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Izkušnje z aplikacijo orodij SDL in CATG za razvoj abstraktnih preskušalnih nizov (ATS)

Experiences of the application of SDL and CATG tools for the development of Abstract Test Suites (ATSs);

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Foreword

This ETSI Technical report (TR) has been produced by the Signalling Protocols and Switching (SPS) Technical Committee of the European Telecommunications Standards Institute (ETSI).

Introduction

This document adds complementary information to EG 201 022. It describes the experiences of the use of SDL as defined in Z.100 [3] and TTCN as defined in ISO/IEC 9646-3 [4] based **tools** for the development of Abstract Test Suites for B-ISDN DSS2 point-to-multipoint as defined in Q.2971 as modified by ETS 300 771-1 [1].

The tools studied were:

- SDT (Telelogic) for SDL simulation;
- ITEX (Telelogic) for TTCN simulation;
- Link and Autolink (Telelogic) for CATG;
- TTCgeN (Verilog) for CATG;
- TTCN Maker (INTOOLs project) for CATG.

1 Scope

The present document objectively documents the experimental use of various tools for Computer Aided Test Generation from the point of view of testing methodology. It is not intended that this document imply any comparison of the tools, nor is it intended that this document be used as a basis for ETSI recommending the use of one tool or another.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.
- 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 300 771-1 (1997): "Broadband Integrated Services Digital Network (B-ISDN); Digital Subscriber Signalling System No. two (DSS2) protocol; B-ISDN user-network interface layer 3 specification for point-to-multipoint call/bearer control; Part 1: Protocol specification; [ITU-T Recommendation Q.2971, modified]".

[2] ETS 300 443-1 (1996): "Broadband Integrated Services Digital Network (B-ISDN); Digital Subscriber Signalling System No. two (DSS2) protocol; B-ISDN user-network interface layer 3 specification for basic call/bearer control; Part 1: Protocol specification; [ITU-T Recommendation Q.2931 (1995), modified]".

[3] ITU-T Recommendation Z.100 (1994): "CCITT Specification and Description Language (SDL)".

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

[5] ITU-T Recommendation Z.120 (1993): "Message Sequence Chart".

[6] ETS 300 771-5 (1998): "Broadband Integrated Services Digital Network (B-ISDN); Digital Subscriber Signalling System No. two (DSS2) protocol; B-ISDN user-network interface layer 3 specification for point-to-multipoint call/bearer control; Part 5: Test Suite Structure and test purposes [TSS&TP] specification for the network".

[7] ETS 300 771-6 (1998): "Broadband Integrated Services Digital Network (B-ISDN); Digital Subscriber Signalling System No. two (DSS2) protocol; B-ISDN user-network interface layer 3 specification for point-to-multipoint call/bearer control; Part 6: Abstract Test Suite (ATS) and PIXIT proforma specification for the network".

[8] EG 201 022: "Broadband integrated Services Digital Network (B-ISDN); Digital Suscriber Signalling system No. two (DSS2) protocol; B-ISDN user-network interface layer 3 specification for point-to-multipoint call/bearer control; service Description Language (SDL) validation model".

3 Abbreviations

For the purposes of this TR, the following abbreviations apply:

ASN.1	Abstract Syntax Notation one
B-ISDN	Broadband ISDN
CATG	Computer-Aided Test Case Generation
DSS2	Digital Subscriber Signalling System two
INAP	Intelligent Networks Application Protocol
ISDN	Integrated Services Digital Network
IUT	Implementation Under Test
MSC	Message Sequence Chart
SDL	Specification and Description Language
TP	Test Purpose
TTCN	Tree and Tabular Combined Notation
UNI	User Network Interface

4 Use of tools for TP development and validation

4.1 Test Purpose development

None of the tools studied offered a real alternative to the intellectual processes that are applied when producing test purposes manually. The tools supported either:

- *semi-automated* techniques which rely on user interaction with a simulator to generate MSCs as defined in Z.120 [5] which express test purposes; or

- *fully-automated* techniques which systematically base test purposes on single state transitions.

While MSCs can be a useful complement to documenting test purposes they should not be regarded as a complete substitute for textual test purposes, which will often contain additional and necessary information not easily expressible in the MSC format (e.g. verdict assignment). Also, MSCs cannot cope with dynamic alternatives, as in this example from N-ISDN, User Side: Ensure that the IUT in Null call state U00, on receipt of a valid SETUP message with the sending complete information element, sends any of a CALL PROCEEDING, ALERTING or CONNECT message and enters the relevant call state Call Proceeding U09, Call Received U07 or Connect Request U08.

With fully-automated techniques there are two difficulties. In the first case, a single-state transition is not always an adequate expression of purpose where we may wish to express test purposes in terms of requirements not necessarily restricted to a single state transition (i.e., the level of granularity is too restrictive).

