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Foreword

This ETSI Guide (EG) has been produced by ETSI Technical Committee Methods for Testing and Specification (MTS).

1 Scope

This ETSI Guide (EG) sets out a number of technical quality criteria applicable to telecommunications standards produced by ETSI. These technical criteria have been established on a market-oriented perception of standards quality (see clauses 4 and 5).

Technical quality criteria are the definition of different aspects of the quality of a standard (an explanation of the notion of criteria is provided in subclause 5.3.1). Technical quality criteria are not "rules".

The present EG of criteria is not in itself a set of practical guidelines to specifiers, but rather the basis, the "scaffolding". The objective of this EG is to serve as a basis for several practical tools, to be used at different stages of the standards-making process; examples of such tools are: practical drafting guides to be used by specifiers, assessment sheets to be used in quality assurance reviews, general recommendations to ETSI at managerial level.

The present EG is concerned with the quality of telecommunications standards **that put direct requirements on implementors** (for example, protocols and radio specifications), as opposed to standards of glossaries, methodologies or architectures.

This EG is limited to an initial analysis made by Technical committee MTS of the current situation of standards-making in 1996. It addresses, in priority order, simple aspects that should be put into practice, since simple aspects are bound to lead to a greater global short term improvement than more complex ones.

NOTE: Some complex criteria are also provided but they will be completed in future versions of this EG.

A companion EG is being developed to offer practical recommendations on the standards-making process. Some of the recommendations in that EG will aim at influencing the standards-making process so that the resulting specifications meet the technical criteria set out here in.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETS 300 414 (1995): "Methods for Testing and Specification (MTS); Use of SDL in European Telecommunication Standards - Rules for testability and facilitating validation".

[2] ETS 300 694 (1995): "Private Integrated Services Network (PISN); Cordless Terminal Mobility (CTM); Call handling additional network features; Service description".

[3] ETR 184 (1995): "Methods for Testing and Specification (MTS); Overview of validation techniques for European Telecommunications Standards (ETSs) containing SDL".

[4] ETR 190 (1995): "Methods for Testing and Specification (MTS); Partial and multi-part Abstract Test Suites (ATS); Rules for the context-dependent re-use of ATSs".

[5] ETR 298 (1996): "Methods for Testing and Specification (MTS); Specification of protocols and Services; Handbook for SDL, ASN.1 and MSC development".

[6] CEN/CENELEC Internal Regulations: Part 3 (1991): "Rules for the drafting and presentation of European standards (PNE Rules)".

[7] ISO/IEC 9646-1 (1992): "Information Technology - Open Systems Interconnection - Conformance Testing Methodology and Framework - Part 1: General concepts".

[8] ETS 300 406 (1995): "Methods for Testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

[9] ITU-T Recommendation I.130 (1988): "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[10] ETR 212 (1995): "Methods for Testing and Specification (MTS); Implementation Conformance Statement (ICS) proforma style guide".

[11] TCR-TR 017(1993): " Methods for Testing and Specification (MTS); Technical Basis for Regulation (TBR) specification methodology".

[12] TCR-TR 006 Edition 2 (1996): " Methods for Testing and Specification (MTS); ETSI and certification in telecommunications; Overview of outstanding issues and some recommendations".

3 Definitions and abbreviations

3.1 Definitions

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

NOTE 1: Tables of correspondence with the terminologies of the PNE Rules [6] and of ISO 9646-1 [7] are provided in subclauses 5.3.2.4.1 and 5.3.2.4.2 respectively.

application logic: A normative statement in a standard, which is supplementary to a requirement (or set of related requirements) and expresses the conditions under which the requirement (or set of related requirements) is to be considered mandatory by an implementor: always (when the requirement is "mandatory"), never (when the requirement is "optional") or depending on other implementation options (when the requirement is "conditional"). Synonyms are: meta-requirement, status, static conformance requirement.

a posteriori standard: A standard written and published after the development and introduction to the marketplace of the product, service or technology which forms the subject of the standard.

a priori standard: A standard written and published before the introduction to the marketplace of the product, service or technology which forms the subject of the standard.

compliance clause: Synonymous to conformance clause.

conformance clause: A clause in a standard that states what is required for an implementation to achieve conformance to the standard: it specifies the capabilities and the combinations of capabilities which shall be present in an implementation that is claimed to be conformant; it specifies the statuses related to the main features of the standard.

NOTE 2: The conformance clause should contain a **status specification**.

conformance requirement: Synonym to requirement.

criteria: Principles and rules to be satisfied by standards and against which an assessment can be made.

declaration: A normative statement in a standard used to set out terminology and notations, to describe models and to establish ground-rules for the interpretation of the standard or of other related standards. Declarations do not place direct requirements upon implementors.

diagram: The graphical representation of an element of a specification.

formal description: A specification which uses a standardized description technique; language, notation, to describe properties of a system with consistency, unambiguity and precision.

handle: Name given, in a standard, to a requirement or a set of requirements, generally related to the same functionality. The handle is used to apply a status on the designated requirement or set of requirements.

ICS proforma: Defined in ISO 9646-1 [7].

informative: Elements in a standard which are included to assist the user in understanding the purpose and use of the standard, i.e. text that is "for information only".

meta-requirement: Synonym to application logic.

normative: Elements in a standard which give the essential principles of that standard and state, directly or indirectly, rules to be followed by an implementor. It is important to note that "normative" does not apply only to requirements, but also to declarations and to statuses.

original requirements: Those specifications of properties or functions that are required to be included in a standard, i.e. the specific objectives that a given standard is developed to achieve.

requirement: A normative statement in a standard constituting an elementary piece of a specification of the mechanisms, properties, characteristics of a conforming implementation.

NOTE 3: The single word "requirement" is used to refer to elements contained in a standard, whereas the term "original requirement" is used to refer to elements on which the standard is based. See subclause 3.3.

status: Synonym to application logic.

status expression: The physical expression of a status in a standard or in an ICS proforma, by means of dedicated notations (e.g. "m" for mandatory, "o" for optional) and/or conditional expressions (e.g. "if <ref.> then m else o").

status specification: Specification of the statuses related to the main features of the standard, in a tabular form. The status specification is in general the only place where the statuses of the main features of the standard are specified.

NOTE 4: The status specification should appear in the conformance clause of the standard. The tables of the status specification are similar to those in the ICS proforma, specifying the statuses of the main features in the standard. The difference between the tables in the status specification and in the ICS proforma is that:

- the tables in the status specification do not contain a blank "status" column for an implementor to state his choice of options;
- the status specification is limited to the main features, and does not contain the very detailed tables related to PDU parameters, timers, etc. as can be found in the ICS proforma.

validation: The process by which appropriate methods, procedures and tools are used to evaluate that a standard:

- satisfies the purpose expressed in the record of original requirements on which the standard is based;
- can be fully implemented;
- when implemented, is able to offer all the functionality and performance expressed in the record of original requirements on which the standard is based;
- conforms to the established criteria for standards.

3.2 Abbreviations

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

ASN.1	Abstract Syntax Notation 1
ATM	Asynchronous Transfer Mode
ATS	Abstract Test Suite
ICS	Implementation Conformance Statement
IXIT	Implementation eXtra Information for Testing
MSC	Message Sequence Chart
PDU	Protocol Data Unit
PNE Rules	Rules for the drafting and presentation of European standards (Présentation de Normes Européenes)
SDL	Specification and Description Language

4 What does the market expect from standards - A word for executives

a) Quality means "satisfaction" of the market, or "success" in the market (and not the most sophisticated technical solution).

To succeed, a standard needs:

- a market demand;
- consensus;
- enough technical quality to achieve its final objectives: interconnection and interoperability.

b) Standardization will not create consensus if it does not exist.

c) Technical quality does not replace market demand. They are complementary.

If a standard is not needed by the market, technical quality alone will not ensure its success. If a standard is expected by the market, appropriate technical quality will give it a chance to achieve its objectives.

Paying attention to the marketing aspects of the standardization business is essential, but this should not lead to a disregard of the technical aspects. The standardization product - i.e. the technical specification - also has to achieve a technical objective.

A perfect standard, if not demanded by the market, will still fail, and the cost of the failure is the wasted effort in its preparation.

A technically deficient standard may appear to succeed in the short term if there is strong market demand and no alternative. However, its deficiencies will cause substantial unnecessary costs and delays for manufacturers, operators and users when products are found not to interoperate in practice. The concerned technology will acquire a bad reputation, as well as the organization that produced the standard.

The danger caused is likely to be substantially greater than the effort wasted in producing a standard for which there is no demand. Thus a technically deficient standard is the most dangerous possible outcome of standardization. Also, having monopolized the effort, this standard will have impeded the emergence of another standard or technology.

The success of European telecommunications standardization is intimately dependent on the technical quality of its products - i.e. the technical specifications being standardized.

d) Technical quality is not the search for technical purity or elegance. Technical quality is not the search for the perfect technical solution.

Technical quality must not be higher in a Rolls-Royce than in a Deux-Chevaux. Technical quality means ensuring that the Rolls-Royce as well as the Deux-Chevaux will achieve the basic objectives for which they were designed.

e) Quality has to be considered as a means to achieve a certain objective. The major objective of telecommunications standardization is interconnection and interoperability (of the products and services that the market demands).

The failure to establish interconnection and interoperability as the main objective of standardization can explain the market failure of some standards (a typical example is OSI). For those standards, the "consensus" was de facto considered as a major objective, and this consensus was achieved to the detriment of the "workability" of the standards: many incompatible options, complex solutions, technically poorer than any of the inputs.

Considering interconnection and interoperability as the main objective of standardization (see note 1) implies a pragmatic attitude, which places the ability of the specification to "work when implemented" above the need to produce a document formally or unanimously agreed. Fora are efficient from this point of view.

NOTE: This does not mean "full" interconnection or interoperability, but "contributing to" interconnection and interoperability. For instance, a standard establishing rules for sharing resources (e.g. radio frequencies) is contributing to interoperability, in the general sense of allowing harmonious co-existence between different products.

f) Technical quality is not a burden: do it right the first time.

Dirty is not necessarily quick or cheap.

Standards, if full of ambiguities and incompatible features, cost money and time to implementors, for an uncertain result when interoperability is eventually dependent on a common choice among incompatible options and on a common interpretation of ambiguities.

Used pragmatically, specification techniques facilitate and accelerate the specification process. They are a powerful means of expression for specifiers. Using appropriate techniques, specifiers do not need to ask themselves questions that previous specifiers have had to solve, when writing a specification of the same nature (such as a protocol, an object definition, or a syntax). Specification techniques help projects to benefit from the experience of others.

Specification techniques need not be rigid - they can take into account the fact that market opportunities are increasingly elusive and mobile.

Specification techniques do not imply "over-specification", and allow the adjustment of depth, or level of detail, of the standards in accordance with their market objectives.

Validation techniques, when used at the right moment, help avoid that, being flawed, standards need long correction cycles (many flaws are not detected before the Public Enquiry) and are available too late.

g) The situation of standardization today: necessary improvements.

