



STM32MP1 Developer Package



Contents



A quality version of this page, approved on 25 September 2020, was based off this revision.

This article describes how to get and use the **Developer Package** of the **STM32MPU Embedded Software** for any development platform of the **STM32MP1 family** (STM32MP15 boards), in order to modify some of its pieces of software, or to add applications on top of it.

It lists some **prerequisites** in terms of knowledges and development environment, and gives the **step-by-step** approach to download and install the STM32MPU Embedded Software components for this Package.

Finally, it proposes some guidelines to upgrade (add, remove, configure, improve...) any piece of software.

Contents

1 Developer Package content	5
2 Developer Package step-by-step overview	6
3 Checking the prerequisites	7
3.1 Knowledges	7
3.2 Development setup	7
4 Installing the Starter Package	10
5 Installing the components to develop software running on Arm Cortex-A (OpenSTLinux distribution) .	11
5.1 Installing the SDK	11
5.1.1 Starting up the SDK	13
5.2 Installing the Linux kernel	13
5.2.1 Downloading the Linux kernel	13
5.2.2 Building and deploying the Linux kernel for the first time	15
5.3 Installing the U-Boot	15
5.3.1 Downloading the U-Boot	15
5.3.2 Building and deploying the U-Boot for the first time	17
5.4 Installing the TF-A	17
5.4.1 Downloading the TF-A	17
5.4.2 Building and deploying the TF-A for the first time	18
5.5 Installing the TF-A-SSP	19
5.5.1 Downloading the TF-A-SSP	19
5.5.2 Building the TF-A-SSP for the first time	20
5.6 Installing the OP-TEE	21
5.6.1 Downloading the OP-TEE	21
5.6.2 Building and deploying the OP-TEE for the first time	22
5.7 Installing the debug symbol files	23
5.7.1 Downloading the debug symbol files	23
5.7.2 Using the debug symbol files	25
6 Installing the components to develop software running on Arm Cortex-M4 (STM32Cube MPU Package)	26
6.1 Installing STM32CubeIDE	26
6.2 Installing the STM32Cube MPU Package	26
7 Developing software running on Arm Cortex-A7	29
7.1 Modifying the Linux kernel	29
7.2 Adding external out-of-tree Linux kernel modules	29
7.3 Adding Linux user space applications	30



7.4 Modifying the U-Boot	30
7.5 Modifying the TF-A	31
7.6 Modifying the OP-TEE	31
8 Developing software running on Arm Cortex-M4	32
8.1 How to create a Cube project from scratch or open/modify an existing one from STM32Cube MPU package	32
9 Fast links to essential commands	33
10 How to go further?	35

1 Developer Package content

If you are not yet familiar with the **STM32MPU Embedded Software** distribution and its **Packages**, please read the following articles:

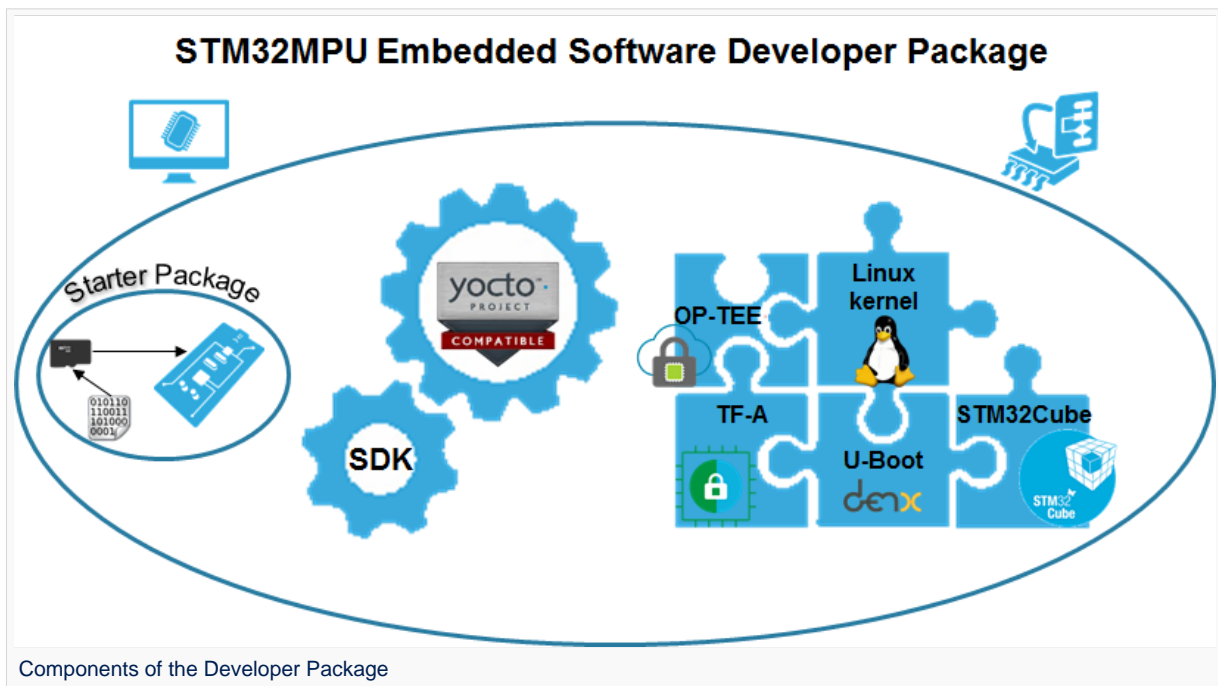
- Which STM32MPU Embedded Software Package better suits your needs (and especially the Developer Package chapter)
- STM32MPU Embedded Software distribution

If you are already familiar with the Developer Package for the STM32MPU Embedded Software distribution, the fast links to essential commands might interest you.

To sum up, this **Developer Package** provides:

- for the **OpenSTLinux distribution** (development on Arm®Cortex®-A processor):
 - the **software development kit** (SDK), based on Yocto SDK, for cross-development on an host PC
 - the following pieces of software in **source code**:
 - Linux® kernel
 - U-Boot
 - Trusted Firmware-A (TF-A)
 - optionally, Open source Trusted Execution Environment (OP-TEE)
 - the **debug symbol files** for Linux® kernel, U-Boot and TF-A
- for the **STM32Cube MPU Package** (development on Arm®Cortex®-M processor):
 - all pieces of software (BSP, HAL, middlewares and applications) in **source code**
 - the **integrated development environment (IDE)** (STM32CubeIDE)

Note that, the application frameworks for the OpenSTLinux distribution are not available as source code in this Package.





