Document Title	Specification of Module E2E Transformer
Document Owner	AUTOSAR
Document Responsibility	AUTOSAR
Document Identification No	650
Document Classification	Standard

Document Status	Final
Part of AUTOSAR Release	4.2.2

Document Change History		
Release	**Changed by**	**Change Description**
4.2.2	AUTOSAR Release Management	• Various minor fixes
4.2.1	AUTOSAR Release Management	• Initial release

Disclaimer

Advice for users

AUTOSAR specifications may contain exemplary items (exemplary reference models, "use cases", and/or references to exemplary technical solutions, devices, processes or software).

Any such exemplary items are contained in the specifications for illustration purposes only, and they themselves are not part of the AUTOSAR Standard. Neither their presence in such specifications, nor any later documentation of AUTOSAR conformance of products actually implementing such exemplary items, imply that intellectual property rights covering such exemplary items are licensed under the same rules as applicable to the AUTOSAR Standard.

Table of Contents

1 Introduction and functional overview

This specification specifies the functionality, API and the configuration of the AUTOSAR Basic Software module E2E Transformer.

E2E Transformer belongs to the class “Safety”, according to SRS Transformer General.

The E2E transformer ensures a correct communication of I-signals through QM communication stack. The communication stack is considered as “black channel” communication.

There is a one-to-one relationship between a data element and I-signal, in the sense that there is no data splitting/merging (i.e. one I-signal is NOT made of several data elements, one data element is not made of several I-signals):

1. On the sender side, one data element maps to exactly one-to-one to an I-signal.
2. On the receiver side, one-or-more data elements represent the entire received I-signal (i.e. receiver fan-out).

There is a fan-out I-signal to one-or-more data elements on receiver side. The following scenarios are supported:

3. On sender side, one data element serialized to one I-signal, and protected with one E2E-protection
4. One or more I-signals placed in one I-PDU, where each I-signal has a different E2E protection. Some I-signals may have no E2E protection at all.
5. On receiver side, one I-signal checked:
    a. Once: resulting with one data element (i.e. no fan-out)
    b. Several times, with the same settings, but by independent functions (e.g. by ASIL-independent receiver SW-Cs),
    c. Several times: with partially different settings (e.g. same DataID, but different counter tolerances), by different functions, resulting with separate data elements each having possibly different E2E-check result,
    d. Several times: with and without E2E-check enabled (e.g. if one receiver is safety-related, and another one is QM and it does not need the results of E2E check).

The E2E Transformer is responsible for the invocation of the E2E Library based on the configuration of specific data element (I-signal).

The E2E Transformer instantiates the E2E configuration and E2E state data structures, based on its configuration. All E2E profiles may be used to protect data.

The E2E Transformer encapsulates the complexity of configuring and handling of the E2E and it offers a standard Transformer interface. Thanks to this, the caller of E2E Transformer does not need to know the E2E internals.

The E2E Transformer is invoked by RTE, and the RTE invocation is a result of invocation of RTE API (read, write, send, receive) by software components.

2 Acronyms and abbreviations

See AUTOSAR glossary.

3 Related documentation

3.1 Input documents

[1] AUTOSAR Layered Software Architecture
AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf

[2] AUTOSAR General Requirements on Basic Software Modules
AUTOSAR_SRS_BSWGeneral.pdf

[3] AUTOSAR General Specification for Basic Software Modules
AUTOSAR_SWS_BSWGeneral.pdf

[4] AUTOSAR Specification of SW-C End-to-End Communication Protection Library
AUTOSAR_SWS_E2ELibrary.pdf

[5] AUTOSAR Specification of RTE
AUTOSAR_SWS_RTE.pdf

[6] AUTOSAR Requirements on E2E
AUTOSAR_SRS_E2E.pdf

[7] System Template
AUTOSAR_TPS_SystemTemplate.pdf

[8] Specification of ECU Configuration
AUTOSAR_TPS_ECUConfiguration.pdf

[9] General Specification of Transformers
AUTOSAR_ASWS_TransformerGeneral.pdf

[10] AUTOSAR Glossary
AUTOSAR_TR_Glossary.pdf

[11] SoftwareComponent Template
AUTOSAR_TPS_SoftwareComponentTemplate.pdf

3.2 Related standards and norms

[12] ISO 26262:2011
www.iso.org

3.3 Related specification

AUTOSAR provides a General Specification on Transformers (ASWS Transformer General) [9], which is also valid for E2E Transformer.

Thus, the specification ASWS Transformer General [9] shall be considered as additional and required specification for E2E Transformer.

4 Constraints and assumptions

4.1 Limitations

The current solution for E2E communication protection is based on some use case constraints. Possibly, they will be reduced or they will be removed in future document versions:

1. Only sender-receiver (queued and non-queued) communication is considered (no client-server),
2. Only cyclic communication of/between Software Components is considered (no event-based),
3. Only inter-ECU communication is considered (communication that is exchanged over COM stack),
4. Only non-blocking characteristics of queued sender-receiver communication is considered (blocking characteristic for queued communication is not supported)

Please note that these constraints do not necessarily limit the use of the E2E Transformer to use cases meeting these constraints.

Further, the following limitations are known:

1. Error reporting to DEM not yet specified.

[UC_E2EXf_00007][The function E2EXf_<transformerId> shall be called cyclically by RTE.] (SRS_E2E_08538)

[UC_E2EXf_00008][The function E2EXf_Inv_<transformerId> shall be called cyclically by RTE, regardless if new data is available or not (e.g. regardless of result reported by Rte_IsUpdated).] (SRS_E2E_08538)

The cyclic invocation is needed because the E2E_Check is responsible (among others) to detect losses and delays, so in case of loss or delay, the E2E_Check is not invoked, resulting with potentially lost error detection. The cyclic invocation of E2E Transformer is ensured by cyclic invocation of corresponding RTE functions by Software Components.

4.2 Applicability to car domains

The E2E Transformer is applicable for safety-related communication.

5 Dependencies to other modules

The E2E Transformer depends on E2E Library. E2E Library provides data types and virtual (i.e. stateless) functions. E2E Transformer executes the E2E Library routines passing the configuration and state as function parameters.

5.1 Supported configuration variants

This document – SWS E2E Transformer – specifies the details of two configuration variants:

1. Link-time
2. Post-build-selectable.

Both are quite similar and use same kind of data structures. In link-time, structures are instantiated only once, while in post-build-selectable they can be instantiated more than once (with different values). Moreover, the configuration structures reside in different files (with suffix LCfg vs. PBCfg, see below).

There are currently no explicit Pre-compile time configuration settings apart from the settings specified in BSW General [3] and ASWS TransformerGeneral [9].

5.2 File structure

The code file structure is not defined within this specification completely. However to allow integration to other modules the following structure is needed.

[SWS_E2EXf_00001]⌈ The E2E transformer module shall provide at least the following code files:

- E2EXf.c.
- E2EXf_Lcfg.c,
- E2EXf_PBcfg.c.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00002]⌈ The E2E transformer module shall provide at least the following include files:

- E2EXf_Cfg.h
- E2EXf_Lcfg.h,
- E2EXf_PBcfg.h,
- E2EXf.h.⌋ (SRS_E2E_08538)

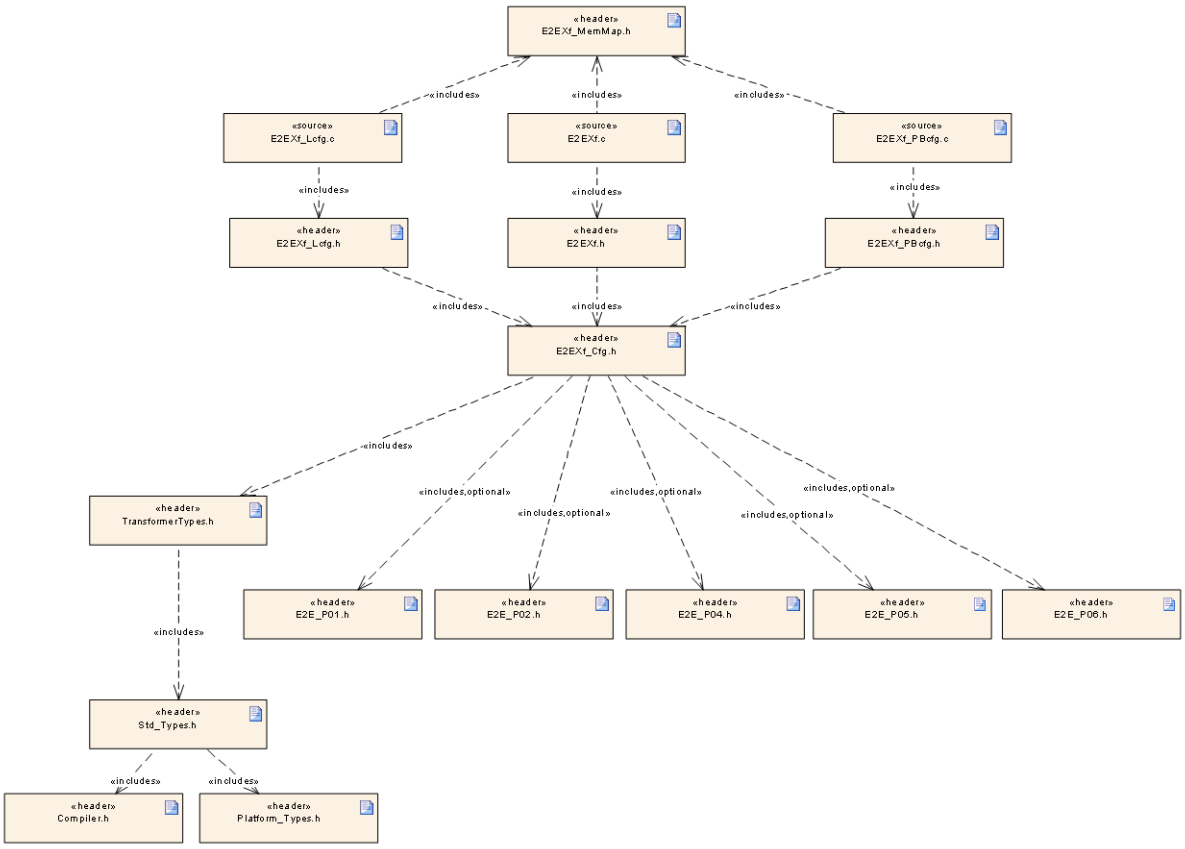
[SWS_E2EXf_00040]⌈ The contents of E2EXf files shall be as follows:

