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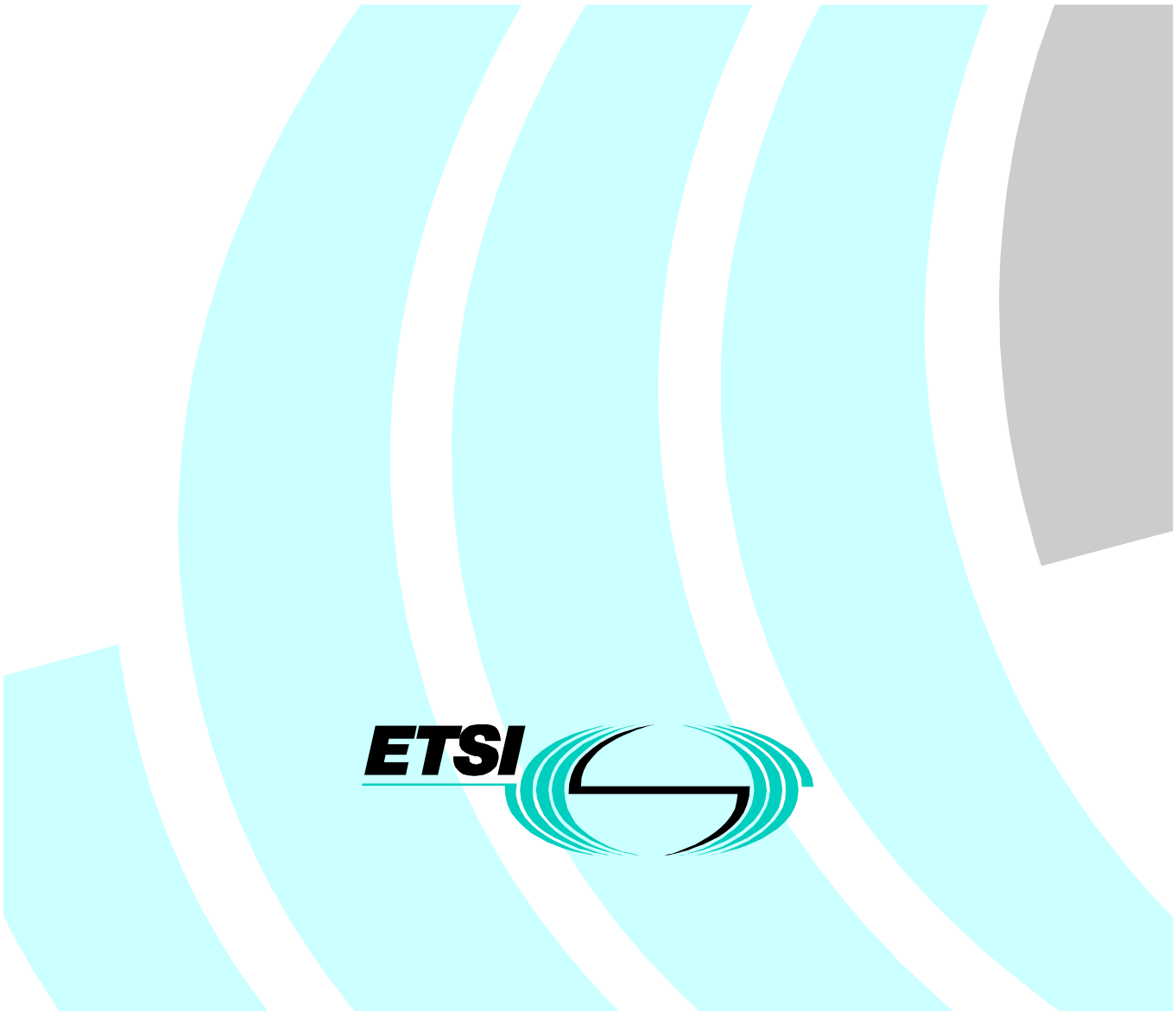
European Standard (Telecommunications series)

Telecommunications Management Network (TMN); Q3 interface at the Access Network (AN) for fault and performance management of V5 interfaces and associated user ports; Part 1: Q3 interface specification



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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Telecommunications Management Network (TMN).

The present document is part 1 of a multi-part EN covering the Access Network (AN), as identified below:

Part 1: "Q3 interface specification";

Part 2: "Managed Objects Conformance Statement (MOCS) proforma" (for further study).

National transposition dates	
Date of adoption of this EN:	15 October 1999
Date of latest announcement of this EN (doa):	31 January 2000
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 July 2000
Date of withdrawal of any conflicting National Standard (dow):	31 July 2000

Introduction

V5 interfaces, as described in EN 300 324-1 [4] and EN 300 347-1 [5], operate between a Local Exchange (LE) and an Access Network (AN) to support various narrowband Integrated Services Digital Network (ISDN) and Public Switched Telephone Network (PSTN) services. These interfaces and their associated user ports need to be managed by the Operations Systems (OSs) within the Telecommunications Management Network (TMN). This management is performed by means of Q3 interfaces.

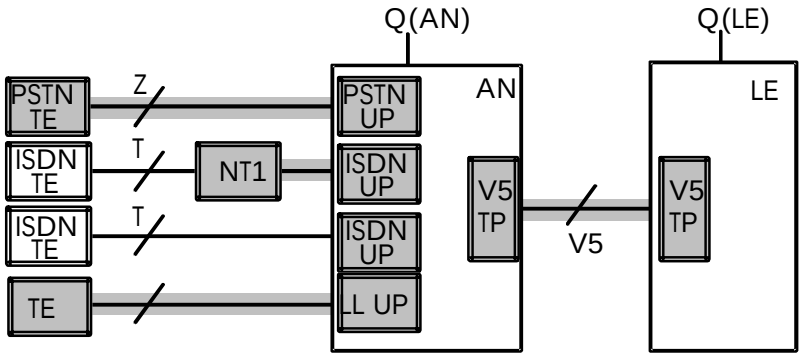
The companion standard on configuration management EN 300 376-1 [6] defines how the Q3 interface of an AN handles the configuration information for V5 interfaces and their associated user ports. The present document specifies the extension to include fault and performance management.

Fault management of V5 interfaces and associated user ports is part of a management activity which is performed by the operator in order to detect failure conditions and to bring the customer access back to its normal state of operation whenever a deviation occurs.

Performance management of V5 interfaces and associated user ports is part of a management activity which is employed in order to maintain the quality of service levels agreed with the customers. The activities undertaken in performance management are monitoring, analysis and problem alerting, diagnosis, optimization and control.

A customer access is considered as being that part of the local network which extends from the network termination equipment up to and including the exchange termination.

Here, only these parts of the activities are covered which are related directly to a V5 interface between a LE and an AN or to that part of the customer access which extends from the AN to the network termination equipment. An ISDN access extends to but does not include the T reference point. An analogue access extends to and may include the Customer Premise Equipment (CPE) (see figure 1).



NOTE: Shaded areas are subject to V5 fault and performance management. User ports represent the different configurations for Line Circuit (LC), Line Termination (LT), Exchange Termination (ET) and Network Termination (NT) as indicated in EN 300 324-1 [4] and EN 300 347-1 [5]. For leased lines (semi-permanent lines), the present document only covers aspects which are common to PSTN and ISDN.

Figure 1: Scope of V5 fault and performance management

The present document details only those functions and management information model components for which V5 specific descriptions are required. However, the use of other components which may be applicable from other specifications is not precluded. In this case, combined applications incorporating both V5 specific and more generic aspects would result. For example, if log control is to be provided in conjunction with the V5 specific alarm reporting function (see annex A), then other specifications (e.g. ITU-T Recommendation X.735 [35]) are available to define this.

The management information model described in the present document complements that for configuration; both information models will normally share the same physical interface.

1 Scope

The present document specifies the Q3 interface between an Access Network (AN) and the Telecommunications Management Network (TMN) for the support of fault and performance management functions for V5 interfaces, as described in EN 300 324-1 [4] and EN 300 347-1 [5], and their associated user ports. The management of transmission, media and services which are not related to V5 interfaces is outside the scope of the present document.

The present document includes the testing of the lines and line circuits at the user ports associated with the V5 interface, and the logging of faults and related functions. Messages on the V5 interface associated with errors or other faults which are handled by local management (e.g. the non-deferred link blocking request) or which involve implementation specific issues (e.g. faults which may result in the connection incomplete information element being used in the Bearer Channel Connection (BCC) protocol) are outside the scope of the present document.

The location of the Q3 interface to which the present document refers is specified in EN 300 376-1 [6].

The present document does not constrain the logical or physical size of the AN or its geographical dispersion.

Existing protocols are used where possible, and the focus of the present document is on defining the object models. The definition of Operations System (OS) functionality is outside the scope of the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETS 300 233 (1994): "Integrated Services Digital Network (ISDN); Access digital section for ISDN primary rate".

[2] Void.

[3] ETS 300 297 (1995): "Integrated Services Digital Network (ISDN); Access digital section for ISDN basic access".

[4] EN 300 324-1 (1999): "V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN); Part 1: V5.1 interface specification".

[5] EN 300 347-1 (1999): "V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN); Part 1: V5.2 interface specification".

[6] EN 300 376-1 (1999): "Telecommunications Management Network (TMN); Q3 interface at the Access Network (AN) for configuration management of V5 interfaces and associated user ports; Part 1: Q3 interface specification".

[7] EN 300 377-1 (1999): "Telecommunications Management Network (TMN); Q3 interface at the Local Exchange (LE) for configuration management of V5 interfaces and associated customer profiles; Part 1: Q3 interface specification".

[8] EN 300 379-1 (1999): "Telecommunications Management Network (TMN); Q3 interface at the Local Exchange (LE) for fault and performance management of V5 interfaces and associated customer profiles; Part 1: Q3 interface specification".

[9] ETR 080 (1997): "Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines".

[10] CEPT Recommendation T/S 54-08 E (1987): "ISDN subscriber access and installation maintenance".

[11] ITU-T Recommendation G.821 (1996): "Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network".

[12] ITU-T Recommendation G.826 (1996): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[13] ITU-T Recommendation M.3010 (1996): "Principles for a Telecommunications management network".

[14] ITU-T Recommendation M.3100 (1995): "Generic network information model".

[15] ITU-T Recommendation Q.543 (1993): "Digital exchange performance design objectives".

[16] ITU-T Recommendation Q.821 (1993): "Stage 2 and stage 3 description for the Q3 interface; Alarm surveillance".

[17] ITU-T Recommendation Q.822 (1994): "Stage 1, stage 2 and stage 3 description for the Q3 interface; Performance management".

[18] CCITT Recommendation X.208 (1988): "Specification of Abstract Syntax Notation One (ASN.1)".

[19] Void.

[20] Void.

[21] ITU-T Recommendation X.721 (1992) | ISO/IEC 10165-2 (1992): "Information technology; Open systems interconnection; Structure of management information: Definition of management information".

[22] ITU-T Recommendation X.730 (1992) | ISO/IEC 10164-1 (1993): "Information technology; Open systems interconnection; Systems management: Object management function".

[23] ITU-T Recommendation X.731 (1992) | ISO/IEC 10164-2 (1993): "Information technology; Open systems interconnection; Systems management: State management function".

[24] ITU-T Recommendation X.732 (1992) | ISO/IEC 10164-3 (1993): "Information technology; Open systems interconnection; Systems management: Attributes for representing relationships".

[25] ITU-T Recommendation X.737 (1995) | ISO/IEC 10164-14: "Information technology; Open systems interconnection; Systems management: Confidence and diagnostic test categories".

[26] ITU-T Recommendation X.738 (1993) | ISO/IEC 10164-13: "Information technology; Open systems interconnection; Systems management: Summarization function".

[27] ITU-T Recommendation X.739 (1993) | ISO/IEC 10164-11 (1994): "Information technology; Open systems interconnection; Systems management: Metric objects and attributes".

[28] ITU-T Recommendation X.745 (1993) | ISO/IEC 10164-12 (1994): "Information technology; Open systems interconnection; Systems management: Test management function".

[29] ITU-T Recommendation X.746 (1995) | ISO/IEC 10164-15: "Information technology; Open systems interconnection; Systems management: Scheduling function".

[30] ITU-T Recommendation M.3603 (1992): "Application of maintenance principles to ISDN basic rate access".

[31] ITU-T Recommendation M.3604 (1992): "Application of maintenance principles to ISDN primary rate access".

[32] ITU-T Recommendation Q.831 (1997): "Fault and performance management of V5 interface environments and associated customer profiles".

[33] ITU-T Recommendation Q.835 (1999): "Line and line circuit test management of ISDN and analogue customer accesses".

[34] ITU-T Recommendation Q.824.5 (1997): "Stage 2 and stage 3 description for the Q3 interface; Customer administration: Configuration management of V5 interface environments and associated customer profiles".

[35] ITU-T Recommendation X.735 (1992) | ISO/IEC 10164-6 (1993): "Information technology; Open systems interconnection; Systems management: Log control functions".

3 Definitions and abbreviations

3.1 Definitions

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

Access Network (AN): see EN 300 324-1 [4].

activation-deactivation of the line: see subclause C.3.5.

bearer channel: see EN 300 324-1 [4].

Bearer Channel Connection (BCC): see EN 300 347-1 [5].

cable pair identification tone: see subclause C.3.5.

capacitance measurement: see subclause C.3.5.

codec testing: see subclause C.3.5.

Communication Channel (C-Channel): see EN 300 324-1 [4].

communication path: see EN 300 324-1 [4].

control protocol: see EN 300 324-1 [4].

dial pulse test: see subclause C.3.5.

dial tone test: see subclause C.3.5.

digit reception: see subclause C.3.5.

dry loop: see subclause C.3.5.

Digital Tone Multi-Frequency (DTMF) dialling test: see subclause C.3.5.

envelope function address: see EN 300 324-1 [4].

feeding current: see subclause C.3.5.

feeding voltage: see subclause C.3.5.

foreign voltage: see subclause C.3.5.

insulation resistance measurement: see subclause C.3.5.

layer 3 address: see EN 300 324-1 [4].

leased lines: see EN 300 324-1 [4].

line testing: see subclause C.3.5.

line circuit testing: see subclause C.3.5.

