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Table of Contents

1 Scope of Document

The purpose of this document is to define functional and non-functional requirements to support the IEEE standardized transport protocol for time-senstive applications in a bridged local area network (see [1, IEEE Std 1722-2016]) in AUTOSAR.

2 Conventions to be used

2.1 Document Conventions

The representation of requirements in AUTOSAR documents follows the table specified in [TPS_STDT_00078], see [2, Standardization Template].

The verbal forms for the expression of obligation specified in [TPS_STDT_00053] shall be used to indicate requirements, see [2, Standardization Template].

2.2 Requirements Guidelines

No guidelines available.

3 Acronyms, Abbreviations and Definitions

3.1 Acronyms and abbreviations

The glossary below includes acronyms and abbreviations relevant to the specification or implementation of `IEEE1722` that are not included in the [3, AUTOSAR glossary].

Abbreviation / Acronym:	Description:
61883_IIDC	IEC 61883/IIDC format as defined by [1, IEEE Std 1722-2016]
AAF	AVTP Audio Format as defined by [1, IEEE Std 1722-2016]
ACF	AVTP Control Format as defined by [1, IEEE Std 1722-2016]
ACF_CAN	Controller Area Network (CAN)/CAN with Flexible Data-Rate (CAN FD) message as defined by [1, IEEE Std 1722-2016]
ACF_CAN_BRIEF	Abbreviated CAN/CAN FD message as defined by [1, IEEE Std 1722-2016]
ACF_LIN	LIN® message as defined by [1, IEEE Std 1722-2016]
AVTP	Audio/Video Transport Protocol as defined by [1, IEEE Std 1722-2016]
AVTPDU	Audio/Video Transport Protocol Data Unit as defined by [1, IEEE Std 1722-2016]
CRF	Control Reference Format as defined by [1, IEEE Std 1722-2016]
gPTP	generalized Precision Time Protocol [4, IEEE Std 802.1AS]
IIDC	Instrumentation and Industrial Digital Camera as defined by [1, IEEE Std 1722-2016]
NTSCF	None Time Sensitive Control Format as defined by [1, IEEE Std 1722-2016]
RVF	Raw Video Format as defined by [1, IEEE Std 1722-2016]
TSCF	Time Sensitive Control Format as defined by [1, IEEE Std 1722-2016]
TSpec	Traffic specification as defined by [5, IEEE Std 802.1Q-2022]

Table 3.1: Acronyms and abbreviations used in the scope of this Document

3.2 Definitions

3.2.1 Ethernet packet

Definition: An "Ethernet packet" is an on wire format defined by [6, IEEE Std 802.3-2022] which includes the following parts: Preamble (7 bytes), SFD (start frame delimiter, 1 byte), Ethernet frame (up to 2000 bytes)

3.2.2 Ethernet frame

Definition: An "Ethernet frame" is on wire format defined [6, IEEE Std 802.3-2022] which includes the following parts: MAC destination address field (6 bytes), MAC source address field (6 bytes), Type field (2 bytes), MAC client data field (inlcude optional Q-Tag (4 bytes)) (up to 1982 bytes), optional PAD (padding bytes), FCS (frame check sequence, 4 bytes)

3.2.3 Stream

Definition: A "stream" represent multiple Ethernet frames which are grouped by similar frame attributes (e.g. MAC source address)

3.2.4 IEEE1722 stream

Definition: A "IEEE1722 stream" represent multiple Ethernet frames which have EtherType set to AVTP Ethertype (0x22F0) (see [1, IEEE Std 1722-2016])), carry an IEEE1722 specified AVTP header and an AVTP stream data subtype (e.g. AAF (AVTP Audio Format))

3.2.5 Stream data producer

Definition: A "stream data producer" represent an end node in an Ethernet network which produces (continously) data. The data is transmitted via a stream and received by 1 or multiple end nodes (stream data consumer).
Note: The term "talker" is synonymous with "stream data producer".

3.2.6 Stream data consumer

Definition: A "stream data consumer" represent an end node in an Ethernet network which consumes (continously) data. The data is received via a stream.
Note: The term "listener" is synonymous with "stream data consumer".

3.2.7 AVTP presentation time

Definition: The "AVTP presentation time" is defined by [1, IEEE1722-2016] and represents the gPTP time at which designated data within an AVTPDU payload is transferred to a time-sensitive application of an stream data consumer. An AVTPDU-header of header format AVTPDU-common-stream-header carries the presentation time as "avtp_timestamp" according to [1, IEEE1722-2016]. AVTP presentation time is calculated as "TavtpPresentationTime" = "TcurrentGlobalTime" + "TmaxTransitTime". Please note: presentation time does not cover format conversion time and processing time of the receiving time-sensitive application (see [1, IEEE1722-2016] figure 6 "Figure 6 - AVTP Timing Reference Planes").

