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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

This Technical Specification (TS) has been produced by ETSI Partnership Project oneM2M (oneM2M).

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1 Scope

The present document specifies a testing framework defining a methodology for development of conformance and interoperability test strategies, test systems and the resulting test specifications for oneM2M standards.

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.

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

- [1] ETSI TS 118 001: "oneM2M; Functional Architecture (oneM2M TS-0001)".
- [2] ETSI TS 118 004: "Service layer Core Protocol (oneM2M TS-0004)".

2.2 Informative 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.

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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.

- [i.1] oneM2M Drafting Rules.

NOTE: Available at <http://www.onem2m.org/images/files/oneM2M-Drafting-Rules.pdf>.

- [i.2] ISO/IEC 9646 (all parts): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework".
 - [i.3] ETSI EG 202 237: "Methods for Testing and Specification (MTS); Internet Protocol Testing (IPT); Generic approach to interoperability testing".
 - [i.4] 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 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

conformance: compliance with requirements specified in applicable standards ISO/IEC 9646 [i.2]

conformance testing: process for testing that an implementation is compliant with a protocol standard, which is realized by test systems simulating the protocol with test scripts executed against the implementation under test

Device Under Test (DUT): combination of software and/or hardware items which implement the functionality of standards and interact with other DUTs via one or more reference points

ICS proforma: document, in the form of a questionnaire, which when completed for an implementation or system becomes an ICS

Implementation Conformance Statement (ICS): statement made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities have been implemented

Implementation eXtra Information for Testing (IXIT): checklist which contains or references all of the information (in addition to that given in the ICS) related to the IUT and its testing environment, which will enable the test laboratory to run an appropriate test suite against the IUT

Implementation Under Test (IUT): implementation of one or more Open Systems Interconnection (OSI) protocols in an adjacent user/provider relationship, being the part of a real open system which is to be studied by testing (ISO/IEC 9646-1 [i.2])

Inopportune Behaviour (BO): test group that handles invalid exchanges of messages, which are properly structured and correctly encoded

interoperability: ability of two systems to interoperate using the same communication protocol

interoperability testing: activity of proving that end-to-end functionality between (at least) two devices is as required by the base standard(s) on which those devices are based

InterWorking Function (IWF): translation of one protocol into another one so that two systems using two different communication protocols are able to interoperate

Invalid Behaviour (BI): test group that handles valid exchanges of messages, which are either not properly structured or incorrectly encoded

IXIT proforma: document, in the form of a questionnaire, which when completed for an implementation or system, becomes an IXIT

Qualified Equipment (QE): grouping of one or more devices that has been shown and certified, by rigorous and well-defined testing, to interoperate with other equipment

NOTE 1: Once an DUT has been successfully tested against a QE, it may be considered to be a QE, itself.

NOTE 2: Once a QE is modified, it loses its status as QE and becomes again an DUT.

test case: specification of the actions required to achieve a specific test purpose, starting in a stable testing state, ending in a stable testing state and defined in either natural language for manual operation or in a machine-readable language (such as TTCN-3) for automatic execution

testing framework: document providing guidance and examples necessary for the development and implementation of a test specification

test purpose: description of a well-defined objective of testing, focussing on a single requirement or a set of related requirements

Valid Behaviour (BV): test group that handles valid exchanges of messages, which are properly structured and correctly

3.2 Abbreviations

For the purposes of the present document, the terms and definitions given in ETSI TS 118 001 [1] and the following apply:

API	Application Programming Interface
APT	Abstract Protocol Tester
ATS	Abstract Test Suite
BI	Invalid Behaviour
BO	Inopportune Behaviour
BV	Valid Behaviour
CoAP	Constrained Application Protocol
EUT	Equipment Under Test
FQDN	Fully Qualified Domain Name
HTTP	HyperText Transfer Protocol
IFS	Interoperable Features Statement
IOP	Interoperability
IUT	Implementation Under Test
IWF	InterWorking Function
JSON	JavaScript Object Notation
MMI	Man-Machine Interface
MQTT	Message Queue Telemetry Transport
PICS	Protocol Implementation Conformance Statement
QE	Qualified Equipment
SUT	System Under Test
TC	Test Case
TCP	Transmission Control Protocol
TD	Test Description
TP	Test Purpose
TSS	Test Suite Structure
TTCN-3	Testing and Test Control Notation version 3
UDP	User Datagram Protocol
URI	Uniform Resource Identifier
XML	eXtensible Markup Language

4 Conventions

The key words "Shall", "Shall not", "May", "Need not", "Should", "Should not" in the present document are to be interpreted as described in the oneM2M Drafting Rules [i.1].

5 Introduction to the oneM2M testing methodology

The present document provides:

- Identification of the implementations under test (IUT) for conformance testing and the device under test (DUTs) for interoperability, i.e. answering the question "what is to be tested".
- Definition of the applicable test procedures, i.e. answering the question "how is it to be tested".
- Definition of the procedure for development of test specifications and deliverables (for instance: TSS&TP, TP proforma, TTCN-3 test suite and documentation).

