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About OSC – Embedded Systems AG

OSC - Embedded Systems AG ("OSC") has been established in 2002 as a subsidiary of the OSC - OFFIS Systems and Consulting GmbH, founded 1999 in Oldenburg, Germany. Since 2008, OSC – Embedded Systems AG is part of the BTC AG Group, which is a corporation in the IT-Area with more than 1000 employees. OSC drives a subsidiary in Munich to support customers in the south of Germany. Also OSC owns a Japanese daughter company called OSC Japan Co., Ltd.

OSC provides products and services for Formal Verification, Validation, and Automated Testing of Embedded Systems. OSC products significantly reduce required efforts for testing and validation of Embedded Systems, and considerably increase the quality of the developed system. Additionally, OSC offers adequate on-site and off-site services around the testing products and testing in general. In order to successfully provide these powerful products and services for test automation and Formal Verification, OSC cooperates very closely with dSPACE GmbH as well as with major OEMs and suppliers in the automotive industries.

The products EmbeddedValidator™ and EmbeddedTester™ have been developed in close cooperation with dSPACE. EmbeddedValidator™ allows verifying TargetLink® models against formally specified requirements on the basis of TargetLink® AutoCode. EmbeddedTester™ provides capabilities to automatically generate and execute test cases for TargetLink® AutoCode. Furthermore, specific standard problems like dead code, division by zero, etc. are automatically analyzed. Additionally, code validation activities and coverage analysis can be performed during the model-based development of control functions in the Simulink®/TargetLink® tool environment.
OSC – Consulting and Services

OSC – Embedded Systems AG is a successful world-wide Consulting Company in the domain of Automatic Test- and Validation techniques for Embedded Software especially in the automotive domain. OSC – Embedded Systems AG provides support in all development and test phases for Embedded Software. This range is defined from the very beginning of the development process (Requirements Engineering) to the very end (Acceptance Tests). In the meantime, OSC – Embedded Systems AG has more than 8 years experience in the Embedded Market concerning Consulting and Service Projects together with most well known OEMs/Suppliers of the Automotive- and Transportation Industry world-wide. The core competences of OSC – Embedded Systems AG are:

- Model-Driven Development Process
- Formal Specification of Requirements
- Formal Verification of Models and AutoCode
- Automatic Test Generation for Models and Requirements
- Automatic Test Generation based on Code
- Automatic Test Case / Trace / Vector Execution
- Model and Code Coverage
- Automatic Model-based Safety Analysis
- AutoCode Generation and Validation
- Safety Standards like IEC61508 and ISO WD 26262
- Automatic Model-based Safety Analysis

Based upon unique technologies and the long term experiences in real industrial projects, OSC – Embedded Systems AG has the knowledge, processes and capacity to successfully support its customers in the Embedded Software Domain.

Service Projects

Service projects like requirements capturing, specification, modeling, Auto Code Generation, and testing in the domain of Embedded Software development is daily business of the OSC Consulting department.

Process Improvement Projects

Training and Coaching
OSC – Embedded Systems AG provides Training and Coaching for all OSC Products and also for the underlying Front-end Tools, worldwide. These OSC Products are

- Matlab®/Simulink®/Stateflow® & dSPACE’s TargetLink®
  - EmbeddedValidator
  - EmbeddedTester

- Statemate®
  - ModelChecker
  - ModelCertifier
  - ATG

- Rhapsody® UML
  - TestConductor
  - ATG

Feasibility Studies / Evaluations
Any kind of Feasibility Studies and Evaluations for Automatic Test- and Validation Technologies in customer development and test environments is provided by OSC – Embedded Systems AG.

Solution and Customization Projects
Re-using OSC core technologies like Formal Verification, Automatic Test Case Generation, Dynamical Code Analysis, Automatic Safety Analysis etc., OSC develops dedicated Solutions based on specific customer requirements.
OSC – Products for TargetLink

EmbeddedTester™

Smoothly integrated into dSPACE’s TargetLink® tool environment for developing control functions, the test and verification tool EmbeddedTester™ sets a milestone for automated test case generation, execution, and code validation. With the TargetLink® and EmbeddedTester™ duo, function and software developers can not only develop and implement functions quite easily and seamlessly from the Simulink® model up to target implementation, but can also perform structured tests and verify the functions at the same time.

