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Broadband Integrated Services Digital Network (B-ISDN); Framework for conformance testing of lower layers in B-ISDN

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Foreword

The purpose of this ETSI Technical Report (ETR) is to define a methodology framework for conformance testing of lower layers in advanced digital networks. On this basis, the relevant literature normally includes B-ISDN and MANs. However, this ETR deals with B-ISDN only. Reasons for this choice are the following:

- the recognition of two largely disjoint classes of problems for the two cases, imposes a need to establish a priority in the approach;

- a standardisation work for MANs has been performed within IEEE, which therefore might undertake a subsequent standardisation work on testing of related protocols;

- a standardisation work on B-ISDN has been performed by ETSI, which is therefore expected to undertake some standardisation work on testing of related protocols.

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0 Introduction

A "conformance testing methodology and framework" for OSI protocols already exists in ISO/IEC 9646 [1]. Under CCITT Recommendations X.290-X.294 [4]-[7], CCITT has promoted the same methodology as ISO/IEC 9646 [1]. The approach has been, and is being, adopted by several international organisations (e.g. SPAG,COS,POSI etc.) and programmes/consortia (e.g. CTS,OSTC etc.) involved in testing of OSI products.

The purpose of this ETR is to clarify whether and how the OSI framework in ISO/IEC 9646 [1] could be extended to B-ISDN. In order to help reasoning about possible extensions, it is appropriate to discuss the requirements of the (narrow-band) ISDN conformance testing and then the additional requirements coming from broad-band characteristics (B-ISDN).

ISO/IEC 9646-1 [1] states that its contents "are also, in principle, applicable to conformance testing for ISDN two-party protocols". As a straightforward consequence, "current ISDN testing is aimed at testing protocols only, either in the D-channel or the B-channel. It is implied that the B/D communication is working. The methodology defined in ISO/IEC 9646, completed with the multi-party testing methodology and the profile testing methodology both being progressed currently, provide a sound basis to properly test ISDN signalling protocols.".

However, complete ISDN conformance testing should also aim at verifying that the desired "functional real effects" actually occur out of the interaction between User/Control planes and Management plane (e.g. that a connection is available on channel B as a result of signalling on channel D). Rigorously speaking, overall conformance in ISDN cannot be inferred by just having assessed the conformance of single protocol entities in the various planes. Otherwise stated, the notion of ISDN conformance testing might not coincide with the mere notion of protocol conformance testing as in OSI. Thus, a truly complete conformance methodology for ISDN cannot be sought as a minor extension of OSI conformance methodology.

The transition from ISDN to B-ISDN implies a major change in the transfer technique. ATM is the all-purpose transfer technique associated with B-ISDN. Consequently, the protocol reference model also changes. The bottom layered stack "Physical, Link" is replaced by a new stack "Physical, ATM, ATM Adaptation Layer (AAL)". Instead, the basic distinction of a User plane (U-plane), a Control plane (C-plane) and a Management plane is maintained. Since a testing methodology mainly depends on the structuring and layering principles of protocols and services and only marginally on the particular nature of the single layers, it is reasonable to assume that extensions to the OSI 9646 [1] methodology covering the problem of inter-plane co-ordination in ISDN also apply entirely in B-ISDN. However, the peculiar functional structure of the AAL has no equivalent in narrow-band ISDN and might require a specialised approach for testing.

The transition from ISDN to B-ISDN implies also a dramatic change in the order of magnitude of transfer rate and volume of data. These non-functional aspects should have no influence on the principles of conformance testing. Of course, they put severe requirements on conformance testing tools, since these should be able to monitor and control high-speed and huge data flows. However, the impact of high speed operation on performance requirements of a conformance test environment is beyond the scope of this ETR.

Quality of service aspects (e.g. quality parameters on bearer services such as bit rate, jitter, error rate, etc.) are very important for B-ISDN. They can be considered as "non-functional real effects" of bearer services. Again, since these are properties that the equipment procurers would like to be guaranteed, they might be the object of an extended B-ISDN notion of conformance testing. Then, a conformance methodology for B-ISDN requires a major extension of ISDN conformance testing methodology.

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1 Scope

A conformance testing methodology and framework for OSI protocols already exists in ISO/IEC 9646 [1]. The purpose of this ETR is to clarify whether and how the OSI framework could be extended to B-ISDN lower layers.

The focus is on requirements for specific extensions to current testing methodology so that conformance testing of B-ISDN protocols becomes viable and effective.

The impact of high speed operation on performance requirements of the necessary testing environment is beyond the scope of this ETR. However, the testing of quality of service aspects (traditionally considered a performance matter in low speed data networks) might be viewed as a subject of conformance in the case of B-ISDN.

2 References

For the purposes of this ETR, the following references apply:

[1] ISO/IEC 9646 (1991): "Information technology - Open System Interconnection - Conformance testing methodology and framework".

[2] CCITT Recommendation I.413 (1992): "B-ISDN User-Network Interfaces".

[3] CCITT Recommendation I.321 (1992): "B-ISDN Protocol Reference Model and its application".

