

AUTOSAR UG-ET Curriculum

AUTOSAR Timing

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1. Timing and Tracing in AUTOSAR

1.1 Terms and Principles

Timing Design, Timing Analysis, Timing Measurement, ARTI, TIMEX, Log and Trace, Timing Events, Timing Event Chains, Scheduling Methods.

Here the AUTOSAR relation of these terms is handled.

1.2 Learning Goals

The learning goals build up on each other, the participants shall follow the sequence (building blocks).

LG 1-1: Timing Design in AUTOSAR Systems

Prerequisites

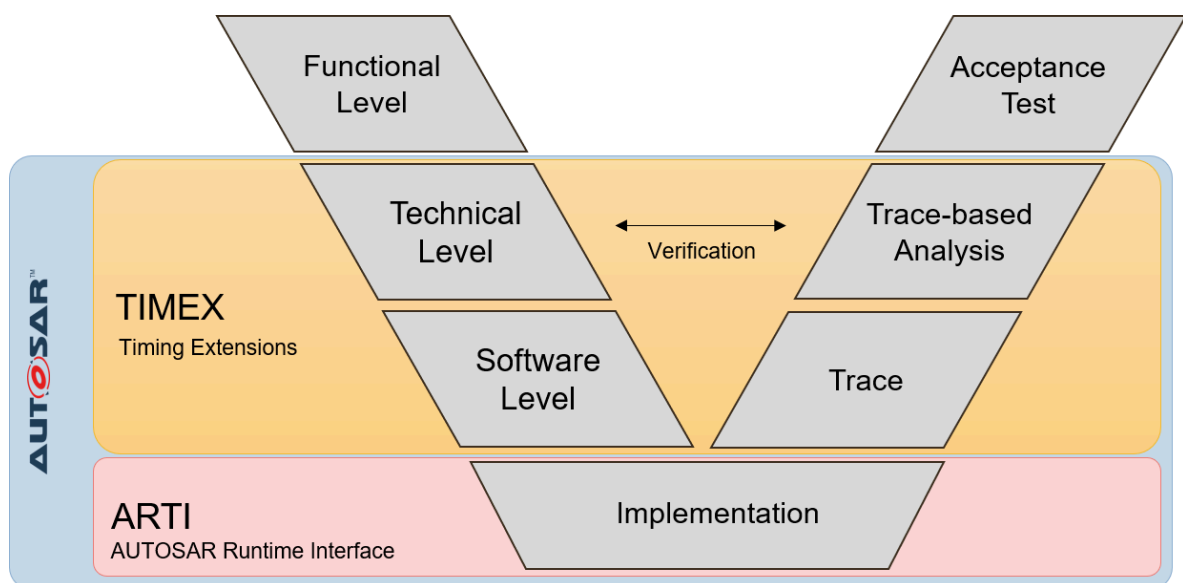
- Understanding of V-Model
- Understanding of System Level Logical Execution Time (SL-LET)

Learning Goals

Participants understand:

- Basic Concepts of Timing in the V-Model of AUTOSAR Systems within the development process
- Diagram of V-Model
- Timing Design on the left hand side of the V-Model and measurement and analysis on the right hand side of the V-Model
- Timing on Functional Level
- Timing for Network Level

- Timing for SW-Integration on ECU Level
- Splitting of Timing into different Levels (Decomposition of Timing)
- How to apply System Level Logical Execution Time to AUTOSAR Systems
- Properties and Methods for Timing
- Properties and Parameters like BUS load, Execution Time, CPU load, Slack Time
- Properties can be latency like or capacity like
- Methods like measurement, simulation or calculation of the properties
- Artifacts for Timing Analysis
- Timing reports
- Performance Analysis Report
- Trace Recording



LG 1-2: Timing Requirements Definition and Description with AUTOSAR TIMEX

The AUTOSAR Timing Extensions (TIMEX) are a specialized set of model elements added to the AUTOSAR meta-model to formally describe, specify, analyze, and validate the temporal behavior and requirements of real-time embedded systems.

