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Foreword

This ETSI Technical Report (ETR) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

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 the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

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1 Scope

This ETR attempts to provide an introduction in DECT conformance testing. It gives a general overview on the DECT system, an introduction on conformance testing and DECT conformance testing in particular. It further shows how a ETSI customer can use the DECT Conformance test standards.

This ETR contains an abstract of the DECT standard, the ISO/IEC 9646 standard and the resulting issues from applying the requirements and techniques of ISO/IEC 9646 on the DECT protocol stack, together with a set of examples derived from the currently available test specification material from the Test suites for different DECT layers.

This ETR is not an overall description of DECT system concepts for which reference should be made to the relevant DECT standard documents, neither a guidance in Conformance testing methodology and framework, for which reference should be made to ISO/IEC 9646 documents.

It is outside the scope of this ETR to define specific equipment or particular implementation of such a product intended to realize the considered ATSs for DECT Conformance testing.

2 References

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

[1] ETS 300 175-1 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 1: Overview".

[2] ETS 300 175-2 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 2 : Physical Layer (PHL)".

[3] ETS 300 175-3 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 3 : Medium Access Control (MAC) layer".

[4] ETS 300 175-4 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 4 : Data Link Control (DLC) layer".

[5] ETS 300 175-5 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 5 : Network (NWK) layer".

[6] ETS 300 175-6 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 6 : Identities and addressing".

[7] ETS 300 175-7 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 7: Security features".

[8] ETS 300 175-8 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 8: Speech coding and transmission".

[9] ETS 300 175-9 (1992): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Part 9: Public Access Profile (PAP)".

[10] ETS 300 444: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

[11] prETS 300 370: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications/Global System for Mobile communications, (DECT/GSM) inter-working profile; Access and mapping (Protocol/procedure description for 3,1 kHz speech service)".

[12] ETS 300 434: "Radio Equipment and Systems (RES); Digital European Telecommunications (DECT) and Integrated Services Digital Network (ISDN) inter-working for end system configuration".

[13] ETS 300 331: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); DECT Authentication Module (DAM)".

[14] CCITT Recommendation G.726 (1991): "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[15] ISO/IEC 9646-1 (1994): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 1: General Concepts".

[16] ISO/IEC 9646-2 (1994): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 2: Abstract Test Suite Specification".

[17] ISO/IEC 9646-3 (1992): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 3: The Tree and Tabular Combined Notation (TTCN)".

[18] ISO/IEC 9646-5 (1994): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 5: Requirements on test laboratories and clients for the conformance assessment process".

[19] ISO/IEC 9646-6 (1994): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 6: Protocol profile test specification".

[20] ISO/IEC 9646-7 (1991): "Information technology - Open Systems Interconnection - Conformance Testing Methodology and Framework - Part 7: Implementation Conformance statement".

[21] prETS 300 406: "Methods for Testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

[22] I-ETS 300 176: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Approval test specification".

[23] TBR 6: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); General terminal attachment requirements".

[24] TBR 10: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); General terminal attachment requirements; Telephony applications".

[25] TBR 11 (1992): "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital European Cordless Telecommunications (DECT); Public Access Profile (PAP) applications".

[26] ETS 300 323 (1993): "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Public Access Profile (PAP); test specification".

[27] prETS 300 476: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Common Interface (CI); Protocol Implementation Conformance Statement (PICS);".

[28] prETS 300 474: "Radio Equipment and Systems (RES); Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP); Profile Implementation Conformance Statement (ICS)".

[29] prETS 300 494: "Radio Equipment and Systems (RES): Digital European Cordless Telecommunications (DECT); General Access Profile (GAP); Profile Test Specification (PTS)".

[30] prTBR 22: "Radio Equipment and Systems (RES); Attachment requirements for terminal equipment for Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP) applications".

[31] 91/263/EEC: "Council Directive of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity (Official Journal L128/1, 23/4/1991)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the definitions given in ISO/IEC 9646-1 [15] and ETS 300 175, Parts 1 to 8 [1]-[8] apply.

3.2 Abbreviations

ATM	Abstract Test Method
ATS	Abstract Test Suite
CI	Common Interface
DCS	Dynamic Channel Selection
DLC	Data Link Control
FP	Fixed Part
FT	Fixed radio Termination
GAP	Generic Access Profile
ICS	Implementation Conformance Statement
IUT	Implementation Under Test
IWU	Inter Working Unit
LLME	Lower Layer Management Entity
LT	Lower Tester
MAC	Medium Access Control
NWK	NetWorK
PAP	Public Access Profile
PCO	Point of Control and Observation
PHL	PHysicaL
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PCTR	Protocol Conformance Test Report
PP	Portable Part
PT	Portable radio Termination
RSE	Remote SinglE layer (test method)
SAP	Service Access Point
SUT	System Under Test
TC	Test Case
TCL	Test Case Library
TP	Test Purpose
TSS	Test Suite Structure
UL	Upper Layer
UT	Upper Tester

4 Introduction to the DECT system and DECT standards

4.1 General description of the system

DECT is based on a micro-cellular radio communication system that provides low-power radio (cordless) access between a DECT handset and DECT Fixed Parts (FPs) at ranges up to a few hundred meters.

The basic technical characteristics are as follows:

Frequency band:	1 880 MHz to 1 900 MHz;
Number of carriers:	10;
Carrier spacing:	1,728 MHz;
Peak transmit power:	250 mW;
Carrier multiplex:	TDMA; 24 slots/frame;
Frame length:	10 msec;
Basic duplexing:	TDD using 2 slots on same RF carrier;
Gross bit rate:	1 152 kbit/s;
Net channel rates:	32 kbit/s B-field (traffic)/slot; 6,4 kbit/s A-field (control/signaling)/slot.

A connection is provided by transmitting bursts of data in the defined time slot.

The protocols are designed to support uncoordinated system installation and an efficient sharing of the radio spectrum is achieved using a so called Dynamic Channel Selection (DCS) mechanism.

The DECT protocols provide internal mechanisms supporting intracell and intercell handover of calls in progress allowing maintaining a high quality of service when transparently re-connecting a Portable Part (PP) to another FP, another physical channel, bearer or connection.

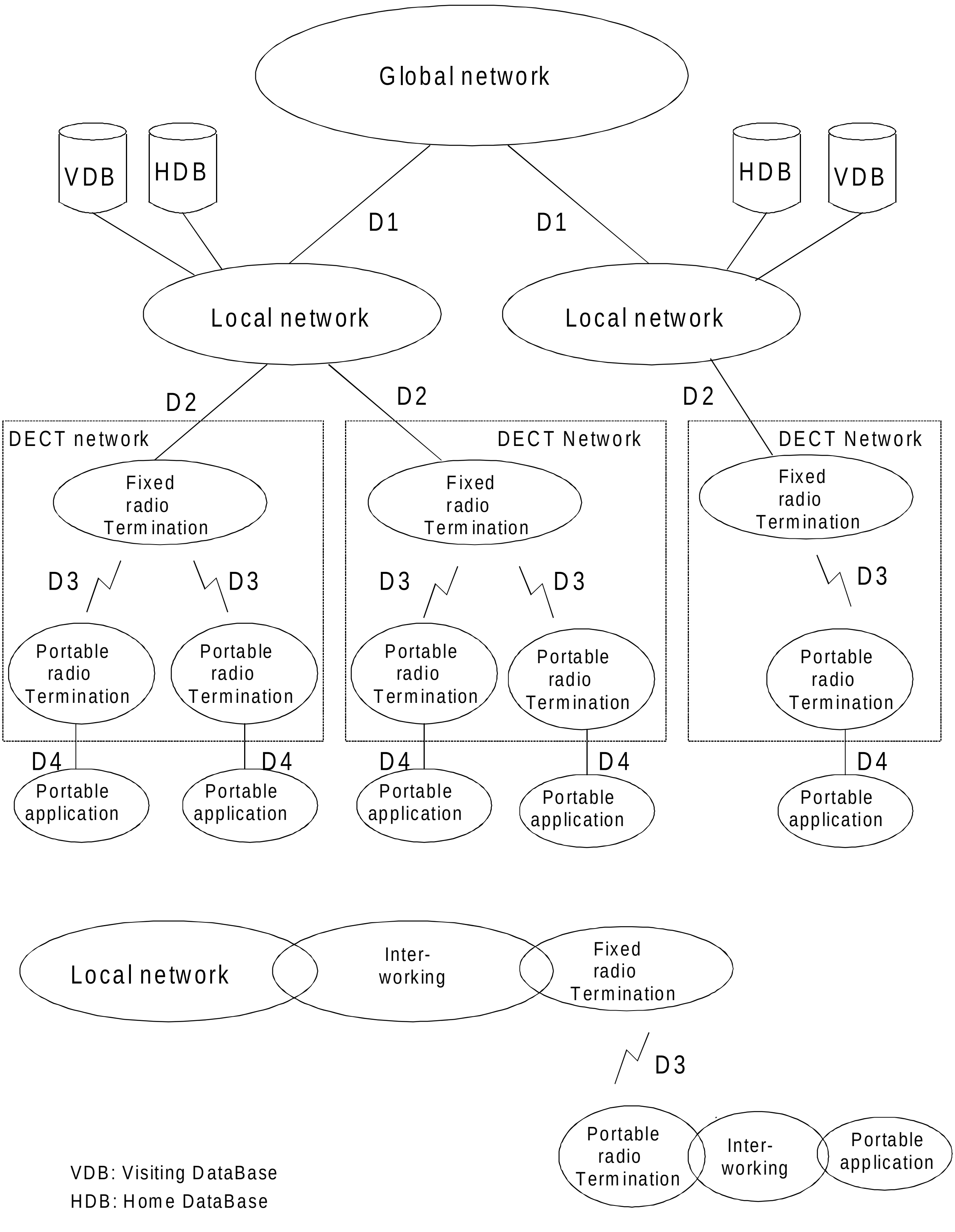

Figure 1: DECT reference model

The DECT reference model shows a functional configuration in which a DECT system is attached to an DECT local network, which in turn may be attached to a global network. In general, a DECT system supports the services offered by the global or DECT local networks to which it is attached (e.g. Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), Global System for Mobile communication (GSM). Separate standards define the inter-working with ISDN and GSM networks.