3.2.8 Max transit time

Definition: "Max transit time" is defined by [1, IEEE1722-2016]) and represents the maximal acceptable delay when data of a stream data producer is added to its egress queue, transfered across the network via an IEEE1722 stream and this data

is forwarded from the ingress queue of the receiving stream data consumer to a time-sensitive application.

3.2.9 Media clock

Definition: "Media clock" is defined by [1, IEEE1722-2016]) and represents an entity which generate a rate (e.g. precise hardware clock with an constant rate (e.g. 48kHz)). The media clock is hosted by the media clock provider.

3.2.10 Media clock provider

Definition: A "media clock provider" is an end node in the network which hosts an media clock. The media clock provider transmit an IEEE1722 stream to 1 or multiple media clock consumer. The IEEE1722 stream is of subtype CRF (clock reference format) and contain several presentation timestamps which correlates to the media clock rate.

3.2.11 Media clock consumer

Definition: A "media clock consumer" is an end node in the network which receive a IEEE1722 stream of subtype CRF (clock reference format) from a media clock provider. The media clock consumer perform a recovery of its media clock (e.g. PLL) based on the received encapsulated data from the media clock provider.

4 Requirements Specification

This chapter describes all requirements driving the work to define the FO_RS_IEEE1722.

4.1 Functional Overview

IEEE specify a transport protocol for time-senstive applications in a bridged local area network (see [1, IEEE Std 1722-2016]). IEEE1722 streams transport data between stream data provider and 1 or multiple stream data consumers. IEEE1722 streams carry among others a so-called "AVTP presentation time". The AVTP presentation time enables the possibilities to handle data synchronously across a local area network at several end nodes which receive the data via an IEEE1722 stream. The IEEE1722 transport protocol support several AVTP subtypes to cover different use cases,e.g. :

- audio and video streaming
- distribution of a generated clock rate of a so-called media clock
- encapsulation of bus frames (e.g. CAN frames, LIN frames) and transport via a IEEE1722 stream across the network

This specification contains requirements to support handling of IEEE1722 streams in classic and adaptive platform.

4.2 Functional Requirements

[FO_RS_IEEE1722_00001] IEEE1722Tp module APIs for IEEE1722 streams ⌈

Description:	The IEEE1722Tp module shall provide APIs to handle transmission and reception of IEEE1722 streams.
Rationale:	Provision of APIs which are used by the upper and lower layer
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	–
AppliesTo:	CP

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[FO_RS_IEEE1722_00002] IEEE1722Tp module handling of IEEE1722 streams ⌈

Description:	The IEEE1722Tp module shall handle IEEE1722 streams at transmission and reception side. Additional Information: Handling of IEEE1722 streams includes: • header inspection • payload inspection and unpack of encapsulated payload data • forwarding of received AVTPDU to the corresponding user • construction of stream headers according the configured AVTP message subtype • calculation of the AVTP presentation time according the configured max transit time.
Rationale:	An AUTOSAR stack provides the possibities to transmit and receive data via IEEE1722 streams.
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	–
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00003] IEEE1722Tp module access to synchronized global time ⌈

Description:	The IEEE1722Tp module shall support the access to the sychronized global time.
Rationale:	An AUTOSAR stack shall be able to calculate AVTP presentation time and to double check if received AVTP presentation time is valid.
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	–
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00004] IEEE1722Tp module media clock handling ⌈

Description:	The IEEE1722Tp module shall support the interaction with a media clock at stream data provider and at stream data consumer side. The IEEE1722Tp module shall support the construction of CRF compliant payload packages and to use the CRF compliant payload packages to perform media clock recovery. Additional Information: Media clock of a stream data producer and stream data consumer has to be synchronized to the same clock rate.
Rationale:	–

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Dependencies:	–
Use Case:	Audio data is produced by a stream data producer and forward to a stream data consumer according a given procession clock rate which could be derived from the system wide synchonized media clock rate.
Supporting Material:	[1, IEEE Std 1722-2016])
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00005] IEEE1722Tp module stream activation and deactivation ⌈

Description:	The IEEE1722Tp module shall provide a possibility to activate and de-activate configured IEEE1722 streams at runtime.
Rationale:	IEEE1722 streams need to follow communication mode of an ECU
Dependencies:	–
Use Case:	Activate and de-active IEEE1722 streams in dependency partial network requests
Supporting Material:	[1, IEEE Std 1722-2016])
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00006] IEEE1722Tp module immediate and deferred transmission request ⌈

