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SERIES Z: LANGUAGES AND GENERAL SOFTWARE ASPECTS FOR TELECOMMUNICATION SYSTEMS

Quality – Quality aspects of protocol-related Recommendations

Quality aspects of protocol-related Recommendations

Recommendation ITU-T Z.450

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Recommendation ITU-T Z.450

Quality aspects of protocol-related Recommendations

Summary

Recommendation ITU-T Z.450 provides guidelines on the quality aspects of protocol-related ITU-T Recommendations with the objective of:

1) improving the quality of protocol-related Recommendations; and

2) helping to improve the interoperability of products based on these Recommendations.

In order to encourage the widest possible use of ITU-T protocol-related Recommendations, it is important that these Recommendations are of the highest possible quality. Several aspects of quality that play an important role for the users of these ITU-T Recommendations have been selected for this purpose. These are: readability, completeness, correctness, consistency, unambiguity, implementability and testability.

Annex A contains a quality checklist to identify the level of compliance of a Recommendation with the quality aspects.

Source

Recommendation ITU-T Z.450 was approved on 13 November 2008 by ITU-T Study Group 17 (2009-2012) under Recommendation ITU-T A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

Introduction

Following WTSC-96 endorsement of the importance of quality in ITU-T Recommendations, TSAG formed a Correspondence Group to develop a guideline document entitled *Guidelines on quality aspects of protocol-related Recommendations*. At the TSAG meeting in September 1998, the work of the Correspondence Group was approved as Supplement 1 to the A-series of ITU-T Recommendations. In the 2001-2004 study period, Study Group (SG) 10 contributed to the work of the TSAG Correspondence Group and subsequently approved a new Question and developed Recommendation ITU-T Z.450 based on Supplement 1. This Recommendation is the result of that work revised to reflect changes up to the end of the 2005-2008 Study Period. All study groups should use this Recommendation when developing new protocol standards or evaluating existing ones.

Recommendation ITU-T Z.450

Quality aspects of protocol-related Recommendations

1 Scope

This Recommendation covers the readability, correctness, consistency, unambiguity, implementability and testability aspects of quality of protocol-related Recommendations and specifies a process that can assist in the development of higher-quality Recommendations.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Z.110] Recommendation ITU-T Z.110 (2008), *Criteria for use of formal description techniques by ITU-T*.

3 Definitions

This Recommendation defines the following terms:

3.1 specification and description language (SDL): Internationally standardized formal language for specifying and describing real-time systems.

3.2 message sequence charts (MSC): Internationally standardized language for describing sequences of messages interchanged between system components and their environment.

3.3 abstract test suite (ATS): A test suite composed of abstract test cases.

3.4 abstract test case: A complete and independent specification of the actions required to achieve a specific test purpose, defined at the level of abstraction of a particular abstract test method, starting in a stable testing state and ending in a stable testing state. This specification may involve one or more consecutive or concurrent connections.

3.5 abstract test method: The description of how an implementation under test is to be tested, given an appropriate level of abstraction to make the description independent of any particular realization of a means of testing, but with enough detail to enable abstract test cases to be specified for this test method.

3.6 executable test suite (ETS): A test suite composed of executable test cases.

3.7 executable test case: A realization of an abstract test case.

3.8 tree and tabular combined notation (TTCN-2): A standardized notation for specifying conformance test suites in a manner that is independent of test methods, layered software architectures or protocols and which reflects the abstract testing methodology defined in [b-ITU-T X.290] and [b-ITU-T X.291].

NOTE – TTCN-2 replaced the version of tree and tabular combined notation previously known as TTCN-1.

3.9 testing and test control notation (TTCN-3): A new version of the test notation has a programming language-like appearance and was designed for many kinds of testing such as interoperability testing, robustness testing, regression testing, system testing and integration testing

and for various emerging testing application areas. TTCN-3 retains the proven features of TTCN-2 but includes many new features for more efficient testing. TTCN-3 core language is defined in [b-ITU-T Z.161] and the related aspects of TTCN-3 are defined in [b-ITU-T Z.162] to [b-ITU-T Z.170].

