Internal peripherals assignment table template

Contents

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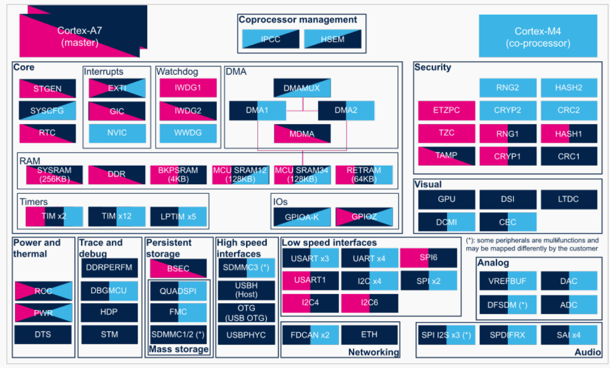
Check boxes illustrate the possible peripheral allocations supported by STM32 MPU Embedded Software:

- means that the peripheral can be assigned () to the given runtime context.
- is used for system peripherals that cannot be unchecked because they are statically connected in the device.

Refer to How to assign an internal peripheral to a runtime context for more information on how to assign peripherals manually or via STM32CubeMX.
The present chapter describes STMicroelectronics recommendations or choice of implementation. Additional possiblities might be described in STM32MP15 reference manuals
.



Internal peripherals

Domain	Periphera l	Runtime allocation				Comment
Instance	Cortex-A7 secure (OP-TEE)	Cortex-A7 non-secure (Linux)	Cortex-M4 (STM32Cub e)			

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Contents

1 Article purpose

This article explains how to configure the software that assigns a peripheral to a runtime context.

2 Introduction

A peripheral can be **assigned** to a runtime context via the configuration defined in the device tree. The device tree can be either generated by the STM32CubeMX tool or edited manually.

On STM32MP15 line devices, the assignement can be strengthened by a hardware mechanism: the ETZPC internal peripheral, which is configured by the TF-A boot loader. The ETZPC internal peripheral isolates the peripherals for the Cortex-A7 secure or the Cortex-M4 context. The peripherals assigned to the Cortex-A7 non-secure context are visible from any context, without any isolation.

The components running on the platform after TF-A execution (such as U-Boot, Linux, STM32Cube and OP-TEE) must have a **configuration** that is consistent with the assignment and the isolation configurations.

The following sections describe how to configure TF-A, U-Boot, Linux and STM32Cube accordingly.

