corstone1000

Arm Limited

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CONTENTS

CHAPTER

ONE

SOFTWARE ARCHITECTURE

1.1 ARM corstone1000

ARM corstone1000 is a reference solution for IoT devices. It is part of Total Solution for IoT which consists of hardware and software reference implementation.

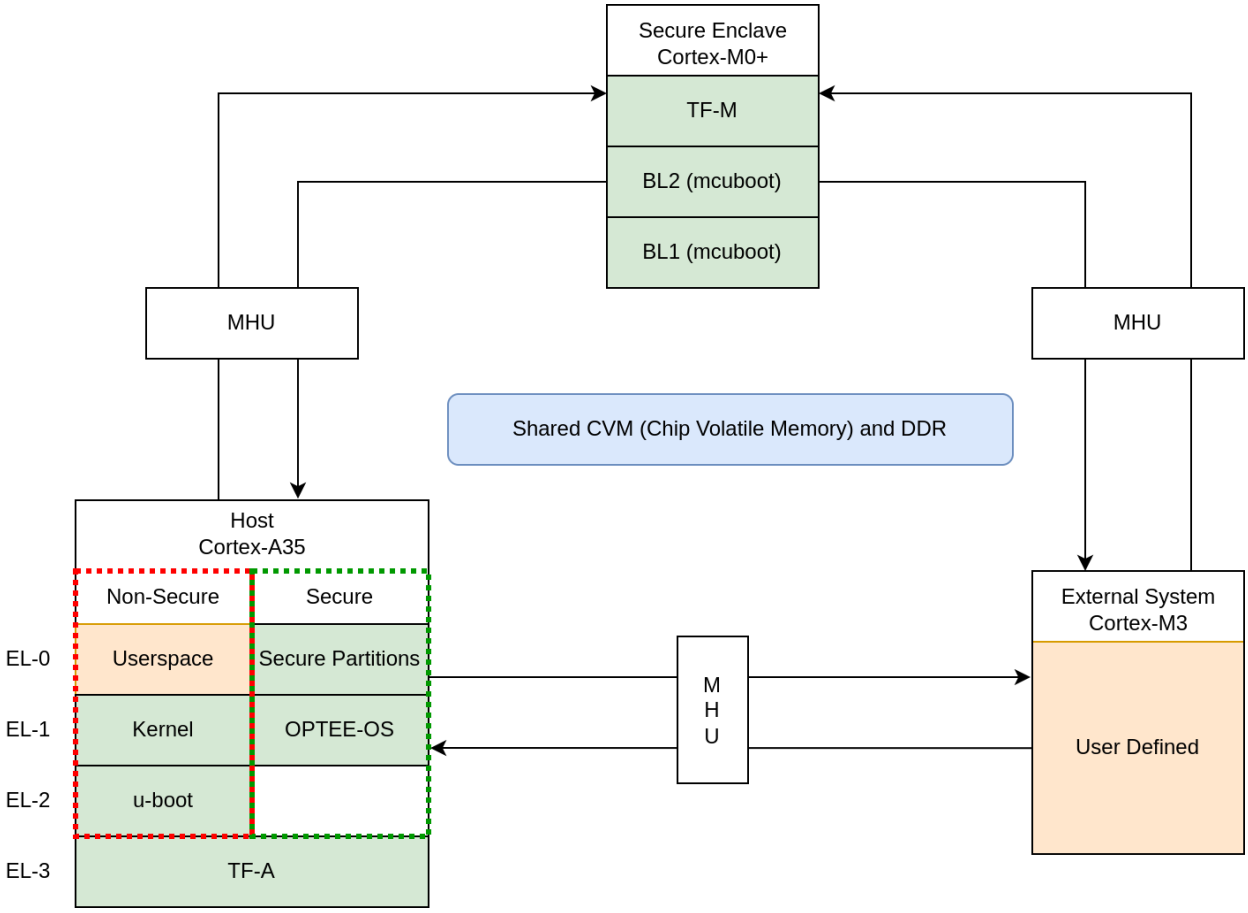
Corstone1000 software plus hardware reference solution is PSA Level-2 ready certified (PSA L2 Ready) as well as System Ready IR certified(SRIR cert). More information on the corstone1000 subsystem product and design can be found at: Arm corstone1000 Software and Arm corstone1000 Technical Overview.

This readme explicitly focuses on the software part of the solution and provides internal details on the software components. The reference software package of the platform can be retrieved following instructions present in the user-guide document.

1.2 Design Overview

The software architecture of corstone1000 platform is a reference implementation of Platform Security Architecture (PSA) which provides framework to build secure IoT devices.

The base system architecture of the platform is created from three different tyes of systems: Secure Enclave, Host and External System. Each subsystem provides different functionality to overall SoC.



The Secure Enclave System, provides PSA Root of Trust (RoT) and cryptographic functions. It is based on an Cortex-M0+ processor, CC312 Cryptographic Accelerator and peripherals, such as watchdog and secure flash. Software running on the Secure Enclave is isolated via hardware for enhanced security. Communication with the Secure Encalve is achieved using Message Hnadling Units (MHUs) and shared memory. On system power on, the Secure Enclaves boots first. Its software comprises of two boot loading stages, both based on mcuboot, and TrustedFirmware-M(TF-M) as runtime software. The software design on Secure Enclave follows Firmware Framework for M class processor (FF-M) specification.

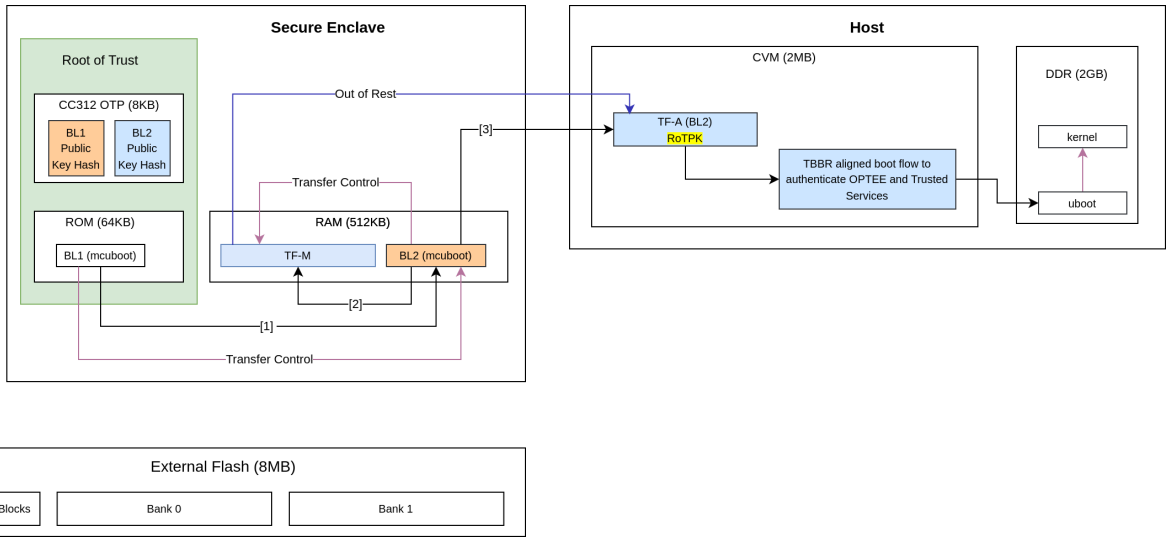
The Host System is based on ARM Cotex-A35 processor with standardized peripherals to allow for the booting of a Linux OS. The Cortex-A35 has the TrustZone technology that allows secure and non-secure security states in the processor. The software design in the Host System follows Firmware Framework for A class procseeor (FF-A) specification. The boot process follows Trusted Boot Base Requirement (TBBR). The Host Subsystem is taken out of reset by the Secure Enclave system during its final stages of the initialization. The Host subsystem runs FF-A Secure Partitions(based on Trusted Services) and OPTEE-OS (OPTEE-OS) in the secure world, and u-boot(u-boot repo) and linux (linux repo) in the non-secure world. The communication between non-secure and the secure world is performed via FF-A messages.

An external system is intended to implement use-case specific functionality. The system is based on Cortex-M3 and run RTX RTOS. Communictaion between external system and Host(cortex-A35) is performed using MHU as transport mechanism and rpmsg messaging system.

Overall, the corstone1000 architecture is designed to cover a range of Power, Performance, and Area (PPA) applications, and enable extension for use-case specific applications, for example, sensors, cloud connectivitiy, and edge computing.