In the second case there is a potential for generating very many test purposes. Although the number of test purposes generated can limited by applying sets of criteria, these criteria are often arbitrary (e.g., maximum depth) and do not always bear relation to what a test engineer would normally call a 'good' test purpose. Finally, even if test purposes *are* generated automatically they must still be subject to a time-consuming manual review if we are to have full confidence in them.

Conclusion: Using SDL/MSC based tools as *aids* to the development and documentation of test purposes is useful and produces high-quality documentation of test purposes. The informal expression of TPs in textual format (using templates as is current ETSI practice) accompanied by the corresponding MSCs is especially effective. Tools are *not* suitable for automatic generation of TPs.

4.2 Test Purpose validation

Using tools to validate test purposes by simulation proved to be more successful. This was done by checking through simulation the behaviour described by each TP. The work was made easier by the implementation of a simple graphical user interface.

NOTE: EG 201 022 [8] describes the use of SDL simulation techniques to develop and validate TPs.

Once the system was setup it took about 8 man-days to validate 830 test purposes taken from ETS 300 771-5 [6]. The following table summarises the results of this process (this does not include the time needed to develop the SDL model (about 2 man-months), or the time needed to build the graphical user interface(about 2 man-weeks)):

Table 1: Errors found by the TP validation process

Errors in the test purposes (missing or too many parameters, incorrect messages etc.)	51
Errors found in the Q.2931 and Q.2971	19
Errors (bugs) found in the SDL model	20

It is worth noting that this process has the effect of not only validating the test purposes (an error rate of 8% was noted) but also the SDL model and, by implication, the standard itself. Due to the fact that all three components in the validation process (the standard, the SDL model and the test purposes) were produced by different parties we have confidence that the exercise was more than an academic.

Conclusion: The use of SDL simulation models can be very useful in the development and validation of test purposes. At this level they can also have the useful side-effect of validating the base standards.

5 Use of tools for Test Suite validation

The SDT/ITEX simulators were used to execute a manually written TTCN test suite for the network B-ISDN DSS2 against an enhanced SDL model.

The basis for the protocol simulation was the SDL model for test purpose validation. However, the test purpose validation model had only limited support of protocol data and could not cope with some special protocol situations. The following additions were necessary:

- detailed protocol data (messages, information elements etc.) descriptions in ASN.1;
- provision of detailed protocol data checking functions in SDL;
- provision of functions which generate appropriate signals with detailed data contents in reaction to protocol activities;
- provision of an encoding/decoding of protocol data;
- provision of a full functional call processing to simulate switch behaviour, define a mechanism how to provide user and network side simulations in one SDL model with minimal maintenance effort;
- the user side simulation (i.e., both network and user).

These tasks were completed in approx. 3 man-months.

NOTE - Much of the SDL work was done on a voluntary basis by Deutsche Telekom

Using the Telelogic ITEX tool, C-code was generated from the test suite. This code could not interwork with the SDT simulation mainly because the data format was not unique. In Tau version 3.11 it is not possible to interchange signals which contain ASN.1 sets with optional fields because there is no tag to distinguish these fields. Therefore the data coding defined in ETS 300 771-1 [1] and ETS 300 443-1 [2] had to be implemented and used as the interchange format between ITEX simulation and SDT simulation. It was necessary to write code for the encoding and decoding of protocol data on the ITEX side.

Other tasks needed to create an executable simulation were:

- provide PIXIT values;
- provide user defined test operations;
- provide protocol data encoding/decoding functions and other tool fixes.

The ITEX fixes that needed doing can be grouped as follows:

- data access errors (CHOICE values, SET fields, wrong type settings); and
- simulation run time errors (logging and scheduling).

The first kind of errors could be fixed in the generated code. The second kind of errors were fixed through a library update provided by Telelogic. These tasks were completed in 1 man-month. Through the provided encoding/decoding, the ITEX and SDT simulation could interwork. All test cases of the network side test suite were executed. Due to time constraints only a few user side test cases were executed. This task took approximately 1 ½ man-months. Through simulation errors in the TTCN specification as well as in the SDL specification were identified.

Table 2: Errors found in the TTCN test suite

Parameter order errors (parameters where not in the right order (these errors could have been detected by a better TTCN checker than ITEX)	33
Procedural errors (race conditions could have invalidated the test case)	12
Parameter value errors (parameters had wrong value)	42

Ignoring the parameter order errors the parallel simulation detected approximately 50 test cases which were erroneous in the 800+ test case test suite (6% error ratio). It is very unlikely that these errors would have been found by a manual review of the test suite.

Conclusion: by using the TTCN/SDL simulation techniques the quality of the TTCN test suite was significantly improved. However, it should be noted that building the SDL model and writing the encoder/decoder interface is probably not economically sensible unless the SDL model is to be used in other contexts (e.g., CATG, implementation etc.).