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SERIES Z: LANGUAGES AND GENERAL SOFTWARE ASPECTS FOR TELECOMMUNICATION SYSTEMS

Formal description techniques (FDT) – Application of formal description techniques

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Criteria for use of formal description techniques by ITU-T

Recommendation ITU-T Z.110

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Recommendation ITU-T Z.110

Criteria for use of formal description techniques by ITU-T

Summary

In view of the complexity and widespread use of Recommendations, it is imperative that adequate and appropriate description techniques and languages be used to ensure the required quality levels of Recommendations.

The purpose of Recommendation ITU-T Z.110 is to guide the use of formal description techniques (FDTs) to ensure the quality of ITU-T Recommendations. Where special requirements for verification and validation exist, FDTs should be used.

The effective use of FDTs requires phased procedures to introduce their use. This Recommendation states the procedures to accomplish this task. Effective use of FDTs implies the use of state-of-the-art tools.

Source

Recommendation ITU-T Z.110 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/.

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Introduction

Supplement 1 to ITU-T A-series Recommendations (09/1998), *Guidelines on quality aspects of protocol related Recommendations*, superseded by Recommendation ITU-T Z.450, states: "Guidelines on the use of FDTs are contained in Recommendation ITU-T Z.110. It provides criteria for their use and should, therefore, be taken as a reference in conjunction with this Supplement. It is planned to extend the scope of Recommendation ITU-T Z.110 to cover a wider range of applications developed by groups such as the OMG."

Resolution 4 on Conformity Assessment and Quality of Standards from the Joint Meeting of Global Standards Collaboration-5/RAST, Williamsburg, USA, 23-26 August 1999, concludes:

a) "that the use of protocol specifications expressed in SDL in conjunction with the available SDL-based commercial software tools will in the end produce higher quality Recommendations;

b) that approval of protocol Recommendations expressed in SDL will be achieved in a shorter time than approval of Recommendations written in natural language.

and resolves:

1) to encourage ITU-T Study Groups to apply Supplement 1 to A-series Recommendations, *Guidelines on quality aspects of protocol related Recommendations,* when developing new protocol related recommendations;

2) to encourage ITU to provide editing and technical support for the development and maintenance of complex Recommendations;

3) to encourage companies that participate in GSC member organizations to make use of commercial SDL/TTCN tools in their reviews of draft Recommendations;

4) to encourage companies that participate in GSC member organizations to assist in the establishment of facilities for training in the use of formalized methodology and tools; and

5) to encourage GSC member organizations to participate in the development of the methodologies that they use in their standardization processes."

The ITU-T formal description techniques are not restricted to specification of protocols, but are applicable to a much larger application area.

NOTE 1 – The current versions of "SDL" and "TTCN" are SDL-2000 and either TTCN-2 or TTCN-3 (see References, Terms and definitions in this Recommendation).

NOTE 2 – Supplement 1 to ITU-T A-series Recommendations has been superseded by Recommendation ITU-T Z.450, *Quality aspects of protocol-related Recommendations*.

The content of a previous version of this Recommendation was also published as ISO Resolution ISO/IEC JTC/SC22 N145. The statement on precedence in case of several descriptions contained in the JTC 1 document is omitted in this Recommendation.

Recommendation ITU-T Z.110

Criteria for use of formal description techniques by ITU-T

1 Scope

This Recommendation applies to the use of formal description techniques (FDTs) in ITU-T Recommendations.

FDTs are intended to be used in the development, specification, implementation and verification of Recommendations (or parts thereof).

2 References

None.

3 Terms and definitions

3.1 Definitions

This Recommendation defines the following terms:

3.1.1 formal definition (FD): Part of a Recommendation based on the use of an FDT.

3.1.2 formal description technique (FDT): A specification technique based on a technical language using rigorous and unambiguous rules both with respect to developing expressions in the language (formal syntax) and interpreting the meaning of these expressions (formal semantics). The main FDTs recommended by ITU-T are ASN.1 [b-ITU-T X.680 series], TTCN-2 [b-ITU-T X.292], TTCN-3 [b-ITU-T Z.161] to [b-ITU-T Z.170], SDL-2000 [b-ITU-T Z.100] to [b-ITU-T Z.106], SDL-2000 combined with UML [b-ITU-T Z.109], MSC [b-ITU-T Z.120] and [b-ITU-T Z.121] and URN [b-ITU-T Z.150] and [b-ITU-T Z.151].

