

Secure Bootloader Guide

M-20892-004
January 2025

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CHAPTER 1

Introduction

1.1 SUMMARY

IMPORTANT: onsemi plans to lead in replacing the terms “white list”, “master” and “slave” as noted in this product release. We have a plan to work with other companies to identify an industry wide solution that can eradicate non-inclusive terminology but maintains the technical relationship of the original wording. Once new terminologies are agreed upon, we will update all documentation live on the website and in all future released documents.

This group of topics describes the functionality and usage of the secure bootloader with RSL15, along with Platform Security Architecture (PSA) compliance, secure storage, and attestation. RSL15 includes a secure bootloader sample application which can be used by developers to acquire familiarity with the secure bootloader.

1.2 DOCUMENT CONVENTIONS

The following typographical conventions are used in this documentation:

`monospace font`

Assembly code, macros, functions, registers, defines and addresses.

italics

File and path names, or any portion of them.

<angle brackets and bold>

Optional parameters and placeholders for specific information. To use an optional parameter or replace a placeholder, specify the information within the brackets; do not include the brackets themselves.

Bold

GUI items (text that can be seen on a screen).

Note, Important, Caution, Warning

Information requiring special notice is presented in several attention-grabbing formats depending on the consequences of ignoring the information:

NOTE: Significant supplemental information, hints, or tips.

IMPORTANT: Information that is more significant than a Note; intended to help you avoid frustration.

CAUTION: Information that can prevent you from damaging equipment or software.

WARNING: Information that can prevent harm to humans.

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Registers:

Registers are shown in `monospace` font using their full descriptors, depending on which core the register is accessing. The full description takes the form `<PREFIX><GROUP>_<REGISTER>`.

All registers are accessible from the Arm Cortex-M33 processor.

A register prefix of `D_` is used in the following circumstances:

- In cases where there are multiple instances of a block of registers, the summary of the registers at the beginning of the Register section have slightly different names from the detailed register sections below that table. For example, the `DMA*_CFG0` registers are referred to as `DMA_CFG0` when we are defining bit-fields and settings.

The firmware provides access to these registers in two ways:

- In the flat header files (e.g.: `sk5_hw_flat_cid*.h`), each register is individually accessible by directly using the naming provided in this manual. This is helpful for assembly and low-level C programming.
- In the normal header files (e.g.: `sk5_hw_cid*.h`), each register group forms a structure, with the registers being defined as members within that structure. The structures defined by these header files provide access to registers under the naming conventions `PREFIX_GROUP->REGISTER` (for the structure) and `GROUP->REGISTER` (for the register).
- For more information, see the Hardware Definitions chapter of the *Montana Firmware Reference*.

Default settings for registers and bit fields are marked with an asterisk (*).

Any undefined bits must be written to 0, if they are written at all.

Numbers

In general, numbers are presented in decimal notation. In cases where hexadecimal or binary notation is more convenient, these numbers are identified by the prefixes "0x" and "0b" respectively. For example, the decimal number 123456 can also be represented as 0x1E240 or 0b11110001001000000.

Sample Rates

All sample rates specified are the final decimated sample rates, unless stated otherwise.

1.3 FURTHER READING

The following documents are installed with the RSL15 system, in the default location `C:/Users/<your_user_name>/AppData/Local/Arm/Packs/ONSemiconductor/RSL15/<version_number>/documentation`. These manuals are available only in PDF format:

- *Arm TrustZone CryptoCell-312 Software Developers Manual*
- multiple CEVA manuals in the `/ceva` folder

For even more information, consult these publicly-available documents:

- *Armv8M Architecture Reference Manual* (PDF download available from <https://developer.arm.com/documentation/ddi0553/latest>).
- *Arm Cortex-M33 Processor Technical Reference Manual*, revision r1p0, from <https://developer.arm.com/documentation/100230/0100>
- *Bluetooth Core Specification version 5.2*, available from <https://www.bluetooth.com/specifications/adopted-specifications>

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- TrustZone documentation available from the Arm website at <https://developer.arm.com/ip-products/security-ip/trustzone/trustzone-for-cortex-m>
- Other ArmCortex-M33 publications, available from the Arm website at <https://developer.arm.com/ip-products/processors/cortex-m/cortex-m33>

For information about the Evaluation and Development Board Manual and its schematics, go to the [RSL15 web page](#) and navigate to the EVB page.

CHAPTER 2

Overview

The secure bootloader for RSL15 is a reference application, called *secure_bootloader*, which can be used to develop an end product bootloader that operates in a secure manner. The application has the following four modes providing increasing levels of secure operation, available as needed depending on the end product's use cases:

1. Basic bootloader (non-secure)
2. Secure bootloader (maintains authenticated Root of Trust set up by the ROM)
3. Secure bootloader with secure storage
4. Secure bootloader with secure storage and device attestation

More detailed information about these four modes is found in [Chapter 1 "RSL15 Secure Bootloader Usage Options" on page 1](#)

2.1 COMMON FEATURES

The four modes of operation build on each other, with available features in one also being available for the next level. For example, all secure bootloader functionality is still available when using the secure storage mode of operation. This is indicated in the [figure "Bootloader Options" \(Figure 1\)](#).

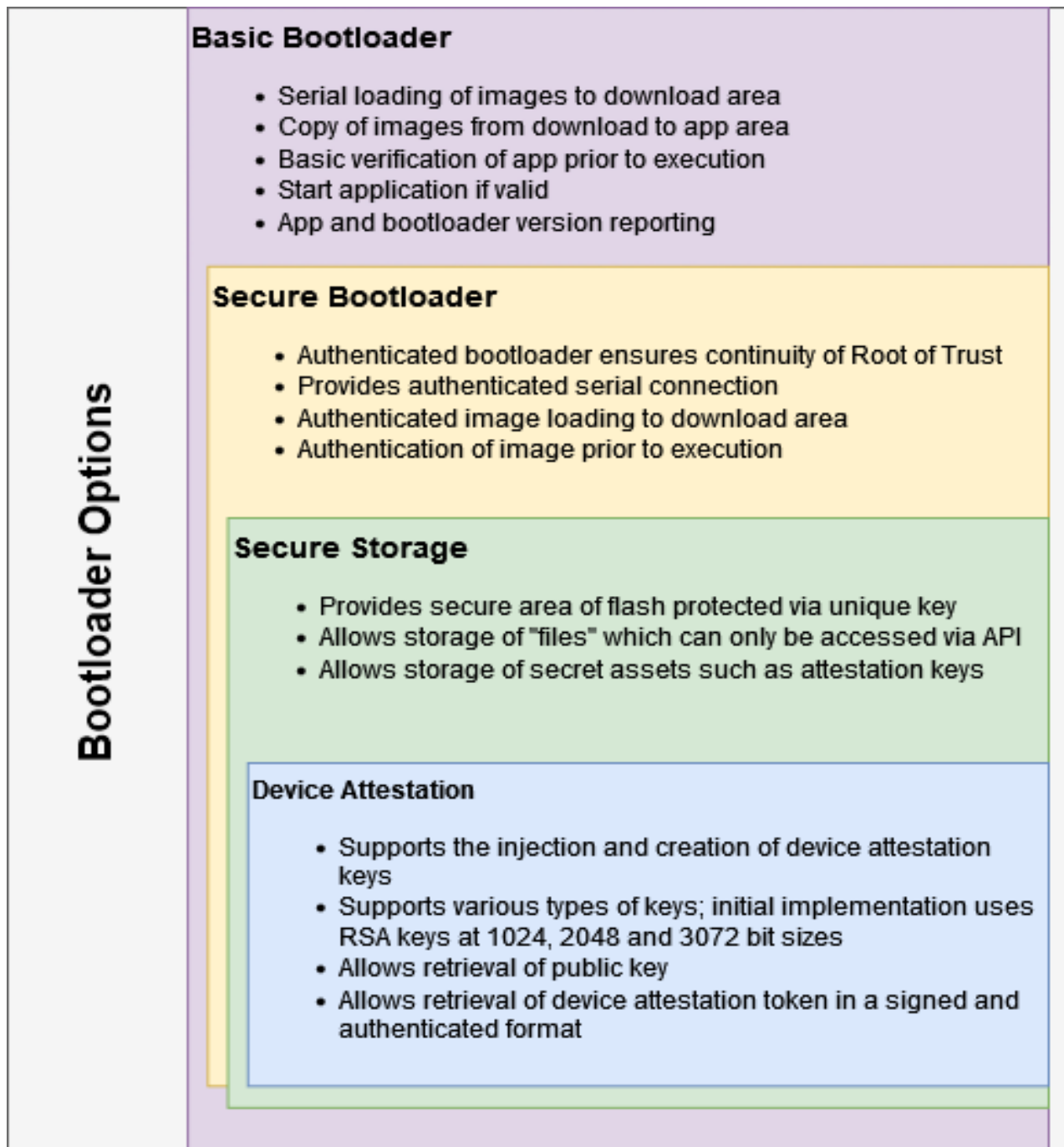


Figure 1. Bootloader Options

The bootloader divides the main flash memory into two areas: the app download area and the app execution area. This division provides a starting point for users who want to use the bootloader for firmware update purposes.

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The bootloader application is the first application entry point after reset. It is located at the base address of the main flash (0x00100000).

Upon start, the bootloader checks the app download area for a valid boot image. This application can be a regular application, or a new bootloader. If there is one, the bootloader copies/overwrites this image into the app execution area, invalidates the data in the download area, and boots this new image. If no valid boot image is found in the download area, the bootloader verifies and boots from the app execution area. If no valid image is found in either area, the bootloader defaults to a mode where the UART can be used to provide updates or perform attestation queries. It prints an error message in the RTT Viewer. Sequence diagrams in [Chapter 4 "Basic Bootloader" on page 23](#), [Chapter 5 "Secure Bootloader" on page 26](#), and [Chapter 7 "Attestation" on page 32](#) show detailed step-by-step procedures.

A valid boot image consists of a binary file generated from a *.hex* file. The *.hex* file is created by building the project as usual, but with certain requirements. A valid boot image for an application must have its *.text* section starting at the base address of the app execution area, instead of at the base address of the main flash. Therefore, making a typical sample application—for example, *blinky*—compatible with the bootloader requires modifications to the linker script (*sections.ld*) and startup code (*startup.S*). An example version of *blinky* is provided along with the secure bootloader, in a *utilities* subfolder. The *sections.ld* file must include the correct start locations and sizes for the sections of flash, and the *startup.S* must include the appropriate update to the IVT (ISR Vector Table) for the image descriptor.

IMPORTANT: For proper operation, the defined app execution area and the application's IVT must be aligned to a 512-byte boundary.

Updating the firmware image, as well as basic attestation operations, can be accomplished using the RSLUpdate utility, packaged along with the RSLSec security tools. Examples of how to use RSLUpdate are included in the readme file of the *secure_bootloader* sample application. More information about the secure operation and updating process is described in [Section 5 "Secure Bootloader" on page 26](#).

When GPIO14 is tied to ground, the device enters the bootloader state, expecting updates via the UART.

When GPIO14 it is not tied to ground, and an update is pending, the device tries to process the update and reset; the bootloader tries to execute an application if one is available; and if no application is available, the device goes into the bootloader state.

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2.2 RSL15 SECURE BOOTLOADER USAGE OPTIONS

2.2.1 Functionality Access Options

The RSL15 secure bootloader sample application includes the following options for accessing increasing levels of functionality depending on the end product needs:

1. Basic bootloader functionality
2. Secure bootloader with support for providing authenticated and validated loading of applications in addition to the bootloader itself
 - Authenticated transport layer
 - Authenticated images verified on load
 - Authenticated images verified again prior to overwriting an existing image
 - Authenticated images booted by the bootloader
3. Secure storage
 - A limited area of flash memory that is allocated as secure storage
 - Enables the storage and retrieval of encrypted assets
 - Simple filing system that also provides storage for general secure storage in addition to asset storage
4. Attestation
 - Support for the injection or creation of attestation keys
 - Attestation keys are stored in secure storage.
 - A public key can be requested from application code using the bootloader interface.
 - Support for an attestation token, which enumerates the hardware and firmware on the device
 - Support for a standard attestation protocol that is robust against replay attacks
 - Optional support for different types of attestation keys:
 - i. AES (not recommended due to lower level of security, and not available in the initial release)
 - ii. RSA (provides the smallest increase in bootloader image size, as RSA is already being included in secure boot features)
 - iii. ECC (provides good balance between small keys, is robust against attack, requires the most application code to support, and is not available in the initial release)

2.2.2 Configuration

The options are provided as preprocessor definitions, and are available in the API file *bl_options.h*.

2.3 MEMORY PARTITIONING OVERVIEW

Depending on the feature set used by the bootloader, the amount of flash memory it occupies can change. This allows a bootloader with a lower feature set to be used in cases where, for instance, the Root of Trust or secure storage is not required. When a reduced feature set bootloader is used, the memory partitioning can be changed, allowing for larger user applications to be loaded.

For illustrative purposes, the [table "Build Configuration Memory Sizes" \(Table 1\)](#) shows the expected sizes of each optional build configuration, with expected allocations of memory for application and download areas depending on build options. The precise values are subject to change depending on the actual optimization levels and feature sets you select, but this provides some guideline figures to help you decide which configuration to use.

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Table 1. Build Configuration Memory Sizes

		Bootloader		Secure Storage		Application		Download	
		Start Address	Size (KB)	Start Address	Size (KB)	Start Address	Size (KB)	Start Address	Size (KB)
Debug	Basic Bootloader	0x100000	24	0	0	0x106000	236	0x141000	236
	Secure Bootloader	0x100000	52	0	0	0x10D000	224	0x145000	224
	Secure Storage	0x100000	64	0x15A400	11	0x110000	212	0x145000	212
	Attestation	0x100000	108	0x15A400	11	0x11B000	192	0x14B000	192
Release	Basic Bootloader	0x100000	16	0	0	0x104000	240	0x140000	240
	Secure Bootloader	0x100000	44	0	0	0x10B000	228	0x144000	228
	Secure Storage	0x100000	52	0x15A400	11	0x10D000	220	0x144000	220
	Attestation	0x100000	92	0x15A400	11	0x117000	200	0x149000	200

Derivation of these start addresses and sizes is available in *bl_memory.h*; this information is output to the RTT Viewer when debugging the secure bootloader in the onsemi IDE with the RTT Viewer connected. This is also shown in the figure "Memory Map Diagram" (Figure 2).

NOTE: There are variations for an RSL15 device with 284 KB of flash rather than 512 KB.

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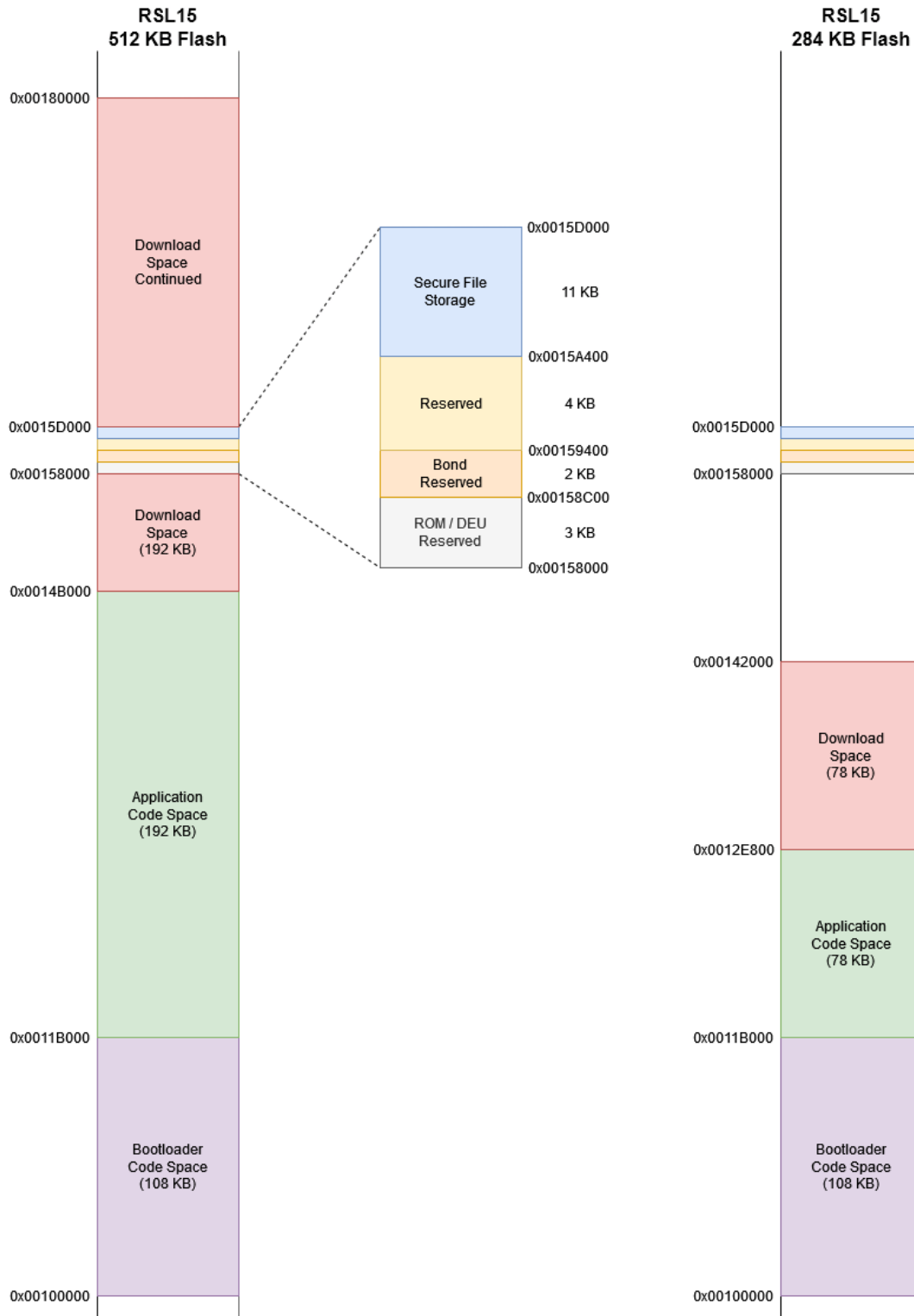


Figure 2. Memory Map Diagram

CHAPTER 3

PSA Compliance Background

The RSL15 secure bootloader is a reference implementation that can be used with associated guidelines to achieve a product that is compliant with Platform Security Architecture (PSA). The RSL15 secure bootloader sample application can be adapted as needed and incorporated into an overall firmware solution. See <https://www.psacertified.org/> for the full background on the PSA certification requirements and components. An overview and the specific implementation details for RSL15 are provided here.