Local Exchange (LE): see EN 300 324-1 [4].

loop detection and ring trip detection: see subclause C.3.5.

loop resistance measurement: see subclause C.3.5.

loop back 1 (line termination loop back): see subclause C.3.5.

loop back 2, 2_1 and 1A (NT1 loop backs): see subclause C.3.5.

monitoring of the line: see subclause C.3.5.

monitoring of the line with mark tone: see subclause C.3.5.

Operations System (OS): see ITU-T Recommendation M.3010 [13].

power feed: see subclause C.3.5.

private meter pulses: see subclause C.3.5.

protection protocol: see EN 300 347-1 [5].

register recall button test: see subclause C.3.5.

subscriber private metering: see subclause C.3.5.

V5 interface: see EN 300 324-1 [4].

V5 interface messages: term refers to all Function Elements (FEs) and other V5 protocol messages as defined in EN 300 324-1 [4] and EN 300 347-1 [5] which are communicated via the V5 interface.

V5 time slot: see EN 300 324-1 [4].

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AIS	Alarm Indication Signal
AN	Access Network
ASN.1	Abstract Syntax Notation One (see CCITT Recommendation X.208 [18])
BA	Basic Access
BCC	Bearer Channel Connection
C-channel	Communication channel
CMIP	Common Management Information Protocol
CPE	Customer Premise Equipment
DTMF	Digital Tone Multi-Frequency
DS	access Digital Section
ET	Exchange Termination
FE	Function Element
FSM	Finite State Machine
ID	Identity, identifier
ISDN	Integrated Services Digital Network
LC	Line Circuit
LE	Local Exchange
LFA	Loss of Frame Alignment
LOS	Loss Of Signal
LT	Line Termination
MORT	Managed Object Referring to Test

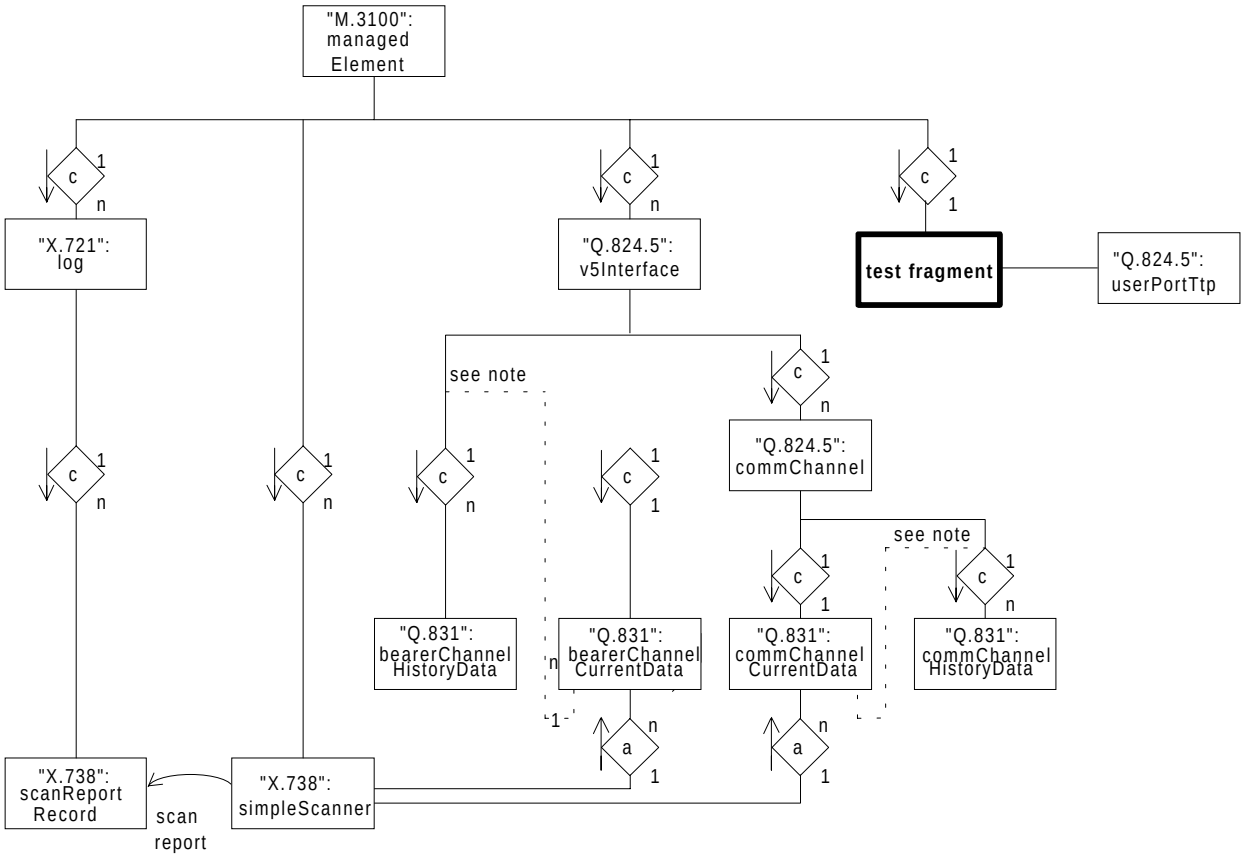
NE	Network Element
NT	Network Termination
OS	Operations System
OS_{AN}	OS of the Access Network
OS_{LE}	OS of the Local Exchange
PL	Permanent Line
PRA	Primary Rate Access
PSTN	Public Switched Telephone Network
$Q3_{AN}$	Q3 interface at the Access Network
$Q3_{LE}$	Q3 interface at the Local Exchange
RDN	Relative Distinguished Name
REG	Regenerator
SPM	Subscriber Private Meter
TIB	Task Information Base
TMN	Telecommunications Management Network

4 Information model diagrams

The entity relationship diagram is given in subclause 4.1 and the inheritance hierarchy (is-a relationships) and naming hierarchy (containment relationships) are given in subclauses 4.2 and 4.3, respectively.

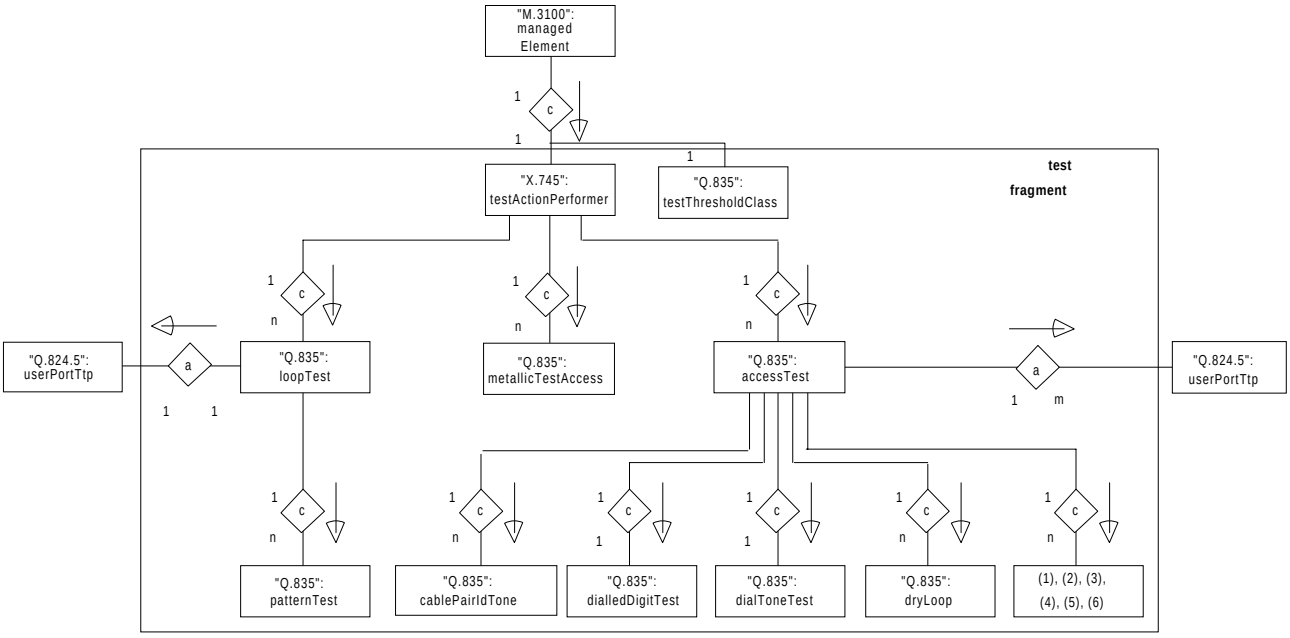
4.1 Entity relationship diagram

Figures 2 and 3 show the various entities related to traffic measurement and line testing at the AN. They extend the information model described in EN 300 376-1 [6], which covers the configuration aspects.



NOTE: History data objects may also be contained in the related current data objects.

Figure 2: Entity relationship diagram - V5 traffic measurement and test fragment



NOTE: (1) = "Q.835": electrical measurement test
(2) = "Q.835": isdn quick test
(3) = "Q.835": ringing
(4) = "Q.835": spm pulses
(5) = "Q.835": test to line circuit
(6) = "Q.835": voice access test

Figure 3: Entity relationship diagram - test fragment

4.1.1 Traffic measurement

Traffic measurements in the AN are concerned with bearer channel allocation and communication channel traffic characteristics. Subclasses of ITU-T Recommendation Q.822 [17] current data object classes are used to store traffic measurement data obtained from the object instance they are contained in. The current data is updated every 15 minutes.

The object class bearer channel current data has attributes for bearer channel oriented performance measurements of a V5.2 interface. These measurements are obtained from the V5 interface object instance representing a V5.2 interface which contains the bearer channel current data instance. For a V5.1 interface, no bearer channel related traffic measurements are foreseen. The object class comm channel current data is contained in an instance of comm channel. It has attributes for communication channel oriented performance measurements related to a V5 communication channel. Both object classes are described in detail in EN 300 379-1 [8].

An instance of the ITU-T Recommendation X.738 [26] simple scanner object class may be used to collect the traffic measurement results stored in comm channel current data and bearer channel current data object instances in a certain time interval. It generates a scan report notification being sent to the managing system. In addition results may be logged in a scan report record object instance which will itself be contained in a log object.

4.1.2 Line testing and line circuit testing

Test requests from the OS are sent as Common Management Information Protocol (CMIP) test request controlled or test request uncontrolled action to an instance of test action performer. In this model, all controlled tests are delegated by instances of test action performer to instances of subclasses of test object, i.e. when receiving a test request the test action performer automatically creates the required instances of these classes. Further instances of subclasses of test object are created if further delegation of the performance of the test is required. This creation is achieved by sending additional test request controlled actions, the test session Id parameter is used to identify in which access test instance the new tests should be contained. All instances of these subclasses of test object exist only for the duration of their delegated operations. Details of the mechanism how to transmit test requests to test action performer and how test results are generated are described in ITU-T Recommendation X.745 [28].

Controlled testing is initially delegated to an instance of access test or to an instance of loop test. Each instance of loop test or access test is contained in an instance of test action performer.

The object class loop test is used to set up loop backs for the user port to which it is associated by an attribute. If patterns are to be injected and compared within the AN as part of the loop back test, then this is delegated to an instance of pattern test which is contained in the delegating instance of loop test.

The object class access test has all non-loop back tests allocated to it. It has an attribute which specifies one or a list of user ports which are to be tested.

The creation of an instance of access test represents a test session and permits test access to lines or line circuits during which a number of different tests can be performed. These delegated tests are handled by specific contained test objects. Each contained test object triggers the specific test on one or more user ports which are specified in access test.

Electrical measurements, such as voltage, capacitance and resistance, are delegated to instances of electrical measurement test (see figure 3). Dialled digit tests, dial tone tests and other tests (in particular those involving sending to the line meter pulses, cable pair identification tone and ringing) are triggered by the creation of instances of dialled digit test, dial tone test, spm pulses, cable pair Id tone and ringing, respectively. The dry loop condition is set up by instances of dry loop test. The inward line circuit tests are delegated to instances of test to line circuit. The voice access test allows for the provision of those test which involve the establishment of a voice connection with the line under test. The metallic test access allows for the provision of those tests which involve the establishment of a physical connection with a measurement interface of an external test system. A quick ISDN test that can be a layer 1 activation, a loop back test, a power feeding test or a function test is set up by instances of isdn quick test.

Instances of test threshold class allow to provision thresholds for line testing.

4.1.3 The test result notifications of the tests

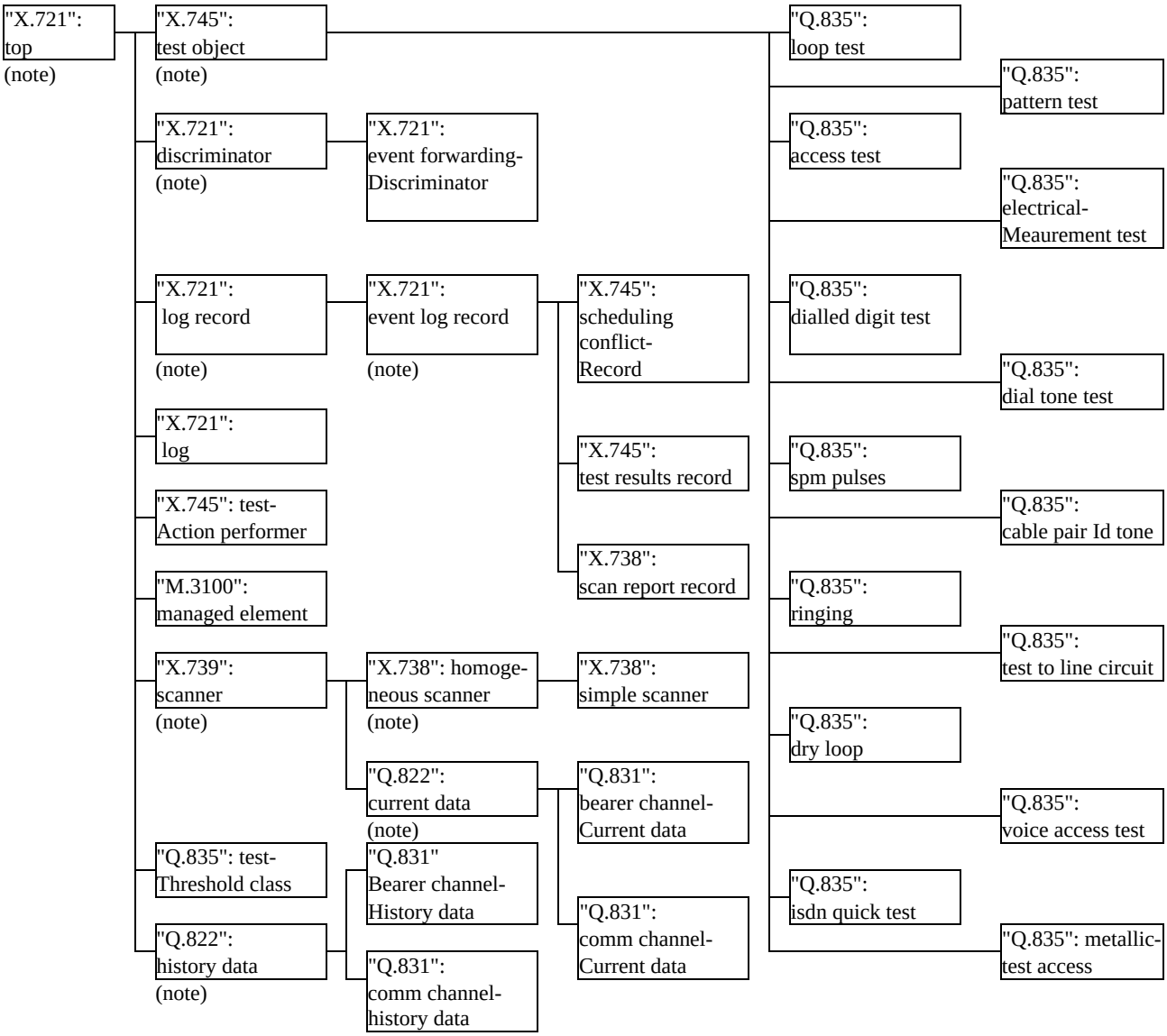
The sending time, the information contents and the number of test result notifications sent per test request are not restricted. It is a matter up to the AN implementation. If the test result notification contains results whose testing time has importance, they shall be ordered in the ASN.1 sequence oldest first.