4.2 Protocol architecture

4.2.1 General

The structure of the DECT standard is based on the layered principles used in the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) model (see figure 2). The complete DECT Common Interface (CI) corresponds to the lower 3 layers of the ISO OSI model, but 4 layers of protocols are defined. The top of the DECT Network (NWK) layer (the highest DECT layer) corresponds to the top of the OSI layer 3, but the intermediate boundaries has no OSI equivalent.

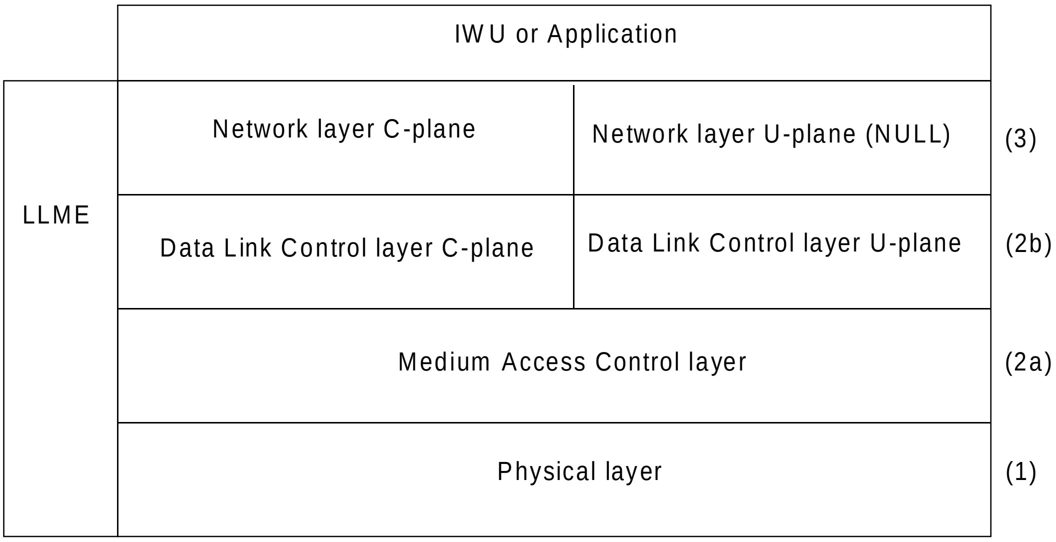

Figure 2: DECT protocol stack and higher layers above the NWK layer

4.2.2 Physical (PHL) layer

The PHL layer specifies radio parameters such as frequency, timing, bit and slot synchronization and transmitter and receiver performance.

4.2.3 Medium Access Control (MAC) layer

The MAC layer provides a broadcast message control service, a connectionless message control service, and multi-bearer (connection oriented) control service, by selecting physical channels and allocating logical channels.

4.2.4 Data Link Control (DLC) layer

The DLC layer is concerned with the provision of reliable data links to the NWK layer. It's function can be compared to the ISDN layer 2 Link Access Procedure on the D-channel (LAPD) protocol.

4.2.5 Network (NWK) layer

The NWK layer is the main signaling layer of the protocol stack, containing the functions for call control, mobility management, connection oriented message service, connectionless message service and supplementary services.

4.2.6 Lower Layer Management Entity (LLME)

The LLME contains defined procedures that concern more than one layer. It contains all functions needed for inter-working between the different layers.

4.2.7 Inter-Working Units (IWU)

The IWUs are required for the communication with the fixed network or with higher layer applications within the PP and FP, e.g. DECT-GSM inter-working profile. The DECT IWU functions are defined in separate standards.

5 Overview on conformance testing

5.1 Scope of conformance testing

Conformance testing is concerned with the assessment of the extent to which a real product or service, based on a standard, actually conforms to the standard.

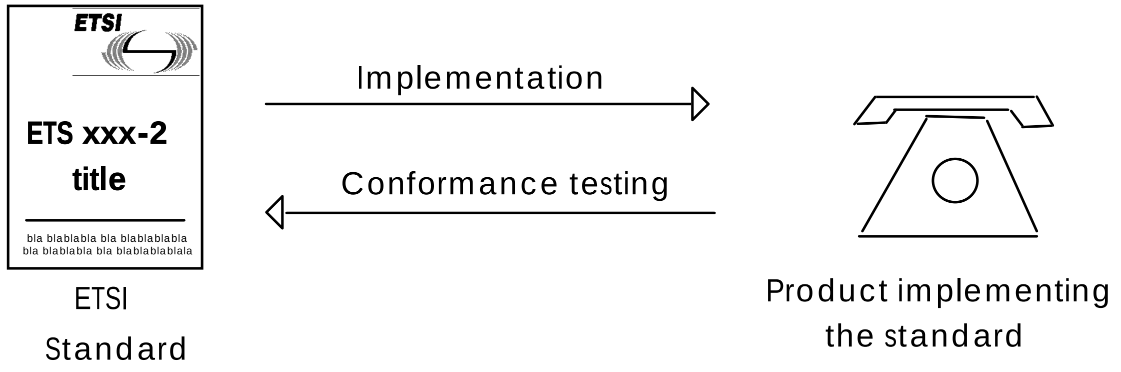

Figure 3

Conformance testing does not add constraints in addition to standards. Conformance testing means testing against the conformance requirements in the standards. The publication of conformance testing standards is not an indirect means to constrain a technology more than the reference standards themselves do.

5.2 Importance and value of conformance testing

The primary objective of conformance testing is to increase the probability that the product, or service, will actually perform correctly the functions it is aimed at. In general, this means to increase the probability that different products based on the same standard will inter-operate.

It should be emphasized that exhaustive testing is impractical on both technical and economical grounds, and even theoretically impossible, and therefore conformance testing cannot guarantee conformance to a standard.

Conformance testing has value only against good standards. The result of conformance testing will be meaningful to a user (e.g. the procurer of a product) if the standard itself is meaningful, i.e. if the fact to implement the standard guarantees in itself a certain degree of interoperability between products.

Initially developed in the OSI context, and thus limited to OSI communication protocols and information objects, the conformance testing has a wider scope in the field of telecommunications, for which it can cover systems, interfaces, services, etc. according to the real needs.

5.3 Benefits of a standard methodology and standard test specifications

Any test can be contentious. When comparing a product to a specification, using concrete tools, it is normal to consider:

- is the product wrong?
- is the specification ambiguous?
- is the test biased?
- is the method adapted?

One way to solve some of these questions is to standardize, i.e. standardize a methodology and standardize test specifications.

The use of standard methods and test procedures, based on approved test specifications developed in time for every standard, lead to the comparability of test results produced by different testers, and thereby to the mutual recognition of test reports.

In other words, the benefits of a standard methodology and standard test specifications are:

- the means to test early, via the availability of test specifications;

- the means to test once, the need for repeated testing being minimized by the achieved comparability of test results;

- the means to test at low cost, by avoiding repeated test campaigns, and using test specifications developed once;

- the flexibility to allow test by a supplier (1st party testing), by a procurer (2nd party testing), or by an independent laboratory (3rd party testing).

5.3.1 A standardized methodology

Initially developed in ISO and the International Consultative Committee for Telegraph and Telephone (CCITT), the conformance testing methodology covers all the aspects that participate to the harmonization of testing procedures: testing methods, development of test specifications, test realization on concrete means of testing, relations between client and laboratory during the conformance assessment process.

The chief principle of this methodology is to respect the freedom to develop and use different test tools, provided that they are based on the same test methods and specifications: the test results will be equivalent. For this reason, the testing methods are called Abstract Testing Methods (ATMs), and the test specifications are called Abstract Test Specifications (ATSs).

5.3.2 Standardized test specifications

Standardized test specifications are essential in order for tests run in different laboratories and with different test tools to have comparable results.

