An Overview on TTCN-3

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Outline

- Overview
- Main Concepts
- TTCN-3 in a Nutshell
- TTCN-3 based test systems
- An Example: IMS Benchmarking
- Summary
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  - Main Concepts
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The Testing and Test Control Notation

- A standardized alternative to proprietary test systems
  - Developed by a large group of testing experts
  - Used by a growing community
  - Proven by tools
  - Maintained at ETSI
- A test specification and implementation language
- A multipart standard covering
  - textual TTCN-3 core
  - graphical TTCN-3
  - execution interfaces TRI and TCI
  - language mappings to TTCN-3, e.g. for IDL
Areas of Testing

- Regression Testing
- Conformance and Functionality Testing
- Interoperability and Integration Testing
- Load/ Stress Testing

Applications

- Mobile communications (GSM, GPRS, UMTS, TETRA)
- Wireless LANs and MANs (Hiperlan, Hiperaccess), cordless phones (DECT)
- Broadband technologies (B-ISDN, ATM)
- Internet protocols (IPv6, SIP, Voice over IP)
- Middleware platforms (CORBA, CCM, EJB, Web services)
- Smart Card Testing, MOST, CAN, Powertrain
Placement of TTCN-3

- One test technology for different tests
  - Distributed, platform-independent testing
  - Integrated graphical test development, documentation and analysis
  - Adaptable, open test environment

- The testing middleware
  - unifying the documentation and definition of tests
  - unifying the tests in IT, Internet- and Telco-based systems (supporting their convergence)
  - unifying the test infrastructure
History (1)

- **TTCN (1992)**
  - Published as an ISO standard
  - Tree and Tabular Combined Notation
  - Used for protocol testing
    (GSM, N-ISDN, B-ISDN)

- **TTCN-2/2++ (1997)**
  - Written by TC MTS
  - Published by ISO
  - Concurrent tests
  - Modularization
  - Manipulate external data
  - Rather for conformance testing
History (2)

  - Testing and Test Control Notation
  - Written by TC MTS
  - Published by ETSI and ITU
  - Proper language
    (well defined syntax and semantics)
  - Enhanced communication, configuration and control
  - Standard test specification
    (SIP, SCTP, HiperLan, HiperAccess, IPv6 etc.)

- **TTCN-3 (2006): version 3**
  - Ongoing maintenance for change requests and extension proposals
TTCN-3 Definition

TTCN-3 Core Language

- ASN.1
- IDL
- XML
- Other Types & Values

Presentation Format

Graphical Format

Tabular Format

Other Types & Values

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TTCN-3 Standards

- ETSI ES 201 873-1  TTCN-3 Core Language (CL)
- ETSI ES 201 873-2  TTCN-3 Tabular Presentation Format (TFT)
- ETSI ES 201 873-3  TTCN-3 Graphical Presentation Format (GFT)
- ETSI ES 201 873-4  TTCN-3 Semantics
- ETSI ES 201 873-5  TTCN-3 Runtime Interfaces (TRI)
- ETSI ES 201 873-6  TTCN-3 Control Interfaces (TCI)
- *ETS* ES 201 873-7  *ASN.1* to *TTCN-3* Mapping
- ETSI ES 201 873-8  IDL to TTCN-3 Mapping
- *ETS* ES 201 873-9  *XML* Schema to *TTCN-3* Mapping
- *ETS* ES 201 873-10  *TTCN-3* Documentation
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TTCN-3 – Based Black-Box Testing

TTCN-3 Test Case

Port.send(Stimulus)       Port.receive(Response)

• Assignment of a Test Verdict

System Under Test
TTCN-3 – Test Configuration
TTCN-3 – Test Verdicts

- Test verdicts: none < pass < inconc < fail < error
- Each test component has its own local verdict, which can be set (setverdict) and read (getverdict).
- A test case returns a global verdict

Verdict returned by the test case when it terminates

- **MTC**
  - F
  - setverdict(fail)

- **PTC₁**
  - P
  - setverdict(pass)

- **PTCₙ**
  - I
  - setverdict(inconc)
The top level entity of TTCN-3 is module.
A module can import definitions from other modules.
A module contains a definition part and a control part.

```ttcn3
module MyModule {
  // definition part

  control {
    // test execution logic
  }
}
```
Major elements of TTCN-3

