UM2550
User manual

Getting started with STM32CubeWB for STM32WB Series

Introduction

STM32Cube™ is an STMicroelectronics original initiative to make developers' lives easier by reducing development effort, time and cost. STM32Cube™ covers the whole STM32 portfolio.

STM32Cube™ includes:

- STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code using graphical wizards.
- A comprehensive embedded software platform, delivered per Series (such as STM32CubeWB for STM32WB Series):
  - The STM32Cube™ HAL, STM32 abstraction layer embedded software ensuring maximized portability across STM32 portfolio. The HAL is available for all peripherals
  - Low-layer APIs (LL) offering a fast light-weight expert-oriented layer which is closer to the hardware than the HAL. LL APIs are available only for a set of peripherals.
  - A consistent set of middleware components such as USB Device, STMTouch (STM32 touch sensing library), STM32_WPAN (Bluetooth® Low Energy 5.0, OpenThread, 802-15-4 MAC), FatFS and FreeRTOS.
  - All embedded software utilities coming with a full set of examples.

This user manual describes how to get started with the STM32CubeWB MCU Package.

Section 1 describes the main features of the STM32CubeWB MCU Package.

Section 2 and *Section 3* provide an overview of the STM32CubeWB architecture and MCU Package structure.

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1 STM32CubeWB main features

The STM32CubeWB MCU Package runs on STM32 32-bit microcontrollers based on the Arm®(a) Cortex®-M processor.

STM32CubeWB gathers, in a single package, all the generic embedded software components required to develop an application on STM32WB microcontrollers. In line with the STM32Cube™ initiative, this set of components is highly portable, not only within STM32WB Series but also to other STM32 Series.

STM32CubeWB is fully compatible with STM32CubeMX code generator that allows generating initialization code. The package includes low-layer (LL) and hardware abstraction layer (HAL) APIs that cover the microcontroller hardware, together with an extensive set of examples running on STMicroelectronics boards. The HAL and LL APIs are available in open-source BSD license for user convenience.

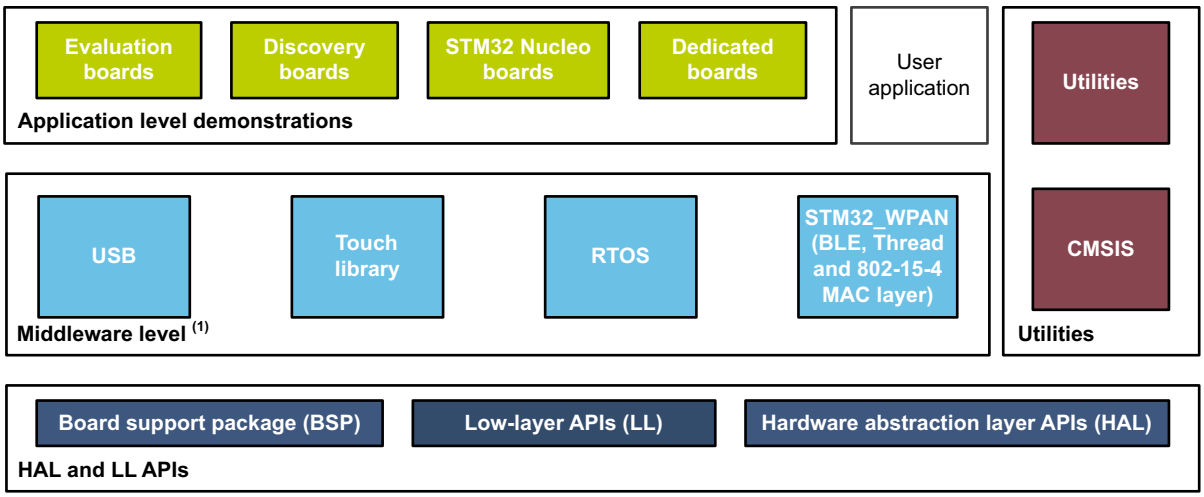
STM32CubeWB MCU Package also contains a set of middleware components with the corresponding examples. They come in free user-friendly license terms:

- CMSIS-RTOS implementation with FreeRTOS™ open source solution
- Full USB Device stack supporting many classes: Audio, HID, MSC, CDC and DFU
- STMTouch, touch sensing library solution
- STM32_WPAN, wireless personal area network middleware developed within the STM32WB framework to support Bluetooth® Low Energy (BLE) 5.0, 802.15.4 OpenThread certified stacks and 802-15-4 MAC layer.
- FAT file system based on open source FatFS solution

Several applications and demonstrations implementing all these middleware components are also provided in the STM32CubeWB MCU Package.

a. Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and or elsewhere.

Figure 1. STM32CubeWB firmware components



(1) The set of middleware components depends on the product Series.

