

Information technology — Open Systems Interconnection — Systems Management: Confidence and diagnostic test categories

(ITU-T Rec. X.737 (1995) | ISO/IEC 10164-14 : 1996)

ICS 35.100.70

National foreword

This British Standard reproduces verbatim ISO/IEC 10164-14 : 1996 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee IST/21, Open Systems Interconnection, Data Management and Open Distributed Processing, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or using the 'Find' facility of the BSI Standards Electronic Catalogue.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the ISO/IEC title page, pages ii to v, a blank page, pages 1 to 65 and a back cover.

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INTERNATIONAL STANDARD

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Information technology — Open Systems Interconnection — Systems Management: Confidence and diagnostic test categories

*Technologies de l'information — Interconnexion de systèmes ouverts
(OSI) — Gestion-systèmes: Catégories de test de confiance et de
diagnostic*



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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 10164-14 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 21, *Open Systems Interconnection, data management and open distributed processing*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.737.

ISO/IEC 10164 consists of the following parts, under the general title *Information technology — Open Systems Interconnection — Systems Management*:

- *Part 1: Object management function*
- *Part 2: State management function*
- *Part 3: Attributes for representing relationships*
- *Part 4: Alarm reporting function*
- *Part 5: Event report management function*
- *Part 6: Log control function*
- *Part 7: Security alarm reporting function*
- *Part 8: Security audit trail function*
- *Part 9: Objects and attributes for access control*
- *Part 10: Accounting metering function*
- *Part 11: Metric objects and attributes*
- *Part 12: Test management function*
- *Part 13: Summarization function*
- *Part 14: Confidence and diagnostic test categories*
- *Part 15: Scheduling function*
- *Part 16: Management knowledge management function*
- *Part 17: Change over function*

- *Part 18: Software management function*
- *Part 19: Management domain and Management policy management function*
- *Part 21: Command Sequencer*

Annexes A to E form an integral part of this part of ISO/IEC 10164. Annexes F to I are for information only.

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – SYSTEMS MANAGEMENT: CONFIDENCE AND DIAGNOSTIC TEST CATEGORIES

1 Scope

This Recommendation | International Standard defines a Systems Management Function that may be used by an application process in a centralised or decentralised management environment to interact for the purpose of systems management, as defined by CCITT Rec. X.700 | ISO/IEC 7498-4. This Recommendation | International Standard defines a function which consists of generic definitions, services and functional units. This function is positioned in the application layer of ITU-T Rec. X.200 | ISO/IEC 7498-1 and is defined according to the model provided by ITU-T Rec. X.207 | ISO/IEC 9545. The role of systems management functions is described by CCITT Rec. X.701 | ISO/IEC 10040.

This Recommendation | International Standard:

- establishes user requirements for this Recommendation | International Standard;
- specifies Confidence and diagnostic test categories that relate generic definitions provided by this Recommendation | International Standard to user requirements;
- defines managed objects, packages, attribute types, operation types, and parameters documented in accordance with CCITT Rec. X.722 | ISO/IEC 10165-4;
- specifies compliance requirements placed on other Recommendations | Standards that make use of the Generic Definitions of this Recommendation | International Standard.

This Recommendation | International Standard does not:

- define the nature of any implementation intended to provide Confidence and diagnostic tests;
- specify the manner in which management is accomplished by the user of Confidence and diagnostic tests;
- define the nature of any interactions which result in the use of Confidence and diagnostic tests;
- specify the services necessary for the establishment, normal and abnormal release of a management association.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardization Bureau of the ITU-T maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*.
- ITU-T Recommendation X.207 (1993) | ISO/IEC 9545:1994, *Information technology – Open Systems Interconnection – Application Layer structure*.

- ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: Conventions for the definition of OSI services.*
- CCITT Recommendation X.701 (1992) | ISO/IEC 10040:1992, *Information technology – Open Systems Interconnection – Systems management overview.*
- CCITT Recommendation X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management Information Model.*
- CCITT Recommendation X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information.*
- CCITT Recommendation X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects.*
- ITU-T Recommendation X.724 (1993) | ISO/IEC 10165-6:1994, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management.*
- ITU-T Recommendation X.745 (1993) | ISO/IEC 10164-12:1994, *Information technology – Open Systems Interconnection – Systems management: Test management function.*

2.2 Paired Recommendation | International Standards equivalent in technical content

- CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1).*
ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1).*
- ITU-T Recommendation X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts.*
ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*
- ITU-T Recommendation X.291 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Abstract test suite specification.*
ISO/IEC 9646-2:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 2: Abstract Test Suite specification.*
- CCITT Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications.*
ISO/IEC 7498-4: 1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework.*
- CCITT Recommendation X.710 (1991), *Common management information service definition for CCITT applications.*
ISO/IEC 9595:1991, *Information technology – Open Systems Interconnection – Common management information service definition.*

2.3 Additional references

- CCITT Recommendation O.151 (1992), *Error performance measuring equipment operating at the primary rate and above.*
- CCITT Recommendation O.152 (1992), *Error performance measuring equipment for bit rates of 64 kbit/s and $N \times 64$ kbit/s.*
- ITU-T Recommendation V.32 (1993), *A family of 2-wire, duplex modems operating at data signalling rates of up to 9 600 bit/s for use on the general switched telephone network and on leased telephone type circuits.*

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 Basic reference model definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

- a) open system;
- b) systems management.

