User Guide

SE Host Services API

Version 1.97.0

SERVICES Library 0.49.1

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Introduction

The Fusion product series is a scalable SoC solution for IoT Edge Computing platforms.

SERVICES provide a method for the Application CPUs (M55_HE, HP, A32) to communicate with the Secure Enclave. This secure communication path is achieved using the MHU (Message Handling Unit) hardware block.

The SERVICES library consists of C code that interfaces with an MHU driver to facilitate this communication.

Services fall into the following categories:

- Non-Power
  - Maintenance Services
  - Crypto Services
  - Update Services
  - Secure Debug Service
  - Application Services
- Power
  - BASIC Use case examples
  - Power number user case examples

The library source code is provided along with a test harness showing the invocation of each SERVICE library call.

The example (test harness) can be used as a framework to copy for integrating SERVICES into your application code. You only need to include the SERVICE header files and link with the SERVICE libraries.

The examples can be built for all Application cores in XIP and Non-XIP mode. ATOC configuration files are also provided.

ARM Clang and ARM GNU CC are both supported.

Known Limitations

A32

A32 bare-metal support is not provided by the ALIF CMSIS packs.

SE-UART Spamming

When using CONTINUOUS mode in the test harness via the SE-UART print SERVICE the amount of print traffic can be very heavy and make the system unresponsive. We recommend you use a local UART (UART 2 or 4) dedicated to the M55_HE or M55_HP. Note that there are mechanisms to stall the spamming within SES.

The SERVICES print capability using the SE-UART was added as a convenience to save having to set up external UARTs.

SE Host Services summary

Service Group		Notes
Maintenance		
	SERVICES_heartbeat	Health status
System Management		
	SERVICES_system_get_toc_data	
	SERVICES_system_get_toc_number	
	SERVICES_system_get_toc_via_name	N/I
	SERVICES_system_get_toc_version	N/I
	SERVICES_system_get_toc_via_cpuid	
	SERVICES_system_get_device_part_number	
	SERVICES_system_get_device_data	
	SERVICES_system_set_services_debug	Debug toggle
	SERVICES_system_get_otp_data	N/I
	SERVICES_system_read_otp	
	SERVICES_get_se_revision	
	SERVICES_system_get_eui_extension	
Application / Pin mux management		
	SERVICES_pinmux	
	SERVICES_padcontrol	
	SERVICES_uart_write	
	SERVICES_application_ospi_write_key	
	SERVICES_SRAM_retention_config	
Power		
	SERVICES_power_stop_mode_request	

	SERVICES_power_ewic_config	
	SERVICES_power_wakeup_config	
	SERVICES_power_mem_retention_config	
	SERVICES_power_m55_he_vtor_save	
	SERVICES_power_m55_hp_vtor_save	
	SERVICES_power_memory_req	
	SERVICES_global_standby_mode	
	SERVICES_get_run_cfg	aiPM
	SERVICES_set_run_cfg	aiPM
	SERVICES_get_off_cfg	aiPM
	SERVICES_set_off_cfg	aiPM
	SERVICES_power_ldo_voltage_control	
	SERVICES_power_dcdc_voltage_control	
	SERVICES_power_setting_configure	
	SERVICES_power_setting_get	
Security /Crypto		
	SERVICES_cryptocell_get_lcs	
	SERVICES_cryptocell_get_rnd	TRNG
	SERVICES_cryptocell_mbedtls_aes_init	
	SERVICES_cryptocell_mbedtls_aes_set_key	
	SERVICES_cryptocell_mbedtls_aes_crypt	
	SERVICES_cryptocell_mbedtls_sha_starts	
	SERVICES_cryptocell_mbedtls_sha_process	
	SERVICES_cryptocell_mbedtls_sha_update	
	SERVICES_cryptocell_mbedtls_sha_finish	
	SERVICES_cryptocell_mbedtls_ccm_gcm_set_key	
	SERVICES_cryptocell_mbedtls_ccm_gcm_crypt	
	SERVICES_cryptocell_mbedtls_ccm_gcm_chachapoly_crypt	
	SERVICES_cryptocell_mbedtls_ccm_gcm_poly1305_crypt	
	SERVICES_cryptocell_mbedtls_cmac_init_setkey	
	SERVICES_cryptocell_mbedtls_cmac_update	
	SERVICES_cryptocell_mbedtls_cmac_finish	
	SERVICES_cryptocell_mbedtls_cmac_reset	
Boot		
	SERVICES_boot_process_toc_entry	
	SERVICES_boot_cpu	
	SERVICES_set_vtor	
	SERVICES_boot_reset_cpu	
	SERVICES_boot_release_cpu	
	SERVICES_boot_reset_soc	
Clock		
	SERVICES_clocks_select_osc_source	
	SERVICES_clocks_select_pll_source	

	SERVICES_clocks_enable_clock	
	SERVICES_clocks_set_ES0_frequency	
	SERVICES_clocks_set_ES1_frequency	
	SERVICES_clocks_select_a32_source	
	SERVICES_clocks_select_aclk_source	
	SERVICES_clocks_set_divider	
	SERVICES_clocks_get_clocks	
	SERVICES_clocks_get_apb_frequency	
	SERVICES_clocks_get_refclk_frequency	
	SERVICES_pll_initialize	
	SERVICES_pll_deinit	
	SERVICES_pll_xtal_start	
	SERVICES_pll_xtal_stop	
	SERVICES_pll_xtal_is_started	
	SERVICES_pll_clkpll_start	
	SERVICES_pll_clkpll_stop	
	SERVICES_pll_clkpll_is_locked	
Update		
	SERVICES_update_stoc	

SE Host Services Delivery Components

A SERVICES release package from ALIF consists of the following components:

- Source code SERVICES library
  - Public header files
- CMAKE files for ARM Clang and ARM GNU C builds
- Example ports for Bare metal
  - Example SERVICE library initializations.
- Example use cases for M55_HE, M55_HP, A32 and M55_HE+M55_HP
  - Example runs a test program calling all available SERVICES API.
  - Output is sent via the SE-UART to save having to install extra UART debug ports.
- Example use cases for Low Power
  - BASIC tests.

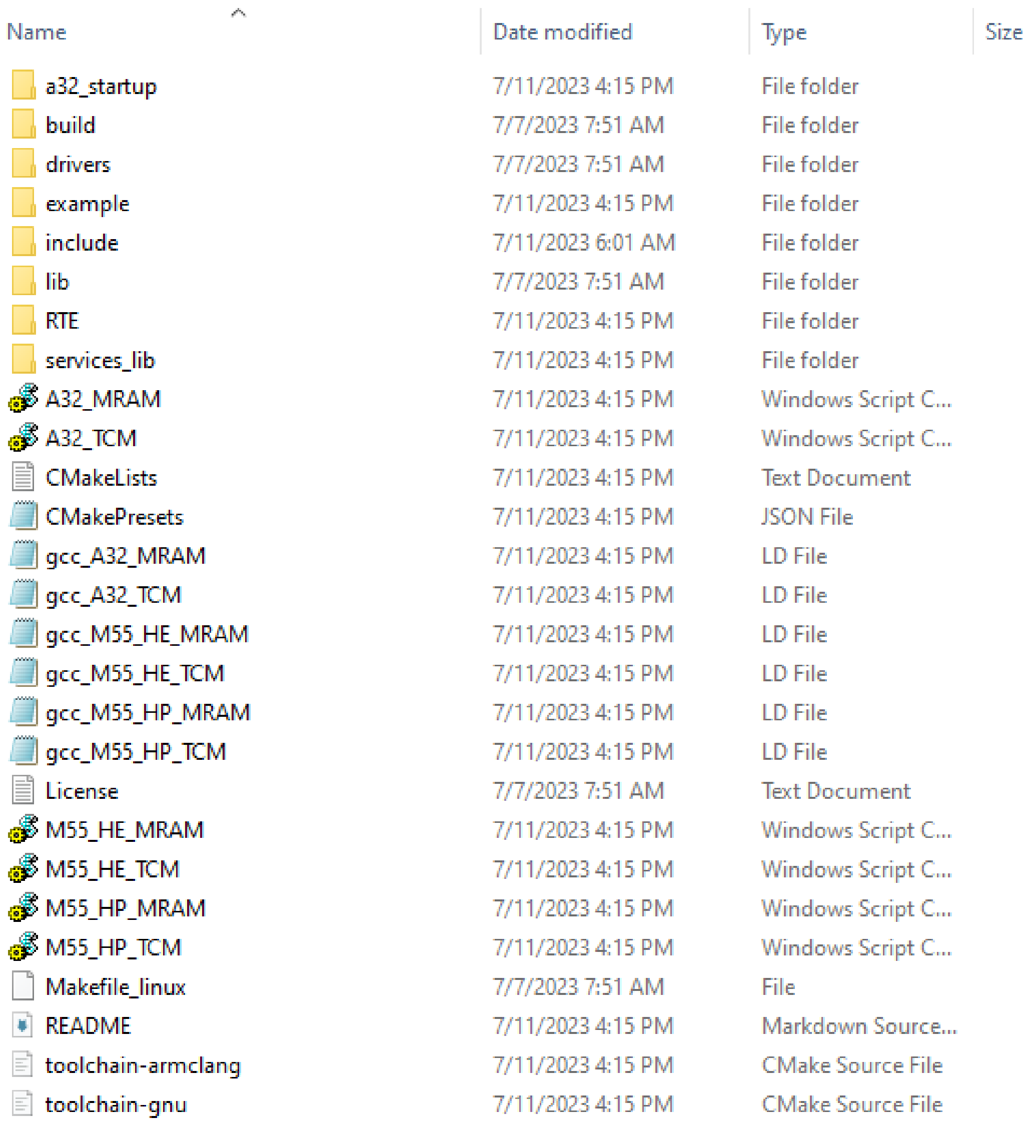
Pre-requisites

The following components are required to be installed before using / building SE SERVICES:

- ALIF Ensemble RTSS Release
  - CMSIS Packs for Ensemble devices
  - Following the installation instructions for this package
- GNU Make V4.4
- Cmake V3.22.2
- Security Toolkit (SETOOLS)
  - Not required for building, but it is required for generating the ATOC packages for the Target and programming them into MRAM.

Building SE Services – Windows / LINUX

Unpack the se-host-services-release-SE_FW_0.<version#>.000_DEV.zip



Name	Date modified	Type	Size
a32_startup	7/11/2023 4:15 PM	File folder	
build	7/7/2023 7:51 AM	File folder	
drivers	7/7/2023 7:51 AM	File folder	
example	7/11/2023 4:15 PM	File folder	
include	7/11/2023 6:01 AM	File folder	
lib	7/7/2023 7:51 AM	File folder	
RTE	7/11/2023 4:15 PM	File folder	
services_lib	7/11/2023 4:15 PM	File folder	
A32_MRAM	7/11/2023 4:15 PM	Windows Script C...	
A32_TCM	7/11/2023 4:15 PM	Windows Script C...	
CMakeLists	7/11/2023 4:15 PM	Text Document	
CMakePresets	7/11/2023 4:15 PM	JSON File	
gcc_A32_MRAM	7/11/2023 4:15 PM	LD File	
gcc_A32_TCM	7/11/2023 4:15 PM	LD File	
gcc_M55_HE_MRAM	7/11/2023 4:15 PM	LD File	
gcc_M55_HE_TCM	7/11/2023 4:15 PM	LD File	
gcc_M55_HP_MRAM	7/11/2023 4:15 PM	LD File	
gcc_M55_HP_TCM	7/11/2023 4:15 PM	LD File	
License	7/7/2023 7:51 AM	Text Document	
M55_HE_MRAM	7/11/2023 4:15 PM	Windows Script C...	
M55_HE_TCM	7/11/2023 4:15 PM	Windows Script C...	
M55_HP_MRAM	7/11/2023 4:15 PM	Windows Script C...	
M55_HP_TCM	7/11/2023 4:15 PM	Windows Script C...	
Makefile_linux	7/7/2023 7:51 AM	File	
README	7/11/2023 4:15 PM	Markdown Source...	
toolchain-armclang	7/11/2023 4:15 PM	CMake Source File	
toolchain-gnu	7/11/2023 4:15 PM	CMake Source File	

The release archive consists of the following target components.

Name	Purpose	Notes
a32_startup	A32 startup code	
Build		
include	Services header files	
lib		
services_lib	Host source code for Services	
example	SERVICES test harnesses	
README.md	instructions	

CMAKE is used.

Building with ARM GNU C

```
$ cd se-host-service-release
$ mkdir build_he_gcc_tcm
$ cd build_he_he_gcc_tcm
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-gnu.cmake
$ make install

$ cd se-host-service-release
$ mkdir build_he_power_gcc_tcm
$ cd build_he_power_gcc_tcm
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-gnu.cmake -DPOWER=ON
$ make install
```

The SERVICE library is built as part of this builds process.

Building with ARM CLANG

```
$ cd se-host-services-release
$ mkdir build_he_power_clang_tcm
$ cd build_he_power_clang_tcm
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -DPOWER=ON
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake
$ make install -j 8

$ cd se-host-services-release
$ mkdir build_he_clang_tcm
$ cd build_he_clang_tcm
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake
$ make install -j 8
```

NOTE: Parallel make (using -j <job#>) is available

SERVICES Library Dependencies

The SERVICES library and support file for starting SERVICES have a few dependencies.

