MOGENTES
MOdel-based GENeration of efficient Tests for Embedded Systems

MOGENTES aims at significantly enhancing testing and verification of dependable embedded systems by generation of efficient test case generation (MBTCG), Dependable embedded systems (DES), Fault modelling, Test coverage metrics

At a Glance: MOGENTES
MOdel-based GENeration of efficient Tests for Embedded Systems

Project Coordinator
Name: Dr. Manfred Gruber
Institution: Austrian Research Centers - ARC
Email: manfred.gruber@arcs.ac.at

Project Technical Manager
Name: Dr. Wolfgang Herzner
Institution: Austrian Research Centers - ARC
Email: wolfgang.herzner@arcs.ac.at

Project website: www.MOGENTES.eu

Partners:
Austrian Research Centers GmbH - ARC (AT)
Budapest Univ. of Technology and Economics (HU)
Ford Forschungszentrum Aachen GmbH (DE)
Graz University of Technology (AT)
University of Oxford (UK)
Prolan Irányítástechnikai ZRT (HU)
Prover Technology AB (SE)
SP Technical Research Institute of Sweden (SE)
Thales Rail Signalling Solutions GmbH (AT)
Re:Lab S.R.L. (IT)

Duration: 36 months
Start: 2008.01.01
Total Cost: € 4.4 Mio
EC Contribution: € 3.1Mio
Contract Number: INFSO-ICT-216679

Main Objectives
The goal of MOGENTES is to significantly enhance testing and verification of dependable embedded systems by means of automated generation of efficient test cases relying on the development of new approaches as well as innovative integration of state-of-the-art techniques. In particular, MOGENTES aims at the application of these technologies in large industrial systems of automotive, railway control, and off-highway vehicles domains to achieve a significant cost reduction.

Today, embedded computer systems become increasingly integrated in safety-relevant systems such as vehicles, medical equipment, or industrial or public control systems. Evidently, any possible measure has to be taken to ensure the dependability of such systems, from early planning and design to final installation and maintenance. While formal verification has been applied successfully for systems of limited size, testing is still the primary though expensive alternative. Therefore, MOGENTES has the objectives:

- To reduce testing effort by at least 20%.
- To generate efficient test cases from system and fault models, for both functional and non-functional system properties of new and existing embedded systems.
- To establish a framework for integration of involved tools, including model transformations, to prepare inputs for model checkers etc., which can be easily used by domain experts.
- To provide traceability of requirements and match them to test analysis results.
- To foster application of automated testing to satisfy functional safety standards requirements.
- In general, to increase the confidence in safety-relevant embedded systems by improving their testing and proving their conformance to safety standards.

MOGENTES will focus on automated generation of efficient test cases, relying on development of new approaches as well as innovative integration of state-of-the-art techniques.
**Technical Approach**

These objectives shall be achieved with the following concepts.

- Define common modelling languages and semantics (meta-models), with UML as primary candidate, such that the domain specific requirements of the demonstrators can be reflected, and the (partial) models of the demonstrators can be mapped to this language.
- Develop a test theory that defines the conformance relation between the model and the implementation, and the notion of success and failure of a test case.
- Define fault models (for software as well as hardware) and extend the modelling languages to allow the integration of the representation of faults into the (application) models.
- Define new coverage criteria under consideration of minimal cut sets (i.e., combinations of faults causing a safety requirement violation), fault injection, mutation testing, and safety aspects, and use existing TCG techniques to generate efficient test cases that achieve this coverage.
- Use model-based fault injection (MBFI) to extend models for automatically calculating minimal cut sets.
- Validate the defined fault models (and thus the generated test cases) with physical fault injection.
- Use (bounded) model checking techniques to generate stress test scenarios.
- Provide semantics-aware transformations from system models to inputs of specific tools, e.g. to enable interaction of generated models with existing simulation environments for allowing evaluation of model coverage.

**Key Issues**

Following obstacles are observed which still today hamper broad application of model-based test generation in industry:

- For existing systems, domain-specific formal notations ("meta-models"), in which their models can be defined, are not always available.
- In general, formal tools are still difficult to use, they often need expert knowledge due to their own terminology and the specific semantics of the applied formalisms.
- For real embedded systems, applicability is still limited due to their complexity and size.

**Expected Impact**

MOGENTES will contribute to both maintaining the competitiveness of Europe's industry by helping to reduce validation and verification costs, and to strengthen the increasing test tools and services branch.

In general, MOGENTES will increase knowledge and develop new techniques and tools in the area of verification and validation of dependable embedded systems which can be applied in model-based development processes also by non-experts in formal methods.