2 Developer Package step-by-step overview

The steps to get the STM32MPU Embedded Software Developer Package ready for your developments, are:

Checking the prerequisites

Installing the Starter Package for your board

Installing the components to develop software running on Arm[®]Cortex[®]-A (OpenSTLinux distribution)

Installing the SDK (**mandatory** for any development on Arm[®]Cortex[®]-A)

Installing the Linux kernel (**mandatory only** if you plan to modify the Linux kernel or to add external out-of-tree Linux kernel modules)

Installing the U-Boot (**mandatory only** if you plan to modify the U-Boot)

Installing the TF-A (**mandatory only** if you plan to modify the TF-A)

Installing the TF-A-SSP (**mandatory only** if you plan to modify the TF-A SSP)

Installing the debug symbol files (**mandatory only** if you plan to debug Linux[®] kernel, U-Boot or TF-A with GDB)

Installing the components to develop software running Arm Cortex-M (STM32Cube MPU Package)

Installing STM32CubeIDE (**mandatory** for any development on Arm[®]Cortex[®]-M)

Installing the STM32Cube MPU Package (**mandatory only** if you plan to modify the Cube firmware)

Once these steps are achieved, you are able to:

- develop software running on Arm Cortex-A
 - Modifying the Linux kernel
 - Adding external out-of-tree Linux kernel modules
 - Adding Linux user space applications
 - Modifying the U-Boot
 - Modifying the TF-A
- develop software running on Arm Cortex-M4



3 Checking the prerequisites

3.1 Knowledges

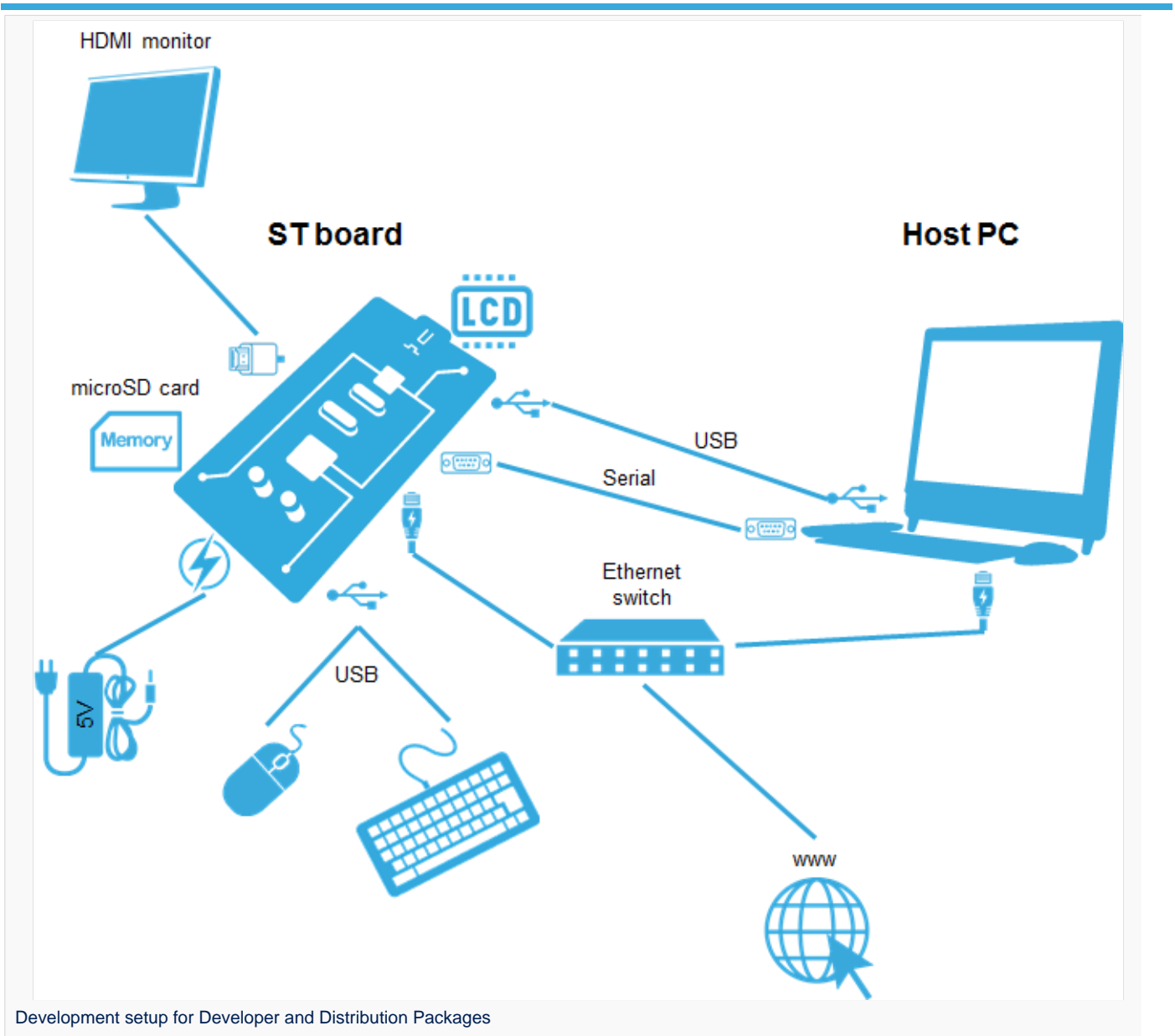
The STM32MP1 Developer Package aims at enriching a Linux-based software for the targeted product: basic knowledges about Linux are recommended to make the most of this Package.

Having a look at the [STM32MPU Embedded Software architecture overview](#) is also highly recommended.

3.2 Development setup

The recommended setup for the development PC (host) is specified in the following article: [PC prerequisites](#).

Whatever the development platform (board) and development PC (host) used, the range of possible development setups is illustrated by the picture below.



The following components are **mandatory**:

- Host PC for cross-compilation and cross-debugging, installed as specified above
- Board assembled and configured as specified in the associated Starter Package article
- Mass storage device (for example, microSD card) to load and update the software images (binaries)

The following components are **optional**, but **recommended**:

- A serial link between the host PC (through [Terminal program](#)) and the board for traces (even early boot traces), and access to the board from the remote PC (command lines)
- An Ethernet link between the host PC and the board for cross-development and cross-debugging through a local network. This is an alternative or a complement to the serial (or USB) link
- A display connected to the board, depending on the technologies available on the board: DSI LCD display, HDMI monitor (or TV) and so on
- A mouse and a keyboard connected through USB ports



Additional optional components can be added by means of the connectivity capabilities of the board: cameras, displays, JTAG, sensors, actuators, and much more.