3.1.3 natural language description: An example of an informal description technique using one of the languages used by ITU-T to publish Recommendations. It may be supplemented with mathematical and other accepted notation, figures, etc.

3.2 Abbreviations

This Recommendation uses the following abbreviations:

ASN.1	Abstract Syntax Notation One
FD	Formal Definition
FDT	Formal Description Technique
GSC	Global Standards Collaboration
IDL	Interface Description Language
MSC	Message Sequence Chart
OMG	Object Management Group
RAST	Radio Standardization
SDL-2000	Specification and Description Language
TTCN-2	Tree and Tabular Combined Notation version 2
TTCN-3	Testing and Test Control Notation version 3

UML Unified Modelling Language

URN User Requirements Notation

XML eXtensible Markup Language

4 FDTs

4.1 Objectives of an FDT

The goal of an FDT is to permit precise and unambiguous specifications. FDTs are also intended to satisfy objectives such as:

– a basis for analysing specifications for correctness, efficiency, etc. (by simulation, verification or systematic test derivation);

– a basis for determining completeness of specifications;

– a basis for validation of specifications against the requirements of the Recommendation;

– a basis for determining conformance of implementations to Recommendations;

– a basis for determining consistency of specifications between Recommendations;

– a basis for implementation support.

In some areas, more than one FDT may be needed to accomplish all objectives.

4.2 Benefits of an FDT

The application of an FDT can provide benefits such as:

– improving the quality of Recommendations, which in turn reduces maintenance costs to both ITU-T and to users of Recommendations;

– reducing dependency on the natural language to communicate technical concepts in a multilingual environment;

– supporting the validation of Recommendations and the easier generation of conformance tests for Recommendations, which then makes it easier to test products;

– reducing development time and cost of implementations by using tools that are based on the properties of the FDTs;

– making the implementation easier, resulting in better products.

4.3 Use of FDTs

FDTs are advanced techniques that are widely used in industry. Significant investment in training and tools have been made by ITU-T members.

There are limited resources for the development (rather than use) of FDTs. The development of FDTs tends to be a lengthy and costly task.

Although there is expertise within the ITU-T Study Groups both to assess the technical merits of the formally described Recommendations and to reach consensus on them, this is also limited.

4.4 Support for FDTs

The development and availability of tutorial and educational materials helps to provide widespread understanding of the complexities and capabilities of FDTs. The benefits of using FDTs can only be assured after some training.

Tools to support an FDT that is used in a Recommendation can ensure that many defects in draft Recommendations are removed before they are published, and that the FDT is used with the semantics defined in the FDT Recommendation. The use of electronic working methods enables

ITU-T members to analyse draft Recommendations and utilize approved Recommendations in their own preferred FDT tools.

TSB continues, and plans to expand, its validation of formal description components of ITU-T Recommendations: "For several years, the TSB has performed a compilation validation of ASN.1 and XML source code that forms an "electronic attachment" to an ITU-T Recommendation, a service which has been the envy of some standard development organizations. TSB is responsible for managing the inventory of the Intellectual Property associated with this growing catalogue of "electronic attachments"."

4.5 Criteria for the use of FDTs

The description techniques used within a Recommendation shall be decided by the study group responsible for the Recommendation taking into account the factors in clauses 4.1 to 4.4 and the procedure in clause 6. The primary criteria for the decision shall be the technical quality of the Recommendation. The description techniques listed in clause 3.1.2 shall be used for those parts of a Recommendation that can be described in this way.

In some cases, other criteria such as existing documentation and urgent market needs are sufficient to justify an alternative description approach. Where a Recommendation could use one of the techniques listed in clause 3.1.2, but a different technique or just natural language is used, the rationale for the choice taken shall be provided, and preferably included in the Recommendation.

5 Criteria for development and Recommendation of FDTs

It is important to avoid unnecessary proliferation of FDTs, because of the cost and difficulty of supporting many FDTs both for ITU-T and for its members. The following criteria shall be met before adopting a new FDT for use in ITU-T Recommendations:

– the need for the FDT shall be demonstrated;

– evidence that it is based on a significantly different model from that of an existing FDT shall be provided;

– the usefulness and capabilities of the FDT shall be demonstrated;

– there should be at least two tools that adequately support the FDT available to any party on reasonable and non-discriminatory terms.

