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

Part 4:
Test realization

Technologies de l'information — Interconnexion de systèmes ouverts — Cadre général et méthodologie des tests de conformité OSI —

Partie 4: Réalisation des tests

Reference number
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Contents

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 9646-4 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 of this part of ISO/IEC 9646 is for information only.

Introduction

ISO/IEC 9646-1 and ISO/IEC 9646-2 define a general methodology for testing the conformance of implementations to OSI protocol specifications and/or transfer syntaxes issued as International Standards or CCITT Recommendations; these parts also put requirements on the production of OSI conformance testing standards and standardized Abstract Test Suites (standardized ATS).

ISO/IEC 9646-3 defines a standardized test notation, the Tree and Tabular Combined Notation (TTCN), for the specification of a standardized Abstract Test Suite.

Once OSI conformance testing standards and standardized Abstract Test Suites are available, the test results obtained by different test laboratories should be comparable, if they base their test operations on the same reference standardized ATS.

ISO/IEC 9646-5 puts requirements on the conformance assessment process, so that test results can be compared with those of other test laboratories, and can have a wide acceptance.

This part of ISO/IEC 9646 concentrates on the intermediate stage, namely, Test Realization. Before the test preparation can begin, a Means of Testing the Implementation Under Test (IUT) has to be made available.

Test Realizers are those organizations which take responsibility for providing such a Means of Testing (MOT).

ISO/IEC 9646-4 places requirements on Test Realization, to ensure that the execution of test cases reflects the behaviour specified in the reference standardized Abstract Test Suite. In this way, the purpose of the standardized ATS is achieved.

This part of ISO/IEC 9646 is also to be published by CCITT as Recommendation X.293(1991).

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

Part 4:
Test realization

1 Scope

This part of ISO/IEC 9646 specifies requirements and gives guidance concerning the realization of a means of testing IUTs, in conformance with a reference OSI standardized ATS, specified in compliance with ISO/IEC 9646-2.

NOTE — This implies the use of standardized abstract test suites as defined in ISO/IEC 9646-1:1991, 3.6.31.

These requirements are limited to those aspects of a means of testing which can be mapped on to the abstract testing functions defined in ISO/IEC 9646-1, or which are essential to a proper use of the standardized ATS. Such aspects might include a facility to produce conformance logs, or the progression of the PIXIT proforma. Further implementation details of test systems and upper testers are outside the scope of this part of ISO/IEC 9646.

Acceptance and installation of means of testing are outside the scope of this part of ISO/IEC 9646.

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 indicated 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).

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 9646-2:1991, *Information technology - Open Systems Interconnection - Conformance Testing Methodology and Framework - Part 2: Abstract test suite Specification.*
(See also CCITT Recommendation X.291(1991)).

ISO/IEC 9646-3:-[1], *Information technology - Open Systems Interconnection - Conformance Testing Methodology and Framework - Part 3: The Tree and Tabular Combined Notation (TTCN).*

ISO/IEC 9646-5:1991, *Information technology - Open Systems Interconnection - Conformance Testing Methodology and Framework - Part 5: Requirements on test laboratories and clients for the Conformance Assessment Process.*
(See also CCITT Recommendation X.294(1991)).

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 purpose of this part of ISO/IEC 9646, the following abbreviations given in ISO/IEC 9646-1:1991, clause 4, apply:

ASP : abstract service primitive.

ATS : abstract test suite.

BIT : basic interconnection test.

ETS : executable test suite.

IUT : implementation under test.

MOT : means of testing.

OSI : open systems interconnection.

PATS : parameterized abstract test suite.

PCO : point of control and observation.

PDU : protocol data unit.

1) To be published.

PETS : parameterized executable test suite.

PICS : protocol implementation conformance statement.

PIXIT : protocol implementation extra information for testing.

SATS : selected abstract test suite.

SETS : selected executable test suite.

SUT : system under test.

TTCN : tree and tabular combined notation.

5 Test Realization overview

5.1 Test Realization is the process of producing a Means of Testing (MOT) IUTs for conformance to OSI protocol specifications, based on a conformance testing standard and its ATS.