- CMSIS Package installation location
- CMSIS Package source and include locations.

CMSIS Package

The SERVICE example uses the CMSIS startup sequences for booting the Application cores.

CMSIS packages consist of an ARM and ALIF component. The ARM components are specific for the various types of cores. The ALIF components contain specific ALIF Device and Board components.

ALIF CMSIS also provides Global Standby support for Low Power.

JSON Configurations

The examples can be built for the following Application cores:

- M55_HE
- M55_HP
- A32

Sample ATOC JSON files are provided for:

- Code running from MRAM (XIP).
- Code running from TCM memory.
- M55_HE
- M55_HP
- M55_HE + M55_HP

JSON File	TCM	MRAM
services_a32	✓	
services_a32-xip		✓
services_he	✓	
services_he_hp	✓	
services_he_hp_a32	✓	
services_he_hp_a32_xip		✓
services_he_hp_xip	✓	
services_he_xip		✓
services_hp	✓	
services_hp_xip		✓
Services-he-tcm-hp-xip	✓	✓

Power Example

The Power examples demonstrate how to use SERVICES to achieve low power states.

The SERVICES are used to configure the device and enable STOP mode.

Power Example Use Cases

Please refer to the README.md file in the SERVICES release for details of the Example use cases e.g., how to build and run.

BASIC1 (No XIP)

- Keeps device ON after wake up from STOP mode.
- M55_HE is booted on wake up.

BASIC2 (XIP)

- Keeps device ON after wake up from STOP mode.
- M55_HE is booted on wake up.

BASIC3 (No XIP)

- Continually cycles from STOP->WAKE.

BASIC4 (No XIP)

- Example
  - Make a Set RUN Config call, to change the clock settings to something different from the default.
  - Measure the CPU speed, to verify that the above call was executed successfully.
  - Make a Set OFF Config call.
  - Make the PM calls to go OFF. It seems now that is Alif CMSIS functionality.
- Can be configured (built) for continuous or limited run (10) mode.
- **NOTE**: There is an issue when measuring the CPU speeds of both M55s at the same time. It seems it is caused by the shared usage of RTC_A, which is also used for wakeup logic.

BASIC5 (No XIP)

- FASTBOOT with SE not retained.

BASIC6

- Global standby example in TCM.

BASIC7 (No XIP)

- IDLE mode example in TCM

BASIC8 to BASIC13 Clock configuration examples (No XIP)

Each of these examples perform a single aiPM call to set the RUN clock configuration of the device.

- BASIC8 – run the device off the PLL at full CPU frequencies.
- BASIC9 – run the device off the PLL at reduced M55 CPUs frequencies.

BASIC14 GET request examples (No XIP)

- Shows use of the get_off and get_run APIs.

BASIC15 Clock Source Cycling (No XIP)

- Cycles the device between PLL, HFXO and HFRC clock sources.
- Can be continuous or limited to 10 cycles.

BASIC16 M55s run in TCM not retained (No XIP)

- SES loads M55 code from MRAM to its TCM. M55-HE is not retained.
- M55 does a set_run() request
- M55 does a set_off() request
- SES puts the device in STOP mode when both m55s go OFF.
- RTC_A expiry causes wake up.
- PLL not enabled on wake up.
  - Run at RC clock speed 76 MHz.
- SES wakes up.
  - Starts PLL
    - Run at 100 Mhz
  - Initializes m55-he TCM memory.
- SES boots both m55-he and m55-hp from ATOC
  - As both CPUs are booted, you will see the chip cycle.

Power Consumption Examples

A series of examples are provided for various use cases.

- GO_MODES
- READY_MODES
- IDLE_MODES
- STANDBY_MODES
- STOP_MODES
- STANDBY_CYCLE
- STOP_CYCLE

These examples are designed to enable a user to obtain Power numbers like the scenarios described in the Device datasheet.

See README.md file for build details.

NOTE: These examples use very low clock settings. In this case, the SE-UART output may not appear.

SES Power Policies

- Logic added to process ATOC and boot M55_HE and M55_HP in case the M55_HE TCM was not retained.
- SES will apply retention settings as soon as a service request is received because they cannot be applied after a subsystem goes OFF.

Power Example Running – Debugging common issues

ISP Nor responding

If you have the device in a Power OFF state, be aware that commands sent from the SETOOLS maintenance command will return '[ERROR] Target not responding' as the device is turned off. ISP is not running / listening on the target when the Power is off.

Cannot use UpdateSystemPackage

- If you have programmed the device to disable the PLL then using Bulk MRAM transfer commands such as UpdateSystemPackage or app-write-mram will probably fail. The reason is that these commands automatically raise the baud rate for ISP which assumes the PLL is enabled. To use these commands

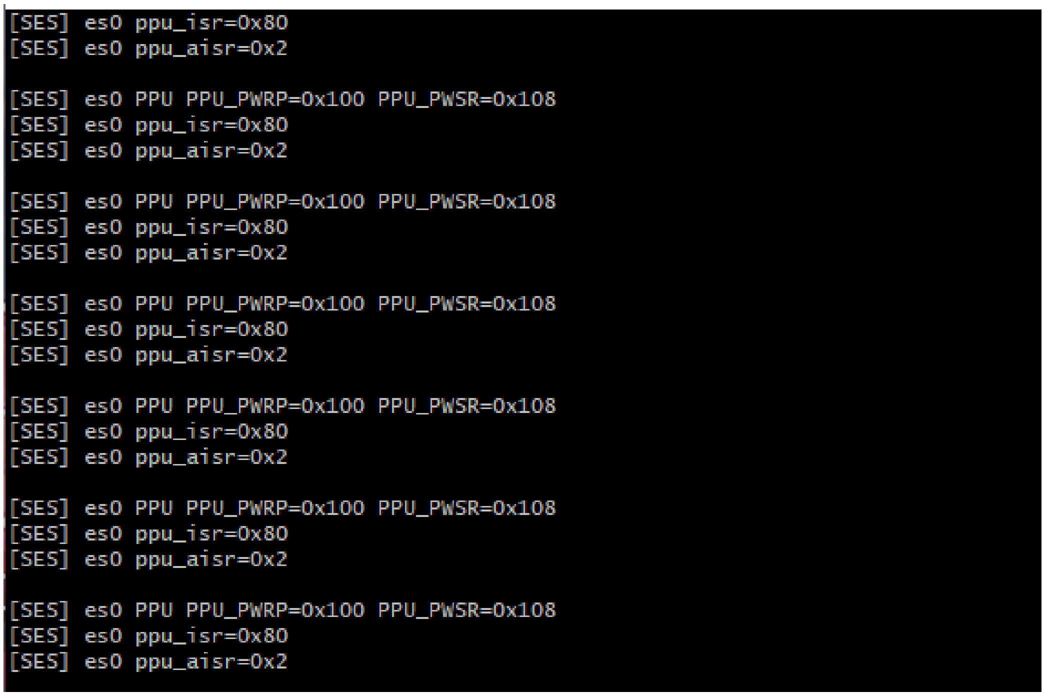
```
$ updatesystempackage -s
$ app-write-mram -s
```

The -s option suppresses the baud rate increase.

To gain control of the device again you will need to enter Hard Maintenance mode.

PPU Interrupt Spamming

There can be cases where the SE-UART will print a constant stream of PPU interrupt messages as seen below:



```
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2

[SES] es0 PPU PPU_PWRP=0x100 PPU_PWSR=0x108
[SES] es0 ppu_isr=0x80
[SES] es0 ppu_aisr=0x2
```

This can be caused by incorrect configuration of aiPM settings such as running your code from XIP (i.e. MRAM) but asking aiPM to disable the Power to MRAM.

SES will print a maximum of 50 of these messages and stop printing them. You should use Hard Maintenance mode to gain control of the Device and remove your Application code from MRAM.

Power Examples Limitations

- Wakeup timers that expire before you enter STOP mode.
  - You will not enter stop mode.
- The booting of specific CPU core as per requested wake up event is not yet supported.
  - On any configured wake up event the m55-he is booted if its TCM is retained or ATOC is processed, and bootable images are booted (potentially both m55-he and m55-hp if the ATOC has bootable images for both)
- Some tests may not report on the SE-UART as the clock rates are too low.

SES Clock Policies

- SES COLD Boot
  - SES checks for presence of Application Conductor objects specifying Clock directions.
  - If no DCT object is present, SES will set the LF Clock Source to the LFXO (Default)

SERVICES test harness example

A test harness example is provided showing calls to all the SERVICES APIs.

See `example\common\services_test.c`.

There are numerous build options available. Not all tests can be run at once as they either do not return or they reboot the system.

Examples customization options.

Output of the results from the example test can be via the ARM-DS Console or the SE-UART.

In `services_test.c` there are the following defines

```
#define TEST_PRINT_ENABLE           1    /* Enable printing from Test harness */
#define PRINT_VIA_CONSOLE           0    /* Print via Debugger console        */
#define PRINT_VIA_SE_UART           1    /* Print via SE UART terminal        */
```

Flag	Meaning
TEST_PRINT_ENABLE	Turn on output from the test
PRINT_VIA_CONSOLE	Print messages to arm-ds (printf())
PRINT_VIA_SE_UART	Print messages to the SE-UART

You can enable both Console and SE-UART.

If you want to run the test from MRAM the PRINT_VIA_CONSOLE must be disabled.

Changing CMSIS Packs

The SERVICES examples use ALIF CMSIS mainly for:

- M55_HE and HP startup sequences.
- MHU interrupt vectors and numbers
- Global Standy APIs for Low Power example

The SERVICES examples build defaults to the latest ALIF CMSIS Packs.

Changing CMSIS versions is as follows:

```
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -Dalifcmsis=”0.9.3”
```

Building and running the Examples

Please see README.md supplied in the SERVICES examples.

Building the M55 HE Example - run from TCM.

There are two json files supplied in the Services release:

- services-he.json
  - Single Core
- services-he-hp.json
  - Dual Core

Follow the instructions to build the M55_HE or HP example.

```
$ cd <host-release directory>
$ mkdir build_he
$ cd build_he
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake
$ make install
```

To boot M55_HE application CPUs you need these steps:

```
$ cd <release directory>/app-release-exec
$ ./app-gen-toc -f build/config/service-he.json
$ ./app-write-mram
```

Building the M55 HE Example - run from MRAM.

There are two json files supplied in the Services release:

- services-he-xip.json
  - Single Core
- services-he-hp-xip.json
  - Dual Core

Follow the instructions to build the M55_HE or HP example.

```
$ cd <host-release directory>
$ mkdir build_he_mram
$ cd build_he_mram
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -DXIP=1
$ make install
```

To boot M55_HE application CPU you need these steps:

```
$ cd <release directory>/app-release-exec
$ ./app-gen-toc -f build/config/service-he-xip.json
$ ./app-write-mram
```

Building and running the M55_HE Power Example (ARM Clang)

```
$ cd se-host-service-release
$ mkdir build_he_power
$ cd build_he_power
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -DPOWER=ON
$ make install

$ cd ../app-release-exec
$ ./app-gen-toc -f build/config/service-he.json
$ ./app-write-mram
```

Building and running the M55_HE Power Example (ARM GNUC)

```
$ cd se-host-service-release
$ mkdir build_he_power
$ cd build_he_power
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-gnu.cmake -DPOWER=ON
$ make install

$ cd ../app-release-exec
$ ./app-gen-toc -f build/config/service-he.json
$ ./app-write-mram
```

Building and running the M55_HP Power Example (ARM Clang)

```
$ cd se-host-service-release
$ mkdir build_hp_power
$ cd build_hp_power
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HP -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -DPOWER=ON
$ make install

$ cd ../app-release-exec
$ ./app-gen-toc -f build/config/service-hp.json
$ ./app-write-mram
```

Building and running the M55_HP Power Example (ARM GNUC)

```
$ cd se-host-service-release
$ mkdir build_hp_power
$ cd build_hp_power
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HP -
DCMAKE_TOOLCHAIN_FILE=toolchain-gnu.cmake -DPOWER=ON
$ make install

$ cd ../app-release-exec
$ ./app-gen-toc -f build/config/service-hp.json
$ ./app-write-mram
```

Building and running the STOC update example

```
$ cd se-host-service-release
$ mkdir stoc_update
$ cd stoc_update
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-gnu.cmake -DEXAMPLE=UPDATE_STOC
 $ make install
 $ cd <app-release-dir>
 $ <copy the STOC update package to build/images/STOC.bin>
 $ app-gen-toc -f build/config/services-he-update-stoc.json
 $ app-write-mram
```

This example shows how to update the ALIF STOC contents.

It requires an ALIF specific binary (Called an Update Package) to be passed as data to a SERVICE call which will update this image in ALIF MRAM area.

This example adds this update binary to an ATOC image so it can be loaded from MRAM into RAM for the test. In a real system this image would arrive from your OTA source.

Building SE Host Services – LINUX

Unpack the se-host-services-release-SE_FW_0.<version#>.000_DEV.zip

There is a separate makefile file for building the Services library for Linux - ‘Makefile_linux’, so that file should be used instead of the default ‘Makefile’ –

```
    $ make -f Makefile_linux lib
```

By default, things are set up to use the native GCC compiler in Cygwin.

To use the Alif Yocto cross compiler toolchain and generate binaries for the Alif Linux distribution, a couple of changes are needed.