File	Contents

E2EXf.c	Definitions of config-independent functions
E2EXf_Lcfg.c	Definitions of all structures, in link-time variant.
E2EXf_PBcfg.c	Definitions of all structures, in post-build-selectable variant.
E2EXf_Lcfg.h	Declarations of all structures, in link-time variant.
E2EXf_PBcfg.h	Declarations of all structures, in post-build-selectable variant.
E2EXf.h	Declarations of config-independent functions
E2EXf_Cfg.h	Pre-compile settings, if any (e.g. #defines). No standard pre-compile settings are defined in SWS E2E Transformer, but in case some custom pre-compile time settings are defined, then this file is used for them.

] (SRS_E2E_08538)

[SWS_E2EXf_00003][The file structure and include-dependencies in E2E Transformer shall be as follows:



] (SRS_E2E_08538)

6 Requirements traceability

Requirement	Description	Satisfied by
-	-	SWS_E2EXf_00138
SRS_E2E_08538	-	SWS_E2EXf_00001, SWS_E2EXf_00002, SWS_E2EXf_00003, SWS_E2EXf_00009, SWS_E2EXf_00011, SWS_E2EXf_00018, SWS_E2EXf_00020, SWS_E2EXf_00021, SWS_E2EXf_00023, SWS_E2EXf_00024, SWS_E2EXf_00025, SWS_E2EXf_00027, SWS_E2EXf_00028, SWS_E2EXf_00029, SWS_E2EXf_00030, SWS_E2EXf_00032, SWS_E2EXf_00034, SWS_E2EXf_00035, SWS_E2EXf_00036, SWS_E2EXf_00037, SWS_E2EXf_00040, SWS_E2EXf_00048, SWS_E2EXf_00087, SWS_E2EXf_00088, SWS_E2EXf_00089, SWS_E2EXf_00090, SWS_E2EXf_00096, SWS_E2EXf_00097, SWS_E2EXf_00102, SWS_E2EXf_00103, SWS_E2EXf_00104, SWS_E2EXf_00105, SWS_E2EXf_00106, SWS_E2EXf_00107, SWS_E2EXf_00108, SWS_E2EXf_00109, SWS_E2EXf_00111, SWS_E2EXf_00112, SWS_E2EXf_00113, SWS_E2EXf_00114, SWS_E2EXf_00115, SWS_E2EXf_00116, SWS_E2EXf_00118, SWS_E2EXf_00119, SWS_E2EXf_00120, SWS_E2EXf_00122, SWS_E2EXf_00123, SWS_E2EXf_00124, SWS_E2EXf_00125, SWS_E2EXf_00126, SWS_E2EXf_00130, SWS_E2EXf_00132, SWS_E2EXf_00133, SWS_E2EXf_00134, SWS_E2EXf_00137, SWS_E2EXf_00139, SWS_E2EXf_00140, SWS_E2EXf_00141, SWS_E2EXf_00142, SWS_E2EXf_00144, SWS_E2EXf_00145, SWS_E2EXf_00146, SWS_E2EXf_00148, SWS_E2EXf_00149, SWS_E2EXf_00150, SWS_E2EXf_00151, SWS_E2EXf_00152, SWS_E2EXf_00153, SWS_E2EXf_00154, SWS_E2EXf_00155, UC_E2EXf_00007, UC_E2EXf_00008

7 Functional specification

E2E transformer is responsible for protecting safety-related data elements. It is invoked by RTE. On the sender side, E2E transformer E2E-protects the data. On the receiver side, E2E transformer E2E-checks the data, providing the result of the E2E-checks through RTE to SW-C.

If a receiving SWC doesn't read the transformer return codes, it is fully transparent to the communicating SWCs whether the data are E2E protected on the bus or not.

All algorithms are provided by E2E Library (protect, check, state machine). E2E transformer invokes E2 Library providing the configuration and state.

E2E transformer is generated to a high extent, where both configuration data structures and functions are generated.

The E2E Transformer has no module specific ECU configuration because its whole configuration is based on the E2ETransformationDescription, the E2ETransformationISignalProps and the E2ETransformationComSpecProps. Thus the generic ECU configuration of the ASWS Transformer General [9] is sufficient.

The configuration input can be found in TPS SystemTemplate ([7]) and TPS SoftwareComponentTemplate ([11]).

7.1 Supported RTE functions

Currently, the following inter-ECU communication functions are supported:

1. Rte_Write/Rte_Read
2. Rte_IWrite/Rte_IRead
3. Rte_Send/Rte_Receive

In future releases, this will be extended to client/server functions.

7.2 Naming for functions and data to be protected by E2E

E2E Transformer functions and structures get the suffix <transformerId>, defined as follows.

The pattern <*transformerId*> is defined in [SWS_Xfrm_00062] of ASWS Transformer General [9] and defines an unique ID for each transformer function.
This name pattern is also used in the names of the E2E transformer's C-APIs and therefore used in the BswModuleEntrys which represent the C-APIs.

This configuration builds the three stages of transformer configuration:

- **EndToEndTransformationDescription**
  defines the E2E configuration profiles, valid for several ISignals

- **EndToEndTransformationISignalProps**
  defines the configuration options valid for a specific referenced ISignal
- **EndToEndTransformationComSpecProps**
  defines the override configuration options valid for the port to which the ReceiverComSpec belongs

It is possible that there are several software components receiving independently data elements that are created (deserialized) from the same I-PDU. The following cases are possible:

1. Some software components have adjusted/special configuration values, related to the tolerances of the E2E state machine, e.g. bigger tolerances. For this, attributes of EndToEndTransformationComSpecProps is used.
2. Some QM software components may not need to E2E-check the data, so the E2E check can be skipped. For this, EndToEndTransformationComSpecProps.disableEndToEndCheck is used.

[SWS_E2EXf_00134]⌈ The configuration options in EndToEndTransformationComSpecProps shall have precedence over the options in EndToEndTransformationDescription and EndToEndTransformationISignalProps.⌋ (SRS_E2E_08538)

That means:
Configuration options in EndToEndTransformationComSpecProps override the configuration options in EndToEndTransformationDescription and EndToEndTransformationISignalProps.

[SWS_E2EXf_00154]⌈
If configuration option EndToEndTransformationComSpecProps.
disableEndToEndCheck is set for a given <*transformerId*>, then E2E Transformer shall skip the invocation of the E2E Library – it shall only perform buffer processing (e.g. copying from inputBuffer to buffer). ⌋ (SRS_E2E_08538)

To support multiple post-build-selectable variants, each configuration has a variant identifier.

[SWS_E2EXf_00090]⌈ In case of post-build-selectable configuration, the variants shall be named according to the configuration attribute PredefinedVariant.shortName. This means:
<v> = PredefinedVariant.shortName.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00089]⌈ In case of link-time configuration, there is just one variant, this means:
<v> = emtpy (NULL string). ⌋ (SRS_E2E_08538)

Note that all variants that are based on the same TransformationTechnology use the same E2E profile (e.g. P04).
This also means that all transformers with the same <transformerId> use the same E2E profile.

All variants have the same E2E-protected data elements.

The functions and state-structures are independent on variants <v> - they depend only on the specific instance of the E2E transformer and therefore on the<transformerId>, whereas config-structures depends on instance (<transformerId>) and configuration variant(<v>).

7.3 Generated structure types

Based on the E2E Transformer configuration (described in SystemTemplate [7], SoftwareComponentTemplate [11]) and the generated ECU configuration (described in ASWS Transformer General [9]), the corresponding C structures are generated as described below.

7.3.1 Overall config and state of E2E Transformer

[SWS_E2EXf_00011]⌈ The E2E Transformer shall generate the following data structure, to store the configuration of E2E Transformer module:
E2EXf_ConfigStruct_<v> (of type E2EXf_ConfigType)⌋ (SRS_E2E_08538)

[SWS_E2EXf_00125]⌈ The E2E Transformer shall derive the required number of independent state data resources of types E2E_PXXProtectStateType, E2E_PXXCheckStateType, and E2E_SMCheckStateType to perform E2E Protection within the E2E Transformer module from the number of E2E-protected data uniquely identified with <transformerId>, protected by profile XX.⌋ (SRS_E2E_08538)

7.3.2 Config and state of each E2E-protected data

[SWS_E2EXf_00126]⌈ The E2E Transformer shall derive the required number of independent statically initialized configuration objects of types E2E_PXXConfigType and E2E_SMConfigType to perform E2E Protection within the E2E Transformer, from:

1. the number of E2E-protected data uniquely identified with <transformerId>, protected by profile XX, and
2. the number of configuration variants (post-build selectable only).⌋ (SRS_E2E_08538)

7.4 Static initialization

7.4.1 Static initialization of config

Configuration is statically initialized based on the following metamodel classes:

1. EndToEndTransformationDescription: definition of E2E variants
2. EndToEndTransformationISignalProps: definition of a specific protection for a given ISignal (e.g. length, DataID)
3. EndToEndTransformationComSpecProps: override of some settings defining the check tolerances, with respect to E2E variants.

