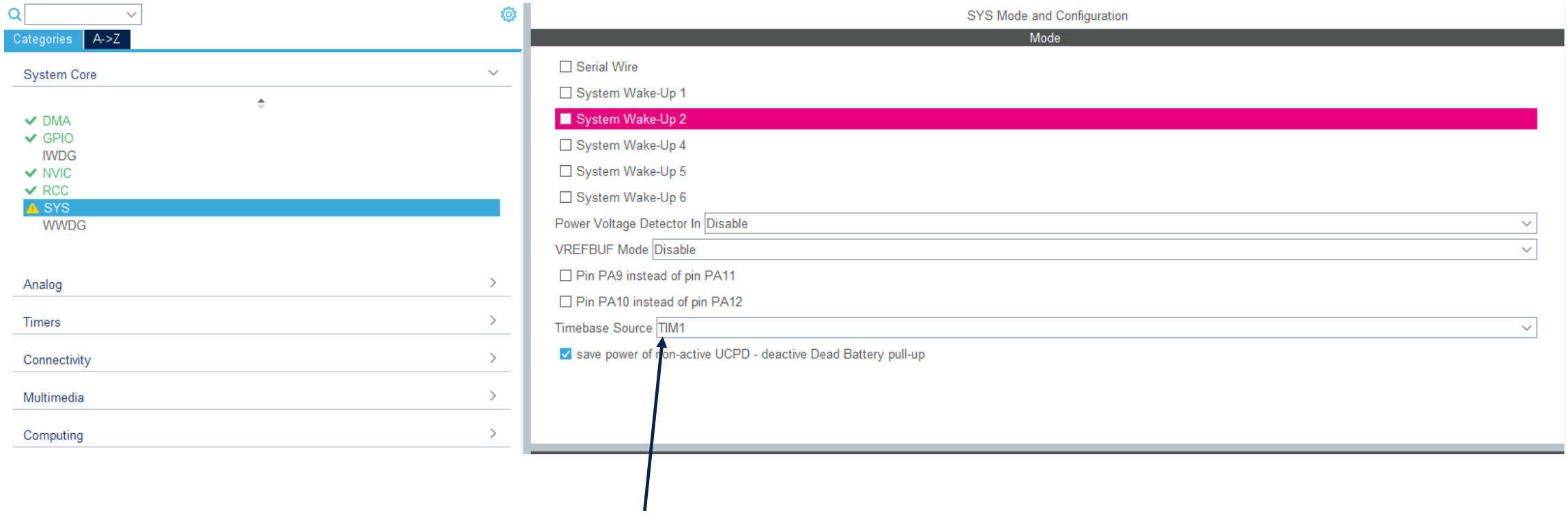
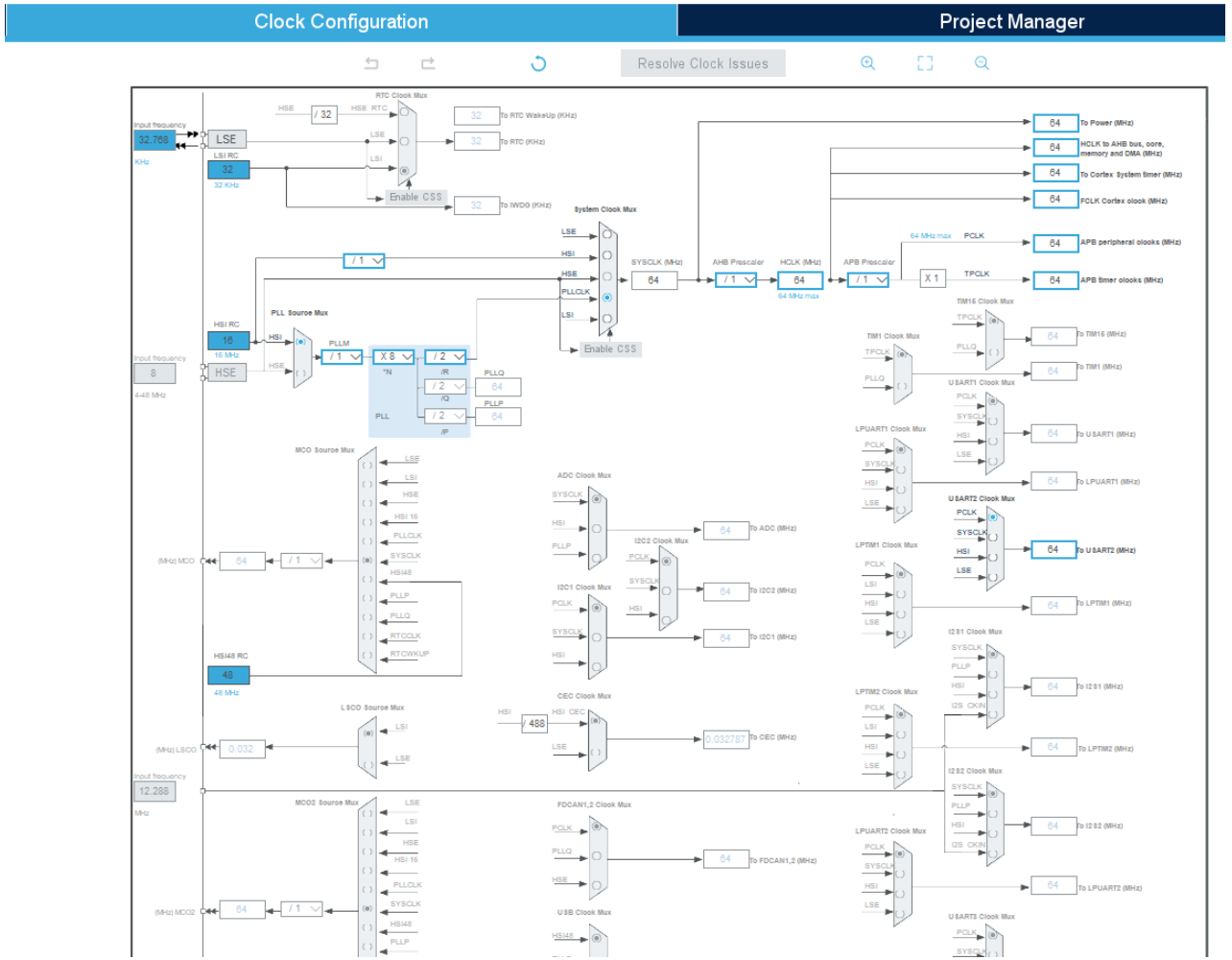
Timer



Sys mode configuration: TIM1 in place of systick

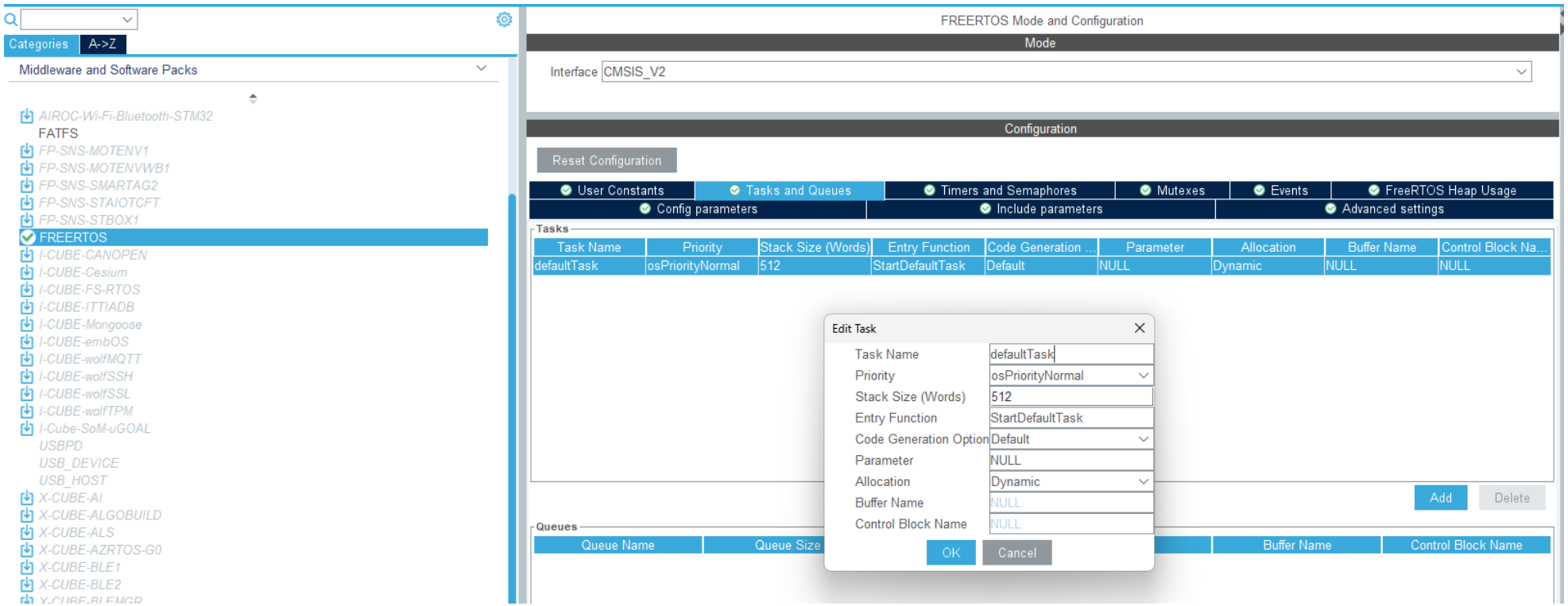
Clock Configuration

- In the "Clock Configuration" panel, system clock is set to the maximum frequency of 64 MHz, which increases the SPI clock speed to 32 MHz.



Middleware & Software Packs
FreeRTOS

- FreeRTOS component can be either be selected from Middleware (FREERTOS) or from the Software Pack (X-CUBE-FREERTOS) depending on the chosen STM32.
- By default, the stack size of the default task defined by STM32CubeMx tool is equal to 128 words. The application default task required **512 words**.



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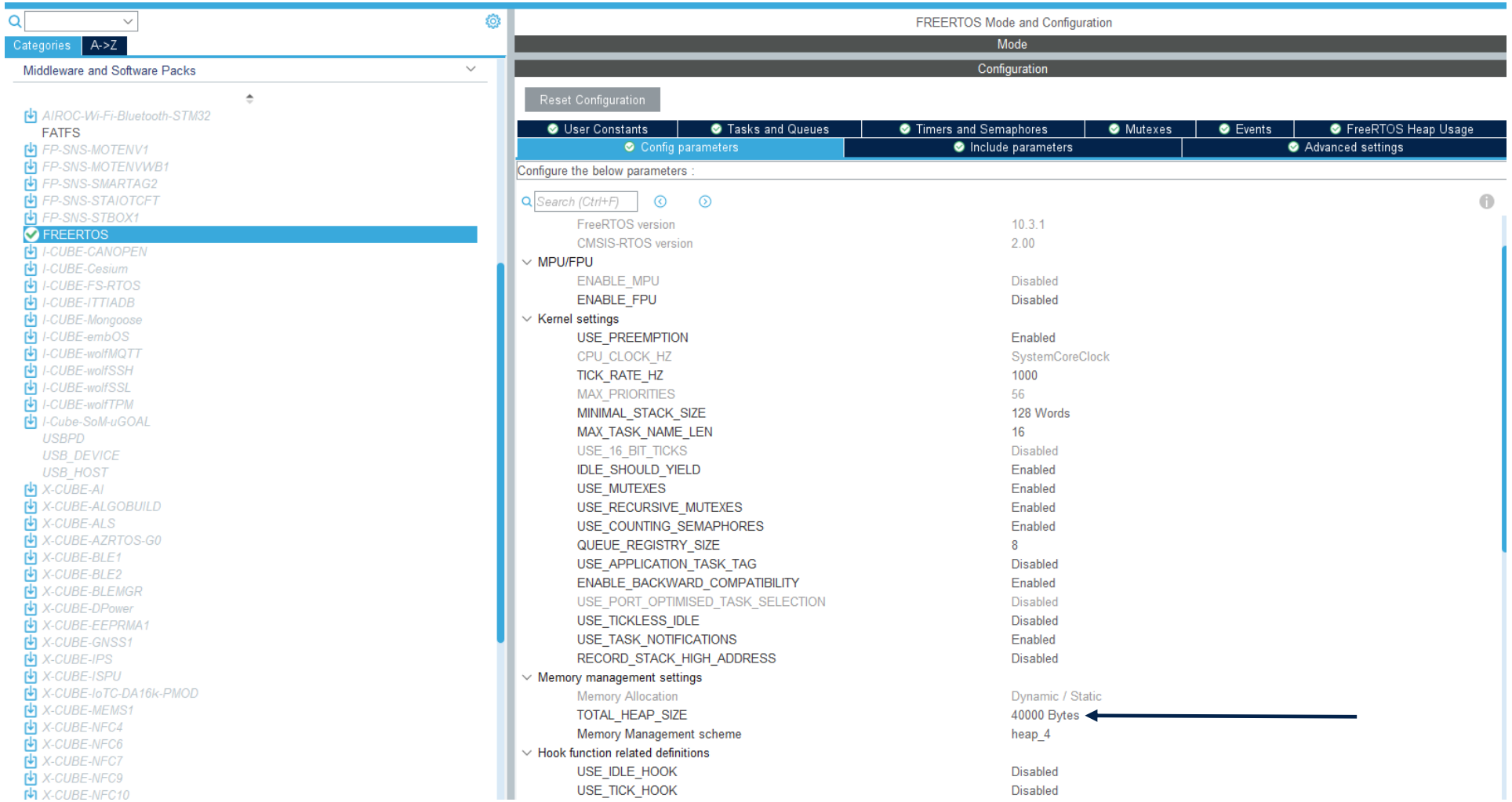
Middleware & Software Packs FreeRTOS

- Adjust heap :The size heap value should be set at least to 40Kbytes. To optimize the memory, this value could be adjusted during integration and validation tests of the application



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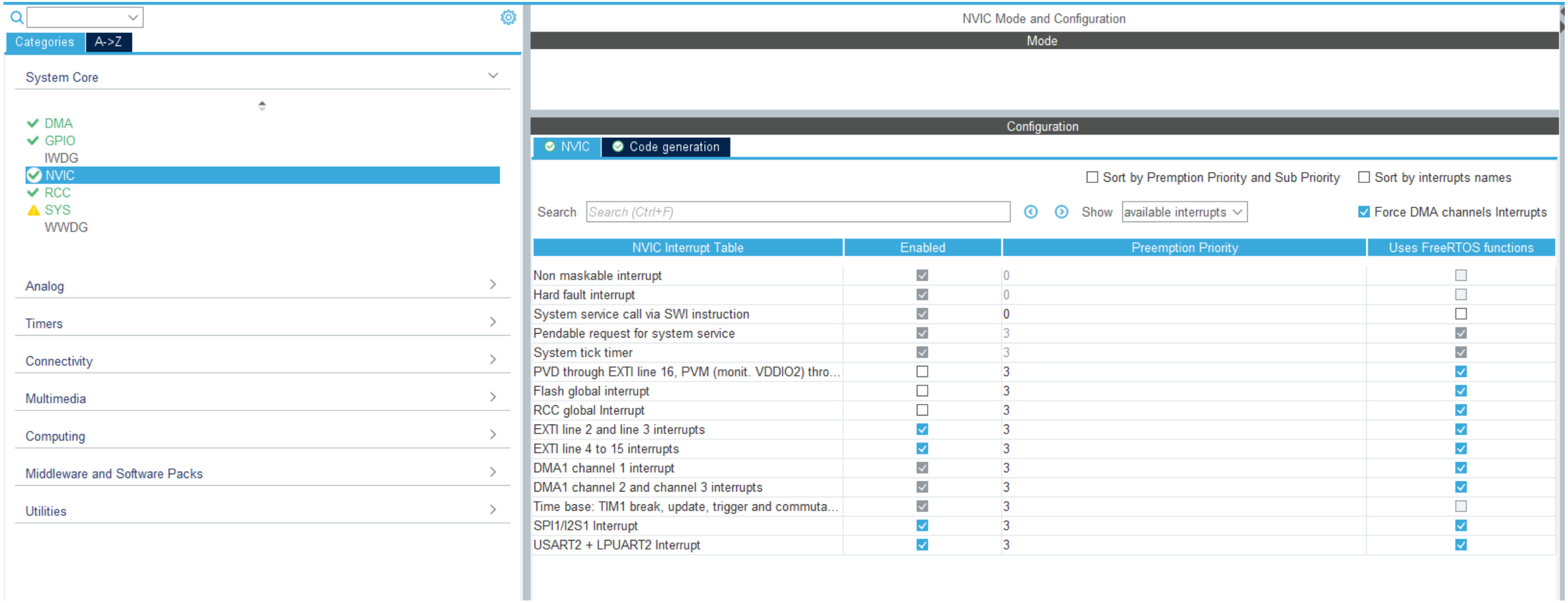
NVIC



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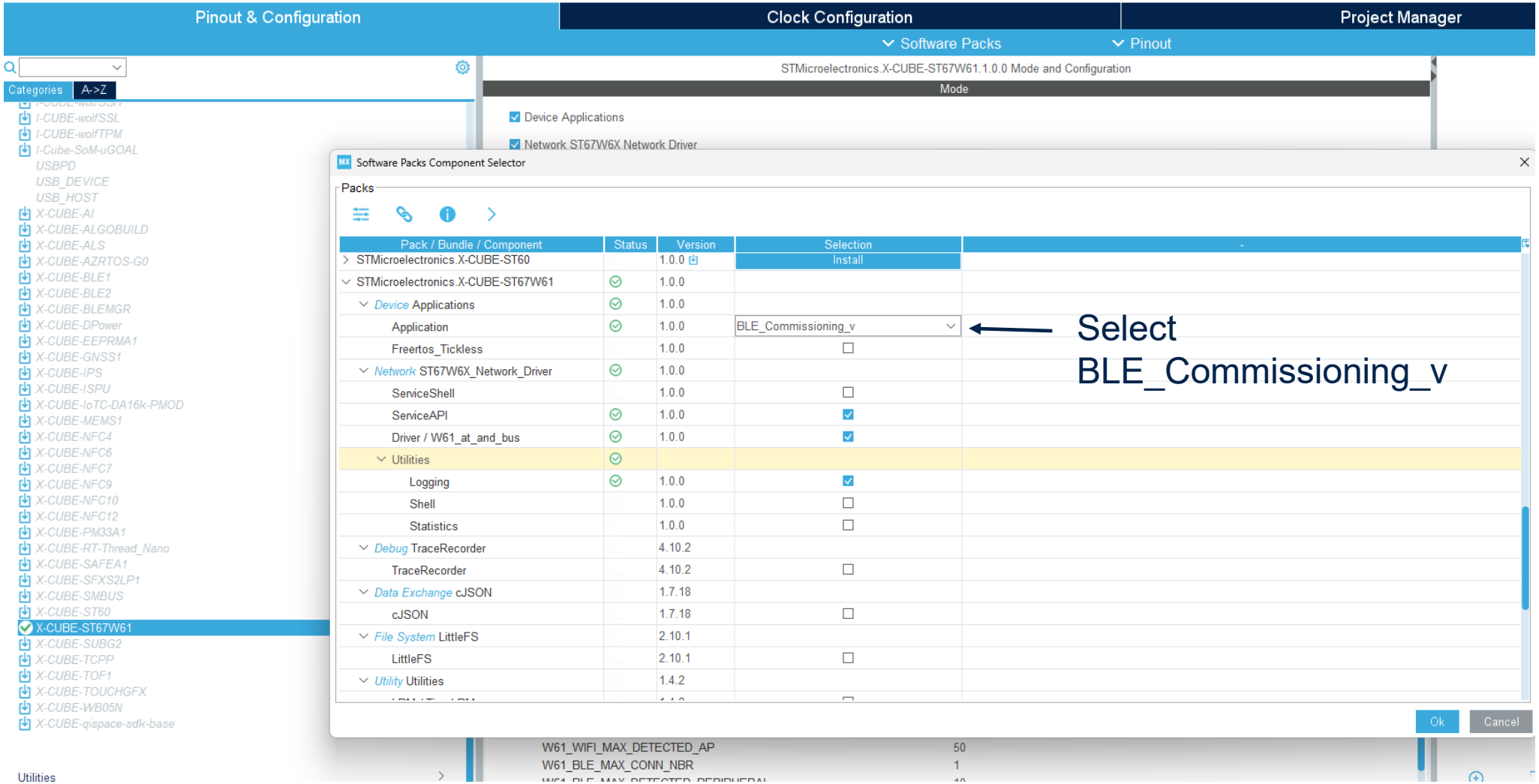
Middleware & Software Packs
X-CUBE-ST67W61 Software package



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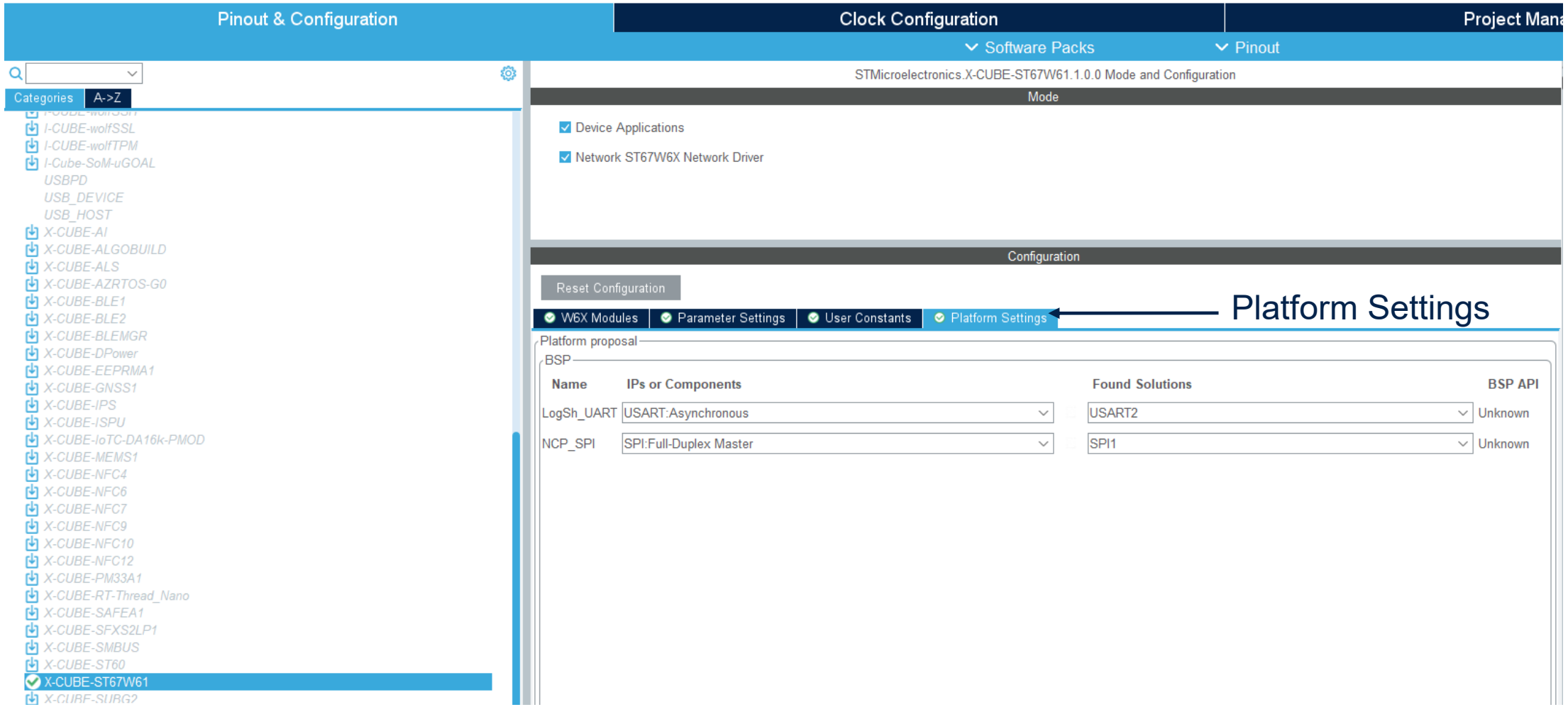
Middleware & Software Packs
X-CUBE-ST67W61 Software package