3.10 user requirements notation (URN): A high-level requirements notation that consists of two complementary languages, goal-oriented requirement language (GRL) and use case maps (UCM), which serve to cover initial phases of requirements elicitation, analysis, and validation with goals and scenarios.

3.11 validation: A process of checking a specification to ensure that it is syntactically and semantically correct and represents the intended behaviour.

3.12 conformance clause: A part of a standard or Recommendation which identifies what in the standard or Recommendation should be met in order to conform to the standard or Recommendation.

3.13 specification: Prescription of the design of an aspect of a product or a set of products.

3.14 protocol implementation conformance statement (PICS): A statement made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities have been implemented.

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

3.16 test tool: Hardware and/or software, excluding the test suite itself, used to carry out or assist in carrying out the testing required.

3.17 means of testing (MOT): Hardware and/or software, and the procedures for its use, including the executable test suite itself, used to carry out the testing required.

3.18 implementation under test (IUT): An implementation of one or more requirements specifications, being that part of a system, which is to be studied by testing.

3.19 interoperability testing: Testing to assess the ability of two or more systems to exchange information and to make mutual use of the information that has been exchanged.

3.20 reference implementation: An implementation of one or more standards or specifications, against which a means of testing and test tools for those standards or specifications are tested for the purpose of validation of those means of testing or test tools.

4 Abbreviations

This Recommendation uses the following abbreviations:

ASN.1 Abstract Syntax Notation One

ATS Abstract Test Suite

ETS Executable Test Suite

FD Formal Definition

FDT Formal Description Technique

GRL Goal-oriented Requirement Language

ICS Implementation Conformance Statement

IUT Implementation Under Test

IXIT	Implementation eXtra Information for Testing
MOT	Means of Testing
MSC	Message Sequence Chart
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
SDL	Specification and Description Language
TTCN-1	Tree and Tabular Combined Notation version 1
TTCN-2	Tree and Tabular Combined Notation version 2
TTCN-3	Testing and Test Control Notation version 3
UCM	Use Case Map
URN	User Requirements Notation

5 Developing high-quality Recommendations

5.1 Overview of the quality aspects

In preparing new Recommendations or making an assessment of the quality of existing Recommendations, the following aspects should be considered:

– **Readability** – This requires that a Recommendation is well-structured and can be easily read and understood. This implies good use of natural and formal languages with adequate use of figures, examples and references. Recommendations should be written in accordance with the appropriate style guide (the ITU English Language Style Guide if the natural language is English).

– **Completeness** – A protocol-related Recommendation should be complete in the sense that it includes all parts necessary for its implementation and, where necessary, testing. This includes clearly stated, precise and unambiguous specifications, that may be expressed in URN, SDL, MSC and ASN.1. To facilitate testing, additional texts with Recommendation status are needed for completeness. These include: protocol requirements stated in point form, test suite structure and test purposes, the abstract test suite, the protocol implementation conformance statement proforma and the protocol implementation extra information for testing proforma.

– **Correctness** – Protocol-related Recommendations should be precise, unambiguous, error-free and should describe the intended behaviour. Protocols should be expressed using formal description techniques, so that use of the appropriate tools with simulation and validation capabilities will ensure that the description is valid and protocol behaviour is correct.

– **Consistency** – Different parts of the Recommendation or a set of related Recommendations shall not contain contradictory information. If there is an inconsistency (for example, between a natural language description and a FD), there is a defect in the Recommendation that needs correcting.

– **Unambiguity** – A Recommendation should not be subject to different interpretations; implementations from different suppliers should be compatible; this is especially important where interoperability is required in a multi-vendor environment. To achieve this, the use of formal description techniques and tools is essential.

– **Implementability** – The specification should focus on the feasibility, ease and accuracy of translating specifications into systems or protocols while helping anticipate barriers to implementation success. To minimize complexity, the specification should avoid optional

features. If options are permitted, the number should be limited and application should be linked such that the number of permutations and combinations is minimized. In particular, there should be no options whose sole purpose is to achieve consensus.

– **Testability** – If products are based on a specification contained in a Recommendation, it should be possible to test whether the product conforms to the specification. A good practice is to start the development of the conformance test suite before the protocol specification is finalized and maintain an ongoing review process that includes information exchange between the test suite designers and the protocol specifiers.