[SWS_E2EXf_00048]⌈ The generated configuration object of type E2E_P01ConfigType shall be initialized according to the following:

- DataID = EndToEndTransformationISignalProps.dataID
- DataLength = EndToEndTransformationISignalProps.dataLength
- CounterOffset = EndToEndTransformationDescription.counterOffset
- CRCOffset = EndToEndTransformationDescription.crcOffset
- DataIDNibbleOffset = EndToEndTransformationDescription.dataIdNibbleOffset
- DataIDMode shall be set to
    - E2E_P01_DATAID_BOTH if EndToEndTransformationDescription.dataIDMode == all16Bit
    - E2E_P01_DATAID_ALT if EndToEndTransformationDescription.dataIDMode == alternating8Bit
    - E2E_P01_DATAID_LOW if EndToEndTransformationDescription.dataIDMode == lower8Bit
    - E2E_P01_DATAID_NIBBLE if EndToEndTransformationDescription.dataIDMode == nibble
- MaxDeltaCounterInit = EndToEndTransformationComSpecProps.maxDeltaCounter-1 or EndToEndTransformationDescription.maxDeltaCounter-1
- MaxNoNewOrRepeatedData = EndToEndTransformationComSpecProps.maxNoNewOrRepeatedData or EndToEndTransformationDescription.maxNoNewOrRepeatedData
- SyncCounterInit = EndToEndTransformationComSpecProps.syncCounterInit or EndToEndTransformationDescription**.** syncCounterInit.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00118]⌈ The generated configuration object of type E2E_P02ConfigType shall be initialized according to the following:

- DataIDList = EndToEndTransformationISignalProps.dataID (array)
- DataLength = EndToEndTransformationISignalProps.dataLength or EndToEndTransformationDescription.dataLength
- Offset = EndToEndTransformationDescription.offset
- MaxDeltaCounterInit = EndToEndTransformationComSpecProps.maxDeltaCounter-1 or EndToEndTransformationDescription.maxDeltaCounter-1

- MaxNoNewOrRepeatedData = EndToEndTransformationComSpecProps.maxNoNewOrRepeatedData or EndToEndTransformationDescription.maxNoNewOrRepeatedData
- SyncCounterInit = EndToEndTransformationComSpecProps.syncCounterInit or EndToEndTransformationDescription**.** syncCounterInit.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00087]⌈ The generated configuration object of type E2E_P04ConfigType shall be initialized according to the following (one-to-one mapping):

- DataID = EndToEndTransformationISignalProps.dataID
- MinDataLength = EndToEndTransformationISignalProps.minDataLength
- MaxDataLength = EndToEndTransformationISignalProps.maxDataLength
- Offset = EndToEndTransformationDescription.offset
- MaxDeltaCounter = EndToEndTransformationComSpecProps.maxDeltaCounter or EndToEndTransformationDescription.maxDeltaCounter⌋ (SRS_E2E_08538)

[SWS_E2EXf_00119]⌈ The generated configuration object of type E2E_P05ConfigType shall be initialized according to the following (one-to-one mapping):

- DataID = EndToEndTransformationISignalProps.dataID
- DataLength = EndToEndTransformationISignalProps.dataLength
- Offset = EndToEndTransformationDescription.offset
- MaxDeltaCounter = EndToEndTransformationComSpecProps.maxDeltaCounter or EndToEndTransformationDescription.maxDeltaCounter ⌋ (SRS_E2E_08538)

[SWS_E2EXf_00120]⌈ The generated configuration object of type E2E_P06ConfigType shall be initialized according to the following (one-to-one mapping):

- DataID = EndToEndTransformationISignalProps.dataID
- MinDataLength = EndToEndTransformationISignalProps.minDataLength
- MaxDataLength = EndToEndTransformationISignalProps.maxDataLength
- Offset = EndToEndTransformationDescription.offset
- MaxDeltaCounter = EndToEndTransformationComSpecProps.maxDeltaCounter or EndToEndTransformationDescription.maxDeltaCounter⌋ (SRS_E2E_08538)

[SWS_E2EXf_00088]⌈ The generated config structure of type E2E_SMConfigType, shall be initialized according to the following (one-to-one mapping):

- WindowSize = EndToEndTransformationComSpecProps.windowSize or EndToEndTransformationDescription.windowSize
- MinOkStateInit = EndToEndTransformationComSpecProps.minOkStateInit or EndToEndTransformationDescription.minOkStateInit

- MaxErrorStateInit = EndToEndTransformationComSpecProps.maxErrorStateInit or EndToEndTransformationDescription.maxErrorStateInit
- MinOkStateValid = EndToEndTransformationComSpecProps.minOkStateValid or EndToEndTransformationDescription.minOkStateValid
- MaxErrorStateValid = EndToEndTransformationComSpecProps.maxErrorStateValid or EndToEndTransformationDescription.maxErrorStateValid
- MinOkStateInvalid = EndToEndTransformationComSpecProps.minOkStateInvalid or EndToEndTransformationDescription.minOkStateInvalid
- MaxErrorStateInvalid = EndToEndTransformationComSpecProps.maxErrorStateInvalid or EndToEndTransformationDescription.maxErrorStateInvalid⌋ (SRS_E2E_08538)

[SWS_E2EXf_00096]⌈ The configuration object E2EXf_ConfigStruct_<v> (see SWS_E2EXf_00011) shall be initialized to contain or to reference the config structures that were instantiated in above requirements of this section.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00097]⌈ In link-time variant, the E2EXf_Config pointer shall be initialized to reference E2EXf_ConfigStruct_0.⌋ (SRS_E2E_08538)

For post-build-selectable variant, the above code snippets are similar, but the initialization is done for every variant. Moreover, E2EXf_Config is set to NULL.

7.4.2 Static Initialization of state

Contrary to config structures, state structures do not depend on variants (<v>).

[SWS_E2EXf_00023]⌈ In all E2E Transformer variants, the generated state objects may be left uninitialized (i.e. without providing explicit initialization values). ⌋ (SRS_E2E_08538)

7.5 Runtime initialization by E2EXf_Init() function

7.5.1 Runtime selection of configuration (post-build variant only)

[SWS_E2EXf_00024]⌈ In post-build-selectable variant, E2EXf_Init() shall check that Config pointer (received as function parameter) points to one of the configuration variants E2EXf_ConfigStruct_<v>.If it is equal, then E2EXf_Init() shall select the passed configuration variant, and it shall set the module initialization state to TRUE according to SWS_E2EXf_00130.⌋ (SRS_E2E_08538)

7.5.2 Runtime initialization of State

[SWS_E2EXf_00021]⌈ The E2EXf_Init() function shall initialize all state structures managed by E2E transformer, calling the corresponding E2E_Init() method on each state variable.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00130]⌈ The E2E Transformer shall maintain a boolean information (Initialization state) that is only set to TRUE, if the module has been successfully initialized via a call to E2EXf_Init(). Otherwise, it is set to FALSE. ⌋ (SRS_E2E_08538)

[SWS_E2EXf_00132]⌈ In case of deinitialization (invocation of E2EXf_DeInit()), the module initialization state shall be set to FALSE.⌋ (SRS_E2E_08538)

7.6 Normal operation

[SWS_E2EXf_00133]⌈ If the E2E Transformer has not been correctly initialized (which means that E2EXf_Init() was not successfully called before), then all generated E2E Transformer APIs shall immediately return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

7.6.1 In-place processing and out-of-place processing

E2E Transformer functions work using in-place processing or out-of-place processing. This is configured by binary setting BufferProperties.inPlace.

In-place means that one buffer is used by a transformer both as input and as output. In-place processing has a performance advantage (less copying, less buffers). Out-of-place means that there is one input buffer and a separate output buffer.