3.1 OVERVIEW OF PSA COMPLIANCE

PSA is a concept originated by Arm and managed by third party labs and certification authorities, with the goal of standardizing the security methods across the varying types of connected devices in the semiconductor industry. It provides established best practices, as well as documentation and methods to determine whether a given device meets the outlined standards.

PSA protects sensitive assets (keys, credentials and firmware) by separating them from the application firmware and hardware. It defines a Secure Processing Environment (SPE) for this data, the code that manages it, and its trusted hardware resources.

The figure "Updatable and Immutable Areas" (Figure 3) shows the updatable and the immutable (non-changable) parts of an RSL15-based system that is intended for PSA compliance and follows the PSA Device Model guidelines. This clearly shows the secure bootloader in relation to the other parts of the system. The secure bootloader forms part of the chip scope, but is also part of the updateable components.

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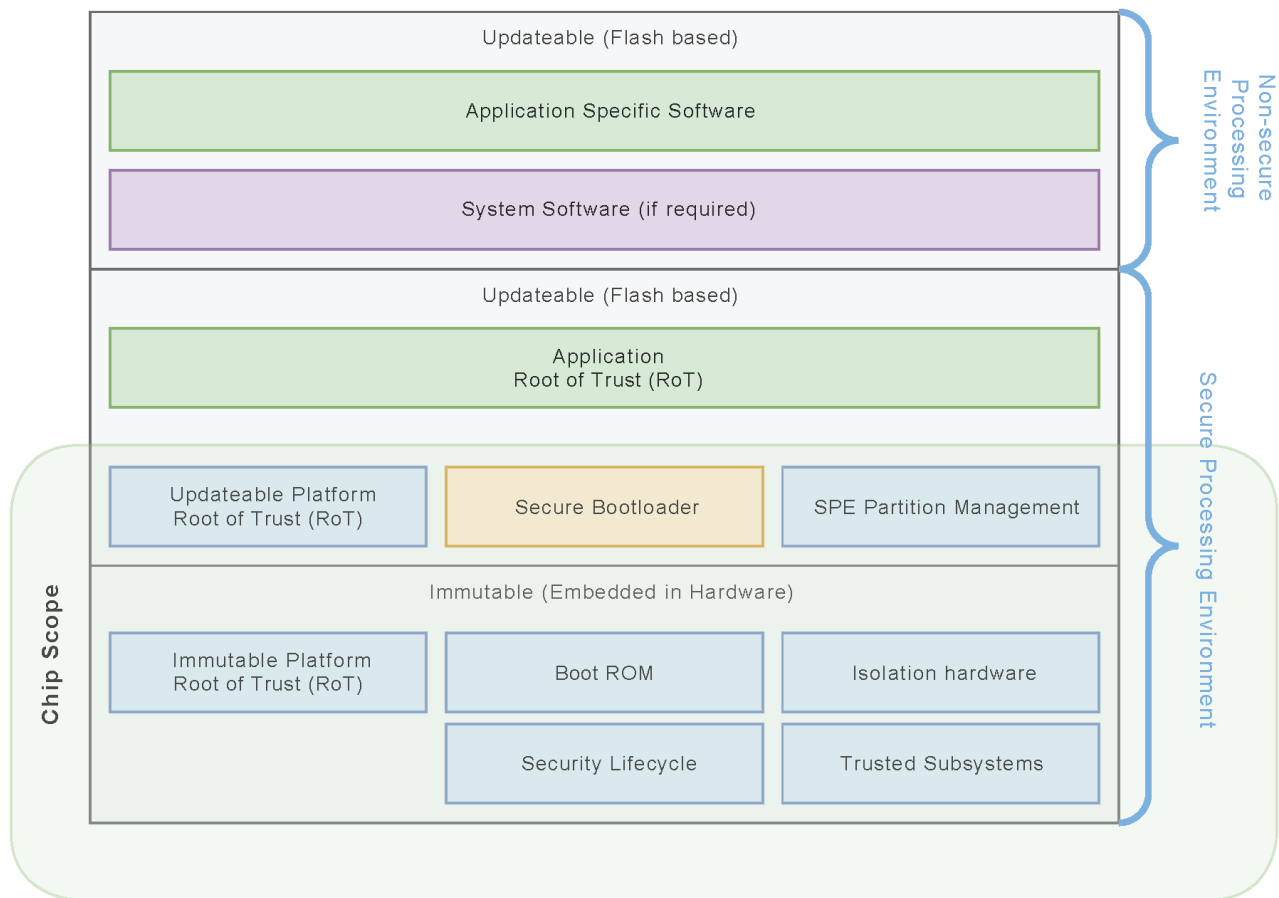


Figure 3. Updateable and Immutable Areas

Similar to the PSA documentation and references available online, we use the following terms in this documentation:

Entity

The device about which the attestation provides information

Manufacturer

The company that made the entity. This can be a chip vendor, a circuit board module vendor, or a vendor of finished consumer products.

Relying Party

The server, service or company that makes use of the information in the Entity Attestation Token (EAT) about the entity. (See [Section 7.3 “Attestation Token” on page 35](#) for more information about the EAT.)

CHAPTER 4

Basic Bootloader

The secure bootloader can be used as a non-secure bootloader if the security features are not needed. In this case, the bootloader provides the following features:

- Booting of an application from flash
- Updating to store a new application in flash
- Updating the bootloader

4.1 GENERAL USAGE

The bootloader must be loaded onto the device. An application to be used with the bootloader must have its start address in the location expected by the bootloader. See [Section 2 “Overview” on page 15](#) for more information.

The [figure "Standard Load and Update Sequence" \(Figure 4\)](#) illustrates the process for updating the application stored in flash.

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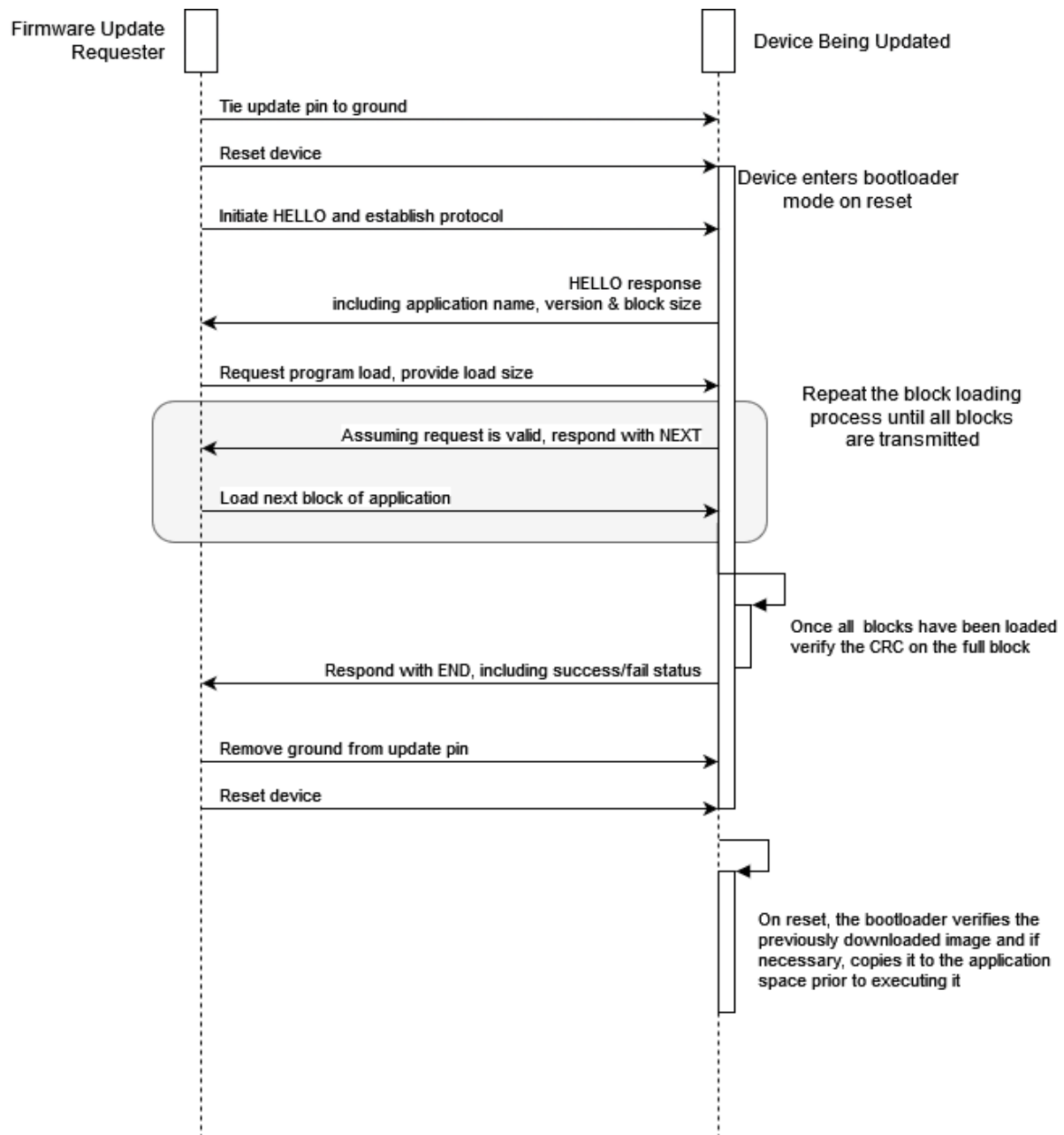


Figure 4. Standard Load and Update Sequence

Each request has a frame consistency sequence on it (a simple CCITT CRC of the data in the request). A block load request includes the length of the application being loaded, and the CRC32 for the whole application. Once a number of blocks have been loaded, the CRC32 is checked to ensure that no frames have been lost or corrupted during transmission. At any stage, if an error is detected (e.g., a timeout or a bad frame), the load process terminates with an END message and an indicator of the reason for the failure.

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The application used in the firmware update process must include *bootloader.h* and use `SYS_BOOT_VERSION` to set the version number of the new application. The bootloader references this information. See the [Device Firmware Update \(DFU\) Guide](#) for further information about this and other basic bootloader features. The standard bootloader sample application is described there, but much of the information is also applicable to the basic bootloader (non-secure) functionality of the secure bootloader operation.

CHAPTER 5

Secure Bootloader

The secure mode of the bootloader provides the following features:

- Booting of a secure application from flash
- Updating to store a new secure application in flash
- Updating the secure bootloader
- Support for PSA (Platform Security Architecture) level 1 compliance

5.1 BOOTING A SECURE APPLICATION

The secure bootloader provides firmware integrity and authenticity validation during a secure or trusted boot process. The main interface consists of an initialization function and a function to authenticate a Root of Trust certificate chain based on a given Root of Trust.

```
blSecureBootStatus_t BL_SecureBootAuthenticate(
    uint32_t opkey1, uint32_t opkey2, uint32_t opcontent,
    bool verifyImages, uint32_t relocation);
```

5.2 UPDATING A SECURE APPLICATION

When a secure application must be updated, the process is as follows:

- Request an update. The bootloader polls a flag to determine if an update is requested, so this must be set.

```
BL_UpdateType_t BL_UpdateIsAvailable(uint32_t address, uint32_t extent);
```

- Provide a new secure application. The bootloader checks if there is a new image in the download area.

```
BL_UpdateType_t BL_UpdateIsAvailable(uint32_t address, uint32_t extent);
```

- Update the image. The bootloader uses the function with this prototype to perform the update.

```
void BL_UpdateImage(BL_UpdateType_t request,
    uint32_t srcAddress, uint32_t dstAddress, uint32_t dstLength);
```

The application must also be authenticated. There are options to share a Root of Trust between the secure application and secure bootloader, such that a tradeoff can be made between boot time and the level of security needed. Alternatively, they can use separate Roots of Trust for increased security, but with increased boot time. The sequence is shown in the [figure "Secure Authenticate/Load/Update Sequence" \(Figure 5\)](#).

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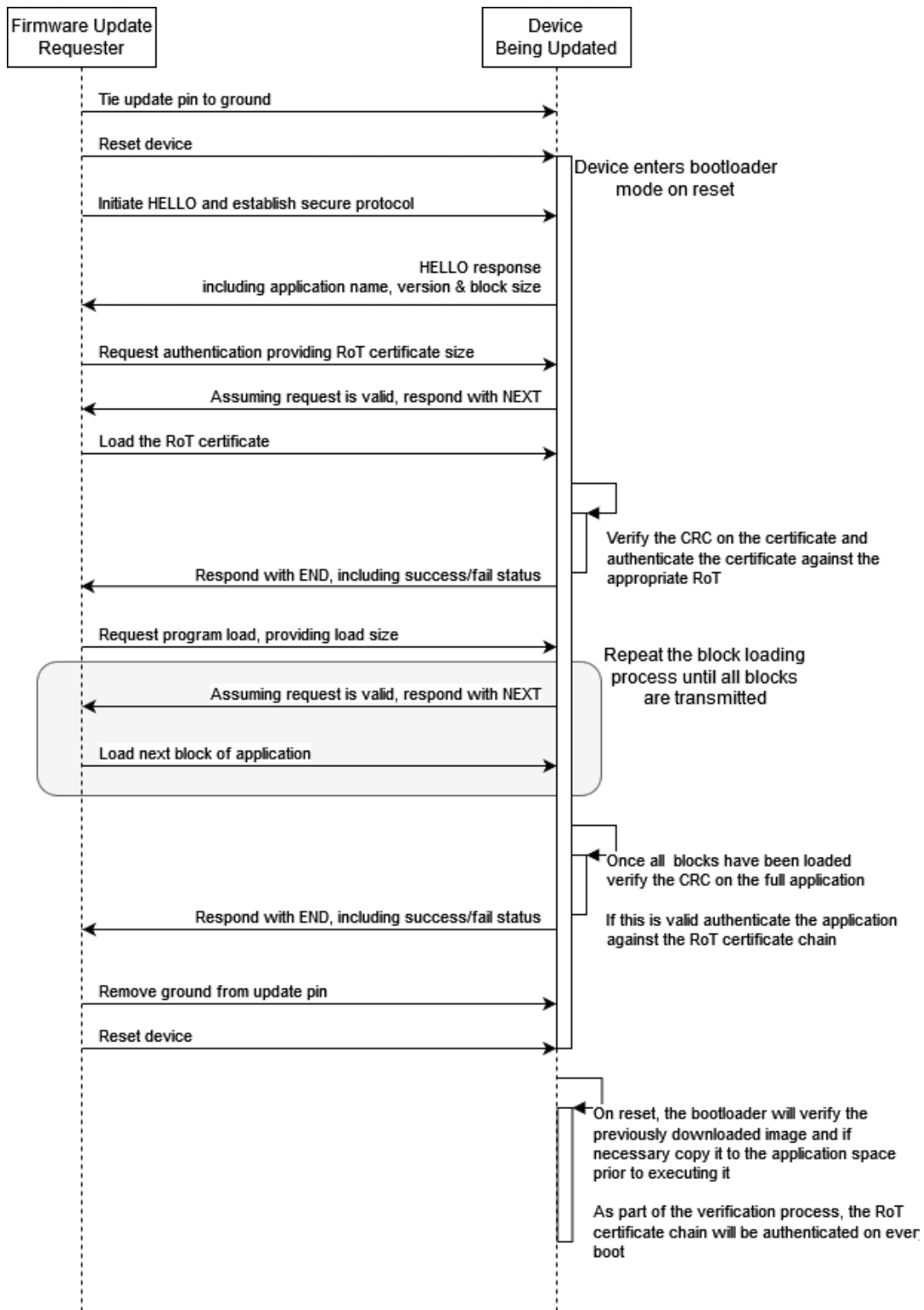


Figure 5. Secure Authenticate/Load/Update Sequence

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The update process for the simple bootloader is very similar to that for the secure bootloader, the main differences being that the secure bootloader uses a different CCITT CRC algorithm on each frame and the connection must be pre-authenticated using a valid key certificate.

5.3 UPDATING THE SECURE BOOTLOADER ITSELF

Updating the secure bootloader itself is much the same as updating a secure application. It uses the same function but with a different image. Flags are used for differentiation between a basic bootloader and a secure bootloader to determine the image size needed, since the secure bootloader uses more memory.

To prepare a secure bootloader, take the following steps:

- Ensure that you have, or make sure to create, all the necessary keys and key certificates. See the *RSL15 Security User's Guide* for details on creating secure applications.
- Create a content certificate based on the key certificates.
- Sign the image using the created certificates.

The new bootloader must be fully validated prior to switching to it, so that a complete copy is held in memory.

IMPORTANT: When updating a bootloader via the secure bootloader download mechanisms, care must be taken to ensure that the image being loaded is correct and that the update process is allowed to run to completion.

The update process is in two parts:

1. Initially, the new application or bootloader is stored in the download area of flash memory.
2. When the system is reset, the secure bootloader verifies and, if necessary, authenticates the image in the download area. If these checks pass, the image is copied to the secure bootloader area of flash memory.

This copying from the download area to the bootloader area by definition corrupts the bootloader at some point before the full image has been copied. If the power is lost during this stage, the system cannot recover, requiring a new bootloader to be loaded using the debug port.

Similarly, if the application or bootloader that has been loaded is faulty or is not a valid bootloader, this renders the secure bootloader unable to function.

In the current design there is no way around this issue; however, there are several mitigation strategies that can be employed to provide a more robust solution. These can include some combination of the following:

- Store a redundant copy of the bootloader, which can be reverted to in case of major system failure.
 - This redundant copy can have limited verification and authentication capabilities if that meets the customer needs.
- Partition the bootloader such that it has a mutable and immutable component. The immutable component could be the part that handles the copying from the download area to the secure bootloader area.
- Disable the ability to update the bootloader itself except under very specific and controlled circumstances where the user cannot unintentionally render the device completely inoperable.