Many standards published today contain incompatible options and ambiguities and operators and manufacturers have to look outside standardization for solutions to their problems of interoperability.

Many standards are (partially) corrected after the Public Enquiry - i.e. too late. In addition, the Public Enquiry is not the most efficient way to detect errors.

Standardization committees have difficulties in reviewing the quality of the specifications. In addition to the fact that voluntary time spent in standardization activities is decreasing, specification requires an increased level of professionalism. This is mainly due to two facts:

- complexity of technologies is increasing;
- the role of standardization has evolved from harmonization towards research and development of emerging technologies (specification in advance of development, urgency, etc.).

Improvements are needed at several levels of Technical Quality: consistency with the objectives that should be clearly defined in the scope, timely availability in an implementable form, external consistency with other standards, intrinsic consistency (accuracy, freedom from errors, maintainability, etc.).

5 A definition of the quality of telecommunications standards

5.1 Quality for standards to achieve a certain objective

There are many acceptable definitions of "Quality" available today. All of them imply the same thing but with different words and they can be summed up by the single definition "satisfaction of the market". The quality of standards, i.e., the satisfaction of the market for standards", cannot be studied without giving some consideration to the objective of standardization. There are four primary objectives for the preparation and publication of European Telecommunications Standards. These are:

- to provide users with a choice of suppliers of telecommunications equipment and services, thus stimulating healthy competition within the European marketplace; e.g.:
  - interface standards for the interconnection of networks and the interoperability of services;
- to provide users with a clear understanding of the purpose and functions of end-to-end services; e.g.:
  - service descriptions;
- to ensure a reasonable measure of protection to the users of telecommunications equipment as well as to the environment and to other services; e.g.:
  - safety original requirements;
  - EMC original requirements;
  - RF radiation envelopes;
- to facilitate the sharing of technological expertise; e.g:
  - ISDN;
  - DECT;
  - GSM.

The criteria contained in this EG are the result of a study of comments on standards made by implementors, test specifiers and other users of standards.

The inability of standardization bodies to establish interconnection and interoperability as the main objectives of standardization may explain the failure of some standards, such as OSI, to achieve public acceptance. In OSI, "consensus" was considered to be a major objective, and this was achieved to the detriment of the "workability" of the standards. The result was that the standards contained many incompatible options and complex solutions and are technically poorer than any of the inputs. See ETR 190 [4].

Considering interconnection and interoperability as major objectives of standardization (see note) leads to the establishment of strong criteria which will tend to minimize the number of incompatible options in the standards. It also means that the technical contents of the standards should be consistent and implementable, that standards for related matters should fit together properly and that the technical solution retained is efficient.

NOTE: This does not mean "Full" interconnection or interoperability, but "Helping" interconnection and interoperability. For instance, a standard establishing rules for sharing resources (e.g. radio frequencies) is helping interoperability, in the general sense of allowing harmonious co-existence between different products.

This pragmatic approach implies an attitude which places the ability of the specification to "work when implemented" above the need to produce a document which has been formally agreed. This is all the more relevant in the case of emerging technologies see table 3.

The purpose of making standards dealing with interconnection and interoperability is to guarantee a certain level of compatibility between different implementations of the same standard. The desired level of compatibility is specific to a given standard, and can be limited to basic services. It can be considered to be the functional achievement expected from the standard. Determining the desired level of compatibility for a given standard is the objective of the "collection of original requirements". It should be agreed upon before the standard is developed and should be documented in the scope of the standard (as "the purpose and objectives of the standard").

Examples of the main criteria that can be established when considering interconnection and interoperability as major objectives of standardization are:

- making mandatory the requirements essential for interconnection and interoperability;
- making clear what conformance to the standard means:
    - what options, if any, must be implemented together;
    - what other standards or clauses also apply and under what conditions;
- keeping options to a minimum;
- ensuring the efficiency of the technical solution:
    - no unnecessary complexity;
    - respect of performance objectives;
    - proper handling of error situations;
- making the standards easy to test against ("testability").

5.2 Interoperability and interconnection: the five golden rules for standardization

Achieving interoperability by means of standards requires the five following principles to be respected:

1 **Having "enough" standards:**

- all the necessary interoperability relationships are covered. For instance, all the protocols involved in an end-to-end connection are covered by the standards.

2 **Having "good" standards:**

- the level of detail and the freedom from ambiguities is sufficient to ensure that interoperability does not depend on a common interpretation.

3 **Having "bridges":**

- 3.1there exist mapping standards (interworking units are specified)
- 3.2 the technologies are designed in a co-ordinated and compatible manner (e.g. supplementary services for ISDN, CN, GSM).

4 **Having "functional standards":**

- functional standards, of profiles, restrict the choice of options in more general standards, in order to ensure real interoperability in a given functional context between two implementations.

5 **Identifying, for each service, what the minimum level of interoperability is.**

5.3 Main concepts and terminology

The purpose of this subclause is to explain the main concepts necessary for the understanding of the criteria set out in clause 6.

The main concepts explained here are: "original requirements", "criteria", "declarations", "requirements", "statuses", "validation","normative".

In other contexts, different terms and definitions are used. In particular, this terminology is different from that of ISO/IEC 9646-1 [7] (which was imported into ETS 300 406 [8]). The decision to use a new terminology has not been taken lightly but rather is designed to overcome some difficulties that have been encountered with the ISO/IEC 9646-1 [7] terminology, particularly in the telecommunications environment. The concepts are essentially the same, but the authors feel that the new terminology helps the clarity of the explanation. There are also other uses of some of the terms in other contexts (e.g. PNE Rules [6]). The relationship between the terminology used here and those used elsewhere, including ISO/IEC 9646 -1[7], is clarified to help those who are familiar with these other terminologies (see 5.3.2.4).

The definitions can be found in the definitions subclause 3.1 and are restated here to facilitate reading.

5.3.1 Elements on which a standard is based

The specification of a standard is based on criteria and original requirements.

5.3.1.1 Criteria

Criteria: principles and rules to be satisfied by standards and against which an assessment can be made.

Although the list of criteria applicable to each standard is likely to be different, there are some criteria which can be considered to be of a general nature, for example:

- "existence of a test for every requirement";
- "consistent cross-references";
- the editorial rules.

Some are detailed or specific to a given category of standards, for example:

- "separate specification of the abstract syntax and of the transfer syntax".

In general, criteria applicable to all standards will be less precise than criteria applicable to a given category. Examples of criteria are:

- the PNE Rules;
- the criteria contained in this EG;
- the rules defined by the standards of formal languages (for example, the syntax and semantics of SDL and ASN.1);
- the specific criteria applicable to the use of formal languages contained in styles guides or application standards such as ETS 300 414 [1];
- the laws of physics.

5.3.1.2 Original requirements

Original requirements: those specifications of properties or functions that are required to be included in a standard, i.e. the specific objectives that a given standard is developed to achieve.

The identification or collection of original requirements should be made before developing a standard. The current situation within ETSI is that the original requirements are sometimes recorded and documented although, in most cases they remain informal and are held as abstract ideas of "what the standard should do", shared in a standardization committee.

Original requirements are twofold and cover:

- the properties and general functions of the technology that will be specified (main architectural descriptions, logical functions, etc.). They may include economic constraints (e.g. expected implementation costs);
- the properties of the specification itself:
  - what aspects of the technology are to be standardized?
  - what standards are needed?
  - what level of detail is appropriate?
    - which aspects will be covered by the standard?
    - which aspects will not be covered by the standard?
    - what specification techniques should be planned to be used?
    - will formal languages be used?
    - if so, how will they be applied?

NOTE: Instead of "original requirements", the terms "initial requirements" or "specification requirements" are sometimes used. The single word "requirement" should be avoided in this context, as it is reserved for elements contained in a standard, see subclause 5.3.2.2.

In short, the original requirements should be:

- recorded so that they are not implicit but agreed upon before the standardization work starts (and not subject to the free interpretation of a given rapporteur);
- used flexibly, in the sense that the record of the original requirements is not bureaucratically binding on the standardization work. If the perception of original requirements changes during the specification, either because the perception of market opportunities has changed or because the specifiers have realized that there are better technical solutions than the ones initially foreseen, the original requirements recorded at the beginning should not inhibit the development of the specification to this new perception;
- traceable, in the sense that any changes to the original requirements, resulting from this flexibility, should be recorded as well. Flexibility is essential, but clear control should be kept on the evolution of the original requirements.

5.3.1.3 Summarizing (elements on which a standard is based)

The specification process starts with the recording of original requirements and the selection of applicable criteria to build the standard. During the validation process the standard is assessed against the original requirements that were recorded for it, and against the criteria applicable to its category ETR 184 [3].

Figure 1 below summarizes these notions.

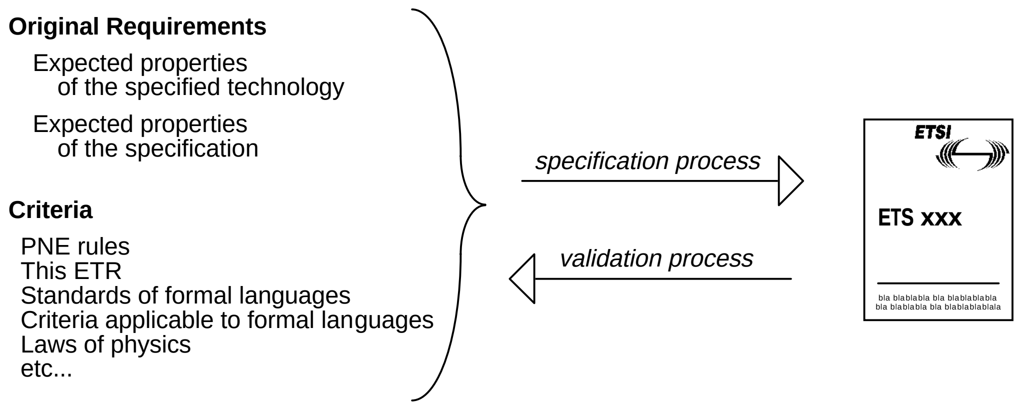

Figure 1: Criteria and original requirements

5.3.2 Elements contained in a standard

A standard contains normative and informative provisions which can both be expressed using informal text, diagrams, formal languages, or a combination of these three.

Normative: elements in a standard which give the essential principles of that standard and state, directly or indirectly, rules to be followed by an implementor. It is important to note that "normative" does not apply only to requirements, but also to declarations and to statuses.

Informative: elements in a standard which are included to assist the user in understanding the purpose and use of the standard, i.e. text that is "for information only".

Normative provisions can be of three different types:

1) declarations;

2) requirements;

3) statuses, also called Meta-requirements, i.e. "required from the requirements".

Normative provisions may also contain tests which can be considered to be requirements placed on another system, i.e., the testing tools and testing operators.

5.3.2.1 Declarations

Declarations are used to set out terminology and notations, to describe models and to establish ground-rules for the interpretation of standards. They do not place direct requirements upon implementors.