3.2 Management framework definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.700 | ISO/IEC 7498-4:

- a) managed object;
- b) management information.

3.3 CMIS definitions

This Recommendation | International Standard makes use of the following term defined in CCITT Rec. X.710 | ISO/IEC 9595:

- attribute.

3.4 Systems management overview definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.701 | ISO/IEC 10040:

- a) agent;
- b) agent role;
- c) generic definitions;
- d) managed object class;
- e) managed object conformance statement;
- f) managed system;
- g) management information conformance statement;
- h) manager;
- i) manager role;
- j) MICS proforma;
- k) MOCS proforma;
- l) notification.

3.5 Management information model definitions

This Recommendation | International Standard makes use of the following term defined in CCITT Rec. X.720 | ISO/IEC 10165-1:

- attribute type.

3.6 Management ICS proforma definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.724 | ISO/IEC 10165-6:

- a) managed relationship conformance statement;
- b) management conformance summary;
- c) MCS proforma;
- d) MRCS proforma.

3.7 Test Management definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.745 | ISO/IEC 10164-12:

- a) Associated Objects (AOs);
- b) controlled test;
- c) MORT;
- d) intrusive test;
- e) non-intrusive test;
- f) uncontrolled test;
- g) Test Action Request Receiver (TARR);
- h) test conductor;
- i) test invocation;
- j) Test Object (TO);
- k) test performer;
- l) test request;
- m) solicited reporting;
- n) time-out period;
- o) unsolicited reporting.

3.8 OSI conformance testing definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.290 | ISO/IEC 9646-1 and ITU-T Rec. X.291 | ISO/IEC 9646-2.

- a) PICS proforma;
- b) point of control and observation;
- b) protocol implementation conformance statement;
- c) system conformance statement.

3.9 Additional definitions

3.9.1 establishment time: The time taken to establish a connection between two protocol entities.

3.9.2 explicit termination: Test terminations on request from the test conductor.

3.9.3 implicit reporting: Results are reported in the form of an event report (i.e. unsolicited reporting) or an action reply.

3.9.4 implicit termination: Test termination on completion or upon error.

3.9.5 loopback timeout: The length of time that a test performer will wait for the transmitted data to be returned.

3.9.6 loopback transmission delay time: The time delay associated with transmitting a pattern to and back from the loopback point.

3.9.7 pattern period time: The amount of time for which each test pattern is transmitted.

3.9.8 start time: Time used for scheduling a test sometime in the future.

3.9.9 test interval time: The time delay between the completion of reception of one test pattern and the start of transmission of the next.

3.9.10 test pattern: The signals or data to be applied to a communications path.

4 Symbols and abbreviations

AO	Associated Object
ASN.1	Abstract Syntax Notation One
LLC	Logical Link Control
MCS	Management Conformance Summary
MICS	Management Information Conformance Statement
MIDS	Management Information Definition Statement
MOCS	Managed Object Conformance Statement
MORT	Managed Object Referring to Test
MRCS	Managed Relationship Conformance Statement
OSI	Open Systems Interconnection
PCO	Point of Control and Observation
PDU	Protocol Data Unit
PICS	Protocol Implementation Conformance Statement
TARR	Test Action Request Receiver
TO	Test Object
XID	Exchange Identification Frame

5 Conventions

This Recommendation | International Standard does not define any special conventions.

6 Requirements

This Recommendation | International Standard defines a basic set of confidence and diagnostic test categories that is required by the user of a communication system or network to:

- confirm the ability of a specified part of the system or network to perform correctly its allotted function (that is, the tested entity continues to perform according to its design);
- perform testing, following notification or detection of a fault, to further isolate the cause of the problem.

This requirement includes the need to:

- verify connection between two known end points;
- verify that connectivity may be established between two entities within a specified time;
- verify whether two entities can exchange data without any corruption and measure time taken for the exchange;
- verify that data can be sent and received over a communications path within a specified interval of time;
- determine if two entities can conduct proper protocol interactions;
- verify the observable behaviour of an entity at its boundaries;
- verify the ability of an entity to perform its allotted function;
- verify the ability to receive incoming test requests and generate appropriate responses.