1.3 Secure Boot Chain

For the security of a device, it is essential that only authorized software should run on the device. The corstone1000 boot uses a Secure Boot Chain process where an already authenticated image verifies and loads the following software in the chain. For the boot chain process to work, the start of the chain should be trusted, forming the Root of Trust (RoT) of the device. The RoT of the device is immutable in nature and encoded into the device by the device owner before it is deployed into the field. In Corstone1000, the BL1 image of the secure enclave and content of the CC312 OTP (One Time Programmable) memory forms the RoT. The BL1 image exists in ROM (Read Only Memory).



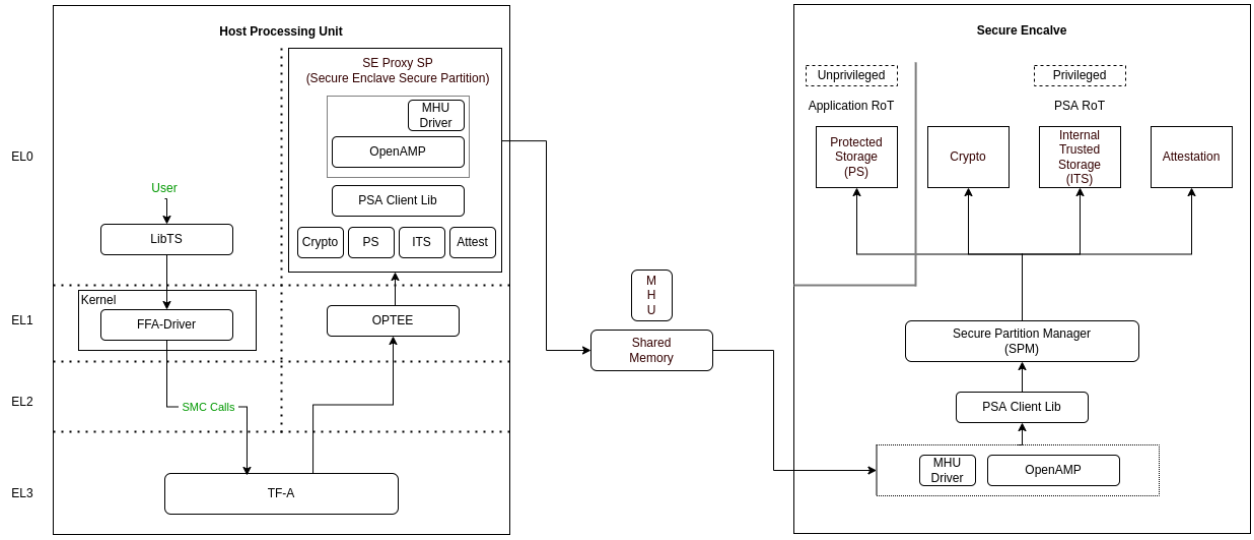
It is a lengthy chain to boot the software on corstone1000. On power on, the secure enclave starts executing BL1 code from the ROM which is the RoT of the device. Authentication of an image involves the steps listed below:

- Load image from flash to dynamic RAM.
- The public key present in the image header is validated by comparing with the hash. Depending on the image, the hash of the public key is either stored in the OTP or part of the software which is being already verfied in the previous stages.
- The image is validated using the public key.

In the secure enclave, BL1 authenticates the BL2 and passes the execution control. BL2 authenticates the initial boot loader of the host (Host BL2) and TF-M. The execution control is now passed to TF-M. TF-M being the run time executable of secure enclaves initializes itself and, in the end, brings the host CPU out of rest. The host follows the boot standard defined in the TBBR to authenticate the secure and non-secure software.

1.4 Secure Services

corstone1000 is unique in providing a secure environment to run a secure workload. The platform has Trustzone technology in the Host subsystem but it also has hardware isolated secure enclave environment to run such secure workloads. In corstone1000, known Secure Services such as Crypto, Protected Storage, Internal Trusted Storage and Attestation are available via PSA Functional APIs in TF-M. There is no difference for a user communicating to these services which are running on a secure enclave instead of the secure world of the host subsystem. The below diagram presents the data flow path for such calls.



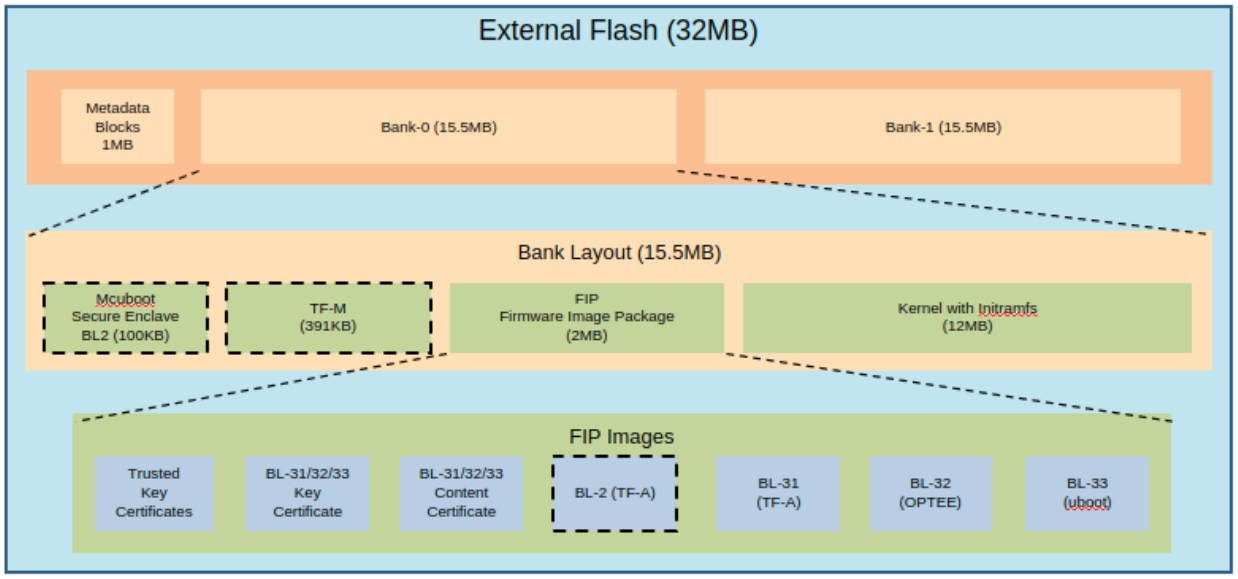
The SE Proxy SP (Secure Enclave Proxy Secure Partition) is a proxy partition managed by OPTEE which forwards such calls to the secure enclave. The solution relies on OpenAMP which uses shared memory and MHU interrupts as a doorbell for communication between two cores. corstone1000 implements isolation level 2. Cortex-M0+ MPU (Memory Protection Unit) is used to implement isolation level 2.

For a user to define its own secure service, both the options of the host secure world or secure encalve are available. It's a trade-off between lower latency vs higher security. Services running on a secure enclave are secure by real hardware isolation but have a higher latency path. In the second scenario, the services running on the secure world of the host subsystem have lower latency but virtual hardware isolation created by Trustzone technology.

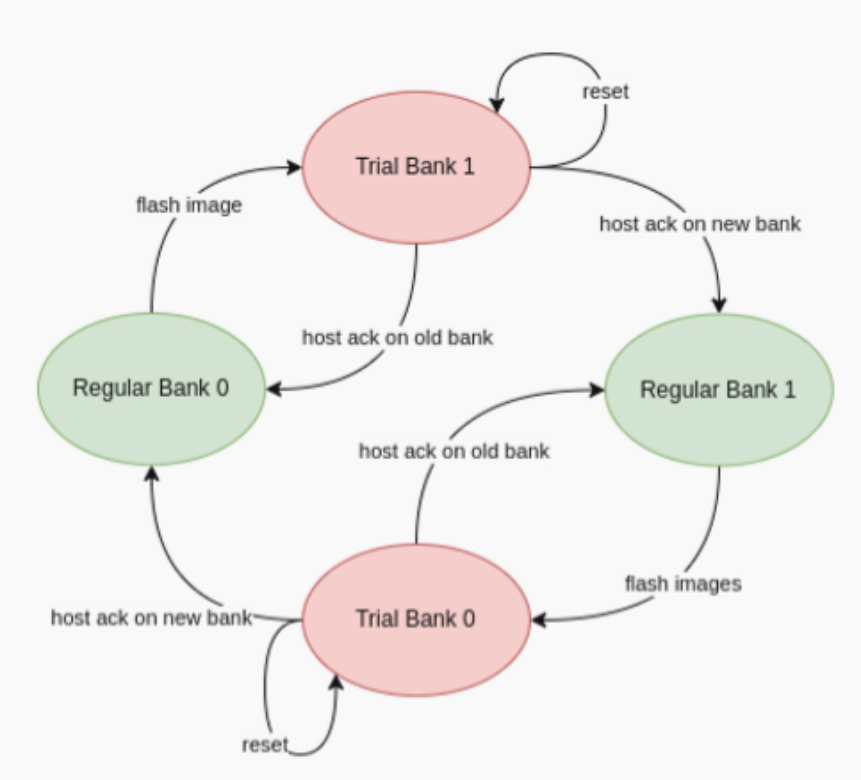
1.5 Secure Firmware Update

Apart from always booting the authorized images, it is also essential that the device only accepts the authorized images in the firmware update process. corstone1000 supports OTA (Over the Air) firmware updates and follows Platform Security Firmware Update sepcification (FWU).