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5.4 SUPPORT FOR IMMUTABLE PORTIONS IN THE SECURE BOOTLOADER

The concept of updateable and immutable portions of a secure processing environment is introduced in [Section 3.1 “Overview of PSA Compliance” on page 21](#). RSL15 has the following support for the immutable portions of the secure processing environment:

- A boot ROM that can handle a Secure Boot and Secure Debug process
- Hardware isolation of cryptographic functions and the storage of security-related assets
- Unique key storage and the concept of a hardware unique key
- A managed security life cycle as described in the *RSL15 Security User's Guide*
- Trusted subsystems providing a separation between the secure and non-secure environments, using TrustZone

CHAPTER 6

Secure Storage

Protected storage is required to hold the keys and any other context that must be maintained. Any secure code has free access to the contents of the secure storage area.

6.1 SECURE STORAGE AREA

The bootloader's *sections.ld* file shows the size and start address of the secure storage area:

```
/* Reserve the remaining 11K from the first data sector for secure storage */
BL_SECURE_STORE (xrw) : ORIGIN = 0x0015A400, LENGTH = 11K
```

6.2 CONTENT TO BE STORED IN SECURE STORAGE

- RSA public/private key pair
- ECC public/private key pair
- AES key

6.3 API

The API for secure storage is defined in *bl_simple_filer.h* and *bl_file_encryption.h*. The former provides the basic file system handler, and the latter provides the encryption layer. See the API reference or the files in the sample implementation for details.

Some important functions are as follows.

From *bl_simple_filer.h*:

```
BL_FStoreStatus_t BL_FStoreWrite(BL_FSFileId_t id,
uint8_t *buffer, uint16_t size, uint16_t flags);

BL_FStoreStatus_t BL_FStoreWrite(BL_FSFileId_t id,
uint8_t *buffer, uint16_t size, uint16_t flags);

BL_FStoreStatus_t BL_FStoreDelete(BL_FSFileId_t id);

BL_FStoreStatus_t BL_FStoreFileList(
uint8_t *buffer, uint16_t *maxsize, bool showHidden);
```

From *bl_file_encryption.h*:

```
BL_EncryptionStatus_t BL_EncryptBuffer(uint8_t *buffer, size_t length);

BL_EncryptionStatus_t BL_DecryptBuffer(uint8_t *buffer, size_t length);
```

6.4 BASIC OPERATION

The secure bootloader offers a simple file system, primarily for storing attestation keys, but it can also be used for the general storage of small files.

The file system location is defined in *bl_memory.h* and occupies a range of sectors in data flash. Due to the limitations of the flash, the file system space is set to 11 KB.

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The file system is organized in blocks that align with the underlying data sectors. Each data sector is 256 bytes in length; therefore, 44 blocks are available for use.

NOTE: A single file can be stored in more than one block. A single block can only contain information for a single file.

The first sector contains the inode table, which describes the blocks that are allocated to each file. There is a single inode entry for each file held in the file system. Each inode is defined as 12 bytes; therefore, a maximum of 21 files are supported by the file system.

Each inode/file contains the following information:

- The list of blocks allocated to the file. This is a 48-bit mask where a 1 indicates that the data block is used by that file.
- The file ID, which is defined as a 16-bit value because space is limited. How this is derived from a textual filename is left to the caller.
- A flags word, which contains a 16-bit value that indicates if the file is readable, writable, or can be deleted
- Size of the file in bytes. This is a 16-bit value because the maximum size of the store is defined as 11 KB. This is large enough to handle any file that can be stored.

IMPORTANT: When using the bootloader in debug mode, the Hardware Unique Key (HUK) is used, and appears differently when debugging compared with its appearance in typical usage. This means that when the key checking is performed, the HUK appears to be invalid, causing all inodes and any prior data stored in the secure storage area to be wiped.

CHAPTER 7

Attestation

Attestation, in this context, refers to providing information about the device to other parties using a very simple, cryptographically secured token; this is part of PSA compliance. Attestation provides a device with the ability to sign an array of bytes with a device private key and return the result to the caller. There are several use cases, ranging from attestation of the device state to generating a key pair and proving that it has been generated inside a secure key store.

7.1 OVERVIEW AND BACKGROUND

To maintain the Root of Trust, the secure bootloader only lets you program the device if you prove that you are allowed to do so. A challenge and response process matches certificates; if you do not have a matching certificate, it is not possible for you to program the device.

Part of attestation is the Entity Attestation Token (EAT), which contains claims that are generated in the device RoT. EAT token generation is expected to be performed many times, possibly for each transaction. It is relatively inexpensive because the claims data is small and ECDSA signing is relatively fast. For further details about the EAT, see [Section 7.3 “Attestation Token” on page 35](#).

The token is sent to the device, and then goes to the relying party, which then relays it (without examining or modifying it) to the attestation service for verification.

7.2 ATTESTATION INTERFACE

The PSA Attestation API is a standard interface provided by the PSA Root of Trust.

For attestation within the context of PSA, the key can be generated or injected into the system. For the RSL15 secure bootloader sample application, there is a function to inject a key. If the application is not given an injected key, it creates an internal key.

The main relevant functions for the RSL15 attestation interface are as follows:

- Inject attestation key
- Get attestation token
- Get attestation token size

A summary and the prototypes of the attestation interface functions are provided below. See the relevant parts of the full API and the *bl_attestation.h* header file for further details on function parameters.

7.2.1 Key Injection

- The key injection interface allows for the injection of keys generated externally to the device.
- It also allows for keys to be generated on the device and then stored for later use.
- AES keys are derived from the HUK (Hardware Unique Key) using some form of initial value.
- If a key is provided, the private component key is stored and the public component is returned. If no key is provided, a new key is generated, the private component is stored and the public component is returned. If a symmetric (AES) key is requested, the key is stored and returned.

```
BL_AttestStatus_t BL_AttestInjectKey(
    const uint8_t *key, size_t keySize, BL_AttestKeyType_t type,
    uint8_t *publicKey, size_t publicKeyMaxSize, size_t *publicKeySize);
```


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7.2.2 Get Token

To use the token, the attestation client issues some form of challenge and the device needs to respond. Part of the challenge is a random value that needs to be in the token to confirm its validity. This function is used to request the token from the device.

```
BL_AttestStatus_t BL_AttestGetToken(  
    const uint8_t *challenge, BL_AttestationChallengeSize_t challengeSize,  
    uint8_t *token, uint32_t *tokenSize);
```

7.2.3 Get Token Size

```
BL_AttestStatus_t BL_AttestGetTokenSize(  
    BL_AttestationChallengeSize_t challengeSize, uint32_t *tokenSize);
```

7.2.4 Key Injection Process

The [figure "Attestation Key Injection Diagram"](#) (Figure 6) illustrates the process of key injection.

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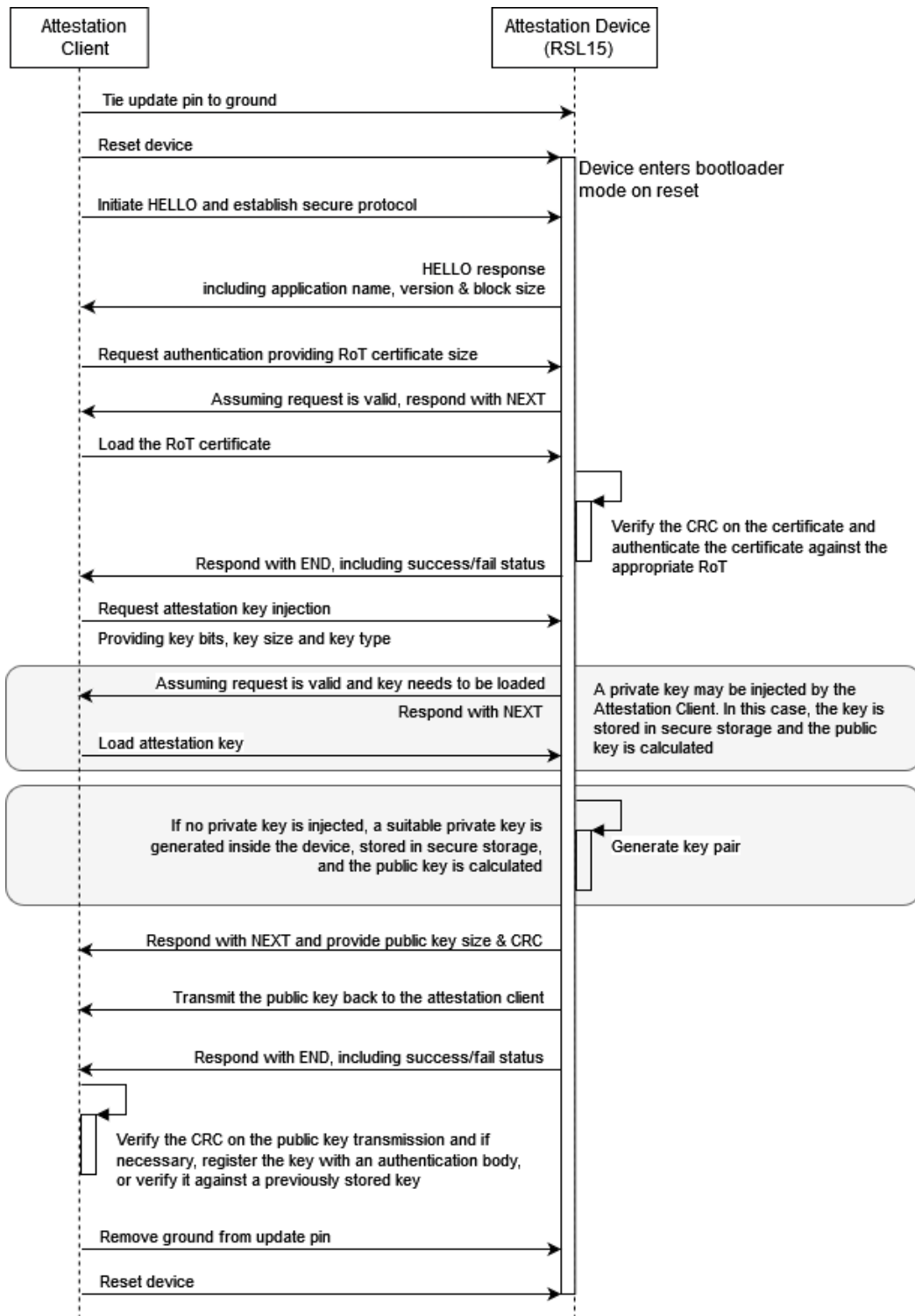


Figure 6. Attestation Key Injection Diagram

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7.3 ATTESTATION TOKEN

7.3.1 Format of Token

The attestation token takes the format of what is becoming an industry standard: an entity attestation token (EAT).

For the purposes of this sample code, a variant of the Arm Platform Security Architecture attestation token has been chosen to provide the basic structure. More information is available at: <https://www.psacertified.org/blog/what-is-an-entity-attestation-token/>.

An EAT is a small blob of data that includes information items and is cryptographically signed. The signing secures the token itself, so that the mechanism that is transmitting the token does not have to provide any security. This allows IoT devices to securely introduce themselves to networks and to IoT platforms. The EAT is wrapped into a compact binary object representation (CBOR)-type message.

Each information item in this token is known as a claim, as shown in the table "Items Included in Token" (Table 2). A claim is a data item, which is represented as a key-value pair.

Table 2. Items Included in Token

Item	Size (bytes)	Description
Authentication Challenge	32/48/64	Input object of random bytes provided by the caller, intended to provide freshness to reports
Instance ID	32	Hash of public key that represents the unique identifier of the instance and is encoded as a byte string
Implementation ID	32	Represents the original implementation signer of the attestation key and identifies the contract between the report and verification. A verification service uses this claim to locate the details of the verification process. Consists of a value encoded as byte string.
Security Lifecycle	4	Positive ID corresponding to secure (0x3000) which represents the current lifecycle state of the instance
Client ID	4	Partition ID which, for the secure bootloader, is a positive value indicating it is a secure caller of the initial attestation API. The value is encoded as a signed integer.
Hardware Version	16	EAN-13, which can be used to reference the security level of the PSA-ROT via a certification website, and is encoded as a text string
Boot Seed	32	Byte string for the random value created at system boot time that allows differentiation of reports from different system sessions
Software Components:		
ROM	32	SHA256 of ROM image
Bootloader	32	SHA256 of Bootloader
Application	32	SHA256 of Application

The size of the attestation token is governed by the fields outlined in the table "Items Included in Token" (Table 2), and by how these values are encoded into a CBOR data stream. In addition, the EAT is wrapped into a signed format which includes a hash of the CBOR data, as well as a signature based on the size and type of the attestation key.

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The [table "Example Token Sizes" \(Table 3\)](#) provides some example token sizes for different challenge and key sizes. All values are in bytes.

Table 3. Example Token Sizes

Key Size	1024					2048					3072				
Challenge Size	EAT	Hash	Sign	CBOR	Total	EAT	Hash	Sign	CBOR	Total	EAT	Hash	Sign	CBOR	Total
32	248	32	128	59	467	248	32	256	60	596	248	32	384	60	724
48	264	32	128	59	483	264	32	256	60	612	264	32	384	60	740
64	280	32	128	59	499	280	32	256	60	628	280	32	384	60	756

An example calculation can be found in the sample application source code in *bl_eat.c*.

NOTE: Some items in the EAT are provided as placeholder default values in the secure bootloader sample application. They are intended to be replaced as needed in a final product implementation.

7.3.2 EAT Additional Details

EAT has the capabilities to provide the source of trust, using a cryptographically signed piece of data containing claims that are generated in the device Root of Trust (RoT). The main use is for the relying party to verify the claims made by the device, such as the following:

- The unique identity of the device
- Installed firmware on the device and its integrity status
- Security assurance and certification status (such as a PSA Certified level)
- Manufacturer of the device hardware

Using this information, the relying party can make informed decisions, such as whether the device is legitimate and should be trusted, or what services to enable based on the information it receives. This is shown in the [figure "Relying Party Decision Diagram" \(Figure 7\)](#).

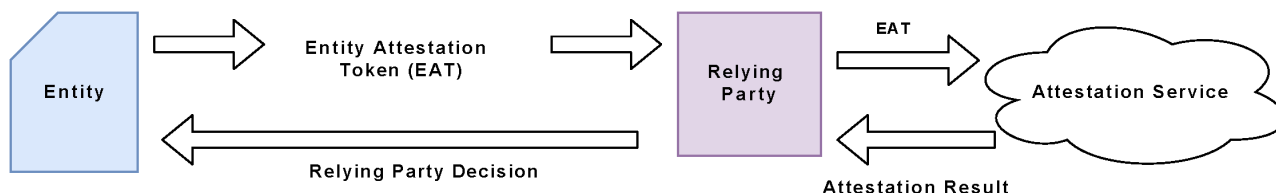


Figure 7. Relying Party Decision Diagram

7.3.3 Attestation Token Request

The [figure "Attestation Token Request" \(Figure 8\)](#) shows the process of requesting an attestation token.

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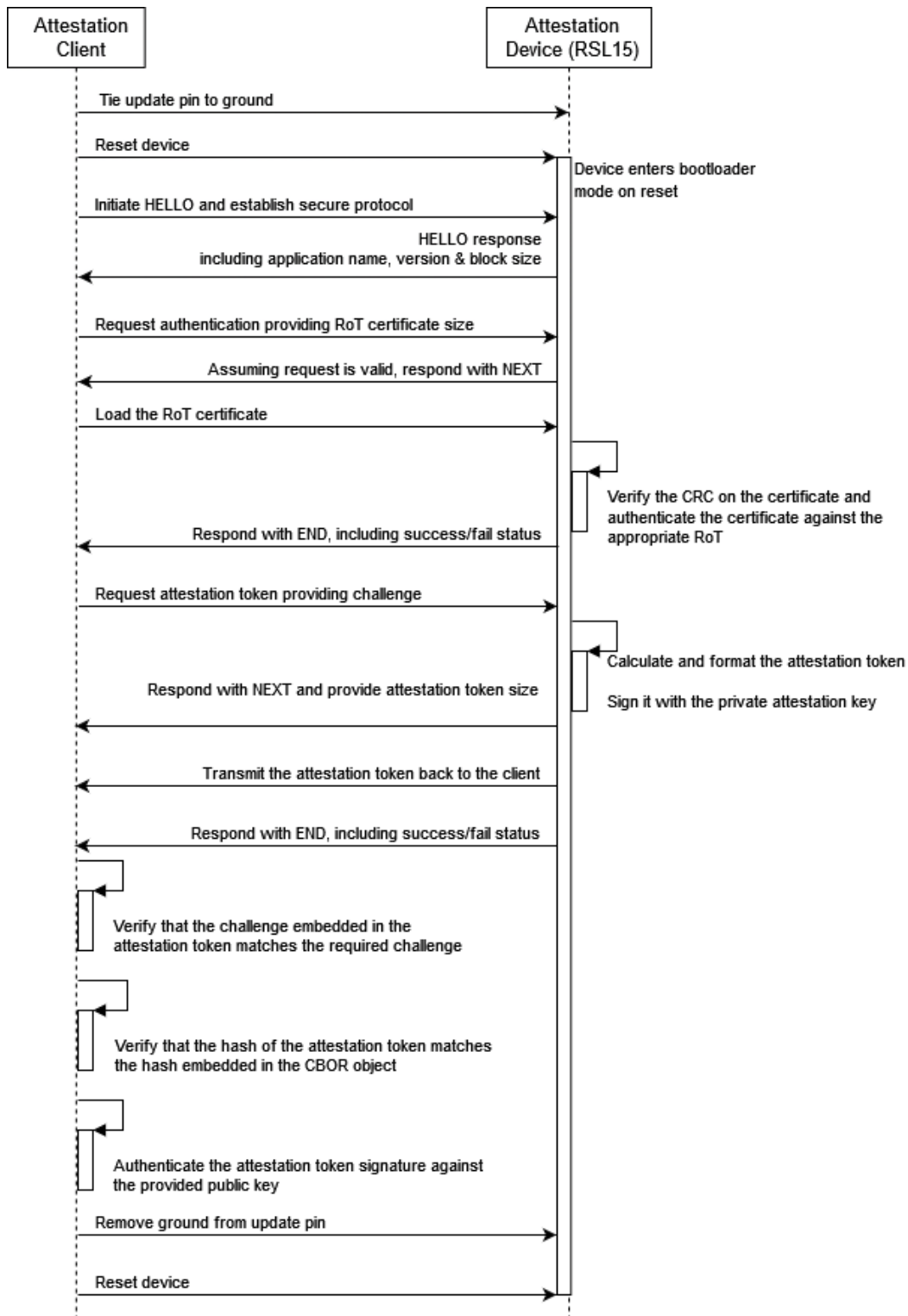


Figure 8. Attestation Token Request

CHAPTER 8

Secure Bootloader Sample Reference

Secure Bootloader Sample Reference.

