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Information technology — Open Systems Interconnection — Conformance testing methodology and framework —

Part 2:
Abstract test suite specification

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Partie 2: Spécification des suites de tests abstraites

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 9646-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

ISO/IEC 9646 consists of the following parts, under the general title *Information technology — Open Systems Interconnection — Conformance testing methodology and framework*:

— *Part 1: General concepts*

— *Part 2: Abstract test suite specification*

— *Part 3: The Tree and Tabular Combined Notation (TTCN)*

— *Part 4: Test realization*

— *Part 5: Requirements on test laboratories and clients for the conformance assessment process*

Annex A forms an integral part of this part of ISO/IEC 9646. Annexes B, C and D are for information only.

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Introduction

This part of ISO/IEC 9646 provides a common approach to the specification of OSI conformance test suites at a level which is independent of the means of executing those test suites (hereafter called "abstract test suites"). This level of abstraction is suitable for standardization and facilitates the comparison of results produced by different organizations which run the corresponding executable test suites.

Clauses 6 and 7 recall that there are requirements on OSI protocol specifiers which have to be fulfilled before there can be an objective basis for the process of developing an abstract test suite. The need is expressed for consistent conformance clauses and for PICS proformas in International Standards or CCITT Recommendations which specify OSI protocol standards.

Clauses 8 to 16 describe the process of developing an abstract test suite, including the design criteria to be used and guidance on its structure and coverage. The possible abstract test methods are defined and guidance is given to help the test suite specifier to decide which test method(s) to use in the production of a particular test suite. Requirements and guidance are given on the specification of abstract test cases. These include the subdivision of test cases into test steps and the assignment of test verdicts to test outcomes.

The test suite specifier is also required to provide information to the test realizers (*e.g.* limitations governing test case selection).

Finally, guidance and requirements are given on test suite maintenance.

This part of ISO/IEC 9646 is also to be published by CCITT as Recommendation X.291 (1991).

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Information technology — Open Systems Interconnection — Conformance testing methodology and framework —

Part 2:
Abstract test suite specification

1 Scope

1.1 This part of ISO/IEC 9646 specifies the requirements and gives guidance for the production of system-independent conformance test suites for one or more OSI International Standards or CCITT Recommendations. In particular, it is applicable to the production of all conformance testing standards for OSI and ISDN two-party protocols, including all draft versions of such conformance testing standards.

1.2 This part of ISO/IEC 9646 is applicable to the production of conformance test cases which check the conformance of an implementation to the relevant static and/or dynamic conformance requirements by controlling and observing protocol behaviour. The Abstract Test Methods included in this part of ISO/IEC 9646 are, in fact, capable of being used to specify any test case which can be expressed abstractly in terms of control and observation of Protocol Data Units and Abstract Service Primitives. Nevertheless, for some protocols, test cases may be needed which cannot be expressed in these terms. The specification of such test cases is outside the scope of this part of ISO/IEC 9646, although the test cases may themselves need to be included in a conformance testing standard.

NOTE – For example, some static conformance requirements related to an Application service element may require testing techniques which are specific to that particular Application.

1.3 The following are outside the scope of this part of ISO/IEC 9646:

a) the relationship between Abstract Test Suite specification and Formal Description Techniques;

b) testing by means of test methods which are specific to particular applications, protocols or systems, including the testing of non-protocol conformance requirements;

c) test methods that involve more than two end-systems communicating together.

NOTE – This part of ISO/IEC 9646 applies fully to some but not all Physical layer protocols. Nevertheless, many of the concepts apply to all protocols.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 9646. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 9646 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7498 : 1984, *Information processing systems – Open Systems Interconnection – Basic Reference Model.*
(See also CCITT Recommendation X.200 (1984))

ISO/TR 8509 : 1987, *Information processing systems – Open Systems Interconnection – Service conventions.*
(See also CCITT Recommendation X.210 (1988))

ISO 8825 : 1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*
(See also CCITT Recommendation X.~~4~~09 (1988)) 2

ISO/IEC 9646-1 : 1991, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*
(See also CCITT Recommendation X.290 (1991))

ISO/IEC 9646-3 : -[1], *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 3: The tree and tabular combined notation.*

3 Definitions

For the purposes of this part of ISO/IEC 9646, all the definitions given in ISO/IEC 9646-1 apply.