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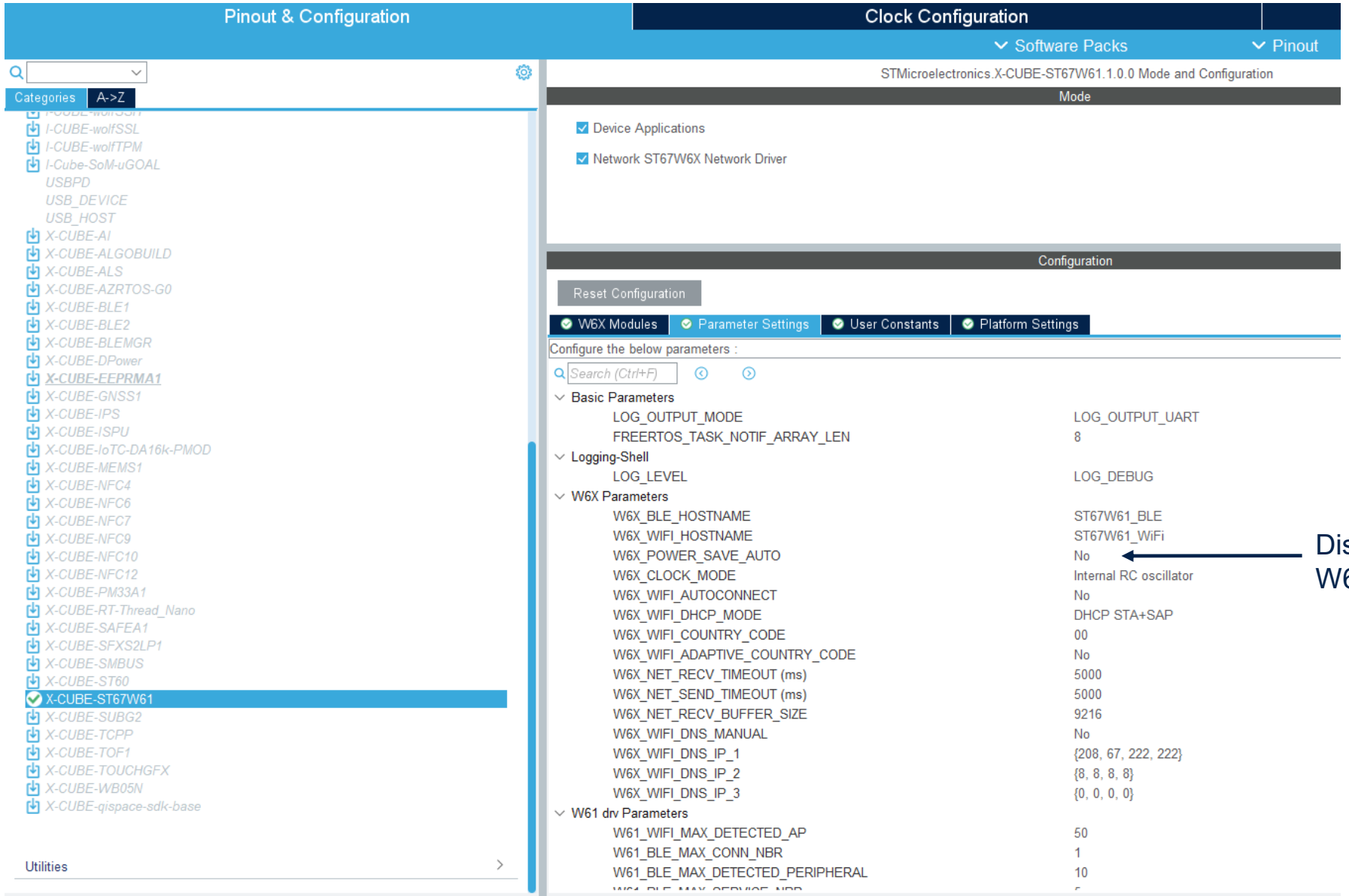
Middleware & Software Packs
X-CUBE-ST67W61 Software package



Disable
W6X_POWER_SAVE_AUTO

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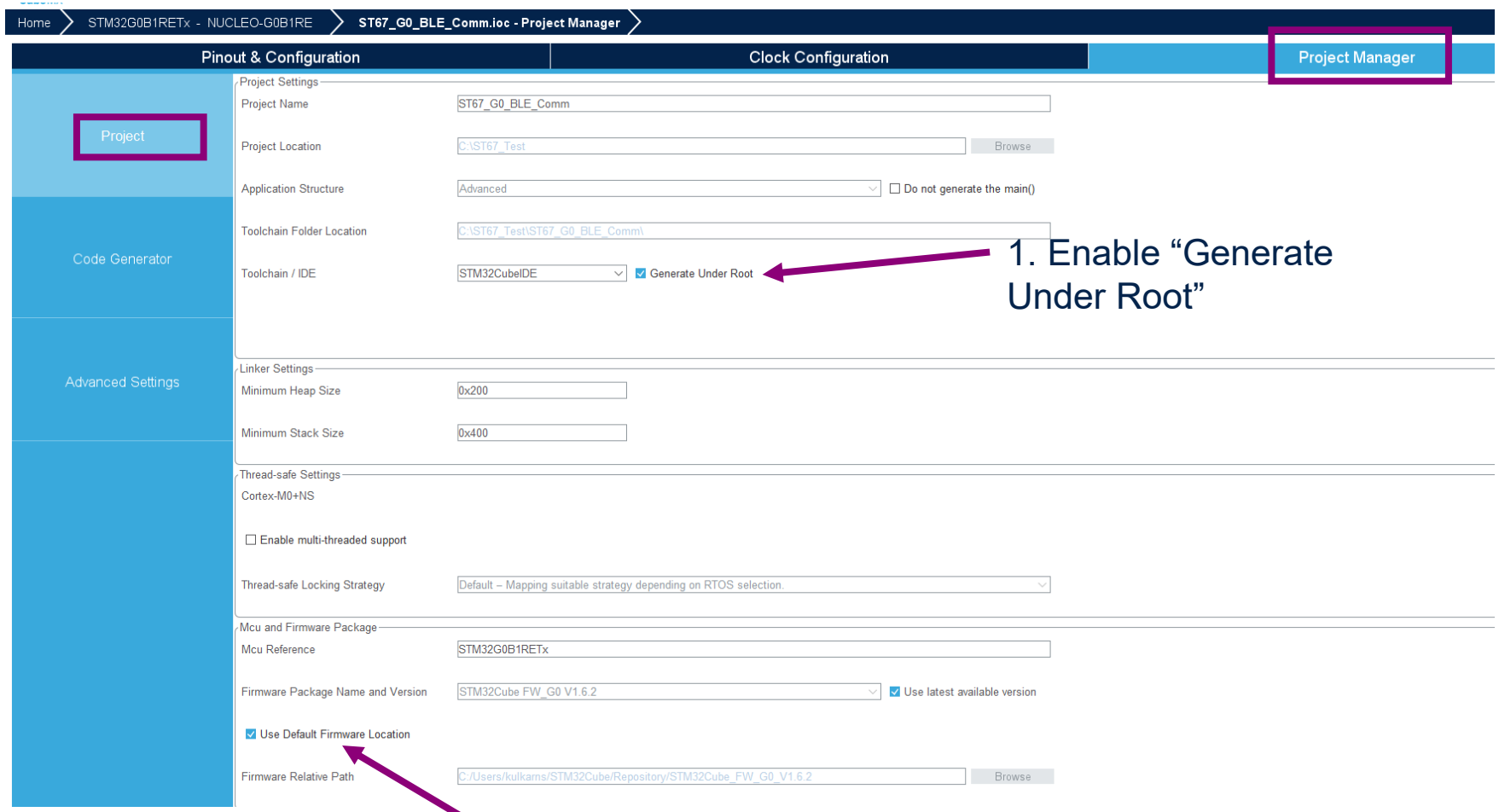
Project Creation



1. Enable “Generate Under Root”

2. Enable “ Use Default Firmware Location”

Here, we are enabling the Flat directory structure: (i.e. Driver and MW directories copied into your project directory)

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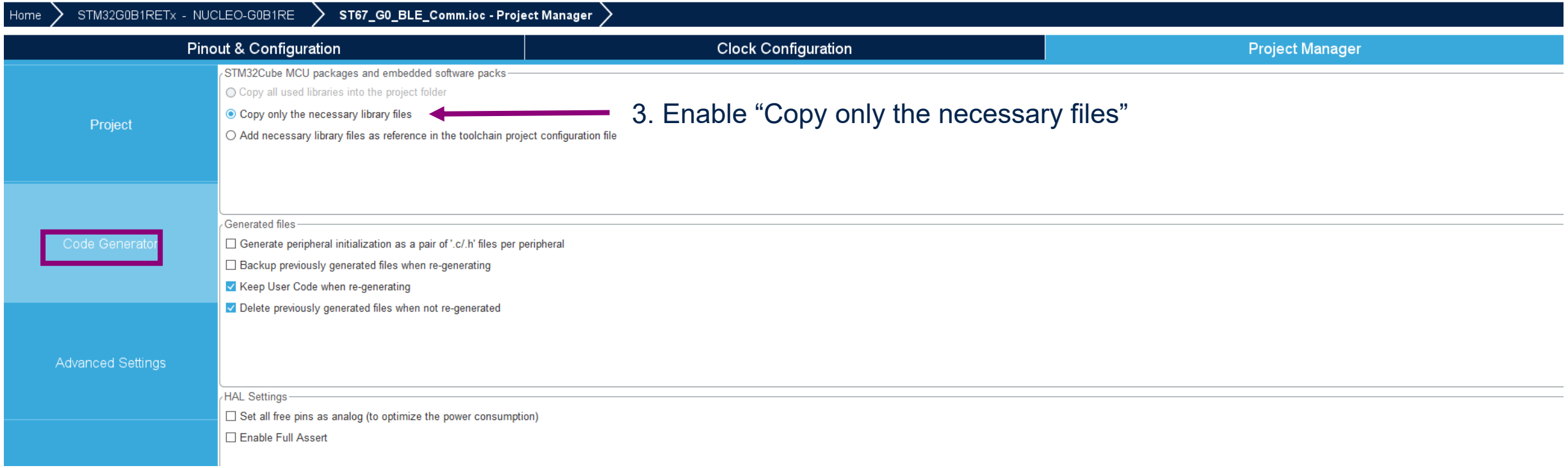
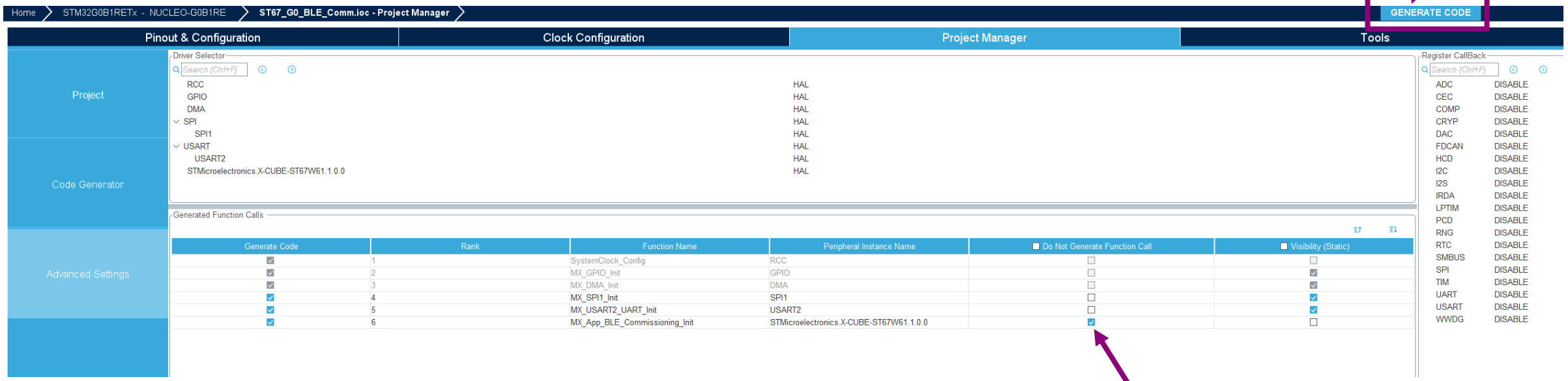
Project Creation



Generate Code

5. Generate Code



4. Enable this option
(here: we are not generating
this function call)

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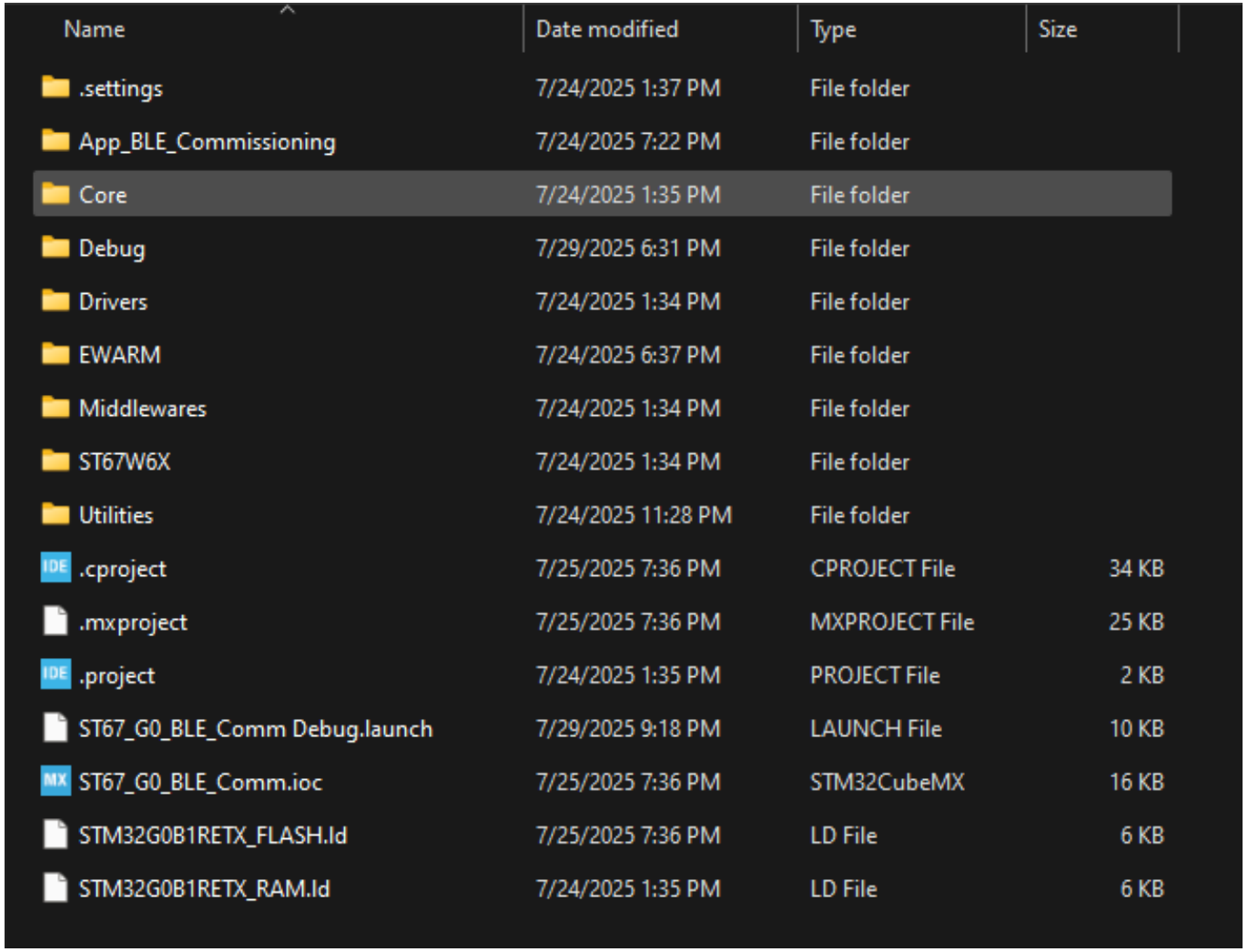
Folder Structure



Name	Date modified	Type	Size
.settings	7/24/2025 1:37 PM	File folder	
App_BLE_Commissioning	7/24/2025 7:22 PM	File folder	
Core	7/24/2025 1:35 PM	File folder	
Debug	7/29/2025 6:31 PM	File folder	
Drivers	7/24/2025 1:34 PM	File folder	
EWARM	7/24/2025 6:37 PM	File folder	
Middlewares	7/24/2025 1:34 PM	File folder	
ST67W6X	7/24/2025 1:34 PM	File folder	
Utilities	7/24/2025 11:28 PM	File folder	
.cproject	7/25/2025 7:36 PM	CPROJECT File	34 KB
.mxproject	7/25/2025 7:36 PM	MXPROJECT File	25 KB
.project	7/24/2025 1:35 PM	PROJECT File	2 KB
ST67_G0_BLE_Comm Debug.launch	7/29/2025 9:18 PM	LAUNCH File	10 KB
ST67_G0_BLE_Comm.ioc	7/25/2025 7:36 PM	STM32CubeMX	16 KB
STM32G0B1RETX_FLASH.ld	7/25/2025 7:36 PM	LD File	6 KB
STM32G0B1RETX_RAM.ld	7/24/2025 1:35 PM	LD File	6 KB

Folder structure view after generating the code from CubeMX

- App code
- Core
- Drivers
- Middlewares
- ST67W6X
- Utilities

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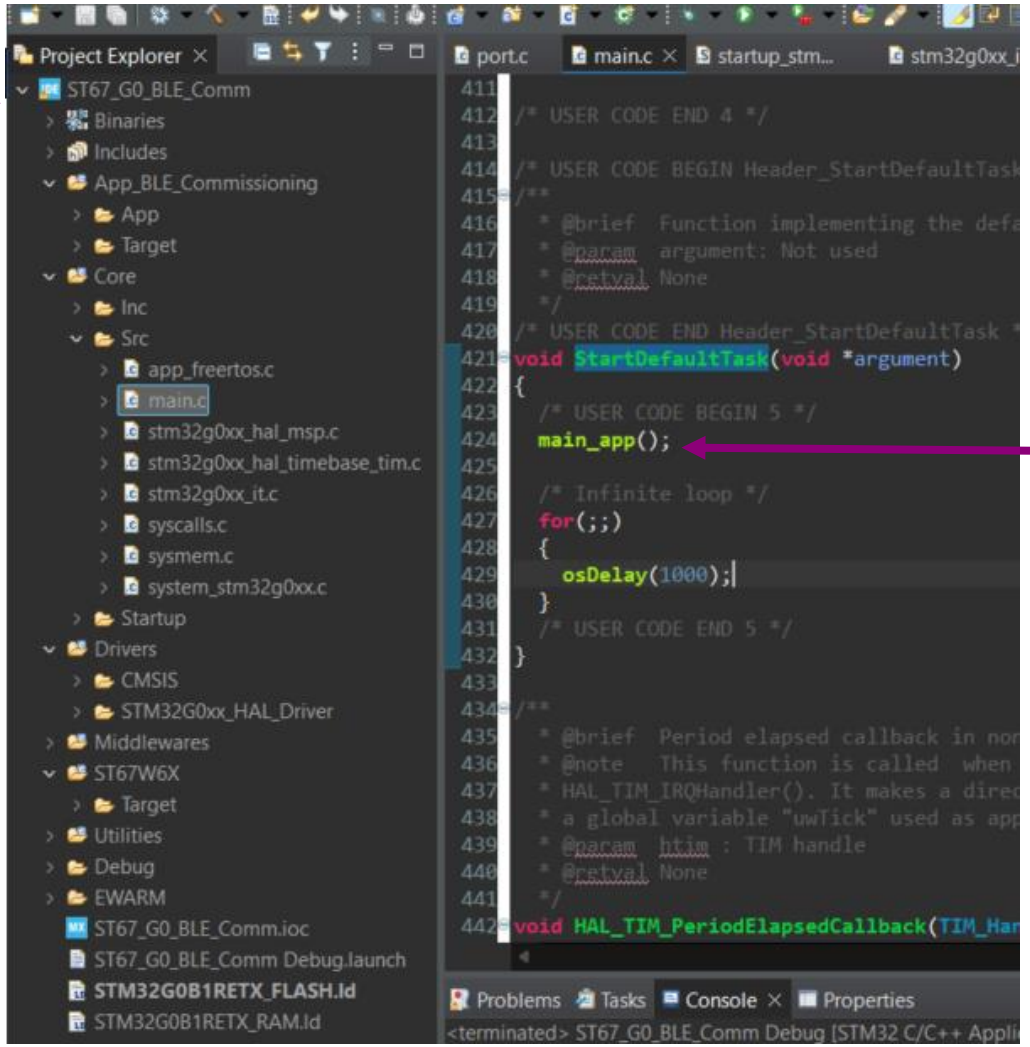
STM32CubeIDE

Load the project on the STM32CubeIDE



Call main_app() function under StartDefaultTask() in main.c file

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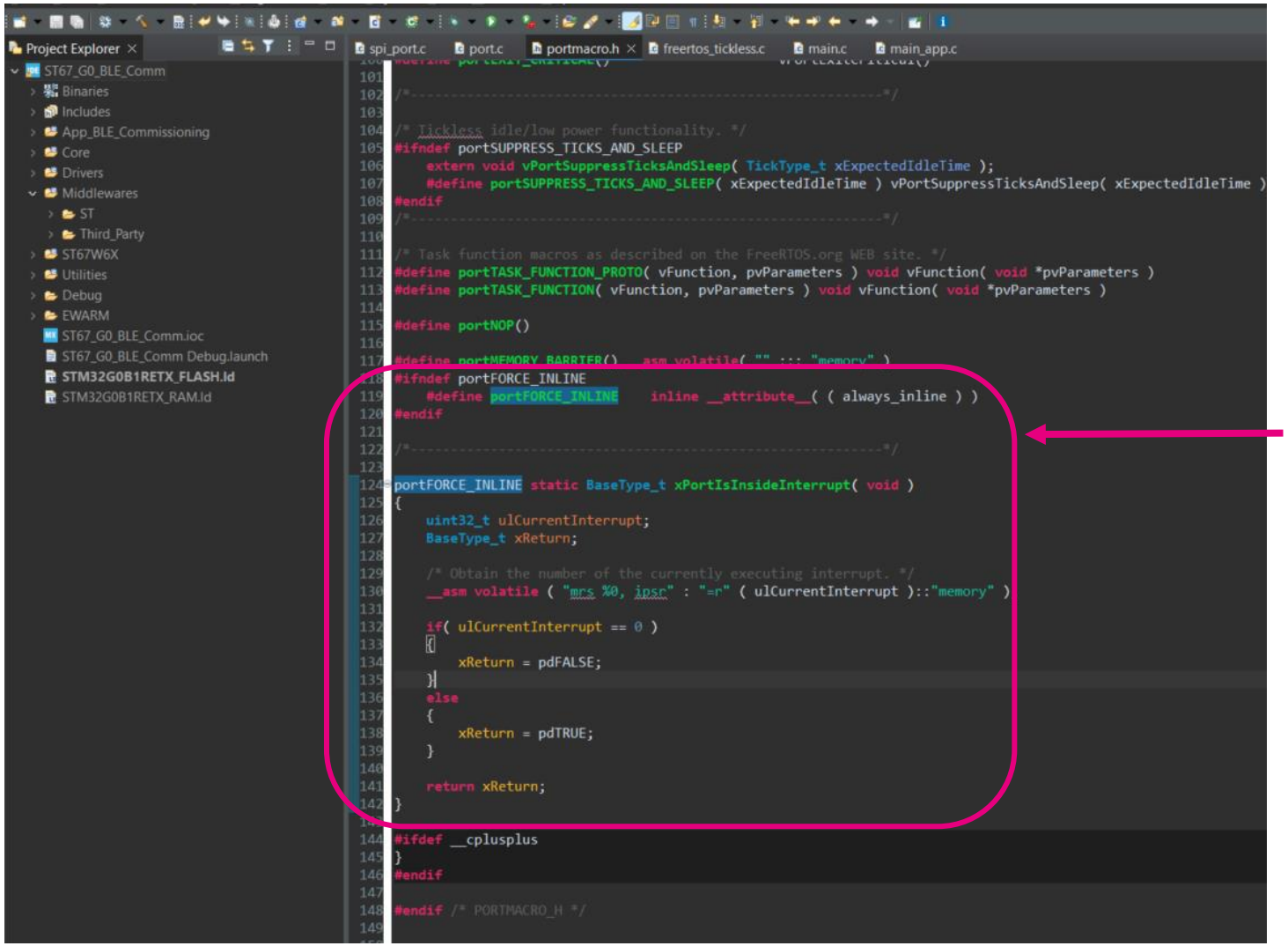
xPortIsInsideInterrupt()

- If the used device embeds an Arm® Cortex®M0+ (e.g. STM32G0) and its FreeRTOS version is older than of V10.6, definition below **must be added manually after project has been generated**.
- The below function definition must be added in the **portmacro.h** file (Project/Middlewares/Third_Party/ FreeRTOS/ Source/Portable/ARM_CM0)

```
#define portINLINE                __inline
#ifndef portFORCE_INLINE
     #define portFORCE_INLINE    inline __attribute__( ( always_inline ) )
#endif

portFORCE_INLINE static BaseType_t xPortIsInsideInterrupt( void )
{
uint32_t ulCurrentInterrupt;
BaseType_t xReturn;
/* Obtain the number of the currently executing interrupt. */
__asm volatile ( "mrs %0, ipsr" : "=r" ( ulCurrentInterrupt )::"memory" );
if( ulCurrentInterrupt == 0 )
{
  xReturn = pdFALSE;
}
else
{
  xReturn = pdTRUE;
}
  return xReturn;
}
```

