



The Testing and Test Control Notation



Curriculum

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1 Document Information

Version	Date	Editors	Remarks
0.1	03/2004	Ina Schieferdecker, Fraunhofer FOKUS Andrej Pietschker, Siemens	First Draft
0.2	05/2005	Ina Schieferdecker, Fraunhofer FOKUS Andrej Pietschker, Siemens	Completed Draft
1.0	08/2006	Ina Schieferdecker, Fraunhofer FOKUS	Revision for TTCN-3 v3 ETSI inclusion
1.1	12/2006	Ina Schieferdecker, Fraunhofer FOKUS	Copyright transfer to GTB in preparation of the con- tract with iSQI
2.0	10/2010	Theofanis Vassiliou-Gioles, Testing Technologies Ina Schieferdecker, Fraunhofer FOKUS	Revision for TTCN-3 v4.2.1 Addition of extension packages

2 Keynote

The Testing and Test Control Notation (TTCN-3) is a widely used and well established test specification and test implementation language that supports all kinds of black-box testing. In particular it is well suited for reactive systems covering testing of local sequential or concurrent systems up to the testing of distributed systems.

TTCN's traditional stronghold is in testing communication protocols however with the release of version 3 it became a universal and adaptable testing language suited for a large variety of application domains. Today TTCN-3 is for example also used to test applications in the automotive industry through CAN and MOST busses. With the ever growing need to test e.g. Web services from a user's point of view, TTCN-3 delivers the concepts and tools to master these challenges. Not all possible applications of TTCN-3 have been evaluated; however also industry and research in domains like eHealth, Finance, Power distribution etc. start to focus on TTCN-3 and its applications in testing as recent test conferences illustrate.

TTCN-3 was developed at the European Telecommunications Standards Institute (ETSI) and is the only standardized test specification language (being also adopted at ITU). It therefore has all the benefits a standardized language possesses. Several vendors support this language with compilers, even more support TTCN-3 with supplementary tools and services making the claim for vendor independence come true. With TTCN-3, test systems move from being expensive proprietary solutions designed for a single purpose to highly adaptive software test platforms supporting a variety of tests being used throughout system development and for system approval and acceptance kind of tests.

Consequences for training

TTCN-3 as such requires a deep understanding and good knowledge to be used efficiently. This calls for well trained, high qualified testing specialists.

Aim of training as a TTCN-3-CERTIFICATE.

It aims at making TTCN-3-Certificate holders to be knowledgeable in TTCN-3 concepts, the practical application of TTCN-3 and the integration of a TTCN-3 based test process into the system development. The curriculum covers the concepts, presentation formats, guidelines of use and concrete application examples of TTCN-3.

Training for a TTCN-3-CERTIFICATE is aimed at all people involved in software testing, who wish to base their knowledge and experience on TTCN-3 on a sound foundation or extend it. The training is suitable for quality and test professionals, programmers, developers, specialists and (project-) managers who are responsible for the execution, planning or control of testing.

- TTCN-3-CERTIFICATE holders are capable of designing and planning the project-specific tests and formalize them in TTCN-3. They are capable of defining ad-

equate test strategies including test objectives, test purposes, test configurations, test suites and the realization of tests on target test platforms.

- TTCN-3-CERTIFICATE holders are capable of developing functional, conformance, interoperability, robustness, scalability, load, stress, etc. tests in TTCN-3
- TTCN-3-CERTIFICATE holders are aware that TTCN-3 is a powerful test technology but not the only one. They are capable of identifying those test targets which gain most from a systematic, formalized test approach with TTCN-3. They are capable of developing mixed test strategies (choosing from a set of test technologies) to have optimized test efficiency.
- TTCN-3-CERTIFICATE holders put into practice the TTCN-3 tests. They are capable of setting up automated tool chains for the execution of tests, creation of corresponding test reports and the interaction with the system developers.
- TTCN-3-CERTIFICATE holders are able to develop a TTCN-3 based testing process and to integrate the testing process with the system development process.

3 Notes on Curriculum and Examination

The curriculum defines:

- the examination-relevant material in its contents,
- the minimum time in which the material must be taught in accredited training courses. The material is to be illustrated and taught using suitable examples and exercises.
- Learning objectives for the topics. This syllabus' content, the terms and purposes of the various TTCN-3 standard parts shall at least be remembered (K1) if not explicitly mentioned in the learning objectives.

