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New presentation - see History box

Contents

Foreword

ETSI Technical Reports (ETRs) are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

This ETR has been produced by the Advanced Testing Methods (ATM) Technical Committee of the European Telecommunications Standards Institute (ETSI). More specifically, it is the result of joint effort of experts contributing to ETSI TC-ATM Project Team 5 (PT 5) and the European Workshop for Open Systems (EWOS) Expert Group in Conformance Testing (EGCT) working on the Bon de Commande BC-IT-02. Due to the similarities in objectives, ETSI TC-ATM and EWOS EGCT have agreed to issue common texts, one per body. The equivalent EWOS document is known as ETG 010.

An element of ETSI TC-ATM is to act as a catalyst for ETSI to adopt a common methodology for the development of Conformance Testing Standards within ETSI (or parts of ETSI Standards dedicated to conformance testing).

ETSI TC-ATM wishes to explore innovative solutions for the long term, but also to be, for the present, a proposer in harmonised approaches to the pressing requirement of developing testing standards in various ETSI Technical Committees. It is essential that ETSI is aware of developments in the field of Information Technology outside ETSI, which are closely related to its own technical activities. This set of objectives requires a preliminary common background spread over ETSI as a whole. ETSI TC-ATM hopes that this ETR can be seen as a guide which is a positive step forward in this direction.

This ETR aims to cover the overall Conformance Testing (CT) scenario, but, at the same time, its objective is to develop an easy and practical tool for focusing the basics of the various issues. For each section to this ETR, references will be provided where detailed and up-to-date information can be found.

The work of ETSI TC-ATM currently covers CT aspects relating to communications (i.e., protocols and interfaces, especially OSI) standards and not physical/electrical specifications. The contents to this ETR reflect this limitation.

This ETR is to be regarded as a preparatory base for a future specific technical guide to the development of ETSI CT standards and it should eventually become the common reference for the various ETSI Technical Committees, and possibly an ETS. This ETR is expected to be revised periodically in order to take into account significant progress of the various issues and to update relevant references.

ETSI TC-ATM advises TC and STC Chairmen, in their role of co-ordinators of standards development, to ensure that groups of experts working in the field of CT in their bodies are fully aware of the status of affairs in this area to allow the proper co-ordination of initiatives. Special care should be devoted to the methodology used (test specifications structure, test notations, criteria for acceptance, etc..), to the need to avoid duplication of effort and to the strategy of improving convergence for testing at the European an international level.

It is recognised that this ETR is of limited use in this respect, but with the co-operation of all ETSI Members, an initial orientation towards a harmonised approach to CT standards and practice is desirable and possible. As part of its 1991 work programme, ETSI TC-ATM is now to produce a comprehensive Methodology Guide to move further towards harmonisation and consistency. To aid in this process, it is essential that all TCs and STCs provide prompt and constructive feedback.

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Introduction

This ETR provides an introduction to the techniques of Protocol Conformance Testing. The state of the art has progressed rapidly during the last 10 years, thanks to the advent of OSI, to intensive standardised efforts at the international level, and to numerous European initiatives. This ETR is a guide which attempts to explain the state of the art without too many details, starting with what is available and actually practised for OSI and the Telecommunications Standards now embedded in the OSI "lower layers". The achievements - and remaining issues - related to the work done in the international standardisation arena (CCITT/ISO) are highlighted.

It also acts as a tutorial on the most recent standardised techniques and procedures for OSI conformance testing, when a product is to be tested against a set of OSI standards. It is based on ISO/IEC 9646, "OSI conformance testing methodology and framework", which is concerned only with single layer base standards. The tutorial has been extended to profiles, taking into account the most recent work within ISO/IEC/JTC1 and the work carried out by Project Team 5 on mandate BC-IT-01-SI. The tutorial applies to OSI proper, but is also a useful reference for conformance testing against any communications standard. Care should be taken, however, when using it for the Physical layer (electrical and mechanical requirements).

The following points are addressed by this ETR:

Part 1 - Conformance testing: scene and players

This introductory part stresses the importance of the conformance testing process. Communication protocol standards are useless if there is no way to verify that products are available which implement the protocol standards with RIGOUR. The major steps of the process and the key technical components are defined, also reasoning explaining the necessity to scaffold the conformance testing process using several types of International or European Standards.

Part 2 - Conformance requirements in protocols

This part provides some background on the base standards and the profiles requirements. It explains how the conformance requirements are expressed, so that all implementors get the same understanding, and can develop conformance claims consistent with the requirements of the standards and profiles.

Part 3 - Conformance testing: methodology overview

A methodology is presented in this part, based on ISO/IEC 9646. Testing methods, test suites, test operations are the main headers.

Part 4 - Design of a conformance testing standard

This part gives the ground rules on the way to structure and write a standardised test suite, as part of a conformance testing standard for a protocol. The ad hoc TTCN notation is briefly presented. The last annex gives an example of this notation.

Part 5 - Harmonisation - certification - accreditation - Arbitration - Maintenance

This final part mentions other testing issues, and the link between the notions of certification and accreditation is established.

Appendix A - Who's who in Conformance Testing

Provides a list of general references on the subject of conformance testing.

Appendix B - Further readings on conformance testing

Appendix C - a TTCN example

Appendix D - List of abbreviations

1.0 CONFORMANCE TESTING: SCENE AND PLAYERS.

1.1 The meaning of conformance to OSI standards.

The primary objectives of OSI standardization is to allow systems developed by different vendors to work together, to exchange and handle information.

Conformance in the context of OSI is concerned with the **conformance of products** (we say also: conformance of implementations or real systems) to the OSI standards, strictly speaking **to the protocol standards**. It is not concerned with conformance to the OSI services nor to the OSI reference model itself. (No conformance rules applicable).

An implementation or a system is declared conformant if its capabilities and external behaviour are shown to satisfy the requirements of a defined set of capabilities or options in the referenced standards.

The set of implemented capabilities is stated by the implemented of the system. The system is submitted to testing for verification of its capabilities and behaviour and for assessment of its conformance.

1.2 Importance of conformance testing

Conformance testing is verification that an implementation meets the formal requirements of the referenced standards and, more precisely, that it meets the conformance clauses contained in the standards. During the test phase, the implementation is referred to as the Implementation Under Test (IUT).

The primary objective of conformance testing is to increase the probability that different product implementations actually **interoperate**. The testing of performance and robustness are not part of the conformance testing process.

No amount of testing can give a full guarantee of successful interworking. The exhaustive testing of every possible aspect of protocol behaviour is unrealistic and impractical for technical and economical reasons. Conformance testing can however give a **reasonable degree of confidence** that an implementation which passes the tests, will comply with the requirements in its communication with other systems. As such, conformance testing can be regarded as a prerequisite for interworking.

Any test can be easily contentious. When comparing a product with its specification, using testing tools, we could ask, in case of discrepancies: Is the product wrong? Is the specification ambiguous? Is the test biased? Is the testing method suitable? Is the testing process agreed and understood?

One way to solve some of these questions in advance is to standardize: **Use of standard protocol specifications, use of standard tests, use of standard methods, use of standard testing process**. This is what Conformance Testing is about, based upon a **standard testing methodology**, as defined by ISO and CCITT.

The benefits of conformance testing can be increased further. The use of standard methods, based on approved test suites developed for each OSI standard protocol, and on testing procedures, lead to the **comparability of results** produced by different testers, and thereby to the **mutual recognition of test reports**. This will minimize the need for repeated conformance testing, and minimize the associated costs.

1.3 Conformance methodology status of ISO/IEC 9646

The methodology for OSI Conformance testing of single protocol base standards is described in a five-part document, ISO/IEC 9646, which contains:

1. General concepts

2. Classification of testing architectures and recommendations for the specifications of conformance test suites.

3. Definition of the notation to be used for the specification of standardized abstract test suites.

4. Requirements and guidance concerning the realization of a tester, i.e. a "tool" and the procedures for building up a testing service.

5. Guidelines to the test laboratory and to the client to conduct the conformance testing process.

All five parts will be soon issued as International Standards (IS). They will also be published as the CCITT X.290 series.

ISO/IEC 9646 will be complemented to incorporate additions in the area of Profiles. But let us define base standards and profiles.

1.4 Base standards and profiles

A standard relative to a single protocol in a given OSI layer is a Base Standard. It is normally an ISO International Standard or a CCITT recommendation. A base standard offers many options and functional variants. When a multilayer stack of several adjacent base standards are implemented in two different real open systems, the chances that they interoperate are best if the two systems implement the same set of options. The harmonization of such common sets of functions lead to the notion of profile.

"A Profile is a set of one or more base standards, and, where applicable, the identification of chosen classes, subsets, options and parameters of those base standards, necessary for accomplishing a particular function" (ISO TR 10000).

Such a function might be a type of Application, or a Transport service based on specific telecommunications techniques, for instance.

The purpose of defining a profile is to facilitate interoperability. The limitation of options is beneficial to the procurement of systems as it offers a more consistent implementation. It is also beneficial to the development of conformance tests as it offers a greater uniformity.

The tutorial refers to the two sources of OSI profiles which are of primary concern for Europe:

the European Functional Standards (FS), and the International Standard Profiles (ISP) issued by ISO.

The test of protocols only is addressed in this tutorial. A protocol can be a base standard by itself, or can belong to a profile. A profile stands for an ISP or a FS.

1.5 Client and test laboratory

The test of conformance is organized between a client and a test laboratory.

The **client** is the organization which implements or supplies the product to be tested. Its responsibility is to state which part of the System Under Test (SUT), called Implementation Under Test (IUT), is to be tested, and to what protocols it claims conformance. It can be a single protocol or a multi-protocol product implementation.

The **test laboratory** is responsible for conducting the test and can be

- The organization which implements or supplies the product (first-party tester)
- The organization which will be using the product, and which is willing to test it (second-party tester)
- Or an independent organization whose business is the testing of products (third-party tester).

1.6 Conformance assessment process

The method used to conduct the test, called the conformance assessment process, is standardized to achieve some degree of comparability of test results on similar products tested by different test laboratories. Recommendation and guidance are given for each of the three steps.

1.6.1 Test Preparation

The initial step, called Test Preparation, verifies that both parties (client and test laboratory) agree on the test and the way to conduct it. The product, the tested protocol, the testing method, the test environment are agreed upon.

Two types of documents are important at this stage:

1. Protocol Information Conformance Statement (PICS)

The PICS is a statement made by the client, the supplier of the OSI implementation. It is based on the PICS proforma which is part of the relevant protocol standard. It states the capabilities and options which have been implemented and the features which have been omitted. Thus the implementation can be tested for conformance against the relevant requirements listed in the PICS, and against those requirements only.

There is one PICS for each protocol implemented in the IUT, for which conformance is claimed. To test against a profile, a "compound" PICS is required. Its definition is in the 1.8, "Applicability to profiles" on page 11.

2. Protocol Implementation eXtra Information for Testing (PIXIT)

The PIXIT is a statement made by the client, the supplier of the OSI implementation. It is based on the PIXIT proforma supplied by the test suite specifier and refined by the test laboratory. It provides additional information about the IUT necessary for the test laboratory to conduct the test. This includes: addressing information, test method information, specific values to complement the range of values stated in the PICS, etc.

There is one PIXIT per test suite used, meaning, in general, one PIXIT for each protocol implemented and under test in the IUT. The PIXIT is also extended to the profiles.

1.6.2 Test Operations

The second step, called Test Operations, is where test campaigns are carried out.

This step requires the preparation of the test tool, the test suite and the test environment. Starting from a standardized collection of test cases (called a standard Abstract Test Suite (ATS)), which is capable of testing a standard protocol in its generality, one builds a collection of test cases executable in the test environment of a specific implementation.

1.6.3 Test suites

The conformance testing methodology distinguishes between abstract and executable test suites.

Abstract Test Suites (ATS) are designed for the protocol specification standard to be tested, are standardized themselves, and are preferably written in the Tree and Tabular Combined Notation (TTCN) protocol independent language. This language is described in 4.7, "Abstract test notation: TTCN" on page 33.

Executable Test Suites (ETS) are derived from the abstract ones in a process consisting of several steps.

- First, a selection of abstract test cases is made, according to the mandatory and optional functions implemented in the IUT. The result is a **Selected Abstract Test Suite (SATS)**

- Second, parameterization is done to adapt the selected set of test to the test environment. The result is a **Parameterized Abstract Test Suite (PATS)**

- Finally derivation is carried out. This includes translation into the language of the tester. This step leads to the **Parameterized executable test suite (PETS).**

1.6.4 Means of testing

The complete process of derivation from the Abstract Test Suite (ATS) to the Parameterized Executable Test Suite (PETS), which is the actual test suite to be run, is controlled by the Means Of Testing (MOT) and relies on the two documents: PICS and PIXIT.

The Means Of Testing (MOT) is a combination of equipment and procedures to create the PETS starting from the ATS, including possibly the creation of the intermediate stops: Selected test suites (SATS, SETS) and Parameterized Abstract test suites (PATS).

The MOT provides a facility to generate a conformance log. The conformance log is a record of information produced as a result of a test campaign, containing the observed test outcomes. It allows verification of the assignments of test results.

1.7 Conformance test reports

The third step of the conformance assessment process is the production by the test laboratory of two types of test report: a System Conformance Test Report (SCTR) and a Protocol Conformance Test Report (PCTR), for each protocol tested. The proforma of each report is standardized, to allow harmonization between test laboratories.

1.7.1 System Conformance Test Report (SCTR)

The SCTR documents the results of the conformance testing on the client's SUT. It contains an identification summary of the different elements (test laboratory, client, SUT, nature of the conformance testing), a system report summary per protocol indicating the reference to the different standard components (protocol, PICS, PIXIT, ATS) and the test results (number of test cases run, passed, failed, inconclusive).

1.7.2 Protocol Conformance Test Report (PCTR)

A PCTR records the results of the conformance testing process of one protocol implemented in the SUT and submitted to test using a specific ATS standard. There are as many PCTRs as there are tested protocols in the SUT.

The PCTR contains the necessary identifiers (Protocol, PICS, PIXIT, ATS, IUT, etc) and the detailed results of the tests (Static and dynamic conformance summary). In addition, the report of the test campaign indicates for every test case of the ATS standard, and in the order of this standard, if the test case was selected, was run to completion, and its execution result (also called verdict). Note that the order of the test case execution can be different from the order of the test report, to allow run time optimization.

1.8 Applicability to profiles

The ideas of conformance to base standards are currently being extended to the conformance to profiles, FS or ISPs. Most of the concepts remain unchanged.

The general approach for dealing with a profile is to list and re-use the material already existing for each base standard referenced in the profile, and to keep the necessary additions for the profile itself to a minimum.

The PICS proforma to be completed by the implementers to indicate the static conformance requirements of the base standards, are to be grouped together in a compound PICS. The test suites developed for each base standard are the basis for testing a profile, layer by layer.

If the testing material for the base standard does not exist, solutions aiming at generating the material of the base standard relative to the profile are adopted by the organization responsible for development.

2.0 CONFORMANCE REQUIREMENTS IN PROTOCOLS

A conformance testing process requires that:

- the conformance requirements of the communication protocols are specified in the protocol standards with vigour and in great of detail, and
- similarly, the implementers claiming to "support" those standards express the conformance of their products with the same level of detail and vigour, using the concept of PICS, and PICS proforma.

It is essential that all EWOS/ETSI standards specifiers in Europe have a clear understanding of the state of the art (and of the ISO/IEC 9646 standard), in terms of conformance requirements. Before issuing a protocol standard or a profile, the ultimate task is to review the protocol and its associated PICS proforma (or the profile and its associate compound PICS proforma), and to make sure that ***the conformance requirements are consistent.***

2.1 Base standards

2.1.1 Protocol specifications

The standardized protocol specifications define the procedures for communicating between real open systems, at a given level of the network architecture (OSI, ISDN...). The external observable behaviour only is described. It is this behaviour that concerns conformance, not the internal behaviour of the implementation.

Protocols are defined in prose, but it is expected that they will eventually be defined by means of one of the Formal Description Techniques (FDT), standardized by ISO and CCITT (SD L Z. 100, ESTELLE IS 9074, LOTOS IS 8807).

Provided prose is used, the protocols can also be specified by state tables representing the (extended) finite state protocol machine. The state tables give the possible event occurrence, valid or invalid, for each defined state, together with the required actions and the transition to the next state.

A worldwide library of communications protocols has been developed by CCITT and ISO/IEC JTC1 (ex ISO TC97) SC6 over the last few decades. Since 1978, the same bodies plus ISO TC97 SC16 (renamed ISO/IEC JTC1 SC21 in 1985/1987) have created the OSI architecture, which organizes the protocols in a new framework, and defines the OSI basic reference model and the "OSI standards".

Other TCs of ISO, and SCs of ISO or ISO/IEC contribute to this realization (Text processing, security, manufacturing protocols, Banking and Library applications, etc.). IEEE and ECMA are noticeable contributors of pre-standards to ISO and CCITT. This helps to speed up the standardization process.