[4] CCITT Recommendation X.290: "OSI Conformance Testing Methodology and Framework for Protocol - General concepts".

[5] CCITT Recommendation X.291: "OSI Conformance Testing Methodology and Framework for Protocol - Abstract Test Suite Specification".

[6] CCITT Recommendation X.293: "OSI Conformance Testing Methodology and Framework for Protocol - Test Realisation".

[7] CCITT Recommendation X.294: "OSI Conformance Testing Methodology and Framework for Protocol - Requirements on Test Laboratories and Clients for Conformance Assessment Process".

[8] ISO/IEC JTC 1/SC 21 N 5076 (1990): "Information Retrieval, Transfer and Management for OSI Working draft for Multi-party Test Methods".

[9] BC-IT-226-CEN-CITC PT001 TASK D/14: Completion of OSI testing methodology, version 2, September 1992, also ATM (92) 100.

3 Definitions, symbols and abbreviations

For the purposes of this ETR, the following abbreviations apply:

A-PCO	Auxiliary Point of Control and Observation
AAL	ATM Adaptation Layer
AN	Access Node
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Service Digital Network
B-NT1	Broadband Network Termination 1
B-NT2	Broadband Network Termination 2
B-TE	Broadband Terminal Equipment
COS	Corporation for Open Systems
CPN	Customer Premises Network
CTS	Conformance and Testing Services (European Programme)

C/U-IUT	Control/User Implementation Under Test
ISDN	Integrated Services Digital Network
IUT	Implementation Under Test
L-PCO	Lower Point of Control and Observation
L-SAP	Lower Service Access Point
LM-SAP	Layer Management Service Access Point
LME	Layer Management Entity
LM-IUT	Layer Management Implementation Under Test
LT	Lower Tester
M-SAP	Management Service Access Point
MA	Medium Adapter
MAN	Metropolitan Area Networks
MPTM	Multi-Party Test Method
MS	Meta-Signalling
OSI	Open Systems Interconnection
OSTC	Open System Testing Consortium
PCO	Point of Control and Observation
PCT	Protocol Conformance Testing
POSI	Promotion for Open Systems in Japan
PRM	Protocol Reference Model
SAP	Service Access Point
SP	Service Primitive
SPAG	Standard Promotion and Application Group
SUT	System Under Test
SVC	Signalling Virtual Channel
U-PCO	Upper Point of Control and Observation
U-SAP	Upper Service Access Point
UT	Upper Tester
VCI	Virtual Channel Identifier
VPI	Virtual Path Identifier

4 Conformance testing requirements for B-ISDN lower layers

Prior to any conformance testing methodology for B-ISDN lower layers, a stable Protocol Reference Model (PRM) should be available. In this ETR, the B-ISDN PRM defined in CCITT Recommendation I.321 [3] is adopted (figure 1). According with this PRM, the term "lower layers" denotes all layers from Physical to AAL.

NOTE: It should be pointed out that the terminology in CCITT Recommendation I.321 [3] is not necessarily aligned with the ISO 7498 OSI Architecture. For instance, whereas in OSI the term "lower layers" indicates the protocol stack from "Physical" to "Network", in B-ISDN PRM it simply denotes the bottom layered stack "Physical, ATM, AAL". Obviously, the complementary notion of "higher layers" also assumes different meanings in the two protocol reference models.

4.1 Overview

The principle of uncoupling, for all telecommunication services, user information transfer functions from control information transfer functions (briefly referred as separation of the user and the control planes) is fundamental in the B-ISDN PRM.

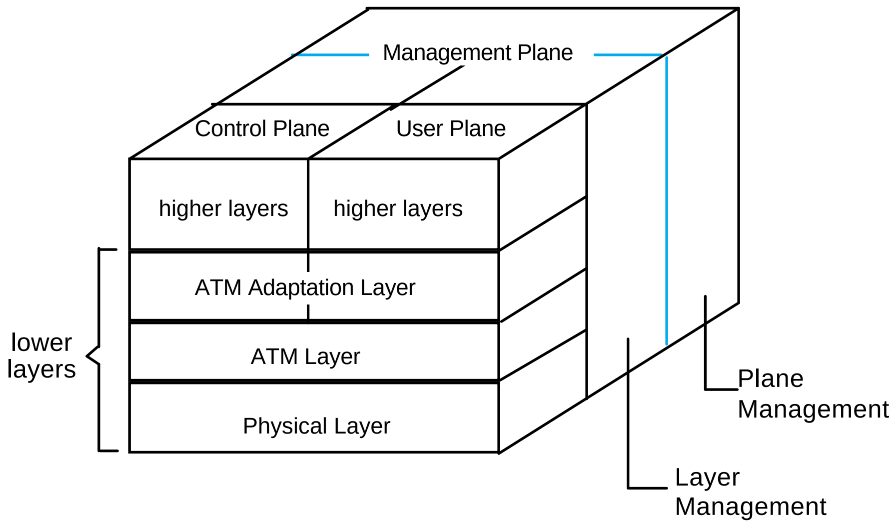


Figure 1: B-ISDN Protocol Reference Model

Application of such a principle allows on one hand a full integration of C-plane (Control plane) procedures for all services supported by the network and on the other hand the definition of services whose U-plane (User plane) characteristics are specifically tailored to the transfer needs of user information only.