The curriculum does not define:

- the details of the TTCN-3 technology, concepts, language features, etc. as the TTCN-3 standard is the main source for the definitions,
- the (chapter-)sequence in which the material has to be taught, or
- the timescales for examples and exercises in accredited training courses.

Learning objectives (the cognitive level of knowledge) follow the definitions of ISTQB as used in the syllabi for the Certified Tester. They are classified as follows:

- K1: remember, recognize, recall
- K2: understand, explain, give reasons, compare, classify, categorize, give examples, summarize
- K3: apply, use
- K4: analyse

For further details on learning objectives please refer to the ISTQB syllabi.

The examination is a multiple-choice test:

- Word definitions, coherence as well as knowledge and understanding of test techniques defined by the TTCN-3 standard series and referenced in the curriculum are tested.

4 Summary of the Curriculum

Nr	Topic	LO	Dur (min)	Content
1	Introduction	K1	30	The TTCN-3 Certification Program
2	Basics of TTCN-3	K2	75	Motivation and History Main Concepts
3	Language Features: Data Types and Templates	K3	60	Basic and structured types Send templates, receive templates, inline templates
4	Language Features: Communication	K3	60	Message-based communication Signature-based communication Port handling
5	Language Features: Test Configurations	K3	60	Basics of configurations Component types Component handling
6	Language Features: Behaviour	K3	180	Functions, altsteps, test cases, external functions Statements Operations Logging and preprocessing macros Timing
7	Language Features: Modules	K3	105	Module definition and control Import Scoping, Grouping Parameterization Attributes Visibility of Definitions
8	Test Execution	K2	90	Test system components Test Runtime Interfaces Test Control Interfaces
9	TTCN-3 Standard	K2	30	TTCN-3 standards Standardization and Maintenance of TTCN-3
10	Test Design and Development	K3	90	Test purposes and test cases Functional, conformance, interoperability test aspects Performance, load and scalability test aspects Naming and design conventions Documentation tags
11	Open Data Interface	K2	30	ASN.1, XML, IDL within TTCN-3
12	Extension packages	K1	60	Advanced parameterization Behaviour types Configuration and deployment Support Real-time and performance testing
13	Test Tools	K2	30	Tool support for TTCN-3 based testing
Overall			900	Corresponds to 20 lectures à 45min and to 3 tutorial days à appr. 7 lectures a day

5 Learning Objectives for the TTCN-3 Certificate

Nr	Topic	LO Level	LO Nr	Learning Objective
1	Introduction	K1	1.1	Recall the elements of the TTCN-3 Certification Program
2	Basics of TTCN-3	K2	2.1	Summarize the history of TTCN-3
			2.2	Explain the main concepts of TTCN-3
3	Language Features: Data Types and Templates	K3	3.1	Define and use basic and structured type definitions in examples
			3.2	Define and use send templates, receive templates, and inline templates
4	Language Features: Communication	K3	4.1	Define and use port definitions and communication operations for message-based communication
			4.2	Define and use port definitions and communication operations for signature-based communication
			4.3	Apply and use port handling operations
5	Language Features: Test Configurations	K3	5.1	Explain basic concepts of test configurations in TTCN-3
			5.2	Define and use component type definitions
			5.3	Apply and use component handling operations
6	Language Features: Behaviour	K3	6.1	Explain and compare functions, altsteps, test cases, and external functions
			6.2	Apply and use basic program statements of TTCN-3
			6.3	Explain and compare operations for alternative behavior, for test configuration, for communication, for timing and for test verdicts
			6.4	Apply and use logging statements and preprocessing macros
			6.5	Apply and use timer operations
7	Language Features: Modules	K3	7.1	Define and use module and control part
			7.2	Explain basic concepts of module imports in TTCN-3
			7.3	Compare scopes and groups in TTCN-3
			7.4	Apply and use parameterization in TTCN-3
			7.5	Apply and use predefined and user-defined attributes
			7.6	Explain visibility of definitions in TTCN-3
8	Test Execution	K2	8.1	Summarize and explain the basic architecture of TTCN-3 based test systems
			8.2	Summarize and explain main elements of the TTCN-3 Test Runtime Interfaces
			8.3	Summarize and explain main elements of the TTCN-3 Test Control Interfaces
9	TTCN-3 Standard	K2	9.1	Summarize and explain the main parts of the TTCN-3 standard series
			9.2	Explain the maintenance process for TTCN-3 at ETSI