4.1.4 Performance monitoring of ISDN user ports

Performance monitoring of layer 1 for ISDN user ports can be carried out in accordance with ITU-T Recommendation Q.822 [17].

4.2 Inheritance hierarchy

Figure 4 traces the inheritance from the highest level object "ITU-T Recommendation X.721 [21]": top to the managed objects defined in the present document.

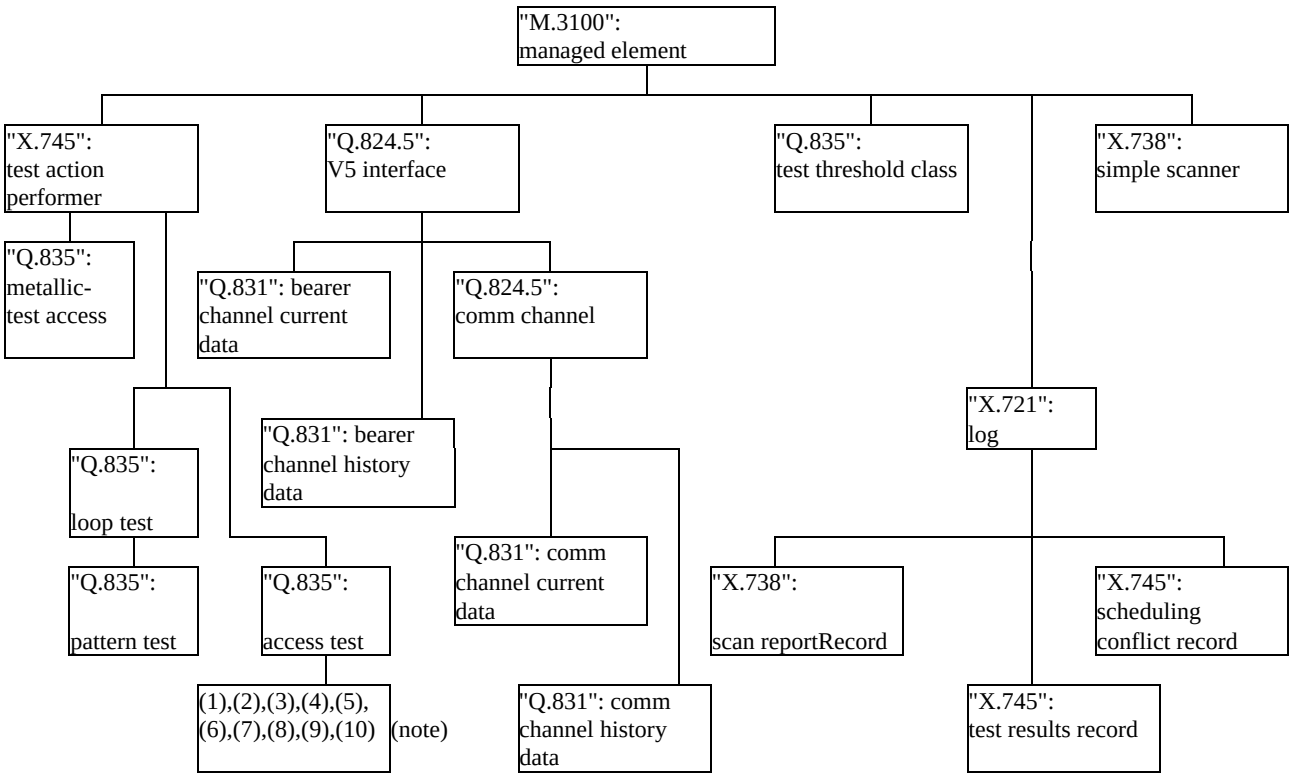


NOTE: Non-instantiable object class.

Figure 4: Inheritance hierarchy

4.3 Naming hierarchy

Figure 5 shows the naming (i.e. containment) relationships for the AN's managed objects associated with fault and performance management.



NOTE: (1) = "Q.835": cable pair Id tone.
(2) = "Q.835": dialled digit test.
(3) = "Q.835": dial tone test.
(4) = "Q.835": dry loop.
(5) = "Q.835": electrical measurement test.
(6) = "Q.835": isdn quick test.
(7) = "Q.835": ringing.
(8) = "Q.835": spm pulses.
(9) = "Q.835": test to line circuit.
(10) = "Q.835": voice access test.

Figure 5: Naming hierarchy

5 Information model description

This clause provides a high-level informal description of the management information model for fault and performance management of the AN.

Subclause 5.1 contains a brief description for each object class or package used in the model as far as it is not described in the reference documents. The description covers:

- the purpose of the object class or package;
- the attributes defined for the object class or package;
- the contents of the event reports defined in the present document;
- the relationship of the object class to other object classes;
- the applicability of these packages.

Attributes which are common to several object classes are described in subclause 5.2. Subclause 5.3 describes actions which are common to several object classes in the information model. Subclause 5.4 describes the common aspects of the notifications used in the information model.

5.1 Managed object classes description

Subclause 5.1 is divided into further subclauses which describe the fragments of the information model.

5.1.1 V5 interface fragment

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.2 User port fragment

For performance monitoring of ISDN basic access, the requirements specified in the following documents apply:

- ETR 080 [9];
- ETS 300 297 [3];
- ITU-T Recommendation G.821 [11];
- ITU-T Recommendation G.826 [12].

For performance monitoring of ISDN primary rate access, the requirements specified in the following documents apply:

- ETS 300 233 [1];
- ITU-T Recommendation G.821 [11];
- ITU-T Recommendation G.826 [12].

Object classes as defined in ITU-T Recommendation Q.822 [17] shall be used for the Q3 interface for ISDN performance monitoring.

In this fragment the following object classes are used. They are defined in ITU-T Recommendation Q.824.5 [34]:

- PSTN user port (pstnUserPort);
- ISDN basic access user port (isdnBAUserPort);
- ISDN primary rate access user port (isdnPRAUserPort);
- Leased port (leasedPort).

5.1.2.1 PSTN user port (pstnUserPort)

A PSTN user port is an object class representing a customer access port which is located in an AN and connected to the LE via a V5 interface.

For V5 fault management, the "ITU-T Recommendation M.3100 [14]": tmn communications alarm information package shall be instantiated with instances of this object class.

The following events shall be reported by instances of this object class using the communications alarm notification (for the specification of the alarm reports and for cross reference to the relevant V5 protocol specifications, see annex A):

a) port control protocol time out errors;

b) port control protocol errors while "Out of Service";

c) port control protocol layer 3 address error;

d) PSTN Protocol time out errors;

e) PSTN protocol layer 3 address error;

f) port control protocol syntax errors (optional);

g) PSTN protocol syntax errors (optional);

h) power feeding problems.

5.1.2.2 ISDN basic access user port (isdnBAUserPort)

An ISDN Basic Access (BA) user port is an object class representing an ISDN basic customer access port which is located in an AN and connected to the LE via a V5 interface.

For V5 fault management the "ITU-T Recommendation M.3100 [14]": tmn communications alarm information package shall be instantiated with instances of this object class.

The following events shall be reported by instances of this object using the communications alarm notification (for the specification of the alarm reports and for cross reference to the relevant V5 protocol specifications, see annex A):

a) ISDN layer 1 activation faults (see note 1);

b) ISDN layer 2 faults (see note 1);

c) LOS/LFA in access Digital Section (DS) or loss of power at NT1, FE: 7 (see note 1);

d) LOS/LFA at T reference point, FE: 12 (see note 1);

e) port control protocol time out errors;

f) port control protocol errors while "Out of Service";

g) port control protocol layer 3 address error;

h) port control protocol syntax errors (optional).

NOTE 1: These events are to be reported only if the port provides Permanent Line (PL) service with permanent layer 1 or layer 2 activation and if the AN is responsible for the activation.

NOTE 2: The defect conditions are more detailed described in ETS 300 297 [3].

For V5 performance management the "ITU-T Recommendation Q.824.5 [34]": grading alarm package shall be instantiated with instances of this object class whenever a degraded quality of service of the access digital section has to be reported to the OS.

5.1.2.3 ISDN primary rate access user port (isdnPRAUserPort)

An ISDN Primary Rate Access (PRA) user port is an object class representing an ISDN primary rate customer access port which is located in an AN and connected to the LE via a V5 interface.

For V5 fault management the "ITU-T Recommendation M.3100 [14]": tmn communications alarm information package shall be instantiated with instances of this object class.

The following events shall be reported by instances of the object class virtual primary rate access using the communications alarm notification (for the specification of the alarm reports and for cross reference to the relevant V5 protocol specifications, see annex A):

a) unintentional loop back;

b) LOS/LFA and power failure. FE: D-L;

c) performance monitoring. FE: U-Y;

d) ISDN layer 2 faults (see note 1);

e) port control protocol time out errors;

f) port control protocol errors while "Out of Service";

g) port control protocol layer 3 address error;

h) port control protocol syntax errors (optional).

NOTE 1: These events are to be reported only if the port provides Permanent Line (PL) service with permanent layer 2 activation and if the AN is responsible for the activation.

NOTE 2: The defect conditions are described in detail in ETS 300 233 [1].

5.1.2.4 Leased port (leasedPort)

A leased port is an object class representing an access port serving a semi-permanent leased line which is located in the AN and connected to the LE via a V5 interface. For V5 fault management the "ITU-T Recommendation M.3100 [14]": tmn communications alarm information package should be instantiated with instances of this object class.

NOTE: In the absence of clear standards for event reporting on leased lines, it is not appropriate to state mandatory requirements.

Events as applicable should be reported by instances of this object class using the communications alarm notification (see also annex A).

5.1.3 Communication path fragment

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.4 Protection fragment

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.5 Performance fragment

5.1.5.1 Bearer channel current data

The bearer channel current data object class is a class of managed objects representing a set of V5.2 bearer channel oriented traffic measurements. It is a subclass of "ITU-T Recommendation Q.822 [17]": current data.

An instance of this object class is contained in an instance of the "ITU-T Recommendation Q.824.5 [34]": V5 interface object class representing the V5.2 interface for which the measurements are to be activated. The measurements can then be performed on the basis of 15 minute intervals.

This managed object class is defined in ITU-T Recommendation Q.831 [32].

The following measurements are represented by attributes of this object class:

a) number of bearer channel allocations;

b) total sum of bearer channel holding times;

c) total sum of bearer channel in-service times.

In addition to the inherited attributes, it has the attributes given in table 1.

Table 1

Name	M/C/O	Value set
"X.739": scanner Id	M	RDN
"Q.831": bearer channel allocations	M	single
"Q.831": bearer channel holding times	M	single
"Q.831": bearer channel in service times	M	single
"Q.831": number of comm channels	M	single
"Q.831": number of V5 links	M	single
bearer channel allocations bothway: number of bearer channel allocations to originated and terminated calls. bearer channel holding times bothway: total sum of bearer channel allocation duration for originated and terminated calls. bearer channel in service times: total sum of in-service times of the V5 time slots. number of comm channels: number of V5 C-channels provisioned for the V5 interface. number of V5 links: number of V5 links which comprise the V5 interface.		

5.1.5.2 Bearer channel history data

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.5.3 Communication channel current data

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.5.4 Communication channel history data

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.6 Alarm surveillance fragment

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.7 Support fragment

Refer to EN 300 379-1 [8] for the contents of this subclause.

5.1.8 Test fragment

The following classes are used for testing.

5.1.8.1 Access test (accessTest)

Instances of the class access test represent configurations and conditions for testing the line and line circuit. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 2.

Table 2

Name		M/O	Value set
"X.745": test object Id		RDN	single
"X.737": test conditions		M	single
"Q.835": wait time		M	single
"X.745": MORTs		M	set
test conditions:	indicates the action to be taken if the port is busy and if a call is attempted during testing.		
wait time:	indicates the wait time if the test conditions attribute indicates a wait if busy.		

5.1.8.2 Cable pair identification Tone (cablePairIdTone)

Instances of the class cable pair Id tone represent identification tone which can be applied to a line. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 3.

Table 3

Name	M/O	Value set
"X.745": test object Id	RDN	single

5.1.8.3 Dialled digit test (dialledDigitTest)

Instances of the class dialled digit test represent a dialled digit tests. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 4.

Table 4

Name		M/O	Value set
"X.745": test object Id		RDN	single
"Q.835": number of digits		M	single
"Q.835": requested result type		M	single
number of digits:	indicates the number of digits for the test.		
requested result type:	indicates whether a test result should be a pass or a fail.		

5.1.8.4 Dial tone test (dialToneTest)

Instances of the class dial tone test represent a dial tone tests. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 5.