- comment out the compiler definitions (like ‘CC = gcc’) in Makefile_linux. The Yocto toolchain provides its own definitions.
- modify the file services_lib\services_host_handler_linux.c and replace ‘#if 0’ with ‘#if 1’, to include the Linux kernel header file for the MHU driver.

Installing examples

The examples come with supplied JSON files for A32, M55_HE and M55_HP processors including variants for MRAM (XIP) and TCM running.

There is an option to install these examples into your Application Release to enable building an ATOC for putting into MRAM. To build the ATOC you need the JSON file and the binary image for Application. These files are copied from the se-host-services-release into your application release.

```
$ cd se-host-services-release
```

Note the use of the `INSTALL_DIR` to specify where your application release lives.

When you unpack your application release you will get a directory structure as follows:

```
app-release-exec-windows-SE-FW_0.<version>
     + app-release-exec
          + build
               + config
               + images
```

The JSON files will be copied to the config directory and the binaries will be copied to images. This is where the ATOC generation tools will look.

A sample sequence would be as follows:

```
$ cd se-host-services-release
$ mkdir build_he
$ cd build_he
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake
$ make install -j 8
```

Installing examples to a different location

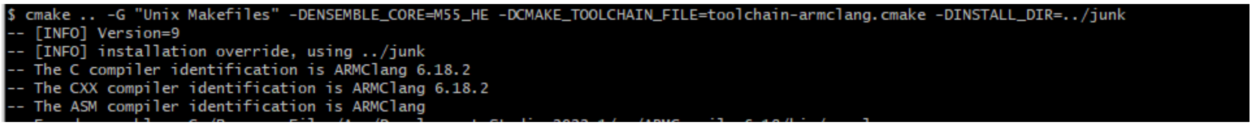
An example of using the INSTALL_DIR is as follows:

```
-DINSTALL_DIR=<some path>
```

If you do not specify the `INSTALL_DIR` then the default is `app-release-exec`

Use the following to override the default:

```
$ cd se-host-services-release
$ mkdir build_he
$ cd build_he
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -
DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -DINSTALL_DIR=<some
location>
$ make install -j 8
```



```
$ cmake .. -G "Unix Makefiles" -DENSEMBLE_CORE=M55_HE -DCMAKE_TOOLCHAIN_FILE=toolchain-armclang.cmake -DINSTALL_DIR=../junk
-- [INFO] Version=9
-- [INFO] installation override, using ../junk
-- The C compiler identification is ARMClang 6.18.2
-- The CXX compiler identification is ARMClang 6.18.2
-- The ASM compiler identification is ARMClang
```

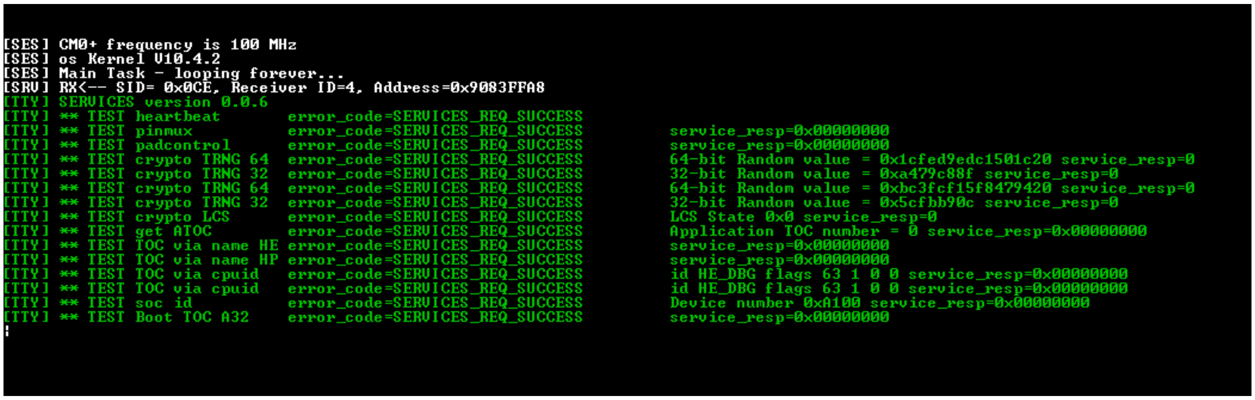
A message shows that installation override is enabled.

The default directory is app-release-exec which is the one used on Windows. LINUX release will have the directory name app-release-exec-linux which you would need to specify using the INSTALL_DIR option (or simply rename the app-release-exec-linux directory to app-release-exec).

Running with SERVICES Debug disabled

The test harness has a call to SERVICES_system_set_services_debug() which can disable or enable the debug traffic from SES for the SERVICE traffic.

With the SERVICES debug set to false:



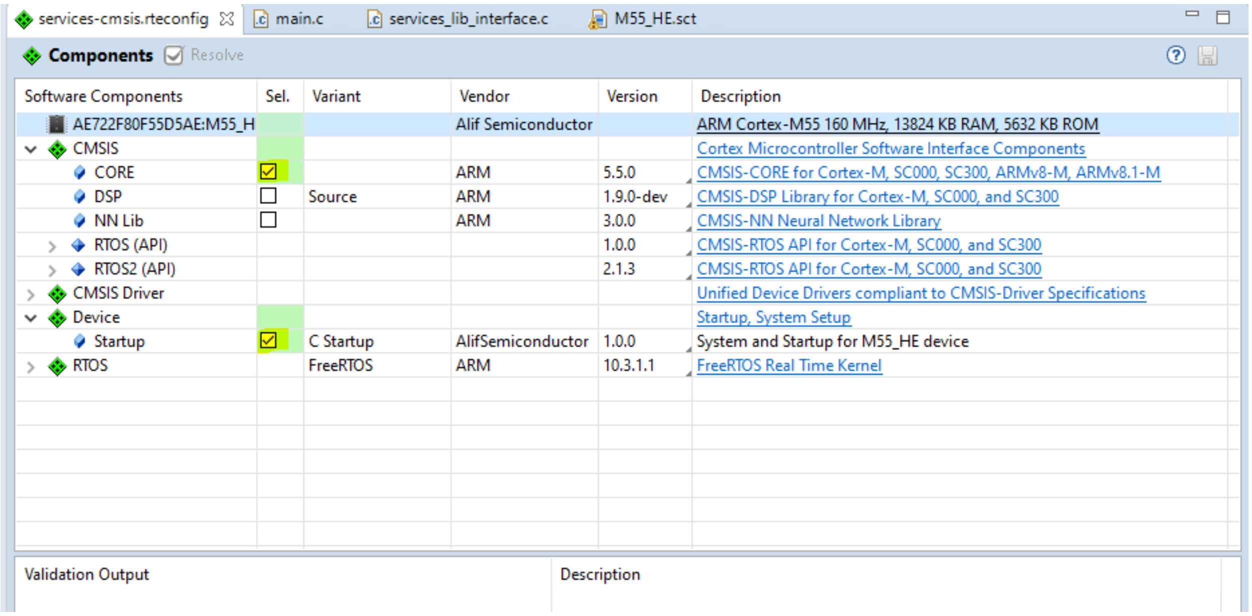
```
[SES] CM0+ frequency is 100 MHz
[SES] os Kernel V10.4.2
[SES] Main Task - looping forever...
[SRV] RX<-- SID= 0x0CE, Receiver ID=4, Address=0x9083FFA8
[TTY] SERVICES version 0.0.6
[TTY] ** TEST heartbeat       error_code=SERVICES_REQ_SUCCESS
[TTY] ** TEST pinmux          error_code=SERVICES_REQ_SUCCESS         service_resp=0x00000000
[TTY] ** TEST padcontrol      error_code=SERVICES_REQ_SUCCESS         service_resp=0x00000000
[TTY] ** TEST crypto TRNG 64  error_code=SERVICES_REQ_SUCCESS         64-bit Random value = 0x1cfed9edc1501c20 service_resp=0
[TTY] ** TEST crypto TRNG 32  error_code=SERVICES_REQ_SUCCESS         32-bit Random value = 0xa479c88f service_resp=0
[TTY] ** TEST crypto TRNG 64  error_code=SERVICES_REQ_SUCCESS         64-bit Random value = 0xbc3fcf15f8479420 service_resp=0
[TTY] ** TEST crypto TRNG 32  error_code=SERVICES_REQ_SUCCESS         32-bit Random value = 0x5cfbb90c service_resp=0
[TTY] ** TEST crypto LCS      error_code=SERVICES_REQ_SUCCESS         LCS State 0x0 service_resp=0
[TTY] ** TEST get ATOC        error_code=SERVICES_REQ_SUCCESS         Application TOC number = 0 service_resp=0x00000000
[TTY] ** TEST TOC via name HE error_code=SERVICES_REQ_SUCCESS         service_resp=0x00000000
[TTY] ** TEST TOC via name HP error_code=SERVICES_REQ_SUCCESS         service_resp=0x00000000
[TTY] ** TEST TOC via cpuid   error_code=SERVICES_REQ_SUCCESS         id HE_DBG flags 63 1 0 0 service_resp=0x00000000
[TTY] ** TEST TOC via cpuid   error_code=SERVICES_REQ_SUCCESS         id HE_DBG flags 63 1 0 0 service_resp=0x00000000
[TTY] ** TEST soc id          error_code=SERVICES_REQ_SUCCESS         Device number 0xA100 service_resp=0x00000000
[TTY] ** TEST Boot TOC A32    error_code=SERVICES_REQ_SUCCESS         service_resp=0x00000000
```

The SERVICE call to set the debug output off can be seen (the default is enabled in SES). After that, there is no SERVICE debug traffic from SES.

Building the M55 Host Example under ARM-DS

Before starting, ensure you have the ALIFSemiconductor CMSIS Pack installed (See AP002 Getting Started with Bare Metal & Azure RTOS)

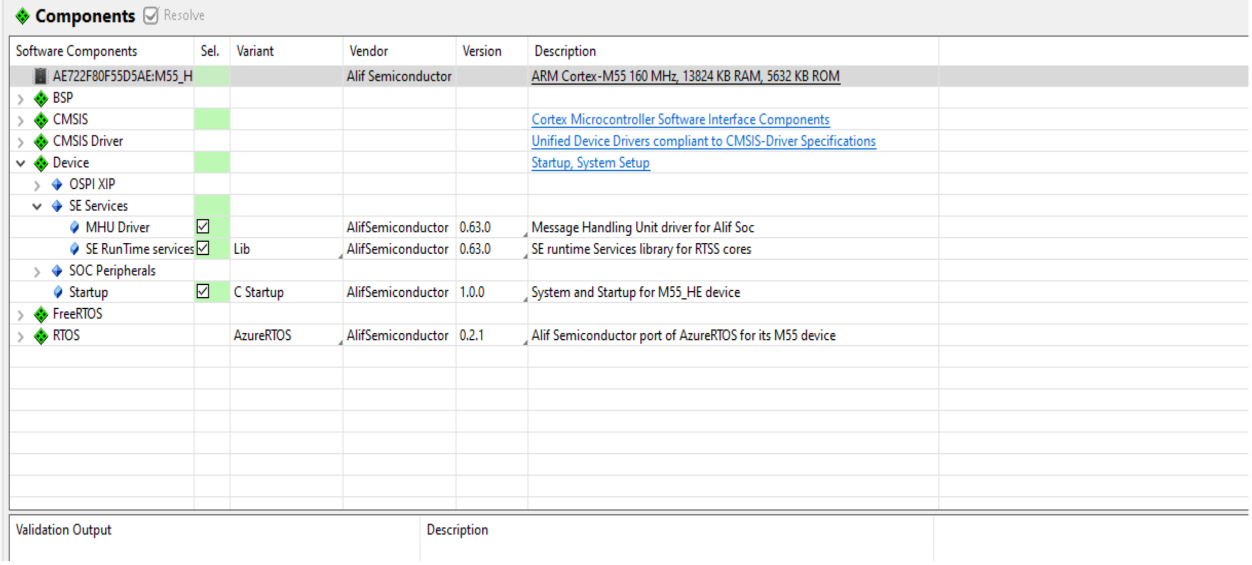
- Create a new Project -> C Project -> CMSIS C/C++ Project
- Select Device -> Alif Semiconductor -> Ensemble -> E7 -> AE722F80F55D5AE (or the other one) -> AE722F80F55AE:M55_HE
- In the Project Components window,
    - Check the following highlighted boxes,
    - Then File -> Save



Software Components	Sel.	Variant	Vendor	Version	Description
AE722F80F55D5AE:M55_H			Alif Semiconductor		ARM Cortex-M55 160 MHz, 13824 KB RAM, 5632 KB ROM
CMSIS					Cortex Microcontroller Software Interface Components
CORE	☑		ARM	5.5.0	CMSIS-CORE for Cortex-M, SC000, SC300, ARMv8-M, ARMv8.1-M
DSP	☐	Source	ARM	1.9.0-dev	CMSIS-DSP Library for Cortex-M, SC000, and SC300
NN Lib	☐		ARM	3.0.0	CMSIS-NN Neural Network Library
RTOS (API)				1.0.0	CMSIS-RTOS API for Cortex-M, SC000, and SC300
RTOS2 (API)				2.1.3	CMSIS-RTOS API for Cortex-M, SC000, and SC300
CMSIS Driver					Unified Device Drivers compliant to CMSIS-Driver Specifications
Device					Startup, System Setup
Startup	☑	C Startup	AlifSemiconductor	1.0.0	System and Startup for M55_HE device
RTOS		FreeRTOS	ARM	10.3.1.1	FreeRTOS Real Time Kernel

Validation Output	Description

Select the SE Services



Software Components	Sel.	Variant	Vendor	Version	Description
AE722F80F55D5AE:M55_H			Alif Semiconductor		ARM Cortex-M55 160 MHz, 13824 KB RAM, 5632 KB ROM
BSP					
CMSIS					Cortex Microcontroller Software Interface Components
CMSIS Driver					Unified Device Drivers compliant to CMSIS-Driver Specifications
Device					Startup, System Setup
OSPI XIP					
SE Services					
MHU Driver	☑		AlifSemiconductor	0.63.0	Message Handling Unit driver for Alif Soc
SE RunTime services	☑	Lib	AlifSemiconductor	0.63.0	SE runtime Services library for RTSS cores
SOC Peripherals					
Startup	☑	C Startup	AlifSemiconductor	1.0.0	System and Startup for M55_HE device
FreeRTOS					
RTOS		AzureRTOS	AlifSemiconductor	0.2.1	Alif Semiconductor port of AzureRTOS for its M55 device

Validation Output	Description

Adding ALIF SE SERVICES to your Application code

Calling SERVICES from your Application requires the following:

- Include the header files:
  - `/service-release/include/services_lib_api.h`
  - `/service-release/include/aipm.h`
- Link with
  - `/service-release/lib/libservices_m55_lib.a (or _a32_)`
  - `/service-release/lib/libmhu_m55_lib.a (or _a32_)`
- Copy or create your own `service_lib_interface.c` file and add it to your build.
  - Change any interrupt sources as required.
  - Implement wait function for your environment.
  - Implement print function for your environment.