10	Test Design and Development	K3	10.1	Explain the development of test purposes and TTCN-3 test cases
			10.2	Explain how to represent functional, conformance, interoperability test aspects in TTCN-3
			10.3	Explain how to represent performance, load and/or scalability test aspects in TTCN-3
			10.4	Explain naming and test design conventions for TTCN-3
			10.5	Apply and use documentation tags in TTCN-3
11	Open Data Interface	K2	11.1	Explain the main concepts of using type and value definitions from external sources such as ASN.1, XML, or IDL
12	Extension packages	K1	12.1	Recall the TTCN-3 extension packages on advanced parameterization, on behaviour types, on configuration and deployment support, and on real-time and performance testing
13	Test Tools	K2	13.1	Characterize and give examples for different tools supporting TTCN-3 based testing

6 Details of the Curriculum

Subject	Learning Objective	Time (min)
6.1 Introduction	K1	30

Introduce the

- Concept of the TTCN-3-Certificate,
- TTCN-3 curriculum and its structure,
- Training and exercises,
- Examination and certification,
- Associated institutions and international connections:
 - accredited training providers
 - certification bodies ISQI and ETSI
 - TTCN-3 standard provider ETSI.

Subject	Learning Objective	Time (min)
6.2 Basics of TTCN-3	K2	75

Introduce the background, history, objectives, and main concepts of TTCN-3.

6.2.1 Motivation, History	15
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Explain that TTCN-3

- Supports
 - Testing current software and software-based systems
 - Different kinds of tests
 - functional, integration, interoperability, conformance, scalability, load, ...
 - Platform-independent testing
 - Adaptable, open test environments
 - Local and distributed test setups
 - Static and dynamic test setups
- Avoids heterogeneous test environments that are hard to maintain and proprietary solutions which are expensive to develop and maintain
- Is
 - The Testing and Test Control Notation
 - The standardised test specification and test implementation language
 - Developed based on the experiences from previous TTCN versions
 - Applicable for all kinds of black-box and white-box testing for reactive and distributed systems
- Was developed to
 - Support specification-based, systematic and documented testing by a widely accepted test notation
 - Enable testing of current and upcoming technologies
 - Consolidate test concepts
 - Widen the scope of application
- Is historically based on
 - The ISO/IEC Conformance Testing Methodology and Framework
 - With the TTCN: Tree and Tabular Combined Notation (version 1,2)
 - Version 2++ developed by ETSI MTS
 - Version 3 (TTCN-3) developed by ETSI MTS
 - And currently continuously maintained by ETSI in major and minor revisions

6.2.2 Main Concepts	60
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Introduce the main aspects of TTCN-3 being:

- Configuration: static and dynamic, local and distributed test configurations using single or multiple test components

- Communication with various communication mechanisms: synchronous and asynchronous; unicast, multicast and broadcast
- Test Control: test case selection, parameterization, and execution
- Module concept: visibility rules, import concepts
- Extendibility through attributes, external functions, and external data
- Well-defined syntax, static and operational semantics

Present the principal structure of the TTCN-3 standard consisting of

- The textual core language covering all the language features
- Operational semantics
- Execution interfaces TRI and TCI
- Open data interface including ASN.1, IDL and XML
- Documentation tags
- Extension packages
- Refer to the graphical and the tabular format as unmaintained parts of the standard

Introduce the basic concepts of TTCN-3 including

- Interaction-/communication-based testing via interfaces, ports, service access points, APIs, and alike: giving stimuli to the SUT via well-defined interfaces, observing and evaluating the response
- Ports: message- and procedure-based, FIFO, queues, port handling statements, port status statements
- Communication: message-based - send and receive statements, procedure-based: roles of client and server, call, getcall, reply, getreply, raise and catch statements
- Connections: unicast, multicast, broadcast, connection handling statements
- Components: component types, normal and alive components, component handling statements
- Configurations: static and dynamic configurations, TSI, MTC, PTC
- Test verdicts: verdict values and precedence, local test component verdict, overall test case verdict, setverdict and getverdict statement

