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△

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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	<p>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.</p> <p>There is only one workspace for each Crypto Driver Object (i.e. only one crypto primitive can be performed at the same time).</p> <p>The only exception of independency between Crypto Driver Object is the usage of a default Random Number Generator (see [SWS_Crypto_00225]).</p>						
Key	<p>A Key can be referenced by a job in the Csm.</p> <p>In the Crypto Driver, the key references a specific key type.</p>						
Key Type	<p>A key type consists of references to key elements.</p> <p>The key types are typically pre-configured by the vendor of the Crypto Driver.</p>						
Key Element	<p>Key elements are used to store data. This data can be e.g. key material or the IV needed for AES encryption.</p> <p>It can also be used to configure the behaviour of the key management functions.</p> <p>Key elements from different keys have different memory area (both NV and RAM area).</p>						
Channel	<p>A channel is the path from a Crypto Service Manager queue via the Crypto Interface to a specific Crypto Driver Object.</p>						
Job	<p>A 'Job' is a configured 'CsmJob'. Among others, it refers to a key, a cryptographic primitive and a reference channel.</p>						
Crypto Primitive	<p>'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, ...).</p>						
Operation	<p>An operation of a crypto primitive declares what part of the crypto primitive shall be performed. There are three different operation modes:</p>						
	<table border="1"> <tr> <td>START</td> <td>Operation mode indicates a new request of a crypto primitive, and it shall cancel all previous requests of the same job and primitive.</td> </tr> <tr> <td>UPDATE</td> <td>Operation mode indicates, that the crypto primitive expects input data.</td> </tr> <tr> <td>FINISH</td> <td>Operation mode indicates, that after this part all data are fed completely and the crypto primitive can finalize the calculations.</td> </tr> </table>	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.
	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.					
<p>It is also possible to perform more than one operation at once by concatenating the corresponding bits of the operation mode argument.</p>							
<p>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.</p>							
Service	<p>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.</p>						

**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\_SRS\_BSWGeneral
- [5] Requirements on Crypto Stack  
AUTOSAR\_CP\_SRS\_CryptoStack
- [6] 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]** [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]** [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.] ()

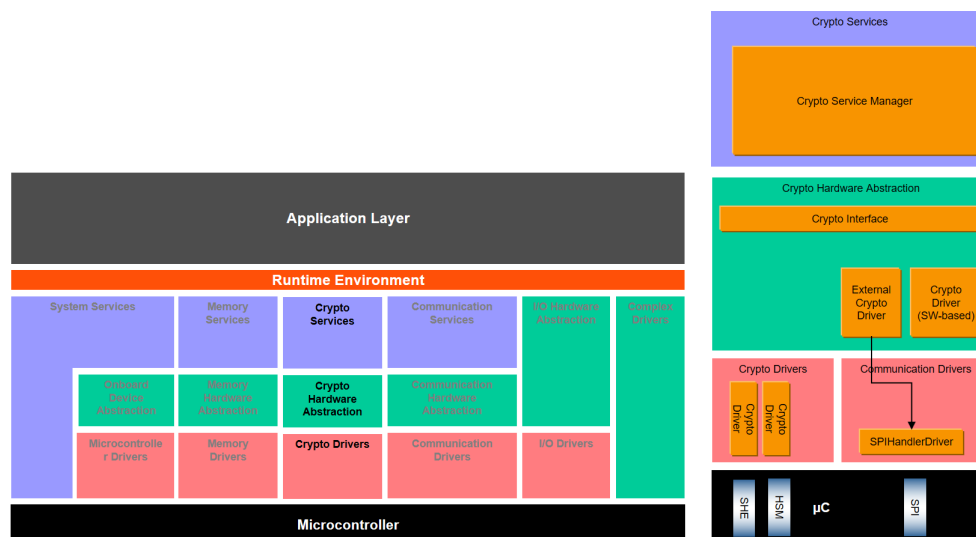
## 6 Requirements Tracing

The following tables reference the requirements specified in [4] and [5] 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_00407]	Each BSW module shall provide a function to read out the version information of a dedicated module implementation	[SWS_Crypto_91001]
[SRS_BSW_00414]	Init functions shall have a pointer to a configuration structure as single parameter	[SWS_Crypto_91000] [SWS_Crypto_91016]
[SRS_CryptoStack_ - 00008]	The Crypto Stack shall allow static configuration of keys used for cryptographic jobs	[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_00243] [SWS_Crypto_00244] [SWS_Crypto_00245] [SWS_Crypto_00246] [SWS_Crypto_00247] [SWS_Crypto_00251] [SWS_Crypto_00254]
[SRS_CryptoStack_ - 00061]	The Crypto Stack shall support detection of invalid keys	[SWS_Crypto_00242] [SWS_Crypto_00248] [SWS_Crypto_00249] [SWS_Crypto_00250] [SWS_Crypto_00251]
[SRS_CryptoStack_ - 00086]	The CSM module shall distinguish between error types	[SWS_Crypto_00040]
[SRS_CryptoStack_ - 00095]	The Crypto Driver module shall strictly separate error and status information	[SWS_Crypto_91018]
[SRS_CryptoStack_ - 00098]	The Crypto Driver shall provide access to all cryptographic algorithms supported by the hardware	[SWS_Crypto_00013]
[SRS_CryptoStack_ - 00117]	Keys shall not be used if they are empty or corrupted	[SWS_Crypto_00248] [SWS_Crypto_00249] [SWS_Crypto_00250] [SWS_Crypto_00251] [SWS_Crypto_91023] [SWS_Crypto_91024]
[SRS_CryptoStack_ - 00118]	Key material shall be securely stored either in NVM or CSM	[SWS_Crypto_00243] [SWS_Crypto_00246] [SWS_Crypto_91023] [SWS_Crypto_91024] [SWS_Crypto_91025] [SWS_Crypto_91026]
[SRS_CryptoStack_ - 00119]	Provide a proof that the key has been programmed correctly	[SWS_Crypto_91026]
[SRS_CryptoStack_ - 00120]	Cleanup all key material on shutdown operation	[SWS_Crypto_00243]
[SWS_BSW_00050]	Check parameters passed to <i>Initialization functions</i>	[SWS_Crypto_00215]

**Table 6.1: RequirementsTracing**

## 7 Functional specification



**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 is configured according to the underlying Crypto Driver Object.

A Crypto Driver Object represents an instance of independent crypto hardware "device" (e.g. AES accelerator). There could be a channel for fast AES and CMAC calculations on an HSM for jobs with high priority, which ends on a native AES calculation service in the Crypto Driver. But it is also possible, that a Crypto Driver Object is a piece of software, e.g. for RSA calculations where jobs are able to encrypt, decrypt, sign or verify data. The Crypto Driver Object is the endpoint of a crypto channel.

### 7.1 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.

### 7.1.1 CryptoPrimitive configuration

The Crypto Driver contains one or more crypto driver objects that each supports one or more crypto primitive service. Algorithm family and mode provides details on how to operate crypto primitive services. For example, the crypto primitive service "Encrypt" supports the Family "AES" and the mode "CBC". Further refinements are required by setting secondary family values.

The CryptoPrimitive configuration of a crypto driver object defines the possible options for a crypto primitive service. From the example above, the driver can support the modes CBC or ECB for an AES algorithm. This is sometimes referred as the "capabilities" of the driver for a specific crypto primitive service. Thus, a CryptoPrimitive may configure several family and mode values if it is applicable for a crypto service primitive.

The job configuration of the CSM contains a reference to a CsmPrimitive. The corresponding Config section of this CsmPrimitive also defines the families and mode, but with multiplicity of 1, to identify uniquely what combination of family and mode shall be used for a job. At least, the associated crypto driver object must contain a CryptoPrimitive that supports the configuration. This shall be ensured on configuration level and at least checked at runtime.

To support new features for a crypto service which aren't yet modelled in the specification (in the various enumerations of family and mode), custom specific algorithm families and modes can be configured in the crypto driver. The CryptoPrimitive references to these custom values to indicate what combination of crypto primitive service, (custom-)family and (custom-)mode are possible.

The CSM job configuration need to reference to these custom configuration items.

**[SWS\_Crypto\_00239]** [A crypto driver that supports algorithm families and algorithm modes beyond the pre-defined ones available in [ECUC\_Crypto\_00035], [ECUC\_Crypto\_00036] and/or [ECUC\_Crypto\_00037] shall define custom specific value algorithm families and algorithm modes through the containers CryptoPrimitiveAlgorithmFamilyCustom and CryptoPrimitiveAlgorithmModeCustom.] ()

**[SWS\_Crypto\_00240]** [The CryptoPrimitiveAlgorithmModeCustom/CryptoPrimitiveAlgorithmModeCustomId and CryptoPrimitiveAlgorithmFamilyCustom/ CryptoPrimitiveAlgorithmFamilyCustomId shall use the reserved range from 128..254.] ()

**[SWS\_Crypto\_00241]** [A CryptoPrimitive shall define one CryptoPrimitiveService and can define one or more items for CryptoPrimitiveAlgorithmFamily, CryptoPrimitiveAlgorithmMode, CryptoPrimitiveAlgorithmSecondaryFamily, CryptoPrimitiveAlgorithmFamilyCustomRef and CryptoPrimitiveAlgorithmModeCustomRef as long as all permutations of the multiple items can be supported. Otherwise, further CryptoPrimitive(s) for this CryptoPrimitiveService must be defined.] ()

Example:

A crypto primitive service ENCRYPT may support AES and 3DES with mode ECB and CBC in all permutations (AES-CBC, AES-ECB, 3DES-CBC and 3DES-ECB). But a crypto primitive service ENCRYPT, with support of family items for AES and RSA and mode CBC are not valid, because RSA-CBC is not reasonably supported. In this case, a new CryptoPrimitive for RSA shall be defined.

### 7.1.2 Cryptographic capabilities

The capabilities of a Crypto Driver can be divided in the two main topics: key storage and supported algorithms. The supported algorithms can be pre-configured by creating a new CryptoPrimitive container (e.g. MacGenerate). In this container the vendor can now specify that the Crypto Driver is for example only capable of doing a CMAC. In this case, an example configuration would be:

```
CryptoPrimitiveAlgorithmFamily = CRYPTO_ALGOFAM_AES
```

```
CryptoPrimitiveAlgorithmMode = CRYPTO_ALGOMODE_CMAC
```

```
CryptoPrimitiveAlgorithmSecondaryFamily = CRYPTO_ALGOMODE_NOT_SET
```

```
CryptoPrimitiveService = MacGenerate
```

The primitive MacGenerate can then be referenced by the Crypto Driver Object to show, that it is capable of doing a CMAC. If no other primitives are pre-configured, the Crypto Driver Object is not able to perform e.g. an AES encryption.

If all primitives are independent from each other, a vendor would pre-configure one Crypto Driver Object for each primitive. Otherwise, there would be one Crypto Driver Object, which would reference all primitives.

### 7.1.3 Available Keys

The keys, which are provided by the Crypto Driver can also be pre-configured. A CryptoKey container references a specific CryptoKeyType. The CryptoKeyType provides the information which key elements are contained in a CryptoKey referencing this CryptoKeyType.

The vendor also pre-configures the key elements to define:

- read/write access
- the maximum size of the element
- if the element can be read/written with data smaller than the maximum size
- the init value after startup if the element is not already initialized

The init value is the value, which is stored into the key element at the initialization of the crypto driver when the key element is empty. It is e.g. used for the key element with the



id CRYPTO\_KE\_<Service>\_ALGORITHM. This way, the key management functions can be configured. To provide e.g. different key exchange algorithms in one Crypto Driver, the vendor can pre-configure the following containers and set the init values of the CRYPTO\_KE\_<Service>\_ALGORITHM key element to a vendor specific value:

#### CryptoKeyElement\_KeyExchange\_Algorithm\_RSA

- ID = 11
- Init value = 0x00
- Size = 1
- Read Access = RA\_NONE
- Write Access = WA\_NONE

#### CryptoKeyElement\_KeyExchange\_Algorithm\_Ed25519

- ID = 11
- Init value = 0x01
- Size = 1
- Read Access = RA\_NONE
- Write Access = WA\_NONE

#### CryptoKeyType\_KeyExchange\_RSA

- CryptoKeyElement\_KeyExchange\_Algorithm\_RSA
- CryptoKeyElement\_KeyExchange\_PartnerPubKey
- CryptoKeyElement\_KeyExchange\_OwnPubKey
- CryptoKeyElement\_KeyExchange\_Base
- CryptoKeyElement\_KeyExchange\_PrivKey
- CryptoKeyElement\_KeyExchange\_SharedValue

#### CryptoKeyType\_KeyExchange\_Ed25519

- CryptoKeyElement\_KeyExchange\_Algorithm\_Ed25519
- CryptoKeyElement\_KeyExchange\_PartnerPubKey
- CryptoKeyElement\_KeyExchange\_OwnPubKey
- CryptoKeyElement\_KeyExchange\_Base
- CryptoKeyElement\_KeyExchange\_PrivKey
- CryptoKeyElement\_KeyExchange\_SharedValue

When a key exchange should be performed with a CryptoKey of type CryptoKeyType\_KeyExchange\_Ed25519, the Crypto Driver knows with the value stored in the key element CRYPTO\_KE\_KEYEXCHANGE\_ALGORITHM that Ed25519 shall be used as underlying cryptographic primitive.

If a key should be used in more than one primitive e.g. KeyExchange and AES-Encrypt-CBC, the CryptoKeyType could be extended by needed elements:

CryptoKeyType\_KeyExchange\_Cipher\_combined

- CryptoKeyElement\_KeyExchange\_Algorithm\_Ed25519
- CryptoKeyElement\_KeyExchange\_PartnerPubKey
- CryptoKeyElement\_KeyExchange\_OwnPubKey
- CryptoKeyElement\_KeyExchange\_Base
- CryptoKeyElement\_KeyExchange\_PrivKey
- CryptoKeyElement\_KeyExchange\_SharedValue
  - ID = 1
- CryptoKeyElement\_Cipher\_IV

Note that CryptoKeyElement\_KeyExchange\_SharedValue has the id set to 1. When calling the encrypt service with a key of CryptoKeyType\_CryptoKeyType\_KeyExchange\_Cipher\_combined, the shared value of the key exchange is automatically used as encryption key.

## 7.2 General Behavior

The Crypto Driver can have one or more Crypto Driver Objects.

**[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\_00013]** [The Crypto Driver may support all crypto primitives that are supported by the underlying hardware object.]([SRS\\_CryptoStack\\_00098](#))

A job, declared in CSM specification [2], is an instance of a configured cryptographic primitive.

**[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 7.2.3.1), do not count as in processing.

**[SWS\_Crypto\_00224]** [If a Crypto Driver requires Random Number Generator services for internal use (e.g. [Crypto\\_KeyExchangeCalcPubVal](#)), it shall configure the first Crypto Driver Object (object number 0) for this purpose. The configuration is done in [\[ECUC\\_Crypto\\_00044\]](#) and [\[ECUC\\_Crypto\\_00045\]](#).] ()

It is also possible to configure and use other Crypto Driver Objects with its own default Random Number Generator.

**[SWS\_Crypto\_00225]** [If a Crypto Driver Object has no default Random Number Generator but requires Random Number values, it shall use Crypto Driver Object 0 to request the Random Numbers.] ()

It should be noted, that this can lead to a conflict that must be arbitrated within the crypto driver and its objects. Especially, additional delays for a crypto service operation can be expected due to the generation of random number values.