STM32CubeIDE



Call xPortIsInsideInterrupt() function under portmacro.h file

IMP: As we are using G0 (CortexM0) -> older version of FreeRTOS, so we need to add this function definition manually.

```
#define portINLINE                  __inline
#ifndef portFORCE_INLINE
     #define portFORCE_INLINE    inline
__attribute__( ( always_inline ) )
#endif

portFORCE_INLINE static BaseType_t
xPortIsInsideInterrupt( void )
{
uint32_t ulCurrentInterrupt;
BaseType_t xReturn;
/* Obtain the number of the currently executing
interrupt. */
__asm volatile ( "mrs %0, ipsr" : "=r" (
ulCurrentInterrupt )::"memory" );
if( ulCurrentInterrupt == 0 )
{
xReturn = pdFALSE;
}
else
{
xReturn = pdTRUE;
}
return xReturn;
}
```

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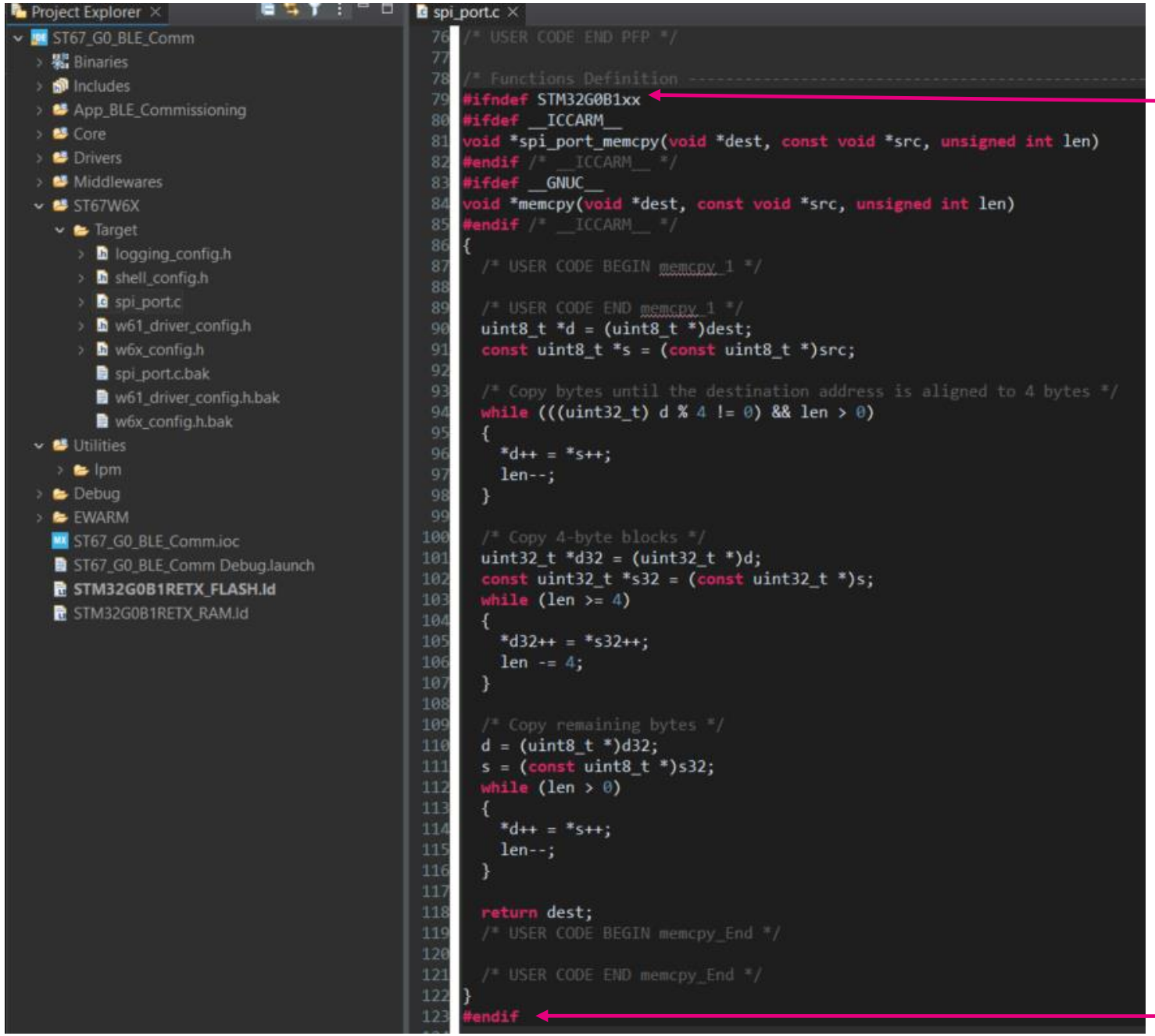
STM32CubeIDE



Add **#ifndef STM32G0B1xx**

Here we are disabling the custom memcpy() definition, as we would be using the memcpy() definition in string.h

Project/ST67W6X/spi_port.c

Add **#endif**

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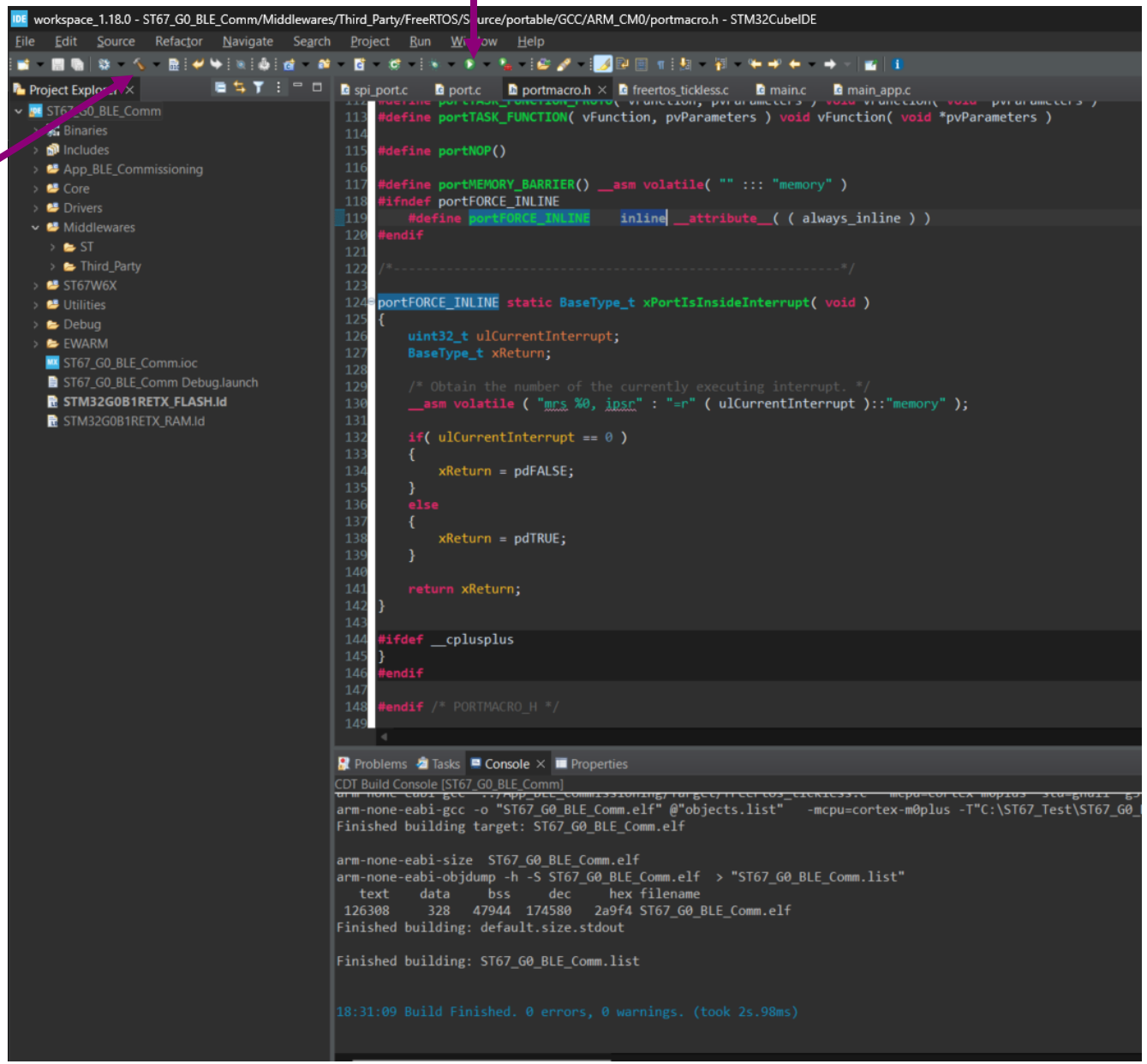
Build and flash

2. Flash the project

1. Build the project



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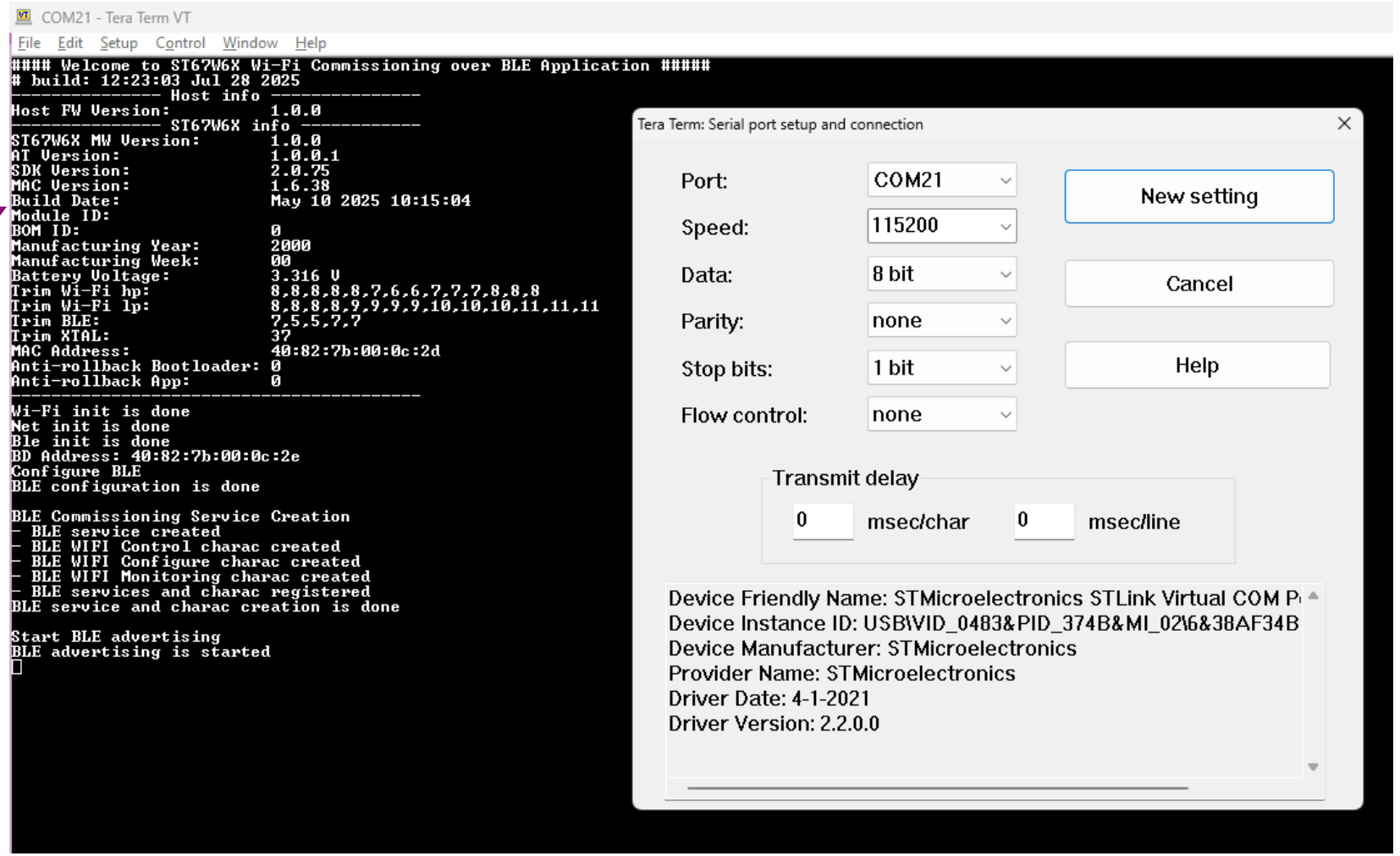
Tera Term Logs

Tera Term Logs after flashing



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ST BLEToolbox/ ST BLE Webpage

To interface with the Wi-Fi commissioning embedded application, you can use STBLEToolbox Andoid/iOS application / ST Web Bluetooth® Interface

Download **STBLEToolBox**

The versions supporting Wi-Fi commissioning service are **v1.4.3 for Android and 1.2.8 for iOS**

Steps to launch and connect to Wi-Fi AP:

1. Launch the smartphone application and enable the scan button, if it is not already activated.
2. You can filter scanned devices by clicking on the SHOW FILTERS button and select ST BLE Wi-Fi to show only devices with Wi-Fi commissioning service.
3. Select your device, named ST_WiFi_XX where XX represents the last BD address digit, and connect to it.

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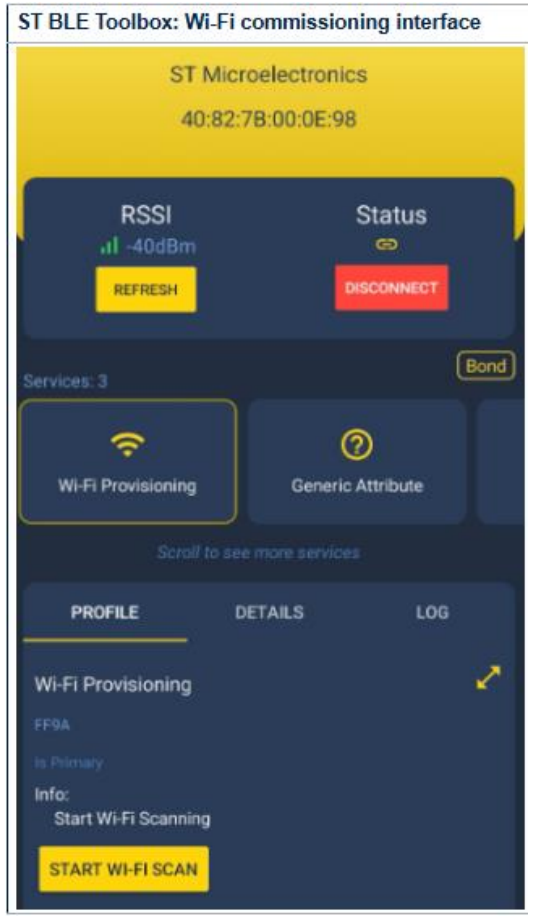
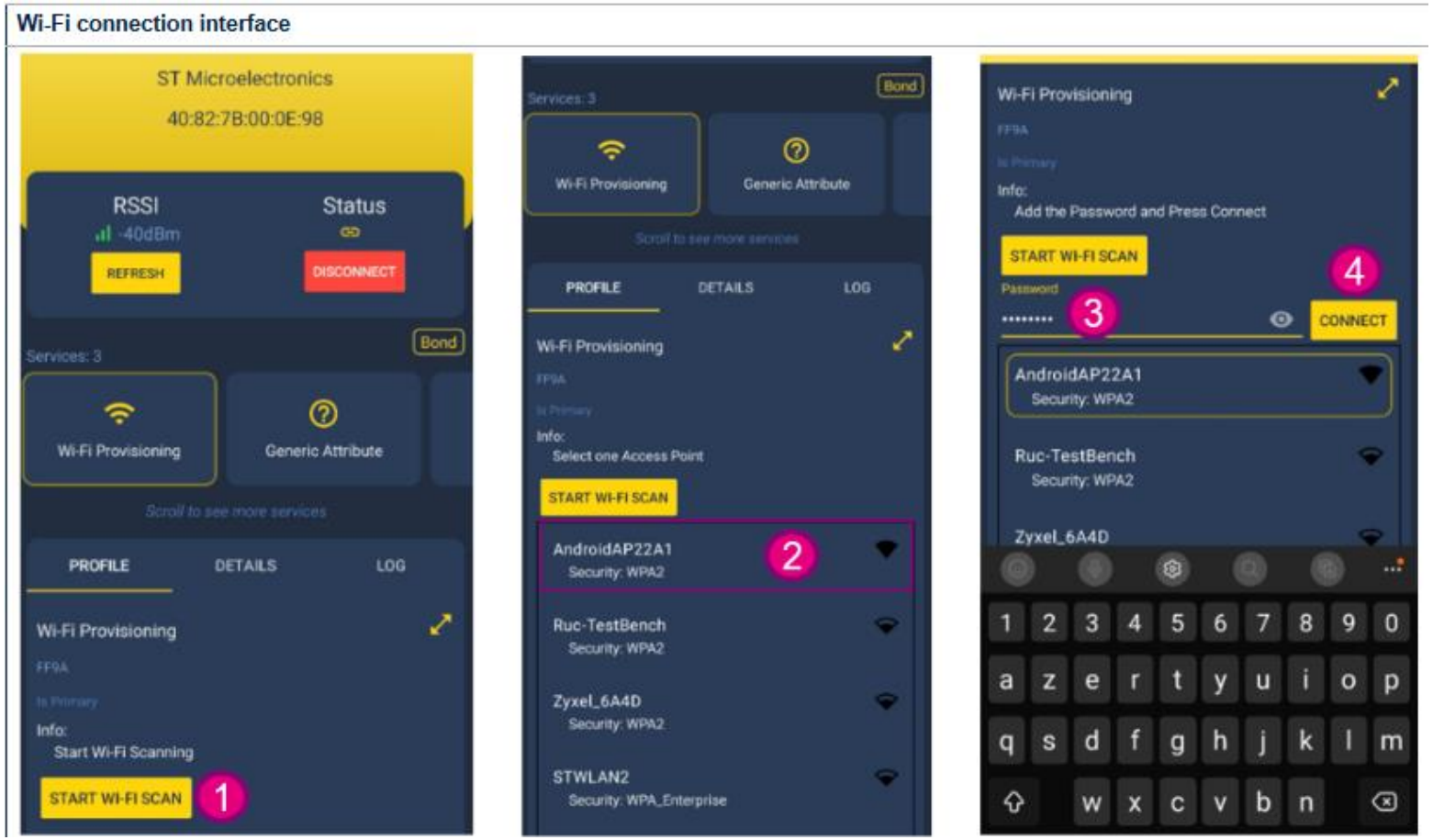
4. Once connected to the Bluetooth® LE device, click on Wi-Fi commissioning button to open the commissioning dedicated interface.



From this interface,
Launch a Wi-Fi scan (1),
To detect and list all available networks(2).
Once the available networks are displayed, select the one you want to connect to (2)
Type a password if needed (3)
Click on CONNECT button (4).