7.6.2 E2EXf_<transformerId> (protect-function)

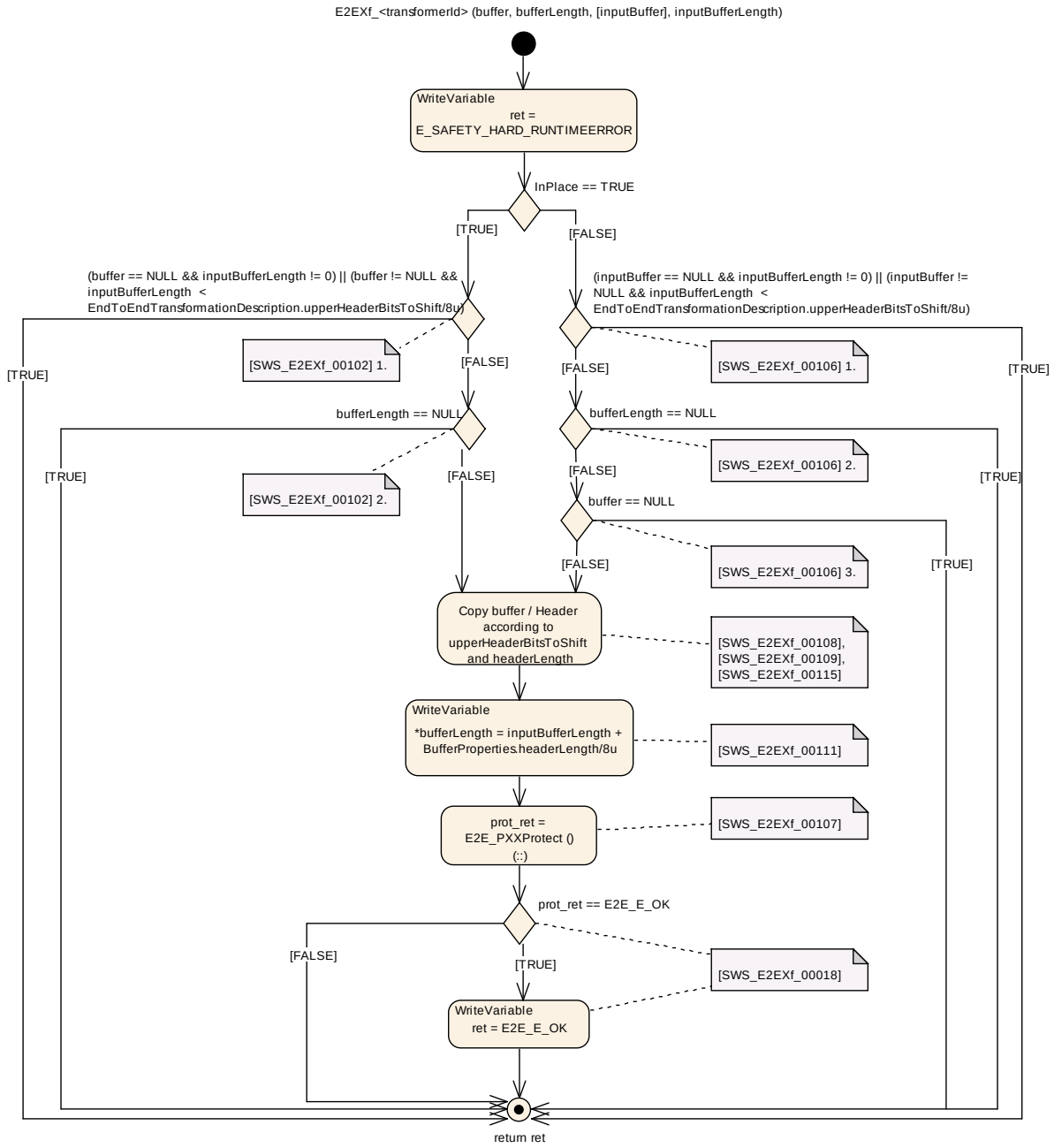


Figure 7-1: E2EXf_<transformerId> function overview

Figure above provides an activity diagram of the functionality provided by the API function E2EXf_<transformerId>.

[SWS_E2EXf_00020]⌈ The function E2EXf_<transformerId> shall be generated for each E2E-protected data element. ⌋ (SRS_E2E_08538)

[SWS_E2EXf_00102]⌈ In-place E2EXf_<transformerId> shall perform the following two precondition checks, without continuing further processing:

1. (buffer == NULL && inputBufferLength != 0)
   ||
   (buffer != NULL && inputBufferLength < EndToEndTransformationDescription.upperHeaderBitsToShift/8u)
2. bufferLength == NULL.

If any of above conditions is TRUE, then the function shall return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

The rationale for the checks is: first check the input parameters for plausibility. The combination of buffer == NULL and inputBufferLength == 0 is valid and signals the unavailability of new data. Then the output parameter bufferLength is checked.

[SWS_E2EXf_00106]⌈ Out-of-place E2EXf_<transformerId> shall perform the following three precondition checks, without continuing further processing:

1. (inputBuffer == NULL && inputBufferLength != 0)
   ||
   (inputBuffer != NULL && inputBufferLength < EndToEndTransformationDescription.upperHeaderBitsToShift/8u)
2. bufferLength == NULL
3. buffer == NULL

If any of above conditions is TRUE, then the function shall return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

The rationale for the checks is: first check the input parameters for plausibility. The combination of buffer == NULL and inputBufferLength == 0 is valid and signals the unavailability of new data. Then the output parameters bufferLength and buffer are checked.

Note that the function E2EXf_<transformerId> can be realized by a plain function or a macro (implementation-specific). The functions E2EXf_<transformerId> may call some internal common functions.

[SWS_E2EXf_00108]⌈ If (buffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift > 0), in-place E2EXf_<transformerId> shall copy the amount upperHeaderBitsToShift bits, in parameter buffer, with starting offset of BufferProperties.headerLength, in direction left by “distance” of BufferProperties.headerLength.⌋ (SRS_E2E_08538)

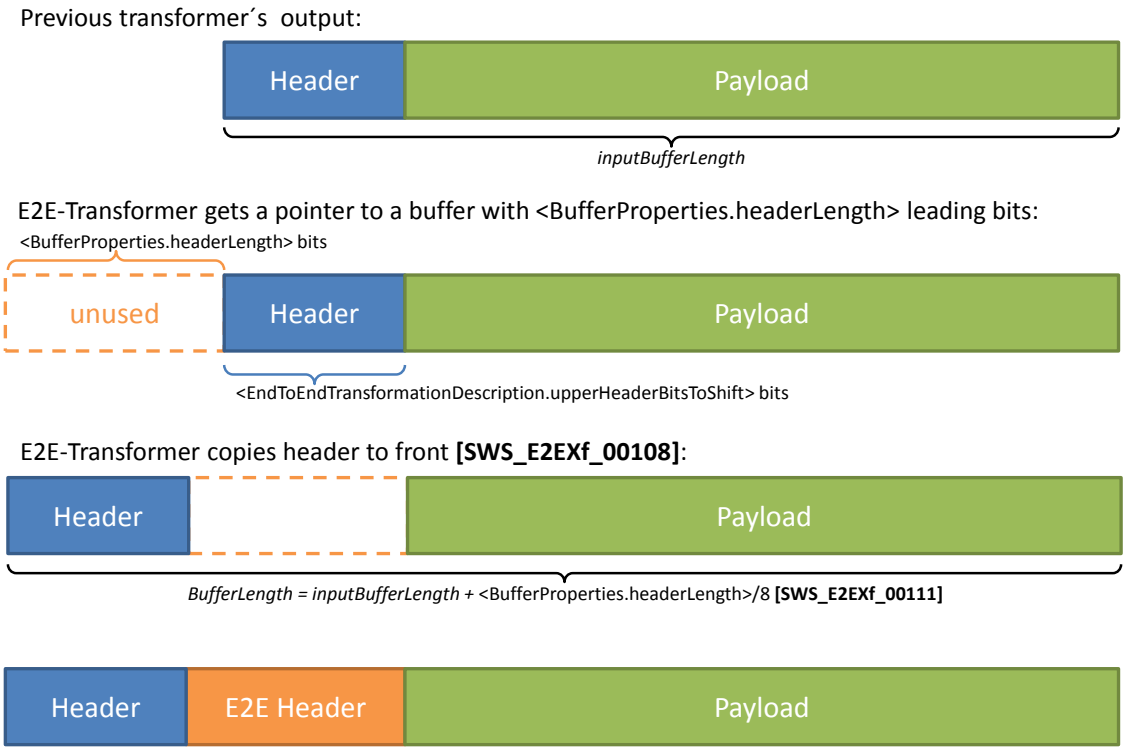


Figure 7-2: Buffer handling of E2EXf_<transformerId>

Figure 7-2 illustrates the buffer handling done by API function E2EXf_<transformerId> for In-Place.

[SWS_E2EXf_00109]⌈ If (inputBuffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift > 0), out-of-place E2EXf_<transformerId> shall copy the first upperHeaderBitsToShift bits from inputBuffer to buffer, and then copy the remaining part of inputBuffer (i.e. starting with offset upperHeaderBitsToShift) to parameter buffer starting with the destination offset of (upperHeaderBitsToShift+ BufferProperties.headerLength).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00115]⌈ If (inputBuffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift == 0), out-of-place E2EXf_<transformerId> shall copy inputBuffer to buffer starting with the destination offset of BufferProperties.headerLength.⌋ (SRS_E2E_08538)