8.1 SUMMARY

Typedefs

- [BL_FCS_t](#) : Define a FCS type.
- [BL_FSFileId_t](#) : Define a file identifier as a sixteen bit word.
- [BL_BootAppId_t](#) : Define the application ID as a six character string.

Variables

- [DRBGContext](#) : Define a CTR_DRBG context structure, used by the RNDContext.
- [BL_ImageWorkspace](#) : Defines a common operation buffer for handling images.

Data Structures

- [BL_AppConfiguration_t](#) : Define a structure which can map onto the configuration area.
- [BL_ImageOperation_t](#) : Buffer used for loading data in chunks, allow 2 blocks.
- [BL_ImageSplitRange_t](#) : define an address range which can wrap-around a reserved block
- [BL_StatusResponse_t](#) : to maintain backwards compatibility, we use a two byte status for most messages.
- [BL_BootAppVersion_t](#) : Define the application version as id and version details.
- [BL_HelloResponse_t](#) : Define the contents of a Hello response.

Enumerations

- [BL_AttestStatus_t](#) : Define the basic attestation status types.
- [BL_AttestKeyType_t](#) : Define the types of attestation keys supported by the system.
- [BL_AttestationChallengeSize_t](#) : Define the supported attestation challenge sizes.
- [BL_AttestTags_t](#) : Define CBOR tag values for each of the attestation fields.
- [BL_UpdateType_t](#) : Define the possible update types.
- [BL_ConfigStatus_t](#) : Define the configuration status values.
- [BL_CryptoStatus_t](#) : Define the status values returned by the cryptography modules.
- [BL_CryptoRSAKeyType_t](#) : Define the supported key types, encoding the key size in bits.
- [BL_EATStatus_t](#) : Define the possible status codes.
- [BL_EATTags_t](#) : Define CBOR tag values for each of the EAT fields.
- [BL_FCSStatus_t](#) : Define the possible FCS status values.
- [BL_FCSAlgorithm_t](#) : Define the possible valid FCS calculators.
- [BL_EncryptionStatus_t](#) : Define the file encryption status values.
- [BL_ImageType_t](#) : Define the known image types.
- [BL_ImageStatus_t](#) : Define the image status values.

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- [BL LoaderCommand t](#) : Enum specifying each of the valid commands the loader recognizes.
- [BL LoaderStatus t](#) : Define a set of supported loader status codes.
- [BL LoaderCertType t](#) : Enum specifying the types of certificate that can be loaded.
- [BL LoaderStatusType t](#) : Define a type for the status messages.
- [BL CBORStatus t](#) : Define the CBOR status values.
- [blSecureBootStatus t](#) : Define the status codes.
- [BL FStoreStatus t](#) : Define the status values possible from the secure filer module.
- [BL FSFlags t](#) : Define the flags associated with stored files.
- [BL FSReservedFilename t](#) : Define a set of reserved file names that should not be accessible directly from the loader.
- [BL UARTStatus t](#) : Define a set of supported error codes.

Macros

- [VT OFFSET STACK POINTER](#) : Vector table offset for the stack pointer.
- [VT OFFSET RESET VECTOR](#) : Vector table offset for the reset vector.
- [VT OFFSET VERSION INFO](#) : Vector table offset for the version information pointer.
- [VT OFFSET IMAGE SIZE](#) : Vector table offset for the used image size pointer.
- [VT OFFSET CERT SIZE](#) : Vector table offset for the certificate size.
- [BL CONFIGURATION BASE](#) : Base address of the boot configuration in flash.
- [BL CONFIGURATION WORDS](#) : Define the size of the configuration area in words.
- [BL CRYPTO BOOT SEED LENGTH](#) : Define the length in bytes of the boot seed value, random number.
- [BL CRYPTO SHA256 DIGEST LENGTH](#) : Define the digest length in bytes for SHA256.
- [BL ENCRYPT KEY SIZE BITS](#) : Define the AES key size in bits when performing AES encryption.
- [BL ENCRYPT KEY SIZE BYTES](#) : Define the AES key size in bytes when performing AES encryption.
- [BL ENCRYPT BLOCK SIZE BITS](#) : Define the block size in bits when performing AES encryption.
- [BL ENCRYPT BLOCK SIZE BYTES](#) : Define the block size in bytes when performing AES encryption.
- [FLASH BOND INFO SIZE](#)
- [BL CODE SECTOR SIZE](#) : The image block size when loading data.
- [BL DATA SECTOR SIZE](#) : The image block size when loading data.
- [BL FLASH RESERVED SIZE](#) : The size of the area reserved for use by the ROM and stack.
- [BL SECURE STORAGE BASE](#) : Define the base address of the secure storage area.
- [BL SECURE STORAGE SIZE](#) : Define a size for the secure storage area.
- [BL SECURE STORAGE TOP](#) : Define the top of the secure storage area.
- [BL BOOTLOADER BASE](#) : The base address of the bootloader flash.
- [BL BOOTLOADER SIZE](#) : Define the size of the bootloader in kB.
- [BL FLASH CODE BASE](#) : The base of the code flash.
- [BL FLASH DATA BASE](#) : The base of the data flash, offset by the reserved areas.
- [BL FLASH CODE TOP](#) : Define the top of code flash in 512K device.
- [BL FLASH DATA TOP](#) : Define the top of data flash in 512K device.
- [BL FLASH CODE SIZE](#) : Code size is derived from the base and top addresses.
- [BL FLASH DATA SIZE](#) : Data size is derived from the base and top addresses.
- [BL APPLICATION BASE](#) : Define the base address of the application.
- [BL AVAILABLE SIZE](#) : Define the total available flash for application and download.
- [BL APPLICATION SIZE](#) : Define the maximum size of an application.
- [BL DOWNLOAD BASE](#) : Define the base address of the download area.
- [BL DOWNLOAD SIZE](#) : Define the maximum size of the download area.
- [BL OPT FEATURE ENABLED](#) : Indicator that a given feature should be enabled.

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- [BL OPT FEATURE DISABLED](#) : Indicator that a given features should be disabled.
- [BL OPT FEATURE BOOTLOADER](#) : Marker indicating that the bootloader feature is enabled.
- [BL OPT FEATURE BOOTLOADER](#) : Marker indicating that the bootloader feature is enabled.
- [BL OPT FEATURE SECURE BOOTLOADER](#) : Marker indicating that the bootloader supports authenticated update of images.
- [BL OPT FEATURE SECURE BOOTLOADER](#) : Marker indicating that the bootloader supports authenticated update of images.
- [BL OPT FEATURE SECURE STORAGE](#) : Marker indicating if the secure storage feature is provided.
- [BL OPT FEATURE SECURE STORAGE](#) : Marker indicating if the secure storage feature is provided.
- [BL OPT FEATURE ATTESTATION](#) : Marker indicating if the bootloader supports attestation protocols.
- [BL OPT ATTEST KEY AES](#) : Marker indicating that the attestation feature supports AES keys.
- [BL OPT ATTEST KEY RSA](#) : Marker indicating that the attestation feature supports RSA keys.
- [BL OPT ATTEST KEY ECC](#) : Marker indicating that the attestation feature supports ECC keys.
- [BL OPT SECURE FILE SYSTEM RESET](#) : Marker indicating that the attestation feature supports AES keys.
- [DEBUG CATCH GPIO](#)
- [BL SEC IGNORE KEY](#) : Define a marker value that indicates a key may be ignored.
- [BL SEC DEFER KEY](#) : Define a marker value that indicates a key should be deferred.
- [BL FS MAX FILE SIZE](#) : Define the maximum supported file size.
- [UART CLK](#) : Set UART peripheral clock.
- [SENSOR CLK](#) : Set sensor clock.
- [USER CLK](#) : Set user clock.
- [VCC BUCK ENABLE](#) : Enable or disable the buck converter.
- [BL TICKER TIME MS](#) : Define the time in ms for each interrupt.
- [BL DEBUG](#) : Define the standard verbose/debug tracing routine.
- [BL TRACE](#) : Define the standard tracing routine.
- [BL WARNING](#) : Define the standard warning message routine.
- [BL ERROR](#) : Define the standard error message routine.
- [BL UART RX TIMEOUT MS](#) : Define the receive timeout in milliseconds.
- [BL WATCHDOG FEED ME MS](#) : While waiting for UART input, ensure watch dog is fed.
- [BL UART TX TIMEOUT MS](#) : Define the send timeout in milliseconds.
- [BL UART MAX RX LENGTH](#) : Define the maximum length of a single receive operation.
- [BL UART MAX TX LENGTH](#) : Define the maximum length of a single send operation.
- [BL BAUD RATE](#) : Define a baud rate for loading.
- [BL UART DELAY CYCLES](#) : Define a delay time to allow the hardware buffers to clear.
- [UPDATE GPIO](#) : Define the GPIO pin to be used to indicate an update is required.
- [MIN](#) : Define a shorthand to get the minimum of two values.
- [MAX](#) : Define a shorthand to get the maximum of two values.
- [BITS2BYTES](#) : Calculate the number of bytes needed to hold x bits.
- [BITS2HALFWORDS](#) : Calculate the number of 16 bit words needed to hold x bits.
- [BL VERSION ENCODE](#) : Define a mechanism to encode a version number as a uint16_t.
- [BL VERSION DECODE](#) : Define a mechanism to decode a version number from a uint16_t.
- [BL BOOT VERSION](#) : Define the boot version including name and ensure it is stored in an easily accessible location.
- [BL WATCHDOG MAX HOLD OFF SECONDS](#) : Define the maximum time that can elapse before the watchdog must be refreshed.

Functions

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- [BL AttestInitialize](#) : Initialize the attestation feature.
- [BL AttestAcceptKey](#) : Determine if it is okay to accept a key injection request.
- [BL AttestFindPublicKeyHash](#) : Retrieve the SHA256 hash of the public key if it exists.
- [BL AttestInjectKey](#) : Inject or create an attestation key.
- [BL AttestGetToken](#) : return the Entity Attestation Token associated with the device.
- [BL AttestGetTokenSize](#) : return the size of the Entity Attestation Token associated with the device.
- [BL CheckRemapAddressSpace](#) : Determine download address based on given address which may be in bootloader or application space.
- [BL CheckGetApplicationSize](#) : Fetch the application size from a buffer defined by base address of the application vector table.
- [BL CheckRelocatedApplicationSize](#) : Fetch the application size from a buffer defined by base address of the application vector table.
- [BL CheckIfImageUpdateAvailable](#) : Check for a valid update using the non-secure file format.
- [BL CheckIfSecureImageUpdateAvailable](#) : Check for a valid update using the secure file format.
- [BL CheckFindSecondaryImageLocation](#) : Based on a primary image address, calculate the potential location and extent of any secondary image.
- [BL ConfigIsValid](#) : Helper function to return the configuration area status.
- [BL ConfigCertificateAddress](#) : Fetch the address of the requested structure.
- [BL CryptoInitialize](#) : Initialize the basic crypto system.
- [BL CryptoGetBootSeed](#) : Fetch the boot seed.
- [BL CryptoHash](#) : Hash a block of memory using SHA256.
- [BL CryptoRSAKeySize](#) : Calculate the size required to serialize a given RSA private key.
- [BL CryptoRSASerialiseKey](#) : Serialize an RSA key to a byte buffer.
- [BL CryptoRSADeserialiseKey](#) : Deserialize an RSA key from a byte buffer.
- [BL CryptoRSAGenerateKey](#) : Generate a new RSA key of the given type.
- [BL CryptoRSASignHash](#) : Sign a message hash using a private RSA key.
- [BL CryptoRSASignMessage](#) : Sign a message using a private RSA key.
- [BL CryptoRSAVerifyMessage](#) : Verify that a given hash and signature are consistent.
- [BL EATPopulate](#) : Populates a buffer with the contents of the entity attestation token.
- [BL EATSize](#) : Calculate the expected size of the EAT token once converted to CBOR.
- [BL FCSInitialize](#) : Initialize the FCS module, deriving the selected algorithm from the provided sample data.
- [BL FCSQuery](#) : Query the currently selected FCS algorithm.
- [BL FCSAuthenticationRequired](#) : Provides a mechanism to determine if the loading process should apply authentication to the protocol and images.
- [BL FCSSelect](#) : Select a specific FCS algorithm.
- [BL FCSCheck](#) : Check the validity of a buffer against a given FCS.
- [BL FCSCalculate](#) : Calculate the FCS of a given buffer.
- [BL FCSAccumulateCRC](#) : Helper method to accumulate a CRC given a buffer and a length.
- [BL EncryptInitialize](#) : Initialization function for the encryption layer.
- [BL EncryptResetEncryption](#) : Reset the encryption operation and introduce a new initial value.
- [BL EncryptResetDecryption](#) : Reset the decryption operation and introduce a new initial value.
- [BL EncryptEncryptBuffer](#) : Encrypt a buffer using the internally derived key.
- [BL EncryptDecryptBuffer](#) : Decrypt a buffer using the internally derived key.
- [BL EncryptComplete](#) : Complete the current encryption or decryption operation.
- [BL FlashInitialize](#) : Initialize the flash subsystem.
- [BL FlashSaveSector](#) : Save a buffer to a specified flash address.
- [BL ImageInitialize](#) : Initialize the image module for a specific set of image attributes.
- [BL ImageAddress](#) : Convert an address to take into account potential offsets.

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- [BL ImageAddressRange](#) : Helper routine which allows access of the image as a contiguous block of addresses, wrapping around the reserved block.
- [BL ImageCopyMemoryRange](#) : Copy a possibly split memory range to a contiguous buffer.
- [BL ImageSaveBlock](#) : Save a block of data from a RAM buffer to the next block in Flash.
- [BL ImageVerify](#) : Verify the most recently loaded image.
- [BL ImageAuthenticate](#) : Authenticate a loaded image.
- [BL ImageAuthenticateCurrent](#) : Authenticate the most recently loaded image.
- [BL ImageIsValid](#) : Check if there is a valid image to start.
- [BL ImageSaveAddress](#) : Return the download address corresponding to the requested address.
- [BL ImageStartApplication](#) : Start the image stored in flash.
- [BL LoaderPerformFirmwareLoad](#) : Perform a firmware update over the UART interface.
- [BL LoaderCertificateAddress](#) : Fetch the address of the requested structure.
- [BL CBORInitialize](#) : Initialize the CBOR renderer giving it a buffer to render to.
- [BL CBORReset](#) : Reset the CBOR renderer pointers to the initial state.
- [BL CBORUsed](#) : Provide an indication of the amount of the buffer that has been used.
- [BL CBORCurrent](#) : Retrieve the current pointer onto the render buffer.
- [BL CBORAddInteger](#) : Add an integer to the CBOR buffer.
- [BL CBORAddBuffer](#) : Add a fixed size buffer to the CBOR buffer.
- [BL CBORAddMap](#) : Add a map with a fixed number of entries to the CBOR buffer.
- [BL CBORAddMapPair](#) : Add a key value pair to a map.
- [BL CBORSizeInteger](#) : Retrieve the rendered size of an integer value.
- [BL CBORSizeBuffer](#) : Retrieve the rendered size of a buffer.
- [BL CBORSizeMap](#) : Retrieve the number of bytes in a rendered map header.
- [BL CBORSizeMapPair](#) : Retrieve the rendered size of a key value pair.
- [BL RecoveryInitialize](#) : Define the initialization routine for the Debug Catch feature.
- [BL SecureBootInitialize](#) : Initialize the Secure Boot subsystem.
- [BL SecureBootAuthenticate](#) : Authenticate a RoT certificate chain based on a given RoT.
- [BL FStoreInitialize](#) : Initialize the secure file system.
- [BL FStoreMakeFilesystem](#) : Try to make a new file system.
- [BL FStoreFileSize](#) : Retrieve the size in bytes of a requested file.
- [BL FStoreFileExists](#) : Determine if the file exists in the store.
- [BL FStoreFileCanRead](#) : Determine if the file exists in the store and can be read.
- [BL FStoreFileCanWrite](#) : Determine if the file exists in the store and can be written.
- [BL FStoreFileCanDelete](#) : Determine if the file exists in the store and can be deleted.
- [BL FStoreWrite](#) : Write a buffer from RAM to the secure file store.
- [BL FStoreRead](#) : Read a file from the secure file store to a RAM buffer.
- [BL FStoreDelete](#) : Delete a file from the secure file.
- [BL FStoreFileList](#) : Retrieve the secure store directory information.
- [BL TargetInitialize](#) : Target initialization function, loads the trim values and sets up the various clocks used in the system.
- [BL TargetReset](#) : Reset the device using NVIC.
- [BL TickerInitialize](#) : Initialize the timer tick.
- [BL TickerTime](#) : Get the current timer tick value.
- [SysTick_Handler](#) : System tick interrupt handler, required by the ticker.
- [BL TraceInitialize](#) : Initialize the trace sub-system.
- [BL UARTInitialize](#) : Initialize the UART subsystem.
- [BL UARTReceiveAsync](#) : Start receiving a fixed length data buffer using the UART.
- [BL UARTReceiveComplete](#) : Complete the reception of an executing receive operation.
- [BL UARTReceive](#) : Receiving a fixed length data buffer using the UART.

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- [BL UARTSendAsync](#) : Start sending a fixed length data buffer using the UART.
- [BL UARTSendComplete](#) : Complete the transmission of an executing send operation.
- [BL UARTSend](#) : Send a fixed length data buffer using the UART.
- [BL UpdateInitialize](#) : Initialize the firmware update component.
- [BL UpdateRequested](#) : Check if a firmware update is being requested.
- [BL UpdateProcessPendingImages](#) : This will check for any pending images which have previously been downloaded and if any are found will copy them to the appropriate location for execution.
- [BL ImageSelectAndStartApplication](#) : This will attempt to start any images which are available.
- [BL VersionsGetInformation](#) : Get the version information from a suitable application.
- [BL VersionsGetHello](#) : Fetch the hello response from the bootloader.
- [BL WatchdogInitialize](#) : Initialise the watchdog module.
- [BL WatchdogSetHoldTime](#) : Set the watchdog hold off time to seconds.
- [WATCHDOG IRQHandler](#) : Define an interrupt handler for the watchdog interrupt.