The distinction between C-plane and U-plane is meaningful for layers above the AAL only. Within a given system, protocol entities in the C-plane communicate with layer management entities (LME). Also protocol entities in the U-plane communicate with LME. In layers for which the distinction between U-plane and C-plane makes sense the interaction between C- and U-plane is obtained via the Management plane.

In view of conformance testing of the lower layers, the Physical, ATM and AAL entities can be characterised as C/U-plane entities interacting with adjacent C/U-plane entities and with the corresponding LMEs. All these entities, in fact, are a subject for protocol standardisation and, therefore, for conformance testing.

The structure of lower layers in terms of entities and their relations is shown in figure 2. Service Access Points (SAPs) are foreseen within the C/U-plane at each upper layer boundary, between the C/U-plane and the Layer Management within each layer, and between Layer Management and Plane Management within each layer.

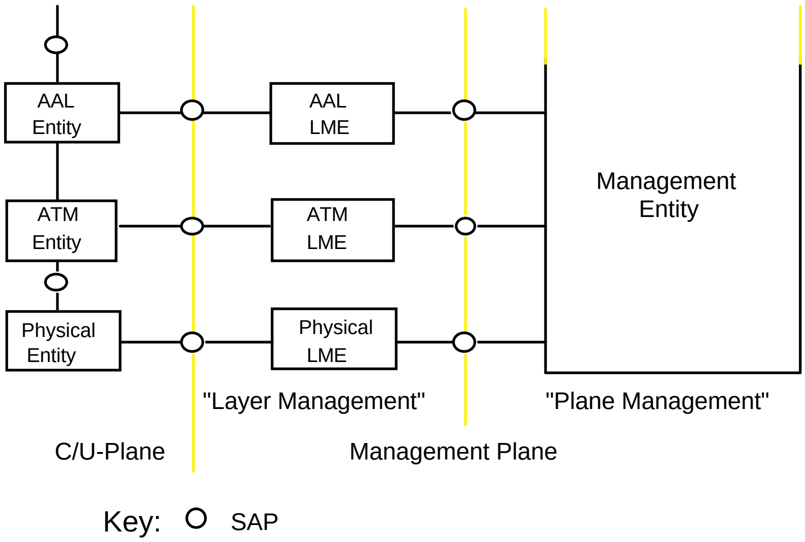


Figure 2: Lower Layers protocol architecture

Four major issues are involved in B-ISDN conformance testing:

- interdependence between C/U-plane and Management plane testing;
- need to cope with multi-peer protocols;
- need to include quality of service aspects into conformance testing;
- physical layer testing.

The next subclauses cover each of these issues.

4.2 C/U-Plane and management plane implications on conformance testing

The need to test the combined operation of entities in the C/U-plane and in the management plane makes a major difference with respect to the ISO/IEC 9646 [1] application scenarios.

In the OSI testing perspective an Implementation Under Test (IUT) has two SAPs, one at the upper layer boundary (U-SAP) and one at the lower layer boundary (L-SAP) (figure 3). These SAPs are fundamental to define possible Points of Control and Observation (PCOs) for the sake of testing and, consequently, the test method to be adopted. In particular:

- the localisation of the lower PCO just at the lower boundary of the IUT or at a remote access point to the underlying service provider originates two possible notions of Lower Tester (LT);
- the set of functions needed to observe and control the U-SAP originates the notion of Upper Tester (UT).

In B-ISDN testing perspective, a more complex situation should be faced:

- within the C/U-plane:
    - single-layer C/U-IUTs have three SAPs, the ordinary U-SAP and L-SAP and a new one at the boundary between the C/U-plane and the Layer Management, denoted LM-SAP in this ETR (figure 4a);
    - multi-layer C/U-IUTs have a U-SAP, an L-SAP and as many LM-SAP as included layers;
- within the Layer Management, LM-IUTs (obviously single-layer) have one LM-SAP at the boundary with the C/U-plane and a SAP at the boundary with the Plane Management, denoted M-SAP in this ETR (figure 4b).