5.2 Upfront identification

Each study group should identify upfront during the formulation of the study group Questions and subsequently in the development phase of Recommendations which quality aspects need to be fulfilled based on market requirements. A checklist to facilitate this identification is contained in Annex A.

As a general guideline, all Recommendations that address interoperability of equipment, networks, protocols or services should consider all quality aspects addressed here.

5.3 Formal description techniques

Formal specifications should be made available in machine-readable format to allow companies to use their facilities for simulation, validation, automatic code generation or other types of automatic processing should they wish to do so.

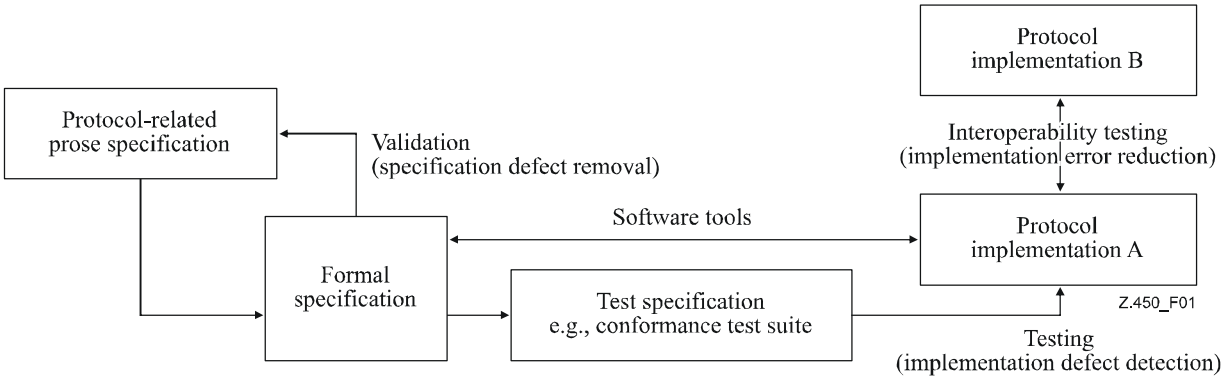
Guidelines on the use of FDTs are contained in [ITU-T Z.110]. It provides criteria for their use and should, therefore, be taken as a reference in conjunction with this Recommendation.

Whenever a discrepancy between a natural language description and FD, or between two FDs, is detected, the discrepancy should be resolved by changing the natural language description or the FDs without necessarily giving preference to one over the other(s). The goal should be the elimination of ambiguity and discrepancies.

When working with FDTs, appropriate software tools should be used. In particular, the tools should include features for editing, validation, simulation, and test generation. When product development from an FDT specification is required, commercial code generators for some FDTs to a suitable programming language and platform are available or may be produced internally by the product developer.

5.4 Overview of the process

The quality of Recommendations is closely connected with the use of formal description techniques (FDTs) and the use of computer-based tools. The main components of the quality process are formal specifications, validation of specifications and testing of prototype implementations. Figure 1 illustrates the complete process.



NOTE 1 - Not all of the illustrated processes in this figure are required for all protocols.
NOTE 2 - Several of the relations indicated by the arrows could be supported by software tools.

Figure 1 – Flow diagram to illustrate the quality process

The main component of the process is the formal specification expressed using an FDT. In this process, a precise and unambiguous formal specification may first be produced from the natural language specification. The FDTs should be widely available, allowing the process to be largely automated using supported, industrial-strength software tools.

The second key component of the process is the specification validation step in which specification defects are detected and removed. Once the specification is verified, it can be used to produce two or more implementations by automatic generation of the implementation code to assess the ease of implementation and subsequently test the conformance and interoperability. The purpose of this is to ensure that the specification is error-free and describes the intended behaviour. At the same time, implementability of the specification can be verified and the conformance test suite developed and validated.

It is preferable to have the conformance test suites generated directly from the formal specification using software tools so that the individual test cases will be traceable to the specification.

6 Quality checks

Before approving each new protocol-related Recommendation, the quality checklist should be completed and made available to the study group meeting. This list will identify the level of compliance with the quality aspects. The list should be included in the report to make the level of quality transparent to readers.

