Test Automation with TTCN-3

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ASQF Software Test, Dresden, 6 April 2011
My TTCN-3 Background

- Standardization at ETSI since 1999
- Tool development at FOKUS with TU Berlin, then Testing Technologies
- Test suite development and testing with numerous industrial partners
- TTCN-3 syllabus and certificate with GTB, iSQI, and ETSI
- TTCN-3 research:
  - test suite quality: coverage, metrics, guidelines, refactorings
  - testing of embedded systems: real-time, continuous
  - performance testing and benchmarking
There have been various TTCN-3 presentations …

… this is indeed my n\textsuperscript{th} one

… including one at the TTCN-3 User Conference

… which had several keynotes on the subject

- Liu Chao: The Future of TTCN-3 in China, 2009

… I will add thoughts on uptakes and perspectives

\textbf{Disclaimer:} What will be said is my personal view only – and in particular not the view of the ETSI maintenance team or of anybody else mentioned beforehand.
Who are you?

1. Are you a tester?

2. Do you work on test automation?

3. Do you have heart about TTCN-3?

4. Do you used/use TTCN-3?
Outline

- Introduction
- TTCN-3 Status
- TTCN-3 Perspective
- Outlook
Outline

- Introduction
- TTCN-3 Status
- TTCN-3 Perspective
- Summary
What is TTCN-3 – see www.ttcn-3.org

- Testing and Test Control Notation Version 3
- Internationally standardized testing language
- Product of the ETSI (European Telecommunication Standards Institute) Technical Committee MTS (Methods for Testing and Specification)
- A programming language that has been used for more than 15 years in standardization as well as industry
- Specifically designed for testing and certification
- Constantly developed and maintained at ETSI by a team of leading testing experts from industry, research institutes, and academia
- A testing technology that applies to a variety of application domains and types of testing
- Knowledge of TTCN-3 is valuable both for employees as well as employers due to its wide applicability
- Offers potential for reducing training and test maintenance costs significantly
- Proven to work in very large and complex industrial tests, e.g., of 3G network elements
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TTCN-3 in a Nutshell (1)

- High-level, technology-independent language for abstract test specifications
- Data templates allow structuring and reusability of test data
- Matching mechanism to compare expected and received data
- Message-, procedure-based and real-time ports
- Parallel test components
TTCN-3 in a Nutshell (2)

**Type Definitions:**
- boolean, integer, float, bitstring, charstring, octectstring, hexstring
- record, set, enumeration, union

**Programming Constructs:**
- message: send/receive
- procedure: call/getcall, reply/getreply, raise/catch
- if-then-else, loops: for, while, do-while
- functions, alternatives
- component/port/timer control

**Predefined Functions:**
- type conversion, lengthof (string), sizeof (records), ...

**Overview:** e.g. TTCN-3 Quick Reference Card
TTCN-3 in a Nutshell (3)

- Test technology for **local/distributed** testing, for **static/dynamic testing**, for **interface-/API-/protocol-oriented** testing
- Concrete test implementation: **adapter and codecs**
- Execution environments based on TRI, TCI
Test Automation

- "The management and performance of test activities to include the development and execution of test scripts so as to verify test requirements, using an automated test tool." – Dustin, Rashka & Paul
- "Testing supported by software tool.” – Faught, Bach
- "Testing is automation, automation, automation.” – Harman

- **Automated test execution**
  - Test cases to test code/scripts
  - Test platforms

- Automated test case generation
  - Models to test cases
  - Model-based testing

- Automated test framework generation
  - Metamodels to test models
Points to make

- Test execution automation is not only about scripting

- It is about
  - Test design and modelling
  - Test quality and validation
  - Test execution for various target systems, on various test devices, etc.
  - Test reuse
  - ...

- It also needs to be integrated with
  - Test process management
  - Defect tracking
  - Configuration management
  - ...

TTCN-3

ISTQB International Software Testing Qualifications Board
TTCN-3 based test execution automation

- Domain-specific solutions: TTCN-3 test suites
- Domain-specific adaptations: TTCN-3 test frameworks
- Generic test automation platform: TTCN-3

Increase of test solution portion
Increase of direct applicability
Professional Services
Outline

- Introduction + History
- TTCN-3 Status
- TTCN-3 Perspective
- Summary
Commercial TTCN-3 tools: www.ttcn-3.org

**TTCN-3 Compilers and Interpreters**
- **Exhaustif/TTCN**: compiler (C++) produced by Métodos y Tecnología (MTP), Spain.
- **OpenTTCN**: interpreter (C, Java, C# interfaces) produced by OpenTTCN Ltd, Finland.
- **MessageMagic**: compiler (C/C++, Java, C#) produced by ELVIOR, Estonia.
- **Real Time Developer Studio**: modelling tool including TTCN-3 compiler by PragmaDev, France.
- **TAU Tester**: compiler (C) by IBM.
- **TTCN-3 toolbox**: compiler (C) by Danet Group, Germany.
- **TTCN-3 Express**: compiler (C#) by Fraunhofer FIRST and Metarga GmbH, Germany.
- **TTWorkbench**: compiler (C, Java) by Testing Technologies, Germany.

