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Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 5: TTCN-3 Runtime Interface (TRI)

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS).

The present document is part 5 of a multi-part deliverable. Full details of the entire series can be found in part 1 [2].

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document consists of two distinct parts, the first part describing the structure of a TTCN-3 test system implementation and the second part presenting the TTCN-3 Runtime Interface specification.

The first part introduces the decomposition of a TTCN-3 test system into four main entities: Test Management (TM), TTCN-3 Executable (TE), SUT Adaptor (SA), and Platform Adaptor (PA). In addition, the interaction between these entities, i.e. the corresponding interfaces, is defined.

The second part of the present document specifies the TTCN-3 Runtime Interface (TRI). The interface is defined in terms of operations, which are implemented as part of one entity and called by other entities of the test system. For each operation, the interface specification defines associated data structures, the intended effect on the test system and any constraints on the usage of the operation. Note that this interface specification only defines interactions between the TSI and the SUT as well as timer operations.

1 Scope

1.1 Scope of the present document

The present document provides the specification of the runtime interface for TTCN-3 test system implementations. The TTCN-3 Runtime Interface provides a standardized adaptation for timing and communication of a test system to a particular processing platform and the system under test, respectively. The present document defines the interface as a set of operations independent of target language.

The interface is defined to be compatible with the TTCN-3 standard (see ETSI ES 201 873-1 [2]). The present document uses the CORBA Interface Definition Language (IDL) to specify the TRI completely. Clauses 6, 7 and 8 present language mappings for this abstract specification to the target languages Java™, ANSI C, and C++. A summary of the IDL based interface specification is provided in annex A.

NOTE: Java™ is the trade name of a programming language developed by Oracle Corporation. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the programming language named. Equivalent programming languages may be used if they can be shown to lead to the same results.

1.2 Compliance

The requirement for a TTCN-3 test system to be TRI compliant is to adhere to the interface specification stated in the present document as well as to one of the target language mappings included.

EXAMPLE: If a vendor supports Java™, the TRI operation calls and implementations, which are part of the TTCN-3 executable, have to comply with the IDL to Java™ mapping specified in the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] Recommendation ITU-T X.290: "OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications - General concepts".

NOTE: The corresponding ISO/IEC standard is ISO/IEC 9646-1: "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework; Part 1: General concepts".

[2] ETSI ES 201 873-1: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 1: TTCN-3 Core Language".

[3] ETSI ES 201 873-4: "Methods for Testing and Specification (MTS); The Testing and Test Control Notation version 3; Part 4: TTCN-3 Operational Semantics".

[4] CORBA 3.0: "The Common Object Request Broker: Architecture and Specification", OMG Formal Document (specifies IDL).

[5] Sun Microsystems: "Java™ Language Specification".

NOTE: See at http://java.sun.com/docs/books/jls/third_edition/html/j3TOC.html.

[6] ISO/IEC 9899: "Information technology -- Programming Languages -- C".

[7] ISO/IEC 14882: "Information technology -- Programming Languages -- C++".

[8] ECMA-334: "C# Language Specification".

NOTE: See at http://www.ecma-international.org/publications/standards/Ecma-334.htm.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI ES 201 873-1 [2] and the following apply:

Abstract Test Suite (ATS): See Recommendation ITU-T X.290 [1].

communication port: abstract mechanism facilitating communication between test components

NOTE: A communication port is modelled as a FIFO queue in the receiving direction. Ports can be message-based, procedure-based or a mixture of the two.

Executable Test Suite (ETS): See Recommendation ITU-T X.290 [1].

explicit timer: timer that is declared in a TTCN-3 ATS and that can be accessed through TTCN-3 timer operations

Implementation eXtra Information for Testing (IXIT): See Recommendation ITU-T X.290 [1].

implicit timer: system timer that is created by the TTCN-3 Executable to guard a TTCN-3 call or execute operation

NOTE: Implicit timers are not accessible to the TTCN-3 user.

Platform Adaptor (PA): entity that adapts the TTCN-3 Executable to a particular execution platform

NOTE: The Platform Adaptor creates a single notion of time for a TTCN-3 test system, and implements external functions as well as explicit and implicit timers.

SUT Adaptor (SA): entity that adapts the TTCN-3 communication operations with the SUT based on an abstract test system interface and implements the real test system interface

System Under Test (SUT): See Recommendation ITU-T X.290 [1].

NOTE: All types are known at compile time, i.e. are statically bound.

test case: See Recommendation ITU-T X.290 [1].

test event: either sent or received test data (message or procedure call) on a communication port that is part of the test system interface

Test Management (TM): entity that provides a user interface and administers the TTCN-3 test system

test system: See Recommendation ITU-T X.290 [1].

