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△

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2016-11-30	4.3.0	AUTOSAR Release Management	• Initial Release

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1 Introduction and functional overview

This specification specifies the functionality, API and the configuration of the AUTOSAR Basic Software module Crypto Driver.

The Crypto Drivers are located in the Microcontroller Abstraction Layer, which is below the Crypto Hardware Abstraction Layer (Crypto Interface [1]) and the upper service layer (Crypto Service Manager [2]). The Crypto Driver is a driver for a specific device, that is only abstracting the features supported by the hardware.

The Crypto Drivers allow defining of different Crypto Driver Objects (i.e. AES accelerator, SW component, etc), which shall be used for concurrent requests in different buffers. For each hardware object a priority-dependent job processing shall be supported. A crypto software solution (i.e. software-based CDD) can define interfaces identical to the Crypto Drivers for interacting with the upper layers, which shall provide an interface to the applications.

2 Acronyms and Abbreviations

Abbreviation / Acronym:	Description:
CDD	Complex Device Driver
CSM	Crypto Service Manager
CRYIF	Crypto Interface
CRYPTO	Crypto Driver
DET	Default Error Tracer
HSM	Hardware Security Module
HW	Hardware
SHE	Security Hardware Extension
SW	Software

Table 2.1: Acronyms and abbreviations used in the scope of this Document

2.1 Glossary of Terms

Term:	Description:	
Crypto Driver Object	A Crypto Driver implements one or more Crypto Driver Objects. The Crypto Driver Object can offer different crypto primitives in hardware or software. The Crypto Driver Objects of one Crypto Driver are independent of each other. There is only one workspace for each Crypto Driver Object (i.e. only one crypto primitive can be performed at the same time). The only exception of independency between Crypto Driver Object is the usage of a default Random Number Generator.	
Key	A Key can be referenced by a job in the Csm. In the Crypto Driver, the key references a specific key type.	
Key Type	A key type consists of references to key elements. The key types are typically pre-configured by the vendor of the Crypto Driver.	
Key Element	Key elements are used to store data. This data can be e.g. key material or the IV needed for AES encryption. It can also be used to configure the behaviour of the key management functions. Key elements from different keys have different memory area (both NV and RAM area).	
Channel	A channel is the statically configured path of a Job provided by the Crypto Service Manager via the Crypto Interface to a specific Crypto Driver Object.	
Job	A Job is the statically configured combination of e.g. a primitive reference, a channel, a priority, an optional key, etc., accessible by the user via its id.	
Crypto Primitive	'Primitive' is an instance of a configured cryptographic algorithm realized in a Crypto Driver Object. Among others it refers to a functionality provided by the CSM to the application, the concrete underlining 'algorithmfamily' (e.g. AES, MD5, RSA, ...), and a 'algorithmmode' (e.g. ECB, CBC, ...).	
Operation	An operation of a crypto primitive declares what part of the crypto primitive shall be performed. There are three different operation modes:	
	START	Operation mode indicates a new request of a crypto primitive, and it shall cancel all previous requests of the same job and primitive.
	UPDATE	Operation mode indicates, that the crypto primitive expects input data.
	FINISH	Operation mode indicates, that after this part all data are fed completely and the crypto primitive can finalize the calculations.
	It is also possible to perform more than one operation at once by concatenating the corresponding bits of the operation mode argument.	
Priority	The priority of a job defines the importance of it. The higher the priority (as well in value), the more immediate the job will be executed. The priority of a cryptographic job is part of the configuration.	
Service	A 'Service' shall be understood as defined in the TR_Glossary document: A service is a type of operation that has a published specification of interface and behavior, involving a contract between the provider of the capability and the potential clients.	

Table 2.2: Glossary of terms used in the scope of this Document

3 Related documentation

3.1 Input documents & related standards and norms

[1] Specification of Crypto Interface
AUTOSAR_CP_SWS_CryptoInterface

[2] Specification of Crypto Service Manager
AUTOSAR_CP_SWS_CryptoServiceManager

[3] General Specification of Basic Software Modules
AUTOSAR_CP_SWS_BSWGeneral

[4] General Requirements on Basic Software Modules
AUTOSAR_CP_RS_BSWGeneral

[5] Specification of Secure Hardware Extensions
AUTOSAR_FO_TR_SecureHardwareExtensions

3.2 Related specification

AUTOSAR provides a General Specification on Basic Software modules [3], which is also valid for Crypto Driver. Thus, the specification SWS BSW General shall be considered as additional and required specification for Crypto Driver.

External related documents include following:

- IEC 7498-1 The Basic Model, IEC Norm, 1994
- ISO/IEC 10118-3:2018 Part 3: Dedicated hash-functions (SM3)
- ISO/IEC 14888-3:2018 IT Security techniques - Digital signatures with appendix - Part 3: Discrete logarithm based mechanisms (SM2)
- Specification of the 3GPP Confidentiality and Integrity Algorithms 128-EEA3 & 128-EIA3:
  - 128-EEA3 and 128-EIA3 Specification, Version 1.7, 30th Dec 2011
  - ZUC Specification, Version 1.6, 28th June 2011
- IETF RFC 3394 Advanced Encryption Standard (AES) Key Wrap Algorithm, 2002

4 Constraints and assumptions

4.1 Limitations

n.a.

4.2 Applicability to car domains

The Crypto Driver can be used for all domain applications when security features are to be used.

5 Dependencies to other modules

[SWS_Crypto_00003]

Upstream requirements: SRS_BSW_00383, SRS_BSW_00384, SRS_BSW_00416

⌈If an off-chip crypto hardware module (e.g. external HSM) is used, the Crypto Driver shall use services of other MCAL drivers (e.g. SPI).⌋

Hint: If the Crypto Driver uses services of other MCAL drivers (e.g. SPI), it must be ensured that these drivers are up and running before initializing the Crypto Driver module.

[SWS_Crypto_00116]

Upstream requirements: SRS_BSW_00383, SRS_BSW_00384

⌈The Crypto Driver shall be able to store key material in a non-volatile way if supported by the dedicated crypto hardware.⌋

Note:

The Crypto Drivers are called by the Crypto Interface (CRYIF), which is implemented according to the cryptographic interface specification [1].

The Crypto Drivers access the underlying hardware and software objects, to calculate results with their cryptographic primitives. The results shall be forwarded to the CRYIF.

5.1 File structure

5.1.1 Code File Structure

The code file structure is not defined within this specification completely.

[SWS_Crypto_00005] ⌈The code file structure shall contain a source file Crypto.c and a code file Crypto_KeyManagement.c.⌋

6 Requirements Tracing

The following tables reference the requirements specified in [4] and links to the fulfillment of these. Please note that if column “Satisfied by” is empty for a specific requirement this means that this requirement is not fulfilled by this document.

Requirement	Description	Satisfied by
[SRS_BSW_00101]	The Basic Software Module shall be able to initialize variables and hardware in a separate initialization function	[SWS_Crypto_91000]
[SRS_BSW_00358]	The return type of init() functions implemented by AUTOSAR Basic Software Modules shall be void	[SWS_Crypto_91000]
[SRS_BSW_00369]	All AUTOSAR Basic Software Modules shall not return specific development error codes via the API	[SWS_Crypto_00045] [SWS_Crypto_00057] [SWS_Crypto_00058] [SWS_Crypto_00059] [SWS_Crypto_00064] [SWS_Crypto_00070] [SWS_Crypto_00075] [SWS_Crypto_00076] [SWS_Crypto_00077] [SWS_Crypto_00078] [SWS_Crypto_00079] [SWS_Crypto_00085] [SWS_Crypto_00086] [SWS_Crypto_00087] [SWS_Crypto_00088] [SWS_Crypto_00089] [SWS_Crypto_00090] [SWS_Crypto_00094] [SWS_Crypto_00095] [SWS_Crypto_00097] [SWS_Crypto_00098] [SWS_Crypto_00103] [SWS_Crypto_00104] [SWS_Crypto_00105] [SWS_Crypto_00106] [SWS_Crypto_00107] [SWS_Crypto_00111] [SWS_Crypto_00112] [SWS_Crypto_00113] [SWS_Crypto_00115] [SWS_Crypto_00123] [SWS_Crypto_00124] [SWS_Crypto_00125] [SWS_Crypto_00128] [SWS_Crypto_00129] [SWS_Crypto_00130] [SWS_Crypto_00131] [SWS_Crypto_00142] [SWS_Crypto_00149] [SWS_Crypto_00150] [SWS_Crypto_00151] [SWS_Crypto_00152] [SWS_Crypto_00153] [SWS_Crypto_00156] [SWS_Crypto_00157] [SWS_Crypto_00158] [SWS_Crypto_00161] [SWS_Crypto_00162] [SWS_Crypto_00180] [SWS_Crypto_00196] [SWS_Crypto_00197] [SWS_Crypto_00202] [SWS_Crypto_00205] [SWS_Crypto_00206] [SWS_Crypto_00232] [SWS_Crypto_00233] [SWS_Crypto_00234] [SWS_Crypto_00236] [SWS_Crypto_00237] [SWS_Crypto_00256] [SWS_Crypto_00257] [SWS_Crypto_00270] [SWS_Crypto_00271] [SWS_Crypto_00272] [SWS_Crypto_00273] [SWS_Crypto_00274] [SWS_Crypto_00275]
[SRS_BSW_00383]	The Basic Software Module specifications shall specify which other configuration files from other modules they use at least in the description	[SWS_Crypto_00003] [SWS_Crypto_00116] [SWS_Crypto_00243] [SWS_Crypto_00246] [SWS_Crypto_00247]
[SRS_BSW_00384]	The Basic Software Module specifications shall specify at least in the description which other modules they require	[SWS_Crypto_00003] [SWS_Crypto_00116] [SWS_Crypto_00243] [SWS_Crypto_00246] [SWS_Crypto_00247]

△

Requirement	Description	Satisfied by
[SRS_BSW_00386]	The BSW shall specify the configuration and conditions for detecting an error	[SWS_Crypto_00045] [SWS_Crypto_00057] [SWS_Crypto_00058] [SWS_Crypto_00059] [SWS_Crypto_00064] [SWS_Crypto_00070] [SWS_Crypto_00075] [SWS_Crypto_00076] [SWS_Crypto_00077] [SWS_Crypto_00078] [SWS_Crypto_00079] [SWS_Crypto_00085] [SWS_Crypto_00086] [SWS_Crypto_00087] [SWS_Crypto_00088] [SWS_Crypto_00089] [SWS_Crypto_00090] [SWS_Crypto_00094] [SWS_Crypto_00095] [SWS_Crypto_00097] [SWS_Crypto_00098] [SWS_Crypto_00103] [SWS_Crypto_00104] [SWS_Crypto_00105] [SWS_Crypto_00106] [SWS_Crypto_00107] [SWS_Crypto_00111] [SWS_Crypto_00112] [SWS_Crypto_00113] [SWS_Crypto_00115] [SWS_Crypto_00123] [SWS_Crypto_00124] [SWS_Crypto_00125] [SWS_Crypto_00128] [SWS_Crypto_00129] [SWS_Crypto_00130] [SWS_Crypto_00131] [SWS_Crypto_00142] [SWS_Crypto_00149] [SWS_Crypto_00150] [SWS_Crypto_00151] [SWS_Crypto_00152] [SWS_Crypto_00153] [SWS_Crypto_00156] [SWS_Crypto_00157] [SWS_Crypto_00158] [SWS_Crypto_00161] [SWS_Crypto_00162] [SWS_Crypto_00180] [SWS_Crypto_00196] [SWS_Crypto_00197] [SWS_Crypto_00202] [SWS_Crypto_00205] [SWS_Crypto_00206] [SWS_Crypto_00207] [SWS_Crypto_00208] [SWS_Crypto_00232] [SWS_Crypto_00233] [SWS_Crypto_00234] [SWS_Crypto_00236] [SWS_Crypto_00237] [SWS_Crypto_00256] [SWS_Crypto_00257] [SWS_Crypto_00270] [SWS_Crypto_00271] [SWS_Crypto_00272] [SWS_Crypto_00273] [SWS_Crypto_00274] [SWS_Crypto_00275]
[SRS_BSW_00395]	The Basic Software Module specifications shall list all configuration parameter dependencies	[SWS_Crypto_CONSTR_00002] [SWS_Crypto_CONSTR_00003] [SWS_Crypto_CONSTR_00004]
[SRS_BSW_00406]	API handling in uninitialized state	[SWS_Crypto_00057]
[SRS_BSW_00414]	Init functions shall have a pointer to a configuration structure as single parameter	[SWS_Crypto_91000] [SWS_Crypto_91016]
[SRS_BSW_00416]	The sequence of modules to be initialized shall be configurable	[SWS_Crypto_00003]
[SRS_BSW_00490]	List possible security events	[SWS_Crypto_00301]
[SRS_BSW_00491]	Specification of trigger conditions and context data	[SWS_Crypto_00302]
[SRS_BSW_00497]	Handling of corrupted NV data.	[SWS_Crypto_00244] [SWS_Crypto_00249]

Table 6.1: Requirements Tracing

7 Functional specification

7.1 Basics

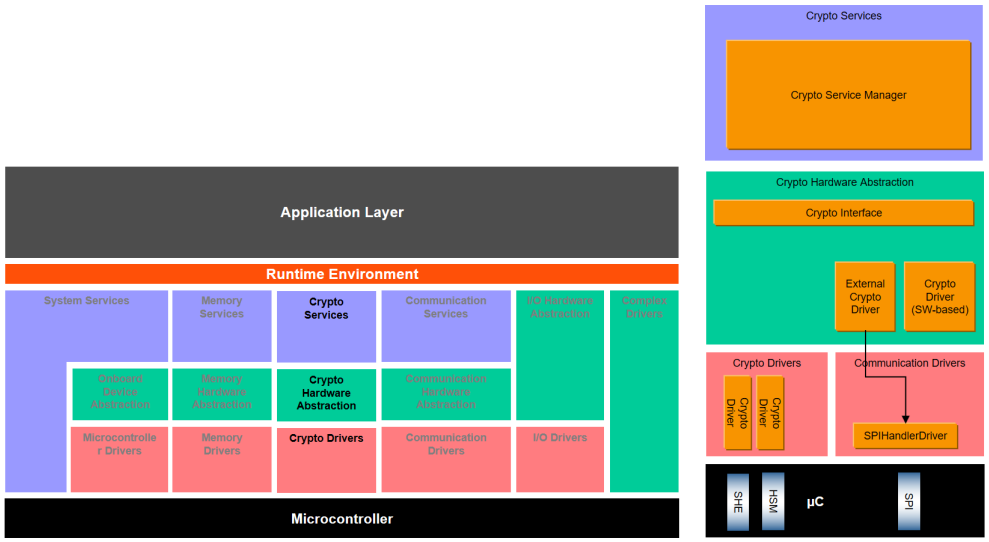


Figure 7.1: AUTOSAR Layered View with Crypto Driver Module

The Crypto Driver module is located in the micro controller abstraction layer and is below the Crypto Interface module and Crypto Service Manager module. It implements a generic interface for synchronous and asynchronous cryptographic primitives. It also supports key storage, key configuration, and key management for cryptographic services.

To provide cryptographic functionalities an ECU needs to integrate one unique Crypto Service Manager module and one Crypto Interface. However, the Crypto Interface can access several Crypto Drivers, each of them individually configured by its underlying Crypto Driver Objects, Crypto Primitives and Crypto Keys.

A Crypto Driver Object represents an independent processing unit for Crypto Primitives. There could be a Crypto Driver Object for processing of Crypto Primitives on an HSM for jobs with high priority. But it is also possible, that a Crypto Driver Object is a piece of software that processes pure software based implementations of Crypto Primitives. The Crypto Driver Object is the endpoint of a Crypto Channel.

A Crypto Primitive represents a specific instance of an implemented cryptographic algorithm. It is primarily characterized by its service, its algorithm family and algorithm mode. Further refinements are possible by assigning subordinated Crypto Primitives.

Examples are the following, possible Crypto Primitives:

- service ENCRYPT, algorithm family AES, algorithm mode ECB
- service ENCRYPT, algorithm family NOTSET, algorithm mode CBC
  AND the subordinated Crypto Primitive with

  - service ENCRYPT, algorithm family AES, algorithm mode NOTSET

- service SIGNATUREGENERATE, algorithm family ECCNIST, algorithm mode NOTSET
  AND the subordinated Crypto Primitives with
  - service HASH, algorithm family SHA2-256, algorithm mode NOTSET
  - service RANDOMGENERATE, algorithm family NOTSET, algorithm mode CTRDRBG
    AND the subordinated Crypto Primitive with
    * service ENCRYPT, algorithm family AES, algorithm mode ECB

Beside supported crypto algorithms via Crypto Primitives usable by Crypto Driver objects, key storage via Crypto Keys is another capability of the Crypto Driver. Crypto Keys are combinations of one or more key elements, in which the actual key material or initialization vectors, etc. are stored.

7.2 Pre-Configuration

The vendor of the Crypto Driver has to provide a pre-configuration for the Crypto Driver which represents the capabilities of the Crypto Driver. The pre-configuration shall be delivered with the BSWMD-file of the Crypto Driver. (see "Basic Software Module Description Template", section "7.2 Configuration Parameter Definitions and Values as Part of a BSWMD"). Depending on the specific characteristics of a Crypto Driver (e.g. does it access a cryptographic HW accelerator or uses it an external cryptographic SW library or none of these, what kind of cryptographic HW accelerator is accessed, what is the firmware version of the cryptographic HW accelerator, what external cryptographic SW library is used in which version, etc.) the pre-configuration of two Crypto drivers can be widely different.

Typical capabilities to be considered by a pre-configuration are Crypto Driver Objects and their set or subset of available Crypto Primitives, Crypto Primitives generally provided by the Crypto Driver and Crypto Keys.

7.3 General Behavior

[SWS_Crypto_00012] ⌈In case several Crypto Driver instances (of same or different vendor) are implemented in one ECU the file names, API names, and published parameters must be distinguished such that no two definitions with the same name are generated.

The name shall be formatted according to [SWS_BSW_00102]: Crypto_<vi>_<ai>, where <vi> is the vendorId and <ai> is the vendorApiInfix.⌋

[SWS_Crypto_00014] ⌈A Crypto Driver Object shall only support processing one job at one time.⌋

[SWS_Crypto_00117] ⌈A Crypto Driver with n Crypto Driver Objects shall be able to process n jobs in parallel.⌋

Hint: Jobs, that are in the job queue (described in chapter 7.3.3.1), do not count as in processing.

7.3.1 Normal Operation

[SWS_Crypto_00017] ⌈"START" indicates a new request of a crypto primitive, and it shall cancel all previous requests of the same job.⌋

Note:

"job is being processed" means that the corresponding crypto driver object is currently and actively processing this job. When a job is not finished but the crypto driver object is not active with it (because, e.g., the operation "FINISH" is outstanding) this does not mean that this job is being processed.

Note:

To unite a single call function and a streaming approach for the crypto services, there is one interface `Crypto_ProcessJob` with a service operation parameter (embedded in job structure parameter). This service operation is a flag field, that indicates the operation modes "START", "UPDATE" or "FINISH". It declares explicitly which operation will be performed.

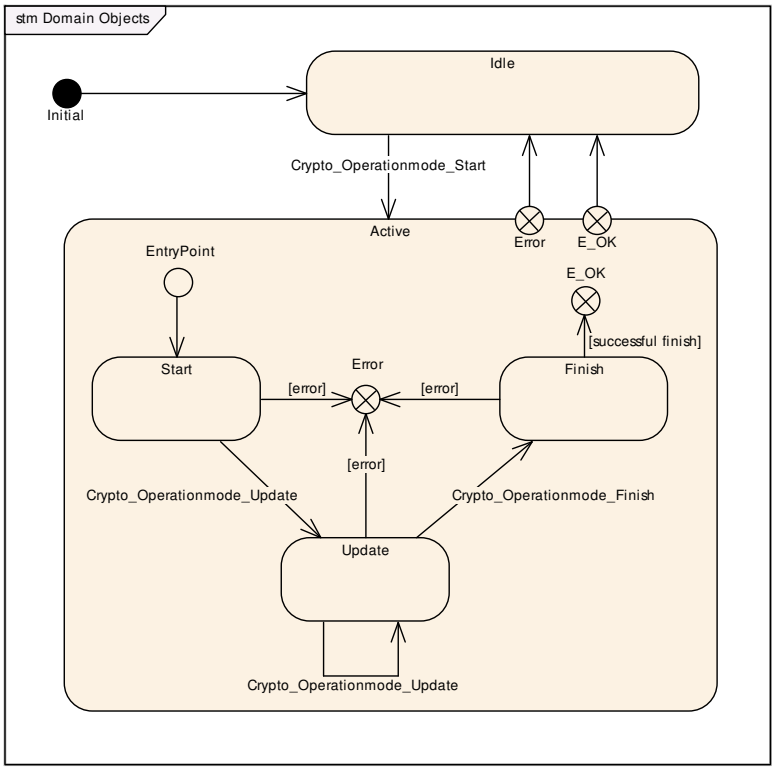
If the "UPDATE" flag is set, the crypto primitive expects input data. "FINISH" indicates, that after this function call, all data are fed completely and the crypto primitive can finalize the calculations.

These operations can be combined to execute multiple operations at once. Then, the operations are performed in the order "START", "UPDATE", "FINISH".

The coherent single call approach could improve the performance due to less overhead. Instead of calling the explicit API multiple times, only one call is necessary. This approach is intended to be used with small data input, which demand fast processing.

The diagram in [SWS_Crypto_00018] shows the state machine of a job of this design without considering the transitions because of errors.

[SWS_Crypto_00018] ⌈



⌋

[SWS_Crypto_00019] ⌈After initialization the crypto driver is in "idle" state.⌋

[SWS_Crypto_00031] ⌈If `Crypto_ProcessJob` is called with "START" flag in the operation mode is set, when the queue is empty and the Crypto Driver Object is not busy the Job shall switch to the state 'active' and execute the crypto primitive.⌋

[SWS_Crypto_00020] ⌈If `Crypto_ProcessJob` is called while in "Active" state and with the operation mode "START", the previous request shall be cancelled. That means, that all previously buffered data for this job shall be reset, and the job shall switch to "Active" state and process the new one.⌋

Note:

Resetting a job using "START" is only possible when the job is not actively being processed.

[SWS_Crypto_00118] ⌈If `Crypto_ProcessJob` is called while the job is in state "Idle" and the "START" flag in the operation mode is not set, the function shall return with `E_NOT_OK`.⌋

Note:

If `Crypto_ProcessJob` is called while in "Active" state and with the operation mode "UPDATE", the crypto primitive is fed with input data. In terms of streaming of arbitrary amounts of user data multiple calls with operation mode "UPDATE" is used, to feed more input data to the previously ones. In the "Update" state, there are usually also calculations of intermediate results of cryptographic primitives. Actually, in some cases (e.g. AES Encryption in CBC mode) there is also the generation of output data. While operating with the streaming approach ("Start", "Update", "Finish") the Crypto Driver Object is waiting for further input ("Update") until the "Finish" state has been reached. No other job could be processed meanwhile.

[SWS_Crypto_00023] ⌈If `Crypto_ProcessJob` is called while in "Active" state and with the operation mode "FINISH", the cryptographic calculations shall be finalized. Additional data (i.e. the MAC to be tested on a MAC verification service) shall be available at this point to process this job successfully. The results of the calculations shall be stored in the output buffers. At end of the processing the Crypto Driver shall switch to "Idle" state.⌋

To process a crypto service with a single call with `Crypto_ProcessJob` the operation mode "CRYPTO_OPERATIONMODE_SINGLECALL" is a disjunction (bitwise OR) of the 3 modes "START", "UPDATE" and "FINISH".

[SWS_Crypto_00025] ⌈If an internal error occurs, the corresponding job state shall be set to "Idle" and all input data and intermediate results shall be discarded.⌋

7.3.2 Functional Requirements

Note: The information whether the job shall be processed synchronously or asynchronously is part of the Crypto_JobType.

7.3.2.1 Synchronous Job Processing

[SWS_Crypto_00026] ⌈When the synchronous job processing is used, the corresponding interface functions shall compute the result synchronously within the context of this function call.⌋

7.3.2.2 Asynchronous Job Processing

[SWS_Crypto_00027] ⌈If the asynchronous job processing is used, the interface functions shall only hand over the necessary information to the primitive. The actual computation may be kicked-off by the main function.⌋

[SWS_Crypto_00028] ⌈For each asynchronous request the Crypto Driver shall notify CRYIF about the completion of the job - whether successful or unsuccessful - by calling the CRYIF_CallbackNotification function passing on the job information and the result of cryptographic operation.⌋

7.3.3 Design Notes

The Crypto Driver provides two services: (1) the crypto services itself and (2) key management.

7.3.3.1 Priority-dependent Job Queue

[SWS_Crypto_00029] ⌈Optionally, every Crypto Driver Object shall be able to line up jobs into a queue to process them one after the other.⌋

[SWS_Crypto_00179] ⌈The Crypto Driver Object shall disable queueing when the size of the crypto driver queue is set to 0.⌋

[SWS_Crypto_00030] ⌈The queue shall sort the jobs according to the configured jobs' priority.⌋

The higher the job priority value, the higher the job's priority.