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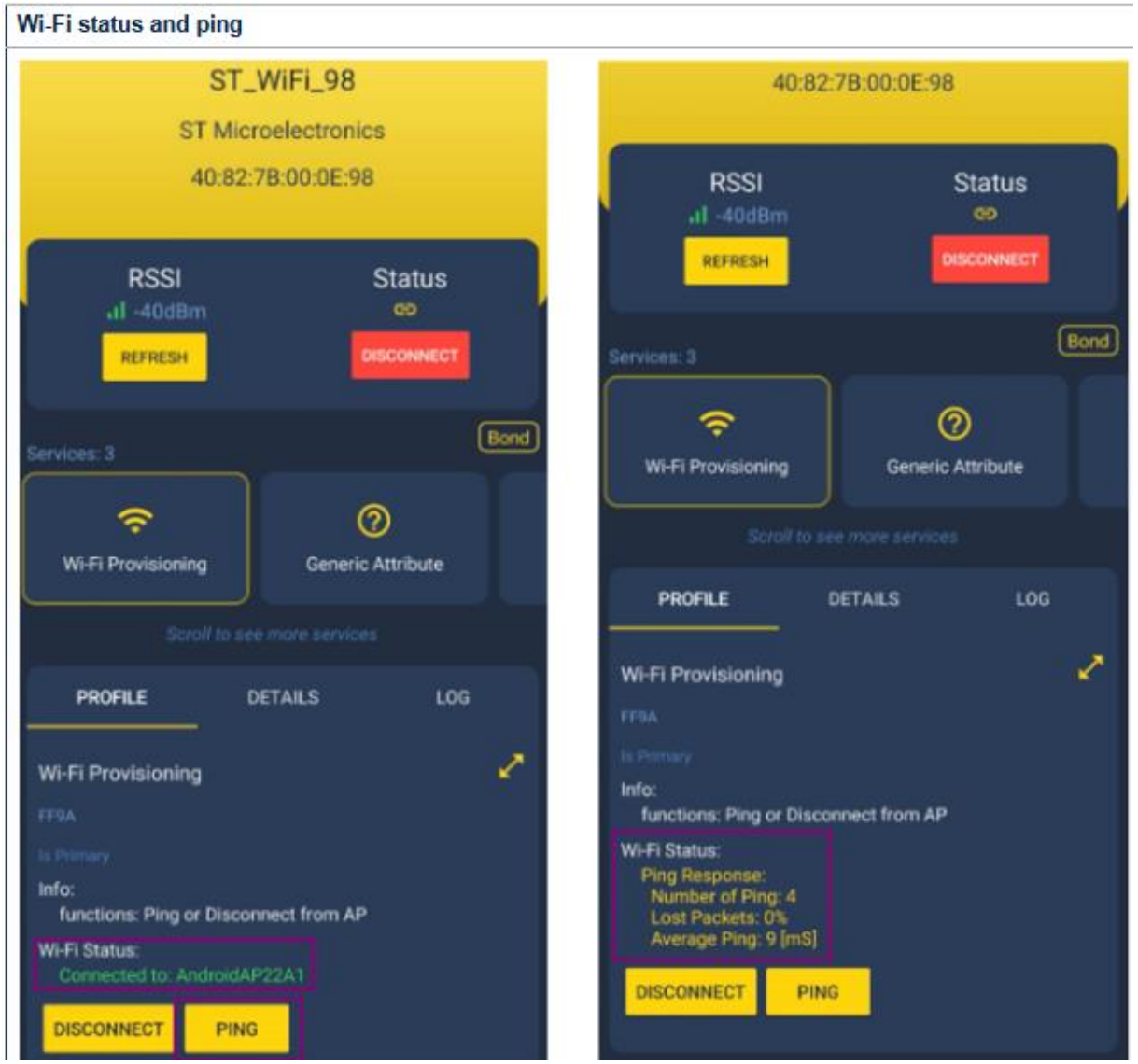
Once the connection request is done, the connection status is displayed in the interface.
Clicking on the Ping button start a ping test with the Wi-Fi access point and returns results in the interface.




```
BLE service and charac creation is done

Start BLE advertising
BLE advertising is started
BLE connected
 -> BLE CONNECTED: Conn_Handle: 0
BLE MTU exchange
BLE notification enabled
 -> BLE NOTIFICATION ENABLED [Service: 0, Charac: 2].
BLE write
 -> BLE WRITE.
 -> Conn_Handle: 0, Service: 0, Charac: 0, length 1, Data:
0x01
WIFI Control Charac
WIFI Scan Enable
WiFi Scan done.
MAC : [ac:8f:a9:df:eb:c4] | Channel:  6 |          WPA2 | RSSI:  -35 | SSID:  Yggdrasil
MAC : [bc:9a:8e:c0:70:94] | Channel:  6 |          WPA2 | RSSI:  -40 | SSID:  ATTAAAA
MAC : [b4:63:6f:aa:22:a4] | Channel: 11 |          WPA2 | RSSI:  -42 | SSID:  DesiWifi
MAC : [ac:db:48:72:1e:a4] | Channel:  1 |          WPA2 | RSSI:  -49 | SSID:  canyouseewhereIP
MAC : [bc:9a:8e:fa:34:94] | Channel: 11 |          WPA2 | RSSI:  -59 | SSID:  HUST_WIRELESS5G
MAC : [00:e6:3a:44:8b:52] | Channel: 11 |          WPA2 | RSSI:  -61 | SSID:  Vista99_WiFi
MAC : [00:e6:3a:44:8b:51] | Channel: 11 |      WPA-EAP | RSSI:  -61 | SSID:  Passpoint
MAC : [00:e6:3a:44:8b:54] | Channel: 11 |          WPA2 | RSSI:  -61 | SSID:  Vista99_Staff
MAC : [00:e6:3a:44:8b:50] | Channel: 11 |          WPA2 | RSSI:  -62 | SSID:  Vista99_IoT
MAC : [44:a5:6e:2f:76:c8] | Channel: 11 |          WPA2 | RSSI:  -62 | SSID:  NETGEAR53
MAC : [00:e6:3a:44:c6:92] | Channel: 11 |          WPA2 | RSSI:  -62 | SSID:  Vista99_WiFi
MAC : [00:e6:3a:44:c6:90] | Channel: 11 |          WPA2 | RSSI:  -63 | SSID:  Vista99_IoT
MAC : [00:e6:3a:44:c6:91] | Channel: 11 |      WPA-EAP | RSSI:  -63 | SSID:  Passpoint
MAC : [00:e6:3a:44:c6:94] | Channel: 11 |          WPA2 | RSSI:  -63 | SSID:  Vista99_Staff
MAC : [4a:bd:ce:d9:7b:7c] | Channel: 11 |          WPA2 | RSSI:  -65 | SSID:  vista3341
MAC : [00:e6:3a:58:79:80] | Channel:  1 |          WPA2 | RSSI:  -69 | SSID:  Vista99_IoT
MAC : [00:e6:3a:58:79:81] | Channel:  1 |      WPA-EAP | RSSI:  -69 | SSID:  Passpoint
MAC : [00:e6:3a:58:79:84] | Channel:  1 |          WPA2 | RSSI:  -69 | SSID:  Vista99_Staff
MAC : [bc:9a:8e:09:cc:f4] | Channel:  6 |          WPA2 | RSSI:  -70 | SSID:  ATTSheldon
MAC : [00:e6:3a:4b:2d:c0] | Channel:  6 |          WPA2 | RSSI:  -71 | SSID:  Vista99_IoT
MAC : [00:e6:3a:4b:2d:c4] | Channel:  6 |          WPA2 | RSSI:  -71 | SSID:  Vista99_Staff
MAC : [00:e6:3a:4b:2d:c1] | Channel:  6 |      WPA-EAP | RSSI:  -71 | SSID:  Passpoint
MAC : [bc:9a:8e:1a:6b:74] | Channel: 11 |          WPA2 | RSSI:  -71 | SSID:  Lair3
MAC : [00:e6:3a:4b:2d:c2] | Channel:  6 |          WPA2 | RSSI:  -72 | SSID:  Vista99_WiFi
MAC : [b4:63:6f:bf:0a:d4] | Channel: 11 |          WPA2 | RSSI:  -72 | SSID:  X.C455
MAC : [a8:b1:3b:d7:33:4c] | Channel:  2 |          WPA2 | RSSI:  -73 | SSID:  DIRECT-4A-HP DeskJet
2700 series
MAC : [c8:a6:08:67:68:44] | Channel:  6 |          WPA2 | RSSI:  -73 | SSID:  Vista99_Staff
MAC : [14:59:c0:ad:4b:e2] | Channel:  6 |          WPA2 | RSSI:  -73 | SSID:  NETGEAR69
MAC : [c8:a6:08:67:68:40] | Channel:  6 |          WPA2 | RSSI:  -73 | SSID:  Vista99_IoT
MAC : [ac:8f:a9:9c:31:94] | Channel:  2 |          WPA2 | RSSI:  -74 | SSID:  ally&latte
MAC : [c8:a6:08:67:68:41] | Channel:  6 |      WPA-EAP | RSSI:  -74 | SSID:  Passpoint
MAC : [bc:9a:8e:e6:83:04] | Channel:  6 |          WPA2 | RSSI:  -74 | SSID:  notyourwifi
MAC : [80:ab:4d:b2:8e:74] | Channel:  6 |          WPA2 | RSSI:  -75 | SSID:  TuWo
MAC : [a8:70:5d:93:a5:11] | Channel:  1 |          WPA2 | RSSI:  -76 | SSID:  access5015
MAC : [d4:6c:6d:ba:16:ff] | Channel:  1 |          WPA2 | RSSI:  -76 | SSID:  home4025
MAC : [8a:9e:68:e4:96:cf] | Channel:  1 |          WPA2 | RSSI:  -76 | SSID:  Jahee Home
MAC : [80:ce:62:b0:f9:e6] | Channel:  6 |          WPA2 | RSSI:  -76 | SSID:  DIRECT-E5-HP DeskJet
3700 series
MAC : [3c:b7:4b:2a:a5:1b] | Channel: 11 |          WPA2 | RSSI:  -77 | SSID:  XFWHG
MAC : [d8:1f:12:b9:9e:ad] | Channel:  6 |          OPEN | RSSI:  -78 | SSID:  SmartLife-9EAD
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
BLE Send Notification
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Walk through of the MQTT application

ST67W611M Wi-Fi® – ST67W6X_MQTT Demonstration - stm32mcu

ST67W6X MQTT
Overview

- **Description**

  The MQTT demonstration available in the X-CUBE-ST67W61 expansion package implements an MQTT client which connects to an MQTT Broker in order to publish environmental sensor data and device local information and subscribe on MQTT topics to receive command.

- In this example, the subscribed topic can be used to receive additional 'control' actions from a remote client publishing to the same topic.

1. Change the LED state on the host board

- To monitor the data sent and received, to/from the topics, a MQTT client can be installed on a PC, smartphone or tablet. Subscribing to the configured topics, allows the client to be notified every time the device publishes data to this topic.

- **Requirements**
  - A X-NUCLEO-67W61M1 Wi-Fi Expansion board.
  - A NUCLEO-U575ZI-Q Host board.
  - A Wi-Fi Access Point with internet access and no firewall blocking the MQTT requests.
  - [Optional] A X-NUCLEO-IKS4A1 Environmental sensors expansion board.

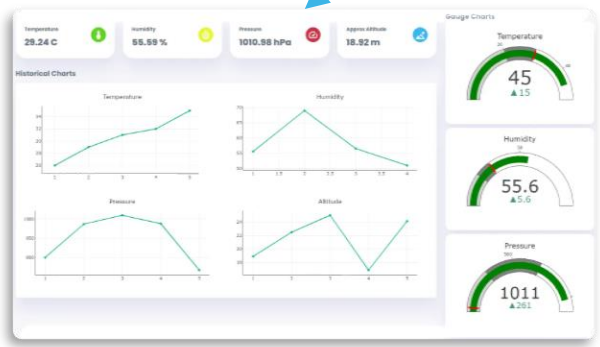
ST67W6X MQTT
Topology

NUCLEO-U575ZI-Q
X-NUCLEO-67W61M1
X-NUCLEO-IKS4A1

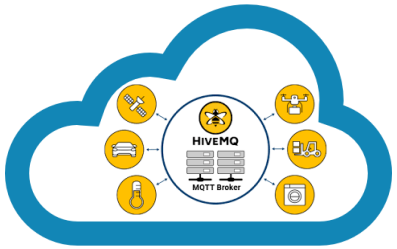
Wi-Fi

Wi-Fi Access Point

Internet



MQTT dashboard



MQTT Broker

USB serial

PC with Hyper Terminal

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ST67W6X MQTT
Usage

- Initialization of Wi-Fi, Net and MQTT modules in the Network Coprocessor.
- Wi-Fi connection establishment with the local Access Point.
- Synchronization of local time in using the Network Coprocessor SNTP client.
- Initialization of MEMS expansion board to get environmental sensor values.
- Connection of MQTT Client to a remote MQTT broker.
- MQTT topic subscription to receive messages from cloud.
- Periodic publication of message including:
  - Environmental sensor values**
  - Local time
  - RSSI of Access Point

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**If MEMS board is not included these values will not be published

MQTT Initialization process

Description	Function	File
Initialize the system (HAL, Clocks, SPI, I2C, UART, RTC, GPIO)	main()	Core/Src/mainc.c
Create the default FreeRTOS task containing the main application execution	MX_FREERTOS_Init()	Core/Src/app_feertos.c
Start all configurated tasks	osKernelStart()	cmsis_os2.c
Run the main_app() enter application function	StartDefaultTask()	Core/Src/app_freertos.c
Initialize the logging utility to forward all traces on UART peripheral	W6X_Util_Init()	ST67W6X_Network_Driver/Core/w6x_sys.c
Initialize the application callbacks to receive events from ST67W6X_Network_Driver	W6X_RegisterAppCb()	ST67W6X_Network_Driver/Core/w6x_sys.c
Initialize the ST67W6X_Network_Driver Power up the Network Coprocessor Display global identification	W6X_Init()	ST67W6X_Network_Driver/Core/w6x_sys.c
Initialize the ST67W6X_Network_Driver Wi-Fi module Set the STA mode Enable the DHCP Client Configure the Country Code Set the Hostname	W6X_WiFi_Init()	ST67W6X_Network_Driver/Core/w6x_wifi.c
Initialize the ST67W6X_Network_DriverNetwork module	W6X_Net_Init()	ST67W6X_Network_Driver/Core/w6x_net.c
Initialize the ST67W6X_Network_Driver MQTT module Register pre-allocated buffer to receive subscription messages	W6X_MQTT_Init()	ST67W6X_Network_Driver/Core/w6x_mqtt.c

MQTT Application Process

The different steps of the application **Process** are described below:

Description	Function	File
Connect the Wi-Fi station device to an available Access Point	W6X_WiFi_Connect()	ST67W6X_Network_Driver/Core/w6x_wifi.c
Enable the time synchronization through a remote SNTP server	W6X_Net_SetSNTPConfiguration()	ST67W6X_Network_Driver/Core/w6x_net.c
Retrieve the SNTP time to update the RTC time configuration	W6X_Net_GetTime()	ST67W6X_Network_Driver/Core/w6x_net.c
Initialize the sensor expansion board	Sys_Sensors_Init()	X-CUBE-MEMS1/App/sys_sensors.c
Configure the device to a MQTT broker	W6X_MQTT_Configure()	ST67W6X_Network_Driver/Core/w6x_mqtt.c
Connect the device to a MQTT broker	W6X_MQTT_Connect()	ST67W6X_Network_Driver/Core/w6x_mqtt.c
Start a topic subscription. When a new message is received, a callback catches and parses the frame.	W6X_MQTT_Subscribe()	ST67W6X_Network_Driver/Core/w6x_mqtt.c
Publish a new message on the selected topic. The RTC time is always set by calling HAL_RTC_GetTime() and HAL_RTC_GetDate(). If a sensor board is available, the environmental measures are added in the frame by calling Sys_Sensors_Read()	W6X_MQTT_Publish()	ST67W6X_Network_Driver/Core/w6x_mqtt.c

Two topics subscription are started:

- /devices/<MQClientID>/control
- /sensors/<MQClientID>

ST67W6X MQTT
User setup

- Local Access Point credentials: *App_MQTT\App\app_config.h*

```
#define WIFI_SSID                "ST_DEMO"
#define WIFI_PASSWORD            "stdemo01"
```

- MQTT parameters: *App_MQTT\App\app_config.h*

```
#define MQTT_HOST_NAME "broker.emqx.io"

#define MQTT_HOST_PORT 1883

#define MQTT_SECURITY_LEVEL 0

#define MQTT_CLIENT_ID "mySTM32_772"

#define MQTT_USERNAME ""

