STM32 Secure Patching Bootloader Quick Start Guide

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Introduction

The *STM32 Secure Patching Bootloader* is a firmware and software product designed by Firmware Modules Inc for use with the popular **STM32** family of microcontrollers (MCUs) by STMicroelectronics. As its name suggests, the *STM32 Secure Patching Bootloader* is a bootloader system offering a secure way to update the firmware on an STM32 device using patch files. This bootloader system is designed to be extremely easy to integrate into an existing project: The on-target bootloader binary is pre-built for specific targets and there is nothing to configure. It is a **plug'n'play system** that just works! Unlike other bootloader and firmware update systems, you do not need to be a bootloader expert to get "production level" functionality.

Integrating the stm32-secure-patching-bootloader into an existing project is a simple **four step process**:

1. Adding bootloader files to your **project repository**.
2. Configuring **STM32CubeIDE**.
3. Adjusting your project's linker script **.ld** file.
4. Adjusting your project's **system_stm32xxxx.c** file.

Each step is described below. We have also created and posted projects you can use as a reference at stm32-secure-patching-bootloader-demoapp.

Integration

Integration Step 1 of 4

Add bootloader files to your project repository.

- Create a directory called \`Bootloader\` in your project root.
- Copy the directories \`Include\`, \`Linker\`, \`Scripts\`, \`Tools\` into it.
- Copy the \`Libs\` directory, but only the board subdirectories that you are needing. E.g. copy DISCO-F769I directory into your Libs directory if you are using that board.
- As an alternative, you can add the bootloader files as a git submodule with *git submodule add https://github.com/firmwaremodules/stm32-secure-patching-bootloader Bootloader*.

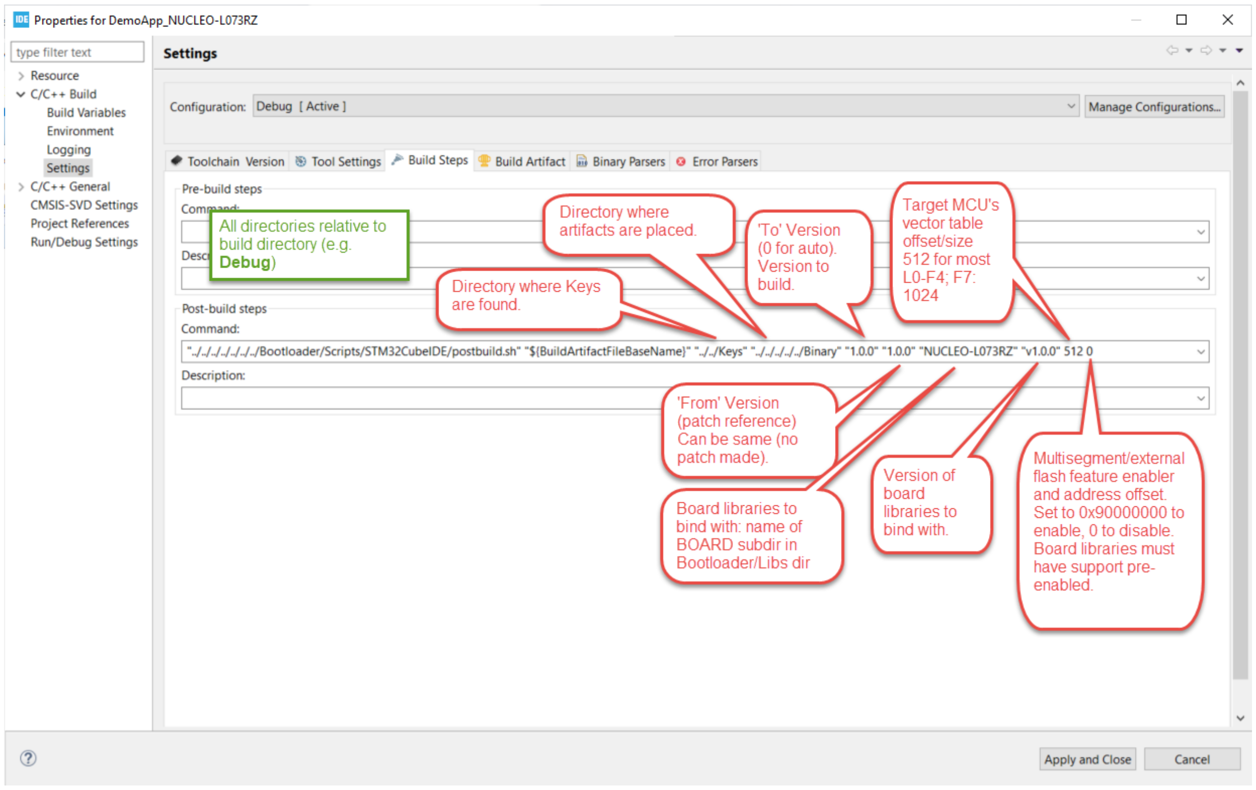
Integration Step 2 of 4

Configure STM32CubeIDE.