SE Host Services Library API

The Host Service API is built on a transport protocol layer. This is to facilitate changing the underlying protocol without affecting the rest of the library.

The services library package consists of the following:

Component	Description
`libservices_m55_lib.a`	Host Services M55 Library
`libservices_a32_lib.a`	Host Services A32 Library
`libmhu_m55_lib.a`	Host Services M55 MHU Library (Baremetal)
`libmhu_a32_lib.a`	Host Services A32 MHU Library (Baremetal)
`services_lib_api.h`	APIs to access the services library
`services_lib_interface.c`	To be completed by the user. Compiled with the host CPU application program

There is a porting / abstraction interface component which the user must update depending upon their operating system choice and driver interface to the Message Handling hardware (MHU).

ALIF supply completed interfaces (currently) for

- Bare metal
- FreeRTOS
- ThreadX
- Linux

The Host services library provides APIs to facilitate service requests from a host CPU to the SE. it must be set up and initialized before dispatching a Host service request to the SE. It needs access to the MHU driver functions to facilitate MHU communication.

The Host services library also requires other generic functions:

`SERVICES_wait_ms(uint32_t wait_time_ms)`	Delay function
`SERVICES_send_mhu_message_to_se(uint32_t message)`	Interface to the MHU driver

This layer is intended for any Operating System abstraction.

Host Services Library Interface API Porting Layer

This needs to be updated by the user depending upon the operating system being used (or base metal) and the interface to the Message handling hardware. The requirements of the operating system are very light.

The file `services_lib_interface.c` is the porting interface which needs to be filled in by the user.

SERVICES_wait_ms

```
// Delay function
int wait_ms(uint32_t wait_time_ms)
```

SERVICES_send_mhu_message_to_se

```
// MHU send message to SE on MHU0 channel0
int send_mhu_message_to_se(uint32_t message)
```

The above functions must be configured in `services_init_params` structure and pass to the service library initialization function below.

Host Services Library API Layer

A Service call from an application processor looks like any other C function call, it can take parameters and return results via pass by reference parameters.

The Host Services library is responsible for taking the application Service call and communicating this to the Secure Enclave using the MHU.

SERVICES_initialize

The SERVICES library needs to be initialized before use. There are several parameters that are needed by the SERVICES library such as which MHU is being used, packet buffers etc.

Please refer to the SE Host Services API section for more details.

```
// Service library initialization
void SERVICES_initialize(services_lib_t * init_params)

SERVICES_initialize(services_lib_t * init_params);

// Service synchronization
int SERVICES_synchronize_with_se(uint32_t services_handle)
```

```
number_of_retries = SERVICES_synchronize_with_se(services_handle);
```

The M55-HE and M55-HP are started before SERAM is ready to process service calls. This function sends heartbeat requests until one of them succeeds. It returns the number of retries. The maximum number of retries is 100.

SERVICES_send_request

```
// Service request call
uint32_t SERVICES_send_request(uint32_t services_handle,
                               uint16_t service_id,
                               uint32_t service_timeout);

Error_code = SERVICES_send_request(handle, SERVICE_HEARTBEAT_ID,
DEFAULT_TIMEOUT);
```

The service request dispatches the service request to the SE. Service calls are synchronous, the function waits for the SE to send a response back and then returns an error code. This is analogous to a remote procedure call. The caller can specify the desired timeout for the service call, or specify DEFAULT_TIMEOUT, in which case the timeout specified when during Services library setup is used.
It needs access to the host CPUs MHU driver functions to send, receive and ACK messages over the MHU.

SERVICES_send_msg_acked_callback

```
// MHU message ACK callback function
void SERVICES_send_msg_acked_callback(void)
```

The above callback function must be passed to the MHU driver during initialization. It is called by the driver when an MHU message is ACKed by the SE. Channel clear interrupt CH_INT_ST is set when SE has received the MHU message and SE clears the channel status CH_ST bits by setting CH_CLR. This is assumed to be an ACK from SE that it has received an MHU message sent by the host CPU.

SERVICES_rx_msg_callback

```
// MHU message received callback function
void SERVICES_rx_msg_callback(uint32_t message);
```

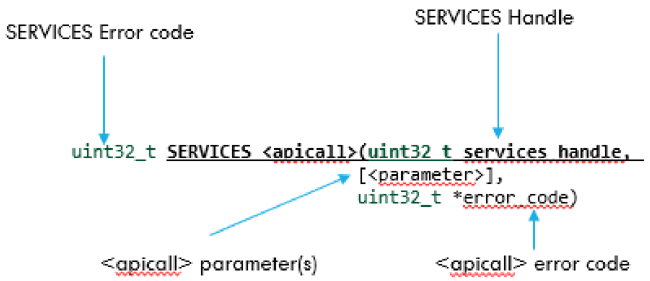
The above callback function must be passed to the MHU driver during initialization. It is called by the driver when an MHU message is received from the SE as a response to a service request earlier to the SE

```
// Pinmux service
int PINMUX_config(Port_t port_num, Pin_t pin_num, Pinfunction_t
function);
```

SE Host SERVICES Library

SE Host SERVICES Library - Anatomy of a SERVICE Call

A SERVICES API call takes the following format:



```
uint32_t SERVICES_<apicall>(uint32_t services_handle,
                            [<parameter>],
                            uint32_t *error_code)
```

- SERVICES API are regular function calls taking the format SERVICES_<module>
- Returns Services error code.
  - This relates to the SERVICES transport layer.
- Other return values are passed in the function prototype.
  - These parameters can be IN and OUT and can be variable sized.
  - Results from the SERVICE call are returned via these variables.
  - The error_code return relates to the error returned from the actual SERVICE call.

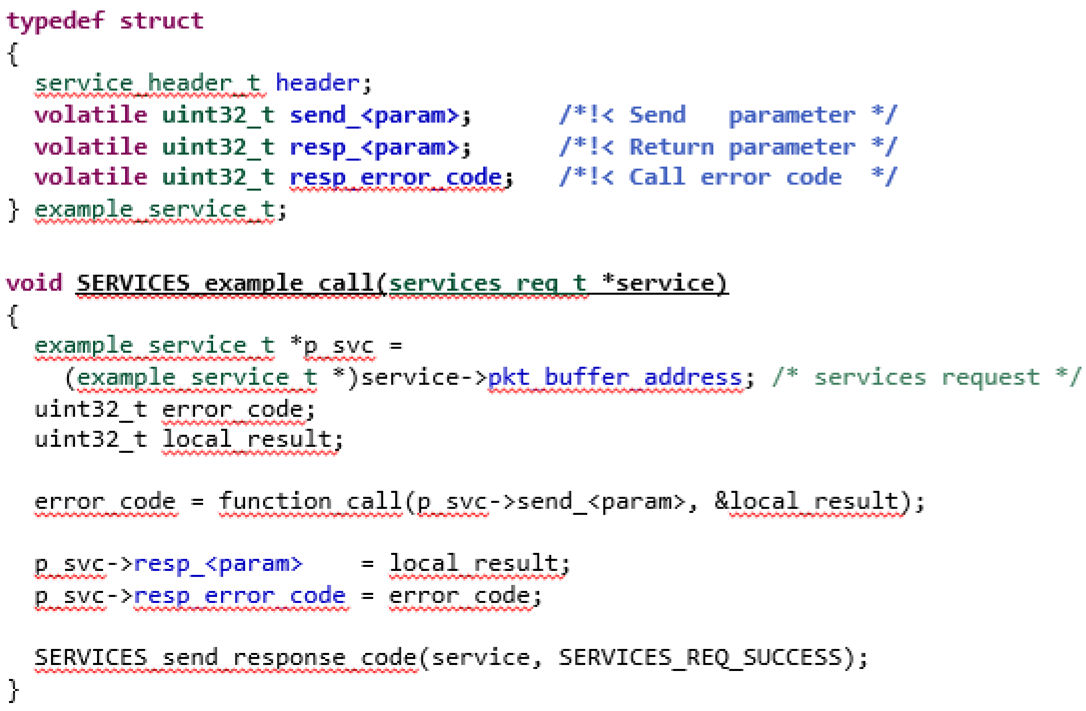
SE Host Service Library Internal implementation

Each SERVICE defines a unique parameter block structure.

- See `example_service_t` in the diagram below.
- This always contains the Header and a return response error code,
- There may be passed parameters from the Caller.
- There may be return parameters to the Caller.

For each SERVICE call processed in SERAM the parameter block is dereferenced

- Sent parameters can be passed to the calling function.
- The Error code from the called function will be sent back as part of the parameter block.

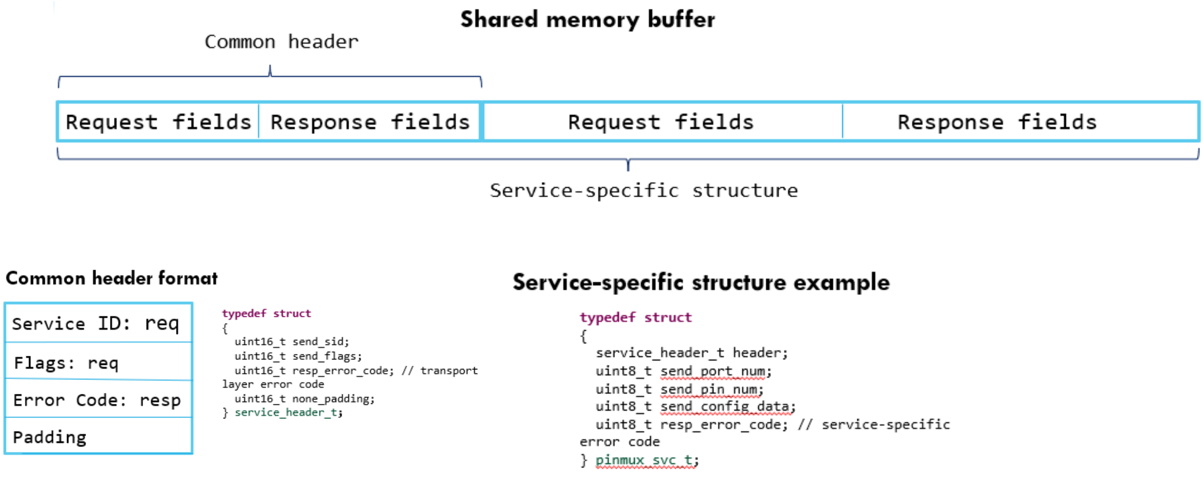


```
typedef struct
{
  service_header_t header;
  volatile uint32_t send_<param>;      /*!< Send   parameter */
  volatile uint32_t resp_<param>;      /*!< Return parameter */
  volatile uint32_t resp_error_code;   /*!< Call error code  */
} example_service_t;

void SERVICES_example_call(services_req_t *service)
{
  example_service_t *p_svc =
    (example_service_t *)service->pkt_buffer_address; /* services request */
  uint32_t error_code;
  uint32_t local_result;

  error_code = function_call(p_svc->send_<param>, &local_result);

  p_svc->resp_<param>     = local_result;
  p_svc->resp_error_code = error_code;

  SERVICES_send_response_code(service, SERVICES_REQ_SUCCESS);
}
```

There is no copying of data between the Host Application CPU and the Secure enclave.