**TTCN-3 Generators**
- **Qtronic** by Conformiq OY, Finland. generate complete TTCN-3 test suites from e.g., UML, Java, or C# models.
- **MaTeLo** by All4Tec, France (TTCN-3 test suites from usage models specified using Markov chains).
- **MOTES** by ELVIOR, Estonia (from the state model of the SUT)
Open source TTCN-3 tools: www.ttcn-3.org

- **LoongTesting** testing platform including TTCN-3 compiler and integrated development environment by Information Processing Center of USTC, China.
- **BBT TTCN-3 Compiler**, by BroadBit, Hungary.
- **TReX**: by University of Göttingen to provide IDE functionality for TTCN-3 core notation, and to support assessment and automatic restructuring of TTCN-3 test suites. (open-source Eclipse plug-in).
- **T3doc** by Federico Engler and further developed by ETSI. for generating HTML documentation via tagged TTCN-3 comments.
- **Codec generator** by IRISA as part of T3DevKit. It automatically generates a codec based on TTCN-3 type module(s), C++ codec functions.
- **T3DevLib** by IRISA as part of T3DevKit. It allows the development or integration of Codec, SUT and Platform Adapter implementations written in C++.

... and more academic prototype/research tools (guideline checking, quality analysis, ...)
Selected test devices with TTCN-3 support – www.testingtech.com

- DCT2000© (Catapult Communications Corporation)
- E6651A Mobile WiMAX Test Set (Agilent Technologies)
- G35 Protocol Analyzer (Tektronix)
- MiNT T2230/1 AIME - 802.16e (Aeroflex)
- Nexus8610 Traffic Simulation System (Nexus Telecom)
- MobileRobot (ServiceForce.Com GmbH)
- Testerlyzer (Ruetz Systems Solutions GmbH)
- …
A seamless chain of TTCN-3 Tools

Developers Perspective for Modification

Test Execution

Test Campaign Designer (Test Automation)

Test Parametrization

Result Analyzer

Test Report

Online Logging, Filter, Reporting
A Selection of TTCN-3 Users

- Telecommunication Vendors
  - ERICSSON
  - MOTOROLA
  - Siemens
  - Nokia
  - TELEKOM AUSTRIA
  - france telecom
  - Deutsche Telekom
  - TELES GROUP
  - ISKRATEGEL

- Service Provider
  - O2
  - Vodafone
  - Telekom Austria
  - VeriSign
  - sunrise

- Test Device Vendors
  - Agilent Technologies
  - Tektronix
  - NAVTEL
  - Alcatel-Lucent
  - AEROFLEX

- Automotive and Avionics
  - DAIMLERCHRYSLER
  - TEXAS INSTRUMENTS
  - FUJITSU
  - Seagate
  - Volkswagen
  - ESA
  - SIEMENS VDO

- Hardware Vendors
  - carmeq
  - intel
  - Samsung
  - CONEXANT
  - WISTRON

- System Integrators
  - NTT DATA
  - HITACHI
  - ORACLE
  - utimaco
  - AUTOSAR

- Standardisation
  - Open Mobile Alliance
  - ETSI
  - 3GPP
  - WiMAX Forum
Sample SUT: IMS components
Test IMS components separately and in different configurations

Definitions using TTCN-3:
• standard call scenarios
  (e.g. voice call, conference call, application call, push-to-talk call)
• traffic set as an aggregation of call scenarios

Performance:
• 5,000 - 10,000 IMS subscribers (per server)
• Up to 250 requests per second (per server)
TTCN-3 domains: Automotive

- Car communication systems
  - Daimler, Volkswagen, Siemens VDO
  - edutainment bus system
- Standardization groups:
  - AUTOSAR consortium
  - MOST cooperation
- Car-to-car communication

Telematics Applications in the Cockpit

- Audio (CD / Radio), Video
- Telephone, SMS
- Navigation
- Speech recognition
- User interface for body electronic
TTCN-3 domains: further examples

- **Medicine**
  - SiemensMED (image processing)
  - HL7 eHealth protocols (Interoperability)

- **Power transmission and distribution:**
  - SiemensPTD (safe and reliable energy system)