Description:	The IEEE1722Tp module shall support immediate and deferred processing of transmission requests per IEEE1722 stream. If a transmission request of an IEEE1722 stream is configured to be processed immediate, then the transmission request is immediately forwarded to the lower layer. If a transmission request of an IEEE1722 stream is configured to be processed deferred, then the transmission request is stored and processed within the main function.
Rationale:	Low latency IEEE1722 streams need an immediate processing to grant expected arrival time at the stream data consumer.
Dependencies:	–
Use Case:	Audio streaming
Supporting Material:	
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00007] IEEE1722Tp module immediate and deferred reception processing ⌈

Description:	The IEEE1722Tp module shall support immediate and deferred processing of reception indications per IEEE1722 stream. If a reception indication of an IEEE1722 stream is configured to be processed immediate, then the reception indication is immediately forwarded to the upper layer. If a reception indication of an IEEE1722 stream is configured to be processed deferred, then the reception indication is stored and processed within the main function.
Rationale:	Low latency IEEE1722 streams need an immediate processing to grant expected processing time at an stream data consumer.
Dependencies:	–
Use Case:	Audio streaming
Supporting Material:	
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00008] IEEE1722Tp module encaspulates bus frames ⌈

Description:	The IEEE1722Tp module shall support the encapsulation of bus frames: • transport encapsulated bus frames via IEEE1722 streams • unpack encapsulate bus frames at stream data consumer side and to forward bus frames to local bus systems and/or local applications.
Rationale:	Zone-based network architectures need inter-zone communication across the communication network, where ECUs of the same bus type interchange encapsulated bus frames via an Ethernet network.
Dependencies:	[FO_RS_IEEE1722_00015]
Use Case:	Inter-zone communication
Supporting Material:	[1, IEEE Std 1722-2016])
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00009] IEEE1722Tp module collecting bus frames for transport ⌈

Description:	The IEEE1722Tp module shall support the collection of bus frames which are encapsulated and transported via an IEEE1722 stream.
Rationale:	Network communication for zone-based network architectures needs measures to balance between low latency and best effort traffic.
Dependencies:	–
Use Case:	Inter zone communication
Supporting Material:	

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AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00010] IEEE1722Tp module transmit trigger conditions for collected bus frames ⌈

Description:	The IEEE1722Tp module shall support at the stream data provider side the configuration of transmit trigger conditions for collected bus frames. The IEEE1722Tp module shall support the following transmission trigger conditions: • transmit trigger condition due to a timeout event • transmit trigger condition due to a exceeding threshold • transmit trigger condition due to a arrival of an bus frame which is configured to always trigger a transmission.
Rationale:	Network communication for zone-based network architectures need measures to balance between low latency and best effort traffic.
Dependencies:	–
Use Case:	Inter zone communication
Supporting Material:	
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00011] IEEE1722Tp module bus frame forwarding ⌈

Description:	The IEEE1722Tp module shall support forwarding of bus frames received via an IEEE1722 stream. If the IEEE1722Tp module receives a bus frame before its AVTP presentation time, then the IEEE1722Tp module shall forward the bus frame at its AVTP presentation time. If the IEEE1722Tp module receives a bus frame after its AVTP presentation time, then the IEEE1722Tp module shall not forward the bus frame.
Rationale:	Network communication for zone-based network architectures may need a synchronous forwarding of bus frames across multiple stream data consumer.
Dependencies:	–
Use Case:	Trigger an synchronous event via bus frames transported by an IEEE1722 stream to multiple stream data consumers.
Supporting Material:	
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00012] IEEE1722Tp module bus frame filtering ⌈

Description:	The IEEE1722Tp module shall support to filter bus frames which are configured for transportation via an IEEE1722 stream at stream data provider and stream data consumer side. If bus frames, which are configured to be transported via an IEEE1722 stream, arrive at a stream data provider, then the IEEE1722Tp module shall support a frame-id-based filter to limit the transport effort for designated bus frames. If a IEEE1722 stream, which carries encapsulated bus frames, arrives at the stream data consumer, then the IEEE1722Tp module shall support a frame-id-based filter to limit the forwarding effort to local applications and local buses.
Rationale:	Network communication for zone-based network architectures need measures to limit traffic of the inter-zone communication.
Dependencies:	–
Use Case:	Inter-zone communication
Supporting Material:	
AppliesTo:	CP, AP

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4.3 Non-Functional Requirements

[FO_RS_IEEE1722_00013] IEEE1722Tp module definition of IEEE1722 streaming ⌈

Description:	The IEEE1722Tp module shall support the definition of • IEEE1722 streams • stream data producers • stream data consumers. The IEEE1722Tp module shall support multiple stream data producers referencing the same IEEE1722 stream. The IEEE1722Tp module shall support multiple stream consumers to consume data from the same IEEE1722 stream.
Rationale:	Communication relation between stream data consumer and stream data producer need to be defined to design a proper network communication behavior.
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	–
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00014] IEEE1722Tp module support of IEEE1722 stream properties ⌈