SE Host Service Library Transport Protocol details

The transport protocol is as follows:



```
typedef struct
{
  uint16_t send_sid;
  uint16_t send_flags;
  uint16_t resp_error_code; // transport
layer error code
  uint16_t none_padding;
} service_header_t;
```

```
typedef struct
{
  service_header_t header;
  uint8_t send_port_num;
  uint8_t send_pin_num;
  uint8_t send_config_data;
  uint8_t resp_error_code; // service-specific
error code
} pinmux_svc_t;
```

SE Host Service Library Transport Error Codes

The following are the valid return and Error codes for the services library.

Error Code	Value	Meaning
SERVICES_REQ_SUCCESS	0x00	
SERVICES_REQ_NOT_ACKNOWLEDGE	0xFF	
SERVICES_REQ_TIMEOUT	0xFD	
SERVICES_REQ_UNKNOWN_COMMAND	0xFC	

This error relates to any operation on the transport layer of the SERVICES library. Most SERVICES library APIs have a second error code which is the error code return from the called function.

SE Host Services Library Error Handling

There are two levels of Error with a SERVICES API call,

- SERVICES Transport layer error code
- Function call error code

Valid SERVICE Error and return codes are:

```
#define SERVICES_REQ_SUCCESS                       0x00
#define SERVICES_REQ_NOT_ACKNOWLEDGE               0xFF
#define SERVICES_REQ_TIMEOUT                       0xFD
#define SERVICES_RESP_UNKNOWN_COMMAND              0xFC
```

SE Host Services Library Memory handling

When passing data from the Application CPUs, the SERVICES library will perform all necessary address translations and handling.

LocalToGlobal() is used inside the SERVICE Library to pass the correct addresses to the SECURE Enclave.

SE Host Services API

The services provided by the SE via the MHU are as follows.

Miscellaneous

SERVICES_Initialize

Syntax:

uint32_t SERVICES_initialize(services_lib_t * init_params)

Description:

Initialize the services library.

A user needs to supply the following platform specific data and functions for the following operations.

- Global address of the CPU's local data memory 0x0 for A32, start of DTCMs for the M55 cores.
- Packet buffer
  - Defined in Application memory space.
  - Used by the SERVICES library.
- Send MHU message function – provided by the MHU driver.
- wait (delay) function – platform and OS specific.
- print function – platform and OS specific.

The examples source contains service_lib_interface.c which shows how to set up the SERVICES library. This is not part of the SERVICES Library code as it is expected to be customized by a User for their application, which is why this is included as source code in the examples.

Parameters:

init_params	Initialization parameters

Returns:

Restrictions:
None

Example:

```
#include “services_lib_api.h” /* services_lib_t lives here */

static uint8_t
  s_packet_buffer[SERVICES_MAX_PACKET_BUFFER_SIZE] __attribute__ ((aligned (4)));

int SERVICES_print(const char * fmt, ...)
{
  /* To be filled in by the user */

  return 0;
}
```

```
int32_t SERVICES_wait_ms(uint32_t wait_time_ms)
{
  /* To be filled in by the user */

  return 0;
}

int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;

  services_lib_t  services_init_params =
  {
    .global_offset          = DTCM_GLOBAL_ADDRESS - M55_DTCM_LOCAL_OFFSET,
    .packet_buffer_address = (uint32_t)s_packet_buffer,
    .fn_send_mhu_message   = send_message,
    .fn_wait_ms            = &SERVICES_wait_ms,
    .wait_timeout          = timeout,
    .fn_print_msg          = &SERVICES_print,
  };

  ErrorCode = SERVICES_initialize(&services_init_params);

  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_version

Syntax:

const char *SERVICES_version(void)

Description:

Returns the version of the Host library.

Parameters:
None

Returns:

Version string

Restrictions:
None

Example:

```
#include <services_lib_api.h>

int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;

  printf("SERVICES version %s\n", SERVICES_version());
}
```

SERVICES_register_channel

Syntax:

uint32_t SERVICES_register_channel(uint32_t mhu_id, uint32_t channel_number);

Description:

Returns a handle for a specific MHU and channel, to be used in subsequent service calls.

Parameters:

mhu_id	MHU ID
channel_number	Channel number (within the MHU)

Returns:

Service channel handle

Restrictions:

The MHU ID and channel number must be valid.

The maximum number of MHU Channels is 124.

Example:

```
#include <services_lib_api.h>

#define NUM_MHU                 2

#define MHU_M55_SE_MHU0         0
#define MHU_M55_SE_MHU1         1

int main (void)
{
  mhu_initialize();
  SERVICES_Setup(s_mhu_driver_out.send_message, MAXIMUM_TIMEOUT);

  uint32_t services_handle = SERVICES_register_channel(MHU_M55_SE_MHU0, 0);

  printf("SERVICES handle %d\n", services_handle);
}
```

SERVICES_prepare_packet_buffer

Syntax:

uintptr_t SERVICES_prepare_packet_buffer(uint32_t size)

Description:

Prepares a packet buffer.

Used by the SERVICES library to allocate a packet buffer from the global Packet buffer memory.

Parameters:

Size	Packet buffer size

Returns:

Pointer to packet buffer.

Restrictions:

Example:

Maintenance Services

The maintenance services provide a mechanism to maintain a reliable connection between the sender and receiver and/or request general information from the receiver. The following maintenance services are supported by SE.

SERVICES_heartbeat

Syntax:

uint32_t SERVICES_heartbeat (uint32_t services_handle)

Description:

Heartbeat request.

This service is analogous to "ping".

It is a message sent by the sender to tell the receiver that it is alive. It can also be sent by SE to check if another core is alive and responding. When this message is ACKed by the receiver, the sender knows that the receiver is alive. This message does not warrant a response from the receiver other than ACK.

Parameters:

services_handle

Returns:

Restrictions:

None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;

  mhu_initialize();
  SERVICES_Setup(s_mhu_driver_out.send_message, MAXIMUM_TIMEOUT);

  //SERVICES_wait_ms(0x1000000);

  uint32_t services_handle = SERVICES_register_channel(MHU_M55_SE_MHU0, 0);

  ErrorCode = SERVICES_heartbeat(services_handle);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }

  return ErrorCode;

}
```

SERVICES_synchronize_with_se

Syntax:

int SERVICES_synchronize_with_se(uint32_t services_handle)

Description:

Wait for the SE to become available. In some warm boot cases the M55_HE is released by SES and so is running, this means the M55 is running before SES has fully completed booting and installing the MHU handlers. In this case the M55_HE needs to synchronize (wait) for SES to be ready.

This function is built on top of SERVICES_heartbeat. A heartbeat call is made (for a maximum of 100 times) until SES responds. If SES responds this function will return an integer number which is the number of retries it made until it got a response. If SES does not respond then a negative number will be returned indicating this call failed.

Parameters:

services_handle

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  int retry_count;

  /* keep sending heartbeat services requests until one succeeds */
  retry_count = SERVICES_synchronize_with_se(services_handle);

}
```

System Management

SERVICES_system_set_services_debug

Syntax:

```
uint32_t SERVICES_system_set_services_debug (uint32_t services_handle,
                                             bool debug_enable,
                                             uint32_t *error_code)
```

Description:

Enable / Disable Service debug traffic from SES.

Parameters:

service_handle	Service Handle
debug_enable	Toggle debug output.
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t service_error_code;

  SERVICES_system_set_services_debug(services_handle,
                                     false,/* False = NO debug output */
                                     &service_error_code);
  if (service_error_code != SERVICES_REQ_SUCCESS)
  {
     /* Deal with error */
  }
}
```

SERVICES_system_read_otp

Syntax:

```
uint32_t SERVICES_system_read_otp      (uint32_t services_handle,
                                        uint32_t otp_offset,
                                        uint32_t *otp_value_word,
                                        uint32_t *error_code)
```

Description:

Read an OTP offset.

Parameters:

service_handle	Service Handle
otp_offset	OTP word offset to read.
otp_value_word	OTP value at otp_offset
error_code	Service Error Code

Returns:
SERVICE_SUCCESS or SERVICE_FAIL

Restrictions:

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_REQ_SUCCESS
  uint32_t service_error_code;
  uint32_t otp_value;

  ErrorCode = SERVICES_system_read_otp(services_handle,
                                       0x51, /* Offset */
                                       &otp_value,
                                       &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_system_write_otp

Syntax:

```
uint32_t SERVICES_system_write_otp       (uint32_t services_handle,
                                          uint32_t otp_offset,
                                          uint32_t otp_value_word,
                                          uint32_t *error_code)
```

Description:

Write an OTP offset.

Parameters:

service_handle	Service Handle
otp_offset	OTP word offset to write.
otp_value_word	OTP value to write to otp_offset
error_code	Service Error Code

Returns:
SERVICE_SUCCESS or SERVICE_FAIL

SERVICES_system_get_otp_data

Syntax:

```
uint32_t SERVICES_system_get_otp_data (uint32_t services_handle,

                                       SERVICES_otp_data_t *otp_info,

                                        uint32_t * error_code)
```

Description:

Returns details of OTP data

Parameters:

service_handle	Service Handle
otp_info	Details of OTP contents
error_code	Service Error Code

Returns:

Restrictions:

Example:

```
int main (void)
```

```
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t service_error_code;
  SERVICES_otp_data_t otp_info;

  ErrorCode = SERVICES_system_get_otp_data(services_handle,
                                          &otp_info,
                                          &service_error_code);

  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_system_get_toc_data

Syntax:

```
uint32_t SERVICES_system_get_toc_data (uint32_t services_handle,

                                       SERVICES_toc_data_t *toc_info,

                                       uint32_t * error_code)
```

Description:

Returns details of TOC objects in MRAM.

```
typedef struct
{
  uint8_t   image_identifier[8];       /**< TOC name    */
  uint32_t  version;                   /**< TOC Version */
  uint32_t  cpu;                       /**< TOC Cpu ID   */
  uint32_t  store_address;
  uint32_t  load_address;              /**< TOC load    */
  uint32_t  boot_address;
  uint32_t  image_size;
  uint32_t  flags;
} SERVICES_toc_info_t;

/**
 * @struct SERVICES_toc_data_t
 */
typedef struct
{
  uint32_t number_of_toc_entries;
  SERVICES_toc_info_t toc_entry[SERVICES_NUMBER_OF_TOC_ENTRIES];

} SERVICES_toc_data_t;
```

The number of TOC entries found is returned followed by the TOC entry details.

Parameters:

service_handle	Service Handle
toc_info	Details for all TOCs found
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t service_error_code;
SERVICES_toc_data_t toc_info;

  ErrorCode = SERVICES_system_get_toc_data(services_handle,
                                          &toc_info,
                                          &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_system_get_toc_number

Syntax:

```
uint32_t SERVICES_system_get_toc_number(uint32_t services_handle,
                                        uint32_t *toc_number,
                                        uint32_t * error_code)
```

Description:

Returns the number of Table of contents in MRAM

Parameters:

service_handle	Service Handle
toc_number	Number of TOCs
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t number_of_tocs;
  uint32_t service_error_code;

  ErrorCode = SERVICES_system_get_toc_number(services_handle,
                                             &number_of_tocs,
                                             &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_system_get_toc_via_name

Syntax:

```
uint32_t SERVICES_system_get_toc_via_name(uint32_t services_handle,
                                          const uint8_t *cpu_name,
                                          uint32_t * error_code);
```

Description:

Returns the TOC information using the CPU name.

Parameters:

service_handle	Service Handle
cpu_name	name of Application
error_code	Service Error Code

Returns:

Restrictions:
This function is deprecated.

Use SERVICES_system_get_toc_data() to obtain all details of the TOC data or SERVICES_system_get_toc_via_cpuid() specifying the CPU ID instead of a name.

Example:

SERVICES_system_get_toc_via_cpuid

Syntax:

```
uint32_t SERVICES_system_get_toc_via_cpuid(uint32_t services_handle,
                                           SERVICE_cpuid_t cpuid,
                                           SERVICES_toc_data_t *toc_info,
                                           uint32_t * error_code);
```

Description:

Returns the TOC information for a given CPU.

Valid CPUs are

```
typedef enum {
      HOST_CPU_0   = 0,                 /**< A32_0 CPU                */
      HOST_CPU_1   = 1,                 /**< A32_1 CPU                */
      EXTSYS_0     = 2,                 /**< M55 HP CPU or other CPU */
      EXTSYS_1     = 3,                 /**< M55 HE CPU               */
} SERVICES_cpuid_t;
```

If there is more than one TOC entry per CPUID this will be reflected in the toc_info structure returned from the SERVICE call.

Parameters:

service_handle	Service Handle
cpuid	Which Application CPU
toc_info	ATOC information
error_code	Service Error Code

Returns:

Restrictions:

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  SERVICES_toc_data_t toc_info;
  Uint32_t service_error_code;

 error_code = SERVICES_system_get_toc_via_cpuid(services_handle,
                                                FUSION_M55_HE,
                                                &toc_info,
                                                &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }

  /* Process each TOC entry found */
  for (int each_toc = 0; each_toc < toc_info.number_of_toc_entries; each_toc++)
  {
    SERVICES_toc_info_t *toc_entry_p;

    toc_entry_p = (SERVICES_toc_info_t *)&toc_info.toc_entry[each_toc];

    /* do something with the TOC information */
}
```

SERVICES_system_get_device_part_number

Syntax:

```
uint32_t SERVICES_system_get_device_part_number(uint32_t services_handle,
                                                uint32_t *device_part_number,
                                                uint32_t *error_code)
```

Description:

Returns the SoC device identifier.