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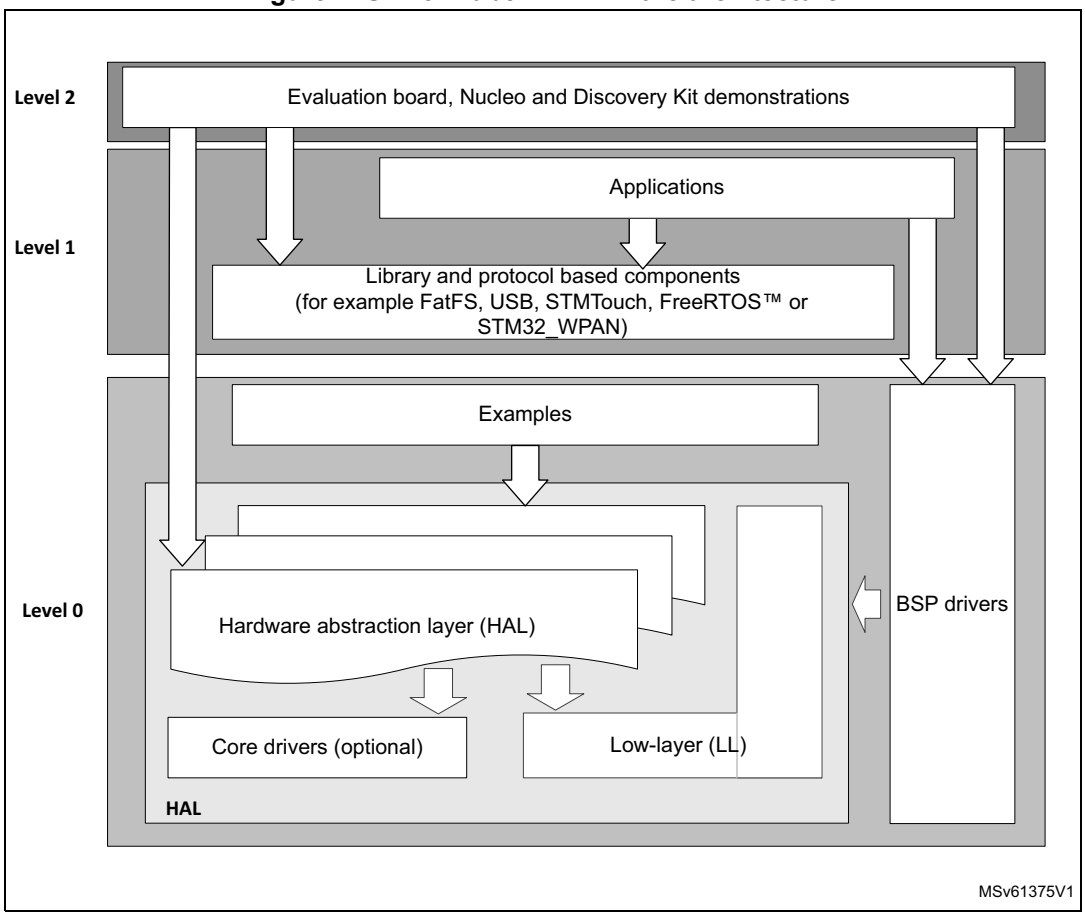
2 STM32CubeWB architecture overview

The STM32CubeWB firmware solution is built around three independent levels that easily interact as described in *Figure 2*.

Figure 2. STM32CubeWB firmware architecture



2.1 Level 0

This level is divided into three sub-layers:

- Board support package (BSP)
- Hardware abstraction layer (HAL)
  - HAL peripheral drivers
  - Low-layer drivers
- Basic peripheral usage examples

2.1.1 Board support package (BSP)

This layer offers a set of APIs relative to the hardware components in the hardware boards (such as LCD, Audio, microSD™ and MEMS drivers). It is composed of two parts:

- Component

  This is the driver relative to the external device on the board and not to the STM32. The component driver provide specific APIs to the BSP driver external components and could be portable on any other board.

- BSP driver

  It allows linking the component driver to a specific board and provides a set of user-friendly APIs. The API naming rule is BSP_FUNCT_Action().

  Example: BSP_LED_Init(), BSP_LED_On()

The BSP is based on a modular architecture allowing an easy porting on any hardware by just implementing the low-level routines.

2.1.2 Hardware abstraction layer (HAL) and low-layer (LL)

The STM32CubeWB HAL and LL are complementary and cover a wide range of applications requirements:

- The HAL drivers offer high-level function-oriented highly-portable APIs. They hide the MCU and peripheral complexity to end user.

  The HAL drivers provide generic multi-instance feature-oriented APIs which simplify user application implementation by providing ready to use process. As example, for the communication peripherals (I^2S, UART, and others), it provides APIs allowing initializing and configuring the peripheral, managing data transfer based on polling, interrupt or DMA process, and handling communication errors that may raise during communication. The HAL driver APIs are split in two categories:

  – Generic APIs which provides common and generic functions to all the STM32 Series

  – Extension APIs which provides specific and customized functions for a specific family or a specific part number.

- The low-layer APIs provide low-level APIs at register level, with better optimization but less portability. They require a deep knowledge of MCU and peripheral specifications.

  The LL drivers are designed to offer a fast light-weight expert-oriented layer which is closer to the hardware than the HAL. Contrary to the HAL, LL APIs are not provided for peripherals where optimized access is not a key feature, or for those requiring heavy software configuration and/or complex upper-level stack.

  The LL drivers feature:

  – A set of functions to initialize peripheral main features according to the parameters specified in data structures

  – A set of functions used to fill initialization data structures with the reset values corresponding to each field

  – Function for peripheral de-initialization (peripheral registers restored to their default values)

  – A set of inline functions for direct and atomic register access

  – Full independence from HAL and capability to be used in standalone mode (without HAL drivers)

  – Full coverage of the supported peripheral features.

2.1.3 Basic peripheral usage examples

This layer encloses the examples build over the STM32 peripheral using only the HAL and BSP resources.

2.2 Level 1

This level is divided into two sub-layers:

- Middleware components
- Examples based on the middleware components.