[SWS_Crypto_00032] ⌈If `Crypto_ProcessJob` is called and the queue is full, the function shall return with `CRYPTO_E_BUSY`.⌋

Note:

It has to be ensured, that the asynchronous jobs are processed fast enough to avoid that the synchronous job has to wait for a long time.

It is also recommended to use CRYPTO_OPERATIONMODE_SINGLECALL for the asynchronous jobs.

Note:

A Crypto Driver Object can handle different jobs with synchronous and asynchronous job processing at the same time. However, synchronous job processing and job-queuing might not be useful. So, if synchronous job processing is chosen, the job

queue will not be used, and a job will only be processed, when the Crypto Driver Object is not busy.

[SWS_Crypto_00121] ⌈If `Crypto_ProcessJob` is called and the Job is in "ACTIVE" state, the `Crypto_ProcessJob` shall check if the requested job matches the current job in the Crypto Driver Object and if yes, shall not queue the job and return `CRYPTO_E_BUSY`.⌋

Note: This implies that only jobs with operation mode "START" shall be queued. If a job with operation mode "START" has been finished, the Crypto Driver Object is waiting for input. The callback function indicates the callee that an "UPDATE" or "FINISH" call shall be performed.

Note:

If update or finish request is received for a job that is currently being actively processed, the request shall be rejected.

[SWS_Crypto_00033] ⌈If `Crypto_ProcessJob` is called with asynchronous job processing and the queue is not full, but the Crypto Driver Object is busy and if the job has the operation mode "START", the Crypto Driver Object shall put the job into the queue and return `E_OK`.⌋

[SWS_Crypto_00034] ⌈If `Crypto_ProcessJob` is called with synchronous job processing and the queue is not full, but the Crypto Driver Object is busy, the Crypto Driver Object shall not queue the job and return `CRYPTO_E_BUSY`. No job shall be put in any queue.⌋

[SWS_Crypto_00199] ⌈If the Crypto Driver has a queue and if a synchronous job is issued and the priority is greater than the highest priority available in the queue, the Crypto Driver shall disable processing new jobs from the queue until the next call of the main function has finished that follows after completion of the currently processed job.⌋

Note:

Channels may hold jobs of both asynchronous and synchronous processing type. If so, a synchronous job might not be accepted for processing although its job's priority is higher than those of all asynchronous jobs.

7.3.4 Key Management

A key consists of one or more key elements.

Examples of key elements are the key material itself, an initialization vector, a seed state for random number generation, or the proof of the SHE standard.

Each key element has a defined access right for read or write access. The access right itself is defined by enumerations with an assigned value (see [ECUC_Crypto_00024] or [ECUC_Crypto_00027]) in the configuration of a CryptoKeyElement. The integer values of these enumerations are chosen in a way, that the assignment of an access right to a key element also deduces further right accesses. The lower the value, the higher the access right. This allows an easy compare of the assigned value to a required right access by numbers.

Example:

If a key element has access rights of CRYPTO_RA_INTERNAL_COPY=2, the right permission also applies to CRYPTO_RA_ENCRYPTED=1 and CRYPTO_RA_ALLOWED=0, because both rights of the assigned enumeration values are lower and therefore are lower in the ranking of the access rights.

[SWS_Crypto_00219] ⌈Access rights shall be taken into account when direct access to key elements are required. This applies for read and write access.⌋

Keys or key elements can be copied using the key copy interface functions. This allows, for example, to store keys in one driver channel that provides secure key storage and to distribute them to other driver implementations that have no such capabilities. However, it is important that access rights to key elements are guarded within the copy operation to avoid unintended disclosure of stored keys.

[SWS_Crypto_00220] ⌈A source key element must have higher or the same rights than the destination key element when key elements are copied using the key copying interfaces. A source key must have at least the rights CRYPTO_RA_INTERNAL_COPY or lower to get copied.⌋

Info:

An internal copy operation can only be performed if the key elements are located in the same crypto driver object.

[SWS_Crypto_00221] ⌈Jobs shall use the assigned key elements without guarding the key access rights with the following exceptions:

- If a key element is used for input using the input re-direction, the key element must have access rights CRYPTO_RA_INTERNAL_COPY or lower.

  If input re-direction is used for CryptoPrimitiveTypeService CRYPTO_ENCRYPT/CRYPTO_DECRYPT or CRYPTO_AEADENCRYPT/CRYPTO_AEADDECRYPT, the access rights must be set to RA_ENCRYPTED or lower.[1]

- If a key element is used for output re-direction, the key element must have access rights CRYPTO_WA_INTERNAL_COPY or lower.

[1]Rationale: This is to avoid using a key element as input and (another for) output for encrypt and successively decrypt that key which would allow to extract the secret key in plaintext at the end.

- Any key element that is used to generate keys using Key Exchange operation shall have access rights of at least CRYPTO_RA_INTERNAL_COPY or lower.
- For Key Derivation, the source key shall have access rights of at least CRYPTO_RA_INTERNAL_COPY or lower. The destination key shall have at least the access right of its source key or lower[2].

⌋

[SWS_Crypto_00037] ⌈The index of the different key elements from the different crypto services are defined as in imported types table [SWS_Csm_01022].⌋

[SWS_Crypto_00038] ⌈A key has a state which is either "valid" or "invalid".⌋

[SWS_Crypto_00039] ⌈If a key is in the state "invalid", crypto services which make use of that key, shall return with CRYPTO_E_KEY_NOT_VALID⌋

Note: In case of error observed during Crypto_KeyElementSet API call, the status of the key element needs to be considered as unknown.

If a key (or key element) is currently in use by a crypto service, the state of the key has to be "valid". When the Crypto_KeyElementSet is called, the key state is set to "invalid". So, the job which is currently running will probably work with an inconsistent key. It is up to the application to only change key, if currently no primitive works with that key (element).

Note: The mapping of keys and key elements to SHE hardware functionality is possible without being subject to any restrictions except that read and write access through key management interfaces must be performed in encrypted form due to hardware constrains. To provide an environment for legacy software the single key used by the hardware can be placed in a key element referenced by several keys. Every key has also a unique reference to a key element containing an identifier. The driver implemented according to this specification can hence wrap existing SHE hard- and software and pass the data from the key elements to the existing SHE driver. In this use case one key element could contain a counter that could be read and written by the driver as well as the application. This counter could be used to detect if the key was overwritten. The loading of a key into the actual hardware key slot could be done immediately before the key is used, which would result in a combined loading and processing of the key, as well as a separate operation following the writing of a key into a key element. This would result in separate operations for loading and processing the key.

If a new driver is to be implemented, it would also be possible to configure keys with completely independent key elements. These independent keys can be stored in RAM and passed to the hardware key slot only when required for an operation. The number of keys stored in the driver can be independent of (and much larger than) the number of hardware key slots. This requires, of course, a handling and storing of keys in software with all potential drawbacks.

[2]This is to avoid to deduce the source key when using weak key derivation algorithms.

Storing key elements with the configuration parameter CryptoKeyElementPersist set to True of a single Crypto key is done by calling Crypto_KeySetValid or Crypto_ProcessJob with a configured job of service CRYPTO_KEYSETVALID. As in most cases writing operation takes some time it is recommended to store key permanently using the CRYPTO_KEYSETVALID job interface.

Different key types can have compatible key elements. In this case the keyElementId has the same value. Key elements with the same keyElementId may be regarded as compatible. This way, the same key can be used for different services.

The key material therefore shall always have the keyElementId 1.

Example is the generation of a key with the Key Management Interface and usage of the same key in a primitive like MacGenerate afterwards.

A key element may not be fully written. In some cases, the size of data to be stored in the key element can vary, e.g. asymmetric key elements. The Crypto Driver shall store the actually written size of data for internal usage and for exporting the element with Crypto_KeyElementGet. If the key element shall allow to be not fully read or written can be configured with the parameter CryptoKeyElementAllowPartialAccess in the CryptoKeyElement container.

7.3.5 Key Formats

The key element with ID 1 is a particular key that provides the cryptographic key for the related cryptographic primitive.

In IETF RFC, keys are described in a specific format to provide a common and compact way to transport them between entities.

To support this standard also within AUTOSAR, the following chapter describes key formats that are supported by AUTOSAR.

This allows to provide a given key in such a format to the crypto driver, e.g. from parts of a certificate without the needs for an application to analyse the structure and to construct that data.

By supporting the IETF RFC within the crypto driver, the key material can be provided as is.

If supported, the extraction of the required key elements, such as private or public key fields, is accomplished in the driver.

It is unlikely to compose such formats back to the application by the crypto driver. Thus, such a key element might only be temporarily stored and may not persisted in "composed" format (M1M2M3), e.g. to retrieve that after reset.

[SWS_Crypto_00184] ⌈Asymmetric key material with identification is specified in accordance to RFC5958 in ASN.1 format. The key material with the format specifier

CRYPTO_KE_FORMAT_BIN_IDENT_PRIVATEKEY_PKCS8 needs to follow this format specification:

OneAsymmetricKey ::= SEQUENCE {

version Version,

KeyAlgorithm KeyAlgorithmIdentifier,

keyMaterial KeyMaterial,

attributes* [0] Attributes OPTIONAL,

...,

[[2: publicKey* [1] PublicKey OPTIONAL]],

...

}

* The optional values for key attributes and the PublicKey are currently not used within the crypto driver and is listed here just for compatibility reason to RFC5958. A driver shall tolerate the provision of this information but doesn't need to evaluate its contents.

The elements have the following meaning:

Version ::= INTEGER { v1(0), v2(1) } (v1, ..., v2)

KeyAlgorithmIdentifier ::= AlgorithmIdentifier

{ PUBLIC-KEY,

{ PrivateKeyAlgorithms } }

KeyMaterial ::= OCTET STRING

– Content varies based on the type of the key and is specified by its AlgorithmIdentifier.

– The KeyAlgorithmIdentifier defines which format specifier for KeyMaterial shall be applied.

AlgorithmIdentifier: A value that identifies the format by its object identifier (OID).⌋

[SWS_Crypto_00254] ⌈Public key material with identification is specified in accordance to RFC5280, section 4.1. The key material with the format specifier CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY needs to follow this format specification:

SubjectPublicKeyInfo ::= SEQUENCE

{ algorithm AlgorithmIdentifier,

subjectPublicKey BIT STRING }

The elements have the following meaning:

AlgorithmIdentifier:

A value that identifies the format by its object identifier (OID).

subjectPublicKey:

The public key itself.⌋

7.3.5.1 Definition of RSA Key Material

[SWS_Crypto_00185] ⌈For CRYPTO_KE_FORMAT_BIN_RSA_PRIVATEKEY the parameter 'KeyMaterial OCTET STRING' for RSA private keys is defined according to IETF RFC8017 and has the following contents:

KeyMaterial ::= RSAPrivateKey

RSAPrivateKey ::= SEQUENCE {

version Version,

modulus INTEGER, – n

publicExponent INTEGER, – e

privateExponent INTEGER, – d

prime1 INTEGER, – p

prime2 INTEGER, – q

exponent1 INTEGER, – d mod (p-1)

exponent2 INTEGER, – d mod (q-1)

coefficient INTEGER – (inverse of q) mod p }

Version ::= INTEGER { two-prime(0), multi(1) }

The fields of type RSAPrivateKey have the following meanings:

- version is the version number, for compatibility with future revisions of this document. It shall be 0 for this version of the document.
- modulus is the modulus n.
- publicExponent is the public exponent e.
- privateExponent is the private exponent d.
- prime1 is the prime factor p of n.
- prime2 is the prime factor q of n.
- exponent1 is d mod (p-1).
- exponent2 is d mod (q-1).

- coefficient is the Chinese Remainder Theorem coefficient (inverse of q) mod p.

⌋

Note:

The values for prime1, prime2, exponent1, exponent2 and coefficient are optional. If prime1 is not provided, none of the following values in the list shall be provided. Otherwise, the key shall be rejected.

[SWS_Crypto_00186] ⌈The RSA public key in the format CRYPTO_KE_FORMAT_BIN_RSA_PUBLICKEY is provided as follows:

RSAPublicKey ::= SEQUENCE {

modulus INTEGER, – n

publicExponent INTEGER, – e

}

The fields of type RSAPublicKey have the following meanings:

- modulus is the modulus n.
- publicExponent is the public exponent e.

⌋

[SWS_Crypto_00187] ⌈For the RSA public key in the format CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY the "subjectPublicKey BIT STRING" is defined as "RSAPublicKey".

Explanation:

Considering RFC5280, section 4.1, the SubjectPublicKeyInfo follows directly the definition described above. Thus, a key type of CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY matches SubjectPublicKeyInfo and CRYPTO_KE_FORMAT_BIN_RSA_PUBLICKEY matches the subjectPublicKey in this definition.⌋

[SWS_Crypto_00188] ⌈The algorithm identifier for RSA keys shall have the value 1.2.840.113549.1.1.1. This corresponds to the ASN.1 coded OID value "2A 86 48 86 F7 0D 01 01 01". This OID shall be provided whenever an AlgorithmIdentifier for RSA is required. In other words, when a key has the format CryptoKeyElementFormat CRYPTO_KE_FORMAT_BIN_IDENT_PRIVATEKEY_PKCS8 or CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY and is used for RSA, the AlgorithmIdentifier must have this value.

Note: In some cases, a NULL value is followed directly to the OID. So, a value that follows directly after this OID in the same sequence is optional and should be tolerated.⌋

7.3.5.2 Definition of ECC Key Material

[SWS_Crypto_00189] ⌈Due to a lack of clear and efficient standard definition for ECC keys, key material for ECC is defined as binary information in the format definition of CRYPTO_KE_FORMAT_BIN_ECC_PRIVATEKEY, CRYPTO_KE_FORMAT_BIN_ECC_PUBLICKEY, CRYPTO_KE_FORMAT_BIN_ED25519_PRIVATEKEY, CRYPTO_KE_FORMAT_BIN_ED25519_PUBLICKEY. The length of data depends on the assigned curve operation.⌋

[SWS_Crypto_00190] ⌈Public keys for NIST and Brainpool ECC curves are provided with their X and Y coordinates (CRYPTO_KE_FORMAT_BIN_ECC_PUBLICKEY):

ECC Public Key = Point X | Point Y.

The points are stored in little endian format.

The number of bytes for the key depends on the implementation of the curve.

Examples:

NIST curve P(256) public key = X(32) | Y(32)

NIST curve P(192) public key = X(24) | Y(24)⌋

[SWS_Crypto_00191] ⌈Private keys for NIST and Brainpool ECC curves are provided with their X and Y coordinates and an additional scalar (CRYPTO_KE_FORMAT_BIN_ECC_PRIVATEKEY):

ECC Private Key = Point X | Point Y | Scalar.

The points and the scalar are stored in little endian format.

Example:

Brainpool curve P(256) = X(32) | Y(32) | SCALAR(32)⌋

[SWS_Crypto_00192] ⌈The public key information for ED25519 contains a point on the curve (CRYPTO_KE_FORMAT_BIN_ED25519_PUBLICKEY):

ED25519 Public Key = Point X

The point is stored in little endian format.

Example:

ED25519 Public Key = X(32).⌋

[SWS_Crypto_00193] ⌈The private key information for ED25519 contains a random constant and the point X on the curve (CRYPTO_KE_FORMAT_BIN_ED25519_PRIVATEKEY):

ED25519 Private Key = Seed K | Point X

The point and the seed are stored in little endian format.

Example:

ED25519 Private Key = Seed K(32) | X(32).⌋

7.3.5.3 Definition of SHE key material

[SWS_Crypto_00255] ⌈If a crypto key element is used as a secret key of a SHE hardware, then the configuration of CryptoKeyFormat/CryptoKeyElementFormat shall be set to CryptoKeyElementFormat `CRYPTO_KE_FORMAT_BIN_SHEKEYS`. This indicates that the key element shall be presented in M1M2M3 format as specified in [5]. The function `Crypto_KeyElementSet` is used to load the key into the SHE hardware (not directly on a call to this function but rather through key-set-valid operation).

With `Crypto_KeyElementSet`, the parameter 'keyElementId' shall be set to 1. This can be taken from e.g. CRYPTO_KE_MAC_KEY or CRYPTO_KE_CIPHER_KEY (see [SWS_Csm_01022]).

The SHE hardware provides M4M5 as the proof of the correct key processing and to confirm the operation. To extract this key information, an additional key element is needed. To read the proof after the key-set-valid operation, the function `Crypto_KeyElementGet` with key element ID value '2' shall be used, e.g. with pre-defined macros CRYPTO_KE_MAC_PROOF or CRYPTO_KE_CIPHER_PROOF. The proof will only be available directly after a successful key-element-set followed by key-set-valid operation, e.g. within an ignition cycle. This means, the proof must not be stored, e.g. in NV-RAM, to provide this information later on.⌋

7.3.6 Key Storage in NVM

To allow a crypto driver to persist key elements in non-volatile memory, access to NVM is required. For this, the configuration of the crypto driver needs a reference to one or more NVM blocks. Keys with key elements that shall be persisted are to be assigned to these blocks. The elements that are to be persisted will then be written by the driver on validation and values are retrieved during initialization of the driver. The principal relation to configuration items is shown in Figure 7-2.

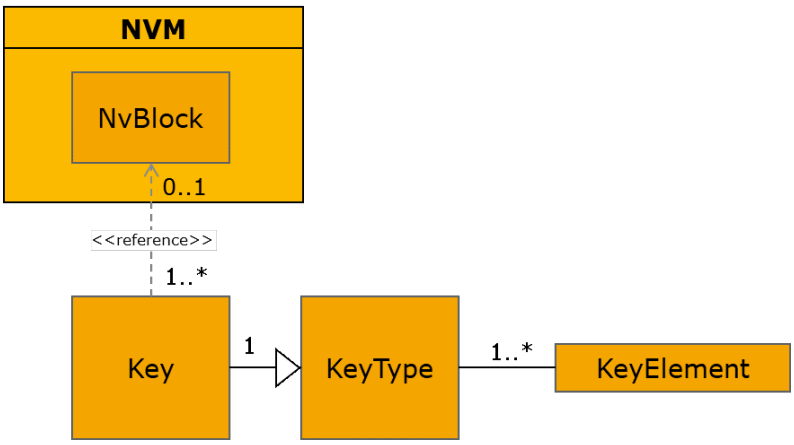


Figure 7.2: NvBlock configuration for key persistence

Important note:

The crypto driver only deals with the functional operation to store data to and read data from an NVM block. Any error handling like defects of NVM blocks must be captured and dealt with in the application.

7.3.6.1 Writing keys to NVM

[SWS_Crypto_00242] ⌈The storage of keys resp. their elements shall be initiated only when KEYSETVALID" is started, either by a call to `Crypto_KeySetValid` or to `Crypto_ProcessJob` with primitive service `CRYPTO_KEYSETVALID` or `CRYPTO_KEYSETINVALID` set. Thus, key element storage in NVM shall not be initiated on a call to `Crypto_KeyElementSet` or similar operation. The storage operation shall only take place if the validation was successfully finished and the operation returns `E_OK` (either directly by a synchronous call or asynchronously through the callback).⌋

Rationale:

Especially when key elements of a key have interdependencies to one or more other key element(s) of the same key, writing the key element immediately when it is set has the risk, that the key itself can be inconsistent. In addition, the explicit initiation of the operation with KEYSETVALID allows the crypto driver to check the consistency and interdependency of all elements and storing will be denied if the check fails. Also, updating several elements of a key will result in a single write operation to NVM and not multiple times for each key element, which can reduce the total number of write operations to NVM.

[SWS_Crypto_00243]

Upstream requirements: SRS_BSW_00383, SRS_BSW_00384

⌈On KEYSETVALID operation, writing the data block to NVM will be initiated by a call of the crypto driver to NvM_SetRamBlockStatus(). This is the typical operation when the configuration CryptoNvBlock/CryptoNvBlockProcessing is set to DEFERRED.

If CryptoNvBlock/CryptoNvBlockProcessing is set to IMMEDIATE, the Crypto Driver will, besides the call to NvM_SetRamBlockStatus(), also call NvM_WriteBlock() immediately afterwards. This will trigger an immediate write of the NV RAM Block to non-volatile memory.⌋

Note:

For proper operation it is recommended to set the parameter NvMBlockUseSetRamBlockStatus and NvMSelectBlockForReadAll of the NVM to TRUE. The value NvMSelectBlockForWriteAll shall be set to TRUE if CryptoNvBlockProcessing is set to DEFERRED.

[SWS_Crypto_00244]

Upstream requirements: SRS_BSW_00497

⌈If a call to an NVM service (NvM_SetRamBlockStatus() or NvM_WriteBlock()) returns with `E_NOT_OK`, or when the callback function Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock> (see [SWS_Crypto_91026]) indicates with Nvm_RequestResultType that the block write operation has failed, the runtime error `CRYPTO_E_RE_NVM_ACCESS_FAILED` shall be reported to the DET. In addition, the service call shall be requested again on the next execution of `Crypto_MainFunction`. The number of retries can be limited by the parameter CryptoNvBlock/CryptoNvBlockFailedRetries.⌋

[SWS_Crypto_00245] ⌈If a key is currently updated in NV RAM Block and has not yet been written by NVM, then this shall be reflected in the key status with CRYPTO_KEYSTATUS_UPDATE_IN_PROGRESS through the `Crypto_KeyGetStatus` interface.⌋

[SWS_Crypto_00246]

Upstream requirements: SRS_BSW_00383, SRS_BSW_00384

⌈For each configured CryptoNvBlock the Crypto driver shall provide a separate set of Crypto_<vi>_<ai>_NvBlock_xxx_<NvBlock>() functions (xxx refers to Init, ReadFrom, WriteTo and Callback) (see chapter Callback notification). The short name of the CryptoNvBlock container replaces the tag <NvBlock>. The tags <vi> and <ai> are replaced as described in [SWS_Crypto_00012]. These functions shall be set as callbacks in the respective fields of the NvmBlockDescriptor.⌋

7.3.6.2 Reading Keys from NVM

[SWS_Crypto_00247]

Upstream requirements: SRS_BSW_00383, SRS_BSW_00384

⌈On initialization of the crypto driver, the callback function Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock>() shall be called to retrieve the previously persisted key elements for the associated Keys.⌋

Note:

The format of the data within the NvBlock are local to the driver. At least, the driver needs to make sure that key elements and keys can be uniquely assigned within the NV RAM Block. Also, versioning of NV RAM Block data for future updates of the format shall be considered. Data consistency of the block may be considered.

[SWS_Crypto_00248] ⌈On initialization, if an NvBlock could be read successfully and the internal consistency check of the NvBlock data was successful, all key elements of the referencing keys to this block shall be set with the value from the NV RAM Block data.⌋

[SWS_Crypto_00249]

Upstream requirements: SRS_BSW_00497

⌈On initialization, when reading an NvBlock for keys and the block is available but corrupted (driver internal data consistency check failed), all related keys shall be set to invalid. The length value of all associated key elements, where CryptoKeyElementPersist is set to TRUE, shall be set to 0 even if CryptoKeyElementInitValue is set for this key.⌋

Rationale:

This shall prevent an attack where NvBlocks are manipulated to force the driver back to an initial state.

[SWS_Crypto_00250] ⌈If an NvBlock has no data, respectively the NvBlock is empty, key elements of all referenced keys, where CryptoKeyElementInitValue is set, shall use this configured init value (as if no key storage is configured for the key).⌋

[SWS_Crypto_00251] ⌈After initialization of all key elements at startup (either with default or with persisted data), the crypto driver shall check all keys and its key elements if they are valid (at least one key element has a value). If so, the corresponding key shall be set to VALID state.⌋

7.3.7 Crypto Profiles

7.3.7.1 Overview of custom service and function profiles

The Crypto Driver can support vendor specific custom services and custom synchronous API functions, triggered by Csm_CustomService and Csm_CustomSync (`Crypto_CustomSync`). In order to align the realization by different Crypto vendors for a particular use case, a mapping of parameters is required. This mapping is defined by the definition of profiles for particular use case.

[SWS_Crypto_00258] ⌈A Crypto profile shall define the mapping for the following parameters for Csm_CustomService:

`uint32`	`JobId`

```
Crypto_OperationModeType  mode
uint32                    targetKeyId
const uint8*              inputPtr
uint32                    inputLength
const uint8 *             secondaryInputPtr
uint32                    secondaryInputLength
const uint8*              tertiaryInputPtr
uint32                    tertiaryInputLength
uint8*                    outputPtr
uint32*                   outputLengthPtr
uint8*                    secondaryOutputPtr
uint32*                   secondaryOutputLengthPtr
Crypto_VerifyResultType*  verifyPtr
```

⌋

[SWS_Crypto_00259] ⌈A Crypto profile shall define the mapping for the following parameters for Csm_CustomSync:

```
uint32        dispatchId **** - unique id to identify the request
uint32        keyId
uint32        keyElementId
uint32        targetKeyId
uint32        targetKeyElementId
const uint8*  inputPtr
uint32        inputLength
uint8*        outputPtr
uint32*       outputLengthPtr
uint8*        secondaryOutputPtr
uint32*       secondaryOutputLengthPtr
```

⌋

7.3.7.2 Custom service and function profile 1 (KeyM and certificate management)

This profile defines how to use a custom service with the certificate management services specified for the KeyM. Using this profile enables the KeyM to forward the actual certificate processing to the Crypto Driver and its associated HSM. The Crypto profile provides a consistent mapping of the parameters from the KeyM services and functions to the Csm job configured for the custom service and to the custom synchronous API function `Crypto_CustomSync`.