We need to add the **postbuild.sh script** command line, update the include and linker paths, and link with the stm32-secure-patching-bootloader application interface. **C/C++ Build -> Settings -> Build Steps**

Postbuild script command examples for some targets:

- "../../../../../../../Bootloader/Scripts/STM32CubeIDE/postbuild.sh" "${BuildArtifactFileBaseName}" "../../Keys" "../../../../../Binary" "1.0.0" "1.0.0" "NUCLEO-L073RZ" "1.0.0" 512 0
- "../../../../../../../Bootloader/Scripts/STM32CubeIDE/postbuild.sh" "${BuildArtifactFileBaseName}" "../../Keys" "../../../../../Binary" "1.0.0" "1.0.0" "DISCO-F769I" "1.0.0" 1024 0x90000000


Properties for DemoApp_NUCLEO-L073RZ
type filter text
Resource
C/C++ Build
Build Variables
Environment
Logging
Settings
C/C++ General
CMSIS-SVD Settings
Project References
Run/Debug Settings
Settings
Manage Configurations...
Toolchain Version
Tool Settings
Build Steps
Build Artifact
Binary Parsers
Error Parsers
Apply and Close
Cancel

Configuration: Debug [Active]

Pre-build steps

Command:

Description:

Post-build steps

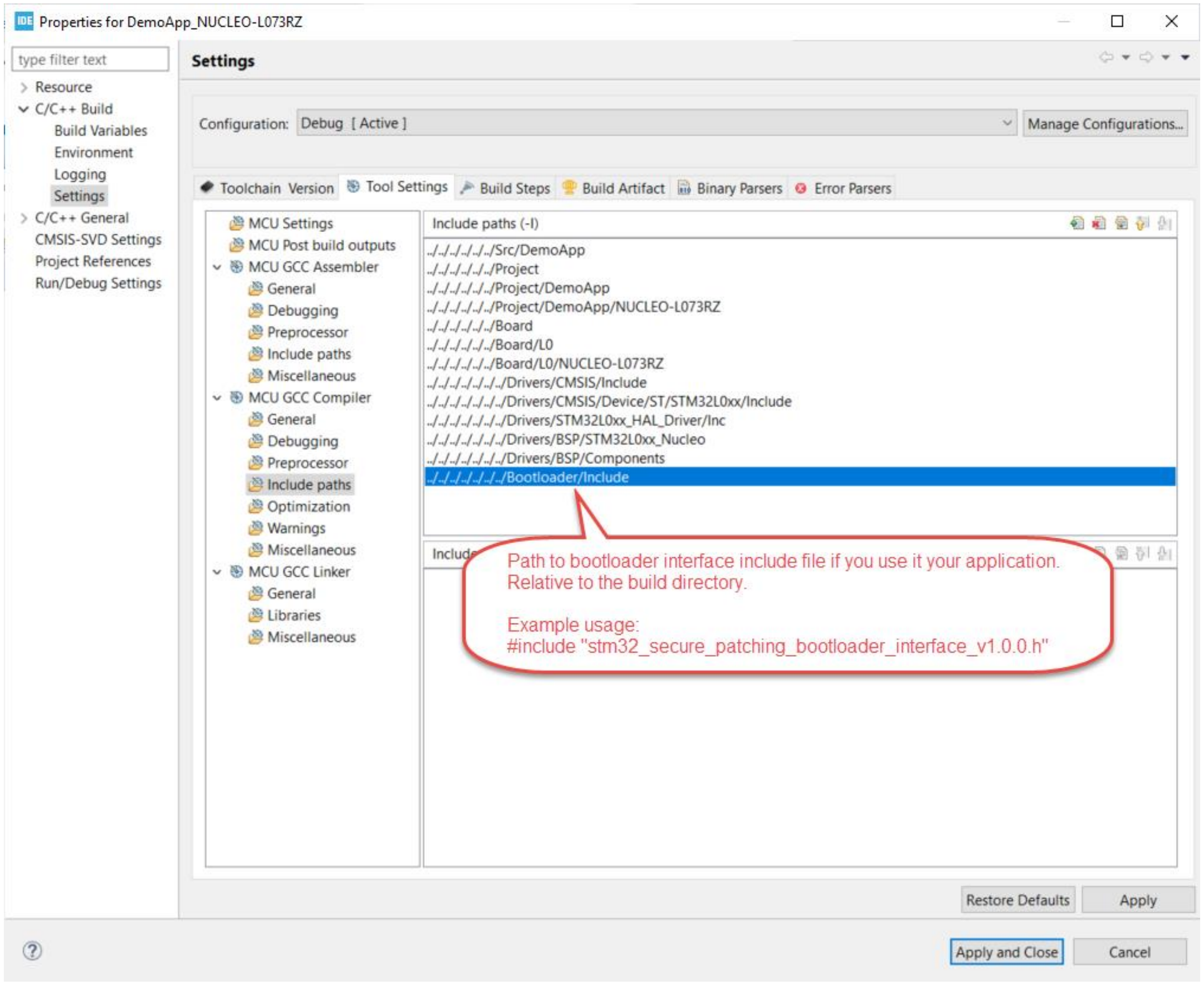
Command:

```
"../../../../../../../Bootloader/Scripts/STM32CubeIDE/postbuild.sh" "${BuildArtifactFileBaseName}" "../../Keys" "../../../../../Binary" "1.0.0" "1.0.0" "NUCLEO-L073RZ" "v1.0.0" 512 0
```