Introduce the basic elements of a TTCN-3 module covering

- Declarations
 - Types
 - Templates
 - Functions, altsteps, and test cases
 - Module parameters and constants
 - Private / Friend relationships
- Control
 - Test case executions

Subject	Learning Objective	Time (min)
6.3 Language Features: Types and Templates	K3	60

Give an overview of the type system of TTCN-3. Discuss the different kinds of types, values and templates and their definitions. Present the matching mechanisms.

6.3.1 Basic and structured types	20
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Explain that data type definitions are built from basic, predefined and user-defined structured types.

Present and explain all basic types and their values:

- integer
- float
- boolean
- verdicttype
- bitstring
- hexstring
- octetstring
- charstring
- universal charstring

Present and explain all structured types and their values:

- record
- record of
- set
- set of
- enumerated
- union (incl. the special data type anytype)

Discuss the usage of different types.

Explain the different possibilities for sub-typing including range, list and length restrictions. Explain and discuss type compatibility rules.

Explain values and expressions and discuss the construction of expressions. Explain the TTCN-3 operators including

- Arithmetic operators
- String operators
- Relational operators
- Logical operators
- Bitwise operators
- Shift operators
- Rotate operators

6.3.2 Send templates, receive templates, inline templates

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Explain that

- templates define test data
- they either transmit a set of distinct values or are used to test whether a set of received values matches a template specification
- they have the following possibilities
 - they are a way to organize and to re-use test data, including a simple form of inheritance;
 - they can be parameterized;
 - they incorporate matching;
 - they can be used with either message-based or procedure-based communication
- send templates contain only concrete values and no matching operations
- Receive templates can contain wildcards or matching operations

Explain that templates

- have global or local scope
- can be parameterized
- can be modified (achieving a simple form of inheritance)
- can be unnamed (so called in-lined templates)
- can be assigned to template variables or template parameters
- can be returned by template returning functions

Explain the different matching mechanisms including

- matching for specific values
- matching instead of values
- special matching symbols inside values
- matching attributes

Discuss the purpose of different template features.

Subject	Learning Objective	Time (min)
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6.4 Language Feature: Communication

K3

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Give an overview on the available forms of communication and their purpose. Explain the differences of unicast, multicast and broadcast communication in TTCN-3.

6.4.1 Message-based communication

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Explain the

- basic FIFO semantics of ports,
- message port types and their compatibility rules.

Discuss the operations available on message-based ports

- send
- receive
- trigger
- check

6.4.2 Signature-based communication

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Explain the

- the logic of an operation call
- client and server role of test components
- procedure port types and their compatibility rules

Discuss the operations on signature-based ports

- call
- getcall
- reply
- getreply
- raise
- catch
- check
- timeout

6.4.3 Port handling

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Discuss

- the initial status of ports
- the setup of connections between ports
- the differences between connected and mapped ports

Explain

- one-to-one and
- one-to-many connections (incl. from/to addressing schemes)
- one-to-all connections

Discuss port handling operations including

- connect, disconnect
- map, unmap
- start, stop, clear, halt

Subject	Learning Objective	Time (min)
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6.5 Language Features: Test Configurations

K3

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Introduce component types, test configurations, and their set-up and teardown.

6.5.1 Basics of configurations

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Explain that

- a configuration consists of
 - a set of inter-connected test components
 - with well-defined communication ports and
 - an explicit test system interface which defines the border of the test system
- within every configuration there is one and only one main test component (MTC)
 - MTC is created automatically at the start of each test case execution.
 - The behaviour defined in the body of the test case is executed on this component.
- during execution of a test case other components can be created dynamically.
 - These test components are called parallel test components (PTC's).

Explain and discuss

- single and multi-component configurations
- dynamics of configurations
- valid and invalid configurations

6.5.2 Component types

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Explain how component types are defined and

- that they can have locally declared
 - variables,
 - timers,
 - ports,
 - constants.
- that functions share data when executed via these locally declared properties of a component type.