As standardized into FWU, the external flash is divided into two banks of which one bank has currently running images and the other bank is used for staging new images. There are four updatable units, i.e. Secure Enclave's BL2 and TF-M, and Host's FIP (Firmware Image Package) and Kernel Image. The new images are accepted in the form of a UEFI capsule.

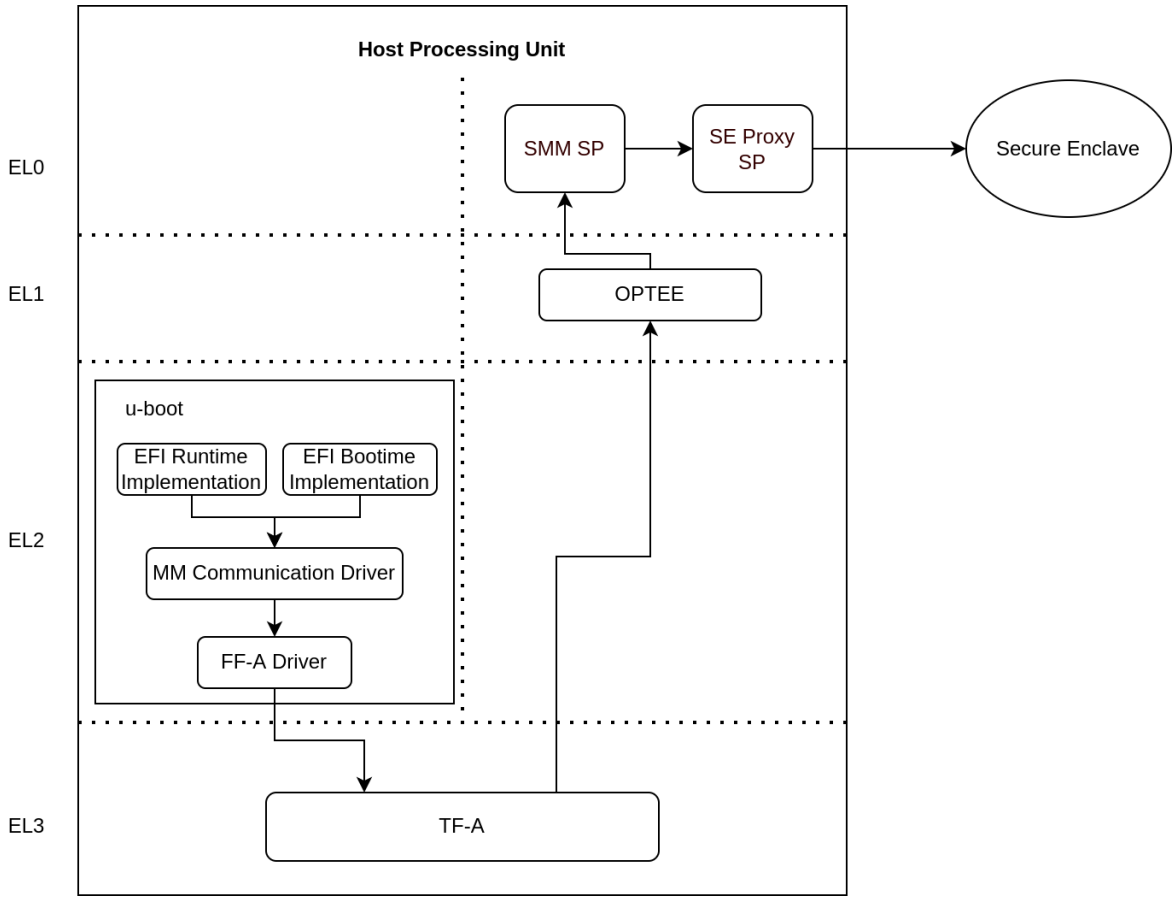


The Metadata Block in the flash has the below firmware update state machine. TF-M runs an OTA service that is responsible for accepting and updating the images in the flash. The communication between the UEFI Capsule update subsystem and the OTA service follows the same data path explained above. The OTA service writes the new images to the passive bank after successful capsule verification. It changes the state of the system to trial state and triggers the reset. Boot loaders in Secure Enclave and Host read the Metadata block to get the information on the boot bank. In the successful trial stage, the acknowledgment from the host moves the state of the system from trial to regular. Any failure in the trial stage or system hangs leads to a system reset. This is made sure by the use of watchdog hardware. The Secure Enclave's BL1 has the logic to identify multiple resets and eventually switch back to the previous good bank. The ability to revert to the previous bank is crucial to guarantee the availability of the device.



1.6 UEFI Runtime Support in u-boot

Implementation of UEFI boottime and runtime APIs require variable storage. In corstone1000, these UEFI variables are stored in the Protected Storage service. The below diagram presents the data flow to store UEFI variables. The u-boot implementation of the UEFI subsystem uses the FF-A driver to communicate with the SMM Service in the secure world. The backend of the SMM service uses the proxy PS from the SE Proxy SP. From there on, the PS calls are forwarded to the secure enclave as explained above.



1.7 References

ARM corstone1000 Search Arm security features

CHAPTER

TWO

USER GUIDE

2.1 Notice

The Corstone-1000 software stack uses the Yocto Project to build a tiny Linux distribution suitable for the Corstone-1000 platform (kernel and initramfs filesystem less than 5 MB on the flash). The Yocto Project relies on the Bitbake tool as its build tool. Please see Yocto Project documentation for more information.

2.2 Prerequisites

These instructions assume your host PC is running Ubuntu Linux 18.04 or 20.04 LTS, with at least 32GB of free disk space and 16GB of RAM as minimum requirement. The following instructions expect that you are using a bash shell. All the paths stated in this document are absolute paths.

The following prerequisites must be available on the host system. To resolve these dependencies, run:

```
sudo apt-get update
sudo apt-get install gawk wget git-core diffstat unzip texinfo gcc-multilib \
 build-essential chrpath socat cpio python3 python3-pip python3-pexpect \
 xz-utils debianutils iputils-ping python3-git libegl1-mesa libsdl1.2-dev \
 xterm zstd liblz4-tool picocom
sudo apt-get upgrade libstdc++6
```

2.3 Provided components

Within the Yocto Project, each component included in the Corstone-1000 software stack is specified as a bitbake recipe. The recipes specific to the Corstone-1000 BSP are located at: `<_workspace>/meta-arm/meta-arm-bsp/`.

The Yocto machine config files for the Corstone-1000 FVP and FPGA targets are:

- `<_workspace>/meta-arm/meta-arm-bsp/conf/machine/include/corstone1000.inc`
- `<_workspace>/meta-arm/meta-arm-bsp/conf/machine/corstone1000-fvp.conf`
- `<_workspace>/meta-arm/meta-arm-bsp/conf/machine/corstone1000-mps3.conf`

2.3.1 Software for Host

Trusted Firmware-A

Based on Trusted Firmware-A

bbappend	<_workspace>/meta-arm/meta-arm-bsp/recipes-bsp/trusted-firmware-a/trusted-firmware-a_2.7.bbappend
Recipe	<_workspace>/meta-arm/meta-arm/recipes-bsp/trusted-firmware-a/trusted-firmware-a_2.7.bb

OP-TEE

Based on OP-TEE

bbappend	<_workspace>/meta-arm/meta-arm-bsp/recipes-security/optee/optee-os_3.18.0.bbappend
Recipe	<_workspace>/meta-arm/meta-arm/recipes-security/optee/optee-os_3.18.0.bb

U-Boot

Based on U-Boot

bbappend	<_workspace>/meta-arm/meta-arm/recipes-bsp/u-boot/u-boot_%.bbappend
Recipe	<_workspace>/poky/meta/recipes-bsp/u-boot/u-boot_2022.07.bb

Linux

The distro is based on the poky-tiny distribution which is a Linux distribution stripped down to a minimal configuration.