NOTE – It is not the objective of this Recommendation | International Standard to define a complete categorization of the test types that may be offered by a particular resource or required for a particular purpose.

7 Model

A test request is directed to a managed object, being managed by the test performer, which has the functionality to receive and respond to such requests. As defined in ITU-T Rec. X.745 | ISO/IEC 10164-12, such functionality is called the Test Action Request Receiver functionality (TARR functionality). Managed objects which refer to functionalities that are the subjects of tests, MORTs, are identified, either explicitly or implicitly, in test requests. Each test involves one or more MORTs. For any test, the TARR may be part of the functionality of either a MORT or another managed object.

A test is uncontrolled or controlled. An uncontrolled test is one which is not subject to monitoring or control, and for which test results are provided in one or more replies to the test request. A controlled test is one for which one or more test TOs are created for the purpose of monitoring and control. The general test behaviour is documented by a test category. Figure 1 provides examples of some configurations.

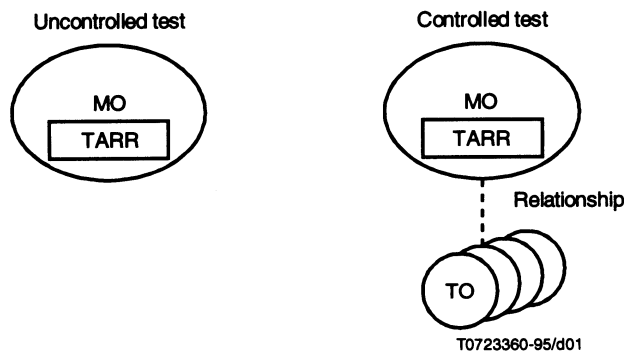


Figure 1 – Managed objects involved in all tests

This clause defines the categories of confidence and diagnostic tests that may be used to investigate the OSI environment. These categories are:

- Connection test, which may be used to verify connection between two known end points.
- Connectivity test, which may be used to verify if connectivity between two entities may be established.
- Data integrity test, which may be used to ascertain two entities can exchange data without any corruption.
- Loopback test, which may be used to verify and measure the time taken for an exchange.
- Protocol integrity test, which may be used to investigate if two communication entities can conduct proper protocol interactions.
- Resource boundary test, which aims to test the behaviour of a resource by observing and controlling the interactions between the resource and its boundaries.
- Resource self test, which may be exercised to investigate the ability of a resource to perform its allotted function.
- Test infrastructure test, which may be used to investigate the capability of a managed system to respond to a test request.

Members of each test category (e.g. the suite of tests offered by a particular managed system) share a common management interface, but will differ in areas such as:

- the function or physical entity that is tested;
- the thoroughness of the test;
- the duration of the test.

For each category, this Recommendation | International Standard defines:

- the purpose of the performed test;
- the resources (MORTs and AOs) that are involved;
- the test environment;
- the controllability (controlled or uncontrolled) of the test;

- the TO class, if controlled test applies;
- other information concerning the test;
- how the test report is delivered (e.g. implicitly or solicited) and the contents of the result report;
- the termination of the test (includes normal test completion, test failure, test abort, test terminate request, test timeout);
- (where appropriate) detailed timing information specific to the test category; and
- the management interface.

NOTE – Test termination is not equivalent to test completion (see ITU-T Rec. X.745 | ISO/IEC 10164-12). Test termination includes: test completion (pass test), test failure or error, test abort request (for controlled tests), test timeout and test terminate request (for controlled tests).

This Recommendation | International Standard also sets out the information required by a user to allow selection between the tests offered by a particular managed system. Typically, this information would be specified by a specialization of a standard test category or communicated by the supplier as a part of the technical documentation of the system, or both (e.g. Recommendation V.32).

For example, a telephone switch may offer functions such as call routing and billing, implemented by hardware and software modules including line cards, processor units, and data storage media (e.g. disc drives). A resource self test may be offered for each of these functions and each of the modules.

Through specialization, a managed object may offer two or more tests of the same internal function/module but for different objectives.

For controlled tests, it is necessary to define TO(s) for each test category. All TO classes are derived from the test object managed object class defined in ITU-T Rec. X.745 | ISO/IEC 10164-12.

These TO classes can be specialized to define more specific tests.

The following subclauses define the aforementioned test categories and their associated test object classes. The inheritance relationships among these TO classes are shown in Figure 2.