Description:	The IEEE1722Tp module shall be able to configure IEEE1722 stream properties. The IEEE1722Tp module shall support usage of TSpec. Additional Information: • IEEE1722 stream properties: e.g. stream id, AVTP subtype • TSpec: defined in [5, IEEE Std 802.1Q-2022] (see ch. 35.2.2.8.4.) • TSpec support: stream properties for communicating traffic, e.g. max transit time
Rationale:	IEEE1722 stream properties impacting behavior of network communication.
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	see [5, IEEE Std 802.1Q-2022] ch. 35.2.2.8.4., [1, IEEE Std 1722-2016]
AppliesTo:	CP, AP

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[FO_RS_IEEE1722_00015] IEEE1722Tp module support of IEEE1722 AVTP stream data subtypes ⌈

Description:	The IEEE1722Tp module shall support the following ATVP stream data subtypes: • 61883_IIDC (0x00) • AAF (0x02) • CRF (0x03) • RVF (0x07) • TSCF (0x05) • NTSCF (0x82) The IEEE1722Tp module shall support the following ACF message types: • ACF_CAN (0x01) • ACF_CAN_BRIEF (0x02) • ACF_LIN (0x03) Additional Information: • ACF message types: carried as payload in the AVTP stream data subtype TSCF and NTSCF.
Dependencies:	–
Use Case:	Audio and video streaming
Supporting Material:	–

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AppliesTo:	CP, AP

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5 References

[1] IEEE Standard 1722-2016 - IEEE Standard for a Transport Protocol for Time-Sensitive Applications in Bridged Local Area Networks

[2] Standardization Template
AUTOSAR_FO_TPS_StandardizationTemplate

[3] Glossary
AUTOSAR_FO_TR_Glossary

[4] IEEE 802.1AS-2011 - IEEE Standard for Local and metropolitan area networks - Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks, Rev. 2011

[5] IEEE 802.1Q-2022 - IEEE Standard for Local and Metropolitan Area Network - Bridges and Bridged Networks
https://ieeexplore.ieee.org/

[6] IEEE 802.3-2022
https://www.ieee802.org/3/

A History of Constraints and Specification Items

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

A.1 Change History of this document according to AUTOSAR Release R25-11

A.1.1 Added Requirements in R25-11

none

A.1.2 Changed Requirements in R25-11

none

A.1.3 Deleted Requirements in R25-11

none

A.2 Change History of this document according to AUTOSAR Release R24-11

A.2.1 Added Requirements in R24-11

none

A.2.2 Changed Requirements in R24-11

none

A.2.3 Deleted Requirements in R24-11

none

A.3 Change History of this document according to AUTOSAR Release R23-11

A.3.1 Added Requirements in R23-11

Number	Heading
[FO_RS_IEEE1722_00001]	IEEE1722Tp module APIs for IEEE1722 streams
[FO_RS_IEEE1722_00002]	IEEE1722Tp module handling of IEEE1722 streams
[FO_RS_IEEE1722_00003]	IEEE1722Tp module access to synchronized global time
[FO_RS_IEEE1722_00004]	IEEE1722Tp module media clock handling
[FO_RS_IEEE1722_00005]	IEEE1722Tp module stream activation and deactivation
[FO_RS_IEEE1722_00006]	IEEE1722Tp module immediate and deferred transmission request
[FO_RS_IEEE1722_00007]	IEEE1722Tp module immediate and deferred reception processing
[FO_RS_IEEE1722_00008]	IEEE1722Tp module encaspulates bus frames
[FO_RS_IEEE1722_00009]	IEEE1722Tp module collecting bus frames for transport
[FO_RS_IEEE1722_00010]	IEEE1722Tp module transmit trigger conditions for collected bus frames
[FO_RS_IEEE1722_00011]	IEEE1722Tp module bus frame forwarding
[FO_RS_IEEE1722_00012]	IEEE1722Tp module bus frame filtering
[FO_RS_IEEE1722_00013]	IEEE1722Tp module definition of IEEE1722 streaming
[FO_RS_IEEE1722_00014]	IEEE1722Tp module support of IEEE1722 stream properties
[FO_RS_IEEE1722_00015]	IEEE1722Tp module support of IEEE1722 AVTP stream data subtypes

Table A.1: Added Requirements in R23-11

A.3.2 Changed Requirements in R23-11

none

A.3.3 Deleted Requirements in R23-11

none