Explain the differences between normal and alive test components.

6.5.3 Component handling

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Explain how components are

- created and optionally named
- started
- terminated including

- stop (by itself, by another test component, when testcase stops)
- kill (by itself or by another component)
- return from or completion of test component behaviour
- testcase.stop
- checked if they are alive, running, done or killed.

Subject	Learning Objective	Time (min)
6.6 Language Features: Behaviour	K3	180

Introduce the principle behavioural elements of TTCN-3 including functions, altsteps, test cases, external functions, statements and operations. Introduce also the timing concepts.

6.6.1 Functions, altsteps, test cases, external functions	60
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Explain that

- functions are the building-blocks of the test system behaviour.
- functions have local declarations and a program part.
- external and pre-defined functions can be used.

Discuss the different kinds of functions. Include:

- "pure" data functions (without component and without port behaviour)
- "behaviour" functions (with runs on clause, port or component parameter and component or port behaviour)
- test case as special "behaviour" functions (with runs on and system clause)
- external functions
- pre-defined functions

Discuss the various predefined functions and their use.

6.6.2 Statements	50
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Introduce basic program statements, behavioural program statements, and statements for default handling.

Explain control structures and assignments in

- Label and goto
- If-else and select
- For loop
- While loop
- Do while loop
- Break and continue
- Stop execution
- Returning control

Explain the snapshot semantics of TTCN-3 and discuss the behavioural program statements

- alternative behaviour
- re-evaluation of alternative behaviour
- interleaved behaviour

Explain the default mechanism of TTCN-3, the use of altsteps in alt statements and the default handling statements

- activate a default
- deactivate a default

6.6.3 Operations

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Give an overview on the set of TTCN-3 operations including

- Configuration operations
 - Connection operations
 - connect
 - disconnect
 - map
 - unmap
 - Test component operations
 - create
 - start (of a test component)
 - stop (of a test component)
 - kill
 - alive
 - running
 - done
 - killed
 - Testcase operations
 - testcase.stop
 - Reference operations
 - mtc
 - system
 - self
- Communication operations
 - Message-based communication
 - send
 - receive
 - trigger
 - Procedure-based communication
 - call
 - reply
 - raise
 - getcall
 - getreply
 - catch
 - check operation
 - Controlling communication port operations
 - clear (a port)
 - start (a port)
 - stop (a port)
 - halt
- Timer operations
 - start (a timer)

- stop (a timer)
- read (a timer)
- running (of a timer)
- timeout
- Verdict operations
 - setverdict
 - getverdict
- External actions
- Execution of test cases

Summarize those operations that have been explained previously, explain those that haven't. Discuss the usage of these operations.

6.6.4 Logging and Preprocessing Macros

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Explain the logging capabilities in TTCN-3 modules including the logging statement and the preprocessing macros:

- Logging statement
- Preprocessing Macros
 - `__MODULE__`
 - `__FILE__`
 - `__BFILE__`
 - `__LINE__`
 - `__SCOPE__`

6.6.5 Timing

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Explain that

- timers are used to observe progress of time
- timers can be declared and used within
 - control part, test cases, functions and altsteps,
 - additionally component wide within component type definition
- timer values are represented as floats, the base unit being seconds
- timers can be started, stopped, read, checked for their status and can timeout
- in addition, the execution of a test case and a call operation can be time-guarded

Subject	Learning Objective	Time (min)
6.7 Language Features: Modules	K3	105

Explain the module concept, the parts of a module definition, the means to reuse declarations from modules and the role of the control part.

6.7.1 Module definition and control	20
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Explain that

- modules are the building blocks of all TTCN-3 specifications
- a test suite is a (set of) module(s)
- a module may consist of a definition and a control part
- modules can be parameterized
- modules can control the visibility of their included definitions

Explain the possibilities within a module control part for

- test case selection,
- test case parameterization, and
- test case execution depending on verdicts of previous test case

6.7.2 Import	20
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Explain the main concepts of import including the different forms of imports for

- a single definition
- all definitions
- groups
- a number of definitions of the same kind
- import statements

Explain the possibilities to import from TTCN-3 modules and from non-TTCN-3 sources.