4 Installing the Starter Package

Before developing with the Developer Package, **it is essential to start up your board thanks to its Starter Package**. All articles relative to Starter Packages are found in [Category:Starter Package](#): find the one that corresponds to your board, and follow the installation instructions (if not yet done), before going further.

In brief, it means that:

- your board boots successfully
- the flashed image comes from the same release of the STM32MPU Embedded Software distribution than the components that will be downloaded in this article

Thanks to the Starter Package, **all Flash partitions are populated**.

Then, with the Developer Package, it is possible to modify or to upgrade the partitions independently one from the others.

For example, if you only want to modify the Linux kernel (part of *bootfs* partition), installing the SDK and the Linux kernel are enough; no need to install anything else.



5 Installing the components to develop software running on Arm Cortex-A (OpenSTLinux distribution)

5.1 Installing the SDK

Optional step: it is mandatory only if you want to modify or add software running on Arm Cortex-A (e.g. Linux kernel, Linux user space applications...).

The SDK for OpenSTLinux distribution provides a stand-alone cross-development toolchain and libraries tailored to the contents of the specific image flashed in the board. If you want to know more about this SDK, please read the [SDK for OpenSTLinux distribution](#) article.

- The STM32MP1 SDK is delivered through a tarball file named : `en.SDK-x86_64-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz`
- Download and install the STM32MP1 SDK.

The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the [software license agreement \(SLA\)](#). The detailed content licenses can be found [here](#).


Warning

To download a package, it is recommended to be logged in to your "myst" account [1]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.

We apologize for this inconvenience

STM32MP1 Developer Package SDK - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on <i>my.st.com</i> before accessing the following link: en.SDK-x86_64-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz
	<ul style="list-style-type: none"> • Uncompress the tarball file to get the SDK installation script <pre>tar xvf en.SDK-x86_64-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz</pre> <ul style="list-style-type: none"> • If needed, change the permissions on the SDK installation script so that it is executable <pre>\$ chmod +x stm32mp1-openstlinux-5.4-dunfell-mp1-20-11-12/sdk/st-image-weston-openstlinux-weston-stm32mp1-x86_64-toolchain-3.1-openstlinux-5.4-dunfell-mp1-20-11-12.sh</pre> <ul style="list-style-type: none"> • Run the SDK installation script <ul style="list-style-type: none"> • Use the <code>-d <SDK installation directory absolute path></code> option to specify the absolute path to the directory in which you want to install the SDK (<code><SDK installation directory></code>) • If you follow the proposition to organize the working directory, it means:



STM32MP1 Developer Package SDK - STM32MP15-Ecosystem-v2.1.0 release	
Installation	<pre>\$./stm32mp1-openstlinux-5.4-dunfell-mp1-20-11-12/sdk/st-image-weston-openstlinux-weston-stm32mp1-x86_64-toolchain-3.1-openstlinux-5.4-dunfell-mp1-20-11-12.sh -d <working directory absolute path>/Developer-Package/SDK</pre> <ul style="list-style-type: none"> A successful installation outputs the following log: <pre>ST OpenSTLinux - Weston - (A Yocto Project Based Distro) SDK installer version 3.1-openstlinux-5-4-dunfell-mp1-20-11-12 ===== ===== You are about to install the SDK to "<working directory absolute path>/Developer-Package/SDK". Proceed [Y/n]? Extracting SDK.....done Setting it up...done SDK has been successfully set up and is ready to be used. Each time you wish to use the SDK in a new shell session, you need to source the environment setup script e.g. \$. <working directory absolute path>/Developer-Package/SDK/environment-setup-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi</pre>
Release note	<p>Details about the content of the SDK are available in the associated STM32MP15 ecosystem release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The SDK is in the *<SDK installation directory>*:

```
<SDK installation directory>
OpenSTLinux distribution: details in Standard SDK directory structure article
├── environment-setup-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi  SDK for
    for Developer Package  Environment setup script
├── site-config-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi
├── sysroots
│   ├── cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi  Target sysroot
│   │   (libraries, headers, and symbols)
│   │   ├── [...]
│   │   └── x86_64-ostl_sdk-linux  Native sysroot
│   │   (libraries, headers, and symbols)
│   │   ├── [...]
│   └── version-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi
```

Warning

Now that the SDK is installed, please do not move or rename the *<SDK installation directory>*.



5.1.1 Starting up the SDK

The SDK environment setup script must be run once in each new working terminal in which you cross-compile:

```
PC $> source <SDK installation directory>/environment-setup-cortexa7t2hf-neon-vfpv4-ostl-
linux-gnueabi
```

The following checkings allow to ensure that the environment is correctly setup:

- Check the target architecture

```
PC $> echo $ARCH
arm
```

- Check the toolchain binary prefix for the target tools

```
PC $> echo $CROSS_COMPILE
arm-ostl-linux-gnueabi-
```

- Check the C compiler version

```
PC $> $CC --version
arm-ostl-linux-gnueabi-gcc (GCC) <GCC version>
[...]
```

- Check that the SDK version is the expected one

```
PC $> echo $OECORE_SDK_VERSION
<expected SDK version>
```



If any of these commands fails or does not return the expected result, please try to reinstall the SDK.

5.2 Installing the Linux kernel

Optional step: it is mandatory only if you want to modify the Linux kernel (configuration, device tree, driver...), or to add external out-of-tree Linux kernel modules.

Prerequisite: the SDK is installed.

5.2.1 Downloading the Linux kernel

- The STM32MP1 Linux kernel is delivered through a tarball file named **en.SOURCES-kernel-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz** for STM32MP157x-EV1  and STM32MP157x-DKx  boards.
- Download and install the STM32MP1 Linux kernel


The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found [here](#).



Warning

To download a package, it is recommended to be logged in to your "myst" account [2]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.