**[SWS\_Crypto\_00226]** [A Crypto Driver Object shall only call a default random number generator of its own Crypto Driver.] ()

### 7.2.1 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.

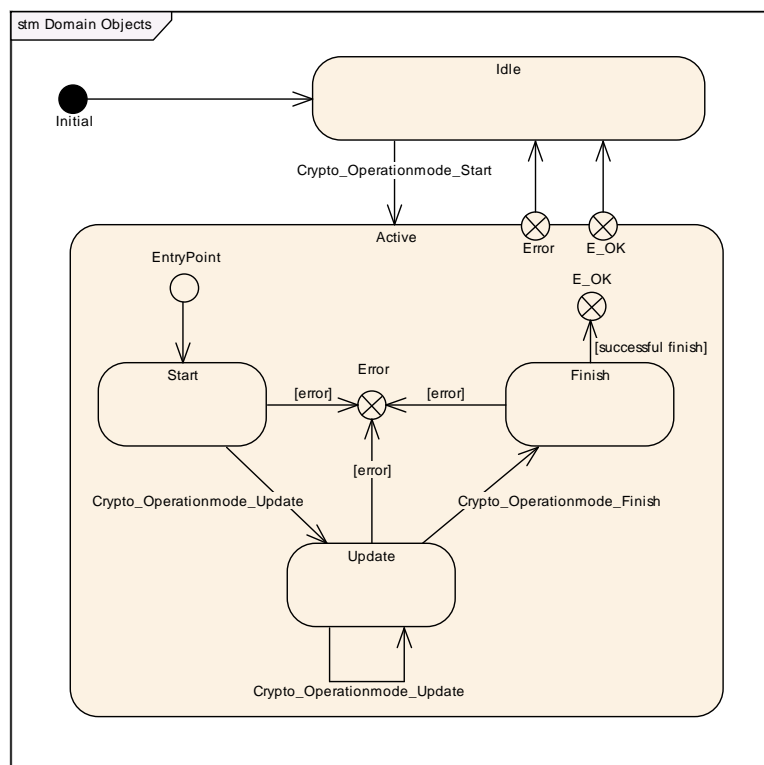
If the "UPDATE" flag is set, the crypto primitive expects input data. "FINISH" indicates, that after this function call, all data are fed completely and the crypto primitive can finalize the calculations.

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\_00020] [If [Crypto\\_ProcessJob](#) is called while in "Idle" or "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.]()

**[SWS\_Crypto\_00119]** [If an internal error occurs while processing an asynchronous job, the corresponding job state shall be set to "Idle" and all input data and intermediate results shall be discarded. Further, the callback notification shall be called with an appropriate error code.]()

## 7.2.2 Functional Requirements

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

### 7.2.2.1 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.]()

**[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.

### 7.2.2.2 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 by calling the CRYIF\_CallbackNotification function passing on the job information and the result of cryptographic operation.]()

### 7.2.3 Design Notes

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

#### 7.2.3.1 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\_00031]** [If [Crypto\\_ProcessJob](#) is called, 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\_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, bypass it from queueing.]()

This implicates 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.

**[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.]()

## 7.2.4 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 `CryptoPrimitiveService ENCRYPT/DECRYPT` or `AEAD_ENCRYPT/AEAD_DECRYPT`, the access rights must be set to `RA_ENCRYPTED` or lower.<sup>1</sup>

- If a key element is used for output re-direction, the key element must have access rights `CRYPTO_WA_INTERNAL_COPY` or lower.
- 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.<sup>2</sup>

]()

**[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].]()

<sup>1</sup>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.

<sup>2</sup>This is to avoid to deduce the source key when using weak key derivation algorithms.



**[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 constraints. 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.

Storing keys permanently is done by calling `Crypto_KeySetValid` with the configuration parameter `CryptoKeyElementPersist` set. 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.

### 7.2.5 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).] ([SRS\\_CryptoStack\\_00008](#))

**[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.]([SRS\\_CryptoStack\\_00008](#))

### 7.2.5.1 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.

]([SRS\\_CryptoStack\\_00008](#))

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.

]([SRS\\_CryptoStack\\_00008](#))

**[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.]([SRS\\_CryptoStack\\_00008](#))

**[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 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.]([SRS\\_CryptoStack\\_00008](#))

### 7.2.5.2 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\_OCTET. The length of data depends on the assigned curve operation.]([SRS\\_CryptoStack\\_00008](#))

**[SWS\_Crypto\_00190]** [Public keys for NIST and Brainpool ECC curves are provided with their X and Y coordinates:

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)] ([SRS\\_CryptoStack\\_00008](#))

**[SWS\_Crypto\_00191]** [Private keys for NIST and Brainpool ECC curves are provided with their X and Y coordinates and an additional scalar:

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)] ([SRS\\_CryptoStack\\_00008](#))

**[SWS\_Crypto\_00192]** [The public key information for ED25519 contains a point on the curve:

ED25519 Public Key = Point X

The point is stored in little endian format.

Example:

ED25519 Public Key = X(32).] ([SRS\\_CryptoStack\\_00008](#))

**[SWS\_Crypto\_00193]** [The private key information for ED25519 contains a random constant and the point X on the curve:

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).] ([SRS\\_CryptoStack\\_00008](#))

### 7.2.5.3 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 CRYPTO\_KE\_FORMAT\_BIN\_SHEKEY. This indicates that the key element shall be presented in M1M2M3 format as specified in [6]. 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. |()

### 7.2.6 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.

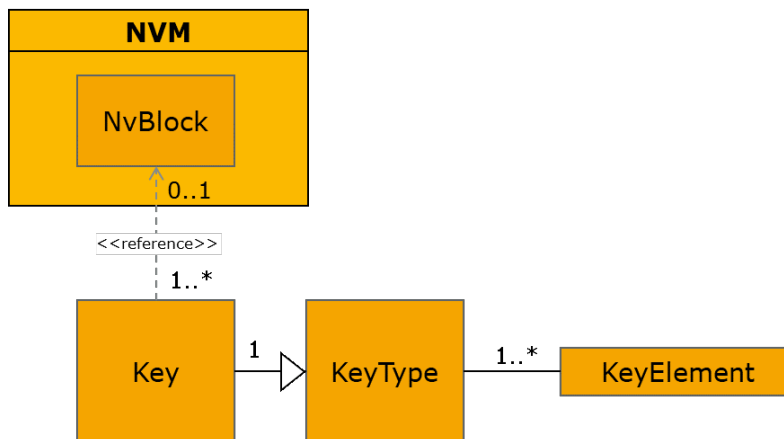


Figure 7.2: NvBlock configuration for key persistence

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.

#### 7.2.6.1 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).]([SRS\\_CryptoStack\\_00061](#))

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]** [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.]([SRS\\_CryptoStack\\_00008](#), [SRS\\_CryptoStack\\_00118](#), [SRS\\_CryptoStack\\_00120](#))

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]** [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`.]([SRS\\_CryptoStack\\_00008](#))

**[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_KeyGet-Status` interface.]([SRS\\_CryptoStack\\_00008](#))

**[SWS\_Crypto\_00246]** [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.](SRS\_CryptoStack\_00008, SRS\_CryptoStack\_00118)

### 7.2.6.2 Reading Keys from NVM

**[SWS\_Crypto\_00247]** [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.](SRS\_CryptoStack\_00008)

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.](SRS\_CryptoStack\_00061, SRS\_CryptoStack\_00117)

**[SWS\_Crypto\_00249]** [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.](SRS\_CryptoStack\_00061, SRS\_CryptoStack\_00117)

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).](SRS\_CryptoStack\_00061, SRS\_CryptoStack\_00117)

**[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.](SRS\_CryptoStack\_00008, SRS\_CryptoStack\_00061, SRS\_CryptoStack\_00117)

## 7.2.7 Crypto Profiles

### 7.2.7.1 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
```

\*\*\*\* `dispatchId` shall be set according to the rule:

```
uint32 dispatchId = (uint32)(
    ((ServiceInfoType << 24) & 0xFF000000) ||
    ((CryptoPrimitiveAlgorithmFamilyCustomId << 16) & 0x00FF0000) ||
    ((Crypto_AlgorithmModeType << 8) & 0x0000FF00) ||
    ((ServiceId << 0) & 0x000000FF))
```

]()

### 7.2.7.2 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 Crypto\_AlgorithmFamilyType is defined as CRYPTO\_ALGOFAM\_KEYM with value 0x80 and need to be configured via [[ECUC\\_Crypto\\_00047](#)] CryptoPrimitiveAlgorithmFamilyCustomId.

The Crypto\_AlgorithmModeType is defined as CRYPTO\_ALGOMODE\_NOT\_SET with value 0x00.

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 uint8\* 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\\_CustomSync](#) to the using KeyM service/function.] ()

Mapping table for Csm\_CustomService:

service Id	0x13	0x0C	0x0D	0x0E
processing type	async	async	async	async
Return type	Std_ReturnType	Std_ReturnType	Std_ReturnType	Std_ReturnType
Csm_CustomService	KeyM_ServiceCertificateByCertId	KeyM_VerifyCertificates	KeyM_VerifyCertificate	KeyM_VerifyCertificateChain
uint32 JobId	JobId of the referenced custom CSM job from the given certificate configuration			
Crypto_OperationModeType mode	empty*	empty*	empty*	empty*
uint32 targetKeyId	uint8 SvclId**	uint8 SvclId**	uint8 SvclId**	uint8 SvclId**
const uint8* inputPtr	uint8 Service***	uint16 CertUpperId	empty*	uint8 NumberOfCertificates
uint32 inputLength	1	2	0	1
const uint8 * secondaryInputPtr	const uint8 * RequestData	empty*	empty*	KeyM_CertDataType[] certChainData
uint32 secondaryInputLength	uint32 RequestDataLength	empty*	empty*	NumberOfCertificates * sizeof (KeyM_CertDataType)
const uint8* tertiaryInputPtr	empty*	empty*	empty*	empty*





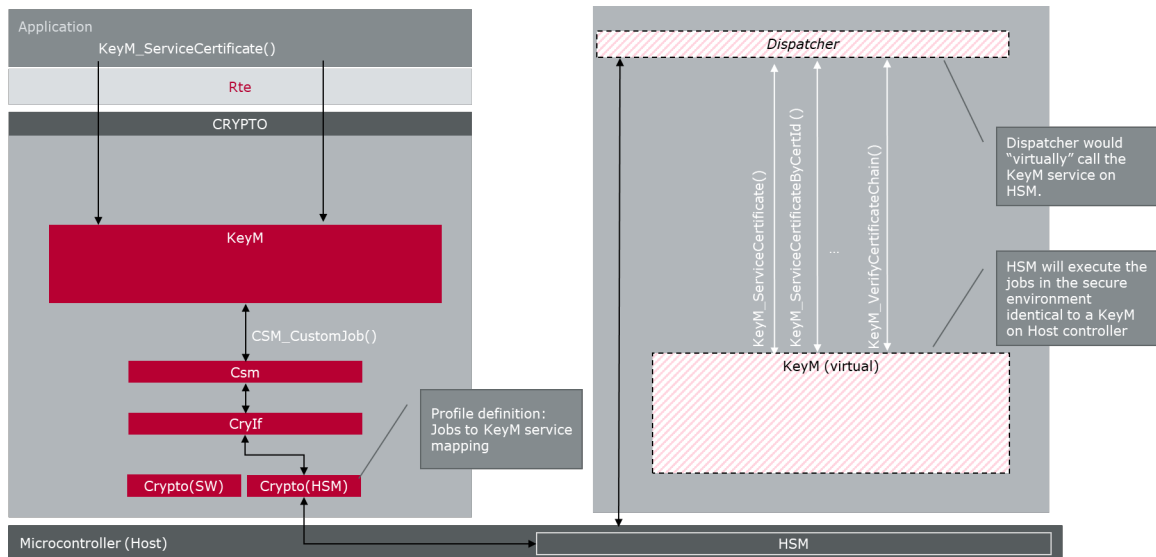
uint32 tertiaryInputLength	empty*	empty*	empty*	empty*
uint8* outputPtr	uint8 ResponseData	empty*	empty*	empty*
uint32* outputLengthPtr	uint32 ResponseDataLength	empty*	empty*	empty*
uint8* secondaryOutputPtr	<specific return value for that custom service>			
uint32* secondary-OutputLengthPtr	< sizeof(Std_ReturnType)>			
Crypto_VerifyResultType* verifyPtr	empty*			

\* "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

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**

Mapping table for Csm\_CustomSync:

service Id	0x0F	0x12	0x1B	0x1C	0x0A	0x0B
processing type	sync					
Return type	Std_ReturnType					





Csm_ CustomSync	KeyM_ CertElement- Get	KeyM_ CertGetStatus	KeyM_ Certifi- cateElement- GetByIndex	KeyM_ CertificateEle- mentGetCount	KeyM_ SetCertificate	KeyM_ GetCertificate
uint32 dispatchId****	0x1580000F	0x15800012	0x1580001B	0x1580001C	0x1580000A	0x1580000B
uint32 keyId	keyId of the referenced key used in the custom CSM job from the given certificate configuration					
uint32 keyElementId	mapped keyId from CertElementId	empty*	mapped keyId from CertElementId	mapped keyId from CertElementId	empty*	empty*
uint32 targetKeyId	empty*	empty*	uint32 index	empty*	empty*	empty*
uint32 targetKeyElementId	empty*	empty*	empty*	empty*	empty*	empty*
const uint8* inputPtr	empty*	empty*	empty*	empty*		KeyM_ CertDataType* CertificateDataPtr
uint32 inputLength	empty*	empty*	empty*	empty*	empty*	empty*
uint8* outputPtr	uint8* CertElementData	KeyM_ CertificateStatusType* Status	uint8* CertElementDataPtr	uint16* CountPtr	empty*	empty*
uint32* outputLengthPtr	uint32* CertElementDataLength	sizeof (KeyM_ CertificateStatusType)	uint32* CertElementDataLengthPtr	empty*	empty*	empty*
uint8* secondaryOutputPtr	Std_ReturnType					
uint32* secondaryOutputLengthPtr	sizeof(Std_ReturnType)					

\*\*\*\* dispatchId: see [[SWS\\_Crypto\\_00259](#)]

[[SWS\\_Crypto\\_00261](#)] [

Crypto Service	key element Name	key element ID	Mandatory
Certificate Parsing			
Certificate	CRYPTO_KE_CERTIFICATE_DATA	0	x
Format	CRYPTO_KE_CERTIFICATE_PARSING_FORMAT	18	
Version	CRYPTO_KE_CERTIFICATE_VERSION	20	
Serial Number	CRYPTO_KE_CERTIFICATE_SERIALNUMBER	21	
Signature Algorithm	CRYPTO_KE_CERTIFICATE_SIGNATURE_ALGORITHM	22	
Issuer	CRYPTO_KE_CERTIFICATE_ISSUER	23	
Validity start	CRYPTO_KE_CERTIFICATE_VALIDITY_NOT_BEFORE	24	
Validity end	CRYPTO_KE_CERTIFICATE_VALIDITY_NOT_AFTER	25	
Subject	CRYPTO_KE_CERTIFICATE_SUBJECT	26	
Subject Public Key	CRYPTO_KE_CERTIFICATE_SUBJECT_PUBLIC_KEY	1	



△

Extensions	CRYPTO_KE_CERTIFICATE_EXTENSIONS	27	
Signature	CRYPTO_KE_CERTIFICATE_SIGNATURE	28	

Certificate element names and Ids

]()

### 7.3 Error Classification

Section "Error Handling" of the document [3] "General Specification of Basic Software Modules" 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.

#### 7.3.1 Development Errors

[SWS\_Crypto\_00040] Definiton 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

] ([SRS\\_CryptoStack\\_00086](#))

#### 7.3.2 Runtime Errors

[SWS\_Crypto\_00194] Definiton 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

]()

### 7.3.3 Transient Faults

There are no transient faults.

### 7.3.4 Production Errors

There are no production errors.

### 7.3.5 Extended Production Errors

There are no extended production errors.

## 7.4 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 [\[SWS\\_Crypto\\_00065\]](#), [\[SWS\\_Crypto\\_00252\]](#)).

## 7.5 Security Events

The module does not report security events.

## 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** [

<i>Module</i>	<i>Header File</i>	<i>Imported Type</i>
Csm	Crypto_GeneralTypes.h	Crypto_AlgorithmFamilyType
	Crypto_GeneralTypes.h	Crypto_AlgorithmInfoType
	Crypto_GeneralTypes.h	Crypto_AlgorithmModeType
	Crypto_GeneralTypes.h	Crypto_JobPrimitiveInfoType
	Crypto_GeneralTypes.h	Crypto_JobPrimitiveInputOutputType
	Crypto_GeneralTypes.h	Crypto_JobRedirectionInfoType
	Crypto_GeneralTypes.h	Crypto_JobStateType
	Crypto_GeneralTypes.h	Crypto_JobType
	Crypto_GeneralTypes.h	Crypto_PrimitiveInfoType
	Crypto_GeneralTypes.h	Crypto_ProcessingType
	Crypto_GeneralTypes.h	Crypto_ServiceInfoType
	Rte_Csm_Type.h	Crypto_KeyStatusType
	Rte_Csm_Type.h	Crypto_OperationModeType
	Rte_Csm_Type.h	Crypto_VerifyResultType
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
	Std_Types.h	Std_VersionInfoType

]()



## 8.2 Type definitions

### 8.2.1 Extension to Std\_ReturnType

#### [SWS\_Crypto\_91018] Definition of Std\_ReturnType-extension for module Crypto

<b>Range</b>	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
	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.
<b>Description</b>	–		
<b>Available via</b>	Crypto_GeneralTypes.h		

|(SRS\_CryptoStack\_00095) 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 [

<b>Name</b>	Crypto_ConfigType	
<b>Kind</b>	Structure	
<b>Elements</b>	implementation specific	
	<b>Type</b>	–
	<b>Comment</b>	The content of the configuration data structure is implementation specific.
<b>Description</b>	Configuration data structure of Crylf module	
<b>Available via</b>	Crypto.h	

]([SRS\\_BSW\\_00414](#))

## 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 [

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

]([SRS\\_BSW\\_00101](#), [SRS\\_BSW\\_00358](#), [SRS\\_BSW\\_00414](#))

[SWS\_Crypto\_00215] [The Configuration pointer configPtr shall always have a null pointer value.] ([SWS\\_BSW\\_00050](#))

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

**[SWS\_Crypto\_00198]** [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]** [If the initialization of the Crypto Driver fails, the Crypto shall report CRYPTO\_E\_INIT\_FAILED to the DET.]()

### 8.3.1.2 Crypto\_GetVersionInfo

**[SWS\_Crypto\_91001]** Definition of API function **Crypto\_GetVersionInfo** [

<b>Service Name</b>	Crypto_GetVersionInfo	
<b>Syntax</b>	<pre>void Crypto_GetVersionInfo (     Std_VersionInfoType* versioninfo )</pre>	
<b>Service ID [hex]</b>	0x01	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant	
<b>Parameters (in)</b>	versioninfo	Pointer to where to store the version information of this module.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	void	-
<b>Description</b>	Returns the version information of this module.	
<b>Available via</b>	Crypto.h	

] ([SRS\\_BSW\\_00407](#))

**[SWS\_Crypto\_00047]** [If the parameter versioninfo is a null pointer and if development error detection for the Crypto Driver is enabled, the function [Crypto\\_GetVersionInfo](#) shall report CRYPTO\_E\_PARAM\_POINTER to the DET.]()

## 8.3.2 Job Processing Interface

### 8.3.2.1 Crypto\_ProcessJob

**[SWS\_Crypto\_91003]** Definition of API function **Crypto\_ProcessJob** [

<b>Service Name</b>	Crypto_ProcessJob	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_ProcessJob (     uint32 objectId,     Crypto_JobType* job )</pre>	





<b>Service ID [hex]</b>	0x03	
<b>Sync/Async</b>	Depends on configuration	
<b>Reentrancy</b>	Reentrant	
<b>Parameters (in)</b>	objectId	Holds the identifier of the Crypto Driver Object.
<b>Parameters (inout)</b>	job	Pointer to the configuration of the job. Contains structures with job and primitive relevant information but also pointer to result buffers.
<b>Parameters (out)</b>	None	
<b>Return value</b>	Std_ReturnType	E_OK: Request successful E_NOT_OK: Request failed CRYPTO_E_BUSY: Request failed, Crypto 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
<b>Description</b>	Performs the crypto primitive, that is configured in the job parameter.	
<b>Available via</b>	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]** [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]** [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]** [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]** [If the parameter job->jobPrimitiveInfo->primitiveInfo->service is not supported by the Crypto Driver Object 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\_00202]** [If the parameter `job->jobPrimitiveInfo->primitiveInfo->service` is set to `CRYPTO_KEYDERIVE`, the parameter `job->targetCryptoKeyId` must be in range; else the function `Crypto_ProcessJob` shall report `CRYPTO_E_PARAM_HANDLE` to DET and return `E_NOT_OK`.]()