Test System Interface (TSI): test component that provides a mapping of the ports available in the (abstract) TTCN-3 test system to those offered by a real test system

Timer IDentification (TID): unique identification for explicit or implicit timer instances that is generated by the TTCN-3 Executable

TTCN-3 Control Interface (TCI): four interfaces that define the interaction of the TTCN-3 Executable with the test management, the coding and decoding, the test component handling, and the logging in a test system

TTCN-3 Executable (TE): part of a test system that deals with interpretation or execution of a TTCN-3 ETS

TTCN-3 Runtime Interface (TRI): two interfaces that define the interaction of the TTCN-3 Executable between the SUT and the Platform Adapter (PA) and the System Adapter (SA) in a test system

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ADT	Abstract Data Type
ANSI	American National Standards Institute
ASN.1	Abstract Syntax Notation One
ATS	Abstract Test Suite
CD	(External) Coding/Decoding
CH	Component Handling
CORBA	Common Object Request Broker Architecture
EDS	(Internal) Encoding/Decoding System
ETS	Executable Test Suite
FIFO	First-In-First-Out (Scheduling Discipline)
IDL	Interface Definition Language
IXIT	Implementation eXtra Information for Testing
MSC	Message Sequence Chart
MTC	Main Test Component
OMG	Object Management Group
PA	Platform Adaptor
SA	SUT Adaptor
STL	Standard Template Library of C++
SUT	System Under Test
T3RTS	TTCN-3 RunTime System
TCI	TTCN-3 Control Interface
TE	TTCN-3 Executable
TID	Timer IDentification
TL	Test Logging
TM	Test Management
TMC	Test Management and Control
TRI	TTCN-3 Runtime Interface
TSI	Test System Interface
TTCN	Testing and Test Control Notation
TTCN-3	Tree and Tabular Combined Notation version 3

4 General Structure of a TTCN-3 Test System

4.1 Entities in a TTCN-3 test system

4.1.0 Types of entities

A TTCN-3 test system can be thought of conceptually as a set of interacting entities where each entity corresponds to a particular aspect of functionality in a test system implementation. These entities manage test execution, interpreting or executing compiled TTCN-3 code, realize proper communication with the SUT, implement external functions, and handle timer operations.

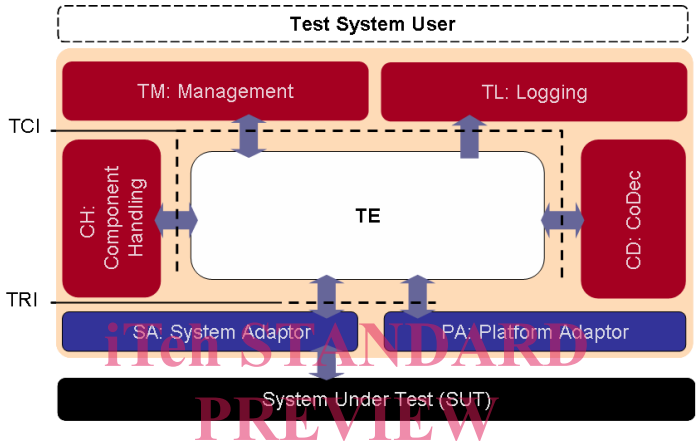

Figure 1: General Structure of a TTCN-3 Test System

The structure of a TTCN-3 test system implementation is illustrated in figure 1. It should be noted that the further refinement of TM into smaller entities, as shown in figure 1 and used in the following clauses of the present document, is purely an aid to define TTCN-3 test system interfaces.

The part of the test system that deals with interpretation and execution of TTCN-3 modules, i.e. the Executable Test Suite (ETS), is part of the TTCN-3 Executable (TE). This corresponds either to the executable code produced by a TTCN-3 compiler or a TTCN-3 interpreter in a test system implementation. It is assumed that a test system implementation includes the ETS as derived from a TTCN-3 ATS.

The remaining part of the TTCN-3 test system, which deals with any aspects that cannot be concluded from information being present in the original ATS alone, can be decomposed into Test Management (TM), SUT Adaptor (SA), and Platform Adaptor (PA) entities. In general, these entities cover a test system user interface, test execution control, test event logging, as well as communication with the SUT and timer implementation.

4.1.1 Test Management and Control (TMC)

4.1.1.0 Test Management and Control Entities

The TMC entity includes functionality related to management of:

- test execution;
- components;
- encoding and decoding; and
- logging.

4.1.1.1 Test Management (TM)

The TM entity is responsible for overall management of the test system. After the test system has been initialized, test execution starts within the TM entity. The entity is responsible for the proper invocation of TTCN-3 modules, i.e. propagating module parameters and/or IXIT information to the TE if necessary. Typically, this entity would also implement a test system user interface.

4.1.1.2 Test Logging (TL)

The TL entity is responsible for maintaining the test log. It is explicitly notified to log test events by the TE. The TL entity has a unidirectional interface where any entity part of the TE may post a logging request to the TL entity. A TM internal interface may also be used to record test management information generated by the TE.