8.2 DETAILED DESCRIPTION

This reference chapter presents a detailed description of all the components included in the secure bootloader reference application. This reference application has four levels of secure operation, available as needed depending on the end product's use cases:

1. Basic bootloader (non-secure)
2. Secure bootloader (maintains authenticated Root of Trust set up by the ROM)
3. Secure bootloader with secure storage
4. Secure bootloader with secure storage and device attestation

8.3 SECURE BOOTLOADER SAMPLE REFERENCE TYPEDEF DOCUMENTATION

8.3.1 BL_FCS_t

```
typedef uint16_t BL_FCS_t
```

Location: bl_fcs.h:86

Define a FCS type.

8.3.2 BL_FSFileId_t

```
typedef uint16_t BL_FSFileId_t
```

Location: bl_simple_filer.h:132

Define a file identifier as a sixteen bit word.

8.3.3 BL_BootAppId_t

```
typedef char BL_BootAppId_t
```

Location: bl_versions.h:109

Define the application ID as a six character string.

8.4 SECURE BOOTLOADER SAMPLE REFERENCE VARIABLE DOCUMENTATION

8.4.1 DRBGContext

```
mbedtls_ctr_drbg_context DRBGContext
```

Location: bl_crypto.h:114

Define a CTR_DRBG context structure, used by the RNDContext.

8.4.2 BL_ImageWorkspace

```
BL_ImageOperation_t BL_ImageWorkspace
```

Location: bl_image.h:119

Defines a common operation buffer for handling images.

8.5 SECURE BOOTLOADER SAMPLE REFERENCE ENUMERATION TYPE DOCUMENTATION

8.5.1 BL_AttestStatus_t

Location: bl_attestation.h:90

Define the basic attestation status types.

Members

- BL_ATTEST_NO_ERROR
- BL_ATTEST_INIT_FAILED
- BL_ATTEST_INVALID_REQUEST
- BL_ATTEST_INVALID_CLAIM
- BL_ATTEST_KEY_GEN_FAILURE
- BL_ATTEST_KEY_FAILURE
- BL_ATTEST_BUFFER_OVERFLOW

8.5.2 BL_AttestKeyType_t

Location: bl_attestation.h:102

Define the types of attestation keys supported by the system.

Members

- BL_ATTEST_AES_128
- BL_ATTEST_AES_192
- BL_ATTEST_AES_256
- BL_ATTEST_RSA_1024
- BL_ATTEST_RSA_2048
- BL_ATTEST_RSA_3072
- BL_ATTEST_ECC_256
- BL_ATTEST_KEYTYPE_MAX

8.5.3 BL_AttestationChallengeSize_t

Location: bl_attestation.h:115

Define the supported attestation challenge sizes.

Members

- BL_ATTEST_CHALLENGE_32 = 32
- BL_ATTEST_CHALLENGE_48 = 48
- BL_ATTEST_CHALLENGE_64 = 64

8.5.4 BL_AttestTags_t

Location: bl_attestation.h:123

Define CBOR tag values for each of the attestation fields.

Members

- BL_ATTEST_CBOR_TAG_HASH = 0xCBAA
- BL_ATTEST_CBOR_TAG_SIGN
- BL_ATTEST_CBOR_TAG_EAT

8.5.5 BL_UpdateType_t

Location: bl_check.h:99

Define the possible update types.

Members

- BL_UPDATE_IMAGE

- BL_UPDATE_BOOTLOADER
- BL_UPDATE_SECURE_IMAGE
- BL_UPDATE_SECURE_BOOTLOADER
- BL_UPDATE_SECONDARY_IMAGE
- BL_UPDATE_NONE

8.5.6 BL_ConfigStatus_t

Location: bl_configuration.h:91

Define the configuration status values.

Members

- BL_CONFIG_OKAY
- BL_CONFIG_CORRUPT

8.5.7 BL_CryptoStatus_t

Location: bl_crypto.h:97

Define the status values returned by the cryptography modules.

Members

- BL_CRYPTO_NO_ERROR
- BL_CRYPTO_RNG_FAIL
- BL_CRYPTO_HASH_FAIL
- BL_CRYPTO_RSA_FAIL
- BL_CRYPTO_RSA_WRITE_FAIL

- `BL_CRYPTTO_RSA_READ_FAIL`
- `BL_CRYPTTO_RSA_HASH_FAIL`
- `BL_CRYPTTO_RSA_SIGN_FAIL`
- `BL_CRYPTTO_RSA_VERIFY_FAIL`
- `BL_CRYPTTO_ECC_FAIL`
- `BL_CRYPTTO_AES_FAIL`

8.5.8 `BL_CryptoRSAKeyType_t`

Location: `bl_crypto_rsa.h:95`

Define the supported key types, encoding the key size in bits.

Members

- `RSA_1024 = 1024`
- `RSA_2048 = 2048`
- `RSA_3072 = 3072`

8.5.9 `BL_EATStatus_t`

Location: `bl_eat.h:88`

Define the possible status codes.

Members

- `BL_EAT_NO_ERROR`
- `BL_EAT_INVALID_OPERATION`
- `BL_EAT_BUFFER_OVERFLOW`

- BL_CHALLENGE_FAILURE
- BL_INSTANCE_FAILURE
- BL_IMPLEMENTATION_FAILURE
- BL_CLIENT_FAILURE
- BL_LIFECYCLE_FAILURE
- BL_EAN_FAILURE
- BL_SEED_FAILURE
- BL_ROM_FAILURE
- BL_BOOTLOADER_FAILURE
- BL_APPLICATION_FAILURE

8.5.10 BL_EATTags_t

Location: bl_eat.h:106

Define CBOR tag values for each of the EAT fields.

Members

- BL_EAT_CBOR_TAG_CHALLENGE = 0xCBEA
- BL_EAT_CBOR_TAG_INSTANCE
- BL_EAT_CBOR_TAG_IMPLEMENTATION
- BL_EAT_CBOR_TAG_CLIENT
- BL_EAT_CBOR_TAG_LIFECYCLE
- BL_EAT_CBOR_TAG_EAN
- BL_EAT_CBOR_TAG_SEED
- BL_EAT_CBOR_TAG_ROM
- BL_EAT_CBOR_TAG_BOOTLOADER
- BL_EAT_CBOR_TAG_APPLICATION
- BL_EAT_CBOR_TAG_MAX

8.5.11 BL_FCSStatus_t

Location: bl_fcs.h:89

Define the possible FCS status values.

Members

- BL_FCS_NO_ERROR
- BL_FCS_VALID
- BL_FCS_INVALID
- BL_FCS_UNRECOGNIZED
- BL_FCS_NOT_INITIALIZED

8.5.12 BL_FCSAlgorithm_t

Location: bl_fcs.h:99

Define the possible valid FCS calculators.

Members

- BL_FCS_CCITT_FFFF = 0
- BL_FCS_MCRF4XX
- BL_FCS_NO_ALGO

8.5.13 BL_EncryptionStatus_t

Location: bl_file_encryption.h:100

Define the file encryption status values.

Members

- BL_ENCRYPT_NO_ERROR
- BL_ENCRYPT_KEY_ERROR
- BL_ENCRYPTION_FAILURE
- BL_DECRYPTION_FAILURE
- BL_ENCRYPTION_INVALID_REQUEST

8.5.14 BL_ImageType_t

Location: bl_image.h:85

Define the known image types.

Members

- BL_IMAGE_BOOTLOADER
- BL_IMAGE_APPLICATION
- BL_IMAGE_UNRECOGNIZED

8.5.15 BL_ImageStatus_t

Location: bl_image.h:92

Define the image status values.

Members

- BL_IMAGE_NO_ERROR = 0
- BL_IMAGE_ADDRESS_ERROR
- BL_IMAGE_LENGTH_ERROR
- BL_IMAGE_FLASH_ERROR
- BL_IMAGE_VERIFY_ERROR
- BL_IMAGE_AUTHENTICATE_ERROR

8.5.16 BL_LoaderCommand_t

Location: bl_loader.h:82

Enum specifying each of the valid commands the loader recognizes.

Members

- BL_LOADER_HELLO = 0
- BL_LOADER_PROGRAM
- BL_LOADER_READ
- BL_LOADER_RESTART
- BL_LOADER_AUTHENTICATE
- BL_LOADER_FILE_LIST
- BL_LOADER_FILE_LOAD
- BL_LOADER_FILE_READ
- BL_LOADER_FILE_REMOVE
- BL_LOADER_FILE_RESET
- BL_LOADER_INJECT_KEY
- BL_LOADER_GET_TOKEN_SIZE
- BL_LOADER_GET_TOKEN
- BL_LOADER_ERROR

- `BL_LOADER_COMMAND_MAX`

8.5.17 `BL_LoaderStatus_t`

Location: `bl_loader.h:115`

Define a set of supported loader status codes.

Members

- `BL_LOADER_NO_ERROR = 0`
- `BL_LOADER_BAD_MSG`
- `BL_LOADER_UNKNOWN_CMD`
- `BL_LOADER_INVALID_CMD`
- `BL_LOADER_GENERAL_FLASH_FAILURE`
- `BL_LOADER_WRITE_FLASH_NOT_ENABLED`
- `BL_LOADER_BAD_FLASH_ADDRESS`
- `BL_LOADER_ERASE_FLASH_FAILED`
- `BL_LOADER_BAD_FLASH_LENGTH`
- `BL_LOADER_INACCESSIBLE_FLASH`
- `BL_LOADER_FLASH_COPIER_BUSY`
- `BL_LOADER_PROG_FLASH_FAILED`
- `BL_LOADER_VERIFY_FLASH_FAILED`
- `BL_LOADER_VERIFY_IMAGE_FAILED`
- `BL_LOADER_NO_VALID_BOOTLOADER`
- `BL_LOADER_RX_FAILURE`
- `BL_LOADER_RX_TIMEOUT`
- `BL_LOADER_IMAGE_FAILURE`
- `BL_LOADER_VERIFICATION_FAILURE`
- `BL_LOADER_CERT_LOAD_FAILURE`

- BL_LOADER_AUTHENTICATION_FAILURE
- BL_LOADER_AUTHENTICATE_IMAGE_FAILED
- BL_LOADER_FILE_SYSTEM_FAILURE
- BL_LOADER_ATTESTATION_FAILURE

8.5.18 BL_LoaderCertType_t

Location: bl_loader.h:144

Enum specifying the types of certificate that can be loaded.

Members

- BL_KEY1_CERT
- BL_KEY2_CERT
- BL_CONTENT_CERT
- BL_DEBUG_CERT

8.5.19 BL_LoaderStatusType_t

Location: bl_loader.h:153

Define a type for the status messages.

Members

- BL_LOADER_STATUS_TYPE_NEXT = 0x55
- BL_LOADER_STATUS_TYPE_END = 0xAA
- BL_LOADER_STATUS_TYPE_CRC = 0xCC

8.5.20 BL_CBORStatus_t

Location: bl_mini_cbor.h:88

Define the CBOR status values.

Members

- BL_CBOR_NO_ERROR
- BL_CBOR_BAD_REQUEST
- BL_CBOR_BUFFER_FULL
- BL_CBOR_OVERFLOW

8.5.21 blSecureBootStatus_t

Location: bl_secure_boot.h:87

Define the status codes.

Members

- BL_SEC_NO_ERROR
- BL_SEC_INIT_FAILED
- BL_SEC_CONTEXT_FAILED
- BL_SEC_KEY1_AUTH_FAILED
- BL_SEC_KEY2_AUTH_FAILED
- BL_SEC_CONTENT_AUTH_FAILED
- BL_SEC_INVALID_OPERATION
- BL_SEC_INVALID_PARAMETER

8.5.22 BL_FStoreStatus_t

Location: bl_simple_filer.h:93

Define the status values possible from the secure filer module.

Members

- BL_FS_NO_ERROR
- BL_FS_INIT_FAILURE
- BL_FS_FS_FULL
- BL_FS_MISSING_FILE
- BL_FS_DUPLICATE_FILE
- BL_FS_INVALID_OPERATION
- BL_FS_ENCRYPTION_FAILURE
- BL_FS_FLASH_READ_FAILURE
- BL_FS_FLASH_WRITE_FAILURE
- BL_FS_FLASH_ERASE_FAILURE

8.5.23 BL_FSFlags_t

Location: bl_simple_filer.h:108

Define the flags associated with stored files.

Members

- BL_FS_CAN_READ = 1
- BL_FS_CAN_WRITE = 2
- BL_FS_CAN_DELETE = 4

8.5.24 BL_FSReservedFilename_t

Location: bl_simple_filer.h:118

Define a set of reserved file names that should not be accessible directly from the loader.

Members

- BL_FS_NOFILE
- BL_FS_ATTEST_AES_128
- BL_FS_ATTEST_AES_192
- BL_FS_ATTEST_AES_256
- BL_FS_ATTEST_RSA_1024
- BL_FS_ATTEST_RSA_2048
- BL_FS_ATTEST_RSA_3072
- BL_FS_ATTEST_ECC_256
- BL_FS_MAX_RESERVED_FILE

8.5.25 BL_UARTStatus_t

Location: bl_uart.h:113

Define a set of supported error codes.

Members

- BL_UART_NO_ERROR = 0
- BL_UART_TX_IDLE
- BL_UART_RX_IDLE

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- BL_UART_TX_BUSY
- BL_UART_RX_BUSY
- BL_UART_TX_TIMEOUT
- BL_UART_RX_TIMEOUT
- BL_UART_INVALID_PARAMETER
- BL_UART_STATE_ERROR
- BL_UART_BAD_FCS
- BL_UART_RX_ERROR
- BL_UART_TX_ERROR

8.6 SECURE BOOTLOADER SAMPLE REFERENCE MACRO DEFINITION DOCUMENTATION

8.6.1 VT_OFFSET_STACK_POINTER

```
#define VT_OFFSET_STACK_POINTER 0
```

Vector table offset for the stack pointer.

Location: bl_check.h:80

8.6.2 VT_OFFSET_RESET_VECTOR

```
#define VT_OFFSET_RESET_VECTOR 1
```

Vector table offset for the reset vector.

Location: bl_check.h:83

8.6.3 VT_OFFSET_VERSION_INFO

```
#define VT_OFFSET_VERSION_INFO 8
```

Vector table offset for the version information pointer.

Location: bl_check.h:86

8.6.4 VT_OFFSET_IMAGE_SIZE

```
#define VT_OFFSET_IMAGE_SIZE 9
```

Vector table offset for the used image size pointer.

Location: bl_check.h:89

8.6.5 VT_OFFSET_CERT_SIZE

```
#define VT_OFFSET_CERT_SIZE 10
```

Vector table offset for the certificate size.

Location: bl_check.h:92

8.6.6 BL_CONFIGURATION_BASE

```
#define BL_CONFIGURATION_BASE ((BL\_AppConfiguration\_t *) FLASH0_DATA_BASE)
```

Base address of the boot configuration in flash.

Location: bl_configuration.h:81

8.6.7 BL_CONFIGURATION_WORDS

```
#define BL_CONFIGURATION_WORDS (sizeof(BL\_AppConfiguration\_t) >> 2)
```

Define the size of the configuration area in words.

Location: bl_configuration.h:84

8.6.8 BL_CRYPT0_BOOT_SEED_LENGTH

```
#define BL_CRYPT0_BOOT_SEED_LENGTH 32
```

Define the length in bytes of the boot seed value, random number.

Location: bl_crypto.h:86

8.6.9 BL_CRYPT_SHA256_DIGEST_LENGTH

```
#define BL_CRYPT_SHA256_DIGEST_LENGTH 32
```

Define the digest length in bytes for SHA256.

Location: bl_crypto.h:89

8.6.10 BL_ENCRYPT_KEY_SIZE_BITS

```
#define BL_ENCRYPT_KEY_SIZE_BITS 128
```

Define the AES key size in bits when performing AES encryption.

Location: bl_file_encryption.h:84

8.6.11 BL_ENCRYPT_KEY_SIZE_BYTES

```
#define BL_ENCRYPT_KEY_SIZE_BYTES (BL\_ENCRYPT\_KEY\_SIZE\_BITS >> 3)
```

Define the AES key size in bytes when performing AES encryption.

Location: bl_file_encryption.h:87

8.6.12 BL_ENCRYPT_BLOCK_SIZE_BITS

```
#define BL_ENCRYPT_BLOCK_SIZE_BITS 128
```

Define the block size in bits when performing AES encryption.

Location: bl_file_encryption.h:90

8.6.13 BL_ENCRYPT_BLOCK_SIZE_BYTES

```
#define BL_ENCRYPT_BLOCK_SIZE_BYTES (BL\_ENCRYPT\_BLOCK\_SIZE\_BITS >> 3)
```

Define the block size in bytes when performing AES encryption.

Location: bl_file_encryption.h:93

8.6.14 FLASH_BOND_INFO_SIZE

```
#define FLASH_BOND_INFO_SIZE 0x800
```

Location: bl_memory.h:78

8.6.15 BL_CODE_SECTOR_SIZE

```
#define BL_CODE_SECTOR_SIZE 2048
```

The image block size when loading data.

(Size of a code sector.)

Location: bl_memory.h:81

8.6.16 BL_DATA_SECTOR_SIZE

```
#define BL_DATA_SECTOR_SIZE 256
```

The image block size when loading data.

(Size of a code sector.)

Location: bl_memory.h:84

8.6.17 BL_FLASH_RESERVED_SIZE

```
#define BL_FLASH_RESERVED_SIZE (FLASH_DEU_RESERVED_SIZE + FLASH_BOND_INFO_SIZE)
```

The size of the area reserved for use by the ROM and stack.

Location: bl_memory.h:87

8.6.18 BL_SECURE_STORAGE_BASE

```
#define BL_SECURE_STORAGE_BASE (FLASH0_DATA_BASE + BL\_FLASH\_RESERVED\_SIZE)
```

Define the base address of the secure storage area.

Location: bl_memory.h:91

8.6.19 BL_SECURE_STORAGE_SIZE

```
#define BL_SECURE_STORAGE_SIZE (FLASH0_DATA_RSL15_284_TOP - BL\_SECURE\_STORAGE\_BASE + 1)
```

Define a size for the secure storage area.

Location: bl_memory.h:94

8.6.20 BL_SECURE_STORAGE_TOP

```
#define BL_SECURE_STORAGE_TOP (BL\_SECURE\_STORAGE\_BASE + BL\_SECURE\_STORAGE\_SIZE - 1)
```

Define the top of the secure storage area.