Parameters:

service_handle	Service Handle
device_part_number	Device id (Soc ID)
error_code	Service Error Code

Returns:

device_part_number as integer e.g., 0x0000B200

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t device_id;
  uint32_t service_error_code;

  ErrorCode = SERVICES_system_get_device_part_number(services_handle,
                                                     &device_part_number,
                                                     &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_system_get_device_data

Syntax:

```
uint32_t SERVICES_system_get_device_data(uint32_t services_handle,

                                         SERVICES_version_data_t *device_info,

                                         uint32_t * error_code)
```

Description:

Retrieves the Device information.

The return is SERVICES_version_data_t as follows:

```
typedef struct
{
  uint32_t revision_id;    /* SoC revision            */
  uint8_t ALIF_PN[16];     /* SoC part number         */
  uint8_t HBK0    [16];    /* ALIF Key                */
  uint8_t HBK1    [16];    /* ALIF Key                */
  uint8_t HBK_FW [20];     /* ALIF Firmware version   */
  uint8_t config [4];      /* Wounding data           */
  uint8_t DCU     [16];    /* DCU settings            */
  uint8_t MfgData[32];     /* Manufacturing data      */
  uint8_t SerialN[8];      /* SoC Serial number       */
  uint8_t LCS;             /* SoC lifecycle state     */
} SERVICES_version_data_t;
```

Parameters:

service_handle	Service Handle
device_info	Device info
error_code	Service Error Code

Returns:

Restrictions:

None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t device_id;
  SERVICES_version_data_t device_data;
  uint32_t service_error_code;

  ErrorCode = SERVICES_system_get_device_info(services_handle,
                                              &device_data,
                                                        &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_get_se_revision

Syntax:

```
uint32_t SERVICES_get_se_revision(uint32_t services_handle,
                                  uint8_t *revision_data,
                                  uint32_t *error_code)
```

Description:

Retrieve the SES Banner string.

Parameters:

service_handle	Service Handle
revision_data	banner string return
error_code	Service Error Code

Returns:

String containing the banner data. Maximum size is 80 characters.

Restrictions:

None

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
  uint32_t service_error_code;
  uint8_t se_revision[80];

  error_code = SERVICES_get_se_revision(services_handle,
                                        (uint8_t*)&se_revision[0],
                                        &services_error_code);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
       /* deal with error */
  }
}
```

SERVICES_system_get_eui_extension

Syntax:

```
uint32_t SERVICES_system_get_eui_extension(uint32_t services_handle,
                                           bool is_eui48,
                                           uint8_t *eui_extension,
                                           uint32_t *error_code)
```

Description:

Retrieve the EUI48/64 unique number.

Parameters:

service_handle	Service Handle
is_eui48	Which format?
eui_extension	Buffer for calculated extension
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

Application Services

Application services provide mechanisms to configure certain functions. The SE can be requested to make these configuration changes.

SERVICES_uart_write

Syntax:

uint32_t SERVICES_uart_write(uint32_t services_handle, size_t size, const uint8_t *uart_data)

Description:

SE-UART write. The buffer provided is printed via the Secure enclave UART (SE-UART) port.

Parameters:

services_handle	Service handle
size	Number of bytes to write
uart_data	Buffer containing print data

None

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint8_t buffer[256];

  ... <format print buffer>

  ErrorCode = SERVICES_uart_write(services_handle,
                                  sizeof(buffer),
                                  (uint8_t *)buffer);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_pinmux

Refer document se-mhu-pinmux-pad_configuration

Syntax:

uint32_t SERVICES_pinmux(uint32_t services_handle, uint8_t port_number,
uint8_t pin_number, uint8_t configuration_value,
uint32_t * error_core)

Description:

Pinmux request

Parameters:

services_handle	
port_number	Port Number
pin_number	Pin Number
configuration_value	?
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t service_error_code;

  ErrorCode = SERVICES_pinmux(services_handle, 1, 14, 0, &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_padcontrol

NOTE: Refer to document se-mhu-pinmux-pad_configuration

Syntax:

uint32_t SERVICES_padcontrol(uint32_t services_handle, uint8_t port_number,
uint8_t pin_number, uint8_t configuration_value,
uint32_t * error_core)

Description:

Pad control request.

Parameters:

services_handle	
port_number	Port Number
pin_number	Pin Number
configuration_value	?
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t service_error_code;

  ErrorCode = SERVICES_padcontrol(services_handle, 1, 14, 0, &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_application_ospi_write_key

Syntax:

uint32_t SERVICES_application_ospi_write_key(uint32_t services_handle, uint32_t command, uint8_t *key, uint32_t * error_code)

Description:

Write an AES decryption key to the OSPI registers. The command field indicates whether to use an externally provided key or a key stored in the OTP, and which OSPI to apply it to – OSPI0 or OSPI1.

```
#define OSPI_WRITE_OTP_KEY_OSPI0              0
#define OSPI_WRITE_OTP_KEY_OSPI1              1
#define OSPI_WRITE_EXTERNAL_KEY_OSPI0         2
#define OSPI_WRITE_EXTERNAL_KEY_OSPI1         3
```

Parameters:

services_handle	Service handle
command	Indicates OSPI0/OSPI1 and external/OTP key
key	Buffer containing print data
error_code	Service error code

Returns:

Restrictions:
None

Example:

SERVICES_SRAM_retention_config

Syntax:

```
uint32_t SERVICES_SRAM_retention_config(uint32_t services_handle,
                                        uint32_t sram_mem_retention,
                                        uint32_t *service_error_code);
```

Description:
Configure retention for global SRAM0 or SRAM1

Parameters:

services_handle	Service handle
sram_mem_retention	Which SRAM
service_error_code	Return error code

```
#define POWER_MEM_RETENTION_SRAM0 0x30

#define POWER_MEM_RETENTION_SRAM1 0x31
```

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Service_error_code ERROR_POWER_SRAM_RETENTION_INVALID Incorrect SRAM bank specified.

Restrictions:
REV_A1 does not configure any retention.

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;

  uint32_t service_error_code;

  error_code = SERVICES_SRAM_retention_config(services_handle,

                                              POWER_MEM_RETENTION_SRAM0,

                                              &service_error_code);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

Power Services

Please see other documentation on how the Ensemble series implements Power modes. The following is details regarding the SERVICES APIs not a deep dive in how they are implemented.

SERVICES_power_stop_mode_request

Syntax:

uint32_t SERVICES_power_stop_mode_request(uint32_t services_handle)

Description:

Request the Secure Enclave to enter stop mode.

Parameters:

services_handle

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;

  error_code = SERVICES_power_stop_mode_request(services_handle);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_power_ewic_config

Syntax:

uint32_t SERVICES_power_ewic_config(uint32_t services_handle,

uint32_t ewic_source);

Description:

Configure the EWIC

Parameters:

services_handle	
ewic_source	EWIC source

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
  uint32_t ewic_config;

  ewic_config &= (1 << 6);
  error_code = SERVICES_power_ewic_config(services_handle,
                                          ewic_config);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_wakeup_config

Syntax:

uint32_t SERVICES_power_wakeup_config(uint32_t services_handle,

uint32_t vbat_wakeup_source,

services_power_profile_t power_profile)

Description:

Configure the wake up source

Parameters:

services_handle

vbat_wakeup_source Wake up source

```
typedef enum
{
  VBAT_WAKEUP_MDM             = 0x1,          // bit0
  VBAT_WAKEUP_RTC_SE          = 0x10,         // bit4
  VBAT_WAKEUP_RTC_A           = 0x20,         // bit5
  VBAT_WAKEUP_LPCMP           = 0x40,         // bit6
  VBAT_WAKEUP_BROWN_OUT       = 0x80,         // bit7
  VBAT_WAKEUP_LPTIMER         = 0XF00,        // bit11:8
  VBAT_WAKEUP_LPGPIO          = 0XFF0000,     // bit23:16
} SERVICES_wakeup_cfg_t;
```

power_profile Power profile

```
typedef enum
{
  LOWEST_POWER_PROFILE = 0,       /**< LOWEST_POWER_PROFILE */
  HIGH_PERFORMANCE_POWER_PROFILE,/**< HIGH_PERFORMANCE_POWER_PROFILE */
  USER_SPECIFIED_PROFILE,         /**< USER_SPECIFIED_PROFILE */
  DEFAULT_POWER_PROFILE,          /**< DEFAULT_POWER_PROFILE */
  NUMBER_OF_POWER_PROFILES        /**< NUMBER_OF_POWER_PROFILES */
} services_power_profile_t;
```

Returns:

`ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE`

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;

  error_code = SERVICES_power_wakeup_config(services_handle,
                                            VBAT_WAKEUP_RTC_SE
                                            | VBAT_WAKEUP_RTC_A,
                                            LOWEST_POWER_PROFILE);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_mem_retention_config

Syntax:

uint32_t

SERVICES_power_mem_retention_config(uint32_t services_handle,

uint32_t mem_retention,

services_power_profile_t power_profile)

Description:

Configure memory retention.

Parameters:

services_handle

mem_retention Memory to be retained.

```
// Memory retention bit encoding for mem_retention_enable
#define POWER_MEM_RET_FIREWALL_RAM             0x01UL
#define POWER_MEM_RET_SE_SRAM                  0x02UL
#define POWER_MEM_RET_BACKUP_RAM_4KB           0x04UL
// M55-HE TCM RET1: ITCM 0-128kb; DTCM 0-128kb
#define POWER_MEM_RET_ES1_TCM_RET1             0x08UL
// M55-HE TCM RET1: ITCM 128-256kb; DTCM 128-256kb
#define POWER_MEM_RET_ES1_TCM_RET2             0x10UL
// XTENSA TCM RET1: ITCM 128-512kb
#define POWER_MEM_RET_XTENSA_TCM_RET1          0x20UL
// XTENSA TCM RET1: ITCM 64-128kb
#define POWER_MEM_RET_XTENSA_TCM_RET2          0x40UL
// XTENSA TCM RET1: ITCM 0-64kb
#define POWER_MEM_RET_XTENSA_TCM_RET3          0x80UL
// M55-M TCM RET1: ITCM 1MB; DTCM 384kb
#define POWER_MEM_RET_M55_M_TCM_RET1           0x100UL
#define POWER_MEM_RET_MODEM_BACKUP_RAM_16KB    0x200UL
```

power_profile Power profile

```
typedef enum
{
  LOWEST_POWER_PROFILE = 0,      /**< LOWEST_POWER_PROFILE */
  HIGH_PERFORMANCE_POWER_PROFILE,/**< HIGH_PERFORMANCE_POWER_PROFILE */
  USER_SPECIFIED_PROFILE,        /**< USER_SPECIFIED_PROFILE */
  DEFAULT_POWER_PROFILE,         /**< DEFAULT_POWER_PROFILE */
  NUMBER_OF_POWER_PROFILES       /**< NUMBER_OF_POWER_PROFILES */
} services_power_profile_t;
```

Returns:

```
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE
```

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;

  error_code = SERVICES_power_mem_retention_config(services_handle,
                                                   POWER_MEM_RETENTION_SE_RAM,
                                                   LOWEST_POWER_PROFILE);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_m55_he_vtor_save

Syntax:

```
SERVICES_power_m55_he_vtor_save(uint32_t services_handle,
                uint32_t ns_vtor_addr,
                uint32_t se_vtor_addr,
                services_power_profile_t power_profile)
```

Description:

m55-he VTOR value save for wake up

Parameters:

services_handle	
ns_vtor_addr	Non-secure VTOR address
se_vtor_addr	Secure VTOR address
power_profile	Power profile

```
typedef enum
{
  LOWEST_POWER_PROFILE = 0,       /**< LOWEST_POWER_PROFILE */
  HIGH_PERFORMANCE_POWER_PROFILE,/**< HIGH_PERFORMANCE_POWER_PROFILE */
  USER_SPECIFIED_PROFILE,         /**< USER_SPECIFIED_PROFILE */
  DEFAULT_POWER_PROFILE,          /**< DEFAULT_POWER_PROFILE */
  NUMBER_OF_POWER_PROFILES        /**< NUMBER_OF_POWER_PROFILES */
} services_power_profile_t;
```

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;

    error_code = SERVICES_power_m55_he_vtor_save(services_handle,
                                                 0x0,
                                                 0x0,
                                                 LOWEST_POWER_PROFILE);
  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_m55_hp_vtor_save

Syntax:

```
SERVICES_power_m55_hp_vtor_save(uint32_t services_handle,
                                uint32_t ns_vtor_addr,
                                uint32_t se_vtor_addr,
                                services_power_profile_t power_profile)
```

Description:

m55-hp VTOR value save for wake up

Parameters:

services_handle	
ns_vtor_addr	Non-secure VTOR address
se_vtor_addr	Secure VTOR address
power_profile	Power profile