5.2 The MOT is a combination of equipment and procedures that can perform

a) the derivation;

b) the selection;

c) the parameterization; and

d) the execution

of the test cases, in conformance with the reference standardized ATS, and can produce a conformance log.

5.3 In the derivation process, the abstract test cases of the reference standardized ATS are converted, so as to be executable on a test system.

In the selection process, the appropriate test cases for the IUT are selected, according to the provisions of the PICS and the PIXIT.

In the parameterization process, the parameters in the selected test cases are given appropriate values, according to the provisions of the PIXIT (and possibly of the PICS).

The MOT is then used in the conformance assessment process of an IUT, resulting in the production of a conformance log.

The output of the derivation process is called an "Executable Test Suite" (ETS). It consists of executable test cases.

5.4 Intermediate forms of test suites may or may not be created, depending upon when the derivation process occurs.

Such intermediate forms are known as

a) SATS : Selected Abstract Test Suites;

b) SETS : Selected Executable Test Suites;

c) PATS : Parameterized Abstract Test Suites;

d) PETS : Parameterized Executable Test Suites.

5.5 Among these various forms, only the Abstract Test Suites are necessarily tangible.

Some MOT may generate the PETS automatically from the reference standardized ATS (given the PICS and PIXIT) at the moment the test cases are actually run. Such a Means of Testing does not exhibit an ETS, nor a SETS, nor a PETS, in a tangible form.

Nevertheless, what is executed is always a Parameterized Executable Test Suite.

6 Requirements concerning Test Realization

6.1 Introduction

The requirements concerning Test Realization address

a) the MOT as a whole;

b) the derivation process, from abstract to executable test cases;

c) facilities for producing a conformance log;

d) progression of the PIXIT proforma;

e) other documentation.

6.2 Requirements concerning the Means of Testing

6.2.1 The Means of Testing an OSI protocol implementation shall be provided in the context of a **single** standard Abstract Test Suite, in compliance with ISO/IEC 9646-2. The Test Realizer shall use only the version of the ATS specification which has the highest standardization status (*e.g.* DIS rather than DP or CD).

The MOT shall provide

a) a realization of the lower tester;

b) the specification of the upper tester, insofar as it is required by the abstract test method;

c) the realization of the upper tester for the Local test method;

d) optionally, the realization of the upper tester for the Coordinated and Distributed test methods;

e) the specification of the test coordination procedures in accordance with the requirements specified in the standardized ATS;

f) the realization of the test coordination procedures within the test system for the Local test method;

g) the realization of the Test Management Protocol within the lower tester for the Coordinated test method.

(See ISO/IEC 9646-1:1991, 7.4, and ISO/IEC 9646-2:1991, 12.3).

6.2.2 The MOT shall include either the executable test cases **derived** from the test cases of the reference standardized ATS, or a means of **deriving** them.

The MOT shall be realized in compliance with the semantics of the test notation chosen in the reference standardized ATS.

The MOT shall provide a means of **selecting** and **parameterizing** the test cases (whether they are at the abstract level or at the executable level), according to the appropriate PICS and PIXIT information provided with an IUT (see ISO/IEC 9646-5:1991, 7.3 and 7.4).

6.2.3 The MOT shall provide a facility for selecting the capability or behaviour test cases mentioned in the list of Basic Interconnection Tests (BIT list), if such a list is specified in the reference standardized ATS, and shall provide a facility for running them initially altogether, before the capability and behaviour tests.

The MOT shall also provide a facility for omitting those test cases indicated in the BIT list from the set of test cases selected for the capability and behaviour tests.

6.2.4 The MOT shall include the capability of **executing** the parameterized executable test cases which result from the derivation, selection and parameterization processes.

6.2.5 The Test Realizer shall provide a statement of conformance of the MOT to the reference standardized ATS, indicating any subset of the ATS that is not supported (see 6.3.4).

The Test Realizer shall identify all restrictions for test execution required by the MOT beyond those stated in the reference standardized ATS (*e.g.* limiting value ranges provided in the PIXIT).

