# The MegaM@Rt2 Approach and Tool Set

## Scalable Model-based Tools and Architecture for Continuous Development and Runtime Validation of Complex Systems

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*Abstract*—A major challenge for the European industry is to enhance the productivity of software-intensive systems as well as to reduce their costs and increase their overall quality. Model-Driven Engineering (MDE) principles and techniques have already shown promising capabilities for software design, development, integration and maintenance. However, they still need to scale up to support real-world scenarios implied by the full deployment and use of complex cyber-physical systems (CPSs). In this context, maintaining efficient traceability, integration and communication between two fundamental system levels (i.e. design time and runtime) is an important challenge. This paper presents an overview of the set of tools and architectural approach envisioned by the H2020 ECSEL[1] MegaM@Rt2 project ("MegaModelling at runtime – Scalable model-based framework for continuous development and runtime validation of complex systems"). The goal of this project is to address the above-mentioned challenges from a MDE perspective. Driven by both large and small industrial enterprises, with the support of research partners and technology providers, MegaM@Rt2 aims to deliver a framework of tools and approaches for: 1) system engineering/design & continuous development, 2) related runtime analysis and 3) global model & traceability management.

### I. Introduction

[1] In the global context, the European electronic industry faces stiff competition. Electronic systems are becoming more and more complex and software intensive, which calls for modern engineering practices to tackle advances in productivity and quality of these, now, cyber-physical systems.

Model-Driven Engineering and related technologies promise significant productivity gains, which have been proven valid in several studies. However, these technologies need to be further developed to scale for real-life industrial projects and provide advantages at runtime. The ultimate objective of enhancing productivity while reducing costs and ensuring quality in development, integration and maintenance can be achieved by the use of techniques that integrate design and runtime aspects within system engineering methods incorporating existing engineering practices. Industrial scale models, which are usually multi-disciplinary, multi-teams, combine several product lines and typically include strong system quality requirements, can be exploited at runtime by advanced tracing and monitoring. – Thus, achieving a continuous system engineering cycle between design and runtime, ensuring the quality of the running system and getting valuable feedback from it that can be used to boost the productivity and provide lessons-learnt for future generations of products.

The major challenge in the Model-Driven Engineering of critical software systems is the integration of design and runtime aspects. The system behavior at runtime has to be matched with the design in order to fully understand the critical situation, failures in design and deviations from requirements. Many methods and tools exist for tracing the execution and performing measurements of runtime properties. However, these methods do not allow the integration with system models – the most suitable level for system engineers for analysis and decision-making.

The vision of MegaM@Rt2 is to create a scalable framework for model-based continuous development and validation of large and complex industrial systems by exploiting important features of:

- MARTE, SysML and others to express both system functional and non-functional properties;
- model-based verification and validation methods at design time and runtime;
- methods for model management / megamodelling;
- methods for traceability over large multi-disciplines models;
- methods for inference of system deviations and affected design elements;

To cover all these topics and deal with the complete value chain, MegaM@Rt2 brings together prominent tool vendors and research organisations with state-of-the-art methods and tools to be validated in highly relevant European industrial case studies. This presentation gives an overview of the set of tools and architectural approach envisioned by the project.

[1] http://www.ecsel-ju.eu/web/index.php