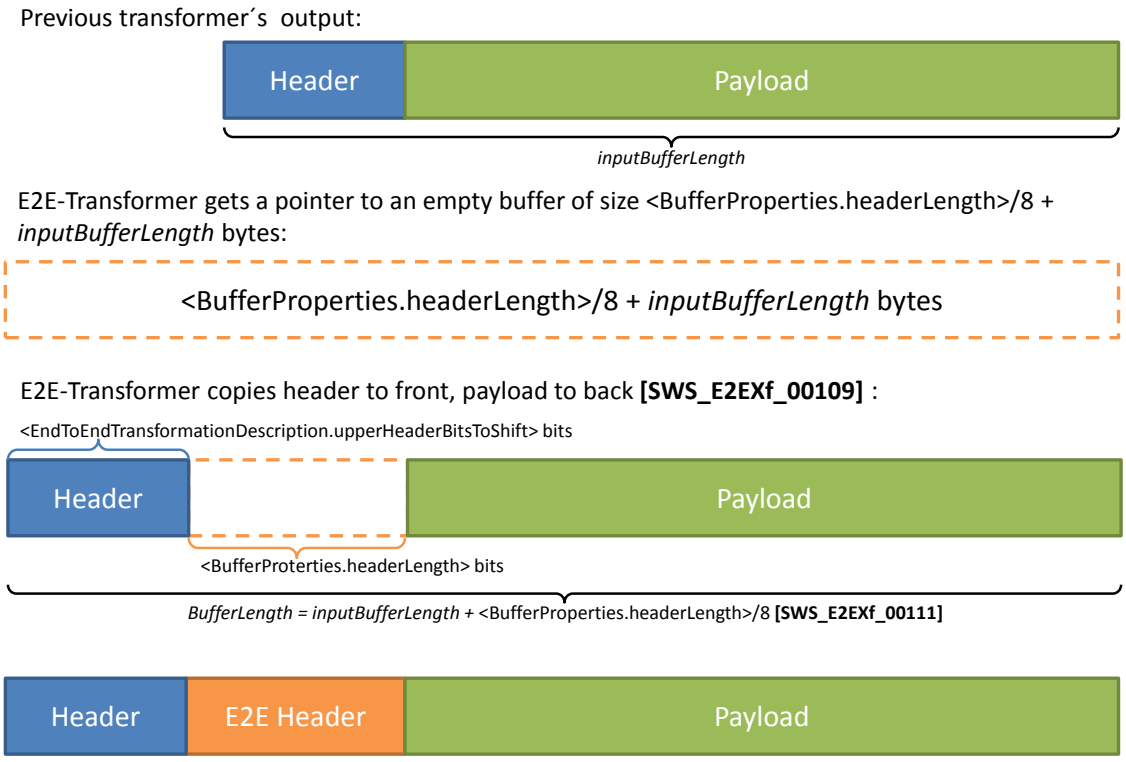


Figure 7-3: E2EXf_<transformerId> header shift Out-of-place

Figure 7-3 illustrates the buffer handling done by API function E2EXf_<transformerId> for Out-of-place.

[SWS_E2EXf_00111]⌈ E2EXf_<transformerId> shall set *bufferLength = inputBufferLength + BufferProperties.headerLength.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00139]⌈ For PXX = 01 or 02, the function E2EXf_<transformerId>() shall perform a check of the *bufferLength (after the computation of *bufferLength):
If (*bufferLength != config->DataLength), then the function shall return immediately E_SAFETY_HARD_RUNTIMEERROR, i.e. without calling an E2E Library function.⌋ (SRS_E2E_08538)

In case Some/IP based transformer is used, the E2E header of profile 1 and 2 are extended to 2 bytes. The extension is done by filling up unused nibble (4 bits) with 0xF. E2E header, when used with Some/IP, is always a consecutive block of bits, so the empty position is always the same: it is the high nibble of the byte after the CRC byte:

[SWS_E2EXf_00155]⌈ If (((PXX = 01 && dataIDMode == nibble) || (PXX == 02)) && BufferProperties.headerLength == 16 [bits]), the function E2EXf_<transformerId>() shall, before calling E2E_PXXProtect(), set 0xF in buffer at the bit offset (EndToEndTransformationDescription.crcOffset+12).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00107]⌈ The function E2EXf_<transformerId>() shall invoke E2E_PXXProtect(), passing to that function the appropriate Config and State structures (see [SWS_E2EXf_00125] and [SWS_E2EXf_00126]) that are associated with <transformerId>, as well as buffer and bufferLength (only for P04, P05 and P06) that were updated in above requirements SWS_E2EXf_00108, SWS_E2EXf_00109, SWS_E2EXf_00115, SWS_E2EXf_00111.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00018]⌈ In case E2E_PXXProtect() returns E2E_E_OK, then E2EXf_<transformerId> shall return E_OK, otherwise E2EXf_<transformerId> shall return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

7.6.3 E2EXf_Inv_<transformerId> (check-function)

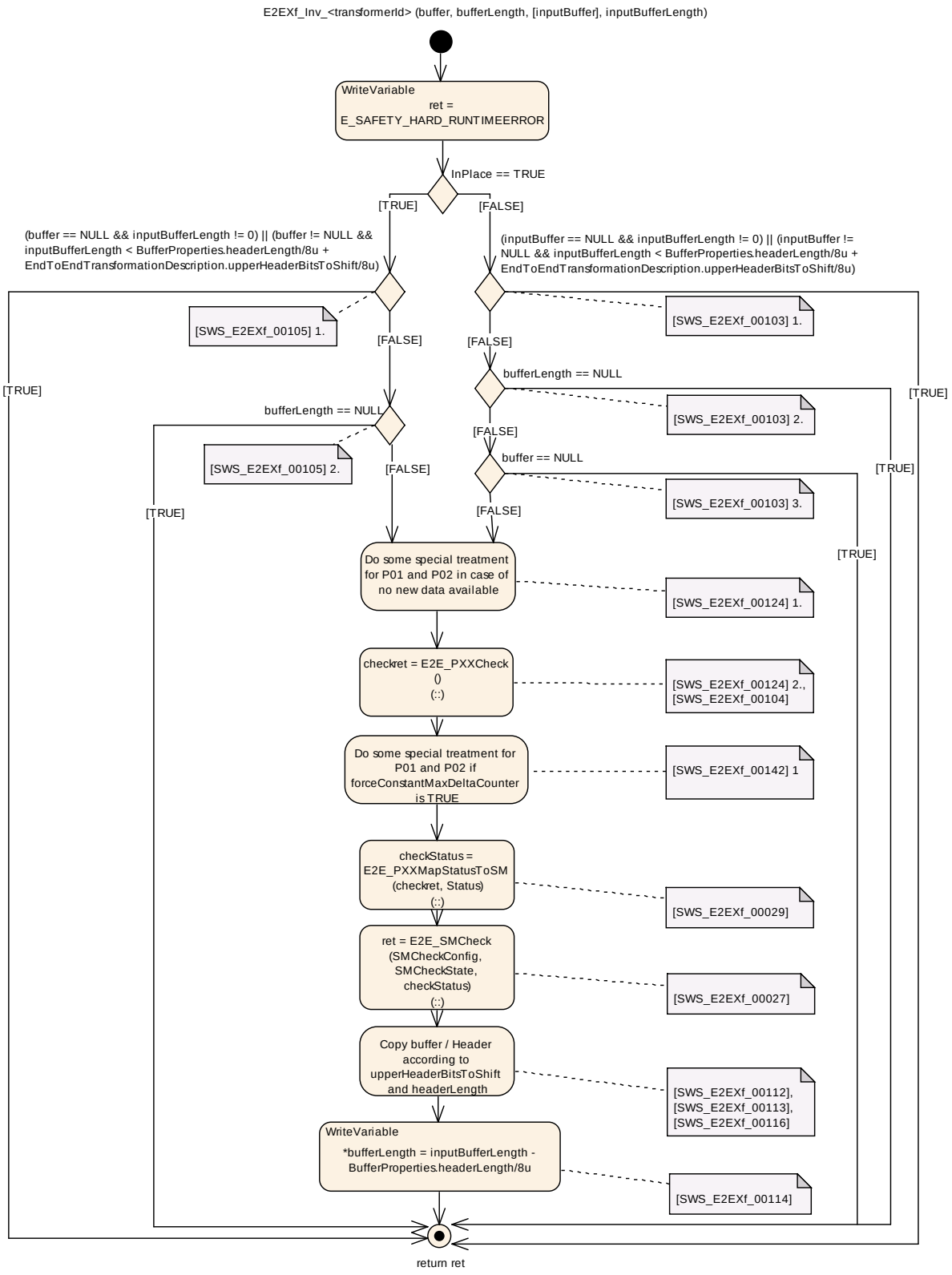


Figure 7-4: E2EXf_Inv_<transformerId> function overview

Figure above provides an activity diagram of the functionality provided by the API function E2EXf_Inv_<transformerId>.

[SWS_E2EXf_00025]⌈ The function E2EXf_Inv_<transformerId> shall be generated for each E2E-protected data element (<transformerId>).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00105]⌈ In-place E2EXf_Inv_<transformerId> shall perform the following two precondition checks, without continuing further processing:

1. (buffer == NULL && inputBufferLength != 0)
   ||
   (buffer != NULL && inputBufferLength < BufferProperties.headerLength/8u + EndToEndTransformationDescription.upperHeaderBitsToShift/8u)
2. bufferLength == NULL.

If any of above conditions is TRUE, then the function shall return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00103]⌈ Out-of-place E2EXf_Inv_<transformerId> shall perform the following three precondition checks, without continuing further processing:

1. (inputBuffer == NULL && inputBufferLength != 0)
   ||
   (inputBuffer != NULL && inputBufferLength < BufferProperties.headerLength/8u + EndToEndTransformationDescription.upperHeaderBitsToShift/8u)
2. If (bufferLength == NULL)
3. If (buffer == NULL).

If any of above conditions is TRUE, then the function shall return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

Note that the function E2EXf_Inv_<transformerId> may be realized by a plain function, inline function or a macro (implementation-specific). The functions E2EXf_Inv_<transformerId> may call some internal common functions.