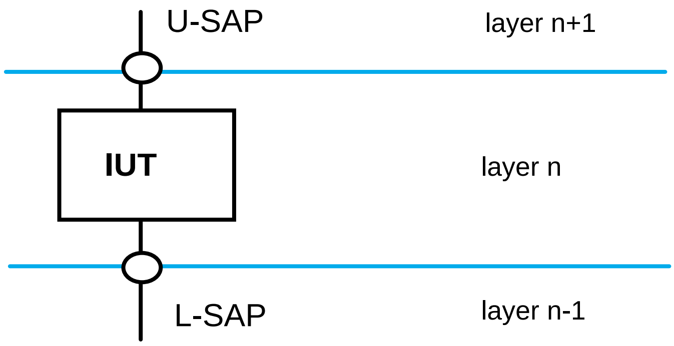


Figure 3: OSI testing perspective

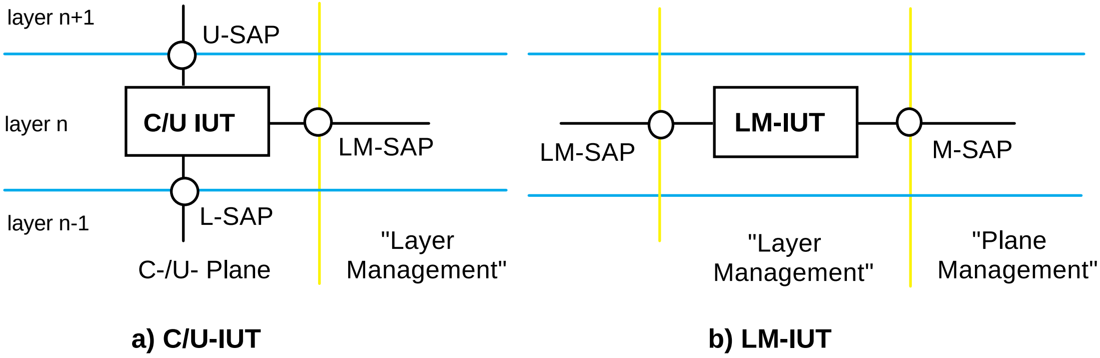


Figure 4: B-ISDN testing perspectives

4.2.1 Conformance testing of C/U-IUTs

In principle two UTs need to be defined for a C/U-IUT:

- a canonical UT to control and observe Service Primitives (SPs) at the U-SAP of the C/U-IUT;

- an "auxiliary" UT to control and observe SPs at the LM-SAP of the C/U-IUT.

The LT can be located either at the lower boundary of the IUT or at any remote access point to the underlying service provider.

Example: In order to test an ATM protocol entity, there is the need to control, through the ATM-LME, the association between the U-SAP (U-PCO) and the chosen VPI/VCI. For this purpose an "auxiliary" UT is needed at the LM-SAP. That is to say, an "auxiliary" PCO (A-PCO) should be foreseen at the LM-SAP (figure 5). For the sake of simplicity, in this example, both the U-SAP and the LM-SAP are assumed accessible.

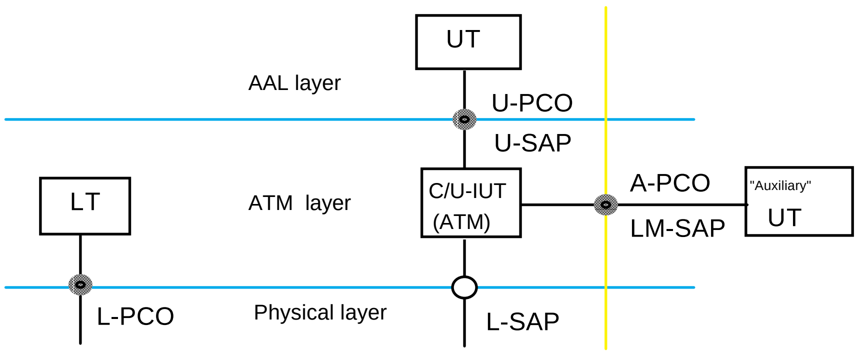


Figure 5: Example-ATM protocol testing

4.2.2 Conformance testing of LM-IUTs

As a minimum requirement, there should be:

- a canonical UT to control and observe SPs between the LM-IUT and the Plane Management at the M-SAP;

- a canonical LT to control and observe SPs between the LM-IUT and the C/U-plane at the LM-SAP.

The canonical LT can be located either at the LM-SAP or at a remote access point to the underlying service provider.

However, if "real effect" testing is considered, i.e. if fair operation of C/U-plane has to be assessed as a consequence of correct operation of protocols in the Management plane, the configuration should be completed by:

- an auxiliary UT to control and observe SPs at the U-SAP of the C/U-entity corresponding to the given LM-IUT;

- an auxiliary LT to control and observe SPs at the L-SAP of the C/U-entity corresponding to the given LM-IUT.

The auxiliary LT can be located either at the L-SAP or at a remote access point to the underlying service provider. In the latter circumstance, the canonical LT and the auxiliary LT may be unified in a single LT.

Example: A full satisfactory test of the Meta-signalling protocol concerning an ATM-LME should include the verification that an SVC has been properly assigned. For this purpose, an "auxiliary" UT is needed at the U-SAP of the ATM protocol entity. That is to say, an A-PCO should be foreseen at such a U-SAP (figure 6). For the sake of simplicity, full accessibility of M-SAP and U-SAP is assumed. The canonical LT is located at the remote side of the physical layer service provider and also includes the functions of the auxiliary LT. In practice the same LT acts as a canonical LT when using the meta-signalling ATM channel and as an auxiliary LT when using other channels.