7 Specific guidelines

7.1 Readability

Recommendations should be clear, well-structured and easily read and understood. This applies both to the natural language text and the formal specification. This applies to all Recommendations irrespective of whether they are protocol-related or not.

Specifically, the functional purpose of the Recommendation should be clearly stated in natural language.

7.2 Completeness of a set of Recommendations

7.2.1 Additional documents related to a protocol specification

For checking completeness, the following documents may be used:

a) *Abstract test suite*

Defines a set of abstract test cases that can be used to check conformance to the protocol specification.

b) *Protocol implementation conformance statement*

For each relevant Recommendation, a PICS may be developed for use by the implementor of the Recommendation to declare what mandatory and optional features affecting interoperability have been implemented and which have not.

c) *Protocol implementation extra information for testing*

For each relevant Recommendation, a PIXIT may be specified to facilitate testing.

7.2.2 Conformance clause

In many cases, specification of mandatory requirements and optional features may be scattered throughout the Recommendation, often mixed with tutorial or explanatory text and examples. It is essential to identify and isolate each normative item in the Recommendation. For this purpose, all normative requirements and optional features should be summarized in point form in a special section, the conformance clause, of a Recommendation indicating individual references to the parts in the Recommendation where the full specification is given.

By extracting normative items and placing them as requirements into the conformance clause as simple statements in point form will reduce the chances of different readers interpreting Recommendation text differently. Same interpretations of Recommendations will facilitate interoperability and help in the development of unique test purposes for testing.

7.2.3 Testing methodology

The checklist should indicate which testing methodology has been used. Methodology for conformance testing is specified in the [b-ITU-T X.290-series] of Recommendations. Methodology for interoperability testing is defined in [b-ITU-T X-Sup.4] and [b-ITU-T X-Sup.5] series of Recommendations.

7.3 Correctness

7.3.1 Validation of specifications

The process of validation is illustrated in Figure 1. It consists of implementation, simulation and testing using commercial computer-based tools. This process requires formal descriptions of protocols and the use of tools to establish correctness of the specification prior to approval.

Examples of guidance for validation of specifications are given in [ITU-T Z.110] and in the methodology supplement to [b-ITU-T Z-Sup.1]. The working group members through pilot projects within their own organizations could do validation.

7.3.2 Abstract test suite

For each relevant Recommendation, the corresponding abstract test suite shall be expressed in the standardized TTCN-2 or TTCN-3 notation and in compliance with the [b-ITU-T X.290-series] of Recommendations.

7.3.3 Publication phase

Specific steps should be taken through the publication phase to ensure the correctness of the published Recommendation, in particular that no errors are introduced into any FD during publication.

7.3.4 Maintenance

Procedures are currently in place (Resolution 1) for identifying and correcting errors in approved Recommendations.

7.4 Consistency

Different parts of the Recommendation or a set of related Recommendations should not contain contradictory information. The goal should be the elimination of ambiguity and discrepancies.

7.5 Unambiguity

A Recommendation should be free from different interpretations, so that it constrains conforming implementations from different suppliers so that they are compatible and interoperable.

7.6 Implementability

7.6.1 Reduction of the number of options

Options reduce the chances of interoperability. The number of options should be reduced so that only the essential options are included and there are no redundancies.

7.6.2 Best technical solutions

Each Recommendation should be based on the principle of "best technical solution" rather than a compromise solution to achieve consensus.

7.7 Testability

Testing interfaces, such as points of control and observation, should be defined for example according to a standardized testing methodology and an appropriate abstract test suite should be specified for each protocol. Reduced complexity of Recommendations is also essential for testability of implementations.

8 Use of tools in developing Recommendations

8.1 Early error detection

The use of appropriate and suitable software tools such as protocol validation, syntax check tools, etc., in conjunction with formal description techniques during the development of Recommendations is essential for early error detection and the development of a common view during the consensus process. The use of tools makes errors visible early, thereby resulting in substantial savings in later efforts to uncover and correct errors.

8.2 Timely Recommendations

The use of automated techniques is essential for timely production of Recommendations. These tools reduce the total time required to develop a Recommendation and the associated abstract test suites.

