ITEA
INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

TT-MEDAL

INNOVATION REPORT

Advanced Test Processes using TTCN-3

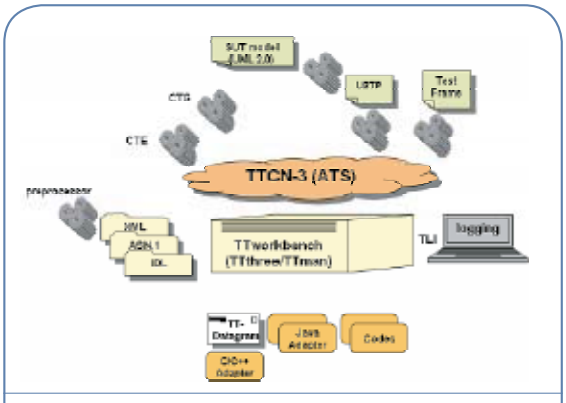
Testing is an important step in the development of a software-intensive system, as it checks the compliance of a system to the (end) user requirements. In order to fulfil the market demands for better and faster system development, testing such systems has to be done in a more effective and efficient way. By more effective testing, a better indication of product quality is provided; by more efficient testing this indication is provided faster.

The ITEA project TT-Medal has focused on the development of testing methods with advanced languages [1] and the demonstration of these test methods in industrial case studies. Special emphasise has been given to standardised test notations like the Testing and Test Control Notation (TTCN-3 [2] [3] [4] [5]) from ETSI and the UML 2.0 Testing Profile (U2TP [6] [7]) from OMG. Due to its high maturity, wide applicability, and existing tool support TTCN-3 became the central focus in the TT-Medal project work.

Although TTCN-3 is a powerful testing technology in its own right, in isolation it only provides one piece of the necessary testing solution. To enable the full potential of this technology to be used in an industrial setting it is vital that the associated methodology, test processes and test environment are developed accordingly. In the TT-Medal project much effort was expended in these areas. In this paper we describe the project results from four key issues from these areas, namely: test process platform, test generation, reuse and test suite adaptation.

Test Process Platform

Industrial requirements from the telecom, automotive, railway, and financial domains have been taken into account to find and demonstrate test solutions that are all based on one standardised test notation using a common test toolset. Thus in TT-Medal, a TTCN-3 test infrastructure has been defined that focuses on the test execution phase and which is applicable for all these industrial domains. In addition, the TT-Medal project adopted various approaches for test development for this test infrastructure: e.g. existing test generation tools from external sources, or imports or mappings from other specification and programming techniques. The resulting toolset that is called TT-Medal test platform is illustrated in the figure below.



TT-Medal test platform

The binding element is the abstract test suite (ATS) in TTCN-3 notation that needs to be compiled into a target programming code (e.g. Java) before tests can be performed using a test management tool. In TT-Medal the tools TTthree (compiler) and TTman (manager) are integrated within an Eclipse-based TTCN-3 toolset, called TTworkbench [8].

The test process that comprises of test development, execution and analysis is supported by TTworkbench. However the development process can be decomposed into distinct

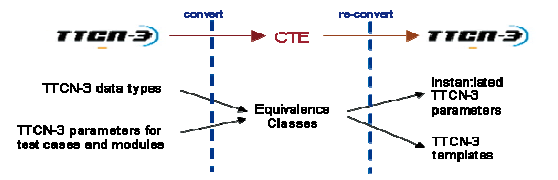
working steps and these steps may be assigned to different people in order to save time by doing work in parallel.

We distinguish the following five tasks within the test process:
(a) requirement analysis and development of the test plan;
(b) generating and/or writing the TTCN-3 test suite;
(c) implementing the system under test (SUT) specific adapter for communication between test system and SUT;
(d) implementing codecs for converting data between the representations of the test system and the transfer syntax towards the SUT; and
(e) executing and analyzing the test suite.

While the steps (a) and (e) are independent of the test notation, the TT-Medal project focuses on the TTCN-3 test suite development and implementation, i.e. on the tasks (b), (c), and (d).

Test Generation

A key topic for the test industry is test development, i.e. the synthesis of test scenarios and test data from the specification of the SUT. There exist a lot of theoretical approaches, and even several tools for the (semi)-automatic generation of tests. But most of them are not applicable in industrial projects because they assume formal specifications of the SUT or produce very complex or very large test suites. In contrast, within TT-medal we applied existing test generation techniques to models of the test system itself. This was demonstrated e.g. with the Classification Tree Editor (CTE) by DaimlerChrysler [9] and the Conformiq Test Generator (CTG) [10].



Data integration of TTCN-3 and CTE

For the CTE integration (see figure), an Eclipse plug-in has been implemented that provides a bridge between the TTCN-3 editor of TTworkbench and CTE. This allows to build test data equivalence classes based on existing TTCN-3 data types and to generate test behaviour using representative test data value combinations. Further details of this approach are described in: [11].