Standardized test specifications are also essential when laboratories or test tools are assessed, e.g. by accreditation authorities.

The art of the conformance test specified resides in finding the good compromise, so that the test campaigns provide a reasonable level of confidence at a reasonable cost. Optimization is always sought, i.e. best ratio coverage/cost.

5.4 What is the use of conformance testing?

Conformance testing may be used in three main contexts.

1) Outside any framework, i.e. as a technical activity, by a supplier or a user. This is aimed at validating a product during its development, before releasing it, or when purchasing it. An agreement between the supplier and the procurer of a product can make the acceptance of the product dependent upon the result of this test.

2) In the voluntary certification framework, i.e. in order to attach, if the tests are passed, a certificate to the product. The conformance testing specifications are the technical basis for any certification framework.

3) In the regulatory type approval framework, i.e. conformance testing is also used as a basis for terminal equipment approval, within the framework of the European Directive 91/263/EEC. Parts of the test specifications then become part of regulatory documents, called CTRs. They are limited to the test against the technical requirements identified as essential in the same CTRs.

5.6 Reference testing documents

ISO/IEC 9646-1 [15] is the chief basis of conformance testing, and covers all related aspects, from the development of test specifications to the conformance assessment process.

ETS 300 406 [21] provides rules and guidance on the test specifications developed for standardization

Further ETSI Technical Reports have been prepared to give guidance to ETSI Technical Committees and include ETR 021, ETR 141 and ETR 153 (see annex A).

5.7 Technical overview

5.7.1 What is tested?

An open system is not tested globally, but, according to the architecture of the standards, each part of the system implementing a different standard is tested separately. In the OSI model, each layer is tested separately.

The part of a system tested against a given standard is called the Implementation Under Test (IUT), whereas the whole system is called the System Under Test (SUT).

The IUT is the part of the SUT implementing the tested protocol (see figure 4).

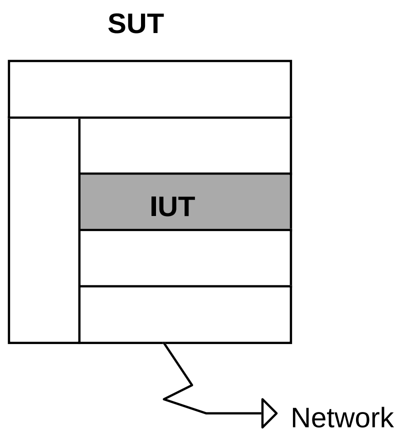

Figure 4

5.7.2 Testing methods

In order to run the tests, the tester will communicate with the IUT at different points, in order to observe the events at protocol level, and also to trigger given elements of behavior in the IUT.

These points, where the tester communicates with the IUT, are called Points of Control and Observation (PCOs).

The IUT is tested as a black box, i.e. the tester never accesses points inside the IUT, but only examines the external behavior of the IUT.

Generally, the tester cannot access directly the IUT, which is not separable from other elements of the SUT. Accessing points inside the SUT is generally complex and costly. Often, the SUT is also treated as a black box.

The PCOs are situated at the boundary, or inside the SUT. Depending on the number and the location of the PCOs an ATM is defined.

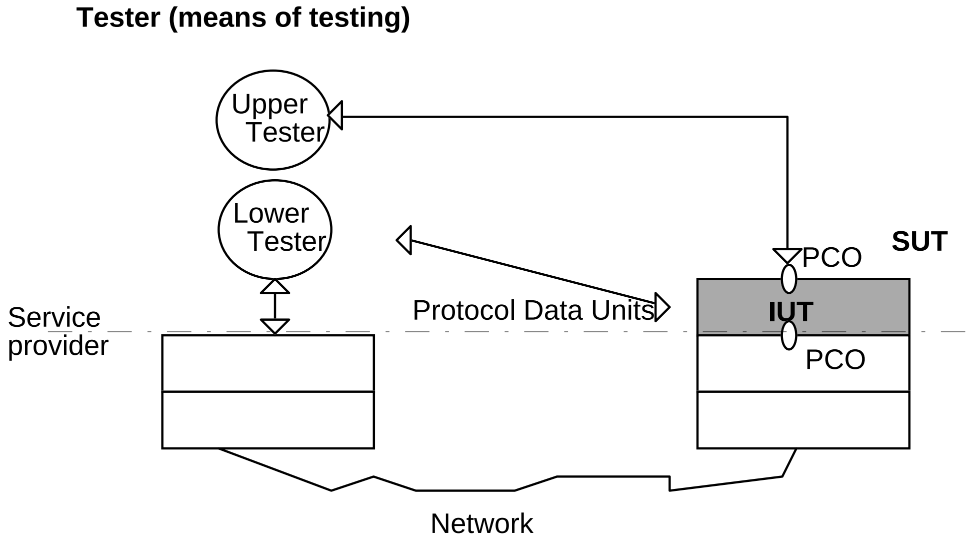

Figure 5: Example of PCOs with the test of a protocol layer

In figure 5 the "lower" PCO, where the protocol of the IUT is observed, is considered to be just below the IUT, ignoring the fact that part of the service provider is within the SUT.

Several classes of test methods are defined. When several PCOs are defined at the protocol level (i.e. the IUT communicates with several other systems concurrently, these other systems being simulated by testers) and the method belongs to a multi-party testing context.

5.7.3 What set of tests?

To each particular element of communication to be tested (syntax, semantics, or behavior), called conformance requirement of the standard, corresponds a particular Test Purpose (TP).

The TPs are organized with a tree structure (groups and subgroups) according to the functionality of the protocol and the types of tests.

When the test method has been chosen, Test Cases (TCs) are specified, corresponding to the TPs.

Each TC is described from the point of view of the behavior of the tester, with the constraints on the data exchanged between the tester and the IUT. The TC describes how the verdict shall be assigned according to the different possible behaviors. The verdict may be Pass, Fail or Inconclusive.

The TCs are called Abstract Test Cases (ATCs) because they are independent of their realization on a particular test tool. The set of ATCs for a given standard is called an Abstract Test Suite (ATS). The implementation of the ATS on a particular tester produces executable tests used in the testing process. The set of executable TCs is called the Executable Test Suite (ETS).

5.7.4 Tree and Tabular Combined Notation (TTCN): A notation for test suites

ISO/IEC 9646-3 [17] defines a dedicated notation, called TTCN, for specifying abstract TCs.

Tree, because TTCN describes the behavior of the tester as a tree of events and actions, leading to verdict assignments (at the leaves). TTCN allows to expect several alternative behaviors of the IUT, and to assign different verdicts to the different observed behaviors.

Tabular, because a Graphical Rendition (GR) form of TTCN presents all the elements of the test suite in tables.

Another form of TTCN, semantically equivalent, is Machine Processable (MP).

Devoted syntactical editors exist for TTCN, and allow the writing of test suites in a more or less assisted manner, with syntax checks.

The TTCN MP can be exchanged between syntactical editors, and can also be compiled on some testers. Several test tool providers propose TTCN compilers or translators as inputs to their testers. However, the compilation of the TTCN never provides the executable test suite totally automatically, since additional information is needed, which depends on each real tester.

A special feature of TTCN is available to describe parallel behaviors, for instance when several testers are use concurrently in a multi-party context. This feature is called Concurrent TTCN. It is part of the TTCN syntax.

5.7.5 Adapting the tester to the tested: Implementation Conformance Statement (ICS) and eXtra Information for Testing (IXIT)

Before a tester is "connected" to a SUT to run the tests, the tester is adapted to the particular SUT.

The tester needs to know the response to two types of questions.

1) Have the options of the standard have been implemented in the IUT?

A standard contains not only mandatory requirements but also conditional and optional ones.

In order to test the conformance of a particular IUT, the capabilities and options actually implemented must be declared in a particular document, called Implementation Conformance Statement (ICS), the format of which is standardized, as a questionnaire to be completed by the supplier of the IUT. The ICS proforma is in principle a part of the protocol standard itself.

The ICS describes in a standardized way the implementation of a standard (see figure 6).