Declarations might appear to be informative, as a result from the fact that they do not place direct requirements on implementors. In reality, declarations are normative, since they are necessary to make normative other statements in the standard. As an example, in ETS 300 694 [2] the following definition of a Cordless Terminal Mobility (CTM) user is given:

> "**CTM user:** A PISN user whose calls are processed by either or both of the CTMI and CTMO ANFs."

In isolation, this definition might appear to be informative, aimed to assist a reader in understanding the standard. Its use within a normative statement in subclause 5.3.2.2, however, justifies why the definition of "CTM user" is normative too:

> "For each CTM user, information shall be maintained relating to the location of the CTM user within the PISN."

Another example of a declaration is:

> "The ISDN PCI functionality is provided by the three planes, User, Control, Administration, with associated message sets to access the functionality."

This statement defines an aspect of the model that is necessary to provide a meaning to the rest of the specification. The breakdown in planes, however, is not a direct requirement on the design structure of an implementation. More obvious examples are naming declarations. For example:

> "Messages associated with the User plane start with "U_".

5.3.2.2 Requirement

A Requirement is a normative statement in a standard constituting an elementary piece of a specification of the mechanisms, properties, characteristics of a conforming implementation.

Requirements are also called conformance requirements (ISO 9646-1 [7], terminology).

Examples of requirements are:

- values of physical characteristics;
- the description of a behaviour, such as, "On receipt of message x, the implementation shall send message y";

- the normative parts of SDL diagrams express requirements. ETS 300 414 [1] identifies the following examples:
  - channels marked as normative in a system or block diagram. The requirements imposed by this are that the signals listed at the normative channels, including the parameters they carry, can be transmitted via a normative interface of a product;
  - data type definitions (in ASN.1 or SDL data types) of signals or signal parameters that are to be exchanged via normative interfaces. These impose requirements on the structure and information contents of signals;
  - process and procedure diagrams specifying the chronological ordering of signals, values of their parameters and timing.
  - the sequence of events expressed by an MSC. Such a requirement is already expressed in the related SDL diagrams.

Requirements alone (although also called conformance requirements) are not enough to establish "what is required to be conformant". It is also necessary to know the statuses (see subclause 5.3.2.3) as some requirements may be optional. An implementation can be conformant even if it does not meet some optional requirements because it does not implement those options.

ISO/IEC 9646-1 [7], subclause 5.2, distinguishes several classes of conformance requirements:

- mandatory, conditional, or optional conformance requirements (this notion is elaborated in the statuses in subclause 5.3.2.3);
- positively or negatively stated conformance requirements (stating respectively what is required to be done or what is required not to be done).

Being defined as an "elementary piece" of a specification, a requirement is not always easy to isolate in a standard. An analogy could be the isolation of "ideas" in a book. Often there is not a unique partitioning of a standard into easily identifiable requirements. Moreover, requirements are often recursively nested in each other, and their identification requires the definition of a level of detail where the analysis should stop.

In textual specifications, requirements are generally easy to isolate by identifying sentences containing the words "shall" or "shall not" (generally mandatory or conditional requirements), or "may" (optional requirements). When a mechanism is specified in a diagrammatic form (with or without the use of formal notations), it can be more difficult to isolate and enumerate the "atomic" requirements contained in the diagram.

Isolating requirements in specifications of physical characteristics is generally easier than in specifications of behaviours.

5.3.2.3 Status or meta-requirement

Status: a normative statement in a standard, which is supplementary to a requirement (or set of related requirements) and expresses the conditions under which the requirement (or set of related requirements) is to be considered mandatory by an implementor: always (when the requirement is "mandatory"), never (when the requirement is "optional") or depending on other implementation options (when the requirement is "conditional").

Synonyms are: **meta-requirement**, **static conformance requirement, application logic**.

A status always *applies* to a requirement or to a set of requirements.

A status can be a simple statement ("the implementation shall" denotes that the requirement is mandatory), or a more complex conditional expression stating a limitation on the possible combinations of allowed behaviours.

Sometimes, requirements and statuses are expressed in the same sentence, for example:

> "If a resume command frame is received after sending a resume command frame, the DLC shall respond with an accept response frame".

This sentence describes the mechanism (requirement) and states that it is mandatory (status).

Requirements and statuses can also be expressed separately:

(Set of requirements);

"Voluntary handover: A LLME request,. Timer <DL.05> shall be started upon receipt of the LLME request. A new MAC connection shall be initiated."

(Status);

"The voluntary handover shall be supported by an equipment of class A".

The introduction of the notion of statuses is of practical benefit and the advantages of introducing a distinction between requirements and statuses are multiple:

- The quality of requirements is determined by criteria different from those that apply to statuses. For instance, the requirements in a process will be checked for their consistency and for their ability to define a behaviour in accordance with expectations. The statuses will be checked for their completeness in the sense that an implementor should know precisely what is allowed, what is forbidden, what is permitted, under what conditions (i.e. what combinations of options are permitted).

- The consistency and completeness of statuses is essential to the quality of a standard. An implementor must know precisely what is allowed or proscribed and what the compatible options are. Giving consideration to the distinction between requirements and statuses at the time of specification is important to ensure this consistency and completeness. Standards that are defective in this way are often identified by the difficulty involved in producing the ICS proforma.

Mixing requirements and statuses in the same text is not necessarily a bad thing. In certain cases, however, it may be useful to keep them separate and a clear understanding of the two notions, requirements and statuses, allows a deliberate choice to be made about mixing them or keeping them separate. The benefits of keeping them separate are:

- When statuses are combined with requirements, a "shall" in a description can have two meanings and this is an ambiguity. The "shall" can contain the expression of a status and express something mandatory. It can also be understood in a relative context and thus not be always mandatory. In the example above (voluntary handover), the sentence, "Timer <DL.05> shall be started." is conditioned by the support of the "voluntary handover" feature.

- When statuses and requirements are expressed separately, the description of a complex process is not further complicated by the logic of selection of options.

- When statuses are combined with the description of dynamic behaviour, it is sometimes difficult to distinguish between permissions and possibilities, because the text states at the same time what may be implemented (status) and what alternatives can occur (in the requirements).

- Statuses apply to requirements, or to sets of requirements. The separate expression of requirements and of statuses makes it necessary to encapsulate the (sets of) requirements under names, called "handles" (such as the "voluntary handover" in the example above). This in turn allows the logic of the selection of options to be clarified by the use of those handles.

- Formal notations are, in general, weak at expressing statuses: sometimes they can express options (e.g. SDL can express implementation options thanks to the *option symbol* and the *transition option symbol*) but cannot express the statuses that govern these options.

- There is a specific place in standards where statuses can be specified. This is the conformance clause, that should contain a status specification. See subclause 6.2.6.

Keeping requirements and statuses separate does not necessarily mean distributing them over different sections in a standard, as this could hinder readability. The objective of this study is to propose a method for distinguishing them, while keeping them close to each other when desirable (in fact, the high-level statuses will be specified in the status specification of the conformance clause, whereas the detailed level statuses will be specified close to the requirements to which they apply).

An example of the confusion that may arise from a mixed formulation of requirements and statuses is as follows:

"if the voluntary connection handover is supported and if the MAC-CON-ind primitive from the new connection indicates connection-handover flag = "on", this shall result in".

In this sentence, an option (support of connection handover) and a dynamic possibility (value of a flag) are placed at the same level. This makes it difficult to check statuses for their completeness, and complicates the description of the behaviour by mixing permissions and possibilities.

This confusion can be overcome quite simply by marking the specification of statuses. Some words, such as "if", "mandatory", "optional" and "conditional" are often used to specify statuses and a common ambiguity comes from the fact that these words can also be used inside the specification of the requirements. A solution to this problem can be to mark these words when they are specifying a status, for instance, using a star * or brackets { }. Another solution could be to reserve these words to the specification of statuses and to use other words for the requirements.

In the example above, confusion could be overcome using "if" only to introduce the conditions of the statuses and by using "when" to introduce the dynamic conditions which are part of the requirements.

In conclusion, figure 2 illustrates a generic way to express statuses and requirements:

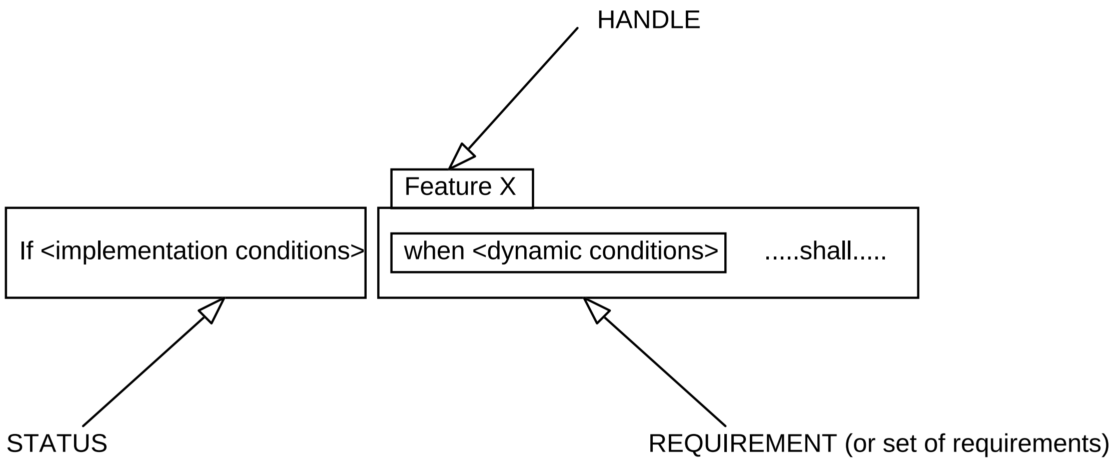

Figure 2: Generic expression of requirements and statuses

The status may be expressed together with the requirement, or may reference the requirement to which it applies by using the handle. The latter is true in an ICS proforma table.

5.3.2.4 Relationships with other terminologies

5.3.2.4.1 Relationship with the PNE Rules

Table 1 specifies the correspondence (when it exists) between the PNE Rules [6] and the terminology used in this EG.

Table 1: Correspondence with terminology in PNE rules [6]

PNE Rules [6] terminology	This EG terminology	Explanation
"Requirement"	either "Requirement" or "mandatory requirement"	In the PNE Rules [6], the term "Requirement", because it is linked with the use of "shall", implies that it can only be used when a specified aspect is mandatory in an implementation. This is a source of ambiguity: the PNE Rules [6] "requirement" can be interpreted with two different meanings, either simply as a requirement or as a mandatory requirement. It is useful to note that in a standard all the requirements are important, not only the mandatory ones. A standard may even contain no mandatory requirement at all, if, for example it specifies two optional classes of equipment which are mutually exclusive.
"Recommendation"	"Optional requirement"	The PNE Rules [6] "recommendation" is basically an optional requirement. The additional semantics that make it a "preferred" or "encouraged" option are not accurate and have no value in a specification. They only have value in informative text.
"Permission"	"Optional requirement"	
"Possibility"		This is not related to a category of information in a standard. It is the description of a possible dynamic occurrence. It is part of the (dynamic) specification of a requirement.