- **Financial data warehouse:**
  - International bank (functional / regression testing)

- **Avionics**
  - European Space Agency

- **Railways**
  - Dutch railways
Google analytics for www.ttcn-3.org

- Statistics since June 2008

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65,194 visits came from 121 countries/territories

- 65,194 Visits
- 181,050 Pageviews
- 2.78 Pages/Visit
- 36.31% Bounce Rate
- 00:02:42 Avg. Time on Site
- 56.46% % New Visits

ASQF Software Test, Dresden: TTCN-3, Slide 24
TTCN-3 today

- A successful testing technology
  - Used in telecommunication, software industry, automotive, etc.
- A textual and graphical test scripting language
  - Human readable
- A test implementation language
  - Automated test execution is built-in
- A test realization framework
  - A variety of ready-to-use tools and test assets provided by an agile community
- A philosophy
  - Specifically made for testers
Challenges in TTCN-3 based Test Execution Automation

1. The home-grown-test-tool syndrom

2. The technology ignorants

3. The test process religion
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TTCN-3 Perspective

- TTCN-3 as target for model-based testing
- TTCN-3 for embedded systems
- TTCN-4
TTCN-3 in MBT

- TTCN-3 is used in several domains as binding link between modelling and execution
- Commercial tools like Qtronic (Conformiq) and TTmodeler (TestingTech) do generate TTCN-3 code for test execution
- Lots of academic prototype tools

Selection of industrial case studies:
see e.g. European D-MINT project [www.d-mint.org](http://www.d-mint.org)
MBT example:
Trimek/Datapixel production engineering case study

- **SUT**: Coordinates Measuring Machines (CMM) control software (CDMS) for controlling a measuring system
- Focus: test case derivation from UML models
- Models in use: *UML class, sequence, state diagrams*
MBT example 2: City street lights case study

- **SUT:** Eliko *street lighting control system* feeder box control unit (FBCU)

- Models for the SUT: *UML state charts*, produced with tool Poseidon

- Elvior test generator derives *TTCN-3 test cases* from state charts
TTCN-3 embedded

- Extensions for testing
  - real time systems (RT-TTCN-3)
  - continuous systems (Continuous TTCN-3)

- RT TTCN-3 Concepts
  - clock as a common basis for time measurement.
  - timestamp redirection for exact time measurement of message interaction.

- Continuous TTCN-3 Concepts
  - sampled clock as a common basis for discretization and stream definitions.
  - sampled streams that provide a data structure to define, access and manipulate discretized signal values and their history in time.
  - hybrid automata that provides a control flow structure to enable and control the simultaneous stimulation and evaluation of stream ports.
TTCN-3 embedded sample

- Test execution platforms
  - Vector Canoe
  - Matlab Simulink
  - DSpace real time environment
My panel slides from 2000 at TestCom, Ottawa:

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**TTCN - is not the end**

TTCN-1  TTCN-2  TTCN-3  TTCN-4  ...

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Too early that time – but may be the right time now.
Outline

- Introduction
- TTCN-3 Status + New Developments
- TTCN-3 Perspective
- Summary
Conclusions

- 1980s – today: long history and value
- Wide range of applicability
  - different communication paradigms and testing types
  - various domains
  - used in industry and research
- Created by an international community, wide-spread expertise, commercial and open source tools
- TTCN-3 is mature, well-established and in progress for the future
Further activities

- Establishment of a **TTCN-3 syllabus and certificate**
  - Cooperation of ETSI, GTB and iSQI
  - accredited TTCN-3 training providers
  - several certificates issued – layered approach proposed

- Improvement of **TTCN-3 tool interoperability**
  - Development of a TTCN-3 reference test suite
  - 1st TTCN-3 **Plugtest** event with commercial tools at ETSI (2009)

- **TTCN-3 user conferences**
  - Europe: since 2004 (F, D, E, S), next: 2011 (SLO)
  - Asia: 2007 (China), 2009 (India), 2010 (China)
TTCN-3 as a testing middleware

A) Forum

Product/Component Specification

Standardization

Specification

Test Execution

Development Process

Functionality Interop./Integr.

Solution Deployment

C) Solution Provider

B) Component Provider

Products
TTCN-3 Sources

- Online information
  → www.ttcn-3.org

- TTCN-3 User Conference
  → 2011 in Bled

- TTCN-3 Standards, Papers, Book
  → http://www.ttcn.de/

- Quick Reference
  → http://www.blukaktus.com/

- Exercises and Tooling
  → research licenses
Make sure you have the right tool!

→ The test specification and test implementation language
Thank you for your attention!

Further Questions?
Contact

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