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ABSTRACT TEST SUITE FOR LAPD CONFORMANCE TESTING

ITU-T Recommendation Q.921 *bis*

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.921 *bis* was prepared by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ABSTRACT TEST SUITE FOR LAPD CONFORMANCE TESTING

(Helsinki, 1993)

1 General

This Recommendation presents the abstract test suite (ATS) for Link Access Procedures on the D-channel (LAPD) described in Tree and Tabular Combined Notation (TTCN), for an ISDN user side terminal equipment on ISDN basic access. This test suite aligns with the principles defined in OSI Conformance Testing Methodology and Framework Recommendations X.290 to X.294, inclusive [1].

For basic rate, user-side testing, two equally valid but different Abstract Test Suites (ATS) have been submitted for CCITT consideration. Although these two ATS share a common subset of test purposes, they employ different test methods. This would make the comparability of the test results between the two ATS extremely difficult. In order to facilitate the comparability of the test results, which is fundamental to the achievement of the desirable goal of one-stop testing on a worldwide basis, it has been agreed that only one internationally standardized ATS is required for each protocol. Given the advanced stage of introduction of conformance testing within some countries, it has further been agreed that a reasonable transition period is required before it is possible to move to a single standardized ATS. This Recommendation therefore contains two recommended ATS, one in the body of the text called *Part I - Basic rate user-side,* see 1.1.1 and 3.1.1 below, and the other in an annex to Part I, called *Annex A to Part I,* see 3.1.2 below. During the transition period, organizations wishing to follow this Recommendation have the option of using either or both ATS, or a subset applicable to their environment. However, from 1 April 1994, the ATS for basic rate, user-side testing, contained in the body of this Recommendation will be the only recommended ATS. The ATS contained in Annex A is recommended for use during the transition period ending 31 March 1994 only.

Subclause 1.1 describes the scope and field of application which provides an objective basis for the applicability of the LAPD tests. Clause 2 contains general aspects of testing and the Protocol Implementation Extra Information for Testing (PIXIT) proforma. Clause 4 contains abbreviations used in this Recommendation.

The type of TTCN used in the development of the test suite for basic rate, user-side testing, pre-dates that to be found in Recommendation X.292 [1]. However, as reflected in X.292 [1], Recommendations produced during the 1989-1992 study period that use a version of TTCN that pre-dates X.292 [1] and which append to the Recommendation a copy of the specification of that version of TTCN used, will be regarded as compliant to Recommendation X.292. For that reason, Appendix III, OSI Conformance Testing Methodology and Framework for Protocol Recommendations for CCITT Applications – Tree and Tabular Combined Notation (TTCN), contains full information on the version of TTCN used for the preparation of the test suite for basic rate, user-side testing.

The General, General Aspects of Testing, Abbreviations, and Reference clauses of this Recommendation are available in printed form. All other clauses and subclauses, including the ATS, are available in electronic format (i.e. diskette) only.

1.1 Scope and field of application

The LAPD abstract test suite for conformance testing is based on Recommendation Q.921 [2]. The Implementation Under Test (IUT) is the user's side implementation of LAPD. The System Under Test (SUT) is functionally a Customer Premises Equipment (CPE), a Terminal Equipment of Type 1 (TE1) or a Terminal Adapter (TA).

The conformance testing for the complete LAPD protocol is covered in four abstract test suites, called Parts I, II, III and IV, presented below.

1.1.1 Part I - Basic rate user-side

The abstract test suite for conformance testing equipment for basic rate access on the user-side of the interface is specified in clause 1.

1.1.2 Part II - Basic rate network-side

For further study.

1.1.3 Part III - Primary rate user-side

For further study.

1.1.4 Part IV - Primary rate network-side

For further study.

