

TIMMO

(ITEA 2 ~ 06005)

Friedhelm Stappert,
Continental Automotive, Germany

Managing in-car timing constraints

The TIMMO project developed and demonstrated a common, standardised infrastructure to ensure optimum handling of timing information during the design of embedded real-time systems for the automotive industry. Building on the existing AUTOSAR standard, this approach will shorten the development cycle of new vehicles and functions, and increase its predictability, benefitting both carmakers and their suppliers. The results will keep development cost of ever more advanced systems under tight control, while speeding design. First applications are expected in the car industry by the end of 2009.



Use of embedded electronics and software has had a major impact on innovation in the automotive industry in recent years, driven in great part by European manufacturers. It has enabled improvements in:

- Comfort – such as parking assistance, automatic climate control and navigation systems;
- Safety – including vehicle stability control, multiple airbag systems and seatbelt pre-tensioners; and
- Environmental protection – such as direct fuel injection and catalytic converter control.

This has meant that today's cars have many computers communicating through in-vehicle data buses in a complex, distributed, electronic architecture that has to integrate both, existing and new functions. Future functions will be even more complex, distributed, interconnected and necessarily inter-dependent. Correct behaviour will not simply be a matter of functional correctness, but will also depend on timing and reliability constraints.

The effects of improper timing range from loss of comfort to life-threatening situations. Building systems in an efficient, predictable and reliable way in spite of the increased complexity of functions and architectures as well as managing the supply chain to ensure predictable integration of software components and platforms is a major challenge.

ENSURING CORRECT SYSTEM TIMING

Systems' communications over the data buses is complex, involving applications sending many messages of differing natures and urgencies. Correct system timing is essential – particularly for safety-critical operations. For example, the safe functioning of vehicle stability control systems which involves differential braking of individual wheels depends on the timely delivery of braking commands.

However, while precise timing and prioritisation of functions are essential for both safety and comfort, timing has only been considered rather late in the design flow. Timing behaviour is verified by means of measurements at testing time, rather than through formal and systematic analysis accompanying the whole design process. Discovery of problems at this late point leads to costly iterations since most of the critical design decisions have already been taken and are difficult to modify.

TIMMO therefore set out to develop a timing-enhanced process covering end-to-end delay and synchronisation – for example fixing 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 this ITEA 2 project was recognised in the Automotive Open System Architecture (AUTOSAR) development partnership, which developed out of the ITEA EAST-EEA project. TIMMO brought together leading European carmakers, their major suppliers, tool vendors and advanced research institutions with the intention of feeding back the results into the global AUTOSAR process. Partners came from Austria, France, Germany, the Netherlands and Sweden.

TARGETING A COMMON, STANDARDISED APPROACH

TIMMO targeted a common approach to handling timing-related information. This has significantly reduced 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 and at all levels of abstraction. The aim was to allow early analysis of whether a system can meet specified timing requirements, while avoiding over- or under-dimensioned systems and unnecessary iterations in the development process. Abstraction is important

to enable timing requirements to be traced from the systems level down to the implementation level.

A key innovation was the development of a formal timing-augmented description language (TADL) for the modelling of timing information. This UML-based language includes a set of timing constructs complementing the EAST-ADL2 architecture description language and the industry standard AUTOSAR. TIMMO also produced a methodology describing how to apply the language, showing the way timing-related information is identified, refined and verified.

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

BENEFITTING MORE THAN THE CAR INDUSTRY

The main beneficiaries of the ITEA project results will be carmakers and their suppliers. Both will use the new TIMMO language and methodology – being part of AUTOSAR 4.0 in late 2009 – for a well-defined exchange of timing information in automotive embedded-system development.

The first practical applications are expected in 2010. And tool vendors will be able to develop and sell improved products that support the new language and methodology.

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

While the AUTOSAR standard is global with application in North America and Asia-Pacific, European carmakers and tool suppliers should be the first to benefit from the new approach, helping a key industry emerge more quickly from the current economic crisis.

More information: www.timmo.org