4.1.1.3 Coding and Decoding (CD)

The CD entity is optionally responsible for the external encoding and decoding data associated with message based or procedure based communication within the TE. The external codecs can be used in parallel with, or instead of, the built-in codecs associated with the TE. Unlike the built-in codecs the external codecs have a standardized interface which makes them portable between different TTCN-3 systems and tools.

4.1.1.4 Component Handling (CH)

The CH entity is responsible for distributing parallel test components. This distribution might be across one or many physical systems. The CH entity allows the test management to create and control distributed test systems in a manner which is transparent and independent from the TE.

4.1.2 TTCN-3 Executable (TE)

4.1.2.0 TTCN-3 Executable Entity

The TE entity is responsible for the interpretation or execution of the TTCN-3 ATS. Conceptually, the TE can be decomposed into three interacting entities: an ETS, TTCN-3 RunTime System (T3RTS), and an optional internal Encoding/Decoding System (EDS) entity. Note that this refinement of the TE into smaller entities is purely a conceptual aid to define TTCN-3 test system interfaces - there is no requirement for this distinction to be reflected in TRI implementations.

The following clauses define the responsibilities of each entity and also discuss the handling of timers in the TRI.

4.1.2.1 Executable Test Suite (ETS)

The ETS entity handles the execution or interpretation of test cases, the sequencing and matching of test events, as defined in the corresponding TTCN-3 modules ETSI ES 201 873-1 [2]. It interacts with the T3RTS entity to send, attempt to receive (or match), and log test events during test case execution, to create and remove TTCN-3 test components, as well as to handle external function calls, action operations, and timers. Note that the ETS entity does not directly interact with the SA via the TRI.

4.1.2.2 TTCN-3 RunTime System (T3RTS)

The T3RTS entity interacts with the TM, SA and PA entities via TCI and TRI, and manages ETS and EDS entities. The T3RTS initializes adaptors as well as ETS and EDS entities. This entity performs all the actions necessary to properly start the execution of a test case or function with parameters in the ETS entity. It queries the TM entity for module parameter values required by the ETS and sends logging information to it. It also collects and resolves associated verdicts returned by the ETS entity as defined in ETSI ES 201 873-1 [2].

The T3RTS entity implements the creation and removal of TTCN-3 test components, as well as the TTCN-3 semantics of message and procedure based communication, external function calls, action operations and timers. This includes notifying the SUT Adaptor (SA) which message or procedure call is to be sent to the SUT, or the Platform Adaptor (PA) which external function is to be executed or which timers are to be started, stopped, queried, or read. Similarly, the T3RTS notifies the ETS entity of incoming messages or procedure calls from the SUT as well as timeout events.

Prior to sending or receiving messages and procedure calls to or from the SA, or handling function calls and action operations in the PA for the ETS entity, the T3RTS invokes the EDS entity for their encoding or decoding. The T3RTS entity should implement all message and procedure based communication operations between test components, but only the TTCN-3 semantics of procedure based communication with the SUT, i.e. the possible blocking and unblocking of test component execution, guarding with implicit timers, and handling of timeout exceptions as a result of such communication operations. All procedure based communication operations with the SUT are to be realized and identified (in the case of a receiving operation) in the SA as they are most efficiently implemented in a platform specific manner. Note that the timing of any procedure call operation, i.e. implicit timers, is implemented in the Platform Adaptor (PA).

The TTCN-3 Executable is required to maintain its own port queues (distinct from those which may be available in the SA or PA) for input test events to perform snapshots for receiving operations as defined in ETSI ES 201 873-1 [2]. Timeout events, which are generated by TTCN-3 timer, call timer, or test case timer implementations, are to be kept in a timeout list as defined in ETSI ES 201 873-1 [2]. In figure B.1, all of this functionality has been assigned to the T3RTS entity. It is responsible to store events that the SA or PA has notified the TE entity of, but which have yet to be processed.

4.1.2.3 Encoding/Decoding System (EDS)

The EDS entity is responsible for the internal encoding and decoding of test data, which includes data used in communication operations with the SUT, as specified in the executing TTCN-3 module. If no encoding has been specified for a TTCN-3 module the encoding of data values is tool specific. This entity is invoked by and returns to the T3RTS entity. Note that the EDS entity does not directly interact with the SA via the TRI.

4.1.2.4 Timers in the TTCN-3 Executable

Timers that have been declared and named in the TTCN-3 ATS can be conceptually classified as explicit in the TE. Timers that are created by the TE for guarding TTCN-3 procedure calls or execute operations are known in the TE as implicit timers. Explicit as well as implicit timers are both created within the TE but implemented by the Platform Adaptor (PA). This is achieved by generating a unique Timer IDentification (TID) for any timer created in the TE. This unique TID should enable the TE to differentiate between different timers. The TID is to be used by the TE to interact with corresponding timer implementation in the PA.