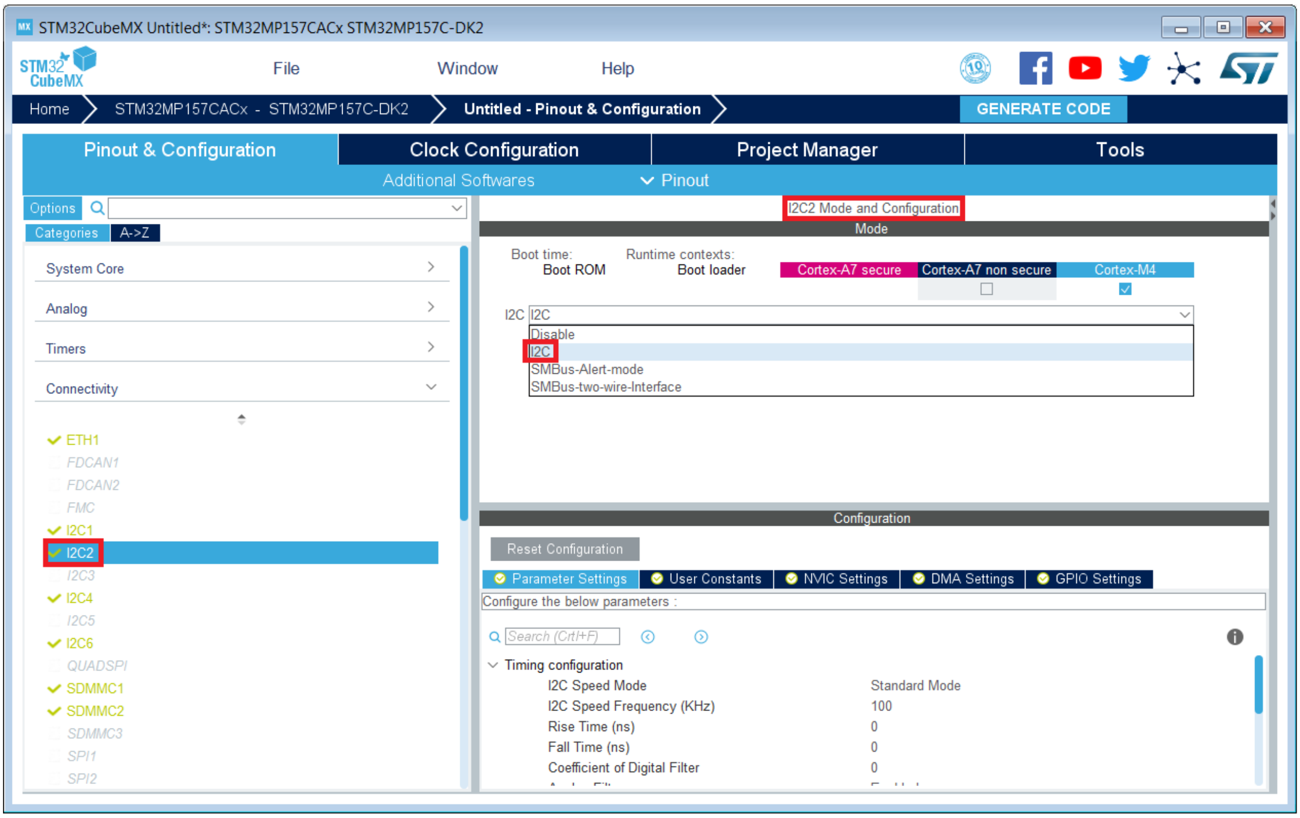
Information

Beyond the peripherals assignment, explained in this article, it is also important to understand How to configure system resources (i.e clocks, regulator, gpio,...), shared between the Cortex-A7 and Cortex-M4 contexts

3 STM32CubeMX generated assignment

The screenshot below shows the STM32CubeMX user interface:

- **I2C2** peripheral is selected, on the left
- **I2C2 Mode and Configuration** panel, on the right, shows that this I2C instance can be assigned to the Cortex-A7 non-secure or the Cortex-M4 (that is selected) runtime context
- **I2C** mode is enabled in the drop down menu



Information

The context assignment table is displayed inside each peripheral **Mode and Configuration** panel but it is possible to display it for all the peripherals in the **Options** menu via the **Show contexts** option

The **GENERATE CODE** button, on the top right, produces the following:

- The **TF-A device tree** with the ETZPC configuration that isolates the I2C2 instance (in the example) for the Cortex-M4 context. This same device tree can be used by **OP-TEE**, when enabled
- The **U-Boot device tree** widely inherited from the Linux one, just below
- The **Linux kernel device tree** with the I2C node disabled for Linux and enabled for the coprocessor
- The **STM32Cube project** with I2C2 HAL initialization code

The Manual assignment section, just below, illustrates what STM32CubeMX is generating as it follows the same example.

Information

In addition of this generation, the user may have to manually complete the system resources configuration in the user sections embedded in the STM32CubeMX generated device tree. Refer to How to configure system resources for details.

4 Manual assignment

This section gives step by step instructions, per software components, to manually perform the peripherals assignments.
It takes the same I2C2 example as the previous section, that showed how to use STM32CubeMX, in order to make the move from one approach to the other easier.