Table 5

Name		M/O	Value set
"X.745": test object Id		RDN	single
"Q.835": off hook simulation		M	single
"Q.835": requested result type		M	single
"Q.835": iterations		M	single
off hook simulation:	indicates how off-hook is to be simulated i.e. loop calling or earth calling.		
requested result type:	indicates whether a test result should be a pass or a fail.		
iterations:	indicates the number of iterations for a test.		

5.1.8.5 Dry Loop (dryLoop)

This object class is instantiated when it is required to disconnect the line from the line circuit. This condition is called "dry loop". After a dry loop is established, tests may be performed on the line outside the influence of the $Q3_{AN}$ or $Q3_{LE}$ interfaces, until normal conditions are re-established.

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 6.

Table 6

Name	M/O	Value set
"X.745": test object Id	RDN	single

5.1.8.6 Electrical measurement test (electricalMeasurementTest)

Instances of the class electrical measurement test represent electrical measurements. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 7.

Table 7

Name		M/O	Value set
"X.745": test object Id		RDN	single
"Q.835": electrical measurement test to be performed		M	single
"Q.835": requested result type		M	single
electrical measurement test to be performed:	indicates the types of electrical measurements.		
requested result type:	indicates whether a test result should be a pass or a fail or a measured value.		

5.1.8.7 ISDN quick test (isdnQuickTest)

Instances of the class isdn quick test represent ISDN quick tests. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 8.

Table 8

Name	M/O	Value set
"X.745": test object Id	RDN	single
"Q.835": isdn quick test to be performed	M	single
"Q.835": requested result type	M	single
isdn quick test to be performed: indicates which quick tests are to be performed. requested result type: used to control the test result notification.		

5.1.8.8 Loop test (loopTest)

Instances of the class loop test represent loop backs which are used for testing. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 9.

Table 9

Name	M/O	Value set
"X.745": test object Id	RDN	single
"X.737": test conditions	M	single
"Q.835": wait time	M	single
"X.745": MORTs	M	set
"Q.835": loop back duration	M	single
"Q.835": loop back position	M	single
"Q.835": loop back channel	M	single
test conditions: indicates the action to be taken if the port is busy and if a call is attempted during testing. wait time: indicates the wait time if the test conditions attribute indicates a wait if busy. loop back duration: indicates the duration of the loop back. loop back position: indicates the location of the loop back. loop back channel: indicates the type of loop back.		

5.1.8.9 Metallic test access (metallicTestAccess)

Instances of the class metallic test access represent tests which establish a physical connection between an instance of MORT and a measurement interface of an external test system. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 10.

Table 10

Name	M/O	Value set
"X.745": test object Id	RDN	single
"X.745": MORTs	M	set
"Q.835": mta time out period	M	single
"Q.835": mta Msg	M	single
"Q.835": proposed MTA	M	single
"X.737": test conditions	O	single
"Q.835": wait time	O	single
"Q.835": type of line	C	single

mta time out period:	indicates the time of a metallic test access connection.
mta Msg:	indicates the return value of a metallic test access connection.
proposed MTA:	indicates the measurement interface where the MORT is connected to.
test conditions:	indicates the action to be taken if the port is busy and if a call is attempted during testing.
wait time:	indicates the wait time if the test conditions attribute indicates a wait if busy.
type of line:	indicates the switched direction of the measurement interface in case of a two wire interface.

5.1.8.10 Pattern test (patternTest)

Instances of the class pattern test represent the generation and comparison of patterns used for testing. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 11.

Table 11

Name	M/O	Value set
"X.745": test object Id	RDN	single
"X.737": test pattern	M	single
"X.737": error ratio report type	M	single
"Q.835": requested result type	M	single

requested result type:	used to control the test result notification.

5.1.8.11 Ringing (ringing)

Instances of the class ringing represent ringing current which can be applied to a line. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 12.

Table 12

Name	M/O	Value set
"X.745": test object Id	RDN	single
"Q.835": ring	M	single
ring: indicates for how long ringing is to be applied.		

5.1.8.12 Subscriber Private Meter (SPM) pulses (spmPulses)

Instances of the class spm pulses represent subscriber private meter pulses which can be applied to a line. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 13.

Table 13

Name	M/O	Value set
"X.745": test object Id	RDN	single
"Q.835": spm pulses no	M	single
spm pulses no: indicates the number of SPM pulses which shall be applied.		

5.1.8.13 Test to line circuit (testToLineCircuit)

Instances of the class test to line circuit represent tests which can be applied to a line circuit. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 14.

Table 14

Name	M/O	Value set
"X.745": test object Id	RDN	single

5.1.8.14 Test threshold class (testThresholdClass)

Instances of the class test threshold class represent provisionable threshold values for tests.

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 15.

Table 15

Name	M/O	Value set
"Q.835": test threshold class Id	RDN	single
"Q.835": capacitance threshold	M	single
"Q.835": resistance threshold	M	single
"Q.835": ac voltage threshold	M	single
"Q.835": dc voltage threshold	M	single
"Q.835": dial speed threshold	M	single
"Q.835": pulse no pulse ratio	M	single

capacitance threshold:	indicates the thresholds for capacitance testing.
resistance threshold:	indicates the thresholds for resistance testing.
ac voltage threshold:	indicates the thresholds for AC voltage testing.
dc voltage threshold:	indicates the thresholds for DC voltage testing.
dial speed threshold:	indicates the thresholds for testing the dial speed.
pulse no pulse ratio:	indicates the thresholds for testing the pulse no pulse ratio.

5.1.8.15 Voice Access Test (voiceAccessTest)

Instances of the class voice access test represent these tests which involve the monitoring of the line. The class is a specialization of the test object class defined in ITU-T Recommendation X.745 [28].

This managed object class is defined in ITU-T Recommendation Q.835 [33].

In addition to the inherited attributes, it has the attributes given in table 16.

Table 16

Name	M/O	Value set
"X.745": test object Id	RDN	single
"Q.835": monitor speak	M	single
"Q.835": ring back no	M	single

monitor speak:	indicates whether the line is to be monitored or if speech can be injected and whether or not a mark tone is used while monitoring.
ring back no:	indicates the number for ring-back.

5.2 Attributes description

Refer to EN 300 377-1 [7] for the contents of this subclause.

5.3 Actions description

In addition to the inherited actions, the actions performed on the various object classes are indicated in table 17.

Table 17

Actions	Defined in object class
"Q.835": loop back select	"Q.835": loop test

loop back select:	is used to alter the conditions of a loop back.

5.4 Notifications description

The following generic notifications are used:

- object creation according to ITU-T Recommendations X.721 [21] and X.730 [22];
- object deletion according to ITU-T Recommendations X.721 [21] and X.730 [22];
- attribute value change according to ITU-T Recommendations X.721 [21] and X.730 [22];
- state change according to ITU-T Recommendations X.721 [21] and X.731 [23];
- relationship change according to ITU-T Recommendations X.721 [21] and X.732 [24];
- test result according to ITU-T Recommendation X.745 [28].

The additional information field of the test result notification is used to carry the detailed measurement results for the test where it is applied.

No specific notifications are used.

6 Formal managed object classes definitions

This clause specifies the object classes for all of the managed objects used in the management information model. These object classes are defined by reference to other specifications.

6.1 V5 interface fragment

In this subclause, the definitions of the classes of the V5 interface fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    V5 interface,
    V5 Ttp,
    V5 time slot
FROM "ITU-T Recommendation Q.824.5 [34]";
END
```

6.2 Access port fragment

In this subclause, the definitions of the classes of the access port fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    pstn user port,
    isdn BA user port,
    isdn PRA user port,
    leased port
FROM "ITU-T Recommendation Q.824.5 [34]";
END
```

6.3 Communication path fragment

In this subclause, the definitions of the classes of the communication path fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    comm channel
FROM "ITU-T Recommendation Q.824.5 [34]";
END
```

6.4 Protection fragment

In this subclause, the definitions of the classes of the protection fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    V5 protection group,
    V5 protection unit
FROM "ITU-T Recommendation Q.824.5 [34]";
END
```

6.5 Performance fragment

In this subclause, the definitions of the classes of the performance fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    simple scanner,
    scan report record
FROM "ITU-T Recommendation X.738 [26]"
    bearer channel current data,
    bearer channel history data,
    comm channel current data,
    comm channel history data
FROM "ITU-T Recommendation Q.831 [32]";
END
```

6.6 Alarm surveillance fragment

In this subclause, the definitions of the classes of the alarm surveillance fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    current alarm summary control,
    management operations schedule
FROM "ITU-T Recommendation Q.821 [16]";
END
```

6.7 Support fragment

In this subclause, the definitions of the classes of the support fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    alarm severity assignment profile
    managed element
FROM "ITU-T Recommendation M.3100 [14]"
    alarm record,
    attribute value change record,
    event forwarding discriminator,
    log
FROM "ITU-T Recommendation X.721 [21]"
    scheduling conflict record,
    test action performer,
    test results record
FROM "ITU-T Recommendation X.745 [28]";
END
```

6.8 Test fragment

In this subclause, the definitions of the new classes specific to the test fragment are specified by importing from other specifications. In this context, the IMPORTS clause specifies the object classes which can be instantiated in the scope of the present document.