The provided distribution is based on busybox and built using muslibc. The recipe responsible for building a tiny version of Linux is listed below.

bbappend	<_workspace>/meta-arm/meta-arm-bsp/recipes-kernel/linux/linux-yocto_%.bbappend
Recipe	<_workspace>/poky/meta/recipes-kernel/linux/linux-yocto_5.19.bb
defconfig	<_workspace>/meta-arm/meta-arm-bsp/recipes-kernel/linux/files/corstone1000/defconfig

External System Tests

Based on Corstone-1000/applications

Recipe	<_workspace>/meta-arm/meta-arm-bsp/recipes-test/corstone1000-external-sys-tests/corstone1000-external-sys-tests_1.0.bb

The recipe provides the systems-comms-tests command run in Linux and used for testing the External System.

2.3.2 Software for Boot Processor (a.k.a Secure Enclave)

Based on Trusted Firmware-M

bbappend	<_workspace>/meta-arm/meta-arm-bsp/recipes-bsp/trusted-firmware-m/trusted-firmware-m_%.bbappend
Recipe	<_workspace>/meta-arm/meta-arm/recipes-bsp/trusted-firmware-m/trusted-firmware-m_1.6.0.bb

2.3.3 Software for the External System

RTX

Based on RTX RTOS

Recipe	<_workspace>/meta-arm/meta-arm-bsp/recipes-bsp/external-system/external-system_0.1.0.bb

2.4 Building the software stack

Create a new folder that will be your workspace and will henceforth be referred to as <_workspace> in these instructions. To create the folder, run:

```
mkdir <_workspace>
cd <_workspace>
```

Corstone-1000 software is based on the Yocto Project which uses kas and bitbake commands to build the stack. To install kas tool, run:

```
pip3 install kas
```

If 'kas' command is not found in command-line, please make sure the user installation directories are visible on $PATH. If you have sudo rights, try 'sudo pip3 install kas'.

In the top directory of the workspace <_workspace>, run:

```
git clone https://git.yoctoproject.org/git/meta-arm -b CORSTONE1000-2022.11.23
```

To build a Corstone-1000 image for MPS3 FPGA, run:

```
kas build meta-arm/kas/corstone1000-mps3.yml
```

Alternatively, to build a Corstone-1000 image for FVP, run:

```
kas build meta-arm/kas/corstone1000-fvp.yml
```

The initial clean build will be lengthy, given that all host utilities are to be built as well as the target images. This includes host executables (python, cmake, etc.) and the required toolchain(s).

Once the build is successful, all output binaries will be placed in the following folders:

- <_workspace>/build/tmp/deploy/images/corstone1000-fvp/ folder for FVP build;
- <_workspace>/build/tmp/deploy/images/corstone1000-mps3/ folder for FPGA build.

Everything apart from the Secure Enclave ROM firmware and External System firmware, is bundled into a single binary, the `corstone1000-image-corstone1000-{mps3,fvp}.wic.nopt` file.

The output binaries run in the Corstone-1000 platform are the following:

- The Secure Enclave ROM firmware: `<_workspace>/build/tmp/deploy/images/corstone1000-{mps3,fvp}/bl1.bin`
- The External System firmware: `<_workspace>/build/tmp/deploy/images/corstone1000-{mps3,fvp}/es_flashfw.bin`
- The flash image: `<_workspace>/build/tmp/deploy/images/corstone1000-{mps3,fvp}/corstone1000-image-corstone1000-{mps3,fvp}.wic.nopt`

2.5 Flash the firmware image on FPGA

The user should download the FPGA bit file image `AN550: Arm® Corstone™-1000 for MPS3 Version 1` from this link and under the section `Arm® Corstone™-1000 for MPS3`.

The directory structure of the FPGA bundle is shown below.

```
Boardfiles
├── MB
│   ├── BRD_LOG.TXT
│   ├── HBI0309B
│   │   ├── AN550
│   │   │   ├── AN550_v1.bit
│   │   │   ├── an550_v1.txt
│   │   │   └── images.txt
│   │   ├── board.txt
│   │   └── mbb_v210.ebf
│   └── HBI0309C
│       ├── AN550
│       │   ├── AN550_v1.bit
│       │   ├── an550_v1.txt
│       │   └── images.txt
│       ├── board.txt
│       └── mbb_v210.ebf
├── SOFTWARE
│   ├── ES0.bin
│   ├── SE.bin
│   └── an550_st.axf
└── config.txt
```

Depending upon the MPS3 board version (printed on the MPS3 board) you should update the images.txt file (in corresponding HBI0309x folder. Boardfiles/MB/HBI0309<board_revision>/AN550/images.txt) so that the file points to the images under SOFTWARE directory.

The images.txt file that is compatible with the latest version of the software stack can be seen below;

```
;*************************************************
;       Preload port mapping                     *
;*************************************************
;  PORT 0 & ADDRESS: 0x00_0000_0000 QSPI Flash (XNVM) (32MB)
;  PORT 0 & ADDRESS: 0x00_8000_0000 OCVM (DDR4 2GB)
```

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```
;  PORT 1        Secure Enclave (M0+) ROM (64KB)
;  PORT 2        External System 0 (M3) Code RAM (256KB)
;  PORT 3        Secure Enclave OTP memory (8KB)
;  PORT 4        CVM (4MB)
;*************************************************

[IMAGES]
TOTALIMAGES: 3      ;Number of Images (Max: 32)

IMAGE0PORT: 1
IMAGE0ADDRESS: 0x00_0000_0000
IMAGE0UPDATE: RAM
IMAGE0FILE: \SOFTWARE\bl1.bin

IMAGE1PORT: 0
IMAGE1ADDRESS: 0x00_0010_0000
IMAGE1UPDATE: AUTOQSPI
IMAGE1FILE: \SOFTWARE\cs1000.bin

IMAGE2PORT: 2
IMAGE2ADDRESS: 0x00_0000_0000
IMAGE2UPDATE: RAM
IMAGE2FILE: \SOFTWARE\es0.bin
```

OUTPUT_DIR = <_workspace>/build/tmp/deploy/images/corstone1000-mps3

1. Copy `bl1.bin` from OUTPUT_DIR directory to SOFTWARE directory of the FPGA bundle.
2. Copy `es_flashfw.bin` from OUTPUT_DIR directory to SOFTWARE directory of the FPGA bundle and rename the binary to `es0.bin`.
3. Copy `corstone1000-image-corstone1000-mps3.wic.nopt` from OUTPUT_DIR directory to SOFTWARE directory of the FPGA bundle and rename the wic.nopt image to `cs1000.bin`.

NOTE: Renaming of the images are required because MCC firmware has limitation of 8 characters before .(dot) and 3 characters after .(dot).

Now, copy the entire folder to board's SDCard and reboot the board.

2.6 Running the software on FPGA

On the host machine, open 4 serial port terminals. In case of Linux machine it will be ttyUSB0, ttyUSB1, ttyUSB2, ttyUSB3 and it might be different on Windows machines.

- ttyUSB0 for MCC, OP-TEE and Secure Partition
- ttyUSB1 for Boot Processor (Cortex-M0+)
- ttyUSB2 for Host Processor (Cortex-A35)
- ttyUSB3 for External System Processor (Cortex-M3)

Run following commands to open serial port terminals on Linux:

```
sudo picocom -b 115200 /dev/ttyUSB0  # in one terminal
sudo picocom -b 115200 /dev/ttyUSB1  # in another terminal
sudo picocom -b 115200 /dev/ttyUSB2  # in another terminal.
sudo picocom -b 115200 /dev/ttyUSB3  # in another terminal.
```

Once the system boot is completed, you should see console logs on the serial port terminals. Once the HOST(Cortex-A35) is booted completely, user can login to the shell using **"root"** login.

If system does not boot and only the ttyUSB1 logs are visible, please follow the steps in *Clean Secure Flash Before Testing (applicable to FPGA only)* under *SystemReady-IR tests* section. The previous image used in FPGA (MPS3) might have filled the Secure Flash completely. The best practice is to clean the secure flash in this case.

2.7 Running the software on FVP

An FVP (Fixed Virtual Platform) model of the Corstone-1000 platform must be available to run the Corstone-1000 FVP software image.

A Yocto recipe is provided and allows to download the latest supported FVP version.

The recipe is located at <_workspace>/meta-arm/meta-arm/recipes-devtools/fvp/fvp-corstone1000.bb

The latest supported Fixed Virtual Platform (FVP) version is 11.19_21 and is automatically downloaded and installed when using the runfvp command as detailed below. The FVP version can be checked by running the following command:

```
<_workspace>/meta-arm/scripts/runfvp <_workspace>/build/tmp/deploy/images/corstone1000-
↪fvp/corstone1000-image-corstone1000-fvp.fvpconf -- --version
```

The FVP can also be manually downloaded from the Arm Ecosystem FVPs page. On this page, navigate to "Corstone IoT FVPs" section to download the Corstone-1000 platform FVP installer. Follow the instructions of the installer and setup the FVP.

To run the FVP using the runfvp command, please run the following command:

```
<_workspace>/meta-arm/scripts/runfvp --terminals=xterm <_workspace>/build/tmp/deploy/
↪images/corstone1000-fvp/corstone1000-image-corstone1000-fvp.fvpconf
```

When the script is executed, three terminal instances will be launched, one for the boot processor (aka Secure Enclave) processing element and two for the Host processing element. Once the FVP is executing, the Boot Processor will start to boot, wherein the relevant memory contents of the .wic.nopt file are copied to their respective memory locations within the model, enforce firewall policies on memories and peripherals and then, bring the host out of reset.

The host will boot trusted-firmware-a, OP-TEE, U-Boot and then Linux, and present a login prompt (FVP host_terminal_0):

```
corstone1000-fvp login:
```

Login using the username root.

The External System can be released out of reset on demand using the systems-comms-tests command.

2.8 SystemReady-IR tests

2.8.1 Testing steps

NOTE: Running the SystemReady-IR tests described below requires the user to work with USB sticks. In our testing, not all USB stick models work well with MPS3 FPGA. Here are the USB sticks models that are stable in our test environment.

- HP V165W 8 GB USB Flash Drive
- SanDisk Ultra 32GB Dual USB Flash Drive USB M3.0
- SanDisk Ultra 16GB Dual USB Flash Drive USB M3.0

NOTE: Before running each of the tests in this chapter, the user should follow the steps described in following section "Clean Secure Flash Before Testing" to erase the SecureEnclave flash cleanly and prepare a clean board environment for the testing.

Clean Secure Flash Before Testing (applicable to FPGA only)

To prepare a clean board environment with clean secure flash for the testing, the user should prepare an image that erases the secure flash cleanly during boot. Run following commands to build such image.

```
cd <_workspace>
git clone https://git.yoctoproject.org/git/meta-arm -b CORSTONE1000-2022.11.23
git clone https://git.gitlab.arm.com/arm-reference-solutions/systemready-patch.git -b␣
↪CORSTONE1000-2022.11.23
cp -f systemready-patch/embedded-a/corstone1000/erase_flash/0001-arm-bsp-trusted-
↪firmware-m-corstone1000-Clean-Secure.patch meta-arm
cd meta-arm
git apply 0001-arm-bsp-trusted-firmware-m-corstone1000-Clean-Secure.patch
cd ..
kas build meta-arm/kas/corstone1000-mps3.yml
```

Replace the bl1.bin and cs1000.bin files on the SD card with following files:

- The ROM firmware: <_workspace>/build/tmp/deploy/images/corstone1000-mps3/bl1.bin
- The flash image: <_workspace>/build/tmp/deploy/images/corstone1000-mps3/corstone1000-image-corstone1000-mps3.wic.nopt

Now reboot the board. This step erases the Corstone-1000 SecureEnclave flash completely, the user should expect following message from TF-M log (can be seen in ttyUSB1):

```
!!!SECURE FLASH HAS BEEN CLEANED!!!
NOW YOU CAN FLASH THE ACTUAL CORSTONE1000 IMAGE
PLEASE REMOVE THE LATEST ERASE SECURE FLASH PATCH AND BUILD THE IMAGE AGAIN
```

Then the user should follow "Building the software stack" to build a clean software stack and flash the FPGA as normal. And continue the testing.

Run SystemReady-IR ACS tests

ACS image contains two partitions. BOOT partition and RESULT partition. Following packages are under BOOT partition

- SCT
- FWTS
- BSA uefi
- BSA linux
- grub
- uefi manual capsule application

RESULT partition is used to store the test results. PLEASE MAKE SURE THAT THE RESULT PARTITION IS EMPTY BEFORE YOU START THE TESTING. OTHERWISE THE TEST RESULTS WILL NOT BE CONSISTENT

FPGA instructions for ACS image

This section describes how the user can build and run Architecture Compliance Suite (ACS) tests on Corstone-1000.

First, the user should download the Arm SystemReady ACS repository. This repository contains the infrastructure to build the Architecture Compliance Suite (ACS) and the bootable prebuilt images to be used for the certifications of SystemReady-IR. To download the repository, run command:

```
cd <_workspace>
git clone https://github.com/ARM-software/arm-systemready.git -b v21.09_REL1.0
```

Once the repository is successfully downloaded, the prebuilt ACS live image can be found in:

- `<_workspace>/arm-systemready/IR/prebuilt_images/v21.07_0.9_BETA/ir_acs_live_image.img.xz`

NOTE: This prebuilt ACS image includes v5.13 kernel, which doesn't provide USB driver support for Corstone-1000. The ACS image with newer kernel version and with full USB support for Corstone-1000 will be available in the next SystemReady release in this repository.

Then, the user should prepare a USB stick with ACS image. In the given example here, we assume the USB device is `/dev/sdb` (the user should use `lsblk` command to confirm). Be cautious here and don't confuse your host PC's own hard drive with the USB drive. Run the following commands to prepare the ACS image in USB stick:

```
cd <_workspace>/arm-systemready/IR/prebuilt_images/v21.07_0.9_BETA
unxz ir_acs_live_image.img.xz
sudo dd if=ir_acs_live_image.img of=/dev/sdb iflag=direct oflag=direct bs=1M␣
↪status=progress; sync
```

Once the USB stick with ACS image is prepared, the user should make sure that ensure that only the USB stick with the ACS image is connected to the board, and then boot the board.

The FPGA will reset multiple times during the test, and it might take approx. 24-36 hours to finish the test. At the end of test, the FPGA host terminal will halt showing a shell prompt. Once test is finished the result can be copied following above instructions.

FVP instructions for ACS image and run

Download ACS image from:

- https://gitlab.arm.com/systemready/acs/arm-systemready/-/tree/linux-5.17-rc7/IR/prebuilt_images/v22.04_1.0-Linux-v5.17-rc7

Use the below command to run the FVP with ACS image support in the SD card.

```
unxz ${<path-to-img>/ir_acs_live_image.img.xz}

tmux

<_workspace>/meta-arm/scripts/runfvp <_workspace>/build/tmp/deploy/images/corstone1000-
↪fvp/corstone1000-image-corstone1000-fvp.fvpconf -- -C board.msd_mmc.p_mmc_file="${
↪<path-to-img>/ir_acs_live_image.img}"
```

The test results can be fetched using following commands:

```
sudo mkdir /mnt/test
sudo mount -o rw,offset=<offset_2nd_partition> <path-to-img>/ir_acs_live_image.img /mnt/
↪test/
fdisk -lu <path-to-img>/ir_acs_live_image.img
->  Device                                                  Start     End Sectors ␣
↪Size Type
    <path-to-img>/ir_acs_live_image_modified.img1    2048 1050622 1048575  512M␣
↪Microsoft basic data
    <path-to-img>/ir_acs_live_image_modified.img2 1050624 1153022  102399   50M␣
↪Microsoft basic data

->   <offset_2nd_partition> = 1050624 * 512 (sector size) = 537919488
```

The FVP will reset multiple times during the test, and it might take up to 1 day to finish the test. At the end of test, the FVP host terminal will halt showing a shell prompt. Once test is finished, the FVP can be stoped, and result can be copied following above instructions.

Common to FVP and FPGA

U-Boot should be able to boot the grub bootloader from the 1st partition and if grub is not interrupted, tests are executed automatically in the following sequence:

- SCT
- UEFI BSA
- FWTS
- BSA Linux

The results can be fetched from the `acs_results` folder in the RESULT partition of the USB stick (FPGA) / SD Card (FVP).

2.9 Manual capsule update and ESRT checks

The following section describes running manual capsule update with the `direct` method.

The steps described in this section perform manual capsule update and show how to use the ESRT feature to retrieve the installed capsule details.

For the following tests two capsules are needed to perform 2 capsule updates. A positive update and a negative update.

A positive test case capsule which boots the platform correctly until the Linux prompt, and a negative test case with an incorrect capsule (corrupted or outdated) which fails to boot to the host software.

Check the "Run SystemReady-IR ACS tests" section above to download and unpack the ACS image file

- `ir_acs_live_image.img.xz`

Download edk2 under <_workspace> :