We apologize for this inconvenience

STM32MP1 Developer Package Linux kernel - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on to <i>my.st.com</i> before accessing the following link en.SOURCES-kernel-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz
Installation	<ul style="list-style-type: none"> Go to the host PC directory in which you want to install the Developer Package (<<i>Developer Package installation directory</i>>); if you follow the proposition to organize the working directory, this means: <pre style="border: 1px dashed black; padding: 5px; margin: 10px 0;">\$ cd <working directory path>/Developer-Package</pre> Download the tarball file in this directory Uncompress the tarball file to get the Linux kernel (Linux kernel source code, ST patches, ST configuration fragments...): <pre style="border: 1px dashed black; padding: 5px; margin: 10px 0;">PC \$> \$ tar xvf en.SOURCES-kernel-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz PC \$> \$ cd stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi/linux-stm32mp-5.4.56-r0 PC \$> \$ tar xvf linux-5.4.56.tar.xz</pre>
Release note	<p>Details of the content of the Linux kernel are available in the associated STM32MP15 OpenSTLinux release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **Linux kernel installation directory** is in the <*Developer Package installation directory*>/stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi directory, and is named *linux-stm32mp-<kernel version>*:

```

linux-stm32mp-5.4.56-r0
├── [*].patch           Linux kernel installation directory
├── fragment-[*].config ST patches to apply during the Linux kernel preparation (see
next chapter)
├── linux-5.4.56       Linux kernel source code directory
├── linux-5.4.56.tar.xz Tarball file of the Linux kernel source code
├── README.HOW_TO.txt Helper file for Linux kernel management: reference for Linux
kernel build
└── series             List of all ST patches to apply
```



5.2.2 Building and deploying the Linux kernel for the first time

It is mandatory to execute once the steps specified below before modifying the Linux kernel, or adding external out-of-tree Linux kernel modules.

The partitions related to the Linux kernel are:

- the *bootfs* partition that contains the Linux kernel U-Boot image (*ulmage*) and device tree
- the *rootfs* partition that contains the Linux kernel modules

The Linux kernel might be cross-compiled, either in the source code directory, or in a dedicated directory different from the source code directory.

This last method is recommended as it clearly separates the files generated by the cross-compilation from the source code files.



Information

The `README_HOWTO.txt` helper file is **THE** reference for the Linux kernel build



Warning

The SDK must be started

Open the `<Linux kernel installation directory>/README.HOW_TO.txt` helper file, and execute its instructions to:

setup a software configuration management (SCM) system (*git*) for the Linux kernel (optional but recommended)

prepare the Linux kernel (applying the ST patches)

configure the Linux kernel (applying the ST fragments)

cross-compile the Linux kernel

deploy the Linux kernel (i.e. update the software on board)



The Linux kernel is now installed: let's modify the Linux kernel, or add external out-of-tree Linux kernel modules.

5.3 Installing the U-Boot

Optional step: it is mandatory only if you want to modify the U-Boot.

Prerequisite: the SDK is installed.

5.3.1 Downloading the U-Boot

- The STM32MP1 U-Boot is delivered through a tarball file named `en.SOURCES-u-boot-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz` for STM32MP157x-EV1  and STM32MP157x-DKx  boards.
- Download and install the STM32MP1 U-Boot

The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found here.




Warning

To download a package, it is recommended to be logged in to your "myst" account [3]. If, trying to



download, you encounter a “403 error”, you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.

We apologize for this inconvenience

STM32MP1 Developer Package U-Boot - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on to <i>my.st.com</i> before accessing the following link en.SOURCES-u-boot-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz
Installation	<ul style="list-style-type: none"> Go to the host PC directory in which you want to install the Developer Package (<<i>Developer Package installation directory</i>>); if you follow the proposition to organize the working directory, this means: <pre style="border: 1px dashed black; padding: 5px;">\$ cd <working directory path>/Developer-Package</pre> Download the tarball file in this directory Uncompress the tarball file to get the U-Boot (U-Boot source code, ST patches and so on): <pre style="border: 1px dashed black; padding: 5px;">PC \$> \$ tar xvf en.SOURCES-u-boot-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz PC \$> \$ cd stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi/u-boot-stm32mp-2020.01.r2-r0 PC \$> \$ tar xvf u-boot-stm32mp-2020.01.r2-r0.tar.gz</pre>
Release note	<p>Details of the content of the U-Boot are available in the associated STM32MP15 OpenSTLinux release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **U-Boot installation directory** is in the <*Developer Package installation directory*>/stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi directory, and is named *u-boot-stm32mp-<U-Boot version>*:

<pre>u-boot-stm32mp-2020.01.r2-r0 ├── [*].patch ├── u-boot-stm32mp-2020.01.r2 ├── Makefile.sdk ├── README.HOW_TO.txt ├── series └── u-boot-stm32mp-2020.01.r2-r0.tar.gz</pre>	<p>U-Boot installation directory ST patches to apply during the U-Boot preparation (see next chapter)</p> <p>U-Boot source code directory Makefile for the U-Boot compilation Helper file for U-Boot management: reference for U-Boot build List of all ST patches to apply Tarball file of the U-Boot source code</p>
---	--



5.3.2 Building and deploying the U-Boot for the first time

It is mandatory to execute once the steps specified below before modifying the U-Boot.

As explained in the [boot chain overview](#), the trusted boot chain is the default solution delivered by STMicroelectronics.

Within this scope, the partition related to the U-Boot is the *ssbl* one that contains the U-Boot and its device tree blob.

Information

The `README_HOWTO.txt` helper file is **THE** reference for the U-Boot build

Warning

The SDK must be started

Open the `<U-Boot installation directory>/README.HOW_TO.txt` helper file, and execute its instructions to:

setup a software configuration management (SCM) system (*git*) for the U-Boot (optional but recommended)

prepare the U-Boot (applying the ST patches)

cross-compile the U-Boot

deploy the U-Boot (i.e. update the software on board)



The U-Boot is now installed: let's modify the U-Boot.

5.4 Installing the TF-A

Optional step: it is mandatory only if you want to modify the TF-A.

Prerequisite: the SDK is installed.

5.4.1 Downloading the TF-A

- The STM32MP1 TF-A is delivered through a tarball file named `en.SOURCES-tf-a-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz` for STM32MP157x-EV1  and STM32MP157x-DKx  boards.
- Download and install the STM32MP1 TF-A

The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found [here](#).


Warning

To download a package, it is recommended to be logged in to your "myst" account [4]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.