#define MQTT_USER_PASSWORD ""
```

Notes :

It uses a public broker
Requires at least one device publisher and one subscriber
TLS (secure broker connection)

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ST67W6X MQTT
IoT MQTT panel app

- Smartphone client : IoT MQTT Panel
  - Android play store: IoT MQTT Panel - Apps on Google Play
  - Android APK-pure: https://apkpure.com/iot-mqtt-panel/snr.lab.iotmqttpanel.prod
  - Apple store: IoT MQTT Panel on the App Store
- PC / Web client (no firewall)
  - HiveMQ: MQTT Client by HiveMQ
  - Mosquitto: Eclipse Mosquitto

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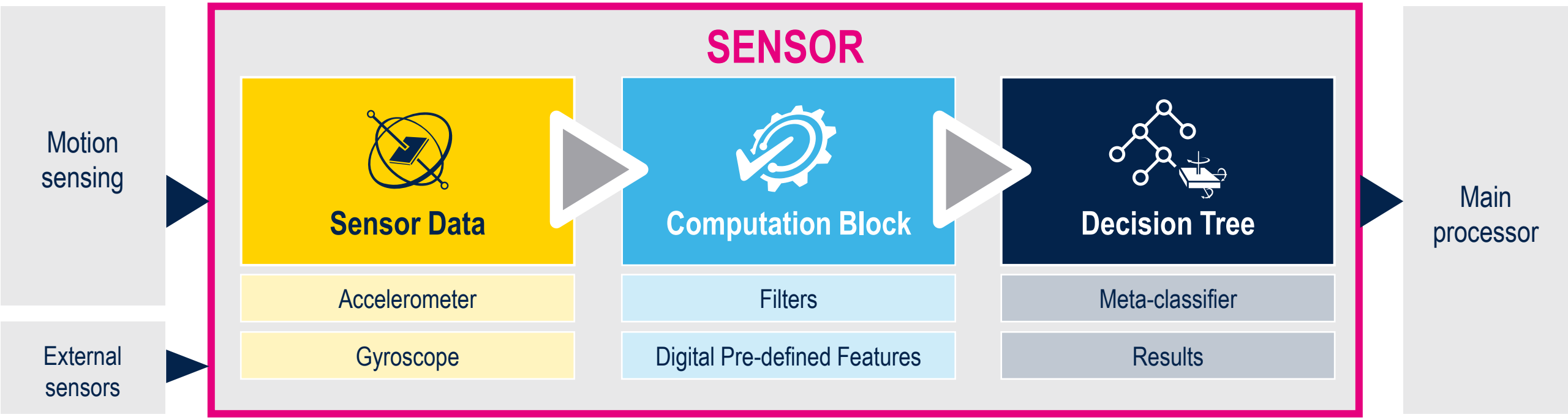
MLC - Machine Learning Core

MLC - Machine Learning Core

MLC is an in-sensor classification engine based on a decision tree logic



MLC is able to **increase accuracy** with a **better context detectability**, **offloading the main processor** while the built-in sensors identify motion data

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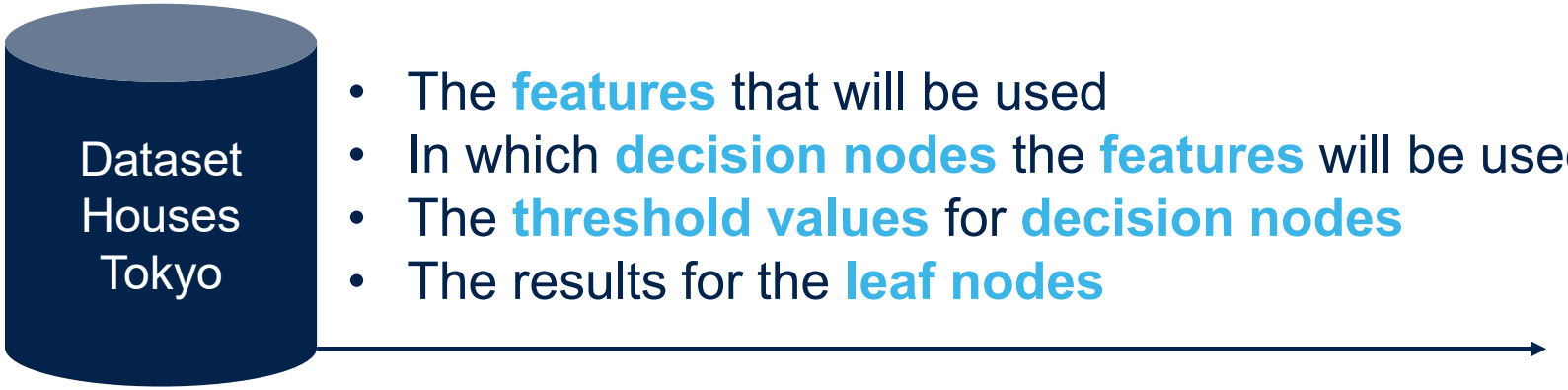
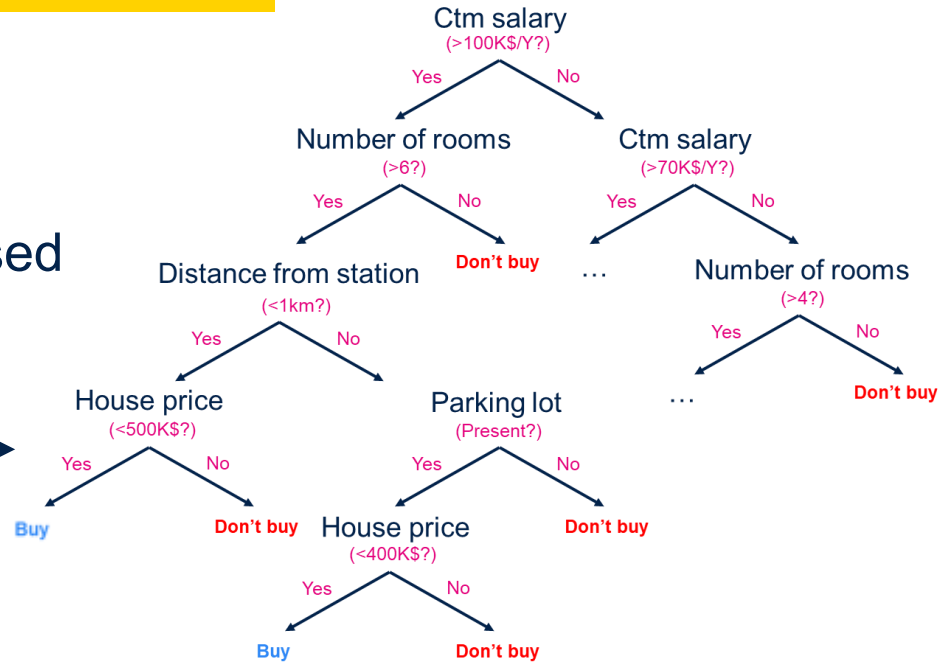
ML model training

What the ML model learn from the data?

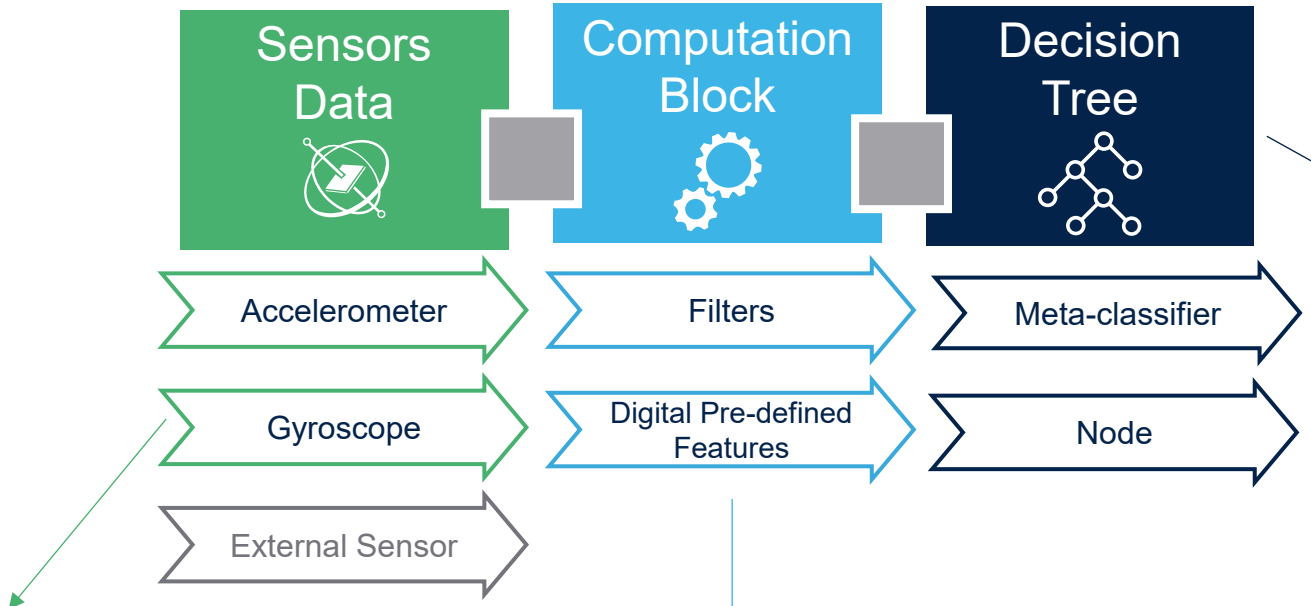


- The **features** that will be used
- In which **decision nodes** the **features** will be used
- The **threshold values** for **decision nodes**
- The results for the **leaf nodes**



Training the same Machine Learning Model with another dataset (i.e. houses in Milan), the resulting decision tree will be different in order to "best fit" the new data given for training

IMU Machine Learning Core - Overview



Sensors Data:

- **Accelerometer** → $[a_x\ a_y\ a_z\ ], [a_v], [a^2_v]$
- **Gyroscope** → $[g_x\ g_y\ g_z\ ], [g_v]\ , [g^2_v]$
- **External sensor** → $[m_x\ m_y\ m_z\ ], [m_v], [m^2_v](i.e.mag)$
- **Magnitude** → $V = \sqrt{X^2 + Y^2 + Z^2}$

Computation Block

- Sensors data can be filtered with a 2nd order IIR **Filter**.
- **Features** are statistical parameter calculated from: Input Data or Filtered Input Data
- Examples of features are: Mean, Variance, Energy, Peak to Peak, …

Decision Tree

- is a predictive model built from **training data**. Outputs of the computation blocks are the inputs of the decision tree.
- Each **Node** is characterized by one «if-then-else» condition.
  - Mean on Acc_X < 0.5 g
  - Variance on Gyro_Z < 200 dps
- Decision tree can either generate a result at every sample or filter the results with a **Meta-classifier**, to have a more robust output.

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ST toolbox for machine learning core (MLC) in the sensor

Machine learning core configuration

Operating mode

Capture data

- Accelerometer
- Gyroscope
- External sensors

Label data

- Filters
- Features

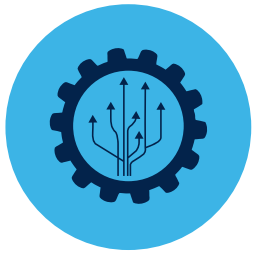
Build decision tree

- Classification
- Results

Embed decision tree

- DT implementation

Process new data



- Real time test

WHAT

HOW

MEMS Studio

STBLESensor

MEMS Studio

MEMS Studio and external tools

WEKA The University of Waikato

rapidminer

MATLAB

python™

MEMS Studio

MEMS Studio

STBLESensor

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Sensors Data

Data collection: Key points

Class definition

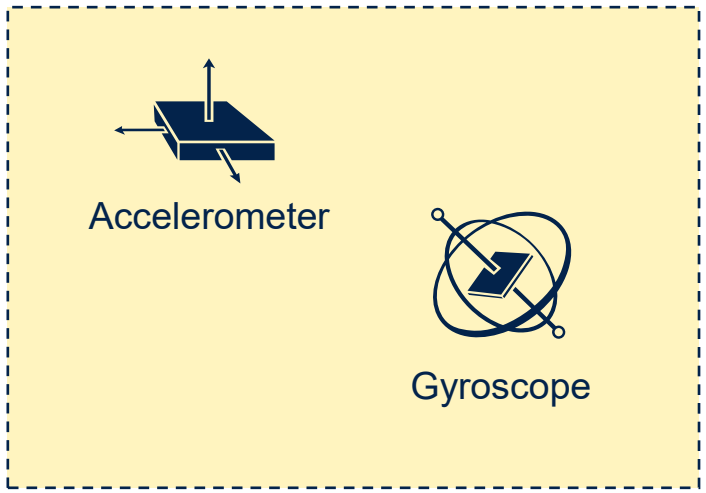
Class 1 >> Motor stop…
Class 2 >> Motor running OK
Class 3 >> Motor running NG

Motor vibration example

Class 1 >> Still
Class 2 >> Walking
Class 3 >> Running
Class 4 >> Riding bicycle
Class 5 >> Car

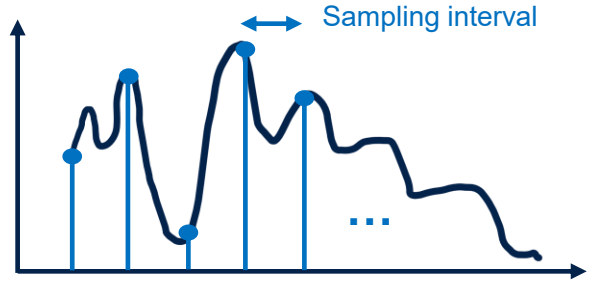
Human Activity Recognition example

Sensor selection

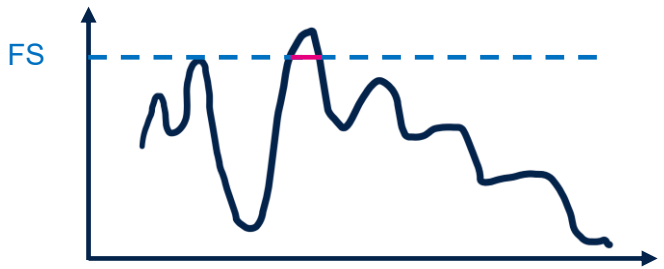


Other external sensors
(Pressure, Compass, …)

Sensor configuration



Output Data Rate (ODR)



Full Scale (FS)

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Features calculation inside MEMS

Computation Block

Raw data

Acc_X, Acc_Y, Acc_Z
Acc_V, Acc_V2

Gyro_X, Gyro_Y, Gyro_Z
Gyro_V, Gyro_V2

ExtSens_X, ExtSens_Y, ExtSens_Z
ExtSens_V, Ext_Sens_V2

Filters

Filtered data
(High-pass, Band-pass, IIR1 and IIR2 filters)

Features

Mean

$$\frac{1}{WL}\sum_{k=0}^{WL-1} I_k$$

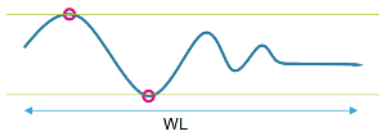
Variance

$$\left(\frac{\sum_{k=0}^{WL-1} I_k^2}{WL}\right) - \left(\frac{\sum_{k=0}^{WL-1} I_k}{WL}\right)^2$$

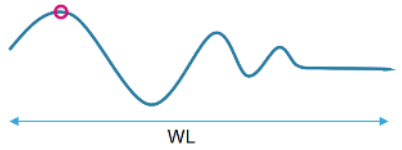
Energy

$$\sum_{k=0}^{WL-1} I_k^2$$

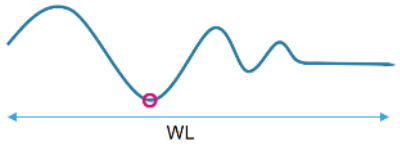
Peak-to-Peak



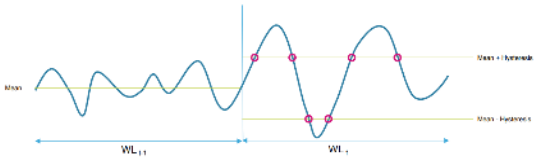
Maximum



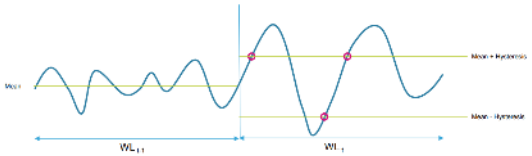
Minimum



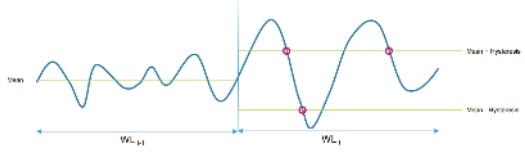
Zero crossing



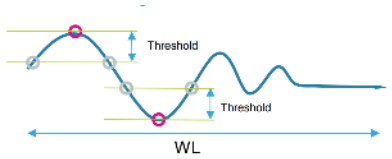
Positive Zero crossing



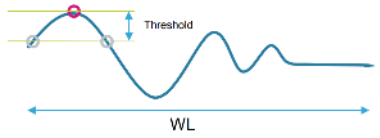
Negative Zero crossing



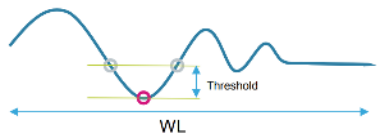
Peak detector



Positive Peak detector



Negative Peak detector



Note: the window for features computation (WL) is configurable (from 1 to 255 samples). It is not a moving window

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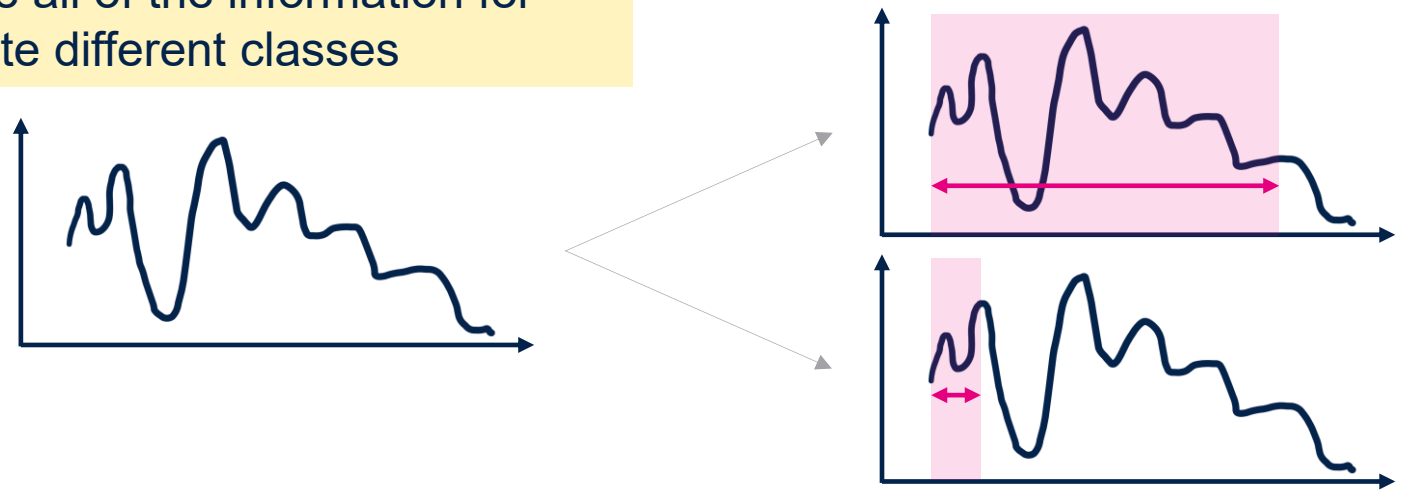
Window size selection

Window length is strongly dependent on the application

The window should capture all of the information for the decision tree to separate different classes



A few tips for selecting the right size:

- Selection by the user **after data analysis and visualization**
- If the **motion is repetitive** at some frequency, ideal window size should be long enough to capture the entire motion pattern
- Short window length could make the **response quick**
- **Consider the slowest varying signal**

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Decision Tree

Decision Tree Output

- Decision tree results are accessible through dedicated registers in IMU
- An interrupt is generated when the decision tree result changes
  Interrupt status bits are available in dedicated registers
- Interrupt can be routed to INT1/2 pad through dedicated register

Register	Content
MLC0_SRC (70h)	Result of decision tree 1
MLC1_SRC (71h)	Result of decision tree 2
MLC2_SRC (72h)	Result of decision tree 3
MLC3_SRC (73h)	Result of decision tree 4
MLC4_SRC (74h)	Result of decision tree 5
MLC5_SRC (75h)	Result of decision tree 6
MLC6_SRC (76h)	Result of decision tree 7
MLC7_SRC (77h)	Result of decision tree 8

Register	Content
MLC_STATUS_MAINPAGE (38h)	Contains interrupt status bits for changes in the decision tree result
MLC_STATUS (15h)	Contains interrupt status bits for changes in the decision tree result
MLC_INT1 (0Dh)	Allows routing of interrupt status bits for decision trees to INT1 pin
MLC_INT2 (11h)	Allows routing of interrupt status bits for decision trees to INT2 pin

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MLC Configuration Demo

MLC Configuration

Machine learning core configuration

Operating mode

Capture data

WHAT

- Accelerometer
- Gyroscope
- External sensors

HOW

MEMS Studio + X-CUBE-MEMS1

Label data

WHAT

- Filters
- Features

HOW

MEMS Studio

Build decision tree

WHAT

- Classification
- Results

HOW

MEMS Studio

Embed decision tree

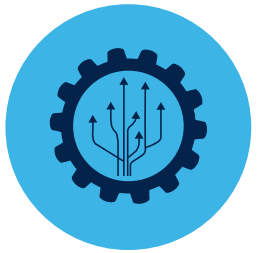
WHAT

- DT implementation

HOW

MEMS Studio

Process new data



WHAT

- Real time test

HOW

MEMS Studio

NOTE: This section is intended to be a live demo, showing how the flow to generate mlc config file works using MEM Studio

Step 1 – Capture Data

Prepare Board for Data Capture

- Use Datalog Extended Firmware from X-CUBE-MEMS1 Package
  - **Note**: Firmware is Board Specific – use the right combo for the board stack you have
  - X-CUBE-MEMS1\Projects\NUCLEO-U575ZI-Q\Examples\IKS4A1\DataLogExtended\Binary

- Use STM32CubeProgrammer to flash the DatalogExtended binary to the board
- Disconnect from board

- Reset the board

Step 1 – Capture Data

Configure Sensors for Data Capture

- Open MEMS Studio
- Connect to the board
- Select LIS2DUXS12 as accelerometer and click select
- In Quick Setup tab, select accelerometer FS=2g and ODR 12.5Hz (these match Motion Intensity example on github)
- Click Save to File tab
- Set log file location, e.g. C:\ST67_Workshop\MLC_Demo\
- In Data box, right click then unselect all. Then check Timestamp and Accelerometer.
- Ensure Time base is set to timestamp

Step 1 – Capture Data

Run Data Capture

- Open Line charts tab to show accel data
- Click Play button (top left) to start data capture
- Hold board in hand for 20s – this is motion intensity 0
- Gently shake the board along all 3 axes for 20s – this is motion intensity 1
- Vigorously shake the board along all 3 axes for 20s – this is motion intensity 2
- Stop the capture by pressing stop button in top left corner of MEMS Studio

Step 2 – Label Data

- Open Data Analysis tab
- Load the accel data capture file you created with the 3 types of motion
- Use time domain graph
- Click on graph to select regions and label Motion Intensity 0, 1 and 2: MI0, MI1, MI2
- Once all 3 MI’s are labeled, click Save Labeled Data to generate 3 individual motion capture files, save them to same folder as original data capture file, e.g: C:\ST67_Workshop\MLC_Demo
- Use file explorer to show that 3 files have been created with label in file name

Step 3 – Build Decision Tree

Load Data Patterns

- Open Advanced Features tab and select MLC
- Make sure Data Patterns tab is selected
- Set workspace to C:\ST67_Workshop\MLC_Demo
- Select the LIS2DUXS12 sensor
- Using Browse button or file explorer drag & drop to load MI0 file. Assign class label MI0 to it. Click “Load”.
- Repeat above step for MI1 and MI2
- You should have 3 pattern files loaded with classes MI0 through MI2

Step 3 – Build Decision Tree

Configure AFS

- Open AFS tab
- Set Machine Learning Core Settings: ODR 12.5 to match captured data, Window length=25 (2s of data)
- Configure Inputs (to match captured data)
  - Accelerometer_only
  - Full Scale 2g
  - ODR: 12.5
- Leave AFS settings at default and click Run to start automatic feature selection
- Once AFS completes, click Apply to Settings to transfer filters/features to ARFF panel

Step 3 – Build Decision Tree

ARFF Generation

- Open ARFF Generation tab
- Note settings from AFS have been set, review them
- Click Generate ARFF File to generate the ARFF file used in the next step (DT generation)

Step 3 – Build Decision Tree

Decision Tree Generation

- Open Decision Tree Generation tab
- Set number of decision trees to 1
- Click Generate Decision Tree
- Once DT is generated review results and show generated decision tree (show Dectree button)

Step 3 – Build Decision Tree

Generation of Configuration Files

- Open Config generation tab
- For output values for the classes select 0, 1 and 2 to match MI0,1 and 2
- Leave counters at 0
- Click Generate Config file
- Show json file
- Click Export to show how to generate corresponding header file

Step 3 – Build Decision Tree

Test Generated Tree

- Click Load Config into Sensor
- Click Decision Tree Output Viewer
- Press Play button to start data capture/testing
- Show Motion Intensities 0, 1 and 2

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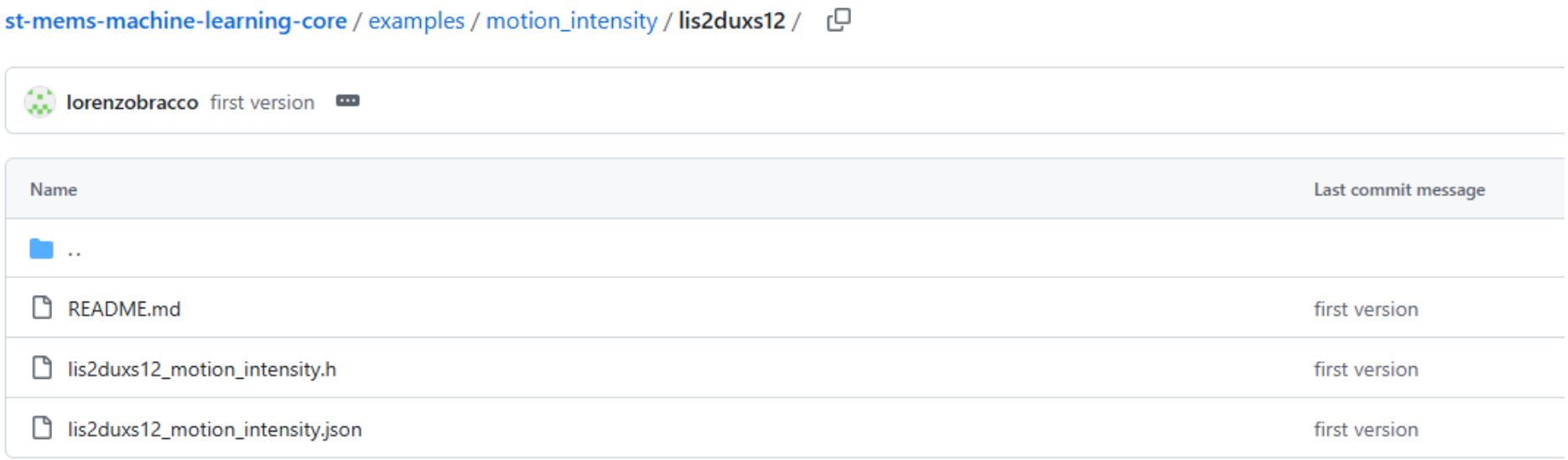
Hands-On: Embed MLC into MQTT App

Enabling MLC in Your STM32 Project

- In this hands-on part of the workshop, we'll use a generated MLC example available on ST's github
- Github: https://github.com/STMicroelectronics/st-mems-machine-learning-core
- We'll use the LIS2DUXS12 sensor



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Enabling MLC in Your STM32 Project

- The README file provides useful information for integration
- Overview, Sensor configuration, MLC outputs, interrupts

1 - Introduction

Simple example of motion intensity detection implemented using the variance feature on the accelerometer norm. The classes recognized in this example are eight different levels of intensity, from 0 to 7.

For information on how to integrate this algorithm in the target platform, please follow the instructions available in the README file of the examples folder.

For information on how to create similar algorithms, please follow the instructions provided in the tutorials folder.

2 - Sensor configuration and orientation

The accelerometer is configured with ±2 *g* full scale and 12.5 Hz output data rate.

Any sensor orientation is allowed for this algorithm.

3 - Machine Learning Core configuration

Just one feature (variance), has been applied to the norm of the accelerometer data. The MLC runs at 12.5 Hz, computing features on windows of 39 samples (corresponding to almost 3 seconds). One decision tree with 7 nodes has been configured to detect the different classes. A meta-classifier has not been used.

- MLC0_SRC (70h) register values
  - 0 = Intensity_0
  - 1 = Intensity_1
  - 2 = Intensity_2
  - 3 = Intensity_3
  - 4 = Intensity_4
  - 5 = Intensity_5
  - 6 = Intensity_6
  - 7 = Intensity_7

4 - Interrupts

The configuration generates an interrupt (pulsed and active high) on the INT1 pin every time the register MLC0_SRC (70h) is updated with a new value. The duration of the interrupt pulse is 77 ms in this configuration.

Enabling MLC in Your STM32 Project

- Folder contains 3 files:
  - README.md – useful info
  - JSON cofig file – useful for testing using ST Tools e.g MEMS Studio
  - C header file – useful for integration into STM32 projects

- We'll use the header file to enable the MLC in out MQTT Project
- We'll send the detected motion intensity to the MQTT broker and display it in the mobile app

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Enabling MLC in Your STM32 Project

- Header file contains an array with a sequence of commands to execute to configure the sensor and MLC
- Each array entry contains an opcode and relevant info, such as register addresses and data

```
static const struct mems_conf_op lis2duxs12_motion_intensity_conf_0[] = {
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x13, .data = 0x10 },
    { .type = MEMS_CONF_OP_TYPE_DELAY, .data = 5 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x14, .data = 0x00 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x3F, .data = 0x80 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x04, .data = 0x00 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x05, .data = 0x00 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x17, .data = 0x40 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x02, .data = 0x01 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x08, .data = 0xB8 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x09, .data = 0xE6 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x09, .data = 0x00 },
    { .type = MEMS_CONF_OP_TYPE_WRITE, .address = 0x09, .data = 0xF0 },
```

Enabling MLC in Your STM32 Project

- We’ve added the necessary code to configure the MLC, read the outputs and publish the motion intensity to the MQTT broker

- Modified files:

  - Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\X-CUBE-MEMS1\App\sys_sensors.h
  - Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\X-CUBE-MEMS1\App\sys_sensors.c

  - Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\App_MQTT\App\app_config.h
  - Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\App_MQTT\App\main_app.c

Enabling MLC in Your STM32 Project

- Modified files: sys_sensors.h

```
/* Includes ------------------------------------------------------------------*/
/* Config --------------------------------------------------------------------*/
#define SENSOR_ENABLED          1
#define MLC_CONFIGURATION lis2duxs12_motion_intensity_conf_0

```

```
typedef struct
{
  float pressure;         /*!< in mbar */
  float temperature;      /*!< in degC */
  float humidity;         /*!< in % */
  Sys_Sensors_Axes_t acceleration;
  Sys_Sensors_Axes_t magnetic_field;
  Sys_Sensors_Axes_t angular_velocity;
#ifdef USE_MLC
  uint8_t motion_intensity; /* motion intensity from mlc, values from 0->7 */
#endif
} Sys_Sensors_Data_t;

```

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Enabling MLC in Your STM32 Project

- Modified files: sys_sensors.c

```
#include "logging.h"

#include "iks4a1_motion_sensors_ex.h"
#include "lis2duxs12_motion_intensity.h" /* MLC Config file */
```

```
/* Private function prototypes -----------------------------------------------*/
static int32_t MLC_Init(void);
```

```
int32_t Sys_Sensors_Read(Sys_Sensors_Data_t *data)
{
…
#ifdef USE_MLC
  /* Get mlc outputs */
    (void)IKS4A1_MOTION_SENSOR_Write_Register(IKS4A1_LIS2DUXS12_0, LIS2DUXS12_FUNC_CFG_ACCESS, 0x80);
    (void)IKS4A1_MOTION_SENSOR_Read_Register(IKS4A1_LIS2DUXS12_0, LIS2DUXS12_MLC1_SRC, &data->motion_intensity);
    (void)IKS4A1_MOTION_SENSOR_Write_Register(IKS4A1_LIS2DUXS12_0, LIS2DUXS12_FUNC_CFG_ACCESS, 0x00);
#endif
…
}
```

Enabling MLC in Your STM32 Project

- Modified files: sys_sensors.c

```
static int32_t Sys_Sensors_IKS4A1_Init(void)
{
…
#ifdef USE_MLC
  /* Initialize the MLC */
  ret = MLC_Init();
#endif
…
}
```

Enabling MLC in Your STM32 Project

- Modified files: sys_sensors.c

```
int32_t MLC_Init(void)
{
…
 length = MEMS_CONF_ARRAY_LEN(MLC_CONFIGURATION);
  i = 0;
  while ((i < length) & (ret == BSP_ERROR_NONE))
  {

              if (MLC_CONFIGURATION[i].type == MEMS_CONF_OP_TYPE_DELAY)
              {
                      HAL_Delay(MLC_CONFIGURATION[i].data);
              }
              else if (MLC_CONFIGURATION[i].type == MEMS_CONF_OP_TYPE_WRITE)
              {
                      ret = IKS4A1_MOTION_SENSOR_Write_Register(IKS4A1_LIS2DUXS12_0, MLC_CONFIGURATION[i].address,
MLC_CONFIGURATION[i].data);
              }
              else
              {
                      /* Unsupported opcode */
                      ret = BSP_ERROR_FEATURE_NOT_SUPPORTED;
              }
              i++;
  }
…
}
```

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Enabling MLC in Your STM32 Project

- Modified files: app_config.h

```
/* Local Access Point (e.g. gateway, hotspot, etc) connection parameters */
#define WIFI_SSID                   “<wifi-ssid>"

#define WIFI_PASSWORD               “<wifi-password>"

/** Host name of remote MQTT Broker
  * Multiple options are possibles:
  *   - broker.hivemq.com
  *   - broker.emqx.io
  *   - test.mosquitto.org
  */
#define MQTT_HOST_NAME              "broker.hivemq.com"

/** Port of remote MQTT Broker */
#define MQTT_HOST_PORT              1883

/** Security level. only non-secure is currently available */
#define MQTT_SECURITY_LEVEL         0

/** MQTT Client ID to be identified on MQTT Broker */
#define MQTT_CLIENT_ID              “<your-client-id>"
```

Enabling MLC in Your STM32 Project

- Injecting Client ID into IotMQTTPanel config file:

Open a command prompt

cd to
Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\resources>

Run the command:
IotMQTTPanel_Helper.py IoTMQTTPanel-250618_134546.json --clientid <Your ClientID> -- broker <MQTT broker> -o IotMQTTPanel-MLC-MotionIntensity.json

Copy the output file IotMQTTPanel-MLC-MotionIntensity.json to your mobile device

Load the configuration file into the IotMQTTPanel app

Enabling MLC in Your STM32 Project

- Modified files: main_app.c

```
static void Subscription_process_task(void *arg)
{
…
 /* Process the field 'motionintensity'. Value type: Int. Format: 1 (range 0-7) */
 json = cJSON_GetObjectItemCaseSensitive(child, "motionintensity");
 if (json != NULL)
 {
    if (cJSON_IsNumber(json) == true)
    {
      LogInfo("  %s: %d\n", json->string, json->valueint);
    }
    else
    {
      LogError("JSON parsing error of %s value.\n", json->string);
    }
  }
…
}
```

Enabling MLC in Your STM32 Project

- Modified files: main_app.c

```
#ifdef USE_MLC
      len += snprintf((char *)&mqtt_pubmsg[len], MQTT_MSG_BUFFER_SIZE - len,
                      ", \"temperature\": %.2f, \"humidity\": %.2f, \"pressure\": %.2f, \"motionintensity\":%d",
                      (double)sensors_data.temperature, (double)sensors_data.humidity,
(double)sensors_data.pressure, (int)sensors_data.motion_intensity);
#else
      len += snprintf((char *)&mqtt_pubmsg[len], MQTT_MSG_BUFFER_SIZE - len,
                              ", \"temperature\": %.2f, \"humidity\": %.2f, \"pressure\": %.2f",
                              (double)sensors_data.temperature, (double)sensors_data.humidity,
(double)sensors_data.pressure);
#endif
```

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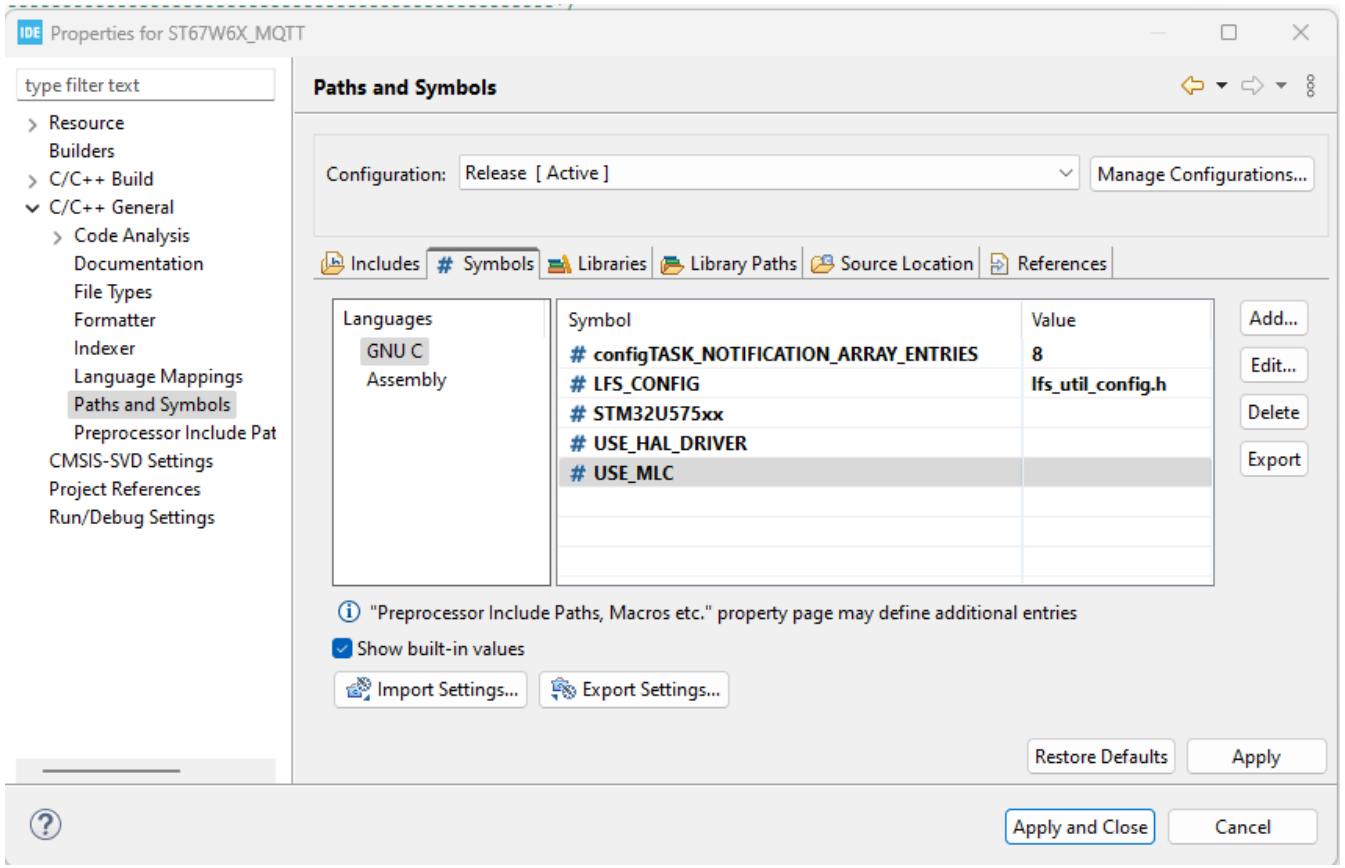
Enabling MLC in Your STM32 Project

- Modified files: main_app.c

