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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS,
NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Internet of things and smart cities and communities –
Frameworks, architectures and protocols

oneM2M – Testing framework

Recommendation ITU-T Y.4500.15

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Recommendation ITU-T Y.4500.15

oneM2M – Testing framework

Summary

The testing framework in Recommendation ITU-T Y.4500.15 provides the methodology for the development of conformance and interoperability test strategies, test systems and the resulting test specifications for oneM2M standards.

History

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FOREWORD

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Recommendation ITU-T Y.4500.15

oneM2M – Testing framework

1 Scope

This Recommendation provides a testing framework defining a methodology for development of conformance and interoperability test strategies, test systems and the resulting test specifications for oneM2M standards.

The Recommendation contains oneM2M Release 2 specification – oneM2M Testing Framework V2.0.0 and is equivalent to standards of oneM2M partners including Association of Radio Industries and Businesses (ARIB), Alliance for Telecommunications Industry Solutions (ATIS) [b-ATIS.oneM2M], China Communications Standards Association (CCSA) [b-CCSA M2M-TS-0015], European Telecommunications Standards Institute (ETSI) [b-ETSI-TS 118 115], Telecommunications Industry Association (TIA), Telecommunications Standards Development Society India (TSDSI) [b-TSDSI STD T1.oneM2M TS-0015], Telecommunications Technology Association (TTA) [b-TTAT.MM-TS.0015] and Telecommunication Technology Committee (TTC) [b-TTC TS-M2M-0015].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T Y.4500.1] Recommendation ITU-T Y.4500.1 (2018), *oneM2M – Functional architecture*.
- [ITU-T Y.4500.4] Recommendation ITU-T Y.4500.4 (2018), *Service Layer Core Protocol*.
- [ITU-T Y.4500.11] Recommendation ITU-T Y.4500.11 (2018), *Common terminology*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application entity [ITU-T Y.4500.11]: Represents an instantiation of application logic for end-to-end M2M solutions.

3.1.2 common services entity (CSE) [ITU-T Y.4500.11]: Represents an instantiation of a set of common service functions of the M2M environments. Such service functions are exposed to other entities through reference points.

3.1.3 conformance [b-ITU-T X Suppl.4]: Compliance with requirements specified in applicable ITU-T X.290-series of Recommendations.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 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.

3.2.2 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.

3.2.3 ICS proforma: Document, in the form of a questionnaire, which when completed for an implementation or system becomes an implementation conformance statement (ICS).

3.2.4 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.

3.2.5 implementation extra information for testing (IXIT): Checklist which contains or references all of the information (in addition to that given in the implementation conformance statement (ICS)) related to the implementation under test (IUT) and its testing environment, which will enable the test laboratory to run an appropriate test suite against the IUT.

3.2.6 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 ([b-ISO/IEC 9646]).

3.2.7 inopportune behaviour (BO): Test group that handles invalid exchanges of messages, which are properly structured and correctly encoded.

3.2.8 interoperability: Ability of two systems to interoperate using the same communication protocol.

3.2.9 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.

3.2.10 interworking function (IWF): Translation of one protocol into another one so that two systems using two different communication protocols are able to interoperate.

3.2.11 invalid behaviour (BI): Test group that handles valid exchanges of messages, which are either not properly structured or incorrectly encoded.

3.2.12 IXIT proforma: Document, in the form of a questionnaire, which when completed for an implementation or system, becomes an implementation extra information for testing (IXIT).

3.2.13 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 a device under test (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.

3.2.14 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 testing and test control notation version 3 (TTCN-3)) for automatic execution.

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

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

3.2.17 valid behaviour (BV): test group that handles valid exchanges of messages, which are properly structured and correctly.

4 Abbreviations and acronyms

For the purposes of this Recommendation, the terms and definitions given in [ITU-T Y.4500.11] and the following apply:

AE	Application Entity
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
CSE	Common Services Entity
DUT	Device Under Test
EUT	Equipment Under Test
FQDN	Fully Qualified Domain Name
HTTP	Hypertext Transfer Protocol
ICS	Implementation Conformance Statement
IFS	Interoperable Features Statement
IOP	Interoperability
IUT	Implementation Under Test
IWF	InterWorking Function
IXIT	Implementation eXtra Information for Testing
JSON	JavaScript Object Notation
M2M	Machine to Machine
MMI	Man-Machine Interface
MQTT	Message Queue Telemetry Transport
PDU	Protocol Data Unit
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
XSD	XML Schema Definition

5 Conventions

The keywords "Shall", "Shall not", "May", "Need not", "Should", "Should not" in the present document are to be interpreted as described:

Shall/Shall not:

Requirements

- 1) effect on this Recommendation: This Recommendation needs to describe the required feature (i.e., specify a technical solution for the Requirement);
- 2) effect on products: every implementation (machine to machine (M2M) solution that complies to this Recommendation) must support it;
- 3) effect on deployments: every deployment (M2M service based on this Recommendation) must use the standardized feature where applicable – otherwise, e.g., interoperability problems with other services could arise.

