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SPECIFICATIONS OF SIGNALLING SYSTEM No. 7

SIGNALLING SYSTEM No. 7 TEST SPECIFICATION – GENERAL DESCRIPTION

ITU-T Recommendation Q.780

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The 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 Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.780 was revised by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

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NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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

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SIGNALLING SYSTEM No. 7 TEST SPECIFICATION – GENERAL DESCRIPTION

(Melbourne, 1988; modified at Helsinki, 1993)

1 General

This Recommendation is an introductory Recommendation to the test specifications of Signalling System No. 7. The test specifications are contained in Recommendations Q.781-Q.787. This Recommendation defines the scope and purpose of the test specification and identifies guidelines that are either specific to the particular protocol under test, or are more general. In addition, it identifies functional requirements imposed by the test specification.

2 General principles of test specifications

The test specification aims at validating a given implementation of a protocol. The specification is independent of a given implementation and does not generally imply any modification of the signalling point under test. However, it is recognized that certain tests require capabilities of the system that are not explicitly defined in the relevant Recommendation, and these capabilities may not be present in all implementations. As a consequence, certain tests may not be possible in all implementations.

3 Scope of the test specification

The test specification is intended to cover all aspects of Signalling System No. 7. The following Recommendations are initially produced as follows:

- Q.781 covers MTP level 2. See Q.701-Q.703.
- Q.782 covers MTP level 3. See Q.704-Q.707.
- Q.783 covers TUP. See Q.721-Q.724.
- Q.784 covers ISDN User Part for basic call control part. See Q.761-Q.764.
- Q.785 covers ISDN User Part for supplementary service part. See Q.730.
- Q.786 covers SCCP. See Q.711-Q.714.
- Q.787 covers TC. See Q.771-Q.775.

The test specification is not a definition of the protocol. The protocol Recommendations are as noted above.

4 Field of application

The test specification applies in the international network, and if appropriate in the national network. In the international network, the actual tests to be performed will be the subject of appropriate bilateral agreements between the two or more Administrations/ROAs concerned.

5 Method of application

The test specifications fulfill the requirements for both validation and compatibility testing and are specific to only the given protocol under test. This clause further identifies the principles and configurations as well as the structure of the test specifications themselves.

5.1 Test principles

For a given protocol test specification, it is assumed that the underlying layers have been implemented correctly and therefore the tests specified are only concerned with the given protocol under test. In so far as is practical, tests are intended to test all aspects of the given protocol, including normal behaviour, abnormal behaviour and compatibility aspects. It is understood that all testing aspects of abnormal behaviour is not realizable. Compatibility aspects include the processing of spare fields as defined in 9.4.7/Q.700, and tests should be made to check that they are ignored when received.

The following criteria are used in defining test requirements in subsequent Recommendations.

a) *Tests should not imply an implementation*

To improve the functional description and understanding of the behaviour of the signalling system, the test specifications model the internal behaviour of the protocols using functional groupings. The functional groupings are only used to facilitate understanding and do not impose constraints on an implementation.

Compatibility is only measured against the external behaviour of the protocol, as described in the protocol specifications. If exceptions to this rule are identified they are specified in the corresponding test specification.

b) *Testing requirements should be independent from the testing environment*

Test requirements are not meant to dictate a specific test environment. Hence, those executing tests should not feel constrained to any specific test generation mechanism (see Recommendation Q.755), traffic simulator or monitoring equipment solely because of the given test specification.

c) *Test Recommendations are intended to be complete test specifications*

It is possible to extract from a test Recommendation, a sub-set of the tests which are appropriate for testing within a selected domain of functionality. These tests may need to be supplemented with specific user/system tests. In order to achieve this, guidance is given to the tester wherever possible, e.g. the purpose of the test, how it could be performed, how tests are selected, etc. Tests which are conditional on the presence of optional items should also be identified.

5.2 Categories of tests

The test specification fulfils the requirements for both validation and compatibility testing. All tests are identified as either validation tests (VAT) and/or compatibility tests (CPT). All tests in the test specification are validation tests (VAT), and in addition those marked with an asterisk are also compatibility tests (CPT). The explanation of these categories follow.

5.2.1 Validation testing

The function of validation testing is to give a level of confidence that a given implementation in accordance with the relevant CCITT Recommendations of the Signalling System No. 7. These validation tests could apply both in the national and international networks. The validation test is a prerequisite of compatibility testing (see 5.2.2) and is performed under the responsibility of each Administration/ROA. These tests will generally be performed without the cooperation of another Administration/ROA, although this is not precluded should this arrangement prove convenient. Validation testing will be performed on a signalling point that is not in service.

