Innovations Syst Softw Eng
DOI 10.1007/s11334-011-0176-x

EDITORIAL

# Model-based approaches and frameworks for embedded software systems

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Received: 3 November 2011 / Accepted: 3 November 2011


Model-driven development (MDD) comprises approaches to software development that heavily rely on modeling and the systematic transition from models to executable code. One of these approaches is the OMG's model-driven architecture (MDA), which is based on the separation between the specification of a system and its implementation using specific platforms.

The workshop on Model-Based Methodologies for Pervasive and Embedded Software (MOMPES) focuses on all the aspects related to the adoption of MDA and other MDD approaches, including language, process, methods, and tools, for supporting the construction of computer-based systems, and more specifically, pervasive and embedded software systems.

In this issue, we are happy to present the best papers from MOMPES 2009 and 2010. MOMPES 2009, the sixth in this series of workshops, took place during the 31st IEEE International Conference on Software Engineering (ICSE 2009) in Vancouver, Canada, on May 16. The seventh workshop, MOMPES 2010, was organized as a satellite event of the 25th IEEE/ACM International Conference on Automated Software Engineering (ASE 2010), which took place in Antwerp, Belgium, on September. The issue contains selected, extended, and revised versions of papers presented in these two workshops following a second round of rigorous review.

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The first paper, "A relationship-based approach to model integration", by Chechik, Nejati, and Sabetzadeh, addresses the problem of integrating a collection of models into a single, larger specification that provides for building an operational system, developing unified understanding, and enabling automated reasoning about properties of the resulting system. The authors suggest that the choice of a particular model integration operator depends on the inter-model relationships that hold between the individual models. They distinguish three key integration operators (merge, composition, and weaving) studied in the literature, and describe each operator along with its underlying relationships.

In the second paper, Nascimento, Oliveira, and Wagner discuss a model-driven engineering (MDE) framework to improve the design of embedded system. Based on a UML-based functional specification of an embedded application, they adopt several concepts and ideas from MDE for automatic generation of control- and data-flow internal representation. Transformation rules applied to the UML models of the embedded system allow an internal representation to be automatically obtained, which is mapped into a hardware/software implementation. This iterative mapping is optimized by a design space exploration method based on a categorical graph product. The transformations produce an implementation model that takes into account a platform model, where the available resources are identified.

The third paper, by Polzer, Merschen, Botterweck, Pleuss, Thomas, Hedenetz, and Kowalewski, presents a framework for model-based product lines of embedded systems. The authors show how to integrate model-based product line techniques into a consistent framework that can handle complex product lines typically found in industrial contexts. The framework shows the strength of model-based techniques such as abstraction, support for customized representations, and a high degree of automation.

Published online: 29 November 2011

In their paper "On the refinement of use case models with variability support", Azevedo, Machado, Bragança, and Ribeiro discuss the utilization of use cases with functional refinement when variability is a major issue. Elaborating on use cases for modeling product lines, the authors explore them in the context of variability using the ≪extend≫ relationship available in the UML.

The fifth paper by Mannadiar and Vangheluwe suggests an approach to artifact generation, where layered model transformations are used to isolate, compile and re-combine various concerns within domain-specific models while maintaining traceability links between corresponding constructs at distinct levels of abstraction. The approach facilitates the manipulation of non-functional requirements, which are of paramount importance for designing embedded systems. The work is illustrated by means of the synthesis of functional Android applications, performance predictions, simulations, and performance measurement facilities from domain-specific models of mobile phone applications.

The sixth paper, co-authored by Angelov, Guan, Marian, Zhou, Sierszecki, and Top, deals with the development of software technology that can enhance engineering of systems that are correct by construction. To this end, COMDES, a component-based framework for distributed embedded control systems, utilizes validated (trusted) components, verification of design models, and automatic configuration of applications from validated design models and trusted components. An application developed in COMDES is conceived as a network of embedded actors that are configured from function blocks, that is, instances of reusable, executable components. System actors operate in accordance with a timed multitasking model of computation, whereby I/O signals are exchanged with the controlled plant at precisely specified time instants, which eliminates I/O jitter. The paper presents an analysis technique that can be used to validate COMDES design models in SIMULINK. It is based on a semantics-preserving transformation of design models into analysis models, whereby executable COMDES components are encapsulated in SIMULINK S-functions and subsystems, making it possible to analyze the embedded application via simulation.

We are deeply grateful to all the authors and reviewers of these papers for their thorough work, and we hope that you will find this set of papers to be useful and inspiring for your research and development activities. We would like also to acknowledge the Editor-in-Chief, Michael G. Hinchey, and the editorial staff at Springer for their help.