Location: bl_memory.h:98

8.6.21 BL_BOOTLOADER_BASE

```
#define BL_BOOTLOADER_BASE FLASH0_CODE_BASE
```

The base address of the bootloader flash.

Location: bl_memory.h:102

8.6.22 BL_BOOTLOADER_SIZE

```
#define BL_BOOTLOADER_SIZE BL_BOOTLOADER_KB
```

Define the size of the bootloader in kB.

The size of the area reserved for use by the bootloader.

Location: bl_memory.h:135

8.6.23 BL_FLASH_CODE_BASE

```
#define BL_FLASH_CODE_BASE (BL\_BOOTLOADER\_BASE + BL\_BOOTLOADER\_SIZE)
```

The base of the code flash.

Location: bl_memory.h:138

8.6.24 BL_FLASH_DATA_BASE

```
#define BL_FLASH_DATA_BASE (BL\_SECURE\_STORAGE\_TOP + 1)
```

The base of the data flash, offset by the reserved areas.

Location: bl_memory.h:141

8.6.25 BL_FLASH_CODE_TOP

```
#define BL_FLASH_CODE_TOP FLASH0_CODE_TOP
```

Define the top of code flash in 512K device.

Location: bl_memory.h:154

8.6.26 BL_FLASH_DATA_TOP

```
#define BL_FLASH_DATA_TOP FLASH0_DATA_TOP
```

Define the top of data flash in 512K device.

Location: bl_memory.h:157

8.6.27 BL_FLASH_CODE_SIZE

```
#define BL_FLASH_CODE_SIZE (BL\_FLASH\_CODE\_TOP - BL\_FLASH\_CODE\_BASE + 1)
```

Code size is derived from the base and top addresses.

Location: bl_memory.h:162

8.6.28 BL_FLASH_DATA_SIZE

```
#define BL_FLASH_DATA_SIZE (BL\_FLASH\_DATA\_TOP - BL\_FLASH\_DATA\_BASE + 1)
```

Data size is derived from the base and top addresses.

Location: bl_memory.h:165

8.6.29 BL_APPLICATION_BASE

```
#define BL_APPLICATION_BASE BL\_FLASH\_CODE\_BASE
```

Define the base address of the application.

Location: bl_memory.h:168

8.6.30 BL_AVAILABLE_SIZE

```
#define BL_AVAILABLE_SIZE (BL\_FLASH\_CODE\_SIZE + BL\_FLASH\_DATA\_SIZE)
```

Define the total available flash for application and download.

Location: bl_memory.h:171

8.6.31 BL_APPLICATION_SIZE

```
#define BL_APPLICATION_SIZE ((BL\_AVAILABLE\_SIZE >> 1) & 0xFFFFF800)
```

Define the maximum size of an application.

(must be 2K aligned)

Location: bl_memory.h:174

8.6.32 BL_DOWNLOAD_BASE

```
#define BL_DOWNLOAD_BASE (BL\_APPLICATION\_BASE + BL\_APPLICATION\_SIZE)
```

Define the base address of the download area.

Location: bl_memory.h:177

8.6.33 BL_DOWNLOAD_SIZE

```
#define BL_DOWNLOAD_SIZE BL\_APPLICATION\_SIZE
```

Define the maximum size of the download area.

Location: bl_memory.h:180

8.6.34 BL_OPT_FEATURE_ENABLED

```
#define BL_OPT_FEATURE_ENABLED 1
```

Indicator that a given feature should be enabled.

Location: bl_options.h:80

8.6.35 BL_OPT_FEATURE_DISABLED

```
#define BL_OPT_FEATURE_DISABLED 0
```

Indicator that a given features should be disabled.

Location: bl_options.h:83

8.6.36 BL_OPT_FEATURE_BOOTLOADER

```
#define BL_OPT_FEATURE_BOOTLOADER BL\_OPT\_FEATURE\_ENABLED
```

Marker indicating that the bootloader feature is enabled.

Location: bl_options.h:89

8.6.37 BL_OPT_FEATURE_BOOTLOADER

```
#define BL_OPT_FEATURE_BOOTLOADER BL\_OPT\_FEATURE\_ENABLED
```

Marker indicating that the bootloader feature is enabled.

Location: bl_options.h:131

8.6.38 BL_OPT_FEATURE_SECURE_BOOTLOADER

```
#define BL_OPT_FEATURE_SECURE_BOOTLOADER BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating that the bootloader supports authenticated update of images.

Location: bl_options.h:95

8.6.39 BL_OPT_FEATURE_SECURE_BOOTLOADER

```
#define BL_OPT_FEATURE_SECURE_BOOTLOADER BL\_OPT\_FEATURE\_ENABLED
```

Marker indicating that the bootloader supports authenticated update of images.

Location: bl_options.h:124

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8.6.40 BL_OPT_FEATURE_SECURE_STORAGE

```
#define BL_OPT_FEATURE_SECURE_STORAGE BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating if the secure storage feature is provided.

Location: bl_options.h:100

8.6.41 BL_OPT_FEATURE_SECURE_STORAGE

```
#define BL_OPT_FEATURE_SECURE_STORAGE BL\_OPT\_FEATURE\_ENABLED
```

Marker indicating if the secure storage feature is provided.

Location: bl_options.h:117

8.6.42 BL_OPT_FEATURE_ATTESTATION

```
#define BL_OPT_FEATURE_ATTESTATION BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating if the bootloader supports attestation protocols.

Location: bl_options.h:105

8.6.43 BL_OPT_ATTEST_KEY_AES

```
#define BL_OPT_ATTEST_KEY_AES BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating that the attestation feature supports AES keys.

Location: bl_options.h:143

8.6.44 BL_OPT_ATTEST_KEY_RSA

```
#define BL_OPT_ATTEST_KEY_RSA BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating that the attestation feature supports RSA keys.

Location: bl_options.h:149

8.6.45 BL_OPT_ATTEST_KEY_ECC

```
#define BL_OPT_ATTEST_KEY_ECC BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating that the attestation feature supports ECC keys.

Location: bl_options.h:155

8.6.46 BL_OPT_SECURE_FILE_SYSTEM_RESET

```
#define BL_OPT_SECURE_FILE_SYSTEM_RESET BL\_OPT\_FEATURE\_DISABLED
```

Marker indicating that the attestation feature supports AES keys.

Location: bl_options.h:200

8.6.47 DEBUG_CATCH_GPIO

```
#define DEBUG_CATCH_GPIO 0
```

Location: bl_recovery.h:78

8.6.48 BL_SEC_IGNORE_KEY

```
#define BL_SEC_IGNORE_KEY 0
```

Define a marker value that indicates a key may be ignored.

Location: bl_secure_boot.h:100

8.6.49 BL_SEC_DEFER_KEY

```
#define BL_SEC_DEFER_KEY 0xFFFFFFFF
```

Define a marker value that indicates a key should be deferred.

Location: bl_secure_boot.h:103

8.6.50 BL_FS_MAX_FILE_SIZE

```
#define BL_FS_MAX_FILE_SIZE BL\_CODE\_SECTOR\_SIZE
```

Define the maximum supported file size.

Location: bl_simple_filer.h:86

8.6.51 UART_CLK

```
#define UART_CLK 8000000
```

Set UART peripheral clock.

Location: bl_target.h:77

8.6.52 SENSOR_CLK

```
#define SENSOR_CLK 32768
```

Set sensor clock.

Location: bl_target.h:80

8.6.53 USER_CLK

```
#define USER_CLK 1000000
```

Set user clock.

Location: bl_target.h:83

8.6.54 VCC_BUCK_ENABLE

```
#define VCC_BUCK_ENABLE (1)
```

Enable or disable the buck converter.

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The system allows for two methods of reducing the battery power supply from a higher voltage (1.2V-3.6V) to usable supply voltage (1.0V-1.31V). If the VBAT supply voltage is less than 1.4V, this should be disabled so that the device uses the low drop out (LDO) regulator. Otherwise, the buck (DC-DC) converter may be enabled. Set this to: => 0 to disable buck converter mode and enable linear mode => 1 to enable buck converter mode and disable linear mode

Location: bl_target.h:97

8.6.55 BL_TICKER_TIME_MS

```
#define BL_TICKER_TIME_MS 10
```

Define the time in ms for each interrupt.

Location: bl_ticker.h:79

8.6.56 BL_DEBUG

```
#define BL_DEBUG swmLogVerbose
```

Define the standard verbose/debug tracing routine.

Location: bl_trace.h:78

8.6.57 BL_TRACE

```
#define BL_TRACE swmLogInfo
```

Define the standard tracing routine.

Location: bl_trace.h:81

8.6.58 BL_WARNING

```
#define BL_WARNING swmLogWarn
```

Define the standard warning message routine.

Location: bl_trace.h:84

8.6.59 BL_ERROR

```
#define BL_ERROR swmLogError
```

Define the standard error message routine.

Location: bl_trace.h:87

8.6.60 BL_UART_RX_TIMEOUT_MS

```
#define BL_UART_RX_TIMEOUT_MS (3000)
```

Define the receive timeout in milliseconds.

Location: bl_uart.h:88

8.6.61 BL_WATCHDOG_FEED_ME_MS

```
#define BL_WATCHDOG_FEED_ME_MS (2000)
```

While waiting for UART input, ensure watch dog is fed.

Location: bl_uart.h:91

8.6.62 BL_UART_TX_TIMEOUT_MS

```
#define BL_UART_TX_TIMEOUT_MS (3000)
```

Define the send timeout in milliseconds.

Location: bl_uart.h:94

8.6.63 BL_UART_MAX_RX_LENGTH

```
#define BL_UART_MAX_RX_LENGTH (2048)
```

Define the maximum length of a single receive operation.

Location: bl_uart.h:97

8.6.64 BL_UART_MAX_TX_LENGTH

```
#define BL_UART_MAX_TX_LENGTH (2048)
```

Define the maximum length of a single send operation.

Location: bl_uart.h:100

8.6.65 BL_BAUD_RATE

```
#define BL_BAUD_RATE 115200
```

Define a baud rate for loading.

Location: bl_uart.h:103

8.6.66 BL_UART_DELAY_CYCLES

```
#define BL_UART_DELAY_CYCLES ((20 * SystemCoreClock) / BL\_BAUD\_RATE)
```

Define a delay time to allow the hardware buffers to clear.

Location: bl_uart.h:106

8.6.67 UPDATE_GPIO

```
#define UPDATE_GPIO 14
```

Define the GPIO pin to be used to indicate an update is required.

Location: bl_update.h:81

8.6.68 MIN

```
#define MIN ((a) < (b) ? (a) : (b))
```


Define a shorthand to get the minimum of two values.

Location: bl_util.h:79

8.6.69 MAX

```
#define MAX ((a) > (b) ? (a) : (b))
```

Define a shorthand to get the maximum of two values.

Location: bl_util.h:82

8.6.70 BITS2BYTES

```
#define BITS2BYTES ((x + 7) >> 3)
```

Calculate the number of bytes needed to hold x bits.

Location: bl_util.h:85

8.6.71 BITS2HALFWORDS

```
#define BITS2HALFWORDS ((x + 15) >> 4)
```

Calculate the number of 16 bit words needed to hold x bits.

Location: bl_util.h:88

8.6.72 BL_VERSION_ENCODE

```
#define BL_VERSION_ENCODE ((m) << 12) | ((n) << 8) | (r)
```

Define a mechanism to encode a version number as a uint16_t.

Location: bl_versions.h:88

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8.6.73 BL_VERSION_DECODE

```
#define BL_VERSION_DECODE ((num >> 12) & 0xF), ((num >> 8) & 0xF), (num & 0xFF)
```

Define a mechanism to decode a version number from a uint16_t.

Location: bl_versions.h:91

8.6.74 BL_BOOT_VERSION

```
#define BL_BOOT_VERSION __attribute__((section(".rodata.boot.version"))) \
const BL\_BootAppVersion\_t blBootAppVersion = \
{ \
    id, BL\_VERSION\_ENCODE(major, minor, revision) \
};
```

Define the boot version including name and ensure it is stored in an easily accessible location.

Location: bl_versions.h:96

8.6.75 BL_WATCHDOG_MAX_HOLD_OFF_SECONDS

```
#define BL_WATCHDOG_MAX_HOLD_OFF_SECONDS 600
```

Define the maximum time that can elapse before the watchdog must be refreshed.

Location: bl_watchdog.h:83

8.7 SECURE BOOTLOADER SAMPLE REFERENCE FUNCTION DOCUMENTATION**8.7.1 BL_AttestInitialize**

```
BL\_AttestStatus\_t BL_AttestInitialize()
```

Initialize the attestation feature.

@return BL_ATTEST_NO_ERROR or BL_ATTEST_INIT_FAILED.

Location: bl_attestation.h:139

8.7.2 BL_AttestAcceptKey

[BL_AttestStatus t](#) BL_AttestAcceptKey([BL_AttestKeyType t](#) keyType, size_t privKeySize, size_t pubKeySize)

Determine if it is okay to accept a key injection request.

Location: bl_attestation.h:148

Parameters

Direction	Name	Description
	<i>keyType</i>	The type of key being injected.
	<i>privKeySize</i>	The size in bytes of the private key buffer.
	<i>pubKeySize</i>	The maximum size of the buffer to hold the public key.

Return

BL_ATTEST_NO_ERROR if the request accepted, error state otherwise.

8.7.3 BL_AttestFindPublicKeyHash

[BL_AttestStatus t](#) BL_AttestFindPublicKeyHash(uint8_t * hash)

Retrieve the SHA256 hash of the public key if it exists.

Location: bl_attestation.h:156

Parameters

Direction	Name	Description
	<i>hash</i>	A buffer to hold the hash, no checking is performed on the size.

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Return

BL_ATTEST_NO_ERROR if success, otherwise an error status.

8.7.4 BL_AttestInjectKey

```
BL\_AttestStatus t BL_AttestInjectKey(uint8_t * key, size_t keySize, BL\_AttestKeyType t type, uint8_t * publicKey, size_t publicKeyMaxSize, size_t * publicKeySize)
```

Inject or create an attestation key.

If a key is provided then the private component key is stored and the public component is returned. If no key is provided then a new key is generated and the private component is stored and the public returned. If a symmetric (AES) key is requested then the key is stored and returned.

Location: bl_attestation.h:173

Parameters

Direction	Name	Description
	<i>key</i>	The key to be stored or NULL if the key should be generated.
	<i>keySize</i>	The number of bytes in the provided key, or zero.
	<i>type</i>	the type of the key being provided or requested.
	<i>publicKey</i>	The buffer into which the public key should be written.
	<i>publicKeyMaxSize</i>	the maximum size of the provided buffer in bytes.
	<i>publicKeySize</i>	The actual size of the returned key in bytes.

Return

NO_ERROR if the key is successfully returned otherwise an error.

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8.7.5 BL_AttestGetToken

[BL_AttestStatus_t](#) BL_AttestGetToken(uint8_t * challenge, [BL_AttestationChallengeSize_t](#) challengeSize, uint8_t * token, size_t * tokenSize)

return the Entity Attestation Token associated with the device.

Location: bl_attestation.h:186

Parameters

Direction	Name	Description
	<i>challenge</i>	The challenge request from the caller.
	<i>challengeSize</i>	The requested challenge size.
	<i>token</i>	The buffer into which the token should be written.
	<i>tokenSize</i>	This provides the maximum size of the token buffer as well as returns the actual size of the returned token.

Return

Status of the get token operation.

8.7.6 BL_AttestGetTokenSize

[BL_AttestStatus_t](#) BL_AttestGetTokenSize([BL_AttestationChallengeSize_t](#) challengeSize, size_t * tokenSize)

return the size of the Entity Attestation Token associated with the device.

Location: bl_attestation.h:197

Parameters

Direction	Name	Description
	<i>challengeSize</i>	The requested challenge size.
	<i>tokenSize</i>	This returns the actual size of any returned token.

Return

Status of the get token size operation.

8.7.7 BL_CheckRemapAddressSpace

```
uint32_t BL_CheckRemapAddressSpace(uint32_t base, uint32_t address)
```

Determine download address based on given address which may be in bootloader or application space.

Location: bl_check.h:120

Parameters

Direction	Name	Description
	<i>base</i>	The base address of the application being checked.
	<i>address</i>	The given address in either bootloader or application space.

Return

The adjusted address.

8.7.8 BL_CheckGetApplicationSize

```
uint32_t BL_CheckGetApplicationSize(uint32_t address)
```

Fetch the application size from a buffer defined by base address of the application vector table.

Location: bl_check.h:128

Parameters

onsemi

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Direction	Name	Description
	<i>address</i>	The address of the base of the vector table.

Return

the size derived from the application or zero if invalid.

8.7.9 BL_CheckRelocatedApplicationSize

```
uint32_t BL_CheckRelocatedApplicationSize(uint32_t address)
```

Fetch the application size from a buffer defined by base address of the application vector table.

Location: bl_check.h:136

Parameters

Direction	Name	Description
	<i>address</i>	The address of the base of the vector table.

Return

the size derived from the application or zero if invalid.

8.7.10 BL_CheckIfImageUpdateAvailable

```
BL\_UpdateType t BL_CheckIfImageUpdateAvailable()
```

Check for a valid update using the non-secure file format.

When dealing with a non-secure image, the following checks must be made:

Location: bl_check.h:149

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- The address must be properly aligned and within a sensible range.
- The stack pointer resides in RAM, is 64 bit aligned, allows 10 words.
- The reset ISR follows the vector table address The address to check for a valid image. extent The maximum extent of the area holding the image.

Return

Type of image update available in download area.

8.7.11 BL_CheckIfSecureImageUpdateAvailable

```
bool BL_CheckIfSecureImageUpdateAvailable()
```

Check for a valid update using the secure file format.

When dealing with a secure image, the following checks must be made:

Location: bl_check.h:165

- The address must be properly aligned and within a sensible range.
- The stack pointer resides in RAM, is 64 bit aligned, allows 10 words.
- The reset ISR follows the vector table.
- The full certificate chain must be authenticated. updateType The type of update being requested. address The address to check for a valid image. extent The maximum extent of the area holding the image.

Return

True if the image has security signature, false otherwise.

8.7.12 BL_CheckFindSecondaryImageLocation

```
void BL_CheckFindSecondaryImageLocation(uint32_t primaryBase, uint32_t primaryExtent,
uint32_t * secondaryBase, uint32_t * secondaryExtent)
```

Based on a primary image address, calculate the potential location and extent of any secondary image.