6.7.3 Scoping, Grouping	15
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Explain the scope rules of

- module definitions part
- control part of a module
- component types
- functions
- altsteps
- test cases
- statement blocks
- templates
- user defined named types

Explain the possibilities of grouping definitions and their use.

6.7.4 Parameterization

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Introduce the possibilities and advantages of parameterization. Explain the concepts of static and dynamic parameterization and of parameters by value and by reference. Explain the concept of default values for parameters.

Explain the parameterization of a

- module
- type
- template
- function
- altstep
- testcase
- signature

6.7.5 Attributes

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Explain the principles of attributes and their use. Explain the different kinds of attributes being

- display
- encode
- variant
- extension

attributes.

Discuss the TTCN-3 concept of attributes as a language extension mechanism.

6.7.6 Visibility of Definitions

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Explain the visibility controls for definitions being

- private
- friend
- public

Explain the friendship relation between modules. Explain the import of definitions and import of imports in combination with visibility controls.

Subject	Learning Objective	Time (min)
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6.8 Test Execution

K2

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Discuss the architecture of a TTCN-3 based test system, present the test system components and their interfaces.

Explain that the test execution interfaces provide standardised means to connect an abstract test suite to the actual SUT and to the actual test platform. Discuss the interfaces.

6.8.1 Test system components

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Introduce the test system architecture consisting of the

- test execution engine (TE)
- TRI components
 - platform adaptor (PA)
 - system adaptor (SA)
- TCI components
 - test management (TM)
 - test logging (TL)
 - codec (CD)
 - component handling (CH)

6.8.2 Test Runtime Interfaces

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Explain the interfaces of the test runtime interfaces (TRI) being

- TE -> PA
- PA -> TE
- TE -> SA
- SA -> TE

Discuss selected operations (like triSend), their implementation and their potential usage.

6.8.3 Test Control Interfaces

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Explain the interfaces of the test control interfaces (TCI) being

- TE -> TM
- TM -> TE
- TE -> TL
- TE -> CD
- CD -> TE
- TE -> CH
- CH -> TE

Discuss selected operations (like tciEncode), their implementation and their potential usage.

Subject	Learning Objective	Time (min)
6.9 TTCN-3 Standard	K2	30

Give an overview of the TTCN-3 standard parts and related documents (like from ITU-T). Explain the role of ETSI in the standardisation of TTCN-3. Mention possibilities of contributing to the development of TTCN-3.

6.9.1 TTCN-3 standards	20
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Present all current parts of TTCN-3 and outline their structure, i.e.

- ES 201 873 Part 1: Core language
- ES 201 873 Part 2: Tabular presentation format (not maintained)
- ES 201 873 Part 3: Graphical presentation format (not maintained)
- ES 201 873 Part 4: Operational semantics
- ES 201 873 Part 5: TTCN-3 runtime interfaces
- ES 201 873 Part 6: TTCN-3 control interfaces
- ES 201 873 Part 7: ASN.1 to TTCN-3 language mapping
- ES 201 873 Part 8: IDL to TTCN-3 language mapping
- ES 201 873 Part 9: XML to TTCN-3 language mapping
- ES 201 873 Part 10: Documentation Tags

Present all current extension packages mechanism and outline and outline their structure, i.e.

- ES 202 781: Configuration and Deployment Support
- ES 202 782: Real-Time and Performance Testing Support
- ES 202 784: Advanced Parameterization
- ES 202 785: Behaviour Types

6.9.2 Standardization and Maintenance of TTCN-3	10
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Explain the standardisation process of TTCN-3. Discuss the roles of ETSI and MTS. Explain the possibilities of influencing the further evolution of TTCN-3 through change requests and active contributions in the TTCN-3 community.

Explain how TTCN-3 is maintained. Explain the change request process for clarifications, fixes and new language features.