The ServiceInfoType is defined as CUSTOM_SERVICE with value 0x15.

The KeyM_ServiceCertificate (ServiceId: 0x09) can be mapped by the KeyM to call KeyM_ServiceCertificateByCertId (ServiceId: 0x13).

In case the data type mapped to a parameter of type unit8* have a bigger size (e.g. uint16) the MSB should be the first byte.

[SWS_Crypto_00260] ⌈Each Crypto profile shall define the mapping of the parameters of Crypto_CustomService to the using KeyM service/function.⌋

[SWS_Crypto_00262] Crypto_CustomService returns the actual error value of the KeyM service ⌈If Crypto_ProcessJob() is called for a job configured with ser-

vice CUSTOM_SERVICE and if CRYPTO_E_CUSTOM_ERROR will be returned then job->action->jobOutputsPtr[1].dataPtr shall contain the appropriate return value from Crypto_KeyM_ReturnType data type.⌋

Note: The remaining return values relevant for service CUSTOM_SERVICE map automatically as their enumeration values are identical, i.e. the following Crypto Driver Std_ReturnType values map directly to the according KeyM Std_ReturnType:

- E_OK → E_OK
- E_NOT_OK → E_NOT_OK
- CRYPTO_E_BUSY → KEYM_E_BUSY

[SWS_Crypto_00263] Crypto_CustomService returns the actual error value of the KeyM_ServiceCertificate ⌈If Crypto_ProcessJob() is called for an asynchronous job configured with service CUSTOM_SERVICE that is mapped from a KeyM API that will trigger KeyM_ServiceCertificateCallbackNotification() and if CRYPTO_E_CUSTOM_ERROR will be returned in the Crypto_ResultType parameter, then job->action->jobOutputsPtr[1].dataPtr shall contain the appropriate value from Crypto_KeyM_ResultType data type.⌋

[SWS_Crypto_00264] Crypto_CustomService returns the actual error value of the KeyM_CertificateVerify ⌈If Crypto_ProcessJob() is called for an asynchronous job configured with service CUSTOM_SERVICE that is mapped from a KeyM API that will trigger KeyM_CertificateVerifyCallbackNotification() and if E_OK or CRYPTO_E_CUSTOM_ERROR will be returned in the Crypto_ResultType parameter, then job->action->jobOutputsPtr[1].dataPtr shall contain the appropriate value from Crypto_KeyM_CertificateStatusType data type.⌋

Note: KeyM distinguishes between KeyM_CertificateVerifyCallbackNotification() and KeyM_ServiceCertificateCallbackNotification() callback functions having different data types of results, KeyM_ResultType and KeyM_CertificateStatusType. The configured Csm_ApplicationCallbackNotification provides the result as a Crypto_ResultType value. In case of an unrecoverable error, e.g. CRYPTO_E_BUSY, it is not possible to provide a value of KeyM_ResultType or KeyM_CertificateStatusType. Therefore, secondaryOutputPtr will only contain a valid result for KeyM if the Csm_ApplicationCallbackNotification returns E_OK or CRYPTO_E_CUSTOM_ERROR.

Mapping table for Csm_CustomService:

Csm_CustomService	KeyM_ ServiceCertificateByCertId	KeyM_ VerifyCertificates	KeyM_ VerifyCertificate	KeyM_ VerifyCertificateChain
service Id	0x13	0x0C	0x0D	0x0E
processing type	async	async	async	async
Return type	Std_ReturnType	Std_ReturnType	Std_ReturnType	Std_ReturnType
uint32 JobId*****	JobId of the referenced custom CSM job from the given certificate configuration			

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Crypto_ OperationModeType mode	CRYPTO_ OPERATIONMODE_ SINGLECALL	CRYPTO_ OPERATIONMODE_ SINGLECALL	CRYPTO_ OPERATIONMODE_ SINGLECALL	CRYPTO_ OPERATIONMODE_ SINGLECALL
uint32 targetKeyId	uint8 SvcId**	uint8 SvcId**	uint8 SvcId**	uint8 SvcId**
const uint8* inputPtr	uint8 Service***	uint16 CertUpperId****	empty*	uint8 NumberOfCertificates
uint32 inputLength	1	2	0	1
const uint8 * secondaryInputPtr	const unit8 * RequestData	empty*	empty*	KeyM_CertDataType[] certChainData
uint32 secondaryIn-putLength	uint32 RequestDataLength	empty*	empty*	NumberOfCertificates * sizeof (KeyM_CertDataType)
const uint8* tertiaryInputPtr	empty*	empty*	empty*	empty*
uint32 tertiaryInputLength	empty*	empty*	empty*	empty*
uint8* outputPtr	uint8 ResponseData	empty*	empty*	empty*
uint32* outputLengthPtr	unit32 ResponseDataLength	empty*	empty*	empty*
uint8* secondaryOutputPtr	<specific return value for that custom service>			
uint32* secondary-OutputLengthPtr	< sizeof(Std_ReturnType)>			
Crypto_ VerifyResultType* verifyPtr	empty*			

Table 7.1: Csm_CustomService to KeyM services mapping table

* "empty": it's up to the vendor how to set the value of the parameter, but will not be used

** "SvcId": is Service ID of the original KeyM API function; casted to uint32

*** "Service" is the parameter KeyM_ServiceCertificateType Service from the caller

**** "CertUpperId": most significant byte (MSB) of uint16 CertUpperId

***** "JobId": Referenced Csm key holds the KeyM certificate

The picture below shows the usage of the crypto driver (on HSM). Service requests from the application go to the standardized KeyM interfaces and if a crypto profile for custom processing defines the handling on HSM the crypto driver transfers the execution onto the HSM.

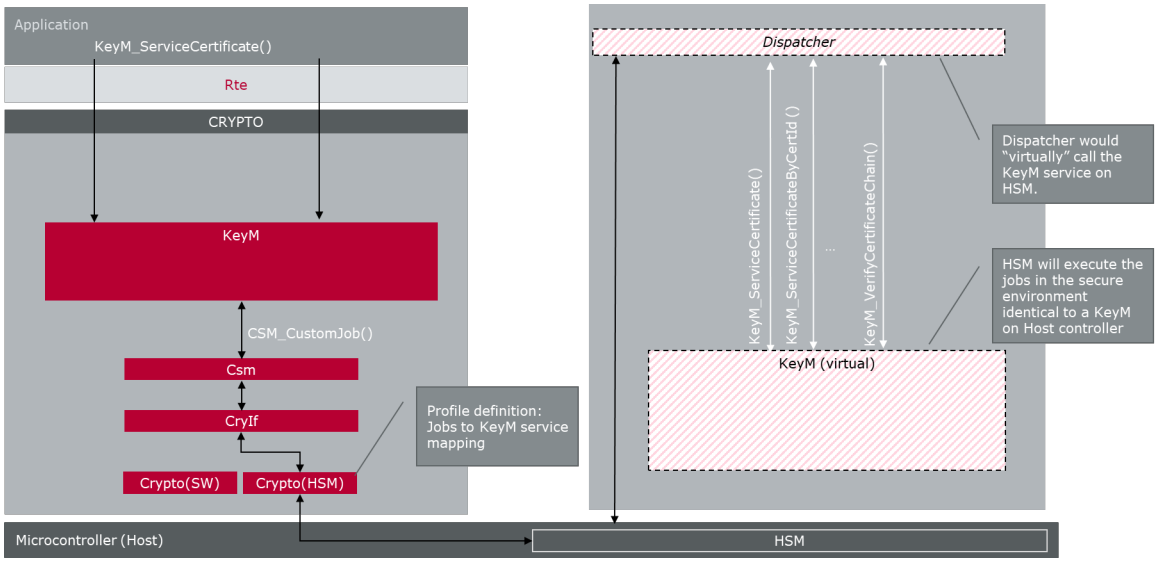


Figure 7.3

[SWS_Crypto_00269] Mapping Crypto profile parameters to KeyM services ⌈Each Crypto profile shall define the mapping of the parameters of Crypto_CustomSync to the using KeyM service/function.⌋

Mapping table for Csm_CustomSync:

Csm_ CustomSync	KeyM_ CertElement-Get	KeyM_ CertGetStatus	KeyM_ Certifi-cateElement-GetByIndex	KeyM_ CertificateEle-mentGetCount	KeyM_ SetCertificate	KeyM_ GetCertificate
service Id	0x0F	0x12	0x1B	0x1C	0x0A	0x0B
processing type	sync					
Return type	Std_ReturnType					
uint32 dispatchId**	0x1580000F	0x15800012	0x1580001B	0x1580001C	0x1580000A	0x1580000B
uint32 keyId	Csm keyId from the certificate's configuration where it is stored to					
uint32 keyElementId	mapped keyElementId from CertElementId	empty*	mapped keyId from CertElementId	mapped keyId from CertElementId	empty*	empty*
uint32 targetKeyId	empty*	empty*	uint32 index	empty*	empty*	empty*
uint32 targetKeyEle-mentId	empty*	empty*	empty*	empty*	empty*	empty*
const uint8* inputPtr	empty*	empty*	empty*	empty*		KeyM_ CertDataType* CertificateDat-aPtr
uint32 inputLength	empty*	empty*	empty*	empty*	empty*	empty*

▽

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uint8* outputPtr	uint8* CertElementData	KeyM_CertificateStatusType* Status	uint8* CertElementDataPtr	uint8* CountPtrArray***	empty*	empty*
uint32* outputLengthPtr	uint32* CertElementDataLength	sizeof (KeyM_CertificateStatusType)	uint32* CertElementDataLengthPtr	empty*	empty*	empty*
uint8* secondaryOutputPtr	Std_ReturnType					
uint32* secondaryOutputLengthPtr	sizeof(Std_ReturnType)					

Table 7.2: Csm_CustomSync to KeyM services mapping table

* "empty": it's up to the vendor how to set the value of the parameter, but will not be used

** "dispatchId": see [SWS_Crypto_00259]

*** "CountPtrArray": CountPtrArray[0] being low byte of CountPtr and CountPtrArray[1] the high byte

[SWS_Crypto_00265] Crypto_CustomSync returns actual error value from KeyM API ⌈If Csm_CustomSync() will return CRYPTO_E_CUSTOM_ERROR then secondaryOutputPtr shall contain the appropriate return value from Crypto_KeyM_ReturnType data type.⌋

Note: The remaining return values relevant for service Csm_CustomSync() map automatically as their enumeration values are identical, i.e. the following Crypto Driver Std_ReturnType values map directly to the according KeyM Std_ReturnType:

- E_OK → E_OK
- E_NOT_OK → E_NOT_OK
- CRYPTO_E_BUSY → KEYM_E_BUSY

Mapping table for KeyMCertificateElementOfStructure:

KeyMCertificateElementOfStructure	key element Name	key element ID	Mandatory
Certificate	CRYPTO_KE_CERTIFICATE_DATA	0	x
Format	CRYPTO_KE_CERTIFICATE_PARSING_FORMAT	18	
CertificateVersionNumber	CRYPTO_KE_CERTIFICATE_VERSION	20	
Serial Number	CRYPTO_KE_CERTIFICATE_SERIALNUMBER	21	
CertificateSignatureAlgorithm	CRYPTO_KE_CERTIFICATE_SIGNATURE_ALGORITHM	22	
CertificateIssuerName	CRYPTO_KE_CERTIFICATE_ISSUER	23	
CertificateValidityPeriodNotBefore	CRYPTO_KE_CERTIFICATE_VALIDITY_NOT_BEFORE	24	

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CertificateValidityPeriodNotAfter	CRYPTO_KE_CERTIFICATE_VALIDITY_NOT_AFTER	25	
CertificateSubjectName	CRYPTO_KE_CERTIFICATE_SUBJECT	26	
CertificateSubjectPublicKeyInfo_SubjectPublicKey	CRYPTO_KE_CERTIFICATE_SUBJECT_PUBLIC_KEY	1	
Extensions	CRYPTO_KE_CERTIFICATE_EXTENSIONS	27	
Signature	CRYPTO_KE_CERTIFICATE_SIGNATURE	28	
CertificateIssuerUniqueIdentifier	CRYPTO_KE_CERTIFICATE_ISSUER_UNIQUE_IDENTIFIER	29	
CertificateSignatureAlgorithmID	CRYPTO_KE_CERTIFICATE_SIGNATURE_ALGORITHM_ID	30	
CertificateSubjectPublicKeyInfo_PublicKeyAlgorithm	CRYPTO_KE_CERTIFICATE_SUBJECT_PUBLICKEYINFO_PUBLICKEYALGORITHM	31	
CertificateSubjectUniqueIdentifier	CRYPTO_KE_CERTIFICATE_SUBJECT_UNIQUE_IDENTIFIER	32	
RevokedCertificates	CRYPTO_KE_CERTIFICATE_REVOKED_CERTIFICATES	33	
CertificateSubjectAuthorization	CRYPTO_KE_CERTIFICATE_SUBJECT_AUTHORIZATION	34	

Table 7.3: KeyMCertificateElementOfStructure to key element mapping

Certificate element names and Ids

[SWS_Crypto_00266] Definition of Std_ReturnType-extension for module Crypto

⌈

Range	CRYPTO_KEYM_E_BUSY	0x02	Key management is busy with other operations.
	CRYPTO_KEYM_E_PENDING	0x03	Operation request accepted, response is pending. It runs now in asynchronous mode, response will be given through callback.
	CRYPTO_KEYM_E_KEY_CERT_SIZE_MISMATCH	0x04	Parameter size does not match the expected value.
	CRYPTO_KEYM_E_PARAMETER_MISMATCH	0x05	Parameter to function does not provide the expected value.
	CRYPTO_KEYM_E_KEY_CERT_INVALID	0x06	Key or certificate is invalid and cannot be used for the operation.
	CRYPTO_KEYM_E_KEY_CERT_WRITE_FAIL	0x07	Certificate or key write operation failed.
	CRYPTO_KEYM_E_KEY_CERT_UPDATE_FAIL	0x08	Key or certificate update operation failed.
	CRYPTO_KEYM_E_KEY_CERT_READ_FAIL	0x09	Certificate or key could not be provided due to a read or permission failure.
	CRYPTO_KEYM_E_KEY_CERT_EMPTY	0x0A	The requested key or certificate is not available, slot is empty.
	CRYPTO_KEYM_E_CERT_INVALID_CHAIN_OF_TRUST	0x0B	Certificate verification failed - Invalid Chain of Trust.
Description	Key management specific return values for use in Std_ReturnType, as needed for mapping return values for custom service and function profile 1.		
Available via	Crypto_GeneralTypes.h		

⌋

[SWS_Crypto_00267] Definition of datatype Crypto_KeyM_ResultType ⌈

Name	Crypto_KeyM_ResultType		
Kind	Type		
Derived from	uint8		
Range	CRYPTO_KEYM_RT_OK	0x00	Key management operation successful.
	CRYPTO_KEYM_RT_NOT_OK	0x01	General error occurred during key management operation.
	CRYPTO_KEYM_RT_KEY_CERT_INVALID	0x02	Key or certificate is invalid and cannot be used for the operation.
	CRYPTO_KEYM_RT_KEY_CERT_WRITE_FAIL	0x03	Key or certificate could not be written to designated storage.
	CRYPTO_KEYM_RT_KEY_CERT_UPDATE_FAIL	0x04	General failure while updating a key or certificate (error code could not be precised by one of the other error codes).
	CRYPTO_KEYM_RT_CERT_INVALID_CHAIN_OF_TRUST	0x05	Certificate verification failed - Invalid Chain of Trust.
Description	Specifies the result type of an asynchronous key management function.		
Available via	Crypto_GeneralTypes.h		

⌋

[SWS_Crypto_00268] Definition of datatype Crypto_KeyM_CertificateStatusType ⌈

Name	Crypto_KeyM_CertificateStatusType		
Kind	Type		
Derived from	uint8		
Range	CRYPTO_KEYM_CERTIFICATE_VALID	0x00	Certificate successfully parsed and verified.
	CRYPTO_KEYM_CERTIFICATE_INVALID	0x01	The certificate is invalid (unspecified failure).
	CRYPTO_KEYM_CERTIFICATE_NOT_PARSED	0x02	Certificate has not been parsed so far.
	CRYPTO_KEYM_CERTIFICATE_PARSED_NOT_VALIDATED	0x03	Certificate parsed but not yet validated.
	CRYPTO_KEYM_CERTIFICATE_NOT_AVAILABLE	0x04	Certificate not set.
	CRYPTO_KEYM_CERTIFICATE_VALIDITY_PERIOD_FAIL	0x05	Certificate verification failed - Invalid Time Period.
	CRYPTO_KEYM_CERTIFICATE_SIGNATURE_FAIL	0x06	Certificate verification failed - Invalid Signature.
	CRYPTO_KEYM_CERTIFICATE_INVALID_CHAIN_OF_TRUST	0x07	Certificate verification failed - Invalid Chain of Trust.

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	CRYPTO_KEYM_CERTIFICATE_INVALID_TYPE	0x08	Certificate verification failed - Invalid Type.
	CRYPTO_KEYM_CERTIFICATE_INVALID_FORMAT	0x09	Certificate verification failed - Invalid Format.
	CRYPTO_KEYM_CERTIFICATE_INVALID_CONTENT	0x0A	Certificate verification failed - Invalid Content.
	CRYPTO_KEYM_CERTIFICATE_REVOKED	0x0B	Certificate verification failed - Invalid Scope.
Description	Enumeration of the result type of certificate verification operations.		
Available via	Crypto_GeneralTypes.h		

⌋

7.4 Error Classification

Chapter [3, General Specification of Basic Software Modules] 7.2 *"Error Handling"* describes the error handling of the Basic Software in detail. Above all, it constitutes a classification scheme consisting of five error types which may occur in BSW modules.

Based on this foundation, the following section specifies particular errors arranged in the respective subsections below.

7.4.1 Development Errors

[SWS_Crypto_00040] Definition of development errors in module Crypto ⌈

Type of error	*Related error code*	*Error value*
API request called before initialization of Crypto Driver.	CRYPTO_E_UNINIT	0x00
Initialization of Crypto Driver failed	CRYPTO_E_INIT_FAILED	0x01
API request called with invalid parameter (Nullpointer without redirection).	CRYPTO_E_PARAM_POINTER	0x02
API request called with invalid parameter (out of range).	CRYPTO_E_PARAM_HANDLE	0x04
API request called with invalid parameter (invalid value).	CRYPTO_E_PARAM_VALUE	0x05
Buffer is too small for operation	CRYPTO_E_SMALL_BUFFER	0x06

⌋

7.4.2 Runtime Errors

[SWS_Crypto_00194] Definition of runtime errors in module Crypto ⌈

Type of error	*Related error code*	*Error value*
Entropy is too low	CRYPTO_E_RE_ENTROPY_EXHAUSTED	0x03
NVM access has failed	CRYPTO_E_RE_NVM_ACCESS_FAILED	0x04

⌋

7.4.3 Production Errors

There are no production errors.

7.5 Error detection

[SWS_Crypto_00217] ⌈The crypto Driver shall check if job->cryptoKeyId and, if applicable, job->targetCryptoKeyId are in range, before it executes a job. If the check fails,

the function Crypto_ProcessJob shall report CRYPTO_E_PARAM_HANDLE to DET and return E_NOT_OK.⌋

[SWS_Crypto_00195] ⌈If a Crypto Driver API is called and any buffer addressed during the operation is too small, then the operation shall not be performed. If development error detection for the Crypto Driver is enabled, then the API function shall report CRYPTO_E_SMALL_BUFFER to the DET, else return E_NOT_OK.⌋

Note:

For CRYPTO_HASH, CRYPTO_MACGENERATE and CRYPTO_RANDOMGENERATE services, truncated results are allowed (see [SWS_Crypto_00065], [SWS_Crypto_00252]).

7.6 Security Events

The Crypto Driver raises the following Security Events:

[SWS_Crypto_00300] Security events for Crypto Driver ⌈

Name	*Description*	*ID*
SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED	The integrity check of a SW component has failed.	99

⌋

[SWS_Crypto_00301] Enable SecurityEvents reporting

Upstream requirements: SRS_BSW_00490

⌈If security event reporting has been enabled for the Crypto Driver module (CryptoEnableSecurityEventReporting = true) the respective security events shall be reported to the IdsM via the interfaces defined in (AUTOSAR_CP_SWS_BSWGeneral [3]).⌋

7.6.1 Security events for secure boot

Secure boot on microcontrollers is typically implemented by a hardware-protected secure environment (HPSE), e.g. an HSM, that performs the required SW integrity checks, and offers an interface or mechanism to communicate the result of these checks. The Crypto Driver module interacts with the HPSE for performing crypto-related tasks and is hence also capable of retrieving the secure boot status from the HPSE.

One possible implementation is depicted in Figure 7-4. The HPSE stores the integrity status of the host in the form of a flag, which can be read out by the Crypto Driver on the host side. Please note that this is only an example to illustrate the case. It is left to the implementer of the HPSE to find a suitable form for providing the integrity status of the host and a mechanism to indicate that integrity could not be verified (e.g. by polling the HPSE from the host or by interrupting the host from HPSE).

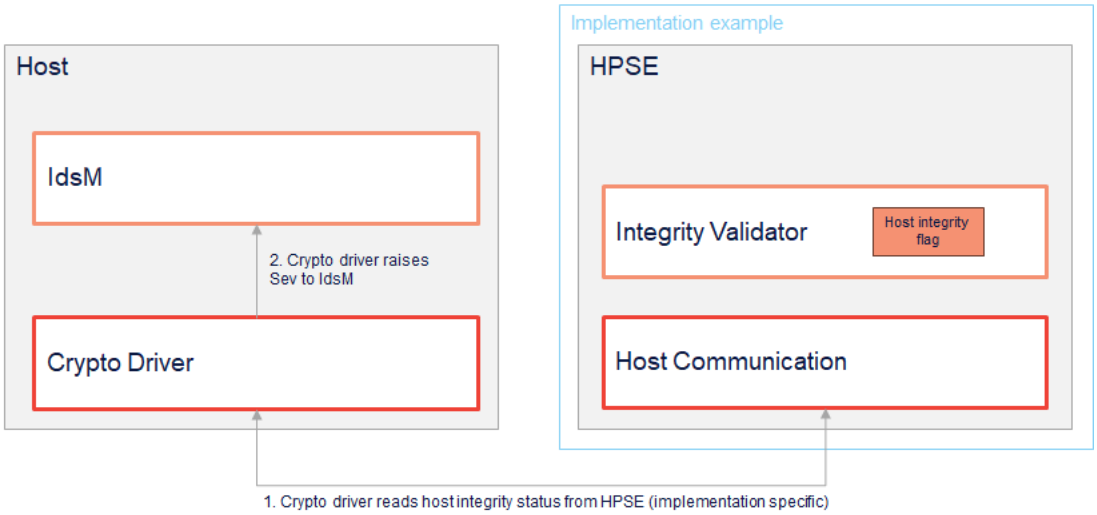


Figure 7.4: Example architecture of the host interacting with a hardware-protected secure environment (HPSE) to retrieve the integrity status.

[SWS_Crypto_00302] Integrity check failed

Upstream requirements: SRS_BSW_00491

⌈If the Crypto Driver is informed by the HPSE that a SW component integrity check failed, it shall raise the SEv SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED.⌋

[SWS_Crypto_00303] Security event context data definition: SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED ⌈

SEV Name	***SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED***	
ID	99	
Description	The integrity check of a SW component has failed.	
Context Data Version	1	
Context Data	***Data Type***	***Allowed Values***
SWComponent	uint16	
VerificationMode	uint8	RECOVERY (0x00) MEASURED_BOOT (0x01) RUNTIME_PERIODIC (0x02) STRICT (0x03)

⌋

The SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED security event contains the following context data:

- SW Component: Defines for which SW component the integrity verification failed. The actual value is highly project specific and cannot be standardized in AUTOSAR
- Verification mode: Specifies the secure boot mode:
  - **RECOVERY:** An integrity verification failure was detected and the ECU entered a recovery mode (e.g. Flash boot-

loader). Within the recovery mode, the ECU can raise the SEv SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED. It is not expected that this mode is supported by the AUTOSAR Crypto Driver.

- **MEASURED_BOOT:** An integrity verification failure was observed during boot, and respective SW component was executed (i.e. booting continued normally).
- **RUNTIME_PERIODIC:** An integrity verification failure was observed by periodic integrity checks during runtime. The behavior of the ECU in this case is project-dependent.
- **STRICT:** An integrity verification failure was observed during boot, and the respective SW component was not executed.

Note that, the ECU executes untrusted code in the secure boot modes MEASURED_BOOT and RUNTIME_PERIODIC, which generally also renders the SEv SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED less trustworthy. However, the attacker goal would rather be to block security events than to raise false alarms with spoofed ones. Hence, also SEvs from raised by an untrusted stack provide benefit for the security analyst receiving the SEv.