**[SWS\_Crypto\_00065]** [If `job->jobPrimitiveInfo->primitiveInfo->service` is set to `CRYPTO_HASH` or `CRYPTO_MACGENERATE`, and the parameter `job->jobPrimitiveInputOutput->outputLengthPtr` is smaller than the result length of the chosen algorithm, the most significant bits of the result shall be placed to the available buffer referenced by `job->jobPrimitiveInputOutput->outputPtr` as a truncated output.]()

**[SWS\_Crypto\_00252]** [If `job->jobPrimitiveInfo->primitiveInfo->service` is set to `CRYPTO_RANDOMGENERATE` and the parameter `job->jobPrimitiveInputOutput->outputLengthPtr` is smaller than the result length of the chosen algorithm, arbitrary bits of the result of the algorithm shall be placed to the available buffer referenced by `job->jobPrimitiveInputOutput->outputPtr` as a truncated output.]()

**[SWS\_Crypto\_00067]** [If the parameter `job->jobPrimitiveInfo->primitiveInfo->algorithm` (with its variation in family, `keyLength` and mode) is not supported by the Crypto Driver Object 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`.]()

Depending of the crypto service configured in `job->jobPrimitiveInfo->primitiveInfo->service`, different parameters of `job->jobPrimitiveInput` 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\_00070]** [If a pointer to a buffer is required as an argument, but it is a null pointer, the `Crypto_ProcessJob` function shall report `CRYPTO_E_PARAM_POINTER` to the DET if development error detection for the Crypto Driver is enabled, and return `E_NOT_OK`.]()

**[SWS\_Crypto\_00142]** [If a length information is required for processing a service request, either as variable or pointer, but the indicated length value is zero, and if development error detection for the Crypto Driver is enabled, the `Crypto_ProcessJob` function report `CRYPTO_E_PARAM_VALUE` to the DET and return `E_NOT_OK`.]()

**[SWS\_Crypto\_00228]** [If `job->jobPrimitiveInputOutput->mode` 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 `job->jobPrimitiveInputOutput->mode` is set to `CRYPTO_OPERATIONMODE_SAVE_CONTEXT` the crypto driver is called, then first the length of `job->outputPtr` provided with `job->outputLengthPtr` shall be checked if all context relevant data can be stored. If not, the function shall return `E_NOT_OK`.]()

**[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->outputPtr` (so-called snapshot of context data). The length of the provided data shall be written to the memory where `job->outputLengthPtr` 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 `job->jobPrimitiveInputOutput->mode` is set to `CRYPTO_OPERATIONMODE_RESTORE_CONTEXT` when the crypto driver is called, then first `job->inputLength` shall be checked if the length of the provided context data is large enough for the currently active primitive. If not, the function shall return `E_NOT_OK` and shall leave the current state untouched. If enough data are provided, the data from `job->inputPtr` shall be extracted and copied to the right place in the current workspace. If the workspace has been successfully restored the function shall return `E_OK`.]()

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] [

Member \ Service*	inputPtr / **redirected input	inputLength	secondaryInputPtr / **redirected input	secondaryInputLength	tertiaryInputPtr / **redirected input	tertiaryInputLength	outputPtr / ***redirected output	outputLengthPtr	secondaryOutputPtr / ***redirected output	secondaryOutputLengthPtr	verifyPtr	mode
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
AADENCRYPT	VGC	VGC	VG	VG			UFC	UFC	F	F		SUFC
AADDECRYPT	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
RANDOMGENERATE							FC	FC				
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\_00072] [All crypto services listed in Crypto\_ServiceInfoType except of CRYPTO\_HASH, and CRYPTO\_RANDOMGENERATE require a key represented as a key identifier.]()

[SWS\_Crypto\_00073] [

Parameter \ Service*	Input**	Secondary Input**	Tertiary Input**	Output**	Secondary Output***	Crylf KeyId	Target Crylf KeyId
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

In this table the content of the different input and output buffers of job.jobPrimitiveInputOutputType are 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

]()



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 the crypto primitive requires input data, its memory location is referred by the pointer `job->jobPrimitiveInput.inputPtr`.

On calling `Crypto_ProcessJob`, the length of this data is stored in `job->jobPrimitiveInput.inputLength`.

This applies analogously to `job->jobPrimitiveInput.secondaryInputPtr` and `job->jobPrimitiveInput.secondaryInputLength` respectively `job->jobPrimitiveInput.tertiaryInputPtr` and

`job->jobPrimitiveInput.tertiaryInputLength`, if they shall be used for the chosen crypto primitive.

If the input is redirected to a key element, the input buffer of the respective key element has to be used.]()

**[SWS\_Crypto\_00203]** [If `job->jobRedirectionInfoRef` is not a NULLPTR and the configuration bit for the `inputRedirection`, `secondaryInputRedirection` and/or `tertiaryInputRedirection` is set within `job->jobRedirectionInfoRef->redirectionConfig`, then the corresponding key element buffer located by `job->jobRedirectionInfoRef->inputKeyId+job->jobRedirectionInfoRef->inputKeyElementId`, `job->jobRedirectionInfoRef->secondaryInputKeyId+job->jobRedirectionInfoRef->secondaryInputKeyElementId`, and/or `jobRedirectionInfoRef->tertiaryInputKeyId+job->jobRedirectionInfoRef->tertiaryInputKeyElementId` and its length shall be used.

Any data provided by the input parameter of the function interface shall be ignored.]()

**[SWS\_Crypto\_00135]** [If the crypto primitive requires a buffer for the result, its memory location is referred by the pointer `job->jobPrimitiveInput.outputPtr`. On calling this function, `job->jobPrimitiveInput.outputLengthPtr` shall contain the size of the associated buffer. When the request has finished, the actual length of the returned value shall be stored.

This applies analogously to `job->jobPrimitiveInput.secondaryOutputPtr` and `job->jobPrimitiveInput.secondaryOutputLengthPtr`, if they shall be used for the chosen crypto primitive.

If the output is redirected to a key element, the output buffer of the respective key element has to be used instead.]()

**[SWS\_Crypto\_00204]** [If `job->jobRedirectionInfoRef` is not a NULLPTR and the configuration bit for the `outputRedirection` and/or `secondaryoutputRedirection` is set within `job->jobRedirectionInfoRef->redirectionConfig`, then the corresponding key element buffer located by `job->jobRedirectionInfoRef->outputKeyId + job->jobRedirectionInfoRef->outputKeyElementId` and/or `job->jobRedirectionInfoRef->secondaryOutputKeyId + job->jobRedirectionInfoRef->secondaryOutputKeyElementId` shall be used as output. The length of the respective key element shall be set according to the length of the output.]()

**[SWS\_Crypto\_00141]** [If the random generator service is chosen and the corresponding entropy, the function shall return `CRYPTO_E_ENTROPY_EXHAUSTED`. The function `Crypto_ProcessJob` shall additionally report the runtime error `CRYPTO_E_RE_ENTROPY_EXHAUSTED`.]()

### 8.3.3 Job Cancellation Interface

#### 8.3.3.1 Crypto\_CancelJob

**[SWS\_Crypto\_00122]** Definition of API function `Crypto_CancelJob` [

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

]()

**[SWS\_Crypto\_00123]** [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]** [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 of range.]()

**[SWS\_Crypto\_00125]** [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]** [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]** [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 and cancel the job in the hardware. If the cancellation is successful `E_OK` shall be returned, 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]** [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`.]()

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)

**[SWS\_Crypto\_00145]** [If the underlying crypto hardware does not allow execution of key management functions at the same time as processing a job, the key management functions shall wait while the current job is executed and start the processing of the key management function afterwards.]()

Note:

It has to be ensured, that the jobs are processed fast enough to avoid that the key management function has to wait for a long time.

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** [

<b>Service Name</b>	Crypto_KeyElementSet	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_KeyElementSet (     uint32 cryptoKeyId,     uint32 keyElementId,     const uint8* keyPtr,     uint32 keyLength )</pre>	
<b>Service ID [hex]</b>	0x04	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Non Reentrant	
<b>Parameters (in)</b>	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.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	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
<b>Description</b>	Sets the given key element bytes to the key identified by cryptoKeyId.	
<b>Available via</b>	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]** [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]** [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]** [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]** [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]** [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]** [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` [

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

]()

**[SWS\_Crypto\_00196]** [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]** [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` [

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

]()

[SWS\_Crypto\_00236] [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] [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] [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 [**

<b>Service Name</b>	Crypto_KeyElementGet	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_KeyElementGet (     uint32 cryptoKeyId,     uint32 keyElementId,     uint8* resultPtr,     uint32* resultLengthPtr )</pre>	
<b>Service ID [hex]</b>	0x06	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant	
<b>Parameters (in)</b>	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.
<b>Parameters (inout)</b>	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.
<b>Parameters (out)</b>	resultPtr	Holds the pointer of the buffer for the returned key element
<b>Return value</b>	Std_ReturnType	<p>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</p>
<b>Description</b>	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).	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00085]** [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]** [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]** [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]** [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]** [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]** [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]** [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` [

