Welcome to the World of Standards

TTCN-3 Tutorial

ETSI Centre for Testing and Interoperability
What is TTCN-3?

- **Testing and Test Control Notation Version 3**
- **Internationally standardized testing language**
  - Product of the ETSI 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 black box testing and certification
  - Constantly developed and maintained at ETSI by a team of leading testing experts from industry, 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., 3G network elements
The TTCN-3 Standards (available at http://www.ttcn-3.org)

- ES 201 873-1 (Z.140)
  - TTCN-3 Core Language

- ES 201 873-2 (Z.141)
  - TTCN-3 Tabular Presentation Format (TFT)

- ES 201 873-3 (Z.142)
  - TTCN-3 Graphical Presentation Format (GFT)

- ES 201 873-4 (Z.143)
  - TTCN-3 Operational Semantics

- ES 201 873-5
  - TTCN-3 Runtime Interface (TRI)

- ES 201 873-6
  - TTCN-3 Control Interfaces (TCI)

- ES 201 873-7 and onwards (under development)
  - Using ASN.1, XML, IDL, C/C++ with TTCN-3
What makes TTCN-3 different ...

From conventional programming or scripting languages?
- Rich type system including native list types and support for subtyping
- Embodies powerful build-in matching mechanism
- Snapshot semantics, i.e., well defined handling of port and timeout queues during their access
- Concept of verdicts and a verdict resolution mechanism
- Support for specification of concurrent test behaviour
- Support for timers
- Allows test configuration at run-time
- Tests focus only on implementation to be tested

From a test tool or vendor proprietary testing language?
- Not tied to a particular application or its interface(s)
- Not tied to any specific test execution environment, compiler or operation system
- TTCN-3 as such is not executable and requires a compiler/interpreter, adapter as well as codec implementations
How does TTCN-3 relate to TTCN-2?

TTCN-3 builds on top of TTCN-2 but extends it significantly

- Core language has now look and feel of a regular programming language: much easier to learn
- No longer uses protocol specific terminology like PCO, ASP, PDU, etc
- Different presentation formats: tabular, graphical, ...
- Completely dynamic test configurations
- Support for synchronous communication
- Support for testing distributed systems
- Standardized test system interfaces (TRI & TCI)
- Improved text string matching: regular expressions
- Better harmonisation with ASN.1
- Extension mechanism to integrate other type systems, e.g., XML, ASN.1, C, ...
TTCN-3 test systems in a nutshell

- TTCN-3 specifies a test but a test system is needed for test execution
- TRI and TCI standards define test system architecture
  - TTCN-3 tools are *required* to support internal interfaces
  - Allows reuse of test platforms with different tools but also for different SUTs
- A test system requires
  - A TTCN-3 tool = TTCN-3 compiler and execution environment
    - ( )
  - A test platform for a specific device under test
    - ( s + s )
- Note: Tools come with default Test Control & Logging

TCI = TTCN-3 Control Interface
TRI = TTCN-3 Runtime Interface
An example adaptation: A IPv6 test system
TTCN-3 Benefits

- TTCN-3 is easy to learn
  - Look and feel of a regular programming language
- Unambiguous specification and execution of tests
  - Well defined syntax, static - and operational semantics
  - Enables completely automated test execution
- Off-the-shelf tools and test systems are readily available
  - Five different commercial TTCN-3 tools on the market
- Open source community now taking shape
  - Tools as well as test suites and useful modules
- Can be used to specify tests for standardization as well as proprietary product features
- Flexible testing technology
  - Virtually no limits to adapt a test system to your needs
  - Scalable – allows test systems to grow over time
TTCN-3 Success stories

At ETSI
- Used for development of any new conformance test suite, e.g., SIP (VoIP), IPv6 (Core, Mobility, Security), HiperMAN / WiMax, 3GPP IP Multimedia Subsystem, ...

In industry
- Applied in a variety of application domains, e.g., telecom, automotive, financial, ... (see www.tt-medal.org)
- Ericsson reported 1,000 active licenses at TTCN-3 User Conference 2006
- Nokia experiences captured in IEEE Software 23(4) 2006
- Motorola reports doubling of testing productivity

Also used beyond Europe
- Strong community in China
Expansion of TTCN-3 Use
TTCN-3 can automate
Conformance and Interoperability Testing

Conformance testing
(of a network element)

Conformance testing
(of terminal equipment)

Interoperability testing
(of terminal equipment)
Main Capabilities of TTCN-3

- Dynamic concurrent testing configurations
- Various communication mechanisms (synch and asynch)
- Data and signature templates with powerful matching mechanisms (including regular expressions)
- Attributes for encoding, display or user-defined information
- Test suite parameterization
- Control of Test Case execution and selection mechanisms
- Control of complex test configurations
- Assignment and handling of test verdicts
- Harmonized with ASN.1 (XML and IDL coming)
- Different presentation formats
- Well-defined syntax, static - and operational semantics
The Core Language and Other Presentation Formats

TTCN-3 Core Language

Text format

Core format is text based (most popular)

TTCN-3 can be edited or viewed in other formats

- Tabular format (for TTCN-2 people)
- Graphical format (good for visual overview)
- Other standardized formats in the future?
- Proprietary formats possible

PresentationFormat

PresentationFormatₙ

PresentationFormat₃

Tabular Format

Graphical Format

Proprietary formats possible
**Example Core (Text) Format**

```c

testcase TC_resolveEtsiWww() runs on DnsClient
{
    timer t_ack;
    serverPort.send(m_dnsQuestion("www.etsi.org"));
    t_ack.start(1.0);
    alt {
        [] serverPort.receive(mw_dnsAnswer("172.26.1.17")) {
            setverdict (pass);
        }
        [] serverPort.receive { // any other message
            setverdict(fail);
        }
        [] t_ack.timeout {
            setverdict(inconc);
        }
    }
    t_ack.stop;
}
```
testcase TC_resolveEtsiWww() runs on DnsClient