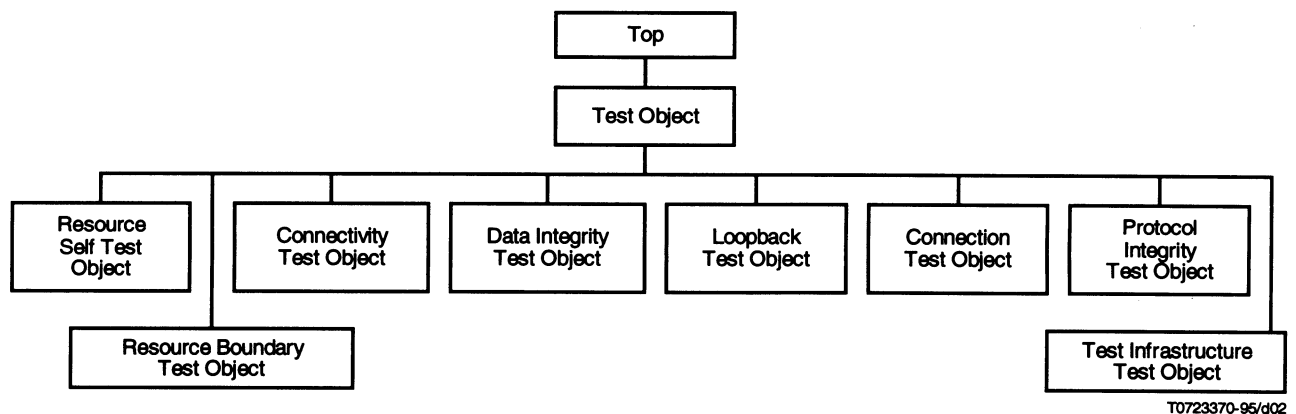


Figure 2 – Inheritance relationships among test categories

7.1 Connection test

7.1.1 Purpose of the test category

The connection test allows investigation of the ability of a communications path (real or virtual) to support a desired service or level of functionality.

The test may be implemented as one or more exercises. The exercises performed are specific to the type of connection concerned and should be sufficient to verify its performance within documented limits.

7.1.2 MORT and AO requirements

The MORT(s) represent the communications path to be tested. Two AOs are defined that reference the resources at the ends of the communications path that drive signals into and receive signals from the communications path. If identities of the MORT(s) or AOs are not specified in the test initiation, then defaults are selected by the managed system that receives the test request. Figure 3 illustrates these managed objects.

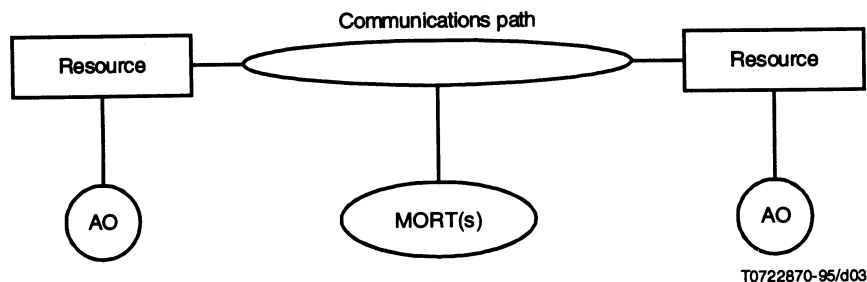


Figure 3 – Connection test test environment

In a case in which a path supports only a single direction of communication, the 'sending' AO will cause a sequence of test patterns or exercises to be applied to the path. The 'receiving' AO will provide a reference to check that the corresponding outputs are correctly received. The precise set of test patterns or exercises to be performed must be identifiable by the AOs that participate in the test (e.g. it will be pre-programmed or built into the two resources).

Note that the individual test patterns or exercises may differ significantly in their character and in the aspect of the path's functionality that is investigated.

In the event that one or more errors are detected, the test may provide diagnostic information in its final report that can be used to assist in fault progression and resolution (e.g. "suspected cable break").

In a case in which a path supports two directions of communication as determined by the test direction in a single test request, exercises of the form described above are performed separately for each direction of communication. The directions of communication will be tested in an implementation-dependent order. Figure 4 provides an example of the transmission of patterns.

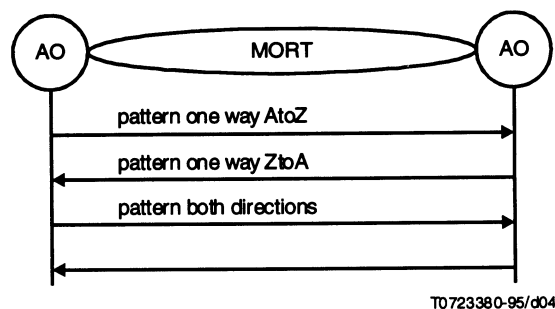


Figure 4 – Example of use of the Connection Test Category

7.1.3 Test environment

The Connection test may be intrusive or non-intrusive to both the MORT(s) and to the AOs.

If the Connection test is intrusive, it will abort under the following conditions:

- if the MORT(s) or AOs have not previously been placed in an appropriate state (e.g. reserved for test);
- if the MORT(s) or AOs cannot be placed in the appropriate state during test initialization.