NOTE — The Test Realizer should note the requirements for a comprehensive testing service stated in the standardized ATS. The Test Realizer may wish to develop an MOT for each of the required abstract test methods in order that a test laboratory may provide a comprehensive testing service.

6.2.6 The MOT shall provide a facility for generating a conformance log (see 6.4).

6.3 Requirements concerning ETS derivation

6.3.1 Introduction

Requirements in 6.3 shall apply to all Executable Test Suites, including SETS or PETS, whether tangible or not.

6.3.2 Conformance to the reference standardized ATS

An ETS shall be derived from a single reference standardized ATS.

For an ETS to conform to the reference standardized ATS, it shall comply with the requirements stated in 6.3.3 to 6.3.5 below. It shall also conform to the requirements stated in the reference standardized ATS itself, and in the other parts of the multi-part conformance testing standard, if applicable (*e.g.* TMP).

6.3.3 Correspondence between ATS and ETS

Each executable test case shall be the realization of a single Abstract Test Case, and shall be selectable for execution on an individual basis. All sequences of test events comprising an abstract test case shall be capable of being realized in the executable test case.

The test purpose and verdict assignments of each Abstract Test Case shall be maintained in the corresponding executable test case.

The MOT shall not perform checking on the validity of PDU parameters received from the IUT in addition to that which is defined in the Abstract Test Case. Any further checking which the test system might be capable of performing is outside the scope of this standard and shall not contribute to the verdict assignment for each test case.

Test group relationships defined in the reference standardized ATS shall be maintained in the ETS. Each test group composed of a named set of test cases in the reference ATS shall be represented in the ETS as a named set of executable test cases.

The standardized ATS includes a mapping of the abstract test case(s) to the PICS and partial PIXIT proforma entries (see ISO/IEC 9646-2:1991, clause 15). This mapping shall be maintained in the ETS.

6.3.4 Subsetting the ATS

The ETS derivation process generally results in the derivation of all abstract test cases of the reference standardized ATS. However, it may be acceptable to derive an ETS for certain subsets of the ATS. If a subset is created, the exclusion of a set of test cases shall be consistent with the test selection process for an IUT, with respect to the mapping between the PICS (and PIXIT) proforma entries and the test cases in the ATS.

NOTE — This means that the test cases which are mandatory for all IUTs would always be included in the subset, but the Test Realizer can choose not to realize particular sets of test cases which are optional or conditional and therefore will not be required to test particular classes of IUTs.

Thus the subset of the reference standardized ATS which is realized shall be equivalent to one or more of the potential SATS.

6.3.5 Derivation process independence

In the MOT, the derivation process shall lead to the same PETS being executed for a given IUT, regardless of when the derivation process occurs relative to the selection and parameterization processes.

NOTE — See A.2.1, figure A.1.

The application of the selection and parameterization processes for a particular IUT is the responsibility of the test laboratory, in the Test Preparation phase.

6.4 Requirements concerning conformance logs

As stated in 6.2, the MOT shall provide a facility for generating a conformance log.

A conformance log is a human-readable record of information produced as a result of a test campaign, sufficient to record the observed test outcomes and verify the assignments of test verdicts.

This information combines the observations of the actual test events which occur when the PETS is run against an IUT, with information which relates those events to the abstract test cases concerned.

A conformance log may be used in the production of conformance test reports and in the resolution of disputes and queries which may arise during or as a result of the conformance assessment process.

A conformance log shall include

a) a unique identification of the conformance log that includes time and date of the start of the execution of the PETS;

b) an identification of the MOT, date of origin, version number, and ETS identification (if any);

c) an indication of the start and end of run of each test case, including a unique reference to the abstract test case as specified in the ATS (*e.g.* TTCN test case reference or test identifier);

d) the PDUs sent by the lower tester to the IUT, and received by the lower tester from the IUT, including a record of the detailed information contained in the PDU parameters and user data;

e) the abstract test events, as specified in the relevant abstract test case; these include all abstract service primitives observed by the lower tester, all test events received via the test coordination procedures by the lower tester containing information from the upper tester, and an identification of the relevant Points of Control and Observation (PCO);

f) an indication of the result for each test case; this will be verdict assignment, abstract or executable test case error, or abnormal test case termination;

g) a time stamp or ordering sequence for all test events logged by the lower tester in the order that they are observed;

h) any additional information required by the reference standardized ATS.