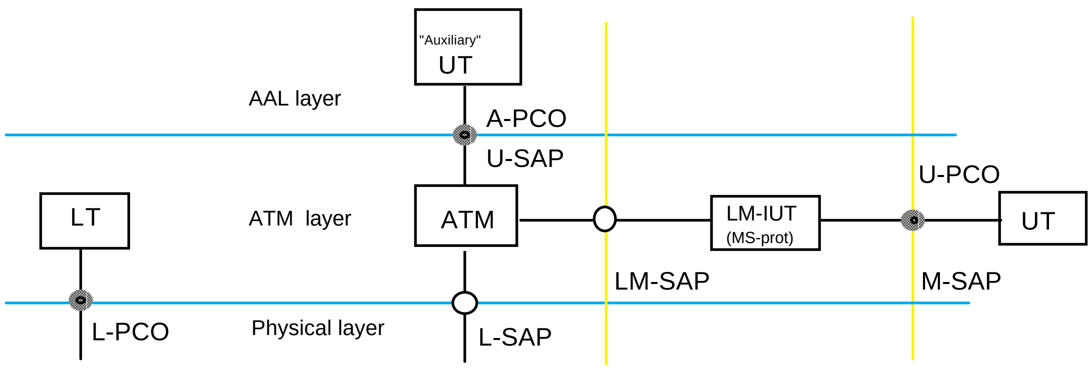


Figure 6: Example: Meta-signalling protocol testing

4.3 Multi-peer protocols

The AAL depends on the class of service offered to the higher layers: as such it is a multi-protocol layer. In particular, it can also include multi-point protocols (e.g. to support broadcast services).

Therefore, in the most general case, testing the AAL layer might require Multi-Party Test Methods (MPTM), see ISO/IEC JTC 1/SC 21 N 5076 [8]. The MPTM is a very general Abstract Test Method. It establishes an architecture for testing IUTs which handle more than one association/connection, each possibly with a different protocol. However, a special extension would be needed for B-ISDN, due to the fact that U/C-AAL entities (unlike OSI entities using two SAPs only) communicate via three SAPs.

NOTE: The impact of the MPTM on lower layer protocol testing cannot be evaluated further, until proper interrelation scenarios among lower layer entities in different planes are described in relevant CCITT Recommendations and ETSI standards.

4.4 Performance testing, quality of service testing and conformance testing

Quality of service (QoS) aspects (e.g. quality parameters on bearer services such as bit rate, jitter, error rate, etc.) are very important for B-ISDN. They can be considered as "non-functional real effects" of bearer services. Since these are properties that the equipment procurers would like to be guaranteed, they might be the object of an extended B-ISDN notion of conformance testing. If this view is adopted, a conformance methodology for B-ISDN cannot be sought as a minor extension of any possible ISDN conformance methodology.

Performance Testing, as the assessment of quality features of an IUT not related to non-functional properties requested by the upper layer, of course still remains outside the scope of conformance testing.

NOTE: The question whether "QoS Testing should be considered, at least partially, within the Conformance Testing framework" needs careful evaluation among a wide group of experts.

4.5 Physical layer testing

In [9] it is said: "Physical layers encompass standards of various nature and conformance requirements as well as test notations can take many forms, inspired by the usual style adopted in literature on applied physics or electronics (diagram, curves with gauges, formulas, etc.)". And also: "Physical layer testing is not of the same nature as testing the layers above - there are doubts that Profile conformance testing for T/profiles should include layers-1 testing".

These consideration can also be applied for B-ISDN physical layer.

NOTE: The question whether "Physical layer testing should be outside the general framework for testing" needs a careful evaluation among a wide group of experts.

5 Possible SUT scenarios

In this subclause, possible scenarios for systems to be tested according to a forthcoming B-ISDN testing methodology are given. They are considered of guidance when reasoning on test methods and test configurations. In order to depict such scenarios, the following steps are taken:

- adopt a B-ISDN Reference Configuration and related Functional Groupings;
- preview a set of possible different implementations of the Reference Configuration (called Implementation Configurations in this ETR);
- identify, in the Implementation Configurations, protocol interfaces relevant for testing;
- identify protocol scenarios in different planes, for selected Functional Groupings.

At the end of this exercise, a set of suitable SUT types is envisaged.

5.1 Reference configuration

The basic B-ISDN Reference Configuration defined in draft CCITT Recommendation I.413 [2] is adopted (figure 7).