Information

The assignments combinations described in the STM32MP15 peripherals overview article are naturally supported by STM32MPU Embedded Software distribution. Note that the STM32MP15 reference manual may describe more options that would require embedded software adaptations

4.1 TF-A

The assignment follows the ETZPC device tree configuration, with below possible values:

- **DECPROT_S_RW** for the Cortex-A7 secure (Secure OS like OP-TEE)
- **DECPROT_NS_RW** for the Cortex-A7 non-secure (Linux)
  - As stated earlier in this article, there is no hardware isolation for the Cortex-A7 non-secure so this value allows accesses from any context
- **DECPROT_MCU_ISOLATION** for the Cortex-M4 (STM32Cube)

Example:

```
@etzpc: etzpc@5C007000 {
       st,decprot = <
           DECPROT(STM32MP1_ETZPC_I2C2_ID, DECPROT_MCU_ISOLATION, DECPROT_UNLOCK)
       >;
};
```

Information

The value **DECPROT_NS_RW** can be used with **DECPROT_LOCK** as last parameter. In Cortex-M4 context, this specific configuration allows the generation of an error in the resource manager utility while trying to use on Cortex-M4 side a peripheral that is assigned to the Cortex-A7 non-secure context. If **DECPROT_UNLOCK** is used, then the utility allows the Cortex-M4 to use a peripheral that is assigned to the Cortex-A7 non-secure context.

4.2 U-boot

No specific configuration is needed in U-Boot to configure the access to the peripheral.

Information

U-Boot does not perform any check with regards to ETZPC configuration before accessing to a peripheral. In case of inconsistency an illegal access is generated.

Information

U-Boot checks the consistency between ETZPC isolation configuration and Linux kernel device tree configuration to guarantee that Linux kernel do not access an unauthorized device. In order to avoid the access to an unauthorized device, the U-boot fixes up the Linux kernel device tree to disable the peripheral nodes which are not assigned to the Cortex-A7 non-secure context.

4.3 Linux kernel

Each assignable peripheral is declared twice in the Linux kernel device tree:

- Once in the **soc** node from arch/arm/boot/dts/stm32mp151.dtsi , corresponding to Linux assigned peripherals
  - Example: i2c2
- Once in the **m4_rproc** node from arch/arm/boot/dts/stm32mp15-m4-srm.dtsi , corresponding to the Cortex-M4 context.

Those nodes are disabled, by default.

  - Example: m4_i2c2

In the board device tree file (*.dts), each assignable peripheral has to be enabled only for the context to which it is assigned, in line with TF-A configuration.
As a consequence, a peripheral assigned to the Cortex-A7 secure has both nodes disabled in the Linux device tree.

Example:

```
&i2c2 {
        status = "disabled";
};
...
&m4_i2c2 {
        status = "okay";
};
```

Information

In addition of this assignment, the user may have to complete the system resources configuration in the device tree nodes. Refer to How to configure system resources for details.

4.4 STM32Cube

There is no configuration to do on STM32Cube side regarding the assignment and isolation. Nevertheless, the resource manager utility, relying on ETZPC configuration, can be used to check that the corresponding peripheral is well assigned to the Cortex-M4 before using it.

Example:

```
int main(void)
{
...
 /* Initialize I2C2------------------------------------------------------ */
 /* Ask the resource manager for the I2C2 resource */
 ResMgr_Init(NULL, NULL);
 if (ResMgr_Request(RESMGR_ID_I2C2, RESMGR_FLAGS_ACCESS_NORMAL | \
```

```
                                         RESMGR_FLAGS_CPU1, 0, NULL) != RESMGR_OK)
  {
    Error_Handler();
  }
...
  if (HAL_I2C_Init(&I2C2) != HAL_OK)
  {
    Error_Handler();
  }
}
```

4.5 OP-TEE

The OP-TEE OS may use STM32MP1 resources. OP-TEE STM32MP1 drivers register the device driver they intend to used in a secure context. This information is used to consolidate system configuration including secure hardening of configurable peripherals.

In most case, the OP-TEE driver probe relies on OP-TEE device tree porperty *secure-status = "okay"*.