```
static void Subscription_process_task(void *arg)
{
…
 /* Process the field 'motionintensity'. Value type: Int. Format: 1 (range 0-7) */
 json = cJSON_GetObjectItemCaseSensitive(child, "motionintensity");
 if (json != NULL)
 {
    if (cJSON_IsNumber(json) == true)
    {
      LogInfo("  %s: %d\n", json->string, json->valueint);
    }
    else
    {
      LogError("JSON parsing error of %s value.\n", json->string);
    }
  }
…
}
```

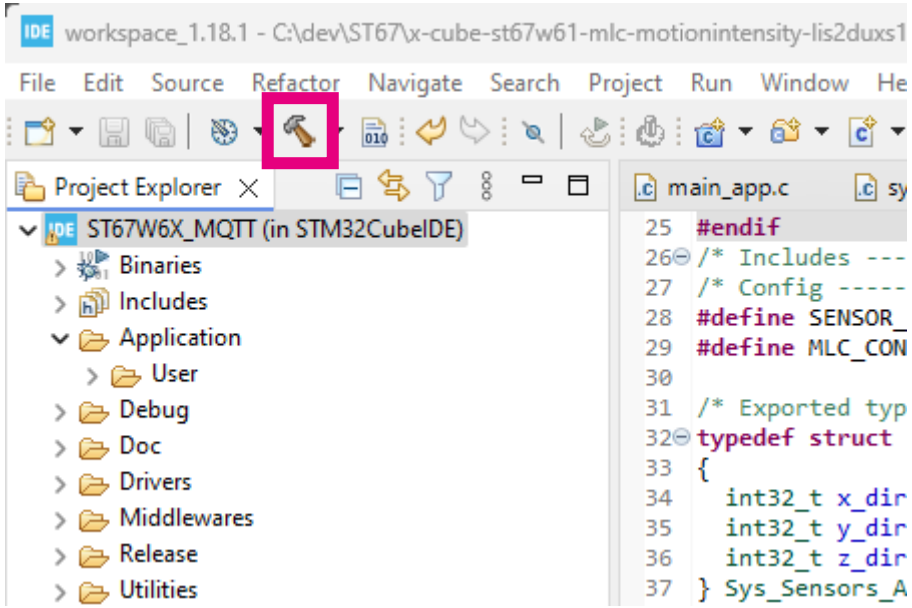
Enabling MLC in Your STM32 Project

- To enable the MLC code, add USE_MLC to project properties

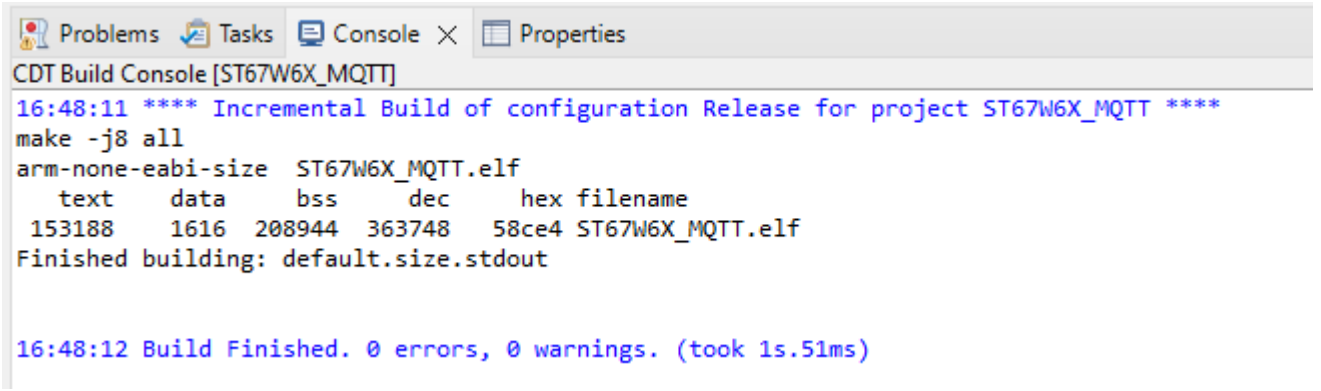


Enabling MLC in Your STM32 Project

- Build the project



- Make sure project builds successfully



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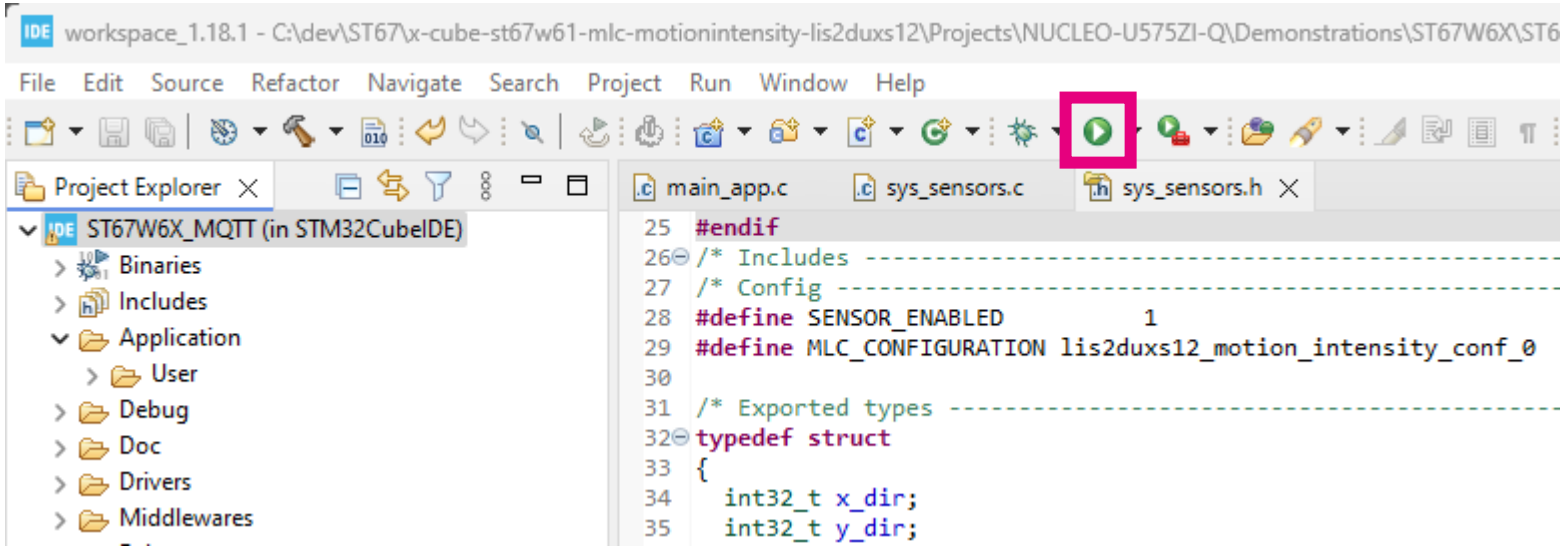
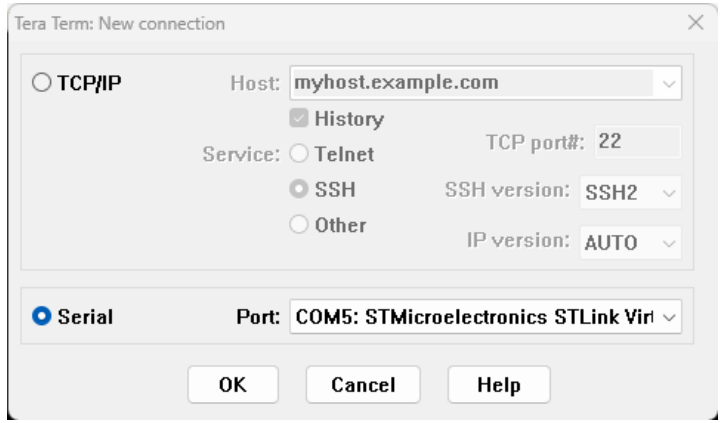
Enabling MLC in Your STM32 Project

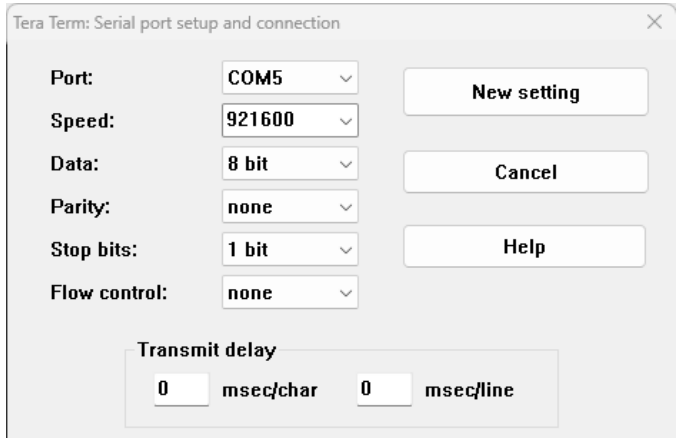
- Flash the board

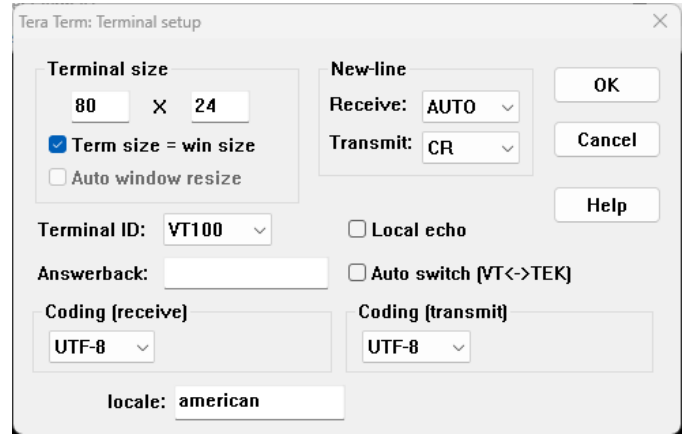


Enabling MLC in Your STM32 Project

- Connect to board using Tera Term



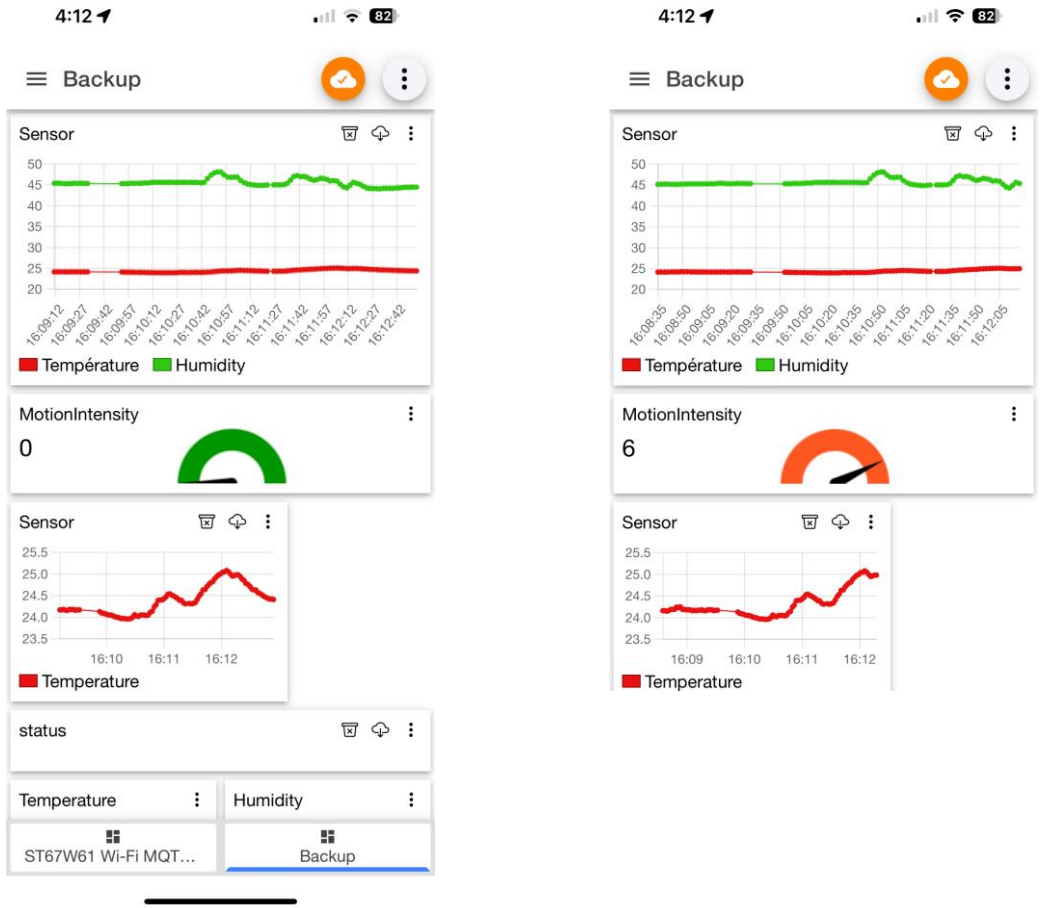





```
Connecting to Local Access Point
NCP is treating the connection request
DHCP client start, this may take few seconds
Connected to following Access Point :
[00:1e:e5:7a:83:f5] Channel: 6 | RSSI: 0 | SSID: BeamsOpenNet
App connected
SNTP Time: Mon Jul 14 00:58:10 2025
WARNING: Accelerometer ODR changed during MLC Config: before 100.00Hz, after 12.50Hz
MEMS Sensors init successful
MQTT Configure successful
MQTT Connect successful
Subscribing to topic /devices/EGTO01/control.
Subscribing to topic /sensors/EGTO01.
MQTT Publish OK
MQTT Subscription Received on topic "/sensors/EGTO01"
  time: 25-07-14 00:58:10
  rssi: -44
  mac: 40:82:7b:00:08:8b
  temperature: 25.50
  pressure: 1005.17
  humidity: 45.79
  motionintensity: 0
```

Enabling MLC in Your STM32 Project

- Open the IotMQTTPanel app and load the configuration file you generated
- Move/shake the board to see motion intensity value change in the Backup panel



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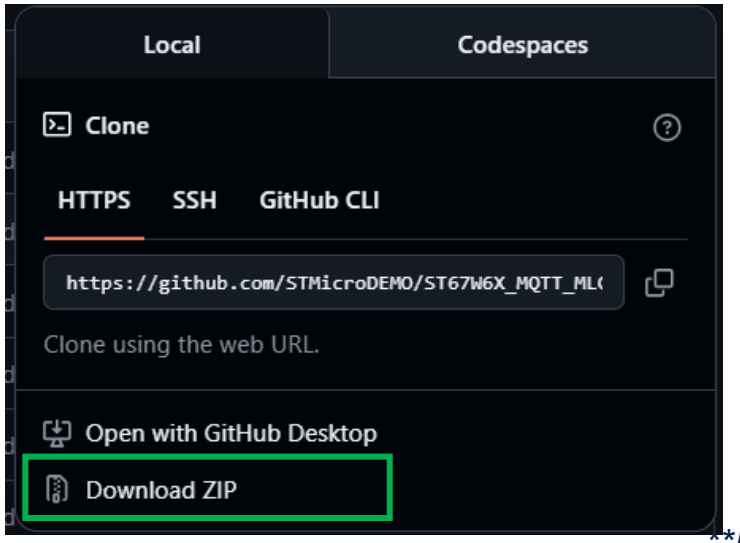
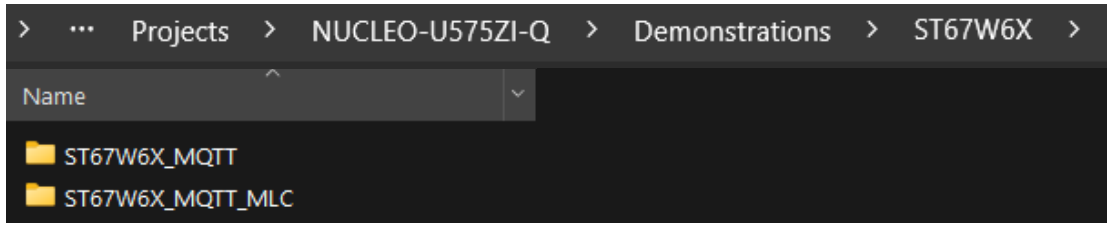
Hands-On: Integrating Embed MLC into MQTTS

ST67W6X MQTT
Hands-On

- In this hands-on we will use a modified MQTT project that includes the MLC portion as well as additional resources located on GitHub
- STMicroDEMO/ST67W6X_MQTT_MLC
- Download the project from GitHub and save the file uncompressed within the X-Cube package:
  - C:\X_CUBE_ST67W61_V1.0.0\Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X





***Note: GitHub may save the project as "ST67W6X_MQTT_MLC-main"*

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ST67W6X MQTT
Higher security schemes

- Higher level security schemes can be enabled to utilize TLS to prevent third party interception of data when publishing data to the cloud.
- Security Schemes:
  - 0 - MQTT over TCP with no authentication and no encryption
  - 1 - MQTT over TLS with username authentication
  - 2 - MQTT over TLS with server certificate
  - 3 - MQTT over TLS with client certificate
  - 4 - MQTT over TLS with both certificates
- The different configurations must be followed when configuring the broker and client.