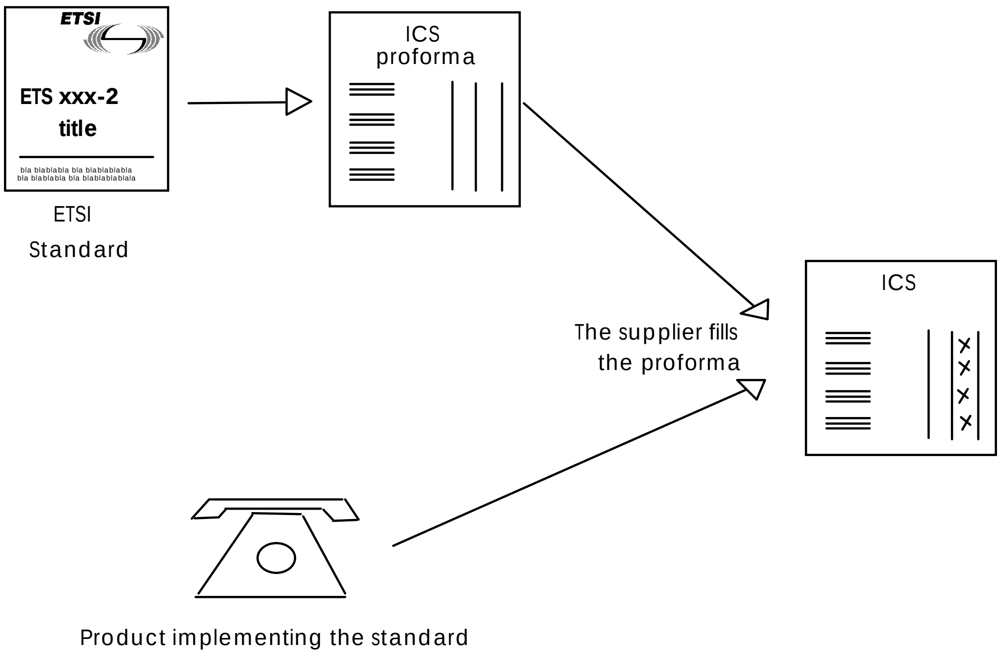

Figure 6

2) Are there other characteristics of the SUT (not specified in the standard) essential for the testing process?

The tester needs to know other characteristics of the IUT or of the whole SUT, such as the characteristics of other layers in the SUT, the network addresses, etc.

This additional information is gathered as another document called eXtra Information for Testing (IXIT). The format of the IXIT is also standardized as a questionnaire associated with the test suite used.

5.7.6 What conformance assessment process ?

ISO/IEC 9646-5 [18] defines the different steps of the conformance assessment process, underlying the test service provided.

The selection of the actual list of tests to be run against a particular IUT is made according to implementation choices declared in the ICS, and also to information in the IXIT.

This process is in fact called de-selection, because the basic principle is that all the tests will be run, unless there is a good reason that prevents a test to be run (e.g. because it corresponds to an option that was not implemented in the IUT (ICS de-selection) or because it is impractical for a given IUT (IXIT de-selection)). It is necessary to justify why a test will not be run, but it is not necessary to justify why a test should be run.

The result of the test itself is a set of traces and logs, from which is derived, generally with the help ,of an expert, a final test report, (Protocol Conformance Test Report (PCTR)), in accordance with a standardized format.

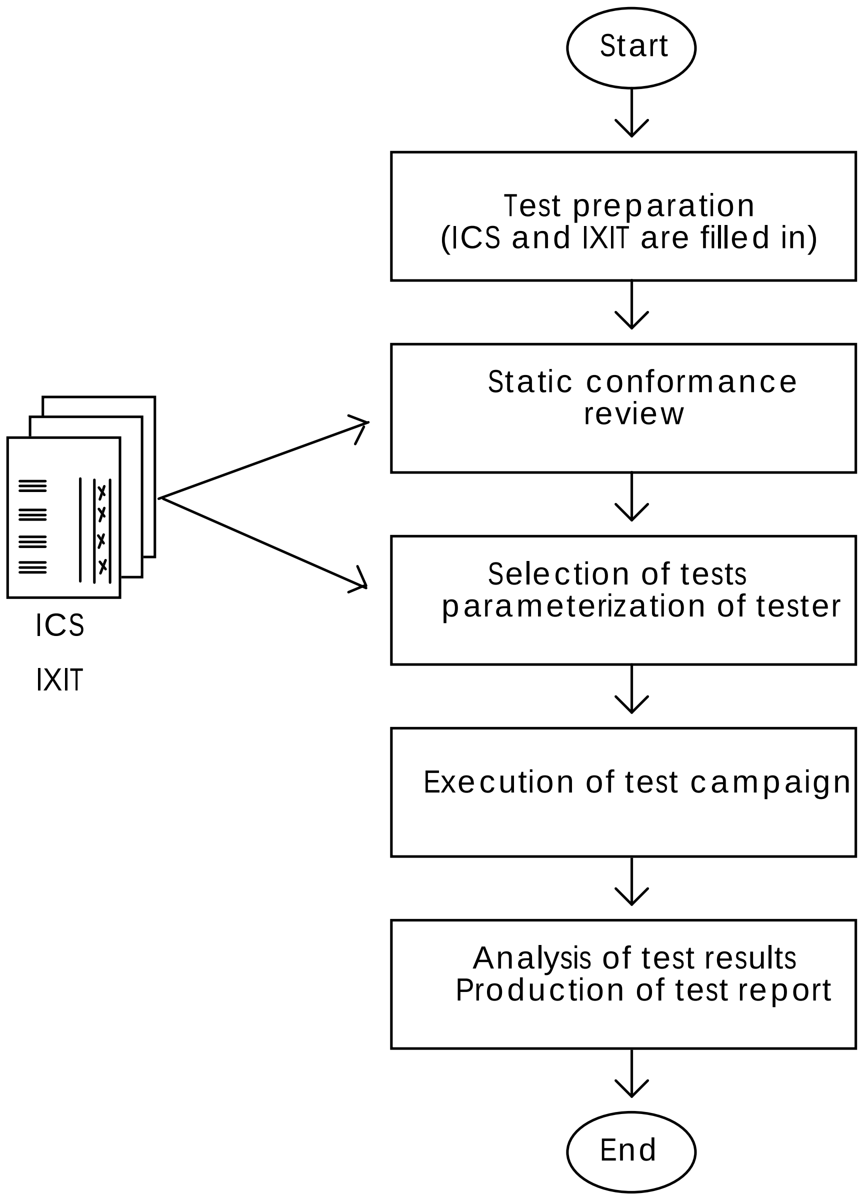

Figure 7

6 DECT conformance testing

6.1 General overview

ETSI has produced several test standards for the DECT CI, ETS 300 175 Parts 1 to 8 [1]-[8] and its profiles. Figure 8 gives an overview of the various DECT standards and the relation between the protocol standards, the test specifications, the ICS standards as well as the relationship between the base standards and its related profile standards. The various standards are today in different states of development. This subclause deals with all DECT standards which have been finalized, or for which at least an ETSI work item and the budget for the development is allocated.

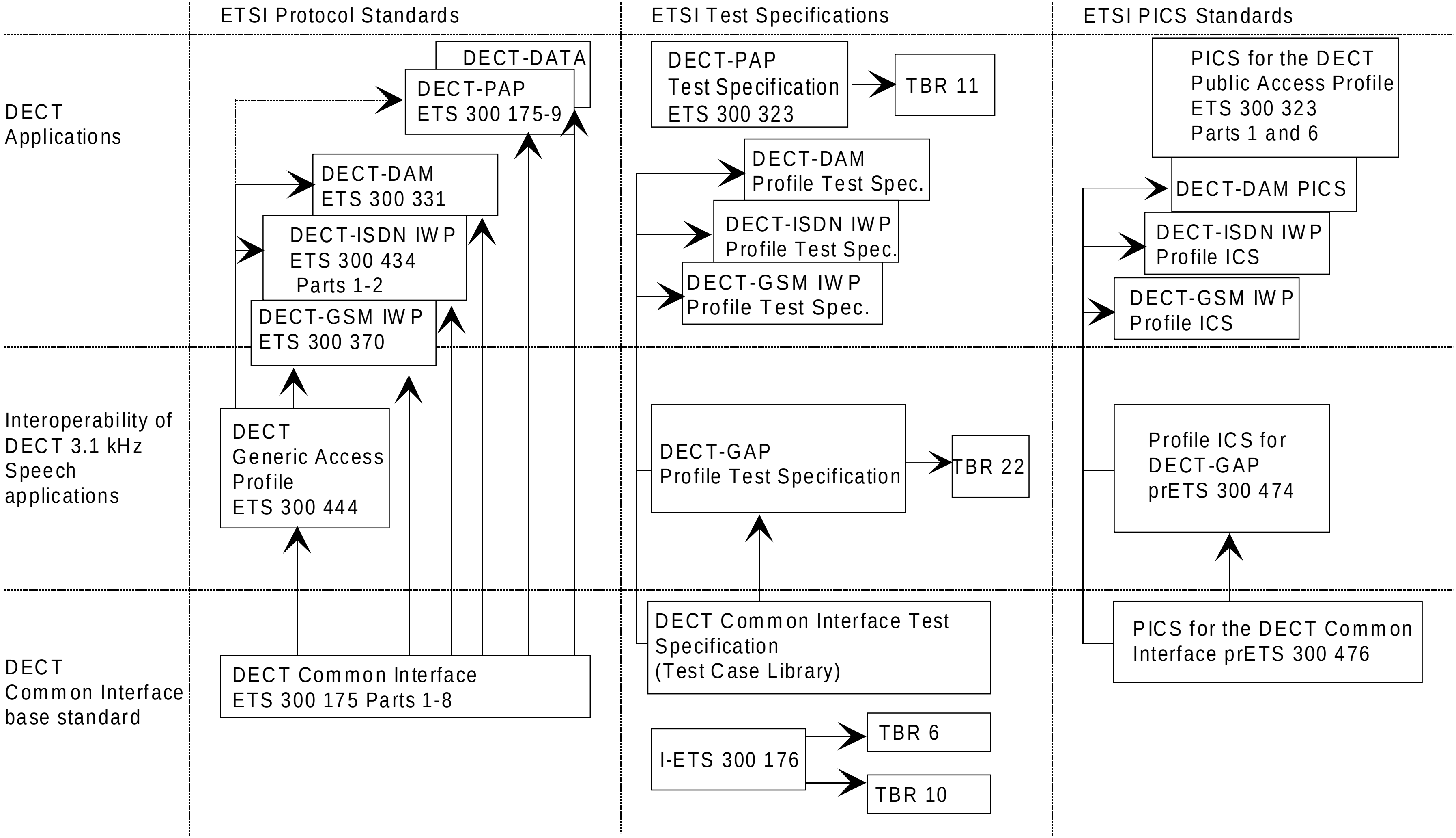

Figure 8: Overview on ETSI DECT standards

6.2 DECT conformance testing standard

6.2.1 Structure

Tables 1 and 2 show the general structure of a conformance test standard. The tables show the components of the standard in addition to the common ETSI standards layout.