Cortex®

Trusted Firmware for Arm® Cortex®-A

Das U-Boot -- the Universal Boot Loader (see U-Boot_overview)

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Inter-Integrated Circuit (Bi-directional 2-wire bus standard for efficient inter-IC control.)

Open Portable Trusted Execution Environment

Hardware Abstraction Layer

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.)

Extended TrustZone Protection Controller

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A quality version of this page, approved on *23 September 2020*, was based off this revision.

1 STM32CubeMX overview

This article describes STM32CubeMX, an official STMicroelectronics graphical software configuration tool.

The STM32CubeMX application helps developers to use the STM32 by means of a user interface, and guides the user through to the initial configuration of a firmware project.

It provides the means to:

- configure pin assignments, the clock tree, or internal peripherals
- simulate the power consumption of the resulting project
- configure and tune DDR parameters
- generate HAL initialization code for Cortex-M4
- generate the Device Tree for a Linux kernel, TF-A and U-Boot firmware for Cortex-A7

It uses a rich library of data from the STM32 microcontroller portfolio.

The application is intended to ease the initial development phase by helping developers to select the best product in terms of features and power.

2 STM32CubeMX main features

- Peripheral and middleware parameters

  Presents options specific to each supported software component
- Peripheral assignment to processors

  Allows assignment of each peripheral to Cortex-A Secure, Cortex-A Non-Secure, or Cortex-M processors
- Power consumption calculator

  Uses a database of typical values to estimate power consumption, DMIPS, and battery life
- Code generation

  Makes code regeneration possible, while keeping user code intact
- Pinout configuration

  Enables peripherals to be chosen for use, and assigns GPIO and alternate functions to pins
- Clock tree initialization

  Chooses the oscillator and sets the PLL and clock dividers
- DDR tunning tool

  Ensures the configuration, testing, and tuning of the MPU DDR parameters. Using U-Boot-SPL Embedded Software.

3 How to get STM32CubeMX

Please, refer to the following link STM32CubeMX to find STM32CubeMX, the Release Note, the User Manual and the product specification.

Doubledata rate (memory domain)

Hardware Abstraction Layer

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Trusted Firmware for Arm® Cortex®-A

Das U-Boot -- the Universal Boot Loader (see U-Boot_overview)

General-Purpose Input/Output (A realization of open ended transmission between devices on an embedded level. These pins available on a processor can be programmed to be used to either accept input or provide output to external devices depending on user desires and applications requirements.)

Microprocessor Unit

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All the resources for the STM32MP1 Series are located in the Resources area of the STM32MP1 Series web page.

The resources below are referenced in some of the articles of this user guide.

Information

The different **STM32MP15** microprocessor **part numbers** available (with their corresponding internal peripherals, security options and packages) are described in the **STM32MP15 microprocessor part numbers**.

NEW means that the document (or its version) is new compared to what was delivered within the previous ecosystem release.

Reference	Name	Link	Version
Application notes			
AN4803	High-speed SI simulations using IBIS and board-level simulations using HyperLynx® SI on STM32 MCUs and MPUs	AN4803.pdf	v2.0
AN5027	Interfacing PDM digital microphones using STM32 MCUs and MPUs	AN5027.pdf	v2.0
AN5031	Getting started with STM32MP15 Series hardware development	AN5031.pdf	v3.0