NOTE 1 — An example of h) above is when an abstract test case written in TTCN specifies that preliminary result information (in the verdict column) or labels (in the label column) shall be recorded in the conformance log if the corresponding test event occurs.

A conformance log shall display all names, abbreviations and values, using the terminology and conventions defined in the protocol specification, transfer syntax (if any), or reference standardized ATS (with precedence given to the first two named).

The MOT shall have the ability to produce the conformance log on paper. It is also recommended that a machine-readable form of the conformance log be made available, with equivalent contents.

NOTE 2 — See annex A., clause A.3, for guidance on the production of conformance logs.

6.5 Requirements on the progression of the PIXIT proforma

The partial PIXIT proforma, as specified in the reference standardized ATS, shall be progressed to take into account the Means of Testing. To achieve this, the Test Realizer shall augment the partial PIXIT proforma by adding those additional questions that need to be answered in order to prepare the MOT for a particular IUT.

The Test Realizer shall include in the augmented partial PIXIT proforma all the information concerning the realization of the reference standardized ATS, which the client needs for completing the PIXIT.

The Test Realizer should refer to ISO/IEC 9646-5:1991, annex C and produce the augmented partial PIXIT proforma in compliance with this annex.

The resulting augmented partial PIXIT proforma shall be provided to the test laboratory, in order that it can fulfil its requirements as specified in ISO/IEC 9646-5:1991, 6.4.3 and annex C.

6.6 Requirements concerning other documentation

Documentation shall accompany the MOT, in order to enable the test laboratory to perform test operations in conformance with the reference standardized ATS, and in

compliance with ISO/IEC 9646-5, with respect to information to be provided to the client.

The documentation shall include

a) identification of the MOT, date of origin, version number, and ETS identification (if any);

b) name and version number of the International Standard or CCITT Recommendation for the protocol specification (and the service definition if appropriate); name and version number of the reference standardized ATS, together with lists of technical corrigenda which have been taken into account;

c) description of the MOT (see clause A.4 for guidance);

d) specifications of the test coordination procedures and of the upper tester, as and when required by the reference standardized ATS;

e) the test cases, if any, which cannot be executed due to limitations in the MOT;

NOTE — Such limitations should be exceptions, and should occur only if particular abstract test cases could not feasibly be realized.

f) description of those procedures for test execution which are to be performed by the test laboratory and/or the client, and which are specific to the MOT;

g) statement of conformance to the reference standardized ATS;

h) statement of compliance with this part (ISO/IEC 9646-4);

i) guidance for interpreting the conformance logs.

If Test Realizers detect errors in any of the abstract test cases or detect any abstract test case which addresses erroneous or ambiguous requirements in the relevant OSI protocol specification, then the Test Realizers shall identify those test cases in the documents accompanying the MOT.

NOTE — The Test Realizers should also forward defect reports which identify the problem(s) to the proper ISO/IEC or CCITT committee.

7 Compliance

A Means of Testing IUTs complies with this part of ISO/IEC 9646 if and only if all the requirements stated in clause 6 are satisfied.

NOTE — The primary means of verifying that a MOT implements the four functions associated with Test Realization (*i.e.* derivation, selection, parameterization, execution) resides in the conformance log.

Annex A
(informative)

Additional guidance on Test Realization

A.1 Additional guidance on the MOT

A.1.1. Introduction

This annex gives guidance on how the three abstract testing functions defined in ISO/IEC 9646-1:1991, 7.4, namely the lower tester, the upper tester and the test coordination procedures, can be defined or realized in an MOT.

NOTE — A test system should be able to accommodate several MOTs.