Subject	Learning Objective	Time (min)
6.10 Test Design and Development		
	K3	90
<p>Outline along concrete examples the design and development of a test solution with TTCN-3. Explain the general steps of test design and development and relate them to the TTCN-3 language concepts. Outline exemplarily parts of a TTCN-3 test design and development methodology.</p>		
6.10.1 Test purposes and test cases		20
<p>Discuss the general concepts of test purpose and test case and explain the TTCN-3 features for specifying test purposes and test cases.</p>		
<p>Explain that TTCN-3 has no dedicated test purpose concept. Instead, TTCN-3 documentation tags or user-defined attributes are to be used to document test purposes and to relate test purposes to test cases.</p>		
<p>Outline the structuring of a TTCN-3 test solution into TTCN-3 modules and groups. Explain the usage of groups to reflect the test suite structure. Explain the usage of modules to enable various control parts for the same set of test cases (provided in separate modules).</p>		
<p>Provide concrete examples in TTCN-3.</p>		
<p>Test Suite Development issues: Naming conventions, module decomposition, validation tasks</p>		
6.10.2 Functional, conformance, interoperability test aspects		20
<p>Discuss the principal aspects of functional, conformance and interoperability testing. Present possible test configurations for functional, conformance and interoperability test solutions.</p>		
<p>Discuss which TTCN-3 language features are typically being used for functional, conformance and interoperability tests (to define test data and test behaviour). Explain how these concepts are being used.</p>		
<p>Explain along an example the specification of functional, conformance, and interoperability tests in TTCN-3.</p>		
6.10.3 Performance, load and scalability aspects		20
<p>Discuss the principal aspects of performance, load, and scalability testing. Present possible test configurations for performance, load, and scalability test solutions.</p>		

Discuss which TTCN-3 language features are typically being used for performance, load, and scalability tests (to define test data and test behaviour). Explain how these concepts are being used.

Explain along an example the specification of performance, load, and scalability tests in TTCN-3.

6.10.4 Naming and design conventions

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Provide guidance how to design tests in TTCN-3 and name TTCN-3 elements in a TTCN-3 test specification.

You may use the ETSI style guide for TTCN-3 or explain your own one.

6.10.5 Documentation tags

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Discuss the various documentation tags for TTCN-3 including @author, @config, @desc, @exception, @member, @param, @purpose, @remark, @return, @see, @since, @status, @url, @verdict, @version, @priority, @requirement.

Give examples of their usage.

Subject	Learning Objective	Time (min)
6.11 Open Data Interface	K2	30

Outline the open data interface of TTCN-3 to link the TTCN-3 type and data system with other external type and data systems.

Explain the principals of the language mapping from external languages to TTCN-3. Select one of the existing language mappings (ASN.1 to TTCN-3, IDL to TTCN-3 or XML to TTCN-3) and provide details of it by giving examples of the mapping rules and of the usage.

Explain how to define own language mappings.

6.11.1 CORBA IDL	15
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(if IDL is selected for a detailed explanation)

Explain the principal structure of the mapping rules. Discuss the usage of the mapping to test CORBA object based systems and applications. Explain the relation of this mapping to other IDL techniques.

Provide the IDL specification for a concrete example and discuss selected mapping rules for this example.

6.11.2 ITU ASN.1	5
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Explain the principal structure of the mapping rules. Discuss the usage of the mapping to test ASN.1 based interfaces and protocols.

6.11.3 W3C XML	5
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Explain the principal structure of the mapping rules. Discuss the usage of the mapping to test XML based interfaces, protocols and applications.

6.11.4 Other Languages	5
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Explain the approach to develop own mapping rules. Explain the central elements of the mapping such as scoping, identifiers, types and values. Use potentially an example such as Java or SQL for the explanation.

Subject	Learning Objective	Time (min)
6.12 TTCN-3 Extension Packages K1		60
Explain the mechanism of extension packages of TTCN-3, i.e. additional, optional concepts with extended syntax and semantics. Provide details on selected extensions packages as needed by the training attendees.		
6.12.1 Concept of Extension Packages		10
Introduce idea, structure and contents of TTCN-3 extension packages.		
6.12.2 Advanced Parameterization		20
(if Advanced Parameterization is selected for a detailed explanation)		
Introduce new language elements and sample applications		
<ul style="list-style-type: none"> • Formal Type Parameter 		
Explain type parameters for types, templates, and behaviors.		
6.12.3 Behaviour Types		5
Introduce new language elements and sample applications		
<ul style="list-style-type: none"> • Behaviour types for functions, altsteps and testcases • Apply statement 		
Discuss uses cases like handling of state machines, callback functions, etc.		
6.12.4 Configuration and Deployment Support		5
Introduce new language elements and sample applications		
<ul style="list-style-type: none"> • Configuration definition • Static test components and static port connections (with map and connect) • Execute on clause • Configuration setup in control part (incl. configuration variables) 		
6.12.5 Real-time and Performance Testing		5
Introduce new language elements and sample applications		
<ul style="list-style-type: none"> • Realtime port definition • Timestamp and now • Wait statement • Time units and stepsize 		

6.12.6 Selected Examples

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Explain along selected examples how extensions packages are used in a TTCN-3 test specification.