The test methodology is the "remote single layer embedded testing" as described in Recommendation X.291 [1]. It is possible that the entire test suite is not applicable for all IUTs. A test selection procedure has to be performed to determine the applicability of a test to a particular IUT. Such selection shall be based on the Protocol Implementation Conformance Statement (PICS) and Protocol Implementation Extra Information for Testing (PIXIT). In doing such a selection, interoperability among ISDN equipment shall be of prime importance. The abstract test cases contained in this Recommendation are a comprehensive reflection of the base standards.

This abstract test suite only tests a single TEI link and assumes that the IUT only supports a single TEI link. If more than one TEI link is supported by the IUT, the test implementor must take actions to filter out messages generated by the TEI links which are not under test.

1.2 Definitions

This test suite uses valid, invalid, and inopportune frames to test the IUT behaviour. These terms are defined as follows:

1.2.1 **valid frames**: A valid frame is an expected frame which arrives at the correct state or phase and does not belong to any of the categories listed under invalid frames.

1.2.2 **invalid frames**: An invalid frame, as per Reference 1, is a frame which:

a) is not properly bounded by two flags; or

b) has fewer than six octets between flags or frames that contain sequence numbers and fewer than five octets between flags of frames that do not contain sequence numbers; or

c) does not consist of an integral number of octets prior to zero bit insertion or following zero bit extraction; or

d) contains a frame check sequence error; or

e) contains a single octet address field; or

f) contains a service access point identifier which is not supported by the receiver.

Currently, test cases for some of the above invalid frames are not included in this Recommendation. Additional test cases for the following type of frames have been written and included under this grouping.

a) supervisory and unnumbered frames (except XID frame) which are too long;

b) undefined command and response frame (error in the control field);

c) frames where the information field is not permitted.

1.2.3 inopportune frames: An inopportune frame is a syntactically valid frame arriving at a time (IUT's state) when it should be considered irrelevant by the IUT.

2 General aspects of testing

As per Recommendations X.290 and X.291 of testing [1], "a complete and independent specification of the actions required to achieve a specific test purpose" is called an abstract test case. The abstract test cases for LAPD are defined at the level of abstraction of remote single layer embedded testing methodology. The test cases, along with the test body, include a preamble and a postamble, which are defined below, to ensure starting and ending in a stable state and involve one or more consecutive or concurrent connections. However, as per Recommendation X.291 [1], it can be useful to use other stable states for starting and ending abstract test cases, in order to concatenate test cases in a manner which permits efficient execution.

2.1 Test groups and sub-groups

ISDN LAPD test cases have been grouped into three major groups:

1) Management (MGMT);

2) Multiple Frame Operation (MFO);

3) System (SYSTEM).

The first group (MGMT) consists of test cases covering the IUT's TEI management procedures in States 1 through 3, and instances in States 4-8 in which an error recovery results in setting the MDL-ERROR primitive by the IUT. The test cases in the Management Group are referenced as LAPD/MGMT/DMx_Lij, where "x" denotes the IUT's State (1-8), followed by a letter "L", which is set to "V", "N", or "I", denoting valid, invalid (not valid) or inopportune sub-groupings, respectively, as indicated below; and "ij" denoting the test case number.

The second group (MFO) includes test cases for States 4 through 8. The bulk of the test cases fall into this group. The test cases in this group are referenced as LAPD/MFO/sx/DLx_Lij, where "x" denotes the IUT's State (4-8), in both the state sub-group, "sx", and in the test case reference, DLx_Lij. The letters "L" and "ij", are defined above.

The MGMT and MFO test Groups are further divided into three sub-groups according to the definitions above and are as follows:

– Sub-group 1 involves those test cases where the tester transmits a valid test frame;

– Sub-group 2 involves those test cases where the tester transmits an invalid test frame;

– Sub-group 3 involves those test cases where the tester transmits an inopportune test frame.

The third group (SYSTEM) is designed to test frames defined in 1.2.2 for correctness of the IUT's system parameters, and window rotation. The test cases in this group are referenced as LAPD/SYSTEM/DSx_Lij, where "x" denotes the IUT's state, and "L", "ij" are defined as above.