[SWS_E2EXf_00140]⌈ For PXX = 01 or 02 (i.e. for profile 1 and 2), the out-of-place function E2EXf_Inv_<transformerId> shall

1. if(inputBuffer == NULL and inputBufferLength == 0), then
   - variable NewDataAvailable of state object of type E2E_PXXCheckStateType (see [SWS_E2EXf_00125]) associated with <transformerId> shall be set to FALSE
2. else if (inputBufferLength == config->DataLength), then
   - variable NewDataAvailable of state object of type E2E_PXXCheckState Type (see [SWS_E2EXf_00125]) associated with <transformerId> shall be set to TRUE.

else return E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00123]⌈ For PXX = 01 or 02 (i.e. for profiles 1 and 2), the out-of-place function E2EXf_Inv_<transformerId> shall
invoke E2E_PXXCheck(), passing to that function:

- config,
- state,
- pointer to data

pointer to data: if(inputBuffer == NULL and inputBufferLength == 0), then it shall pass a pointer to a 1-byte static variable of E2E transformer, otherwise it shall pass buffer (out-of-place) respectively inputBuffer (in-place).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00141]⌈ For PXX = 01 or 02 (i.e. for profiles 1 and 2), the in-place function E2EXf_Inv_<transformerId> shall

1. If(buffer == NULL and inputBufferLength == 0), then
   - variable NewDataAvailable of state object of type E2E_PXXCheckStateType (see [SWS_E2EXf_00125]) associated with <transformerId> shall be set to FALSE.
2. Else if (inputBufferLength == config->DataLength), then
   - variable NewDataAvailable of state object of type E2E_PXXCheckState Type (see [SWS_E2EXf_00125]) associated with <transformerId> shall be set to TRUE.
3. Else return E_SAFETY_HARD_RUNTIMEERROR.

⌋ (SRS_E2E_08538)

[SWS_E2EXf_00124]⌈ For PXX = 01 or 02 (i.e. for profiles 1 and 2), the in-place function E2EXf_Inv_<transformerId> shall invoke E2E_PXXCheck(), passing to that function:

- config,
- state,
- inputBufferLength

pointer to data: if(buffer == NULL and inputBufferLength == 0), then it shall pass a pointer to a 1-byte static variable of E2E transformer, otherwise it shall pass inputBuffer.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00142]⌈ If configuration parameter profileBehavior is PRE_R4_2, then for PXX = 01 or 02, E2EXf_Inv_<transformerId> () shall set the variable MaxDeltaCounter of the state object to the value of variable MaxDeltaCounterInit of the corresponding configuration object.⌋ (SRS_E2E_08538)

SWS_E2EXf_00123 and SWS_E2EXf_00124 either pass the pointer to valid buffer containing the E2E-protected data (in case data is available / is received) or otherwise provide a pointer to a dummy local variable, which is anyway not used by the E2E checks (NewDataAvailable is set to FALSE at the same time). Additionally, the length of the Buffer is checked, which is not done by profiles 1 and 2. It is necessary because the profiles P1 and P2 behave different from the newer profiles 4, 5 and 6. Profile 1 and 2 do not accept a NULL pointer, and they provide a sophisticated dynamic MaxDeltaCounter and re-synchronization mechanism different to the less complex checks provided in the newer profiles.
However, changes in the legacy profiles are not done to keep full backward-compatibility with existing implementations. Therefore, the new configuration parameter profileBehavior configures the E2EXf to reset the MaxDeltaCounter after each call of E2E_PXXCheck(), and the provided recommended configuration values for MaxNoNewOrRepeatedData and SyncCounterInit together with the different behavior of the mapping function E2E_PXXMapStatusToSM enforce a common behavior of all profiles when combined with the E2E state machine.

[SWS_E2EXf_00104]⌈ For PXX = 04, 05, 06: the function E2EXf_Inv_<transformerId> shall invoke E2E_PXXCheck(), passing to that function:
- config,
- state,
- data length: inputBufferLength

pointer to data: inputBuffer (out-of-place version) or buffer (in-place version).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00029]⌈ The function E2EXf_Inv_<transformerId> shall invoke E2E_MapPXXToSM(), passing to that function the return value of E2E_PXXCheck and the profile's check Status (variable Status of state object of type E2E_PXXCheckStateType, see [SWS_E2EXf_00125]), to obtain the profile-independent check status. For P1/P2 mapping functions, there is an additional call parameter profileBehavior:
- if configuration parameter profileBehavior is R4_2, then E2E_MapPXXToSM() shall be invoked with the call parameter profileBehavior = 1
- if configuration parameter profileBehavior is PRE_R4_2, then E2E_MapPXXToSM() shall be invoked with call parameter profileBehavior = 0⌋ (SRS_E2E_08538)

[SWS_E2EXf_00028]⌈ The function E2EXf_Inv_<transformerId> shall invoke the E2E_SMCheck() function, passing to that function the configuration object of type E2E_SMConfigType (see [SWS_E2EXf_00126] and [SWS_E2EXf_00088]) and state object of type E2E_SMCheckStateType (see [SWS_E2EXf_00125]) that are associated with <transformerId>, plus the profile-independent check status that was computed by E2E_MapPXXToSM() in SWS_E2EXf_00029. ⌋ (SRS_E2E_08538)

[SWS_E2EXf_00027]⌈ If E2E_SMCheck() returns E2E_E_OK, then:
- the high nibble of the return of the function E2EXf_Inv_<transformerId> shall be set to the low nibble of the state of the state machine (member SMState of object of type E2E_SMStateType that is associated with <transformerId>, see [SWS_E2EXf_00125]).
- The low nibble of the return of the function E2EXf_Inv_<transformerId> shall be set to the low nibble of the profile-independent check status of type E2E_PCheckStatusType.

If E2E_SMCheck() does not return E2E_E_OK, the return value shall be E_SAFETY_SOFT_RUNTIMEERROR.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00112]⌈ If (buffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift > 0), in-place E2EXf_Inv_<transformerId> shall copy the first upperHeaderBitsToShift bits, in parameter buffer, in direction right by "distance" of BufferProperties.headerLength.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00113]⌈ If (inputBuffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift > 0), out-of-place E2EXf_Inv_<transformerId> shall copy the first upperHeaderBitsToShift bits from inputBuffer to buffer, and then copy the remaining part of inputBuffer skipping E2E header (i.e. starting with offset

upperHeaderBitsToShift+BufferProperties.headerLength) to parameter buffer starting with the destination offset of (upperHeaderBitsToShift).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00116]⌈ If (inputBuffer != NULL && EndToEndTransformationDescription.upperHeaderBitsToShift == 0), out-of-place E2EXf_Inv_<transformerId> shall copy inputBuffer starting with the offset of BufferProperties.headerLength, to buffer.⌋ (SRS_E2E_08538)

[SWS_E2EXf_00114]⌈ If inputBufferLength == 0, then E2EXf_Inv_<transformerId> shall set *bufferLength = 0, otherwise it shall set *bufferLength = inputBufferLength - BufferProperties.headerLength.⌋ (SRS_E2E_08538)

The case where inputBufferLength is > 0 but shorter than header is covered by [SWS_E2EXf_00105].

7.6.4 De-Initialization

[SWS_E2EXf_00148] ⌈ E2EXf_DeInit() shall check shall set the module initialization state to FALSE.⌋ (SRS_E2E_08538)

7.7 Error classification

7.7.1 Development Errors

[SWS_E2EXf_00137]⌈ The E2E Transformer shall be able to detect the following development errors:

Type of error	*Related error code*	*Value [hex]*
Error code if any other API service, except GetVersionInfo is called before the transformer module was initialized with Init or after a call to DeInit	`E2EXF_E_UNINIT`	0x01
Error code if an invalid configuration set was selected	`E2EXF_E_INIT_FAILED`	0x02
API service called with wrong parameter	`E2EXF_E_PARAM`	0x03
API service called with invalid pointer	`E2EXF_E_PARAM_POINTER`	0x04

⌋ (SRS_E2E_08538)

[SWS_E2EXf_00144]⌈ If the E2EXfDevErrorDetect switch is enabled and the configuration variant is VARIANT-POST-BUILD, the function E2EXf_Init shall check if a NULL pointer is passed for the ConfigPtr parameter. In case of an error the remaining function shall not be executed and the function E2EXf_Init shall report

development error code E2EXF_E_PARAM_POINTER to the Det_ReportError service of the Development Error.] (SRS_E2E_08538)

[SWS_E2EXf_00145][If the E2EXfDevErrorDetect switch is enabled and the configuration variant is VARIANT-POST-BUILD, the function E2EXf_Init shall check the contents of the given configuration set for being within the allowed boundaries. If the function E2EXf_Init detects an error, then it shall skip the initialization of the E2E Transformer, keep the module internal state as uninitialized and it shall report development error code E2EXF_E_INIT_FAILED to the Det_ReportError service of the Default Error Tracer.] (SRS_E2E_08538)

[SWS_E2EXf_00146][If the configuration parameter E2EXfDevErrorDetect is enabled, the function E2EXf_DeInit shall check if the E2E transformer is initialized. In case of an error, the function E2EXf_DeInit shall return without any effect and shall report the error to the Default Error Tracer with the error code E2EXF_E_UNINIT.] (SRS_E2E_08538)

[SWS_E2EXf_00149][If the E2EXfDevErrorDetect switch is enabled, the function E2EXf_GetVersionInfo shall check if a NULL pointer is passed for the VersionInfo parameter. In case of an error the remaining function E2EXf_GetVersionInfo shall not be executed and the function E2EXf_GetVersionInfo shall report development error code E2EXF_E_PARAM_POINTER to the Det_ReportError service of the Default Error Tracer.
] (SRS_E2E_08538)

[SWS_E2EXf_00150][If the configuration parameter E2EXfDevErrorDetect is enabled, all parameters of API E2EXf_<transformerId> (see SWS_E2EXf_00032) shall be checked for being in the allowed range. In case of an error the mode switch shall not be executed, the error shall be reported to the Development Error Tracer with the value E2EXF_E_PARAM resp. E2EXF_E_PARAM_POINTER in case of a pointer argument and the routine shall return the value E_SAFETY_HARD_RUNTIMEERROR.
] (SRS_E2E_08538)