Reference	Name	Link	Version
Application notes			
AN5036	Thermal management guidelines for STM32 applications	AN5036.pdf	v3.0
AN5109	STM32MP1 Series using low-power modes	AN5109.pdf	v4.0
AN5122	STM32MP1 Series DDR memory routing guidelines	AN5122.pdf	v3.0
AN5168	STM32MP1 series DDR configuration	AN5168.pdf	NEW v2.0
AN5225	USB Type-C™ Power Delivery using STM32xx Series MCUs and STM32xxx Series MPUs	AN5225.pdf	NEW v5.0
AN5253	Migration of microcontroller applications from STM32F4x9 lines to STM32MP151, STM32MP153 and STM32MP157 lines microprocessor	AN5253.pdf	v1.0
AN5256	STM32MP151, STM32MP153 and STM32MP157 discrete power supply hardware integration	AN5256.pdf	v2.0
AN5260	STM32MP151/153/157 MPU lines and STPMIC1B integration on a battery powered application	AN5260.pdf	v2.0
AN5275	USB DFU/USART protocols used in STM32MP1 Series bootloaders	AN5275.pdf	v1.0
AN5284	STM32MP1 series system power consumption	AN5284.pdf	v1.0
AN5348	FDCAN peripheral on STM32 devices	AN5348.pdf	v1.0
AN5431	The STPMIC1 PCB layout guidlines	AN5431.pdf	v1.0
AN5438	STM32MP1 Series lifetime estimates	AN5438.pdf	v1.0
AN5510	Overview of the secure secret provisioning (SSP) on STM32MP1 Series	AN5510.pdf	v1.0
Datasheets[1]			
DS12505	STM32MP157C/F datasheet (secure)	DS12505.pdf	NEW v6.0
DS12504	STM32MP157A/D datasheet (basic)	DS12504.pdf	NEW v6.0
DS1250	STM32MP153C/F datasheet	DS125	

Reference	Name	Link	Version
Application notes			
3	(secure)	03.pdf	NEW v6.0
DS12502	STM32MP153A/D datasheet (basic)	DS12502.pdf	NEW v6.0
DS12501	STM32MP151C/F datasheet (secure)	DS12501.pdf	NEW v6.0
DS12500	STM32MP151A/D datasheet (basic)	DS12500.pdf	NEW v6.0
DS12792	STPMIC1 datasheet	DS12792.pdf	NEW v8.0
Errata sheets			
ES0438	STM32MP15xx device errata	ES0438.pdf	v6.0
Reference manuals[1]			
RM0436	STM32MP157 reference manual (STM32MP157xxx advanced Arm®-based 32-bit MPUs)	RM0436.pdf	v5.0
RM0442	STM32MP153 reference manual (STM32MP153xxx advanced Arm®-based 32-bit MPUs)	RM0442.pdf	v5.0
RM0441	STM32MP151 reference manual (STM32MP151xxx advanced Arm®-based 32-bit MPUs)	RM0441.pdf	v5.0
Boards schematics			
MB1262 schematics	STM32MP157C-EV1 motherboard schematics MB1262-C01 board schematic (Evaluation board)	MB1262-C01.pdf	v1.0
MB1263 schematics	STM32MP157F-EV1 daughterboard schematics MB1263-C04 board schematic (Evaluation board)	MB1263-C04.pdf	v4.0
MB1230 schematics	DSI 720p LCD display daughterboard schematics MB1230-C board schematic (Evaluation board)	MB1230-C.pdf	v1.1
MB1379 schematics	Camera daughterboard schematics MB1379-A01 board schematic (Evaluation board)	MB1379-A01.pdf	v1.0
MB1272 schematics	STM32MP157x-DKx motherboard schematics MB1272-DK2-C01 board schematic (Discovery kit)	MB1272-C01.pdf	v1.0

Reference	Name	Link	Version
Application notes			
MB1407 schematics	STM32MP157x-DKx daughterboard schematics MB1407-LCD-C01 board schematic (Discovery kit)	MB1407-C01.pdf	v1.0
Boards user manuals			
UM2535	STM32MP157x-EV1 evaluation board user manual	UM2535.pdf	v2.0
UM2534	STM32MP157x-DKx discovery board user manual	UM2534.pdf	v1.0
Tools user manuals			
UM2563	STM32CubeIDE installation guide	UM2563.pdf	NEW v3.0
UM2579	Migration guide from System Workbench to STM32CubeIDE	UM2579.pdf	v1.0
UM2553	STM32CubeIDE quick start guide	UM2553.pdf	NEW v3.0
AN5360	Getting started with projects based on the STM32MP1 Series in STM32CubeIDE	AN5360.pdf	v1.0
UM2609	STM32CubeIDE user guide	UM2609.pdf	NEW v5.0
UM1718	STM32CubeMX user manual	UM1718.pdf	NEW v36.0
UM2237	STM32CubeProgrammer tool user manual	UM2237.pdf	NEW v17.0
UM2238	STM32 Trusted Package Creator tool user manual	UM2238.pdf	NEW v9.0
UM2542	STM32 Series Key Generator tool user manual	UM2542.pdf	NEW v2.0
UM2543	STM32 Series Signing tool user manual	UM2543.pdf	NEW v2.0