7.1.4 Uncontrolled/controlled

The test may be modelled either as an uncontrolled test or as a controlled test.

7.1.5 TO requirements

This Recommendation | International Standard defines a connection test object. This TO can be specialized to define more specific TO classes.

7.1.6 Initiation specific to test category

When requesting an uncontrolled test, the time-out period defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 shall be specified.

In addition to the parameters that are required by ITU-T X.745 | ISO/IEC 10164-12, the following optional parameters defined in ITU-T X.745 | ISO/IEC 10164-12 may also be required:

- identity of the AOs, and if appropriate, additional AO information;
- identity of the MORT;
- time-out period.

The following optional parameters may be needed:

- The test pattern to be used during the test – If this parameter is not present, the test pattern is implementation specific.
- The test direction applied to the MORT – If this parameter is not present, the MORT represents the transmitting direction at the near end of a uni-directional path.
- The test duration applied to the test – If this parameter is not present, the test duration is implementation specific.
- The test-threshold to be used to determine the test outcome – If this parameter is not present, the error threshold is implementation specific.
- The reporting interval time for intermediate test result reporting – If this parameter is not present, there is no intermediate result reporting or the intermediate result reporting time is implementation specific.

7.1.7 Reporting and termination events

The events that trigger implicit intermediate result reporting are:

- completion of the test exercise(s) performed on a single direction of communication;
- expiry of the specified reporting interval time.

The events that trigger implicit result reporting are:

- completion of the test exercise(s) performed on a single direction of communication;
- completion of the test;
- time-out;
- if the test is modelled as a controlled test, reception of a termination request.

The events that trigger test termination are:

- completion of the test;
- failure of the test to complete normally;
- expiry of the time interval during which the test is required to be completed (time-out);
- if the test is modelled as a controlled test, reception of a termination request.

7.1.8 Result report

When the test is modelled as an uncontrolled test, implicit reporting is used by means of one or more action replies. When the test is modelled as a controlled test, solicited reporting is supported by means of a get request; also, conditionally implicit reporting may be used by means of the TEST-RESULT service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 (also known as unsolicited reporting).

In addition to the parameters that are required by ITU-T Rec. X.745 | ISO/IEC 10164-12, the following parameters are required in the result report:

- the identity of the MORT(s), if not specified in the initiation;
- the identities of the AOs, if not specified in the initiation;
- if this is the final result report, the test outcome – chosen as described below.

The following optional parameters may also be returned:

- received test signal;
- error ratio detected through the test;
- test direction made on the MORT;
- test duration time;
- detailed result information for the test (implementation dependent);
- if the outcome is fail, additional diagnostic information to assist in fault progression and resolution;
- other result information specific to the test implementation.

The outcome of the test is determined as follows:

- if all exercises have been completed correctly, the outcome will be Pass;
- if any exercise detected an error, the outcome will be Fail;
- if the test duration exceeded the specified time-out period, the outcome will be Timed-out;
- if the test terminated as a result of a procedural error being encountered or as the result of receipt of a TERMINATION REQUEST, the result will be Premature termination;
- otherwise, the outcome will be Inconclusive.

7.1.9 Test termination

For an uncontrolled test, this test category uses implicit termination.

For a controlled test, both implicit and explicit termination are used. For explicit termination, the TEST-TERMINATION service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 is used.

7.2 Connectivity test

7.2.1 Purpose of the test category

The Connectivity Test is used to verify that connectivity may be established between two entities (represented by a MORT and an AO) within a specified time.

7.2.2 MORT and AO requirements

The test invocation involves two entities, represented by two managed objects (one the MORT and the other the AO), between which connectivity is to be verified. Whilst in the testing state the MORT tries to establish contact with the AO. This may be done in the case of a connection oriented protocol by establishing a connection, or in the case of a connectionless protocol by an exchange of data unit, such as the LLC XID exchange. The time taken between the issuing of the request by the MORT until the receipt of the corresponding confirmation from the AO is measured and called establishment time. A time-out period may be associated with the test. The time-out period may be specified indirectly as the value of a timer attribute provided by the MORT. Figures 5 and 6 provide examples of use of the Connectivity test.

7.2.3 Test environment

The connectivity test is intrusive to both the MORT and to the AO. The Connectivity test will abort under the following conditions:

- if the MORT or AO have not previously been placed in an appropriate state (e.g. reserved for test);
- if the MORT or AO cannot be placed in the appropriate state during test initiation.