Figure 1 illustrates the oneM2M testing framework and the interactions with oneM2M base standards and test specifications. The oneM2M testing framework is based on concepts defined in ISO/IEC 9646 [i.2], TTCN-3 [i.4], ETSI EG 202 237 [i.3].

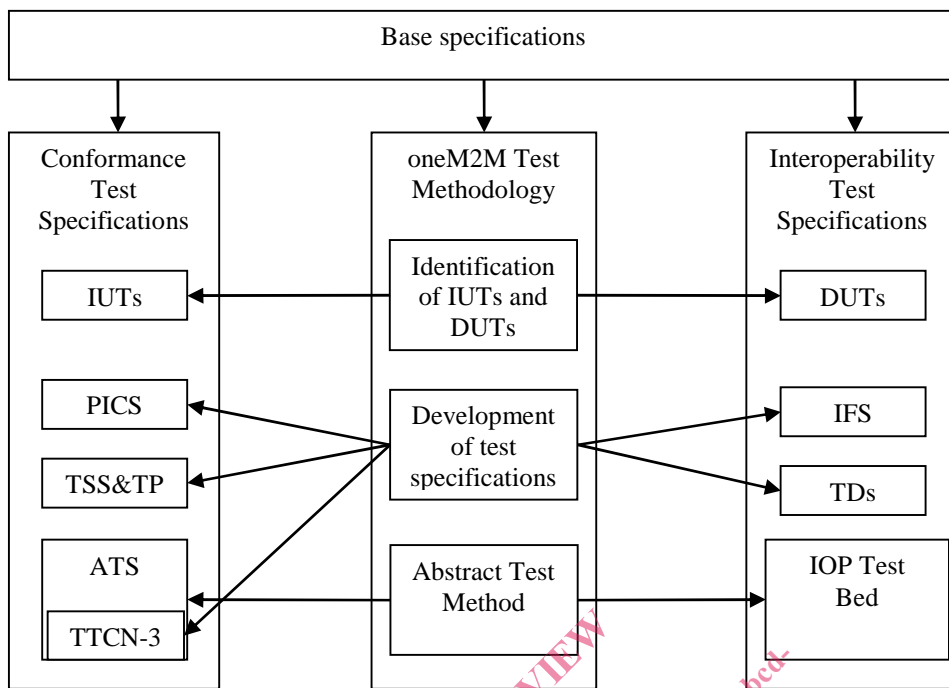


Figure 5-1: oneM2M testing methodology interactions

The test specifications are usually developed for a single base protocol standard or for a coherent set of standards. As such, it is possible to follow the methodology specified for conformance test development in ISO/IEC 9646-1 [i.2] without much difficulty. However, oneM2M testing requirements are, in many cases, distributed across a wide range of documents and, thus, an adaptation of the ISO/IEC 9646 [i.2] approach to test development is necessary. Also, for readability, consistency and to ease reusability of TTCN-3 code it is necessary to apply some guidelines on the use of TTCN-3.

It is this approach that is referred to as the "oneM2M testing framework".

As its name implies, the framework is oriented towards the production of Test specifications. The oneM2M testing Framework comprises:

- a documentation structure:
 - catalogue of capabilities/features/functions (PICS or IFS);
 - Test Suite Structure (TSS);
 - Test Purposes:
 - Conformance;
 - Interoperability.
- a methodology linking the individual elements of a test specification together:
 - style guidelines and examples;
 - naming conventions;
 - a structured notation for TP;
 - guidelines on the development of TTCN-3 Test Cases (TCs);
 - guidelines on the use of tabulated English Test Descriptions (TDs).

6 Conformance testing

6.1 Introduction

The clause 6 shows how to apply the oneM2M conformance testing methodology in order to properly produce oneM2M conformance test specifications.

The Conformance testing can show that a product correctly implements a particular standardized protocol, that is, it establishes whether or not the implementation under test meets the requirements specified for the protocol itself.

EXAMPLE: It will test protocol message contents and format as well as the permitted sequences of messages. In that context, tests are performed at open standardized interfaces that are not (usually) accessible to an end user, and executed by a dedicated test system that has full control of the system under test and the ability to observe all incoming and out coming communications; the high degree of control of the test system over the sequence and contents of the protocol messages allows to test both valid and invalid behaviour.



Figure 6.1-1: Conformance testing

Conformance test specifications should be produced following the methodology described in ISO/IEC 9646-1 [i.2]. In summary, this methodology begins with the collation and categorization of the features and options to be tested into a tabular form which is normally referred to as the "Implementation Conformance Statement" (ICS). All implemented capabilities supported by the Implementation Under Test (IUT) are listed by the implementer in the ICS, so that the tester knows which options have to be tested. This ensures that complete coverage is obtained.