2.2 Preamble

The preamble of a test case consists of the steps required to bring the IUT to the appropriate initial state. There may be alternate sequences of test steps which can be performed to initialize the IUT. These test steps in the preamble for LAPD have been chosen carefully, considering the test methodology and the other test coordination procedures that are available. In general, it is preferred that these steps be built on an "idle state" which is stable and "most likely" under many testing situations.

The bulk of the test suite is to test the IUT's behaviour in multiple frame operations. Choosing the TEI-Unassigned state (State 1) as the "idle state", upon which a preamble is built, would result in unnecessary and sometimes lengthy TEI assignment procedures. Also, the IUT, depending upon the TEI value it supports, may not present itself in the TEI-unassigned state. In view of this, the preferred "idle state" for the entire test suite covering multiple frame operations is the TEI-assigned state (State 4). The alternative, whenever State 4 is not feasible, is multiple frame-established (MFE) state (State 7.0). Therefore, preambles may be different for different IUTs, depending upon the choice of idle state.

The selection of "idle state" is determined by the PIXIT, and is applicable for the entire test suite, except for States 1.0 and 2.0.

2.3 Test body

The test body is the sequence of steps within a test case that is essential to achieve the test purpose, followed by the verification of the IUT's ending state. A verdict of Pass (P), Fail (F), or Inconclusive (I) is assigned to the possible outcomes of the test cases.

It is important to test the observable behaviour of the IUT, which includes state transitions and Protocol Data Unit (PDU) responses. If one assumes that all states are implemented, it is not possible to obtain unique traces or signatures which would guarantee that the IUT is in the expected state. Also, many of the LAPD states are transitional and may not be implemented.

The constraint references specify the frames which are sent and received by the IUT. The basic naming convention for these references is:

FrameType/P or F bit (0 or 1) /_ / User(U) or Network(N)/Command(C) or Response(R).

For example, DM1_UC denotes a DM frame with a P/F bit = 1, sent by the User, and is a Command frame.

2.4 Postamble

At the end of the execution of a test body, the IUT may not be in an "idle state". A postamble is required to bring the IUT from the ending state to an "idle state".

For multiple frame operations, as mentioned previously, the "idle state" is either State 4 or 7.0. Therefore, postamble procedures may differ for various IUTs depending on the selected "idle state".

2.5 Timer definitions

The timer types used by the tester are T200, T202, T203, as defined in Recommendation Q.921 [2]. There are additional timers defined that may be used during dynamic conformance testing:

a) *Td* – Time delay to be allowed before concluding that there is no frame response from the IUT;

b) *Topr* – Time required for a test operator in initiating some test action. This is used in conjunction with an Implicit_send for test coordination;

c) *T1* – Timer used to ensure timely response from the IUT when Layer 3 messages are expected.

It should be noted that some timers, for example T200, are executed synchronously both in the IUT and in the tester. Any undue transmission or processing delay on either side because of the testing environment may have an adverse effect on the test cases which have verdicts based on timer expiry. Care should be exercised to compensate for these "delta" delays. The exact value of "delta" is a function of the testing environment and is not specified here.

2.6 Layer 2 information frame content

The IUT is treated as an embedded single layer. This test suite requires the use of Layer 3 initiated I frames. The entity above the IUT may be call control, X.25 packet layer, or equivalent mechanism. Therefore, the information content in Layer 2 frames may belong to any of the above protocols. However, in the context of the Layer 2 abstract test suite in this Recommendation, the Layer 2 information frame content shall not force a Layer 3 response from the upper entity.

2.7 PICS/PIXIT relationship to abstract test suite

There are instances when the execution of a test case depends on the answer to a PICS or PIXIT question. In such instances, a boolean expression is added to the beginning of the test body, which makes the execution of the test case conditional. However, it should be noted that such conditional execution has no bearing on static conformance.