We apologize for this inconvenience

STM32MP1 Developer Package TF-A - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on <i>my.st.com</i> before accessing the following link: <code>en.SOURCES-tf-a-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz</code>



STM32MP1 Developer Package TF-A - STM32MP15-Ecosystem-v2.1.0 release	
Installation	<ul style="list-style-type: none"> Go to the host PC directory in which you want to install the Developer Package (<Developer Package installation directory>); if you follow the proposition to organize the working directory, it means: <pre style="border: 1px dashed black; padding: 5px;">\$ cd <working directory path>/Developer-Package</pre> Download the tarball file in this directory Uncompress the tarball file to get the TF-A (TF-A source code, ST patches...): <pre style="border: 1px dashed black; padding: 5px;">PC \$> \$ tar xvf en.SOURCES-tf-a-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz PC \$> \$ cd stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi/tf-a-stm32mp-2.2.r2-r0 PC \$> \$ tar xvf tf-a-stm32mp-2.2.r2-r0.tar.gz</pre>
Release note	<p>Details about the content of the TF-A are available in the associated STM32MP15 OpenSTLinux release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **TF-A installation directory** is in the <Developer Package installation directory>/stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi directory, and is named *tf-a-stm32mp-<TF-A version>*:

<pre>tf-a-stm32mp-2.2.r2-r0 ├── [*].patch ├── tf-a-stm32mp-2.2.r2 ├── Makefile.sdk ├── README.HOW_T0.txt ├── build ├── series └── tf-a-stm32mp-2.2.r2-r0.tar.gz</pre>	<p>TF-A installation directory ST patches to apply during the TF-A preparation (see next chapter)</p> <p>TF-A source code directory Makefile for the TF-A compilation Helper file for TF-A management: reference for TF-A</p> <p>List of all ST patches to apply</p> <p>Tarball file of the TF-A source code</p>
---	--

5.4.2 Building and deploying the TF-A for the first time

It is mandatory to execute once the steps specified below before modifying the TF-A.

As explained in the [boot chain overview](#), the trusted boot chain is the default solution delivered by STMicroelectronics.

Within this scope, the partition related to the TF-A is the *fsbl* one.



Information

The `README_HOWTO.txt` helper file is **THE** reference for the TF-A build



Warning

The SDK must be started



Open the *<TF-A installation directory>/README.HOW_TO.txt* helper file, and execute its instructions to:

- setup a software configuration management (SCM) system (*git*) for the TF-A (optional but recommended)
- prepare the TF-A (applying the ST patches)
- cross-compile the TF-A
- deploy the TF-A (i.e. update the software on board)

The TF-A is now installed: let's modify the TF-A.

5.5 Installing the TF-A-SSP

Optional step: it is mandatory only if you want to modify the TF-A to use Secure Secret provisioning feature.

Prerequisite: the SDK is installed.

5.5.1 Downloading the TF-A-SSP

- The STM32MP1 TF-A-SSP is delivered through a tarball file named **en.SOURCES-tf-a-ssp-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz**
- Download and install the STM32MP1 TF-A-SSP


The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found [here](#).

Warning

To download a package, it is recommended to be logged in to your "myst" account [5]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.
We apologize for this inconvenience

STM32MP1 Developer Package TF-A SSP - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on <i>my.st.com</i> before accessing the following link: en.SOURCES-tf-a-ssp-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz
Installation	<ul style="list-style-type: none"> • Go to the host PC directory in which you want to install the Developer Package (<i><Developer Package installation directory></i>); if you follow the proposition to organize the working directory, it means: <div style="border: 1px dashed black; padding: 10px; margin: 10px 0;"> <pre>\$ cd <working directory path>/Developer-Package</pre> </div> • Download the tarball file in this directory • Uncompress the tarball file to get the TF-A SSP (TF-A SSP source code, ST patches...):



STM32MP1 Developer Package TF-A SSP - STM32MP15-Ecosystem-v2.1.0 release	
	<pre>PC \$> \$ tar xvf en.SOURCES-tf-a-ssp-stm32mp1-openstlinux-5-4- dunfell-mp1-20-11-12.tar.xz PC \$> \$ cd stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources /arm-ostl-linux-gnueabi/tf-a-stm32mp-ssp-2.2.r2-r0 PC \$> \$ tar xvf tf-a-stm32mp-ssp-2.2.r2-r0.tar.gz</pre>
Release note	<p>Details about the content of the TF-A SSP are available in the associated STM32MP15 OpenSTLinux release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **TF-A SSP installation directory** is in the `<Developer Package installation directory>/stm32mp1-openstlinux-20-11-12/sources/arm-ostl-linux-gnueabi` directory, and is named `tf-a-stm32mp-ssp-<TF-A version>`:

<pre>tf-a-stm32mp-ssp-2.2.r2-r0 ├── [*].patch ├── tf-a-stm32mp-ssp-2.2.r2 ├── Makefile.sdk ├── README.HOW_TO.txt ├── series └── tf-a-stm32mp-ssp-2.2.r2-r0.tar.gz</pre>	<p>TF-A SSP installation directory</p> <p>ST patches to apply during the TF-A SSP preparation (see next chapter)</p> <p>TF-A SSP source code directory</p> <p>Makefile for the TF-A SSP compilation</p> <p>Helper file for TF-A SSP management: reference for TF-A SSP build</p> <p>List of all ST patches to apply</p> <p>Tarball file of the TF-A SSP source code</p>
---	--

5.5.2 Building the TF-A-SSP for the first time

It is mandatory to execute once the steps specified below before modifying the TF-A SSP.

Information

The `README_HOWTO.txt` helper file is **THE** reference for the TF-A SSP build

Warning

The SDK must be started



Open the `<TF-A SSP installation directory>/README.HOW_TO.txt` helper file, and execute its instructions to:

- setup a software configuration management (SCM) system (*git*) for the TF-A SSP (optional but recommended)
- prepare the TF-A SSP (applying the ST patches)
- cross-compile the TF-A SSP



The TF-A SSP is now built.

5.6 Installing the OP-TEE

Optional step: it is mandatory only if you want to modify the OP-TEE.

Prerequisite: the SDK is installed.

5.6.1 Downloading the OP-TEE

- The STM32MP1 OP-TEE is delivered through a tarball file named `en.SOURCES-optee-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz` for STM32MP157x-EV1  and STM32MP157x-DKx  boards.
- Download and install the STM32MP1 OP-TEE


The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the [software license agreement \(SLA\)](#). The detailed content licenses can be found [here](#).