Description:

All directories relative to build directory (e.g. **Debug**)
Directory where artifacts are placed.
'To' Version (0 for auto). Version to build.
Target MCU's vector table offset/size 512 for most L0-F4; F7: 1024
Directory where Keys are found.
'From' Version (patch reference) Can be same (no patch made).
Board libraries to bind with: name of BOARD subdir in Bootloader/Libs dir
Version of board libraries to bind with.
Multisegment/external flash feature enabler and address offset. Set to 0x90000000 to enable, 0 to disable. Board libraries must have support pre-enabled.

Add path to bootloader include: **C/C++ Build -> Settings -> MCU GCC Compiler -> Include paths : ../../../../../../../Bootloader/Include**



Configuration: Debug [Active]

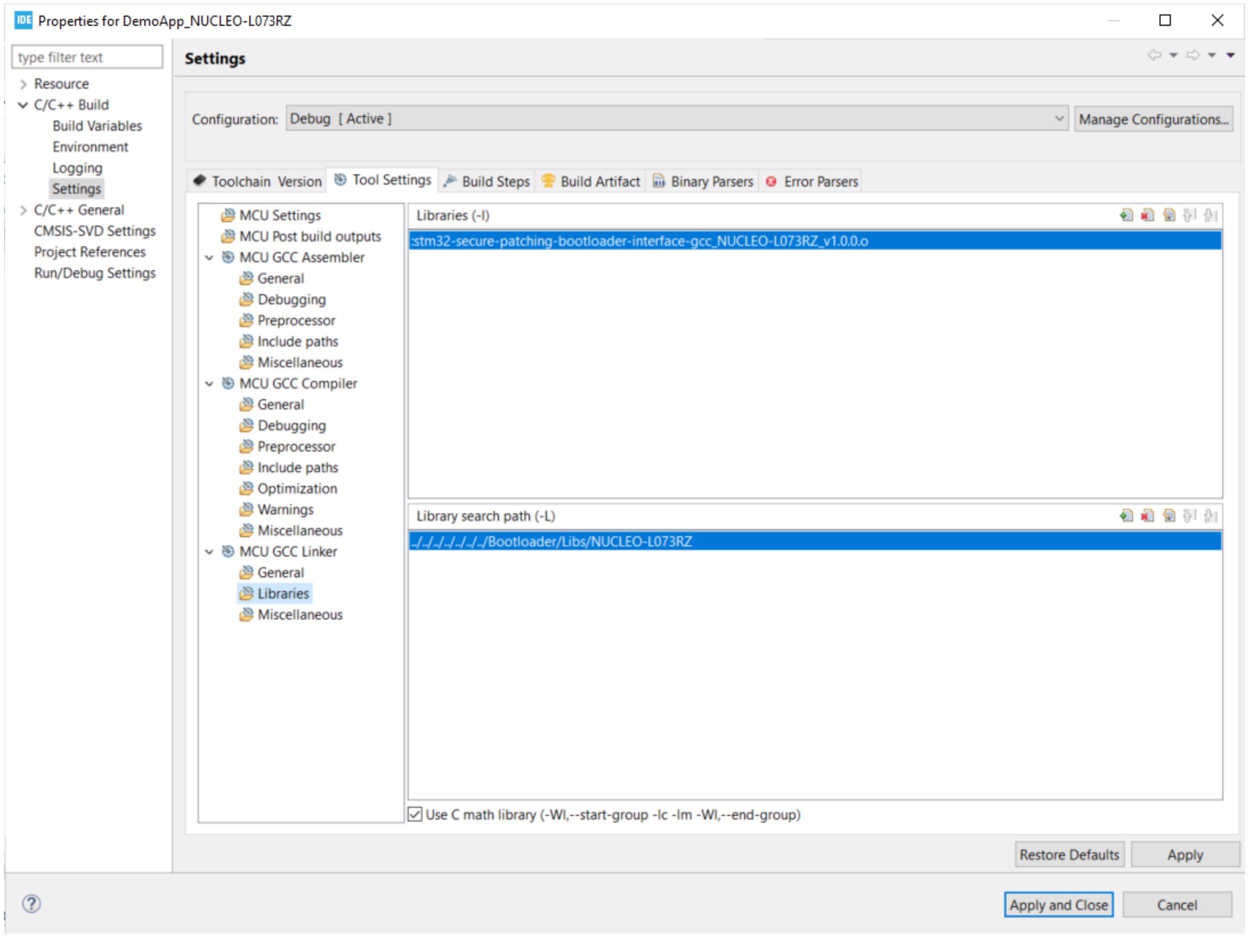
Include paths (-I)

```
../../../../../../Src/DemoApp
../../../../../../Project
../../../../../../Project/DemoApp
../../../../../../Project/DemoApp/NUCLEO-L073RZ
../../../../../../Board
../../../../../../Board/L0
../../../../../../Board/L0/NUCLEO-L073RZ
../../../../../../../Drivers/CMSIS/Include
../../../../../../../Drivers/CMSIS/Device/ST/STM32L0xx/Include
../../../../../../../Drivers/STM32L0xx_HAL_Driver/Inc
../../../../../../../Drivers/BSP/STM32L0xx_Nucleo
../../../../../../../Drivers/BSP/Components
../../../../../../../Bootloader/Include
```

Path to bootloader interface include file if you use it your application.
Relative to the build directory.

Example usage:
#include "stm32_secure_patching_bootloader_interface_v1.0.0.h"

Add paths and links to bootloader library files: **C/C++ Build -> Settings -> MCU GCC Linker -> Libraries** : (Libraries) :stm32-secure-patching-bootloader-interface-gcc_NUCLEO-L073RZ_v1.0.0.o (Library search paths) ../../../../../../../Bootloader/Libs/NUCLEO-L073RZ



Settings

Configuration: Debug [Active]

Libraries (-l)