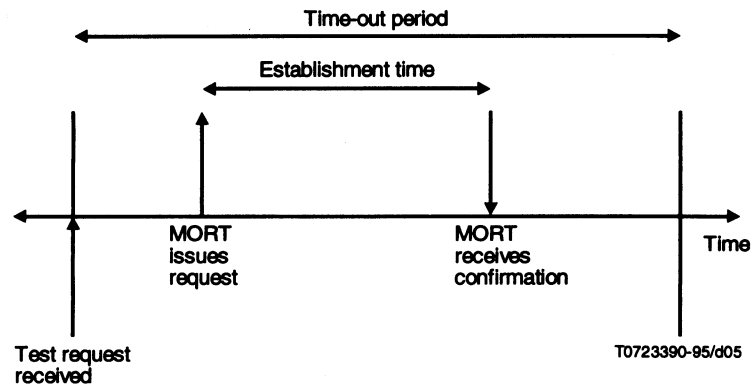


Figure 5 – Connectivity test example 1

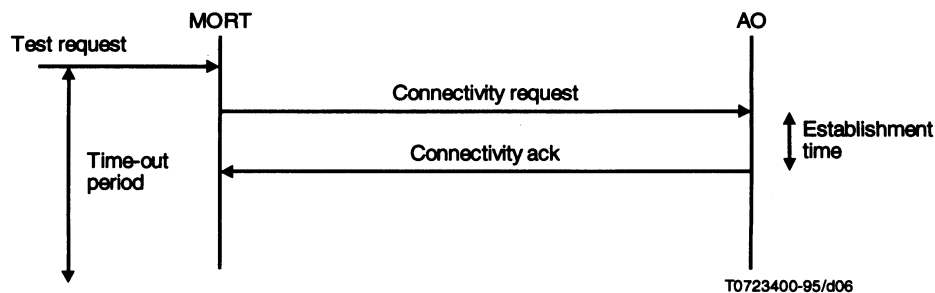


Figure 6 – Connectivity test example 2

7.2.4 Uncontrolled/controlled

A connectivity test may be modelled either as an uncontrolled test or as a controlled test.

7.2.5 TO requirements

This Recommendation | International Standard defines a connectivity test object. This TO can be specialized to define more specific TO classes.

7.2.6 Initiation specific to test category

In addition to the parameters that are required by ITU-T X.745 | ISO/IEC 10164-12, the following optional parameters defined in ITU-T X.745 | ISO/IEC 10164-12 are also required:

- identity of the AO, and if appropriate, additional AO information;
- identity of the MORT if not implicitly known by the TARR;
- time-out period, if not implicitly known by the MORT.

7.2.7 Reporting and termination events

The events that trigger implicit result reporting and implicit test termination are:

- receipt of confirm from AO prior to expiry of time-out period;
- time-out period expiration.

7.2.8 Result report

When the test is modelled as an uncontrolled test, implicit reporting is used by means of one or more action replies. When the test is modelled as a controlled test, solicited reporting is supported by means of a get request; also, conditionally implicit reporting may be used by means of the TEST-RESULT service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 (also known as unsolicited reporting).

In addition to the parameters that are required by ITU-T X.745 | ISO/IEC 10164-12, the following parameters are required:

- the identity of the AO, if it was not explicitly specified in the test request;
- identity of the MORT, if it was not explicitly specified in the test request.

The following optional parameters may also be returned:

- if this is the final report, the test outcome chosen as appropriate from ITU-T X.745 | ISO/IEC 10164-12 shall be returned;
- if outcome is Pass, then Establishment time in time-units;
- if outcome is Fail, then the time taken from the issuing of the request by the MORT until the receipt of the corresponding confirmation from the AO, or the termination of the request;
- any additional information specific to the test.

The value of the test outcome to be returned in the final test result report is determined according to the following:

- if positive confirmation is received before the time-out period, the test outcome is Pass;
- if a negative confirmation is received, the outcome is Fail;
- if the confirmation was not received before the expiration of the pre-specified time-out period, the test outcome is Timed-out;
- if the test terminates as a result of a procedural failure, or as a result of receipt of a TERMINATE REQUEST, the test outcome is Premature termination;
- otherwise, the test outcome is Inconclusive.

7.2.9 Test termination

For an uncontrolled test, this test category uses implicit termination.

For a controlled test, both implicit and explicit termination are used. For explicit termination, the TEST-TERMINATION service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 is used.

7.3 Data integrity test

7.3.1 Purpose of the test category

The test ascertains whether two entities can exchange data without any corruption, and measures the time taken for the data exchange.

7.3.2 MORT and AO requirements

While in the testing state the MORT transmits data to an AO. The AO, upon detecting the reception of the data, causes a copy of the data to be reflected back to the MORT. The transfer mechanism used to carry the data may be either connection oriented or connectionless. If it is connection oriented, the MORT must ensure that a connection exists prior to transmitting the data. During the connection establishment, the TO is placed in the initiating test state. While the connection is closing down, the TO is put in the terminating state. Figures 7 and 8 provide examples of use of the data integrity test.