The validation test is performed on a signalling point.

It is suggested that the validation test, or subset, is repeated when the implementation is upgraded or modified in any functional way.

Validation testing may require the use of a simulator to check the operation of the signalling point under test. The specification of this simulator is not explicitly covered by these Recommendations although the general requirements are implicit in the test specification.

In validation testing, the signalling point under test is called SP “A.”

5.2.2 Compatibility testing

The objective of compatibility testing is to give a level of confidence that two different implementations are able to interwork. To perform compatibility testing, the two nodes involved are interconnected. The specification is written for the interconnection of two given implementations for the first time. For subsequent interconnections of the same two implementations, a subset of tests may prove sufficient. These tests will not only be performed on a new signalling point, but also on a signalling point already in service.

Each Recommendation identifies a list of tests that may be suitable for compatibility testing, but the actual tests to be performed will be bilaterally agreed between the Administrations/ROAs concerned.

Certain of the tests identified in the test list as compatibility tests may disturb the operation of the exchange, whereas others may not. Any tests which may cause disturbance to the exchange should be carefully selected to meet the operational criteria of the two Administrations/ROAs.

The satisfactory completion of compatibility testing should be bilaterally agreed.

When a change to the signalling network is made, tests selected from those identified as compatibility tests may be appropriate. In general the tests performed under these circumstances will be the minimum number to ensure that compatibility between points in the network is still maintained.

In compatibility testing, each signalling point may in turn consider itself to be SP "A," i.e. tests are performed on both signalling points involved.

5.3 Structure of test Recommendations

The individual test Recommendations should contain the following:

- *Introduction* – This clause describes the outline of the individual test specification.
- *Scope of test* – This clause mentions the functions to be tested.
- *Objective of test* – This clause explains the basic concept for deciding test items or test configurations.
- *Test environment* – This clause describes the nature of the facilities necessary to perform testing such as traffic generator/terminator and logging equipment for test traffic.
- *Test configuration* – This clause describes the configurations of SPs and link(s) or signalling relations which are necessary to perform tests.
- *Presentation of test traffic* – This clause illustrates the format of the messages for testing such as address type and the content of individual data fields.
- *Test list* – This clause presents test items categorized on a certain criterion.
- *Test script* – This clause illustrates the flows of messages transferred to perform the required test. It includes test numbers, reference to protocol Recommendations, title, subtitle, purpose, pre-test conditions, configuration, SP types, test type, message sequence described by arrow diagrams and test description.

5.4 Test configuration

For both validation and compatibility testing the point under test is connected to the test environment and becomes part of the "test configuration". The test configuration satisfies all of the following three criteria:

- the point under test will be connected by one or more signalling link sets (real or simulated), which may or may not be interconnected;
- the capability of generation and reception of test traffic, where applicable;
- the ability to perform the described test, notably the facility to store and analyse messages to the appropriate degree.

For some tests, the sentence "Repeat the tests in the reverse direction" is present and indicates that the signalling point under test; becomes SP B.

6 Functional requirements imposed by the test specification

The functional description that follows is intended to identify the functional requirements imposed by the test specification. It does not imply any physical partitioning of equipment in real systems. See also 2.2.1/Q.701.

6.1 MTP Level 1

The test specification assumes the availability of a suitable signalling data link with the parameters identified in the relevant Q-Series Recommendations, e.g. Q.702 (referring to Recommendation G.821).

In validation testing the signalling data link may be a pseudo-signalling data link, in which case it should preferably have similar/identical characteristics to the signalling data links likely to be encountered in service. Simulation of deterioration of the transmission link may not be necessary if the emulator includes the capability to simulate abnormal conditions on the signalling data link.

In compatibility testing the signalling data link is the actual signalling data link that will be used in service.

6.2 MTP Level 2

The MTP Level 2 test environment consists of four items (see Figure 1):

– the MTP Level 3 simulator;

– the test simulator;

– the signalling link monitor (see clause 7);

– the signalling data link.

