TIMMO-2-USE
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Daniel Karlsson, Volvo Technology,
Sweden

Getting more for less
More predictable development, less time to market

The automotive industry is one of the main driving forces behind economic and employment wellbeing in Europe. Currently, European automotive suppliers and manufacturers are leading in electronic control for comfort, safety and environment protection. Within this context, the European automotive industry has continuously improved development and logistics processes whereby the AUTOSAR standard is the key factor in significantly strengthening the supply chain and achieving better quality and warranty at lower cost.

Innovations in the automotive sector require new development approaches in order to cope with the increasing complexity of large and decentralised control systems. In modern vehicles both existing and new functions must be integrated into a common electronic architecture such as comfort functions (e.g., park assist, climate control, navigation), safety functions (e.g., stability control, airbag, belt pretensioner), and functions for protecting the environment (e.g., direct fuel injection, catalytic optimisation).

In recent years there have been several approaches to manage the complexity challenges of new automotive electronic systems. AUTOSAR can be seen as the basis for a common in-vehicle software infrastructure and can already be found in series production cars. For comprehensive architecture description features, the EAST-ADL language, which dates back to the ITEA project EAST-EEA and has been enhanced in the EU FP7 projects ATESST and ATESST2, offers a viable means for specifying in-vehicle electronic architectures. But there is still a lack of sufficient support for handling timing information and constraints throughout the entire development process of complex electronic automotive systems. Timing is often deemed relevant in late development phases only such as the implementation and integration phases. As the effort for the development of innovative automotive functions steadily increases, new functions can often not be implemented in a cost-efficient way in the context of a considerably complex supply chain. In particular, when designing distributed real-time automotive systems, mastery of different types of timing constraints and dynamic behaviour in the supply chain of the complex development process is crucial. This requires adequate management and transformation of timing information in the complete development process as well as efficient exchange of timing information between different tools and various roles in the overall tool and supply chain (e.g., between OEM and Tier-1 suppliers).

BRIDGING THE GAP

A first step in this direction was undertaken by the ITEA 2 project Timing Model (TIMMO) with the development of the Timing Augmented Description Language (TADL) and the description of timing information on higher abstraction levels by referencing discrete events in the underlying EAST-ADL or AUTOSAR model. TIMMO-2-USE aimed to significantly increase automation for more predictable development cycles in order to substantially reduce development risks and time-to-market. To increase reliability, safety, robustness and fault tolerance by a much higher degree of design automation, TIMMO-2-USE addresses the specification, transition and exchange of relevant timing information throughout different steps of the AUTOSAR-based development process and tool chain. In other words, it bridges the gap between the continuous control domain (functional) and the software domain (implementation). The result is greatly improved methodology with respect to the derivation and tracing of different types of timing information and requirements with true design process improvements.

PROJECT STRUCTURE

The project was composed of seven work packages. Work packages 2, 3 and 4 developed technical extensions with respect to the state-of-the-art concerning language, algorithms and tools, and methodology respectively. The work was driven by use cases and requirements, developed in Work package 1 at the beginning of the project, encompassing issues covered by the technical work packages. This ensured that the work conducted in the work packages was well harmonised and suitable for practical use. Work package 5 validated the results of the main work packages by the means of validators based on the use cases defined in Work package 1 and validating Work package 1 requirements. The validation result was to be fed back to the respective main work package for evaluation and appropriate measures.

FOUR CORNERSTONES

The timing framework developed in the project consists of four cornerstones. The first is use cases that define industrially applicable timing problems that have been addressed in the project. They serve as a harmonising factor for the other cornerstones. The

second cornerstone centres on the development of a *methodology* that gives advice on how to approach the timing problems formulated by the use cases. The methodology consists of a set of independent processes (with tasks and work products), each dedicated to a specific use case. However, in order to keep them harmonised, they all share the same structure – called Generic Methodology Pattern (GMP). In this way, users are guided in combining the use case processes and to adopt them in their own organisations. The third cornerstone concerns *tools and algorithms* for management and analysis of timing information management and conversions in the development process as suggested by the methodology. The fourth cornerstone is an advanced *timing modelling language*, called TADL2, in which data can be transported between tools in a standard and unambiguous way, and is fully compliant and aligned with the AUTOSAR and EAST-ADL standards. The tools and algorithms and the language moreover relate to the methodology via tool mentors and TADL2 guides in order to create a harmonised whole. Tool mentors are attached to tasks in the methodology suggesting appropriate tools to perform the task. TADL2 guides provide a hint on how to use TADL2 to describe the necessary input and output work products of the tasks.

KEY ACHIEVEMENTS

The major achievements of TIMMO-2-USE were a formal XML-based language, Timing Augmented Description Language 2 (TADL2), which is used for system wide timing constraints of automotive functions, and a systematic development methodology which supports the practical application of the TADL2 within (real-world) automotive development cycles so that timing requirements can be specified over different stages of development. Both TADL2 and the corresponding methodology of TIMMO-2-USE are strongly based on AUTOSAR and EAST-ADL. The aim is to enhance the existing concepts within these initiatives.

The applicability and industrial relevance of the TIMMO-2-USE developments are guaranteed by the strong consortium of the TIMMO-2-USE project with renowned European automotive companies, system suppliers, tool vendors, and research institutions, including AbsInt, Arcticus Systems, Chalmers University of Technology, Continental Automotive, Delphi France, dSPACE, INCHRON, INRIA, Märadalen University, Rapita Systems, RealTime-at-Work, Robert Bosch GmbH, Symtavision, Technical University of Braunschweig, Time Critical Networks, University of Paderborn, and Volvo Technology.

TIMMO-2-USE established an OEM advisory board for early feedback and transfer of project results during the course of the project. The participation of leading automotive organisations not only guaranteed a high level of automotive engineering expertise but also excellent exploitation of the project's results. As many TIMMO-2-USE partners are AUTOSAR members, the project results will be deployed in the respective AUTOSAR working groups. This joint partnership with AUTOSAR has proven to be successful, giving TIMMO-2-USE an excellent internationally competitive position.

BENEFITS

The impact that such results have generated include shortened, predictable development cycles, reduced time-to-market through massive reuse, more efficient communication and collaboration between different parties involved in development, and less development risk with improved quality. The benefits need not be restricted to the automotive or transportation domains since they apply to any domain that needs to distribute functionality over a cluster of computation units.

In the near future, the TIMMO-2-USE results will be applied during the development of time-critical systems while the long-term strategy will see continuous standardisation through AUTOSAR, including adequate tool support. Also, as new releases of AUTOSAR are adopted in the development process TIMMO-2-USE results will be naturally exploited. Furthermore. TIMMO-2-USE results will enhance and adapt real-time modelling and verification while from an academic perspective, project results will be exploited in the form of scientific publications, and increased tool support for experiments with novel analysis algorithms.

MORE INFORMATION:

www.timmo-2-use.org