The PNE Rules [6] also state that normative text "may be in the form of requirements, recommendations, permissions or possibilities". This is too restrictive, since declarations and statuses are also normative. The main weakness of the PNE Rules [6] is perhaps exactly this, that they ignore the existence of declarations and of statuses.

5.3.2.4.2 Relationship with the ISO/IEC 9646-1

ISO/IEC 9646-1 [7], provides a terminology in widespread use in the context of protocol conformance testing.

NOTE: That terminology has been used in ETSI, in particular in TC MTS publications such as ETS 300 406 [8]. It is also the terminology used in EWOS.

ISO/IEC 9646 [7] defines in particular the notions of "dynamic conformance requirement" and "static conformance requirement" as follows:

- "Dynamic conformance requirement: one of the requirements which specifies what observable behaviour is permitted by the relevant specification(s) in instances of communications".

- "Static conformance requirement: one of the requirements that specifies the limitations on the combinations of implemented capabilities permitted in a real open system which is claimed to conform to the relevant specification(s)".

Table 2 specifies the correspondence (when it exists) between the ISO/IEC 9646-1 [7] and the terminology used in this EG.

Table 2: Correspondence with terminology in ISO/IEC 9646-1 [7]

ISO/IEC 9646-1 [7] terminology	This EG terminology	Explanation
"Dynamic conformance requirement"	"Requirement"	The term "dynamic" is the problem as it implies the description of dynamic processes, and it is not clear from the name that it applies, for instance, to the specification of physical characteristics, and to the list of parameters of a PDU (although these are clearly intended by ISO/IEC 9646-1 [7]).
"Static conformance requirement"	"Meta-requirement" also named "Status", "Application logic"	People find the adjective "static" confusing and have difficulty understanding that a "static conformance requirement" places requirements upon one or more "dynamic conformance requirements", and belongs to a different category of normative provisions in a standard. The term "status" is felt to express this better. Furthermore, since we do not wish to use the adjective "dynamic" then there is no reason to retain the adjective "static" as the two form a contrasting pair.
"Status"	"Status"	In ISO/IEC 9646 -1[7], "status" is defined as the *physical* expression of the "static conformance requirement", that constitutes an entry in the status column of an ICS proforma. In this EG, it was chosen not to distinguish between logical concepts ("static conformance requirement") and physical concepts ("status"), this subtle distinction being of limited practical value.
(static) "Item name"	"Handle"	"Item name" is used by ISO/IEC 9646 -1[7] in an ICS proforma or status expression. It is the name of the "dynamic conformance requirement" (or set of "dynamic conformance requirements", generally related to a functionality, to which the status is applied. It is therefore strictly equivalent to the "handle".

5.3.2.5 Summarizing (elements contained in a standard)

Figure 3 summarizes the different categories of information that can be contained in a standard. Note that it does not imply a structure, or an ordering of "different parts", but rather refers to logical types of information.

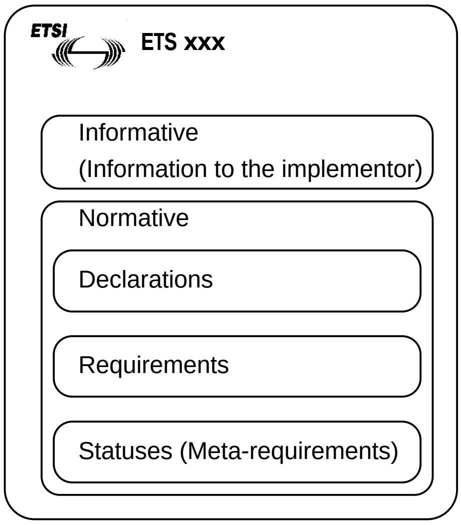

Figure 3: Categories of information contained in a standard

5.4 The need for a categorization of standards

It is clear that criteria may not be applicable to all standards, and not with the same weight.

It is a natural approach to attempt to categorize standards, in order to identify which criteria are applicable to which category.

Several approaches have been considered, e.g., looking into standards describing the functioning of single items of equipment, interworking between items of equipment, the sharing of resources (such as radio frequencies) and services. Such approaches are too complex to be useful for criteria definition.

In a more practical manner, it has been concluded that:

a) an essential distinction has to be made between:

- the standards of **emerging technologies**, for which ETSI facilitates the Research & Development effort. The main purpose of standardization, here, is "**development**";

- a **posteriori standards**, for which ETSI builds the compromise between contributions. The main purpose of standardization, here, is "**harmonization**".

The priorities of criteria applied to these two kinds of standards cannot be the same (see note 1) See table 3.

NOTE 1: This conclusion had already been drawn in PT69V, and documented in the MTS Communication Plan permanent document TC MTS (95) 9. This view is shared by the experts in PT76V having the most experience in standardization.

b) two technical categories can be identified: **physical** specifications such as radio, layer 1 and aerial characteristics and **behavioural** specifications such as protocols, APIs, service descriptions and object specifications.

The first essential distinction between emerging technologies and a posteriori standards can be summarized in terms of importance of the main criteria shown in table 3.

Table 3: Importance of main criteria

	Main criteria			
	Urgency	**Level of detail and limitation of options**	**Freedom from errors**	**Formalized consensus (see note 4)**
Emerging technologies (development)	High	High	Medium	Low
A posteriori standards (harmonization)	Low	Low	High	High
NOTE 2: By a formal Public Enquiry, involving the NSOs.				

This categorization is used in this EG as follows:

emerging technology vs a posteriori: For each quality criterion in this EG, its importance in the case of an emerging technology standard and its importance in the case of an a posteriori standard are mentioned.

physical vs behavioural: This EG deals with general quality criteria, applicable to both physical and behavioural standards. Further study should be conducted to design more specialized criteria, applicable to one of these two types of standards.

5.5 The four categories of quality criteria

Four categories are used for classifying the quality criteria in this EG:

Category 1 (subclause 6.1): The relationships between standards and the structure of a set of standards.

EXAMPLE 1: The external consistency of a standard (the consistency of a standard vis-à-vis other standards).

Category 2 (subclause 6.2): Formulation (how is it said).

EXAMPLE 2: The terminology used within a standard.

Category 3 (subclause 6.3): Technical accuracy (what is said).

EXAMPLE 3: The technical consistency of a standard.

Freedom from errors.

Category 4: Criteria related to the objective.

The fourth category of criteria is related to the achievement of the objective of the standard, i.e. of the original requirements (see 5.3.1.2) for the standard.

EXAMPLES: The ability of the standard to guarantee a level of interoperability between different implementations.

The ability of the specified technology to satisfy performance objectives.

The timely availability.

This fourth category is mentioned for completeness, but no general criteria are specified in this EG for it, since criteria in this category depend on original requirements for a given standard.

In addition, the measurement of the achievement of these criteria is difficult, and cannot be distinguished from the measurement of the validity of the objectives themselves, generally only possible via an a posteriori assessment of the acceptance by the market of the specified technology.

5.6 The relationship between quality criteria and quality factors

Some classical approaches distinguish between quality criteria and quality factors.

Examples of quality factors are:

- understandability;
- readability;
- usability;
- maintainability;
- reliability;
- efficiency;
- testability.

Quality factors are the abstract benefits that can be drawn from the applicable criteria.

It is by complying with particular quality criteria that the related quality factors can be achieved.

For instance, the use of editorial rules (quality criteria) is related to the readability (quality factor) of a standard.

This EG has taken a pragmatic approach to this theoretical distinction between factors and criteria. In practice, it is very difficult to identify exhaustively which factors are met by which criteria. Furthermore, this activity has limited practical benefit.

Quality factors are mentioned only for the sake of clarifying why a criterion has been retained. There has been no attempt to compile exhaustive lists. For instance, the criterion "to keep abstract syntax and encoding separate" is mainly justified by the maintainability factor.

It is important to note that different factors are concerned by the different categories introduced in subclause 5.5. For instance (this list is not exhaustive):

- readability is achieved by criteria of category 2 (Formulation);
- testability is achieved by criteria of category 3 (Technical accuracy);
- efficiency is achieved by criteria of category 4 (Achievement of objective).

5.7 Quality and processes

5.7.1 Validation

According to its accepted definition within ETSI, the purpose of the validation process is to ensure that a standard:

a) satisfies the purpose expressed in the record of original requirements on which the standard is based;

b) can be fully implemented;

c) when implemented, is able to offer all the functionality and performance expressed in the record of original requirements on which the standard is based;

d) conforms to the established criteria for standards.

Following the concepts developed in 5.3.1, the aspects of validation are very closely linked with the original requirements (points a and c), and with the quality criteria discussed in this document (points b and d). The automatic validation of a standard (particularly one specifying behaviour) will directly test its technical accuracy and, in some cases, its relationship with other standards. Validation will also indirectly assess the formulation of a standard and its achievement of objectives.

A significant part of validation consists in assessing the standard against criteria, such as those in this EG.

5.7.2 Measurement of quality

The quality of a standard cannot be measured without some form of measurement units to compare it against. The criteria identified in this EG provide those units. The rational definition and identification of relevant criteria at the start of development will provide useful guidelines to the rapporteur and should ensure that the standard meets all of its original requirements by the time it is published.

6 Quality criteria

The quality criteria specified in this section are applicable in principle to all types of standards, whether behavioural or physical.

In order to reach a level of quality in standards that could be considered to be the optimum, there is a large number of criteria that must be met. However, a significant improvement in the quality of standards can be achieved in a relatively short time by meeting a subset of these criteria. This smaller group, identified in this section by non-shaded criteria boxes, generally does not require extensive changes to the current methods of work and its intention is to provide a perceivable increase in the quality of ETSI's deliverables and a solid base to move on to greater improvements in the future. This clause identifies the wider range of criteria and identifies the benefits to be gained by meeting each one. It also provides detailed explanations and recommendations, in particular for the "immediate" subset of criteria, of high impleed boxes = Impmentation priority.

The intended level of quality and the quality objectives for each standard may be different. The list of quality criteria applicable to a specific standard should be documented in the record of original requirements for the present EG.

Legend:

Non-shaded boxes	=Implementation is of high priority (i.e. Important return if implemented AND relatively easy to implement

Shaded boxes	=Implementation is of low priority

6.1 Category 1: Relationships between standards

6.1.1 Well organized, application orientated structure for a set of standards

1.1	**Well organized, application orientated structure for a set of standards**	Where standards have been produced as a related set, the allocation of functions and characteristics to individual standards is made in a logical fashion.

Detailed explanation:

This criterion covers two aspects:

- the allocation of functions and characteristics to individual standards should be made in a logical fashion, in order to minimize the number of standards that a user will need for a particular application (to implement a particular set of functions);
- the relationship between several standards needs to be clearly defined. For instance:
  - standard A is a profile of standard B;
  - standard A specifies additional functions not defined in standard B;
  - standard A specifies functions replacing certain parts of standard B;
  - standard A inherits and adds detail to elements of specification contained in standard B;

Ambiguous situations such as "standard A is a profile of standard B but modifies standard B" should be avoided.