The same standard bodies are in charge of developing all additional material for conformance testing (PICS proformas, conformance testing standards, abstract test suites).

For more information on the contribution of each group, refer to the annex 'Who’s who on Conformance testing on page 48.

2.1.2 Conformance requirements in base standards

The protocol standards, Implicitly and by definition, contain requirements to be met by the implementers. The standard must define clearly what conformance to this standard means, what shall be done, what is permitted, mandatory, optional, what is not permitted in such and such case...

But it is current practice in ISO - and a stringent ISO/IEC 9646 requirement - that requirements are expressed more explicitly.

A specific clause must appear in the protocol standards, stating the conformance requirements. Logically, the conformance requirements can be:

- Mandatory, meaning: to be observed in the external behaviour, in all cases;
- Optional, meaning: may or may not be selected to suit the implementation.
- Conditional, meaning: to be observed if conditions set out in the standard apply (usually the selection of an option);

In the protocol standard, conformance requirements fall into two groups:

- Static conformance requirements

They define the minimum capabilities to be 'supported' by an implementation, in order to facilitate interworking. All capabilities not explicitly stated as mandatory static conformance requirements become optional.

In particular, they specify:

  - the options to support the transmission, the receipt and response to Protocol Data Units (PDUs);
  - the options to initiate or accept a connection, in the case of connection oriented protocols;
  - the permitted range of values for the PDU parameters.

- Dynamic conformance requirements

  They specify what observable behaviour is permitted by the protocol standards, when the implementation uses the protocol functions to **communicate.**

  In particular, they specify the PDU types and encoding rules.

The dynamic conformance requirements are to be found in the body of the standard itself, but they are also listed, for convenience, in the clause on "conformance requirements".

2.1.3 Conformance statements - PICS

When a protocol is implemented, all implemented capabilities must be clearly stated in a complete list of the capabilities of the relevant protocol. To harmonize such lists in the industry, the concept of a standard Protocol Information Conformance Statement (PICS) is introduced.

A PICS is a statement made by the supplier of an OSI implementation or system, stating which capabilities and options have been implemented for a given OSI base protocol.

A PICS makes a contribution to the conformance assessment process, where it is used in:

- the static conformance review;
- the test selection process, as a means of adapting the executable test suite to the options supported by the implementation;
- the results analysis process, as a reference document.

2.1.4 Standard PICS proforma

The format of the PICS for a given protocol is standardized: it is the PICS proforma.

The PICS proforma is a document, **part of the standard** of a base protocol, in the form of a questionnaire, designed by the protocol specifier or the conformance test suite specifier, which when completed for an OSI implementation or system, becomes the PICS.

It defines explicitly the implementation flexibility allowed by the protocol standard. It details in a tabular form:

- the implementation options, i.e. the optional and conditional functions additional to those which are mandatory to implement; and

- the legitimate range of variation of the global parameters controlling the implementation of the functions, as specified in the protocol standard.

A PICS proforma completed for an implementation by answering Yes or No to the questions, becomes the PICS for the implementation in question.

The PICS proforma is also used by:

- the specifiers of Abstract Test Suite, who need to ensure that the structure of the test suite matches the allowed implementation flexibility;

- the specifiers of Profiles, who require a detailed definition of the implementation flexibility available in each base standard.

The PICS proforma is used as input to the design of the ATS of a base standard.

Often, the development of a PICS proforma by the protocol designers - to complement the protocol standard - has proved to be a difficult task, with room for interpretation of ISO/IEC 9646, and of the protocol standard itself, The reference tools are ISO/IEC 9646-2, Annex A (use IS version), and the catalogue of PICS proforma notation (SC21 N 5078 until May 1991). This notation is explained in chapter 2.3, "PICS, IPRL/FSRL notations" on page 20.

2.1.5 PIXIT proforma and PIXIT

The PIXIT proforma is a document, related to a base standard, in the form of a questionnaire, provided by the test laboratory. When completed during the preparation for testing, the PIXIT proforma becomes the PIXIT for the specific test campaign.

A PIXIT is a statement made by the supplier or implementer of an IUT which contains or references all of the information (in addition to that given in the PICS) related to the IUT and its testing environment, and which will enable the test laboratory to run an appropriate test suite against the IUT.

Typical PIXIT questions relate to the actual duration of some timers in the implementation (when there are no conformance requirements on that timer), or to addressing information to prepare the connection between the testing machine and the system under test.

2.2 Functional Standards and Profiles

2.2.1 Definitions

Products supporting OSI and communications protocols are developed either as "platforms" able to fit a variety of uses and applications, or as specific products, providing a given function or set of functions. In both neither case can the developers support every octet of all base standards. Instead they market a selection of options and alternatives.

As the objective is interoperability of products, the selection process must be harmonized and eventually standardized. This is what is known as Functional Standardization, the development of functional standards or profiles.

A profile, in the context of OSI, is a combination of base standards necessary for accomplishing a particular function (for such purposes as interoperability).

A profile specification is the specification of the **set** of referenced base standards, **together with** the expression, where applicable, of a choice of classes, subsets, options and parameters, necessary for accomplishing the function of the profile.

The development of FS has been pioneered in Europe by SPAG and endorsed by ITSTC in the field of IT and Telecommunications. The concept has been accepted by ISO (SGFS group).

North America (OIW workshop) and Japan (INTAP, AOW) have similar projects. The process is gaining international momentum, and convergence between all these approaches is of course actively pursued.

2.2.2 European FS, EN and ENV

The main reference for FS in Europe is the ITSTC Memorandum M-IT-02, which provides a full “Directory of Functional Standards". For each FS that is deemed necessary in Europe, M-IT-02 outlines the profile (a stack or other combination of base standards), the expected function, and typical scenarios for using it. M-IT-02 is updated at intervals.

Once on the list, the technical development of FS in Europe is governed by ITSTC and performed by EWOS and/or ETSI. When a draft has received approval by the technical body identified by ITSTC as the responsible entity, it is handed over to CEN/CENELEC to enter the formal approval procedure, which is based on the principle of public enquiry and national weighted voting.

When the final approval has been achieved, the FS gains the status of ENV then EN after at least a 2 year period, and is numbered as such in the Register of CEN/CENELEC.

2.2.3 International Standardized Profiles (ISP)

A special group for functional standardization (ISO/IEC JTC1 SGFS) is in charge of the ISO profiles. The first achievement of SGFS is the Technical Report TR 10000, which defines a taxonomy of profiles similar to the European one.

Profile work is facilitated by direct inputs from "feeders" (SPAG, MAP, POSI, COS,...) and the regional workshop (EWOS in Europe).

When agreed at the international level a Profile becomes an International Standardized Profile (ISP).

An ISP is an ISO document, "internationally agreed-to and harmonized", which comprises the specifications of one or more profiles already defined in the "taxonomy document".

2.2.4 European Telecommunications Standards (ETSI's ETS)

European Telecommunications Standards (ETS) are the standards produced by ETSI in its own right under the ETSI Rules of Procedures and as such they have an autonomous status with respect to EN's.

The development of an ETS is in many respects similar to the process of defining a FS, at least in those cases where a reference base standard exists or is sufficiently developed. This seems particularly true in the area of protocols. As a consequence it may be reasonable to expect that in certain areas (most of the ETSI-TC-TE activities for instance) some convergence in the methodology to develop ETS's and FS is obtained. Similarly this should happen for the associated Conformance Testing standards also.

NOTE - ETSI contributes also to the development of EN/ENVs.

2.2.5 Profile classification (taxonomy)

The two taxonomies (FS in Europe or ISP for-ISO) are not too different from one another. In both cases, the 7 layers of the OSI reference model are split into two families .

- The Application profiles, from layer 5 to 7.

- The Transport profiles, from layer 1 to 4.

1. In the ISP taxonomy (ISO/IEC JTC1 SGFS - TR 10000), the two families are further subdivided according to the transport service required or provided.

Figure 1 on page 17 illustrates this classification (for ISPs).

- Application profiles
  - **F-profile:** Interchange Format and representation profile
  - **A-profile:** application profile requiring Connection-mode transport service (i.e. using T-profiles). Examples:
    - AFT for File Transfer,
    - AMH for Message Handling,
    - AVT for Virtual terminal,
    - ATP for transaction processing, etc.
  - **B-profile:** application profile requiring connection-less mode transport service (i.e. using U-profiles).

Distinction between A/B-profiles and F-profiles is that of the difference between the communications protocol support (A/B) and the characteristics of the information which is communicated (F).

- Transport profiles:
  - **T-profile:** Transport profile providing connection- mode Transport service, divided into TA, TB, TC, TD, TE according to the Transport class and physical layers.
  - **U-profile:** Transport profile providingconnection-less mode Transport service, also divided into UA, UB.

F, A, B, T and U profiles apply to End System profiles. In addition, R-profiles are Relay System profiles.

2. In the European taxonomy (M-IT-02), the profiles are identified by prefixes like A/ and T/.

- Q/ profiles for Interchange format and representation profiles
- A/ profiles - examples:
  - A/1xxx for File Transfer,
  - A/3xxx for Message Handling,
  - A/4xxx for Virtual terminal,
  - A/8xxx for transaction processing, etc.
- T/ profiles - examples:
  - T/1 xxx for ISDN connections,
  - T/3xxx for packet switching,
  - T/6xxx for LANs...
- R/, C/, and Y/ profiles cover Relay profiles, Combined techniques, or "others», like Y/11-Y/12 for X.3/X.28/X.29.

European profiles are often referred to by their EN/ENV number, when a Functional Standard is issued. Example: ENV 41201 for A/3211 HMS profile

An alignment of the European taxonomy is being prepared by EWOS. European profile names will be the same as in ISO, but with a slash (/) after the first letter to retain some of the old style and distinguish the two sources. Some classification will be changed, like Q/ will become F/xx.

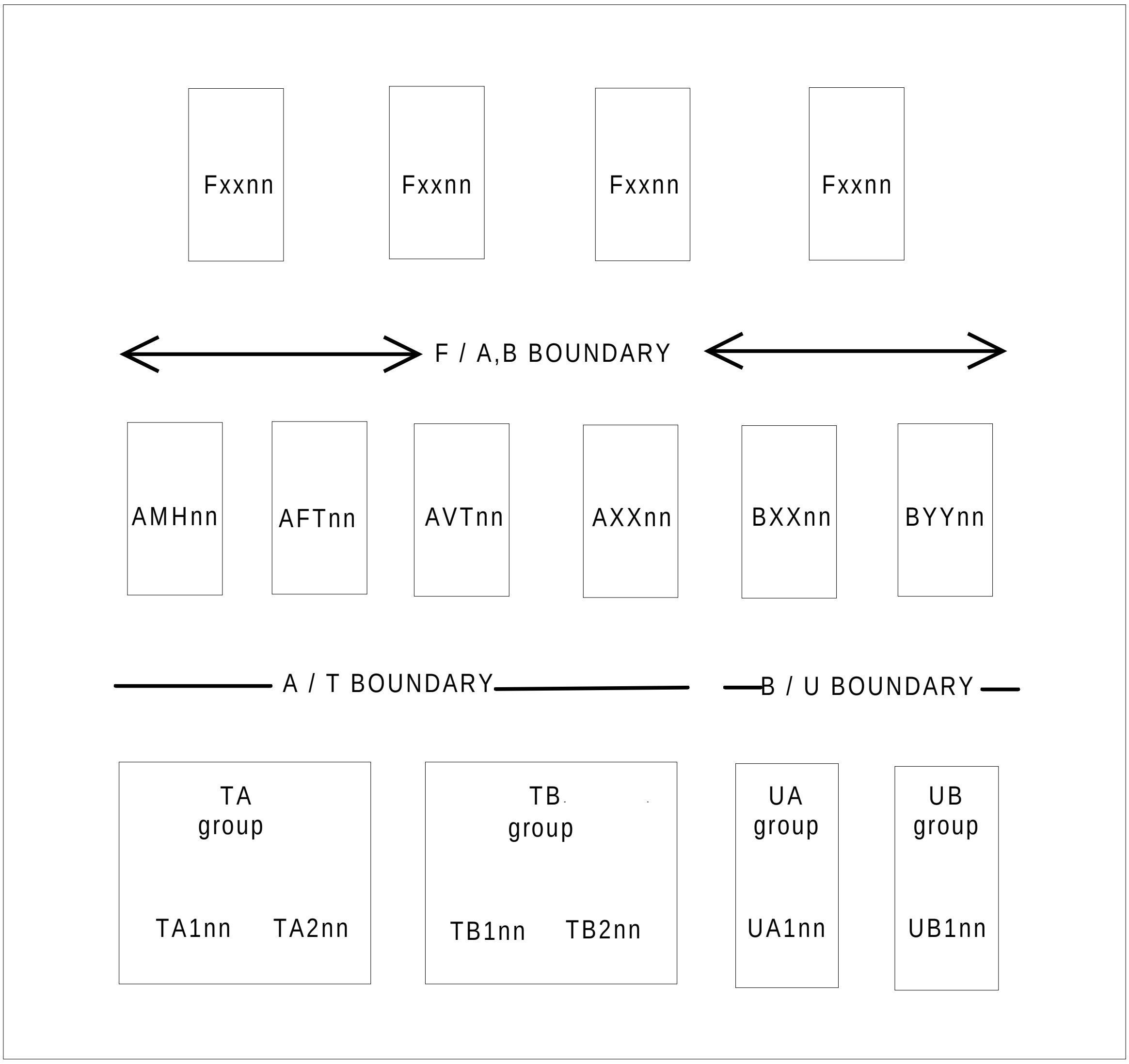

Figure 1. Profile taxonomy as per TR l0000 (ISO/IEC JTC1).

2.2.6 onformance requirements in the Profiles

The concept of conformance requirements must be extended to the profiles:

- for the profiles to be useful and implemented with care;
- for the profile to be consistent with the conformance requirements of the base standards.

In this document, conformance and conformance testing information related to the profiles will be given for both ISPs (ISO) and FS (Europe):

- For the Functional Standards (Europe), the Technical Report of the Project Team 5 on the mandate BC-IT-01-SI is the reference document. Acronyms begin with FS.
- For the International Standardized Profiles, the reference documents are the ISO/IEC JTC1 SGFS TR 10000 and the working draft on Protocol Profile Testing Methodology (ISO/IEC JTC1 SC21 N 5075). Acronyms begin with ISP (e.g ISPICS) or I (e.g IPRL).

A remark: a profile is in itself an extended set of static conformance requirements, as it makes a selection of the static conformance requirements of the base standard(s). Dynamic conformance requirements do not need to be repeated in a Functional Standard or ISP. There are exceptions, but the principle is: Profile = Static Selection and Parameterization, as appropriate.

2.2.7 SPICS and IPRL

The following applies only to ISPs of ISO. See next clause for European profiles (Functional Standards)

When an implementer supports a profile, TR 10000 requires that he completes an ISP Implementation Conformance Statement (ISPICS).

An ISPICS is a compound PICS, i.e. a statement made by the supplier of a system which claims to conform to an ISP, stating the capabilities and options which have been implemented, and all optional features which have been omitted, with respect to the requirements of the ISP.

An ISPICS Requirements List (IPRL) is a document specifying how to write an ISPICS. TR 10000 specifies that an IPRL must be provided for each Problem contained in the ISP document,

- presenting the general options of the Profile as a whole,
- giving a list of the standards selected and combined in the Profile,
- referring to the standardized PICS proformas of those base standards,
- expressing, for each of those PICS proformas, in a separate section, the constraints upon allowable answers necessary to achieve the purpose of the profile.

The ISPICS can be developed by the implementer, by combining the relevant completed PICS proformas, taking into account the IPRL constraints, and answering additional questions, if any.

The specification of an IPRL in an ISP which is constructed from explicit references to PICS proformas of base standards, is possible only if all the PICS proformas of the relevant base standards have been published as standards, and are in an adequate form to meet the needs of the ISP.

When a set of PICS is produced in accordance with the IPRL by the supplier of a system implementing the profile, the set of PICS becomes an ISPICS, stating the system's conformance to the mandatory and optional features of the profile, and by way of them, its conformance to the selected features of the referenced base standards.

In some exceptional cases, the profile may specify additional profile specific conformance requirements, which are wholly outside the scope of any of the base standards referenced. This may require additional questions and answers in the IPRL, for which the base standard PICS proformas are not appropriate. Care should be taken that the number of such statements is kept as small as possible.

ISPICS, and more generally compound PICS proformas documents, are used as input to the design of the conformance testing standards for a profile. Figure 2 describes the relationship between PICS, ISPICS and IPRL. This figure is derived from ISO/IEC SC21 N 5075 on Profile Methodology.