```
BEGIN
IMPORTS
    access test,
    cable pair Id tone,
    dialled digit test,
    dial tone test,
    dry loop,
    electrical measurement test,
    isdn quick test,
    loop test,
    metallic test access,
    pattern test,
    ringing,
    spm pulses,
    test to line circuit,
    test threshold class,
    voice access test
FROM "ITU-T Recommendation Q.835 [33]";
END
```

7 Protocol requirements

The protocol stack for use on this Q3 interface is the same as that specified in the companion standard on configuration management, EN 300 376-1 [6].

Annex A (normative): Specification of parameters for V5 specific alarm reports

Alarm reports shall be generated using the communications alarm notification, as defined in ITU-T Recommendation X.721 [21], whenever one of the following events occur. The reports shall use the alarm report parameters as specified below.

The parameters are defined in ITU-T Recommendation Q.821 [16], ITU-T Recommendation X.721 [21] and EN 300 379-1 [8], respectively.

The values for the parameter perceived severity as given below are defaults. They may be modified by means of the alarm event criteria function as specified in ITU-T Recommendation Q.821 [16].

NOTE: All parameters and parameter values given in the following list are mandatory in the context of V5 alarm reporting if not marked as optional.

A.1 Alarm reports related to the V5 interface object class

A.1.1 Control protocol errors

Event:	Control protocol timer expiration error
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	common control protocol time out error
Perceived severity:	critical

Event:	Control protocol syntax errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	common control protocol syntax error
Perceived severity:	major

NOTE 1: Reporting of this event is optional.

Event:	Port control protocol layer 3 address errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	port control protocol layer 3 address error
Perceived severity:	warning
Additional Information:	layer 3 port address or envelope function address

NOTE 2: This event report shall be used to indicate that an unknown layer 3 address has been received.

A.1.2 Link control protocol errors

Event:	Link control protocol layer 3 address errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol layer 3 address error
Perceived severity:	major
Monitored attribute:	assoc V5 interface, link Id
Additional Information:	layer 3 port address

NOTE: This event report shall be used to indicate that an unknown layer 3 address has been received.

A.1.3 BCC protocol errors

Event:	BCC protocol timer expiration errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	bcc protocol time out error
Perceived severity:	critical
Additional Information:	cause value

NOTE 1: If a protocol error message has been received in the LE the cause value contained in this message shall be included in the additional information parameter.

Event:	BCC protocol syntax errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	bcc protocol syntax errors
Perceived severity:	major

NOTE 2: Reporting of this event is optional.

A.1.4 Protection protocol errors

Event:	Protection protocol timer expiration errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	protection protocol time out error
Perceived severity:	critical

NOTE 1: If a protocol error message has been received in the LE the cause value contained in this message shall be included in the additional information parameter.

Event:	Protection protocol syntax errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	protection protocol syntax error
Perceived severity:	major

NOTE 2: Reporting of this event is optional.

A.1.5 PSTN protocol errors

Event:	Restart timer error
Reference:	V5.1: EN 300 324-1 [4]
	V5.2: EN 300 347-1 [5]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol time out error
Perceived severity:	major

Event:	PSTN protocol layer 3 address errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol layer 3 address error
Perceived severity:	warning
Additional Information:	layer 3 port address

NOTE: This event report shall be used to indicate that an unknown layer 3 address has been received.

A.1.6 Interface control failures

Event:	Interface identification failure
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	configuration or customization error (ITU-T Recommendation X.721 [21])
Specific problems:	V5 interface Id failure
Perceived severity:	critical

Event:	V5 Interface provisioning mismatch failure
Reference:	For V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	configuration or customization error (ITU-T Recommendation X.721 [21])
Specific problems:	V5 interface provisioning mismatch failure
Perceived severity:	major

NOTE: This alarm report shall be used to indicate a mismatch of the provisioning variants used in AN and LE during a start-up or restart procedure.

A.1.7 V5 data link failures

Event:	Persistent link control protocol data link failures
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol data link error
Perceived severity:	critical

Event:	Persistent BCC protocol data link failures
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	bcc protocol data link error
Perceived severity:	critical

Event:	Persistent protection protocol data link failures
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	protection protocol data link error
Perceived severity:	critical (when both data links fail) warning (when only one data link fails)

Event:	Persistent common control protocol data link failures
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	common control protocol data link error
Perceived severity:	critical

Event:	Persistent PSTN protocol data link failures
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	V5 interface
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol data link error
Perceived severity:	major

A.2 Alarm reports related to the V5 trail termination point object class

A.2.1 Link control failures

Event:	Link identification failure
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable cause:	configuration or customization error (ITU-T Recommendation X.721 [21])
Specific problems:	link Id failure
Perceived severity:	critical
Monitored attribute:	assoc V5 interface, link Id

Event:	Link control protocol timer expiration errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable cause:	communications subsystem failure (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol time out error
Perceived severity:	critical

Event:	Link control protocol syntax errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol syntax error
Perceived severity:	major

NOTE: Reporting of this event is optional.

Event:	Link control protocol errors while "Out of Service"
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol out of service
Perceived severity:	major
Monitored attribute:	assoc V5 interface, link Id

Event:	Link control protocol layer 3 address errors
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	link control protocol layer 3 address error
Perceived severity:	major
Monitored attribute:	assoc V5 interface, link Id
Additional Information:	layer 3 port address

A.2.2 Link layer 1 failures

Event:	Reception of Alarm Indication Signal (AIS)
Reference:	V5.1: EN 300 324-1 [4] V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable causes:	AIS (ITU-T Recommendation Q.821 [16])
Perceived severity:	minor

Event:	LFA
Reference:	V5.1: EN 300 324-1 [4] V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable causes:	loss of frame (ITU-T Recommendation Q.821 [16], ITU-T Recommendation X.721 [21])
Perceived severity:	minor

Event:	Reception of remote alarm indication
Reference:	V5.1: EN 300 324-1 [4] V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable causes:	remote alarm interface (ITU-T Recommendation M.3100 [14])
Perceived severity:	minor

Event:	Persistent CRC error
Reference:	V5.1: EN 300 324-1 [4]
	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable causes:	transmission error (ITU-T Recommendation M.3100 [14])
Specific problems:	crc error
Perceived severity:	minor

NOTE: The exact specification of the meaning of persistent is outside the scope of the present document.

Event:	Internal failure
Reference:	V5.1: EN 300 324-1 [4]
	V5.2: EN 300 347-1 [5]
Managed object class:	V5 Ttp
Event type:	communications alarm
Probable causes:	local node transmission error (ITU-T Recommendation X.721 [21])
Specific problems:	internal failure
Perceived severity:	minor

A.3 Alarm reports related to the V5 time slot object class

A.3.1 V5 communication channel failures

Event:	Cessation of flags on a C-channel
Reference:	V5.2: EN 300 347-1 [5]
Managed object class:	V5 time slot
Event type:	communications alarm
Probable cause:	local node transmission error (ITU-T Recommendation X.721 [21])
Specific problems:	cessation of flags error
Perceived severity:	minor

A.4 Alarm reports related to the user port object class and subclasses

A.4.1 Control protocol errors

Event:	Port control protocol timer expiration errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	user port Ttp and subclasses
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	port control protocol time out error
Perceived severity:	minor

Event:	Port control protocol errors while "Out of Service"
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	user port Ttp and subclasses
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	port control protocol error
Perceived severity:	warning

Event:	Port control protocol syntax errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	user port Ttp and subclasses
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	port control protocol syntax error
Perceived severity:	warning

NOTE: Reporting of this event is optional.

Event:	Port control protocol layer 3 address errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	user port Ttp and subclasses
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	port control protocol layer 3 address error
Perceived severity:	warning
Additional Information:	layer 3 port address or envelope function address

A.4.2 PSTN protocol errors

Event:	PSTN protocol syntax errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	pstn user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol syntax error
Perceived severity:	warning

NOTE: Reporting of this event is optional.

Event:	PSTN protocol layer 3 address errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	pstn eser port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol layer 3 address error
Perceived severity:	warning

Event:	PSTN protocol timer expiration errors
Reference:	V5.1 and V5.2: EN 300 324-1 [4]
Managed object class:	pstn user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	pstn protocol time out error
Perceived severity:	minor

A.4.3 ISDN layer 1 faults (Q(AN) only)

A.4.3.1 ISDN BA layer 1 faults (Q(AN) only)

Event:	LOS/LFA in DS or loss of power at NT1
Reference:	-
Managed object class:	isdn BA user port,
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	LOS/LFA in DS or loss of power at NT1
Perceived severity:	warning

Event:	LOS/LFA at T reference point
Reference:	-
Managed object class:	isdn BA user port,
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	LOS/LFA at T reference point
Perceived severity:	minor

Event:	ISDN layer 1 activation fault.
Reference:	-
Managed object class:	isdn BA user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	ISDN layer 1 activation fault.
Perceived severity:	warning

NOTE: These events indicate layer 1 faults. They are relevant only when the AN is responsible for the activation.

A.4.3.2 ISDN PRA layer 1 faults (Q(AN) only)

Event:	unintentional loop back, FE: C
Reference:	-
Managed object class:	isdn PRA user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	this parameter may be used for specific detailed indications related to the unintentional loop back,
Perceived severity:	warning

Event:	LOS/LFA and power failure, FE: D-L
Reference:	-
Managed object class:	isdnPRAUserPort
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	this parameter may be used for specific detailed indications related to the LOS/LFA and power failure
Perceived severity:	warning

Event:	Performance monitoring, FE: U-Y
Reference:	-
Managed object class:	isdn PRA user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	this parameter may be used for specific detailed indications related to the performance monitoring
Perceived severity:	minor

NOTE: These events indicate layer 1 faults. They are relevant only when the AN is responsible for the activation.

A.4.4 ISDN layer 2 faults (Q(AN) only)

Event:	ISDN Layer 2 fault
Reference:	CEPT Recommendation T/S 54-08 E [10]
Managed object class:	isdn BA user port, isdn PRA user port
Event type:	communications alarm
Probable cause:	communications protocol error (ITU-T Recommendation X.721 [21])
Specific problems:	isdn layer 2 fault
Perceived severity:	warning

NOTE: This event indicates a layer 2 fault of an ISDN access with PL service and permanent layer 2. It is relevant only when the AN is responsible for the activation.

A.4.5 Line faults (Q(AN) only)

Event:	Power feeding problem
Reference:	CEPT Recommendation T/S 54-08 E [10]
Managed object class:	user port Ttp
Event type:	communications alarm
Probable cause:	power problem (ITU-T Recommendation X.721 [21])
Specific problems:	this parameter may be used for specific detailed indications related to the power feeding problem
Perceived severity:	warning

Annex B (normative): V5 specific traffic measurement

V5 specific traffic measurement is described in EN 300 379-1 [8].

Annex C (normative): Requirements and specification of parameters for user port tests

It is not mandatory to implement test requirements and functionalities described in the present document, but if any test is required to be managed via the Q3 interface on the AN, it shall be modelled as described in the relevant subclause(s) of the present document.

C.1 General test requirements

These are the general requirements for the test management of V5 interfaces and related user ports via the Q3 interface of an AN.

C.1.1 Scheduled testing

The Q3 interface provides the functionality to control scheduling of tests in the AN, if the scheduling functionality is implemented in the AN.

C.1.2 Test capability

Information about which tests the AN is able to perform is required at the Q3 interface. The manager should be able to retrieve information about the test capabilities of an AN. If the OS is requesting the execution of a non-existing test, then the AN shall reply with an error message.

C.2 V5 interface test requirements

These are the requirements for the test management of V5 interfaces via the Q3 interface of an AN. They are covered by the information model defined in EN 300 379-1 [8].

C.2.1 V5 interface ID testing

The testing of consistency between the V5 interface IDs at either side of a V5 interface is required.

C.2.2 Link ID testing

The testing of consistency between the link IDs at either side of a V5 2 048 kbit/s link is required.

C.2.3 Provisioning variant testing

The testing of consistency between the provisioning variant labels at either side of a V5 interface is required.

C.3 User port test requirements

