

## Project Results

# Mastering in-car timing constraints

## Standardised infrastructure meets design challenges for in-vehicle embedded systems

*The TIMMO project developed a common, standardised infrastructure for the handling of timing information during the design of embedded real-time systems in the automotive industry. This reduces the development cycle and increases its predictability to the benefit of carmakers and their suppliers. The result will be keep development cost of ever more advanced systems under tight control.*

Over the past decade, European carmakers have made extensive use of electronics to provide innovative features which improve vehicle comfort and safety while reducing environmental impact. Such innovations have been implemented on embedded architectures in the vehicle with communication over shared data buses.

### ENSURING CORRECT SYSTEM TIMING

Systems' interaction over the data buses is complex, involving applications sending many messages of differing natures and urgencies. A major challenge is to ensure correct system timing – particularly for safety-critical operations such as braking or vehicle stability. However, timing usually has only been considered at the network integration phase. Discovery of problems at this late stage can lead to costly iterations since most of the critical design decisions

have already been taken and are difficult to modify.

TIMMO set out to develop a timing-enhanced process covering end-to-end delay and synchronisation – for example setting the maximum delay between hitting the brake pedal and the brakes actuating, while ensuring all brakes act at the same time. This takes into account timing aspects in all development phases as well as abstraction levels and is capable of verifying the timing behaviour of real-time systems early in the design flow.

The need for TIMMO was recognised in the Automotive Open System Architecture (AUTOSAR) development partnership. This ITEA 2 project brought together carmakers, suppliers, tool vendors and research institutions with the intention of feeding back the results into the global AUTOSAR standard.

### TARGETING A COMMON, STANDARDISED APPROACH

TIMMO targeted a common approach to handling timing-related information. This significantly reduces the complexity and cost of the development cycle, while improving reliability. Consequently, complex innovative vehicle functionalities can be designed and implemented more easily, at less cost and with more confidence.

The principal goals were:

- Formal and standardised specification, analysis and verification of timing constraints across all development phases: This allows early analysis of whether a system can meet desired timing requirements, and avoids over- or under-dimensioned systems and unnecessary iterations in the development process; and
- Formal and standardised specification, analysis and verification of timing constraints at all levels of abstraction: Timing requirements have to be traced from the system level down to the implementation level.

## TIMMO (ITEA 2 ~ 06005)

### Partners

Audi Electronics Venture  
CEA-LIST  
Continental Automotive  
DENSO Europe  
ETAS  
Mentor Graphics  
Robert Bosch  
Siemens  
Symtavision  
TTTech Computertechnik  
University of Chalmers  
University of Paderborn  
Volkswagen  
Volvo Technology  
ZF Friedrichshafen

### Countries involved

Austria  
France  
Germany  
The Netherlands  
Sweden

### Project start

April 2007

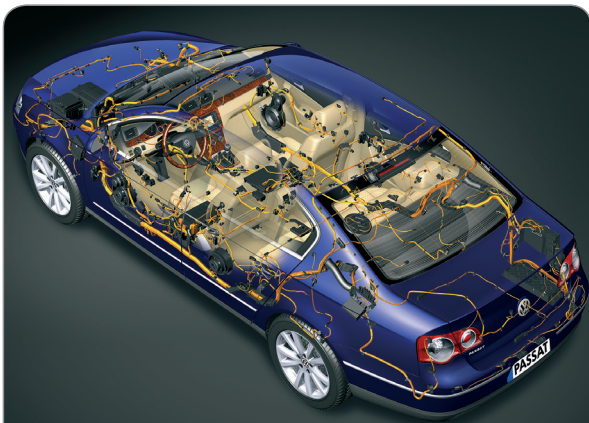
### Project end

September 2009

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Embedded electronics in a Volkswagen Passat

## Project Results

### DEVELOPING LANGUAGE AND METHODOLOGY

TIMMO developed a formal timing-augmented description language (TADL) for the modelling of timing information that includes a set of timing constructs complementing the EAST-ADL and AUTOSAR structural models. The project also produced a methodology describing how to apply the TADL, showing how timing-related information is identified, refined and verified during the design flow.

Several demonstrators validated the concepts and showed the applicability of the TADL and methodology. These included:

- A brake-by-wire system including an anti-lock braking system (ABS);
- A steer-by-wire system with active steering wheel, wheel actor and damping test bed;
- An engine-management system controlling ignition, injection and throttle;
- A transmission control implementing a simplified gearshift; and

- A cruise control system as well as a security system for car-access control implemented on three electronic control units (ECUs) – engine management, instrument cluster, and body.

### BENEFITING MORE THAN THE CAR INDUSTRY

The main beneficiaries of the TIMMO project results are carmakers and their suppliers. Both will use the new language and methodology for a well-defined exchange of timing information in automotive embedded-system development, with first practical results expected in 2010. And tool vendors will be able to develop and sell improved products that support the language and methodology.

Moreover, it is expected that TIMMO results will also interest the aerospace sector. And they can also inspire more general work in the Object Management Group (OMG) and other modelling tool groups.

## Major project outcomes

### DISSEMINATION

- 42 publications including conference presentations (IEEE, Springer, SAE International, etc).
- Numerous event presentations & demos (DATE 2009, ECRTS 2009, TIMMO Open workshops, ArtistDesign, ITEA 2 Symposia, RTIS)
- TIMMO's Timing Augmented Description Language (TADL) and the TIMMO methodology are available as public documents via [www.timmo.org](http://www.timmo.org).
- Other activities include: [www.timmo.org](http://www.timmo.org), brochure, newsletter, flyer.

### EXPLOITATION

Products:

- New tools and functionalities to edit, import/export, utilize TADL as description language for models and file interchange.
- ECUs with critical timing requirements, e.g. from chassis or powertrain domain.

Services:

- In-house workshops and trainings
- Consulting and optimization services to customers
- Creation of expertise for in-house services and developments
- Process enhancements by introducing TIMMO results into corporate methodologies

Systems:

- Strong commitment for supporting TADL as a standard exchange format
- New ECU platforms, SW architectures and corporate tool chains
- New vehicle platforms and E/E design systems / processes

### STANDARDISATION

TIMMO results are taken over by the two most relevant de-facto standards for automotive system design

- AUTOSAR uses TADL as base for its R4.0 timing model
- EAST-ADL2 takes over TADL and methodology

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■ ITEA 2 – Information Technology for European Advancement – is Europe's premier co-operative R&D programme driving pre-competitive research on embedded and distributed software-intensive systems and services.

As a EUREKA strategic Cluster, we support co-ordinated national funding submissions and provide the link between those who provide finance, technology and software engineering. Our aim is to mobilise a total of 20,000 person-years over the full eight-year period of our programme from 2006 to 2013.

■ ITEA 2-labelled projects are industry-driven initiatives building vital middleware and preparing standards to lay the foundations for the next generation of products, systems, appliances and services. Our programme results in real product innovation that boosts European competitiveness in a wide range of industries. Specifically, we play a key role in crucial application domains where software dominates, such as aerospace, automotive, consumer electronics, healthcare/medical systems and telecommunications.

■ ITEA 2 projects involve complementary R&D from at least two companies in two countries. We issue annual Calls for Projects, evaluate projects and help bring research partners together. Our projects are open to partners from large industrial companies and small and medium-sized enterprises (SMEs) as well as public research institutes and universities.



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**TIMMO**

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