TWINS
(ITEA 05004)

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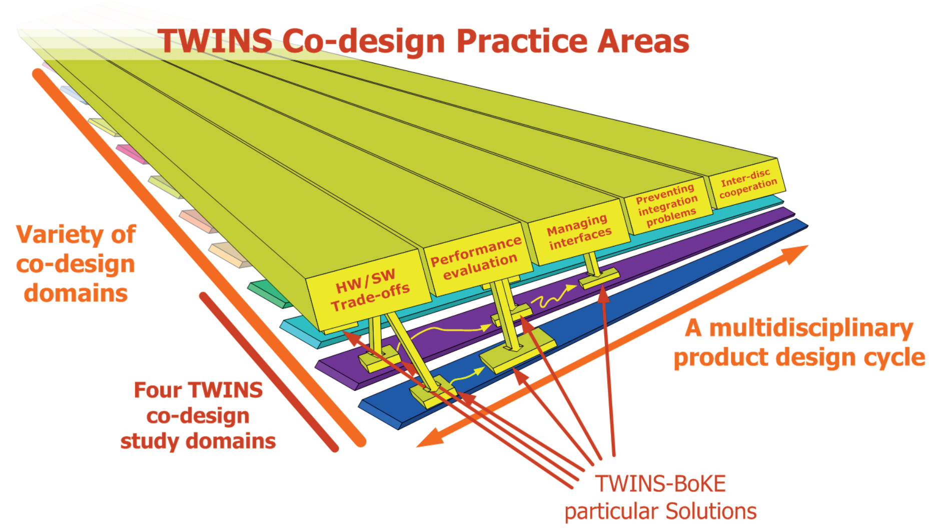
Optimising hardware/software co-design for software-intensive systems development

The TWINS project has elaborated a common set of methodologies and tools to simplify and accelerate the design, development and realisation of hardware/software intensive systems. The resulting solutions were generalised to provide practice areas to pinpoint bottlenecks and sources of quality problems in the hardware/software co-design lifecycle and help in the choice and tailoring of solutions according to specific domains and situations. These decision processes are based on real-life solutions for modern complex multidisciplinary product developments that have been proved in industry. The results of the project have already been applied widely in one of the major project partner's design processes.



With the ever wider proliferation of consumer electronics, the number of embedded systems is growing dramatically, while increasing in size and complexity. At the same time, there is a major trend to implement functionality increasingly in software. Design teams are using software to differentiate products, increase flexibility, respond to changing standards, enable inexpensive upgradability and get products to market sooner.

RE-EVALUATING FUNDAMENTAL DESIGN PRACTICES

This confluence of forces is confronting design teams with a host of new challenges – particularly designing hardware and software in concert – and encouraging them to re-evaluate fundamental design practices.

However, hardware/software co-design requires companies to face up to:

- An extended, discipline-independent design space, posing challenges in the allocation of functionality to either software or hardware under given performance requirements in an efficient way;
- A wide range of different electronic, mechanical and software component that have to be highly integrated – often difficult to achieve in practice;
- Expensive prototyping that demands the maximum of verification and validation before building hardware; and
- Difficulties in modelling whole systems as different modelling paradigms, computational models and tools are used for various parts of the system as a result of the diverse engineering disciplines involved.

Specifically, co-design requires deployment of best practices in a seamless workflow but this is not easy. As technology gets deeply integrated in contemporary society, multidisciplinary designs are becoming omnipresent. Yet, academic engineering curricula are still predominantly monodisciplinary, as are the design methods and tools available, causing problems for high-technology industry.

FOCUSED ON INTEROPERABILITY

TWINS focused in the first half on interoperability of engineering methods and tools to decrease the gap between the problem and solutions. This involved selecting, combining and extending mono- and inter-disciplinary co-design methods and tools used by the consortium partners, which included large and small companies, research institutes and universities.