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

]()

**[SWS\_Crypto\_00232]** [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]** [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]** [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]** [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` [

<b>Service Name</b>	Crypto_KeyElementCopy	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_KeyElementCopy (     uint32 cryptoKeyId,     uint32 keyElementId,     uint32 targetCryptoKeyId,     uint32 targetKeyElementId )</pre>	
<b>Service ID [hex]</b>	0x0f	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same <code>cryptoKeyId</code>	
<b>Parameters (in)</b>	<code>cryptoKeyId</code>	Holds the identifier of the key whose key element shall be the source element.
	<code>keyElementId</code>	Holds the identifier of the key element which shall be the source for the copy operation.
	<code>targetCryptoKeyId</code>	Holds the identifier of the key whose key element shall be the destination element.
	<code>targetKeyElementId</code>	Holds the identifier of the key element which shall be the destination for the copy operation.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	





<b>Return value</b>	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
<b>Description</b>	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)	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00149]** [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]** [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]** [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]** [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]** [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]** [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

<b>Service Name</b>	Crypto_KeyElementCopyPartial	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_KeyElementCopyPartial (     uint32 cryptoKeyId,     uint32 keyElementId,     uint32 keyElementSourceOffset,     uint32 keyElementTargetOffset,     uint32 keyElementCopyLength,     uint32 targetCryptoKeyId,     uint32 targetKeyElementId )</pre>	
<b>Service ID [hex]</b>	0x13	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same cryptoKeyId	
<b>Parameters (in)</b>	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.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	Std_ReturnType	<p>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</p>
<b>Description</b>	<p>Copies a key element to another key element in the same crypto driver. The keyElementSourceOffset 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.</p> <p>Note: If the actual key element is directly mapped to flash memory, there could be a bigger delay when calling this function (synchronous operation).</p>	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00205]** [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]** [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]** [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]** [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]** [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]** [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]** [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` [

<b>Service Name</b>	Crypto_KeyCopy
<b>Syntax</b>	Std_ReturnType Crypto_KeyCopy ( uint32 cryptoKeyId, uint32 targetCryptoKeyId )
<b>Service ID [hex]</b>	0x10





<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same cryptoKeyld	
<b>Parameters (in)</b>	cryptoKeyld	Holds the identifier of the key whose key element shall be the source element.
	targetCryptoKeyld	Holds the identifier of the key whose key element shall be the destination element.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	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
<b>Description</b>	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)	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00156]** [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]** [If cryptoKeyld 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]** [If targetCryptoKeyld 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]** [If no errors are detected by the Crypto Driver, the function shall copy all key elements in the key referenced by cryptoKeyld to the key the key referenced by targetCryptoKeyld.]()

### 8.3.4.4.4 Crypto\_KeyElementIdsGet

#### [SWS\_Crypto\_00160] Definition of API function Crypto\_KeyElementIdsGet [

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

]()

**[SWS\_Crypto\_00161]** [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]** [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 [

<b>Service Name</b>	Crypto_RandomSeed	
<b>Syntax</b>	<pre>Std_ReturnType Crypto_RandomSeed (     uint32 cryptoKeyId,     const uint8* seedPtr,     uint32 seedLength )</pre>	
<b>Service ID [hex]</b>	0x0d	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant, but not for the same cryptoKeyId	
<b>Parameters (in)</b>	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.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	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 crylId is "invalid".
<b>Description</b>	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	
<b>Available via</b>	Crypto.h	

]()

[SWS\_Crypto\_00128] [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] [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] [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] [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 [

<b>Service Name</b>	Crypto_KeyGenerate	
<b>Syntax</b>	Std_ReturnType Crypto_KeyGenerate ( uint32 cryptoKeyId )	
<b>Service ID [hex]</b>	0x07	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same cryptoKeyId	
<b>Parameters (in)</b>	cryptoKeyId	Holds the identifier of the key which is to be updated with the generated value.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	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 crylId is "invalid".
<b>Description</b>	Generates new key material store it in the key identified by cryptoKeyId.	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00094]** [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]** [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]** [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 [

<b>Service Name</b>	Crypto_KeyDerive	
<b>Syntax</b>	Std_ReturnType Crypto_KeyDerive ( uint32 cryptoKeyId, uint32 targetCryptoKeyId )	
<b>Service ID [hex]</b>	0x08	







<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same cryptoKeyld	
<b>Parameters (in)</b>	cryptoKeyld	Holds the identifier of the key which is used for key derivation.
	targetCryptoKeyld	Holds the identifier of the key which is used to store the derived key.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	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 crylIfKeyld is "invalid".
<b>Description</b>	Derives a new key by using the key elements in the given key identified by the cryptoKeyld. 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 targetCryptoKeyld. The number of iterations is given in the key element CRYPTO_KE_KEYDERIVATION_ITERATIONS.	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00097]** [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]** [If the parameter cryptoKeyld 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]** [If the parameter targetCryptoKeyld 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]** [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 cryptoKeyld.

### 8.3.4.7 Key Exchange Interface

#### 8.3.4.7.1 Crypto\_KeyExchangeCalcPubVal

#### [SWS\_Crypto\_91009] Definition of API function Crypto\_KeyExchangeCalcPubVal [

<b>Service Name</b>	Crypto_KeyExchangeCalcPubVal	
<b>Syntax</b>	Std_ReturnType Crypto_KeyExchangeCalcPubVal ( uint32 cryptoKeyId, uint8* publicValuePtr, uint32* publicValueLengthPtr )	
<b>Service ID [hex]</b>	0x09	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Reentrant but not for the same cryptoKeyId	
<b>Parameters (in)</b>	cryptoKeyId	Holds the identifier of the key which shall be used for the key exchange protocol.
<b>Parameters (inout)</b>	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 publicValuePtr. When the request has finished, the actual length of the returned value shall be stored.
<b>Parameters (out)</b>	publicValuePtr	Contains the pointer to the data where the public value shall be stored.
<b>Return value</b>	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".
<b>Description</b>	Calculates the public value for the key exchange and stores the public key in the memory location pointed by the public value pointer.	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00103]** [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]** [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]** [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]** [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]** [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]** [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]** [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**

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





<b>Description</b>	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.
<b>Available via</b>	Crypto.h

]()

**[SWS\_Crypto\_00111]** [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]** [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]** [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]** [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

**[SWS\_Crypto\_91027] Definition of API function Crypto\_CustomSync [**

<b>Service Name</b>	Crypto_CustomSync
<b>Syntax</b>	<pre>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 )</pre>
<b>Service ID [hex]</b>	0x1a
<b>Sync/Async</b>	Synchronous





<b>Reentrancy</b>	Non Reentrant	
<b>Parameters (in)</b>	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.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	outputPtr	Pointer to the output data.
	outputLengthPtr	Contains the output length in bytes.
	secondaryOutputPtr	Pointer to the secondary output data.
	secondaryOutputLengthPtr	Contains the secondary output length in bytes.
<b>Return value</b>	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
<b>Description</b>	Requests the execution of a function that is specified by the given dispatch id.	
<b>Available via</b>	Crypto.h	

]()

**[SWS\_Crypto\_00256]** [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]** [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`.]()

## 8.4 Callback notifications

### 8.4.1 Crypto\_NvBlock\_Init\_<NvBlock>

[SWS\_Crypto\_91023] Definition of callback function Crypto\_<vi>\_<ai>\_NvBlock\_Init\_<NvBlock> [