2.2.1 Middleware components

The middleware is a set of libraries covering FatFS. FreeRTOS™, USB Device, STMTouch (STM32 touch sensing library), and STM32_WPAN middleware. Horizontal interactions between the components of this layer is done directly by calling the feature APIs while the vertical interaction with the low-layer drivers is done through specific callbacks and static macros implemented in the library system call interface. For example, the FatFS implements the disk I/O driver to access microSD™ drive.

The main features of each middleware component are as follows:

- FAT file system
  - FatFS FAT open source library
  - Long file name support
  - Dynamic multi-drive support
  - RTOS and standalone operation
  - Examples with microSD™
- FreeRTOS™
  - Open source standard
  - CMSIS compatibility layer
  - Tickless operation during low-power mode

  - Integration with all STM32Cube™ middleware modules
- USB Device library
  - Support for several USB classes (Mass-Storage, HID, CDC, DFU, AUDIO and MTP)
  - Support for multipacket transfer: large amount of data can be sent without splitting the transfer into transactions of maximum size packets.
  - Use of configuration files to change the core and the library configuration without changing the read-only library code.
  - RTOS and standalone operation,
  - Link with low-level driver through an abstraction layer using the configuration file, to avoid any dependency between the library and the low-level drivers.
- STM32 touch sensing library

  Robust STMTouch capacitive touch sensing solution supporting proximity, touchkey, linear and rotary touch sensor. It is based on a proven surface charge transfer acquisition principle.
- STM32 wireless personal area network middleware (STM32_WPAN) developed within the STM32WB framework
  - BLE 5.0 certified stacks
  - BLE stack: link layer, HCI, L2CAP, ATT, SM, GAP and GATT database (Declaration ID D042164, available from see https://launchstudio.bluetooth.com)
  - BLE multiprofile subsystem: a complete coverage of BLE software stack profiles and services (Declaration ID D042214, available from https://launchstudio.bluetooth.com)
  - 802.15.4 Thread® v1.1 certified applications

    The Thread® stack is provided by OpenThread, an open-source implementation of the Thread® networking protocol (refer to https://openthread.io for more information on this stack). The stack supports two configurations:

    FTD (Full Thread Device), to be used for Leader, Router and End Device Thread roles (except for Border Router).

    MTD (Minimal Thread Device), to be used for End Device and Sleepy End Device Thread roles.
  - 802.15.4 MAC layer

    This MAC API is based on the latest official IEEE Std 802.15.4-2011 document available from http://grouper.ieee.org

    It supports Full Function Devices (FFD) and can ensure the role of Personal Area Network (PAN) coordinator and Reduced Function Device (RFD) that serve as node for extremely simple applications.

2.2.2 Examples based on the middleware components

Each middleware component comes with one or more examples (called also Applications) showing how to use it. Integration examples that use several middleware components are provided as well.

2.3 Level 2

This level is composed of a single layer which consist in a global real-time and graphical demonstration based on the middleware service layer, the low-level abstraction layer and the basic peripheral usage applications for board based features.

3 STM32CubeWB firmware package overview

3.1 Supported STM32WB devices and hardware

STM32Cube™ offers a highly portable hardware abstraction layer (HAL) built around a generic architecture. It allows the build-upon layers, such as the middleware layer, to implement their functions without knowing, in-depth, the MCU used. This improves the library code re-usability and guarantees an easy portability on other devices.

In addition, thanks to its layered architecture, the STM32CubeWB offers full support of all STM32WB Series. The user has only to define the right macro in *stm32wbxx.h*.

Table 1 shows the macro to define depending on the STM32WB device used. This macro must also be defined in the compiler preprocessor.

Table 1. Macros for STM32WB Series

Macro defined in *stm32wbxx.h*	STM32WB devices
STM32WB55xx	STM32WB55CGU6, STM32WB55CEU6, STM32WB55CCU6, STM32WB55RGV6, STM32WB55REV6, STM32WB55RCV6, STM32WB55VGY6, STM32WB55VEY6, STM32WB55VCY6, STM32WB55VGQ6, STM32WB55VEQ6, STM32WB55VCQ6

STM32CubeWB features a rich set of examples and applications at all levels making it easy to understand and use any HAL driver and/or middleware components. These examples run on the STMicroelectronics boards listed in *Table 2*.

Table 2. Boards for STM32WB Series

Kit	Supported boards
P-NUCLEO-WB55	P-NUCLEO-WB55.Nucleo: STM32WB55RG
	P-NUCLEO-WB55.USBDongle: STM32WB55CG

The P-NUCLEO-WB55 kit contains two boards to demonstrate STM32WB connectivity functionalities:

- a Nucleo-68 board: P-NUCLEO-WB55.Nucleo
- a USB dongle: P-NUCLEO-WB55.USBDongle

The P-NUCLEO-WB55.Nucleo is compatible with Adafruit LCD display Arduino™ UNO shields which embed a microSD™ connector and a joystick in addition to the LCD.