[SWS_E2EXf_00151][If the configuration parameter E2EXfDevErrorDetect is enabled, the API E2EXf_<transformerId> (see SWS_E2EXf_00032) shall check if the E2E Transformer is initialized. In case of an error the routine shall not be executed, the error shall be reported to the Default Error Tracer with the error code E2EXF_E_UNINIT and the routine shall return the value E_SAFETY_HARD_RUNTIMEERROR.
] (SRS_E2E_08538)

[SWS_E2EXf_00152][If the configuration parameter E2EXfDevErrorDetect is enabled, all parameters of API E2EXf_Inv_<transformerId> (see SWS_E2EXf_00034) shall be checked for being in the allowed range. In case of an error the mode switch shall not be executed, the error shall be reported to the Development Error Tracer with the value E2EXF_E_PARAM resp. E2EXF_E_PARAM_POINTER in case of a pointer argument and the routine shall return the value E_SAFETY_HARD_RUNTIMEERROR.] (SRS_E2E_08538)

[SWS_E2EXf_00153]⌈ If the configuration parameter E2EXfDevErrorDetect is enabled, the API E2EXf_Inv_<transformerId> (see SWS_E2EXf_00034) shall check if the E2E Transformer is initialized. In case of an error the routine shall not be executed, the error shall be reported to the Default Error Tracer with the error code E2EXF_E_UNINIT and the routine shall return the value E_SAFETY_HARD_RUNTIMEERROR.⌋ (SRS_E2E_08538)

7.7.2 Runtime Errors

[SWS_E2EXf_00122]⌈ The runtime errors detected by the E2EXf_<transformerId> function shall be reported as return value to the caller (i.e. to RTE).⌋ (SRS_E2E_08538)

[SWS_E2EXf_00009]⌈ The runtime errors detected by E2EXf_Inv_<transformerId> function and errors in the protected E2E communication shall be reported as return value to the caller (i.e. to RTE).⌋ (SRS_E2E_08538)

7.7.3 Transient Faults

There are no Transient Faults reported by E2E Transformer.

7.7.4 Production Errors

There are no production errors reported to DEM by E2E Transformer, because the error information is returned synchronously to the caller (RTE), which is then forwarded to calling software component.

7.7.5 Extended Production Errors

All Extended Production Errors valid for E2E Transformer are specified in ASWS Transformer General [9].

8 API specification

8.1 Imported types

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

[SWS_E2EXf_00047] Imported Types

Module	*Imported Type*
E2E	E2E_P01CheckStateType
	E2E_P01CheckStatusType
	E2E_P01ConfigType
	E2E_P01ProtectStateType
	E2E_P02CheckStateType
	E2E_P02CheckStatusType
	E2E_P02ConfigType
	E2E_P02ProtectStateType
	E2E_P04CheckStateType
	E2E_P04CheckStatusType
	E2E_P04ConfigType
	E2E_P04ProtectStateType
	E2E_P05CheckStateType
	E2E_P05CheckStatusType
	E2E_P05ConfigType
	E2E_P05ProtectStateType
	E2E_P06CheckStateType
	E2E_P06CheckStatusType
	E2E_P06ConfigType
	E2E_P06ProtectStateType
	E2E_PCheckStatusType
	E2E_SMCheckStateType
	E2E_SMConfigType
Std_Types	Std_ReturnType
	Std_VersionInfoType

] (SRS_E2E_08538)

Furthermore, ASWS Transformer General [9] defines types which shall be imported.

8.2 Type definitions

8.2.1 E2EXf_ConfigType

[SWS_E2EXf_00030] E2EXf_ConfigType

[

Name:	`E2EXf_ConfigType`
Type:	`Structure`

Element:	`void`	`implementation specific`	--
Description:	Parent container for the configuration of E2E Transformer. The content is implementation-specific.		

] (SRS_E2E_08538)

8.3 Function definitions

8.3.1 E2EXf_<transformerId>

[SWS_E2EXf_00032][

Service name:	E2EXf_<transformerId>	
Syntax:	`uint8 E2EXf_<transformerId>( uint8* buffer, uint16* bufferLength, const uint8* inputBuffer, uint16 inputBufferLength )`	
Service ID[hex]:	0x03	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	inputBuffer	This argument holds the length of the E2E transformer's input data (in the inputBuffer argument). If executeDespiteDataUnavailability is set to true and the transformer is executed without valid input data, the length will be equal to 0.
	inputBufferLength	This argument holds the length of the E2E transformer's input data (in the inputBuffer argument). If executeDespiteDataUnavailability is set to true and the transformer is executed without valid input data, the length will be equal to 0.
Parameters (inout):	buffer	This argument is only an INOUT argument for E2E transformers which are configured for in-place transformation. This is the buffer where the E2E transformer places its output data. If the E2E transformer is configured for in-place transformation, it also contains its input data. If the E2E transformer uses in-place transformation and has a headerLength different from 0, the output data of the previous transformer begin at position headerLength. This argument is only an OUT argument for E2E transformers configured for out-of-place transformation. It is the buffer allocated by the RTE, where the transformed data has to be stored by the transformer.
Parameters (out):	bufferLength	Used length of the buffer
Return value:	uint8	0x00 (E_OK): Function performed successfully. 0x77 (E_SAFETY_SOFT_RUNTIMEERROR):

		A runtime error occured, safety properties could not be checked (state or status cannot be determined) but non-protected output data could be produced nonetheless. 0xFF (E_SAFETY_HARD_RUNTIMEERROR): A runtime error occured, safety properties could not be checked and no output data could be produced.
Description:	Protects the array/buffer to be transmitted, using the in-place transformation.	

] (SRS_E2E_08538)

The return codes of E2EXf_<transformerId> are specified in TransformerTypes, see ASWS Transformer General.

8.3.2 E2EXf_Inv_<transformerId>

[SWS_E2EXf_00034][

Service name:	E2EXf_Inv_<transformerId>	
Syntax:	`uint8 E2EXf_Inv_<transformerId>( uint8* buffer, uint16* bufferLength, const uint8* inputBuffer, uint16 inputBufferLength )`	
Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	inputBuffer	This argument only exists for E2E transformers configured for out-of-place transformation. It holds the input data for the transformer. If executeDespiteDataUnavailability is set to true, Rte will hand over a NULL pointer to the transformer.
	inputBufferLength	This argument holds the length of the transformer's input data (in the inputBuffer argument). If executeDespiteDataUnavailability is set to true, the length will be equal to 0.
Parameters (inout):	buffer	This argument is only an INOUT argument for E2E transformers, which are configured for in-place transformation. It is the buffer where the input data are placed by the RTE and which is filled by the transformer with its output. This argument is only an OUT argument for E2E transformers configured for out-of-place transformation. It is the buffer allocated by the RTE, where the transformed data has to be stored by the transformer
Parameters (out):	bufferLength	Used length of the output buffer.
Return value:	uint8	The high nibble represents the state of the E2E state machine, the low nibble represents the status of the last E2E check. For the following return codes, please see SWS Transformer General: 0x00 (E_OK) This means VALID_OK 0x01 (E_SAFETY_VALID_REP) 0x02 (E_SAFETY_VALID_SEQ)

		0x03 (E_SAFETY_VALID_ERR) 0x05 (E_SAFETY_VALID_NND) 0x20 (E_SAFETY_NODATA_OK) 0x21 (E_SAFETY_NODATA_REP) 0x22 (E_SAFETY_NODATA_SEQ) 0x23 (E_SAFETY_NODATA_ERR) 0x25 (E_SAFETY_NODATA_NND) 0x30 (E_SAFETY_INIT_OK) 0x31 (E_SAFETY_INIT_REP) 0x32 (E_SAFETY_INIT_SEQ) 0x33 (E_SAFETY_INIT_ERR) 0x35 (E_SAFETY_INIT_NND) 0x40 (E_SAFETY_INVALID_OK) 0x41 (E_SAFETY_INVALID_REP) 0x42 (E_SAFETY_INVALID_SEQ) 0x43 (E_SAFETY_INVALID_ERR) 0x45 (E_SAFETY_INVALID_NND) 0x77 (E_SAFETY_SOFT_RUNTIMEERROR) A runtime error occured, safety properties could not be checked (state or status cannot be determined) but non-protected output data could be produced nonetheless. 0xFF (E_SAFETY_HARD_RUNTIMEERROR): A runtime error occured, safety properties could not be checked and no output data could be produced.
Description:	Checks the received data. If the data can be used by the caller, then the function returns E_OK.	

] (SRS_E2E_08538)

The return codes of E2EXf_Inv_<transformerId> are specified in TransformerTypes, see ASWS Transformer General.

8.3.3 E2EXf_Init

Add the following function:

[SWS_E2EXf_00035] E2EXf_Init
[

Service name:	E2EXf_Init	
Syntax:	`void E2EXf_Init( const E2EXf_ConfigType* config )`	
Service ID[hex]:	0x01	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	config	Pointer to a selected configuration structure, in the post-build-selectable variant. NULL in link-time variant.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	

Description:	Initializes the state of the E2E Transformer. The main part of it is the initialization of the E2E library state structures, which is done by calling all init-functions from E2E library.

] (SRS_E2E_08538)

8.3.4 E2EXf_DeInit

[SWS_E2EXf_00138][

Service name:	E2EXf_DeInit
Syntax:	`void E2EXf_DeInit( void )`
Service ID[hex]:	0x02
Sync/Async:	Synchronous
Reentrancy:	Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	Deinitializes the E2E transformer.