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

] ([SRS\\_CryptoStack\\_00117](#), [SRS\\_CryptoStack\\_00118](#))

### 8.4.2 Crypto\_NvBlock\_ReadFrom\_<NvBlock>

[SWS\_Crypto\_91024] Definition of callback function Crypto\_<vi>\_<ai>\_NvBlock\_ReadFrom\_<NvBlock> [

<b>Service Name</b>	Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock>	
<b>Syntax</b>	Std_ReturnType Crypto_<vi>_<ai>_NvBlock_ReadFrom_<NvBlock> ( const void* NvmBuffer )	
<b>Service ID [hex]</b>	0x17	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Non Reentrant	
<b>Parameters (in)</b>	NvmBuffer	The address of the buffer where the data can be read from.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	Std_ReturnType	E_OK: callback function has been processed successfully any other: callback function has been processed unsuccessfully





<b>Description</b>	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} / NvmReadRamBlockFromNvCallback
<b>Available via</b>	Crypto_cfg.h

]([SRS\\_CryptoStack\\_00117](#), [SRS\\_CryptoStack\\_00118](#))

### 8.4.3 Crypto\_NvBlock\_WriteTo\_<NvBlock>

[SWS\_Crypto\_91025] Definition of callback function Crypto\_<vi>\_<ai>\_NvBlock\_WriteTo\_<NvBlock> [

<b>Service Name</b>	Crypto_<vi>_<ai>_NvBlock_WriteTo_<NvBlock>	
<b>Syntax</b>	Std_ReturnType Crypto_<vi>_<ai>_NvBlock_WriteTo_<NvBlock> ( void* NvmBuffer )	
<b>Service ID [hex]</b>	0x18	
<b>Sync/Async</b>	Synchronous	
<b>Reentrancy</b>	Non Reentrant	
<b>Parameters (in)</b>	None	
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	NvmBuffer	The address of the buffer where the data shall be written to
<b>Return value</b>	Std_ReturnType	E_OK: callback function has been processed successfully other: callback function has been processed unsuccessfully
<b>Description</b>	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	
<b>Available via</b>	Crypto_cfg.h	

]([SRS\\_CryptoStack\\_00118](#))

### 8.4.4 Crypto\_NvBlock\_Callback\_<NvBlock>

[SWS\_Crypto\_91026] Definition of API function Crypto\_<vi>\_<ai>\_NvBlock\_Callback\_<NvBlock> [

<b>Service Name</b>	Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock>	
<b>Syntax</b>	Std_ReturnType Crypto_<vi>_<ai>_NvBlock_Callback_<NvBlock> ( Nvm_BlockRequestType BlockRequest, Nvm_RequestResultType JobResult )	
<b>Service ID [hex]</b>	0x19	
<b>Sync/Async</b>	Synchronous	





<b>Reentrancy</b>	Non Reentrant	
<b>Parameters (in)</b>	BlockRequest	The request type (read, write, ... etc.) of the previous processed block job
	JobResult	The request result of the previous processed block job.
<b>Parameters (inout)</b>	None	
<b>Parameters (out)</b>	None	
<b>Return value</b>	Std_ReturnType	E_OK: callback function has been processed successfully other: callback function has been processed unsuccessfully
<b>Description</b>	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}/NvmSingleBlockCallbackFnc	
<b>Available via</b>	Crypto_cfg.h	

](SRS\_CryptoStack\_00118, SRS\_CryptoStack\_00119)

## 8.5 Scheduled functions

### 8.5.1 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` [**

<b>Service Name</b>	Crypto_MainFunction
<b>Syntax</b>	<pre>void Crypto_MainFunction (     void )</pre>
<b>Service ID [hex]</b>	0x0c
<b>Description</b>	If asynchronous job processing is configured and there are job queues, the function is called cyclically to process queued jobs.
<b>Available via</b>	SchM_Crypto.h

]()

## 8.6 Expected interfaces

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

### 8.6.1 Interfaces to Standard Software Modules

**[SWS\_Crypto\_00126]** [The Crypto Driver shall use an AUTOSAR DET module for development error notification.]()



### 8.6.2 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 in module Crypto [

<i>API Function</i>	<i>Header File</i>	<i>Description</i>
There are no mandatory interfaces.		

]()

### 8.6.3 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 in module Crypto [

<i>API Function</i>	<i>Header File</i>	<i>Description</i>
Det_ReportError	Det.h	Service to report development errors.
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 the chapter 10.1 “Introduction to configuration specification” in [3].

### 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

<b>SWS Item</b>	[ECUC_Crypto_00001]
<b>Module Name</b>	Crypto
<b>Description</b>	Configuration of the Crypto (CryptoDriver) module
<b>Post-Build Variant Support</b>	false
<b>Supported Config Variants</b>	VARIANT-PRE-COMPILE

Included Containers		
Container Name	Multiplicity	Scope / Dependency
<a href="#">CryptoDriverObjects</a>	1	Container for CRYPTO Objects
<a href="#">CryptoGeneral</a>	1	Container for common configuration options
<a href="#">CryptoKeyElements</a>	0..1	Container for Crypto key elements
<a href="#">CryptoKeyTypes</a>	0..1	Container for CRYPTO key types
<a href="#">CryptoKeys</a>	0..1	Container for CRYPTO keys
<a href="#">CryptoNvStorage</a>	0..1	Container of NV block storage. Contains a collection of all NV storage blocks used for key storage.
<a href="#">CryptoPrimitives</a>	0..*	Container for CRYPTO primitives

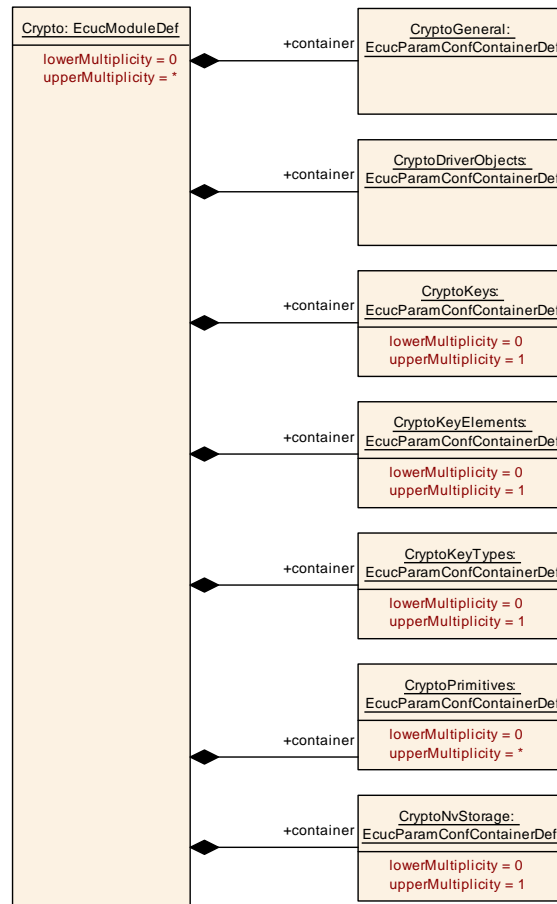


Figure 10.1

## 10.2.2 CryptoGeneral

SWS Item	[ECUC_Crypto_00002]		
Container Name	CryptoGeneral		
Parent Container	<a href="#">Crypto</a>		
Description	Container for common configuration options		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

SWS Item	[ECUC_Crypto_00006]		
Parameter Name	CryptoDevErrorDetect		
Parent Container	<a href="#">CryptoGeneral</a>		
Description	Switches the development error detection and notification on or off. true: detection and notification is enabled. false: detection and notification is disabled		





<b>Multiplicity</b>	1		
<b>Type</b>	EcucBooleanParamDef		
<b>Default value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00040]</b>		
<b>Parameter Name</b>	CryptoInstanceId		
<b>Parent Container</b>	<a href="#">CryptoGeneral</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucIntegerParamDef		
<b>Range</b>	0 .. 255		
<b>Default value</b>	–		
<b>Post-Build Variant Value</b>	false		
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00038]</b>		
<b>Parameter Name</b>	CryptoMainFunctionPeriod		
<b>Parent Container</b>	<a href="#">CryptoGeneral</a>		
<b>Description</b>	Specifies the period of main function Crypto_MainFunction in seconds.		
<b>Multiplicity</b>	0..1		
<b>Type</b>	EcucFloatParamDef		
<b>Range</b>	]0 .. INF[		
<b>Default value</b>	–		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00007]</b>		
<b>Parameter Name</b>	CryptoVersionInfoApi		
<b>Parent Container</b>	<a href="#">CryptoGeneral</a>		





<b>Description</b>	Pre-processor switch to enable and disable availability of the API Crypto_GetVersionInfo(). True: API Crypto_GetVersionInfo() is available False: API Crypto_GetVersionInfo() is not available.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucBooleanParamDef		
<b>Default value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00042]</b>		
<b>Parameter Name</b>	CryptoEcucPartitionRef		
<b>Parent Container</b>	<a href="#">CryptoGeneral</a>		
<b>Description</b>	Maps the Crypto driver to zero or multiple ECUC partitions to make the modules API available in this partition. The module will operate as an independent instance in each of the partitions.		
<b>Multiplicity</b>	0..*		
<b>Type</b>	Reference to EcucPartition		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: ECU		

<b>No Included Containers</b>
-------------------------------

**[SWS\_Crypto\_00212]** [The Crypto Driver module shall reject configurations with partition mappings which are not supported by the implementation.]()

**[SWS\_Crypto\_CONSTR\_00001]** [The Crypto Driver module will operate as an independent instance in each of the partitions, means the called API will only target the partition it is called in.]()

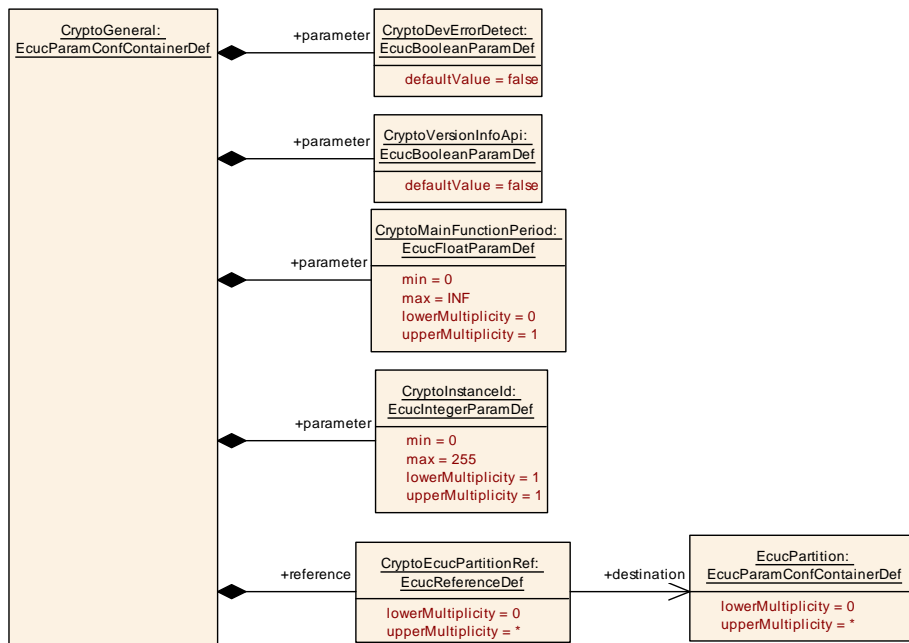


Figure 10.2

### 10.2.3 CryptoDriverObjects

SWS Item	[ECUC_Crypto_00003]		
Container Name	CryptoDriverObjects		
Parent Container	Crypto		
Description	Container for CRYPTO Objects		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	-	
	Post-build time	-	
Configuration Parameters			

Included Containers		
Container Name	Multiplicity	Scope / Dependency
CryptoDriverObject	0..*	Configuration of a CryptoDriverObject

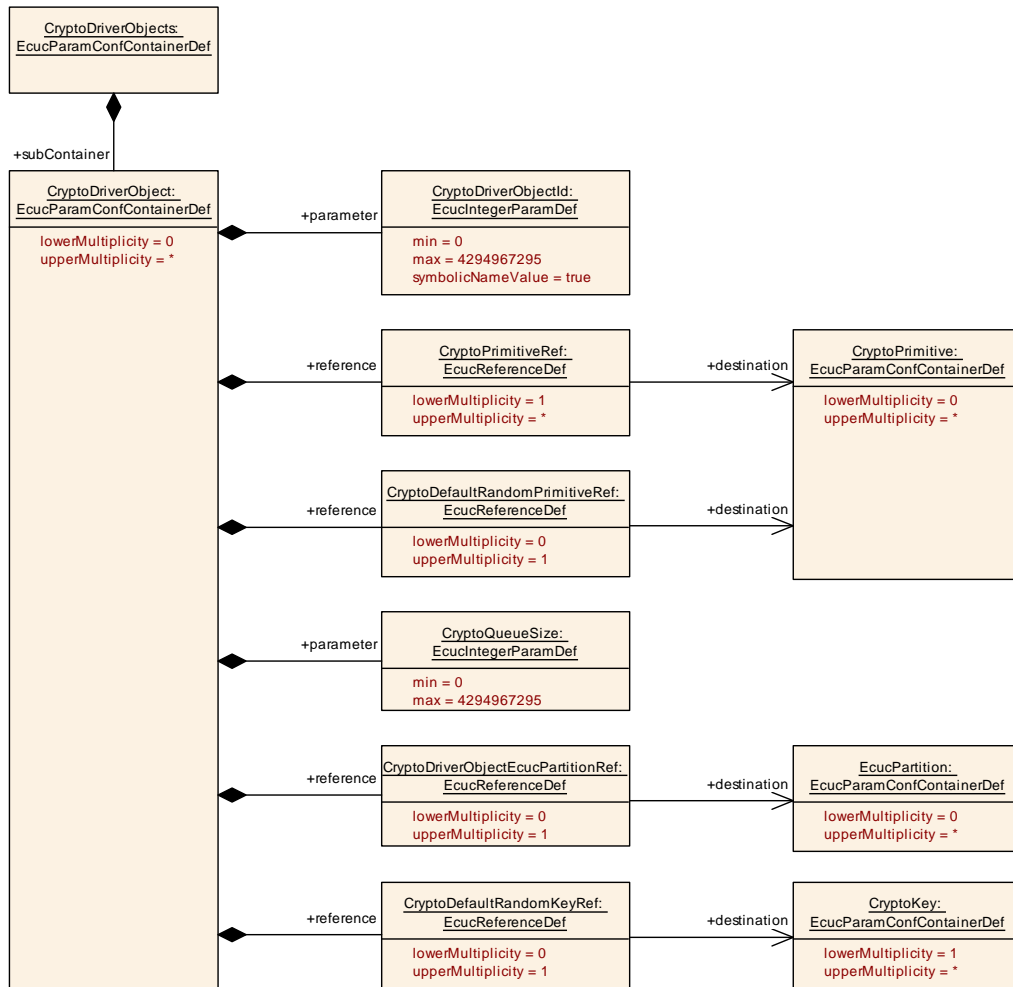


Figure 10.3

### 10.2.4 CryptoDriverObject

SWS Item	[ECUC_Crypto_00008]
Container Name	CryptoDriverObject
Parent Container	<a href="#">CryptoDriverObjects</a>
Description	Configuration of a CryptoDriverObject
Configuration Parameters	

SWS Item	[ECUC_Crypto_00009]
Parameter Name	CryptoDriverObjectId
Parent Container	<a href="#">CryptoDriverObject</a>
Description	Identifier of the Crypto Driver Object. The Crypto Driver Object offers different crypto primitives.
Multiplicity	1
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)







<b>Range</b>	0 .. 4294967295		
<b>Default value</b>	-		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00019]</b>		
<b>Parameter Name</b>	CryptoQueueSize		
<b>Parent Container</b>	<a href="#">CryptoDriverObject</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucIntegerParamDef		
<b>Range</b>	0 .. 4294967295		
<b>Default value</b>	-		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00045]</b>		
<b>Parameter Name</b>	CryptoDefaultRandomKeyRef		
<b>Parent Container</b>	<a href="#">CryptoDriverObject</a>		
<b>Description</b>	<p>This is a reference to the CryptoKey that is used by the CryptoDefaultRandomPrimitive Ref. The key contains key elements that are necessary to seed the random number generator.</p> <p>This element shall only be set if the primitive referenced by CryptoDefaultRandom PrimitiveRef requires a seed value.</p>		
<b>Multiplicity</b>	0..1		
<b>Type</b>	Reference to <a href="#">CryptoKey</a>		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00044]</b>		
<b>Parameter Name</b>	CryptoDefaultRandomPrimitiveRef		
<b>Parent Container</b>	<a href="#">CryptoDriverObject</a>		
<b>Description</b>	<p>This is a reference to a primitive that configures a default random number generator. If a crypto driver object needs to perform a crypto primitive that requires a random number generator, but the configuration of this primitive does not provide parameter for a random number generator, then this default random number generator shall be used (i.e. the elements of algorithm family, secondary algorithm family and algorithm mode do not provide this information).</p> <p>Example: The crypto driver shall generate a signature based on elliptic curve but the primitive for signature generation lacks information about a random number generator.</p>		