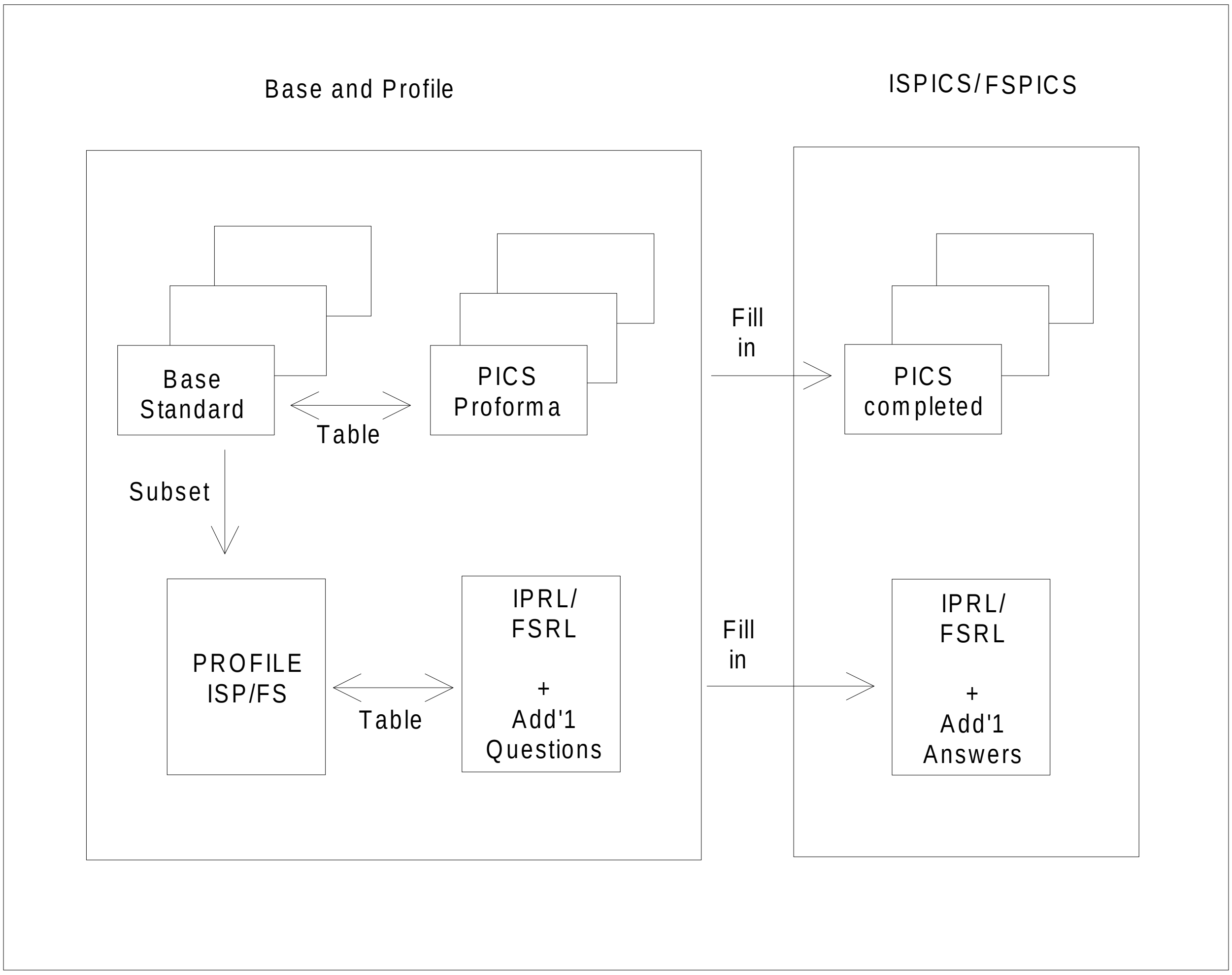

Figure 2. Relationship between PICS proformas, IPRL and ISPICS.

2.2.8 SPICS and FSRL

The following applies only to European FS.

When an implementer supports a profile, he will be required to complete an FS Implementation Conformance statement (FSPICS). This is similar to ISO requirements, but is using a different terminology.

An FSPICS is a statement made by the supplier of a system which claims to conform to a Functional Standard, stating the capabilities and options which have been implemented, and all optional features which have been omitted, with respect to the FSRL (similar to ISPICS for ISPs).

An FSPICS Requirements List (FSRL) will be a document accompanying a Functional Standard in Europe and form part of the FSTS (see 4.8.3, "FSTS and FSTS-S" on page 37). It plays the same role as an IPRL for the ISPs of ISO.

The same remarks as for IPRL in 2.2.7, "ISPICS and IPRL" on page 18 apply.

Figure 2 on page 19 describes the relationship between PICS, FSPICS and FSRL. This figure was modified for this tutorial to show the convergence between the ISP and FS approaches.

2.3 ICS, IPRL/FSRL notations

A PICS proforma is a set of questions related to the capabilities of the protocol.

PICS proforma notation is defined in ISO/IEC 9646-2, Annex A. Additions to the notation have been and will be recorded In a Catalogue of PICS notations, owned by SC21/WG1. Current version is SC21 N 5078.

Each PICS proforma question (or entry) shall indicate a **status** for each capability, according to this notation.

This status can be:

- mandatory (M) - the capability is required to be implemented, in conformance with the protocol standard;
- optional (O) - the capability may be implemented, and if it is implemented it is required to conform to the protocol specification; options can be Boolean, mutually exclusive, or selectable, as described in ISO/IEC 9646-1, clause A.3);
- prohibited (X) - there is a requirement not to use this capability in a given context (applicable only to dynamic requirements embedded in a PICS proforma;
- not applicable (N/A or-) - no requirement can be expressed in a given context.
- conditional (C) - the requirement on the capability depends on the selection of other optional or conditional items; the PICS proforma cannot define in advance a definite status for the capability, it can only indicate that the status (mandatory, optional, prohibited, or non applicable) depends on the evaluation of a predicate or conditional expression.

ISO defines also the set of options o. < i >, meaning one out of the alternatives from the set identified by i. (See the catalogue of PICS notations SC21 N 5078).

Room is provided in front of each capability listed in the PICS proforma, to indicate if it is supported.

The value of the support can be:

- implemented (Y, y, YES, yes)
- not implemented (N, n, NO, no)
- N/A or - for not-applicable.

I (implemented) and X (not implemented) are deprecated.

2.3.1 Conditional expression

Conditional requirements need a reference to a predicate in the PREDICATE column of the PICS proforma, or to the label of a conditional expression in the STATUS column.

When a single predicate P is indicated, the PICS proforma makes clear in a global statement which assumption is made, or which convention applies. P is usually another entry in the PICS, and is true if that entry is supported by the product implementation.

When a reference to a conditional expression is indicated, e.g. C1, the expression itself appears as a note at the end of the table. For instance:

```
C1: IF P THEN m ELSE o
```

where P is a predicate name or a direct reference to a PICS proforma entry. In the latter case, C1 evaluates as "mandatory" if the capability P is supported, and "optional" if it is not.

Complex Boolean expressions can be provided, using the Boolean expression from TTCN. For instance:

```
C3: IF (p1 AND NOT p2) OR (p3 < 2) THEN m ELSE -
```

where p1 is a PICS proforma entry (yes/no)
p2 is a PICS proforma entry (yes/no)
p3 is a PICS proforma question expecting an integer answer.

Several syntaxes to refer to a condition are permitted.

```
         Item      Status    Predicate

EXAMPLE  Item A    c: m      P1
                      o      not P1

EXAMPLE  Item B    c: m      P2

(default for B: not applicable if P2 not true)

EXAMPLE  Item C    C3
```

2.3.2 Extension to profiles

In the base standard, the static requirements are explicit in the PICS, while the dynamic requirements are expressed in the behaviour of the standard itself.

Profiles can place additional requirements. For example while a profile should not exclude a permitted capability of a base standard, nor allow a prohibited one, the optional facilities of the base standard can become either Mandatory or Optional or Conditional. All these modifications must be identified in the IPRL or FSRL, and the notation should distinguish between static and dynamic facilities.

A two-letter notation allows the following requirements to be expressed:

- **mm** mandatory to be implemented AND used.
- **mo** mandatory to be implemented, optional to be used.
- **oo** optional to be implemented, optional to be used if implemented.
- **ox** optional to be implemlented, prohibited from use.

An ISPICS or FSPICS line will look like this, for example:

ITEM	STATUS	SUPPORT	USE
a	mm	yes	yes
b	mo	yes	no
b	ox	no	n/a

3.0 CONFORMANCE TESTING: METHODOLOGY OVERVIEW

This section describes the main principles of the methodology applied to Base Standard conformance testing, as defined by the standard ISO/IEC 9646, expanded to ISP conformance testing by the ISO/IEC TR 1000O, and (at working draft level) by the ISO/IEC 9646 addendum on Protocol Profile Testing Methodology (SC21 N 5075). It is further expanded to FS conformance testing by the Technical Report (Project Team 5) on the mandate BC-IT-01-SI, in Europe. ***The next clauses apply first to conformance testing against base standards, Explicit extensions then address the profiles.***

3.1 Types of conformance tests

There are four types of tests which may possibly be applied to the Implementations Under Test.

- Basic interconnection tests:

  These establish that there is sufficient conformance for interconnection to be possible, and that the main features of the protocol are implemented, without undergoing thorough testing.

  Basic interconnection tests are standardized (part of the standard conformance test suite), but may be omitted.

- Capability tests:

  The capability tests check that the observable external static capabilities of the implementation are valid with respect to the static conformance requirements expressed in the PICS of the IUT.

  Capabilities tests are standardized (part of the conformance test suite) and mandatory.

- Behaviour tests:

  These tests check, as thoroughly as practical, the dynamic conformance of an implementation with respect to the dynamic conformance requirements specified in the protocol standard.

  The implementation is submitted to a hint number of combinations of events and timing of events, as defined in a test suite. The behaviour of the IUT is checked by the tester and, according to the presence or absence of error, the IUT is declared conformant, to a specific aspect of the protocol specifications covered by this test, or non conformant, In other words, the verdict of each test case is either Pass (meaning conformant), Fail (not conformant), or Inconclusive if no definite conclusion can be derived from this test.

  Behaviour tests are standardized (the test suite being standardized) and mandatory.

- Conformance resolution tests:

  These tests comprise an in-depth checking of conformance of the implementation to a specific protocol requirement, to provide definite diagnostic information or a yes/no answer to a specific conformance problem.

  Conformance resolution tests are not standardized and not mandatory, and used only when it is necessary to restrict a test to a narrow field.

3.2 Conformance testing architecture

The general architectural framework consists of the connection of a well known and controllable system called a **test system,** to the OSI system to be tested, using a link or a network, as shown in Figure 3 on page 23.

The **Implementation Under Test or IUT** is that part of the open system supporting the OSI protocols, **which is to be tested.** The IUT may include one or more OSI protocols in adjacent layers, from layer N to layer N+n, with n = 0 for a single layer IUT.

A full stack of OSI layers from 2 to 7 is an example of an IUT for the test of MHS X.400, with N = 2 and N + n = 7. Another example is a partial stack of layers 2 and 3 for X.25 testing, or a single layer IUT like Transport or Session.

Although the IUT can be defined from any layer to any layer, the System Under Test must start from layer 1, then onwards, to comply with ISO/IEC 9646.

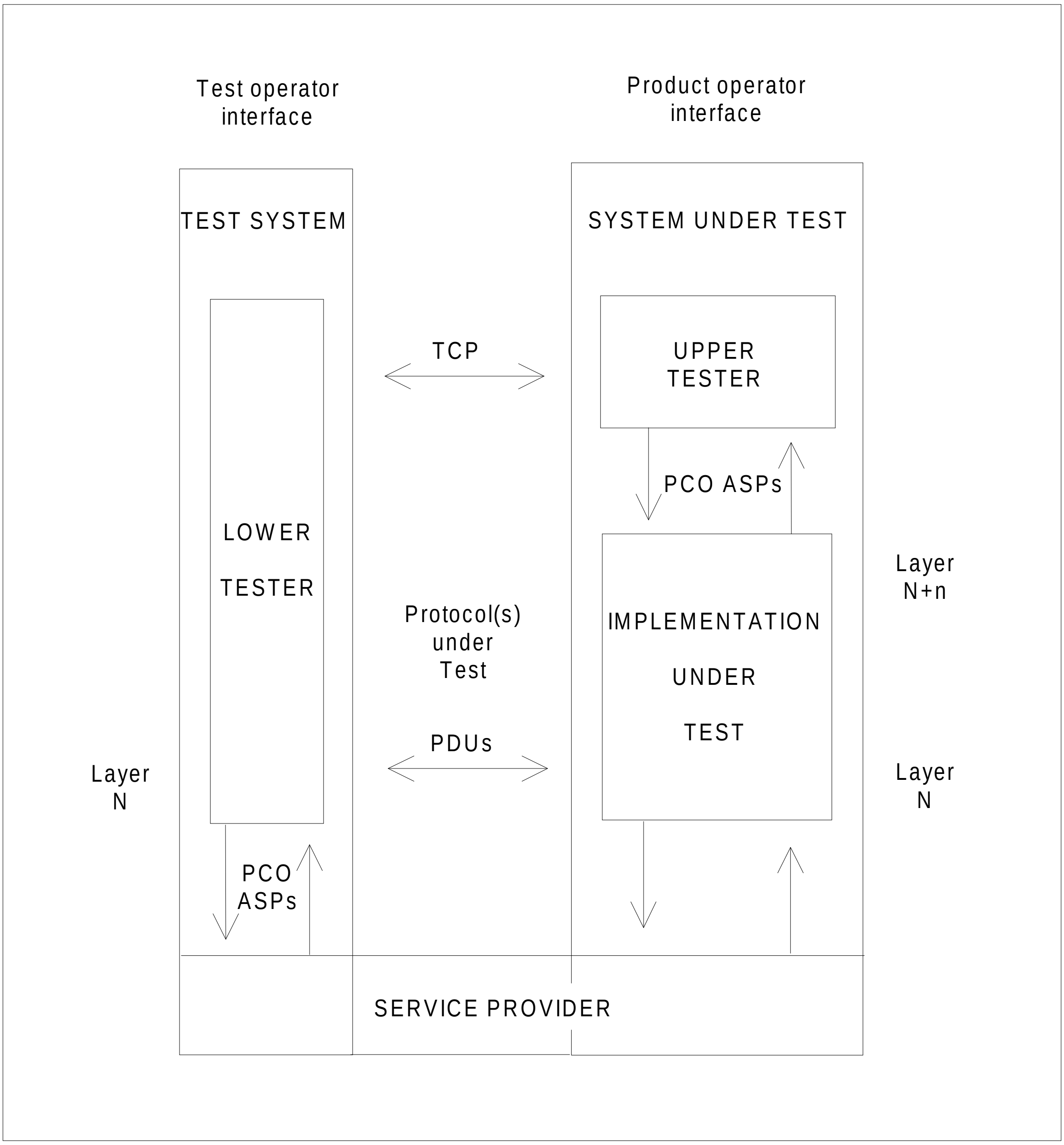

Figure 3. Conformance testing architecture

The system under test (SUT) is therefore composed of the layers 1 to N-1 which provide the communication service between the 2 systems, the IUT itself (N to N+n), and finally the Upper Tester- (UT); we will see later that the UT is optional.

The test system communicating with the IUT is composed of the layers 1 to N-1, plus the lower tester (LT), covering N to N +n and the communication with the UT, plus many auxiliary functions.

The name of the tester, lower or upper, refers to the side of the IUT with which the tester interfaces.

The layer N of the lower tester is always accessible (e.g. by an intercept trace function), and is either below the IUT or remote from the IUT, depending on the testing method. It can be considered as an image of the layer N of the IUT, and it is a privileged position from which to observe the IUT.

The upper tester (which does not exist in some abstract testing methods) is a piece of software or equipment or an operator acting above the IUT.

The two testers interact with the IUT by exchanging OSI service primitives, (called Abstract Service Primitives (ASP) in ISO/IEC 9646) and Protocol Data Units (PDU). The exchanges of ASPs and PDUs are the **test events** by which the tester drives the IUT in specific test cases (Control), and observes the consequent behaviour of the IUT (Observation).

The points where the LT and UT issue and monitor the test events are called Points of Control and Observation (PCO), if they correspond to accessible interfaces. The PCOs are, except for the upper layer, the Service Access Points (SAP) where this particular service would be offered to normal users.

A test suite is designed on the principle that **the IUT is seen as a black box,** and that the test events can be controlled and observed only from the available PCOs, at layer N (always), and N+n (possibly). As the upper PCO is optional, the style of the test suites will be different depending on whether there are one or two PCOs.

The UT and LT need to be coordinated by means of Test Coordination Procedures (TCP) which vary from one test method to another.

3.3 Abstract test methods

Figure 4 on page 25 distinguishes the four different configurations of conformance testing, called Abstract Test Methods (ATM), which have been specified in ISO/IEC 9646.

