Towards Translation of Timing Constraints during Vehicular Embedded Systems Development

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***Extended Abstract*—In the vehicular industry, different models are used at various abstraction levels and phases during the development of embedded real-time systems. Among other artifacts, timing requirements and specified timing constraints should be unambiguously translated among these models at various abstraction levels. In this context, we aim to provide unambiguous translation of timing constraints among various models, methodologies and languages for vehicular embedded real-time systems. This allows the holistic timing analysis to be performed not only at the implementation level but also at higher abstraction levels. As a first step, we propose translation of timing constraints, that are specified at higher abstraction levels using the Timing Augmented Description Language (TADL2), to an industrial model the Rubus Component Model.**

Introduction: The size and complexity of embedded software in vehicular embedded systems has drastically increased in the past few years. In the vehicular domain, for example, the embedded software in a high-end car consists of nearly 100 million lines of code that may reach up to the size of 1 GB [1]. This software may be realized by more than 2000 software functions, e.g., adaptive cruise control function. In order to deal with this complexity, the research community proposed to use model- and component-based development approach for these systems [2], [3]. This approach uses the principles of Model-Based Software Engineering (MBSE) and Component-Based Software Engineering (CBSE) . MBSE provides the means to use models to describe functions, structures and other design artifacts. Whereas, CBSE supports the development of large software systems by integration of software components. Hence, it raises the level of abstraction for software development and aims to reuse software components and their architectures. Within the segment of construction-equipment vehicles and similar segments for heavy special-purpose vehicles, model-based development of software architectures for embedded real-time systems has had a surge the last few years.

Motivation and Objectives: In the vehicular domain, different models, methodologies and tools are used at various *abstraction levels* and phases during the development of embedded systems. Often timing requirements and constraints are specified using one modeling technology, whereas detailed timing analysis is performed using the tools accompanying another. Hence, the timing information should be unambiguously translated among several modeling approaches, languages and tools. Within this context, we take a first step by considering TIMMO methodology [4] at the higher abstraction levels. This methodology makes use of EAST-ADL [5] for modeling of software architecture and TADL2 [6] for annotation of timing constraints. At the lower abstraction level, we consider modeling and timing analysis support of an existing industrial model the Rubus Component Model (RCM) [7] and accompanying tool suite Rubus-ICE [8]. RCM and Rubus-ICE are mainly used for model-and component-based development of control functionality in vehicles by several international companies. We propose unambiguous translation of timing constraints from TADL2 to RCM. The work in this paper is a step towards a bigger goal, i.e., development of a seamless tool-chain for model-based development of vehicular embedded systems; and support for inter-operating various modeling and analysis tools including the AUTOSAR-based tool chain [9], [10].

Proposed Approach: Timing requirements in TADL2 are modeled by means of timing constraints specified on events and event chains. There are tens of timing constraints in TADL2 that correspond to different types of timing requirements. These constraints are able to constrain, for example, execution times; delays in pair of events and event chains; various types of repetition patterns; and synchronization among events and event chains. In this initial work, we discuss only two constraints that are concerned with specific types of delay in event chains namely reaction and age. Reaction delay finds its applications in body electronics domain, whereas age delay is vital in control applications where the freshness of received data is important. First we discuss their semantics according to TADL2 specification [6]. Then we provide their unambiguous translation in RCM. We also propose extensions in RCM that are required for these translations. Finally, we discuss these constraints from the viewpoint of analysis engines.

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