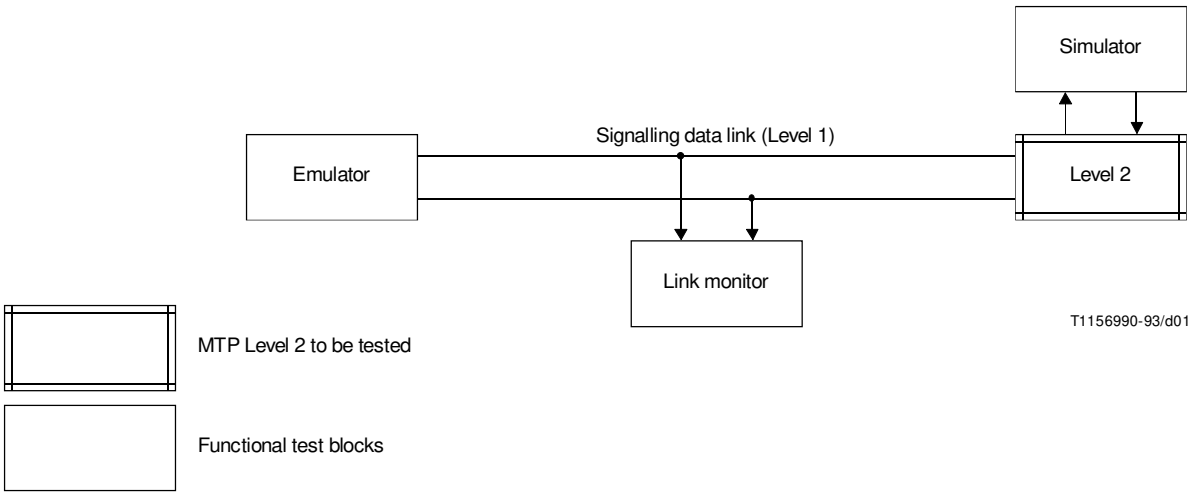

FIGURE 1/Q.780

Level 2 test environnement

6.2.1 MTP Level 3 simulator

During the MTP Level 2 tests it is necessary to inject signalling messages and indications to and from the MTP Level 2 under test. It is desirable that the MTP Level 3 function used is the actual MTP Level 3 of the MTP with some additional functions for test purposes.

6.2.2 Test simulator

During MTP Level 2 testing it is necessary to inject some abnormal signal units (as well as normal signal units) to fully test the MTP Level 2 under test, the test simulator should have this function. In addition, the simulator should have the capability to receive and check signal units from the MTP Level 2 under test. The generation of certain abnormal sequences of signal units should also be a capability of the test simulator.

6.3 MTP Level 3

The MTP Level 3 test specification assumes that the MTP Level 2 has already been tested satisfactorily. However, certain tests will in addition explicitly test the MTP Level 2/3 interface.

The MTP Level 3 tests environment consists of three items (see Figure 2):

- the simulator of upper levels;
- simulated network including test simulator and signalling data links;
- the signalling link monitor(s) (see clause 7).

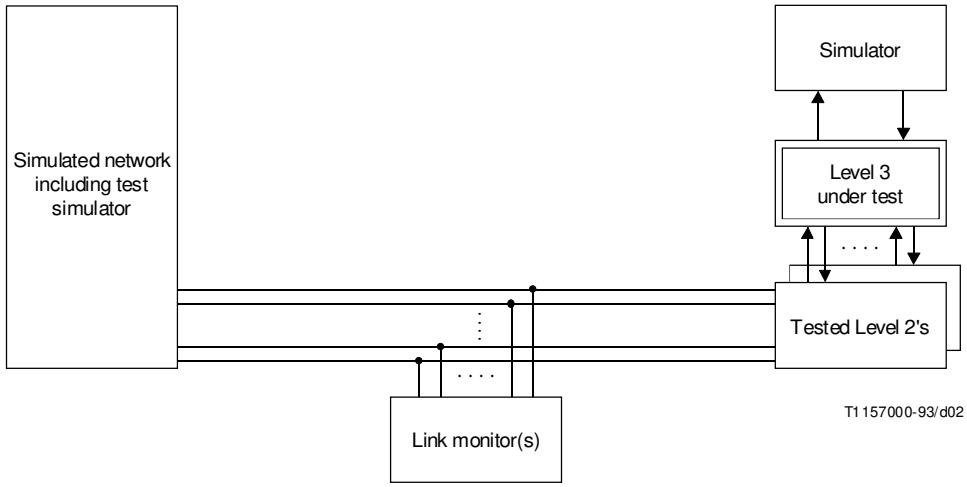

FIGURE 2/Q.780

Level 3 test environnement

6.3.1 Simulator of upper levels

During MTP Level 3 testing it is necessary to inject signalling messages into MTP Level 3 for testing, e.g. message loss during changeover. It is desirable that the simulator used should be as close as possible to the actual upper level to be used. In addition, an MML interface is assumed. The MTP Level 3 under test must use an already tested MTP Level 2.