2.8 Test implementation strategies

This Recommendation, in addition to defining the abstract conformance test suite, presents strategies related to efficient implementation of the test suite. The strategy called "the grouping method", given in Appendix I, entitled "A Method for Implementing Test Cases", describes a means for efficient implementation and maintenance of the test cases. Appendix II, entitled "A Method for Minimizing Run-Time of Test Cases", describes a method for achieving run-time efficiencies by conditional execution of the preambles and postambles based on the previous test case verdict.

Both strategies are compliant with ISO DIS 9646. They are intended to guide the implementors and should not be considered as mandatory. Note that these two strategies do not preclude each other.

2.9 Initialization procedures

Whenever the execution begins for an entire group of tests or for several test cases for States 4-8, in either the Management (MGMT) or Multiple Frame Operations (MFO) Group, the IUT should go through initialization procedures described in the DL_MFOINIT routine, which used the DL4_INIT and DL7_INIT routines located in the test steps library. Basically, these procedures bring the IUT to the "idle state" (State 4 or 7) based upon the PIXIT. If the IUT cannot be forced to send a TEI_ID_REQUEST on demand, as required in the initialization procedures, then a manual initialization procedure must be performed to bring the IUT into the desired "idle state".

Note that the procedure represented by DL_MFOINIT is intended only as an illustrative example of one implementation of the initialization procedure. Due to variations in the behaviour of IUTs, it may be necessary for the implementor to either modify the procedure or provide a unique replacement for DL_MFOINIT to permit the IUT to be placed in the appropriate "idle state".

2.10 PIXIT proforma

Information supplied by the IUT provider in this subclause will be used to configure the tester to execute the conformance test suite.

PIXIT Proforma for ISDN D-channel, Layer 2, Basic rate access, user side

Copyright release for PIXIT proformas

Users of this Recommendation may freely reproduce the PIXIT proforma of this Recommendation so that it may be used for its intended purpose and may further publish the completed PIXIT.

Identification summary

PIXIT Number:

Means of Testing:

Test Laboratory Name:

Date of Issue:

Issued to:

Abstract test suite summary

Protocol Standard:

ISDN D-channel Layer 2 Basic Access User side

Recommendation:

Recommendation Q.921

ATS Standard:

Recommendation:

Abstract Test Method:

Remote single layer

Test laboratory

Test Laboratory Identification:

Test Laboratory Manager:

Network Address(es):

Instructions for Completion:

Client

Client Identification:

Client Test Manager:

Test Facilities Required:

IUT

Name:

Version:

Machine Configuration:

Operating System Identification:

Upper Tester Identification (if any):

Upper Tester Validation Date (if appropriate):

IUT Identification:

PICS Reference for IUT:

Limitations of the IUT:

General information

1.	Is TEI assignment automatic?	_____
2.	TEI number to be used for testing	_____
3.	If IUT is non-automatic TEI equipment, enter all TEI values assigned	_____
4.	SAPI number to be used for testing	_____
5.	Enter SAPI number which is currently unsupported in IUT	_____
6.	Window size (k) of the IUT	_____
7.	Maximum number of re-transmissions (N200) of the IUT	_____
8.	Maximum number of re-transmissions TEI Identity Request (N202) of the IUT	_____