8.3 Lower cost

Appropriate steps should be taken to reduce the cost to develop Recommendations. The use of computer-aided techniques and automation tools during the development of Recommendations will reduce the overall cost of developing Recommendations.

Annex A

Quality checklist for protocol-related Recommendations

(This annex forms an integral part of this Recommendation)

A.1 General checklist

The checklist in Table A.1 is provided to assist the developers of new protocol-related Recommendations in determining which clauses of the quality guidelines have been addressed.

Table A.1 – Quality checklist

Item	Quality aspect	Clause	Addressed		
1	Readability	7.1	Yes	No	N/A
2	Completeness	7.2	Yes	No	N/A
3	Conformance clause	7.2.2	Yes	No	N/A
4	Completeness checking	7.2.1	Yes	No	N/A
5	Testing methodology	7.2.3	Yes	No	N/A
6	Correctness	7.3	Yes	No	N/A
7	Formal descriptions	7.3.1	Yes	No	N/A
8	Abstract Test Suite	7.3.2	Yes	No	N/A
9	Publication phase	7.3.3	Yes	No	N/A
10	Maintenance	7.3.4	Yes	No	N/A
11	Consistency	7.4	Yes	No	N/A
12	Unambiguity	7.5	Yes	No	N/A
13	Implementability	7.6	Yes	No	N/A
14	Reduced number of options	7.6.1	Yes	No	N/A
15	Best technical solution	7.6.2	Yes	No	N/A
16	Testability	7.7	Yes	No	N/A
17	Use of tools	8	Yes	No	N/A
18	Early error detection	8.1	Yes	No	N/A
19	Timely Recommendations	8.2	Yes	No	N/A
20	Lower cost	8.3	Yes	No	N/A

A.2 Specific checklist

In addition to the quality checklist of Table A.1, a more specific set of questions is needed to:

- identify upfront what quality level should be aimed at;
- assess whether the quality goals have been met;
- distinguish between various means/levels of qualities;
- enable quality control across these means.

A.3 Specific questions

Natural language texts

1) Is readability of the text validated?
2) Are all terms, definitions and parameter names used in the text consistent with the terminology in the description technique specification?
3) Are references and cross-references up to date.

Illustrations

4) Is the readability of the illustrations validated?
5) Do the illustrations use description technique notations only?
6) Does any label refer to items that do not appear in the natural language texts?
7) Does any label refer to items that do not appear in the description technique specification?

Description techniques

8) Is use of description techniques required for the Recommendation?
9) Has [ITU-T Z.110] been used to identify relevant description techniques?
10) Are alphanumeric notations provided for the description techniques?
11) Are graphic notations provided for the description techniques?
12) Is the syntax of the description techniques formally specified?
13) Is the semantics of the description techniques formally specified?
14) Are mappings between the used description techniques formally specified?
15) Are the description techniques standardized?
16) If yes, which technique by which organization?

Description technique specification

17) Is the description technique specification well-structured?
18) Is completeness of the specification validated?
19) What testing methodology has been used for completeness validation?
20) Was the correctness of the specification verified?
21) Is consistency within the description technique specification validated?
22) What testing methodology has been used for consistency validation?
23) Is consistency to natural language texts and illustrations validated?
24) Is the specification unambiguous?

Completeness

25) Is the conformance clause specified in the standard?
26) Is the protocol implementation conformance statement (PICS) proforma specified?
27) Is the conformance abstract test suite specified?
28) Is the conformance testing methodology specified?
29) Is the protocol implementation extra information for testing (PIXIT) proforma specified?

Implementability

30) Are all not strictly needed options removed?
31) Is the best technical solution specified?
32) Are algorithms provided for the specification computable?

Testability

33) Are test specifications needed for the Recommendation?

34) Are interoperability tests needed?

35) Are abstract test suites provided for the specification?

36) Are the abstract test suites produced automatically from the specifications?

37) Are testing facilities offered for implementations?

Implementation testing

38) Are implementation tests needed for the Recommendation?

39) What implementations are provided?

40) What implementations are tested by using the abstract test suites?

41) Is module testing undertaken?

42) Is system testing undertaken?

43) Is user testing undertaken?

44) Is interoperability testing undertaken?

45) What performance tests have been undertaken?

46) Are the performance measurements satisfactory?

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