Warning

To download a package, it is recommended to be logged in to your "myst" account [6]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.
We apologize for this inconvenience

STM32MP1 Developer Package OP-TEE - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on <i>my.st.com</i> before accessing the following link: <code>en.SOURCES-optee-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz</code>
Installation	<ul style="list-style-type: none"> • Go to the host PC directory in which you want to install the Developer Package (<i><Developer Package installation directory></i>); if you follow the proposition to organize the working directory, it means: <div style="border: 1px dashed gray; padding: 10px; margin: 10px 0;"> <pre>\$ cd <working directory path>/Developer-Package</pre> </div> • Download the tarball file in this directory • Uncompress the tarball file to get the OP-TEE (OP-TEE source code, ST patches...):



STM32MP1 Developer Package OP-TEE - STM32MP15-Ecosystem-v2.1.0 release	
	<pre>PC \$> \$ tar xvf en.SOURCES-optee-stm32mp1-openstlinux-5-4- dunfell-mp1-20-11-12.tar.xz PC \$> \$ cd stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources /arm-ostl-linux-gnueabi/optee-os-stm32mp-3.9.0.r2-r0 PC \$> \$ tar xvf optee-os-stm32mp-3.9.0.r2-r0.tar.gz</pre>
Release note	<p>Details about the content of the OP-TEE are available in the associated STM32MP15 OpenSTLinux release note.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **OP-TEE installation directory** is in the `<Developer Package installation directory>/stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/sources/arm-ostl-linux-gnueabi` directory, and is named `optee-os-stm32mp-<OP-TEE version>`:

<pre>optee-os-stm32mp-3.9.0.r2-r0 ├── [*].patch ├── optee-os-stm32mp-3.9.0.r2 ├── Makefile.sdk ├── optee-os-stm32mp-3.9.0.r2-r0.tar. gz ├── README.HOW_T0.txt └── series</pre>	<p>OP-TEE installation directory ST patches to apply during the OP-TEE preparation (see next chapter)</p> <p>OP-TEE source code directory Makefile for the OP-TEE compilation</p> <p>Tarball file of the OP-TEE source code</p> <p>Helper file for OP-TEE management: reference for OP-TEE build</p> <p>List of all ST patches to apply</p>
--	--

5.6.2 Building and deploying the OP-TEE for the first time

It is mandatory to execute once the steps specified below before modifying the OP-TEE.

As explained in the [boot chain overview](#), the trusted boot chain is the default solution delivered by STMicroelectronics.

Within this scope, the partition related to the OP-TEE is the `fsbl` one.

Information

The `README_HOWTO.txt` helper file is **THE** reference for the OP-TEE build

Warning

The SDK must be started



Open the *<OP-TEE installation directory>/README.HOW_TO.txt* helper file, and execute its instructions to:

- setup a software configuration management (SCM) system (*git*) for the OP-TEE (optional but recommended)
- prepare the OP-TEE (applying the ST patches)
- cross-compile the OP-TEE
- deploy the OP-TEE (i.e. update the software on board)

The OP-TEE is now installed: let's [modify the OP-TEE](#).

5.7 Installing the debug symbol files

Optional step: it is mandatory only if you want to debug Linux[®] kernel, U-Boot or TF-A with GDB.

5.7.1 Downloading the debug symbol files

- The STM32MP1 debug symbol files is delivered through a tarball file named **en.DEBUG-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz** for STM32MP157x-EV1 and STM32MP157x-DKx boards.
- Download and install the STM32MP1 debug symbol files


The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found [here](#).

Warning

To download a package, it is recommended to be logged in to your "myst" account [7]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.
We apologize for this inconvenience

STM32MP1 Developer Package debug symbol files - STM32MP15-Ecosystem-v2.1.0 release	
Download	You need to be logged on to <i>my.st.com</i> before accessing the following link en.DEBUG-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz
Installation	<ul style="list-style-type: none"> • Go to the host PC directory in which you want to install the Developer Package (<i><Developer Package installation directory></i>); if you follow the proposition to organize the working directory, this means: <div style="border: 1px dashed gray; padding: 5px; margin: 5px 0;"> <pre>\$ cd <working directory path>/Developer-Package</pre> </div> • Download the tarball file in this directory • Uncompress the tarball file to get the debug symbol files (for Linux kernel, U-Boot, TF-A and OP-TEE OS): <div style="border: 1px dashed gray; padding: 5px; margin: 5px 0;"> <pre>PC \$> \$ tar xvf en.DEBUG-stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12.tar.xz</pre> </div>



release	
Release note	 If you are interested in older releases, please have a look into the section Archives .

- The debug symbol files are in the `<Developer Package installation directory>/stm32mp1-openstlinux-5-4-dunfell-mp1-20-11-12/images/stm32mp1` directory:

```

stm32mp1
├── arm-trusted-firmware
│   ├── tf-a-bl2-optee.elf
│   ├── tf-a-bl2-serialboot.elf
│   ├── tf-a-bl2-trusted.elf
│   ├── tf-a-bl32-serialboot.elf
│   └── tf-a-bl32-trusted.elf
├── bootloader
│   ├── u-boot-stm32mp157a-dk1-optee.elf
│   └── u-boot-stm32mp157a-dk1-trusted.elf
elf
├── u-boot-stm32mp157a-ev1-optee.elf
└── u-boot-stm32mp157a-ev1-trusted.elf
elf
├── u-boot-stm32mp157c-dk2-optee.elf
└── u-boot-stm32mp157c-dk2-trusted.elf
elf
├── u-boot-stm32mp157c-ev1-optee.elf
└── u-boot-stm32mp157c-ev1-trusted.elf
elf
├── u-boot-stm32mp157d-dk1-optee.elf
└── u-boot-stm32mp157d-dk1-trusted.elf
elf
└── u-boot-stm32mp157d-ev1-optee.elf

```

Debug symbol file for TF-A
 → TF-A for OP-TEE boot stage
 Debug symbol file for TF-A
 → fsbl for flasher
 Debug symbol file for TF-A
 → TF-A for OP-TEE boot stage
 Debug symbol file for TF-A
 → secure monitor for flasher
 Debug symbol file for TF-A
 → runtime software stage

Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Discovery kits
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot
 → STM32MP15 Evaluation boards
 Debug symbol file for U-Boot



elf	u-boot-stm32mp157d-ev1-trusted.	→ STM32MP15 Discovery kits Debug symbol file for U-Boot
elf	u-boot-stm32mp157f-dk2-optee.elf	→ STM32MP15 Discovery kits Debug symbol file for U-Boot
elf	u-boot-stm32mp157f-dk2-trusted.	→ STM32MP15 Evaluation boards
elf	u-boot-stm32mp157f-ev1-optee.elf	Debug symbol file for U-Boot
elf	u-boot-stm32mp157f-ev1-trusted.	→ STM32MP15 Evaluation boards
	kernel	
	vmlinux	
	optee	
	tee-stm32mp157a-dk1-optee.elf	Debug symbol file for Linux kernel
	tee-stm32mp157a-ev1-optee.elf	
	tee-stm32mp157c-dk2-optee.elf	
	tee-stm32mp157c-ev1-optee.elf	
	tee-stm32mp157d-dk1-optee.elf	Debug symbol file for OP-TEE OS → STM32MP15 Discovery kits
	tee-stm32mp157d-ev1-optee.elf	Debug symbol file for OP-TEE OS → STM32MP15 Evaluation boards
	tee-stm32mp157f-dk2-optee.elf	Debug symbol file for OP-TEE OS → STM32MP15 Discovery kits
	tee-stm32mp157f-ev1-optee.elf	Debug symbol file for OP-TEE OS → STM32MP15 Evaluation boards

5.7.2 Using the debug symbol files

These files are used to debug the Linux[®] kernel, U-Boot or TF-A with GDB. Especially, the Debug OpenSTLinux BSP components chapter explains how to load the debug symbol files in GDB.



6 Installing the components to develop software running on Arm Cortex-M4 (STM32Cube MPU Package)

6.1 Installing STM32CubeIDE

Optional step: it is needed if you want to modify or add software running on Arm Cortex-M.

The table below explains how to download and install STM32CubeIDE which addresses STM32 MCU, and also provides support for Cortex-M inside STM32 MPU.

It is available on Linux[®] and Windows[®] host PCs, but it is **NOT** on macOS[®].

	STM32CubeIDE for Linux host PC	STM32CubeIDE for Windows [®] host PC
Download	<p>Version 1.5.0</p> <ul style="list-style-type: none"> Download the preferred all-in-one Linux installer from my.st.com <ul style="list-style-type: none"> <i>Generic Linux Installer - STM32CubeIDE-Lnx</i> <i>RPM Linux Installer - STM32CubeIDE-RPM</i> <i>Debian Linux Installer - STM32CubeIDE-DEB</i> 	<p>Version 1.5.0</p> <ul style="list-style-type: none"> Download the all-in-one Windows installer from my.st.com <ul style="list-style-type: none"> <i>Windows Installer - STM32CubeIDE-Win</i>
Installation guide	<ul style="list-style-type: none"> Please refer to <i>STM32CubeIDE Installation guide (UM2563)</i> available on my.st.com. 	
User manual	<ul style="list-style-type: none"> When the installation is over, please see additional information about the STM32CubeIDE in my.st.com: <ul style="list-style-type: none"> <i>STM32CubeIDE quick start guide (UM2553)</i> <i>Getting started with projects based on the STM32MP1 Series in STM32CubeIDE (AN5360)</i> 	
Detailed release note	<ul style="list-style-type: none"> Details about the content of this tool version are available in Release Notes <i>STM32CubeIDE release v1.5.0</i> from my.st.com 	

Minor releases may then be available from update site, please check chapter 10 in (UM2609) for more information on how to update STM32CubeIDE.

6.2 Installing the STM32Cube MPU Package

Optional step: it is mandatory only if you want to modify the STM32Cube MPU Package.

Prerequisite: the STM32CubeIDE is installed.

- The STM32CubeMP1 Package is delivered through an archive file named **en.STM32Cube_FW_MP1_V1.3.0.zip**.



- Download and install the STM32CubeMP1 Package

The software package is provided AS IS, and by downloading it, you agree to be bound to the terms of the software license agreement (SLA). The detailed content licenses can be found [here](#).

Warning

To download a package, it is recommended to be logged in to your "myst" account [8]. If, trying to download, you encounter a "403 error", you could try to empty your browser cache to workaround the problem. We are working on the resolution of this problem.

We apologize for this inconvenience

STM32MP1 Developer Package STM32CubeMP1 Package - v2.1.0 release	
Download	You need to be logged on <i>my.st.com</i> before accessing the following link: en.STM32Cube_FW_MP1_V1.3.0.zip
Installation	<ul style="list-style-type: none"> • Go to the host PC directory in which you want to install the Developer Package (<Developer Package installation directory>); if you follow the proposition to organize the working directory, it means: <pre style="border: 1px dashed gray; padding: 5px;">\$ cd <working directory path>/Developer-Package</pre> <ul style="list-style-type: none"> • Download the archive file in this directory • Uncompress the archive file to get the STM32CubeMP1 Package: <pre style="border: 1px dashed gray; padding: 5px;">\$ unzip en.STM32Cube_FW_MP1_V1.3.0.zip</pre>
Release note	<p>Details about the content of the STM32CubeMP1 Package are available in the <i>STM32Cube_FW_MP1_V2.1.0/Release_Notes.html</i> file.</p> <p> If you are interested in older releases, please have a look into the section Archives.</p>

- The **STM32CubeMP1 Package installation directory** is in the <Developer Package installation directory> directory, and is named *STM32Cube_FW_MP1_V1.2.0*:

<pre>STM32Cube_FW_MP1_V1.3.0 CubeMP1 Package content article ├── Drivers │ ├── BSP │ └── STM32MP1 boards │ ├── [...] │ ├── CMSIS │ │ ├── [...] │ └── STM32MP1xx_HAL_Driver ├── STM32MP1 devices │ └── [...] ├── htmresc │ └── [...] ├── License.md └── Middlewares</pre>	<p>STM32CubeMP1 Package: details in STM32</p> <p>BSP drivers for the supported</p> <p>HAL drivers for the supported</p>
--	--



└─ [...]	
└─ package.xml	
└─ Projects	
└─ STM32CubeProjectsList.html	List of examples and applications for
STM32CubeMP1 Package	
└─ STM32MP157C-DK2	Set of examples and applications →
STM32MP15 Discovery kits	
└─ [...]	
└─ STM32MP157C-EV1	Set of examples and applications →
STM32MP15 Evaluation boards	
└─ [...]	
└─ Readme.md	
└─ Release_Notes.html	Release note for STM32CubeMP1 Package
└─ Utilities	
└─ [...]	

The **STM32Cube MPU Package** is now installed: let's develop software running on Arm Cortex-M4.