Location: bl_check.h:177

Parameters

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Direction	Name	Description
	<i>primaryBase</i>	The base address of the primary image, used to locate the secondary one.
	<i>primaryExtent</i>	The maximum extent of the primary application;
	<i>secondaryBase</i>	
	<i>secondaryExtent</i>	

8.7.13 BL_ConfigIsValid

[BL_ConfigStatus_t](#) BL_ConfigIsValid([BL_AppConfiguration_t](#) * configBase)

Helper function to return the configuration area status.

Location: bl_configuration.h:119

Parameters

Direction	Name	Description
	<i>configBase</i>	Defines the base address of the configuration block.

Return

BL_CONFIG_OKAY if the configuration area has a valid CRC, BL_CONFIG_CORRUPT otherwise.

8.7.14 BL_ConfigCertificateAddress

uint32_t BL_ConfigCertificateAddress([BL_AppConfiguration_t](#) * configBase, [BL_LoaderCertType_t](#) cert)

Fetch the address of the requested structure.

Location: bl_configuration.h:127

Parameters

onsemi
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Direction	Name	Description
	<i>configBase</i>	Defines the base address of the configuration block.
	<i>cert</i>	A requested certificate.

Return

The address of the requested certificate or zero if invalid request.

8.7.15 BL_CryptoInitialize

[BL_CryptoStatus_t](#) BL_CryptoInitialize()

Initialize the basic crypto system.

Location: bl_crypto.h:125

Return

BL_CRYPTO_NO_ERROR if success otherwise an error state.

8.7.16 BL_CryptoGetBootSeed

uint8_t * BL_CryptoGetBootSeed()

Fetch the boot seed.

This is calculated on first boot.

Location: bl_crypto.h:136

Return

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A pointer to a buffer containing the boot seed random number.

8.7.17 BL_CryptoHash

[BL_CryptoStatus_t](#) BL_CryptoHash(uint8_t * buffer, uint32_t base, uint32_t length)

Hash a block of memory using SHA256.

Location: bl_crypto.h:145

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer to which the should be written.
	<i>base</i>	The base address of the memory to be hashed.
	<i>length</i>	The length in bytes of the memory to be hashed.

Return

BL_CRYPTO_NO_ERROR if success otherwise an error state.

8.7.18 BL_CryptoRSAKeySize

uint16_t BL_CryptoRSAKeySize([BL_CryptoRSAKeyType_t](#) type, bool public)

Calculate the size required to serialize a given RSA private key.

Location: bl_crypto_rsa.h:112

Parameters

Direction	Name	Description
	<i>type</i>	The type of the key to calculate the size for.
	<i>public</i>	Flag indicating the key being considered is public or private.

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Return

The calculated size or zero if the type is invalid.

8.7.19 BL_CryptoRSASerialiseKey

[BL_CryptoStatus_t](#) BL_CryptoRSASerialiseKey([BL_CryptoRSAKeyType_t](#) type, mbedtls_rsa_context * pKey, uint8_t * buffer, size_t length, bool public)

Serialize an RSA key to a byte buffer.

Location: bl_crypto_rsa.h:124

Parameters

Direction	Name	Description
	<i>type</i>	The type of the key to be serialized.
	<i>pKey</i>	a pointer to a RSA context containing a key.
	<i>buffer</i>	The buffer into which the key should be written.
	<i>length</i>	The length of the buffer receiving the serialized key.
	<i>public</i>	True if the public components of the key should be saved.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

8.7.20 BL_CryptoRSADeserialiseKey

[BL_CryptoStatus_t](#) BL_CryptoRSADeserialiseKey([BL_CryptoRSAKeyType_t](#) type, mbedtls_rsa_context * pKey, uint8_t * buffer, size_t length, bool public)

Deserialize an RSA key from a byte buffer.

Location: bl_crypto_rsa.h:137

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Parameters

Direction	Name	Description
	<i>type</i>	The type of the key to be deserialized.
	<i>pKey</i>	a pointer to a RSA context containing a key.
	<i>buffer</i>	The buffer from which the key should be read.
	<i>length</i>	The length of the buffer holding the serialized key.
	<i>public</i>	True if the public components of the key should be extracted.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

8.7.21 BL_CryptoRSAGenerateKey

[BL_CryptoStatus](#) t BL_CryptoRSAGenerateKey([BL_CryptoRSAKeyType](#) t keyType, mbedtls_rsa_context * pKey)

Generate a new RSA key of the given type.

Location: bl_crypto_rsa.h:147

Parameters

Direction	Name	Description
	<i>keyType</i>	The type of the key to be generated.
	<i>pKey</i>	A pointer to an uninitialised rsa context to hold the key.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

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8.7.22 BL_CryptoRSASignHash

[BL_CryptoStatus_t](#) BL_CryptoRSASignHash([BL_CryptoRSAKeyType_t](#) keyType, mbedtls_rsa_context * pKey, uint8_t * sign, size_t signLength, uint8_t * hash, size_t hashLength)

Sign a message hash using a private RSA key.

Location: bl_crypto_rsa.h:161

Parameters

Direction	Name	Description
	<i>keyType</i>	The type of the RSA key to be used when signing the message.
	<i>pKey</i>	A pointer to a private key.
	<i>sign</i>	The resultant signature for the message.
	<i>signLength</i>	The length of the buffer to which the signature is written.
	<i>hash</i>	The resultant hash of the message.
	<i>hashLength</i>	The length of the buffer holding the hash.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

8.7.23 BL_CryptoRSASignMessage

[BL_CryptoStatus_t](#) BL_CryptoRSASignMessage([BL_CryptoRSAKeyType_t](#) keyType, mbedtls_rsa_context * pKey, uint8_t * msg, size_t msgLength, uint8_t * sign, size_t signLength, uint8_t * hash, size_t hashLength)

Sign a message using a private RSA key.

Location: bl_crypto_rsa.h:183

Parameters

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Direction	Name	Description
	<i>keyType</i>	The type of the RSA key to be used when signing the message.
	<i>pKey</i>	A pointer to a private key.
	<i>msg</i>	A pointer to a buffer holding the message to be signed.
	<i>msgLength</i>	The length of the message to be signed.
	<i>sign</i>	The resultant signature for the message.
	<i>signLength</i>	The length of the buffer to which the signature is written.
	<i>hash</i>	The resultant hash of the message.
	<i>hashLength</i>	The length of the buffer holding the hash.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

NOTE: This method is suitable for signing small messages which are held in RAM, if larger messages need to be handled it may be more suitable to perform the hashing separately using BL_CryptoHash and then sign the hash in isolation using BL_CryptoRSASignHashRSA.

8.7.24 BL_CryptoRSAVerifyMessage

```
BL_CryptoStatus_t BL_CryptoRSAVerifyMessage(mbedtls_rsa_context * pKey, uint8_t * sign,
uint8_t * hash, size_t hashLength)
```

Verify that a given hash and signature are consistent.

Location: bl_crypto_rsa.h:196

Parameters

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Direction	Name	Description
	<i>pKey</i>	A pointer to a private key.
	<i>sign</i>	The signature to be verified.
	<i>hash</i>	The hash of the original message which has been signed.
	<i>hashLength</i>	The length of the hash.

Return

BL_CRYPTO_NO_ERROR if success, an error state otherwise.

8.7.25 BL_EATPopulate

```
BL\_EATStatus\_t BL_EATPopulate(uint8_t * challenge, size_t size)
```

Populates a buffer with the contents of the entity attestation token.

Location: bl_eat.h:132

Parameters

Direction	Name	Description
	<i>challenge</i>	A pointer to the challenge buffer.
	<i>size</i>	The size of the challenge in bytes.

Return

BL_EAT_NO_ERROR if token written otherwise an error state.

8.7.26 BL_EATSize

```
size_t BL_EATSize(size_t challengeSize)
```

Calculate the expected size of the EAT token once converted to CBOR.

Location: bl_eat.h:139

Parameters

Direction	Name	Description
	<i>challengeSize</i>	The size in bytes fo the challenge accompanying the EAT.

Return

the number of bytes required to hold the EAT.

8.7.27 BL_FCSInitialize

[BL_FCSStatus_t](#) BL_FCSInitialize(uint8_t * buffer, size_t length, [BL_FCS_t](#) fcs)

Initialize the FCS module, deriving the selected algorithm from the provided sample data.

Location: bl_fcs.h:120

Parameters

Direction	Name	Description
	<i>buffer</i>	A buffer of bytes to be FCS'd.
	<i>length</i>	The number of bytes.
	<i>fcs</i>	The expected FCS value.

Return

BL_FCS_NO_ERROR if the FCS algorithm can be identified. BL_FCS_UNRECOGNIZED if the FCS algorithm cannot be identified.

8.7.28 BL_FCSQuery

[BL_FCSAlgorithm t](#) BL_FCSQuery()

Query the currently selected FCS algorithm.

Location: bl_fcs.h:126

Return

The currently selected algorithm.

8.7.29 BL_FCSAuthenticationRequired

bool BL_FCSAuthenticationRequired()

Provides a mechanism to determine if the loading process should apply authentication to the protocol and images.

Location: bl_fcs.h:133

Return

True if authentication is required

8.7.30 BL_FCSelect

[BL_FCSStatus t](#) BL_FCSelect([BL_FCSAlgorithm t](#) algo)

Select a specific FCS algorithm.

Location: bl_fcs.h:142

Parameters

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Direction	Name	Description
	<i>algo</i>	Selected from BL_FCSAlgorithm_t .

Return

BL_FCS_NO_ERROR If the algorithm is valid. BL_FCS_UNRECOGNIZED If the algorithm is not valid.

8.7.31 BL_FCSCheck

[BL_FCSStatus_t](#) BL_FCSCheck(uint8_t * buffer, size_t length, [BL_FCS_t](#) fcs)

Check the validity of a buffer against a given FCS.

Location: bl_fcs.h:153

Parameters

Direction	Name	Description
	<i>buffer</i>	A buffer of bytes to calculate a FCS over.
	<i>length</i>	The number of bytes.
	<i>fcs</i>	The expected FCS value.

Return

BL_FCS_VALID if the FCS matches the data. BL_FCS_INVALID if the FCS does not match the data.

8.7.32 BL_FCSCalculate

[BL_FCSStatus_t](#) BL_FCSCalculate(uint8_t * buffer, size_t length, [BL_FCS_t](#) * fcs)

Calculate the FCS of a given buffer.

Location: bl_fcs.h:164

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Parameters

Direction	Name	Description
	<i>buffer</i>	A buffer of bytes to calculate a FCS over.
	<i>length</i>	The number of bytes.
	<i>fcs</i>	The calculated FCS value.

Return

BL_FCS_NO_ERROR if the FCS can be calculated. BL_FCS_INVALID if an error is detected when calculating the FCS.

8.7.33 BL_FCSAccumulateCRC

```
uint32_t BL_FCSAccumulateCRC(uint8_t * buffer, size_t length)
```

Helper method to accumulate a CRC given a buffer and a length.

Location: bl_fcs.h:175

Parameters

Direction	Name	Description
	<i>buffer</i>	A buffer of bytes to calculate a CRC on.
	<i>length</i>	The number of bytes.

NOTE: This is expected to be used for RAM buffers where the use of the flash copier can't be used. The CRC engine should be initialised prior to calling this function.

8.7.34 BL_EncryptInitialize

```
BL\_EncryptionStatus\_t BL_EncryptInitialize(const uint8_t * label, size_t length)
```

Initialization function for the encryption layer.

Location: `bl_file_encryption.h:119`

Parameters

Direction	Name	Description
	<i>label</i>	A label value to be used when creating the derived key.
	<i>length</i>	The length of the label in bytes.

Return

`BL_ENCRYPT_NO_ERROR` if the initialization succeeds.

8.7.35 BL_EncryptResetEncryption

[`BL_EncryptionStatus_t`](#) `BL_EncryptResetEncryption(const uint8_t * iv)`

Reset the encryption operation and introduce a new initial value.

Location: `bl_file_encryption.h:130`

Parameters

Direction	Name	Description
	<i>iv</i>	The new initial value, must be a pointer to a buffer of <code>BL_ENCRYPT_KEY_SIZE_BYTES</code> bytes.

8.7.36 BL_EncryptResetDecryption

[`BL_EncryptionStatus_t`](#) `BL_EncryptResetDecryption(const uint8_t * iv)`

Reset the decryption operation and introduce a new initial value.

Location: `bl_file_encryption.h:140`

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Parameters

Direction	Name	Description
	<i>iv</i>	The new initial value, must be a pointer to a buffer of BL_ENCRYPT_KEY_SIZE_BYTES bytes.

8.7.37 BL_EncryptEncryptBuffer

[BL_EncryptionStatus_t](#) BL_EncryptEncryptBuffer(uint8_t * buffer, size_t length)

Encrypt a buffer using the internally derived key.

Location: bl_file_encryption.h:151

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer to be encrypted.
	<i>length</i>	The length of the buffer being encrypted.

Return

BL_ENCRYPT_NO_ERROR if encryption succeeds, otherwise error.

NOTE: The length must be a multiple of 16 bytes otherwise an error will be reported.

8.7.38 BL_EncryptDecryptBuffer

[BL_EncryptionStatus_t](#) BL_EncryptDecryptBuffer(uint8_t * buffer, size_t length)

Decrypt a buffer using the internally derived key.

Location: bl_file_encryption.h:162

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer to be decrypted.
	<i>length</i>	The length of the buffer being decrypted.

Return

BL_ENCRYPT_NO_ERROR if decryption succeeds, otherwise error.

NOTE: The length must be a multiple of 16 bytes otherwise an error will be reported.

8.7.39 BL_EncryptComplete

[BL_EncryptionStatus_t](#) BL_EncryptComplete()

Complete the current encryption or decryption operation.

Location: bl_file_encryption.h:168

Return

BL_ENCRYPT_NO_ERROR if success, otherwise error.

8.7.40 BL_FlashInitialize

void BL_FlashInitialize()

Initialize the flash subsystem.

Location: bl_flash.h:89

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8.7.41 BL_FlashSaveSector

```
FlashStatus_t BL_FlashSaveSector(uint8_t * address, size_t length, uint8_t * buffer)
```

Save a buffer to a specified flash address.

Location: bl_flash.h:101

Parameters

Direction	Name	Description
	<i>address</i>	The address in flash to save the buffer.
	<i>length</i>	The number of bytes to save.
	<i>buffer</i>	A pointer to a buffer of data to be written.

Return

FLASH_ERR_NONE if the operation is successful otherwise an error code the flash library.

NOTE: The start address is expected to start on a sector boundary.

8.7.42 BL_ImageInitialize

```
BL\_ImageType\_t BL_ImageInitialize(uint8_t * address, size_t length, uint32_t crc)
```

Initialize the image module for a specific set of image attributes.

Location: bl_image.h:132

Parameters

onsemi

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Direction	Name	Description
	<i>address</i>	The base address of the image being loaded.
	<i>length</i>	The length of the image in bytes.
	<i>crc</i>	the crc of the image being loaded.

Return

The type of image recognized.

8.7.43 BL_ImageAddress

```
uint32_t BL_ImageAddress(uint32_t address)
```

Convert an address to take into account potential offsets.

Location: bl_image.h:141

Parameters

Direction	Name	Description
	<i>address</i>	The address in an image.

Return

The converted address.

8.7.44 BL_ImageAddressRange

```
void BL_ImageAddressRange(uint8_t * address, size_t length, BL\_ImageSplitRange\_t * range)
```

Helper routine which allows access of the image as a contiguous block of addresses, wrapping around the reserved block.

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Location: bl_image.h:152

Parameters

Direction	Name	Description
	<i>address</i>	An address within an image that may need to be adjusted.
	<i>length</i>	the length of the address range.
	<i>range</i>	A split range object that indicates where the address range needs to be split.

8.7.45 BL_ImageCopyMemoryRange

```
void BL_ImageCopyMemoryRange(uint8_t * dst, BL\_ImageSplitRange\_t * range)
```

Copy a possibly split memory range to a contiguous buffer.

Location: bl_image.h:161

Parameters

Direction	Name	Description
	<i>dst</i>	The destination buffer.
	<i>range</i>	The range defining the source locations.

8.7.46 BL_ImageSaveBlock

```
BL\_ImageStatus\_t BL_ImageSaveBlock(BL\_ImageOperation\_t * operation)
```

Save a block of data from a RAM buffer to the next block in Flash.

Location: bl_image.h:169

Parameters

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Direction	Name	Description
	<i>operation</i>	Defines the address and length of the block to be saved.

Return

Status code indicating if the save operation failed

8.7.47 BL_ImageVerify

[BL_ImageStatus_t](#) BL_ImageVerify()

Verify the most recently loaded image.

Location: bl_image.h:178

Return

BL_IMAGE_NO_ERROR If the CRC matches the data. BL_IMAGE_VERIFY_ERROR If the CRC does not match the data.

8.7.48 BL_ImageAuthenticate

[BL_ImageStatus_t](#) BL_ImageAuthenticate([BL_ImageType_t](#) imageType, uint32_t * address, size_t length, bool verifyImages)

Authenticate a loaded image.

Location: bl_image.h:191

Parameters

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Direction	Name	Description
	<i>imageType</i>	The type of the image being authenticated.
	<i>address</i>	The base address of the image to be authenticated.
	<i>length</i>	The size of the area in bytes.
	<i>verifyImages</i>	Flag indicating that the s/w images must be validated.

Return

BL_IMAGE_NO_ERROR If the CRC matches the data. BL_IMAGE_AUTHENTICATE_ERROR If the authentication fails.

8.7.49 BL_ImageAuthenticateCurrent

[BL_ImageStatus_t](#) BL_ImageAuthenticateCurrent()

Authenticate the most recently loaded image.

Location: bl_image.h:201

Return

BL_IMAGE_NO_ERROR If the CRC matches the data. BL_IMAGE_AUTHENTICATE_ERROR If the authentication fails.

8.7.50 BL_ImagesValid

bool BL_ImagesValid(uint32_t address, size_t length)

Check if there is a valid image to start.

Location: bl_image.h:210

Parameters

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Direction	Name	Description
	<i>address</i>	The address of the image in flash.
	<i>length</i>	The length of the image in bytes.

Return

True if there is a valid application to start. False otherwise.

8.7.51 BL_ImageSaveAddress

```
uint32_t BL_ImageSaveAddress(BL\_ImageType\_t imageType, uint32_t address)
```

Return the download address corresponding to the requested address.