If the Crypto Driver cannot provide the security event SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED (e.g. because it is a SW Crypto Driver), the implementer can express this constraint by setting the upper multiplicity of SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED in the CryptoSecurityEventRefs to zero.

8 API specification

8.1 Imported types

In this chapter all types included from the following modules are listed:

[SWS_Crypto_00042] Definition of imported datatypes of module Crypto ⌈

Module	*Header File*	*Imported Type*
Csm	Rte_Csm_Type.h	Crypto_DataInputType
	Rte_Csm_Type.h	Crypto_DataOutputType
	Rte_Csm_Type.h	Crypto_DataRedirectionType
	Rte_Csm_Type.h	Crypto_JobActionType
	Rte_Csm_Type.h	Crypto_JobConfigType
	Rte_Csm_Type.h	Crypto_JobType
	Rte_Csm_Type.h	Crypto_KeyStatusType
	Rte_Csm_Type.h	Crypto_OperationModeType
	Rte_Csm_Type.h	Crypto_ProcessingType
	Rte_Csm_Type.h	Crypto_ServiceInfoType
	Rte_Csm_Type.h	Crypto_VerifyResultType
IdsM	IdsM.h	IdsM_SecurityEventIdType
	Rte_IdsM_Type.h	IdsM_TimestampDataType
NvM	Rte_NvM_Type.h	NvM_BlockIdType
	Rte_NvM_Type.h	NvM_BlockRequestType
	Rte_NvM_Type.h	NvM_InitBlockRequestType
	Rte_NvM_Type.h	NvM_RequestResultType
Std	Std_Types.h	Std_ReturnType

⌋

8.2 Type definitions

8.2.1 Extension to Std_ReturnType

[SWS_Crypto_91018] Definition of Std_ReturnType-extension for module Crypto ⌈

Range	CRYPTO_E_BUSY	0x02	The service request failed because the service is still busy
	CRYPTO_E_ENTROPY_EXHAUSTED	0x04	The service request failed because the entropy of the random number generator is exhausted
	CRYPTO_E_KEY_READ_FAIL	0x06	The service request failed because read access was denied

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	CRYPTO_E_KEY_WRITE_FAIL	0x07	The service request failed because the writing access failed
	CRYPTO_E_KEY_NOT_AVAILABLE	0x08	The service request failed because at least one required key element is not available.
	CRYPTO_E_KEY_NOT_VALID	0x09	The service request failed because the key is invalid.
	CRYPTO_E_KEY_SIZE_MISMATCH	0x0A	The service request failed because the key size does not match.
	CRYPTO_E_JOB_CANCELED	0x0C	The service request failed because the Job has been canceled.
	CRYPTO_E_KEY_EMPTY	0x0D	The service request failed because of uninitialized source key element.
	CRYPTO_E_CUSTOM_ERROR	0x0E	Custom processing failed.
Description	–		
Available via	Crypto_GeneralTypes.h		

⌋

Note:

CRYPTO_E_KEY_NOT_AVAILABLE is meant to indicate that required key elements of a key in the context of a specific Crypto Primitive or key management function have been programmed before but at least one of these key elements cannot be accessed at the moment (for instance it is temporarily not accessible, e.g. when the key is disabled due to debugger connection).

CRYPTO_E_KEY_EMPTY is meant to indicate that the referred key content has not been written so far and has no default value (For example, in SHE 1.1, the error code ERC_KEY_EMPTY would be returned then, "if the application attempts to use a key that has not been initialized".)

Furthermore, it should be noted, that the Crypto Stack API uses the key element index definition from the CSM module (see [SWS_Csm_00122]).

8.2.2 Crypto_ConfigType

[SWS_Crypto_91016] Definition of datatype Crypto_ConfigType

Upstream requirements: SRS_BSW_00414

⌈

Name	Crypto_ConfigType
Kind	Structure
Elements	implementation specific

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	Type	–
	Comment	The content of the configuration data structure is implementation specific.
Description	Configuration data structure of CryIf module	
Available via	Crypto.h	

⌋

8.3 Function definitions

This is a list of functions provided for upper layer modules.

8.3.1 General API

8.3.1.1 Crypto_Init

[SWS_Crypto_91000] Definition of API function Crypto_Init

Upstream requirements: SRS_BSW_00101, SRS_BSW_00358, SRS_BSW_00414

⌈

Service Name	Crypto_Init	
Syntax	`void Crypto_Init ( const Crypto_ConfigType* configPtr )`	
Service ID [hex]	0x00	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	configPtr	Pointer to a selected configuration structure
Parameters (inout)	None	
Parameters (out)	None	
Return value	void	–
Description	Initializes the Crypto Driver.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00215] Configuration pointer is always null ⌈The Configuration pointer configPtr shall always have a null pointer value.⌋

The Configuration pointer configPtr is currently not used and shall therefore be set to null pointer value.

[SWS_Crypto_00198] invalidate key status incase of load failure ⌈If during initialization of the Crypto Driver the value of a persistent key could not be loaded, the Crypto Driver shall set the state of the corresponding key to invalid.⌋

Note: After initialization of the Crypto Driver and before the application starts, the application should consider to check the state of the configured keys and to implement an appropriate handling if the key's state is invalid.

[SWS_Crypto_00045] Report initialization failure

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the initialization of the Crypto Driver fails, the Crypto shall report CRYPTO_E_INIT_FAILED to the DET.⌋

8.3.2 Job Processing Interface

8.3.2.1 Crypto_ProcessJob

[SWS_Crypto_91003] Definition of API function Crypto_ProcessJob ⌈

Service Name	Crypto_ProcessJob	
Syntax	`Std_ReturnType Crypto_ProcessJob ( uint32 objectId, Crypto_JobType* job )`	
Service ID [hex]	0x03	
Sync/Async	Depends on configuration	
Reentrancy	Reentrant	
Parameters (in)	objectId	Holds the identifier of the Crypto Driver Object.
Parameters (inout)	job	Pointer to the configuration of the job. Contains structures with job and primitive relevant information but also pointer to result buffers.
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypro Driver Object is busy or queue is full CRYPTO_E_KEY_NOT_VALID: Request failed, the key is not valid CRYPTO_E_KEY_SIZE_MISMATCH: Request failed, a key element has the wrong size CRYPTO_E_KEY_READ_FAIL: The service request failed, because key element extraction is not allowed CRYPTO_E_KEY_WRITE_FAIL: The service request failed because the writing access failed CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, at least one required key element is not available. CRYPTO_E_ENTROPY_EXHAUSTED: Request failed, the entropy is exhausted CRYPTO_E_JOB_CANCELED: The service request failed because the synchronous Job has been canceled CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element CRYPTO_E_CUSTOM_ERROR: Custom processing failed
Description	Performs the crypto primitive, that is configured in the job parameter.	
Available via	Crypto.h	

⌋

This Interface has a different behavior depending on the content of the job parameter (i.e. the type of crypto service).

Depending on this configuration, other input parameters within the job need to be set, in order to call this function successfully. I.e. the MAC Generate crypto primitive requires a key, a plaintext to be used, and a buffer for the generated MAC.

[SWS_Crypto_00057] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386, SRS_BSW_00406

⌈If the module is not initialized and if development error detection for the Crypto Driver is enabled, the function `Crypto_ProcessJob` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00058] Report parameter out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter objectId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_ProcessJob` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00059] Report null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter job is a null pointer and if development error detection for the Crypto Driver is enabled, the function `Crypto_ProcessJob` shall report `CRYPTO_E_PARAM_POINTER` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00064] Report unsupported service error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_HANDLE` when the Crypto Primitive assigned to the requested job (job->action->jobPrimitiveId) is not supported.⌋

[SWS_Crypto_00202] Target CryptoKeyId in range for key derivation service

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_HANDLE` when the service of the Crypto Primitive assigned to the requested job (job->config->jobService) equals `CRYPTO_KEYDERIVE` and the target key id (job->action->jobTargetKeyId) is out of range or CRYPTO_NULL_ID.⌋

[SWS_Crypto_00065] truncated output for HASH and MAC services ⌈If the service of the Crypto Primitive assigned to the requested job (job->config->jobService) equals `CRYPTO_HASH` or `CRYPTO_MACGENERATE` and the length of the first output (job->action->jobOutputsPtr[0].dataLengthPtr) is smaller than the result length of the cryptographic algorithm on which the Crypto Primitive assigned to the requested job is based, then the most significant bits of the result shall be placed to the first output (job->action->jobOutputsPtr[0].dataPtr) as truncated data.⌋

[SWS_Crypto_00252] truncated output for random generate service ⌈If the service of the Crypto Primitive assigned to the requested job (job->config->jobService) equals CRYPTO_RANDOMGENERATE and the length of the first output (job->action->jobOutputsPtr[0].dataLengthPtr) is smaller than the result length of the cryptographic algorithm on which the Crypto Primitive assigned to the requested job is based, then arbitrary bits of the result shall be placed to the first output (job->action->jobOutputsPtr[0].dataPtr) as truncated data.⌋

Depending on the crypto service configured in job->config->jobService, different parameters job->action->jobInput*Ptr and job->action->jobOutput*Ptr are required to be set with valid values. The table in [SWS_Crypto_00071] specifies which parameters are required or optional for a service in different modes. The following requirements specify the behavior if a required member is a null pointer.

[SWS_Crypto_00270] Report out-of-range job input count

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function Crypto_ProcessJob shall report the DET error CRYPTO_E_PARAM_HANDLE if the parameter job->config->jobInputsCount is greater than CRYPTO_MAX_INPUTS.⌋

[SWS_Crypto_00271] Report invalid redirected input handle

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function Crypto_ProcessJob shall report the DET error CRYPTO_E_PARAM_HANDLE if the parameter job->config->jobInputRedirectionsPtr is not NULL_PTR and one of the members keyId of the parameters job->action->jobInputsPtr[Idx], with Idx < job->config->jobInputsCount, is not in a valid range and not equal to CRYPTO_NULL_ID.⌋

[SWS_Crypto_00070] Report null pointer error for required members

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function Crypto_ProcessJob shall report the DET error CRYPTO_E_PARAM_POINTER if one of the members dataPtr of one of the required parameters job->action->jobInputsPtr[Idx], with Idx < job->config->jobInputsCount, is equal to NULL_PTR.⌋

[SWS_Crypto_00142] Report zero length error for required lengths

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function Crypto_ProcessJob shall report the DET error CRYPTO_E_PARAM_VALUE if one of the members dataLength of one of the required parameters job->action->jobInputsPtr[Idx], with Idx < job->config->jobInputsCount, is equal to zero.⌋

[SWS_Crypto_00272] Report out-of-range output count

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_HANDLE` if the parameter job->config->jobOutputsCount is greater than CRYPTO_MAX_OUTPUTS.⌋

[SWS_Crypto_00273] Report out-of-range redirected output keyId

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_HANDLE` if the parameter job->config->jobOutputRedirectionsPtr is not NULL_PTR and at least one of the members keyId of the parameters job->action->jobOutputsPtr[Idx], with Idx < job->config->jobOutputsCount, is not in a valid range and not equal to CRYPTO_NULL_ID.⌋

[SWS_Crypto_00274] Report missing required output pointers

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_POINTER` if the member dataPtr or the member dataLengthPtr of at least one of the required parameters job->action->jobOutputsPtr[Idx], with Idx < job->config->jobOutputsCount, is equal to NULL_PTR.⌋

[SWS_Crypto_00275] Report zero length error for required output lengths

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection is enabled for the Crypto module, then the function `Crypto_ProcessJob` shall report the DET error `CRYPTO_E_PARAM_VALUE` if the referenced value of the member dataLengthPtr of at least one of the required parameters job->action->jobOutputsPtr[Idx], with Idx < job->config->jobOutputsCount, is equal to zero.⌋

[SWS_Crypto_00228] ⌈If job->action->jobOperationMode is set to CRYPTO_OPERATIONMODE_SAVE_CONTEXT or CRYPTO_OPERATIONMODE_RESTORE_CONTEXT the crypto driver shall check if CryptoPrimitive/CryptoPrimitiveSupportContext is set to TRUE. If not, the function shall return `E_NOT_OK`.⌋

[SWS_Crypto_00229] ⌈If the operation mode for the requested job (job->action->jobOperationMode) equals CRYPTO_OPERATIONMODE_SAVE_CONTEXT, then the function `Crypto_ProcessJob` shall return `E_NOT_OK` when the referenced value of the dataLengthPtr member of the required job->action->jobOutputsPtr[0], that is the provided memory area to store the context, is too small.⌋

[SWS_Crypto_00230] ⌈To save the context the crypto driver object shall store all relevant workspace data of the currently active primitive that was modified by

previously processed START and UPDATE operation and shall place them into job->action->jobOutputsPtr[0].dataPtr (so-called snapshot of context data). The length of the provided data shall be written to the memory where job->action->jobOutputsPtr[0].dataLengthPtr references to. The function shall return E_OK if the operation was successful.⌋

Note:

The context data shall contain all data that is needed to restore a workspace with this data, so that the crypto primitive can resume the operation at exactly this point. For example, if a MAC calculation is currently processed, all internal data of the workspace shall be provided so that subsequent update and finish operation provides the same MAC as if the job is newly setup, e.g. with a START operation, the context is restored and the same set of data is provided when the context snapshot was saved. This shall result in the same MAC.

[SWS_Crypto_00231] ⌈If the operation mode for the requested job (job->action->jobOperationMode) equals CRYPTO_OPERATIONMODE_RESTORE_CONTEXT, then the function Crypto_ProcessJob shall return E_NOT_OK when the value of the dataLength member of the required job->action->jobInputsPtr[0], that is the provided context data to be restored, is not of the expected size.⌋

[SWS_Crypto_00276] Crypto Restore Context ⌈If the operation mode for the requested job (job->action->jobOperationMode) equals CRYPTO_OPERATIONMODE_RESTORE_CONTEXT, then the function Crypto_ProcessJob shall return E_OK and restore the data provided via job->action->jobInputsPtr[0] to the current workspace when the value of the dataLength member of job->action->jobInputsPtr[0] has the expected size.⌋

Note:

The provision of context data to software components can have high security impacts. A thorough security analysis should be made before this feature is activated and used. At least, it bears the risk of leaking key material to a malicious caller of this function.

It is up to the crypto driver (object) to perform a consistency check or to encrypt, respectively decrypt the context data. But for security reason it is highly recommended to use encryption.

[SWS_Crypto_00071] Members per each crypto service ⌈

Member \ Service*	job->action->jobInputsPtr[0].dataPtr/**redirected input / **redirected input	job->action->jobInputsPtr[0].dataLength	job->action->jobInputsPtr[1].dataPtr / **redirected input	job->action->jobInputsPtr[1].dataLength	job->action->jobInputsPtr[2].dataPtr / **redirected input	job->action->jobInputsPtr[2].dataLength	job->action->jobOutputsPtr[0].dataPtr / ***redirected output	job->action->jobOutputsPtr[0].dataLengthPtr	job->action->jobOutputsPtr[1].dataPtr/ ***redirected output	job->action->jobOutputsPtr[1].dataLengthPtr	job->action->jobOutputVerifyPtr	job->action->jobOperationMode
HASH	UGC	UGC					FC	FC				SUFC
MACGENERATE	UGC	UGC					FC	FC				SUFC
MACVERIFY	UGC	UGC	F	F				C			F	SUFC
ENCRYPT	UGC	UGC					UFC	UFC				SUFC
DECRYPT	UGC	UGC					UFC	UFC				SUFC
AEADENCRYPT	VGC	VGC	VG	VG			UFC	UFC	F	F		SUFC
AEADDECRYPT	UGC	UGC	VG	VG	F	F	VFC	VFC			F	SUFC
SIGNATUREGENERATE	UGC	UGC					FC	FC				SUFC
SIGNATUREVERIFY	UGC	UGC	F	F			C	C			F	SUFC
CUSTOM	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV	ZGV

*: Service names are derived from Crypto_ServiceInfoType (part of job struct)
**: In case of input redirection the corresponding key element is used as input instead of the inputBuffer.
***: In case of output redirection the corresponding key element is used as output instead of the outputBuffer
***: Which parameter is optional or not may depend on the actual algorithm implementation and it can also be influenced by the parameter processing order.
S: member required in Start mode.
U: member required in Update mode.
F: member required in Finish mode.
C: member required for Context Save/Restore operation.
Z: member optional in Start mode.
G: member optional in Finish mode.
V: member optional in Update mode.

⌋

[SWS_Crypto_00073] Parameters for each crypto service ⌈

Parameter \ Service*	job->action->jobInputsPtr[0].dataPtr**	job->action->jobInputsPtr[1].dataPtr**	job->action->jobInputsPtr[2].dataPtr**	job->action->jobOutputsPtr[0].dataPtr***	job->action->jobOutputsPtr[1].dataPtr***	job->action-> jobKeyId	job->action->jobTargetKeyId
HASH	plaintext			generated hash			
MACGENERATE	plaintext			generated MAC			
MACVERIFY	plaintext	MAC to be verified					
ENCRYPT	plaintext			encrypted ciphertext			
DECRYPT	ciphertext			decrypted plaintext			
AEADENCRYPT	plaintext	associated Data		encrypted ciphertext	generated Tag		
AEADDECRYPT	ciphertext	associated Data	Tag to be verified	decrypted Plaintext			
SIGNATUREGENERATE	plaintext			generated signature			
SIGNATUREVERIFY	plaintext	signature to be verified					
RANDOMGENERATE				Generated random			
RANDOMSEED	Seed					KeyId	
KEYGENERATE						KeyId	
KEYDERIVE						KeyId	Target KeyId
KEYEXCHANGE CALCPUBVAL				Public Value		KeyId	
KEYEXCHANGE CALCSECRET	Partner's Public Value					KeyId	
KEYSETVALID						KeyId	
KEYSETINVALID						KeyId	
CUSTOM	Input	Secondary Input	Tertiary Input	Output	Secondary Output	KeyId	Target KeyId
KEYWRAP				Wrapped Key	Authenti-cator****	Id of key wrap-ping key	Id of key to be wrapped

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Parameter \ Service*	job->action->jobInputsPtr[0].dataPtr**	job->action->jobInputsPtr[1].dataPtr**	job->action->jobInputsPtr[2].dataPtr**	job->action->jobOutputsPtr[0].dataPtr***	job->action->jobOutputsPtr[1].dataPtr***	job->action-> jobKeyId	job->action->jobTargetKeyId
KEYUNWRAP	Wrapped Key	Authenti-cator****				Id of key wrap-ping key	Target KeyId

In this table the content of the different input and output buffers of job->action is specified:
*: Service names are derived from Crypto_ServiceInfoType.
**: In case of input redirection the corresponding key element is used as input instead of the inputBuffer.
***: In case of output redirection the corresponding key element is used as output instead of the output buffer.
****: In case the algorithm has no authentication, this parameter is optional.

⌋

If no errors are detected by the Crypto Driver, the Crypto Driver processes the crypto service, configured in job, with the underlying hardware or software solutions.

[SWS_Crypto_00134] ⌈If a Crypto Primitive requires input data, its memory location is referred by the pointers job->action->jobInputsPtr[Idx].dataPtr, with Idx < job->config->jobInputsCount. The length of this data is stored in job->action->jobInputsPtr[Idx].dataLength. If an input is redirected to a key element, the memory area of the respective key element (job->config->jobInputRedirectionsPtr[Idx].keyElementId) in the defined key (job->action->jobInputsPtr[Idx].keyId) shall be used.⌋

[SWS_Crypto_00203] ⌈If an input redirection configuration for the requested job is specified (job->config->jobInputRedirectionsPtr != NULL_PTR), then for all inputs job->action->jobInputsPtr[Idx], with Idx < job->config->jobInputsCount, whose parameter keyId of the corresponding redirection specification job->config->jobInputRedirectionsPtr[Idx] is not equal to CRYPTO_NULL_ID, the Crypto key element identified by the parameter job->config->jobInputRedirectionsPtr[Idx].keyElementId in the Crypto key identified by the parameter job->action->jobInputsPtr[Idx].keyId shall be used.⌋

[SWS_Crypto_00135] ⌈If a Crypto Primitive provides output data, its memory location is referred by the pointers job->action->jobOutputsPtr[Idx].dataPtr, with Idx < job->config->jobOutputsCount. The length of this data is stored in job->action->jobOutputsPtr[Idx].dataLengthPtr.

On calling this function, job->action->jobOutputsPtr[Idx].dataLengthPtr shall contain the size of the associated buffer. When the request has successfully finished, job->action->jobOutputsPtr[Idx].dataLengthPtr must be overwritten with the actual length of the calculated output result value.⌋

[SWS_Crypto_00204] ⌈If an output redirection configuration for the requested job is specified (job->config->jobOutputRedirectionsPtr != NULL_PTR), then for all outputs job->action->jobOutputsPtr[Idx], with Idx < job->config->jobOutputsCount, whose parameter keyId of the corresponding redirection specification job->config->jobOutputRedirectionsPtr[Idx] is not equal to CRYPTO_NULL_ID, the Crypto key element identified by the parameter job->config->jobOutputRedirectionsPtr[Idx].keyElementId in the Crypto key identified by the parameter job->action->jobOutputsPtr[Idx].keyId shall be used.⌋

[SWS_Crypto_00141] ⌈If the service of the Crypto Primitive assigned to the requested job (job->config->jobService) equals `CRYPTO_RANDOMGENERATE` and entropy is exhausted, then the function `Crypto_ProcessJob` shall return `CRYPTO_E_ENTROPY_EXHAUSTED` and report the runtime error `CRYPTO_E_ENTROPY_EXHAUSTED`.⌋

8.3.3 Job Cancellation Interface

8.3.3.1 Crypto_CancelJob

[SWS_Crypto_00122] Definition of API function Crypto_CancelJob ⌈

Service Name	Crypto_CancelJob	
Syntax	`Std_ReturnType Crypto_CancelJob ( uint32 objectId, Crypto_JobType* job )`	
Service ID [hex]	0x0e	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for same Crypto Driver Object	
Parameters (in)	objectId	Holds the identifier of the Crypto Driver Object.
Parameters (inout)	job	Pointer to the configuration of the job. Contains structures with job and primitive relevant information.
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: Request successful, job has been removed. `E_NOT_OK`: Request failed, job couldn't be removed. `CRYPTO_E_JOB_CANCELED`: The job has been cancelled but is still processed. No results will be returned to the application.
Description	This interface removes the provided job from the queue and cancels the processing of the job if possible.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00123] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection for the Crypto Driver is enabled: The function Crypto_CancelJob shall raise the error CRYPTO_E_UNINIT and return E_NOT_OK if the module is not yet initialized.⌋

[SWS_Crypto_00124] Report out of range error for parameter objectId

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection for the Crypto Driver is enabled: The function Crypto_CancelJob shall raise the error CRYPTO_E_PARAM_HANDLE and return E_NOT_OK if the parameter objectId is out or range.⌋

[SWS_Crypto_00125] Report null pointer error for parameter job

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If development error detection for the Crypto Driver is enabled: The function Crypto_CancelJob shall raise the error CRYPTO_E_PARAM_POINTER and return E_NOT_OK if the parameter job is a null pointer.⌋

[SWS_Crypto_00214] accept Cancel job request even if cancel is not supported ⌈If no errors are detected by Crypto Driver and the driver does currently not process this job, the service Crypto_CancelJob shall return E_OK without any processing.⌋

[SWS_Crypto_00143] Cancel ongoing job immediately ⌈If no errors are detected by Crypto Driver and the driver is able to cancel the job immediately, the service Crypto_CancelJob shall remove the job from the queue or cancel the job in the hardware. If the cancellation is successful E_OK shall be returned and for asynchronous jobs, CryIf_CallbackNotification shall be called with the result value CRYPTO_E_JOB_CANCELED, otherwise it shall return E_NOT_OK.⌋

Note:

Especially hardware implementations may not support a cancelation. If Crypto_CancelJob is called and immediate cancelation is not possible at least all results and notifications of the job shall be suppressed. The caller can be sure, that there will be no (intermediate) results by callback or synchronous result value.

[SWS_Crypto_00183] job canceled but is still processed to the end ⌈If no errors are detected by Crypto Driver and the driver is not able to cancel the job (e.g. due to hardware limitations), the service Crypto_CancelJob shall return CRYPTO_E_JOB_CANCELED. If processing of a job that could not be canceled finishes later, CryIf_CallbackNotification shall be called for asynchronous jobs with result value CRYPTO_E_JOB_CANCELED.⌋

Note:

[SWS_Crypto_00183] should not have any effect on the job processing in the Crypto Driver. The processing should be completed as any other regular job. The CSM guarantees that the result buffer pointer is valid until the job is finished.

8.3.4 Key Management Interface

Note:

If the actual key element to be modified is directly mapped to flash memory, there could be a bigger delay when calling the key management functions (synchronous operation)

It is also recommended to use CRYPTO_OPERATIONMODE_SINGLECALL for the jobs.