Recommendations:

- encourage STCs to reach consensus on the distribution of functions and characteristics to standards before work begins. Where this is not possible (as may be the case with new technologies), STCs should continue to monitor the development so that new aspects can be allocated to new or existing standards in a consistent and logical manner;
- review proposed structure with potential implementors before standards are written.

Benefits:

- users find it easier to select the appropriate standards for a particular application;
- groups of related standards are easier to understand;
- duplication is avoided (as much as possible) in the specification.

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.1.2 Absence of overlap in the scope and purpose of standards

1.2	**Absence of overlap in the scope and purpose of standards**	The scope and normative contents of the standard do not overlap with other standards.

Detailed explanation:

With the large number of standards being produced by ETSI Technical Committees, it is not difficult for the scopes of some standards to overlap inadvertently with those of others. Generally, this should be avoided but it should not preclude:

- the reproduction of requirements or statuses (if this is justifiable and traceable);
- the specification of the same requirements or statuses at different levels (for example, in a stage 2 and in a stage 3 where the purposes of these standards are clearly complementary).

Recommendations:

- at the time that the Work Item is raized encourage STCs to develop:
- a full "Scope" clause (exactly as it would appear in the standard itself);
- a meaningful list of keywords;
- ECS and/or TC Programme Officer should check Scopes of other Work Items with similar keywords in the ETSI database.

Benefits:

- confusion and mis-interpretation by users is avoided;
- risk of contradictory specification is limited;
- duplication of effort in specification is avoided.

Importance for emerging technologies: Low

Importance for a posteriori standards: Low

6.1.3 Consistency with other standards ("external" consistency)

1.3	**Consistency with other standards ("external" consistency)**	The contents of the standard support and do not contradict the contents of other related standards.

Detailed explanation:

When related standards are produced at different times and, in some instances, by different committees, it is possible that statements in one standard will contradict similar statements in another. Sometimes this is difficult to avoid because global requirements may change and technology may advance during the period between the development of the two standards. In most cases, however, such contradiction is unnecessary and should be avoided as it can lead to incompatibility between items of equipment and may prevent interworking and interoperability.

Recommendations:

- the scope and purpose of each standard in a related set should be established by the responsible STC in a structured way before beginning work on the set. This should include:
- the range of functions and/or characteristics to be covered by each standard;
- requirements for key parameters that may appear in more than one standard;
- a list of common normative references, definitions, abbreviations and declarations to be used by all standards in the set;
- the responsible STC should check the ETSI database for existing Work Items and published standards with similar keywords to ensure that the normative statements of the proposed standard do not conflict with existing standards or Work Items in progress within other committees.

Benefits:

- unnecessary contradiction, that can lead to incompatibility between items of equipment and may prevent interworking and interoperability, is avoided;
- duplication of effort and specification is avoided;
- confusion and mis-interpretation by users is avoided.

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.1.4 Commonality of approach

1.4	**Commonality of approach**	When several standards are specified at the same level (for instance, several "supplementary services" of the same technology), they are specified in a homogenous fashion.

Detailed explanation:

This criterion means that the approach is the same at different levels:

- the techniques used for specifying are the same (e.g. if it is chosen to use references in a standard, replication should not be used in another standard at the same level);
- the technical design should be as homogenous as possible. For instance, if a supplementary service uses a particular protocol mechanism to underlie a particular function, another supplementary service should use the same mechanism if the same function is to be realized (unless explicit original requirements differ and make necessary a different approach).

Recommendations:

- ensure that different working groups responsible for the development of different standards at the same level (e.g. different supplementary services, different profiles based on the same technology) agree on the techniques used. The TCs and STCs should be responsible for ensuring this co-ordination.

Benefits:

- implementation cost is reduced;
- multi-profile or multi-mode equipment (e.g. a dual mode terminal DECT/GSM) are easier to design and produce;
- understanding of the different standards is improved.

Importance for emerging technologies: High

Importance for a posteriori standards: Low

6.1.5 Visibility of relationships between standards

1.5	**Visibility of relationships between standards**	Where standards are being produced as a related set, any user can determine easily what standards apply where and when.

Detailed explanation:

It is one thing to have a satisfactory structure to a set of standards (see criterion 1.1) but another to ensure that this structure is visible to the user. The user should be able to understand what standards apply where and when, without being obliged to analyse thoroughly the technical contents of all related standards.

In particular:

- it may be useful to publish a "route-map" document to guide users to the standards that they need in a set of related standards;
- when a standard is an endorsement of another specification, e.g. an ITU-T Recommendation, this should be stated in the title;
- the scope of the standards should indicate:
- the structure (e.g. a diagram should show the different standards and their relations);
- the nature of the relationships between standards (e.g. "standard A is a profile of standard B"), as well as the logical constraints (e.g. "to implement standard A, standard B is needed");
- the applicability of the different related standards;
- the versions that are compatible (e.g. "this version of standard A is based on that version of standard B").

Recommendations:

- the ETSI Secretariat should improve the existing Publications Catalogue so that a user is easily able to determine which standards relate to a particular application;
- a new heading, "Relationship with other standards", should be added as a subclause within the "Scope" clause in the template for standards.

Benefits:

- groups of related standards are easier to understand;
- users find it easier to select the appropriate standards for a particular application.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Medium

6.1.6 Traceability of reproduced requirements and statuses

1.6	**Traceability of reproduced requirements and statuses**	Requirements and statuses reproduced from other standards are explicitly justfied and documented.

Detailed explanation:

For ease of understanding, it is sometimes beneficial to include requirements or statuses from one standard in another. If such requirements are not clearly identified where they are reproduced, it is likely that will be treated as new requirements and that test cases will be developed even though identical tests may already exist.

Recommendations:

- reproduced requirements and statuses should be identified as such; a reference to the source should be indicated in the text.

Benefits:

- the relationship between one standard and another is easier to understand;
- duplication of test development effort is avoided.

Importance for emerging technologies: Medium

Importance for a posteriori standards: High

6.2 Category 2: Formulation

6.2.1 Completeness of the scope

2.1	**Completeness of the scope**	The scope of the standard clearly specifies at least: - the subject of the standard; - the purpose and objective of the standard; - the area of applicability of the standard, the type of product or service to which the standard applies; - the purpose of the product or service being standardized (if applicable); - any limitations on the content or application of the standard; - the existence of any major implementation option contained in the standard; - the relationship of the standard with other standards (mentioning in particular which versions of other standards are compatible); - the capabilities or limitations of upwards compatibility.

Detailed explanation:

In the absence of a fully specified scope, it is unlikely that any rapporteur will produce exactly the standard that is required except by accident. The scope provides the constraints within which a standard is to be written and must be completed before work begins on the development of the requirements and statuses. The scope is primarily a tool for controlling the standards development process. It also helps the implementor understand what standards are applicable to the equipment he needs to produce.

Recommendations:

- a full scope statement should be produced and agreed by the responsible TC/STC at the time that the Work Item is raised. The presence of a correctly formulated scope statement should be a gating factor in determining whether a Work Item is to be registered on the ETSI Database;
- where appropriate, as in the case of rapidly evolving technology, the scope should be reviewed as the work progresses.

Benefits:

- a clear and agreed scope statement will assist the author in the production of the required standard, and the standardization committee in the control of this production;
- users are better able to understand the purpose of a standard.

Importance for emerging technologies: High

Importance for a posteriori standards: Medium

6.2.2 Presence and completeness of the conformance clause

2.2	**Presence and completeness of the conformance clause**	The Conformance clause states what is required for an implementation to achieve conformance to the standard: it specifies the capabilities and the combinations of capabilities which shall be present in an implementation that is claimed to be conformant; it specifies the statuses related to the main features of the standard.

Detailed explanation:

NOTE: The term "Compliance clause" is sometimes used instead. It relates to the same concept. Although "Conformance" is, strictly speaking, more accurate than "Compliance" in this context, it may be interesting to adopt "Compliance", in order to avoid the common confusion that "Conformance" automatically would mean "Conformance testing".

The purpose of a conformance clause is to state the capabilities and the combinations of capabilities which shall be present in an implementation that is claimed to be conformant.

A conformance clause enables an implementor to answer the question, "what shall be implemented to be conformant?".

A conformance clause:

a) specifies the statuses of the main features or functions (i.e. the main implementation options and their relationships);

b) points at the clauses of the standard where the requirements are expressed;

c) indicates the need or the possibility to implement features of other standards.

In order to specify the statuses of the main features (item a), the conformance clause should contain a **status specification**, made of tables. The status specification is in general the only place where the statuses of the main features or functions of the standard are specified.

The tables of the status specification are similar to those in the ICS proforma, specifying the statuses of the main features in the standard. The difference between the tables in the status specification and in the ICS proforma is that:

- the tables in the status specification do not contain a blank "status" column for an implementor to state his choice of options;

- the status specification is limited to the main features, and does not contain the very detailed tables related to PDU parameters, timers, etc. as can be found in the ICS proforma.

The status specification is a good basis for, and makes easier, the writing of the ICS proforma.

Recommendations:

- a new heading, "Conformance", should be added to the list of fixed introductory clauses in the template for standards;

- the conformance clause should contain a status specification in tabular form, and models of tables should be provided in the template for standards;

- a draft standard should not receive STC approval unless a realistic and appropriate conformance clause has been included in the standard.

Benefits:

- implementors have a clearer understanding of how to interpret the main body of a standard once they know how conformance is to be tested;

- implementors and other users of a standard are able to understand unambiguously what constitutes conformance to a standard.

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.2.3 Use of defined terms and abbreviations

2.3	**Use of defined terms and abbreviations**	The main terms and abbreviations used within a standard are defined; their use is consistent in the standard, and consistent with other standards

Detailed explanation:

- terms used in the normative text and terms used in the informative text of a standard should be clearly defined and consistently used throughout the document. The definitions of terms should include:
- terms which are essential to the correct interpretation of the normative text (declarations, requirements and statuses);
- terms that are not in common English usage;
- terms that have several meanings in the context of telecommunications and where their use is unavoidable (e.g. "interface", "service".). These terms should always be qualified by an adjective when their interpretation is not unique. This applies also to terms having an intuitive but not accurate meaning, such as "normal", "exceptional".
- not only the terms that refer to concrete "things" (systems, blocks, functions, interfaces, messages, etc.) but also abstract terms, such as "language and operating system binding", and some verbs, such as "to ignore" a message.

The following should be avoided where possible:

- words without a clear objective definition (e.g. "immediately");
- use of the same term or of the same abbreviation with different meanings within the standard itself.

Recommendations:

- provide master lists of standard terms and definitions (both at the project level and across ETSI) for use by rapporteurs;
- a definitive list of abbreviations in common use within ETSI deliverables must be set up and maintained by the ETSI secretariat. This list is to be considered as a reference point for rapporteurs, not for readers. It must not be considered to be a substitute for a pertinent list included in the document text;
- encourage ECS department to read standards to check for non-defined terms that may not be understood in the same way by all readers of the standard;
- ETSI must take care in the future to ensure that identical abbreviations for different terms do not come into common use.