- **Imports**: Importing definitions from other modules defined in TTCN-3 or other languages.
- **Data Types**: User defined data types (messages, PDUs, information elements, …).
- **Test Data**: Test data transmitted/received during test execution (templates, values).
- **Test Configuration**: Definition of the test components and communication ports.
- **Test Behavior**: Specification of the dynamic test behavior.
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Example: Test Configuration

Test Component (MTC)

UA

System Under Test (SUT)

SA

Medium Service
Example: Test Behavior

msc Example

UA

SUT

SA

loop<100>

DATreq("data")

DATind(DT,nr,"data")

DATind(RE,nr,"resp")

DATind()
testcase Example( ) runs on MTC_Type {

var default mydefault := activate (DefaultDef());
T1.start;
for (integer i:=1; i<=100; i:=i+1) {
    UA.send(DATreq:{"data"});
    SA.receive(DATind:{DT, nr, "data"});
    SA.send(DATind:{RE,nr, "resp"});
    UA.receive(DATind :{});
}
setverdict(pass);
T1.stop;
}
The same graphically

testcase Example() runs on MTC_Type

MTC_Type

UA_Type

SA_Type

var default mydefault := activate(MyDefault())

for (i:=1; i<=100; i:=i+1)

DATreq

("data")

DATind

(DT,nr,"data")

DATind

(RE,nr,"resp")

DATind

pass
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Aspects of TTCN-3 Tooling

Test Automation

- TTCN-3 development tools
- TTCN-3 based solutions
- TTCN-3 community
Aspects of TTCN-3 Tooling

Test Automation

<table>
<thead>
<tr>
<th>Editing</th>
<th>Closed-Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementing</td>
<td>Test Device Support</td>
</tr>
<tr>
<td>Executing</td>
<td>Test Suite Frameworks</td>
</tr>
</tbody>
</table>

- Standard Bodies
- Users
- Educational Institutions
TTCN-3 Development Tools
The Foundation

- **Editing**
  - Textual
  - Graphical
  - Tabular

- **Implementing**
  - Compilers / Interpreters
  - Standardized Implementation Interfaces (TRI / TCI)
  - Multiple Platform Support (Java / C / C++)

- **Executing**
  - Interactive: Graphical user interfaces
  - Fully automated: Command line user interfaces
  - Distributed: Distributed execution environments

- Recently, test generation tools towards TTCN-3
TTCN-3 Solutions
The Nuts and Bolts

- Closed-Box Solutions
  - Ready-to-Run
  - Optimized application
    - Conformance test scenario
- Test Device Support
  - Test scripting language
  - Multiple interface support
    - User defined test scenarios
- Test Suite Frameworks
  - Ready-to-Run
  - Modifiable and extensible
    - Combining compliance and development tests
Data Interface → Generation of test data structure → TTCN-3

Adaptor acc. to the mapping rules → Compilation to Executable Tests

System → Test System → Test Component
The Execution Interfaces

Test System User

TM: Management

TE: Test Execution

SA: System Adaptor

PA: Platform Adaptor

CD: CoDec

CH: Component Handling

TCI

TRI

SUT: System Under Test
Local and distributed test setups

Special TE: Initiating StartTestCase & Calculating Final Verdict
TTCN-3 Community
Resources and Users

- **Standard Bodies**
  - ETSI, ITU, WiMAX, 3GPP, others
    - *Standard bodies produce TTCN-3 test suites*
  - TTCN-3 Web Site/Forum at ETSI ([www.ttcn-3.org](http://www.ttcn-3.org))

- **Educational Institutions**
  - Universities, Research Institutes
  - European Research Projects
    - *Free academic licenses available*

- **Users**
  - Different Domains: Telco, IT, Automotive, Embedded Systems
  - Education Tracks available
    - *TTCN-3 Users Conference*
    - *TTCN-3 Certificate*
An Example: TTworkbench – textual test design

The TTCN-3

Compile Button

Problems

File Overview

Outline view
TTworkbench - graphical test design

1. Project View
2. Full GFT Support
3. Data Import
4. TTCN-3 Code Im- and Export
TTworkbench – TTCN-3 Execution

1. Test Case Management
2. Parameterization
3. Test Data View
4. Detail Logging
5. Graphical Logging
6. Test Report Generation
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IMS in a Nutshell

- IMS = IP Multimedia Subsystem
The importance of testing

- to validate the key IMS subsystems
- protocol conformance ...