Location: bl_image.h:219

Parameters

Direction	Name	Description
	<i>imageType</i>	The type of the image being authenticated.
	<i>address</i>	The requested address

Return

The download address

8.7.52 BL_ImageStartApplication

```
void BL_ImageStartApplication(uint32_t imageBaseAddress)
```

Start the image stored in flash.

Location: bl_image.h:226

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Parameters

Direction	Name	Description
	<i>imageBaseAddress</i>	The base address of the image to be started

8.7.53 BL_LoaderPerformFirmwareLoad

```
void BL_LoaderPerformFirmwareLoad()
```

Perform a firmware update over the UART interface.

Location: bl_loader.h:181

8.7.54 BL_LoaderCertificateAddress

```
uint32_t BL_LoaderCertificateAddress(BL\_LoaderCertType t cert)
```

Fetch the address of the requested structure.

Location: bl_loader.h:188

Parameters

Direction	Name	Description
	<i>cert</i>	A requested certificate.

Return

The address of the requested certificate or zero if invalid request.

8.7.55 BL_CBORInitialize

```
BL\_CBORStatus t BL_CBORInitialize(uint8_t * buffer, size_t size)
```

Initialize the CBOR renderer giving it a buffer to render to.

Location: bl_mini_cbor.h:106

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer to render to.
	<i>size</i>	The size of the buffer in bytes.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.56 BL_CBORReset

[BL_CBORStatus_t](#) BL_CBORReset ()

Reset the CBOR renderer pointers to the initial state.

Location: bl_mini_cbor.h:113

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.57 BL_CBORUsed

[BL_CBORStatus_t](#) BL_CBORUsed(size_t * size)

Provide an indication of the amount of the buffer that has been used.

Location: bl_mini_cbor.h:121

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Parameters

Direction	Name	Description
	<i>size</i>	Pointer to <code>size_t</code> object to receive the number of used bytes.

Return

`BL_CBOR_NO_ERROR` if everything is okay, otherwise error status.

8.7.58 BL_CBORCurrent

```
uint8_t * BL_CBORCurrent()
```

Retrieve the current pointer onto the render buffer.

Location: `bl_mini_cbor.h:128`

Return

A pointer to the next write point of the buffer.

8.7.59 BL_CBORAddInteger

```
BL\_CBORStatus\_t BL_CBORAddInteger(uint32_t value)
```

Add an integer to the CBOR buffer.

Location: `bl_mini_cbor.h:137`

Parameters

Direction	Name	Description
	<i>value</i>	The value to render to the buffer..

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.60 BL_CBORAddBuffer

[BL_CBORStatus_t](#) BL_CBORAddBuffer(uint8_t * value, uint32_t size)

Add a fixed size buffer to the CBOR buffer.

Location: bl_mini_cbor.h:146

Parameters

Direction	Name	Description
	<i>value</i>	A pointer to an array of bytes to be added.
	<i>size</i>	The size of the buffer to add.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.61 BL_CBORAddMap

[BL_CBORStatus_t](#) BL_CBORAddMap(uint32_t numItems)

Add a map with a fixed number of entries to the CBOR buffer.

Location: bl_mini_cbor.h:154

Parameters

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Direction	Name	Description
	<i>numItems</i>	The number of items that will be in the map.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.62 BL_CBORAddMapPair

[BL_CBORStatus_t](#) BL_CBORAddMapPair(uint32_t tag, uint8_t * value, uint32_t size)

Add a key value pair to a map.

Location: bl_mini_cbor.h:164

Parameters

Direction	Name	Description
	<i>tag</i>	The key value to add.
	<i>value</i>	a pointer to a buffer of data to write.
	<i>size</i>	The number of bytes in the value being written.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.63 BL_CBORSizeInteger

size_t BL_CBORSizeInteger(uint32_t value)

Retrieve the rendered size of an integer value.

Location: bl_mini_cbor.h:173

Parameters

Direction	Name	Description
	<i>value</i>	The value to size.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.64 BL_CBORSizeBuffer

```
size_t BL_CBORSizeBuffer(uint32_t size)
```

Retrieve the rendered size of a buffer.

Location: bl_mini_cbor.h:181

Parameters

Direction	Name	Description
	<i>size</i>	The number of bytes in the buffer being rendered.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.65 BL_CBORSizeMap

```
size_t BL_CBORSizeMap(uint32_t numItems)
```

Retrieve the number of bytes in a rendered map header.

Location: bl_mini_cbor.h:189

Parameters

Direction	Name	Description
	<i>numItems</i>	the number of items in the map.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.66 BL_CBORSizeMapPair

```
size_t BL_CBORSizeMapPair(uint32_t tag, uint32_t size)
```

Retrieve the rendered size of a key value pair.

Location: bl_mini_cbor.h:198

Parameters

Direction	Name	Description
	<i>tag</i>	The key value.
	<i>size</i>	The size of the buffer associated with the value.

Return

BL_CBOR_NO_ERROR if everything is okay, otherwise error status.

8.7.67 BL_RecoveryInitialize

```
void BL_RecoveryInitialize()
```

Define the initialization routine for the Debug Catch feature.

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Location: bl_recovery.h:91

8.7.68 BL_SecureBootInitialize

[blSecureBootStatus_t](#) BL_SecureBootInitialize()

Initialize the Secure Boot subsystem.

Location: bl_secure_boot.h:114

Return

BL_SEC_NO_ERROR if the initialization is okay, BL_SEC_INIT_FAILED if an error is detected.

8.7.69 BL_SecureBootAuthenticate

[blSecureBootStatus_t](#) BL_SecureBootAuthenticate(uint32_t opkey1, uint32_t opkey2, uint32_t opcontent, bool verifyImages, uint32_t relocation)

Authenticate a RoT certificate chain based on a given RoT.

Location: bl_secure_boot.h:128

Parameters

Direction	Name	Description
	<i>opkey1</i>	The address of the first key certificate.
	<i>opkey2</i>	The address of the second key certificate.
	<i>opcontent</i>	The address of a content certificate.
	<i>verifyImages</i>	Flag indicating if full verification is to be done.
	<i>relocation</i>	The address of the s/w images in memory if not accurate in the content certificate.

Return

BL_SEC_NO_ERROR if the authentication passes, suitable error state from [blSecureBootStatus_t](#) if an error occurs.

8.7.70 BL_FStoreInitialize

[BL_FStoreStatus_t](#) BL_FStoreInitialize()

Initialize the secure file system.

Location: bl_simple_filer.h:143

Return

The status of the operation, BL_FS_NO_ERROR if the initialization succeeds.

8.7.71 BL_FStoreMakeFilesystem

[BL_FStoreStatus_t](#) BL_FStoreMakeFilesystem()

Try to make a new file system.

Location: bl_simple_filer.h:149

Return

BL_FS_NO_ERROR if a new file system can be initialized.

8.7.72 BL_FStoreFileSize

uint32_t BL_FStoreFileSize([BL_FSFileId_t](#) id)

Retrieve the size in bytes of a requested file.

Location: bl_simple_filer.h:156

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

The size in bytes or 65535 if the file cannot be found.

8.7.73 BL_FStoreFileExists

```
bool BL_FStoreFileExists(BL\_FSFileId t id)
```

Determine if the file exists in the store.

Location: bl_simple_filer.h:163

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

True if the file exists, false otherwise.

8.7.74 BL_FStoreFileCanRead

```
bool BL_FStoreFileCanRead(BL\_FSFileId t id)
```

Determine if the file exists in the store and can be read.

Location: bl_simple_filer.h:170

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Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

True if the file exists and can be read, false otherwise.

8.7.75 BL_FStoreFileCanWrite

```
bool BL_FStoreFileCanWrite(BL\_FSFileId t id)
```

Determine if the file exists in the store and can be written.

Location: bl_simple_filer.h:177

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

True if the file exists and can be written, false otherwise.

8.7.76 BL_FStoreFileCanDelete

```
bool BL_FStoreFileCanDelete(BL\_FSFileId t id)
```

Determine if the file exists in the store and can be deleted.

Location: bl_simple_filer.h:184

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Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

True if the file exists and can be deleted, false otherwise.

8.7.77 BL_FStoreWrite

[BL_FStoreStatus_t](#) BL_FStoreWrite([BL_FSFileId_t](#) id, uint8_t * buffer, uint16_t size, uint16_t flags)

Write a buffer from RAM to the secure file store.

Location: bl_simple_filer.h:195

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.
	<i>buffer</i>	A pointer to a RAM buffer containing the file contents.
	<i>size</i>	The size of the buffer in bytes.
	<i>flags</i>	The set of flags associated with the file.

Return

BL_FS_NO_ERROR if the file is successfully written, error state otherwise..

8.7.78 BL_FStoreRead

[BL_FStoreStatus_t](#) BL_FStoreRead([BL_FSFileId_t](#) id, uint8_t * buffer, uint16_t * maxsize)

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Read a file from the secure file store to a RAM buffer.

Location: bl_simple_filer.h:207

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.
	<i>buffer</i>	A pointer to a RAM buffer to write the file contents.
	<i>maxsize</i>	The maximum size of the buffer in bytes. On exit, this value is updated to reflect the actual number of bytes read.

Return

BL_FS_NO_ERROR if the file is successfully read, error state otherwise..

8.7.79 BL_FStoreDelete

[BL_FStoreStatus_t](#) BL_FStoreDelete([BL_FSFileId_t](#) id)

Delete a file from the secure file.

Location: bl_simple_filer.h:216

Parameters

Direction	Name	Description
	<i>id</i>	The file identifier.

Return

BL_FS_NO_ERROR if the file is successfully deleted, error state otherwise..

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8.7.80 BL_FStoreFileList

```
BL\_FStoreStatus\_t BL_FStoreFileList(uint8_t * buffer, uint16_t * maxsize, bool showHidden)
```

Retrieve the secure store directory information.

Location: bl_simple_filer.h:227

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a RAM buffer to write the directory contents.
	<i>maxsize</i>	The maximum size of the buffer in bytes. On exit, this
	<i>showHidden</i>	Flag indicating if the reserved files should be included. value is updated to reflect the actual number of bytes read.

Return

BL_FS_NO_ERROR if the directory is successfully read, error state otherwise..

8.7.81 BL_TargetInitialize

```
void BL_TargetInitialize()
```

Target initialization function, loads the trim values and sets up the various clocks used in the system.

Location: bl_target.h:111

8.7.82 BL_TargetReset

```
void BL_TargetReset()
```

Reset the device using NVIC.

Location: bl_target.h:116

8.7.83 BL_TickerInitialize

```
void BL_TickerInitialize()
```

Initialize the timer tick.

Location: bl_ticker.h:92

8.7.84 BL_TickerTime

```
uint32_t BL_TickerTime()
```

Get the current timer tick value.

Location: bl_ticker.h:98

Return

The time since the ticker was initialized in ms.

8.7.85 SysTick_Handler

```
void SysTick_Handler()
```

System tick interrupt handler, required by the ticker.

Location: bl_ticker.h:103

8.7.86 BL_TraceInitialize

```
void BL_TraceInitialize()
```

Initialize the trace sub-system.

Location: bl_trace.h:100

8.7.87 BL_UARTInitialize

```
void BL_UARTInitialize()
```

Initialize the UART subsystem.

Location: bl_uart.h:136

8.7.88 BL_UARTReceiveAsync

```
BL\_UARTStatus\_t BL_UARTReceiveAsync(uint8_t * buffer, size_t length)
```

Start receiving a fixed length data buffer using the UART.

Location: bl_uart.h:153

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer in which to store the incoming data.
	<i>length</i>	The number of bytes to store in the buffer. (> 0)

Return

BL_UART_NO_ERROR if the operation is started successfully. BL_UART_INVALID_PARAMETER if the length is zero. BL_UART_RX_BUSY if another receive operation is currently active.

NOTE: No checking is performed to ensure that the buffer is big enough to hold the requested number of bytes. The calling function must ensure this is valid.

NOTE: There must be no pending receive operation pending when this is invoked.

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8.7.89 BL_UARTReceiveComplete

[BL_UARTStatus_t](#) BL_UARTReceiveComplete(uint8_t * buffer, size_t length, [BL_FCS_t](#) * fcs)

Complete the reception of an executing receive operation.

Location: bl_uart.h:171

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer in which to store the incoming data.
	<i>length</i>	The number of bytes to store in the buffer. (> 0)
	<i>fcs</i>	Indicating if a FCS should be calculated on the input. NULL indicates no FCS calculation needed.

Return

BL_UART_NO_ERROR if the operation completes successfully. BL_UART_RX_IDLE if there is no pending receive operation. BL_UART_RX_TIMEOUT if the receive operation timed out. BL_UART_BAD_FCS if the receive operation had an invalid FCS.

NOTE: There must be an existing receive operation pending.

NOTE: This is a blocking operation.

8.7.90 BL_UARTReceive

[BL_UARTStatus_t](#) BL_UARTReceive(uint8_t * buffer, size_t length, [BL_FCS_t](#) * fcs)

Receiving a fixed length data buffer using the UART.

Location: bl_uart.h:195

Parameters

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Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer in which to store the incoming data.
	<i>length</i>	The number of bytes to store in the buffer. (> 0)
	<i>fcs</i>	Indicating if a FCS should be calculated on the input. NULL indicates no FCS calculation needed.

Return

BL_UART_NO_ERROR if the operation is started successfully. BL_UART_INVALID_PARAMETER if the length is zero. BL_UART_RX_BUSY if another receive operation is currently active. BL_UART_RX_TIMEOUT if the receive operation timed out. BL_UART_BAD_FCS if the receive operation had an invalid FCS.

NOTE: No checking is performed to ensure that the buffer is big enough to hold the requested number of bytes. The calling function must ensure this is valid.

NOTE: There must be no pending receive operation pending when this is invoked.

NOTE: This is a blocking operation.

8.7.91 BL_UARTSendAsync

[BL_UARTStatus_t](#) BL_UARTSendAsync(uint8_t * buffer, size_t length, [BL_FCS_t](#) * fcs)

Start sending a fixed length data buffer using the UART.

Location: bl_uart.h:209

Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer holding the outgoing data.
	<i>length</i>	The number of bytes to send. (> 0)
	<i>fcs</i>	The FCS of the buffer to accompany the transmission.

Return

BL_UART_NO_ERROR if the operation is started successfully. BL_UART_INVALID_PARAMETER if the length is zero. BL_UART_TX_BUSY if another send operation is currently active.

NOTE: There must be no pending transmit operation pending when this is invoked.

8.7.92 BL_UARTSendComplete

[BL_UARTStatus_t](#) BL_UARTSendComplete()

Complete the transmission of an executing send operation.

Location: bl_uart.h:222

Return

BL_UART_NO_ERROR if the operation completes successfully. BL_UART_TX_IDLE if there is no pending receive operation. BL_UART_TX_TIMEOUT if the send operation timed out.

NOTE: There must be an existing transmit operation pending.

NOTE: This is a blocking operation.

8.7.93 BL_UARTSend

[BL_UARTStatus_t](#) BL_UARTSend(uint8_t * buffer, size_t length, [BL_FCS_t](#) * fcs)

Send a fixed length data buffer using the UART.

Location: bl_uart.h:239

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Parameters

Direction	Name	Description
	<i>buffer</i>	A pointer to a buffer holding the outgoing data.
	<i>length</i>	The number of bytes to send. (> 0)
	<i>fcs</i>	The FCS of the buffer to accompany the transmission.

Return

BL_UART_NO_ERROR if the operation is started successfully. BL_UART_INVALID_PARAMETER if the length is zero. BL_UART_TX_BUSY if another send operation is currently active. BL_UART_TX_TIMEOUT if the send operation timed out.

NOTE: There must be no pending transmit operation pending when this is invoked.

NOTE: This is a blocking operation.

8.7.94 BL_UpdateInitialize

```
void BL_UpdateInitialize()
```

Initialize the firmware update component.

Location: bl_update.h:94

8.7.95 BL_UpdateRequested

```
bool BL_UpdateRequested()
```

Check if a firmware update is being requested.

Location: bl_update.h:100

Return

True if the update pin has been pulled low. False otherwise.

8.7.96 BL_UpdateProcessPendingImages

```
void BL_UpdateProcessPendingImages()
```

This will check for any pending images which have previously been downloaded and if any are found will copy them to the appropriate location for execution.

Location: bl_update.h:107

8.7.97 BL_ImageSelectAndStartApplication

```
void BL_ImageSelectAndStartApplication()
```

This will attempt to start any images which are available.

This will first try to validate and if necessary authenticate the primary image. If this is successful it will then perform similar validation and authentication on the secondary image. If both the primary and secondary image validation is successful then it will start the secondary image. If only the primary image is valid then it will be started instead. If both the primary and secondary image fail the validation steps then no image will be started and the function will return to the caller and the bootloader will enter the loading state.

Location: bl_update.h:124

8.7.98 BL_VersionsGetInformation

```
void BL_VersionsGetInformation(BL\_BootAppVersion\_t * version, uint32_t address)
```

Get the version information from a suitable application.

Location: bl_versions.h:135

Parameters

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Direction	Name	Description
	<i>version</i>	The structure into which the information should be copied.
	<i>address</i>	The base address of the application under consideration.

8.7.99 BL_VersionsGetHello

```
void BL_VersionsGetHello(BL\_HelloResponse\_t * response)
```

Fetch the hello response from the bootloader.

Location: bl_versions.h:142

Parameters

Direction	Name	Description
	<i>response</i>	The structure into which the hello response should be copied.

8.7.100 BL_WatchdogInitialize

```
void BL_WatchdogInitialize()
```

Initialise the watchdog module.

Location: bl_watchdog.h:97

8.7.101 BL_WatchdogSetHoldTime

```
void BL_WatchdogSetHoldTime(uint32_t seconds)
```

Set the watchdog hold off time to seconds.

Location: bl_watchdog.h:109

Parameters

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Direction	Name	Description
	<i>seconds</i>	The number of seconds to allow before the watchdog bites.

NOTE: This allows the watchdog interrupt to fire but refreshes the watchdog itself until the requested number of seconds has elapsed. This is a crude mechanism to prevent long running calculations such as RSA key generation from causing a system reset.

8.7.102 WATCHDOG_IRQHandler

```
void WATCHDOG_IRQHandler()
```

Define an interrupt handler for the watchdog interrupt.

Location: bl_watchdog.h:115

Secure Bootloader Guide

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