ITEA

INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

PROJECT RESULTS

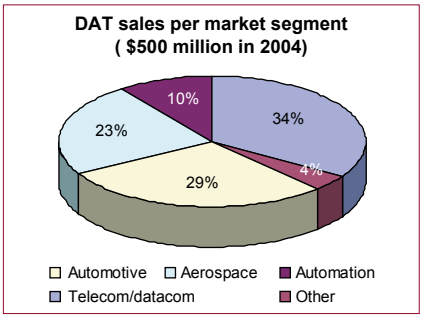
Bringing systems faster to market

Seamless design flow for embedded systems in industrial products

Europe has traditionally been strong in systems technology, and has a prominent position in domains such as telecommunications, aerospace and automotive. In all of these industries, where most innovations are based on embedded systems, market growth and expansion are limited principally by companies' lack of capacity to introduce new products. PROMPT2IMPLEMENTATION (P2I) now provides a system-level co-design approach that allows unambiguous specification, simulation, testing and implementation of proven real-time embeddable systems.

With methodologies and tools only available for high-level specification of complex systems using UML or other application-oriented languages, ensuring coherence between the design and the implementation phases has been a major issue for the telecommunication, aerospace and automotive industries. The traditional approach was to validate real-time embedded applications using manual optimisation very late in the process. This required the availability of all hardware and software, which was expensive and increased the time to market.

Rapid development of cost-effective and high quality embedded systems was thus recognised as a key crucial competitive factor. It has given rise to a dedicated market for design automation tools (automating the design and prototyping of systems). This trend (see figure) generated more than $500 million of revenue in 2004, and is expected to keep growing over the next three years.



The P2I approach takes into account both functional and architectural constraints, providing a seamless end-to-end flow from early specification to final implementation. It is based on a UML 2.0 dedicated profile for real-time embedded systems and extensively uses MDA (model driven architecture) concepts. It guarantees a clear separation between models and execution platforms.

Three models have been introduced:

1. The **application model** allows systems to be designed as hierarchical compositions of reusable building blocks having precise semantics. Both asynchronous and synchronous components are supported. Two flavours of behaviours are available: Data-flow oriented (activity) and control oriented (State Machine);

2. The **hardware architecture model** enables resources to be defined according to functional or structural criteria. The user can specify topologies, dimension processing, storage or communication channels, etc.;

3. The **association model** (also called mapping) expresses the associations between the functional and the hardware components.

PROMPT2 IMPLEMENTATION (ITEA 01009)

Partners
Esterel Technologies
INRIA
LIFL
Nokia
Tampere University of Technology
THALES Communications
University of Turku

Countries involved
Finland
France

Start of the project
February 2002

End of the project
December 2004

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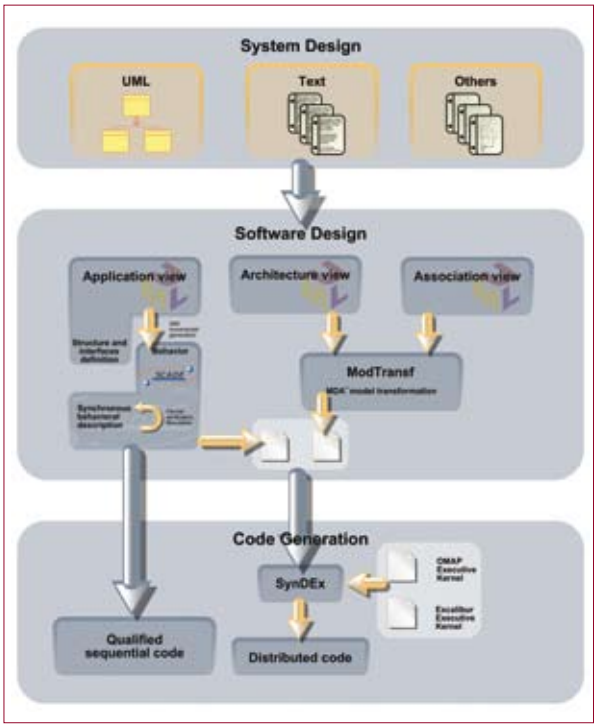
All models are platform-independent: the targeted technology is selected at the last stage during code generation. During model refinement, the user can perform simulations and model coverage measurements, or formally verify properties.



Tools

In the workflow, the user starts to design the system using a UML modeller tool (e.g. Objecteering™, Rational Rose™). Achieving a correct design depends upon re-using the artefacts defined in the P2I profile. When this stage is considered to be complete, the options are to:

- Export the UML application description to SCADE™ (see www.esterel-technologies.com), with which it is possible to finalise the synchronous behaviour specification and perform simulation and formal property verification; or,
- Export the architecture and association description to SynDEx™ (see www.syndex.org) via ModTransf (see www.lifl.fr/west/modtransf/).

Sequential code can be generated directly in SCADE™ (which also supports a qualified DO-178 B code generator), while SynDEx™ provides for the generation of distributed optimised code. The use of these tools guarantees that the distributed code is consistent with the sequential code and that all properties formally verified on the model hold for both sequential and distributed execution.

The methodology and technologies developed in the project implement the model-based engineering principle, providing practical solutions for industry. The software tools can be used differently, according to end-users' specific requirements:

- **System/architecture design space**. The profile provides for semantically strong architectural descriptions in UML.
- **Embedded software design space**. Executable/testable UML models supporting full code generation allow earlier exploration of design alternatives. Formal verification permits exhaustive verification of complex functional properties, detects hard-to-find corner-case bugs, and explores complex design behaviours.
- **Hardware design space**
  - P2I UML profile can be used to describe hardware architectures.
  - Executable UML (P2I profile application view) could complement hardware description languages (HDLs) for behavioural modelling.

Major project outcomes

About 35 papers and presentations were issued. The partners actively participated in the 'UML to SystemC System Design Flow' workshop organised by ECSI in Lille (May 2004) and in the organisation of FDL'04 (Forum on specification & design languages) in Lille, with a special session called 'What is MDA good for in embedded system design?'.

The developed profile will be submitted to the Object Management Group (OMG) as an answer to its last request for proposals on UML for systems engineering.

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