Development Partners and Success Stories

EmbeddedTester™ has been developed over the last 3 - 4 Years together with the Automotive OEMs NISSAN Motor Co., Ltd. (Japan) and MAN Nutzfahrzeuge AG (Germany) and the Japanese Automotive Supplier HITACHI Automotive Systems.

For example MAN Nutzfahrzeuge AG is now using EmbeddedTester™ as a standard testing tool:

"MAN Nutzfahrzeuge AG successfully uses EmbeddedTester in its production as a standard Automatic Test Environment for the leading AutoCode Generator TargetLink in the Model Driven Development of Power Train applications. The automatic test generation, execution, analysis and debug capabilities of EmbeddedTester is one important key to fulfill the high efficiency and quality levels of MAN Nutzfahrzeuge AG, under the permanent time-to-market pressure."

Stefan Teuchert,
Head of the Department Software-Development and Base Technologies, MAN Nutzfahrzeuge AG (Munich).

Field of Application

EmbeddedTester™ requires TargetLink® and is seamlessly integrated in the Simulink®/TargetLink® development environment. EmbeddedTester™ supports the entire TargetLink® block-set on the one hand, as well as external legacy code on the other. EmbeddedTester™ generates extremely high code coverage and test objective coverage for any hierarchically developed TargetLink® fixed-point code. This has been proven for the past three years in production projects at major manufacturers and suppliers from Germany and Japan.
Automatic Test Vector Generation and Code Validation

On the basis of the production code generated by TargetLink®, EmbeddedTester™ can automatically find input sequences to cover any kind of defined test objectives. For test objectives, EmbeddedTester™ can also prove if the code is unreachable, up to any desired analysis depth. These two capabilities are guaranteed by special algorithms from the field of formal methods, a well-established application approach for the past 15 years. Thanks to the tight tool integration between EmbeddedTester™ and TargetLink®, scalability is guaranteed even for rather large industrial applications, due to the automatic hierarchical approach.

For code coverage criteria such as statement coverage, condition coverage, decision coverage and MC/DC coverage, as well as for production code specific tests with division-by-zero, over- and underflow, type (down)-casting, saturation und relational operations (fixed-point vs. floating-point), automatic test objectives and coverage reports are managed, and high coverage and analysis rates of up to 100 % are reached automatically.

Automatic Test Case Execution

EmbeddedTester™ automatically executes the previously generated and/or imported Stimuli Vectors in order to create the complete deterministic test cases, consisting of input signals and monitoring/expectation signals. In this task EmbeddedTester™ leverages the TargetLink® Model information in order to support the hierarchical approach even during automatic test case execution. This test execution/simulation can be performed automatically by EmbeddedTester™ on any execution level such as Simulink model-in-the-loop (“SL-MIL”), TargetLink model-in-the-loop (“TL-MIL”), software-in-the-loop (“SIL”) and processor-in-the-loop (“PIL”).

Automatic Test Evaluation

In regression mode EmbeddedTester™ automatically compares the test cases, including the monitoring/expectation signals, with all of the levels (SL-MIL, TL-MIL, SIL und PIL) and shows the differences in automatically generated reports. Comparison tolerances can also be defined in EmbeddedTester™.