```
/* MQTT Broker connection */
static W6X_MQTT_Connect_t mqtt_connect =
{
  .HostName = MQTT_HOST_NAME,       /*!< Host name of remote MQTT Broker */
  .HostPort = MQTT_HOST_PORT,       /*!< Port of remote MQTT Broker */
  .Scheme = MQTT_SECURITY_LEVEL,    /*!< Security level. only non-secure is currently available */
  .MQClientId = MQTT_CLIENT_ID,     /*!< MQTT Client ID to be identified on MQTT Broker */
  .MQUserName = MQTT_USERNAME,      /*!< MQTT Username to be identified on MQTT Broker. Not used in non-secure */
  .MQUserPwd = MQTT_USER_PASSWORD,  /*!< MQTT Password to be identified on MQTT Broker. Not used in non-secure */
  .Certificate = MQTT_Certificate,  /*!< Client Certificate. Required when the scheme is greater or equal to 2 */
  .PrivateKey = MQTT_Key,           /*!< Client Private key. Required when the scheme is greater or equal to 2 */
  .CACertificate = MQTT_CA_CERTIFICATE, /*!< CA certificate. Required when the scheme is greater or equal to 2 */
  .SNI_enabled = 0
};
```

mqtt_connect structure that must be configured for each MQTT use case.

ST67W6X MQTT

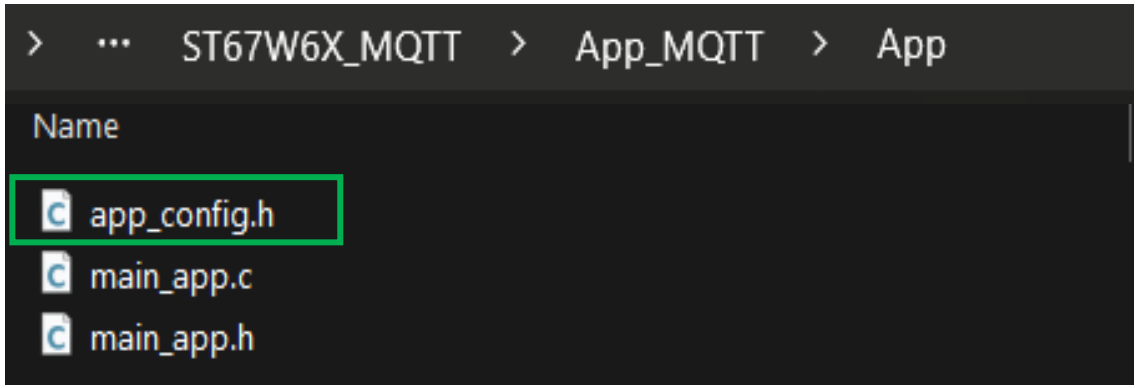
Enabling Higher security schemes

- When enabling security schemes 2 or higher, certificates and keys must be provided to verify security credentials.
- The NCP utilizes littlefs to read certificates and keys from the host MCU that are then stored internally.
- To load certificates and keys onto the host MCU, desired certificates and keys must be placed within the lfs folder in the MQTT demonstration folder:
  - *Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT\littlefs\lfs*
- The desired certificates and keys are loaded onto the host MCU as a littlefs.bin using linker input specified in the project settings.
- This binary can be built from the user specified certificates and keys using the build.bat script once the certificates and keys are placed in the lfs folder.

ST67W6X MQTT

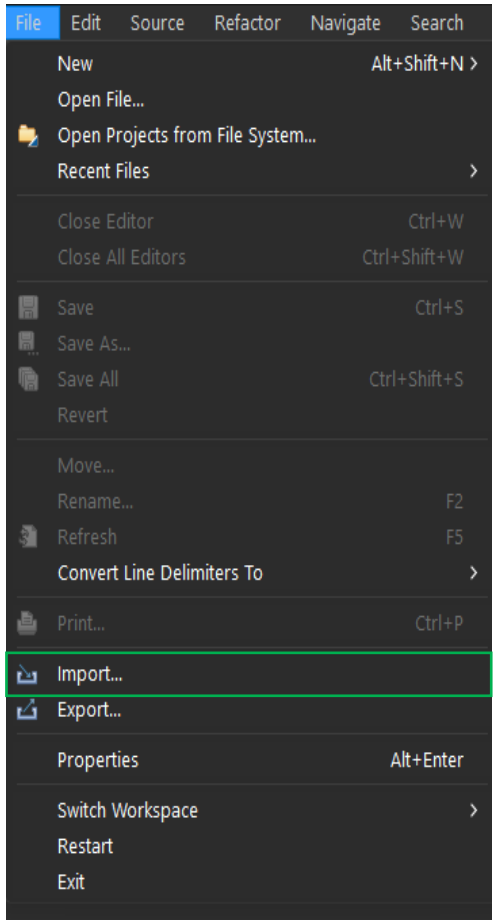
ST67 Client Setup - Security Scheme 1

- In this hands-on portion of the work-shop TLS will be utilized within the MQTT demo using security scheme 1.
- Security scheme 1 - MQTT over TLS with username and password
- MQTT Local Client configuration – Setup on ST67 within CubeIDE in app_config.h



ST67W6X MQTT

Import Project into STM32CubeIDE



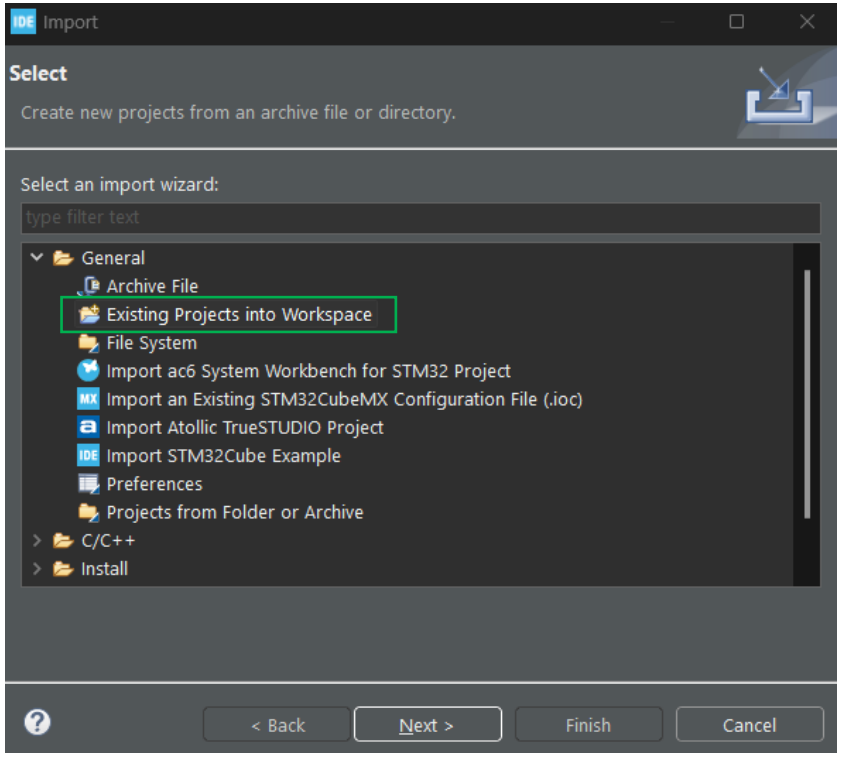
Import the modified MQTT application into CubeIDE

1. Select “File”
2. Select “Import…”

ST67W6X MQTT

Import Project into STM32CubeIDE

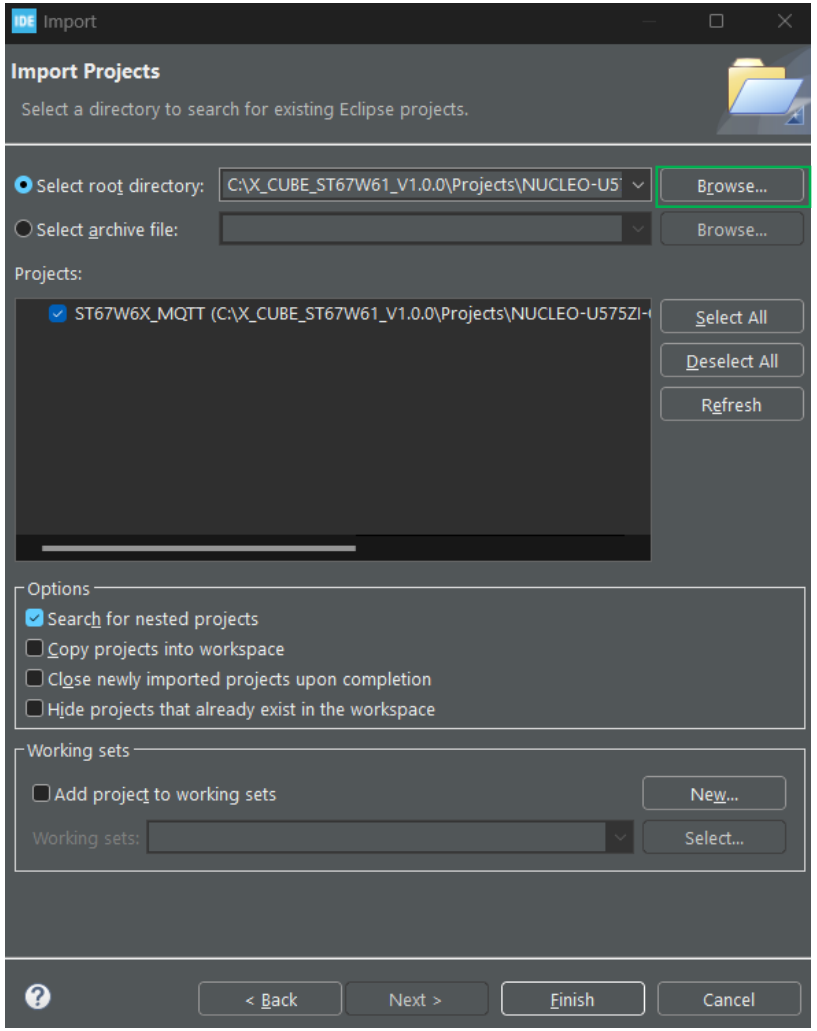
3. Select “Exisiting Projects into Workspace”
4. Select “Next”



ST67W6X MQTT

Import Project into STM32CubeIDE

5. Select “Browse…”
6. Navigate to “C:\ x-cube-st67w61-v1.0.0\Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT_MLC”
7. Select “Finish”



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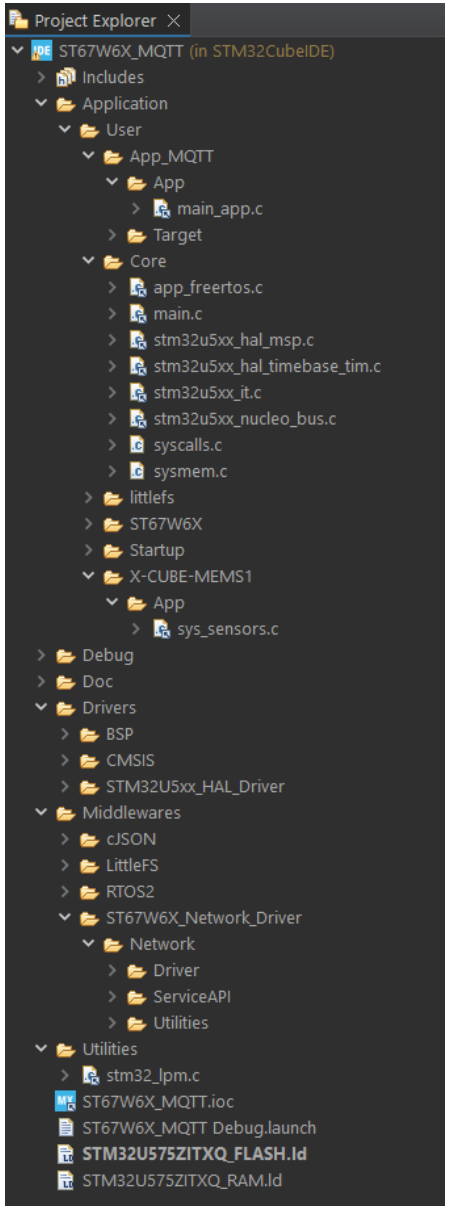
ST67W6X MQTT

Project into STM32CubeIDE



Project Structure:

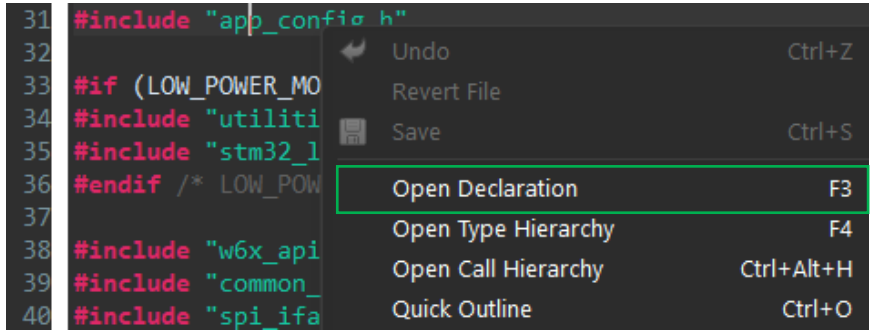
- Application – Contains the files for the application functionality (i.e. main.c, main_app.c, sys_sensors.c, etc.)
- Drivers – Contains the HAL driver, CMSIS, and BSP libraries for STM32U575 and IKS4A1.
- Middlewares – Contains the network driver libraries for the ST67 modules.
- Utilities – Contains the stm32_lpm.c file.

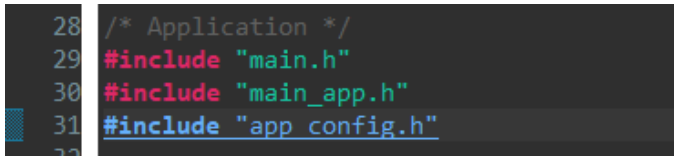
ST67W6X MQTT
Project into STM32CubeIDE

Open app_config.h:

- Open the file main_app.c found in the Application library under User/App_MQTT/App.

- With main_app.c open, to open app_config.h, “right-click” and select “Open Declaration” on app_config.h or hold CTRL and “left-click” on app_config.h.**





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***Note: You must first try building the application to open the file by selecting “Open Declaration”.*

ST67W6X MQTT

ST67 Client Setup - Security Scheme 1

- Modified app_config.h to enable security scheme 1

```
/** Port of remote MQTT Broker */
#define MQTT_HOST_PORT              8883

/** Security level. only non-secure is currently available */
#define MQTT_SECURITY_LEVEL         1

/** MQTT Client ID to be identified on MQTT Broker */
#define MQTT_CLIENT_ID              "hands-on"

/** MQTT Username to be identified on MQTT Broker. Not used in non-secure */
#define MQTT_USERNAME               "st67workshop"

/** MQTT Password to be identified on MQTT Broker. Not used in non-secure */
#define MQTT_USER_PASSWORD          "12345678"

/** MQTT Client Certificate. Required when the scheme is greater or equal to 3 */
#define MQTT_CERTIFICATE            "client_1.crt"

/** MQTTClient Private key. Required when the scheme is greater or equal to 3 */
#define MQTT_KEY                    "client_1.key"

/** MQTT Client CA certificate. Required when the scheme is greater or equal to 2 */
#define MQTT_CA_CERTIFICATE         "ca_1.crt"

/** MQTT Server Name Indication (SNI) enabled */
#define MQTT_SNI_ENABLED            1
```

- Modifying the port to 8883 corresponding to TLS rather than TCP
- Security scheme set to 1 corresponding to use username and password fields
- Specified to unique client ID (not necessary for when enabling security)
- Specified username, please avoid username with spaces
- Specified password

ST67W6X MQTT

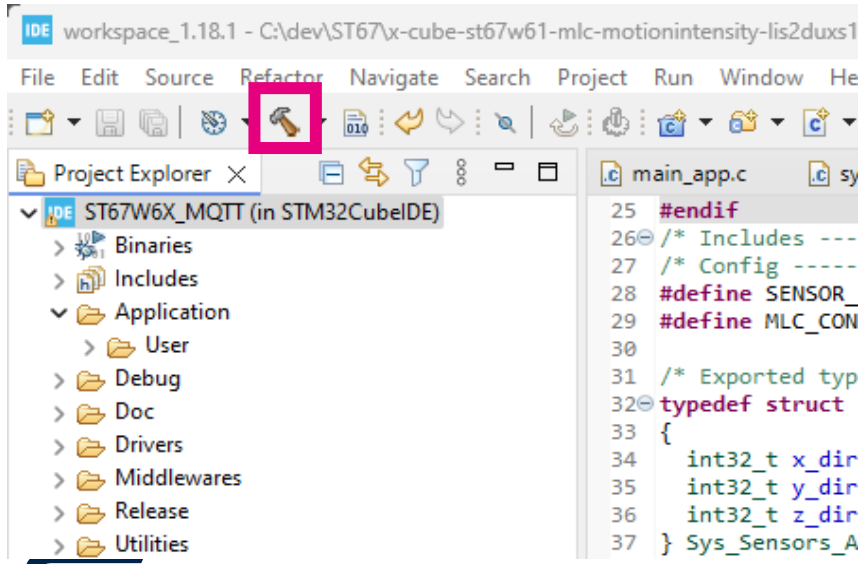
ST67 Client Setup - Security Scheme 1

- Modified app_config.h to provide access point credentials

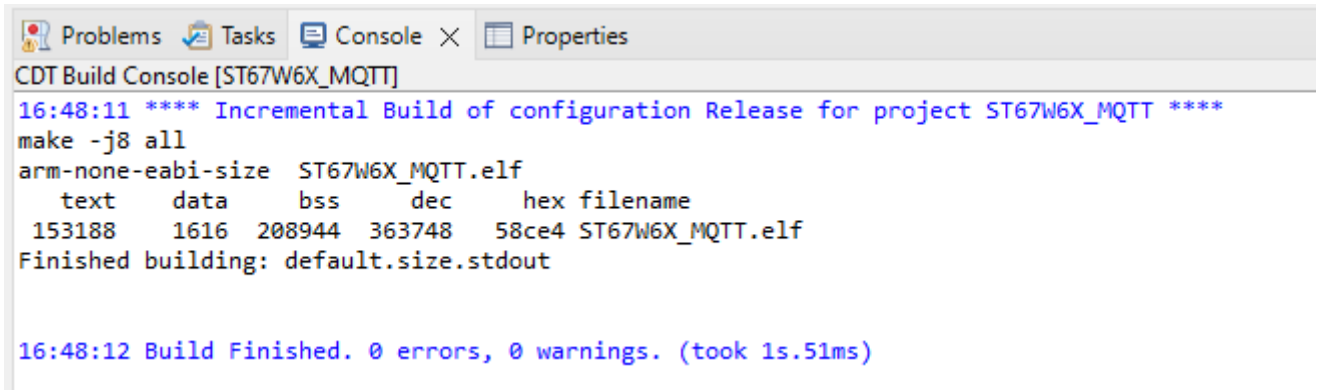
```
61 /* Local Access Point (e.g. gateway, hotspot, etc) connection parameters */
62 #define WIFI_SSID                    "SSID"
63
64 #define WIFI_PASSWORD                "PSWD"
```

*Note: SSID **cannot** have special characters, and both SSID and password should **not** have spaces*

- Once modified with these security changes and with the changes made to enable to MLC portion, save the project and build the application.



- Make sure project builds successfully



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ST67W6X MQTT

Nucleo-U575ZI-Q Serial Terminal Output

```
#### Welcome to ST67W6X MQTT Application #####
# build: 14:31:36 Jul 17 2025
--------------- Host info ---------------
Host FW Version:          1.0.0
--------------- ST67W6X info ------------
ST67W6X MW Version:       1.0.0
AT Version:               1.0.0.1
SDK Version:              2.0.75
MAC Version:              1.6.38
Build Date:               May 10 2025 10:15:04
Module ID:
BOM ID:                   0
Manufacturing Year:       2000
Manufacturing Week:       00
Battery Voltage:          3.340 V
Trim Wi-Fi hp:            6,6,6,6,6,6,5,5,5,5,5,5,4,5
Trim Wi-Fi lp:            5,5,6,6,6,7,7,7,7,7,8,8,8,8
Trim BLE:                 4,4,4,3,4
Trim XTAL:                38
MAC Address:              40:82:7b:00:0e:c1
Anti-rollback Bootloader: 0
Anti-rollback App:        0
-----------------------------------------
mount success
Wi-Fi init is done
Net init is done
MQTT init is done
```

```
MQTT Publish OK
MQTT Subscription Received on topic "/sensors/hands-on"
  time: 25-07-23 18:37:22
  rssi: -47
  mac: 40:82:7b:00:0e:c1
  temperature: 23.55
  pressure: 1005.77
  humidity: 63.05
  motionintensity: 0
MQTT Publish OK
MQTT Subscription Received on topic "/sensors/hands-on"
  time: 25-07-23 18:37:24
  rssi: -48
  mac: 40:82:7b:00:0e:c1
  temperature: 23.57
  pressure: 1005.78
  humidity: 63.16
  motionintensity: 0
MQTT Publish OK
MQTT Subscription Received on topic "/sensors/hands-on"
  time: 25-07-23 18:37:26
  rssi: -48
  mac: 40:82:7b:00:0e:c1
  temperature: 23.56
  pressure: 1005.78
  humidity: 63.06
  motionintensity: 0
```

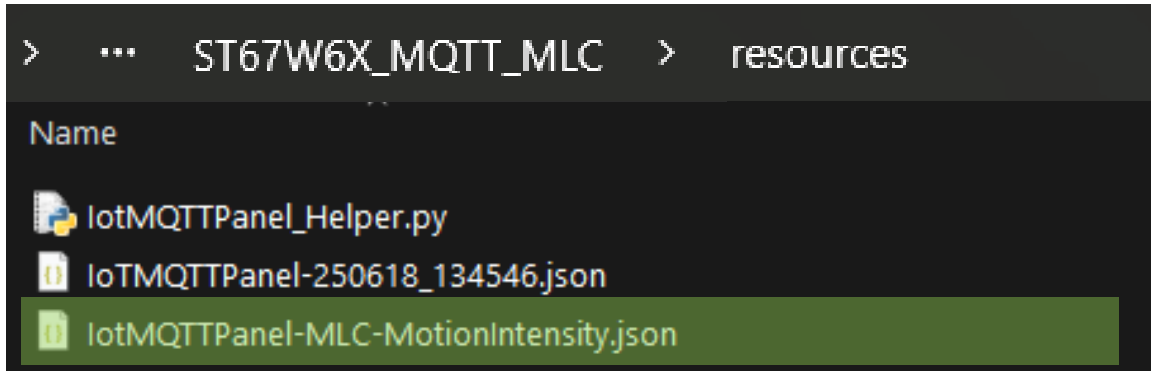
Application running and displaying messages on serial terminal and expected output:

- See FW versions for both host MCU and ST67W6X
- Module initializations (i.e. Wi-Fi, Net, MQTT)
- Scan and connection to AP
- MEMS Init
- MQTT Configure
- MQTT Publish and Subscription received

ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

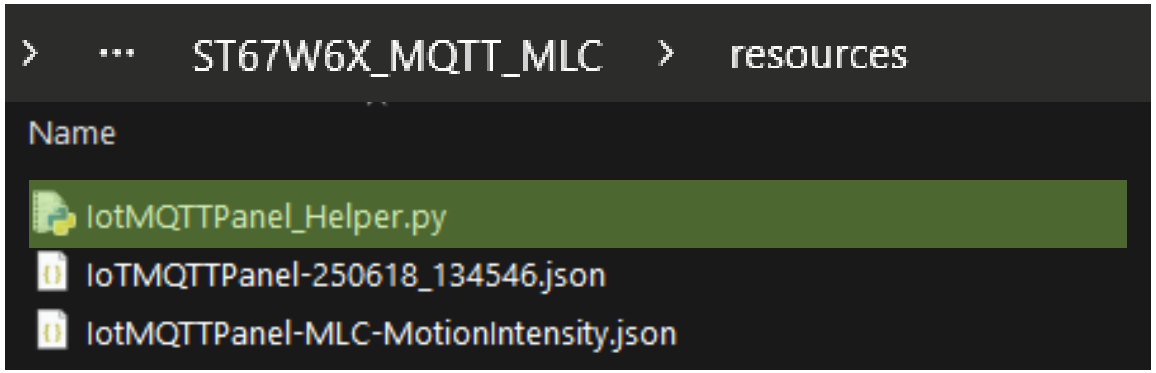
- The IoT MQTT Panel application must be modified to use a username and password as well as match user specifications.
- The IoTMQTTPanel-MLC-MotionIntensity.json is used to configure the IoT MQTT Panel application.



ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

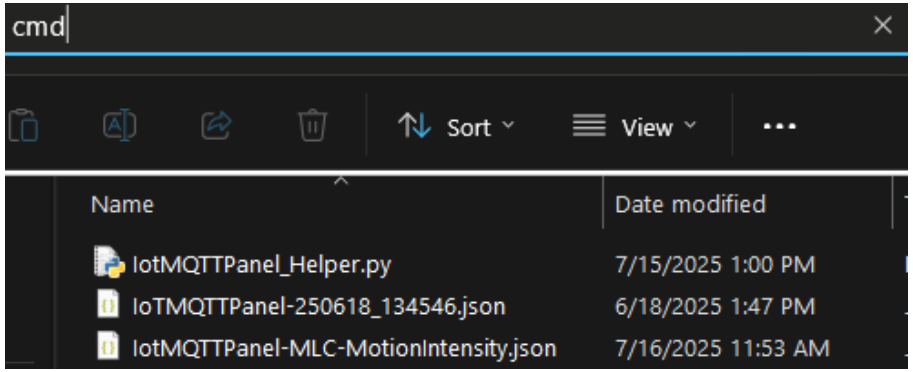
- The .json file can be modified quickly to match the user's specifications using the IoTMQTTPanel_Helper.py script.
  - The Python script is located within the project directory at:
    - Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT_MLC\resources

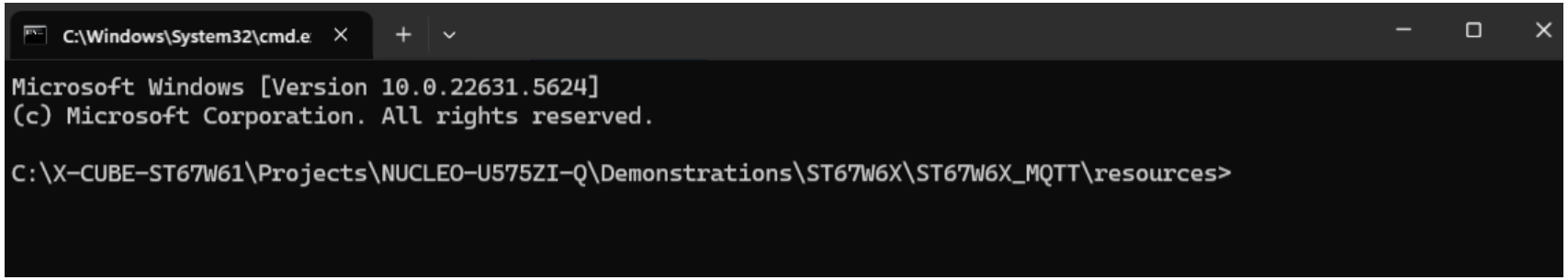


ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- A command window can be opened at the directory containing the python script by typing in “cmd” in the address bar of the file explorer window.





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ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- To see the available parameters that can be edited within the IoTMQTTPanel_Helper.py provide the option ‘-h’ when calling the script

```
C:\X_CUBE_ST67W61_V1.0.0\Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT_MLC\resources>python IotMQTTPanel
_Helper.py -h
usage: IoTMQTTPanel_Helper [-h] [-o OUT] [-b BROKER] [-c CLIENTID] [-u USERNAME] [-p PASSWORD] [--version] JSONin

Pretty print JSON converter and ClientID injection

positional arguments:
  JSONin                Input JSON File

options:
  -h, --help            show this help message and exit
  -o OUT, --out OUT     Output JSON to file
  -b BROKER, --broker BROKER
                        MQTT broker
  -c CLIENTID, --clientid CLIENTID
                        MQTT Client ID to inject
  -u USERNAME, --username USERNAME
                        MQTT Username credentials
  -p PASSWORD, --password PASSWORD
                        MQTT Password credentials
  --version             show program's version number and exit
```

ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- When calling the script the JSONin file **must** be specified
- For this hands-on we will be using the IotMQTTPanel-MLC-MotionIntensity.json
- We also recommend specifying the “out” file which will save any changes specified in the python script to another .json file

ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- Configure the .json file with the configurations specified in app_config.h

```
C:\X_CUBE_ST67W61_V1.0.0\Projects\NUCLEO-U575ZI-Q\Demonstrations\ST67W6X\ST67W6X_MQTT_MLC\resources>python IotMQTTPanel
_Helper.py IotMQTTPanel-MLC-MotionIntensity.json -o NewPanel.json -c hands-on -u st67workshop -p 12345678