4 Abbreviations

For the purposes of this part of ISO/IEC 9646 the abbreviations given in ISO/IEC 9646-1 apply. The following abbreviations also apply to this part of ISO/IEC 9646.

CS : coordinated single-layer (test method)

CSE : coordinated single-layer embedded (test method)

DS : distributed single-layer (test method)

DSE : distributed single-layer embedded (test method)

FDT : formal description technique

LS : local single-layer (test method)

LSE : local single-layer embedded (test method)

RS : remote single-layer (test method)

RSE : remote single-layer embedded (test method)

TSS&TP : test suite structure and test purposes

YL : loop-back (test method)

YT : transverse (test method)

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5 Compliance

5.1 An International Standard or CCITT Recommendation which specifies a protocol in compliance with this part of ISO/IEC 9646 shall satisfy all the requirements stated in clauses 6 and 7 plus annex A.

NOTE – Such compliance is a precondition for the protocol specification to be an effective basis for conformance testing of implementations.

5.2 An ATS specification which complies with this part of ISO/IEC 9646

a) shall be a conformance test suite;

b) shall be specified in a test notation standardized by ISO/IEC or CCITT;

c) shall satisfy all the requirements stated in clauses 9 to 14 inclusive;

d) shall be an International Standard or CCITT Recommendation or, in the absence of such an International Standard or CCITT Recommendation, shall be a publicly available document which is in the process of being standardized within ISO/IEC or CCITT, which has the highest standardization status available, and which has the status of at least a Committee Draft, Draft Recommendation or equivalent.

NOTE - ATSs outside the standardization process need to be submitted for international standardization before they can fully comply with this part of ISO/IEC 9646, in order to ensure that they are subject to public scrutiny, correction and acceptance, internationally.

5.3 It is recommended that the test notation used be TTCN. If TTCN is used, the ATS shall comply with ISO/IEC 9646-3.

NOTE - X.290 (1988) is considered to be obsolete for this purpose.

6 Conformance requirements in OSI International Standards and CCITT Recommendations

6.1 Introduction

The meaning of conformance in OSI is discussed in ISO/IEC 9646-1. It is necessary that there be an unambiguous and objective understanding of the conformance requirements of an OSI protocol or transfer syntax specification, as a prerequisite to the production of an ATS for that specification. Clauses 6 and 7 state the requirements on protocol specifiers to ensure that there is such an understanding of the conformance requirements.

Additional guidance is given in annex B.

6.2 General requirements

6.2.1 A clear distinction shall be made between static and dynamic conformance requirements. To avoid ambiguity, they should be stated separately from one another.

6.2.2 It shall be clear what conformance to the International Standard or CCITT Recommendation means, in the sense of what shall be done, what is permitted but not mandatory, and what shall not be implemented, in order to conform to it.

6.2.3 It shall always be decidable whether an instance of communication conforms dynamically or not. For example, it should be possible to look at a record of PDU activity and decide whether or not it is valid with respect to the relevant International Standard or CCITT Recommendation.

6.3 Conformance clauses

6.3.1 Each International Standard or CCITT Recommendation which specifies an OSI protocol or transfer syntax shall include a conformance clause, which shall be expressed clearly and unambiguously.

6.3.2 Conformance clauses shall distinguish between the following categories of information:

a) *references to* clauses which state dynamic conformance requirements;

b) static conformance requirements concerning the protocol implementation;

c) static conformance requirements concerning multi-layer dependencies.

6.3.3 The requirement to produce a PICS, in compliance with the PICS proforma, shall be stated separately from the requirements on the protocol implementation itself.

6.3.4 The conformance clause should also include

a) the requirement to be able to accept all correct sequences of PDUs received from peers, and respond with correct PDU sequences;

b) the requirement to be able to respond correctly to all incorrect sequences of PDUs received;

c) in connection oriented protocols, the option to support either the initiation of a connection or the acceptance of a connection, or both;

d) in connectionless protocols, the option to support the transmission of a PDU, the receipt of a PDU, or both.

7 Requirements on PICS proformas

7.1 The specific requirements to be met by suppliers in respect of each PICS they provide shall be stated in the relevant International Standard or CCITT Recommendation which specifies the protocol. The specification of these requirements shall include a PICS proforma. The PICS proforma shall be found in a separate part of the International Standard or CCITT Recommendation which specifies the protocol.

7.2 The PICS proforma shall be in the form of a questionnaire or checklist to be completed by the supplier or implementor of an implementation of the relevant OSI protocol.