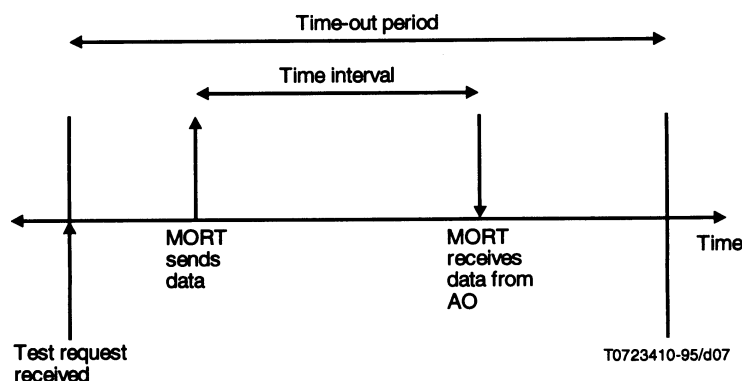


Figure 7 – Data integrity test example 1

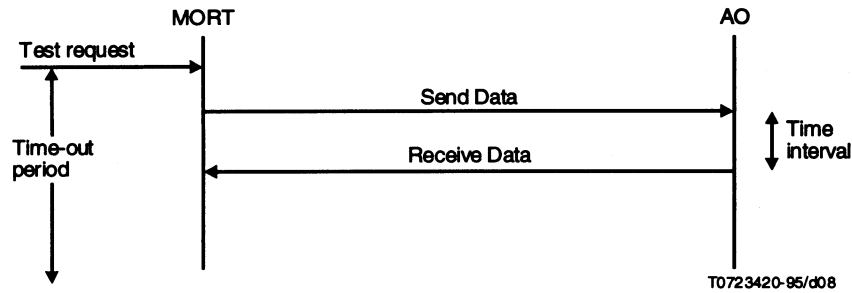


Figure 8 – Data integrity test example 2

7.3.3 Test environment

The Data integrity test is intrusive to both the MORT(s) and to the AO(s). The Data integrity test will abort under the following conditions:

- if the MORT or AOs have not previously been placed in an appropriate state (e.g. reserved for test);
- if the MORTs or AOs cannot be placed in the appropriate state during test initialization.

7.3.4 Uncontrolled/controlled

A data integrity test may be modelled either as an uncontrolled test or as a controlled test.

7.3.5 TO requirements

This Recommendation | International Standard defines a data integrity test object. This TO can be specialized to define more specific TO classes.

7.3.6 Initiation specific to test category

In addition to the parameters that are required by ITU-T X.745 | ISO/IEC 10164-12, the following optional parameters defined in ITU-T X.745 | ISO/IEC 10164-12 are also required:

- identity of the AO, and if appropriate, additional AO information;
- identity of the MORT if not implicitly known by the TARR;
- time-out period, if not implicitly known by the MORT.

The following optional parameter may be specified:

- The data units for the test. If not provided, the test units are object specific.

7.3.7 Reporting and termination events

The events that trigger implicit result reporting and implicit test termination are:

- receipt of confirmation from AOs prior to expiry of time-out period;
- time-out period expiration.

7.3.8 Result report

When the test is modelled as an uncontrolled test, implicit reporting is used by means of one or more action replies. When the test is modelled as a controlled test, solicited reporting is supported by means of a get request; also, conditionally implicit reporting may be used by means of the TEST-RESULT service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 (also known as unsolicited reporting).

In addition to the parameters that are required by ITU-T X.745 | ISO/IEC 10164-12, the following parameters are required:

- the identity of the AO, if it is not explicitly specified in the test request;
- identity of the MORT, if it is not explicitly specified in the test request.

The following optional parameters may also be returned:

- If this is the final report, the test outcome chosen as appropriate from ITU-T X.745 | ISO/IEC 10164-12 shall be returned;
- If the test outcome is Pass, the actual time interval for the data exchange is returned;
- If outcome is Fail, then the time taken from the issuing of the request by the MORT until the receipt of the corresponding confirmation from the AO, or the termination of the request;
- If the test failed due to the received data, then the data received. Furthermore, if the data units used in the test were not provided in the test request parameter, the data units shall also be returned;
- Any additional information specific to the test.

The test outcome is returned in the final test result report. The value of the test outcome is determined according to the following:

- if all data units were successfully transmitted and received, the test outcome is Pass;
- if errors were detected in received data, the test outcome is Fail;
- if the test duration exceeds the pre-specified time-out period, the test outcome is TIMEOUT;
- if the test terminates as a result of a procedural failure, or as a result of receipt of a TERMINATE REQUEST, the test outcome is Premature termination;
- otherwise, the test outcome is Inconclusive.