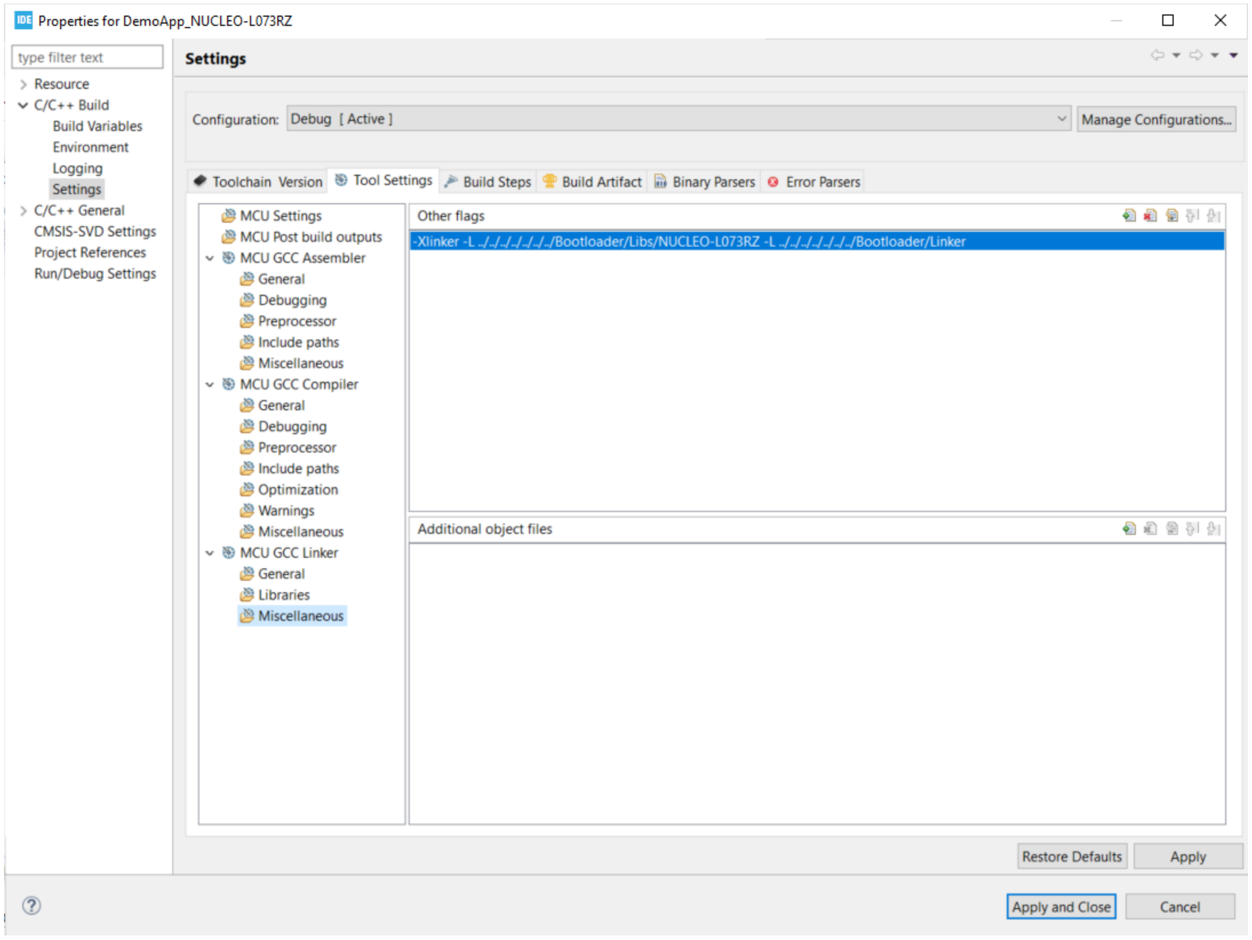
:stm32-secure-patching-bootloader-interface-gcc_NUCLEO-L073RZ_v1.0.0.o

Library search path (-L)

../../../../../../../Bootloader/Libs/NUCLEO-L073RZ

☑ Use C math library (-Wl,--start-group -lc -lm -Wl,--end-group)

Add paths to bootloader linker files: **C/C++ Build -> Settings -> MCU GCC Linker -> Miscellaneous** : -Xlinker -L ../../../../../../../Bootloader/Libs/NUCLEO-L073RZ -L ../../../../../../../Bootloader/Linker


Properties for DemoApp_NUCLEO-L073RZ

Settings

Configuration: Debug [Active]

Other flags

```
-Xlinker -L ../../../../../../../Bootloader/Libs/NUCLEO-L073RZ -L ../../../../../../../Bootloader/Linker
```

Integration Step 3 of 4

Adjust your application's linker script.

At minimum we need to tell the linker where your application's new start offset is in flash. This is defined by the bootloader's linker configuration file **stm32-secure-patching-bootloader-linker-gcc_<BOARD>_<version>.ld**.

It defines some symbols that we may need, minimally it is **STM32_SECURE_PATCHING_BOOTLOADER_SLOT0_START**. Then your application's interrupt vector table has to be offset from this by the minimum size of your vector table (to account for the image header), also defined as VECTOR_SIZE in the linker configuration file.