A.1.2. The realization of the lower tester

A.1.2.1 For every abstract test method defined in ISO/IEC 9646-2, the primary focus for coordination and control of the test is the lower tester. The functions of the lower tester are to

a) run executable test cases which are derived from abstract test cases;

b) produce verdict indications in accordance with the reference standardized ATS;

c) control and observe the test events which are included in an abstract test case (these events include generation and receipt of PDUs, abstract service primitives, generation and receipt of Test Management PDUs, events related to test coordination procedures).

The lower tester is part of an independent real system, referred to as the test system. Both that test system and the SUT provide the underlying service, below the lowest layer of protocols in the IUT.

A.1.2.2 The OSI entities in the lower tester, peer of the IUT, can be designed according to different techniques, for example:

a) encoder/decoder - simply encodes and decodes the ASPs and PDUs as required for the test case being run, without being an implementation of the protocol in question;

b) enhanced implementation - an implementation of the protocol concerned, modified by the addition of an error generator, configuration module or similar device to ensure that invalid or unusual ASPs or PDUs can be generated as required by the test case being run.

A.1.3. The realization of the upper tester

An MOT provides a realization of, or a specification of, the functions of an upper tester, according to the abstract test method used in the reference standardized ATS.

The upper tester can take different forms, for example:

a) a software implementation of the upper tester (which may or may not be independent of the design of the SUT and IUT), installed in the SUT above the IUT, with a mapping region that interfaces with the local realization of the ASPs;

b) a human operator - the functions of an upper tester are performed by a person having access to a user interface that maps onto the IUT service boundary and accesses and manipulates the realization of the appropriate ASPs;

c) a notional upper tester - *i.e.* the upper layers of the SUT are used to realize the functions of the upper tester, without any additional mechanism being installed (this can be used to realize the Remote abstract test method only).

A.1.4 The realization of the test coordination procedures

There are many ways in which the lower tester can interact with the upper tester, *e.g.* with or without synchronization, with or without using a communication channel additional to the one used between the lower tester and the IUT, *etc.*

Several common types of implementation can be identified:

a) human operator - the functions of an upper tester are performed by a person having access to a user interface that maps onto the IUT service boundary; this operator synchronizes with the lower tester, the progress of which can be detected by various means; *e.g.* via a set of prompting messages from a user interface of the lower tester;

b) scenario interpreter - the upper tester is realized by a remote scenario interpreter; it takes its instructions from files generated in conjunction with the lower tester installation, with a mapping region between it and the IUT service boundary;

c) Test Management Protocol - the upper tester is synchronized with the lower tester by means of a test management protocol, which uses the service provided by the IUT and its underlying layers, and the corresponding functions of the lower tester.