Procedural information

9.	Can the IUT be forced to send TEI Identity Request on demand?	_____
10.	Can the IUT be forced to send a SABME in State 4 on demand?	_____
11.	Can the IUT be forced to send a SABME in any state on demand?	_____
12.	Can the IUT be forced to send a DISC on demand?	_____
13.	What is the preferred idle state for the IUT for Multiple Frame Operation (States 4.0 through 8.7)? Select States 4 or 7	_____
14.	If idle state is 7, can the IUT be forced to stay in State 4 for testing?	_____
15.	Can the IUT be forced into a busy condition on demand?	_____
16.	Can the IUT be forced to clear a busy condition on demand?	_____
17.	Can the IUT be forced to send one I frame on demand?	_____
18.	Can the IUT be forced to send more than one I frame on demand?	_____
19.	Does the IUT implement TEI Identity Verify Procedures?	_____
20.	Does the IUT initiate TEI Identity Verify Procedures upon receipt of an unsolicited UA received in States 4-8?	_____
21.	Does the IUT initiate Identity Verification or TEI removal procedure for MDL Error Indications A and B?	_____
22.	Does the IUT initiate Identity Verification or TEI removal procedure for MDL Error Indications G or H?	_____
23.	Is the timer T203 for link monitoring implemented?	_____

24. Enter the values used by the IUT for the following timers:
(Enter 0 if not implemented)

T200 _____

T202 _____

T203 _____

25. Enter the delay time (in milliseconds) for processing and transferring messages between the IUT and tester _____

26. If it is necessary to have the tolerance of timer T200 tested, please specify the tolerance of your timer T200 _____

27. Enter the value of a timer to ensure a response from the IUT when Layer 3 messages are expected _____

28. Does the IUT remove its TEI value upon receipt of an ID_Assign with Ai duplicated? _____

29. Is Q.931 software capability implemented (or present) in the IUT? _____

30. Does the IUT discard an unbounded frame if two times the longest permissible frame plus two octets are received without a flag detection? _____

– If yes, enter the length of a frame at which a frame is considered unbounded. _____

31. Does the IUT check the TEI number of the Identity assigned message received if there is no Identity check request message outstanding? _____

32. Does the IUT remain in the TEI Unassigned state after removal of the TEI number? _____

3 Electronic format of the abstract test suite

Two sets of diskettes are provided; the first describing the abstract test suites in tabular format, the second in machine procesable format. This applies also for Annex A.

3.1 Diskette interface and format

3.1.1 Abstract test suit: Part I - Basic rate user-side

Copies of the test suite are available from the ITU on 3½″ diskettes. The diskettes were created under MS-DOS operating system (version 3.0 or newer), and are of the 1.4 Mbyte high-density double-sided 96 tracks per inch MS-DOS format.

The files of the first set, the abstract test suite in tabular format, are in Postscript format compatible for printers with Postscript capability. The file of the second set, the machine processable format, is in ASCII.

3.1.2 Abstract test suite: Annex A to Part I (recommended until 31 March 1994)

Copies of the test suite are available from the ITU on 3½″ diskette. The diskette was created under MS-DOS operating system (version 3.0 or newer), and are of the 1.4 Mbyte high-density double-sided 96 tracks per inch MS-DOS format.

The files of the first set, the abstract test suite in tabular format, are in RTF (Rich Text Format) compatibile with Word for Windows, Word for MAC and Word for DOS. The file of the second set, the machine processable format, is in ASCII.

4 Abbreviations

For the purpose of this Recommendation, the following abbreviations are used:

Ai	Action Indicator
ATS	Abstract Test Suite
CPE	Customer Premise Equipment
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
IUT	Implementation Under Test
k	Window size
LAPD	Link Access Procedures on the D-channel
MFE	Multiple Frame Established
MFO	Multiple Frame Operation
MGMT	Management group
OSI	Open System Interconnection
PDU	Protocol Data Units
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation Extra Information for Testing
SUT	System Under Test
TA	Terminal Adaptor
TE1	Terminal Equipment of type 1
TEI	Terminal Endpoint Identifier
TTCN	Tree and Tabular Combined Notation
XID	Exchange Identification

References

[1] CCITT Recommendations X.290 to X.294, inclusive, *OSI Conformance Testing Methodology and Framework for Protocol Recommendations for CCITT Applications*, 1992.

[2] CCITT Recommendation Q.921 *ISDN User-Network Interface-Data Link Layer Specification*, 1992.