<b>Multiplicity</b>	0..1		
<b>Type</b>	Reference to <a href="#">CryptoPrimitive</a>		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00043]</b>		
<b>Parameter Name</b>	CryptoDriverObjectEcucPartitionRef		
<b>Parent Container</b>	<a href="#">CryptoDriverObject</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	0..1		
<b>Type</b>	Reference to EcucPartition		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: ECU		

<b>SWS Item</b>	<b>[ECUC_Crypto_00018]</b>		
<b>Parameter Name</b>	CryptoPrimitiveRef		
<b>Parent Container</b>	<a href="#">CryptoDriverObject</a>		
<b>Description</b>	Refers to primitive in the CRYPTO. The CryptoPrimitive is a pre-configured container of the crypto service that shall be used.		
<b>Multiplicity</b>	1..*		
<b>Type</b>	Reference to <a href="#">CryptoPrimitive</a>		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	



△

	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

**[SWS\_Crypto\_CONSTR\_00002]** [The ECUC partitions referenced by [CryptoDriverObjectEcucPartitionRef](#) shall be a subset of the ECUC partitions referenced by [CryptoEcucPartitionRef](#).]()

**[SWS\_Crypto\_CONSTR\_00003]** [If the [CryptoDriverObjectEcucPartitionRef](#) shall be configured for an HSM it shall be mapped to 0 or 1 ECUC partitions only.]()

**[SWS\_Crypto\_CONSTR\_00004]** [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

SWS Item	[ECUC_Crypto_00004]
Container Name	CryptoKeys
Parent Container	<a href="#">Crypto</a>
Description	Container for CRYPTO keys
Configuration Parameters	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
<a href="#">CryptoKey</a>	1..*	Configuration of a CryptoKey

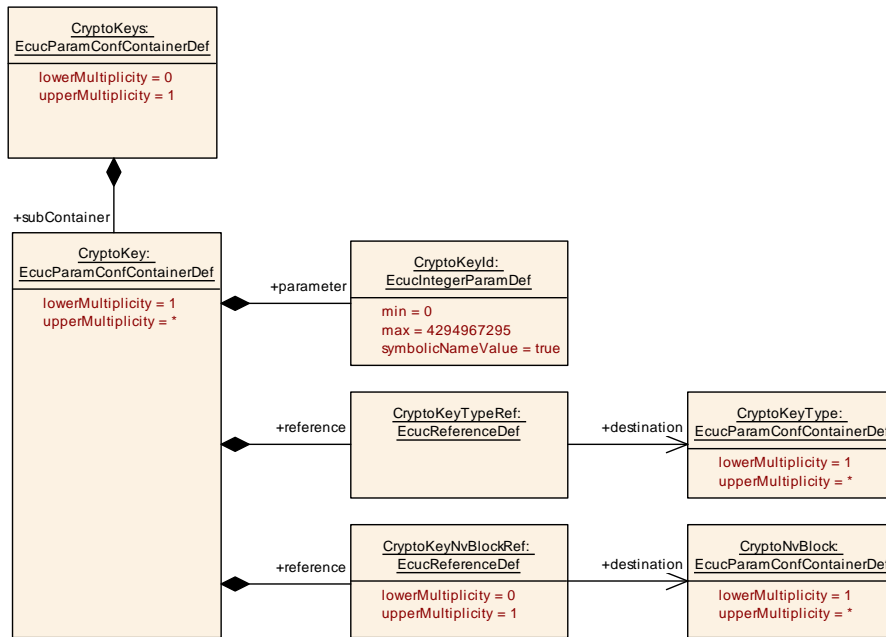


Figure 10.4

## 10.2.6 CryptoKey

SWS Item	[ECUC_Crypto_00011]		
Container Name	CryptoKey		
Parent Container	CryptoKeys		
Description	Configuration of a CryptoKey		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Configuration Parameters			

SWS Item	[ECUC_Crypto_00012]		
Parameter Name	CryptoKeyId		
Parent Container	CryptoKey		
Description	Identifier of the CRYPTO Key		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 4294967295		
Default value	–		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	





Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

SWS Item	[ECUC_Crypto_00059]		
Parameter Name	CryptoKeyNvBlockRef		
Parent Container	<a href="#">CryptoKey</a>		
Description	Reference to the NV block where the persistent key elements of this key shall be stored to.		
Multiplicity	0..1		
Type	Reference to <a href="#">CryptoNvBlock</a>		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

SWS Item	[ECUC_Crypto_00020]		
Parameter Name	CryptoKeyTypeRef		
Parent Container	<a href="#">CryptoKey</a>		
Description	Refers to a pointer in the CRYPTO to a CryptoKeyType. The CryptoKeyType provides the information which key elements are contained in a CryptoKey.		
Multiplicity	1		
Type	Reference to <a href="#">CryptoKeyType</a>		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers
------------------------

## 10.2.7 CryptoKeyElements

SWS Item	[ECUC_Crypto_00005]
Container Name	CryptoKeyElements
Parent Container	<a href="#">Crypto</a>





<b>Description</b>	Container for Crypto key elements
<b>Configuration Parameters</b>	

<b>Included Containers</b>		
<b>Container Name</b>	<b>Multiplicity</b>	<b>Scope / Dependency</b>
<a href="#">CryptoKeyElement</a>	1..*	Configuration of a CryptoKeyElement

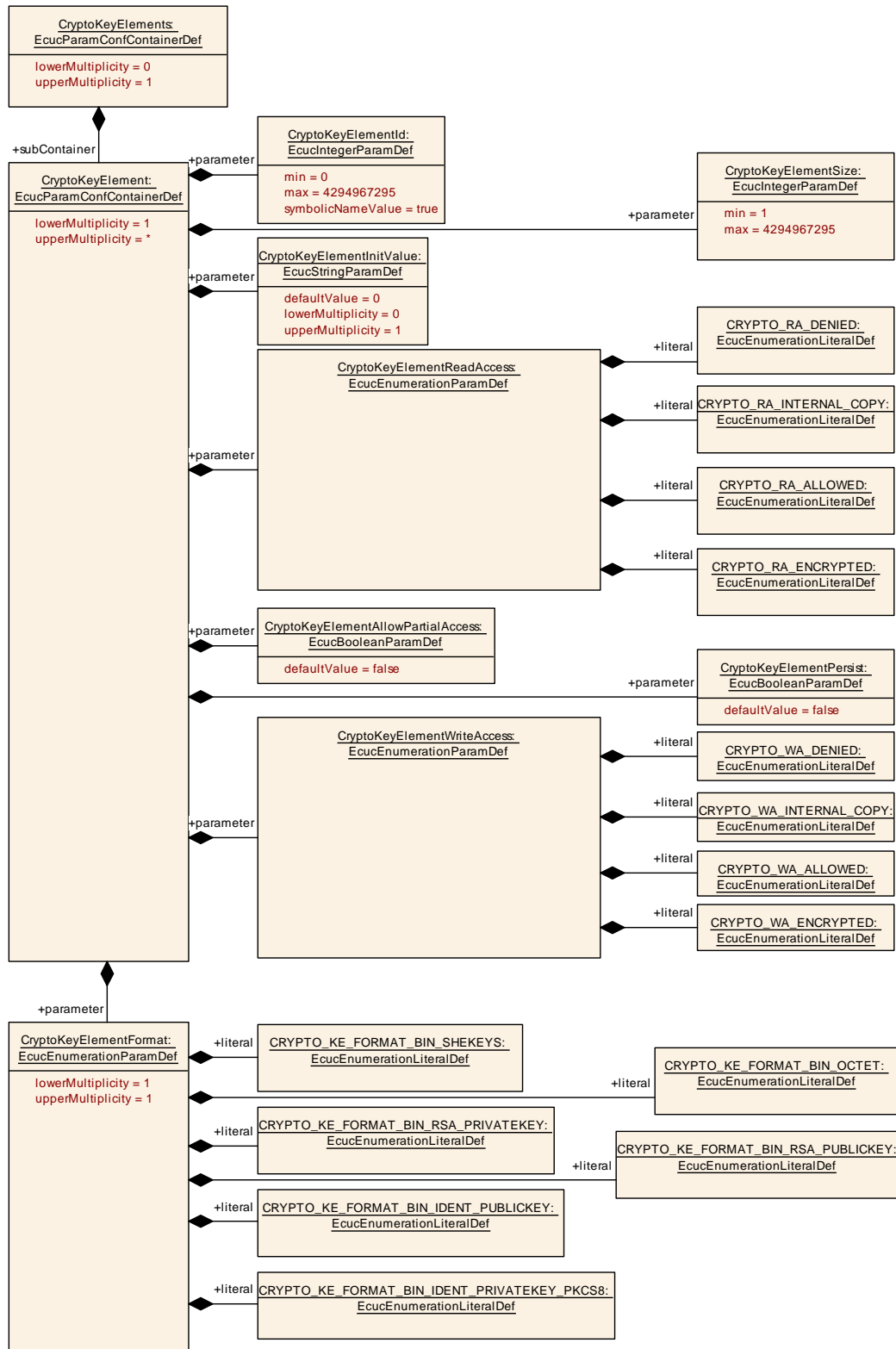


Figure 10.5

## 10.2.8 CryptoKeyElement

<b>SWS Item</b>	[ECUC_Crypto_00014]
<b>Container Name</b>	CryptoKeyElement
<b>Parent Container</b>	<a href="#">CryptoKeyElements</a>
<b>Description</b>	Configuration of a CryptoKeyElement
<b>Configuration Parameters</b>	

<b>SWS Item</b>	[ECUC_Crypto_00025]		
<b>Parameter Name</b>	CryptoKeyElementAllowPartialAccess		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	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		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucBooleanParamDef		
<b>Default value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	[ECUC_Crypto_00041]		
<b>Parameter Name</b>	CryptoKeyElementFormat		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	Defines the format for the key element. This is the format used to provide or extract the key data from the driver.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	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	
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	







	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>			

<b>SWS Item</b>	<b>[ECUC_Crypto_00021]</b>		
<b>Parameter Name</b>	CryptoKeyElementId		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	Identifier of the CRYPTO key element		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
<b>Range</b>	0 .. 4294967295		
<b>Default value</b>	-		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00023]</b>		
<b>Parameter Name</b>	CryptoKeyElementInitValue		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	0..1		
<b>Type</b>	EcucStringParamDef		
<b>Default value</b>	0		
<b>Regular Expression</b>	-		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00026]</b>		
<b>Parameter Name</b>	CryptoKeyElementPersist		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucBooleanParamDef		
<b>Default value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants





	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00024]</b>		
<b>Parameter Name</b>	CryptoKeyElementReadAccess		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_RA_ALLOWED	0x00	
	CRYPTO_RA_DENIED	0x03	
	CRYPTO_RA_ENCRYPTED	0x01	
	CRYPTO_RA_INTERNAL_COPY	0x02	
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local dependency: The values for the enumeration types are chosen in a way that its value can be used to deduce a hierarchical access level.		

<b>SWS Item</b>	<b>[ECUC_Crypto_00022]</b>		
<b>Parameter Name</b>	CryptoKeyElementSize		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	Maximum Size size of a CRYPTO key element in bytes		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucIntegerParamDef		
<b>Range</b>	1 .. 4294967295		
<b>Default value</b>	–		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	





<b>Scope / Dependency</b>	scope: local		
<b>SWS Item</b>	[ECUC_Crypto_00027]		
<b>Parameter Name</b>	CryptoKeyElementWriteAccess		
<b>Parent Container</b>	<a href="#">CryptoKeyElement</a>		
<b>Description</b>	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 rewritten as plaintext CRYPTO_WA_ENCRYPTED = key element can be written encrypted. E.g. SHE load key.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_WA_ALLOWED	0x00	
	CRYPTO_WA_DENIED	0x03	
	CRYPTO_WA_ENCRYPTED	0x01	
	CRYPTO_WA_INTERNAL_COPY	0x02	
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local  dependency: The values for the enumeration types are chosen in a way that its value can be used to deduce a hierarchical access level.		

No Included Containers

## 10.2.9 CryptoKeyTypes

<b>SWS Item</b>	[ECUC_Crypto_00017]		
<b>Container Name</b>	CryptoKeyTypes		
<b>Parent Container</b>	<a href="#">Crypto</a>		
<b>Description</b>	Container for CRYPTO key types		
<b>Post-Build Variant Multiplicity</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Configuration Parameters</b>			

Included Containers		
Container Name	Multiplicity	Scope / Dependency
<a href="#">CryptoKeyType</a>	1..*	Configuration of a CryptoKeyType

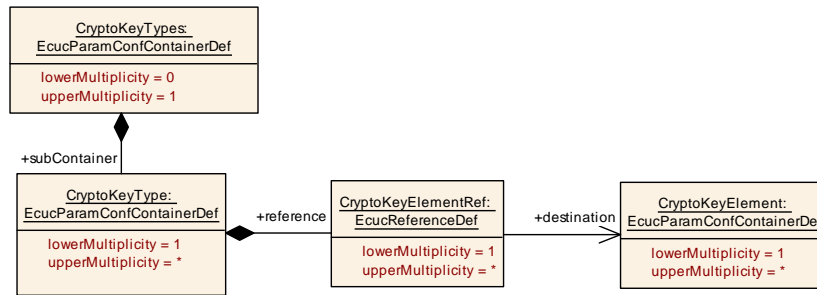


Figure 10.6

### 10.2.10 CryptoKeyType

SWS Item	[ECUC_Crypto_00030]
Container Name	CryptoKeyType
Parent Container	<a href="#">CryptoKeyTypes</a>
Description	Configuration of a CryptoKeyType
Configuration Parameters	

SWS Item	[ECUC_Crypto_00031]		
Parameter Name	CryptoKeyElementRef		
Parent Container	<a href="#">CryptoKeyType</a>		
Description	Refers to a pointer in the CRYPTO Crypto Key Element, which holds the data of the crypto key element.		
Multiplicity	1..*		
Type	Reference to <a href="#">CryptoKeyElement</a>		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	–	
	Post-build time	–	
Scope / Dependency	scope: local		

No Included Containers

### 10.2.11 CryptoPrimitives

SWS Item	[ECUC_Crypto_00032]		
Container Name	CryptoPrimitives		
Parent Container	<a href="#">Crypto</a>		
Description	Container for CRYPTO primitives		
Multiplicity Configuration Class	Pre-compile time	X	All Variants
	Link time		
	Post-build time		





	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Configuration Parameters</b>			

<b>Included Containers</b>		
<b>Container Name</b>	<b>Multiplicity</b>	<b>Scope / Dependency</b>
<a href="#">CryptoPrimitive</a>	0..*	Configuration of a CryptoPrimitive
<a href="#">CryptoPrimitiveAlgorithmFamily Custom</a>	0..*	Container of custom algorithm family values. The container name serves as a symbolic name for the identifier of the custom algorithm family type.
<a href="#">CryptoPrimitiveAlgorithmMode Custom</a>	0..*	Container of custom algorithm family values. The container name serves as a symbolic name for the identifier of the custom algorithm family type.

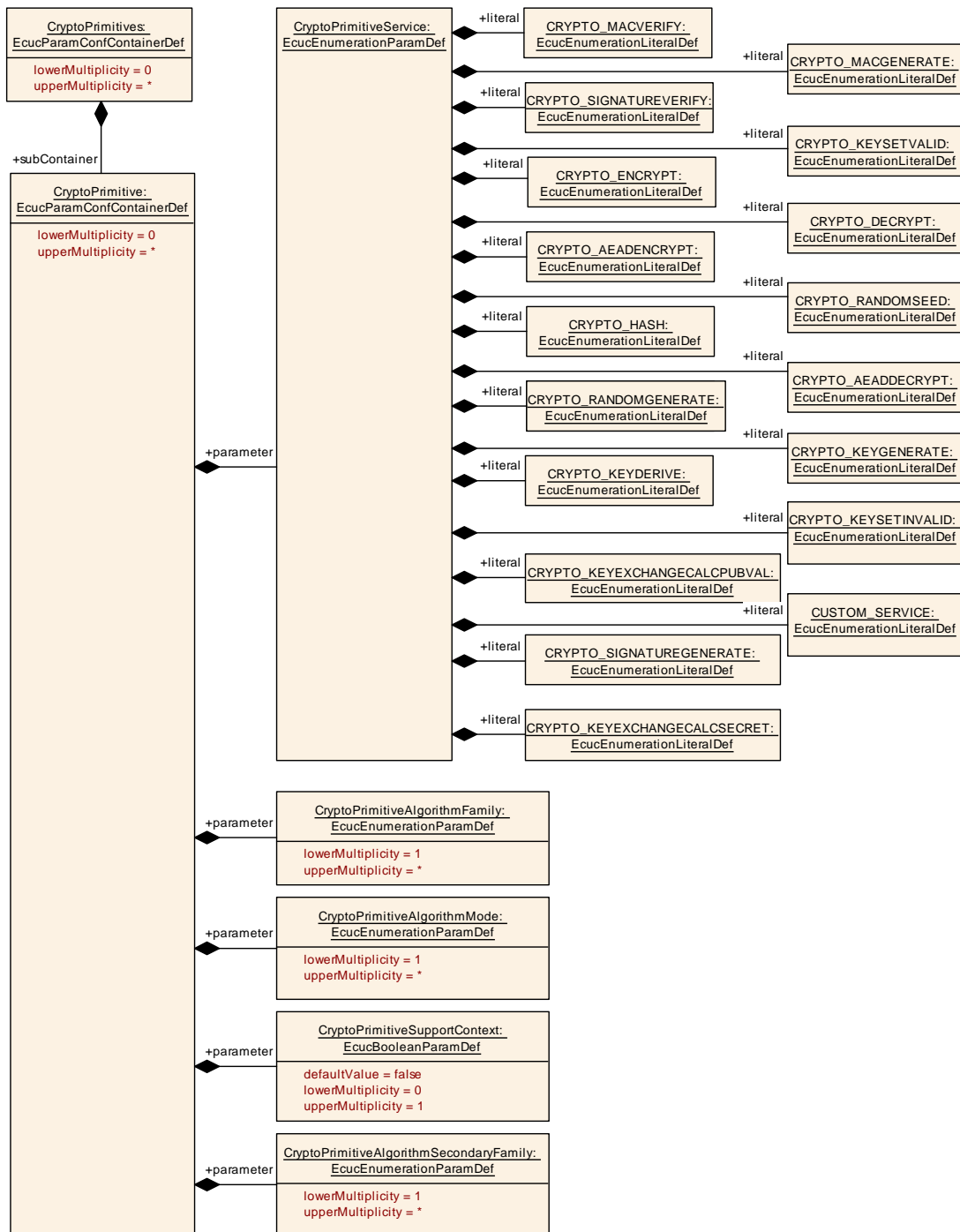


Figure 10.7

### 10.2.12 CryptoPrimitive

<b>SWS Item</b>	<b>[ECUC_Crypto_00033]</b>		
<b>Container Name</b>	CryptoPrimitive		
<b>Parent Container</b>	<a href="#">CryptoPrimitives</a>		
<b>Description</b>	Configuration of a CryptoPrimitive		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Configuration Parameters</b>			

<b>SWS Item</b>	<b>[ECUC_Crypto_00035]</b>		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmFamily		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Determines the algorithm family used for the crypto service		
<b>Multiplicity</b>	1..*		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_ALGOFAM_3DES	–	
	CRYPTO_ALGOFAM_AES	–	
	CRYPTO_ALGOFAM_BLAKE_1_256	–	
	CRYPTO_ALGOFAM_BLAKE_1_512	–	
	CRYPTO_ALGOFAM_BLAKE_2s_256	–	
	CRYPTO_ALGOFAM_BLAKE_2s_512	–	
	CRYPTO_ALGOFAM_BRAINPOOL	–	
	CRYPTO_ALGOFAM_CHACHA	–	
	CRYPTO_ALGOFAM_CUSTOM	–	
	CRYPTO_ALGOFAM_DH	–	
	CRYPTO_ALGOFAM_DRBG	–	
	CRYPTO_ALGOFAM_ECCANSI	–	
	CRYPTO_ALGOFAM_ECCNIST	–	
	CRYPTO_ALGOFAM_ECCSEC	–	
	CRYPTO_ALGOFAM_ECDH	–	
	CRYPTO_ALGOFAM_ECDSA	–	
	CRYPTO_ALGOFAM_ED25519	–	
	CRYPTO_ALGOFAM_EEA3	–	
	CRYPTO_ALGOFAM_EIA3	–	
	CRYPTO_ALGOFAM_FIPS186	–	
	CRYPTO_ALGOFAM_HKDF	–	
	CRYPTO_ALGOFAM_KDFX963	–	
	CRYPTO_ALGOFAM_NOT_SET	–	
CRYPTO_ALGOFAM_PADDING_ONEWITHZEROS	–		