Service-oriented testing

- Combines research and industrial interests
- Metrics for the correctness, reliability and scalability of IMS solution

- Objective performance comparison for network/service providers

Protocol Conformance

Protocol Interoperability

Service Conformance and Performance
IMS Performance Testing

- Benchmarking
  - for comparison
- Load/stress
  - how system performs under load conditions
- Capacity testing
  - max load the system can handle before failing
- Scalability testing
  - to plan capacity improvements
Benchmark Procedure

Estimated Maximum Load

Initial Call Load

No Load  Initial Load  Plus Load  Plus Load  Plus Load  Plus Load

Load Ramp

Load Step

Rate Increase

Stability Or Settling Time

Time To Stop

DOC (Design Objective Capacity of the SuT)
IMS Test Bodies

- ETSI
  - Methodology for IMS network integration testing
  - SIP testing
- SIG
  - IMS benchmarking methodology
- TISPAN
  - Standardisation of converged networks
  - IMS benchmark
FOKUS Open Source IMS

- A Home Subscriber Server
- 3GPP compliant IMS Call Session Control Functions (CSCFs)
- A SIP2IMS gateway
## FOKUS Test System

<table>
<thead>
<tr>
<th>Scenario Description</th>
<th>TTCN-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardized implementation-independent test notation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Execution Platform</th>
<th>TTworkbench Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributed Test Execution Platform</td>
<td></td>
</tr>
<tr>
<td>Deploys, creates and coordinates distributed parallel test components emulating user equipment on several hosts</td>
<td></td>
</tr>
<tr>
<td>Synchronized traffic load, measurement and logging of results</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visualization</th>
<th>TraVis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merge CSV files logged separately by Test Daemons</td>
<td></td>
</tr>
<tr>
<td>Various graphs &amp; statistics</td>
<td></td>
</tr>
</tbody>
</table>
First Benchmark Examples

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Server</th>
<th>5.1.2.1 Successful Initial Registration (SAPS)</th>
<th>5.2.2.4 Successful Call (SAPS)</th>
<th>5.3.2.1 Successful Message Exchange (SAPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>kennicot</td>
<td></td>
<td>80</td>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>DTI</td>
<td></td>
<td>140</td>
<td>310</td>
<td>690</td>
</tr>
<tr>
<td>damascus</td>
<td></td>
<td>110</td>
<td>390</td>
<td>900</td>
</tr>
</tbody>
</table>
Example: Visualization of Fail Rate
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TTCN-3

- Is
  - a test specification and implementation technique
  - open to various domains
  - open to various development and test processes

- For conformance, interoperability and performance testing!

- TTCN-3 is widely supported by tools
  - TTCN-3 is the choice for technical testing and automated test execution
  - It supports the development of telecommunication, Internet and IT standards via well-defined test suites
TTCN-3 is ...

- adopted by ITU-T

- taken for numerous ETSI test suites
  - SIP
  - IPv6
  - SIP/ISUP
  - Hiperlan/Hiperman

- taken for tests of other consortia like AutoSar, MOST Forum, WiMax Forum
Gains from Using TTCN-3 Tools
What Users Say

- Users of TTCN-3 report that...
  - productivity,
  - system quality and
  - test reuse ... are doubled

- SUT coverage is substantially increased

- Testers can concentrate on the test logic
  - i.e. what to test

- The test execution is fully automated
  - i.e. how to test technically
At the End: Standardized Test Specifications

- Well-defined test notation for many testing applications
- Universally understood syntax and operational semantics
- Off-the-shelf tools
- Cheaper education and training costs
- Standardization, exchange and reuse of test suites
- Easier maintenance of test suites

- Transparency for the test process
- Increase of the objectiveness of tests
- Comparability of test results
Thank You!

Any Questions?

Please be invited to the 4th TTCN-3 User Conference
@ Ericsson, Sweden, May 2007