- 1.01.1 The part numbers are specified in STM32MP15 microprocessor part numbers

Archives

STM32MP15 release	ST documentation
STM32MP15-Ecosystem-v3.0.0	STM32MP15 resources - v3.0.0 page for the previous v3 ecosystem release
STM32MP15-Ecosystem-v2.1.0	STM32MP15 resources - v2.1.0 page for the v2 ecosystem releases (in archived wiki)
STM32MP15-Ecosystem-v2.0.0	STM32MP15 resources - v2.0.0 page for the v2 ecosystem releases (in archived wiki)
STM32MP15-Ecosystem-v1.2.0	STM32MP15 resources - v1.2.0 page for the v1 ecosystem releases (in archived wiki)
STM32MP15-Ecosystem-v1.1.0	STM32MP15 resources - v1.1.0 page for the v1 ecosystem releases (in archived wiki)
STM32MP15-Ecosystem-v1.0.0	STM32MP15 resources - v1.0.0 page for the v1 ecosystem releases (in archived wiki)

Doubledata rate (memory domain)

USB port or connector

Microprocessor Unit

Device Firmware Upgrade

Universal Synchronous/Asynchronous Receiver/Transmitter

Printed Circuit Board

Secure Secret Provisioning

Secure secrets provisioning

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Display Serial Interface (MIPI® Alliance standard)