These are the requirements for the fault and performance management of user ports managed via the Q3 interface of an AN.

Further complex test procedures may be operator dependant. Examples are given in an informative way in annex G. These procedures may involve the execution of simple tests or other procedures such as subscriber assisted tests described in this subclause.

C.3.1 User port test management functions

Whenever a test request is sent by the manager to the AN, the following information may be associated to it, as given in table C.1.

Table C.1: Possible test request parameters and values

Parameter	Value
type of tests and/or procedures	see list of test requirement description.
scheduling of test	start time, stop time.
repetition of test	number of repetitions and/or period of repetition.
ID of user ports under test	list of 1 or N user port object instances involved in the test.
type of result	any conceivable combination among three possible results: passed, not passed, values.
thresholds (on a per test basis)	values of thresholds.

If one of the parameters is not permitted in the relevant test request, it shall be ignored by the AN.

If the AN is not able to manage one of the parameters listed above, a notification shall be emitted to the manager indicating the error cause.

C.3.2 Test scheduling

The following tests are suitable for scheduled tests:

- foreign voltage and current measurement;
- capacitance measurement;
- insulation resistance measurement;
- all line circuit tests;
- dial tone test;
- loop back test;
- activation and deactivation of the line.

The following requirements are valid for scheduling:

- routine tests shall have lower priority than on-demand test and normal traffic;
- the test result shall indicate those ports which have not been tested due to any reason;
- it shall be possible to specify the start time and the stop time of the whole test sequence;
- it shall be possible to specify the number of times a test attempt is to be repeated in case the first attempt failed due to any reason;
- it shall be possible to add new MORTs to a routine test and to delete MORTs from a routine test;
- it shall be possible to specify the test internal between the start of consecutive test sequences (e.g. daily, weekly, seconds between repeated tests) or the number of times a test is to be repeated.

The information model for scheduling and test repetition shall be based on already existing models specified in ITU-T Recommendation X.746 [29].

NOTE: The requirements for scheduling and test repetition are not satisfied by the current standard. Therefore further amendments are for further study.

C.3.3 Test result management

The result for a test request shall be reported on a per test and per port basis. These reports are controlled by a combination of the following three Boolean conditions:

a) pass: if TRUE send a result report if the port passed the test (the test outcome field of the test result notification in ITU-T Recommendation X.745 [28] contains the value "pass");

b) not passed: if TRUE send a result report only if the port did not pass the test (in this case the test outcome field of the test result notification in ITU-T Recommendation X.745 [28] contains one of the following values: "fail", "inconclusive", "timed out" or "premature termination");

c) measured values: if TRUE send the measured values (for that tests producing values as result).

These Boolean values shall be combined by means of the logical operator AND in order to determine when the result is to be sent.

EXAMPLE: When the following combination is used:

- pass = FALSE;
- not passed = TRUE;
- values = TRUE,

the expected result contains the list of measured values for such ports that have not passed the test.

C.3.4 Test threshold management

When a passed/not passed result is requested, a predefined AN threshold value is used, unless the test request contains threshold values which override predefined thresholds. After the termination of that test the predefined thresholds shall be restored.

C.3.5 Test requirements description

This subclause deals with requirements for line testing purposes. It is subdivided into PSTN line tests and PSTN inward tests; ISDN BA testing and ISDN PRA testing.

Accuracy and range of measurements are out of the scope of the present document.

C.3.5.1 PSTN line testing

In general, line testing requires that a certain line condition is established (e.g. off-hook or a line termination), then a test is performed and after the test the line is restored to its normal condition. In some cases, not all of these steps are under the control of the Q3 interface (e.g. where the test action is carried out by craft personnel), and so a test function may include all, or only some of these steps. The dry loop test, for example, is concerned only with disconnecting a line from the line circuit. In this case, the actual test conduction and the observation of the test outcome are assumed to be controlled separately.

In the following, subscriber assisted and voice connection mean that an operator gives instructions to the subscriber on how to perform a test. The subscriber returns the result back to the operator, when applicable.

C.3.5.1.1 Foreign voltage or current

It is required to check for the presence of foreign voltage or foreign current on the line.

This test is performed by disconnecting the line from the line circuit and measuring foreign voltage or foreign current between a/b, a/E or b/E. Both AC and DC voltage measurement are required. The manager may select one or more of these measurements. Results shall be passed, not passed and/or the values. Units are V (Volt) or A (Ampere).

C.3.5.1.2 Capacitance measurement

It is required to measure the capacitance on the line.

This test is performed by disconnecting the line from the line circuit and measuring the capacitance between a/b, a/E or b/E. The manager may select one or more of these measurements. Results shall be passed, not passed and/or the values. Units are F (Farad).

C.3.5.1.3 Insulation resistance measurement

It is required to measure the insulation resistance.

This test is performed by disconnecting the line from the line circuit and measuring the insulation resistance between a/b, a/Earth, b/Earth, a to battery or b to battery (both polarities are possible). The manager may select one or more of these measurements. Results shall be passed, not passed and/or the values. Units are Ω (Ohm).

C.3.5.1.4 Loop resistance measurement

It is required to measure the loop resistance during off-hook.

The loop resistance between a/b (both polarities are possible) is measured during off-hook. The manager may select one or both measurements. Results shall be passed, not passed and/or the values. Subscriber assistance may be required. Units are Ω (Ohm).

C.3.5.1.5 Dial pulse test

It is required to check the proper operation of the subscriber terminal.

The subscriber is requested to dial one or more digits: it is required to verify that the correct sequence of dialled digits is received by the AN. Results shall be passed, not passed and/or the values. The reported values are number of pulses, average make and break duration.

C.3.5.1.6 DTMF dialling test

It is required to check the proper operation of the subscriber terminal.

The subscriber is requested to dial one or more digits. It is required to verify that the correct sequence of digits is received by the AN in normal operation. DTMF handling is out of the scope of the V5 interface, because the tones are carried transparently through the AN and call processing is performed at the LE. However, an AN implementation may have this test functionality, thus providing a common maintenance support for both types of dialling. Results shall be: passed, not passed and/or values for dialled digits, tone levels, tone frequencies, pulse length. Units are: dBm (decibel relative to 1milliwatt), Hz (Hertz), s (seconds).

C.3.5.1.7 Subscriber private meter testing

It is required to check the subscriber's private meter.

The AN sends a specified number of metering pulses to the subscriber. The private meter at the customer premises should then step the same number of pulses. As a result, a comparison is made at the manager between subscriber answer and the notification from the AN about the number of pulses sent. The result parameter is number of pulses.

C.3.5.1.8 Ring subscriber

It is required to check the proper operation of the subscriber terminal.

The test is carried out by applying the ring signal and checking the answer of the subscriber. When off-hook is detected (both during the ringing tone itself or during the silent interval), no ringing current shall be sent anymore, according to the limits described in ITU-T Recommendation Q.543 [15]. The digital exchange performance design objectives are:

a) < 100 ms (mean value);

b) < 150 ms (95% value).

C.3.5.1.9 Monitoring of the line

It is required, at either AN or LE side, that the operator may either listen into the line with or without sending a mark tone, or listen and speak.

C.3.5.1.10 Cable pair identification tone

It is required to assist the identification of cable pairs in the field, by generating a trace tone at the AN side. The tone shall continue until it is stopped by a manager command or after a timeout.

C.3.5.1.11 Dry loop

It is required to disconnect the line from the line circuit. This condition is called "dry loop". After a dry loop is established, tests may be performed on the line outside the influence of the $Q3_{AN}$ or $Q3_{LE}$ interfaces, until normal conditions are re-established.

a and b wires are disconnected from the line circuit leaving them in an open circuit state. The subscriber line shall remain in dry loop condition until re-connected by a manager command or after a timeout.

C.3.5.1.12 Register recall button test

It is required to check the proper operation of the register recall button of the subscriber terminal.

The subscriber is requested to press the button. The pulse break time is then checked for acceptability. Results shall be passed/not passed.

C.3.5.1.13 Ring back procedure

The installer at the subscriber site may initiate a test procedure by dialling a special ring back code to the LE. The LE shall then initiate the ring back procedure. If during this procedure line or line circuit tests are required those already defined in the present document shall be applied. The co-ordination between the manager of the AN and the manager of the LE is out of the scope of the present document. More detailed information on executing this procedure is contained in annex F.

C.3.5.2 PSTN inward tests

C.3.5.2.1 Line circuit testing

PSTN line circuit test results shall be reported as passed/not passed covering all circuit tests in a global way, in order to identify the replaceable units.

If the AN is able to provide the relevant information, the manager may be notified about which test failed and the related measured values. Even if the AN supports this information, the management application still requires a pass/fail (passed/not passed) result.

In the following detailed requirements are described. This list is not exhaustive, and new items may be added in the future.

Thresholds for result comparison are specific to the line card implementation and the manager is not required to manage (both reading and setting) them.

C.3.5.2.1.1 Feeding voltage

Feeding voltage between a and b wires shall be measured.

C.3.5.2.1.2 Feeding current

Feeding current between a and b wires shall be measured.

C.3.5.2.1.3 Loop and ring trip detection

It is checked whether the line circuit is able to detect a loop (i.e. an off-hook) with both normal and reversed polarity, while the line circuit busy or idle (busy means ongoing call on the line). The ring trip detection is carried out by applying the ring signal and simulating the answer of the subscriber. When off-hook simulation is detected (during the ringing tone itself or during the silent interval), the ringing current shall be stopped immediately, according to the limits described in ITU-T Recommendation Q.543 [15]:

a) < 100 ms (mean value);

b) < 150 ms (95% value).

C.3.5.2.1.4 Ringing current sending

The ringing current shall be measured at the line side of the line circuit.

C.3.5.2.1.5 Private meter pulses

The duration and the level of private meter pulses shall be tested.

C.3.5.2.1.6 Codec testing

The analogue to digital and the digital to analogue conversion shall be tested including hybrid functionality.

C.3.5.2.1.7 Digit reception

The line circuit is tested to check whether it receives a decadic digit. The test shall be performed with both normal and reversal polarities.

C.3.5.2.2 Other inward tests

C.3.5.2.2.1 Dial tone test

An off-hook condition is simulated in the AN. It shall be checked whether the dial tone appears at the LC termination or not.

C.3.5.3 ISDN BA testing

C.3.5.3.1 ISDN BA line testing

If copper wires are used, the following line tests as defined for PSTN lines shall be carried out:

- foreign voltage;
- current measurement;
- capacitance measurement;
- insulation resistance measurement (only normal polarity is possible);
- dry loop.

C.3.5.3.2 ISDN BA line termination testing

C.3.5.3.2.1 Loop backs

Generally, a loop back is set up to test the integrity of the devices and the line between two points, by applying a known signal (pattern) on one side and checking whether the signal received is the same as the sent one. The input signal may be applied either by a device embedded in the network element which contains the port (or related line) under test, or by an external equipment. In the latter case, it is required that a loop back is set up without signal generation.

According to ITU-T Recommendation M.3603 [30], the terminology for ISDN BA loop backs is:

- loop back 1: complete Line Termination (LT) loop back;
- loop back 1A: Regenerator (REG) loop back;
- loop back 2: complete NT1 loop back;
- loop back 2_1: B1, B2, NT1 loop back.

The NT1 may be located either within or outside the AN (see figure 1).

All the loop backs mentioned above may be applied in connection with either an AN internal equipment or an external equipment to inject and detect a test pattern. The line under test is activated and a loop back is established.

The manager shall be notified whether the loop back is set up or not.

If the pattern injection and detection equipment are under the control of the manager via the Q3 interface, pattern injection and detection shall be initiated after the set up of the loop back. The pattern may be injected at a particular point and detected either at the same point or at another one. The received pattern shall be compared with the sent one and the result shall be reported as passed, not passed and/or bit error rate.

C.3.5.3.2.2 Activation and deactivation of lines

It is required to check the capability for activating and deactivating the line under test.

C.3.5.3.3 ISDN BA line circuit testing

C.3.5.3.3.1 Power feed

It is required to measure the feeding voltage between a and b wires provided by the line circuit. The voltage between a and b shall be measured in order to verify the proper operation of the power feeding of the NT1. The reported result shall be passed/not passed.