Debugging Support

If differences between the execution levels are discovered, finding the source of an error and fixing it becomes an issue. EmbeddedTester™ supports the user in this process with linked coverage reports and dedicated debugging facilities. Within EmbeddedTester™ reports, the differences in the target code and the TargetLink® model can be referenced with a single mouse-click. This is achieved by a close integration of TargetLink® and EmbeddedTester™. Test vectors can be debugged using EmbeddedTester™ step-by-step on MIL and SIL levels. This can be done even in parallel, thereby massively decreasing debugging efforts.
Import- and Export Interfaces

EmbeddedTester™ allows importing and exporting test cases in and from numerous file formats such as XML, MAT, CSV, etc. This lets a user easily reuse already existing test sets from various sources. Through importing test cases in EmbeddedTester™, it shows the coverage rates (code coverage) achieved by them. In the same manner, test cases can also be used, which were generated using EmbeddedValidator™ on the basis of requirements. EmbeddedTester™ test cases can be exported as MAT files and reused in dSPACE tools such as AutomationDesk®.
**EmbeddedValidator™**

**Application Area**
EmbeddedValidator™ provides a tool suite for formal, automatic, and model-based verification. It performs model checking for reactive embedded systems designed using Simulink, Stateflow, together with TargetLink®. The tool suite supports Stateflow charts and a large set of TargetLink® blocks for open-loop control. In contrast to conventional testing approaches, model checking technology is fully automatic and complete in a mathematical sense, meaning that it can detect every logical design flaw and error in the model being verified.

**Development Partners and Success Stories**
EmbeddedValidator™ has been developed together with the Automotive OEM Volkswagen AG (Germany) and the German Automotive Suppliers Conti Temic microelectronic GmbH and Hella KGaA & Co.

**Benefits**
Model checking analyzes a model of a system with regard to arbitrary input scenarios and can thus be viewed as a “complete test” that is performed against a formally specified requirement. Such requirements may be simple Boolean expressions such as “an error state is never reached”, or more sophisticated ones expressing temporal and causal properties like “an output is set only after certain input values are observed”. Applying EmbeddedValidator™ produces designs that meet requirements regarding robustness and correctness, and decreases design faults and costs.

**Risk Identification**
Open-loop control systems usually have deep dependencies that designers cannot completely analyze with traditional methods. Today’s embedded control units have such enormous functionality that designers and testers cannot ensure correct functioning under all environmental conditions by means of conventional testing methods. Hence, complexity has increased enormously, as has time-to-market pressure, and as a consequence the error rate is also rising.

**Early Model and Code Verification**
The combination of EmbeddedValidator™ and TargetLink® allows early testing and verification. Applying EmbeddedValidator’s model checking method in early development phases not only verifies models, it is also a step towards production code verification. TargetLink® builds the bridge between verified models and verified AutoCode. It is the only code generator for Simulink that has official Formal Verification support with EmbeddedValidator™.
EmbeddedValidator™ and EmbeddedTester™ greatly complement the well established Software development process as supported by dSPACE TargetLink.

EmbeddedValidator™ helps to formally verify the TargetLink models against functional requirements. The high quality verified TargetLink models enable a very efficient transition through the subsequent phases of the software development and testing.

EmbeddedTester™ supports automatic generation of test cases, automatic MIL/SIL/PIL regression testing, easy debugging, and test as well as coverage evaluation. These capabilities lead to much better tested applications while saving time and costs with EmbeddedTester.

The model-driven development and testing with TargetLink™, EmbeddedTester™, and EmbeddedTester™ helps software engineers to significantly increase product quality while saving cost at the same time.
Some OSC Product – Customers

Automotive
- MAN Nutzfahrzeuge AG, Munich
- BMW, Munich
- Volkswagen AG, Germany
- NISSAN Motor Co., Ltd Japan, Yokohama
- NISSAN R&D, Japan
- Hitachi Automotive Systems, Japan
- Ford, Germany
- Daimler AG, Germany
- Robert Bosch GmbH, Germany
- JATCO, Japan
- Calsonic Kansei, Japan
- DENSO Corporation, Japan & USA
- Continental Temic, Germany
- Siemens VDO, Europe
- Renault, France
- VALEO, France
- Chrysler, USA

Military and Aerospace
- Airbus UK
- Airbus Germany
- EADS, Munich
- Alenia, Italy
- Boeing, USA
- Lockheed Martin, USA

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