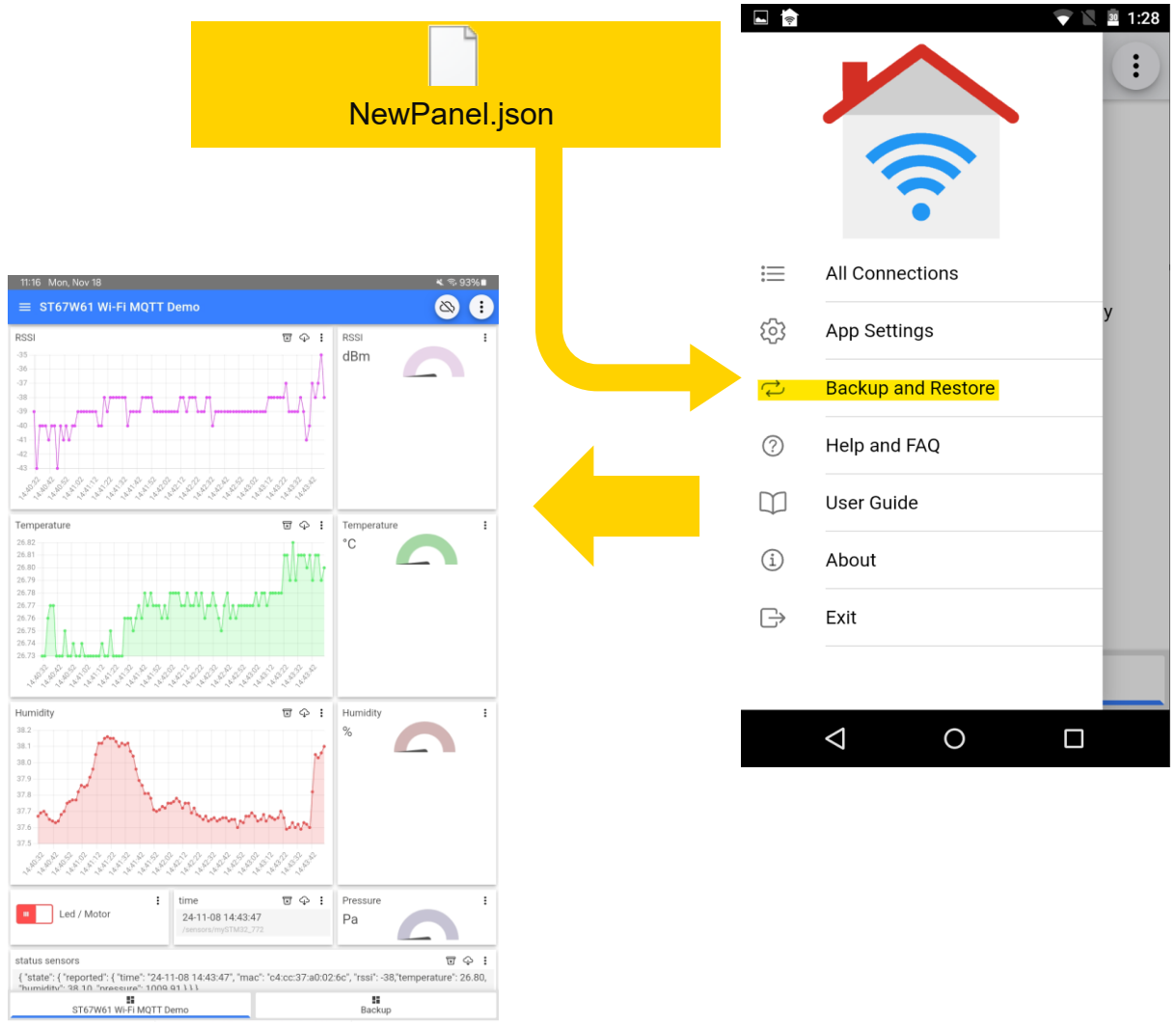
IoTMQTTPanel_Helper
JSON in:  IotMQTTPanel-MLC-MotionIntensity.json
Inserted ClientID "hands-on" 16 times
Inserted Username "st67workshop" 1 times
Inserted Password "12345678" 1 times
Saving output to: NewPanel.json
Done
```

ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- Setup MQTT Client on IoT MQTT Panel Application

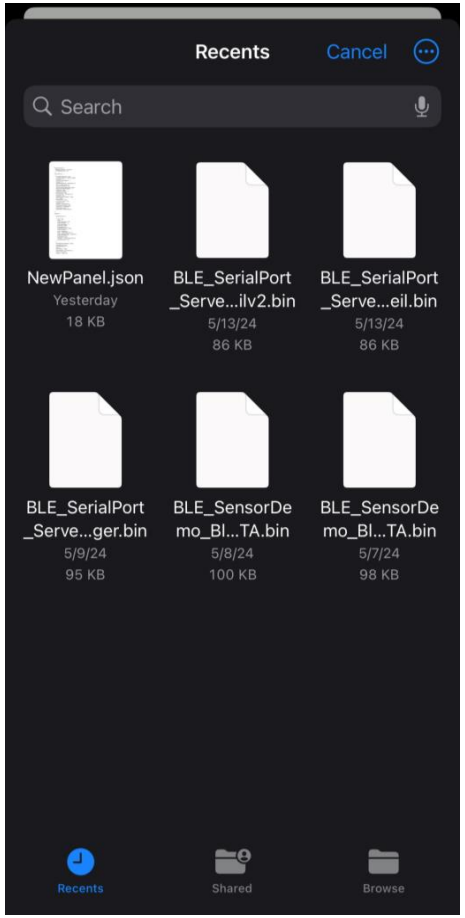
1. Load modified .json file onto smart device
2. Restore connection based on configurations set in .json file
3. Verify connection and data in app with application running on STM32U5+ST67



ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

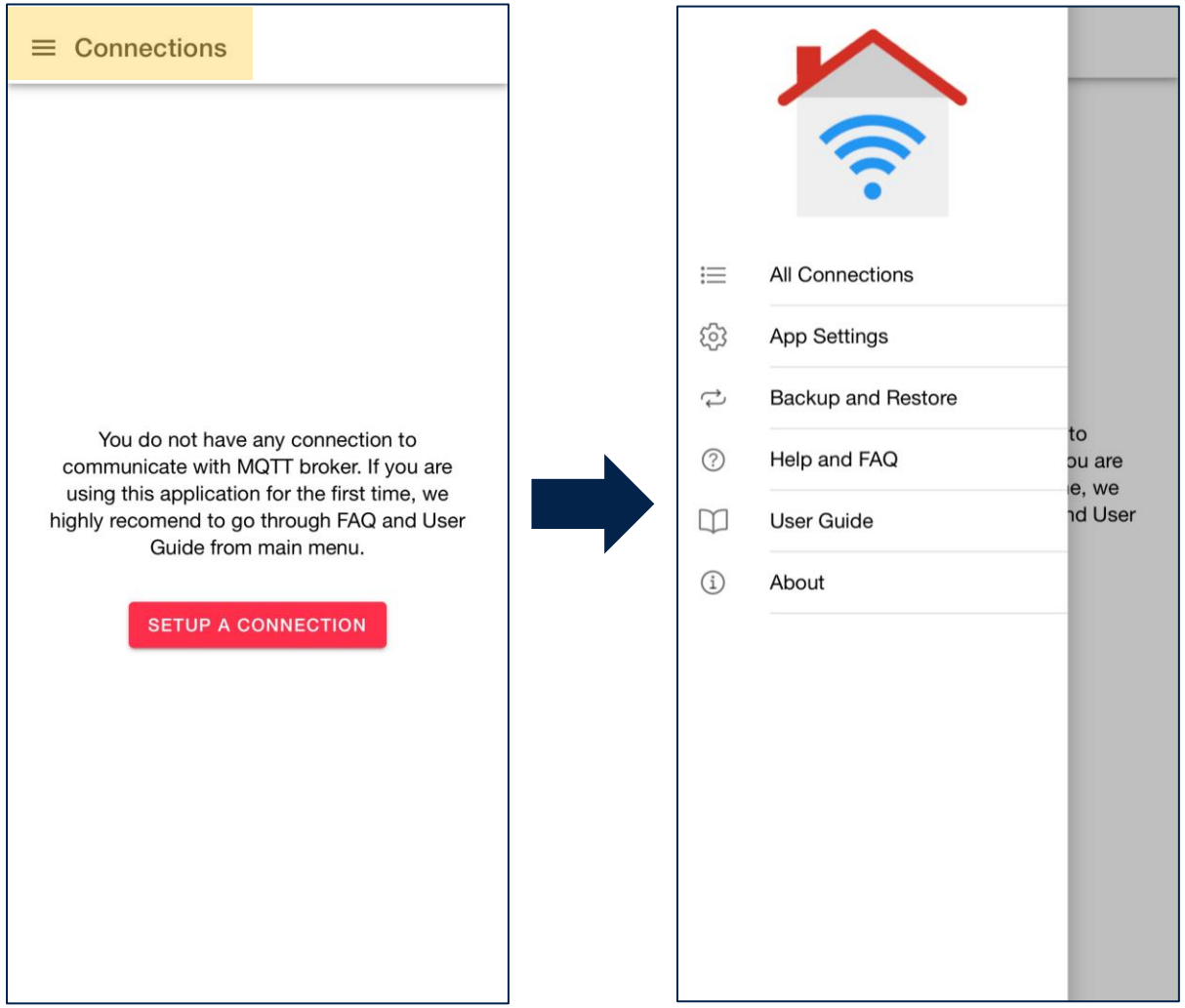
- Modified .json file must be provided to a mobile device with IoT MQTT Panel installed
  - Recommended method is to use a personal email to send the file to your mobile device.



ST67W6X MQTT

IoT MQTT Panel Client Setup – Connection Setup

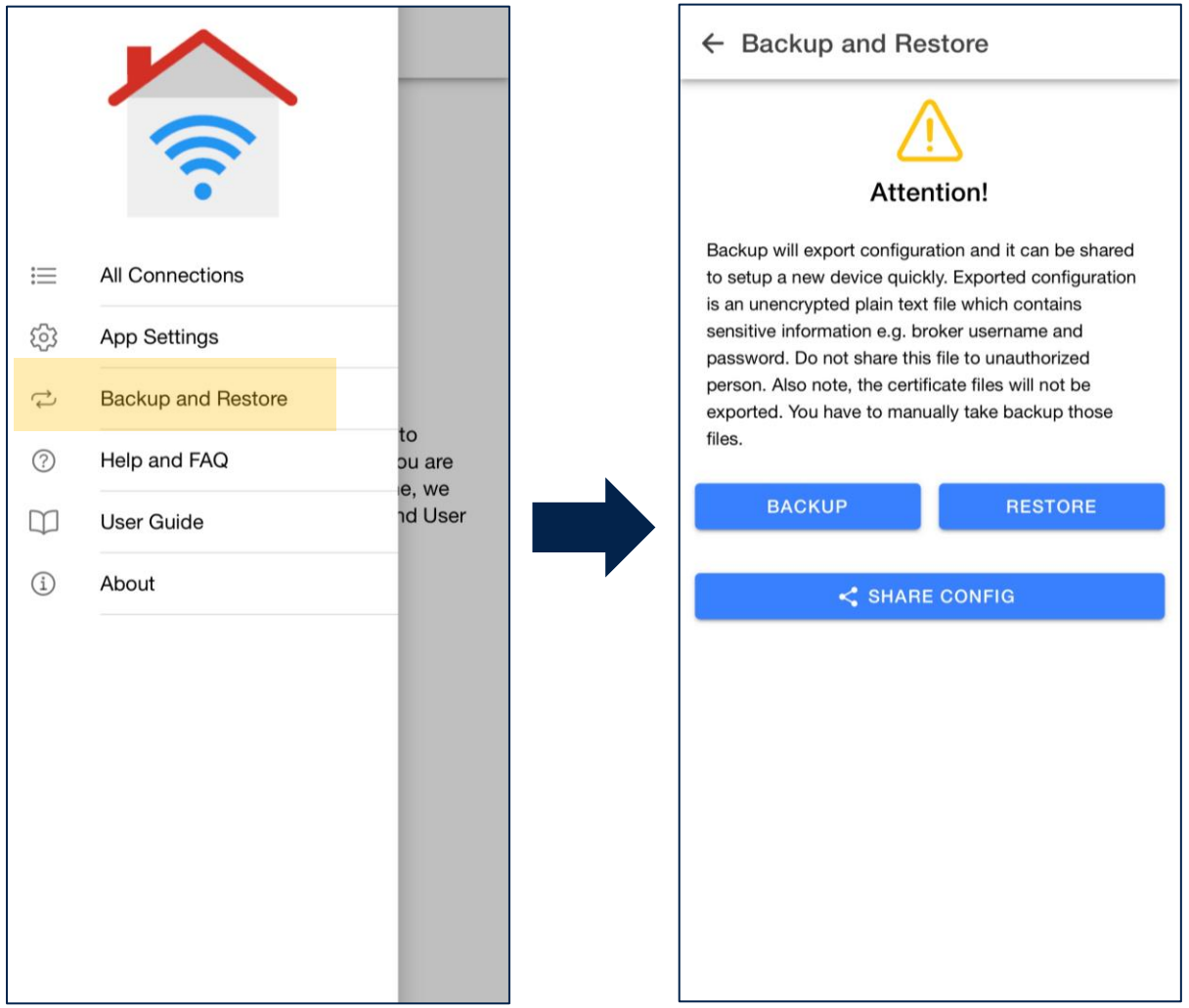
- With IoT MQTT Panel Application open select “Connections” to bring up MQTT Panel application menu.



ST67W6X MQTT

IoT MQTT Panel Client Setup – Connection Setup

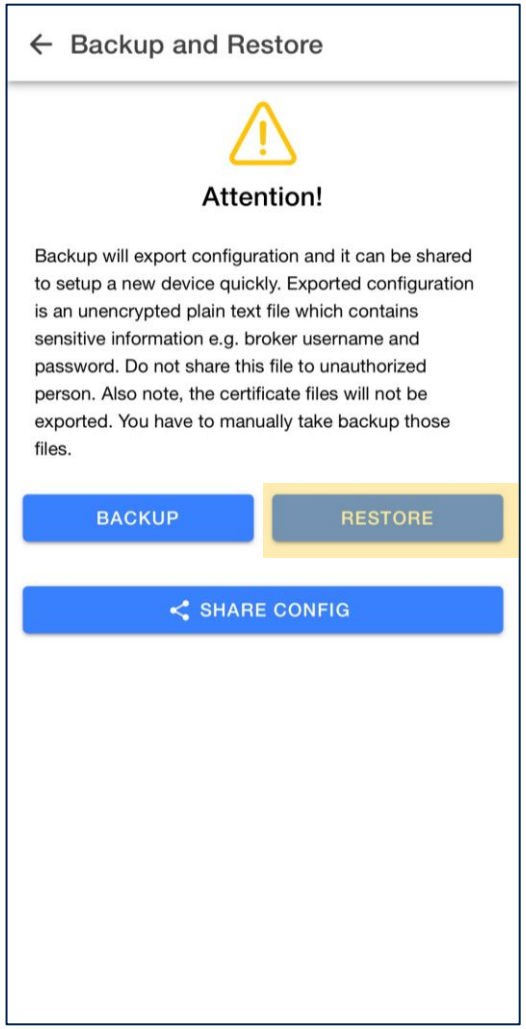
- Select “Backup and Restore” to “Backup” an existing connection or “Restore” a preconfigured connection.

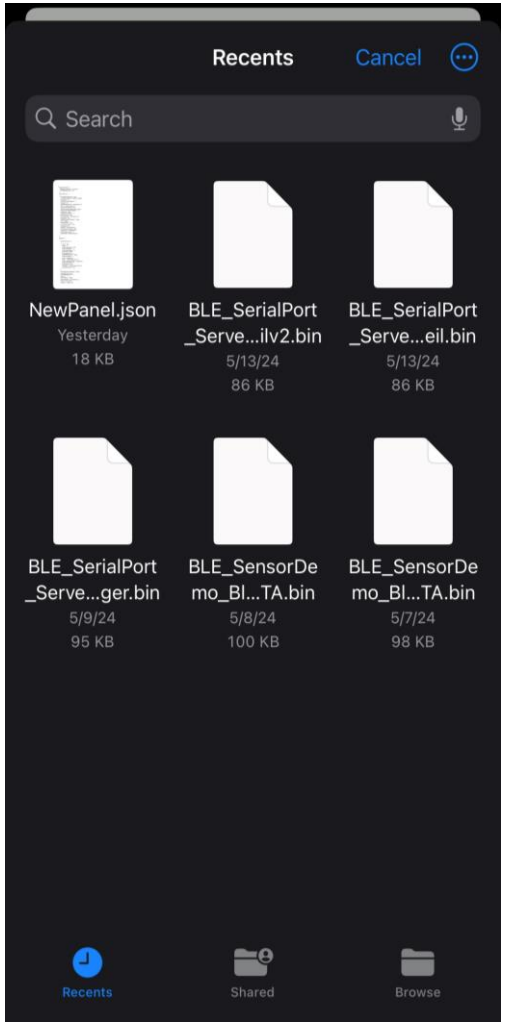


ST67W6X MQTT

IoT MQTT Panel Client Setup – Connection Setup

- Select “Restore” to bringup file storage and select preconfigured .json file stored within smart device’s memory

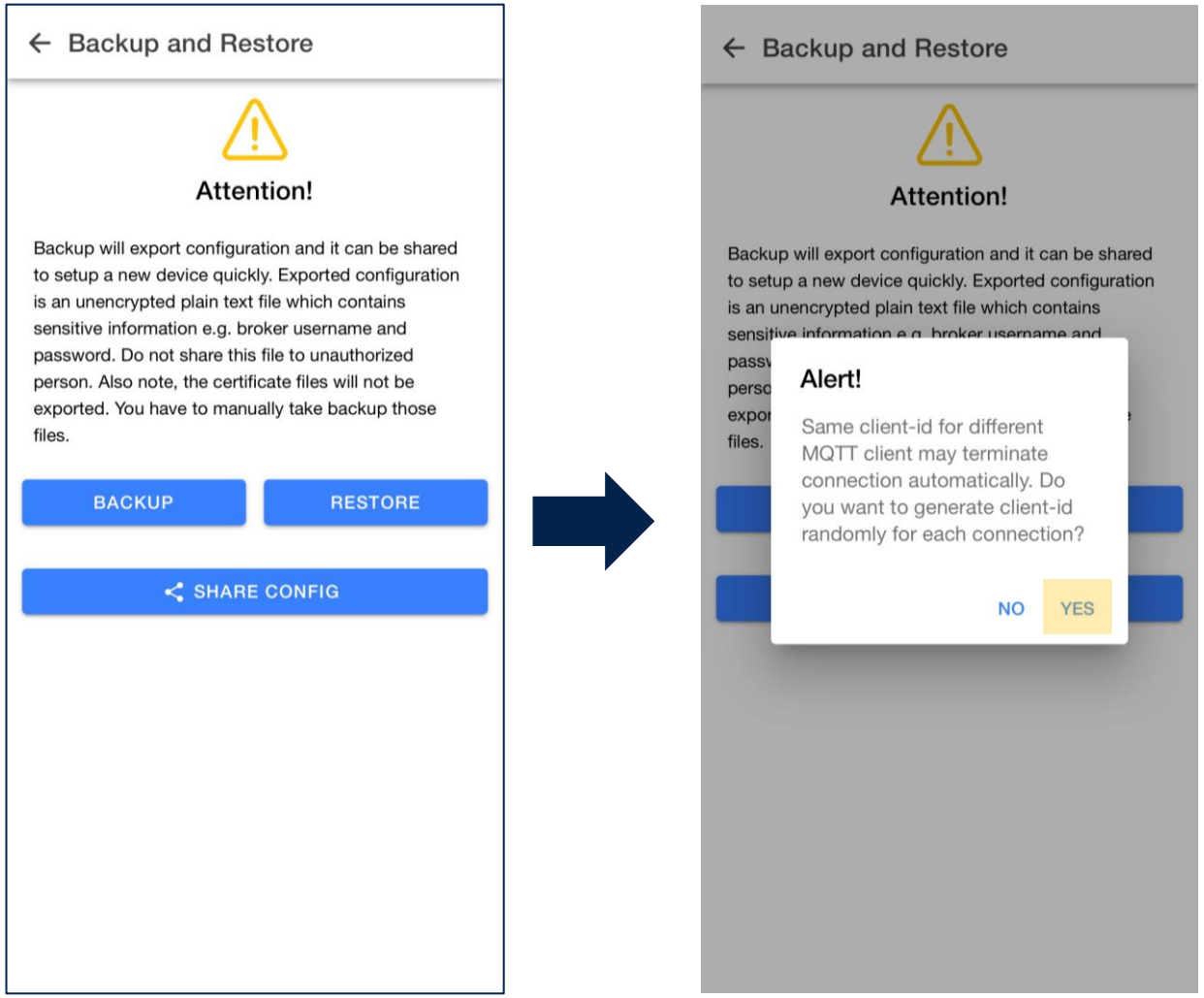




ST67W6X MQTT

IoT MQTT Panel Client Setup – Connection Setup

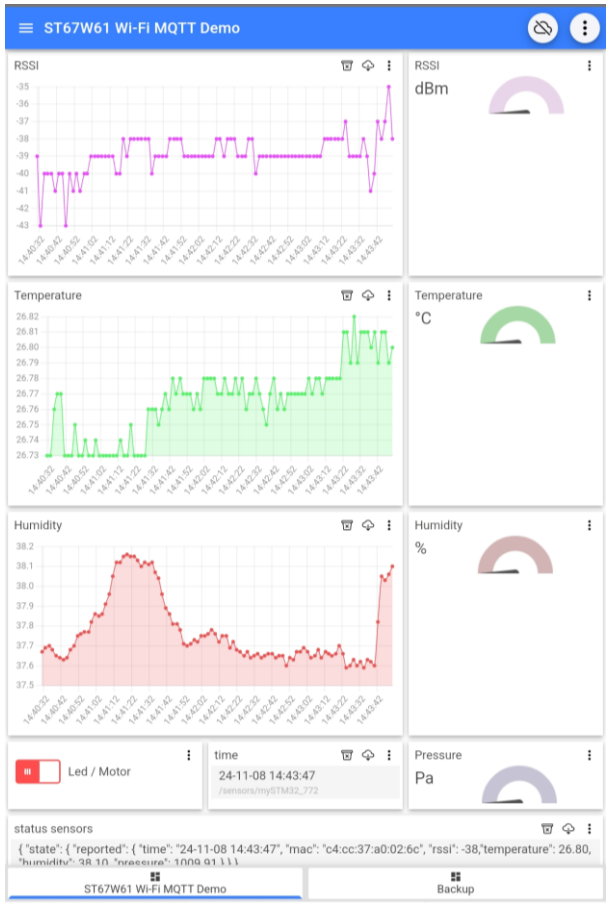
- With preconfigured .json file selected, the IoT MQTT Panel application will “Alert!” the user regarding same client-id.
- Select “Yes”.
  - Client-ID referred to here is correlated to the connection. Client-ID configured previously in the .json and app_config.h is correlated to the topic data is published under.

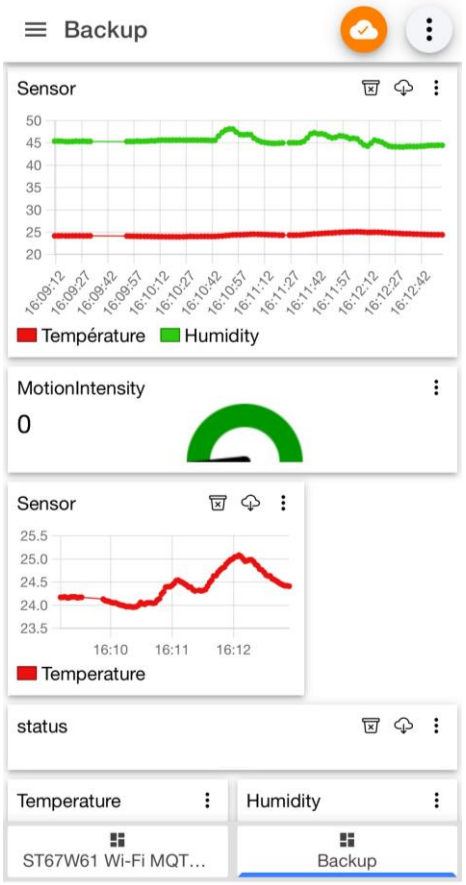


ST67W6X MQTT

IoT MQTT Panel Client Setup - Security Scheme 1

- The main dashboard:
  - Display the graphical values of RSSI, Temperature, Humidity and Pressure from device published message
  - The Green LED statues on the NUCLEO-U575 Host board can be managed through Button panel
- The backup dashboard:
  - Display the graphical values of Humidity, Temperature and Motion Intensity





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Documentation

Wifi wiki

Access:

The wifi wiki is opened to all

Wiki address of the main page

https://wiki.st.com/stm32mcu/wiki/Connectivity:Introduction_to_Wi-Fi

We will be happy to get your feedback!

Wiki Wi-Fi®: pages breakdown

About Wi-Fi

Details about ST67W611M1

X-CUBE-ST67W61

Host boards supported

Tools & References

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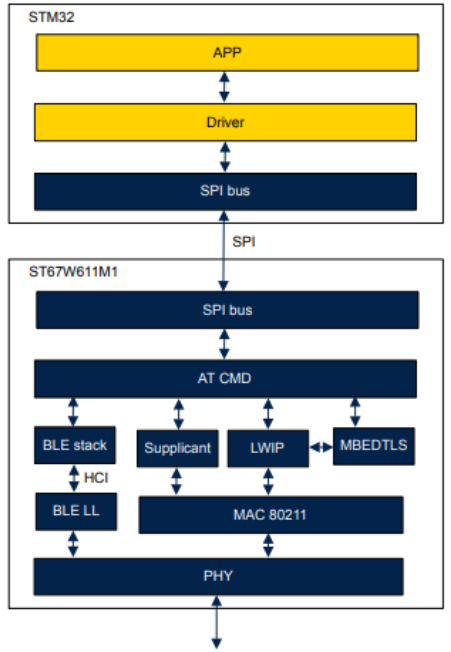
Other documentation

- Getting started with X-CUBE-ST67W61 here

2 X-CUBE-ST67W61 architecture overview

The X-CUBE-ST67W61 is a set of software components implementing host applications driving a Wi-Fi® and Bluetooth® LE coprocessor. The coprocessor is controlled via AT command over SPI interface.
The figure below illustrates the architecture of the solution:

Figure 1. **X-CUBE-ST67W61 architecture view**



- MW API documentation is available:
  - X-CUBE-ST67W61_V1.0.0\Middlewares\ST\ST67W6X_Network_Driver\Doc\ST67W6X_Network_Driver.chm

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ST Customer Support

- ST Support Home
  - Tickets can be submitted under the part number X-CUBE-ST67W61 or ST67W611M1

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Backup Slides