The four methods fit the general architecture described above, but they differ in the degree and kind of coordination between the UT and LT testers and the accessibility of the upper IUT boundary to connect the upper tester. They apply directly to single layer IUTs.

Testing a multilayer IUT is done incrementally, layer by layer (protocol by protocol). Testing the top layer of a multilayer IUT resembles single-layer testing. Testing the layers below, without changing the testing configuration, requires what is called embedded testing. See 3.3.2, "Distributed test method (D)" and 3.3.5, "Embedded test methods and terminology" on page 26.

3.3.1 Local method (L)

In this method, both the UT and LT are part of the System Under Test (SUT). There is one PCO beneath the lower tester, and one PCO at upper boundary of the IUT, which must be a standardized hardware interface.

This method is appropriate for the testing of a hardware component.

3.3.2 Distributed test method (D)

The lower tester is remote and accesses the System Under Test through a network or a service provider. There is one PCO beneath the lower tester, and one at the upper boundary of the IUT, which must be a standardized software interface, or a human user interface.

This method can be used for the test of a full stack of OSI layers, when there is an operator interface as upper PCO.

If the IUT encompasses several layers under the top one which provides the interface, then the other layers have to be tested in an embedded mode, i.e. with one or more layers between them and the UT. The coverage of the test is not as good as with a direct contact with the UT, since the intermediate layers may screen some of the subtleties of the test cases. For those layers, the Distributed method becomes “embedded" (DSE). *This is the case for the OSI Session layer being tested within a stack with FTAM at the top.*

3.3.3 Coordinated test method (C)

The lower tester is remote and accesses the System Under Test through a network or a service provider. There is only one PCO, beneath the lower tester.

The top of the IUT is not accessible. But an upper tester must be incorporated into the SUT, to handle an explicit and standardized form of test coordination procedures, the Test Management Protocol (TMP). The semantics and syntax of Test Management Protocol Data Units (TM-PDUs) are fully specified. The TMP dictates the behaviour of the UT, to achieve the purpose of each test case, in a language which can be "spoken" from the lower tester PCO.

This method is applicable for the test of mid-layer protocols, such as the test of OS/ Session as a Coordinated Single layer (CS) test.

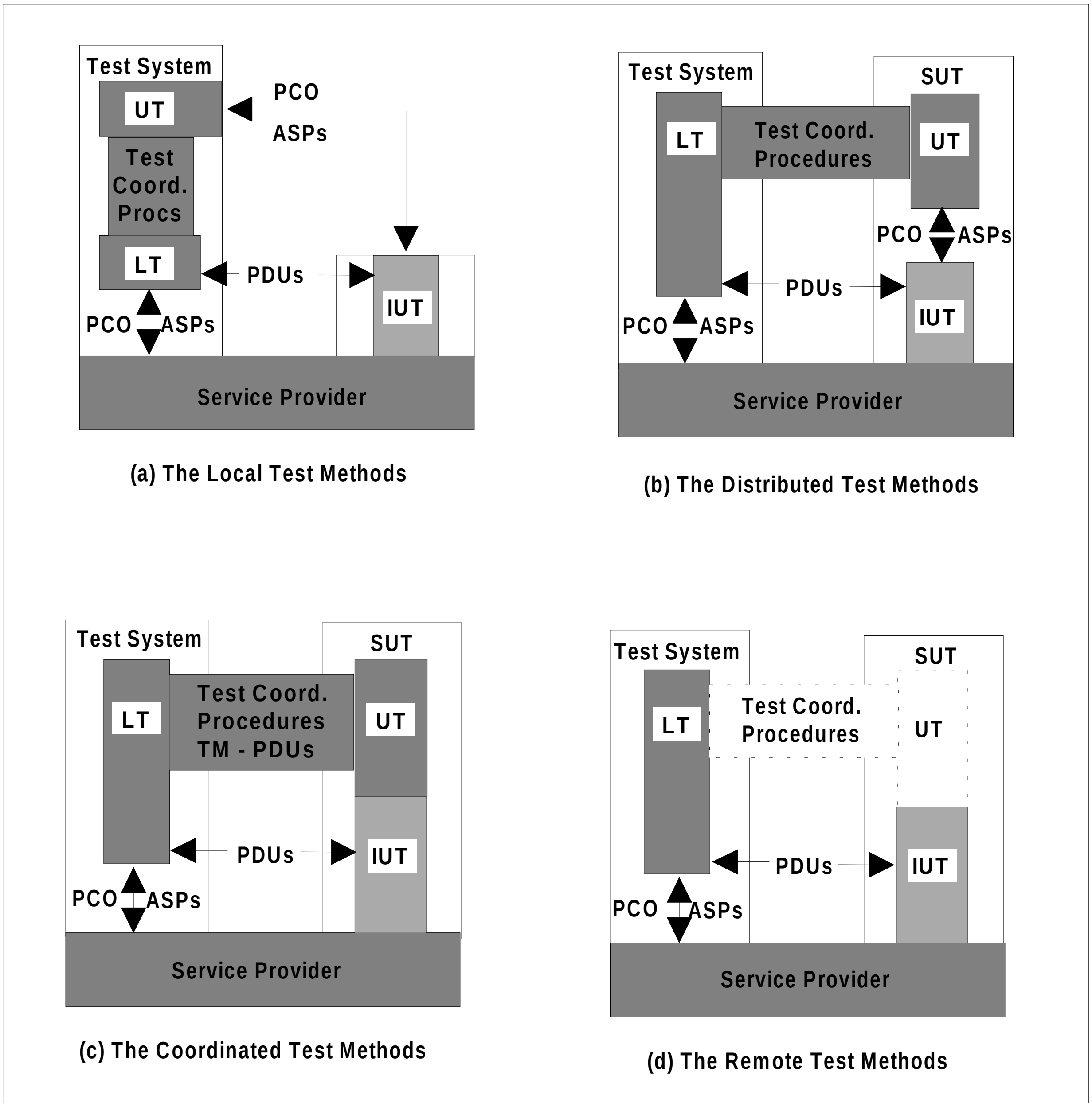

Figure 4. Abstract test methods.

3.3.4 Remote test method (R)

This method assumes that it is not possible to observe and control the upper boundary of the IUT. It offers the most limited error detection power. TCP are not formally expressed in the abstract test suite.

This method is used by FTAM, for the test of the Responder role, and for X.25 (ISO 8208, 7776) also.

3.3.5 Embedded test methods and terminology

Any of the test methods can be embedded, but... there is no standardized term for non embedded. ISO/IEC 9646 stresses the fact that all suites - for the time being - should test a single protocol or layer only. Such suites are called single-layer, or single-protocol. Hence the naming convention: single for non embedded, single-embedded for embedded. For instance CS for Coordinated Single, CSE for Coordinated single embedded. Similarly DS/DSE, RS/RSE, LS/LSE...

3.3.6 Why four different abstract test methods?

The four methods have been designed to fit a broad range of product configurations. The OSI conformance testing ground rule is that a test laboratory cannot require a product to have more features than:

- those required by the protocols,
- those normally marketed in the SUT.

Therefore, to test a product, the best possible use of the software, hardware, operator interfaces where they exist, and the possibility of inserting an upper tester and/or implement a TMP, ... must be sought. This leads to the selection of the most suitable abstract test method for each layer of the IUT.

The implementer may choose to facilitate testing by offering the test laboratory the ability to enable more features than those normally marketed. This is not mandatory however. On the contrary, ISO/IEC 9646-2 (12.7.2) defines the concept of a Comprehensive Testing Service, which includes at least one abstract test method which places **no additional requirements upon the SUT other than those contained in the protocol standards.**

In practice, that means that the Remote test method must be available, unless a DSE or Local test suite can do the job.

3.4 Abstract Test suites

An abstract test suite is a standard, applicable to the test of a protocol standard according to a given abstract test method. There can be as many ATS as there are Abstract Test Methods chosen to test a protocol.

The principle adopted in ISO/IEC 9646 is that a given protocol implementation layer can be tested by any of the test methods.

In theory, a different abstract test suite must be written for each protocol and for each test method. In practice, as the development of the test suites and the installation of testing services is very expensive, the industry concentrates on a limited range of protocol/method combinations.

So far, *the CS and DS/DSE methods have been widely used. SESSION* layer uses *both* the *DSE and CS methods.*

Clause 4.0, "DESIGN OF A CONFORMANCE TESTING STANDARD" on page 30 of this document details how to design a standard Abstract Test Suite.

3.5 Test case selection and parameterization

A test suite must be designed so that test selection and parameterization are possible.

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

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

There must be a mapping of the abstract test cases to the PICS and PIXIT proforma entries to determine whether or not each abstract test case must be selected for a particular IUT, and if it has to be parameterized; the mapping should be specified in a notation suitable for Boolean expressions.

3.6 ATM and ATS: extension to profiles

A conforming implementation of a profile is a conforming implementation of a set of related OSI protocols (base standards). Any concept applicable to the base standards is applied to the profiles in a straightforward manner.

The choice of test methods, for instance, is not influenced by the profile, but by the architecture of the products which contain the IUT. A profile may define a stack of protocols at layers 1, 2, 3, 4 and another stack for layers 5, 6, 7: a product implementing these two profiles may offer an accessible interface at layer 3 and 7, quite independently from the profile structure. However, when speaking of **testing against a profile,** it is necessary that the IUT encompasses at least the same range of protocols as the profile.

In profile testing, it is necessary to group together the conformance testing documents pertaining to each protocol. A summary document and a new terminology have been defined in 4.8, "Extension to profiles" on page 36.

3.7 Test Realization

Test realization is the process of producing a means of testing for conformance to OSI protocol standards, by reference to an Abstract Test Suite standard.

The means of testing IUTs is a combination of equipment and procedures that perform the derivation, selection, parameterization and execution of the test cases, in conformance with the reference ATS, and can produce a conformance log.

3.7.1 Means of testing for base standard protocols

Figure 5 on page 28 illustrates the many possibilities of combining the test derivation, selection, parameterization and execution processes. All possibilities are allowed by ISO/IEC 9646. If the PETS is prepared in advance, we say it is an effective derivation; if it is generated on-line during the test campaign by an interpretative tool, we say it is a potential derivation.

3.7.2 Means of testing for profiles

Additional concepts must be defined before explaining how to build a Means of Testing for a profile. This is detailed in 4.9, "Means of testing for profiles" on page 38.

3.8 Test operation overview

Figure 6 on page 29 outlines the conformance test procedure. There are five main steps in this procedure.

- PICS analysis. The PICS accompanying the IUT is analysed for its own consistency, and for its consistency with the static conformance requirements specified in the relevant standard.

- Test selection and parameterization, derivation (potential or effective) of a Parameterized Executable Test Suite (PETS) to be run on the tester.

- Test execution. Basic interconnecting tests, Capability tests and Behaviour tests are run. Behaviour tests verify that the implementation behaviour conforms to the dynamic requirements of the protocol standard.

  This step is performed using test equipment or a test tool and test procedures. Note that ***the equipment is not standardized***.

- Result analysis. The result of each test case is evaluated by comparing the possible outcomes of the test (foreseen outcomes) with the actual behaviour of the IUT (observed outcome). Verdicts of Pass, Fail or Inconclusive for each test case are consolidated into an overall summary for the IUT.

- Final conformance review. All the test results (PICS review, capability, behaviour tests) help to form the conclusion as to whether the implementation 'was found or not' to be non conformant to the static and dynamic requirements.

Conformance testing of profiles follows identical procedures.

```
                          effective
Reference ATS -------- derivation -------->  ETS (executable test suite)
   |                                             |
   |                                             |
selection,                                   selection,
with PICS (and PIXIT)                        with PICS (and PIXIT)
   |                                             |
   v                      effective              v
SATS -------------------- derivation -------->  SETS (selected ETS)
(selected ATS)                                   |
   |                                             |
   |                                             |
parameterization,                            parameterization,
with PIXIT (or PICS)                         with PIXIT (or PICS)
   |                                             |
   v                      effective              v
PATS --------------------  derivation ------->  PETS (parameterized SETS)
(parameterized SATS)                             |
   |                                             |
   |                                         execution
   |                                             |
   v                                             v
execution/derivation ------------------------>   executed PETS
```

Figure 5. Base standard test suite: selection, parameterization, derivation, execution

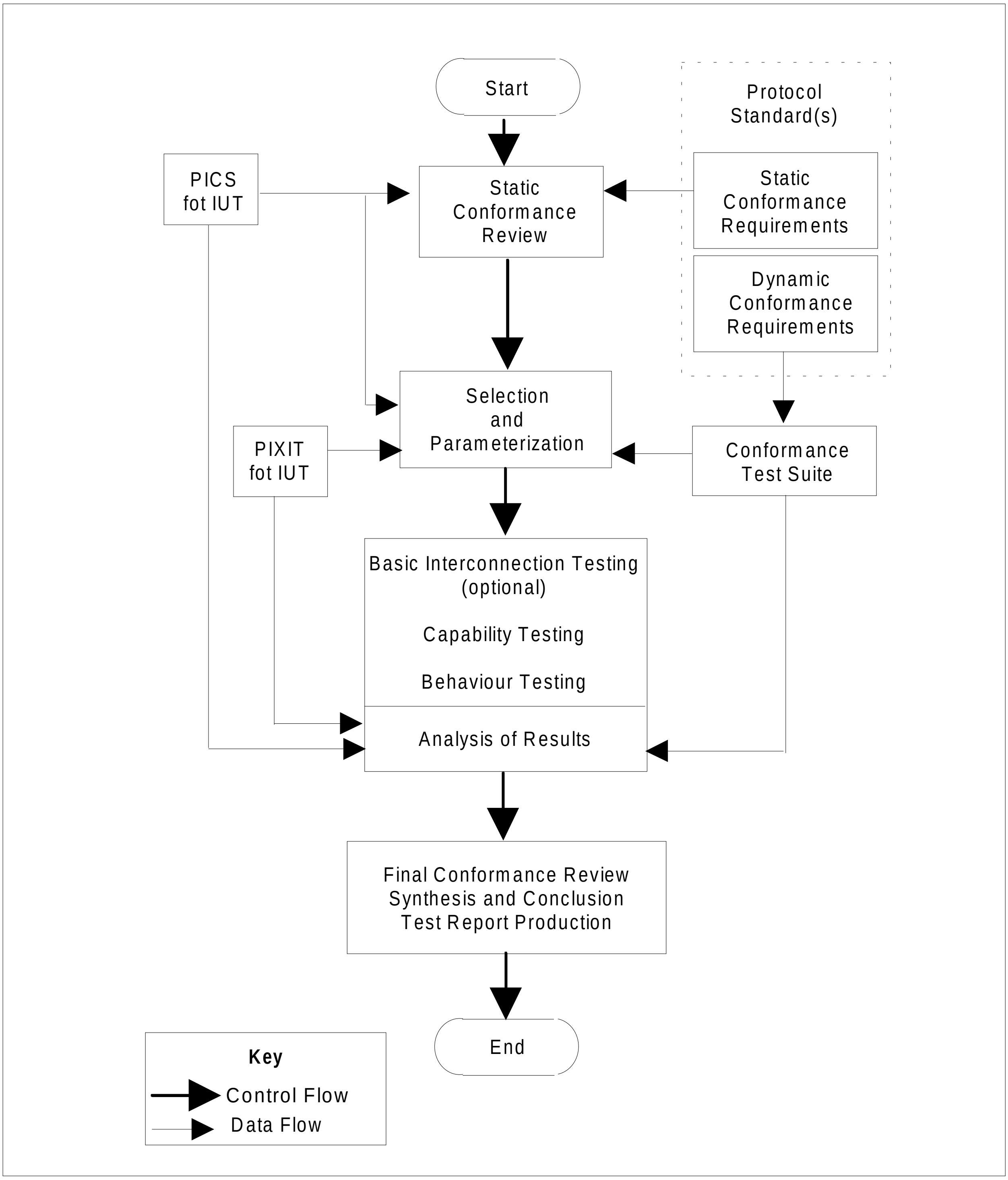

Figure 6 . Test procedure overview

4.0 DESIGN OF A CONFORMANCE TESTING STANDARD

4.1 General

The Conformance Testing Methodology specified in ISO/IEC 9646, and explained in the previous chapter, is based on the availability of standardized abstract test suite specifications (standardized ATS). It is understood that not all test suites have reached the status of international standard (we are far from this point), but the principle of a standard ATS, developed in a open environment, available to everybody, is seen as the foundation of mutual recognition of test results, region-wide or even better, world-wide.

The following clauses apply first to conformance testing against base standards, then to explicit extensions addressing the profiles.

4.2 Elaboration of a Conformance Testing standard

ISO/IEC 9646 does not fully detail the process. It is a standard, not a recipe book. It does not say that a program of work and a structure must be established by a standard body, that a call of experts must be made, that ground material must be gathered to serve as a basis to draft the standard documents... (all documents need to be in the public domain and copyright free)....It does not say either - yet - how to apply automation to the process of producing test suites.