With CTG the starting point of test generation are UML models of the test system. These models can be either executed directly or they can be used to generate TTCN-3 test cases. These generated test cases can be used in conjunction with manually written test cases, thus allowing the execution of test cases derived by complementary means on a single test platform.

Reusing System and Test Artefacts in Test Development

In addition to the work on test generation methods, within TT-Medal we investigated also the reuse of system interface descriptions and data definitions in specification techniques such as IDL and XML and the use of other proprietary test notations like the TestFrame Language (TFL) that is popular in the financial domain [12].

As a result, data type and value specifications given in ASN.1, IDL, and XML can be directly imported into TTCN-3 modules. However, due to the versatility of XML specifications in most cases a case-specific pre-processing is needed to restrict to test relevant parts or to re-organise the type structures to obtain useful TTCN-3 code from the automated mapping.

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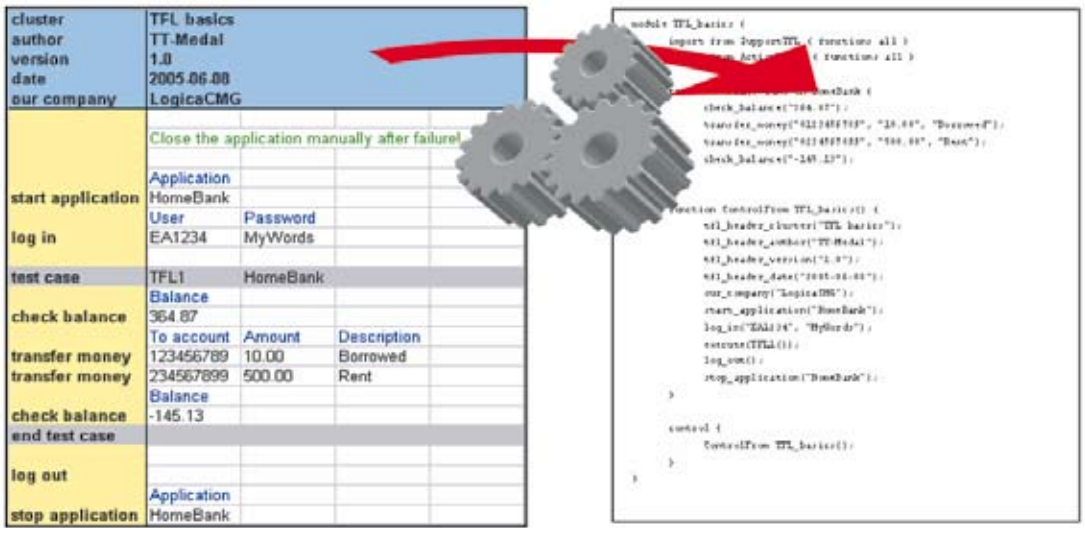

Mapping TestFrame language to TTCN-3

The mapping of complete test descriptions given in proprietary notations to TTCN-3 has been implemented for TFL and successfully demonstrated in TT-Medal. In addition to the pure language mapping from TFL to TTCN-3, a set of system adapters and codecs have been provided to execute the former TFL programs on the TT-Medal tool platform [13].

Besides the use of information provided in other notations, it has been investigated how to increase the efficiency of the TTCN-3 test system development through reuse [15]. Test patterns and their specification in TTCN-3 have been investigated [15] to support a development process in those cases where system specifications for automated test generation do not exist.

Test Suite Adaptation

Considering the complete TTCN-3 test implementation process, the adaptation of the executable test suite to the SUT has to be implemented in each TTCN-3 test development project. The SUT system adapter (SA) and the codec have to be available for the programming platform and operation system used for the test execution.

There are both generic codecs and SAs applicable to a whole class of systems as well as specific codecs and SAs for dedicated SUTs. TT-Medal worked in particular on the development of generic adapters and codecs for CORBA [16] and for XML [17]. As however not all adapters and codecs can be developed generically, the development of a codec generation framework has been investigated as well [8]. Such a codec generator limits the manual coding work and reduces the development time of codecs.

Conclusions

The objective of the TT-Medal project was to develop advanced, test specification based test processes as well as to gain industrial experience to enable European industry to test more effectively and efficiently. TTCN-3, being the latest testing technology, has been combined with advanced methods and tools to improve its usage on an industrial scale. The methods and tools enable test reuse between

products and between different phases of the development process, enable automatic generation of tests as well as automated deployment and execution of tests. They have been evaluated in real industrial cases in the automotive, railway, telecommunications, and financial domain. All performed case studies show that the TTCN-3 testing technology is ready for use in a broad range of European industry.

In any software product testing requires 25-50% of development resources. The latest research shows that TTCN-3 can provide up to 50% savings in these testing activities. Therefore the greatest benefit TT-Medal provided is the further development of the testing technology that can save industry hundreds of million Euros.

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