Benefits:

- mis-interpretation and confusion by users is avoided.

Examples:

- the word *interface* has several meanings. For instance, it can designate an abstract service interface, an application programming interface, an interface between different network elements (it is then a protocol);
- in the scope of ETS 300 325 (ISDN PCI) can be found the following text, "..*provides language and operating system binding for common operating system environments*". The meaning of "*language and operating system binding*" is not obvious and is not defined;
- in the writing of the Validation Experimentation Report for the GSM CCBS service, it was very difficult to avoid the confusion created by the dual use of the abbreviation "MSC". From the validation point of view, MSC

represents the term "Message Sequence Chart" whereas in GSM common use terminology, the same abbreviation represent "Mobile Switching Centre".

Importance for emerging technologies: High

Importance for a posteriori standards: Low

6.2.4 Provision and segregation of background information

2.4	**Provision and segregation of background information**	Background information is provided to ease understandability. Informative text is always clearly distinguished from normative provisions, using one of the following techniques: notes, when text is short and related to normative provisions; informative clauses or subclauses within the standard; informative annexes, or separate ETRs. Their use is encouraged for extensive bodies of informative text.

Detailed explanation:

The ability to read and understand the requirements and statuses of a standard and the basis used for the development of the requirements is of great importance, particularly to those users of standards who did not participate in the standardization process.

On the other hand those users who are familiar with the standard prefer that background information should not be mixed with the requirements, because it may hide some important requirements.

This criterion covers four aspects:

- informative text should be provided, in support of the strict normative text;
- informative text should be distinguishable, from the normative text (requirements, statuses, declarations);
- where the informative text is more than a few paragraphs, it should be segregated and placed in a clause or subclause of the standard marked as informative. Not only informative annexes or ETRs should be considered, but informative sections should be allowed within the standard. For instance: "2.4.1 General description (informative)";
- extensive bodies of informative text should be placed in informative annexes or separate ETRs.

Recommendations:

- ensure notes are used wherever informative text is inserted with normative provisions;
- allow informative clauses or subclauses within a standard, and mark them by the word: (informative);
- encourage the use of separate ETRs or annexes for extensive bodies of informative text or background information.

Benefits:

- easier check of the consistency and validity of the requirements and statuses;
- greater clarity for the reader - be he interested in background information or in requirements and statuses.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Low

6.2.5 Distinction of declarations, requirements, statuses

2.5	**Distinction of declarations, requirements, statuses**	Within the normative text, the different types of information: declarations, requirements, statuses are clearly identified, distinguished from each other, and distinguished from supporting information.

Detailed explanation:

The notion of "Requirements" imported from the PNE Rules is too primitive for telecommunications standards. It results in serious ambiguities in the standards.

The PNE Rules contain a confusion between normative text, requirements, mandatory requirements.

The PNE Rules define a requirement as something which is *"strictly to be followed in order to comply with the standard and from which no deviation is permitted"*. However, standards frequently need to allow choice over the implementation of options.

It is, therefore, necessary to be able to specify the conditions under which a specified characteristic is mandatory for an implementor if it depends on the options chosen from those offered by the standard or by other standards. The old intuitive notion of "requirement" covers two distinct aspects:

a) the specification of the required behaviour or characteristics (technical property);

b) the specification of the logic that relates the choice of options.

The specification of the logic is the "context" in which a provision in a standard is mandatory. This context is often implicit and the absence of an explicit specification can introduce ambiguity.

The definition of "requirements" in the PNE Rules may appear to be absolute but, in reality, it often needs to be interpreted as *"strictly to be followed in order to comply with the standard and from which no deviation is permitted* ***..according to the context****"*. This context has to be specified somewhere in the standard.

This distinction is needed in all ETSI standards whether addressing physical characteristics or behaviour. It is particularly needed in standards addressing protocols, in which the logic of choice of options is more complex. The recent rapid increase in the volume of protocol standards is making this need for clarity and precision urgent. The PNE Rules do not provide sufficient flexibility. Lack of clarity leads to incompatible implementations which result in wasted expense and gives the standards a reputation for poor quality.

Further ambiguity can be caused by the use the word "should" (a "Strong Recommendation") within normative text. Such recommendations should only be used in informative text but not in normative text.

The specification of statuses may also suffer from the ambiguous use of some words: Words such as "if", "mandatory", "optional" and "conditional" are often used to specify statuses and a common ambiguity comes from the fact that these words can also be used inside the specification of the requirements. For instance, "if" can be used to describe a dynamic condition depending on previous events; "optional" may be used to specify the "dynamic presence" of a parameter in the specification of a message syntax (that is the meaning of the keyword OPTIONAL in ASN.1).

TC MTS is developing several techniques to improve the way declarations, requirements and statuses can be specified and distinguished.

Recommendations:

- the distinction between Declarations, Requirements and Statuses should be introduced as a primary - foreground - principle of standard specification;

- the PNE concepts of Requirements, Recommendations, Permissions and Possibilities should also be maintained but as secondary - background - principles;

- the word "should" (a "recommendation") should only be used in informative text but not in normative text;

- the first normative sections of a standard should contain declarations;

- appropriate editing techniques should be developed and used to distinguish declarations, requirements, statuses. In particular:
  - better use of status specification / ICS proforma (see criterion 2.6);
  - marking of some keywords ("if", "mandatory", "optional", "conditional") used to specify status information (the appropriate marking remains to be decided upon with the ETSI Secretariat - it could be a star * or brackets { });
  - the use of new presentational tools, in particular the combined requirements/status tables, should be allowed in the drafting rules and appropriate guidelines should be developed;
  - avoid a requirement formulation for other normative aspects of a specification (a typical example is: avoid a "shall" for expressing a declaration);
  - ensure that the rules in ETS 300 414 [1] relating to the marking of normative parts of an SDL model are used.

Benefits:

- much ambiguity is removed;
- implementation is simplified as requirements can be clearly distinguished from other information contained in the standard.

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.2.6 Clear and complete specification of statuses

2.6	**Clear and complete specification of statuses**	Implementation options are clearly identified; the logic related to their selection is separately stated (statuses) and indicates whether they are truly optional or are mandatory if certain conditions are met. Completeness: The status of every requirement is fully specified.

Detailed explanation:

Subclause 5.3.2.3 provides a detailed description of statuses and their relationship with requirements.

Different techniques can be used to present statuses and to associate them with the requirements to which they apply.

Summarizing these techniques, there are two complementary places for statuses in a standard:

- detailed statuses may be presented in association with the requirements to which they relate, e.g. in a combined table of requirements and statuses;
- statuses at a general feature level should be expressed in the Conformance clause, using **status specification** tables.

NOTE 1: In the case of TBRs, in the"Requirements Tables".

In order to allow the expression of statuses in status specification tables without the need to describe dynamic mechanisms, it is essential to assign names, called "handles", to groups of related requirements. Those "handles" are then used in the status specification tables (and in the ICS proformas).

NOTE 2: More information on ICS proformas can be found in ISO/IEC 9646-1 [7], ETS 300 406 [8], ETR 212 [10].

Statuses should be complete, in the sense that every requirement in the standard should be covered by a status. When the status is specified in the status specification, the requirement in the standard should contain a reference to the status specification item.

Recommendations:

- recommendations on the distinction of types of information (criterion 2.5) apply here;
- handles should be associated in the standards with all requirements or sets of requirements (generally related to a specific functionality) likely to be assigned a status in the status specification;
- each general requirement in the base standard should contain a reference to the status specification item where its status is specified.

Example:

A typical case is the distinction between permissions and possibilities: When, in the description of a behaviour, a condition is expressed "*if xxx then*", the reader should know, without referring to another (part of the) specification, if the condition expresses:

- a (static) implementation option (a permission), on a feature that may be implemented,
- a (dynamic) possibility that depends on the state of the specified system,
- a (dynamic) possibility that depends on the state of other systems, or a part of the system not specified in the standard in question. Within the context of the specific standard, this possibility becomes a mandatory requirement.

EXAMPLE: "*If the LAPC entity is able to accept the re-establishment request, it shall..*".

This could be an option, if the re-establishment procedure is optional.

If this is a possibility (it seems to be, because if the re-establishment procedure was optional that would probably be stated when the procedure is defined), it is not clear if being able to accept the request depends on the state of the LAPC entity itself, or if it depends on, for instance, other layers in the system.

In such a situation, a few additional words of text can remove the ambiguity entirely. The example above can be re-expressed in different ways to emphasize which of the three classifications it falls into:

A permission:
"i*f the option to process re-establishment requests is implemented then on receipt of such a request, the LAPC entity shall..*";

A possibility dependant upon an internal state:
"i*f the operational status of the LAPC entity is such that it is able to accept the re-establishment request, it shall..*";

A possibility dependant upon an external event:
"i*f the LAPC entity receives the re-establishment request, it shall..*".

Benefits:

- implementors are able to distinguish clearly between options that can be included or omitted at the implementor's discretion and those which become mandatory if certain conditions arise;
- the same applies to test specifiers.

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.2.7 No mix of requirements that apply to different things

2.7	**No mix of requirements that apply to different things**	When several aspects of a specification are included in a standard (for instance, the behaviour of a terminal, the behaviour of a calling network and the behaviour of a called network), the requirements related to each aspect are not interleaved.

Detailed explanation:

An implementor implements one type of equipment at a time. The requirements on the type of equipment he is currently building are the only ones of interest to him.

Interleaving the specifications of the behaviour of different types of equipment (e.g. of the terminal and of the network) requires that the implementor "extracts" the information relevant to him. This extraction is a complex process, and prone to errors, since the description of a behaviour involving several communicating entities may be ambiguous on the entity responsible for the behaviour in question.

This quality criterion applies to "standards placing direct requirements on implementors". For instance, it applies to a protocol standard (stage 3), but does not apply to the description of functional requirements and services (stages 1 and 2 of the ITU-T Recommendation I.130 [9] methodology).

Recommendations:

- awareness of specifiers should be raised about the problems that mixing requirements for different types of equipment may generate;
- ECS should check that this criterion is respected.

Benefits:

- ease of implementation;
- removal of ambiguity.

Importance for emerging technologies: High

Importance for a posteriori standards: Medium

6.2.8 Documentation of choices and justification of options

2.8	**Documentation of choices and justification of options**	Significant decisions regarding the technical direction taken in the standard are documented. The reason(s) for selecting a particular choice are explained. This explanation is either in the standard or in a report. The inclusion of implementation options is accompanied with text of justification.

Detailed explanation:

When reading a standard, it is useful to know why a particular design decision was taken, especially where there is an obvious, and perhaps simpler, alternative available. Such explanations usually help a user of the standard to understand its real purpose.

Although it is recommended that standards should not contain implementation options, it is sometimes impossible to avoid them for technical or political reasons. In these cases an explanation needs to be given so that the reasons for including the option are clear.