8.3.4.1 Key Setting Interface

8.3.4.1.1 Crypto_KeyElementSet

[SWS_Crypto_00223] ⌈The crypto driver shall only perform this operation if CryptoKeyElement/CryptoKeyElementWriteAccess is set to `CRYPTO_WA_ALLOWED` or `CRYPTO_WA_ENCRYPTED`.⌋

Note: If the key element references a SHE-key, it is recommended to set CryptoKeyElementWriteAccess to `CRYPTO_WA_ENCRYPTED`. The key itself must be provided as SHE-keys in the format M1M2M3.

[SWS_Crypto_91004] Definition of API function Crypto_KeyElementSet ⌈

Service Name	Crypto_KeyElementSet	
Syntax	`Std_ReturnType Crypto_KeyElementSet ( uint32 cryptoKeyId, uint32 keyElementId, const uint8* keyPtr, uint32 keyLength )`	
Service ID [hex]	0x04	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	cryptoKeyId	Holds the identifier of the key whose key element shall be set.
	keyElementId	Holds the identifier of the key element which shall be set.
	keyPtr	Holds the pointer to the key data which shall be set as key element.
	keyLength	Contains the length of the key element in bytes.
Parameters (inout)	None	
Parameters (out)	None	

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Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_WRITE_FAIL:Request failed because write access was denied CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, the requested key element of the requested key is not available CRYPTO_E_KEY_SIZE_MISMATCH: Request failed, key element size does not match size of provided data
Description	Sets the given key element bytes to the key identified by cryptoKeyId.	
Available via	Crypto.h	

⌋

Note:

This service works synchronously. However, it is possible that the underlying key material is resident in the flash memory. Hence it may take some time to execute this function.

[SWS_Crypto_00075] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the Crypto Driver is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementSet shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00076] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementSet shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00077] Report keyElementId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter keyElementId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementSet shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00078] Report null pointer error for parameter keyPtr

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter keyPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementSet shall report CRYPTO_E_PARAM_POINTER to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00079] Report zero length error for parameter keyLength

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If keyLength is zero and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementSet` shall report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00146] key size mismatch error with no partial access ⌈If keyLength is smaller than the size of the key element, and the key element is not configured to allow partial access, the function `Crypto_KeyElementSet` shall return `CRYPTO_E_KEY_SIZE_MISMATCH`.⌋

8.3.4.1.2 Crypto_KeySetValid

[SWS_Crypto_91014] Definition of API function Crypto_KeySetValid ⌈

Service Name	Crypto_KeySetValid	
Syntax	`Std_ReturnType Crypto_KeySetValid ( uint32 cryptoKeyId )`	
Service ID [hex]	0x05	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	cryptoKeyId	Holds the identifier of the key which shall be set to valid.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypro Driver Object is busy
Description	Sets the key state of the key identified by cryptoKeyId to valid.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00196] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and development error detection for the Crypto Driver is enabled, the function `Crypto_KeySetValid` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00197] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeySetValid` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

If no errors are detected by Crypto Driver, the service `Crypto_KeySetValid` sets the key cryptoKeyId to "valid".

8.3.4.1.3 Crypto_KeySetInvalid

[SWS_Crypto_91020] Definition of API function Crypto_KeySetInvalid ⌈

Service Name	Crypto_KeySetInvalid	
Syntax	`Std_ReturnType Crypto_KeySetInvalid ( uint32 cryptoKeyId )`	
Service ID [hex]	0x15	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	cryptoKeyId	Holds the identifier of the key for which the status shall be set to invalid.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypro Driver Object is busy
Description	Sets invalid for the status of the key identified by cryptoKeyId.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00236] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and development error detection for the Crypto Driver is enabled, the function `Crypto_KeySetInvalid` shall report `CRYPTO_E_UNINIT` to the DET.⌋

[SWS_Crypto_00237] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeySetInvalid` shall report `CRYPTO_E_PARAM_HANDLE` to the DET.⌋

[SWS_Crypto_00238] Set key status to invalid ⌈If no errors are detected by Crypto Driver, the service `Crypto_KeySetInvalid` sets the status of key cryptoKeyId to invalid.⌋

8.3.4.2 Key Extraction Interface

8.3.4.2.1 Crypto_KeyElementGet

[SWS_Crypto_00222] ⌈The crypto driver shall only perform this operation if CryptoKeyElement/CryptoKeyElementReadAccess is set to `CRYPTO_RA_ALLOWED` or `CRYPTO_RA_ENCRYPTED`.⌋

Note: Reading keys from SHE hardware is not possible, except if it is a SHE RAM-Key. In this case, reading the SHE key will provide M1M2M3. The key element should be set to CRYPTO_RA_ENCRYPTED in this case.

[SWS_Crypto_91006] Definition of API function Crypto_KeyElementGet ⌈

Service Name	Crypto_KeyElementGet	
Syntax	`Std_ReturnType Crypto_KeyElementGet ( uint32 cryptoKeyId, uint32 keyElementId, uint8* resultPtr, uint32* resultLengthPtr )`	
Service ID [hex]	0x06	
Sync/Async	Synchronous	
Reentrancy	Reentrant	
Parameters (in)	cryptoKeyId	Holds the identifier of the key whose key element shall be returned.
	keyElementId	Holds the identifier of the key element which shall be returned.
Parameters (inout)	resultLengthPtr	Holds a pointer to a memory location in which the length information is stored. On calling this function this parameter shall contain the size of the buffer provided by resultPtr. If the key element is configured to allow partial access, this parameter contains the amount of data which should be read from the key element. The size may not be equal to the size of the provided buffer anymore. When the request has finished, the amount of data that has been stored shall be stored.
Parameters (out)	resultPtr	Holds the pointer of the buffer for the returned key element
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, the requested key element of the requested key is not available CRYPTO_E_KEY_READ_FAIL: Request failed because read access was denied CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element
Description	This interface shall be used to get a key element of the key identified by the cryptoKeyId and store the key element in the memory location pointed by the result pointer. Note: If the actual key element is directly mapped to flash memory, there could be a bigger delay when calling this function (synchronous operation).	
Available via	Crypto.h	

⌋

[SWS_Crypto_00085] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementGet shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00086] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementGet shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00087] Report Invalid KeyElementId error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter keyElementId is not contained in the respective key type and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementGet` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00088] Report resultPtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter resultPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementGet` shall report `CRYPTO_E_PARAM_POINTER` the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00089] Report resultLengthPtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter resultLengthPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementGet` shall report `CRYPTO_E_PARAM_POINTER` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00090] Report Invalid resultLengthPtr length value error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the value, which is pointed by resultLengthPtr is zero and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementGet` shall report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.⌋

If no errors are detected by Crypto Driver, the service `Crypto_KeyElementGet` retrieves the value of the key element and store it in the buffer, which is pointed by the resultPtr.

[SWS_Crypto_00092] retrieve key element data and its actual length ⌈The pointer resultPtr holds the memory location, where the data of the key element shall be stored. On calling this function, resultLengthPtr shall contain the size of the buffer provided by resultPtr. When the request has finished, the actual length of the returned value shall be stored.⌋

8.3.4.3 Key Status Interface

8.3.4.3.1 Crypto_KeyGetStatus

[SWS_Crypto_91019] Definition of API function Crypto_KeyGetStatus ⌈

Service Name	Crypto_KeyGetStatus	
Syntax	`Std_ReturnType Crypto_KeyGetStatus ( uint32 cryptoKeyId, Crypto_KeyStatusType* keyStatusPtr )`	
Service ID [hex]	0x14	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	cryptoKeyId	Holds the identifier of the key for which the key state shall be returned.
Parameters (inout)	None	
Parameters (out)	keyStatusPtr	Contains the pointer to the data where the status of the key shall be stored.
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy
Description	Returns the key state of the key identified by cryptoKeyId.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00232] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and development error detection for the Crypto Driver is enabled, the function Crypto_KeyGetStatus shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00233] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyGetStatus shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00234] Report KeyStatusPtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter keyPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyGetStatus shall report CRYPTO_E_PARAM_POINTER to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00235] retrieve key status ⌈If no errors are detected by the Crypto Driver, the status of the key shall be placed into keyStatusPtr. If the key is in valid state, the value CRYPTO_KEYSTATUS_VALID shall be reported. If the key is currently not valid, the status CRYPTO_KEYSTATUS_INVALID shall be reported.⌋

8.3.4.4 Key Copying Interface

8.3.4.4.1 Crypto_KeyElementCopy

[SWS_Crypto_00148] Definition of API function Crypto_KeyElementCopy ⌈

Service Name	Crypto_KeyElementCopy	
Syntax	`Std_ReturnType Crypto_KeyElementCopy ( uint32 cryptoKeyId, uint32 keyElementId, uint32 targetCryptoKeyId, uint32 targetKeyElementId )`	
Service ID [hex]	0x0f	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key whose key element shall be the source element.
	keyElementId	Holds the identifier of the key element which shall be the source for the copy operation.
	targetCryptoKeyId	Holds the identifier of the key whose key element shall be the destination element.
	targetKeyElementId	Holds the identifier of the key element which shall be the destination for the copy operation.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, the requested key element of at least one requested key is not available CRYPTO_E_KEY_READ_FAIL: Request failed, not allowed to extract key element CRYPTO_E_KEY_WRITE_FAIL: Request failed, not allowed to write key element CRYPTO_E_KEY_SIZE_MISMATCH: Request failed, key element sizes are not compatible CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element
Description	Copies a key element to another key element in the same crypto driver. Note: If the actual key element is directly mapped to flash memory, there could be a bigger delay when calling this function (synchronous operation)	
Available via	Crypto.h	

⌋

[SWS_Crypto_00149] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the Crypto Driver is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementCopy shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00150] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementCopy` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00151] Report targetCryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If targetCryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementCopy` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00152] Report keyElementId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter keyElementId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementCopy` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00153] Report targetKeyElementId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If parameter targetKeyElementId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementCopy` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00154] copy source KeyElement into target KeyElement ⌈If no errors are detected by the Crypto Driver, the function shall copy the key element referenced by keyElementId in the key referenced by cryptoKeyId to the key element referenced by targetKeyElementId in the key referenced by targetCryptoKeyId.⌋

8.3.4.4.2 Crypto_KeyElementCopyPartial

[SWS_Crypto_91015] Definition of API function Crypto_KeyElementCopyPartial ⌈

Service Name	Crypto_KeyElementCopyPartial

Syntax	`Std_ReturnType Crypto_KeyElementCopyPartial (`
	`  uint32 cryptoKeyId,`
	`  uint32 keyElementId,`
	`  uint32 keyElementSourceOffset,`
	`  uint32 keyElementTargetOffset,`
	`  uint32 keyElementCopyLength,`
	`  uint32 targetCryptoKeyId,`
	`  uint32 targetKeyElementId`
	`)`

▽

△

Service ID [hex]	0x13	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key whose key element shall be the source element.
	keyElementId	Holds the identifier of the key element which shall be the source for the copy operation.
	keyElementSourceOffset	This is the offset of the of the source key element indicating the start index of the copy operation.
	keyElementTargetOffset	This is the offset of the of the target key element indicating the start index of the copy operation.
	keyElementCopyLength	Specifies the number of bytes that shall be copied.
	targetCryptoKeyId	Holds the identifier of the key whose key element shall be the destination element.
	targetKeyElementId	Holds the identifier of the key element which shall be the destination for the copy operation.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, the requested key element of at least one requested key is not available CRYPTO_E_KEY_READ_FAIL: Request failed, not allowed to extract key element CRYPTO_E_KEY_WRITE_FAIL: Request failed, not allowed to write key element CRYPTO_E_KEY_SIZE_MISMATCH: Request failed, key element sizes are not compatible CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element
Description	Copies a key element to another key element in the same crypto driver. The keyElementSource Offset and keyElementCopyLength allows to copy just a part of the source key element into the destination. The offset of the target key is also specified with this function. Note: If the actual key element is directly mapped to flash memory, there could be a bigger delay when calling this function (synchronous operation).	
Available via	Crypto.h	

⌋

[SWS_Crypto_00205] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the Crypto Driver is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementCopyPartial shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00206] Report KeyId/KeyElementId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If cryptoKeyId, keyElementId , targetKeyElementId or targetCryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyElementCopyPartial shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00207] Report key size mismatch error

Upstream requirements: SRS_BSW_00386

⌈If the total length of the key element specified with keyElementId of the key referenced by cryptoKeyId is smaller than keyElementSourceOffset + keyElementCopyLength `Crypto_KeyElementCopyPartial` shall return `CRYPTO_E_KEY_SIZE_MISMATCH`.⌋

[SWS_Crypto_00208] Report buffer size mismatch error

Upstream requirements: SRS_BSW_00386

⌈If the maximum available buffer of the key element specified with targetKeyElementId of the key referenced by targetCryptoKeyId is smaller than keyElementTargetOffset + keyElementCopyLength, the function `Crypto_KeyElementCopyPartial` shall return `CRYPTO_E_KEY_SIZE_MISMATCH`.⌋

[SWS_Crypto_00209] partial copy of source KeyElement into target KeyElement ⌈If no errors are detected by the Crypto Driver, the function `Crypto_KeyElementCopyPartial` shall copy a part of the key element referenced by keyElementId of the key referenced by cryptoKeyId with the offset of keyElementSourceOffset and with the length specified by keyElementCopyLength to the key element referenced by targetKeyElementId of the key referenced by targetCryptoKeyId.⌋

[SWS_Crypto_00210] target keyElement length remains unchanged ⌈If the current length of the target key element is greater or equal than (keyElementTargetOffset + keyElementCopyLength), the key element length remains unchanged.⌋

[SWS_Crypto_00211] target keyElement length is updated ⌈If the current length of the target key element is lower than (keyElementTargetOffset + keyElementCopyLength) and the maximum length of the key element is greater or equal than (keyElementTargetOffset + keyElementCopyLength), then the source data shall be copied into the target key element and the length shall be set to (keyElementTargetOffset + keyElementCopyLength).⌋

8.3.4.4.3 Crypto_KeyCopy

[SWS_Crypto_00155] Definition of API function Crypto_KeyCopy ⌈

Service Name	Crypto_KeyCopy
Syntax	`Std_ReturnType Crypto_KeyCopy ( uint32 cryptoKeyId, uint32 targetCryptoKeyId )`
Service ID [hex]	0x10
Sync/Async	Synchronous
Reentrancy	Reentrant but not for the same cryptoKeyId

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Parameters (in)	cryptoKeyId	Holds the identifier of the key whose key element shall be the source element.
	targetCryptoKeyId	Holds the identifier of the key whose key element shall be the destination element.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_NOT_AVAILABLE: Request failed, at least one of the requested keys is not available CRYPTO_E_KEY_READ_FAIL: Request failed, not allowed to extract key element CRYPTO_E_KEY_WRITE_FAIL: Request failed, not allowed to write key element CRYPTO_E_KEY_SIZE_MISMATCH: Request failed, key element sizes are not compatible CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element
Description	Copies a key with all its elements to another key in the same crypto driver. Note: If the actual key element is directly mapped to flash memory, there could be a bigger delay when calling this function (synchronous operation)	
Available via	Crypto.h	

⌋

[SWS_Crypto_00156] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the Crypto Driver is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyCopy shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00157] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyCopy shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00158] Report targetCryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If targetCryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyCopy shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00159] copy source cryptoKey into target cryptoKey ⌈If no errors are detected by the Crypto Driver, the function shall copy all key elements in the key referenced by cryptoKeyId to the key the key referenced by targetCryptoKeyId.⌋

8.3.4.4.4 Crypto_KeyElementIdsGet

[SWS_Crypto_00160] Definition of API function Crypto_KeyElementIdsGet ⌈

Service Name	Crypto_KeyElementIdsGet	
Syntax	`Std_ReturnType Crypto_KeyElementIdsGet ( uint32 cryptoKeyId, uint32* keyElementIdsPtr, uint32* keyElementIdsLengthPtr )`	
Service ID [hex]	0x11	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key whose available element ids shall be exported.
Parameters (inout)	keyElementIdsLengthPtr	Holds a pointer to the memory location in which the number of key elements in the given key is stored. On calling this function, this parameter shall contain the size of the buffer provided by key ElementIdsPtr. When the request has finished, the actual number of key elements shall be stored.
Parameters (out)	keyElementIdsPtr	Contains the pointer to the array where the ids of the key elements shall be stored.
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypto Driver Object is busy
Description	Used to retrieve information which key elements are available in a given key.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00161] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the Crypto Driver is not yet initialized and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementIdsGet` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00162] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyElementIdsGet` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

If no errors are detected by the Crypto Driver, the function stores all ids of the key elements available in the key identified by cryptoKeyId to an array provided by keyElementIdsPtr. It also stores the number of elements to the value, which is pointed by keyElementIdsLengthPtr.

Note:

This function is needed by the CRYIF when a whole key should be copied from one Crypto Driver to another Crypto Driver by the CRYIF.

8.3.4.5 Key Generation Interface

8.3.4.5.1 Crypto_RandomSeed

[SWS_Crypto_91013] Definition of API function Crypto_RandomSeed ⌈

Service Name	Crypto_RandomSeed	

Syntax	`Std_ReturnType Crypto_RandomSeed (`
	`  uint32 cryptoKeyId,`
	`  const uint8* seedPtr,`
	`  uint32 seedLength`
	`)`	

Service ID [hex]	0x0d	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key for which a new seed shall be generated.
	seedPtr	Holds a pointer to the memory location which contains the data to feed the seed.
	seedLength	Contains the length of the seed in bytes.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_KEY_NOT_VALID: Request failed, the key state of the key identified by cryIfKeyId is "invalid". CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy
Description	This function generates the internal seed state using the provided entropy source. Furthermore, this function can be used to update the seed state with new entropy	
Available via	Crypto.h	

⌋

[SWS_Crypto_00128] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_RandomSeed shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00129] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_RandomSeed shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00130] Report seedPtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter seedPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function Crypto_RandomSeed shall report CRYPTO_E_PARAM_POINTER to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00131] Report seedLength zero length error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If seedLength is zero and if development error detection for the Crypto Driver is enabled, the function `Crypto_RandomSeed` shall report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.⌋

If no errors are detected by Crypto Driver, the service `Crypto_RandomSeed` feeds the given key with a seed state derived from the entropy source. The internal state of the random generator is stored in the key element CRYPTO_KE_RANDOM_SEED.

8.3.4.5.2 Crypto_KeyGenerate

[SWS_Crypto_91007] Definition of API function Crypto_KeyGenerate ⌈

Service Name	Crypto_KeyGenerate	
Syntax	`Std_ReturnType Crypto_KeyGenerate ( uint32 cryptoKeyId )`	
Service ID [hex]	0x07	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key which is to be updated with the generated value.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypto Driver Object is busy `CRYPTO_E_KEY_EMPTY`: Request failed because of uninitialized source key element `CRYPTO_E_KEY_NOT_VALID`: Request failed, the key state of the key identified by cryIfKeyId is "invalid".
Description	Generates new key material store it in the key identified by cryptoKeyId.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00094] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyGenerate` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00095] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyGenerate` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00165] generate a new key ⌈If no errors are detected by Crypto Driver, the service `Crypto_KeyGenerate` generates the corresponding key.⌋

8.3.4.6 Key Derivation Interface

8.3.4.6.1 Crypto_KeyDerive

[SWS_Crypto_91008] Definition of API function Crypto_KeyDerive ⌈

Service Name	Crypto_KeyDerive	
Syntax	`Std_ReturnType Crypto_KeyDerive ( uint32 cryptoKeyId, uint32 targetCryptoKeyId )`	
Service ID [hex]	0x08	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key which is used for key derivation.
	targetCryptoKeyId	Holds the identifier of the key which is used to store the derived key.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypto Driver Object is busy `CRYPTO_E_KEY_EMPTY`: Request failed because of uninitialized source key element `CRYPTO_E_KEY_NOT_VALID`: Request failed, the key state of the key identified by cryIfKeyId is "invalid".
Description	Derives a new key by using the key elements in the given key identified by the cryptoKeyId. The given key contains the key elements for the password, salt. The derived key is stored in the key element with the id 1 of the key identified by targetCryptoKeyId. The number of iterations is given in the key element CRYPTO_KE_KEYDERIVATION_ITERATIONS.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00097] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyDerive` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00098] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyDerive` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00180] Report targetCryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter targetCryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyDerive` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00166] derive a new key using salt and password ⌈If no errors are detected by Crypto Driver, the service `Crypto_KeyDerive` derives a key element with the aid of a salt and a password.⌋

The key derivation service needs a salt and password to derivate a new key. The salt and the password therefore are stored as key elements in the key referred by cryptoKeyId.

8.3.4.7 Key Exchange Interface

8.3.4.7.1 Crypto_KeyExchangeCalcPubVal

[SWS_Crypto_91009] Definition of API function Crypto_KeyExchangeCalcPubVal ⌈

Service Name	Crypto_KeyExchangeCalcPubVal	
Syntax	`Std_ReturnType Crypto_KeyExchangeCalcPubVal ( uint32 cryptoKeyId, uint8* publicValuePtr, uint32* publicValueLengthPtr )`	
Service ID [hex]	0x09	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key which shall be used for the key exchange protocol.
Parameters (inout)	publicValueLengthPtr	Holds a pointer to the memory location in which the public value length information is stored. On calling this function, this parameter shall contain the size of the buffer provided by public ValuePtr. When the request has finished, the actual length of the returned value shall be stored.
Parameters (out)	publicValuePtr	Contains the pointer to the data where the public value shall be stored.
Return value	Std_ReturnType	`E_OK`: Request successful `E_NOT_OK`: Request failed `CRYPTO_E_BUSY`: Request failed, Crypto Driver Object is busy `CRYPTO_E_KEY_EMPTY`: Request failed because of uninitialized source key element `CRYPTO_E_KEY_NOT_VALID`: Request failed, the key state of the key identified by cryIfKeyId is "invalid".
Description	Calculates the public value for the key exchange and stores the public key in the memory location pointed by the public value pointer.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00103] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled: The function `Crypto_KeyExchangeCalcPubVal` shall report `CRYPTO_E_UNINIT` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00104] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyExchangeCalcPubVal` shall report `CRYPTO_E_PARAM_HANDLE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00105] Report publicValuePtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter publicValuePtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyExchangeCalcPubVal` shall report `CRYPTO_E_PARAM_POINTER` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00106] Report pubValueLengthPtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter pubValueLengthPtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyExchangeCalcPubVal` shall report `CRYPTO_E_PARAM_POINTER` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00107] Report pubValueLengthPtr zero length error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the value, which is pointed by pubValueLengthPtr is zero and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyExchangeCalcPubVal` shall report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.⌋

[SWS_Crypto_00167] perform keyExchange public value calculation ⌈If no errors are detected by Crypto Driver, the service `Crypto_KeyExchangeCalcPubVal` calculates the public value of the current job for the key exchange.⌋

[SWS_Crypto_00109] store KeyExchange public value and its actual length ⌈The pointer publicValuePtr holds the memory location, where the data of the public value shall be stored. On calling this function, publicValueLengthPtr shall contain the size of the buffer provided by publicValuePtr. When the request has finished, the actual length of the returned value shall be stored.⌋

8.3.4.7.2 Crypto_KeyExchangeCalcSecret

[SWS_Crypto_91010] Definition of API function Crypto_KeyExchangeCalcSecret
⌈

Service Name	Crypto_KeyExchangeCalcSecret	
Syntax	`Std_ReturnType Crypto_KeyExchangeCalcSecret ( uint32 cryptoKeyId, const uint8* partnerPublicValuePtr, uint32 partnerPublicValueLength )`	
Service ID [hex]	0x0a	
Sync/Async	Synchronous	
Reentrancy	Reentrant but not for the same cryptoKeyId	
Parameters (in)	cryptoKeyId	Holds the identifier of the key which shall be used for the key exchange protocol.
	partnerPublicValuePtr	Holds the pointer to the memory location which contains the partner's public value.
	partnerPublicValueLength	Contains the length of the partner's public value in bytes.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto Driver Object is busy CRYPTO_E_KEY_EMPTY: Request failed because of uninitialized source key element CRYPTO_E_KEY_NOT_VALID: Request failed, the key state of the key identified by cryIfKeyId is "invalid".
Description	Calculates the shared secret key for the key exchange with the key material of the key identified by the cryptoKeyId and the partner public key. The shared secret key is stored as a key element in the same key.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00111] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyExchangeCalcSecret shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00112] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyExchangeCalcSecret shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK⌋

[SWS_Crypto_00113] Report partnerPublicValuePtr null pointer error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter partnerPublicValuePtr is a null pointer and if development error detection for the Crypto Driver is enabled, the function Crypto_KeyExchangeCalcSecret shall report CRYPTO_E_PARAM_POINTER to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00115] Report partnerPublicValueLength zero length error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If partnerPublicValueLength is zero and if development error detection for the Crypto Driver is enabled, the function `Crypto_KeyExchangeCalcSecret` shall report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.⌋

If no errors are detected by Crypto, the service `Crypto_KeyExchangeCalcSecret` calculated the shared secret key for the key exchange and store it as key element in cryptoKeyId.