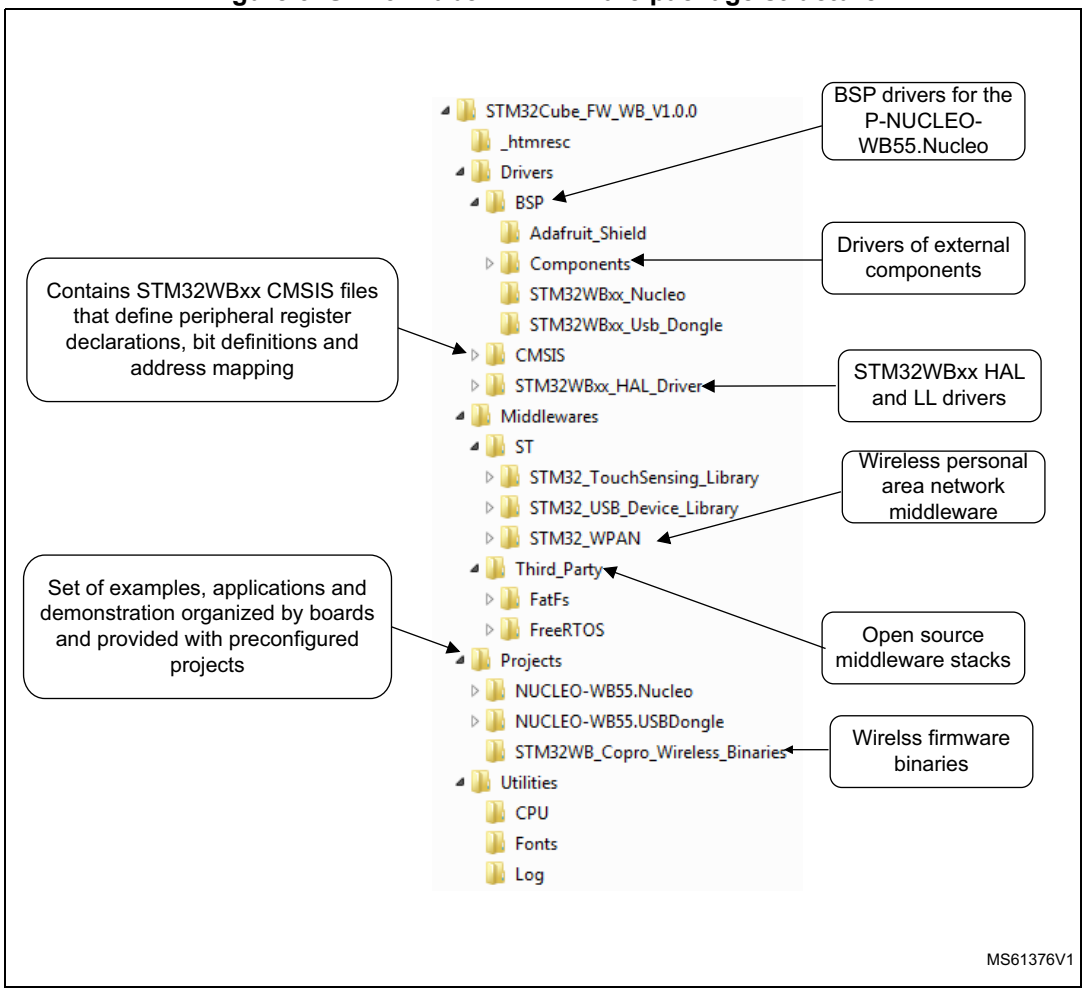
The Arduino™ shield drivers are provided within the BSP component. Their usage is illustrated by a demonstration firmware.

The STM32CubeWB firmware is able to run on any compatible hardware. The user simply updates the BSP drivers to port the provided examples on his own board, if this latter has the same hardware features (LED, LCD display, buttons...).

3.2 Firmware package overview

The STM32CubeWB firmware solution is provided in one single zip package having the structure shown in *Figure 3*.