Recommendations:

- wherever possible, decisions affecting the specification of a standard should be made and documented during the pre-normative phase of a standardization project;
- ensure that the documentation of significant decisions is published as part of the standard or as a report;
- introduce a documentation review checklist for STCs and Working Groups and include "Check documentation of design decisions and justification of implementation options" in that list.

Benefits:

- the true purpose of the standard is clearer to a user of the standard;
- arbitrary design decision are avoided;
- if the reasons for making a particular design decision are recorded, it is less likely that such a decision will be "undone" during the maintenance of the standard.

Examples:

EXAMPLE (of a specification that could appear as an unnecessary complexity). Q-SIG information elements can appear in any order. This may look as an unnecessary complexity to an encoder/decoder, that shall be able to interpret all the possible orderings. It is in reality justified by the fact that information elements may be added to a message by transit implementations.

EXAMPLE (of a specification that looks like over specification). An upper limit of five diversions for each call is imposed by the standard for the ISDN Call Forwarding, Unconditional Supplementary Service (ETS 300 199). There is no reason why this number should be chosen and such a restriction goes beyond the "minimum requirements" which should be specified in a standard.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Low

6.2.9 Correct use of formalisms

2.9	**Correct use of formalisms**	Where formal descriptions are used to express functional or physical characteristics within a standard: - the description is syntactically and semantically correct; - the appropriate rules and guidelines established by ETSI for the use of such descriptions have been followed; - the description accurately represents the desired characteristics.

Detailed explanation:

The use of formal descriptions in a standard can be a very good method for reducing ambiguity and the possible mis-interpretation of requirements. However, this can only be guaranteed if the description is prepared according to an appropriate methodology for the application. This implies the correct use of syntax and semantics as well as rules and guidelines established specifically for the use of the formalism within standards. Formal specifications have the added benefit that they can be modelled, simulated and validated using automatic tools.

Recommendations:

- ensure that methodologies exist for all formal modelling methods recommended for use in standards;
- ensure that methodologies are followed;
- provide the necessary training to rapporteurs and PT experts;

- provide automatic tools to assist in the development and validation of formal specifications and models.

Benefits:

- specifications are likely to be:
  - complete;
  - internally consistent;
  - technically accurate;
  - validated formal models and specifications can be made available in electronic format to users to simplify implementation.

Examples:

The following are examples of specific rules taken from existing methodologies related to the use of formal methods in standards.

- "To every normative channel of the standardized system a comment "normative" shall be attached" (in SDL specifications)" - ETS 300 414 [1].
  - The purpose of this rule is to avoid ambiguity and to simplify the identification of the normative parts of the model.
- "The unit for time data should be recorded in a comment in the system diagram".
  - SDL Methodology Handbook (ETR 298 [5]).

Importance for emerging technologies: High

Importance for a posteriori standards: High

6.2.10 Accuracy and precision of the cross-references

2.10	**Accuracy and precision of the cross-references**	Accuracy: references made to the clauses and subclauses in other standards are appropriate and not erroneous. The list of normative references provided at the beginning of the standard contains only references to documents that are necessary from a normative point of view. Precision: references are made to specific clauses and subclauses of specific versions of other standards.

Detailed explanation:

- references made to whole standards can often be ambiguous and may require the reader to study the complete referenced document in order to find the appropriate clause or subclause. In some cases, this study may, in fact, lead the reader to the wrong point in the referenced document;
- references without version number or date may be misleading (paragraph numbering may change between versions);
- standards often need to refer to a number of other documents but not all of them will be for normative purposes. Some references will be included primarily as "recommended reading" for the user of the standard to assist in the understanding of the standard itself. In a standard, the list of normative references shall be limited to those which have a specific normative purposes. Referenced documents which are "for information only" should be listed in a bibliography annex.

Recommendations:

- introduce a documentation review checklist for STCs and Working Groups and include "Check accuracy and precision of normative references" in that list;
- software tools to help checking.

Benefits:

- requirements which include normative references to other standards can be read without ambiguity or the risk of mis-interpretation.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Medium

6.2.11 Changes identified since last issue

2.11	**Changes identified since last issue**	The changes made to a standard to take it from one version level to the next are clearly identified within the text of the standard

Detailed explanation:

The evaluation of a new version of a document is made very much simpler if the changes made to the text and diagrams can be easily identified. The process of identifying and, possibly, annotating changes causes a rapporteur to give greater consideration to the reasons for making those particular modifications.

A similar process would be valuable during the draft development stages of a standard as well as post-publication.

Recommendations:

- implement an automated source management system for controlling changes to ETSI documents;
- develop and implement a version and change control procedure within ETSI to provide a management structure within which all ETSI deliverables can be developed and maintained. Such a procedure should support:
- a common, structured numbering scheme for ETSI documents (this already exists but is not adhered to by all committees);
- a common version numbering system which should cover draft documents as well as published standards and reports;
- a "permission to change" process to be managed by the responsible TC/STC and not by ECS;
- a library system which ensures that all drafts reviewed by STC or TC are stored electronically for future reference.

Benefits:

- changes are very much easier to trace and, if necessary, earlier versions can be recovered at the subclause level rather than the whole document level;
- readers have clearer visibility of the changes that have been made to a document.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Low

6.2.12 Presence of an ICS proforma

2.12	**Presence of an ICS proforma**	An ICS proforma is produced and standardized, either as part of the standard, or as a companion standard.

Detailed explanation:

(Extract from ETR 212 [10]) "An Implementation Conformance Statement (ICS) proforma is a document in the form of a questionnaire, part of a telecommunication specification (e.g. protocol, interface, telecommunication service). It needs to be filled in by the supplier of an implementation, and when completed, becomes an ICS. The objective of the ICS is to provide a statement of which capabilities and options of the telecommunication specification have been implemented. The ICS is used in two contexts:

- for conformance testing purposes: it is mainly used to check the static conformance of the implementation, and to select and parameterize the tests;
- outside the conformance testing context: it is used to provide information on the capabilities supported by the implementation - as an identity card, in order for example, to have an idea of the chances of interoperability of two implementations".

When a standard contains a status specification made of tables in the conformance clause, the ICS proforma can be easily drawn from those tables.

Recommendations:

- for every standard placing requirements on an implementor, an ICS proforma should be produced, as part of the standard or as a companion standard. It should be written according to ETR 212 [10] (this recommendation is already present in TCR-TR 006 [12]).

Benefits:

- see above: The presence of an ICS proforma helps implementors provide an identity card of their products, that can be used to determine the capabilities of different products on the market to effectively interoperate.

Importance for emerging technologies: Medium

Importance for a posteriori standards: Medium

6.3 Category 3: Technical accuracy

6.3.1 Internal consistency

3.1	**Internal consistency**	Where more than one method is used for expressing a single requirement (e.g. as a result of a combination of text, diagrams, formal notations) or status, the various instances of the requirement or status do not contradict each other.

Detailed explanation:

Requirements or statuses in many standards can be expressed using more than one notation. Often, a combination of text, diagrams and other formal notations are used. Within a standard, there should be no contradictions between the various methods used to express the requirements or statuses. This should be the case even in instances where one or more of the notations is considered to be informative rather than normative.

Recommendations:

- progressively develop and introduce into STCs and PTs appropriate methodologies aimed at ensuring that consistency between specification notations is maintained within a standard.

Benefits:

- consistency within the standard simplifies the task of the user and reduces the risk of uncertainty.

Importance for emerging technologies: Medium

Importance for a posteriori standards: High

6.3.2 Validity of requirements

3.2	**Validity of requirements**	The requirements specified in a standard are technically meaningful, imply practically achievable tests and satisfy the objectives (e.g. functionality, performance) of the standard.

Detailed explanation:

This criterion relates to the implementability of the requirements, and to the fact that they do not contain technical errors.

For physical/radio standards, it mainly means that requirements are in accordance with the laws of physics, do not specify values beyond the measurement possibilities; for behavioural standards, it mainly means that the requirements do not contain "bugs", such as possible deadlock situations.

From a practical point of view, the satisfaction of this criterion may be ensured mainly by validation, using the different validation techniques, that range from systematic analysis to simulation and pilot implementations.

In the interests of perfection it is often tempting to write requirements in a standard such that an implementor is mandated to provide characteristics which are "over the technical horizon" or beyond the bounds of practical engineering. This temptation must be resisted so that implementations can be developed, and subsequently tested, at a reasonable cost and within a reasonable time.

Recommendations:

- plan appropriate validation - and perform it according to plan. See TCR-TR 006 [12].

Benefits:

- implementability.

Examples:

This is not always obvious, for instance when the specifications were established on the basis of models validated mathematically.

It may happen that:

- some of the values specified (for electrical power, or probabilities), although mathematically valid, are smaller than any physically measurable value;
- some values are theoretical (for instance, the interference of the receiver while the transmitter is in function).

The recommended solution is to publish an informative specification of "performance objectives", and then a standard of meaningful values and a test specification aligned with the standard. The discouraged solution is to specify the theoretical requirements in the standard, and their meaningful interpretation in the testing specification.

Importance for emerging technologies: Medium

Importance for a posteriori standards: High

6.3.3 Minimal use of options

3.3	**Minimal use of options**	Few, if any, options are specified within the standard. Where they exist, they do not introduce incompatibility.

Detailed explanation:

Options should be designed as an allowance to suppliers to *add* functionalities to their products and distinguish them from the others in the market. *Not* as a means to make their products *incompatible*.

This means in particular that options should never be encountered in the basic functionalities specified in a standard. A minimal level of compatibility should always exist between products having implemented different options. It also means that *technical options* (e.g. the use of some parameters in messages) should in general be related to clearly identified *functional options*.

Generally speaking, the number of options should be kept to a minimum (as much as consensus allows).

Limits should be set on the introduction of options supporting compromise in order, for instance, to prevent the "pasting together of various technologies". "Choose the best technical solution, rather than merge different solutions to produce something that is poorer quality than any of the inputs".

Recommendations:

- when a new Work Item is raised, any necessary options should be listed in the scope;
- during the review of draft standards by STCs and Working Groups, rapporteurs and PT experts should be expected to justify the inclusion of all options in the standard;
- for each defined function or service, a minimum level of interoperability should be specified;
- technical options should always be related to clearly identified functional options;
- requirements essential to satisfy the standard's basic objective (e.g. interconnection, interoperability at a minimal level) should always be mandatory.

Benefits:

- interoperability between implementations is easier to achieve;
- implementation is simpler.

Examples:

EXAMPLE A specification which reads "the system should close the connection by sending [..] *or by any other unspecified procedure*" (ETS 300 172) is hardly testable, and may induce many problems of compatibility.

EXAMPLE The extreme of the compromise is when two incompatible solutions are simply standardized under one or several covers - this was, for instance, retained for the standards of file transfer over ISDN (ETS 300 383 based on Eurofile and ETS 300 388 based on FTAM) and of ISDN programming interfaces (ETS 300 325). But this is still better than making up a merged solution of low quality - "non-workable".

