

Chapter 8

MADES FP7 EU Project: Effective High Level SysML/MARTE Methodology for Real-Time and Embedded Avionics Systems

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ABSTRACT

This chapter presents the EU-funded MADES FP7 project that aims to develop an effective model-driven methodology to improve the current practices in the development of real-time embedded systems for avionics and surveillance industries. MADES developed an effective SysML/MARTE language subset, and a set of new tools and technologies that support high-level design specifications, validation, simulation, and automatic code generation, while integrating aspects such as component re-use. This chapter illustrates the MADES methodology by means of a car collision avoidance system case study; it presents the underlying MADES language, the design phases, and the set of tools supporting on one hand model verification and validation and, on the other hand, automatic code generation, which enables the implementation on execution platforms such as state-of-the-art FPGAs.

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INTRODUCTION

In recent years, continuous technological advances in hardware/software along with rapid increase in targeted application domains have led to new challenges in the design specification and implementation of real-time embedded systems (RTES). These systems are now omnipresent, and it is difficult to find a domain where RTES have not made their mark. Thus, large complex RTES are becoming increasingly difficult to manage, resulting in critical issues and what has finally led to the notorious productivity gap. The design space, representing all technical decisions that need to be elaborated by the design team, is therefore becoming difficult to explore. Similarly, manipulation of these systems at low implementation levels such as Register Transfer Level (RTL) can be hindered by human interventions and the subsequent errors.

Henceforth, effective design methodologies and efficient design tools are needed to decrease overall development costs and time-to-market, while resolving issues such as those related to system complexity, verification and validation, etc. High-level system design approaches have been developed in this context such as Model-Driven Engineering (MDE) (OMG, 2007), in which the system is modeled through, for example, the Unified Modeling Language (UML), thus increasing the level of abstraction in the design phases.

In addition to fostering the introduction of better abstractions, MDE facilitates the partitioning of the system design by allowing for parallel independent specifications of the system hardware and software, their eventual allocation, and the possibility of integrating heterogeneous components into the system. Usage of UML models increases system comprehensibility as it allows designers to provide high-level descriptions of the system, easily illustrating its internal concepts (hierarchy, connections, dependencies etc.). The implementation-independent nature of these specifications also facilitates reuse, depending

upon underlying tools and user requirements. MDE exploits different technologies and tools such as UML and related profiles for high-level system specifications. Model transformations (Sendall & Kozaczynski, 2003) can be used to automatically generate executable models or code from these abstract high-level design models.

This chapter provides an overview of the results of the MADES project (Bagnato et al., 2010; MADES, 2011). MADES aims to develop novel MDE techniques to improve the current practices in the development of real-time embedded systems for the avionics and surveillance domains. It proposes an effective subset of existing UML profiles for embedded systems modeling, in particular (OMG, 2012), and MARTE (OMG, 2011), while avoiding incompatibilities resulting from simultaneous usage of both profiles. The MADES methodology integrates new tools and technologies that support high-level SysML/MARTE system design specification, their verification and validation (V&V), component re-use, and automatic code generation to enable execution platform implementation.

Whereas many works deal with embedded systems specifications using only either SysML or MARTE, the MADES approach combines them in a synergic way. This, by itself, is a significant contribution as while both these profiles provide numerous concepts and supporting tools, they are difficult to be mastered by system designers. The presented approach is based on the MADES language, which defines an effective subset of the SysML and MARTE profiles and proposes a specific set of diagrams for expressing different aspects related to a system. This chapter provides an overview of the diagrams comprising the MADES language, which enables rapid design and incremental composition of system specifications. MADES models are used by the underlying toolset to achieve component re-use, verification and validation of designs, or automatic code generation, as briefly described in this chapter.

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