C.3.5.4 ISDN PRA testing

C.3.5.4.1 ISDN PRA line testing

Not applicable

C.3.5.4.2 ISDN PRA line termination testing

Set up of loop backs at the LT (loop back 1), at the regenerator (if more than one regenerator is installed, it shall be the one which is closest to the line termination; loop back 1A) and at the NT1 (loop back 2) shall be possible.

According to ITU-T Recommendation M.3604 [31], the terminology for ISDN PRA loop backs is:

- loop back 1: complete LT loop back;
- loop back 1A: REG loop back;
- loop back 2: complete NT1 loop back.

Annex D (normative): Test categories

This annex specifies the test categories for all tests in an access network which are invoked by the uncontrolled test request as defined in ITU-T Recommendation X.745 [28].

D.1 Dialled digit test

D.1.1 Test category name

Dialled Digit Test

D.1.2 Test category purpose

The purpose of tests of this category is to check the proper operation of the subscriber equipment's (pulse or DTMF) dialling. Possible tests according to the ASN.1 definition of dialled digit test, e.g.:

- dial pulse test;
- DTMF dialling test;
- register recall button test.

D.1.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. Only one object instances can be involved in the test.

D.1.4 Associated object requirements

There are no associated object classes.

D.1.5 Test environment

Tests of this test category are outward tests.

Tests of this category require customer assistance.

D.1.6 Test request service type

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.1.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.1.8 Test category information parameter

The dialled digit test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.1.9 Uncontrolled test response additional information parameter

The dialled digit test uncontrolled result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.2 Dial tone test

D.2.1 Test category name

Dial Tone Test.

D.2.2 Test category purpose

The purpose of tests of this category is to check the ability of the line circuit to detect an off-hook and to check the provision of the dial tone from the LE.

Possible tests according to the ASN.1 definition of dial tone test:

- dial tone test.

D.2.3 MORT requirements

The test invocation involves one object class (user Port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. One or more object instances can be involved in the test.

D.2.4 Associated object requirements:

There are no associated object classes.

D.2.5 Test environment

Tests of this test category are inward tests. They are performed with disconnected line.

Tests of this category do not require customer assistance.

D.2.6 Test request service type

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.2.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.2.8 Test category information parameter

The dial tone test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.2.9 Uncontrolled test response additional information parameter

The dial tone test Uncontrolled Result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request Uncontrolled Action.

D.3 Electrical measurement tests

D.3.1 Test category name

Electrical Measurement Tests.

D.3.2 Test category purpose

The purpose of tests of this category is measurement of electrical parameters.

Possible tests according to the ASN.1 definition of electrical measurement test, e.g.:

- foreign voltage;
- foreign current;
- capacitance;
- resistance.

D.3.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the user port under test. One or more object instances can be involved in the test.

D.3.4 Associated object requirements

There are no associated object classes.

D.3.5 Test environment

Tests of this category are outward tests or inward tests.

Tests of this category do not require customer assistance.

D.3.6 Test request service type

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.3.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.3.8 Test category information parameter

The electrical measurement test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.3.9 Uncontrolled test response additional information parameter

The electrical measurement test uncontrolled result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.4 ISDN quick test

D.4.1 Test category name

ISDN quick Test.

D.4.2 Test category purpose:

The purpose of tests of this category is to perform a set of quick tests for ISDN basic or primary rate accesses. Possible tests according to the ASN.1 definition of isdn quick test:

- layer 1 activation;
- loop back test;
- power feeding test;
- function test.

D.4.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. One or more object instances can be involved in the test.

D.4.4 Associated object requirements

There are no associated object classes.

D.4.5 Test environment

Tests of this test category are outward tests.

Tests of this category do not require customer assistance.

D.4.6 Test request service type:

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.4.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.4.8 Test category information parameter

The isdn quick test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.4.9 Uncontrolled test response additional information parameter

The isdn quick test uncontrolled result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.5 Loop back test

D.5.1 Test category name

Loop back Test.

D.5.2 Test category purpose:

The purpose of tests of this category is to perform an internal loop test for ISDN basic or primary rate accesses. Possible tests according to the ASN.1 definition of loop test:

- loop back test.

D.5.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. One or more object instances can be involved in the test.

D.5.4 Associated object requirements

There are no associated object classes.

D.5.5 Test environment

Tests of this test category are outward tests.

Tests of this category do not require customer assistance.

D.5.6 Test request service type:

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.5.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": Mistyped test category information.

D.5.8 Test category information parameter

The loopback test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": Test request uncontrolled action.

D.5.9 Uncontrolled test response additional information parameter

The loopback test uncontrolled result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.6 Ringing test

D.6.1 Test category name

Ringing Test.

D.6.2 Test category purpose

The purpose of tests of this category is to check the cable and equipment in the customer's premises by applying ringing to the subscriber.

Possible tests according to the ASN.1 definition of ringing test:

- ringing test.

D.6.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. One or more object instances can be involved in the test.

D.6.4 Associated object requirements

There are no associated object classes.

D.6.5 Test environment

Tests of this test category are outward tests. They are performed with the line connected to the line circuit or with disconnected line.

Tests of this category either require customer assistance or assist an operator's craftsman in detecting an error in the field.

D.6.6 Test request service type

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.6.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.6.8 Test category information parameter

The ringing test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.6.9 Uncontrolled test response additional information parameter

None.

D.7 Subscriber private meter pulses test

D.7.1 Test category name

SPM Pulses Test.

D.7.2 Test category purpose

The purpose of tests of this category is to check the cable and equipment in the customer's premises by sending SPM pulses to the private meter of the subscriber.

Possible tests according to the ASN.1 definition of spm pulses test:

- subscriber private meter testing.

D.7.3 MORT requirements

The test invocation involves one object class (user port Ttp as defined in ITU-T Recommendation Q.824.5 [34]), which represents the line being measured. One or more object instances can be involved in the test.

D.7.4 Associated object requirements

There are no associated object classes.

D.7.5 Test environment

Tests of this test category are outward tests. They are performed with the line connected to the line circuit or with disconnected line.

Tests of this category either require customer assistance or assist an operator's craftsman in detecting an error in the field.

D.7.6 Test request service type

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.7.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.7.8 Test category information parameter

The spm pulses test uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.7.9 Uncontrolled test response additional information parameter

None.

D.8 Test to line circuit test

D.8.1 Test category name

Test To Line Circuit.

D.8.2 Test category purpose

The purpose of tests of this category is to check the ability of the inward test to provide or detect certain signals or feeding voltage. The test comprises of a set of possible tests, which are predefined in the NE and performed all together:

- feeding voltage;
- feeding current;
- loop detection and ring trip detection;
- ringing current sending;
- private meter pulse generator test;
- codec testing;
- digit reception.

D.8.3 MORT requirements

The test invocation involves one object class (user port as defined in ITU-T Recommendation Q.824.5 [34]) as under test, which represents the line being measured. One or more object instances can be involved in the test.

D.8.4 Associated object requirements

There are no associated object classes.

D.8.5 Test environment

Tests of this test category are inward tests. They are performed with disconnected line.

Tests of this category do not require customer assistance.

D.8.6 Test request service type:

"ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.8.7 Specific errors

"ITU-T Recommendation X.745 [28]": no such MORT;

"ITU-T Recommendation X.745 [28]": MORT not available;

"ITU-T Recommendation X.745 [28]": mistyped test category information.

D.8.8 Test category information parameter

The test to line circuit uncontrolled request parameter as content of the test category information field in the information syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

D.8.9 Uncontrolled test response additional information parameter

The test to line circuit uncontrolled result parameter as content of the additional information field in the reply syntax of "ITU-T Recommendation X.745 [28]": test request uncontrolled action.

Annex E (informative): Task Information Base (TIB)

TIB is described in EN 300 379-1 [8].

Annex F (informative): Description of management functions

Management functions are described in EN 300 379-1 [8].

Annex G (informative): Description of test procedures

G.1 Background

This annex describes complex test procedures, as ring back service and all subscriber assisted tests at the AN side, to show the impact that they have on both Q3 interfaces.

G.2 Test procedures scenario

The general scenario, which is referred to, includes four functional blocks and all reference points between them as described in ITU-T Recommendation M.3010 [13].

The functional blocks are: NE functionalities which represent LE and AN, and OS functionalities managing AN and LE.

The reference points are: q (between AN or LE and respective OS) and q (or x if they belong to different TMNs) between OSs.

NOTE: This reference point and the interface relating to it are out of the scope of the present document.

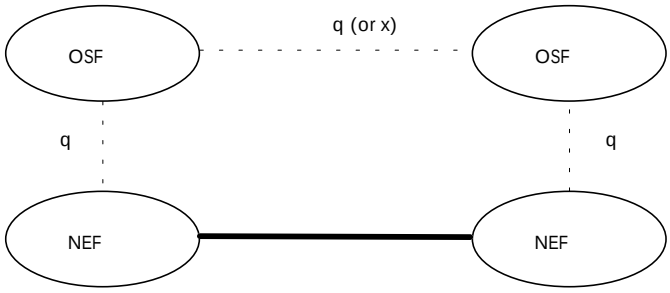


Figure G.1: Functional architecture for test procedures

The following subclauses describe examples of test procedures and the interactions between functional blocks via reference points.

G.2.1 Scenario for faultsman ringback tests in an AN environment

Figure G.2 gives a synopsis of all elements involved in maintenance of an AN subscriber line and set: in this example, all the previous reference points have been translated to interfaces and the OSs belong to different TMNs. The telephone set located at the AN operator premises will not be used for this scenario as the operator at the subscriber location will only get responses from the system:

1) the operator at the subscriber location (installer) dials a special service code. This special code is detected at the LE over the V5 interface (③ in figure G.2):

   a) the LE notifies the OS_{LE} via the $Q3_{LE}$ interface (⑤ in figure G.2);

   b) the OS_{LE} "informs" OS_{AN} via the X interface (⑥ in figure G.2);

   c) OS_{AN} checks via $Q3_{AN}$ if Test Equipment is available at AN level and reserves this equipment (④ in figure G.2);

   d) reporting back from OS_{AN} to OS_{LE} via X interface (⑥ in figure G.2);

   e) OS_{LE} initiates tone LE via $Q3_{LE}$ (⑤ in figure G.2);

2) if test equipment is available the LE answers with a ringing tone (③ in figure G.2), otherwise with a busy tone (③ in figure G.2);

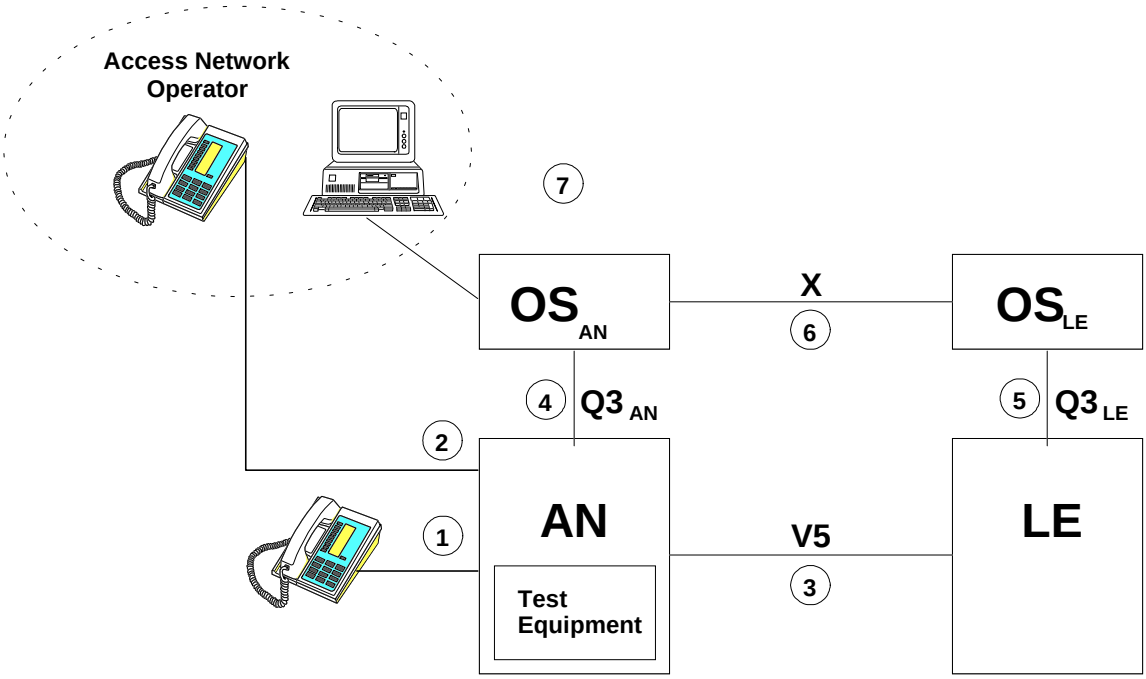
3) the installer puts the set on-hook (③ in figure G.2):

   a) the LE notifies the OS_{LE} via the $Q3_{LE}$ interface of the on-hook (⑤ in figure G.2);

   b) the OS_{LE} "informs" OS_{AN} via the X interface (⑥ in figure G.2);

   c) OS_{AN} requests testing at AN level via $Q3_{AN}$ (④ in figure G.2);

   d) the AN blocks the related user port object instance via the V5 protocol (③ in figure G.2);



NOTE: The operator's telephone set may also be connected to another AN, or to this or another LE.

Figure G.2: Physical architecture for the faultsman ringback service and for subscriber assisted tests in an AN environment

4) automatic testing is performed by the AN (foreign voltage, insulation, capacitance, etc.):

   a) the AN notifies the test results via $Q3_{AN}$ to OS_{AN} (④ in figure G.2);

   b) the test equipment is disconnected at the AN;

   c) reporting back the passed/not passed result from OS_{AN} to OS_{LE} via X interface (⑥ in figure G.2);

   d) OS_{LE} initiates ringing to LE via $Q3_{LE}$ (⑤ in figure G.2) and indicates which tone to apply;

5) the LE rings the installer back;

6) the installer takes the set off-hook (implying the ringer is OK);

7) the test results (of item 4 above) are communicated with a tone (passed: dial tone, not passed: busy tone) to the installer (③ in figure G.2);

8) faultsman receives dial tone and sends digits (DTMF or DECADIC) in a given order, removal of dial tone after first digit (③ in figure G.2). This is just a check of the capability to dial (i.e. no measurements are performed on the dial performance);

9) passed/not passed tone to report a successful test (③ in figure G.2);

10) end of test, set on-hook:

   a) the LE notifies the OS_{LE} via the $Q3_{LE}$ interface of the on-hook and successful test (⑤ in figure G.2);

   b) the OS_{LE} "informs" OS_{AN} via the X interface (⑥ in figure G.2);

   c) report is printed on the AN operator printer (⑦ in figure G.2).

G.2.2 Scenario for a subscriber assisted test in an AN environment