Prerequisites

- Knowledge about AUTOSAR modeling
- Knowledge about RTE, e.g. Virtual Function Bus (VFB), ports, Runnables

Learning Goals

Participants understand:

- What TIMEX is about and what it is used for

- The Concept of Timing Views
- Model Elements of TIMEX:
 - TimingCondition
 - TimingDescription
 - TimingConstraint
- How to model timing with TIMEX
- Applying TIMEX model elements to AUTOSAR Systems, i.e.:
 - Sequence of timing events (event chains)
 - Deadlines
 - Periods
- How to use TIMEX in specific use cases, i.e.:
- Logical Execution Time
- System Level Logical Execution Time
- Worst Case Execution Time
- Thresholds of Latencies

LG 1-3: Defining Observable Locations in AUTOSAR

Prerequisites

- Knowledge about tasks, processes

Learning Goals

Participants understand:

- Which events have to be observed to get a specific timing parameter
- E.g. observe Runnable entries and exits to get the (Worst Case) Core Execution Time ((W)CET) of a Runnable
- E.g. observe task state changes to analyze the scheduling
- E.g. observe ports to identify an end-to-end timing
- The importance of observable locations
- How to identify observable locations in the system
- The possible observable locations in AP and CP

LG 1-4: Tracing Timing Events and Run-Time Behaviour

Prerequisites

- None specified

Learning Goals

Participants understand:

- How to utilize the methods of tracing in AUTOSAR
- Classic Platform (CP)
 - Using features of Diagnostic Log and Trace (DLT)
 - Using trace functionality of Virtual Function Bus (VFB)
 - Using the AUTOSAR Runtime Interface (ARTI)
- Adaptive Platform (AP)
 - Using features of Log and Trace (LT)
 - Using AUTOSAR Runtime Interface (ARTI) at Functional Cluster and Application Level
 - Using AUTOSAR Runtime Interface (ARTI) at OS level
- Using the DLT viewer as protocol analyzer
- The possibilities and necessities of filtering the trace
- Using a prefilter on AUTOSAR Runtime Interface (ARTI) on Classic Platform (CP)
- Using a prefilter on AUTOSAR Runtime Interface (ARTI) on Adaptive Platform (AP)
- Using dynamic filters of Log and Trace (LT)
- How to perform a tracing in AUTOSAR
- Different tracing methods (software/hardware oriented)
- Impact to runtime due to instrumentation/tracing
- How to exchange traced data
- Standardized exchange formats (ASAM TDF)

LG 1-5: Analyzing Timing and Verification against Requirements

Prerequisites

- None specified

Learning Goals

Participants understand:

- The Timing Parameters
- E.g. Initial Pending Time, Core Execution Time, Gross Execution Time, Response Time, Dead Line, Delta Time, Period, Slack Time, Net Slack Time, Jitter, Preemption Time, CPU Load, Bus Load
- How the timing parameters are calculated based on the traced events
- The use cases, e.g. Function-level, End-to-End, Network, ECU

- How to verify the timing against requirements
- Based on high level requirements
- Based on TIMEX
- The background and limits of analysis tools
- Especially calculation with insufficient trace data
 - Ambiguous or no observable location
 - Incomplete trace data, e.g. bandwidth limitations, storage limits, start/end of tracing
- Limits of expressiveness of terms (e.g. Bus Load, CPU Load)

1.3 References

- AUTOSAR_FO_TR_TimingAnalysis.pdf
- AUTOSAR_CP_TPS_TimingExtensions.pdf
- AUTOSAR_CP_SWS_ARTI.pdf
- AUTOSAR_CP_EXP_ARTI.pdf
- AUTOSAR_CP_SWS_DiagnosticLogAndTrace.pdf
- AUTOSAR_AP_SWS_LogAndTrace.pdf
- iSAQB LG 4-8: Real-Time Analysis of "Curriculum for Certified Professional for Software Architecture (CPSA)® Advanced Level: Module EMBEDDED"
- ASAM TDF