Subject	Learning Objective	Time (min)
6.13 TTCN-3 Tools	K2	30

Various tools have been established to support TTCN-3 based testing. Explain the different kinds of tools. Explain the tool kind objectives and provide selected tool examples.

6.13.1 Overview on TTCN-3 Tools	15
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Discuss the different kinds of tools and characteristics including tools for

- Test design and development support
 - Editing
 - Generation
 - Compilation
- Test quality and analysis support
 - Metrics, Patterns and/or Guidelines
 - Refactorings
 - Simulation
 - Debugging
- Test execution and reporting support
 - Test execution
 - Logging
 - Reporting
 - Debugging

6.13.2 TTCN-3 based test process	15
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Outline a TTCN-3 based test process in relation to the fundamental test process (as defined by ISTQB).

Explain that TTCN-3 is a test technology for test specification and execution. Explain that TTCN-3 needs to be linked with test planning and control, and with the evaluation of exit criteria and reporting.

7 Glossary

ASN.1	Abstract Syntax Notation One
CD	TCI Codec Interface (Encoder/Decoder)
CH	TCI Component Handling Interface
CT	Certified Tester, International Software Tester Certification by
ISTQB	
CTMF	Conformance Testing Methodology and Framework
ISQI	International Software Quality Institute
ETSI	European Telecommunication Standards Institute
ETSI ES	ETSI European Standard
ETSI MTS	ETSI Working Group on Methods for Testing and Specification
FIFO	First In First Out
GFT	Graphical Format of TTCN-3
GTB	German Testing Board
GUI	Graphical User Interface
IDE	Integrated Development Environment
IDL	Interface Description Language
ICS	Implementation Conformance Statement (defined in CTMF)
ISO	International Standards Organization
ISTQB	International Software Testing Qualification Board
ITU-T	International Telecommunication Union
IUT	Implementation Under Test
IXIT	Implementation Extra Information for Testing (defined in CTMF)
LO	Learning Objective
MTC	Main Test Component
PA	TRI Platform Adapter Interface
PCO	Point of Control and Observation
PTC	Parallel Test Component
SA	TRI System Adapter Interface
SUT	System Under Test
TA	TRI Test Adapter Interface
TC	Test Component
TCI	TTCN-3 Control Interfaces
TE	TTCN-3 Executable
TFT	Tabular Format of TTCN-3
TL	TCI Logging Interface
TM	TCI Test Management Interface
TRI	TTCN-3 Runtime Interfaces
TSI	Test System Interface
TTCN-2	Tree and Tabular Combined Notation
TTCN-3	Test and Testing Control Notation
XML	Extended Markup Language

8 References

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- [7] ETSI ES 201 873-7 (V4.2.1): "Methods for Testing and Specification (MTS); The Testing and Test Control Notation; Part 7: Using ASN.1 with TTCN-3".
- [8] ETSI ES 201 873-8 (V4.2.1): "Methods for Testing and Specification (MTS); The Testing and Test Control Notation TTCN-3; Part 8: The IDL to TTCN-3 Mapping".
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- [12] ETSI ES 202 782 (V1.1.1) "Methods for Testing and Specification (MTS); The Testing and Test Control Notation; TTCN-3 Language Extensions: TTCN-3 Performance and Real Time Testing".
- [13] ETSI ES 202 784 (V1.1.1) "Methods for Testing and Specification (MTS); The Testing and Test Control Notation; TTCN-3 Language Extensions: Advanced Parameterization".
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- [16] GTB TTCN-3-Certificate Web Site, www.german-testing-board.de/de/ttcn3_certificate.shtm (last visited Oct. 15, 2010).
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