Timing Constraints in EAST-ADL and MARTE
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Introduction

Real-Time Embedded Systems (RTESs) are soft or hard, based on how strict their timing constraints are. Safety-critical RTESs are systems whose failure would lead to the loss of human lives or environmental disaster.

Figure 1. Model-based development

Performance and timing analysis, the key features of RTES development, can be done in the early development stages using model-based engineering (Figure 1).

Objectives

1) Review of state-of-the-art modelling languages for RTESs (Table 1).

Table 1. Summary of the modelling languages that have been reviewed

<table>
<thead>
<tr>
<th>Timing in</th>
<th>First release</th>
<th>Latest release</th>
<th>Developed by</th>
<th>Inspired by</th>
</tr>
</thead>
<tbody>
<tr>
<td>UML</td>
<td>UML 1.0 (1997)</td>
<td>UML 2.4 (2011)</td>
<td>OMG</td>
<td>Bosch, OMG/GDI</td>
</tr>
<tr>
<td>SPT</td>
<td>SPT 1.0 (2003)</td>
<td>SPT 1.1 (2005)</td>
<td>OMG</td>
<td>UML</td>
</tr>
<tr>
<td>MARTE</td>
<td>MARTE 0.2 (2009)</td>
<td>MARTE 3.0 (2011)</td>
<td>OMG</td>
<td>SPT</td>
</tr>
<tr>
<td>AUTOSAR</td>
<td>AUTOSAR 2003</td>
<td>AUTOSAR 4.1 (2013)</td>
<td>AUTOSAR Partnership</td>
<td></td>
</tr>
</tbody>
</table>

2) Case study: Analysis of TIMMO-2-USE’s validator of a Brake-By-Wire (BBW) system in a vehicle modelled in EAST-ADL.

EAST-ADL is a high level abstraction of AUTOSAR. It introduces 4 abstraction levels:

- Vehicle Level: Technical Feature Model
- Analysis Level: Functional Analysis Architecture
- Design Level: Functional and Hardware Design Architecture
- Implementation Level: AUTOSAR compliant code

The BBW model by TIMMO-2-USE includes multiform timing constraints: The vehicle shall start to brake within 5 meters after the brake pedal is pressed.

3) Design of a model of a BBW system in MARTE

MARTE is a UML profile for RTESs. We used custom Clocks, the TimedConstraint stereotype and non-functional properties from MARTE, Requirements from SysML, and OCL (Figure 2).

Figure 2. A MARTE class diagram constraint

Conclusions

Timing constraints can be specified using different mechanisms in all of the state-of-the-art modelling languages for RTESs.

TIMMO-2-USE’s BBW system modelled in EAST-ADL shows how EAST-ADL (and TADL) can be used in a model-based development of an RTES. A large number of tools can be used for modelling, implementation, and timing analysis but it is difficult to use a single tool-chain.

Our BBW model shows how MARTE (using elements from SysML and OCL) can be used in a model-based development of an RTES from the automotive industry.

Table 2. Comparison of EAST-ADL and MARTE timing constraints

References


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