	CRYPTO_ALGOFAM_PADDING_PKCS7	–	
	CRYPTO_ALGOFAM_PBKDF2	–	
	CRYPTO_ALGOFAM_POLY1305	–	
	CRYPTO_ALGOFAM_RIPEMD160	–	
	CRYPTO_ALGOFAM_RNG	–	
	CRYPTO_ALGOFAM_RSA	–	
	CRYPTO_ALGOFAM_SHA1	–	
	CRYPTO_ALGOFAM_SHA2_224	–	
	CRYPTO_ALGOFAM_SHA2_256	–	
	CRYPTO_ALGOFAM_SHA2_384	–	
	CRYPTO_ALGOFAM_SHA2_512	–	
	CRYPTO_ALGOFAM_SHA2_512_224	–	
	CRYPTO_ALGOFAM_SHA2_512_256	–	
	CRYPTO_ALGOFAM_SHA3_224	–	
	CRYPTO_ALGOFAM_SHA3_256	–	
	CRYPTO_ALGOFAM_SHA3_384	–	
	CRYPTO_ALGOFAM_SHA3_512	–	
	CRYPTO_ALGOFAM_SHAKE128	–	
	CRYPTO_ALGOFAM_SHAKE256	–	
	CRYPTO_ALGOFAM_SIPHASH	–	
	CRYPTO_ALGOFAM_SM2	–	
	CRYPTO_ALGOFAM_SM3	–	
	CRYPTO_ALGOFAM_X25519	–	
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00036]</b>		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmMode		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Determines the algorithm mode used for the crypto service		
<b>Multiplicity</b>	1..*		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_ALGOMODE_12ROUNDS	–	
	CRYPTO_ALGOMODE_20ROUNDS	–	







	CRYPTO_ALGOMODE_8ROUNDS	-	
	CRYPTO_ALGOMODE_AESKEYWRAP	-	
	CRYPTO_ALGOMODE_CBC	-	
	CRYPTO_ALGOMODE_CFB	-	
	CRYPTO_ALGOMODE_CMAC	-	
	CRYPTO_ALGOMODE_CTR	-	
	CRYPTO_ALGOMODE_CTRDRBG	-	
	CRYPTO_ALGOMODE_CUSTOM	-	
	CRYPTO_ALGOMODE_ECB	-	
	CRYPTO_ALGOMODE_GCM	-	
	CRYPTO_ALGOMODE_GMAC	-	
	CRYPTO_ALGOMODE_HMAC	-	
	CRYPTO_ALGOMODE_NOT_SET	-	
	CRYPTO_ALGOMODE_OFB	-	
	CRYPTO_ALGOMODE_PXXXR	-	
	CRYPTO_ALGOMODE_RSAES_OAEP	-	
	CRYPTO_ALGOMODE_RSAES_PKCS1_v1_5	-	
	CRYPTO_ALGOMODE_RSASSA_PKCS1_v1_5	-	
	CRYPTO_ALGOMODE_RSASSA_PSS	-	
	CRYPTO_ALGOMODE_SIPHASH_2_4	-	
	CRYPTO_ALGOMODE_SIPHASH_4_8	-	
	CRYPTO_ALGOMODE_XTS	-	
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00037]</b>		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmSecondaryFamily		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Determines the algorithm secondary family used for the crypto service		
<b>Multiplicity</b>	1..*		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_ALGOFAM_3DES	-	





	CRYPTO_ALGOFAM_AES	–	
	CRYPTO_ALGOFAM_BLAKE_1_256	–	
	CRYPTO_ALGOFAM_BLAKE_1_512	–	
	CRYPTO_ALGOFAM_BLAKE_2s_256	–	
	CRYPTO_ALGOFAM_BLAKE_2s_512	–	
	CRYPTO_ALGOFAM_BRAINPOOL	–	
	CRYPTO_ALGOFAM_CHACHA	–	
	CRYPTO_ALGOFAM_CUSTOM	–	
	CRYPTO_ALGOFAM_DRBG	–	
	CRYPTO_ALGOFAM_ECCANSI	–	
	CRYPTO_ALGOFAM_ECCNIST	–	
	CRYPTO_ALGOFAM_ECCSEC	–	
	CRYPTO_ALGOFAM_ED25519	–	
	CRYPTO_ALGOFAM_FIPS186	–	
	CRYPTO_ALGOFAM_NOT_SET	–	
	CRYPTO_ALGOFAM_PADDING_ONEWITHZEROS	–	
	CRYPTO_ALGOFAM_PADDING_PKCS7	–	
	CRYPTO_ALGOFAM_POLY1305	–	
	CRYPTO_ALGOFAM_RIPEMD160	–	
	CRYPTO_ALGOFAM_RNG	–	
	CRYPTO_ALGOFAM_RSA	–	
	CRYPTO_ALGOFAM_SHA1	–	
	CRYPTO_ALGOFAM_SHA2_224	–	
	CRYPTO_ALGOFAM_SHA2_256	–	
	CRYPTO_ALGOFAM_SHA2_384	–	
	CRYPTO_ALGOFAM_SHA2_512	–	
	CRYPTO_ALGOFAM_SHA2_512_224	–	
	CRYPTO_ALGOFAM_SHA2_512_256	–	
	CRYPTO_ALGOFAM_SHA3_224	–	
	CRYPTO_ALGOFAM_SHA3_256	–	
	CRYPTO_ALGOFAM_SHA3_384	–	
	CRYPTO_ALGOFAM_SHA3_512	–	
	CRYPTO_ALGOFAM_SHAKE128	–	
	CRYPTO_ALGOFAM_SHAKE256	–	
	CRYPTO_ALGOFAM_SIPHASH	–	
	CRYPTO_ALGOFAM_X25519	–	
<b>Post-Build Variant Value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	





<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00034]</b>		
<b>Parameter Name</b>	CryptoPrimitiveService		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Determines the crypto service used for defining the capabilities		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_AEADDECRYPT	0x06	
	CRYPTO_AEADENCRYPT	0x05	
	CRYPTO_DECRYPT	0x04	
	CRYPTO_ENCRYPT	0x03	
	CRYPTO_HASH	0x00	
	CRYPTO_KEYDERIVE	0x0E	
	CRYPTO_KEYEXCHANGEALCPUBVAL	0x0F	
	CRYPTO_KEYEXCHANGEALCSECRET	0x10	
	CRYPTO_KEYGENERATE	0x0D	
	CRYPTO_KEYSETINVALID	0x14	
	CRYPTO_KEYSETVALID	0x13	
	CRYPTO_MACGENERATE	0x01	
	CRYPTO_MACVERIFY	0x02	
	CRYPTO_RANDOMGENERATE	0x0B	
	CRYPTO_RANDOMSEED	0x0C	
	CRYPTO_SIGNATUREGENERATE	0x07	
	CRYPTO_SIGNATUREVERIFY	0x08	
CUSTOM_SERVICE	0x15		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00053]</b>		
<b>Parameter Name</b>	CryptoPrimitiveSupportContext		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	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.		
<b>Multiplicity</b>	0..1		





<b>Type</b>	EcucBooleanParamDef		
<b>Default value</b>	false		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	[ECUC_Crypto_00050]		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmFamilyCustomRef		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Reference to a customer specific algorithm family custom container		
<b>Multiplicity</b>	0..*		
<b>Type</b>	Reference to <a href="#">CryptoPrimitiveAlgorithmFamilyCustom</a>		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local dependency: This reference is only needed if the driver also supports custom specific features for PrimitiveAlgorithmFamily for the specific CryptoPrimitiveService.		

<b>SWS Item</b>	[ECUC_Crypto_00051]		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmModeCustomRef		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Reference to a customer specific algorithm mode custom container		
<b>Multiplicity</b>	0..*		
<b>Type</b>	Reference to <a href="#">CryptoPrimitiveAlgorithmModeCustom</a>		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	dependency: This reference is only needed if the driver also supports custom specific features for PrimitiveAlgorithmMode for the specific CryptoPrimitiveService.		

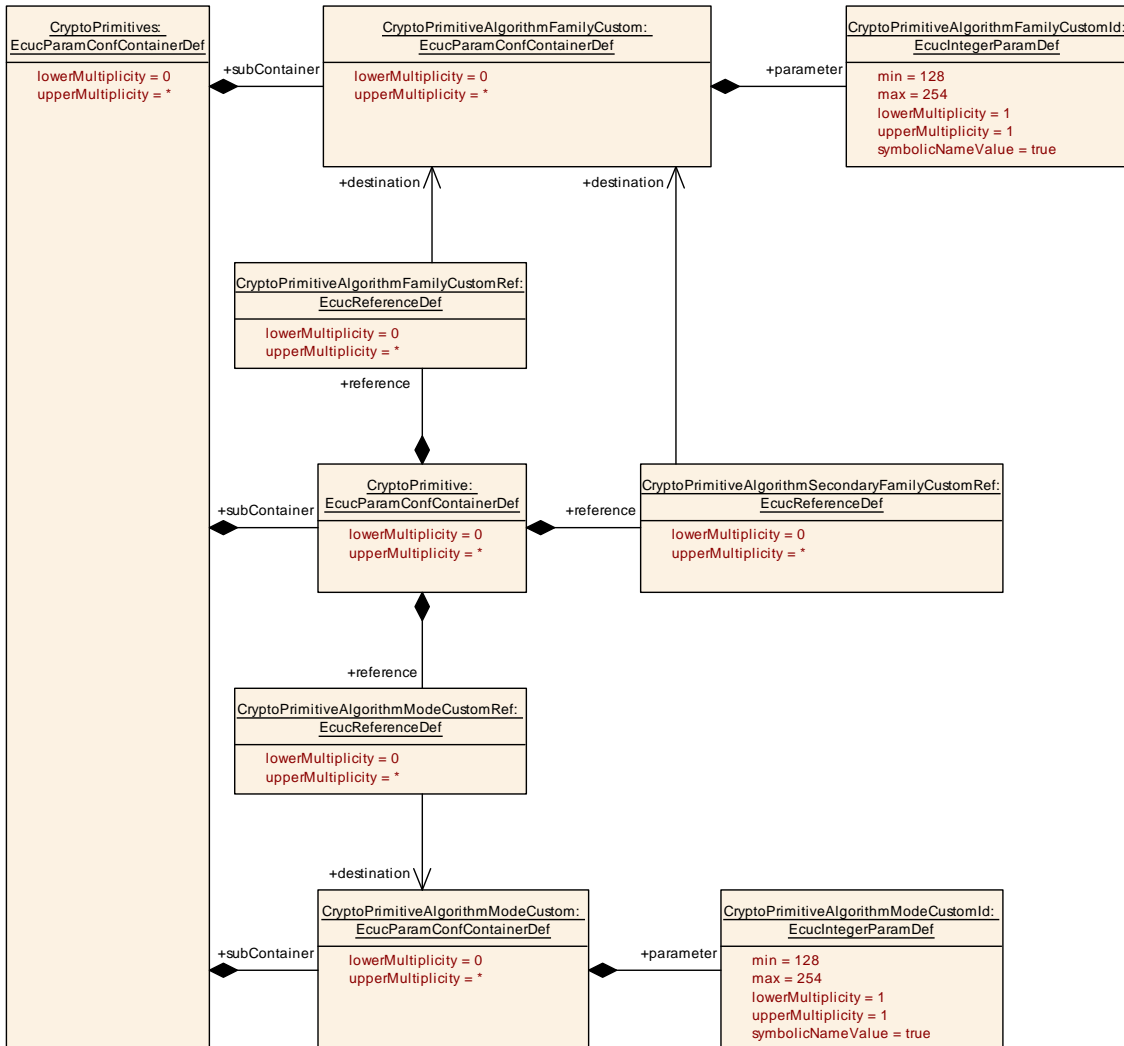
<b>SWS Item</b>	[ECUC_Crypto_00052]		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmSecondaryFamilyCustomRef		
<b>Parent Container</b>	<a href="#">CryptoPrimitive</a>		
<b>Description</b>	Reference to a customer specific algorithm family custom container		
<b>Multiplicity</b>	0..*		





<b>Type</b>	Reference to <a href="#">CryptoPrimitiveAlgorithmFamilyCustom</a>		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	–	
	<b>Post-build time</b>	–	
<b>Scope / Dependency</b>	scope: local  dependency: This container is only needed if the driver also supports custom specific features for PrimitiveSecondaryAlgorithmFamily for the specific CryptoPrimitiveService.		

**No Included Containers**



**Figure 10.8**

### 10.2.13 CryptoPrimitiveAlgorithmFamilyCustom

<b>SWS Item</b>	[ECUC_Crypto_00046]
<b>Container Name</b>	CryptoPrimitiveAlgorithmFamilyCustom
<b>Parent Container</b>	<a href="#">CryptoPrimitives</a>
<b>Description</b>	Container of custom algorithm family values. The container name serves as a symbolic name for the identifier of the custom algorithm family type.
<b>Configuration Parameters</b>	

<b>SWS Item</b>	[ECUC_Crypto_00047]		
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmFamilyCustomId		
<b>Parent Container</b>	<a href="#">CryptoPrimitiveAlgorithmFamilyCustom</a>		
<b>Description</b>	The custom value of this algorithm family		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
<b>Range</b>	128 .. 254		
<b>Default value</b>	-		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local  dependency: The CustomIds are used to distinguish the different custom algorithm family. Thus, every designated family shall have a unique ID that shall be fixed over updates and lifetime of the driver.		

<b>No Included Containers</b>
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### 10.2.14 CryptoPrimitiveAlgorithmModeCustom

<b>SWS Item</b>	[ECUC_Crypto_00048]
<b>Container Name</b>	CryptoPrimitiveAlgorithmModeCustom
<b>Parent Container</b>	<a href="#">CryptoPrimitives</a>
<b>Description</b>	Container of custom algorithm family values. The container name serves as a symbolic name for the identifier of the custom algorithm family type.
<b>Configuration Parameters</b>	

<b>SWS Item</b>	[ECUC_Crypto_00049]
<b>Parameter Name</b>	CryptoPrimitiveAlgorithmModeCustomId
<b>Parent Container</b>	<a href="#">CryptoPrimitiveAlgorithmModeCustom</a>
<b>Description</b>	The custom value of this algorithm mode
<b>Multiplicity</b>	1
<b>Type</b>	EcucIntegerParamDef (Symbolic Name generated for this parameter)





<b>Range</b>	128 .. 254		
<b>Default value</b>	-		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local dependency: The CustomIds are used to distinguish the different custom algorithm mode. Thus, every designated mode shall have a unique ID that is fixed over updates and lifetime of the driver.		

**No Included Containers**

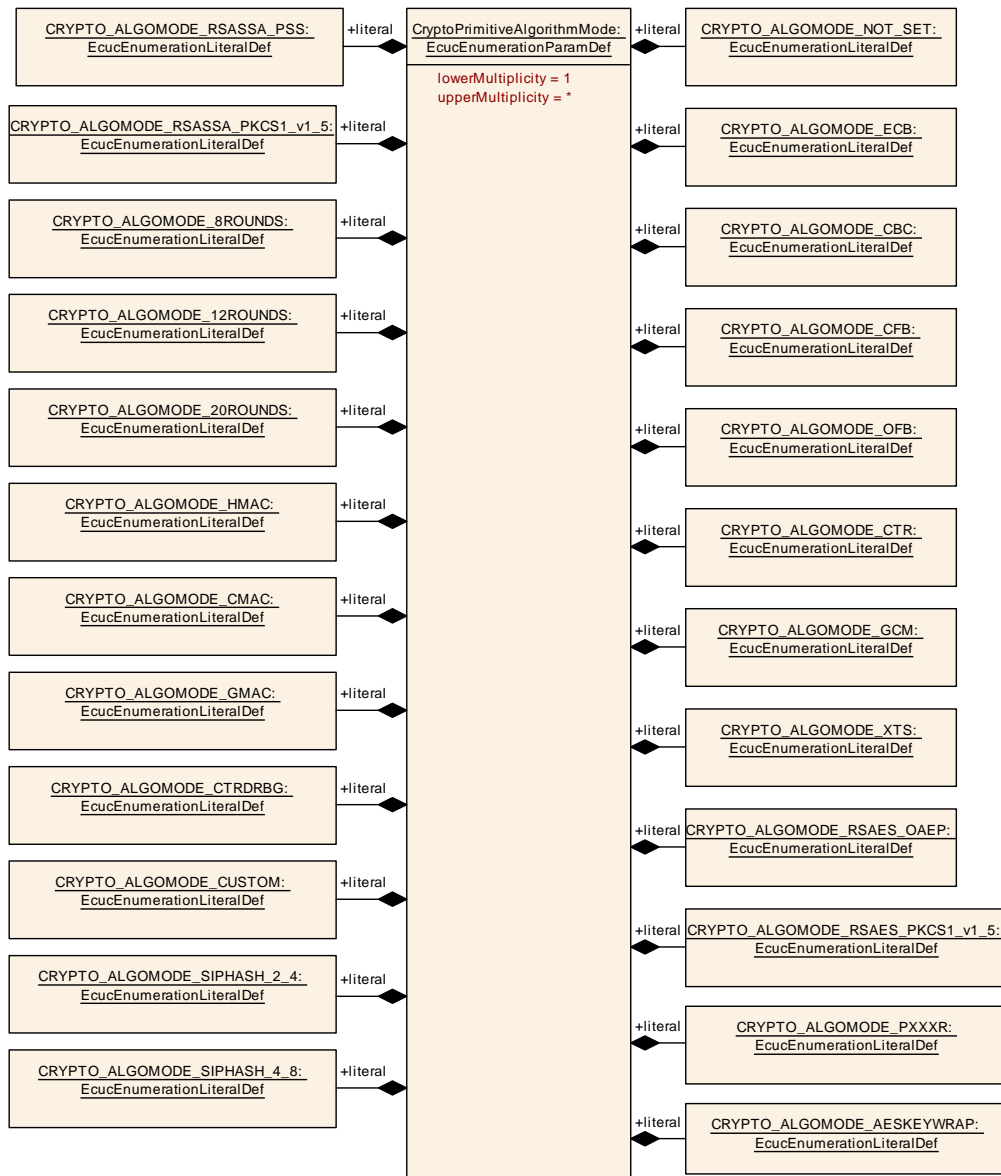


Figure 10.9

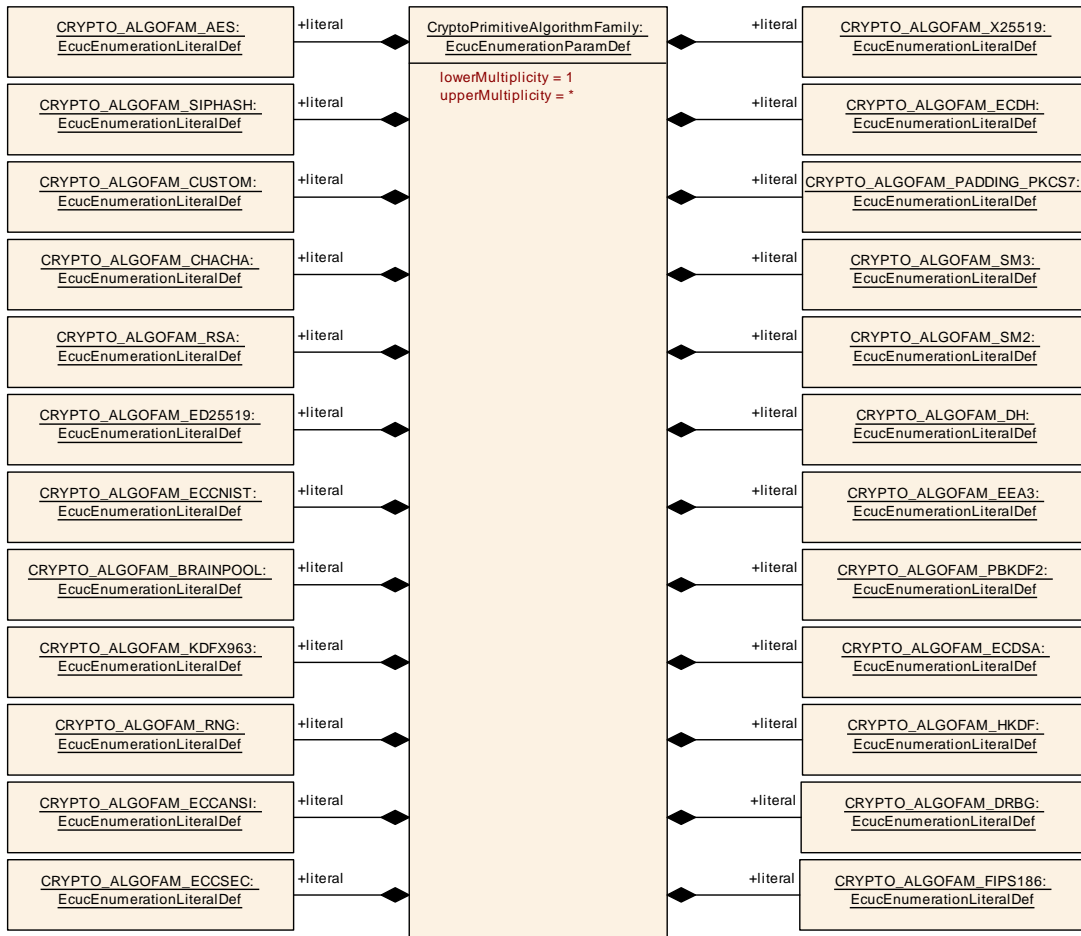


Figure 10.10



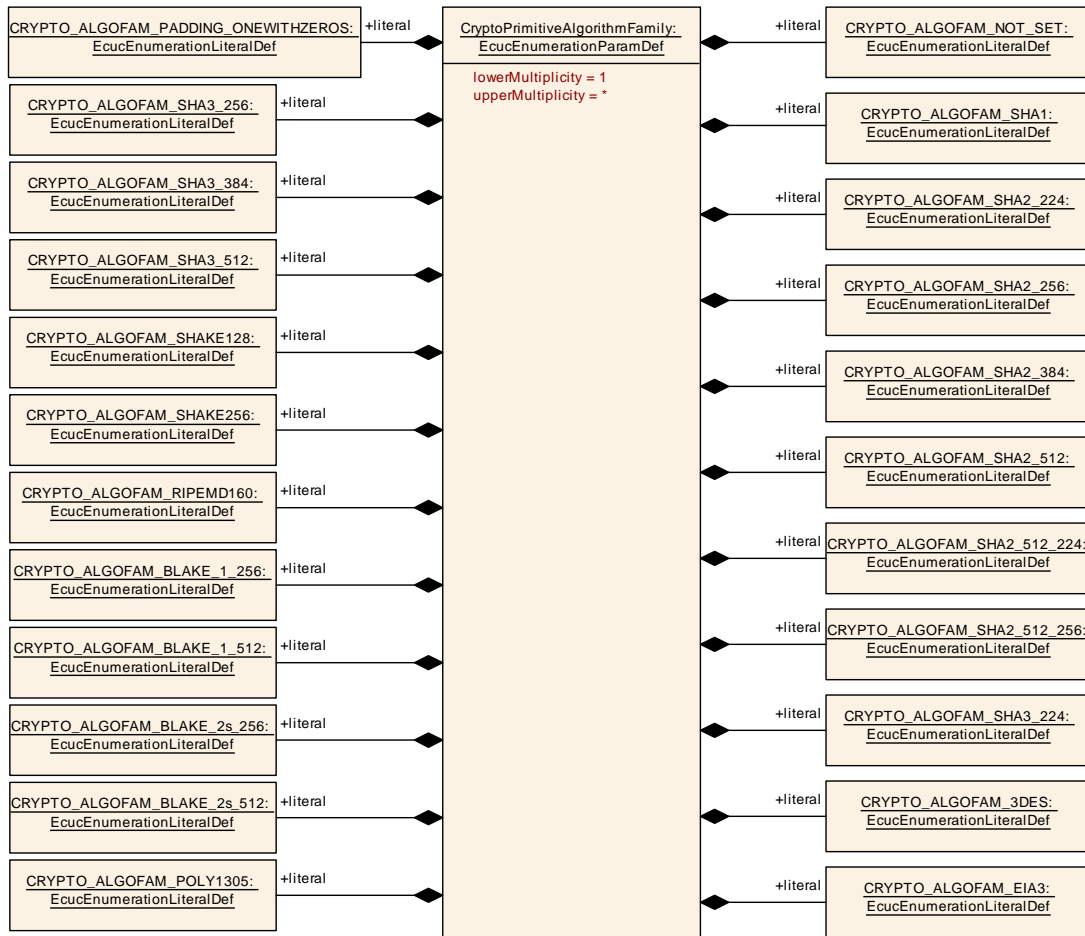


Figure 10.11

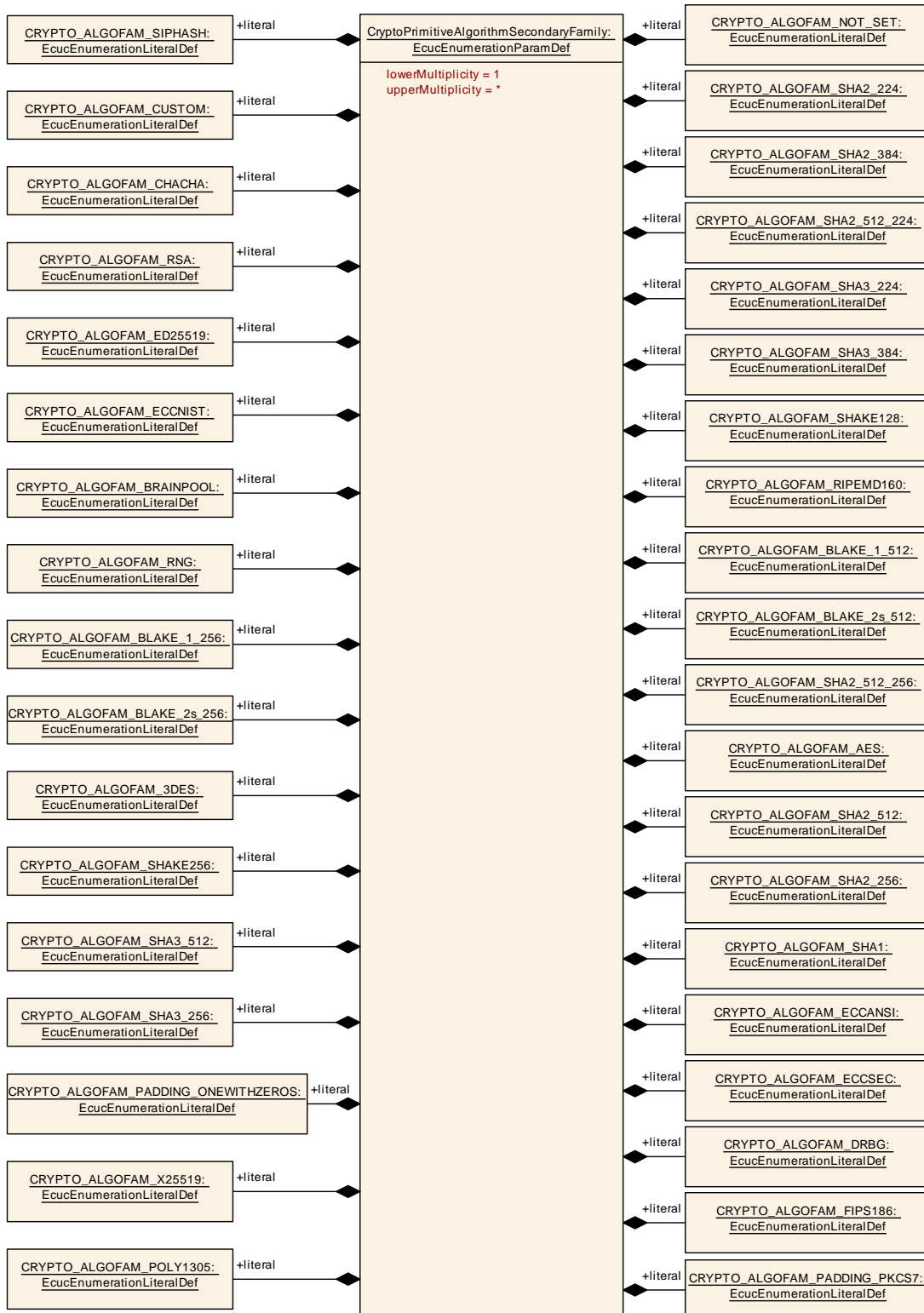


Figure 10.12

### 10.2.15 CryptoNvStorage

<b>SWS Item</b>	[ECUC_Crypto_00054]
<b>Container Name</b>	CryptoNvStorage
<b>Parent Container</b>	Crypto
<b>Description</b>	Container of NV block storage. Contains a collection of all NV storage blocks used for key storage.
<b>Configuration Parameters</b>	

Included Containers		
Container Name	Multiplicity	Scope / Dependency
CryptoNvBlock	1..*	Container to configure key storage in NVM

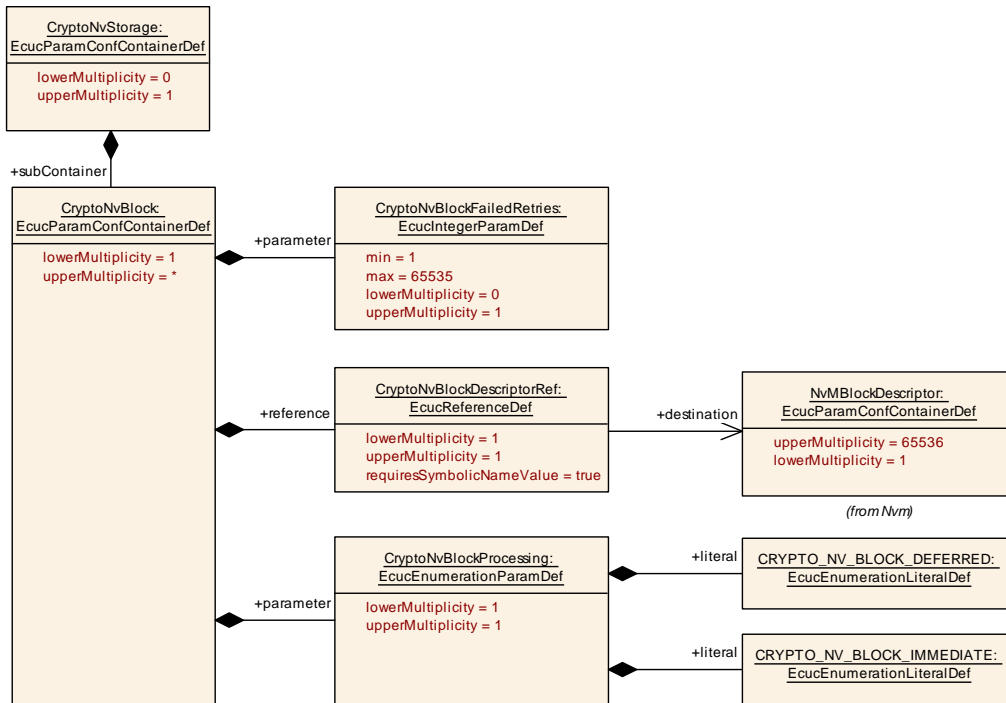


Figure 10.13

### 10.2.16 CryptoNvBlock

<b>SWS Item</b>	[ECUC_Crypto_00055]
<b>Container Name</b>	CryptoNvBlock
<b>Parent Container</b>	CryptoNvStorage
<b>Description</b>	Container to configure key storage in NVM
<b>Configuration Parameters</b>	

<b>SWS Item</b>	<b>[ECUC_Crypto_00057]</b>		
<b>Parameter Name</b>	CryptoNvBlockFailedRetries		
<b>Parent Container</b>	<a href="#">CryptoNvBlock</a>		
<b>Description</b>	Number of retries to request an NVM service operation.		
<b>Multiplicity</b>	0..1		
<b>Type</b>	EcucIntegerParamDef		
<b>Range</b>	1 .. 65535		
<b>Default value</b>	-		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00058]</b>		
<b>Parameter Name</b>	CryptoNvBlockProcessing		
<b>Parent Container</b>	<a href="#">CryptoNvBlock</a>		
<b>Description</b>	Selects the operation mode when an NV block shall be updated.		
<b>Multiplicity</b>	1		
<b>Type</b>	EcucEnumerationParamDef		
<b>Range</b>	CRYPTO_NV_BLOCK_DEFERRED	0x01	
	CRYPTO_NV_BLOCK_IMMEDIATE	0x02	
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

<b>SWS Item</b>	<b>[ECUC_Crypto_00056]</b>		
<b>Parameter Name</b>	CryptoNvBlockDescriptorRef		
<b>Parent Container</b>	<a href="#">CryptoNvBlock</a>		
<b>Description</b>	Reference to an NvM block descriptor		
<b>Multiplicity</b>	1		
<b>Type</b>	Symbolic name reference to NvMBlockDescriptor		
<b>Multiplicity Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Value Configuration Class</b>	<b>Pre-compile time</b>	X	All Variants
	<b>Link time</b>	-	
	<b>Post-build time</b>	-	
<b>Scope / Dependency</b>	scope: local		

**No Included Containers**

### **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.