8.3.5 Custom Service Interface

8.3.5.1 Crypto_CustomSync

[SWS_Crypto_91027] Definition of API function Crypto_CustomSync ⌈

Service Name	Crypto_CustomSync	
Syntax	`Std_ReturnType Crypto_CustomSync ( uint32 dispatchId, uint32 keyId, uint32 keyElementId, uint32 targetKeyId, uint32 targetKeyElementId, const uint8* inputPtr, uint32 inputLength, uint8* outputPtr, uint32* outputLengthPtr, uint8* secondaryOutputPtr, uint32* secondaryOutputLengthPtr )`	
Service ID [hex]	0x1a	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	dispatchId	unique id to identify the request
	keyId	key Id
	keyElementId	key element Id
	targetKeyId	–
	targetKeyElementId	–
	inputPtr	Pointer to the input data.
	inputLength	Contains the input length in bytes.
Parameters (inout)	None	
Parameters (out)	outputPtr	Pointer to the output data.
	outputLengthPtr	Contains the output length in bytes.
	secondaryOutputPtr	Pointer to the secondary output data.
	secondaryOutputLength Ptr	Contains the secondary output length in bytes.

▽

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Return value	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: The service request failed because the service is still busy CRYPTO_E_CUSTOM_ERROR: Custom processing failed
Description	Requests the execution of a function that is specified by the given dispatch id.	
Available via	Crypto.h	

⌋

[SWS_Crypto_00256] Report uninitialized module error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the module is not yet initialized and if development error detection for the Crypto Driver is enabled,

the function Crypto_CustomSync shall report CRYPTO_E_UNINIT to the DET and return E_NOT_OK.⌋

[SWS_Crypto_00257] Report cryptoKeyId out of range error

Upstream requirements: SRS_BSW_00369, SRS_BSW_00386

⌈If the parameter cryptoKeyId is out of range and if development error detection for the Crypto Driver is enabled,

the function Crypto_CustomSync shall report CRYPTO_E_PARAM_HANDLE to the DET and return E_NOT_OK.⌋

8.3.6 Callback notifications

8.3.6.1 Crypto_NvBlock_Init_<NvBlock>

[SWS_Crypto_91023] Definition of callback function Crypto_<vi>_<ai>_NvBlock_Init_<NvBlock> ⌈

Service Name	Crypto_<vi>_<ai>_NvBlock_Init_<NvBlock>	
Syntax	`Std_ReturnType Crypto_<vi>_<ai>_NvBlock_Init_<NvBlock> ( NvM_InitBlockRequestType initBlockRequest )`	
Service ID [hex]	0x16	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	initBlockRequest	The request type
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	E_OK: callback function has been processed successfully any other: callback function has been processed unsuccessfully

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Description	This function will be called by NVM. The crypto driver has the task to initialize the NVRAM block. The resulting function name shall be set to the container associated with the NvmBlock Descriptor:{CryptoNvBlock/CryptoNvBlockDescriptorRef}/NvmInitBlockCallback}/NvmInitBlock CallbackFnc
Available via	Crypto_cfg.h

⌋

8.3.6.2 Crypto_NvBlock_ReadFrom_<NvBlock>

[SWS_Crypto_91024] Definition of callback function Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock> ⌈

Service Name	Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock>	
Syntax	`Std_ReturnType Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock> ( const void* NvmBuffer )`	
Service ID [hex]	0x17	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	NvmBuffer	The address of the buffer where the data can be read from.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: callback function has been processed successfully any other: callback function has been processed unsuccessfully
Description	This function is called by NVM to let the crypto driver copy the key data from the mirror of the NVM ram block to an internal RAM buffer of the crypto driver. The resulting function name shall be set to the container associated with the NvmBlock Descriptor: {CryptoNvBlock/{CryptoNvBlockDescriptorRef} / NvMReadRamBlockFromNv Callback	
Available via	Crypto_cfg.h	

⌋

8.3.6.3 Crypto_NvBlock_WriteTo_<NvBlock>

[SWS_Crypto_91025] Definition of callback function Crypto_<vi>_<ai>_NvBlock_WriteTo_<NvBlock> ⌈

Service Name	Crypto_<vi>_<ai>_NvBlock_WriteTo_<NvBlock>
Syntax	`Std_ReturnType Crypto_<vi>_<ai>_NvBlock_WriteTo_<NvBlock> ( void* NvmBuffer )`
Service ID [hex]	0x18
Sync/Async	Synchronous
Reentrancy	Non Reentrant

▽

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Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	NvmBuffer	The address of the buffer where the data shall be written to
Return value	Std_ReturnType	`E_OK`: callback function has been processed successfully any other: callback function has been processed unsuccessfully
Description	This function is called by NVM to let the crypto driver copy the internal key element data to a mirror of the NVM ram block shortly before the data are written to NVM. The resulting function name shall be set to the container associated with the NvmBlock Descriptor: {CryptoNvBlock/{CryptoNvBlockDescriptorRef} / NvMWriteRamBlockToNvCallback	
Available via	Crypto_cfg.h	

⌋

8.3.6.4 Crypto_NvBlock_Callback_<NvBlock>

[SWS_Crypto_91026] Definition of API function Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock> ⌈

Service Name	Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock>	
Syntax	`Std_ReturnType Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock> ( NvM_BlockRequestType BlockRequest, NvM_RequestResultType JobResult )`	
Service ID [hex]	0x19	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	BlockRequest	The request type (read, write, ... etc.) of the previous processed block job
	JobResult	The request result of the previous processed block job.
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_ReturnType	`E_OK`: callback function has been processed successfully any other: callback function has been processed unsuccessfully
Description	This function is called from NVM to notify the crypto driver that an asynchronous single block request has been finished. The resulting function name shall be set to the container associated with the NvmBlock Descriptor: {CryptoNvBlock/{CryptoNvBlockDescriptorRef} /NvmSingleBlockCallback}/Nvm SingleBlockCallbackFnc	
Available via	Crypto_cfg.h	

⌋

8.4 Scheduled functions

8.4.1 Crypto_MainFunction

The `Crypto_MainFunction` is necessary for asynchronous job processing. For synchronous job processing providing the main function is optional.

[SWS_Crypto_91012] Definition of scheduled function Crypto_MainFunction ⌈

Service Name	Crypto_MainFunction

Syntax	`void Crypto_MainFunction (`
	`  void`
	`)`

Service ID [hex]	0x0c
Description	If asynchronous job processing is configured and there are job queues, the function is called cyclically to process queued jobs.
Available via	SchM_Crypto.h

⌋

8.5 Expected interfaces

In this chapter all interfaces required from other modules are listed.

8.5.1 Interfaces to Standard Software Modules

[SWS_Crypto_00126] ⌈The Crypto Driver shall use an AUTOSAR DET module for development error notification.⌋

8.5.2 Mandatory interfaces

This section defines all interfaces, which are required to fulfill the core functionality of the module.

[SWS_Crypto_91028] Definition of mandatory interfaces required by module Crypto ⌈

API Function	***Header File***	***Description***
There are no mandatory interfaces.		

⌋

8.5.3 Optional interfaces

This section defines all interfaces, which are required to fulfill an optional functionality of the module.

[SWS_Crypto_91017] Definition of optional interfaces requested by module Crypto ⌈

API Function	*Header File*	*Description*
Det_ReportError	Det.h	Service to report development errors.
IdsM_ReportSecurityEvent	IdsM.h	This API is the interface to report security events to the IdsM.
NvM_SetRamBlockStatus	NvM.h	Service for setting the RAM block status of a permanent RAM block or the status of the explicit synchronization of a NVRAM block.
NvM_WriteBlock	NvM.h	Service to copy the data of the RAM block to its corresponding NV block.

⌋

9 Sequence diagrams

n/a

10 Configuration specification

In general, this chapter defines configuration parameters and their clustering into containers. In order to support the specification Chapter 10.1 describes fundamentals. It also specifies a template (table) you shall use for the parameter specification. We intend to leave Chapter 10.1 in the specification to guarantee comprehension.

Chapter 10.2 specifies the structure (containers) and the parameters of the module Crypto.

Chapter 10.3 specifies published information of the module Crypto.

10.1 How to read this chapter

For details refer to [3] Chapter 10.1 *"Introduction to configuration specification"*.

10.2 Containers and configuration parameters

The following chapters summarize all configuration parameters. The detailed meanings of the parameters describe Chapter 7 and Chapter 8.

Note: The Ids in the configuration containers shall be consecutive, gapless and shall start from zero.

10.2.1 Crypto

[ECUC_Crypto_00001] Definition of EcucModuleDef Crypto ⌈

Module Name	Crypto
Description	Configuration of the Crypto (CryptoDriver) module
Post-Build Selectable Support	false
Post-Build Loadable Support	false

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoDriverObjects	1	Container for CRYPTO Objects
CryptoGeneral	1	Container for common configuration options
CryptoKeyElements	0..1	Container for Crypto key elements
CryptoKeyTypes	0..1	Container for CRYPTO key types
CryptoKeys	0..1	Container for CRYPTO keys
CryptoNvStorage	0..1	Container of NV block storage. Contains a collection of all NV storage blocks used for key storage.
CryptoPrimitiveSettings	0..1	Container for configuring Crypto primitive settings.

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Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoPrimitiveTypes	0..1	Container for configuring Crypto primitive types.
CryptoPrimitives	0..1	Container for CRYPTO primitives

⌋

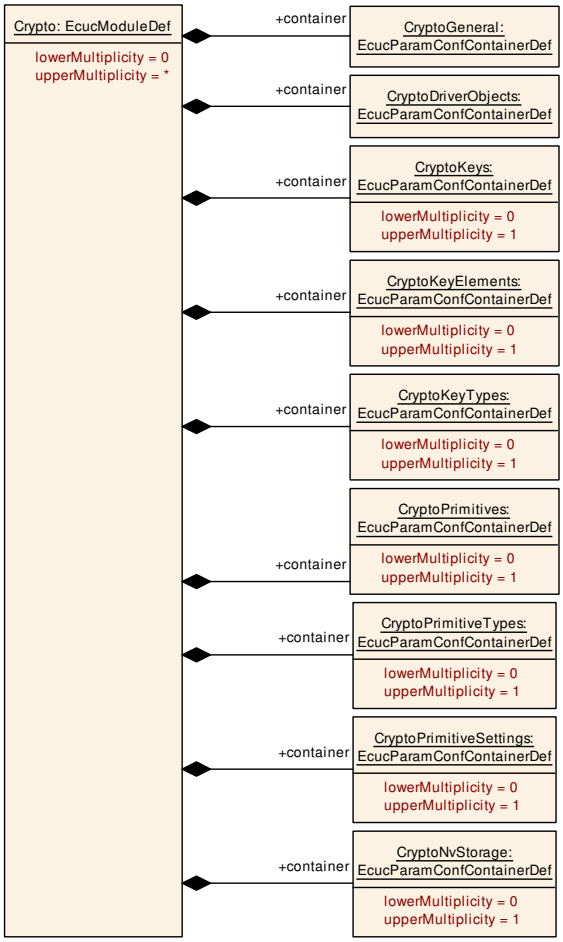


Figure 10.1

10.2.2 CryptoGeneral

[ECUC_Crypto_00002] Definition of EcucParamConfContainerDef CryptoGeneral

⌈

Container Name	CryptoGeneral
Parent Container	Crypto
Upstream mapping defined	–

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Description	Container for common configuration options
Multiplicity	1
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoDevErrorDetect	1	[ECUC_Crypto_00006]
CryptoEnableSecurityEventReporting	1	[ECUC_Crypto_00060]
CryptoInstanceId	1	[ECUC_Crypto_00040]
CryptoMainFunctionPeriod	0..1	[ECUC_Crypto_00038]
CryptoEcucPartitionRef	0..*	[ECUC_Crypto_00042]

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoSecurityEventRefs	0..1	Container for the references to IdsMEvent elements representing the security events that the Crypto module shall report to the Ids M in case the corresponding security related event occurs (and if CryptoEnableSecurityEventReporting is set to "true"). The standardized security events in this container can be extended by vendor-specific security events. **Tags:** atp.Status=draft

⌋

[ECUC_Crypto_00006] Definition of EcucBooleanParamDef CryptoDevErrorDetect ⌈

Parameter Name	CryptoDevErrorDetect
Parent Container	CryptoGeneral
Upstream mapping defined	–
Description	Switches the development error detection and notification on or off. true: detection and notification is enabled. false: detection and notification is disabled
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false
Pre-Compile only	true

⌋

[ECUC_Crypto_00060] Definition of EcucBooleanParamDef CryptoEnableSecurityEventReporting

Status: DRAFT

⌈

Parameter Name	CryptoEnableSecurityEventReporting
Parent Container	CryptoGeneral
Upstream mapping defined	–

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△

Description	Switches the reporting of security events to the IdsM: • true: reporting is enabled. • false: reporting is disabled. **Tags:** atp.Status=draft
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false
Pre-Compile only	true

⌋

[ECUC_Crypto_00040] Definition of EcucIntegerParamDef CryptoInstanceId ⌈

Parameter Name	CryptoInstanceId	
Parent Container	CryptoGeneral	
Upstream mapping defined	–	
Description	Instance ID of the crypto driver. This ID is used to discern several crypto drivers in case more than one driver is used in the same ECU.	
Multiplicity	1	
Type	EcucIntegerParamDef	
Range	0 .. 255	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00038] Definition of EcucFloatParamDef CryptoMainFunctionPeriod ⌈

Parameter Name	CryptoMainFunctionPeriod	
Parent Container	CryptoGeneral	
Upstream mapping defined	–	
Description	Specifies the period of main function Crypto_MainFunction in seconds.	
Multiplicity	0..1	
Type	EcucFloatParamDef	
Range	]0 .. INF[	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00042] Definition of EcucReferenceDef CryptoEcucPartitionRef ⌈

Parameter Name	CryptoEcucPartitionRef
Parent Container	CryptoGeneral
Upstream mapping defined	–
Description	Maps the Crypto driver to zero or multiple ECUC partitions to make the modules API available in this partition.

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Multiplicity	0..*
Type	Reference to EcucPartition
Pre-Compile only	true

⌋

[ECUC_Crypto_00061] Definition of EcucParamConfContainerDef CryptoSecurityEventRefs

Status: DRAFT

⌈

Container Name	CryptoSecurityEventRefs
Parent Container	CryptoGeneral
Upstream mapping defined	–
Description	Container for the references to IdsMEvent elements representing the security events that the Crypto module shall report to the IdsM in case the corresponding security related event occurs (and if CryptoEnableSecurityEventReporting is set to "true"). The standardized security events in this container can be extended by vendor-specific security events. **Tags:** atp.Status=draft
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED	0..1	[ECUC_Crypto_00062]

No Included Containers

⌋

[ECUC_Crypto_00062] Definition of EcucReferenceDef SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED

Status: DRAFT

⌈

Parameter Name	SEV_EXEC_SW_COMPONENT_INTEGRITY_CHECK_FAILED
Parent Container	CryptoSecurityEventRefs
Upstream mapping defined	–
Description	The integrity check of a SW component has failed. **Tags:** atp.Status=draft
Multiplicity	0..1
Type	Symbolic name reference to IdsMEvent
Pre-Compile only	true

⌋

[SWS_Crypto_00212] ⌈The Crypto Driver module shall reject configurations with partition mappings which are not supported by the implementation.⌋

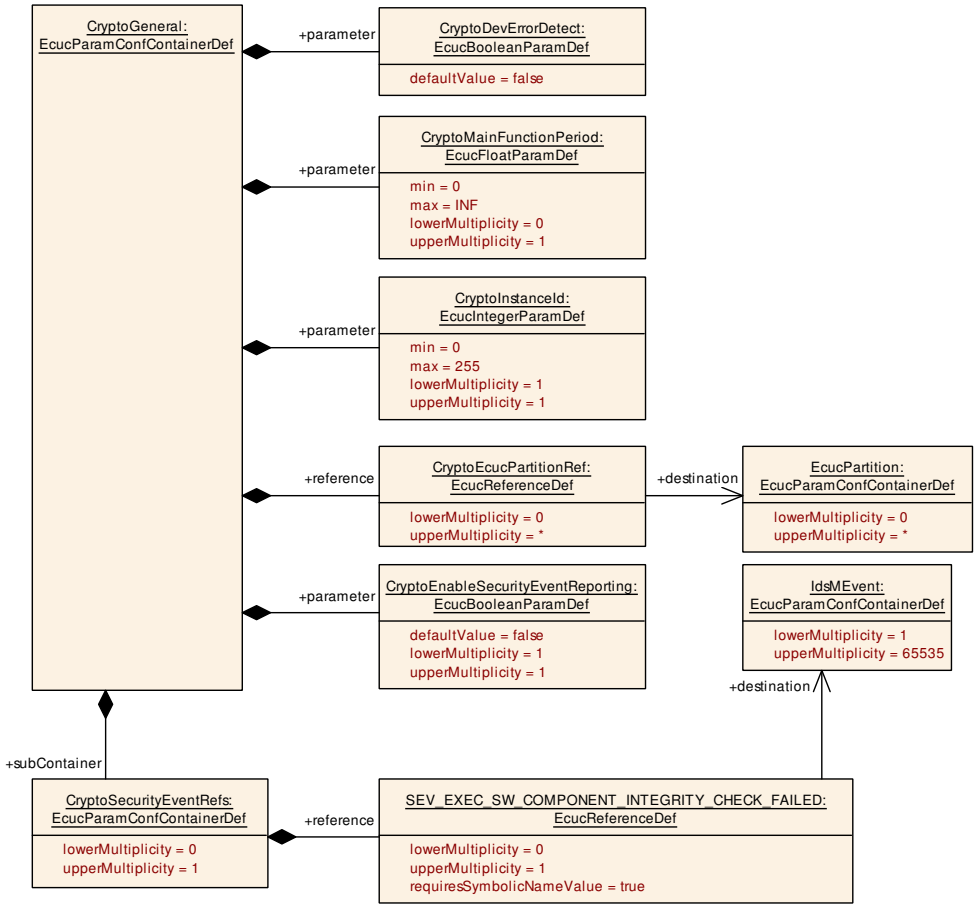


Figure 10.2

10.2.3 CryptoDriverObjects

[ECUC_Crypto_00003] Definition of EcucParamConfContainerDef CryptoDriver Objects ⌈

Container Name	CryptoDriverObjects
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for CRYPTO Objects
Multiplicity	1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoDriverObject	0..*	Configuration of a CryptoDriverObject

⌋

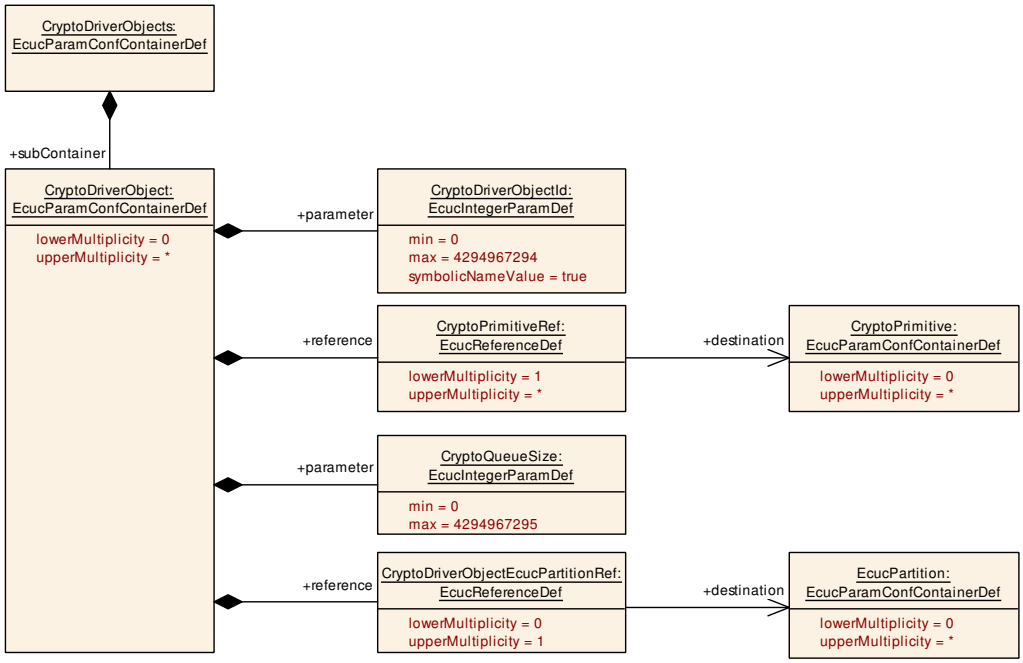


Figure 10.3

10.2.4 CryptoDriverObject

[ECUC_Crypto_00008] Definition of EcucParamConfContainerDef CryptoDriver Object ⌈

Container Name	CryptoDriverObject
Parent Container	CryptoDriverObjects
Upstream mapping defined	–
Description	Configuration of a CryptoDriverObject
Multiplicity	0..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoDriverObjectId	1	[ECUC_Crypto_00009]
CryptoQueueSize	1	[ECUC_Crypto_00019]
CryptoDriverObjectEcucPartitionRef	0..1	[ECUC_Crypto_00043]
CryptoPrimitiveRef	1..*	[ECUC_Crypto_00018]

No Included Containers

⌋

[ECUC_Crypto_00009] Definition of EcucIntegerParamDef CryptoDriverObjectId ⌈

Parameter Name	CryptoDriverObjectId	
Parent Container	CryptoDriverObject	
Upstream mapping defined	–	
Description	Identifier of the Crypto Driver Object. The Crypto Driver Object offers different crypto primitives. Dependency: The range is limited to 0xFFFFFFFE, to have the value 0xFFFFFFFF (CRYPTO_NO_ID) reserved for stack internal use. This is common for Crypto stack "Id" parameters.	
Multiplicity	1	
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)	
Range	0 .. 4294967294	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00019] Definition of EcucIntegerParamDef CryptoQueueSize ⌈

Parameter Name	CryptoQueueSize	
Parent Container	CryptoDriverObject	
Upstream mapping defined	–	
Description	Size of the queue in the Crypto Driver. Defines the maximum number of jobs in the Crypto Driver Object queue. If it is set to 0, queueing is disabled in the Crypto Driver Object.	
Multiplicity	1	
Type	EcucIntegerParamDef	
Range	0 .. 4294967295	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00043] Definition of EcucReferenceDef CryptoDriverObjectEcucPartitionRef ⌈

Parameter Name	CryptoDriverObjectEcucPartitionRef
Parent Container	CryptoDriverObject
Upstream mapping defined	–
Description	Maps a crypto driver object to zero or one ECUC partition. The ECUC partition referenced is a subset of the ECUC partitions where the Crypto driver is mapped to.
Multiplicity	0..1
Type	Reference to EcucPartition

▽

△

Pre-Compile only	true

⌋

[ECUC_Crypto_00018] Definition of EcucReferenceDef CryptoPrimitiveRef ⌈

Parameter Name	CryptoPrimitiveRef
Parent Container	CryptoDriverObject
Upstream mapping defined	–
Description	Refers to primitive in the CRYPTO. The CryptoPrimitive is a pre-configured container of the crypto service that shall be used.
Multiplicity	1..*
Type	Reference to CryptoPrimitive
Pre-Compile only	true

⌋

[SWS_Crypto_CONSTR_00002]

Upstream requirements: SRS_BSW_00395

⌈The ECUC partitions referenced by `CryptoDriverObjectEcucPartitionRef` shall be a subset of the ECUC partitions referenced by `CryptoEcucPartitionRef`.⌋

[SWS_Crypto_CONSTR_00003]

Upstream requirements: SRS_BSW_00395

⌈If the `CryptoDriverObjectEcucPartitionRef` shall be configured for an HSM it shall be mapped to 0 or 1 ECUC partitions only.⌋

[SWS_Crypto_CONSTR_00004]

Upstream requirements: SRS_BSW_00395

⌈If `CryptoEcucPartitionRef` references one or more ECUC partitions, `CryptoDriverObjectEcucPartitionRef` shall have a multiplicity of greater than zero and reference one or several of these ECUC partitions as well.⌋

10.2.5 CryptoKeys

[ECUC_Crypto_00004] Definition of EcucParamConfContainerDef CryptoKeys ⌈

Container Name	CryptoKeys
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for CRYPTO keys
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoKey	1..*	Configuration of a CryptoKey