The subscriber assisted tests, i.e. those in which the subscriber at its premises handles the telephone set and observes the SPM, are normally carried out with a speech connection between him and the operator who is also working at the OS_{AN}. This speech connection can be in two modes, as specified in the voice access package.

G.2.2.1 Existing connection mode

1) A normal connection is set-up between the subscriber and the operator. This connection can be e.g. due to a claiming call from the subscriber (1-3-2 in figure G.2) (no charging should be applied) or may be originated by the operator (2-3-1 in figure G.2).
   The operator indicates to the subscriber that some tests are going to be performed, and requests assistance for this purpose according to the following instructions.

2) The operator, by means of a test request on the $Q3_{AN}$ interface (7-4 in figure G.2), converts the existing voice connection into a test connection (by creating an access test object and a voice access test object contained in it with the monitor speak parameter set to existing connection). The test connection condition means that the voice connection is kept (1-3-2) but the line signalling is put under the control of the OS_{AN} interface instead of the LE, which will not receive any V5 signal message.

3) If, e.g. the ringing function of the telephone set has to be tested, the operator asks the subscriber to hang up and to pick up again when the set rings (or after a given time otherwise). The on-hook is noticed by the operator by hearing to the line (or by previously creating within the access test object a dialled digit test object which reports the on-hook signal event through the $Q3_{AN}$ interface).
   Then the operator creates within the access test object a ringing test object. This causes the AN to generate ringing to the subscriber's line. The test object will generate a result either upon the off-hook detection or when a built-in timer expires (e.g. a little before the subscriber should pick up if the ringing does not work). In both cases the ringing test object is automatically deleted.

4) If, e.g. the dialling function of the telephone set has to be tested, the operator creates within the access test object a dialled digit test object and then asks the subscriber to dial a given sequence of digits. Information on detected digits at the AN and their performance (e.g. make/break duration) are reported by the test object to the OS_{AN} where the operator checks it. The dialled digit test object is automatically deleted.

5) If, e.g. the SPM pulse reception function has to be tested, the operator asks to the subscriber to watch how many pulses are going to be received, then creates within the access test an SPM pulse test object with the desired number of pulses to be sent as a parameter. This causes the generation of those pulses. The subscriber counts the number of pulses accumulated in the SPM and it is checked against the generated number.

6) When no more subscriber assisted testing is needed, the operator terminates the voice access test object and the access test object through the $Q3_{AN}$ interface. An implementation may restore the original normal connection condition (voice connection kept and line signalling again under LE control) or release the connection completely.

G.2.2.2 Parallel voice path mode

1) The operator creates through the $Q3_{AN}$ interface (7-4 in figure G.2) an access test object and contained in it a voice access test object with the monitor speak parameter set to speak and monitor. This causes the AN to block the port (3 in figure G.2) and to generate a call from the AN-internal test function (simulating to be a telephone) to the telephone number of the operator, provided in the ring back no parameter of the test request (3-2 in figure G.2, though the V5 interface and the LE for the test function may not be the same as for the port to be tested).

2) Once the voice path between the operator and the test function is established, the test function is connected to the subscriber's line so that the operator and the subscriber can speak to each other.

3), 4) and 5) as in the existing connection mode above.

6) When no more subscriber assisted testing is needed, the operator terminates the voice access test object and the access test object through the $Q3_{AN}$ interface. The user port is unblocked (3 in figure G.2) and gets ready for normal traffic.

Annex H (informative): Summary of requirements

Table H.1 summarizes all the test requirements and maps them against test characteristics.

Table H.1

	Test is affecting			Test access of the TU			Test result							
	Q_{AN}	Q_{LE}	LE	line	line circuit	bridged	values	passed/ not passed	subscriber assistance	voice connection	source	sink	routine/ on demand	remark
voltage	yes	no	no	yes	no	no	yes	yes	no	no	line	TU	r/d	AC+DC, a/b, a/E, b/E and reverse
resistance	yes	no	no	yes	no	no	yes	yes	no	no	line	TU	r/d	a/b, a/E, b/E and reverse
capacitance	yes	no	no	yes	no	no	yes	yes	no	no	line	TU	r/d	a/b, a/E, b/E
dial pulse test	yes	no	no	no/yes	no	no/yes	yes	no	yes	yes	CPE	TU/LC	d	voice connection preferably in interaction with tests
register recall button	yes	no	no	no/yes	no	no/yes	yes	no	yes	yes	CPE	TU/LC	d	
DTMF dialling	no/yes	no/yes	no/yes	no/yes	no	no/yes	yes	no	yes	yes	CPE	TU/LC	d	
meter pulses	yes	no	no	no/yes	no	no/yes	no	no	yes	yes	TU/LC	CPE	d	
ring subscriber	yes	no	no	no/yes	no	no/yes	no	no	yes	yes	TU/LC	CPE	d	
loop resistance	yes	no	no	yes	no	no	yes	yes	yes	yes	line	TU	d	
monitoring w mark	no/yes	no/yes	no/yes	no	no	no/yes	no	no	no	no/yes	speech connection between OS and CPE		d	no: implemented in the LE
monitoring w/o mark	no/yes	no/yes	no/yes	no	no	no/yes	no	no	no	no/yes	speech connection between OS and CPE		d	yes: implemented in the AN
identification tone	yes	no	no	no/yes	no	no	no	no	no	no	TU	line	d	
dry loop	yes	no	no	no	no	no	no	no	no	no			d	disconnection between line and line circuit
ring back service	no/yes	no/yes	no/yes	no	no	no	no	yes	yes	no	CPE	LE	d	
dial tone test	yes	no	no	no	yes	no	no/yes	yes	no	no/yes	TU / LC		r/d	
feeding voltage	yes	no	no	no	yes	no	no/yes	yes	no	no	LC	TU	r/d	
feeding current	yes	no	no	no	yes	no	no/yes	yes	no	no	LC	TU	r/d	
loop detection	yes	no	no	no	yes	no	no	yes	no	no	LC	TU	r/d	
ring signal sending	yes	no	no	no	yes	no	no/yes	yes	no	no	LC	TU	r/d	
meter pulse test	yes	no	no	no	yes	no	no/yes	yes	no	no	LC	TU	r/d	
digit reception	yes	no	no	no	yes	no	no	yes	no	no	LC	TU	r/d	
codec testing	yes	no	no	no	yes	no	no	yes	no	no	LC	TU	r/d	
simple loop back	yes	no	no	no	no	no	no	yes	no	no	AN/LT, REG, NT		d	normal condition of the line: line circuit connected to the line; no connection to the test unit
activation/deactivation	yes	no	no	no	no	no	no	yes	no	no	AN / NT		r/d	
LT loop back	yes	no	no	no	no	no	no	yes	no	no	AN / LT		r/d	
REG loop back	yes	no	no	no	no	no	no	yes	no	no	AN / REG		r/d	
NT1 loop back	yes	no	no	no	no	no	no	yes	no	no	AN / NT		r/d	
power feed	yes	no	no	yes	no	no	no	yes	no	no	AN	CPE	d	

Annex J (informative): State management in relation with line testing - Application for V5 access networks

J.1 Intrusive tests

Tests can be intrusive or non-intrusive. A test on a resource is intrusive when its testing phase is incompatible with the normal working of that resource.

Most of the test functionality modelled in the present document is intrusive, with the only exceptions of the monitoring function and of the monitor-and-speak function while a previous connection between the user port being tested and a third party is still on (if this connection is cleared then the monitor-and-speak function becomes intrusive).

Additionally, any tests performed during a speech connection between the operator and the user in the "existing connection" mode (as described in the voice access test object) are not considered as intrusive.

J.2 Dealing with conflicts between intrusive tests and normal service

When a resource is disabled for any reason, it cannot provide its normal service and thus there is no conflict with intrusive tests. For V5-related user ports, the disabled state of the object implies the blocked state of the corresponding V5 FSM. Disabling reasons are AN-internal, e.g. faults or a (V5-specific) blocking procedure initiated at the LE, as specified in EN 300 376-1 [6].

When a resource is not disabled, a way of avoiding conflicts between intrusive testing on that resource and its normal working is by preventing the latter by setting its administrative state to "locked" (via shutting down, if desired). This state also allows to hold a test session without risk of interruption due to call attempts between consecutive tests. With V5-related user ports, the locked state implies that the V5 FSM is blocked (see EN 300 376-1 [6]).

However, the locking or shutting down and the subsequent unlocking operations on the Q3 interface may be cumbersome e.g. in the case of series of single tests on many user ports, and for this reason the model allows to avoid them. In this case, the AN shall solve interferences between an intrusive test and normal traffic according to the priority criterion defined in the test conditions parameter of the request for the containing access test. As specified in the object model, tests to be initiated when the port is not idle may have to be rejected ("reject if busy"), or wait until the port becomes idle ("wait if busy", with a time limit set by the waitTime parameter), or force the clearance of the call ("test if busy").

NOTE 1: A test session without call interruptions between tests can be supported, without using the locked administrative state, by means of the access test object along with the test session Id parameter.

NOTE 2: The above approach of using the administrative state does not cover the "reject if busy" case or the timing facility for the "wait if busy" case.

In order for the AN to appropriately use the test conditions and the waitTime parameters, two functions are necessary:

1) capability to know whether there is an ongoing call;

2) procedures for the possible cases of interference.

Regarding function 1, the general principles for ANs and in particular the V5 specifications state that the AN has limited or no knowledge of the state of the call. On that basis, there are two ways out:

1) for V5-related user ports, an approach is the use of the V5 blocking mechanisms. They only indirectly provide some call information, but at the same time cover function 2 (they are active procedures), as explained in clause J.4;

2) it is possible for an AN to have additional capabilities allowing it to get call state information, if an implementation goes beyond the definition of AN in the V5 specification. This approach has the disadvantage of making the AN more complex and dependent on possibly network-specific and time-evolving signalling issues, against the spirit of the V5 specification. However, it cannot be ruled out, and for that reason the V5 blocking approach described below is not in the normative part of the present document. Moreover, keeping independence on the V5 specificities allows the model to be used in non-V5 environments.

Regarding function 2, in the case of a user port related to a V5 interface, the normal way is by means of the V5 blocking mechanisms, even if a different approach is used for function 1.

A second aspect of possible interference between service and testing is when a call attempt occurs during the execution of a test. The test conditions parameter may also be used by the manager to choose which function prevails, as described in the model. The "customer overrides" option, which is not possible if the locked administrative state is used, requires the AN to be able to detect the call attempt, as well as procedures to abort the test, and for this aspect the same considerations above
are valid.

J.3 State values during intrusive testing

Whenever the user port is in the testing phase of an intrusive test it cannot give normal service. Thus the testing phase of an intrusive test is an AN-internal disabling reason, i.e. one of the possible reasons for its disabled operational state.

For short tests, this general rule may be simplified so that the Q3 interface state attributes of the user port are not affected, thus avoiding the corresponding notifications and manager processing. This means that during the test execution the disabled condition of the port is only known by the AN.

For V5-related user ports, the disabled condition (even if not reflected on the Q3 interface) means the blocked state of the
V5 FSM, as defined in EN 300 376-1 [6]. Exceptions are or may be:

- the dial tone test requires the unblocked state due to its special nature;
- for other tests, if their execution have a very short duration, an implementation might not follow this rule.

J.4 V5 blocking mechanism

This clause describes the use of the V5 blocking mechanism for V5-related user ports to cover functions 1 and 2 (as described in clause J.2) as a complement of the generic behaviour description of the test environment conditions package.

- If the test conditions parameter is set to "test if busy" the V5 urgent blocking procedure is started, so that the test proceeds (as far as this mechanism is concerned, the AN does not know if there was a call).
- If the parameter is set to "wait if busy" the V5 deferred blocking is started, and it is up to the LE to block the port (when this happens, the AN "knows" that the call has finished). If the timer expires, the AN cancels the block request.
- The least elegant case for this approach is when the test conditions parameter is set to "reject if busy", as there is no direct V5 mechanism. Then the AN starts the deferred blocking procedure; if after "a few seconds" the LE has not yet confirmed the blocking, the AN assumes that there is a call and rejects the test, while the block request to the LE is cancelled.

For the dial tone test, these procedures need to be complemented, once the port is blocked, by the unblocking procedure (if the concept of test session were to be supported to avoid a call to interrupt a sequence of dial tone tests, the user port would be immediately blocked after each test).

It is possible for an implementation to follow the above V5 blocking approach with the variation that, for PSTN ports and/or ISDN-BA ports without permanent line activation, the AN determines by itself whether the line is busy, only in order to simplify the "reject if busy" case (direct rejection if the port is found busy); and, on PSTN ports, also to simplify the dial tone test (direct testing when the port is found idle).

Annex K (informative): Message flows

In the following figures the principles of the message flows are introduced as examples.

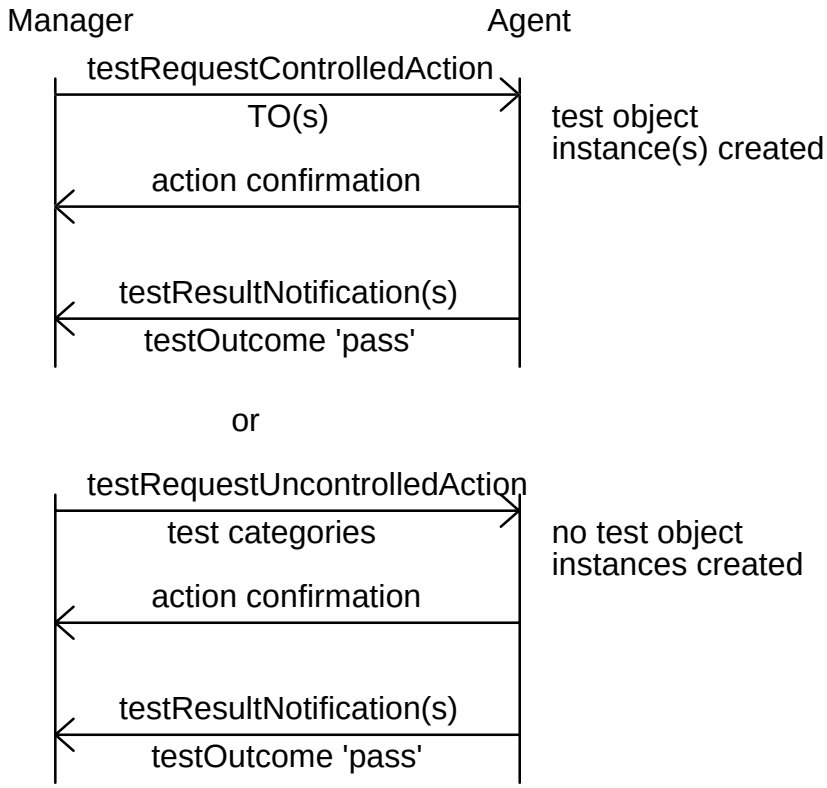


Figure K.1: The simple cases: a successful on-demand test

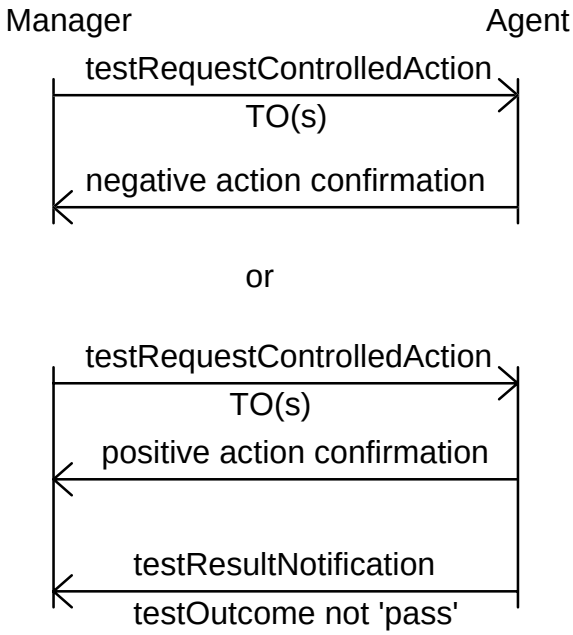


Figure K.2: Any failed test

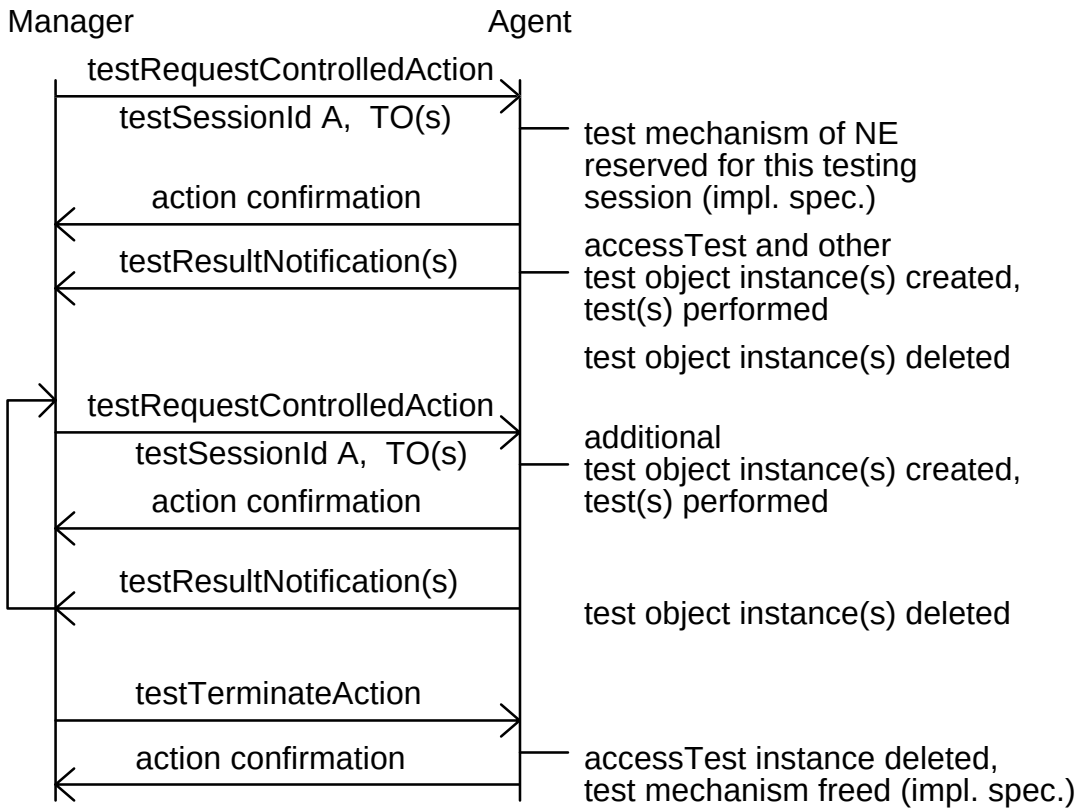


Figure K.3: A test session

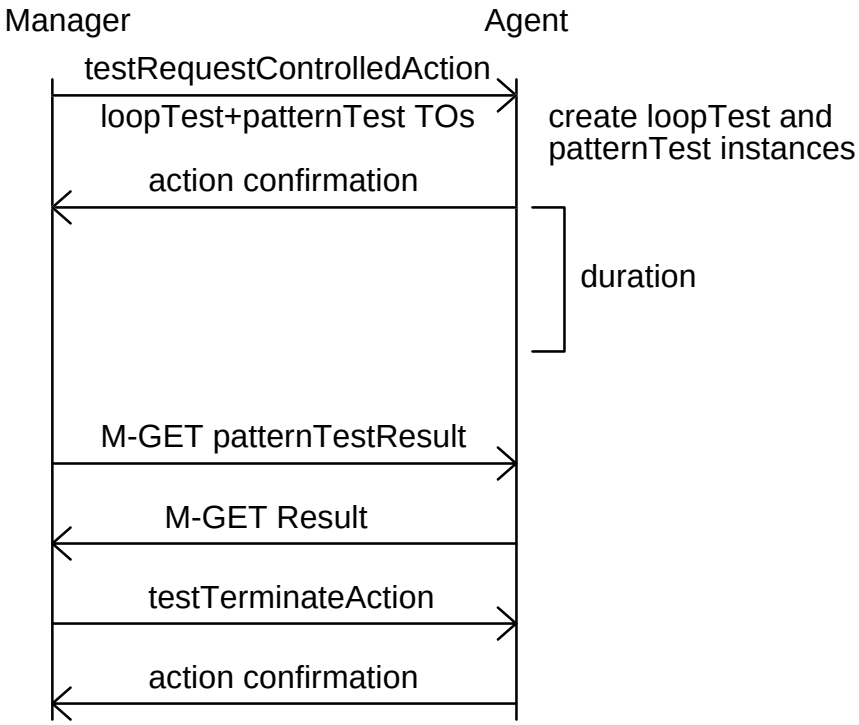


Figure K.4: Internal Pattern Injection

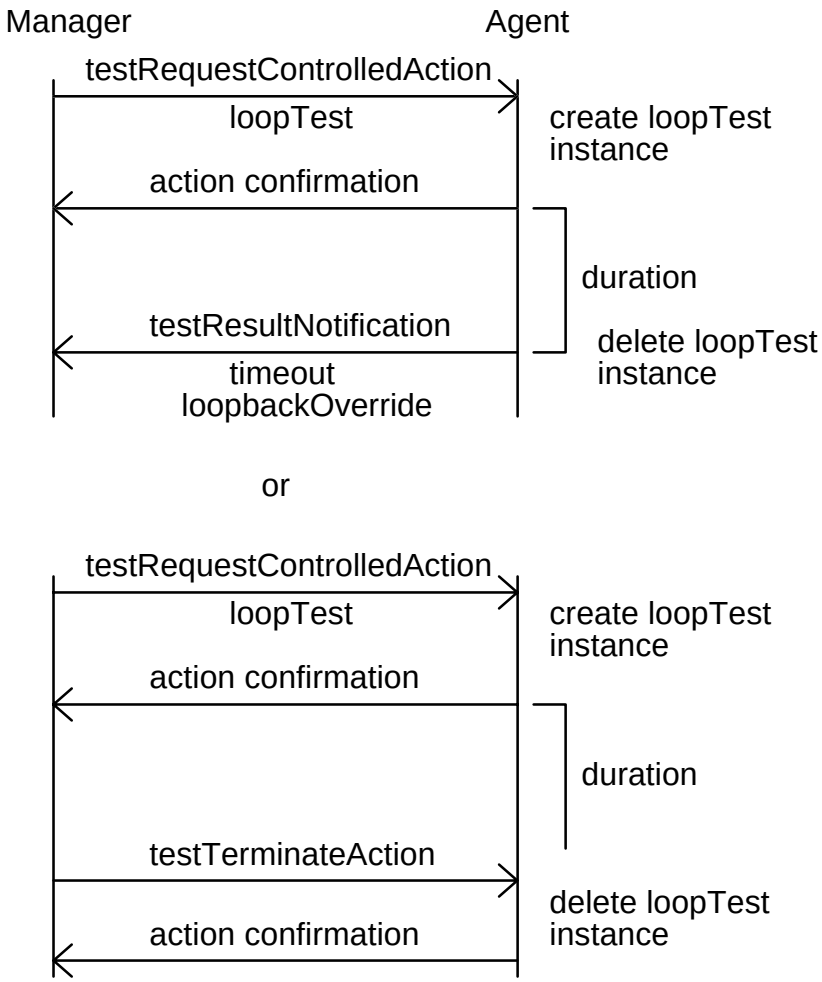


Figure K.5: External Pattern Injection

Bibliography

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