But ISO/IEC 9646 does give guidance on several aspects and expresses specific requirements to foster mutual recognition of test results. ISO/IEC 9646-2 deals with "abstract test suite specification", and ISO/IEC 9646-3 specifies the TTCN notation.

It is recommended that you study the protocol carefully and determine which conformance testing standards must be developed first, from market research and application of the ISO/IEC 9646 requirements.

Then, the conformance requirements of the protocol to be tested must be analysed. When they are well understood, the next task is to develop

an overall structure for the planned conformance testing standard for that protocol.

This structure has the following parts, according to the IS version of ISO/iec 9646:

- the test suite structure and test purpose.
- one or more standardized abstract test suites each of them being adapted to a given abstract test method (usually one ATS only is developed initially).
- the test management protocol of the chosen abstract test method, if applicable.

An agreement must be reached on the contents and the coverage of the test suites, and on the chosen test methods.

4.3 Internal structure of an ATS

Figure 7 on page 32 shows the hierarchical structure of a test suite.

The test suite is structured as follows:

- A test suite relative to a standard method is composed of test groups.
- A test group is composed of groups or cases.
- A test case (with its verdict) is composed of steps.
- A test step is composed of step or events.
- A test event is at the Send/receive event level.

4.4 Test suite structure (TSS) and Test Purposes (TP)

The test suite specifier must ensure that the ATS provides adequate test coverage of the conformance requirements of the protocol or profile. One way to achieve this goal is to define a hierarchical structure from top to bottom, with classified categories of tests, such as:

- Basic interconnection tests (Optional)
- Capability tests
  - Mandatory features
  - Optional features
- Behaviour test cases
  - Valid/invalid syntax
  - Connection establishment (from/to IUT)
  - Data transfer
  - Connection release
  - Variations on timers
  - Variations on parameters

The test suite specifier creates a set of test purposes Each test purpose focuses on a single conformance requirement. This requirement can be derived from the protocol state table, from the PDU encoding definition, or from a text or description parameter which specifies this requirement.

Each test case of the test suite is designed to achieve one of the specified test purposes.

Note that the Test Suite Structure and the Test Purposes (TSS & TP) are very important and are the initial part of the conformance testing standard.

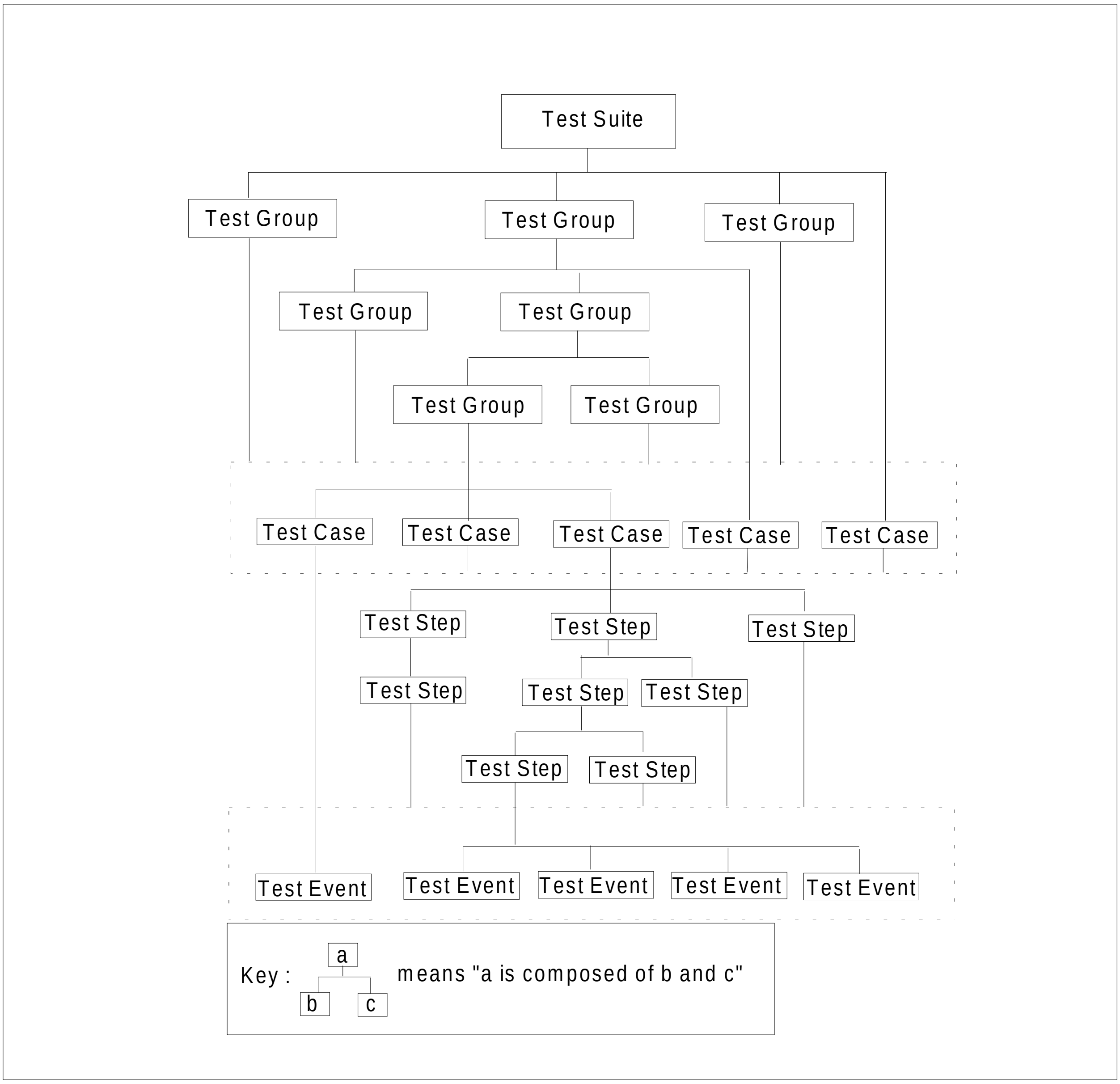

Figure 7. Test suite hierarchy.

4.5 Test coverage

The orderly construction technique of a test suite and of its test purposes aims at optimizing the coverage and minimizing test duplication. ISO/IEC 9646-2 gives guidance and examples.

4.6 Test components

A test case is derived from a test purpose and

comprises:

- The Test body, with alternative sequences of events, each possible sequence acceding to a verdict.
- The test preamble, which is the sequence of events necessary to place the IUT in the state for executing the test body, if this state is different from the idle state.
- The test postamble, which is the sequence of events necessary to bring back the IUT to the idle state after test body execution.

Each test case is autonomous, and goes from idle to idle protocol machine state.

It is possible to skip the preamble and arrange the test execution in a sequence which optimizes the testing time for example.

4.7 Abstract test notation: TTCN

4.7.1 General

TTCN is the standardized test notation recommended by ISO/IEC 9646 for writing standardized abstract test suites and test cases.

It is independent of layer, protocol, and abstract test method. But it is especially adapted to layers 2 to 7. Attempts to describe a physical layer test suite **entirely** with TTCN have failed so far.

TTCN combines compact references of data fields used many times with pictorial view of pass/fail paths in test case dialogues.

TTCN IS version will be issued in ISO/IEC 9646-3 early in 1991 (the TTCN specification has been balloted several times; text was fully revised in Dec 1988, and in July 1989, and was under ballot as DIS 9646-3 till October 1990. Certain features will be developed as addenda, during 1990-1991, for example an architecture and a notation for test cases running parallel trees).

The 1987 version of TTCN appended to X.290:1988 should not be used. A new X.292 consistent with ISO/IEC 9646-3 will be re-issued in 1991.

TTCN resembles a structured programming language like Pascal or C. There must be a descriptive part and a procedural part. However, the definition of tables for displaying most material is very specific, and the “notation”, not a language, is also specifically oriented towards protocol testing.

4.7.2 Two forms of the notation

TTCN is defined under two forms, which are semantically equivalent

- TTCN.GR (GRaphical) - for human readability; the syntax is described in prose and examples;

    - he procedural part of the tests is coded as trees, and the trees and descriptive parts are all inserted into tables with specific headers.

    - All data (PDUs, variables) are defined in tables with specific headers.

    - As an alternative, some data (PDUs, ASPs, user-defined types) can be defined in ASN.1.

- TTCN.MP (Machine Processable and transferable); the syntax is described in Backus-Naur form. The machine processable form facilitates the use of tools for automated processing, for storing and transferring test suites between laboratories. In the TTCN.MP form, keywords, instead of boxes, are used as information delimiters. This form should be favored by the testing laboratories and the standard bodies, so as to take advantage of its extended capabilities. Tools are already available.

4.7.3 Contents of a TTCN test suite

An ATS specification written in TTCN must contain four parts:

- The overview, giving the structure of the test suite, for general information and under-standing.

- The declarations, giving all the data referenced such as PDUs, ASPs, timers, the PCOs.

- The constraints parts giving the actual values of the PDUs and ASPs.

- The dynamic part describing the behaviour of each test case.

4.7.4 TTCN Test Suite Overview

It is a sort of Test Suite directory and table of contents. It provides an index to the test suite, and can be used for documentation and reference.

The overview indicates:

- the name of the test suite;
- reference to the relevant base standards;
- reference to PICS and PIXIT proformas;
- information on where to find the PICS entry mapping to be used for test selection;
- information on the abstract test method,
- a three-part index:
  - test case index (order = TS structure)
  - test step index (order = step library)
  - default (trees) index

4.7.5 TTCN Declaration and Constraint Parts

The declaration part should be used for any object used in the dynamic part. There is a format for all sorts of objects, e.g user defined data types, ASN.1 types, test suite parameters, test “suite constants, test suite and test case variables, PCO, timer, ASP, PDUs. There are no values assigned to the data types at this stage.

The constraint part specifies the actual values to be sent or received, e.g. in the ASPs and PDUs declared in Declarations Part.

An ASP or PDU may be defined ("constrained") in many different ways. At least one constraint value is required per declared item.

ASN.1 can be used for these parts. See ISO/IEC 9646-3.

4.7.6 Structure of the dynamic behaviour part

The dynamic part contains the main body of the test suite, i.e.

- the test cases grouped into test groups (the test cases call the test step by the ATTACH construct);
- the test Steps grouped into test step library; a test step can be called by several test cases (test step groups are possible);
- the Default Groups, i.e. the groups of Default behaviour trees.

TTCN supports the test suite structure defined by ISO/IEC 9646-1 (see Figure 7 on page 32) Groups (and steps) can be nested to any depth-.

4.7.7 Behaviour trees

In the behaviour part, each test case contains a precise description of sequences of anticipated events occurring at PCOs, and related verdicts. The description of a test case or of its test steps locks like a tree turned on its side. Each path corresponds to one possible execution scenario of the test case, from the root to the leaf, leading to a verdict.

A TTCN line is a TTCN statement, i.e. event, pseudo-event or TTCN construct.

Each TTCN statement appears on a separate line.

Statements shown at the **same level of indentation** are possible alternatives which may occur at time of execution.

Indentation of statement towards the right side of the page represents the sequencing of events, as time progresses.

Alternative statements are to be "attempted" one after the other by the test system until one is true.

Incoming queues and timers are considered frozen during each evaluation of a given level.

When a matching alternative is found, the event or pseudo-event has occurred, and the test can continue at the next indented levee. Never backwards. Never upwards (except via a GoTo...).

This forms the path through the tree

```
entry point                       exits

mmmmmmmmmmmm
            aaaaaaaaaaaa
                  eeeeeeeeeeee
                        ttttttttttt      exit 1
                        uuuuuuu          exit 2
            ffffffffffffffff             exit 3
      bbbbbbbbbbbbbbbb                   exit 4
      cccccccccccc
            xxxxxxxxxxx                  exit 5
            yyyyyyyyyyy            exit 6
      dddddddddddd
            gggggggggggg                 exit 7
            hhhhhhhhhhh                  exit 8
```

4.7.8 TTCN statements

TTCN statements include the Events, the PseudoEvents, and miscellaneous Constructs.

The events are SEND (prefix !) meaning controlled events, RECEIVE (prefix ?) meaning observable events, OTHERWISE or TimeOut. Events are prefixed by the identifier of the PCO where they occur (e.g. L for Lower tester PCO, U for Upper tester PCO).

The identifier following the prefix ! or ? denotes the ASP or PDU sent or received.

OTHERWISE is a "receive any garbage" event which of course leads to a FAIL verdict.

Constructs include GoTo, Attach (a subtree), Repeat.

PseudoEvents: TTCN expressions or Timer operations

TTCN expressions: Assignments and/or Boolean expressions

Timer Operations: START, CANCEL (a timer), READTIMER.

4.7.9 Verdicts

Verdicts apply at the test case level. TTCN has both preliminary (running) verdicts and final verdicts. Both are stated in the Verdicts column.

The syntax indicates which form is being used:

- Preliminary verdicts are enclosed in parentheses;
- Final verdicts have no parentheses

The permissible verdicts are:

- PASS or P or (PASS) or (P)
- FAIL or F or (FAIL) or (F)
- INCONC or I or (INCONC) or (I)
- RESULT or R

The test case writer has read-only access to the running verdict, the name of which is R. Each test case begins with the current VERDICT R set to “NONE". If the test case ends with this verdict, it must be changed to "Test Case Error".

Precedence is used when updating the current verdict:

- PASS (lowest), INCONC, FAIL (highest)
- INCONC can be overridden by FAIL
- PASS can be overridden by INCONC or FAIL

A preliminary verdict (coded in parentheses) means "update the running verdict and continue with the test". A final verdict (coded without parentheses) means "update the running verdict and stop the test". When RESULT or R is coded, it means "use the running verdict as the final verdict".

4.7.10 Default Trees

"DEFAULT" refers to default library. A DEFAULT tree is needed to group all possible alternative answers of the IUT to tester stimuli, which are normally all wrong, but need to be matched and checked.

The test suite writer prepares defaults for every possible abnormal end of a test case.

4.7.11 TTCN example

A TTCN example is given in appendix B on page 54

4.8 Extension to profiles

4.8.1 General

Conformance testing standards for profiles (ISP or FS) are ideally a subset of those issued for the base standards, in the same way as the profile itself specifies a subset of the base protocol standards.

It is assumed that a selection and parameterization process can be applied to the set of ATS standards defined for the referenced base standards of the profile, in order to tailor them to the needs of that profile.

Additional abstract test cases may be needed for additional profile specific test purposes. If so,they are to be referenced in the PTS or FSTS-S (see 4.8.3, "FSTS and FSTS-S" on page 37) together with an indication of which ATS standard they complement, and where they fit in the structure of that ATS.

The new concepts and types of documents created to extend OSI conformance testing methods to the profiles deal mainly with the grouping of the components necessary to test an IUT against a profile. The following clauses explain them.

4.8.2 Profile Test Specification (PTS)

ISO defines - for the ISPs - a document called **Profile Test Specification** or PTS. This document is intended to be an Annex to an ISP, for ONE profile of the ISP.

It specifies how to test each protocol, and refers to the relevant PICS proformas, conformance testing standards and standardized ATS to be used in each case.

The PTS is the document which allows a test realiser to build an MOT for a profile, and allows a test laboratory and its clients to perform a conformance assessment process against the profile.

Document ISO/IEC SC21 N 5075 on Protocol Profile Testing Methodology (PPTM) details the PTS contents.

As an illustration, Figure 8 on page 37 list the various components of a multi-part (multi-profile) ISP, which contains one PTS per profile.

```
                                                 ┌ - -
I S P ****************************               :        P T S  for Profile  A
                                                 :
Part 1    :    Profile A                         :    *   PROFILE name:  A
               IPRL A                            :    *   IPRL reference:   IPRL A
                                                 :    *   ISPIXIT  proforma ref:
Part 2    :    Profile  B                        :
               IPRL B                            :
   .                                             :    *   PROTOCOL WWWWW
   .                                             :         PICS ref:
   .                                             :         TSS & TP ref:
                                                 :          -  ATM1
Part  n   :    Profile  N                        :               ATS1 ref :
               IPRL  N                           :                PIXIT1 ref:
                                                 :          - ATM2
Part  n + 1   PTS for Profile  A ------------>---:               ATS2 ref:
                                                 :               PIXIT2 ref:
                                                 :          - . . .
Part  n + 2   PTS for Profile  B                 :
                                                 :
                                                 :    *   PROTOCOL XXXXX
                                                 :          PICS ref:
                                                 :          TSS & TP ref:
                                                 └ - -
```

Figure 8. Parts of an ISP and detail of a PTS within an ISP

4.8.3 FSTS and FSTS-S

In Europe, the Functional Standard Test Specifications (FSTS) is the collection of the conformance testing specifications and documents applicable to a Functional Standard, and needed by the test realisers, test laboratories and their clients in order to perform a conformance assessment against the FS.