```
typedef enum
{
  LOWEST_POWER_PROFILE = 0,      /**< LOWEST_POWER_PROFILE */
  HIGH_PERFORMANCE_POWER_PROFILE,/**< HIGH_PERFORMANCE_POWER_PROFILE */
  USER_SPECIFIED_PROFILE,        /**< USER_SPECIFIED_PROFILE */
  DEFAULT_POWER_PROFILE,         /**< DEFAULT_POWER_PROFILE */
  NUMBER_OF_POWER_PROFILES       /**< NUMBER_OF_POWER_PROFILES */
} services_power_profile_t;
```

Returns:

ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;

    error_code = SERVICES_power_m55_hp_vtor_save(services_handle,
                                                 0x0,
                                                 0x0,
                                                 LOWEST_POWER_PROFILE);
  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_corestone_standby_mode

Syntax:

SERVICES_corestone_standby_mode (uint32_t services_handle,

host_cpu_clus_pwr_req_t host_cpu_clus_pwr_req,

bsys_pwr_req_t bsys_pwr_req,

uint32_t *error_code)

Description:

Function to configure corestone standby mode

Parameters:

services_handle	
host_cpu_clus_pwr_req	Host CPU cluster power state request configuration
bsys_pwr_req	Base system power request configuration
power_profile	Power profile

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
    host_cpu_clus_pwr_req_t host_cpu_clus_pwr_req;
    bsys_pwr_req_t bsys_pwr_req;

    host_cpu_clus_pwr_req.word = 0;
    host_cpu_clus_pwr_req.bits.mem_ret_req = 0;
    host_cpu_clus_pwr_req.bits.pwr_req = 1;

    bsys_pwr_req.word = 0;
    bsys_pwr_req.bits.systop_pwr_req = 1;
    bsys_pwr_req.bits.dbgtop_pwr_req = 0;
    bsys_pwr_req.bits.refclk_req = 1;
    bsys_pwr_req.bits.wakeup_en = 0;


    error_code = SERVICES_corestone_standby_mode(services_handle,
                                              host_cpu_clus_pwr_req,
                                              bsys_pwr_req,
                                              &service_error_code);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_memory_req

Syntax:

```
uint32_t SERVICES_power_memory_req(uint32_t services_handle,
                                   uint32_t memory_request,
                                   uint32_t *error_code)
```

Description:

Function to disable power to SERAM0, SERAM1 or MRAM

The following are Memory requests:

```
POWER_MEM_SRAM_0_ENABLE
POWER_MEM_SRAM_1_ENABLE
POWER_MEM_SRAM_0_ISOLATION_ENABLE
POWER_MEM_SRAM_1_ISOLATION_ENABLE
POWER_MEM_MRAM_ENABLE
```

NOTE: This is subject to change

Parameters:

services_handle	
memory_request,	Which Memory to deal with

Returns:

`ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE`

Restrictions:

MRAM may not be able to be disabled directly (To be checked on real device).

Example:

```
int main (void)
{
  error_code = SERVICES_power_memory_req(services_handle,
                                        (POWER_MEM_SRAM_0_ENABLE |
                                         POWER_MEM_SRAM_1_ISOLATION_ENABLE),
                                        &return_error_code);


  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_get_run_cfg

Syntax:

uint32_t SERVICES_get_run_cfg(uint32_t services_handle,
run_profile_t *pp,
uint32_t *error_code);

Description:

Retrieve the current RUN mode status.

Parameters:

services_handle	
pp	Run mode parameter block.
error_code	Return error code

Returns:

ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
  run_profile_t runp;

  error_code = SERVICES_get_run_cfg(services_handle, &runp,
                                    &service_error_code);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_set_run_cfg

Syntax:

uint32_t SERVICES_set_run_cfg(uint32_t services_handle,
run_profile_t *pp,
uint32_t *error_code);

Description:

Set the RUN mode parameters.

Parameters:

services_handle	
pp	Run mode parameters.
error_code	Return error code

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
  run_profile_t runp;

  error_code = SERVICES_set_run_cfg(services_handle, &runp,
                                    &service_error_code);


  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_get_off_cfg

Syntax:

uint32_t SERVICES_get_off_cfg(uint32_t services_handle,
off_profile_t *wp,
uint32_t *error_code);

Description:

Retrieved the current OFF mode parameters.

Parameters:

services_handle	
wp	Off mode parameter block
error_code	Return error code

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
                                          ewic_config);
  off_profile_t off_mode;

  error_code = SERVICES_set_off_cfg(services_handle,
                                    &off_mode,
                                    &service_error_code);


  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_set_off_cfg

Syntax:

```
uint32_t SERVICES_set_off_cfg(uint32_t services_handle,
                              off_profile_t *wp,
                              uint32_t *error_code);
```

Description:

Set the OFF-mode parameters.

Parameters:

services_handle	
wp	off mode parameter block
error_code	Return error

Returns:
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE

Restrictions:

Example:

```
int main (void)
{
  uint32_t error_code = SERVICES_REQ_SUCCESS;
  off_profile_t off_mode;

  error_code = SERVICES_get_off_cfg(services_handle,
                                    &runp,
                                    &service_error_code);

  if (error_code != SERVICES_REQ_SUCCESS)
  {
    return error_code;
  }
}
```

SERVICES_power_dcdc_voltage_control

Syntax:

```
uint32_t
SERVICES_power_dcdc_voltage_control(uint32_t services_handle,
                                    uint32_t dcdc_vout_sel,
                                    uint32_t dcdc_vout_trim,
                                    uint32_t *error_code)
```

Description:

Sets the DCDC voltage and trimming.

Parameters:

services_handle	
dcdc_vout_sel	Selection shift
dcdc_vout_trim	Trimming shift
error_code	Return error

Returns:
`ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE`

Restrictions:

Example:

SERVICES_power_ldo_voltage_control

Syntax:

```
uint32_t
SERVICES_power_ldo_voltage_control(uint32_t services_handle,
                                   uint32_t ret_ldo_voltage,
                                   uint32_t aon_ldo_voltage,
                                   uint32_t *error_code)
```

Description:

LDO voltage control

Parameters:

services_handle	
ret_ldo_voltage	retention voltage
aon_ldo_voltage	AON voltage
error_code	Return error

Returns:

```
ErrorCode - SERVICES_REQ_SUCCESS, SERVICES_REQ_CANNOT_EXECUTE_SERVICE
```

SERVICES_power_setting_configure

Syntax:

uint32_t SERVICES_power_setting_configure(uint32_t services_handle, power_setting_t setting_type, uint32_t value, uint32_t *error_code)

```
typedef enum {
  POWER_SETTING_BOR_EN,
  POWER_SETTING_SCALED_CLK_FREQ,
} power_setting_t;
```

Description:

Configure a power-related setting. Currently, BOR_EN and SCALED_CLK_FREQ are supported.

Parameters:

services_handle	
setting_type	Power setting type
value	Setting value
error code	Service error code

Returns:

Transport layer error code

SERVICES_power_setting_get

Syntax:

uint32_t SERVICES_power_setting_get(uint32_t services_handle, power_setting_t setting_type, uint32_t *value, uint32_t *error_code)

Description:

Get a power-related setting. Currently, BOR_EN and SCALED_CLK_FREQ are supported.

Parameters:

services_handle	
setting_type	Power setting type
value	Setting value
error code	Service error code

Returns:

Transport layer error code

Clocks Services

Services to control the Clock, PLL and XTAL (High-frequency external oscillator) settings.

SERVICES_clocks_select_osc_source

Syntax:

uint32_t SERVICES_clocks_select_osc_source (uint32_t services_handle, oscillator_source_t source, oscillator_target_t target, uint32_t * error_code)

Description:

Selects between RC or XTAL clock source for various modules (HF or LF). The selected clock is referred to as the 'OSC' clock.

Parameters:

services_handle	
source	RC or XTAL (either HF or LF, depending on the target)
target	SYS clocks, PERIPH clocks, S32K clock
error code	Service error code

Returns:
Transport layer error code

SERVICES_clocks_select_pll_source

Syntax:

uint32_t SERVICES_clocks_select_pll_source(uint32_t services_handle, pll_source_t source, pll_target_t target, uint32_t * error_code)

Description:

Select OSC or PLL as the source clock for various modules.

Parameters:

services_handle	
source	OSC or PLL
target	SYSREFCLK, SYSCLK, ES0, ES1
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_enable_clock

Syntax:

uint32_t SERVICES_clocks_enable_clock(uint32_t services_handle, clock_enable_t clock, bool enable, uint32_t * error_code)

Description:

Enable or disable a clock.

Parameters:

services_handle	
clock	Clock to enable or disable
enable	Enable/disable flag
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_set_ES0_frequency

Syntax:

uint32_t SERVICES_clocks_set_ES0_frequency(uint32_t services_handle, clock_frequency_t frequency, uint32_t * error_code)

Description:

Set the frequency of External System 0 (M55-HP).

Parameters:

services_handle	
frequency	Frequency to set
error code	Service error code

Returns:
Transport layer error code

SERVICES_clocks_set_ES1_frequency

Syntax:

uint32_t SERVICES_clocks_set_ES1_frequency(uint32_t services_handle, clock_frequency_t frequency, uint32_t * error_code)

Description:

Set the frequency of External System 1 (M55-HE).

Parameters:

services_handle	
frequency	Frequency to set
error code	Service error code

Returns:
Transport layer error code

SERVICES_clocks_select_a32_source

Syntax:

uint32_t SERVICES_clocks_select_a32_source (uint32_t services_handle, a32_source_t source, uint32_t * error_code)

Description:

Selects the clock source for the A32 CPU cores.

Parameters:

services_handle	
source	Clock source – CPUPLL, SYSPLL, REFCLK, Clock gate
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_select_aclk_source

Syntax:

uint32_t SERVICES_clocks_select_aclk_source (uint32_t services_handle, aclk_source_t source, uint32_t * error_code)

Description:

Selects the clock source for the AXI bus.

Parameters:

services_handle	
source	Clock source – SYSPLL, REFCLK, Clock gate
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_set_divider

Syntax:

uint32_t SERVICES_clocks_set_divider (uint32_t services_handle, clock_divider_t divider, uint32_t value, uint32_t * error_code)

Description:

Selects the value of a clock divider.

Parameters:

services_handle	
divider	Which divider to set – CPUPLL, SYSPLL, ACLK (Corstone), HCLK, PCLK (Alif)
value	Divider value. 0x0 to 0x1F for Corstone dividers, 0x0 to 0x2 for Alif divider
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_get_clocks

Syntax:

```
uint32_t SERVICES_clocks_get_clocks(uint32_t services_handle,
                                    clk_get_clocks_svc_t **pp_svc,
                                    uint32_t * error_code)
```

Description:

Get the values of the clocks registers.

Parameters:

services_handle	
pp_svc	Return values of clocks registers
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_get_apb_frequency

Syntax:

```
uint32_t SERVICES_clocks_get_apb_frequency(uint32_t services_handle,
                                           uint32_t *frequency,
                                           uint32_t *error_code)
```

Description:

Get the values of the APB clocks frequency.

Parameters:

services_handle	
frequency	Return frequency
error code	Service error code

Returns:

Transport layer error code

SERVICES_clocks_get_refclk_frequency

Syntax:

```
uint32_t SERVICES_clocks_get_refclk_frequency(uint32_t services_handle,
                                              uint32_t *frequency,
                                              uint32_t *error_code)
```

Description:

Get the values of the REFCLK frequency.

Parameters:

services_handle	
frequency	Return frequency
error code	Service error code

Returns:

Transport layer error code

SERVICES_pll_xtal_start

Syntax:

uint32_t SERVICES_pll_xtal_start(uint32_t services_handle, bool faststart, bool boost, uint32_t delay_count, uint32_t * error_code)

Description:

Start the external HF crystal.

Parameters:

services_handle	
faststart	Enable ‘fast start’ mode
boost	Enable ‘boost’ mode
delay_count	Timeout to wait for crystal startup
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_xtal_stop

Syntax:

uint32_t SERVICES_pll_xtal_stop(uint32_t services_handle, uint32_t * error_code)

Description:

Stop the external HF crystal.

Parameters:

services_handle	
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_xtal_is_started

Syntax:

uint32_t SERVICES_pll_xtal_is_started(uint32_t services_handle, bool * is_started, uint32_t * error_code)

Description:

Check if the external HF Crystal is started.

Parameters:

services_handle	
is_started	External HF Crystal started status
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_clkpll_start

Syntax:

uint32_t SERVICES_pll_clkpll_start(uint32_t services_handle, bool faststart, uint32_t delay_count, uint32_t * error_code)

Description:

Start the PLL.

Parameters:

services_handle	
faststart	Enable ‘fast start’ mode
delay_count	Timeout to wait for PLL lock
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_clkpll_stop

Syntax:

uint32_t SERVICES_pll_clkpll_stop(uint32_t services_handle, uint32_t * error_code)

Description:

Stop the PLL.

Parameters:

services_handle	
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_clkpll_is_locked

Syntax:

uint32_t SERVICES_pll_clkpll_is_locked(uint32_t services_handle, bool * is_locked, uint32_t * error_code)

Description:

Check if the PLL is started and locked.

Parameters:

services_handle	
is_locked	PLL locked status
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_initialize

Syntax:

uint32_t SERVICES_pll_initialize(uint32_t services_handle, uint32_t * error_code)

Description:

Initialize the device to enable XTAL and PLL and switch all clocks to PLL.

Parameters:

services_handle	
error code	Service error code

Returns:
Transport layer error code

SERVICES_pll_deinit

Syntax:

uint32_t SERVICES_pll_deinit(uint32_t services_handle, uint32_t * error_code)

Description:

De-initialize the device – switch all clocks to TC and disable XTAL and PLL.