```
git clone https://github.com/tianocore/edk2.git
```

2.9.1 Generating Capsules

The capsule binary size (wic.nopt file) should be less than 15 MB.

Based on the user's requirement, the user can change the firmware version number given to `--fw-version` option (the version number needs to be >= 1).

Generating FPGA Capsules

```
<_workspace>/edk2/BaseTools/BinWrappers/PosixLike/GenerateCapsule -e -o \
cs1k_cap_mps3_v5 --fw-version 5 --lsv 0 --guid \
e2bb9c06-70e9-4b14-97a3-5a7913176e3f --verbose --update-image-index \
0 --verbose <_workspace>/build/tmp/deploy/images/corstone1000-mps3/corstone1000-image-
↪corstone1000-mps3.wic.nopt
```

```
<_workspace>/edk2/BaseTools/BinWrappers/PosixLike/GenerateCapsule -e -o \
cs1k_cap_mps3_v6 --fw-version 6 --lsv 0 --guid \
e2bb9c06-70e9-4b14-97a3-5a7913176e3f --verbose --update-image-index \
0 --verbose <_workspace>/build/tmp/deploy/images/corstone1000-mps3/corstone1000-image-
↪corstone1000-mps3.wic.nopt
```

Generating FVP Capsules

```
<_workspace>/edk2/BaseTools/BinWrappers/PosixLike/GenerateCapsule -e -o \
cs1k_cap_fvp_v6 --fw-version 6 --lsv 0 --guid \
e2bb9c06-70e9-4b14-97a3-5a7913176e3f --verbose --update-image-index \
0 --verbose <_workspace>/build/tmp/deploy/images/corstone1000-fvp/corstone1000-image-
↪corstone1000-fvp.wic.nopt
```

```
<_workspace>/edk2/BaseTools/BinWrappers/PosixLike/GenerateCapsule -e -o \
cs1k_cap_fvp_v5 --fw-version 5 --lsv 0 --guid \
```

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```
e2bb9c06-70e9-4b14-97a3-5a7913176e3f --verbose --update-image-index \
0 --verbose <_workspace>/build/tmp/deploy/images/corstone1000-fvp/corstone1000-image-
↪corstone1000-fvp.wic.nopt
```

2.9.2 Copying Capsules

Copying the FPGA capsules

The user should prepare a USB stick as explained in ACS image section (see above). Place the generated `cs1k_cap` files in the root directory of the boot partition in the USB stick. Note: As we are running the direct method, the `cs1k_cap` file should not be under the EFI/UpdateCapsule directory as this may or may not trigger the on disk method.

```
sudo cp cs1k_cap_mps3_v6 <mounting path>/BOOT/
sudo cp cs1k_cap_mps3_v5 <mounting path>/BOOT/
sync
```

Copying the FVP capsules

First, mount the IR image:

```
sudo mkdir /mnt/test
sudo mount -o rw,offset=1048576 <path-to-img>/ir_acs_live_image.img  /mnt/test
```

Then, copy the capsules:

```
sudo cp cs1k_cap_fvp_v6 /mnt/test/
sudo cp cs1k_cap_fvp_v5 /mnt/test/
sync
```

Then, unmount the IR image:

```
sudo umount /mnt/test
```

NOTE:

Size of first partition in the image file is calculated in the following way. The data is just an example and might vary with different ir_acs_live_image.img files.

```
fdisk -lu <path-to-img>/ir_acs_live_image.img
->  Device                                                  Start     End Sectors ␣
↪Size Type
    <path-to-img>/ir_acs_live_image_modified.img1    2048 1050622 1048575  512M␣
↪Microsoft basic data
    <path-to-img>/ir_acs_live_image_modified.img2 1050624 1153022  102399   50M␣
↪Microsoft basic data

->  <offset_1st_partition> = 2048 * 512 (sector size) = 1048576
```

2.9.3 Performing the capsule update

During this section we will be using the capsule with the higher version (cs1k_cap_<fvp/mps3>_v6) for the positive scenario and the capsule with the lower version (cs1k_cap_<fvp/mps3>_v5) for the negative scenario.

Running the FVP with the IR prebuilt image

Run the FVP with the IR prebuilt image:

```
<_workspace>/meta-arm/scripts/runfvp --terminals=xterm <_workspace>/build/tmp/deploy/
↪images/corstone1000-fvp/corstone1000-image-corstone1000-fvp.fvpconf -- -C "board.msd_
↪mmc.p_mmc_file ${<path-to-img>/ir_acs_live_image.img}"
```

Running the FPGA with the IR prebuilt image

Insert the prepared USB stick then Power cycle the MPS3 board.

Executing capsule update for FVP and FPGA

Reach u-boot then interrupt the boot to reach the EFI shell.

```
Press ESC in 4 seconds to skip startup.nsh or any other key to continue.
```

Then, type FS0: as shown below:

```
FS0:
```

In case of the positive scenario run the update with the higher version capsule as shown below:

```
EFI/BOOT/app/CapsuleApp.efi cs1k_cap_<fvp/mps3>_v6
```

After successfully updating the capsule the system will reset.

In case of the negative scenario run the update with the lower version capsule as shown below:

```
EFI/BOOT/app/CapsuleApp.efi cs1k_cap_<fvp/mps3>_v5
```

The command above should fail and in the TF-M logs the following message should appear:

```
ERROR: flash_full_capsule: version error
```

Then, reboot manually:

```
Shell> reset
```

FPGA: Select Corstone-1000 Linux kernel boot

Remove the USB stick before u-boot is reached so the Corstone-1000 kernel will be detected and used for booting.

NOTE: Otherwise, the execution ends up in the ACS live image.

FVP: Select Corstone-1000 Linux kernel boot

Interrupt the u-boot shell.

```
Hit any key to stop autoboot:
```

Run the following commands in order to run the Corstone-1000 Linux kernel and being able to check the ESRT table.

NOTE: Otherwise, the execution ends up in the ACS live image.

```
$ run retrieve_kernel_load_addr
$ unzip $kernel_addr 0x90000000
$ loadm 0x90000000 $kernel_addr_r 0xf00000
$ bootefi $kernel_addr_r $fdtcontroladdr
```

2.9.4 Capsule update status

Positive scenario

In the positive case scenario, the user should see following log in TF-M log, indicating the new capsule image is successfully applied, and the board boots correctly.

```
...
SysTick_Handler: counted = 10, expiring on = 360
SysTick_Handler: counted = 20, expiring on = 360
SysTick_Handler: counted = 30, expiring on = 360
...
metadata_write: success: active = 1, previous = 0
accept_full_capsule: exit: fwu state is changed to regular
...
```

It's possible to check the content of the ESRT table after the system fully boots.

In the Linux command-line run the following:

```
# cd /sys/firmware/efi/esrt/entries/entry0
# cat *

0x0
e2bb9c06-70e9-4b14-97a3-5a7913176e3f
0
6
0
6
0
```

capsule_flags: 0x0

fw_class: e2bb9c06-70e9-4b14-97a3-5a7913176e3f
fw_type: 0
fw_version: 6
last_attempt_status: 0
last_attempt_version: 6
lowest_supported_fw_ver: 0

Negative scenario

In the negative case scenario (rollback the capsule version), the user should see appropriate logs in the secure enclave terminal.

```
...
  uefi_capsule_retrieve_images: image 0 at 0xa0000070, size=15654928
  uefi_capsule_retrieve_images: exit
  flash_full_capsule: enter: image = 0x0xa0000070, size = 15654928, version = 10
  ERROR: flash_full_capsule: version error
  private_metadata_write: enter: boot_index = 1
  private_metadata_write: success
  fmp_set_image_info:133 Enter
  FMP image update: image id = 0
  FMP image update: status = 1version=11 last_attempt_version=10.
  fmp_set_image_info:157 Exit.
  corstone1000_fwu_flash_image: exit: ret = -1
...
```

If capsule pass initial verification, but fails verifications performed during boot time, secure enclave will try new images predetermined number of times (defined in the code), before reverting back to the previous good bank.

```
...
metadata_write: success: active = 0, previous = 1
fwu_select_previous: in regular state by choosing previous active bank
...
```

It's possible to check the content of the ESRT table after the system fully boots.