Table 1: Structure of a protocol conformance test standard

Document type	Components associated with the document type
TSS and TP	- Test Suite Structure - Test Purposes
ATS	- Abstract Test Method - Untestable Test Purposes - ATS Conventions - ATS - Partial PIXIT - PCTR proforma

Table 2: Structure of profile conformance test standard

Document type	Components associated with the document type
Profile Test Specification	- Relevant Test Case List - Test Cases replacement list - Additional Test Cases list - Modified selection expressions - Profile IXIT proforma

6.2.1.1 Components of a protocol conformance test standard

6.2.1.1.1 Test Suite Structure (TSS)

The TSS reflects the structure of the test specifications in terms of subjects and requirements which are covered. The TSS represents an adequate coverage of the protocol conformance requirements.

6.2.1.1.2 Test Purposes (TP)

For all relevant protocol conformance requirements a TP will be defined. A TP focuses on a single protocol conformance requirement and gives indication how it will be tested.

6.2.1.1.3 Abstract Test Method (ATM)

The ATM defines in an abstract manner how the IUT will be accessed for the purpose of conformance tests. The ATM is always related to a particular ATS. It might be necessary to define several ATMs, and respective ATSs to allow TC definition for all protocol conformance requirements.

6.2.1.1.4 ATS conventions

To achieve consistency within an ATS on the use of the TTCN notation as well as on implementation aspects, conventions are agreed. This convention will be followed during development and later maintenance, they ease understanding for the developer as well as for the user.

6.2.1.1.5 ATS

The ATS is a set of TCs which is based on the TSS and TP. The TCs for the higher DECT layers, above the PHL layer, are defined in the TTCN notation ISO 9649-3 [17].

6.2.1.1.6 Partial Protocol Implementation eXtra Information for Testing (PIXIT)

The PIXIT is a set of tabled questions which shall primarily provide information about the testing environment of the IUT. Besides address and parameter values it also provides information about the invocation of implicit events.

6.2.1.1.7 PCTR proforma

The PCTR records the conformance status of the IUT obtained during a test campaign.

6.2.1.2 Components of a profile conformance test standard

6.2.1.2.1 Relevant TCs list

This subclause provides a list of TCs defined in other test specifications which are relevant for the protocol profile and will be thus applied for its conformance testing.

6.2.1.2.2 TCs replacement list

This subclause provides a list of TCs which have to be replaced or modified in a existing test specification for the purpose of protocol profile testing.

6.2.1.2.3 Additional TCs list

This subclause provides a list of TCs to cover additional profile specific requirements.

6.2.1.2.4 Modified selection expressions

This subclause defines how the selection expressions have to be modified for protocol profile testing.

6.2.1.2.5 Profile IXIT proforma

The Profile IXIT define the necessary modifications and additions to the PIXITs of the base standard test specification regarding the profile test specification.

6.2.2 Scope of testing

The test specifications provide a base for DECT equipment validation and certification. The test specifications will give good confidence in protocol conformity and interoperability of equipment provided by various manufactures and which have been tested against these test specifications. However the test specifications do not provide extensive testing.

The test specifications are split and structured in a way that partial testing of the interface side, Fixed radio Termination (FT) or Portable radio Termination (PT), as well as testing against the DECT base specification or against single DECT profiles, is possible.

6.2.3 Introduction to DECT test specifications

This subclause gives an introduction to the various DECT test standards (see also figure 8) which have been published, are under development, or for which an ETSI work item and budget is available.

6.2.3.1 I-ETS 300 176

The objective of this test specification is to provide a basis for approval tests on the PHL layer RF aspects.

6.2.3.2 TBR 6

TBR 6 [23] provides the Technical Base for Regulation and certification of DECT equipment concerning the PHL layer RF aspects.

6.2.3.3 TBR 10

TBR 10 [24] provides the Technical Base for Regulation and certification of DECT equipment concerning general terminal attachment requirements for telephony applications.

6.2.3.4 DECT CI test specification

The objective of this test specification is to provide a basis for protocol conformance and approval tests for DECT equipment giving a high probability of air interface inter-operability between different manufacturer's DECT equipment. The test specification is based on ETS 300 175, Parts 1 to 8 [1]-[8]. As this test specification will provide the base for all other DECT test specifications, it is also called Test Case Library (TCL).

6.2.3.5 DECT GAP Profile Test Specification (PTS)

The objective of the GAP PTS, ETS 300 494 [29], is to provide tests for DECT 3,1 kHz speech applications based on ETS 300 444 [10]. This test specification is a Protocol Profile Test Specification (PPTS) which is based on the TCL and follows the rules defined in ISO 9646 Part 6 [19].

6.2.3.6 TBR 22

TBR 22 [30] provides the Technical Base for Regulation and certification of DECT 3,1 kHz speech application. TBR 22 [30] covers, in addition to TBR 6 [23] and TBR 10 [24], requirements identified by the Council Directive 91/263/EEC [31] in articles 4d, 4e, 4f and 4g. The TBR is based on the DECT GAP Profile Test Specification ETS 300 494 [29].

6.2.3.7 DECT-GSM IWP PTS

The objective of this test specification is to provide tests for equipment build to ETS 300 370 [11]. The tests ensure the inter-working of a DECT/GSM PP with DECT FP attached to GSM Public Land Mobile Networks (PLMNs). This test specification is a PPTS which is based on the TCL and DECT GAP PTS ETS 300 494 [29], and it follows the rules defined in ISO 9646 Part 6 [19]. The test specification will be applied in addition to the DECT GAP PTS ETS 300 494 [29].

6.2.3.8 DECT-ISDN IWP profile test specification

The objective of this test specification is to provide tests for equipment build on ETS 300 434 [12]. The tests shall assure the inter-working of a DECT-ISDN equipment with a public ISDN network. This test specification is a PPTS which is based on the TCL and DECT GAP PTS ETS 300 494 [29], and it follows the rules defined in ISO 9646 Part 6 [19]. The test specification will be applied in addition to the DECT GAP PTS ETS 300 494 [29].

6.2.3.9 DECT Authentication Module (DAM) test specification

The objective of this test specification is to provide tests for the DAM in ETS 300 331 [13] which may be used in various DECT applications. The test specification will be applied in addition to the DECT GAP PTS and the relevant DECT application test specification (e.g. DECT-ISDN).

6.2.3.10 DECT PAP test specification

The objective of this test specification is to provide tests for the DECT PAP ETS 300 175-9 [9]. As this test specification was build at an earlier stage it does not have direct relations to the TCL and the TCL based PTSs.

6.2.3.11 TBR 11

TBR 11 [25] will provide the Technical Base for Regulation and certification of DECT equipment built according to ETS 300 175-9 [9]. TBR 11 [25] covers in addition to TBR 6 [23] and TBR 10 [24], requirements identified by the Council Directive 91/263/EEC [31] in article 4d, 4e, 4f and 4g. The TBR is based on the DECT PAP test specification.

6.2.4 Testing of different DECT layers

6.2.4.1 PHL layer testing

ETS 300 176 [22] specifies the approval tests applicable to all DECT equipment accessing the frequency band 1 880 - 1 900 MHz, including provisions for testing other or extended frequency bands, and the approval tests applicable to DECT speech transmission using CCITT Recommendation G.726 [14] Adaptive Differential Pulse Code Modulation (ADPCM) speech codec at 32 kbit/s.

The aims of the standard are to ensure:

- efficient use of frequency spectrum;
- no harm done to any connected network and its services;
- no harm done to other radio networks and services;
- no harm done to other DECT equipment or its services;
- inter-working of terminal equipment via the public network;

through testing those provisions of ETS 300 175, Parts 1 to 8 [1]-[8] which are relevant to these aims.