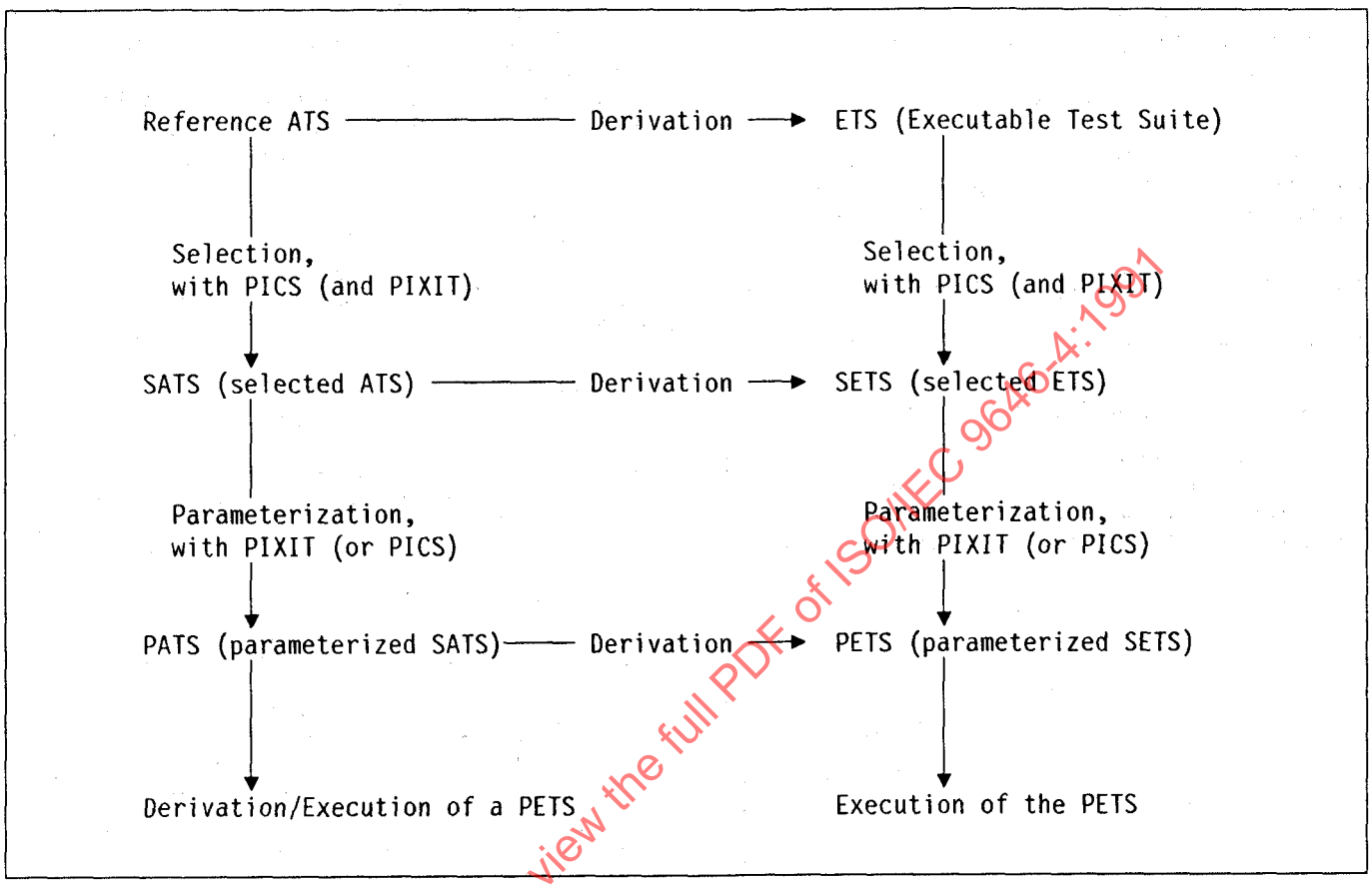

Figure A.1 - The PETS derivation/execution process

A.2 Additional guidance on the ETS derivation process

A.2.1 Overview

The derivation process can occur

a) during test realization;

b) during the installation of the MOT by the test laboratory;

c) during test preparation, intermixed with the selection and the parameterization processes, for a particular IUT;

d) during test operations, as a result of interpreting or compiling the reference ATS.

Figure A.1 illustrates the many possibilities of combining the test derivation, selection, parameterization and execution processes which are described in clause 5 (Test Realization overview), and for which requirements are specified in clause 6.

A.2.2 Inputs to ETS derivation

The Test Realizer has to consider the following inputs:

a) the reference standardized ATS for a particular OSI protocol, based on a particular abstract test method, and containing the specifications of the test coordination procedures;

b) the PICS proforma for the OSI protocol;

c) the partial PIXIT proforma, normally attached to the reference standardized ATS.

A.2.3. ETS maintenance

Once the capability of executing a PETS has been implemented in an MOT, and the MOT is in use, the test realizer may receive problem reports from the test laboratories. Problems may arise with the execution procedures, or with conformance to the reference standardized ATS. The Test Realizer should in such circumstances make available the appropriate corrections.

The Test Realizer should also provide an update of the MOT every time there is an update to the reference standardized ATS.

A.3 Additional guidance on conformance logs

In order to produce a conformance log it is necessary to

a) record the actual test events in their order of occurrence during the execution of the PETS;

b) analyse this information with respect to the relevant selected and parameterized abstract test cases, mapping the actual test events onto the abstract test events and recording all other necessary information.