7.3 The PICS proforma shall cover all optional and conditional functions, elements of procedure, parameters, options, PDUs, timers, multi-layer dependencies and other capabilities identified in the protocol specification.

There shall be a well-defined mapping (by references) from the PICS proforma to the static conformance requirements.

Annex A provides requirements and guidance on the construction of PICS proformas.

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8 Abstract Test Suite production process leading to conformance testing standards

8.1 In order to present the requirements and general guidance for ATS specification, it is useful to assume a normal form of the process of ATS production leading to a conformance testing standard. This clause describes the process in just such a normal form. ATS specifiers are not required to follow this normal form exactly, however they are recommended to use a similar process involving the same steps, possibly in a different order.

8.2 For the purposes of this part of ISO/IEC 9646, the ATS production process is assumed to be as follows:

a) study the relevant specifications and PICS proformas to determine what the conformance requirements (including options) are which need to be tested (see clause 9);

b) decide which test groups will be needed to achieve the appropriate coverage of the conformance requirements (see 10.2);

c) optionally develop test group objectives: the common testing objectives of the elements of each test group (see 10.3);

d) develop test purposes which reflect the test group objectives (if any) of the test groups in which they are contained, and which provide adequate coverage of the conformance requirements to be tested (see 10.3 and 10.4);

e) optionally, specify generic test cases for each test purpose, using some appropriate test notation (see clause 11);

f) choose the test method(s) for which the complete abstract test cases need to be specified, and decide what restrictions need to be placed on the capabilities of the lower tester and (if appropriate to the chosen test method(s)) the upper tester and test coordination procedures (see clause 12);

g) apply a standardized test notation to specify the set of abstract test cases, including the test step structure to be used (see clause 13);

h) specify the interrelationships

1) among the test cases,

2) between the test cases and the PICS, and

3) as far as possible, between the test cases and the PIXIT,

in order to determine the restrictions on the selection and parameterization of test cases for execution, and the restrictions, if any, on the orders in which they can be executed (see clause 15);

i) consider the procedures for maintaining the ATS (see clause 16).

8.3 It is also assumed that during the ATS production process an overall structure for the conformance testing standard(s) will be developed, with appropriate parts for

a) the Test Suite Structure and Test Purposes (TSS&TP) (see clause 10);

b) optionally, a generic test suite (see clause 11);

c) one or more ATSs (see clause 13) for one or more Abstract Test Methods (see clause 12);

d) the specification of a TMP (if applicable) (see clause 14).

8.4 Clauses 9 to 16 provide requirements and guidance which relate to each step in the above process.

9 Conformance requirements and PICS proforma

9.1 Before an ATS can be specified, the ATS specifier shall first determine what the conformance requirements are for the relevant protocol and/or transfer syntax specifications and what is stated in the PICS proforma concerning the implementation of those specification(s).

9.2 Clauses 6 and 7 specify the requirements to be met by protocol specifiers as a prerequisite to the production of an ATS for a particular protocol.

9.3 If the static conformance requirements are not properly specified, the ATS specifier should contribute to the production of an amendment to or revision of the relevant International Standard or CCITT Recommendation to clarify the conformance requirements. Pending resolution of the problem, additional guidance for the ATS specifier is given in annex C.

10 Test Suite Structure and Test Purposes

10.1 Basic requirements

10.1.1 The test suite structure and set of test purposes applicable to all ATSs to be specified for the same OSI protocol shall be specified in the relevant conformance testing standard, preferably in a separate part.

10.1.2 Each ATS shall comprise a number of test cases, each of which is designed to achieve one of the specified test purposes. The test cases may be grouped into test groups, if necessary nested. The structure shall be hierarchical; thus, an item at a lower level shall be completely contained within a higher level item. The structure need not, however, be strictly hierarchical: thus, any one test case may occur in more than one test suite or test group. Similar test groups may occur in more than one higher level test group or test suite.

10.1.3 The ATS specifier shall ensure that a subset of the test purposes of each ATS is concerned with capability testing, and another subset is concerned with behaviour testing. This need not lead to distinct test cases for behaviour and capability testing because it may be possible to use the same test steps for both a behaviour test purpose and for a capability test purpose. The ATS specifier shall provide an explanation of how the test purposes are derived from or relate to the protocol specification. The ATS specifier shall also provide a summary of the coverage achieved by the ATS.