Note that it is the responsibility of the TE to implement the different TTCN-3 semantics for explicit and implicit timers correctly as defined in ETSI ES 201 873-1 [2], e.g. the use of keywords any and `all` with timers only applies to explicit timers. In the PA all timers, i.e. implicit and explicit, are treated in the same manner.

4.1.3 SUT Adaptor (SA)

The SA adapts message and procedure based communication of the TTCN-3 test system with the SUT to the particular execution platform of the test system. It is aware of the mapping of the TTCN-3 test component communication ports to test system interface ports and implements the real test system interface as defined in ETSI ES 201 873-1 [2]. It is responsible to propagate send requests and SUT action operations from the TTCN-3 Executable (TE) to the SUT, and to notify the TE of any received test events by appending them to the port queues of the TE.

Procedure based communication operations with the SUT are implemented in the SA. The SA is responsible for distinguishing between the different messages within procedure-based communication (i.e. call, reply, and exception) and to propagate them in the appropriate manner either to the SUT or the TE. TTCN-3 procedure based communication semantics, i.e. the effect of such operation on TTCN-3 test component execution, are to be handled in the TE.

The SA has an interface with the TE, which is used to send SUT messages (issued in TTCN-3 SUT action operations) to the SA and to exchange encoded test data between the two entities in communication operations with the SUT.

4.1.4 Platform Adaptor (PA)

The PA implements TTCN-3 external functions and provides a TTCN-3 test system with a single notion of time. In this entity, external functions are to be implemented as well as all timers. Notice that timer instances are created in the TE. A timer in the PA can only be distinguished by its Timer IDentification (TID). Therefore, the PA treats both explicit and implicit timers in the same manner.

The interface with the TE enables the invocation of external functions and the starting, reading, and stopping of timers as well as the inquiring of the status of timers using their timer ID. The PA notifies the TE of expired timers.

4.2 Interfaces in a TTCN-3 Test System

As previously depicted in figure 1, a TTCN-3 test system has two interface sets, the TTCN-3 Control Interface (TCI) and the TTCN-3 Runtime Interface (TRI), which specify the interface between Test Management (TM), Test Logging (TL), Component Handling (CH), Encoding/Decoding (CD) and TTCN-3 Executable (TE) entities, and the TE, SUT Adaptor (SA) and Platform Adaptor (PA) entities, respectively.

The present document defines the TRI. The interaction of the TE with SA and PA are defined in terms of TRI operations.

4.3 Execution requirements for a TTCN-3 test system

Each TRI operation call shall be treated as an atomic operation in the calling entity. The called entity, which implements a TRI operation, shall return control to the calling entity as soon as its intended effect has been accomplished or if the operation cannot be completed successfully. The called entity shall not block in the implementation of procedure-based communication. Nevertheless, the called entity shall block after the invocation of an external function implementation and wait for its return value. Notice that depending on the test system implementation failure to return from an external function implementation may result in the infinite blocking of test component execution, the TTCN-3 executable, the Platform Adaptor, or even of the entire test system.

The execution requirements stated above can be realized in a tightly integrated test system implementation. Here, the entire TTCN-3 test system is implemented in a single executable or process where each test system entity is assigned at least one thread of execution. TRI operations can be implemented here as procedure calls.

Note that a looser integration of a test system implementation is still possible, e.g. an implementation of a TTCN-3 test system with multiple SUT Adaptors in a distributed computing environment. In this case only a small part of the SUT Adaptor is tightly integrated with the remainder of the TTCN-3 test system whereas actual SA Adaptors may be realized in separate processes. That small part of SA may then only implement a routing of information provided by TRI operations to the desired SUT Adaptor processes, possibly being executed on remote hosts, and vice versa.

5 TTCN-3 Runtime Interface and operations

5.1 Overview of the TRI

5.1.0 Sub-interfaces

The subclauses in clause 5 define TRI operations in terms of when they are to be used and what their effect is intended to be in a TTCN-3 test system implementation. Also a set of abstract data types is defined which is then used for the definition of TRI operations. The definitions also include a more detailed description of the input parameters required for each TRI operation call and its return value.

The TRI defines the interaction between the TTCN-3 Executable (TE), SUT Adaptor (SA), and Platform Adaptor (PA) entities within a TTCN-3 test system implementation. Conceptually, it provides a means for the TE to send test data to the SUT or manipulate timers, and similarly to notify the TE of received test data and timeouts.

The TRI can be considered to consist of two sub-interfaces, a triCommunication and a triPlatform interface. The triCommunication interface addresses the communication of a TTCN-3 ETS with the SUT, which is implemented in the SA. The triPlatform interface represents a set of operations, which adapt an ETS to a particular execution platform.