7 Developing software running on Arm Cortex-A7

7.1 Modifying the Linux kernel

Prerequisites:

- the SDK is installed
- the SDK is started up
- the Linux kernel is installed

The *<Linux kernel installation directory>/README.HOW_TO.txt* helper file gives the commands to:

configure the Linux kernel

cross-compile the Linux kernel

deploy the Linux kernel (that is, update the software on board)

You can refer to the following simple examples:

- Modification of the kernel configuration
- Modification of the device tree
- Modification of a built-in device driver
- Modification of an external in-tree module

7.2 Adding external out-of-tree Linux kernel modules

Prerequisites:

- the SDK is installed
- the SDK is started up
- the Linux kernel is installed

Most device drivers (or modules) in the Linux kernel can be compiled either into the kernel itself (built-in, or internal module) or as Loadable Kernel Modules (LKMs, or external modules) that need to be placed in the root file system under the `/lib/modules` directory. An external module can be in-tree (in the kernel tree structure), or out-of-tree (outside the kernel tree structure).

External Linux kernel modules are compiled taking reference to a Linux kernel source tree and a Linux kernel configuration file (`.config`).

Thus, a makefile for an external Linux kernel module points to the Linux kernel directory that contains the source code and the configuration file, with the `"-C <Linux kernel path>"` option.

This makefile also points to the directory that contains the source file(s) of the Linux kernel module to compile, with the `"M=<Linux kernel module path>"` option.

A generic makefile for an external out-of-tree Linux kernel module looks like the following:

```
# Makefile for external out-of-tree Linux kernel module

# Object file(s) to be built
obj-m := <module source file(s)>.o

# Path to the directory that contains the Linux kernel source code
# and the configuration file (.config)
KERNEL_DIR ?= <Linux kernel path>

# Path to the directory that contains the generated objects
```



```

DESTDIR ?= <Linux kernel installation directory>

# Path to the directory that contains the source file(s) to compile
PWD := $(shell pwd)

default:
    $(MAKE) -C $(KERNEL_DIR) M=$(PWD) modules

install:
    $(MAKE) -C $(KERNEL_DIR) M=$(PWD) INSTALL_MOD_PATH=$(DESTDIR) modules_install

clean:
    $(MAKE) -C $(KERNEL_DIR) M=$(PWD) clean

```

Such module is then cross-compiled with the following commands:

```

$ make clean
$ make
$ make install

```

You can refer to the following simple example:

- Addition of an external out-of-tree module

7.3 Adding Linux user space applications

Prerequisites:

- the SDK is installed
- the SDK is started up

Once a suitable cross-toolchain (OpenSTLinux SDK) is installed, it is easy to develop a project outside of the OpenEmbedded build system.

There are different ways to use the SDK toolchain directly, among which Makefile and Autotools.

Whatever the method, it relies on:

- the sysroot that is associated with the cross-toolchain, and that contains the header files and libraries needed for generating binaries (see [target sysroot](#))
- the environment variables created by the SDK environment setup script (see [SDK startup](#))

You can refer to the following simple example:

- Addition of a "hello world" user space application

7.4 Modifying the U-Boot

Prerequisites:

- the SDK is installed
- the SDK is started up
- the U-Boot is installed

The *<U-Boot installation directory>/README.HOW_TO.txt* helper file gives the commands to:

cross-compile the U-Boot

deploy the U-Boot (that is, update the software on board)



You can refer to the following simple example:

- Modification of the U-Boot

7.5 Modifying the TF-A

Prerequisites:

- the SDK is installed
- the SDK is started up
- the TF-A is installed

The *<TF-A installation directory>/README.HOW_TO.txt* helper file gives the commands to:

cross-compile the TF-A

deploy the TF-A (that is, update the software on board)

You can refer to the following simple example:

- Modification of the TF-A

7.6 Modifying the OP-TEE

Prerequisites:

- the SDK is installed
- the SDK is started up
- the OP-TEE is installed

The *<OP-TEE installation directory>/README.HOW_TO.txt* helper file gives the commands to:

cross-compile the OP-TEE

deploy the OP-TEE (that is, update the software on board)



8 Developing software running on Arm Cortex-M4

8.1 How to create a Cube project from scratch or open/modify an existing one from STM32Cube MPU package

Please refer to [STM32CubeMP1 Package](#) article.



9 Fast links to essential commands

If you are already familiar with the Developer Package for the STM32MPU Embedded Software distribution, fast links to the essential commands are listed below.

Information

With the links below, you will be redirected to other articles; use the *back* button of your browser to come back to these fast links

Link to the command
Starter Packages
Essential commands of the STM32MP15 Evaluation board Starter Package
Essential commands of the STM32MP15 Discovery kit Starter Package
SDK
Download and install the latest SDK
Start the SDK
Linux kernel
Download and install the latest Linux kernel
Helper file for the Linux kernel build, and update on board
U-Boot
Download and install the latest U-Boot
Helper file for the U-Boot build, and update on board
TF-A
Download and install the latest TF-A
Helper file for the TF-A build, and update on board
TF-A SSP
Download and install the latest TF-A SSP
Helper file for the TF-A SSP build, and update on board
OP-TEE
Download and install the latest OP-TEE
Helper file for the OP-TEE build, and update on board
Linux user space
Simple user space application
STM32Cube MPU Package



Link to the command

Download and install the latest STM32CubeMP1 Package
--

Create or modify a Cube project



10 How to go further?

Now that your developments are ready, you might want to switch to the STM32MP1 Distribution Package, in order to create your own distribution and to generate your own SDK and image.

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



Cortex®

Software development kit (A programming package that enables a programmer to develop applications for a specific platform.)

Linux® is a registered trademark of Linus Torvalds.

Das U-Boot -- the Universal Boot Loader (see [U-Boot_overview](#))

Trusted Firmware for Arm Cortex-A

Open Portable Trusted Execution Environment

Microprocessor Unit

Board support package

Hardware Abstraction Layer

(Software)Integrated development/design/debugging environment

Secure Secret Provisioning

Secure secrets provisioning

GNU dedugger, a portable debugger that runs on many Unix-like systems

Display Serial Interface (MIPI® Alliance standard)

High-Definition Multimedia Interface (HDMI standard)

debug and test protocol, named from the Joint Test Action Group that developed it

Operating System

Microcontroller Unit (MCUs have internal flash memory and are intended to operate with a minimum amount of external support ICs. They commonly are a self-contained, system-on-chip (SoC) designs.)

Cortex Microcontroller Software Interface Standard