```
/* For this example end of RAM on STM32L073 is 0x20005000 = 20 KB*/
APPLI_region_intvec_start__  = STM32_SECURE_PATCHING_BOOTLOADER_SLOT0_START + VECTOR_SIZE;
APPLI_region_ROM_start    = STM32_SECURE_PATCHING_BOOTLOADER_SLOT0_START  + VECTOR_SIZE +
VECTOR_SIZE;
APPLI_region_ROM_length   = STM32_SECURE_PATCHING_BOOTLOADER_SLOT0_END -
APPLI_region_ROM_start + 1;
APPLI_region_RAM_start    = STM32_SECURE_PATCHING_BOOTLOADER_RAM_START;
APPLI_region_RAM_length    = 0x20005000 - APPLI_region_RAM_start;

MEMORY
{
  ISR_VECTOR (rx)   : ORIGIN = APPLI_region_intvec_start__, LENGTH = VECTOR_SIZE
  APPLI_region_ROM  : ORIGIN = APPLI_region_ROM_start, LENGTH = APPLI_region_ROM_length
  APPLI_region_RAM  : ORIGIN = APPLI_region_RAM_start, LENGTH = APPLI_region_RAM_length

  /* If your application links with the bootloader interface library, add this section: */
  SE_IF_region_ROM (rx) : ORIGIN = SE_IF_REGION_ROM_START, LENGTH = SE_IF_REGION_ROM_LENGTH
}
```
```

To your SECTIONS, add the following:

```
          /* If your application links with the bootloader interface library, add this section
        after .isr_vector */

          .SE_IF_Code : {
            KEEP(*se_interface_app.o (.text .text*))
          } >SE_IF_region_ROM

          /* Extra ROM section (last one) to make sure the binary size is a multiple of the AES
        block size (16 bytes) */
          .align16 :
          {
            . = . + 1;   /* _edata=. is aligned on 8 bytes so could be aligned on 16
        bytes: add 1 byte gap */
            . = ALIGN(16) - 1; /* increment the location counter until next 16 bytes aligned
        address (-1 byte)   */
```
```

```
        BYTE(0);           /* allocate 1 byte (value is 0) to be a multiple of 16 bytes
    */
      } > APPLI_region_ROM
```

A multi-target generic linker script that works with most STM32 targets is provided in the bootloader **Linker** directory. See this reference project linker script.

Integration Step 4 of 4

Adjust your application's system_stm32xxxx.c file.

This file programs the VTOR register (Vector Table Offset Register) by your application in the early startup phase so that interrupts invoke your application's handlers at the linked offset instead of the bootloader's.

system_stm32xxxxxx.c :

```
extern uint32_t APPLI_region_intvec_start__;
#define INTVECT_START ((uint32_t)& APPLI_region_intvec_start__)

void SystemInit(void)
{
   ...

   /* Configure the Vector Table location add offset address ------------------*/
   SCB->VTOR = INTVECT_START;
}
```

Build Products

The *stm32-secure-patching-bootloader* **postbuild** process produces three or four artifacts and places them in the specified output directory (typically Binary).

Naming convention: BOOT_`<Your Artifact Name>`_`<Board Name>`_`<version>`

1. Combined binaries: BOOT_DemoApp_NUCLEO-`L073RZ_1.0.0.hex`, BOOT_DemoApp_NUCLEO-`L073RZ_1.0.0.bin` (.bin produced only when MultiSegment is not enabled)
2. Secured in-field firmware full update file: DemoApp_NUCLEO-`L073RZ_1.0.0.sfb` (full image)
3. Secured in-field firmware patch update file: DemoApp_NUCLEO-`L073RZ_1.0.0_1.1.0.sfbp` (patch - produced only if reference version 1.0.0 exists in Binary\PatchRef)

Notes

- Patch files .sfbp only work if the source version already exists on the target device. E.g. to update from v1.1.7 to v1.2.0, version v1.1.7 must exist on the device as the active image in SLOT0.
- To update from v1.0.0 to v1.4.0 when only patches of v1.0.0_v1.1.0, v1.1.0_v1.2.0, v1.2.0_v1.3.0, v1.3.0_v1.4.0 are available, each patch must be applied in series. For each one, firmware is installed by the bootloader through a reboot cycle.
- The build system (STM32CubeIDE) postbuild command line must explicitly set what the reference firmware version is to build a patch from. With this flexibility it is possible to build patches from any version. Commonly this 'from version' is updated from one release to the next to build a series of patchable updates (v1.0.0->v1.1.0, v1.1.0->v1.2.0 etc). Of course, you could create a patch from v1.0.0->v1.2.0 and post this to your update server; if your 'patch picker' algorithm was smart enough it could select the best patch from a list of available patches.
- Full image files .sfb can be used to update to any version and do not depend on what is currently on the device. These could serve as a fall-back in case the hypothetical 'patch picker' implemented in the user application cannot find a suitable patch for download.
- The 'patch picker' is implemented in the USB flash drive updater to select the first patch in the root directory that matches the current version on the device and contains the highest 'to' version. It is able to perform a 'patch chain' update as described above by repeatedly rebooting and updating to the next higher patch version.