] ()

8.3.5 E2EXf_GetVersionInfo

Add the following function:

[SWS_E2EXf_00036] E2EXf_GetVersionInfo
[

Service name:	E2EXf_ GetVersionInfo
Syntax:	`void E2EXf_GetVersionInfo( Std_VersionInfoType* versioninfo )`
Service ID[hex]:	0x05
Sync/Async:	Synchronous
Reentrancy:	Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	versioninfo | Pointer to where to store the version information of this module.
Return value:	None
Description:	Returns the version information of this module.

] (SRS_E2E_08538)

8.4 Call-back notifications

None

8.5 Scheduled functions

None

8.6 Expected Interfaces

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

8.6.1 Mandatory Interfaces

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

[SWS_E2EXf_00037] Mandatory Interfaces
[

API function	*Description*
E2E_P01Check	Checks the Data received using the E2E profile 1. This includes CRC calculation, handling of Counter and Data ID.
E2E_P01CheckInit	Initializes the check state
E2E_P01MapStatusToSM	The function maps the check status of Profile 1 to a generic check status, which can be used by E2E state machine check function. The E2E Profile 1 delivers a more fine-granular status, but this is not relevant for the E2E state machine.
E2E_P01Protect	Protects the array/buffer to be transmitted using the E2E profile 1. This includes checksum calculation, handling of counter and Data ID.
E2E_P01ProtectInit	Initializes the protection state.
E2E_P02Check	Check the array/buffer using the E2E profile 2. This includes checksum calculation, handling of sequence counter and Data ID.
E2E_P02CheckInit	Initializes the check state
E2E_P02MapStatusToSM	The function maps the check status of Profile 2 to a generic check status, which can be used by E2E state machine check function. The E2E Profile 2 delivers a more fine-granular status, but this is not relevant for the E2E state machine.
E2E_P02Protect	Protects the array/buffer to be transmitted using the E2E profile 2. This includes checksum calculation, handling of sequence counter and Data ID.
E2E_P02ProtectInit	Initializes the protection state.
E2E_P04Check	Checks the Data received using the E2E profile 4. This includes CRC calculation, handling of Counter and Data ID. The function checks only one single data in one cycle, it does not determine/compute the accumulated state of the communication link.
E2E_P04CheckInit	Initializes the check state
E2E_P04MapStatusToSM	The function maps the check status of Profile 4 to a generic check status, which can be used by E2E state machine check function. The E2E Profile 4 delivers a more fine-granular status, but this is not relevant for the E2E state machine.
E2E_P04Protect	Protects the array/buffer to be transmitted using the E2E profile 4. This includes checksum calculation, handling of counter and Data ID.
E2E_P04ProtectInit	Initializes the protection state.
E2E_P05Check	Checks the Data received using the E2E profile 5. This includes CRC calculation, handling of Counter.

	The function checks only one single data in one cycle, it does not determine/compute the accumulated state of the communication link.
E2E_P05CheckInit	Initializes the check state
E2E_P05MapStatusToSM	The function maps the check status of Profile 5 to a generic check status, which can be used by E2E state machine check function. The E2E Profile 5 delivers a more fine-granular status, but this is not relevant for the E2E state machine.
E2E_P05Protect	Protects the array/buffer to be transmitted using the E2E profile 5. This includes checksum calculation, handling of counter.
E2E_P05ProtectInit	Initializes the protection state.
E2E_P06Check	Checks the Data received using the E2E profile 6. This includes CRC calculation, handling of Counter. The function checks only one single data in one cycle, it does not determine/compute the accumulated state of the communication link.
E2E_P06CheckInit	Initializes the check state
E2E_P06MapStatusToSM	The function maps the check status of Profile 6 to a generic check status, which can be used by E2E state machine check function. The E2E Profile 6 delivers a more fine-granular status, but this is not relevant for the E2E state machine.
E2E_P06Protect	Protects the array/buffer to be transmitted using the E2E profile 6. This includes checksum calculation, handling of counter.
E2E_P06ProtectInit	Initializes the protection state.
E2E_SMCheck	Checks the communication channel. It determines if the data can be used for safety-related application, based on history of checks performed by a corresponding E2E_P0XCheck() function.
E2E_SMCheckInit	Initializes the state machine.

⌋ (SRS_E2E_08538)

8.6.2 Optional Interfaces

None

8.6.3 Configurable interfaces

None

9 Sequence diagrams

9.1 Protect – E2EXf_<transformerId>

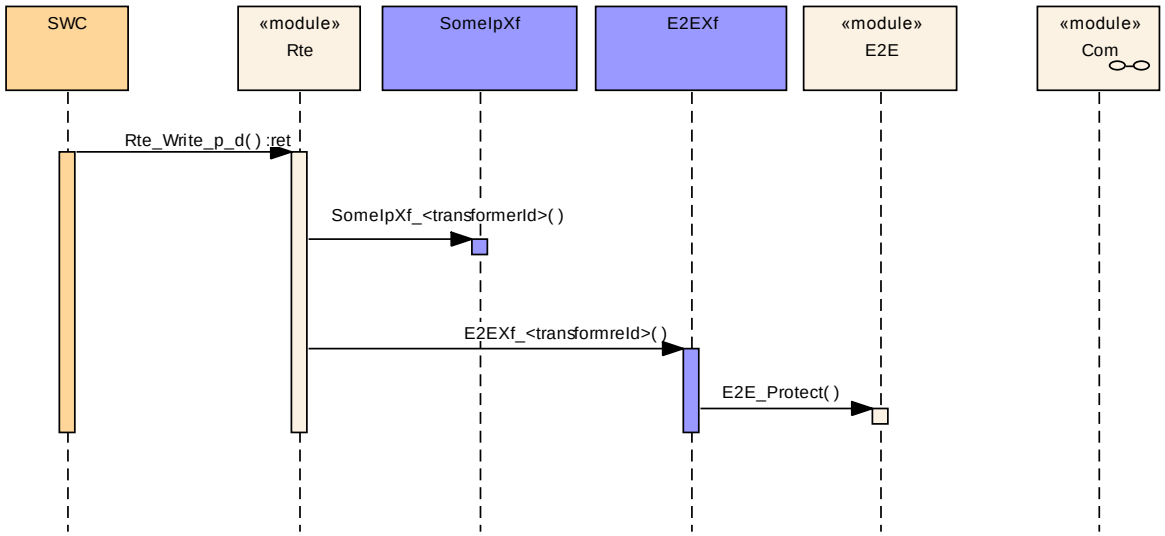


Figure 9-1: E2EXf

9.2 Check – E2EXf_Inv_<transformerId>

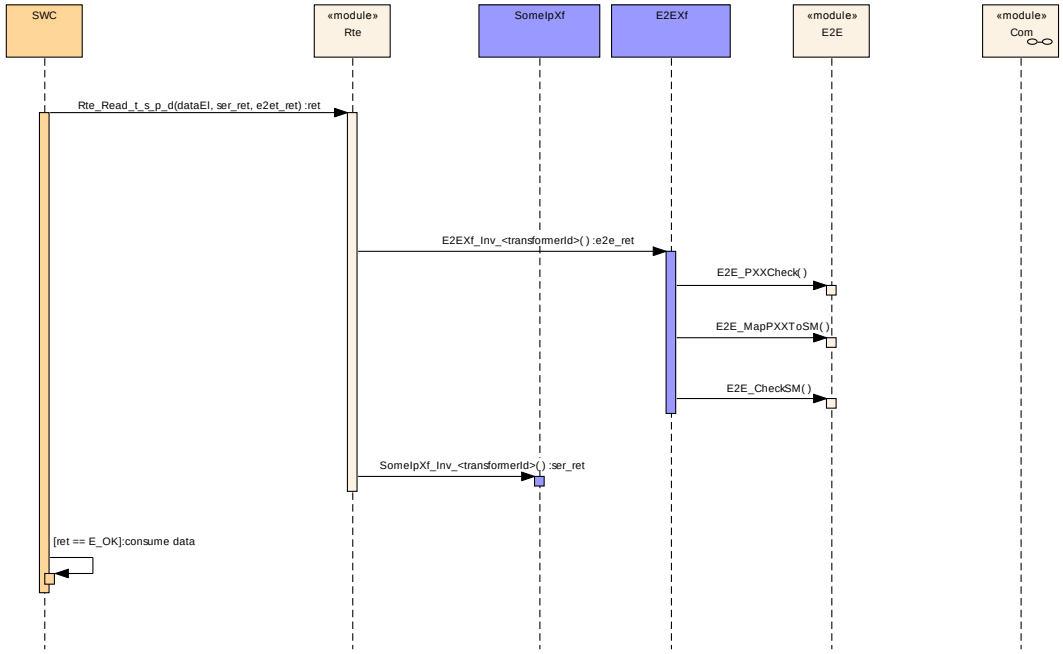


Figure 9-2: E2EXf_Inv

10 Configuration specification

There is no module specific ECU configuration for E2E Transformer. The following is used for the generation of E2E transformer:

1. Options defined in TPS System Template (defining functional options related to protection, e.g. IDs, counters)
2. Options defined in TPS Software Component template (defining options for specific ports that override options defined in TPS System Template)
3. Options defined in ASWS Transformer General (Mapping of TransformationTechnology entities of a DataTransformation to the implementing BswModuleEntry entities).

In order to avoid redundancy and inconsistency, the configuration is not repeated here.

11 Not applicable requirements

-