The tests of ETS 300 176 [22] are split into two parts:

- **Part 1** covers testing of radio frequency parameters, security elements and those DECT protocols that facilitate the radio frequency tests and efficient use of frequency spectrum. Part A includes optional tests for physical (radio) interfaces to PAP, DECT/GSM, DECT/ISDN and DAM protocols testing. These tests apply for equipment implementing the profiles;

- **Part 2** describes testing of DECT 32 kbit/s ADPCM speech requirements between network interface and DECT PT, or between a DECT CI air interface and alternatively a DECT PT or FT. Part B is not applicable to terminal equipment specially designed for the disabled (e.g. with amplification of received speech as an aid for the hard-of-hearing).

6.2.4.2 Medium Access Control (MAC) layer testing

The message exchange between the PHL and the MAC layer is very time critical. Due to this fact, it is not possible to derive from an ATS, applying the conventional Remote Single Layer (RSL) test method, an executable test suite. Instead of generating a test sequence on a PCO between the PHL and the MAC layer which can be controlled and observed, a particular test scenario is executed on the PCO above the MAC layer. Then the expected test behavior is only observed on the PCO between the PHL layer and the MAC layer. Observed means the expected behavior is only defined in terms of receive events. This test method was chosen for the following reasons:

- the ATM is less time critical. An ATS based on this ATM can be implemented as the events of the Physical layer PCO could be traced and a later automatic off-line analyze based on the ATC is possible (as only receive events are defined);

- this ATM is ISO 9646 [15] to [20] conformant.

This test method allows valid behavior tests to be carried out, but it is not possible to generate invalid or inopportune test events.

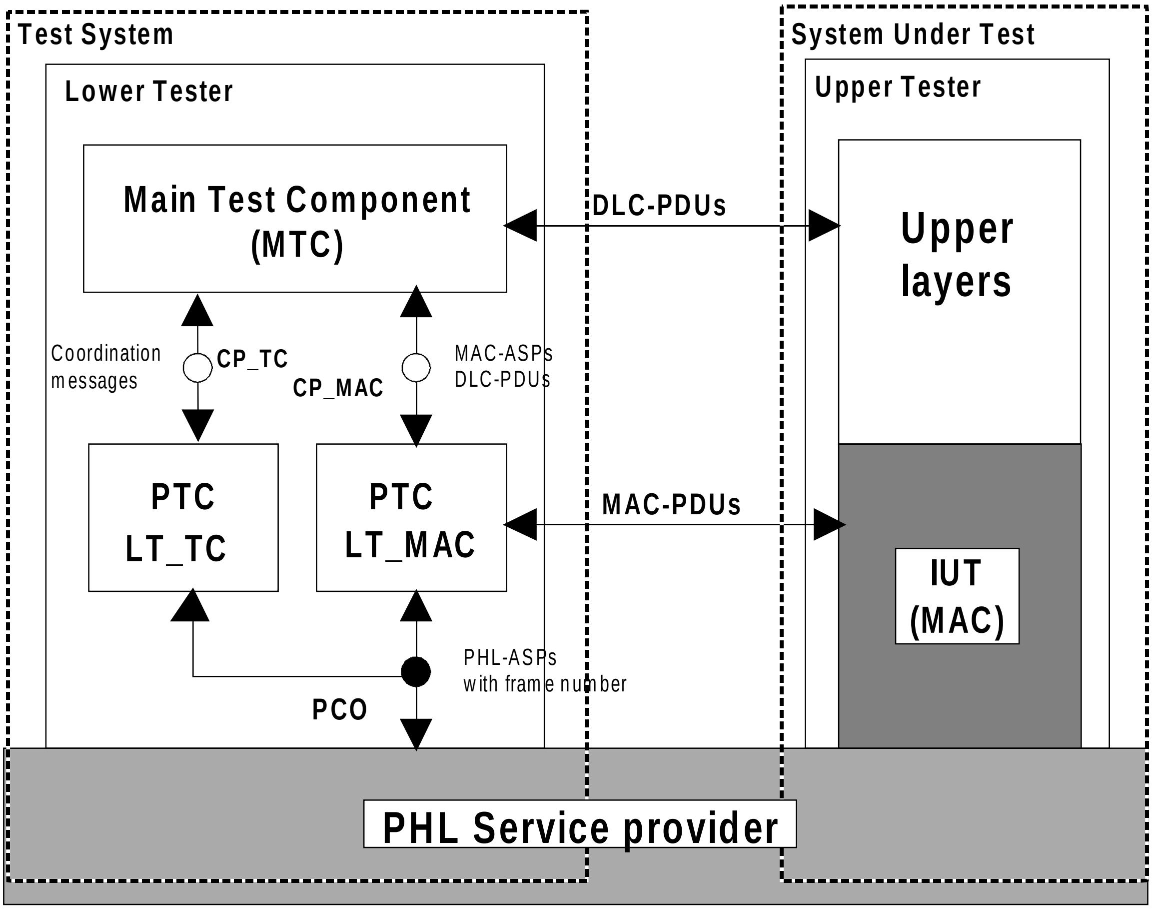

Figure 9: ATM for MAC layer testing, remote test method, embedded variant

A single-party testing context is used, which consists of the following abstract testing functions:

PCO: The PCO for MAC Layer testing is located at the D-SAP between the MAC layer and the Physical layer. All test events at the PCO are specified in terms of PHL-ASPs (frame number parameter added).

CP_TC: Coordination Point Test Case (CP_TC) is located between the MTC and PTC LT_TC in the test system. It is used for passing coordination messages between these two testing functions.

CP_MAC: Coordination Point MAC (CP_MAC) is located between the MTC and PTC LT_MAC in the test system. It is equivalent to the PCO used for DLC layer testing (see subclause 6.2.3.3). All coordination messages at this CP are specified in terms of MAC-ASPs and DLC-PDUs.

PTC LT_TC: The Lower Tester Parallel Test Component LT_TC (PTC LT_TC) is located in the test system. It makes restricted use of the PCO by only observing the test events in both directions. It assigns preliminary verdicts (the MTC assigns the final verdict).

NOTE: This restricted use of the PCO is a non-ISO 9646-2 [16] application of the PCO.

PTC LT_MAC: The Lower Tester Parallel Test Component LT_MAC (PTC LT_MAC) is located in the test system. It provides indirect control and observation of the IUT during test execution, via the underlying service-provider. It does not assign any verdicts.

MTC: The Main Test Component (MTC) is located in the test system. It is responsible for creating and terminating the PTCs, managing the coordination points CP_TC and CP_MAC, and computation of the final TC verdict.

Upper layers: No explicit Upper Tester (UT) exists in the test system. However, the SUT (upper layers) needs to carry out some UT functions to achieve some effects of test co-ordination procedures.

The primitives used at the PCO (physical SAP - DSAP) are defined according to ETS 300 175-2 [2], clause 7 and associated subclauses.

The co-ordination messages used at CP_MAC co-ordination point are abstract primitives including Protocol Data Units (PDUs) and frames. The abstract primitives (MAC ASPs) are defined according to ETS 300 175-3 [3], clause 8 and associated subclauses. Two abstract primitives for starting and stopping the synchronization between the main test component and the parallel test component LT_MAC are added for the needs of the tester. The PDUs (DLC C-plane PDUs) are defined according to ETS 300 175-4 [4], clause 7 and associated subclauses. The frames (DLC U-plane frames) are defined according to ETS 300 175-4 [4], clause 12 and associated subclauses.

This ATM requires the use of concurrent TTCN, which is specified in ISO/IEC 9646-3 [17], Amendment 1. The parallel test components PTC_TC and PTC_MAC is, however, seen as two independent entities. This means that there is no communication or synchronization between the two PTCs during the test.

PTC_TC is specified in TTCN. Since PTC_TC is only observing at the PCO, this ATS does not contain any send statements. Once the TP is fulfilled, the PTC_TC terminates, i.e. there are no post ambles, unless required by the TP. No explicit coordination messages is exchanged at CP_TC. To simplify the TTCN TCs, the underlying service provider has been assigned the task of frame numbering. Consequently, a frame parameter has been added to some of the PHL-ASPs.

The requirements for PTC_MAC are specified using the GAP Profile ICS ETS 300 474 [28].

The Main Test Component (MTC) creates the two PTCs (using CREATE operation), stimulates the PTC_MAC (using MAC ASPs at CP_MAC) and then waits for the two PTCs to terminate (using the DONE event). The final verdict is computed as follows:

a) A PASS is assigned if PTC_TC returns a PASS verdict and the expected event is received from PTC_MAC at CP_MAC;

b) A FAIL verdict is assigned if PTC_TC returns a FAIL verdict independently of what is received from PTC_MAC at CP_MAC;

c) An INCONC verdict is assigned if:

   - PTC_TC returns an INCONC verdict and the expected event is received from PTC_MAC at CP_MAC; or

   - PTC_TC returns a PASS verdict and an unexpected event is received from PTC_MAC at CP_MAC.