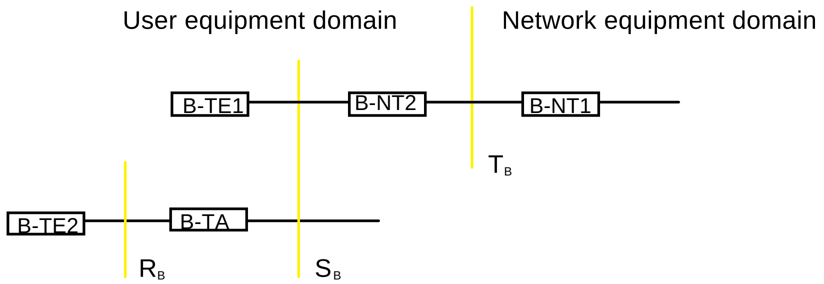


Figure 7: B-ISDN Reference Configuration

The priority target of Conformance Testing procedures is constituted by protocol implementations in user equipment rather than in network equipment. In the user equipment domain, in fact, there will presumably be the maximum degree of competition with a highly multi-vendor environment. As for the network equipment domain, the degree of competition will be lower and, on the other hand, network providers may set up their own acceptance testing procedures in their product procurement process, without necessarily relying on internationally recommended methodologies.

In this ETR only the priority target of user equipment domain is considered. The boundary between user and public domain is located at the reference point T_B. Therefore this ETR applies to testing of terminal (B-TE1) and to network termination B-NT2.

The R_B reference point is not considered here, due to a minimal interest in conformance testing of TAs and B-TE2, on the basis of the following considerations:

- dealing with TAs from S_B reference point does not add any value to the methodology to be devised, because, as far as Testing Scenarios are concerned, it would be very much like referring to S_B reference point in view of B-TE1 testing;

- dealing with TAs from R_B reference point would complicate the approach since a number of different types of B-TE2s should be considered; a limited choice of B-TE2 types would be of interest in the perspective of implementing industrial test systems but not in a methodological framework.

5.2 Implementation configurations

The possible ways in which the Reference Configuration materialises in real implementations are of primary relevance for a testing methodology. Three different streams of implementation choices are possible:

- location of physical interfaces with respect to Reference Points;

- functionality of B-NT2;

- topology of B-NT2.

5.2.1 Mapping reference points into physical interfaces

Conformance Testing methodologies are closely dependent on the actual location of physical interfaces with respect to the reference points. CCITT Recommendation I.413 [2] provides a list of examples of physical configurations for broadband user applications. According to such examples, physical interfaces can occur:

a) at distinct reference points S_B and T_B;

b) at reference point S_B only;

c) at reference point T_B only;

d) at a location where both reference points S_B and T_B coincide.

In case a) there is full accessibility of reference points S_B and T_B. In case b) reference point T_B is not physically accessible because B-NT2 and B-NT1 are implemented in one single equipment. In case c) reference point S_B is not physically accessible because B-NT2 and B-TE are implemented in one single equipment. In case d), the functions associated to B-NT2 vanish at all.

Case a) is the most meaningful for a general approach to testing methodologies.

5.2.2 Functionality of B-NT2

The following two cases apply:

- B-NT2 supporting a number of terminals which access the user/network interface and require local B-ISDN exchange intervention, both for communication with remote terminals (external traffic) and for communication with other terminals within the same customer premises (internal traffic);

- B-NT2 supporting a number of terminals and directly providing internal traffic among them without involvement of B-NT1 and local B-ISDN exchange; B-NT2 includes necessary switching functions for internal traffic.

The aggregation of B-NT2 and of the attached B-TE1s and terminal equipment of other types is also known as the Customer Premises Network (CPN).

5.2.3 Topology of B-NT2

The topology of B-NT2 can be either centralised or distributed.

- A centralised B-NT2 gathers traffic from a number of B-TE1, switching it among attached terminals or forwarding it to the public network (figure 8a);

- A distributed B-NT2 provides a multipoint access to a shared medium at the S_B interface. It has a distributed structure consisting of an AN (Access Node) and a number of MA (Medium Adapter), each providing physical adaptation to the shared medium used for the CPN (interface W). The AN also provides access facilities to the public network at T_B interface (figure 8b).

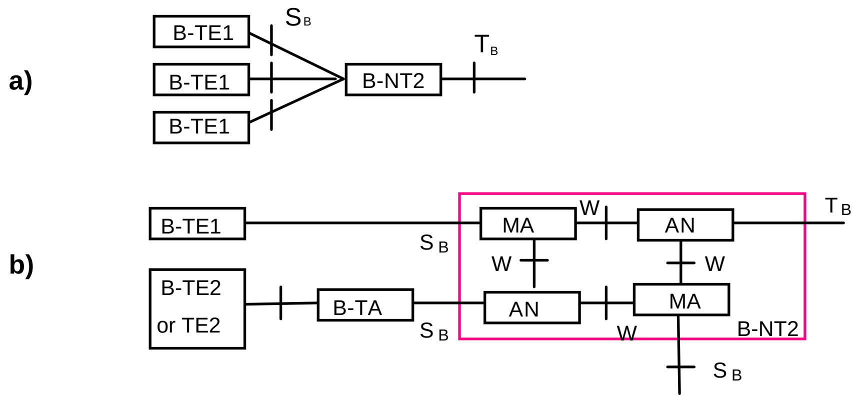
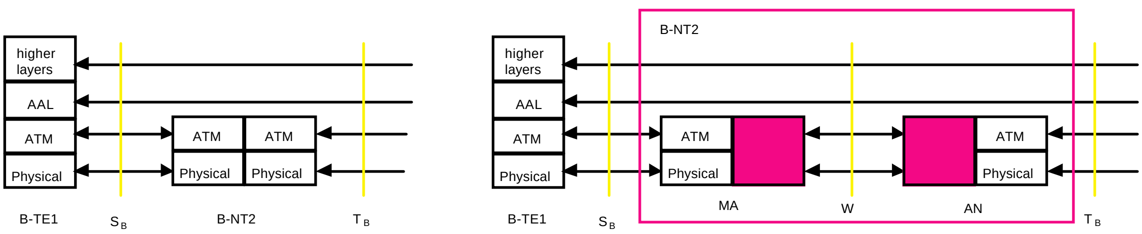