Figure 3. STM32CubeWB firmware package structure

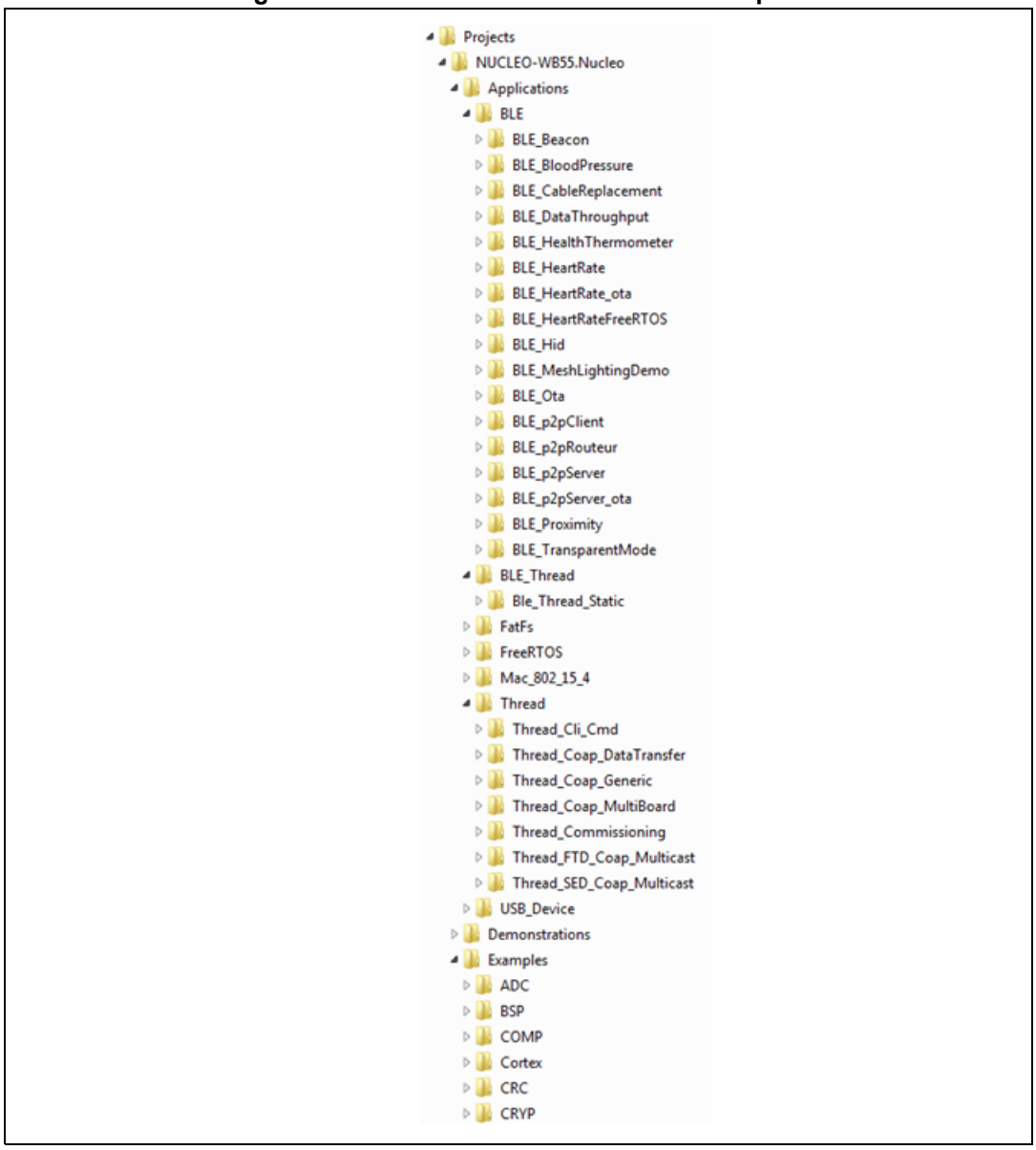


1. The components files must not be modified by the user. Only the *\Projects* sources are eligible to changes by the user.

For each board, a set of examples are provided with pre-configured projects for EWARM, MDK-ARM, and SW4STM32 toolchains.

Figure 4 shows the project structure for the P-NUCLEO-WB55.Nucleo board.

Figure 4. Overview of STM32CubeWB examples



The examples are classified depending on the STM32Cube™ level they apply to, and are named as explained below:

- Level 0 examples are called *Examples*, *Examples_LL* and *Examples_MIX*. They use respectively HAL drivers, LL drivers and a mix of HAL and LL drivers without any middleware component.
- Level 1 examples are called *Applications.* They provide typical use cases of each middleware component.

  The *BLE* folder contains typical BLE 5.0 use cases.

  The *Thread* folder contains typical thread use cases.

  The *BLE_Thread* folder contains an application illustrating the switching from BLE to Thread and vice-versa.

Templates projects available in the Templates and Templates_LL directories allow to quickly build any firmware application on a given board.

All examples have the same structure:

- *Inc* folder that contains all header files.
- *Src* folder for the sources code.
- *EWARM*, *MDK-ARM*, and *SW4STM32* folders contain the pre-configured project for each toolchain.
- *readme.txt* describing the example behavior and needed environment to make it working
- **.ioc* file that allows users to open most of firmware examples within STM32CubeMX (starting from STM32CubeMX 5.1)

4 Getting started with STM32CubeWB

4.1 Running your first example

This section explains how simple is to run a first example within STM32CubeWB. It uses as illustration the generation of a simple LED toggle running on P-NUCLEO-WB55.Nucleo board:

1. Download the STM32CubeWB firmware package. Unzip it into a directory of your choice. Make sure not to modify the package structure shown in *Figure 3*. Note that it is also recommended to copy the package at a location close to your root volume (e.g. C\Eval or G:\Tests) because some IDEs encounter problems when the path length is too long.
2. Browse to *\Projects\NUCLEO-WB55-Nucleo\Examples*.
3. Open *\GPIO*, then *\GPIO_EXTI* folders.
4. Open the project with your preferred toolchain. A quick overview on how to open, build and run an example with the supported toolchains is given below.
5. Rebuild all files and load your image into target memory.
6. Run the example: each time you press the user pushbutton (SW1), LED2 toggles (for more details, refer to the example readme file).

To open, build and run an example with the supported toolchains:, follow the steps below:

- EWARM
  a) Under the example folder, open *\EWARM* sub-folder
  b) Launch the Project.eww workspace(b)
  c) Rebuild all files: **Project->Rebuild all**
  d) Load project image: **Project->Debug**
  e) Run program: **Debug->Go(F5)**
- MDK-ARM
  a) Under the example folder, open *\MDK-ARM* sub-folder
  b) Launch the Project.uvprojx workspace(b)
  c) Rebuild all files: **Project->Rebuild all target files**
  d) Load project image: **Debug->Start/Stop Debug Session**
  e) Run program: **Debug->Run (F5)**.
- SW4STM32
  a) Open the SW4STM32 toolchain
  b) Click **File->Switch Workspace->Other** and browse to the SW4STM32 workspace directory
  c) Click **File->Import**, select **General->Existing Projects into Workspace** and then click **Next**
  d) Browse to the SW4STM32 workspace directory and select the project
  e) Rebuild all project files: select the project in the **Project explorer** window then click the **Project->build project** menu
  f) Run program: Run->Debug (F11)

4.2 Developing your own application

4.2.1 Using STM32CubeMX to develop or update your application

In the STM32CubeWB MCU Package, all Example projects are generated with the STM32CubeMX tool to initialize the system, peripherals and middleware.