6.2.4.3 Data Link Control (DLC) layer testing

For testing the DLC layer protocol the embedded variant of Remote Single layer test method (RSE) is applied. The RSE test method has been selected, because:

- this test method implies no specific requirements from the IUT;
- the Upper Service Access Point (U-SAP) of the IUT cannot be directly observed;
- the variety of the possible DECT implementations is a serious technical obstacle for the adoption of a different ATM;
- this test method places the minimum limitations in the realization of conformance testing.

The Embedded variant of the Remote test method provides sufficient control of the IUT DLC behavior, through NWK layer messages conveyed by DLC frames.

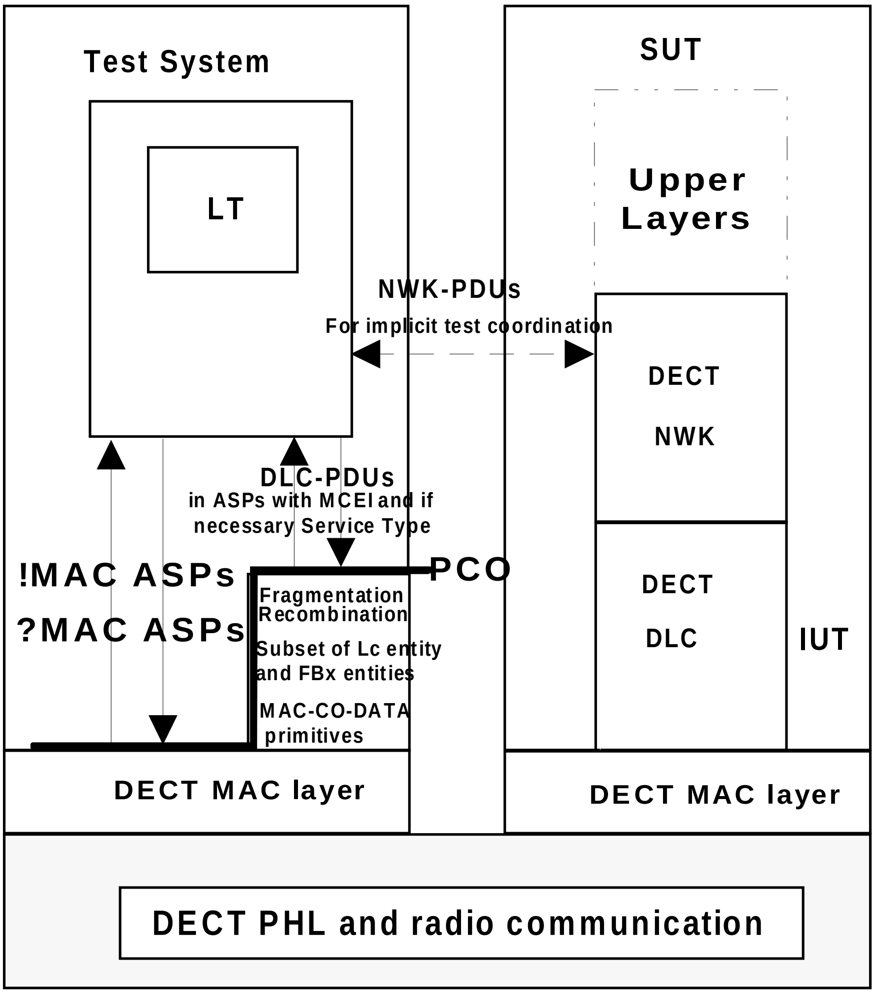

Figure 10: ATM for DLC layer testing, remote single layer test method embedded variant

LT: A Lower Tester (LT) is located in a remote DECT test system. It controls and observes the behavior of the IUT.

MSAP: A unique MAC SAP is defined at the DECT interface and used to exchange service data of the DLC protocol. To avoid the complexity of data fragmentation and recombination testing, the SAP is defined below these functions of the DLC layer.

PCO: The PCO for DLC layer testing is located on the MSAP. All test events at the PCO are specified in terms of MAC ASPs and DLC layer PDUs.

Notional UT: No explicit Upper Tester (UT) exists in the SUT. Nevertheless, some network messages are sent to the SUT for the need of the co-ordination procedures. The NWK layer of the SUT is used as a notional UT as defined in ISO 9646 [15] to [20].

The MSAP primitives are defined according to ETS 300 175-3 [3], clause 8 and associated subclauses.

6.2.4.4 Network (NWK) layer testing

For testing the NWK layer protocol the embedded variant of Remote SinglE layer test method (RSE) is applied. The RSE test method has been selected, because:

- this test method implies no specific requirements from the IUT;

- the U-SAP of the IUT cannot be directly observed;

- the variety of the possible DECT implementations is a serious technical obstacle for the adoption of a different ATM;

- this test method places the minimum limitations in the realization of conformance testing.

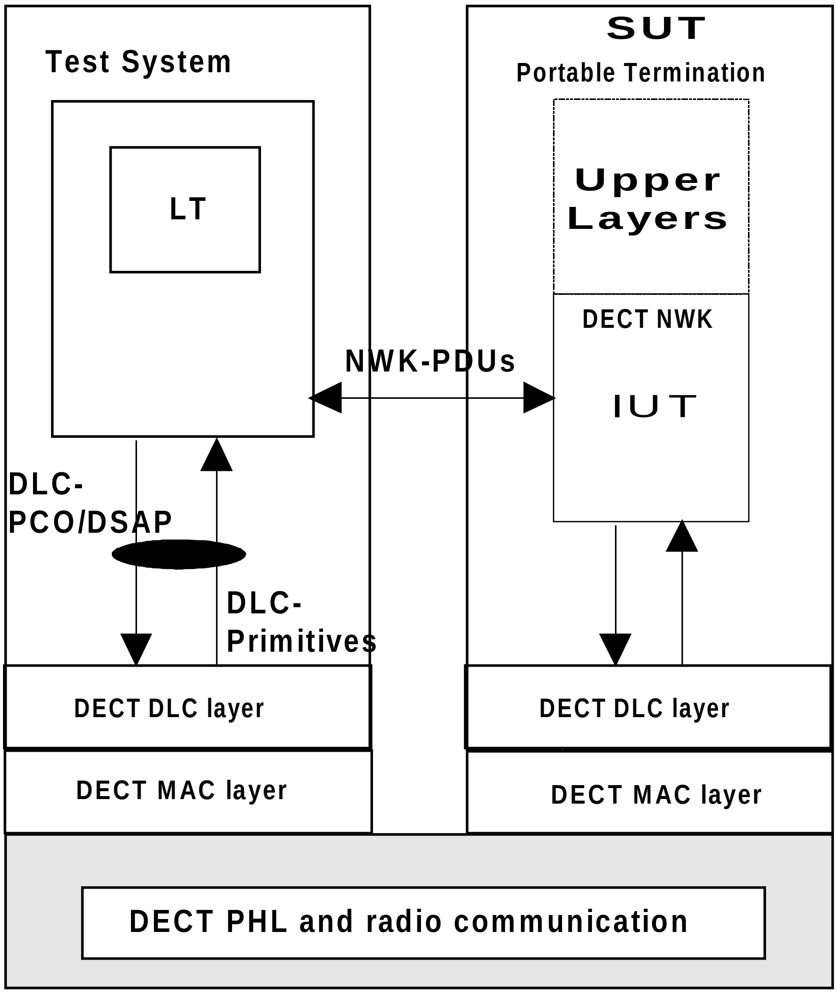

Figure 11: Remote single layer test method embedded variant

LT1: A Lower Tester (LT1) is located in a remote DECT test system. It controls and observes the behavior of the IUT.

DSAP: A unique DLC SAP is defined at the DECT interface and used to exchange service data of the NWK layer protocol.

PCO: The PCO for NWK layer testing is located on the DSAP. All test events at the PCO are specified in terms of DLC ASPs and NWK layer PDUs.

Upper layers/tester No explicit Upper Tester (UT) exists in the test system. However, the SUT needs to carry out some UL functions to achieve some effects of test co-ordination procedures. Designing ATS, the capability of the IWU, such as PSTN, ISDN or GSM IWUs might be taken in account. The invocation An example of such controls could be to provoke restarting of the IUT through the Q interface.

The DSAP primitives are defined according to ETS 300 175-4 [4], subclause 8.3.2 (SSAP primitives) and subclause 8.3.3 (B-SAP primitives).

6.3 DECT Protocol Implementations Conformance Statements (PICS)

6.3.1 Scope

The PICS proforma is a list of essential protocol requirements which is defined in a tabular form of a questionnaire. A question is provided for each optional, and for each mandatory DECT protocol requirement.

The PICS provide an overview of the DECT capabilities and allow a static check of the inter-working capabilities as well as of the static protocol conformance.

6.3.2 Structure

Table 1 and table 2 show the general structure of an ICS standard. The tables show the components of the standard in addition to the common ETSI standards layout.