10.2 Specification of the test suite structure

10.2.1 In order to ensure that the resulting ATS provides adequate coverage of the relevant conformance requirements, the test suite specifier is advised to design the test suite structure in terms of nested test groups in a top down manner.

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There are many ways of structuring the same test suite into test groups; no one way is necessarily right and the best approach for one test suite may not be appropriate for another test suite. Nevertheless, the test suite specifier shall ensure that the test suite includes test cases for whichever of the following categories is relevant:

a) capability tests (for static conformance requirements);

b) behaviour tests of valid behaviour;

c) behaviour tests that investigate the reaction of the IUT to invalid test events; these may be subdivided into those concerned with syntactically invalid test events, semantically invalid test events, and inopportune test events, as relevant to the protocol concerned;

d) tests focusing on PDUs sent to the IUT;

e) tests focusing on PDUs received from the IUT;

f) tests focusing on interactions between PDUs sent and PDUs received;

g) tests related to each mandatory capability;

h) tests related to each optional capability;

i) tests related to each protocol phase;

j) variations in the test event occurring in a particular state;

k) timing and timer variations;

l) PDU encoding variations;

m) variations in values of individual parameters;

n) variations in combinations of parameter values.

This list is not exhaustive; additional categories might be needed to ensure adequate coverage of the relevant conformance requirements for a specific test suite. Furthermore, these categories overlap one another and it is the task of the test suite specifier to arrange them into an appropriate hierarchical structure.

10.2.2 The following structure is an example of a single-layer test suite, provided for guidance:

A. Capability tests

A.1 Mandatory capabilities

A.2 Optional capabilities

B. Behaviour tests: response to valid behaviour by peer implementation

B.1 Connection establishment phase (if relevant)

B.1.1 Focus on what is sent to the IUT

B.1.1.1 Test event variation in each state

B.1.1.2 Timing/timer variation

B.1.1.3 Encoding variation

B.1.1.4 Individual parameter value variation

B.1.1.5 Combination of parameter values

B.1.2 Focus on what is received from the IUT

– substructured as B.1.1

B.1.3 Focus on interactions

– substructured as B.1.1

B.2 Data transfer phase

– substructured as B.1

B.3 Connection release phase (if relevant)

– substructured as B.1

C. Behaviour tests: response to syntactically or semantically invalid behaviour by peer implementation

C.1 Connection establishment phase (if relevant)

C.1.1 Focus on what is sent to the IUT

C.1.1.1 Test event variation in each state

C.1.1.2 Encoding variation of the invalid event

C.1.1.3 Individual invalid parameter value variation

C.1.1.4 Invalid parameter value combination variation

C.1.2 Focus on what the IUT is requested to send

C.1.2.1 Individual invalid parameter values

C.1.2.2 Invalid combinations of parameter values

C.2 Data transfer phase

– substructured as C.1

C.3 Connection release phase (if relevant)

– substructured as C.1

D. Behaviour tests: response to inopportune events by peer implementation

D.1 Connection establishment phase (if relevant)

D.1.1 Focus on what is sent to the IUT

D.1.1.1 Test event variation in each state

D.1.1.2 Timing/timer variation

D.1.1.3 Special encoding variations

D.1.1.4 Major individual parameter value variations

D.1.1.5 Variation in major combination of parameter values

D.1.2 Focus on what is requested to be sent by the IUT

– substructured as D.1.1

D.2 Data transfer phase

– substructured as D.1

D.3 Connection release phase (if relevant)

– substructured as D.1

10.2.3 This test group structure does not cover basic interconnection tests. These may be provided as a list of selected capability and/or behaviour tests, but shall not involve any additional test purposes.

10.3 Specification of the test purposes

10.3.1 The test suite specifier shall create a set of test purposes, with each test purpose focused on a single conformance requirement of the relevant specification(s). It is suggested that test groups of related test purposes are identified first (as described in 10.2) and that text defining the test group objective be produced for each test group. Within each test group, several more specific test objectives should be defined, to become either nested test group objectives or individual test purposes. By successive refinement of the test

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group objectives in this way, a structured set of test purposes may be produced.

The test purposes could be produced directly from studying those clauses in the relevant specification(s) which are appropriate to the test group concerned. For some test groups, the test purposes might be derivable directly from the protocol state table; for others, they might be derivable from the PDU encoding definitions or the descriptions of particular parameters, or from text which specifies the relevant conformance requirements.