Figure 8: Examples of physical configurations of CPNs

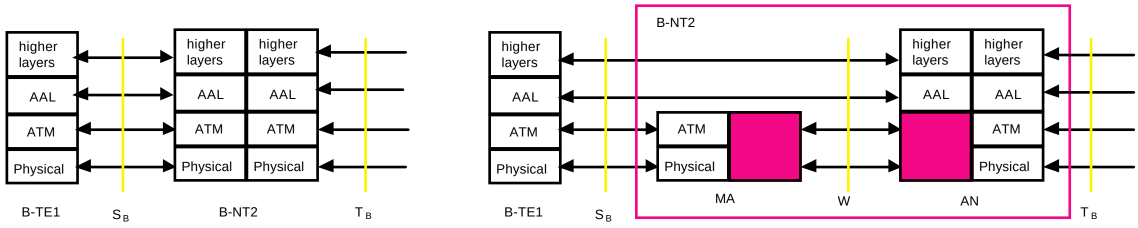
5.3 Protocol interfaces

Under the assumption already made in subclause 5.2.1 that, in general, reference points S_B and T_B are mapped onto distinct physical interfaces, the two kinds of functionality and the two kinds of topology for B-NT2 give rise to the four scenarios depicted in figure 9 and in figure 10 for protocol interfaces of relevance to a testing methodology. For the sake of simplicity the distinction among planes is not shown in these pictures. It should be noted that the layering structure of AN is similar to the layering structure of a centralised B-NT2, with the only exception that lower protocols at the W interface may be proprietary. For each functional grouping shown in there, not all layers are relevant in both C- and U-plane. This subject is briefly explained in subclause 5.4.



a) Centralized B-NT2 **b) Distributed B-NT2**

Figure 9: Protocol interfaces in the CPN (case of B-NT2 with no switching functions)



a) Centralized B-NT2 **b) Distributed B-NT2**

Figure 10: Protocol interfaces in the CPN (case of B-NT2 with switching functions)

5.4 Protocol scenarios for the most relevant functional groupings

It is worth pointing out how for each functional grouping shown in figures 9 and 10 protocol layers are located in the C- and U-plane, respectively.

5.4.1 Application to B-TE1

In this case the layering structure comprises all possible layers for user, control and management plane. Figure 11 shows the corresponding complete layered structure.

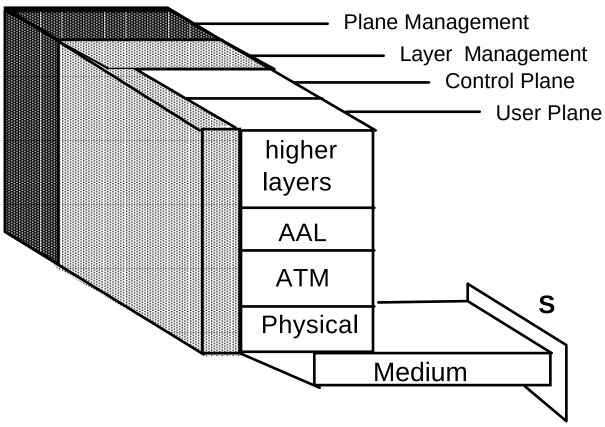


Figure 11: B-TE1

5.4.2 Application to B-NT2

Among the Functional Groupings, it is clearly understood that B-NT2 is most subject to a wide range of protocol structures and implementations.

The most general structure is obtained in case of a B-NT2 supporting a set of terminals and providing switching functions among them. In case of a centralised configuration the layering structure is given in figure 12.