In the Linux command-line run the following:

```
# cd /sys/firmware/efi/esrt/entries/entry0
# cat *

0x0
e2bb9c06-70e9-4b14-97a3-5a7913176e3f
0
6
1
5
0
```

capsule_flags: 0x0
fw_class: e2bb9c06-70e9-4b14-97a3-5a7913176e3f

fw_type: 0
fw_version: 6
last_attempt_status: 1
last_attempt_version: 5
lowest_supported_fw_ver: 0

2.10 Linux distros tests

2.10.1 Debian/OpenSUSE install and boot (applicable to FPGA only)

To test Linux distro install and boot, the user should prepare two empty USB sticks (minimum size should be 4GB and formatted with FAT32).

Download one of following Linux distro images:

- Debian installer image: https://cdimage.debian.org/cdimage/weekly-builds/arm64/iso-dvd/
- OpenSUSE Tumbleweed installer image: http://download.opensuse.org/ports/aarch64/tumbleweed/iso/ - The user should look for a DVD Snapshot like openSUSE-Tumbleweed-DVD-aarch64-Snapshot<date>-Media.iso

Once the .iso file is downloaded, the .iso file needs to be flashed to your USB drive.

In the given example here, we assume the USB device is `/dev/sdb` (the user should use *lsblk* command to confirm). Be cautious here and don't confuse your host PC's own hard drive with the USB drive. Then copy the contents of an iso file into the first USB stick, run:

```
sudo dd if=<path-to-iso_file> of=/dev/sdb iflag=direct oflag=direct status=progress␣
↪bs=1M; sync;
```

Boot the MSP3 board with the first USB stick connected. Open following minicom sessions:

```
sudo picocom -b 115200 /dev/ttyUSB0  # in one terminal
sudo picocom -b 115200 /dev/ttyUSB2  # in another terminal.
```

Now plug in the second USB stick (once installation screen is visible), the distro installation process will start. The installation prompt can be seen in ttyUSB2. If installer does not start, please try to reboot the board with both USB sticks connected and repeat the process.

NOTE: Due to the performance limitation of Corstone-1000 MPS3 FPGA, the distro installation process can take up to 24 hours to complete.

Once installation is complete, unplug the first USB stick and reboot the board. After successfully installing and booting the Linux distro, the user should see a login prompt:

```
debian login:
```

Login with the username root.

NOTE: The Debian installer has a known issue "Install the GRUB bootloader - unable to install " and these are the steps to follow on the subsequent popups to solve the issue during the installation:

1. Select "Continue", then "Continue" again on the next popup
2. Scroll down and select "Execute a shell"
3. Select "Continue"

4. Enter the following command:

```
in-target grub-install --no-nvram --force-extra-removable
```

5. Enter the following command:

```
in-target update-grub
```

6. Enter the following command:

```
exit
```

7. Select “Continue without boot loader”, then select “Continue” on the next popup
8. At this stage, the installation should proceed as normal.

2.10.2 OpenSUSE Raw image install and boot (applicable to FVP only)

Steps to download openSUSE Tumbleweed raw image:

- Go to: http://download.opensuse.org/ports/aarch64/tumbleweed/appliances/
- The user should look for a Tumbleweed-ARM-JeOS-efi.aarch64-* Snapshot, for example, `openSUSE-Tumbleweed-ARM-JeOS-efi.aarch64-<date>-Snapshot<date>.raw.xz`

Once the .raw.xz file is downloaded, the raw image file needs to be extracted:

```
unxz <file-name.raw.xz>
```

The above command will generate a file ending with extension .raw image. Now, use the following command to run FVP with raw image installation process.

```
<_workspace>/meta-arm/scripts/runfvp --terminals=xterm <_workspace>/build/tmp/deploy/
↪images/corstone1000-fvp/corstone1000-image-corstone1000-fvp.fvpconf -- -C board.msd_
↪mmc.p_mmc_file="${openSUSE raw image file path}"
```

After successfully installing and booting the Linux distro, the user should see a openSUSE login prompt.

```
localhost login:
```

Login with the username ‘root’ and password ‘linux’.

2.11 PSA API tests

2.11.1 Run PSA API test commands (applicable to both FPGA and FVP)

When running PSA API test commands (aka PSA Arch Tests) on MPS3 FPGA, the user should make sure there is no USB stick connected to the board. Power on the board and boot the board to Linux. Then, the user should follow the steps below to run the tests.

When running the tests on the Corstone-1000 FVP, the user should follow the instructions in *Running the software on FVP* section to boot Linux in FVP host_terminal_0, and login using the username `root`.

First, load FF-A TEE kernel module:

```
insmod /lib/modules/5.19.14-yocto-standard/extra/arm-ffa-tee.ko
```

Then, check whether the FF-A TEE driver is loaded correctly by using the following command:

```
cat /proc/modules | grep arm_ffa_tee
```

The output should be:

```
arm_ffa_tee 16384 - - Live 0xffffffc0004f0000 (O)
```

Now, run the PSA API tests in the following order:

```
psa-iat-api-test
psa-crypto-api-test
psa-its-api-test
psa-ps-api-test
```

2.12 External System tests

2.12.1 Running the External System test command (systems-comms-tests)

Test 1: Releasing the External System out of reset

Run this command in the Linux command-line:

```
systems-comms-tests 1
```

The output on the External System terminal should be:

```
 ___  ___
|    / __|
|=== \___
|___ |___/
External System Cortex-M3 Processor
Running RTX RTOS
v0.1.0_2022-10-19_16-41-32-8c9dca7
MHUv2 module 'MHU0_H' started
MHUv2 module 'MHU1_H' started
MHUv2 module 'MHU0_SE' started
MHUv2 module 'MHU1_SE' started
```

Test 2: Communication

Test 2 releases the External System out of reset if not already done. Then, it performs communication between host and External System.

After running Test 1, run this command in the Linux command-line:

```
systems-comms-tests 2
```

Additional output on the External System terminal will be printed:

```
MHUv2: Message from 'MHU0_H': 0xabcdef1
Received 'abcdef1' From Host MHU0
CMD: Increment and return to sender...
MHUv2: Message from 'MHU1_H': 0xabcdef1
Received 'abcdef1' From Host MHU1
CMD: Increment and return to sender...
```

When running Test 2 the first, Test 1 will be run in the background.

The output on the External System terminal should be:

```
 ___  ___
|    / __|
|=== \___
|___ |___/
External System Cortex-M3 Processor
Running RTX RTOS
v0.1.0_2022-10-19_16-41-32-8c9dca7
MHUv2 module 'MHU0_H' started
MHUv2 module 'MHU1_H' started
MHUv2 module 'MHU0_SE' started
MHUv2 module 'MHU1_SE' started
MHUv2: Message from 'MHU0_H': 0xabcdef1
Received 'abcdef1' From Host MHU0
CMD: Increment and return to sender...
MHUv2: Message from 'MHU1_H': 0xabcdef1
Received 'abcdef1' From Host MHU1
CMD: Increment and return to sender...
```

The output on the Host terminal should be:

```
Received abcdf00 from es0mhu0
Received abcdf00 from es0mhu1
```

2.13 Tests results

As a reference for the end user, reports for various tests for Corstone-1000 software (CORSTONE1000-2022.11.23) can be found in here.

2.14 Running the software on FVP on Windows

If the user needs to run the Corstone-1000 software on FVP on Windows. The user should follow the build instructions in this document to build on Linux host PC, and copy the output binaries to the Windows PC where the FVP is located, and launch the FVP binary.

CHAPTER

THREE

RELEASE NOTES

3.1 Disclaimer

You expressly assume all liabilities and risks relating to your use or operation of Your Software and Your Hardware designed or modified using the Arm Tools, including without limitation, Your software or Your Hardware designed or intended for safety-critical applications. Should Your Software or Your Hardware prove defective, you assume the entire cost of all necessary servicing, repair or correction.