This orderly construction technique helps to ensure the adequate coverage of the conformance requirements to be tested. It also avoids unnecessary duplication of text in the test purposes, because the full description of each test purpose does not have to be written explicitly, but can be assembled by tracing a path down through the nested structure of objectives.

NOTE – If the test suite specifier employs a formal description of the protocol(s) concerned, test purposes may be derived from that by means of some automated method. If an automated method is used, the same requirements apply. However, methods based on FDTs are outside the scope of this part of ISO/IEC 9646. Nevertheless, if an FDT is to be used for this purpose, it is preferred that it be a standardized one.

10.3.2 In order to increase the efficiency of testing individual parameters on a single PDU, combined test purposes may be specified for a single abstract test case. Test purposes for invalid parameter values shall not be combined with other test purposes of valid or invalid values.

10.3.3 As part of the process of designing the TSS&TP, it is suggested that test purposes be identified initially for each specific parameter that is to be tested. As a second stage, combinations of individual parameter test purposes related to the same PDU may be specified. If this is done

a) a combined test purpose shall be written, combining and referencing individual test purposes;

b) an indication shall be given that one abstract test case is to be produced for that combined test purpose, rather than a distinct test case for each of the individual test purposes that have been combined;

c) the individual test purposes shall remain in the set of test purposes, but shall reference the appropriate combined test purpose.

10.3.4 The result of defining and then combining particular test purposes is a specification of a test suite structure and a list of names of the test cases that shall apply to both the test purposes and to any ATS produced for those test purposes.

10.3.5 Whatever method is used to derive the test purposes, the test suite specifier should ensure, as far as possible, that they provide an adequate coverage of the conformance requirements of the relevant specification(s). There shall be at least one test purpose related to each distinct conformance requirement.

10.3.6 Test purposes should be specified not only for clearly testable conformance requirements, but also for conformance requirements that may be untestable using the test methods defined in this part of ISO/IEC 9646.

NOTE – Test purposes for untestable requirements serve to inform protocol specifiers which conformance requirements are untestable, by indicating gaps in the standardized ATSs.

10.4 Coverage

It is possible to give guidance on the meaning of "adequate" coverage with reference to the test suite structure example in 10.2. In order to express this, a shorthand notation will be used: the letter "x" will represent all appropriate values for the first digit in the test group identifier, and similarly "y" for the second digit, so that B.x.y.1 stands for B.1.1.1, B.1.2.1, B.1.3.1, B.2.1.1, B.2.2.1, B.2.3.1, B.3.1.1, B.3.2.1 and B.3.3.1.

With this notation, a minimum "adequate" coverage for the example given in 10.2 is considered to be as follows:

a) for capability test groups (A.1, A.2)

1) at least one test purpose per relevant capability,

2) at least one test purpose per relevant PDU type and each major variation of each such type, using "normal" or default values for each parameter;

b) for test groups concerned with test event variation in each state (B.x.y.1, C.x.1.1, D.x.y.1), at least one test purpose per relevant state/event combination;

c) for test groups concerned with timers and timing (B.x.y.2, D.x.y.2), at least one test purpose concerned with the expiry of each defined timer;

d) for test groups concerned with encoding variations (B.x.y.3, C.x.1.2, D.x.y.3), at least one test purpose for each relevant kind of encoding variation per relevant PDU type;

e) for test groups concerned with valid individual parameter values (B.x.y.4, D.x.y.4)

1) for each relevant integer parameter, test purposes concerned with the boundary values and one randomly selected mid-range value,

2) for each relevant bitwise parameter, test purposes for as many values as practical, but not less than all the "normal" or common values,

3) for other relevant parameters, at least one test purpose concerned with a value different from what is considered "normal" or default in other test groups;

NOTE - Tests for valid parameter values should focus on the relevant claims made in the PICS.

f) for test groups concerned with syntactically or semantically invalid individual parameter values (C.x.1.3, C.x.2.1)

1) for each relevant integer parameter, test purposes concerned with invalid values adjacent to the allowed boundary values defined in the protocol specification, plus one other randomly selected invalid value,

2) for each relevant bitwise parameter, test purposes for as many invalid values as practical,

3) for all other relevant types of parameter, at least one test purpose per parameter;

NOTE - Tests for invalid parameter values should focus on values outside the range defined in the relevant protocol specification, rather than valid values outside the range claimed in the PICS.

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