The next step is to collect the requirements from the specification that is tested. For each requirement, one or more tests should be identified and classified into a number of groups which will provide a structure to the overall test suite (TSS). A brief Test Purpose (TP) should then be written for each identified test and this should make it clear what is to be tested but not how this should be done. Although not described or mandated in ISO/IEC 9646-1 [i.2], in many situations (particularly where the TPs are complex) it may be desirable to develop a Test Description (TD) for each TP. The TD describes in plain language (often tabulated) the actions required to reach a verdict on whether an implementation passes or fails the test. Finally, a detailed Test Case (TC) is written for each TP. In the interests of test automation, TCs are usually combined into an Abstract Test Suite (ATS) using a specific testing language such as TTCN-3. The TCs in the ATS are then "Verified" against a number of IUTs for correct operation according to some agreed procedures, before being released for use by the industry. An Implementation eXtra Information for Test (IXIT) proforma associated to the ATS, should be produced in supplement of the ICS document and Test Cases to help to execute Protocol conformance testing using oneM2M dedicated test equipment.

In summary, the oneM2M Conformance Testing methodology consists of:

- Selection of Implementations Under Test (IUT).
- Identification of reference points.
- Development of test specifications, which includes:
 - Development of "Implementation Conformance Statements" (ICS), if not already provided as part of the base standard.
 - Development of "Test Suite Structure and Test Purposes" (TSS&TP).
 - Development of "Abstract Test Suite and Implementation eXtra Information for Test" (ATS&IXIT) including:
 - Definition of the Abstract Protocol Tester (APT).
 - Definition of TTCN-3 test architecture.

- Development of TTCN-3 test suite, e.g. naming conventions, code documentation, test case structure.
- Verification of ATS (TTCN-3)
- IXIT proforma.

6.2 Test architecture

6.2.1 Selection of Implementation Under Test

6.2.1.1 Definition

The "Implementation Under Test" (IUT) is a protocol implementation considered as an object for testing. This means that the test process will focus on verifying the compliance of this protocol implementation (IUT) with requirements set up in the related base standard. An IUT normally is implemented in a "System Under Test" (SUT). For testing, a SUT is connected to a test system over at least a single interface. Such an interface is identified as "Reference Point" (RP) in the present document. Further details on RPs are presented in clause 6.2.2.

NOTE: Other interfaces between the test system and the IUT may be used to control the behaviour of the IUT during the test process.

Figure 6.2.1.1-1 shows a complete view of communication layer for oneM2M domain. Further details are presented in the following clauses.

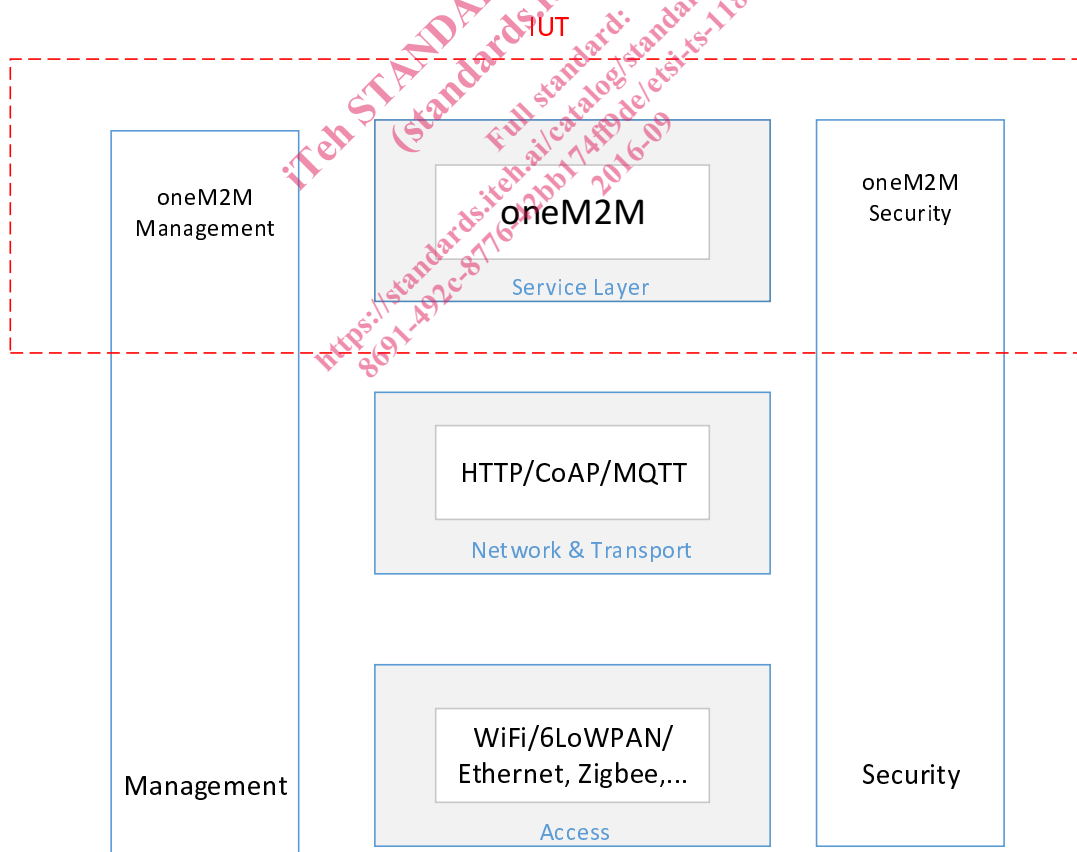


Figure 6.2.1.1-1: Example of IUT in the oneM2M reference architecture