The Functional Standard Test Specifications Summary (FSTS-S) is a document, preferably standardized and being itself a part of the FSTS, which lists and refers to all the components of a FSTS (similar to PTS for ISPs).

4.8.4 FSPIXIT proforma

For FS in Europe, an FSPIXIT proforma is defined. It is a document, accompanying the Functional Standard and being a part of the FSTS set, which, for each standardized abstract test suite mentioned in the FSTS-Summary,

- refers to the standardized partial PIXIT proforma accompanying the ATS,

- expresses, in a separate section, the constraints upon allowable answers necessary to achieve the purpose of the profile,

- adds any specific questions pertaining to the profile as a whole.

4.8.5 ISPIXIT proforma

The same concept applies to the ISP area, the document is called ISPIXIT proforma.

4.9 Means of testing for profiles

Producing a means of testing in conformance with a PTS (ISP) or an FSTS-S (FS) is more complex than producing a means of testing implementations with reference to a single ATS standard. This is because the test realiser must take a decision about the following process:

- Select and parameterize the set of ATS standards defined in the PTS (or the FSTS-S), according to the profile requirements, i.e. according to the IPRL or FSRL. This process may have several variants and combinations, if the PTS or FSTS-S mentions available ATS for more than one abstract test method per layer. This results in the production of a SATS.

- Select and parameterize the result of the previous operation according to the needs of a client of a test laboratory, according to the provisions of an ISPICS or FSPICS for a particular IUT.

- During this double process of selection and parameterization, decide when the derivation of the abstract test suite to executable test suite shall occur. The time when the derivation process occurs may be after the selection and parameterization processes are complete or at some intermediate stage.

Figure 9 on page 39 illustrates these processes applicable to the profiles.

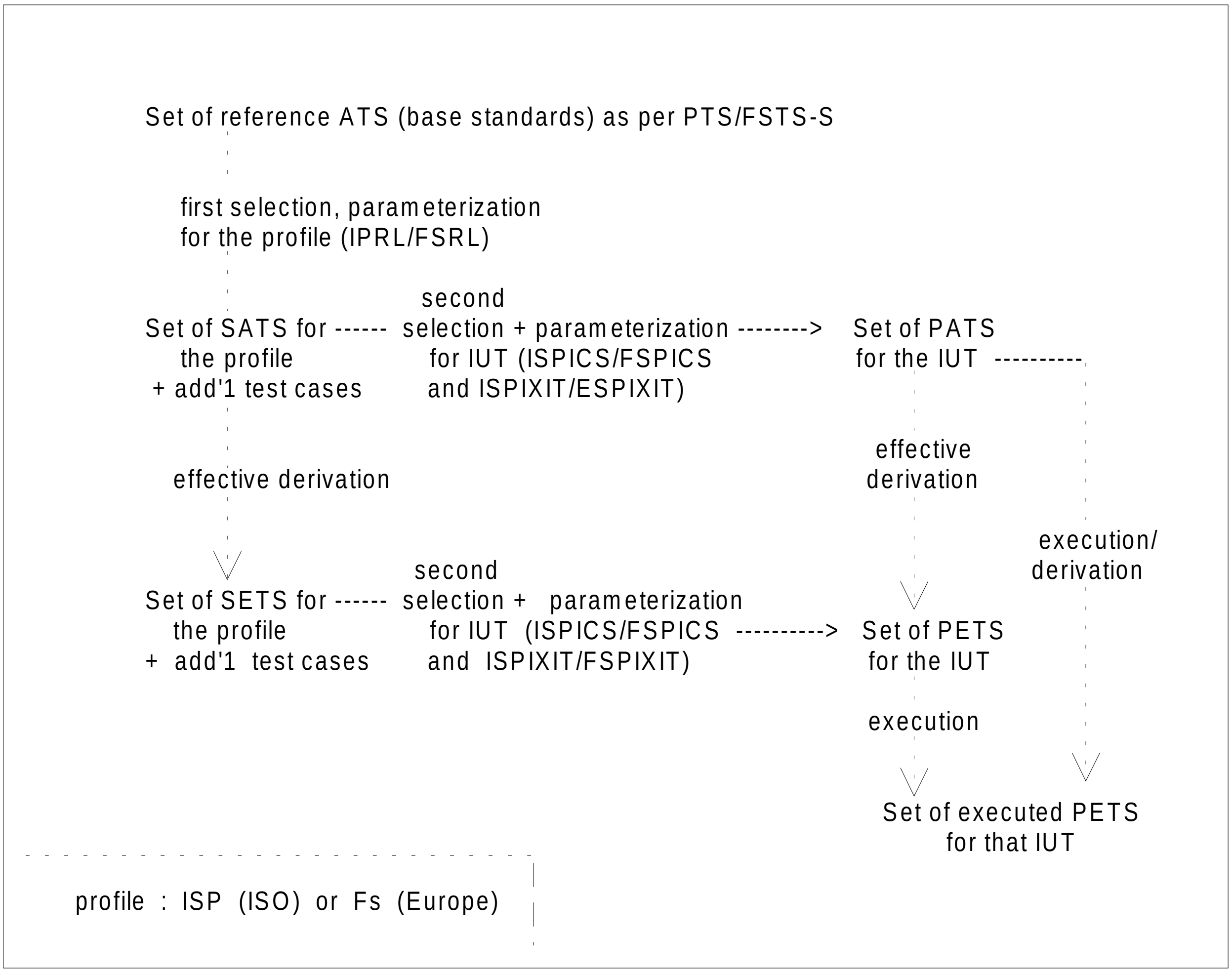

Figure 9. Profile test suites: selection, parameterization, derivation, execution

5.0 HARMONIZATION - CERTIFICATION - ACCREDITATION ARBITRATION-MAINTENANCE

5.1 Interworking and harmonized testing

The use of standardized base protocols, ISPs, conformance testing methodology, conformance testing standards and their abstract test suites, profile testing specification, ... has only one global objective: increase the probability that "real open systems", basing their communications on OSI protocols, do interwork in practice.

If an implementation is tested for conformance to the base standards only, then the degree of freedom in the optional capabilities of those standards is so high that this implementation will interoperate with another one only if their PICS match closely.

In order to reduce the number of options and the ranges of the parameter values, functional standards or profiles have been devised and promoted. The additional benefit is that product implementation, product procurement and testing for conformity to standards become more straight forward. Conformance testing methodology has been adapted to profiles.

5.2 Standardization of test suites specifications

The next step is to standardize conformance testing methodology and conformance testing specifications. That is in progress - and EWOS / ETSI have a key role to play in this work.

There is international agreement on a common testing methodology and related test methods (ISO/IEC 9646) and, based on this methodology, work is now proceeding in ISO and in Europe to extend the methodology to protocol profile testing. This work should be the base for developing standardized test suites.

The process of standardization of test specifications is divided in three steps:

- Elaboration: see 4.2, "Elaboration of a Conformance Testing standard" on page 30.

- Standardization: the document(s) are thoroughly reviewed and assessed prior to their publication as European or international standard(s).

- Maintenance: the document, like any standard, is continually updated in order to cope with identified defects and misalignments to base standards. See 5.8, "An issue: the maintenance of standardized ATS" on page 45 on the implications.

Test methods or test suites are not only used for third-party testers, but also for self testing by the manufacturer, (manufacturer's declaration of conformity) network operator or user.

Comparability and reproducibility of test results obtained by different testers are necessary to avoid repeated conformity testing of the same system. Therefore it is important that test specifications have the status of standard, to ensure their general acceptance.

5.3 Harmonization of testing services

It remains, in practice, to "harmonize" the testing services that will use the standardized test suites,

- to get the full benefit of those services and make sure they lead to interoperability of those products which pass the tests successfully, and

- to give the laboratories confidence in the results obtained by their peers, and promote the mutual recognition of results, which can in turn lead to great savings for the developers, thanks to the "one-stop" testing concept. This concept enables conformance test reports, and certificates issued after a single test in one test location, to be recognized as valid all over, irrespective of where they are produced.

Harmonization of testing services has been fostered by different approaches so far.

- The establishment of a certification system for Information Technology in Europe is aimed at the mutual recognition of results. This system drives mutual recognition of results. See 5.5, "The European Certification system" on page 42.

- The CTS programs have been a major step forward in Europe to give the test laboratories an opportunity to work together and to harmonize their techniques.

- Lastly, studies are in progress, in Europe and at the international level (TLFF/CC), to determine what sort of procedures could be developed to assess the "equivalence" of testing services. Some details on this approach follow.

Harmonized conformance testing services are achieved through the five following steps:

- Agree on testing methodology, as specified in ISO/IEC 9646. and verify that it applies to the scope of the harmonization (e.g., are there special layer-1 or layer-7 issues?). Agree on the general PCTR and SCTR proformas to be used for the test reports.

- Agree on the set of base protocol standards that are within the scope of harmonization, then agree on the set of PICS proformas and the Test Purposes for each protocol.

- Agree on the abstract test methods which are applicable to the set of protocols. Determine if abstract test suites exist for each method. Associated with each abstract test suite is a partial PIXIT proforma and the statement concerning the order in which the results of the test cases should be presented in the PCTR. Whatever abstract test methods and related ATS are used, the systems that support the same set of protocols must be tested using the same test methodology and the same test purposes. In theory, a product must be tested by any of the abstract test methods defined in ISO/IEC 9646. No restriction should be imposed on a product to make it testable by a method preferred by a Recognition Arrangement or a given laboratory (see 3.3.6, "Why four different abstract test methods?" on page 26).

  However, it is known that the cost of supporting all methods for all protocols is too high in the current environment. It is therefore pragmatic if not legitimate to offer testing services that are not "comprehensive". In that case, an evaluation of the additional constraints put on the products must be available, and the situation must be considered as interim.

- Agree on the Functional Standards or ISP falling within the scope of the harmonization. This implies agreement on the requirements of the compound profile PICS (IPRL for ISPs), agreement on the conformance testing document specifically issued for the profiles (PTS for ISPs), and finally agreement on a full PIXIT proforma.

- Verify the equivalence of the Means of Testing to be used by different test laboratories for each of the test suites.

The ultimate objective is to be able to achieve mutual recognition of test reports for OSI products conforming to the same base standards and profiles. The objective of the equivalence methodology is to lay the groundwork for achieving the higher goal of 'one-stop testing'.

5.4 Validation of a testing service

A positive step towards harmonization of testing services is to undertake verification of the equivalence of their tools and procedures, through validation, calibration and compliance testing of the various components of a Means of Testing (MOT) defined in 1.6.4, "Means of testing" on page 11, against a given set of test specifications. Validation only is addressed here.

What is validated is the relationship between a MOT and the Profile Test Specifications (PTS) which it should support (Test method, Abstract test suites, etc). Like the conformance assessment process of an implementation, the validation process of a MOT requires two phases: a static and a dynamic validation phase. For this purpose, the MOT supplier will fill in a proforma, or PTS compliance statement.

5.4.1 Static validation

The most critical operation in the static validation process is the verification of the ATS-ETS mapping, i.e. verifying:

- If the coverage (i.e. completeness) of the Parameterized Executable Test Suite as implemented by the MOT is 100% of the coverage of the Parameterized Abstract Test Suite, as defined by the PTS, for each layer within the profile.

- The correctness of the selection and parameterization procedures resulting in the PETS, given a compound PICS and PIXIT for the SUT.

5.4.2 Dynamic validation

This process concerns the validation of test selection and parameterization, test execution and test report production.

The objective of test execution validation is to demonstrate that all tests identified in the PETS for the profile are executed and that the validity of the verdicts assigned can be verified by examination of the conformance log.

The objective of report production validation is to demonstrate that the results of the static and dynamic phases of the test campaign are properly recorded and that correct verdicts are assigned.

During dynamic validation, stability of the IUT is essential. This stable IUT is commonly called a Reference Implementation. The behaviour of this reference implementation must be controllable, in order to exercise both valid and invalid test paths, and must be consistent across validations.

5.5 The European Certification system

Given the complexity of Information Technology, the Information Technology Steering Committee (ITSTC) decided (11-12-84) to set up an Information Technology Advisory Expert Group on Certification (ITAEGC). That group was given the task of advising the ITSTC on how to handle the certification of complex systems. Memorandum M-IT-03 is the result of the discussions in that group. It was approved by ITSTC in March 1987.

The European Certification system is operational since 1989, on the basis of M-IT-03.

The organisation diagram for the European IT-Certification scheme given in M-IT-03 is still valid, and is reproduced in Figure 10 on page 44. However Testing Support Services have been replaced by the more dynamic concept of Recognition Arrangements between the testers.

The European certification scheme is based on the guarantee, within Europe, of mutual recognition of national certification activities, because it is built upon existing national practices and not upon replacement of these. This requires mutual confidence among the institutes involved in testing and evaluation of test results, as well as proper formal procedures.

Provisions have been made for a clear separation of responsibilities in order to ensure the necessary independence and impartiality of the different functions.

- Laboratories are asked to seek accreditation at the national level, in order to prove they conform to the EN 45000 on the quality of testing, that they have good control of their testing tools and procedures, and that their testing tools do conform or comply to the protocol, to ISO/IEC 9646 and to the standardized or harmonized test suites relevant to the protocol. See 5.6, "Test laboratory accreditation" on page 44.

- Laboratories are also invited to group into Recognition Arrangements (RA), to adjust their technical levels and work together to define the state of the art within their scope. To-day, two RAs deal with IT-protocols: OSTC for the WAN area, ETCOM for the LAN area. See 5.7, " Recognition Arrangements" on page 45.

- A Certification Committee in each European Country relays the action of a Certification Committee for IT at the European level (ECITC). ECITC has approved ("accepted") ETCOM and OSTC and gives advice to the accreditation bodies to facilitate their involvement in Information Technology (they were more accustomed, in the past, to accredit testing labs in Chemistry, Food industry, Oil, Electricity, Transportation, etc.)

- ECITC has not yet laid down the conditions for mutual recognition of Certificates in Europe, but all prerequisite steps have been now taken.

- Plans are being made to establish a general European Organization for Testing and Certification (EOTC), within which ECITC would act as the sector specific committee for IT. EOTC would provide the framework for harmonizing Testing and Certification across all sectors in Europe, as appropriate, (eg definitions, methods, etc.).

The European System for IT-certification is closely connected to the development of IT standards. Areas covered by the European programme of IT standardization and related to this report are:

- Open Systems Interconnection (OSI) and inter-office working protocols of both lower and upper layers (ISO/IEC/JTC1 and CCITT). These include teletex, videotex, teletype compatible, file transfer, local area network protocols, formal description techniques, physical connections, message handling systems, document architecture, character encoding, and data interchange on magnetic tapes or flexible disks.

- Terminals (e.g. voice and non-voice as covered by Normes Europeennes de Telecommunications (NETs) and/or European standards (ENs) and Prestandards (ENVs).

- Security issues in IT applications.

- Satety issues in IT-equipment

- Quality systems assessment, for developers and testers.

The development of conformity testing services” and certification mechanisms in the field of OSI is given the highest priority.