When a significant modification to an existing FDT is considered, this shall be treated in basically the same way as a new FDT, regardless of whether the change is backwards compatible or not. The objectives are to keep both the number of FDTs low and each FDT itself stable to the benefit of all parties.

Any adoptions of new FDTs or modifications of existing FDTs should be communicated to the lead study group for languages and description techniques (see clause 7).

6 Procedure for development of formal definitions

6.1 Only standard FDTs (or FDTs in the process of being standardized) shall be used in formal definitions of Recommendations.

6.2 The adoption of an FDT for any particular Recommendation is a decision of the study group (in consultation with the involved standardization organizations for collaborative standards). If an FD shall be developed for a new Recommendation, the FD shall be progressed at least as fast as the Recommendation itself.

6.3 For the evolutionary introduction of FDs into Recommendations, three phases can be identified. It is the responsibility of the study group to decide which phase initially applies to each FD and the possible evolution of the FD toward another phase. It is not mandatory for an FD to go

through the three phases described below and, more generally, it is not mandatory for an FD to evolve. Whenever practical, it is suggested that a study group omits phase 1 and phase 2.

6.3.1 Phase 1

This phase is characterized by the fact that widespread knowledge of FDTs and experience in FDs are lacking; there may not be sufficient resources in the study groups to produce or review FDs.

The development of Recommendations is based on conventional natural language approaches, leading to Recommendations where the natural language description is the definitive Recommendation.

Study groups should develop FDs of their Recommendations since these efforts will contribute to the quality of the Recommendations by detecting defects and other issues in the natural language description, may provide additional understanding to readers, and will support the evolutionary introduction of FDTs.

A FD produced by a study group that is considered to represent faithfully a significant part of the Recommendation or the complete Recommendation should be published as an appendix to the Recommendation. If the study group considers the FD is correct and adds to the Recommendation, it is suggested to consider the FD to be published as an annex (to be normative, rather than an appendix which is informative) as in phase 2.

Meanwhile study groups should develop and provide educational material for the FDTs to support their widespread introduction in the ITU-T and liaison organizations.

6.3.2 Phase 2

This phase is characterized by the fact that knowledge of FDTs and experience in FDs are more widely available; study groups can provide enough resources to support the production of FDs. However, it cannot be assured that enough ITU-T members can review FDs in order to enable them to approve a proposed formally defined Recommendation.

The development of Recommendations should still be based on conventional natural language approaches, leading to Recommendations where the natural language description is the definitive standard. However, these developments should be accompanied and supported by the development of FDs of these Recommendations with the objective of improving and supporting the structure, consistency, and correctness of the natural language description and including the FD in the Recommendations.

A FD, produced by a study group, that is considered to represent faithfully a significant part of the Recommendation or the complete Recommendation, should be published as an annex to the Recommendation. If the FD is published as an annex, any discrepancy between the natural language description and the FD shall be treated in the same way as in phase 3.

Meanwhile educational work should continue.

6.3.3 Phase 3

This phase is characterized by the fact that a reasonable knowledge of FDTs within the study group and most users is assumed; ITU-T members can provide sufficient resources both to produce and review FDs, and assurance exists that the application of FDTs does not unnecessarily restrict freedom of the implementations.

Study groups should use FDTs routinely to develop their Recommendations, and the FD(s) become part of the Recommendation together with natural language descriptions, as additional text with informal diagrams or embedded annotation in the FD or a combination of both of these.

Whenever a discrepancy between a natural language description and an FD, or between two FDs, is detected, the discrepancy should be resolved by changing or improving the natural language

description or the FDs without necessarily giving preference to one over the other(s). Any inconsistency between any two parts of a Recommendation (regardless of whether either part uses an FD or not) means that there is an error in the Recommendation that needs to be corrected.

6.4 The above procedures for phased development of FDs are intended to aid the progression of FDs within the standards process, not to hinder their progression. Should procedural problems arise, the lead study group for languages and description techniques (see clause 7) should be informed and, where possible, recommended procedural modifications should be proposed to alleviate the problems.

7 Lead study group for languages and description techniques

If a lead study group for languages and description techniques (or equivalent body) is not otherwise identified, the study group responsible for the majority of the FDTs defined by ITU-T Recommendations shall take the responsibilities identified above.

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