The direct use of an existing Example project from within STM32CubeMX requires STM32CubeMX 5.1 or higher:

- After the installation of STM32CubeMX, open and eventually update a proposed project. The simplest way to open an existing project is to double-click on the **.ioc* file so that STM32CubeMX automatically opens the project and its source files.
- The initialization source code of such projects is generated by STM32CubeMX; the main application source code is delimited by comments `USER CODE BEGIN` and `USER CODE END`. In case of a modification of the IP selection and setting, STM32CubeMX updates the initialization part of the code but preserves the main application source code.

For developing an own project in STM32CubeMX, follow the step-by-step process:

1. Select the STMicroelectronics STM32 microcontroller that matches the required set of peripherals.
2. Configure each required embedded software thanks to a pinout-conflict solver, a clock-tree setting helper, a power consumption calculator, and the utility performing MCU peripheral configuration (such as GPIO or USART) and middleware stacks (such as USB).
3. Generate the initialization C code based on the configuration selected. This code is ready to use within several development environments. The user code is kept at the next code generation.

For more information about STM32CubeMX, refer to the STM32CubeMX user manual (UM1718).

For a list of the Example projects available in STM32CubeWB, and their content, refer to the *STM32Cube firmware examples for STM32WB Series* application note (AN5155).

b. The workspace name may change from one example to another.

4.2.2 HAL application

This section describes the steps required to create your own HAL application using STM32CubeWB:

1. **Create your project**

   To create a new project, you either start from the *Template* project provided for each board under *\Projects\<STM32xxx_yyy>\Templates* or from any available project under *\Projects\<STM32xxy_yyy>\Examples or \Projects\<STM32xx_yyy>\Applications* (where *<STM32xxx_yyy>* refers to the board name, such as P-NUCLEO-WB55.Nucleo).

   The *Template* project is providing empty main loop function, however it is a good starting point to get familiar with project settings for STM32CubeWB. The template has the following characteristics:

   – It contains the source code of HAL, CMSIS and BSP drivers which are the minimal components required to develop a code on a given board.

   – It contains the include paths for all the firmware components.

   – It defines the STM32WB device supported, thus allowing to configure the CMSIS and HAL drivers accordingly.

   – It provides read-to-use user files pre-configured as shown below:

   HAL initialized with default time base with ARM Core SysTick.

   SysTick ISR implemented for `HAL_Delay()` purpose.

Note: When copying an existing project to another location, make sure to update the include paths.

2. **Add the necessary middleware to your project (optional)**

   The available middleware stacks are: FatFS, FreeRTOS™, USB Device, STMTouch and STM32_WPAN. To know which source files must be added to the project file list, refer to the documentation provided for each middleware. It is possible to look at the applications available under *\Projects\STM32xxx_yyy\Applications\<MW_Stack>* (where *<MW_Stack>* refers to the middleware stack, such as USB_Device) to know which source files and which include paths must be added.

3. **Configure the firmware components**

   The HAL and middleware components offer a set of build time configuration options using macros # define declared in a header file. A template configuration file is provided within each component, it has to be copied to the project folder (usually the configuration file is named *xxx_conf_template.h*, the word '_template' needs to be removed when copying it to the project folder). The configuration file provides enough

information to know the impact of each configuration option. More detailed information is available in the documentation provided for each component.

4. **Start the HAL Library**

   After jumping to the main program, the application code must call `HAL_Init()` API to initialize the HAL Library, which do the following tasks:

   a) Configuration of the Flash prefetch and SysTick interrupt priority (through macros defined in *stm32wbxx_hal_conf.h*).

   b) Configuration of the SysTick to generate an interrupt every millisecond at the SysTick interrupt priority `TICK_INT_PRIO` defined in *stm32wbxx_hal_conf.h*.

   c) Setting of NVIC Group Priority to 0.

   d) Call of `HAL_MspInit()` callback function defined in *stm32wbxx_hal_msp.c* user file to perform global low-level hardware initializations.

5. **Configure the system clock**

   The system clock configuration is done by calling the two APIs described below:

   a) `HAL_RCC_OscConfig()`: this API configures the internal and/or external oscillators, as well as the PLL source and factors. The user chooses to configure one oscillator or all oscillators. The PLL configuration can be skipped if there is no need to run the system at high frequency.

   b) `HAL_RCC_ClockConfig()`: this API configures the system clock source, the Flash memory latency and AHB and APB prescalers.

6. **Initialize the peripheral**

   a) First write the peripheral `HAL_PPP_MspInit` function. Proceed as follows:

      - Enable the peripheral clock.
      - Configure the peripheral GPIOs.
      - Configure the DMA channel and enable DMA interrupt (if needed).
      - Enable peripheral interrupt (if needed).

   b) Edit the *stm32xxx_it.c* to call the required interrupt handlers (peripheral and DMA), if needed.

   c) Write process complete callback functions if you plan to use peripheral interrupt or DMA.

   d) In your *main.c* file, initialize the peripheral handle structure then call the function `HAL_PPP_Init()` to initialize your peripheral.

7. **Develop your application**

   At this stage, your system is ready and you start developing your application code.

   – The HAL provides intuitive and ready-to-use APIs to configure the peripheral. It supports polling, interrupts and DMA programming model, to accommodate any application requirements. For more details on how to use each peripheral, refer to the rich examples set provided in the STM32CubeWB MCU Package.

   – If your application has some real-time constraints, you find a large set of examples showing how to use FreeRTOS™ and integrate it with all middleware stacks provided within STM32CubeWB. This is a good starting point to develop your application.