Parameters:
services_handle
error code   Service error code

Returns:
Transport layer error code

Boot Services

Most Services in this group have a cpu_id parameter. The supported CPU ids are –

HOST_CPU_0	A32_0
HOST_CPU_1	A32_1
EXTSYS_0	M55 HP CPU or other CPU
EXTSYS_1	M55 HE CPU

SERVICES_boot_process_toc_entry

Syntax:

uint32_t SERVICES_boot_process_toc_entry(uint32_t services_handle, const uint8_t * entry_id, uint32_t *error_code)

Description:

Request to process a TOC entry. Depending on the information in the TOC entry, this could result in the booting of a CPU core.

This is a higher-level function compared to the other Boot services and is a convenient way to boot a CPU core.

Parameters:

services_handle

entry_id	ID of the TOC entry to process. The 'entry_id' field is 8 bytes in size, matching the corresponding TOC entry field 'image_identifier'.
error_code	Service Error Code

Returns:

Restrictions:
None

SERVICES_boot_cpu

Syntax:

uint32_t SERVICES_boot_cpu(uint32_t services_handle, uint32_t cpu_id, uint32_t address, uint32_t * error_code)

Description:

Request to boot a CPU core.

This service does not perform image loading, verification, etc., it just boots the core, specifying the boot address. You would need to use an ATOC to achieve these.

For the M55 cores, there are cases in which this service does not work. The currently known case is the M55-HP core in FUSION REV_Bx devices, where resetting the core also invalidates its TCM content. For that reason, it is recommended that the M55 cores are booted using one of the following methods –

- SERVICES_boot_process_toc_entry().
- SERVICES_set_vtor(), SERVICES_reset_cpu(), and SERVICES_release_cpu(), described in the next sections.

Parameters:

services_handle	
cpu_id	ID of the CPU to boot
address	Boot address for the CPU
error_code	Service Error Code

Returns:

Restrictions:
None

SERVICES_boot_set_vtor

Syntax:

uint32_t SERVICES_boot_set_vtor(uint32_t services_handle, uint32_t cpu_id, uint32_t address, uint32_t * error_code)

Description:

Request to initialize the VTOR value for a M55 CPU core.

Note that the address value is stored in a Global register, not in the CPU's internal VTOR register. To transfer the address to the internal VTOR, call SERVICES_reset_cpu() after this call.

Parameters:

services_handle	
cpu_id	ID of the CPU to boot
address	The address to be stored in the VTOR
error_code	Service Error Code

Returns:

Restrictions:
EXT_SYS0 is not a valid operation on Ensemble devices.

SERVICES_boot_reset_cpu

Syntax:

uint32_t SERVICES_boot_reset_cpu(uint32_t services_handle, uint32_t cpu_id, uint32_t * error_code)

Description:

Request to reset a CPU core, which effectively stops the core. For M55 cores, it also transfers the VTOR value from the Global VTOR register to the CPU's internal VTOR.

Parameters:

services_handle	
cpu_id	ID of the CPU to boot
error_code	Service Error Code

Returns:

Restrictions:
None

SERVICES_boot_release_cpu

Syntax:

uint32_t SERVICES_boot_release_cpu(uint32_t services_handle, uint32_t cpu_id, uint32_t * error_code)

Description:

Request to release a CPU core. This service does not perform image loading, verification, etc., and does not reset the CPU or specify the boot address, it just releases the core.

If the CPU is not running, this function can be called to release it.

If the CPU is running, SERVICES_boot_reset_cpu() must be called before this function to stop the core.

Notes on releasing M55 cores –

- in some cases, resetting the core also invalidates its TCM. A known case is the M55-HP core in Ensemble devices. Because of that, after calling SERVICES_boot_reset_cpu() to stop the core, the image in the TCM must be reloaded, before calling SERVICES_boot_release_cpu() to start the core.
- If the VTOR value of the core needs to be changed, that too requires calling SERVICES_boot_reset_cpu(), to transfer the new address value to the core's internal VTOR.
  So, the call order of services in this case is –
  1. SERVICES_boot_set_vtor(),
  2. SERVICES_boot_reset_cpu(),
  3. load the image in the TCM, 3. SERVICES_boot_release_cpu().

Parameters:

services_handle	
cpu_id	ID of the CPU to boot
error_code	Service Error Code

Returns:

Restrictions:

SERVICES_boot_reset_soc

Syntax:

uint32_t SERVICES_boot_reset_soc(uint32_t services_handle)

Description:

Request to reset the entire SoC.

Parameters:

services_handle

Returns:

Restrictions:
None

Crypto Services

The SE provides several crypto services to other cores as detailed below.

SERVICES_cryptocell_get_rnd

Syntax:

uint32_t SERVICES_cryptocell_get_rnd(uint32_t services_handle, uint16_t rnd_length, void * rnd_value, uint32_t * error_code)

Description:

Request random number.

The service SERVICES_cryptocell_get_rnd returns a random vector generated by the cryptocell-rt library using the MBedTLS API call mbedtls_ctr_drbg_random().

The desired length of the vector to generate is passed as an input parameter. Currently, the maximum supported vector length is 128 bytes.

Parameters:

services_handle	
rnd_length	Length of random number vector
rnd_value	returned Random number
error_code	Service Error Code

None

Returns:

Restrictions:

None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint64_t rnd_value;
  uint32_t service_error_code;

  ErrorCode = SERVICES_cryptocell_get_rnd(services_handle,
                 sizeof(uint64_t),/* random number/vector length in bytes*/
                 &rnd_value,
            &service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

SERVICES_cryptocell_get_lcs

Syntax:

uint32_t SERVICES_cryptocell_get_lcs(uint32_t services_handle, uint32_t *lcs_state, uint32_t * error_code)

Description:
The service SERVICES_cryptocell_get_lcs returns the current Life Cycle State.

Parameters:

services_handle	
lcs_state	Life cycle state
error_code	Service Error Code

Returns:

Restrictions:
None

Example:

```
int main (void)
{
  uint32_t ErrorCode = SERVICES_OK;
  uint32_t lcs_state;
  uint32_t service_error_code

  ErrorCode = SERVICES_cryptocell_get_lcs(services_handle, &lcs_state,
&service_error_code);
  if (ErrorCode != SERVICES_REQ_SUCCESS)
  {
    return ErrorCode;
  }
}
```

MbedTLS Services

These services expose the hardware accelerated functionality provided by the Arm CryptoCell-RT library in SES.

Arm has chosen to use MbedTLS as the public API to that functionality. For that reason, the exposed Services correspond to MbedTLS public APIs.

IMPORTANT: **These Services are not intended to be used directly by applications**. Instead, they should be used by a client-side MbedTLS library implementation in which hardware acceleration is done by calling the Services.

To simplify the Services APIs and to avoid introducing MbedTLS types into them, all parameters of the MbedTLS functions are passed as uint32_t. The client-side MbedTLS implementation must convert them to the appropriate types. Also, to reduce the number of Service APIs, some of them cover multiple MbedtTLS API functions.

Please refer to the MbedTLS documentation for more information on these APIs, usage and parameters.

SERVICES_cryptocell_mbedtls_hardware_poll

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_hardware_poll(uint32_t services_handle,
                                   uint32_t * error_code,
                                   uint32_t data,
                                   uint32_t output,
                                   uint32_t len,
                                   uint32_t olen)
```

Description:

Service API replacement for mbedtls_hardware_poll()

SERVICES_cryptocell_mbedtls_aes_init

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_aes_init(uint32_t services_handle,
                                   uint32_t * error_code,
                                   uint32_t ctx)
```

Description:

Service API replacement for mbedtls_aes_init()

SERVICES_cryptocell_mbedtls_aes_set_key

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_aes_set_key(uint32_t services_handle,
                                   uint32_t * error_code,
                                         uint32_t ctx,
                                         uint32_t key,
                                         uint32_t keybits,
                                         uint32_t dir)
```

Description:
Service API replacement for mbedtls_aes_set_key_enc() and mbedtls_aes_set_key_dec()

SERVICES_cryptocell_mbedtls_aes_crypt

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_aes_crypt(uint32_t services_handle,
                                        uint32_t * error_code,
                                        uint32_t ctx,
                                        uint32_t crypt_type,
                                        uint32_t mode,
                                        uint32_t length,
                                        uint32_t iv,
                                        uint32_t input,
                                        uint32_t output)
```

Description:
Service API replacement for the mbedtls_aes_crypt_XXX functions

SERVICES_cryptocell_mbedtls_sha_starts

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_sha_starts(uint32_t services_handle,
                                         uint32_t * error_code,
                                         uint32_t ctx,
                                         uint32_t sha_type)
```

Description:
Service API replacement for mbedtls_sha_starts()

SERVICES_cryptocell_mbedtls_sha_process

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_sha_process(uint32_t services_handle,
                          uint32_t * error_code,
                          uint32_t ctx,
                          uint32_t sha_type,
                          uint32_t data)
```

Description:
Service API replacement for mbedtls_sha_process()

SERVICES_cryptocell_mbedtls_sha_update

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_sha_update(uint32_t services_handle,
                          uint32_t * error_code,
                          uint32_t ctx,
                          uint32_t sha_type,
                          uint32_t data,
                          uint32_t data_length)
```

Description:
Service API replacement for mbedtls_sha_update()

SERVICES_cryptocell_mbedtls_sha_finish

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_sha_finish(uint32_t services_handle,
                          uint32_t * error_code,
                          uint32_t ctx,
                          uint32_t sha_type,
                          uint32_t data)
```

Description:
Service API replacement for mbedtls_sha_finish()

SERVICES_cryptocell_mbedtls_ccm_gcm_set_key

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_ccm_gcm_set_key(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t key_type,
   uint32_t cipher,
   uint32_t key_addr,
   uint32_t key_bits)
```

Description:
Service API replacement for mbedtls_ccm_set_key() and mbedtls_gcm_set_key()

SERVICES_cryptocell_mbedtls_ccm_gcm_crypt

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_ccm_gcm_crypt(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t crypt_type,
   uint32_t length,
   uint32_t iv_addr,
   uint32_t iv_length,
   uint32_t add_addr,
   uint32_t add_length,
   uint32_t input_addr,
   uint32_t output_addr,
   uint32_t tag_addr,
   uint32_t tag_length)
```

Description:
Service API replacement for the mbedtls CCM and GCM crypto functions

SERVICES_cryptocell_mbedtls_chacha20_crypt

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_chacha20_crypt(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t key_addr,
   uint32_t nonce_addr,
   uint32_t counter,
   uint32_t data_len,
   uint32_t input_addr,
   uint32_t output_addr)
```

Description:
Service API replacement for mbedtl_chacha20_crypt()

SERVICES_cryptocell_mbedtls_chachapoly_crypt

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_chachapoly_crypt(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t crypt_type,
   uint32_t length,
   uint32_t nonce_addr,
   uint32_t aad_addr,
   uint32_t aad_len,
   uint32_t tag_addr,
   uint32_t input_addr,
   uint32_t output_addr)
```

Description:
Service API replacement for the mbedtl chachapoly crypto functions

SERVICES_cryptocell_mbedtls_poly1305_crypt

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_poly1305_crypt(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t key_addr,
   uint32_t input_addr,
   uint32_t ilen,
   uint32_t mac_addr)
```

Description:
Service API replacement for mbedtl_poly1305_mac()

SERVICES_cryptocell_mbedtls_cmac_init_setkey

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_cmac_init_setkey(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t key_addr,
   uint32_t key_bits)
```

Description:
Service API replacement for mbedtls_cmac_init_setkey()

SERVICES_cryptocell_mbedtls_cmac_update

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_cmac_update(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t input_addr,
   uint32_t input_length)
```

Description:
Service API replacement for mbedtls_cmac_update()

SERVICES_cryptocell_mbedtls_cmac_finish

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_cmac_finish(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr,
   uint32_t output_addr)
```

Description:
Service API replacement for mbedtls_cmac_finish()

SERVICES_cryptocell_mbedtls_cmac_reset

Syntax:

```
uint32_t SERVICES_cryptocell_mbedtls_cmac_reset(uint32_t services_handle,
   uint32_t * error_code,
   uint32_t context_addr)
```

Description:
Service API replacement for mbedtls_cmac_finish()

Update Services

SERVICES_update_stoc

Syntax:

```
uint32_t SERVICES_update_stoc(uint32_t services_handle,
                              uint32_t image_address,
                              uint32_t image_size,
                              uint32_t *error_code)
```

Description:

Update the ALIF STOC using the provided image.

This image uses the ALIF Update Package format (as this is used to update the ALIF System FW). Packages are either FULL or PARTIAL.

The processing steps are as follows:

- Stage#1 Check package header is an UPDate package
- Stage#2 Verify UPDate package signature
- Stage#3 Check UPDPackage Part# matches this device
- Stage#4 Write MRAM

Parameters:

services_handle	
image_address	Address of the source of the update image.
Image_size	Size of the update image, only used with UNSIGNED Packages
error_code	

Returns:

BL_ERROR_ENTRY_NOT_SIGNED	0x17	
BL_ERROR_UPD_SIGNATURE_INCORRECT	0x21	Package is not in ALIF UPD format

Restrictions:

The UPDATE Package is supplied by ALIF.

This SERVICE is not intended to be used for Application or Customer Over-the-air updates.

Document History

Version	Change Log
0.41.1	Editing version derived from v0.41 engineering input