DnsClient

mtc

timer t_ack

DnsPort

serverPort

m_dnsQuestion("www.etsi.org")

mw_dnsAnswer("172.26.1.17")

pass

fail

inconc


## Example Tabular Format

<table>
<thead>
<tr>
<th>Testcase</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>TCResolveEtsiWww()</td>
</tr>
<tr>
<td>Group</td>
<td></td>
</tr>
<tr>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>System Interface</td>
<td></td>
</tr>
<tr>
<td>MTC Type</td>
<td>DnsClient</td>
</tr>
<tr>
<td>Comments</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local Def Name</th>
<th>Type</th>
<th>Initial value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_ack</td>
<td>timer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Behavior

```c
serverPort.send(m_dnsQuestion("www.etsi.org"));
t_ack.start(1.0);
alt {
    alt {
        [] serverPort.receive(mw_dnsAnswer("172.26.1.17"))
        {
            setverdict(pass);
        }
        [] serverPort.receive // any other message
        {
            setverdict(fail);
        }
        [] t_ack.timeout
        {
            setverdict(inconc);
        }
    }
}
t_ack.stop;
```

**Detailed Comments:**
Use of TTCN-3 With Other Languages

TTCN can be integrated with types systems of other languages

Fully harmonized with ASN.1 (1997)

Harmonized with other languages
- IDL, XML, C/C++
Minimal Test Configuration

- All test behavior is executed on one (main) test component
A test involves execution of many parallel test components
Dynamic instantiation of components and communication links
Test Suite

Test Data Types

Data types which specify
- Structure of messages or calls and their information elements (fields, parameters)
- Internal data structures (e.g., for computation)
- Possibly encoding or display information

Built-in basic types
- integer, boolean, float,
- bitstring, hexstring, octetstring,
- charstring, universal charstring

... and structured types
- record, record of, set, set of
- union, enumerated

... and special types such as
- component, port, verdicttype, default, etc
Actual test data (values) used during testing

- Constants or Templates for specific message or call parameter values
- Matching expressions for allowing multiple message or call parameter values
  - value range, value list, wildcards, presence, length, size, permutation
  - regular expressions
- Using also template decomposition, parameterization and modification
Building blocks of a TTCN-3 Test Suite

Test Suite

- Test Data Types
- Actual Test Data
- Test Configuration

Static aspects
- Test component and port types

Dynamic aspects
- Dynamic instantiation and management of test components
- Mappings of test components to abstract test system interfaces
- Connections between test component interfaces
- Management of test components
Building blocks of a TTCN-3 Test Suite

- Test cases
  - specify sending/receiving messages, computation (e.g., checksums), and verdict assignment
  - can be decomposed with functions and altsteps
  - can (re)use default behaviour
  - can use timers and timeouts

- Test execution control (optional)
  - order, repetition, conditions, etc
module EtsiDnsTests
{
    // Test definition part

    control
    {
        // Test execution part
        // (optional)
    }
}
module EtsiDnsTests
{
    // Message structure
    // Actual test data
    // Test configuration
    // Test Case definitions
}
module EtsiDnsTests
{
    group MessageStructure
    {
        // Definitions of message types
    }
    group TestData
    {
        // Templates for messages instances
    }
    group TestSystemConfiguration
    {
        // Port and component types and mappings
    }
    group TestCases
    {
        // Test case definitions
    }
}
type record DnsMsg // simplified message structure!
{
  DnsMsgKind kind,
  charstring question,
  charstring answer optional
}
type enumerated DnsMsgKind {e_query, e_response}
template DnsMsg m_dnsQuestion( charstring p_question )
{
  kind := e_query,
  question := p_question,
  answer := omit // no answer
}
template DnsMsg mw_dnsAnswer( charstring p_answer )
{
  kind := e_answer,
  question := ?, // any question ok
  answer := p_answer
}
type port DnsPort message
{
  inout DnsMsg
}
// Note: port types may also allow multiple different
//       message types or restrict the direction

type component DnsClient
{
  port DnsPort serverPort
}
// Note: component types can also define multiple port
//       instances of the same or different port type and
//       declare timers, constants or variables
testcase TC_resolveEtsiWww() runs on DnsClient
{
    timer t_ack;
    serverPort.send(m_dnsQuestion("www.etsi.org");
    t_ack.start(1.0);
    alt {
        [] serverPort.receive(mw_dnsAnswer("172.26.1.17")) {
            setverdict(pass);
        }
        [] serverPort.receive { // any other message
            setverdict(fail);
        }
        [] t_ack.timeout {
            setverdict(inconc);
        }
    }
    t_ack.stop;
}
module EtsiDnsTests {
    // Test definition part
    modulepar boolean mp_example;

    testcase TC_resolveEtsiWww() runs on DnsClient {
        // .. as in previous slide
    }

    // Test execution part
    control {
        if (mp_example) {
            execute(TC_resolveEtsiWww());
        }
    }
}
Where can I learn more?

- Visit ETSI’s official TTCN-3 web site (www.ttcn-3.org)
  - Public TTCN-3 test suites, useful TTCN-3 modules
  - Links to commercial as well as open source tools

- Read well written TTCN-3 standard suites

- Join the ETSI mailing list (list.etsi.org/TTCN3.html)

- Take a course

- Read publications
  - Proceedings of Conference for Testing of Communicating Systems (TESTCOM)
  - Presentations of yearly TTCN-3 User Conferences in Europe or Asia (see www.ttcn-3.org)

- Register for the next TTCN-3 user conference!
Contact Details:

www.ttcn-3.org

ttcn-3@etsi.org

Thank you!