7.3.9 Test termination

For an uncontrolled test, this test category uses implicit termination.

For a controlled test, both implicit and explicit termination are used. For explicit termination, the TEST-TERMINATION service defined in ITU-T Rec. X.745 | ISO/IEC 10164-12 is used.

7.4 Loopback test

7.4.1 Purpose of the test category

The Loopback test is used to verify that data may be sent and received over a communications path within a specified loopback time-out period with an acceptable error ratio. A loopback may be implemented in a variety of ways, for example by physical loopback or by echoing data received. Loopbacks may be analogue or digital. Other examples include non-transparent physical loopback, transparent physical loopback, payload physical loopback, echo data back, etc. A loopback test may be performed over a communication path that is connection oriented or connectionless.

7.4.2 MORT and AO requirements

7.4.2.1 Loopback configuration

To allow the invocation of loopback tests, the configuration in which the MORTs and AOs are to be placed must be specified. The MORTs represent the resources that are being tested by the loopback test. However, these MORTs need not necessarily cover the entire communications path as there may be other unidentified managed objects to be tested along the communications path. The AOs references the resources providing the loopback points. This Recommendation | International Standard and the use of these AOs are implementation specific. If AOs are not specified, a manual loopback configuration is assumed.

In some cases, it is desirable to be able to specify that a loopback occurs within a MORT. This may occur when a resource is modelled as a single managed object but is actually complex enough to allow loopbacks to occur in several places within the MORT (e.g. a “path” may be modelled as a single MO but may actually consist of multiple sections each of which could be looped). To allow this to be modelled, AOs are allowed to be present at locations that will test only a part of the MORT.

Figures 9 and 10 show two possible configurations of MORTs and AOs.

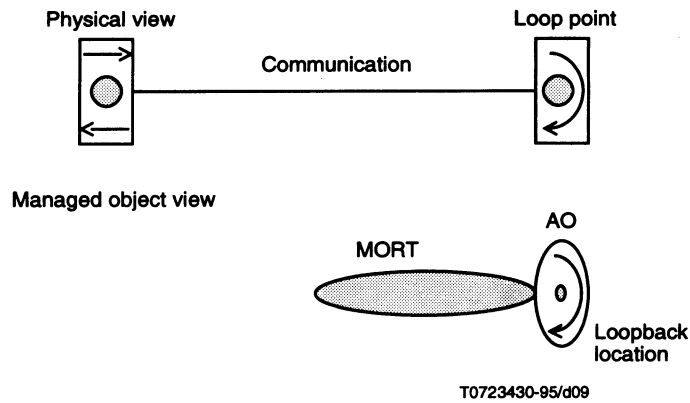


Figure 9 – Loopback configuration example – First case

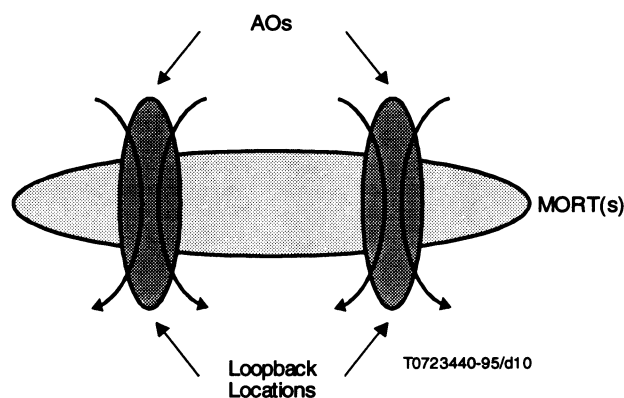


Figure 10 – Loopback configuration example – Second case

The first configuration shows a simple loopback example. The MORT is an object modelling the communication path between the two resources. A single AO models the resource which provides the loopback. The location of the loopback within the AO is indicated. The resource providing the point at which test data is injected is not modelled in this example.

The second configuration represents the capability of invoking a loopback test at different locations within the same MORT. In this case, the manager must specify the AO that is to be used for the loopback test.

The manager may request that multiple loopback tests be performed on the same MORT, or collection of MORTs, by specifying multiple AOs. When this is done the tests are applied, in an unspecified order, from the managed object having TARR functionality to each AO.

7.4.2.2 Test timing terminology

A number of timing parameters is used to control the operation of the loopback test in addition to the time-out period optionally used by all test categories defined in this Recommendation | International Standard. This subclause defines various timing terms, illustrated in Figures 11 and 12, and provides examples of how a test conductor may specify a legitimate and useful loopback test.

Figure 11 shows a test comprising three separate test patterns, with a test result notification being generated after completion of each pattern. Figure 12 shows one long test pattern, with test results being generated at intermediate points during the pattern. Many more configurations can be generated using combinations of these concepts.