There are requirements only on the information to be recorded in the conformance log, and how it is to be expressed.

The analysis of the ordered list of actual test events can be built into, and performed after the execution of, each executable test case; it may also be performed as a distinct process after the execution of the PETS, or performed by some combination of these techniques. The means of performing this analysis, and the timing of this analysis with respect to the execution of the PETS, are not standardized.

As specified in 6.4, the MOT shall have the ability to produce the conformance log on paper. It is also recommended that a machine-readable conformance log, with equivalent contents, be made available.

The process of producing the conformance log can be illustrated conceptually as in figure A.2.

NOTE — It is intended that the test laboratory retains, as a minimum, either the ordered list of actual test events or the machine readable version of the conformance log.

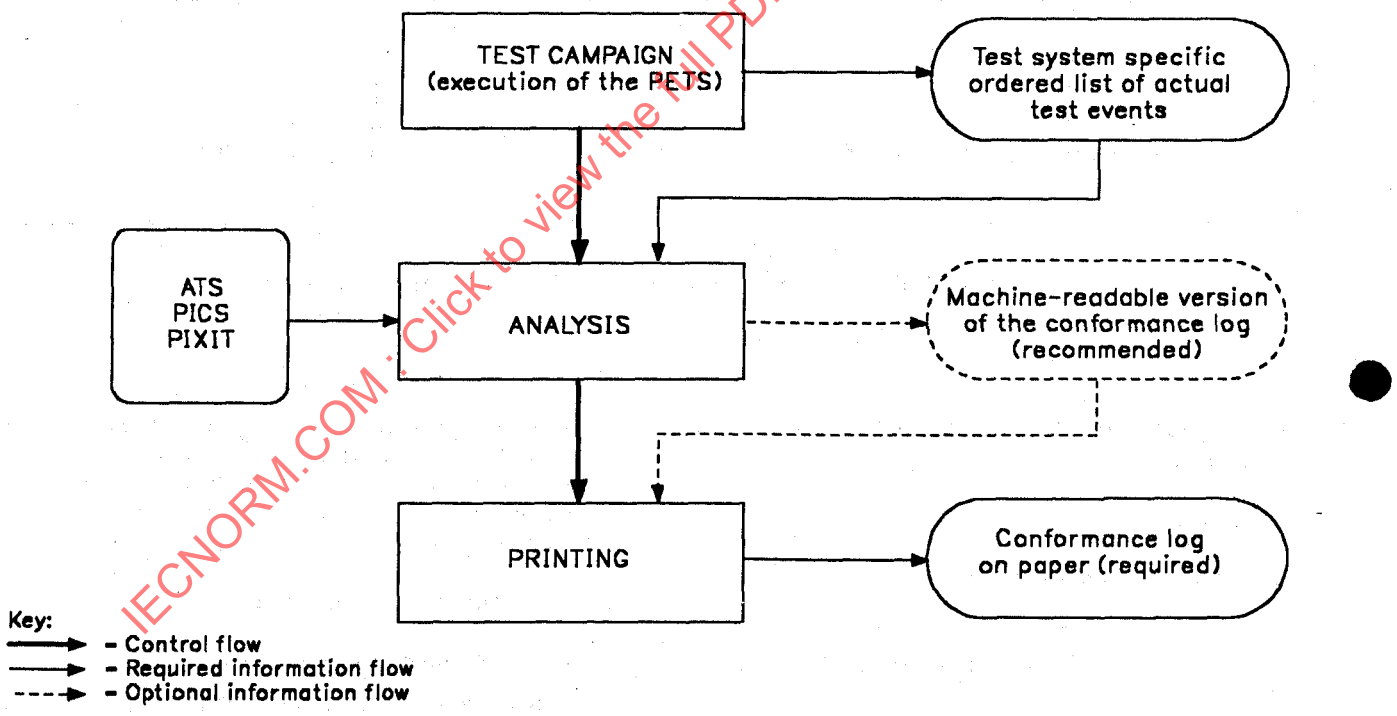

Figure A.2 - Conformance log production