Caution: In the default HAL implementation, SysTick timer is used as timebase: it generates interrupts at regular time intervals. If `HAL_Delay()` is called from peripheral ISR process, make sure that the SysTick interrupt has higher priority (numerically lower) than the peripheral interrupt. Otherwise, the caller ISR process will be blocked. Functions affecting

timebase configurations are declared as `__weak` to make override possible in case of other implementations in user file (using a general purpose timer for example or other time source). For more details, refer to `HAL_TimeBase` example.

4.2.3 LL application

This section describes the steps needed to create your own LL application using STM32CubeWB.

1. **Create your project**

   To create a new project you either start from the *Templates_LL* project provided for each board under *\Projects\<STM32xxx_yyy>\Templates_LL* or from any available project under *\Projects\<STM32xxy_yyy>\Examples_LL* (*<STM32xxx_yyy>* refers to the board name, such as P-NUCLEO-WB55.Nucleo).

   The *Template* project provides an empty main loop function, however it is a good starting point to get familiar with project settings for STM32CubeWB.

   Template main characteristics are the following:

   – It contains the source codes of the LL and CMSIS drivers which are the minimal components needed to develop code on a given board.
   – It contains the include paths for all the required firmware components.
   – It selects the supported STM32WB device and allows to configure the CMSIS and LL drivers accordingly.
   – It provides ready-to-use user files, that are pre-configured as follows:

     main.h: LED & USER_BUTTON definition abstraction layer.

     main.c: System clock configuration for maximum frequency.

2. **Port an existing project to another board**

   To port an existing project to another target board, start from the *Templates_LL* project provided for each board and available under *\Projects\<STM32xxx_yyy>\Templates_LL*:

   a) Select a LL example

      To find the board on which LL examples are deployed, refer to the list of LL examples *STM32CubeProjectsList.html* or to application note *"STM32Cube firmware examples for STM32WB Series"* (AN5155).

   b) Port the LL example

   – Copy/paste the *Templates_LL* folder - to keep the initial source - or directly update existing *Templates_LL* project.
   – Then porting consists principally in replacing *Templates_LL* files by the *Examples_LL* targeted project.
   – Keep all board specific parts. For reasons of clarity, board specific parts have been flagged with specific tags:

```
/* ============== BOARD SPECIFIC CONFIGURATION CODE BEGIN ============== */
/* ============== BOARD SPECIFIC CONFIGURATION CODE END ============== */
```

   Thus the main porting steps are the following:

   – Replace the *stm32wbxx_it.h* file
   – Replace the *stm32wbxx_it.c* file
   – Replace the *main.h* file and update it: keep the LED and user button definition of the LL template under '`BOARD SPECIFIC CONFIGURATION`' tags.

– Replace the *main.c* file and update it:

  Keep the clock configuration of the `SystemClock_Config()` LL template function under '`BOARD SPECIFIC CONFIGURATION`' tags.

  Depending on LED definition, replace each LEDx occurrence with another LEDy available in *main.h*.

Thanks to these adaptations, the example should be functional on the targeted board.

4.2.4 Installing and running the STM32CubeUpdater program

Follow the sequence below to install and run the STM32CubeUpdater:

1. To launch the installation, double-click the *SetupSTM32CubeUpdater.exe* file.
2. Accept the license terms and follow the different installation steps.
3. Upon successful installation, STM32CubeUpdater becomes available as an STMicroelectronics program under *Program Files* and is automatically launched. The STM32CubeUpdater icon appears in the system tray. Right-click the updater icon and select **Updater Settings** to configure the Updater connection and whether to perform manual or automatic checks. For more details on Updater configuration, refer to section 3 of STM32CubeMX user manual (UM1718).

5 How to flash the wireless coprocessor binary

The STM32CubeWB firmware package contains several wireless stack binaries located under *Projects\STM32WB_Copro_Wireless_Binaries*.

The supported binaries are the following:

- *stm32wb5x_BLE_Stack_fw.bin*

  Full BLE stack, certified 5.0: link layer, HCI, L2CAP, ATT, SM, GAP and GATT database

  BT SIG certificate: declaration ID D042164
- *stm32wb5x_BLE_HCILayer_fw.bin*

  HCI layer, only mode 5.0 certified: link layer and HCI

  BT SIG certification listing: declaration ID D042213
- *stm32wb5x_Thread_FTD_fw.bin*

  Full Thread Device, certified v1.1

  Usage: Leader, Router and End Device Thread roles (full featured except for Border Router)
- *stm32wb5x_Thread_MTD_fw.bin*

  Minimal Thread Device, certified v1.1.

  Usage: End Device and Sleepy End Device Thread roles
- *stm32wb5x_BLE_Thread_fw.bin*

  Static Concurrent Mode BLE Thread, supporting full BLE stack certified 5.0 and Full Thread Device certified v1.1
- *stm32wb5x_Mac_802_15_4_fw.bin*

  MAC API based on the latest official IEEE Std 802.15.4-2011

  Usage: MAC FFD and RFD devices

Follow the steps below to flash the wireless coprocessor binary into the device memory:

1. Install STM32CubeProgrammer version 1.4 or higher (refer to "*STM32CubeProgrammer software description*" (UM2237)

   The STM32CubeProgrammer software is available as command line interface (CLI).

   It gives access to the firmware upgrade service (FUS) through the bootloader.
2. Set the device in bootloader mode

   This is achieved by connecting BOOT0 pin to V_{DD}.