Table 3: Structure of a PICS standard

Document type	Components associated with the Document type
PICS proforma	- Identification of the Implementation - Identification of the protocol - Global statement of conformance - List of capabilities

Table 4: Structure of profile ICS standard

Document type	Components associated with the Document type
Profile ICS	- Requirement list
Profile specific ICS proforma	- Identification of the Implementation - Identification of the protocol profile - Global statement of conformance - List of capabilities

6.3.2.1 Components of a PICS standard

6.3.2.1.1 Identification of the implementation

This subclause provides a proforma for the identification of the implementation and its supplier.

6.3.2.1.2 Identification of the protocol

This subclause provides a proforma for the identification of the protocol specification to which the ICS proforma applies.

6.3.2.1.3 Global statement of conformance

This subclause requests from the implementation supplier a statement whether all mandatory capabilities of the protocol specification are implemented.

6.3.2.1.4 List of capabilities

This subclause provides a proforma for all optional and significant mandatory capabilities. Each capability has a specific item including an item identifier and its conformance status (mandatory, optional, conditional, etc.).

6.3.2.2 Components of a profile ICS standard

6.3.2.2.1 Requirement List (RL)

In the RL all items are listed which change their conformance status in the profile implementation regarding the base protocol specification.

6.3.2.2.2 Identification of the implementation

This subclause provides a proforma for the identification of the implementation and its supplier.

6.3.2.2.3 Identification of the protocol profile

This subclause provides a proforma for the identification of the profile protocol specification to which the ICS proforma applies.

6.3.2.2.4 Global statement of conformance

This subclause requests from the implementation supplier a statement whether all mandatory capabilities of the profile protocol specification are implemented.

6.3.2.2.5 List of capabilities

This subclause provides a proforma for all profile specific optional and significant mandatory capabilities. Each capability has a specific item including an item identifier and its conformance status (mandatory, optional, conditional, etc.).

6.3.3 Introduction to DECT PICS and profile ICS

This subclause gives an introduction to the various ETSI DECT ICS standards (see also figure 3) either produced, under development, or for which an ETSI work item and budget is available.

6.3.3.1 ETS 300 476, DECT CI PICS

The objective of this standard is to provide the basic PICS for the DECT Common Interface. The PICS are based on ETS 300 175, Parts 1 to 8 [1]-[8]. This PICS provide the base for all other DECT Profile ICS.

6.3.3.2 ETS 300 374, DECT GAP profile ICS

The objective of this standard is to provide the ICS for the DECT Generic Access Profile (GAP) standard (ETS 300 444 [10]). These ICSs are a profile of ETS 300 476 [27] and are applied together with ETS 300 476 [27]. The standard follows the rules defined in ISO 9646 Part 6 [19] and Part 7 [20].

6.3.3.3 DECT-GSM profile ICS

The objective of this standard is to provide the ICS for the DECT-GSM inter-working profile standard (ETS 300 370 [11]). These ICSs are a profile of ETS 300 476 [27] and ETS 300 474 [28], and it is applied together with prETS 300 476 [27]. The standard follows the rules defined in ISO 9646 Part 6 [19] and Part 7 [20].

6.3.3.4 DECT-ISDN profile ICS

The objective of this standard is to provide the ICS for the DECT-ISDN inter-working profile standard (ETS 300 434 [12]). These ICSs are a profile of ETS 300 476 [27] and ETS 300 474 [28], and it is applied together with these standards. The standard follows the rules defined in ISO 9646 Part 6 [19] and Part 7 [20].

6.3.3.5 DECT-DAM PICS

The objective of this standard is to provide the PICS for the DAM standard ETS 300 331 [13].

6.3.3.6 ETS 300 323, DECT PAP PICS

The objective of this standard is to provide the PICS for the DECT PAP ETS 300 175-9 [9].

6.4 DECT test strategy

6.4.1 DECT abstract test methods

It is a major requirement of all DECT test methods not to make any assumptions on the internal functions of the IUT. None of the ETSI DECT protocol test specifications requires access to any of the internal interfaces between the OSI layers (see figure 2).

6.4.2 The use of implicit events

All test events which can not be invoked from the DECT air interface, events which have to be invoked in the PP (e.g. by keyboard operations) or by the network simulator on the network interface of the FP, are defined as implicit events. This is a standardized ISO/IEC 9646-3 [17] conformant way, which gives freedom to the DECT equipment manufactures what concerns the invocation of such events.

6.4.3 The use of DECT test messages

DECT test messages are only used for physical layer testing in TBR 6 [23] and TBR 10 [24]. To avoid any additional test specific requirements on DECT equipment, for the purpose of protocol testing on any layers above the PHL layer, no DECT test messages are use.

7 Application of DECT conformance test specifications and DECT PICS

7.1 Use of DECT conformance test specifications

The DECT test specification serves in the area of voluntary conformance testing as well as for certification in conjunction with the related TBRs. The TBR 22 [30] is based on the GAP profile test specification ETS 300 494 [29]. The difference between the two specifications is limited to a minimum to avoid confusion on the value of GAP conformance testing against either of these specifications.

7.2 Use of TBRs

The TBRs are the base for Common Technical Requirements (CTRs). These specifications are used for certification of equipment which falls under the Council Directive 91/263/EEC [31]. A TBR is produced by ETS and can be adopted by the Approvals Committee for Terminal Equipment (ACTE) as a CTR. Once adopted as a CTR all equipment relevant to this CTR has to be certified against this CTR if the manufacture intends to sell it on the European market. A certificate can be obtained from an accredited test laboratory.

7.3 Use of DECT PICS and profile ICS

A test laboratory will request the equipment manufacturer to fill in the PICS for the equipment to be tested. If the equipment is to be tested against a specific profile (e.g. GAP), the equipment has not only to fulfil at least the mandatory requirements of the PICS, it has also to fulfil the requirements of the RL which is a part of the profile specific ICS. In addition, the Profile specific ICS proforma has to be filled in. This procedure is shown in figure 12, which shows this procedure applied in the case of a GAP equipment.

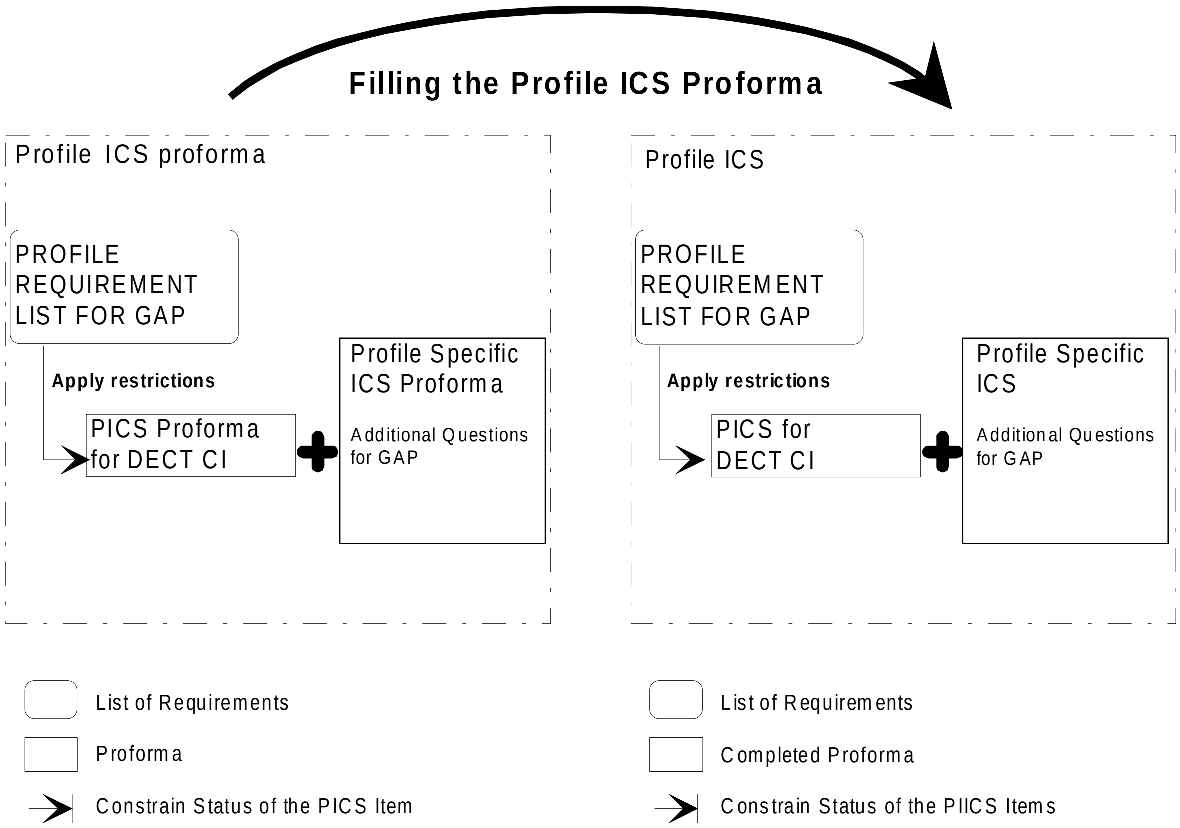

Figure 12: Example of DECT GAP profile ICS

Annex A (informative): Bibliography

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