⌋

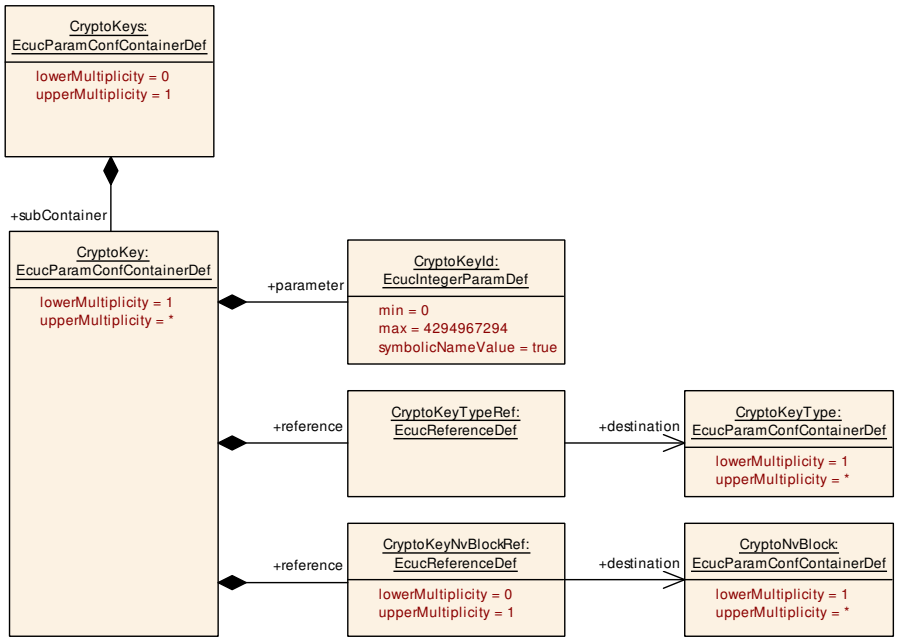


Figure 10.4

10.2.6 CryptoKey

[ECUC_Crypto_00011] Definition of EcucParamConfContainerDef CryptoKey ⌈

Container Name	CryptoKey
Parent Container	CryptoKeys
Upstream mapping defined	–
Description	Configuration of a CryptoKey
Multiplicity	1..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoKeyId	1	[ECUC_Crypto_00012]
CryptoKeyNvBlockRef	0..1	[ECUC_Crypto_00059]
CryptoKeyTypeRef	1	[ECUC_Crypto_00020]

No Included Containers

⌋

[ECUC_Crypto_00012] Definition of EcucIntegerParamDef CryptoKeyId ⌈

Parameter Name	CryptoKeyId
Parent Container	CryptoKey
Upstream mapping defined	–
Description	Identifier of the CRYPTO Key Dependency: The range is limited to 0xFFFFFFFE, to have the value 0xFFFFFFFF (CRYPTO_NO_ID) reserved for stack internal use. This is common for Crypto stack "Id" parameters.
Multiplicity	1
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)
Range	0 .. 4294967294
Default value	–
Pre-Compile only	true

⌋

[ECUC_Crypto_00059] Definition of EcucReferenceDef CryptoKeyNvBlockRef ⌈

Parameter Name	CryptoKeyNvBlockRef
Parent Container	CryptoKey
Upstream mapping defined	–
Description	Reference to the NV block where the persistent key elements of this key shall be stored to.
Multiplicity	0..1
Type	Reference to CryptoNvBlock
Pre-Compile only	true

⌋

[ECUC_Crypto_00020] Definition of EcucReferenceDef CryptoKeyTypeRef ⌈

Parameter Name	CryptoKeyTypeRef
Parent Container	CryptoKey
Upstream mapping defined	–
Description	Refers to a pointer in the CRYPTOto a CryptoKeyType. The CryptoKeyType provides the information which key elements are contained in a CryptoKey.
Multiplicity	1
Type	Reference to CryptoKeyType
Pre-Compile only	true

⌋

10.2.7 CryptoKeyElements

[ECUC_Crypto_00005] Definition of EcucParamConfContainerDef CryptoKeyElements ⌈

Container Name	CryptoKeyElements
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for Crypto key elements
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoKeyElement	1..*	Configuration of a CryptoKeyElement

⌋

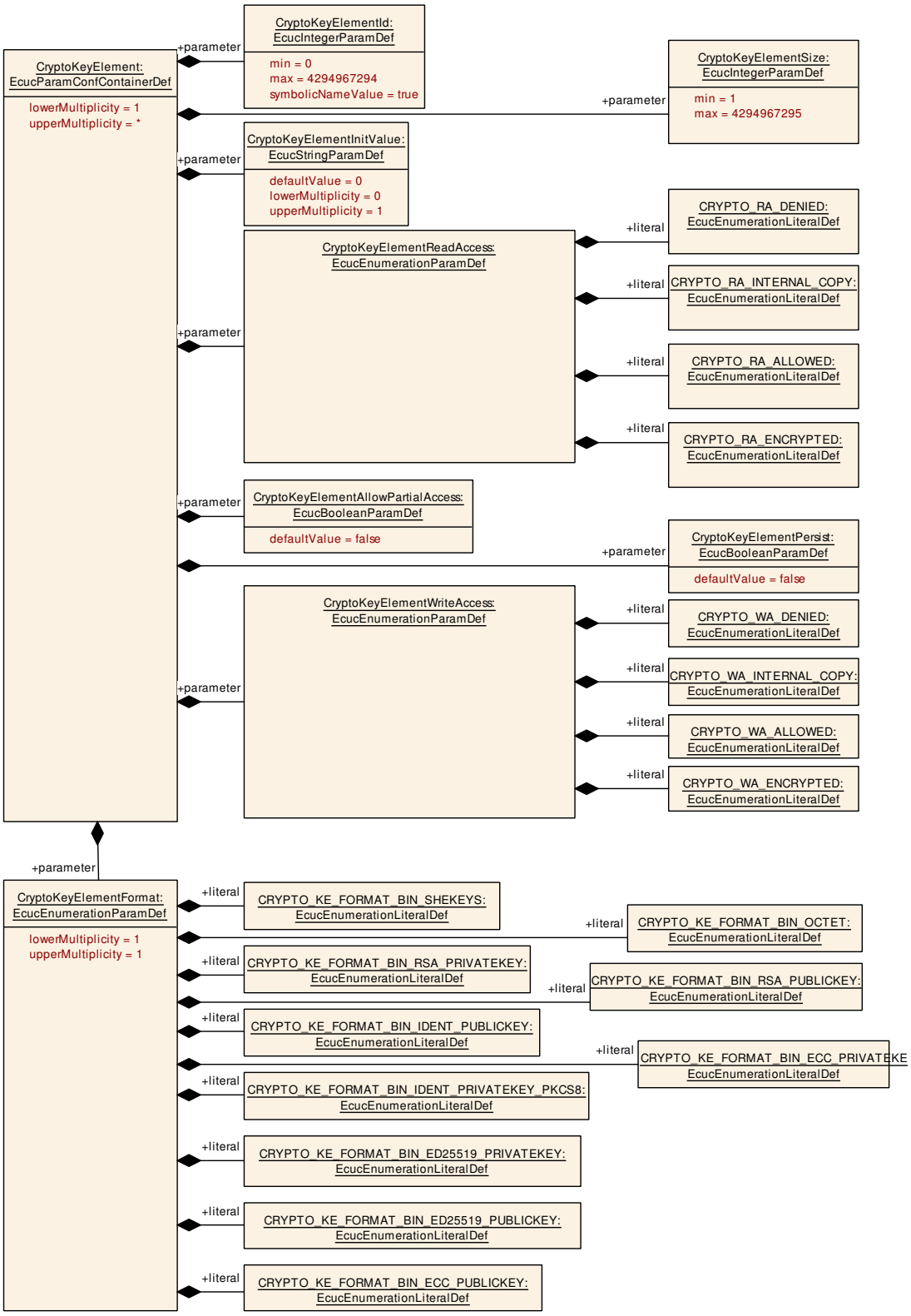

CryptoKeyElement:
EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+parameter
CryptoKeyElementId:
EcucIntegerParamDef
min = 0
max = 4294967294
symbolicNameValue = true
CryptoKeyElementSize:
EcucIntegerParamDef
min = 1
max = 4294967295
CryptoKeyElementInitValue:
EcucStringParamDef
defaultValue = 0
lowerMultiplicity = 0
upperMultiplicity = 1
CryptoKeyElementReadAccess:
EcucEnumerationParamDef
CRYPTO_RA_DENIED:
EcucEnumerationLiteralDef
CRYPTO_RA_INTERNAL_COPY:
EcucEnumerationLiteralDef
CRYPTO_RA_ALLOWED:
EcucEnumerationLiteralDef
CRYPTO_RA_ENCRYPTED:
EcucEnumerationLiteralDef
CryptoKeyElementAllowPartialAccess:
EcucBooleanParamDef
defaultValue = false
CryptoKeyElementPersist:
EcucBooleanParamDef
defaultValue = false
CryptoKeyElementWriteAccess:
EcucEnumerationParamDef
CRYPTO_WA_DENIED:
EcucEnumerationLiteralDef
CRYPTO_WA_INTERNAL_COPY:
EcucEnumerationLiteralDef
CRYPTO_WA_ALLOWED:
EcucEnumerationLiteralDef
CRYPTO_WA_ENCRYPTED:
EcucEnumerationLiteralDef
CryptoKeyElementFormat:
EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
CRYPTO_KE_FORMAT_BIN_SHEKEYS:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_OCTET:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_RSA_PRIVATEKEY:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_RSA_PUBLICKEY:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_ECC_PRIVATEKE
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_IDENT_PRIVATEKEY_PKCS8:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_ED25519_PRIVATEKEY:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_ED25519_PUBLICKEY:
EcucEnumerationLiteralDef
CRYPTO_KE_FORMAT_BIN_ECC_PUBLICKEY:
EcucEnumerationLiteralDef

Figure 10.5

10.2.8 CryptoKeyElement

[ECUC_Crypto_00014] Definition of EcucParamConfContainerDef CryptoKeyElement ⌈

Container Name	CryptoKeyElement
Parent Container	CryptoKeyElements
Upstream mapping defined	–
Description	Configuration of a CryptoKeyElement
Multiplicity	1..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoKeyElementAllowPartialAccess	1	[ECUC_Crypto_00025]
CryptoKeyElementFormat	1	[ECUC_Crypto_00041]
CryptoKeyElementId	1	[ECUC_Crypto_00021]
CryptoKeyElementInitValue	0..1	[ECUC_Crypto_00023]
CryptoKeyElementPersist	1	[ECUC_Crypto_00026]
CryptoKeyElementReadAccess	1	[ECUC_Crypto_00024]
CryptoKeyElementSize	1	[ECUC_Crypto_00022]
CryptoKeyElementWriteAccess	1	[ECUC_Crypto_00027]

No Included Containers

⌋

[ECUC_Crypto_00025] Definition of EcucBooleanParamDef CryptoKeyElement AllowPartialAccess ⌈

Parameter Name	CryptoKeyElementAllowPartialAccess
Parent Container	CryptoKeyElement
Upstream mapping defined	–
Description	Enable or disable writing and reading the key element with data smaller than the size of the element. True: enable partial access of the key element False: disable partial access of the key element
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false
Pre-Compile only	true

⌋

[ECUC_Crypto_00041] Definition of EcucEnumerationParamDef CryptoKeyElementFormat ⌈

Parameter Name	CryptoKeyElementFormat	
Parent Container	CryptoKeyElement	
Upstream mapping defined	–	
Description	Defines the format for the key element. This is the format used to provide or extract the key data from the driver.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CRYPTO_KE_FORMAT_BIN_ECC_PRIVATEKEY	0x07
	CRYPTO_KE_FORMAT_BIN_ECC_PUBLICKEY	0x08
	CRYPTO_KE_FORMAT_BIN_ED25519_PRIVATEKEY	0x09
	CRYPTO_KE_FORMAT_BIN_ED25519_PUBLICKEY	0x0A
	CRYPTO_KE_FORMAT_BIN_IDENT_PRIVATEKEY_PKCS8	0x03
	CRYPTO_KE_FORMAT_BIN_IDENT_PUBLICKEY	0x04
	CRYPTO_KE_FORMAT_BIN_OCTET	0x01
	CRYPTO_KE_FORMAT_BIN_RSA_PRIVATEKEY	0x05
	CRYPTO_KE_FORMAT_BIN_RSA_PUBLICKEY	0x06
	CRYPTO_KE_FORMAT_BIN_SHEKEYS	0x02
Pre-Compile only	true	

⌋

[ECUC_Crypto_00021] Definition of EcucIntegerParamDef CryptoKeyElementId ⌈

Parameter Name	CryptoKeyElementId	
Parent Container	CryptoKeyElement	
Upstream mapping defined	–	
Description	Identifier of the CRYPTO key element Dependency: The range is limited to 0xFFFFFFFE, to have the value 0xFFFFFFFF (CRYPTO_NO_ID) reserved for stack internal use. This is common for Crypto stack "Id" parameters.	
Multiplicity	1	
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)	
Range	0 .. 4294967294	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00023] Definition of EcucStringParamDef CryptoKeyElementInitValue ⌈

Parameter Name	CryptoKeyElementInitValue
Parent Container	CryptoKeyElement
Upstream mapping defined	–
Description	Value which will be used to fill the key element during startup (i) for all non-persistent key elements, and (ii) for those persistent key elements that have never been written.
Multiplicity	0..1
Type	EcucStringParamDef
Default value	0
Regular Expression	–
Pre-Compile only	true

⌋

[ECUC_Crypto_00026] Definition of EcucBooleanParamDef CryptoKeyElementPersist ⌈

Parameter Name	CryptoKeyElementPersist
Parent Container	CryptoKeyElement
Upstream mapping defined	–
Description	Enable or disable persisting of the key element in non-volatile storage. True: enable persisting of the key element. False: disable persisting of the key element.
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false
Pre-Compile only	true

⌋

[ECUC_Crypto_00024] Definition of EcucEnumerationParamDef CryptoKeyElementReadAccess ⌈

Parameter Name	CryptoKeyElementReadAccess	
Parent Container	CryptoKeyElement	
Upstream mapping defined	–	
Description	Define the reading access rights of the key element through external API. CRYPTO_RA_DENIED = key element cannot be read from outside the Crypto Driver CRYPTO_RA INTERNAL_COPY = key element can be copied to another key element in the same crypto driver. CRYPTO_RA_ALLOWED = key element can be read as plaintext CRYPTO_RA_ENCRYPTED = key element can be read encrypted. E.g. SHE Ram-Key export. Dependency: The values for the enumeration types are chosen in a way that its value can be used to deduce a hierarchical access level.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CRYPTO_RA_ALLOWED	0x00
	CRYPTO_RA_DENIED	0x03
	CRYPTO_RA_ENCRYPTED	0x01
	CRYPTO_RA_INTERNAL_COPY	0x02

▽

△

Pre-Compile only	true

⌋

[ECUC_Crypto_00022] Definition of EcucIntegerParamDef CryptoKeyElement Size ⌈

Parameter Name	CryptoKeyElementSize	
Parent Container	CryptoKeyElement	
Upstream mapping defined	–	
Description	Maximum Size size of a CRYPTO key element in bytes	
Multiplicity	1	
Type	EcucIntegerParamDef	
Range	1 .. 4294967295	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00027] Definition of EcucEnumerationParamDef CryptoKeyElementWriteAccess ⌈

Parameter Name	CryptoKeyElementWriteAccess	
Parent Container	CryptoKeyElement	
Upstream mapping defined	–	
Description	Define the writing access rights of the key element through external API. CRYPTO_WA_DENIED = key element can not be written from outside the Crypto Driver CRYPTO_WA INTERNAL_COPY = key element can be filled with another key element in the same crypto driver. CRYPTO_WA_ALLOWED = key element can be rwritten as plaintext CRYPTO_WA_ENCRYPTED = key element can be written encrypted. E.g. SHE load key. Dependency: The values for the enumeration types are chosen in a way that its value can be used to deduce a hierarchical access level.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CRYPTO_WA_ALLOWED	0x00
	CRYPTO_WA_DENIED	0x03
	CRYPTO_WA_ENCRYPTED	0x01
	CRYPTO_WA_INTERNAL_COPY	0x02
Pre-Compile only	true	

⌋

10.2.9 CryptoKeyTypes

[ECUC_Crypto_00017] Definition of EcucParamConfContainerDef CryptoKeyTypes ⌈

Container Name	CryptoKeyTypes
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for CRYPTO key types
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	Multiplicity	Description
CryptoKeyType	1..*	Configuration of a CryptoKeyType

⌋

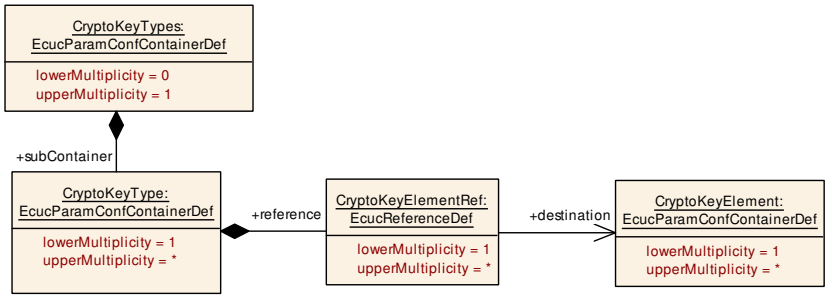


Figure 10.6

10.2.10 CryptoKeyType

[ECUC_Crypto_00030] Definition of EcucParamConfContainerDef CryptoKeyType ⌈

Container Name	CryptoKeyType
Parent Container	CryptoKeyTypes
Upstream mapping defined	–
Description	Configuration of a CryptoKeyType
Multiplicity	1..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	Multiplicity	ECUC ID
CryptoKeyElementRef	1..*	[ECUC_Crypto_00031]

No Included Containers

⌋

[ECUC_Crypto_00031] Definition of EcucReferenceDef CryptoKeyElementRef ⌈

Parameter Name	CryptoKeyElementRef
Parent Container	CryptoKeyType
Upstream mapping defined	–
Description	Refers to a pointer in the CRYPTOCrypto Key Element, which holds the data of the crypto key element.
Multiplicity	1..*
Type	Reference to CryptoKeyElement
Pre-Compile only	true

⌋

10.2.11 CryptoPrimitiveTypes

[ECUC_Crypto_00063] Definition of EcucParamConfContainerDef CryptoPrimitiveTypes ⌈

Container Name	CryptoPrimitiveTypes
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for configuring Crypto primitive types.
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoPrimitiveType	1..*	Container for configuring the general characteristics of a cryptographic primitive.

⌋

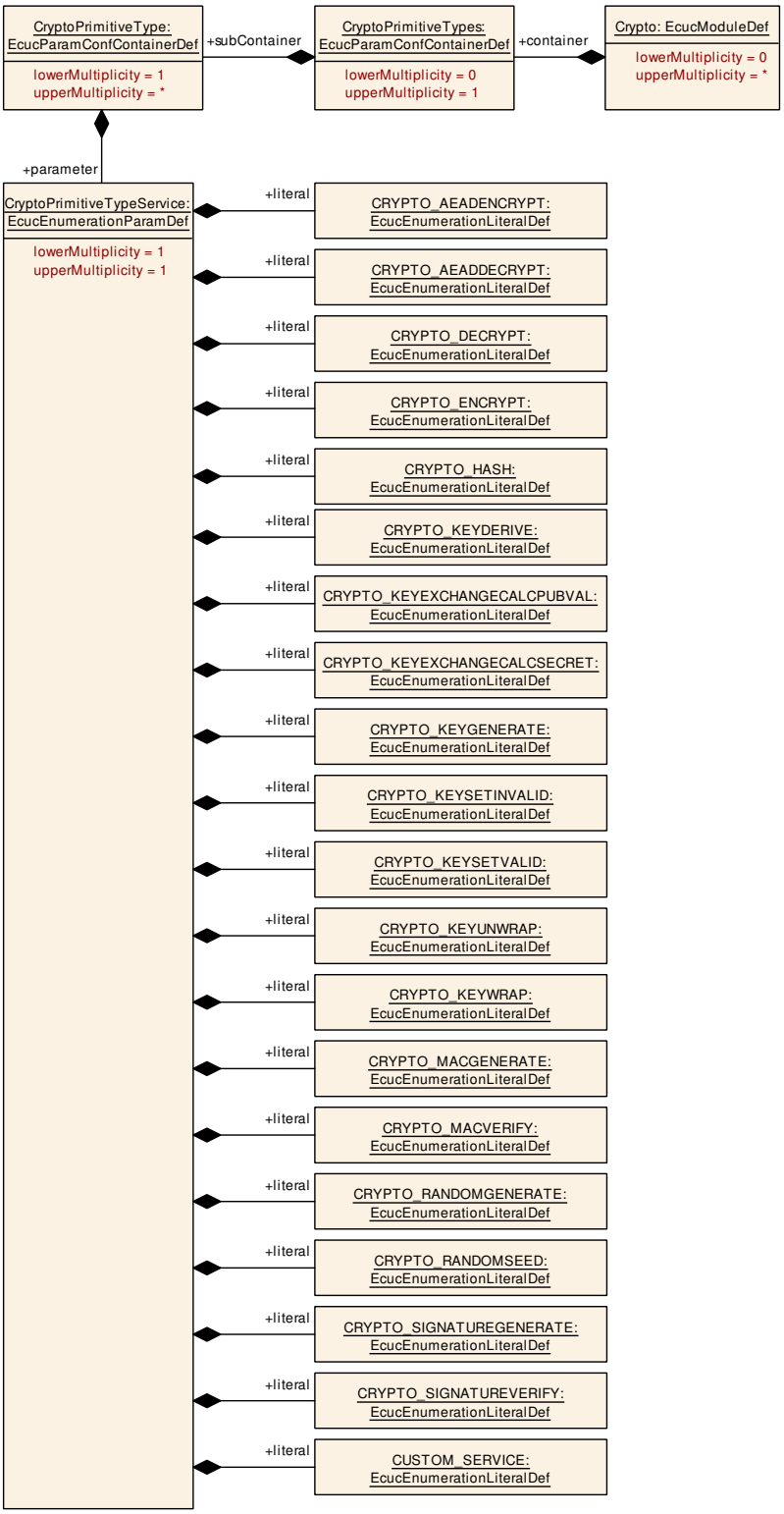

CryptoPrimitiveType:
EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+subContainer
CryptoPrimitiveTypes:
EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+container
Crypto: EcucModuleDef
lowerMultiplicity = 0
upperMultiplicity = *
+parameter
CryptoPrimitiveTypeService:
EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
CRYPTO_AEADENCRYPT:
EcucEnumerationLiteralDef
CRYPTO_AEADDECRYPT:
EcucEnumerationLiteralDef
CRYPTO_DECRYPT:
EcucEnumerationLiteralDef
CRYPTO_ENCRYPT:
EcucEnumerationLiteralDef
CRYPTO_HASH:
EcucEnumerationLiteralDef
CRYPTO_KEYDERIVE:
EcucEnumerationLiteralDef
CRYPTO_KEYEXCHANGECALCPUBVAL:
EcucEnumerationLiteralDef
CRYPTO_KEYEXCHANGECALCSECRET:
EcucEnumerationLiteralDef
CRYPTO_KEYGENERATE:
EcucEnumerationLiteralDef
CRYPTO_KEYSETINVALID:
EcucEnumerationLiteralDef
CRYPTO_KEYSETVALID:
EcucEnumerationLiteralDef
CRYPTO_KEYUNWRAP:
EcucEnumerationLiteralDef
CRYPTO_KEYWRAP:
EcucEnumerationLiteralDef
CRYPTO_MACGENERATE:
EcucEnumerationLiteralDef
CRYPTO_MACVERIFY:
EcucEnumerationLiteralDef
CRYPTO_RANDOMGENERATE:
EcucEnumerationLiteralDef
CRYPTO_RANDOMSEED:
EcucEnumerationLiteralDef
CRYPTO_SIGNATUREGENERATE:
EcucEnumerationLiteralDef
CRYPTO_SIGNATUREVERIFY:
EcucEnumerationLiteralDef
CUSTOM_SERVICE:
EcucEnumerationLiteralDef

Figure 10.7

10.2.12 CryptoPrimitiveType

Note: `CryptoPrimitiveType` can be extended with vendor-defined parameters and containers.

[ECUC_Crypto_00065] Definition of EcucParamConfContainerDef CryptoPrimitiveType ⌈

Container Name	CryptoPrimitiveType
Parent Container	CryptoPrimitiveTypes
Upstream mapping defined	–
Description	Container for configuring the general characteristics of a cryptographic primitive.
Multiplicity	1..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoPrimitiveTypeService	1	[ECUC_Crypto_00066]

No Included Containers

⌋

[ECUC_Crypto_00066] Definition of EcucEnumerationParamDef CryptoPrimitiveTypeService ⌈

Parameter Name	CryptoPrimitiveTypeService	
Parent Container	CryptoPrimitiveType	
Upstream mapping defined	–	
Description	Determines the crypto service used for defining the capabilities.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CRYPTO_AEADDECRYPT	0x06
	CRYPTO_AEADENCRYPT	0x05
	CRYPTO_DECRYPT	0x04
	CRYPTO_ENCRYPT	0x03
	CRYPTO_HASH	0x00
	CRYPTO_KEYDERIVE	0x0E
	CRYPTO_ KEYEXCHANGECALCPUBVAL	0x0F
	CRYPTO_ KEYEXCHANGECALCSECRET	0x10
	CRYPTO_KEYGENERATE	0x0D
	CRYPTO_KEYSETINVALID	0x14
	CRYPTO_KEYSETVALID	0x13
	CRYPTO_KEYUNWRAP	0x17
	CRYPTO_KEYWRAP	0x16

▽

△

	CRYPTO_MACGENERATE	0x01
	CRYPTO_MACVERIFY	0x02
	CRYPTO_RANDOMGENERATE	0x0B
	CRYPTO_RANDOMSEED	0x0C
	CRYPTO_ SIGNATUREGENERATE	0x07
	CRYPTO_SIGNATUREVERIFY	0x08
	CUSTOM_SERVICE	0x15
Pre-Compile only	true	

⌋

10.2.13 CryptoPrimitiveSettings

[ECUC_Crypto_00064] Definition of EcucParamConfContainerDef CryptoPrimitiveSettings ⌈

Container Name	CryptoPrimitiveSettings
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for configuring Crypto primitive settings.
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

No Included Containers

⌋

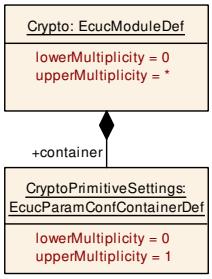


Figure 10.8

10.2.14 CryptoPrimitiveSetting

[SWS_Crypto_00280] Vendor-defined choice container CryptoPrimitiveSetting ⌈The crypto driver shall provide a vendor-defined choice container CryptoPrimitiveSetting that contains the vendor-specific set of subcontainers for every supported primitive. The subcontainers contain the detailed configuration of the respective primitive.