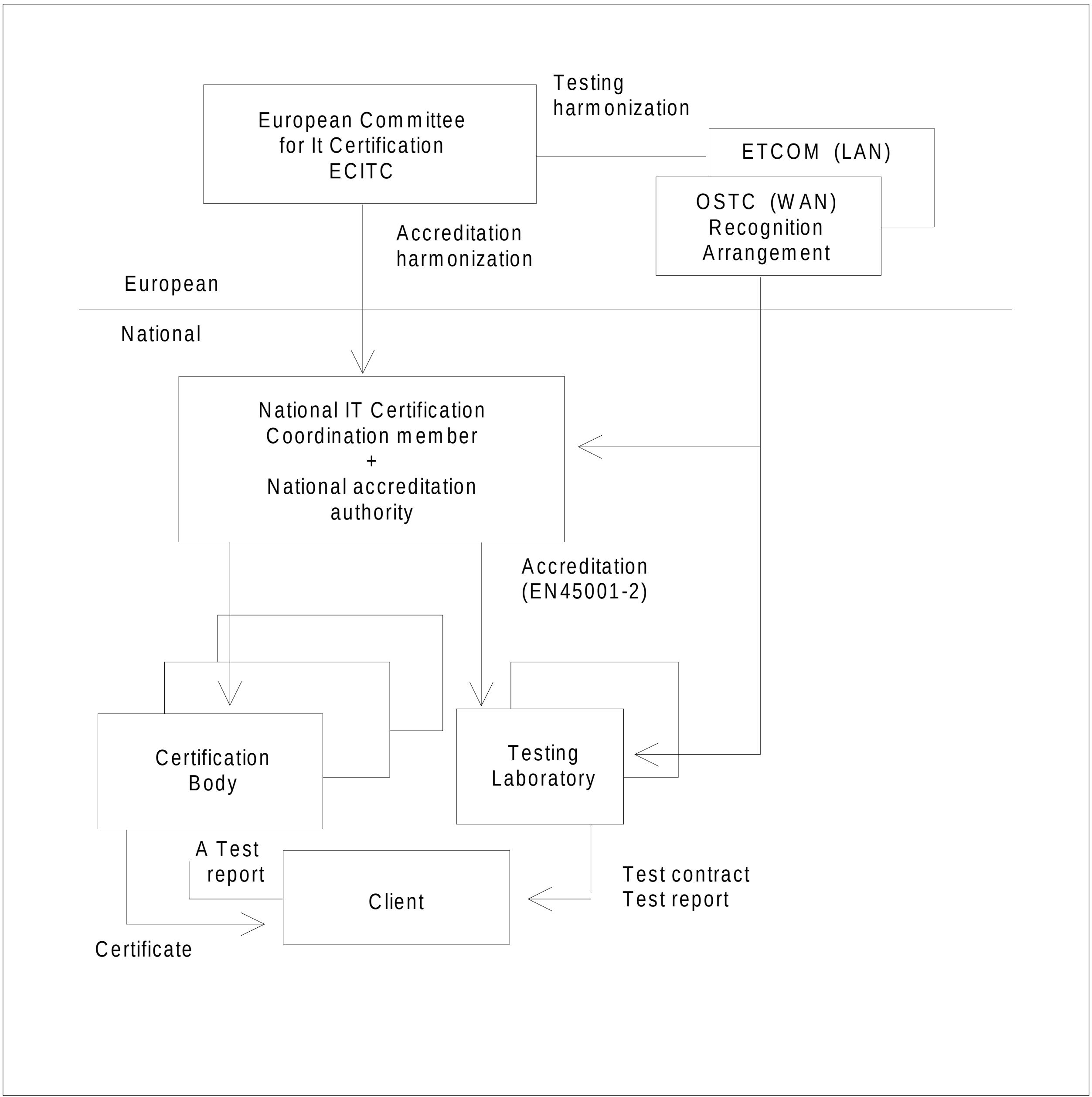

Figure 10. Principle of the European IT-Certification system.

5.6 Test laboratory accreditation

Certification bodies, first at a national level, then at the European level will issue certificates, stating that the product conforms to the specified standard(s), on the basis of test reports produced by accredited laboratories. The first step towards a harmonised certification scheme is the harmonisation of the accreditation criteria, which will lead to mutual recognition of test reports by laboratories accredited under similar rules.

Accreditation of test laboratories is governed by the EN 45000 set of standards. Nationai accreditation bodies will, upon request by a laboratory, assess its competence with respect to the criteria defined in EN 45001:

- impartiality, independence and integrity
- technical competence:
  - organisation
  - personnel

  - equipment
  - procedures
- cooperation with
  - clients
  - accreditation bodies
  - other laboratories

5.7 Recognition Arrangements

ECITC (the European Committee for IT-Certification) is composed of representatives of all participating National IT-Certification Coordinating Members, nominated by local members of CEN, CENELEC and CEPT. The Committee will establish the specific rules which are necessary for general recognition of harmonised European certificates. This Committee is also organized so as to "accept" one or more Testing Support Services or Recognition Arrangements

A Recognition Arrangement, in its scope of competence, gives support for the test methods, tools and report formats which are applied by the testing laboratories and which should be available to all interested parties. An RA, upon request, can also advise and assist in the accreditation and monitoring of testing laboratories (under discussion by ECITC), and can provide expertise in arbitration issues.

The RAs are further responsible for:

- the definition of the test service operation requirement specifications and accreditation technical criteria. These specifications and criteria are distributed to the relevant accreditation and certification bodies.

- the liaison with standardization and certification activities in Europe and worldwide in the relevant domains.

By defining harmonised procedures, documents and reports proformas, the RAs set the ground for a harmonised certification scheme in their respective domains. There are two RAs in the domain of Communications protocols:

- OSTC (Open Systems Testing Consortium): This consortium has established recognition arrangements for several OSI based protocols over WANs (e.g. MHS, FTAM, Teletex, Transport & Session, and Network (X.21, X.21 bis, X.25)).

- ETCOM (European Testing Consortium for Office and Manufacturing): the scope of ETCOM covers OSI based protocols over LANs, Manufacturing Messaging Specifications MMS (MAP layer 7 ISO standard), Network management, Directory services (for MAP profiles), FTAM, intermediate OSI layers over Connection-less Network Service, LLC1, LLC3, MAC and Physical 8802.3 and 8802.4., routers and bridges.

5.8 An issue: the maintenance of standardized ATS

5.8.1 The maintenance process

As seen above, there are three stages in the lifetime of a standardized test suite: elaboration of the suite, standardization proper, and maintenance.

With the two levels of standardization: Profile Testing Methodology and Standard Conformance Methodology, the maintenance process is rather complex.

We address here the test specifications referred to in a PTS (Profile Test Specification).

It is often assumed that the Base standard test specifications (PICS proforma, PIXIT proforma, ATS) exist and are stable and that the PTS simply refer to these documents. But this is not always so. The resources available in ISO and CCITT to develop ATS for the base standards are not sufficient to keep to the time schedule. Because test specifications for ISP's and functional standards must not be delayed by this situation, coordination and maintenance procedures between the organization responsible of the base standards and the regional and the international levels have to be set up.

Three cases fall within the scope of maintenance of test specifications:

- misalignment to base standard or the profile due to defects in the specification; this is the case when, for instance, a test case does not conform to the base standard or profile standard. This is likely to happen due to the size and the technical content of those specifications; maintenance in that situation follows the defect report procedure;

- misalignment to base standard due to base standard maintenance: this may happen when a defect report is resolved or an addendum to the base standard is issued. Maintenance implies amendment of existing test cases and/or specifications of new test cases extending the test suite coverage to additional functionalities of the protocol.

- misalignment to test methodology: the ISO/IEC 9646 standard and, in particular, part 3 on TTCN may evolve. Alignment to the latest version of TTCN should be sought.

5.8.2 Impact on implementation of means of testing

Up to now, implementation of means of testing has been an expensive process in cases where derivation is not automated. This situation is evolving as TTCN matures, and with the development of TTCN interpreters. However, it should be kept in mind that ISO/IEC 9646 does not impose that ETS should be derived from ATS in an automated manner.

Lack of complete automated derivation implies that a corresponding ETS maintenance scheme has to be set up by test laboratories. This will guarantee that the test laboratory performs the proper tests as defined in the test specifications. Actual maintenance of the MOT will be carried out by test tool/test suite developers under the supervision of the test laboratory.

5.8.3 Impact on accreditation

Accreditation bodies set up at the national level must require that the laboratories they are accrediting commit to updating their testing services when new versions of the reference standardized ATS are issued. This requirement can be either specific (with a date of application), or general, as appropriate, at accreditation time.

This does not prevent the accreditation bodies from keeping an up-to-date list of reference documents defining the test methods and test specifications under which the accreditation is awarded (EN 45003, clause 10.1). Moreover, accreditation could be awarded for a limited period of time, in unstable areas.

5.8.4 Impact on certification

Certification, like accreditation, is closely linked to the state of the test specifications it refers to. Clear statement of the reference protocol and test standards must be made in the test report submitted for certification.

5.9 Another issue: arbitration

In the domain of IT testing and certification, arbitration may be required at three levels:

- technical level: when, for example, a client and a laboratory disagree on the verdict of a test case. Arbitration is done by reference to existing protocol and testing standards.

- contractual level: this level is not specific to this domain, but to every contract established between two parties. It is governed by applicable laws.

- legal level: this may concern legal aspects implied by the certification process.

Due to the multiplicity of people involved and possible sources of disagreement it is not practical nor desirable to advocate the creation of a single arbitration body. In fact some of these people already contain in their formal procedures part or all of the means required for arbitration.

The following list, by no means exhaustive, provides a picture of the expected needs.

1. Client - Test Laboratory

   Arbitration at the technical level can be provided by the Recognition Arrangement experts, acting on a third-party basis. Reference documents and procedures are already made available from RA to Test labs and clients. It should be noted however that the decision may imply a technical modification to the reference standards. Such a modification may have legal consequences on the certification process.

2. Test Laboratory - Accreditation Body

   Arbitration needs are mainly covered by EN 45000 standards. EN 45003, clause 11 specifies that the accreditation body should provide appropriate and non discriminatory appeals procedures.

3. Client - Certification body

   It is likely that a certification body will provide the same kind of support as the accreditation body does. However, mutual recognition of certificates may fall outside the scope of these procedures and may require arbitration between two certification bodies.

4. Vendor- Client

   Certified products purchased by a client may exhibit deficiencies which were undetected by the test laboratory. Although a certificate will be issued with a "disclaimer clause" stating that no absolute proof of conformance is given, a client may still appeal if he feels that the flaw should have been detected. The certification body should be the appropriate body in that case, possibly in liaison with the accreditation body.

   (NB: this chapter is given for preliminary information only. The subject has not yet been studied by EWOS, ETSI or ECITC in detail)

Appendix A. WHO'S WHO IN CONFORMANCE TESTING

The objective of this annex is to briefly identify bodies and/or groups active in the Conformance Testing arena. The list may not be considered exhaustive; in particular regional not European bodies/groups are mentioned if they have direct significant relations with Europe in the conformance testing field. For further details reference can be made to document OTL N 264 and its successors.

A.1.1 STANDARDS BODIES AND FEEDERS

ISO/IEC: International Organisation for Standardisation/International Electrotechnical Commission

- Programme:
  ISO and IEC form a Joint Technical Committee (JTC1), responsible for Information Technology standards including OSI. Several Sub-Committees are responsible for a specific programme, as listed below.

- Contributors:
  National member bodies

ISO/IEC/JTC1/SGFS: Special Group on Functional Standards

- Programme:
  Methodology for drafting International Standards Profiles
  Methodology for associated conformance testing specifications

- Contributors (in addition to National member bodies)
  TLFF
  Regional workshops

ISO/IEC/JTC1/SC21/ULCT Upper Layers Conformance Testing

- Programme:
  Conformance Test suites for base standards:
    FTAM
    Presentation
    ACSE
    Session
    TP and CCR
  Associated PICS proformas.

ISO/IEC/JTC1/SC21 WG1 Conformance Group (Project 1.21.23)

- Programme:
  OSI Conformance Testing Methodology and Framework ISO/IEC 9646
  Addenda to cover ISP testing methodology, multi party test methods.
  Appendix A. WHO'S WHO IN CONFORMANCE TESTING 49

ISO/IEC/JTC1/SC6 WG4 Conformance

- Programme:
  Transport Conformance Test Suite and PICS proforma

ISO/IEC/JTC 1/SC6/WG I Conformance ad-hoc

- Programme:
  X.25 DTE Conformance Test Suite and PICS proforma

CCITT: Comite Consultatif International Telegraphique et Telephonique

- Programme:
  Standardization of Public Telecommunication Services. Sub-Groups are responsible for a specific programme, as listed below.

- Contributors:
  National Governments represented by national Telcos & PTT's
  Private operating agencies
  Scientific and Industrial organization

CCITT SG Vll

- Programme:
  X.290 Conformance Testing Methodology (Question 5)
  X.400 MHS Test suite, PICS proforma (Question 18)
  X.500 Directory services Test suite, PICS proforma (Question 20)

CCITT SG VIII

- Programme:
  Teletex test suite

CCITT SG X:

- Programme:
  Formal methods for conformance testing (Question 10)

CCITT SG Xl:

- Programme:
  Signalling System 7 testing and test specifications (Question 14)
  ISDN layer 2 and 3 conformance testing (question 22)

CEN/CENELEC: Comite Europeen de Normalisation

- Programme:
  European committee for standardisation of European OSI Functional Standards (EN,ENV) and associated suites.

- Contributors:
  National Standard Bodies (EC and EFTA countries)

ETSI: European Telecommunications Standards Institute

- Programme:
  European Telecom Standards (ETS, NET) European OSI Functional Standards and testing methodology.

- Contributors:
  EEC, EFTA PTTs and any industrial company, user organisation or government authority that wishes to contribute.

Note: the CEN/CENELEC/ETSI Functional Standards programme (M-IT-02) is coordinated by ITSTC.

EWOS: European Workshop for Open Systems

- Programme
  Established by CEN, CENELEC, SPAG, ECMA, OSITOP, RARE, COSINE and EMUG.

  - Production of EN/ENV for European OSI Functional Standards
  - Production of EN/ENV for test specifications

- Contributors Suppliers and users.

OIW: Open Systems Implementation Workshops

NIST workshops for the implementation of Open Systems. NIST is the National Institute of Standards and Technology, formerly NBS.

- Programme
  Defining Implementation Agreements for North America. (The US government may write FIPS which points to specific chapters in the agreements which they wish to see implemented. When a FIPS specifies OSI protocols, it is a GOSIP FIPS. FIPS stands for Federal Information technology Procurement Specifications.)

  Contributors:
  Anybody

AOW: ASIA/OCEANIC OSI Workshop

- Programme
  Submits FS to POSI for international harmonisation via Feeders Forum.

- Contributors
  Japan(INTAP), China, Korea, Singapore, Australia etc..

IEEE 802 Institute of Electrical and Electronics Engineers

- Programme
  LAN standards

- Contributors
  International Professionals (must be presented by a member)

TLFF Technical Levels Feeders Forum

- Programme
  Harmonisation of SPAG/COS/POSI/WFMTUG input to SGFS.
  TLFF/CC now working on methodology of conformance testing for ISPs and producing harmonised test specification for AFT-11 FTAM profile.

- Contributors
  SPAG, COS, POSI, WFMTUG, OSTC, ETCOM, OTL

OSI/NMF OSI Network Management Forum

- Programme
  Implementation of standards for the management of networks

- Contributors
  International Industry

A.1.2 COMMERCIAL/ RESEARCH/ PROMOTION/ PROCUREMENT GROUPS

COS Corporation for Open Systems

- Programme
  Develops test suites and provides test tools for MAP 3.0 (FTAM, MHS, Transport, Internet etc..)
  Supervise COS Mark.
- Contributors
  COS Members, International suppliers primarily US ones.

COSINE Cooperation for OSI Networking in Europe

- Programme
  Creation of OSI based network for interworking between European Research Organisations.

- Contributors
  European Research Organisations.

EMUG European MAP Users Group

- Programme
  Coordinates European Interests in MAP activity

- Contributors
  European MAP community- approx 150 members.

EPHOS European Procurement Handbook for Open Systems

- Programme
  A European GOSIP, based on UK GOSIP for France, Germany and UK

- Contributors

ETCOM European Testing Consortium for Office and Manufacturing

- Programme
  RA for harmonised conformance testing of LAN based OSI protocols throughout European Community and EFTA countries. Promotes mutual recognition of test reports and equivalence of accredited test laboratories.

- Contributors
  European test labs.

INTAP Interoperability Technology Association for Information Processing

- Programme
  Japanese OSI Users Group which Develops national functional standards, implements and evaluates OSI systems and carries out conformance testing.

- Contributors
  Japanese industry

OSITOP A European OSI User Association

- Programme
  Promotes the user requirements in OSI base and profile standards.

- Contributors
  120 members (European suppliers and users)

OSTC Open Systems Testing Consortium

- Programme
  RA for testing to European WAN FS, according to M-IT-03 framework, using range of test specifications and test tools developed and harmonised by CTS-WAN programme.

- Contributors
  European test labs. (mainly, but not exclusively, PTTs).

POSI Promoting Conference for OSI

- Programme
  Japanese OSI Functional Standards

- Contributors
  Japanese industry and suppliers

SPAG Standards Promotion and Application Group

- Programme
  Provides conformance testing tools and service for CNMA (MAP/TOP 3.0) Promotes open market based on standard, testing and certification

- Contributors
  European Industry

GOSIP Government Open Systems Interconnection Profile

- Programme
  Drafts and adopts functional specifications for Government OSI procurement and defines policy for conformance and interoperability testing and certification. Currently exists in US, UK, France, and is being defined for Europe. See EPHOS.

- Contributors
  Country industries (respectively in US, UK, France, etc.)

WFMTUG World Federation of MAP/TOP User Groups

- Programme Supervisory body for international harmonisation of regional MAP/TOP RAs (e.g. ETCOM). Arbitration authority for accreditation of test labs and certification of products.

- Contributors Regional MAP/TOP RAs and MAP/TOP test labs.

A.1.3 CEC Directed Policy Groups

SOGITS: Senior Officials Group on IT Standardization

- Programme
  Draft and check standardisation orders in the private IT sector. This authority defines the Bons de Commande related to European IT-standardization work itemss, and registers which Functional Standards projects are eligible for a Bon de Commande.

- Members National Government representatives

SOGT: Senior Official Group, Telecommunication

- Programme
  Draft and check standardisation orders in the public telecom sector.

- Members
  National Government representatives

ITSTC: IT Steering Committee (CEN/CENELEC/ETSI)

- Programme
  Responsible for the joint CEN / CENELEC / ETSI (initially CEPT) programme of IT-standardization in Europe (EEC and EFTA countries).
  Has set up and given missions to specific ITAEG groups, and issued several Memoranda on Information Technology (M-IT-xx) prepared by those groups.