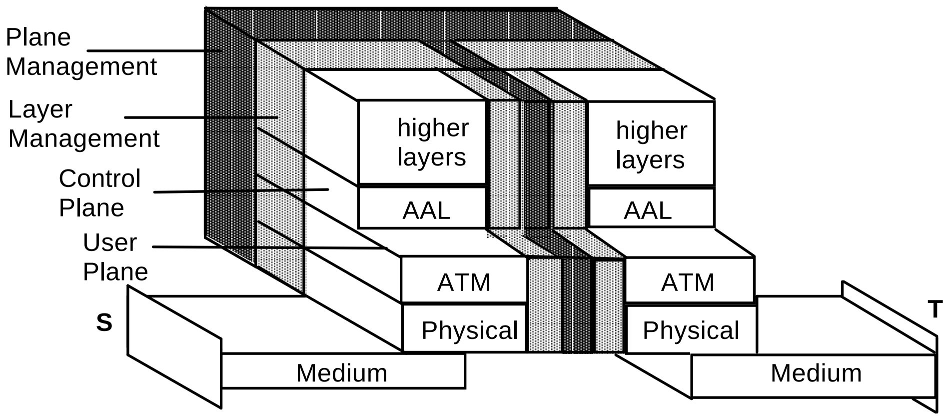


Figure 12: Centralised B-NT2 with switching functions

In case of a distributed configuration, the layered structure of the MA is given in figure 13. As already mentioned in subclause 5.4.1, the layered structure of the AN is identical to that of a centralised B-NT2, but with possibly proprietary ATM and physical layers at the W interface.

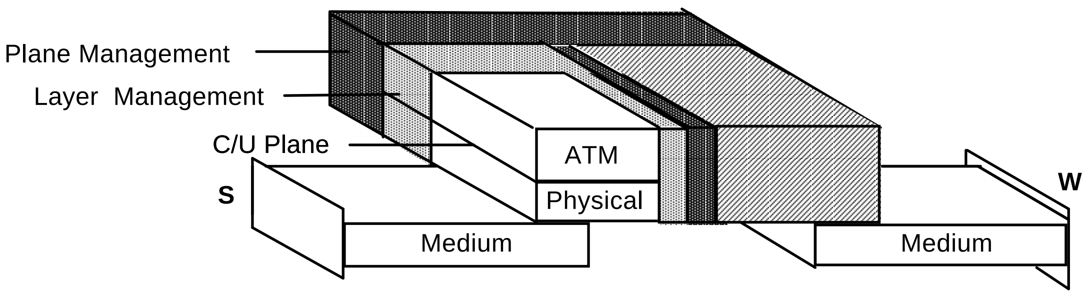


Figure 13: MA (in case of distributed B-NT2 with switching functions)

5.5 Identification of suitable SUT types

Following the analysis performed in the previous subclause, the B-TE1 and B-NT2 functional groupings have been identified as the relevant objects of the B-ISDN lower layers Protocol Conformance Testing (PCT).

According to such analysis four SUTs must be taken into account:

1) centralised B-NT2;

2) MA (in case of distributed B-NT2 only);

3) AN (in case of distributed B-NT2 only);

4) B-TE1.

The main concern deals with considering how the B-ISDN lower layers stack Physical, ATM and AAL is implemented. The following, mutually exclusive, alternatives apply:

- monolithic: the entire stack is implemented as a whole; this implies no accessibility to any internal boundary between layers or planes; however, it does not necessarily imply accessibility to the AAL upper boundary within the C/U-plane;

- layered: the entire stack is implemented in two or three parts (sub-stacks); this implies the accessibility to each upper layer of the sub-stacks within the C/U-plane and, of course, no accessibility to any other layers (internal boundaries among planes might be accessible);

- partial: only a monolithic sub-stack including the Physical layer is implemented.

The above implementation types are the most likely from the view point of the manufacturers. It is well understood that a testing methodology should not impose any constraints on the implementation choices of manufacturers. However, future investigation is advisable, in order to understand which accessibility requirements could be usefully incorporated in the protocol standards for the sake of testability.

For centralised B-NT2, for AN (distributed B-NT2) and for B-TE1 lower layers can be implemented either as a monolithic stack or as a layered stack. A monolithic lower layer stack might even be embedded below its higher layers; in this case there is no accessibility to the AAL upper boundary within the C/U-plane.

For MA (distributed B-NT2) a monolithic sub-stack including the ATM and the Physical layer is implemented (partial stack). It is possible that no access to the upper ATM layer boundary is provided. However, at least the possibility to exchange transparent data (e.g. ATM cells) above it is desirable.

6 Conclusions

In this ETR the problem of testing lower layers of advanced digital networks has been approached by identifying requirements on suitable extensions of the OSI testing methodology. Requirements have been identified in two steps: from OSI to (narrow-band) ISDN and from ISDN to B-ISDN.

The evolution from an OSI environment to ISDN consists in differentiating between U-plane and C-plane and in co-ordinating the respective protocols by means of LMEs in the management plane. As a result, several protocol entities are involved in the testing of a single layer and, thus, additional types of SAPs and PCOs have been identified. Consequently, new types of UTs and LTs have been targeted as a subject for further investigation.

The evolution from an ISDN environment to B-ISDN implies that:

a) a multi-protocol layer (the AAL) be introduced, which adapts the same transfer technique (ATM) to the different needs of various service classes (in general, also multi-party protocols should be foreseen);

b) testing of non-functional properties, in the form of measurement of performance-related parameters, become a subject for conformance testing.

As a result of point a, multi-party test methods, as emerging in the current proposed extensions to OSI testing methodology, might be required. As an implication of point b) above, measurement methods not found at all in OSI testing methodology should be developed.

History

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