The choice container CryptoPrimitiveSetting shall have the following attributes:

- Parent container: `CryptoPrimitiveSettings`
- Multiplicity: 1..*
- Pre-compile only: True

⌋

10.2.15 CryptoPrimitives

[ECUC_Crypto_00032] Definition of EcucParamConfContainerDef CryptoPrimitives ⌈

Container Name	CryptoPrimitives
Parent Container	Crypto
Upstream mapping defined	–
Description	Container for CRYPTO primitives
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	**Multiplicity**	**Description**
CryptoPrimitive	0..*	Configuration of a CryptoPrimitive

⌋

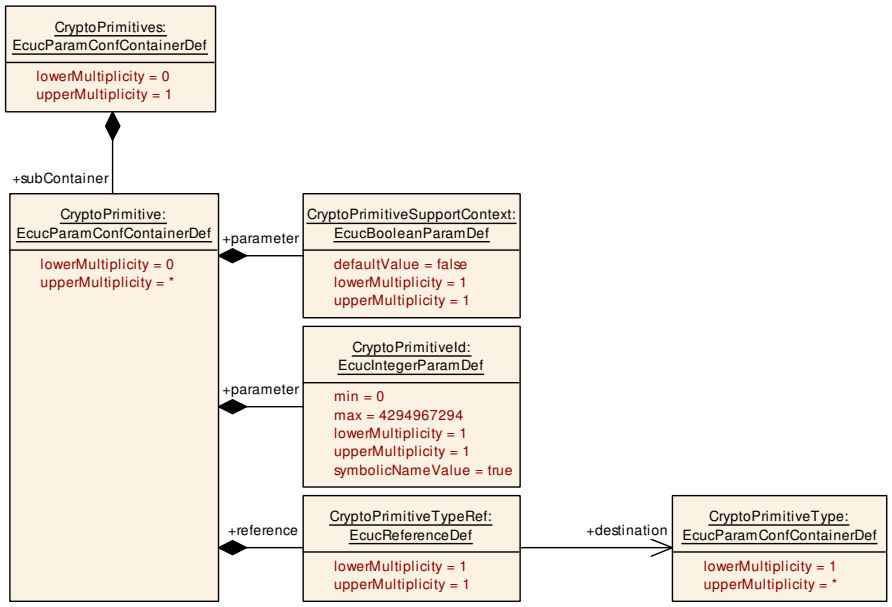


Figure 10.9

10.2.16 CryptoPrimitive

Note: `CryptoPrimitive` shall be extended with a corresponding reference if implementation-specific containers are used (see [SWS_Crypto_00280])

[ECUC_Crypto_00033] Definition of EcucParamConfContainerDef CryptoPrimitive ⌈

Container Name	CryptoPrimitive
Parent Container	CryptoPrimitives
Upstream mapping defined	–
Description	Configuration of a CryptoPrimitive
Multiplicity	0..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	**Multiplicity**	**ECUC ID**
CryptoPrimitiveId	1	[ECUC_Crypto_00068]
CryptoPrimitiveSupportContext	1	[ECUC_Crypto_00053]
CryptoPrimitiveTypeRef	1	[ECUC_Crypto_00070]

No Included Containers

⌋

[ECUC_Crypto_00068] Definition of EcucIntegerParamDef CryptoPrimitiveId ⌈

Parameter Name	CryptoPrimitiveId
Parent Container	CryptoPrimitive
Upstream mapping defined	–
Description	Identifier of the Crypto Primitive. Dependency: The range is limited to 0xFFFFFFFE, to have the value 0xFFFFFFFF (CRYPTO_NO_ID) reserved for stack internal use. This is common for Crypto stack "Id" parameters.
Multiplicity	1
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)
Range	0 .. 4294967294
Default value	–
Pre-Compile only	true

⌋

[ECUC_Crypto_00053] Definition of EcucBooleanParamDef CryptoPrimitiveSupportContext ⌈

Parameter Name	CryptoPrimitiveSupportContext
Parent Container	CryptoPrimitive
Upstream mapping defined	–
Description	Configures if the crypto primitive supports to store or restore context data of the workspace. Since this option is vulnerable to security, it shall only set to TRUE if absolutely needed.
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false
Pre-Compile only	true

⌋

[ECUC_Crypto_00070] Definition of EcucReferenceDef CryptoPrimitiveTypeRef ⌈

Parameter Name	CryptoPrimitiveTypeRef
Parent Container	CryptoPrimitive
Upstream mapping defined	–
Description	Reference to the primitive type used for the crypto primitive.
Multiplicity	1
Type	Reference to CryptoPrimitiveType
Pre-Compile only	true

⌋

10.2.17 CryptoNvStorage

[ECUC_Crypto_00054] Definition of EcucParamConfContainerDef CryptoNvStorage ⌈

Container Name	CryptoNvStorage
Parent Container	Crypto
Upstream mapping defined	–
Description	Container of NV block storage. Contains a collection of all NV storage blocks used for key storage.
Multiplicity	0..1
Pre-Compile only	true
Configuration Parameters	

No Included Parameters

Included Containers		
Container Name	Multiplicity	Description
CryptoNvBlock	1..*	Container to configure key storage in NVM

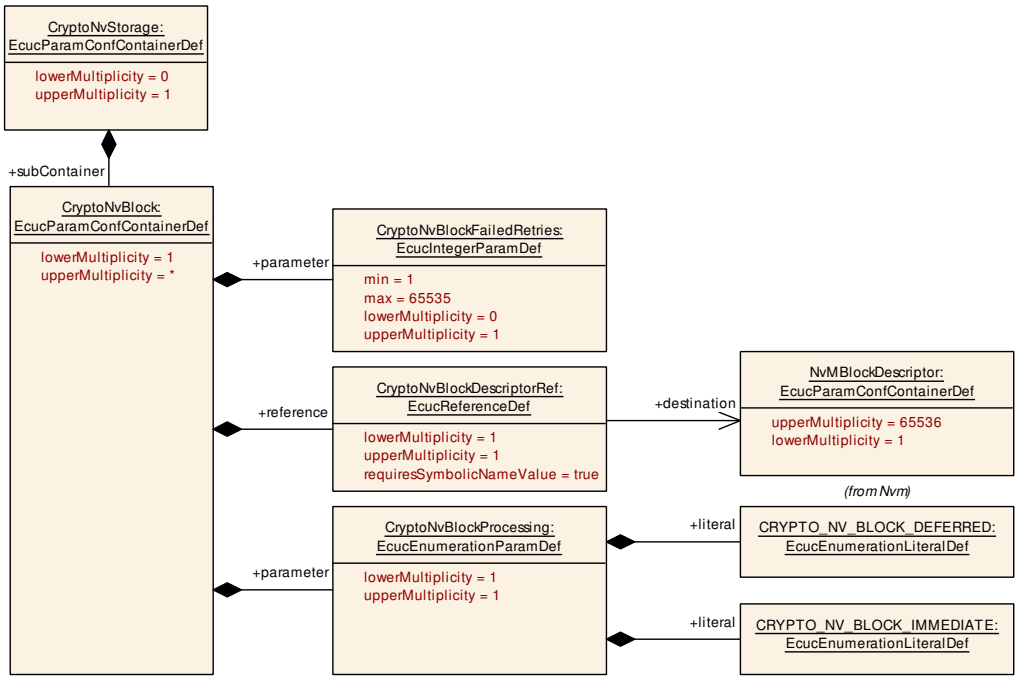


Figure 10.10

10.2.18 CryptoNvBlock

[ECUC_Crypto_00055] Definition of EcucParamConfContainerDef CryptoNv Block ⌈

Container Name	CryptoNvBlock
Parent Container	CryptoNvStorage
Upstream mapping defined	–
Description	Container to configure key storage in NVM
Multiplicity	1..*
Pre-Compile only	true
Configuration Parameters	

Included Parameters		
Parameter Name	Multiplicity	ECUC ID
CryptoNvBlockFailedRetries	0..1	[ECUC_Crypto_00057]
CryptoNvBlockProcessing	1	[ECUC_Crypto_00058]
CryptoNvBlockDescriptorRef	1	[ECUC_Crypto_00056]

No Included Containers

⌋

[ECUC_Crypto_00057] Definition of EcucIntegerParamDef CryptoNvBlockFailed Retries ⌈

Parameter Name	CryptoNvBlockFailedRetries	
Parent Container	CryptoNvBlock	
Upstream mapping defined	–	
Description	Number of retries to request an NVM service operation.	
Multiplicity	0..1	
Type	EcucIntegerParamDef	
Range	1 .. 65535	
Default value	–	
Pre-Compile only	true	

⌋

[ECUC_Crypto_00058] Definition of EcucEnumerationParamDef CryptoNvBlock Processing ⌈

Parameter Name	CryptoNvBlockProcessing	
Parent Container	CryptoNvBlock	
Upstream mapping defined	–	
Description	Selects the operation mode when an NV block shall be updated.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	CRYPTO_NV_BLOCK_DEFERRED	0x01
	CRYPTO_NV_BLOCK_IMMEDIATE	0x02
Pre-Compile only	true	

⌋

[ECUC_Crypto_00056] Definition of EcucReferenceDef CryptoNvBlockDescriptorRef ⌈

Parameter Name	CryptoNvBlockDescriptorRef
Parent Container	CryptoNvBlock
Upstream mapping defined	–
Description	Reference to an NvM block descriptor
Multiplicity	1
Type	Symbolic name reference to NvMBlockDescriptor
Pre-Compile only	true

⌋

10.3 Published Information

Published information contains data defined by the implementer of the SW module that does not change when the module is adapted (i.e. configured) to the actual HW/SW environment. It thus contains version and manufacturer information.

Additional module-specific published parameters are listed below if applicable.

A Change history of AUTOSAR traceable items

Please note that the lists in this chapter also include traceable items that have been removed from the specification in a later version. These items do not appear as hyperlinks in the document.

A.1 Traceable item history of this document according to AUTOSAR Release R26-11

A.1.1 Added Specification Items in R26-11

[ECUC_Crypto_00063] [ECUC_Crypto_00064] [ECUC_Crypto_00065] [ECUC_Crypto_00066] [ECUC_Crypto_00068] [ECUC_Crypto_00070] [SWS_Crypto_00270] [SWS_Crypto_00271] [SWS_Crypto_00272] [SWS_Crypto_00273] [SWS_Crypto_00274] [SWS_Crypto_00275] [SWS_Crypto_00276] [SWS_Crypto_00280]

A.1.2 Changed Specification Items in R26-11

[ECUC_Crypto_00001] [ECUC_Crypto_00002] [ECUC_Crypto_00003] [ECUC_Crypto_00004] [ECUC_Crypto_00005] [ECUC_Crypto_00006] [ECUC_Crypto_00008] [ECUC_Crypto_00009] [ECUC_Crypto_00011] [ECUC_Crypto_00012] [ECUC_Crypto_00014] [ECUC_Crypto_00017] [ECUC_Crypto_00018] [ECUC_Crypto_00019] [ECUC_Crypto_00020] [ECUC_Crypto_00021] [ECUC_Crypto_00022] [ECUC_Crypto_00023] [ECUC_Crypto_00024] [ECUC_Crypto_00025] [ECUC_Crypto_00026] [ECUC_Crypto_00027] [ECUC_Crypto_00030] [ECUC_Crypto_00031] [ECUC_Crypto_00032] [ECUC_Crypto_00033] [ECUC_Crypto_00038] [ECUC_Crypto_00040] [ECUC_Crypto_00041] [ECUC_Crypto_00042] [ECUC_Crypto_00043] [ECUC_Crypto_00053] [ECUC_Crypto_00054] [ECUC_Crypto_00055] [ECUC_Crypto_00056] [ECUC_Crypto_00057] [ECUC_Crypto_00058] [ECUC_Crypto_00059] [ECUC_Crypto_00060] [ECUC_Crypto_00061] [ECUC_Crypto_00062] [SWS_Crypto_00003] [SWS_Crypto_00018] [SWS_Crypto_00020] [SWS_Crypto_00028] [SWS_Crypto_00031] [SWS_Crypto_00040] [SWS_Crypto_00042] [SWS_Crypto_00064] [SWS_Crypto_00065] [SWS_Crypto_00070] [SWS_Crypto_00071] [SWS_Crypto_00073] [SWS_Crypto_00116] [SWS_Crypto_00121] [SWS_Crypto_00134] [SWS_Crypto_00135] [SWS_Crypto_00141] [SWS_Crypto_00142] [SWS_Crypto_00143] [SWS_Crypto_00183] [SWS_Crypto_00184] [SWS_Crypto_00185] [SWS_Crypto_00186] [SWS_Crypto_00187] [SWS_Crypto_00188] [SWS_Crypto_00189] [SWS_Crypto_00190] [SWS_Crypto_00191] [SWS_Crypto_00192] [SWS_Crypto_00193] [SWS_Crypto_00202] [SWS_Crypto_00203] [SWS_Crypto_00204] [SWS_Crypto_00221] [SWS_Crypto_00228] [SWS_Crypto_00229] [SWS_Crypto_00230] [SWS_Crypto_00231] [SWS_Crypto_00242] [SWS_Crypto_00243] [SWS_Crypto_00244] [SWS_Crypto_00245] [SWS_Crypto_00246]

[SWS_Crypto_00247] [SWS_Crypto_00248] [SWS_Crypto_00249] [SWS_Crypto_00250] [SWS_Crypto_00251] [SWS_Crypto_00252] [SWS_Crypto_00254] [SWS_Crypto_00259] [SWS_Crypto_00262] [SWS_Crypto_00263] [SWS_Crypto_00264] [SWS_Crypto_00266] [SWS_Crypto_00267] [SWS_Crypto_00268] [SWS_Crypto_00300] [SWS_Crypto_00301] [SWS_Crypto_00302] [SWS_Crypto_00303] [SWS_Crypto_91017] [SWS_Crypto_91018] [SWS_Crypto_91023] [SWS_Crypto_91024] [SWS_Crypto_91025] [SWS_Crypto_91026]

A.1.3 Deleted Specification Items in R26-11

[ECUC_Crypto_00007] [ECUC_Crypto_00034] [ECUC_Crypto_00035] [ECUC_Crypto_00036] [ECUC_Crypto_00037] [ECUC_Crypto_00044] [ECUC_Crypto_00045] [ECUC_Crypto_00046] [ECUC_Crypto_00047] [ECUC_Crypto_00048] [ECUC_Crypto_00049] [ECUC_Crypto_00050] [ECUC_Crypto_00051] [ECUC_Crypto_00052] [SWS_Crypto_00013] [SWS_Crypto_00047] [SWS_Crypto_00067] [SWS_Crypto_00072] [SWS_Crypto_00119] [SWS_Crypto_00224] [SWS_Crypto_00225] [SWS_Crypto_00226] [SWS_Crypto_00239] [SWS_Crypto_00240] [SWS_Crypto_00241] [SWS_Crypto_91001]

A.1.4 Added Constraints in R26-11

none

A.1.5 Changed Constraints in R26-11

[SWS_Crypto_CONSTR_00002] [SWS_Crypto_CONSTR_00003] [SWS_Crypto_CONSTR_00004]

A.1.6 Deleted Constraints in R26-11

none

A.2 Traceable item history of this document according to AUTOSAR Release R25-11

A.2.1 Added Specification Items in R25-11

[ECUC_Crypto_00060] [ECUC_Crypto_00061] [ECUC_Crypto_00062] [SWS_Crypto_00300] [SWS_Crypto_00301] [SWS_Crypto_00302] [SWS_Crypto_00303]

A.2.2 Changed Specification Items in R25-11

[ECUC_Crypto_00002] [ECUC_Crypto_00003] [ECUC_Crypto_00004] [ECUC_Crypto_00005] [ECUC_Crypto_00008] [ECUC_Crypto_00011] [ECUC_Crypto_00014] [ECUC_Crypto_00017] [ECUC_Crypto_00030] [ECUC_Crypto_00032] [ECUC_Crypto_00033] [ECUC_Crypto_00034] [ECUC_Crypto_00046] [ECUC_Crypto_00048] [ECUC_Crypto_00054] [ECUC_Crypto_00055] [SWS_Crypto_91013] [SWS_Crypto_91019]

A.2.3 Deleted Specification Items in R25-11

[SWS_Crypto_00145] [SWS_Crypto_00261]

A.2.4 Added Constraints in R25-11

none

A.2.5 Changed Constraints in R25-11

none

A.2.6 Deleted Constraints in R25-11

none

A.3 Traceable item history of this document according to AUTOSAR Release R24-11

A.3.1 Added Specification Items in R24-11

[SWS_Crypto_00262] [SWS_Crypto_00263] [SWS_Crypto_00264] [SWS_Crypto_00265] [SWS_Crypto_00266] [SWS_Crypto_00267] [SWS_Crypto_00268] [SWS_Crypto_00269]

A.3.2 Changed Specification Items in R24-11

[ECUC_Crypto_00034] [SWS_Crypto_00073] [SWS_Crypto_00260] [SWS_Crypto_00261] [SWS_Crypto_91013]

A.3.3 Deleted Specification Items in R24-11

none

A.3.4 Added Constraints in R24-11

none

A.3.5 Changed Constraints in R24-11

none

A.3.6 Deleted Constraints in R24-11

[SWS_Crypto_CONSTR_00001]

A.4 Traceable item history of this document according to AUTOSAR Release R23-11

A.4.1 Added Specification Items in R23-11

[SWS_Crypto_00003] [SWS_Crypto_00005] [SWS_Crypto_00012] [SWS_Crypto_00013] [SWS_Crypto_00014] [SWS_Crypto_00017] [SWS_Crypto_00018] [SWS_Crypto_00019] [SWS_Crypto_00020] [SWS_Crypto_00023] [SWS_Crypto_00025] [SWS_Crypto_00026] [SWS_Crypto_00027] [SWS_Crypto_00028] [SWS_Crypto_00029] [SWS_Crypto_00030] [SWS_Crypto_00031] [SWS_Crypto_00032] [SWS_Crypto_00033] [SWS_Crypto_00034] [SWS_Crypto_00037] [SWS_Crypto_00038] [SWS_Crypto_00039] [SWS_Crypto_00040] [SWS_Crypto_00042] [SWS_Crypto_00045] [SWS_Crypto_00047] [SWS_Crypto_00057] [SWS_Crypto_00058] [SWS_Crypto_00059] [SWS_Crypto_00064] [SWS_Crypto_00065] [SWS_Crypto_00067] [SWS_Crypto_00070] [SWS_Crypto_00071] [SWS_Crypto_00072] [SWS_Crypto_00073] [SWS_Crypto_00075] [SWS_Crypto_00076] [SWS_Crypto_00077] [SWS_Crypto_00078] [SWS_Crypto_00079] [SWS_Crypto_00085] [SWS_Crypto_00086] [SWS_Crypto_00087] [SWS_Crypto_00088] [SWS_Crypto_00089] [SWS_Crypto_00090] [SWS_Crypto_00092] [SWS_Crypto_00094] [SWS_Crypto_00095] [SWS_Crypto_00097] [SWS_Crypto_00098] [SWS_Crypto_00103] [SWS_Crypto_00104] [SWS_Crypto_00105] [SWS_Crypto_00106] [SWS_Crypto_00107] [SWS_Crypto_00109] [SWS_Crypto_00111] [SWS_Crypto_00112] [SWS_Crypto_00113] [SWS_Crypto_00115] [SWS_Crypto_00116] [SWS_Crypto_00117] [SWS_Crypto_00118] [SWS_Crypto_00119] [SWS_Crypto_00121] [SWS_Crypto_00122] [SWS_Crypto_00123] [SWS_Crypto_00124] [SWS_Crypto_00125] [SWS_Crypto_00126] [SWS_Crypto_00128] [SWS_Crypto_00129] [SWS_Crypto_00130] [SWS_Crypto_00131]

[SWS_Crypto_00134] [SWS_Crypto_00135] [SWS_Crypto_00141] [SWS_Crypto_00142] [SWS_Crypto_00143] [SWS_Crypto_00145] [SWS_Crypto_00146] [SWS_Crypto_00148] [SWS_Crypto_00149] [SWS_Crypto_00150] [SWS_Crypto_00151] [SWS_Crypto_00152] [SWS_Crypto_00153] [SWS_Crypto_00154] [SWS_Crypto_00155] [SWS_Crypto_00156] [SWS_Crypto_00157] [SWS_Crypto_00158] [SWS_Crypto_00159] [SWS_Crypto_00160] [SWS_Crypto_00161] [SWS_Crypto_00162] [SWS_Crypto_00165] [SWS_Crypto_00166] [SWS_Crypto_00167] [SWS_Crypto_00179] [SWS_Crypto_00180] [SWS_Crypto_00183] [SWS_Crypto_00184] [SWS_Crypto_00185] [SWS_Crypto_00186] [SWS_Crypto_00187] [SWS_Crypto_00188] [SWS_Crypto_00189] [SWS_Crypto_00190] [SWS_Crypto_00191] [SWS_Crypto_00192] [SWS_Crypto_00193] [SWS_Crypto_00194] [SWS_Crypto_00195] [SWS_Crypto_00196] [SWS_Crypto_00197] [SWS_Crypto_00198] [SWS_Crypto_00199] [SWS_Crypto_00202] [SWS_Crypto_00203] [SWS_Crypto_00204] [SWS_Crypto_00205] [SWS_Crypto_00206] [SWS_Crypto_00207] [SWS_Crypto_00208] [SWS_Crypto_00209] [SWS_Crypto_00210] [SWS_Crypto_00211] [SWS_Crypto_00212] [SWS_Crypto_00214] [SWS_Crypto_00215] [SWS_Crypto_00217] [SWS_Crypto_00219] [SWS_Crypto_00220] [SWS_Crypto_00221] [SWS_Crypto_00222] [SWS_Crypto_00223] [SWS_Crypto_00224] [SWS_Crypto_00225] [SWS_Crypto_00226] [SWS_Crypto_00228] [SWS_Crypto_00229] [SWS_Crypto_00230] [SWS_Crypto_00231] [SWS_Crypto_00232] [SWS_Crypto_00233] [SWS_Crypto_00234] [SWS_Crypto_00235] [SWS_Crypto_00236] [SWS_Crypto_00237] [SWS_Crypto_00238] [SWS_Crypto_00239] [SWS_Crypto_00240] [SWS_Crypto_00241] [SWS_Crypto_00242] [SWS_Crypto_00243] [SWS_Crypto_00244] [SWS_Crypto_00245] [SWS_Crypto_00246] [SWS_Crypto_00247] [SWS_Crypto_00248] [SWS_Crypto_00249] [SWS_Crypto_00250] [SWS_Crypto_00251] [SWS_Crypto_00252] [SWS_Crypto_00254] [SWS_Crypto_00255] [SWS_Crypto_00256] [SWS_Crypto_00257] [SWS_Crypto_00258] [SWS_Crypto_00259] [SWS_Crypto_00260] [SWS_Crypto_00261] [SWS_Crypto_91000] [SWS_Crypto_91001] [SWS_Crypto_91003] [SWS_Crypto_91004] [SWS_Crypto_91006] [SWS_Crypto_91007] [SWS_Crypto_91008] [SWS_Crypto_91009] [SWS_Crypto_91010] [SWS_Crypto_91012] [SWS_Crypto_91013] [SWS_Crypto_91014] [SWS_Crypto_91015] [SWS_Crypto_91016] [SWS_Crypto_91017] [SWS_Crypto_91018] [SWS_Crypto_91019] [SWS_Crypto_91020] [SWS_Crypto_91023] [SWS_Crypto_91024] [SWS_Crypto_91025] [SWS_Crypto_91026] [SWS_Crypto_91027] [SWS_Crypto_91028]

A.4.2 Changed Specification Items in R23-11

none

A.4.3 Deleted Specification Items in R23-11

none

A.4.4 Added Constraints in R23-11

[SWS_Crypto_CONSTR_00001] [SWS_Crypto_CONSTR_00002] [SWS_Crypto_CONSTR_00003] [SWS_Crypto_CONSTR_00004]

A.4.5 Changed Constraints in R23-11

none

A.4.6 Deleted Constraints in R23-11

none