   For P-NUCLEO-WB55.Nucleo:

   a) Add a jumper between CN7.5 (V_{DD}) and CN7.7 (BOOT0).

   b) Power on the board via USB_USER and J2 jumper (USB_MCU).

   For P-NUCLEO-WB55.USBDongle:

   a) Move SW2 switch to BOOT0 position.

   b) Connect P-NUCLEO-WB55.USBDongle to you PC USB port.
3. Delete the current wireless stack by executing the following command line

   ```
   STM32_Programmer_CLI.exe -c port=usb1 -fwdelete
   ```

4. Download the new wireless stack

   Each binary version must be installed at a different address provided in *Projects\STM32WB_Copro_Wireless_Binaries\Release_Notes.html*:

   ```
   STM32_Programmer_CLI.exe -c port=usb1 -fwupgrade
   Wireless_Coprocessor_Binary] [Install address] firstinstall=1
   ```

   where

   [Wireless_Coprocessor_Binary] corresponds to the location of the binary

   [Install address] corresponds to the value indicated in the *Projects\STM32WB_Copro_Wireless_Binaries\Release_Notes.html* and depending on the selected binary and version.

5. Go to step 2) to put back device in Normal mode.

   For P-NUCLEO-WB55.Nucleo:

   a) Remove the jumper between CN7.5 (V_{DD}) and CN7.7 (BOOT0).

   b) Power on the device through the ST-LINK connector.

   For P-NUCLEO-WB55.USBDongle:

   a) Move SW2 switch to "IO" position.

6 FAQ

6.1 What is the license scheme for the STM32CubeWB firmware?

The HAL is distributed under a non-restrictive BSD (Berkeley Software Distribution) license.

The middleware stacks made by STMicroelectronics (USB Device Libraries, STemWin, STM32_WPAN) come with a licensing model allowing easy reuse, provided it runs on an STMicroelectronics device.

The middleware based on well-known open-source solutions (FreeRTOS™ and FatFS) have user-friendly license terms. For more details, refer to the license agreement of each middleware.

6.2 What boards are supported by the STM32CubeWB firmware package?

The STM32CubeWB firmware package provides BSP drivers and ready-to-use examples for the following STM32WB boards:

- P-NUCLEO-WB55.Nucleo
- P-NUCLEO-WB55.USBDongle

6.3 Are any examples provided with the ready-to-use toolset projects?

Yes. STM32CubeWB provides a rich set of examples and applications. They come with the pre-configured projects for IAR™, Keil® and GCC-based toolchains.

6.4 Is there any link with Standard Peripheral Libraries?

The STM32Cube™ HAL and LL drivers are the replacement of the standard peripheral library:

- The HAL drivers offer a higher abstraction level compared to the standard peripheral APIs. They focus on peripheral common features rather than hardware. Their higher abstraction level allows defining a set of user-friendly APIs that are easily portable from one product to another.
- The LL drivers offer low-layer APIs at registers level. They are organized in a simpler and clearer way than direct register accesses. LL drivers also include peripheral initialization APIs, which are more optimized compared to what is offered by the SPL, while being functionally similar. Compared to HAL drivers, these LL initialization APIs allows an easier migration from the SPL to the STM32Cube™ LL drivers, since each SPL API has its equivalent LL API(s).

6.5 Does the HAL layer take benefit from interrupts or DMA? How can this be controlled?

Yes. The HAL layer supports three API programming models: polling, interrupt and DMA (with or without interrupt generation).

6.6 How are the product/peripheral specific features managed?

The HAL drivers offer extended APIs, i.e. specific functions as add-ons to the common API to support features available on some products/lines only.

6.7 How can STM32CubeMX generate code based on embedded software?

STM32CubeMX has a built-in knowledge of STM32 microcontrollers, including their peripherals and software, that allows to provide a graphical representation to the user and generate **.h*/**.c* files based on user configuration.

6.8 When should I use HAL versus LL drivers?

HAL drivers offer high-level and function-oriented APIs, with a high level of portability. Product/IPs complexity is hidden for end users.

LL drivers offer low-layer APIs at registers level, with a better optimization but less portability. They require a deep knowledge of product/IPs specifications.

6.9 How can I include LL drivers in my environment? Is there any LL configuration file as for HAL?

There is no configuration file. Source code shall directly include the necessary *stm32wbxx_ll_ppp.h* file(s).

6.10 Can I use HAL and LL drivers together? If yes, what are the constraints?

It is possible to use both HAL and LL drivers. One handles the IP initialization phase with HAL and then manages the I/O operations with LL drivers.

The major difference between HAL and LL is that HAL drivers require to create and use handles for operation management while LL drivers operates directly on peripheral registers. Mixing HAL and LL is illustrated in Examples_MIX example.

6.11 Are there any LL APIs which are not available with HAL?

Yes, there are.

A few Cortex® APIs have been added in *stm32wbxx_ll_cortex.h* , for instance for accessing SCB or SysTick registers.

6.12 Why are SysTick interrupts not enabled on LL drivers?

When using LL drivers in standalone mode, you do not need to enable SysTick interrupts because they are not used in LL APIs, while HAL functions requires SysTick interrupts to manage timeouts.

6.13 How are LL initialization APIs enabled?

The definition of LL initialization APIs and associated resources (structure, literals and prototypes) is conditioned by the `USE_FULL_LL_DRIVER` compilation switch.

To be able to use LL APIs, add this switch in the toolchain compiler preprocessor.

7 Revision history

Table 3. Document revision history

Date	Revision	Changes
06-Feb-2019	1	Initial release.