The partners were grouped around the TWINS results in terms of application, knowledge and exploitation. Application partners posed and worked on their co-design needs and ideas; knowledge partners helped survey and categorise the needs and ideas, and proposed improvements of existing or contributed new tools/methods; and exploitation partners provided support for companies applying TWINS results both within and outside the consortium.

Major innovations are situated at two levels: development of new tools and methods; and/or integration of existing/extended tools and methods. For example: bridges were developed between well-established design methods such as SystemC and formal checking via the mCRL2 formal specification language developed by the Technical University of Eindhoven.

PRACTICE AREAS OFFERING DECISION PROCEDURE

A major outcome of the shared results is organisation of this very complex domain in a set of practice areas offering a decision procedure with the tools and methods to address typical problems. This allows a company to pinpoint bottlenecks and sources of quality problems in their hardware/software co-design lifecycle. They can then select and tailor solutions for the challenges identified according to their specific domain and situation.

TWINS generalised the Co-design Practice Areas from elaboration of the co-design imperatives in four typical domains covered by the consortium:

- Mechatronics;
- Balanced hardware, software and firmware;
- Information driven; and
- Electronic hardware modelling.

A sample co-design flow was proposed and tested for each of these domains. This offers a complete and integrated flow of solutions for the whole co-design process – a need clearly identified by the industrial partners. As each company-specific flow is different, the project worked on identifying flows that are tailored to the four domains selected.

Each of the domains' partners contributed their existing or extended tools to handle co-design domains workflows. By the end of the project, an analysis showed which methods and tools were the most useful also for inter-domain exploitation.

ACCESS TO KNOWLEDGE AND EXPERIENCE

When faced with a co-design problem, a prospective user is able to access the TWINS Body of Knowledge and Experiences (BoKE) in various ways to look efficiently for appropriate methods/tools or co-design experience. The TWINS Co-design Process Areas offer designers a method to access maturity in multidisciplinary co-design, and then identify the most useful results of TWINS to strengthen their own co-design workflows.

While not a commercial co-design platform, TWINS helped to build seamless co-design flows from existing fragmented solutions. It will have an important impact on users by helping in the faster selection of suitable architecture, avoiding integration problems and detecting any remaining problems earlier, so speeding time to market, reducing costs and improving quality of the shipped product.

TWINS BoKE makes an important contribution by providing a significant example of knowledge repository in the immature co-design super discipline. When properly applied, TWINS Co-design Process Areas can provoke a rethinking of co-design processes and tooling in many high-technology companies.

Applications are numerous in industries as diverse as automotive, avionics, copiers and printers, electrical distribution systems and communications networks. The results of TWINS will enrich individual product offerings from tool and service vendors, help develop new advisory services for software-intensive product manufacturers and improve overall software-intensive product development in Europe.

REAL SUCCESS ALREADY ACHIEVED

TWINS directly addressed integration of several technologies that serve numerous and large markets. This ITEA project involved a consortium of European companies and research organisations with several global leaders in their respective fields. The integrating technologies chosen are state of the art in the targeted disciplines – such as model-driven development, formal methods and virtualisation in software engineering, visualisation in developing physical systems, and sophisticated analysis paradigms in integration of large-scale systems such as in telecommunications.

Several partner use cases executed during the project have already grown into real success stories. For example, by:

- Reducing project schedule overruns by more than 75% thanks to applying a co-design process that improved multi-disciplinary communication and interaction;
- Improving development efficiency by more than 10% thanks to the introduction of hardware/software interface simulation that reduced integration artefacts; and
- Cutting to all project design cost by 20% thanks to the use of emulation methodologies for concept validation that reduced the cost of making mock-ups/prototypes.

The impact of the project on how a large industrial development team manages its software development can be seen from its effect on imaging giant BARCO. This project partner has now based its new company hardware/software codesign methodology – used by all its development teams – on the TWINS results.

More information: www.twins-itea.org

M – ITEA 2 Magazine • April 2010 - no. 6