3.2 Release notes - 2022.11.23

3.2.1 Known Issues or Limitations

- The external-system can not be reset individually on (or using) AN550_v1 FPGA release. However, the system-wide reset still applies to the external-system.
- FPGA supports Linux distro install and boot through installer. However, FVP only supports openSUSE raw image installation and boot.
- Due to the performance uplimit of MPS3 FPGA and FVP, some Linux distros like Fedora Rawhide can not boot on Corstone-1000 (i.e. user may experience timeouts or boot hang).
- Below SCT FAILURE is a known issues in the FVP: UEFI Compliant - Boot from network protocols must be implemented – FAILURE
- Below SCT FAILURE is a known issue when a terminal emulator (in the system where the user connects to serial ports) does not support 80x25 or 80x50 mode: EFI_SIMPLE_TEXT_OUT_PROTOCOL.SetMode - SetMode() with valid mode – FAILURE
- Known limitations regarding ACS tests: The behavior after running ACS tests on FVP is not consistent. Both behaviors are expected and are valid; The system might boot till the Linux prompt. Or, the system might wait after finishing the ACS tests. In both cases, the system executes the entire test suite and writes the results as stated in the user guide.

3.2.2 Platform Support

- This software release is tested on Corstone-1000 FPGA version AN550_v1 https://developer.arm.com/downloads/-/download-fpga-images
- This software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.19_21 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.3 Release notes - 2022.04.04

3.3.1 Known Issues or Limitations

- FPGA support Linux distro install and boot through installer. However, FVP only support openSUSE raw image installation and boot.
- Due to the performance uplimit of MPS3 FPGA and FVP, some Linux distros like Fedora Rawhide cannot boot on Corstone-1000 (i.e. user may experience timeouts or boot hang).
- Below SCT FAILURE is a known issues in the FVP: UEFI Compliant - Boot from network protocols must be implemented – FAILURE

3.3.2 Platform Support

- This software release is tested on Corstone-1000 FPGA version AN550_v1
- This software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.17_23 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.4 Release notes - 2022.02.25

3.4.1 Known Issues or Limitations

- The following tests only work on Corstone-1000 FPGA: ACS tests (SCT, FWTS, BSA), manual capsule update test, Linux distro install and boot.

3.4.2 Platform Support

- This software release is tested on Corstone-1000 FPGA version AN550_v1
- This software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.17_23 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.4.3 Release notes - 2022.02.21

3.4.4 Known Issues or Limitations

- The following tests only work on Corstone-1000 FPGA: ACS tests (SCT, FWTS, BSA), manual capsule update test, Linux distro install and boot, psa-arch-test.

3.4.5 Platform Support

- This software release is tested on Corstone-1000 FPGA version AN550_v1
- This software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.16.21 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.4.6 Release notes - 2022.01.18

3.4.7 Known Issues or Limitations

- Before running each SystemReady-IR tests: ACS tests (SCT, FWTS, BSA), manual capsule update test, Linux distro install and boot, etc., the SecureEnclave flash must be cleaned. See user-guide "Clean Secure Flash Before Testing" section.

3.4.8 Release notes - 2021.12.15

3.4.9 Software Features

The following components are present in the release:

- Yocto version Honister
- Linux kernel version 5.10
- U-Boot 2021.07
- OP-TEE version 3.14
- Trusted Firmware-A 2.5
- Trusted Firmware-M 1.5
- OpenAMP 347397decaa43372fc4d00f965640ebde042966d
- Trusted Services a365a04f937b9b76ebb2e0eeade226f208cbc0d2

3.4.10 Platform Support

- This software release is tested on Corstone-1000 FPGA version AN550_v1
- This software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.16.21 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.4.11 Known Issues or Limitations

- The following tests only work on Corstone-1000 FPGA: ACS tests (SCT, FWTS, BSA), manual capsule update test, Linux distro install and boot, and psa-arch-tests.
- Only the manual capsule update from UEFI shell is supported on FPGA.
- Due to flash size limitation and to support A/B banks,the wic image provided by the user should be smaller than 15MB.
- The failures in PSA Arch Crypto Test are known limitations with crypto library. It requires further investigation. The user can refer to PSA Arch Crypto Test Failure Analysis In TF-M V1.5 Release for the reason for each failing test.

3.4.12 Release notes - 2021.10.29

3.4.13 Software Features

This initial release of Corstone-1000 supports booting Linux on the Cortex-A35 and TF-M/MCUBOOT in the Secure Enclave. The following components are present in the release:

- Linux kernel version 5.10
- U-Boot 2021.07
- OP-TEE version 3.14
- Trusted Firmware-A 2.5
- Trusted Firmware-M 1.4

3.4.14 Platform Support

- This Software release is tested on Corstone-1000 Fast Model platform (FVP) version 11.16.21 https://developer.arm.com/tools-and-software/open-source-software/arm-platforms-software/arm-ecosystem-fvps

3.4.15 Known Issues or Limitations

- No software support for external system(Cortex M3)
- No communication established between A35 and M0+
- Very basic functionality of booting Secure Enclave, Trusted Firmware-A , OP-TEE , u-boot and Linux are performed

3.4.16 Support

For technical support email: support-subsystem-iot@arm.com

For all security issues, contact Arm by email at arm-security@arm.com.

CHAPTER

FOUR

CHANGE LOG

This document contains a summary of the new features, changes and fixes in each release of Corstone-1000 software stack.

4.1 Version 2022.11.23

4.1.1 Changes

- Booting the External System (Cortex-M3) with RTX RTOS
- Adding MHU communication between the HOST (Cortex-A35) and the External System
- Adding a Linux application to test the External System
- Adding ESRT (EFI System Resource Table) support
- Upgrading the SW stack recipes
- Upgrades for the U-Boot FF-A driver and MM communication

4.1.2 Corstone-1000 components versions

arm-ffa-tee	1.1.1
arm-ffa-user	5.0.0
corstone1000-external-sys-tests	1.0
external-system	0.1.0
linux-yocto	5.19
u-boot	2022.07
optee-client	3.18.0
optee-os	3.18.0
trusted-firmware-a	2.7.0
trusted-firmware-m	1.6.0
ts-newlib	4.1.0
ts-psa-{crypto, iat, its. ps}-api-test	451aa087a4
ts-sp-{se-proxy, smm-gateway}	3d4956770f

4.1.3 Yocto distribution components versions

meta-arm	langdale
poky	langdale
meta-openembedded	langdale
busybox	1.35.0
musl	1.2.3+git37e18b7bf3
gcc-arm-none-eabi-native	11.2-2022.02
gcc-cross-aarch64	12.2
openssl	3.0.5

4.2 Version 2022.04.04

4.2.1 Changes

- Linux distro openSUSE, raw image installation and boot in the FVP.
- SCT test support in FVP.
- Manual capsule update support in FVP.

4.3 Version 2022.02.25

4.3.1 Changes

- Building and running psa-arch-tests on Corstone-1000 FVP
- Enabled smm-gateway partition in Trusted Service on Corstone-1000 FVP
- Enabled MHU driver in Trusted Service on Corstone-1000 FVP
- Enabled OpenAMP support in SE proxy SP on Corstone-1000 FVP

4.4 Version 2022.02.21

4.4.1 Changes

- psa-arch-tests: recipe is dropped and merged into the secure-partitons recipe.
- psa-arch-tests: The tests are align with latest tfm version for psa-crypto-api suite.

4.5 Version 2022.01.18

4.5.1 Changes

- psa-arch-tests: change master to main for psa-arch-tests
- U-Boot: fix null pointer exception for get_image_info
- TF-M: fix capsule instability issue for Corstone-1000

4.6 Version 2022.01.07

4.6.1 Changes

- Corstone-1000: fix SystemReady-IR ACS test (SCT, FWTS) failures.
- U-Boot: send bootcomplete event to secure enclave.
- U-Boot: support populating Corstone-1000 image_info to ESRT table.
- U-Boot: add ethernet device and enable configs to support bootfromnetwork SCT.

4.7 Version 2021.12.15

4.7.1 Changes

- Enabling Corstone-1000 FPGA support on: - Linux 5.10 - OP-TEE 3.14 - Trusted Firmware-A 2.5 - Trusted Firmware-M 1.5
- Building and running psa-arch-tests
- Adding openamp support in SE proxy SP
- OP-TEE: adding smm-gateway partition
- U-Boot: introducing Arm FF-A and MM support

4.8 Version 2021.10.29

4.8.1 Changes

- Enabling Corstone-1000 FVP support on: - Linux 5.10 - OP-TEE 3.14 - Trusted Firmware-A 2.5 - Trusted Firmware-M 1.4
- Linux kernel: enabling EFI, adding FF-A debugfs driver, integrating ARM_FFA_TRANSPORT.
- U-Boot: Extending EFI support
- python3-imgtool: adding recipe for Trusted-firmware-m
- python3-imgtool: adding the Yocto recipe used in signing host images (based on MCUBOOT format)