Should/Should not:

Recommendation

- 1) effect on this Recommendation: This Recommendation needs to describe a solution that allows the presence and the absence of the feature;
- 2) effect on products: an implementation may or may not support it, however support is recommended;
- 3) effect on deployments: a deployment may or may not use it, however usage is recommended.

May/Need not:

Permission/Option

- 1) effect on this Recommendation: This Recommendation needs to describe a solution that allows the presence and the absence of the required feature;
- 2) effect on products: an implementation may or may not support it;
- 3) effect on deployments: A deployment may or may not use it.

6 Introduction to the oneM2M testing methodology

The present document provides:

- identification of the implementation under test (IUT) for conformance testing and the device under test (DUT) 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 and TP, TP proforma, testing and test control notation version 3 (TTCN-3) test suite and documentation).

Figure 6-1 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 [b-ISO/IEC 9646], TTCN-3 [b-ETSI ES 201 873-1] and ETSI EG 202 237 [b-ETSI EG 202 237].

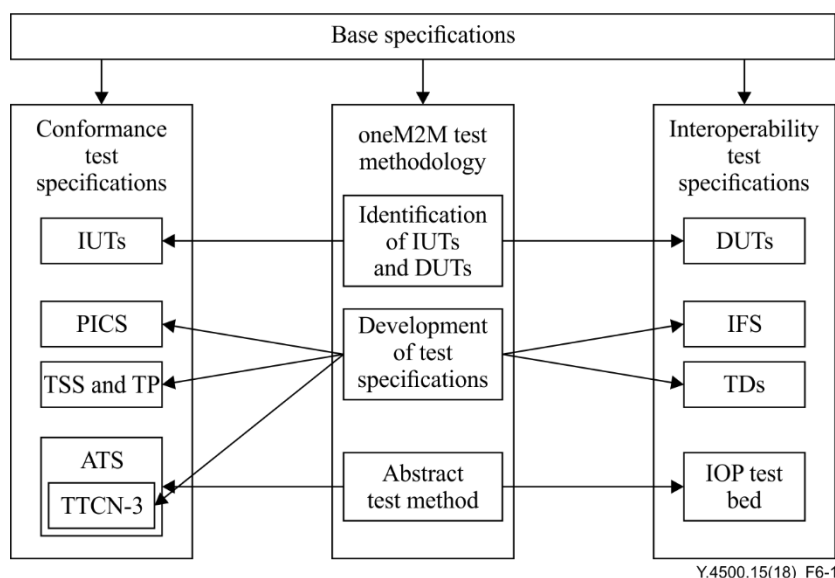


Figure 6-1 – oneM2M testing methodology interactions

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 [b-ISO/IEC 9646] 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 [b-ISO/IEC 9646] 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 [b-ETSI ES 201 873-1].

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 (protocol implementation conformance statement (PICS) or interoperable features statement (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 test purpose (TP);
 - guidelines on the development of TTCN-3 test cases (TCs);
 - guidelines on the use of tabulated English test descriptions (TDs).

7 Conformance testing

7.1 Introduction

The clause 7 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 IUT meets the requirements specified for the protocol itself.

EXAMPLE – Conformance testing 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 will be executed by a dedicated test system that has full control of the SUT 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 7.1-1 – Conformance testing

Conformance test specifications should be produced following the methodology described in [b-ISO/IEC 9646]. 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 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 structure (TSS). A brief 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 [b-ISO/IEC 9646], in many situations (particularly where the TPs are complex) it may be desirable to develop a 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 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 TCs to help to execute protocol conformance testing using oneM2M dedicated test equipment.

In summary, the oneM2M conformance testing methodology consists of:

- selection of IUT;
- identification of reference points;
- development of test specifications, which includes:
 - development of ICS, if not already provided as part of the base standard;
 - development of TSS and TP;
 - development of ATS and 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);