Stable: 26.03.2021 - 11:32 / Revision: 12.03.2021 - 11:07

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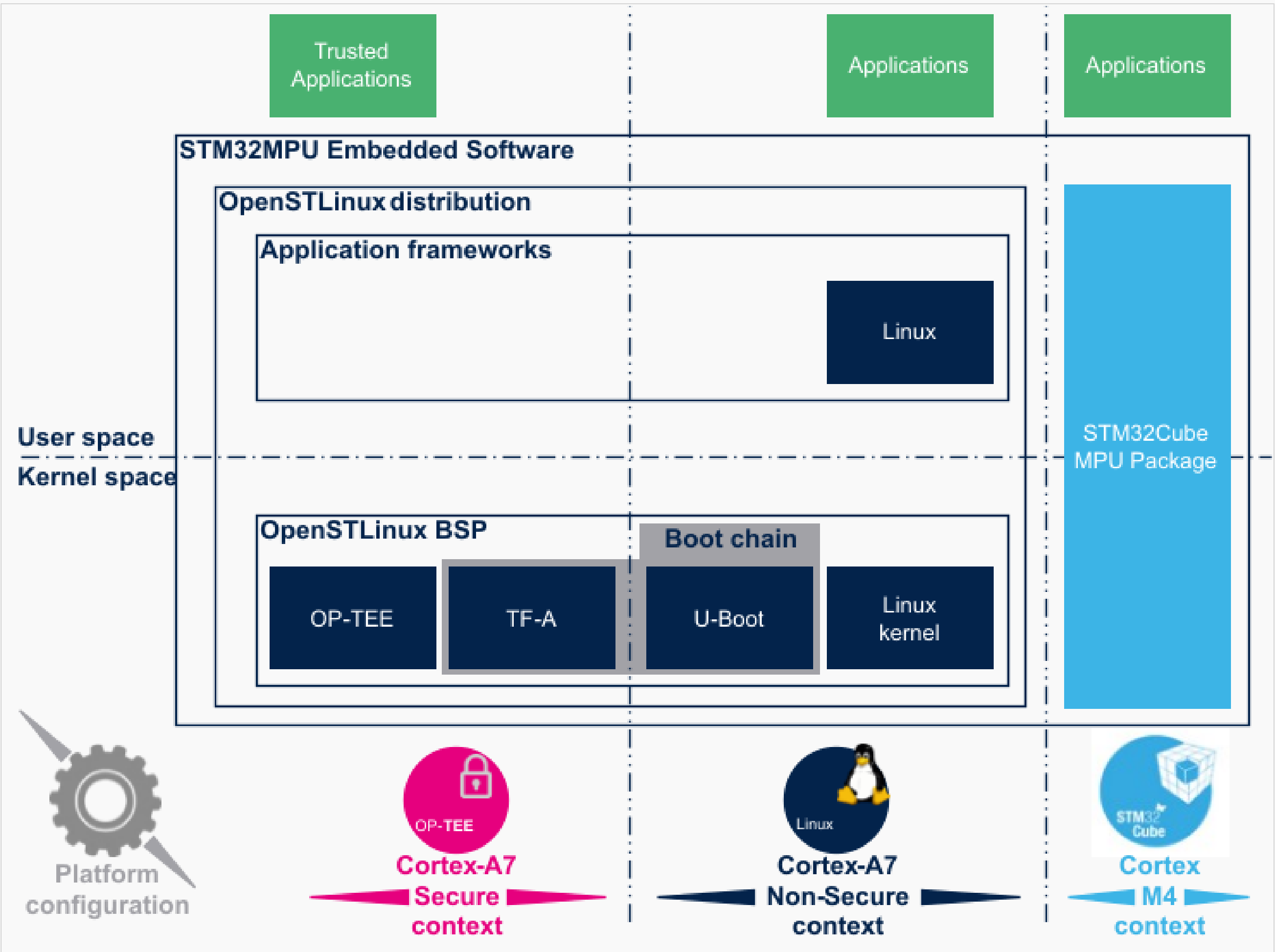
1 STM32MPU Embedded Software overview

The diagram below shows STM32MPU Embedded Software distribution main components:

- The **OpenSTLinux distribution**, running on the Arm®Cortex®-A, including:
  - The **OpenSTLinux BSP** with:
    - The boot chain based on TF-A and U-Boot.
    - The OP-TEE secure OS running on the Arm®Cortex®-A in secure mode.
    - The **Linux® kernel** running on the Arm®Cortex®-A in non-secure mode.
  - The **application frameworks** are composed of middlewares relying on the BSP and providing API, on **Linux** side, to run **Applications** that typically interact with the user via the display, the touchscreen, etc.
  - On **OP-TEE** side, the **Trusted Applications (TA)** relies on the OP-TEE core for secrets operations (not visible from the Linux and STM32Cube MPU Package)
- The **STM32Cube MPU Package** is running on the Arm®Cortex®-M: it is based on HAL drivers and middlewares, like other STM32 microcontrollers, completed with coprocessor management.

The figure below is clickable so that the user can directly jump to one of the sub-levels listed above.



STM32MPU Embedded Software architecture overview.

Legend	
3rd Party	
ST	Community

2 Open Source Software (OSS) philosophy

The **Open source software** source code is released under a license in which the copyright holder grants users the rights to study, change and distribute the software to anyone and for any purpose[1].
STMicroelectronics maximizes the using of open source software and contributes to those communities. Notice that, due to the software review life cycle, it can take some time before getting all developments accepted in the communities, so STMicroelectronics can also temporarily provide some source code on github[2], until it is merged in the targeted repository.

3 References

- https://en.wikipedia.org/wiki/Open-source_software
- STM32MP1 Distribution Package

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Cortex®

Board support package

Operating System

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Application programming interface

Open Portable Trusted Execution Environment

Trusted Application

Microprocessor Unit

Hardware Abstraction Layer

Open Source Software