Importance for emerging technologies: High

Importance for a posteriori standards: Low

6.3.4 Standard has proper depth

3.4	**Standard has proper depth**	The level of detail specified in the standard is appropriate to the application and for the intended users.

Detailed explanation:

Under-specification occurs when not enough details are specified and therefore no functionality (even limited to basic capabilities) results from the implementation of a standard. For instance, implementing the standard does not provide, by itself, any level of interoperability, even limited to basic interconnection. Underspecifying will frequently lead to a lack of interoperability.

Over-specification occurs when too many details are specified and therefore little room is left for competitive manufacturers to distinguish their products. Such standards are more like product design specifications. Overspecifying may stifle innovation in product development.

There is no general rule, and the optimal point on the line going from under-specification to over-specification should be determined on a case per case basis.

The use of formal description techniques does not imply too detailed specification.

The specifications produced by fora (e.g. ATM forum) are generally very detailed.

It is useful to note that the limited depth of a standard is taken into account by the validation mechanisms proposed by the methodologists. In order to validate it, a standard should be temporarily complemented with a specification of the aspects left out of the standards, in order to build a *validation model*.

Recommendations:

- the desired depth for a given standard should be agreed upon as early as possible in the standard specification process. It should be part of the original requirements for the standard;
- the identification of the desired depth for a standard should be an a priori activity, part of the identification of original requirements, not an a posteriori activity.

Benefits:

- standards constrain implementations sufficiently that they will interoperate satisfactorily while leaving implementors free to add value in order to compete.

Importance for emerging technologies: Medium

Importance for a posteriori standards: High

6.3.5 Enough standards exist

3.5	**Enough standards exist**	All the aspects of a technology that need to be standardized are effectively covered by the standards.

Detailed explanation:

The objective of standardization is not achieved by a unique standard, but generally by a set of related standards, that cover the different aspects of a technology (e.g. DECT, GSM, SDH, etc.).

Whatever depth of standardization is desirable (see 0), it is necessary to ensure that the different aspects of the technology are covered, and that no link is missing.

The coverage of a technology by standards should in particular be ensured by:

- the existence of "**standards for the different interfaces**" involved in the different architectures and scenarios of interoperability;
- the existence of "**functional standards**", i.e. standards that restrict the choice of options in more general standards, in order to ensure real interoperability in a given functional context between two implementations;
- the existence of "**bridges**" between technologies, such as standards of interworking units, e.g. DECT-ISDN, DECT-GSM.

Recommendations:

- encourage STCs and standardization projects to reach consensus on the distribution of functions and characteristics to standards, and on the standards needed, before work begins. Where this is not possible (as may be the case with new technologies), STCs should continue to monitor the development so that new aspects can be allocated to new or existing standards in a consistent and logical manner.

Benefits:

- quicker standardization - there is no "late" understanding that some standards (e.g. interworking profiles) are missing - such missing standards needing to be specified rapidly;
- better chance of interoperability of equipment (as a result of functional standards in particular);
- better integration of a technology with others (as a result of "bridges" in particular) - protection of users' investment.

Importance for emerging technologies: High

Importance for a posteriori standards: Medium

6.3.6 No unnecessary complexity

3.6	**No unnecessary complexity**	The standard does not require the implementation of features that introduce complexity without being justified.

Detailed explanation:

Related to achieving an objective of "acceptable technical solution", in terms of efficiency of the technical solution retained and in terms of implementation (or resulting product) cost vs. market needs.

Recommendations:

- draft standards should be reviewed at early stages with some implementors, to validate the choices made, and, in particular, ensure that the "perfect" technical solution was not chosen to the detriment of the cost of implementation.

Benefits:

- ease of implementation.

Importance for emerging technologies: High

Importance for a posteriori standards: Low

6.3.7 Consistency of tests with requirements

3.7	**Consistency of tests with requirements and statuses**	The tests specified in the standard or in a related testing standard are technically aligned with the requirements and the statuses.

Detailed explanation:

It should not be specified to test for more than what is specified in the requirements. In other words, implicit requirements in tests should be avoided. This risk is higher in the area of physical standards. The consequence is to oblige an implementor to design its products "according to the tests", instead of "according to the standard".

In the area of behavioural standards, the risk is more to encounter misalignments between the base standard and the test suites. These errors should be corrected by validation and maintenance of standards. Maintenance should include alignment of the test suites with the successive versions of the base standard.

Recommendations:

- validation of the tests (by human inspection in the case of physical standards; by implementation of test suites in the case of behavioural standards);
- maintenance of the tests, including alignment with the successive versions of the base standards.

Importance for emerging technologies: Medium

Importance for a posteriori standards: High

6.3.8 Upward compatibility

3.8	**Upward compatibility**	Wherever possible, the standard is designed to make future evolution as easy as possible, and to ensure the maximum possible level of compatibility between the implementations based on the present version and those based on future versions.

Detailed explanation:

The upward compatibility is a design question that covers two aspects:

a) making the evolution of the standard possible and easy;

b) ensuring the maximum possible level of compatibility between the implementations based on the present version and those based on future versions.

Several specification techniques exist that allow to meet this criterion - see the examples thereafter.

Recommendations:

- original requirements for upward compatibility should be identified before the work begins in the scope of the standard, and techniques applied to satisfy them.

Benefits:

- easier evolution of standards to meet new market needs (new "original requirements");
- easier upgrade of existing equipment, in particular network infrastructures; partial upgrade possible; protection of investment.

Examples:

An example of making the evolution of the standard possible and easy: a code set should be open and values should be reserved for future use.

Two examples of ensuring the maximum possible level of compatibility between the implementations based on the present version and those based on future versions:

- a protocol may be designed with a specific parameter allowing future versions to identify themselves and to negotiate a fall-back mode of communication;
- a protocol may be designed to ignore (without rejecting or crashing) parts of PDUs that are not "decodable", those parts of PDUs being assumed to belong to future versions of the standard. ISUP V.2 will "accept" PDUs of the future ISUP V.3.

Importance for emerging technologies: High

Importance for a posteriori standards: Medium

7 Summary of criteria

Non-shaded boxes	= Implementation is of high priority (i.e. Important return if implemented AND relatively easy to implement)

Shaded boxes	= Implementation is of low priority

7.1 Category 1: Relationships between standards

1.1	**Well organized, application orientated structure for a set of standards**	Where standards have been produced as a related set, the allocation of functions and characteristics to individual standards is made in a logical fashion.
1.2	**Absence of overlap in the scope and purpose of standards**	The scope and normative contents of the standard do not overlap with other standards.
1.3	**Consistency with other standards ("external" consistency)**	The contents of the standard support and do not contradict the contents of other related standards.
1.4	**Commonality of approach**	When several standards are specified at the same level (for instance, several "supplementary services" of the same technology), they are specified in a homogenous fashion.
1.5	**Visibility of relationships between standards**	Where standards are being produced as a related set, any user can determine easily what standards apply where and when.
1.6	**Traceability of reproduced requirements and statuses**	Requirements and statuses reproduced from other standards are explicitly justified and documented.

7.2 Category 2: Formulation

2.1	**Completeness of the scope**	The scope of the standard clearly specifies at least: - the subject of the standard; - the purpose and objective of the standard; - the area of applicability of the standard, the type of product or service to which the standard applies; - the purpose of the product or service being standardized (if applicable); - any limitations on the content or application of the standard; - the existence of any major implementation option contained in the standard; - the relationship of the standard with other standards (mentioning in particular which versions of other standards are compatible); - the capabilities or limitations of upwards compatibility.
2.2	**Presence and completeness of the conformance clause**	The conformance clause states what is required for an implementation to achieve conformance to the standard: it specifies the capabilities and the combinations of capabilities which shall be present in an implementation that is claimed to be conformant; it specifies the statuses related to the main features of the standard.
2.3	**Use of defined terms and abbreviations**	The main terms and abbreviations used within a standard are defined; their use is consistent in the standard, and consistent with other standards.
2.4	**Provision and segregation of background information**	Background information is provided, to ease understandability. Informative text is always clearly distinguished from normative provisions, using one of the following techniques: - notes, when text is short and related to normative provisions; - informative clauses or subclauses within the standard; - informative annexes, or separate ETRs. Their use is encouraged for extensive bodies of informative text.
2.5	**Distinction of declarations, requirements, statuses**	Within the normative text, the different types of information: declarations, requirements, statuses are clearly identified, distinguished from each other, and distinguished from supporting information.
2.6	**Clear and complete specification of statuses**	Implementation options are clearly identified; the logic related to their selection is separately stated (statuses) and indicates whether they are truly optional or are mandatory if certain conditions are met. Completeness: The status of every requirement is fully specified.
2.7	**No mix of requirements that apply to different things**	When several aspects of a specification are included in a standard (for instance, the behaviour of a terminal, the behaviour of a calling network and the behaviour of a called network), the requirements related to each aspect are not interleaved.

2.8	**Documentation of choices and justification of options**	Significant decisions regarding the technical direction taken in the standard are documented. The reason(s) for selecting a particular choice are explained. This explanation is either in the standard or in a report. The inclusion of implementation options is accompanied with text of justification.
2.9	**Correct use of formalisms**	Where formal descriptions are used to express functional or physical characteristics within a standard: - the description is syntactically and semantically correct; - the appropriate rules and guidelines established by ETSI for the use of such descriptions have been followed; - the description accurately represents the desired characteristics.
2.10	**Accuracy and precision of the cross-references**	Accuracy: references made to the clauses and subclauses in other standards are appropriate and not erroneous. The list of normative references provided at the beginning of the standard contains only references to documents that are necessary from a normative point of view. Precision: references are made to specific clauses and subclauses of specific versions of other standards.
2.11	**Changes identified since last issue**	The changes made to a standard to take it from one version level to the next are clearly identified within the text of the standard.
2.12	**Presence of an ICS proforma**	An ICS proforma is produced and standardized, either as part of the standard, or as a companion standard.

7.3 Category 3: Technical accuracy

3.1	**Internal consistency**	Where more than one method is used for expressing a single requirement (e.g. as a result of a combination of text, diagrams, formal notations) or status, the various instances of the requirement or status do not contradict each other.
3.2	**Validity of requirements**	The requirements specified in a standard are technically meaningful, imply practically achievable tests and satisfy the objectives (e.g. functionality, performance) of the standard.
3.3	**Minimal use of options**	Few, if any, options are specified within the standard. Where they exist, they do not introduce incompatibility.
3.4	**Standard has proper depth**	The level of detail specified in the standard is appropriate to the application and for the intended users.
3.5	**Enough standards exist**	All the aspects of a technology that need to be standardized are effectively covered by the standards.
3.6	**No unnecessary complexity**	The standard does not require the implementation of features that introduce complexity without being justified.
3.7	**Consistency of tests with requirements and statuses**	The tests specified in the standard or in a related testing standard are technically aligned with the requirements and the statuses.
3.8	**Upward compatibility**	Wherever possible, the standard is designed to make future evolution as easy as possible, and to ensure the maximum possible level of compatibility between the implementations based on the present version and those based on future versions.

History

Document history		
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