- Members
  CEN, CENELEC, CEPT, CEC, EFTA representatives.

ITAEGS: IT Advisory Expert Group on Standardization

- Programme
  This ITSTC group prepared and keeps up-to-date the Functional Standards programme (M-IT-01 and M-IT-02).

- Members

ITAEGT: IT Advisory Expert Group on Private Telecom Networks

- Programme
  This ITSTC group prepared and keeps up-to-date the Directory of Private Telecom Network Standards (M-IT-05).

- Members

ECITC: European Committee for IT Certification

- Programme
  Promotes the general acceptance of test reports and certificates from one organization to the others of the same Recognition Arrangement.

- Members
  National members of CEN, CENELEC, CEPT.

ECITC/OTL: OSI Testing Liaison

- Programme
  Assist ECITC on technical matters related to accreditation of laboratories and certification of products in the OSI area.

- Members
  Experts designated by CEN CENELEC CEPT national members, OSTC, ETCOM or national IT-certification committees, and accepted by ECITC. Speak only for themselves.

Appendix B. FURTHER READINGS ON CONFORMANCE TESTING

(1) Study and Investigation mandate, BC-IT-01-SI, SOGITS DG.XI11, date 1 989-05-24

(2) Project and Technical reports from EWOS/ETSI Project team 5, working on BC-IT-01-SI mandate (Oct 90)

(3) Mandate BC-IT-88, SOGITS DG.XI11, 1989-05-19

(4) M-IT-01 Concept and structure of Functional standards

(5) M-IT-02 Directory of Functional Standards

(6) M-IT-03 Certification of Information Technology Products

(7) M-IT-05 Directory of private telecom network standards

(8) ISO/IEC 9646, five parts, DIS level.

(9) CCITT SG.VII: X.290 series (to be re-issued in 1991). Do not use X.290:1988 version.

(10) ISO/IEC JTC1 TR 10000-1 Framework of International Standard Profiles 1 989-1 2-01

(11) EN 45001 General criteria for the operation of testing laboratories

(12) EN 45002 General criteria for the assessment of testing laboratories

(13) EN 45003 General criteria for laboratory accreditation bodies

(14) ISO/IEC JTC1 SC21 N 5075 - May 1990 --PROTOCOL PROFILE TESTING METHODOLOGY

(15) ISO/IEC JTC1 SC21 N 5076 - May 1990 - MULTIPARTY TESTING METHODOLOGY

(16) ISO/IEC JTC1 SC21 N 5077 - May 1990 - TTCN Extensions

(17) ISO/IEC JTC1 SC21 N 5078 - May 1990 - Register of PICS proforma notations.

Appendix C. A TTCN EXAMPLE

The following pages contain an example of a test case which is part of the GSM_MS_Layer 2 test suite.

The GSM Layer 2 Data Link Interface Test Case tests the interface between the Mobile Station and the Base Station, which is based on the GSM 04.06 ETSI standard, to be published as ETS 300 021.

This standard specifies the frame structure, the elements of procedure, the format of fields and procedures for the proper operation of the Link Access Procedure on the Dm channel, LAPDm.

The frame formats defined for LAPDm are based on those defined for LAPD. The major differences come from the frame delimitation methods and transparency mechanisms, and are due to the constraints set by the radio path.

Courtesy Televerket / Teletest

1 Test Suite Overview

Test Suite Overview	
Suite Name :	GSM_MS_Layer2
Standards ref :	
PICS proforma ref :	
PIXIT proforma ref :	
PICS/PIXIT use :	
Test Method (s) :	
Comments :	

Test Case/Group Index

TC/Group Id	TC/Group Ref	Page	Description
SDCCH	GSM_MS_Layer2/SDCCH	25	
Init	GSM_MS_Layer2/SDCCH/Init	25	
CR	GSM_MS_Layer2/SDCCH/Init/CR	25	
L2TC001_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR-/normal_init	25	To test the normal establishment of multiple frame operation between the SS and the MS when contention resolution is required.
Fail	GSM_MS_Layer2/SDCCH/Init/CR/Fail	26	
L2TC002_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR/Fail-/loss_UA	26	To test the MS response to the loss of a Layer 2 UA frame during initialisation.
L2TC003_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR/Fail-/UA_different_info	26	To test that the MS will leave the channel and return to the idle state when multiple frame establishment fails because a UA frame with a different information field.
L2TC004_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR/Fail-/else_UA	27	To test that the MS will ignore receipt of frames other than a UA when received in response to the SABM frame.
L2TC005_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR-/init_denial	27	To test that the MS takes the appropriate action if the network side indicates that it can not enter the multi frame established state.
L2TC006_SDCCH	GSM_MS_Layer2/SDCCH/Init/CR/init_ failure	28	To test the MS response to the lack of the system to response to request to initialise the data link.
No_CR	GSM_MS_Layer2/SDCCH/Init/No_CR	29	
L2TC007_SDCCH	GSM_MS_Layer2/SDCCH/Init/No_CR-/normal_init	29	To test the normal initialisation of multiple-frame operation when the contention resolution is not required.
Fail	GSM_MS_Layer2/SDCCH/Init/No_CR-/Fail	30	
L2TC008_SDCCH	GSM_MS_Layer2/SDCCH/Init/No_CR-/Fail/loss_UA	30	To test the MS response to the loss of a layer 2 UA frame during initialisation.
L2TC009_SDCCH	GSM_MS_Layer2/SDCCH/Init/No_CR-/Fail/init_denial	30	To test that the MS takes appropriate action if the data link can not be initialised if the network side indicates the layer 3 process is busy.
L2TC0010_SDCCH	GSM_MS_Layer2/SDCCH/Init/No_CR-/Fail/init_failure	31	To test the MS response to the lack of the system to response to request to initialise the data link.
Normal_Info_Trans	GSM_MS_Layer2/SDCCH/Normal_Info-_Trans	32	
L2TC0011_SDCCH	GSM_MS_Layer2/SDCCH/Normal_Info-_Trans/sequence_count	32	To test the operation of layer 2 sequence numbering. Since there are 8 sequence numbers the test cycles through 9 information frame transfers.
L2TC0012_SDCCH	GSM_MS_Layer2/SDCCH/Normal_Info-_Trans/recovery_state	33	To test that the MS is able to respond to I frames whilst in the timer recovery state.
L2TC0013_SDCCH	GSM_MS_Layer2/SDCCH/Normal_Info-_Trans/Segment_concat	33	To test the proper use of segmentation and concatenation, suspend and resume.
L2TC0014_SDCCH	GSM_MS_Layer2/SDCCH-/normal_L2_disc	34	To test the normal data link disconnection sequences.
Link_Fail	GSM_MS_Layer2/SDCCH/Link_Fail	35	
L2TC0015_SDCCH	GSM_MS_Layer2/SDCCH/Link_Fail-/RR_Loss_MS_SS	35	To test the layer 2 recovery mechanism in the event of RR frame loss.
Incorrect_CR	GSM_MS_Layer2/SDCCH/Incorrect_C-R	36	
L2TC0016_SDCCH	GSM_MS_Layer2/SDCCH/Incorrect_C-R/I_frame_C_0	36	To test that the MS will react correctly upon reception of a frame with incorrect C/R value. in this case we test that the MS will take no action when it receives an I frame.
L2TC0017_SDCCH	GSM_MS_Layer2/SDCCHIncorrect_C-R/SABM_frame_C_0	36	To test that the MS will react correctly upon the reception of a frame with incorrect C/R value. In this case we test that the MS will take no action when it receives an
Errors_Control_Field	GSM_MS_Layer2/SDCCH/Errors_Control_Field	37	

Test Case Dynamic Behaviour				
Reference: GSM_MS_Layer2/SDCCH/Incorrect_CR/I_frame_C_0 **Identifier:** L2TC016_SDCCH **Purpose:** To test that the MS will react correctly upon the reception of a frame with incorrect C/R value. In this case we test that the MS will take no action when it receives an I-frame with the C bit set to zero (R). **Default:** Otherwise_Fail				
Behaviour Description	**L**	**Cref**	**V**	**C**
+pre1_SDCCH				
+L2TS001_ SDCCH				
L?UI		Fill_frame		
+L2TS016_SDCCH (938)				
+post1_SDCCH				
Extended Comments: Ref.GSM 11.10 II.5.2.2.5.1				

Test Step Dynamic Behaviour				
Reference: GSM_MS_Layer2/Lib/L2TS001_SDCCH **Identifier:** L2TS001_SDCCH **Objective:** **Default:** Otherwise_Fail				
Behaviour Description	**L**	**Cref**	**V**	**C**
L?SABM		SABM1		
L!UA		UA1		
Extended Comments:				

Test Step Dynamic Behaviour				
Reference: GSM_MS_Layer2/Lib/L2TS016_SDCCH **Identifier:** L2TS016_SDCCH (t:INTEGER) **Objective:** **Default:** Otherwise_Fail				
Behaviour Description	**L**	**Cref**	**V**	**C**
L!1		Test_Request		C=0, P=1, NS=0, NR=0
START T(t)				T=4xT200
?TIMEOUT T	L1			
L!RR		RR1		
L?RR		RR2	(P)	
L?UI		Fill_frame		
GOTO L1				
Extended Comments:				

Default Dynamic Behaviour				
Reference: GSM_MS_Layer2/Otherwise_Fail **Identifier:** Otherwise_Fail **Objective:**				
Behaviour Description	**L**	**Cref**	**V**	**C**
L?OTHERWISE			FAIL	
Extended Comments:				

Test Case Dynamic Behaviour				
Reference:	GSM_MS_Layer2/SDCCH/Init/CR/Fail/else			
Identifier:	L2TC004_SDCCH			
Purpose:	To test that the MS will ignore receipt of frames other than UA when received in response to the SABM frame			
Default:	Otherwise_Fail			
Behaviour Description	**L**	**Cref**	**V**	**C**
+prel_SDCCH				
L!I START T200 (235)		I1		
?TIMEOUT T200				
L?SABM		SABM1		
L!RR START T200 (235)		RR1		
?TIMEOUT T200				
L?SABM		SABM1		
L!REJ START T200 (235)		REJ1		
?TIMEOUT T200			(P)	
+post1				
Extended Comments:	Ref. GSM 11.10 II.5.2.2.1.1.2.3			

Test Case Dynamic Behaviour				
Reference:	GSM_MS_Layer2/SDCCH/Init/CR/Fail/else			
Identifier:	L2TC004_SDCCH			
Purpose:	To test that the MS will ignore receipt of frames other than UA when received in response to the SABM frame			
Default:	Otherwise_Fail			
Behaviour Description	**L**	**Cref**	**V**	**C**
+pre1_SDCCH				
+L2TC004 (235)				
+post1				
Extended Comments:	Ref. GSM 11.10 II.5.2.2.1.1.2.3			

Test Step Dynamic Behaviour				
Reference:	GSM_MS_Layer2/Lib/L2TC004			
Identifier:	L2TC004 (t:INTEGER)			
Objective:				
Default:	Otherwise_Fail			
Behaviour Description	**L**	**Cref**	**V**	**C**
L?SABM		SABM1		
L!I START T200 (t)		I1		
?TIMEOUT T200				
L?SABM		SABM1		
L!RR START T200 (t)		RR1		
?TIMEOUT T200				
L?SABM		SABM1		
L!REJ START T200 (t)		REJ1		
?TIMEOUT T200			(P)	
Extended Comments:				

Test Step Dynamic Behaviour				
Reference: GSM_MS_Layer2/preamble/pre1_SDCCH **Identifier:** pre1_SDCCH **Objective:** Establishment of the dedicated physical resource. **Default:** Otherwise_Fail				
Behaviour Description	**L**	**Cref**	**V**	**C**
L!UI		Paging_Request		
L!UI		Channel_Request		
L!UI		Immediate_Assign_SDCCH		
Extended Comments: Ref. GSM 11.10 II.5.2.1.1.5				

Test Step Dynamic Behaviour				
Reference: GSM_MS_Layer2/postamble/post1_SDCCH **Identifier:** post1_SDCCH **Objective:** Release of the dedicated physical resource. **Default:** Otherwise_Fail				
Behaviour Description	**L**	**Cref**	**V**	**C**
L!I		Channel_Release_SDCCH		
L!DISC		DISC1		
L?UA		UA1	R	
L?DM		DM1	R	
Extended Comments: Ref. GSM II 5.2.1.1.6				

PDU Type Declaration		
PDU Name: UA	PCO Type: PhSAP	Comments: Unnumbered acknowledgment
PDU Field Information		
Field Name	Type	Comments
Address_field	Octetstring[1]	
Control_field	GROUP	U_format_Control_field
Lenght_Indicator_field	Bitstring[8]	
Information_field	Octetstring	
Fill_bits	Octetstring	

PDU Type Declaration		
PDU Name: UI	PCO Type: PhSAP	Comments: Unnumbered information command
PDU Field Information		
Field Name	Type	Comments
Address_field	Octetstring[1]	
Control_field	GROUP	U_format_Control_field
Lenght_Indicator_field	Octetstring	
Fill_bits	Octetstring	

PDU Type Declaration		
PDU Name: I	PCO Type: PhSAP	Comments: Information
PDU Field Information		
Field Name	Type	Comments
Address_field	Octetstring[1]	
Control_field	GROUP	U_format_Control_format
Lenght_Indicator_field	Bitstring[8]	
Information_field	Octetstring	
Fill_bits	Octetstring	

PDU Constraint Declaration	
PDU Name: UI	Constraint Name: UI1
Field Name	Value
Address_field	‘01‘H
Control_field	UI_CF
Length_indicator_field	‘01‘H
Fill_bits	Fillbits
Comments:	

PDU Constraint Declaration	
PDU Name: UA	Constraint Name: UA2
Field Name	Value
Address_field	‘01‘H
Control_field	UA_CF
Length_indicator_field	‘00000001’B
Information_field	-
Fill_bits	Fillbits
Comments:	

PDU Constraint Declaration	
PDU Name: I	Constraint Name: I1
Field Name	Value
Address_field	‘01’H
Control_field	I_CF
Length_indicator_field	‘01010001’B
Information_field	-
Fill_bits	Fillbits
Comments:	The information field is arbitrary chosen

Appendix D. List of Abbreviations

Note: For abbreviations of organizations and standard bodies, please refer to appendix 'WHO IS WHO in Conformance Testing on page 49.

ASP	Abstract Service Primitive
ATM	Advanced Test Method
ATS	Abstract Test Suite
A/ or Axx	Application Profile (ISP: connection mode)
Bxx	Application profile (IS P connectionless)
CS(E)	Coordinated Single-layer (Embedded) Testing Method
CTR	Conformance Test Report. See also PCTR, SCTR
C/	Combined profile (M-IT-02)
DS(E)	Distributed Single-layer (Embedded) testing method
EN	European Standard
ENV	European standard (Preliminary)
ETS	Executable Test Suite
ETS	European Telecommunications Standard
FDT	Formal Description Technique
FS	Functional Standard
FSRL	Functional Standard Requirements List
FSTS	Functional Standard (conformance) Testing Specifications
FSTS-S	Functional Standard Testing Specifications-Summary
F/ or Fxx	Interchange Format and representation profile
IPRL	ISP Requirement List
ISP	International Standardized Profile
ISPATS	ISP Abstract Test Suite
ISPETS	ISP Executable Test Suite
ISPICS	ISP Implementation Conformance Statement
IT	Information Technology
IUT	Implementation Under Test
LT	Lower Tester
OSI	Open Systems Interconnection
MOT	Means Of Testing
NET	Norme Europeenne de Telecommunication
PATS	Parameterized Abstract Test Suite
PCO	Point of Control and Observation
PCTR	Protocol Conformance Test Report
PDU	Protocol Data Unit
PETS	Parameterized Executable Test Suite
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing

PTS	Profile Test Specification
Q/	Interchange Format and representation profile (M-IT-02)
RA	Recognition Arrangement
RS(E)	Remote Single-layer (Embedded) test method
R/	Relay profile (M-IT-02)
SAP	Service Access Point
SATS	Selected Abstract Test Suite
SCS	System Conformance Statement
SCTR	System Conformance Test Report
SETS	Selected Executable Test Suite
SUT	System Under Test
T/ or Txx	Transport Profile (ISP: connection mode)
TCP	Test Coordination Procedure
TMP	Test Management Protocol
TM PDU .	Test Management- Protocol Data Unit
TP	Test Purpose
TSS	Test Suite Structure
TTCN	Tree and Tabular Combined Notation
TTCN.GR	Tree and Tabular Combined Notation Graphical
TTCN.MP	Tree and Tabular Combined Notation Machine Processable
Uxx	Transport Profile (ISP connection less)
UT	Upper Tester
Y/	"Other" profile (M-IT-02)

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