6.3.2 Simulated network including test simulator

During MTP Level 3 testing it is necessary to inject some abnormal messages (as well as normal messages) to check the MTP Level 3 under test, the simulated network including test simulator should have this function. In addition, the test simulator should have the capabilities to receive and check messages from the MTP Level 3 under test. The generation of certain abnormal sequences of messages should also be a capability of the test simulator. The test simulator must include an already tested MTP Level 2.

6.4 TUP

The TUP test specification assumes a tested MTP for compatibility tests but no assumption is made about message transfer between the TUP under test and the TUP tester for validation tests.

The TUP test environment consists of three items (see Figure 3):

– the TUP tester;

– a stable signalling relation and telephone circuits;

– a monitor of TUP messages and telephone circuits.

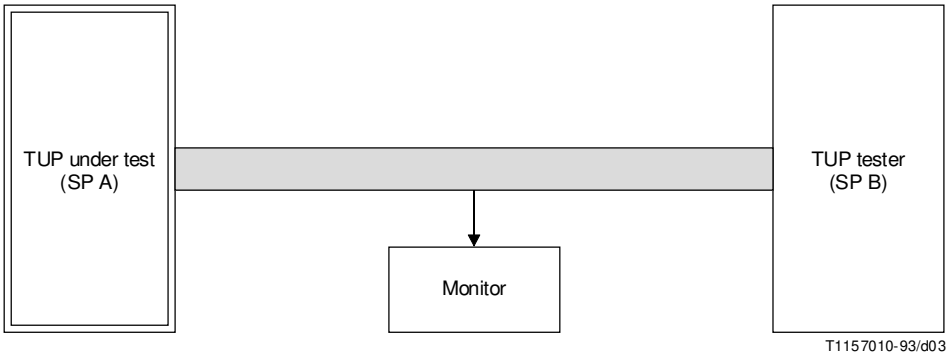

FIGURE 3/Q.780

TUP test environnement

6.4.1 TUP tester

The TUP tester is required to simulate TUP protocol operations and some exchange call control operations.

6.4.2 Monitor

The monitor is required to monitor and record TUP message sequences and to monitor the result of call control operations on the controlled telephone circuits. This includes checking that tones are correctly received and that speech/information transfer is possible.

6.5 ISDN User Part

The ISDN User Part test specifications assumes a tested MTP for compatibility tests but no assumption is made about message transfer between the ISDN User Part under test and the ISDN User Part tester for validation tests.

The ISDN User Part test environment consists of three items (see Figure 3):

– the ISDN User Part Tester;

– a stable signalling relation and user information transfer circuits;

– a monitor of ISDN User Part messages and user information transfer circuits.

6.5.1 ISDN User Part Tester

The ISDN User Part Tester is required to simulate ISDN User Part protocol operations and some exchange call control operations.

6.5.2 Monitor

The monitor is required to monitor and record ISDN User Part message sequences and parameters and to monitor the result of call control operations on the controlled user information transfer circuits. This includes checking that the tones, if necessary, are correctly received and user information transfer is possible.

6.5.3 User information transfer circuits

User information transfer circuits are required to check the connectivity of all types of bearer services. The following types of user information transfer circuits are established:

- user information transfer circuits which convey all types of bearer services using DCME functions; or
- user information transfer circuits which consist of some circuit groups according to the type of bearer service.

6.6 SCCP

The Signalling Connection Control Part Test Specifications are composed to validate routing/addressing and data transfer capabilities by monitoring and analysing SCCP messages and their contents.

The test environment assumes that SCCPs under test are using previously tested and compatible MTPs. The test environment consists of the following:

- the SCCP Tester;
- a stable signalling relation between SCCP termination points;
- a monitor of SCCP messages.

6.6.1 SCCP Tester

The SCCP Tester is required to simulate SCCP protocol operations and generate SCCP unit data messages. SCCP management and connection oriented procedure simulation are for further study.

6.6.2 Monitor

The monitor is required to monitor and record SCCP message sequences, parameters for normal and abnormal system operations. This includes verifying appropriate return of messages if return options are requested, etc. for correct operation.

6.7 TC

The Transaction Capabilities Test Specifications are composed to validate transaction, component and dialogue handling mechanisms and data transfer capabilities by monitoring and analysing TC messages and their contents.

The test environment assumes that TCs under test are using previously tested and compatible SCCPs. The test environment consists of the following:

- the TC Tester;
- a stable signalling relation and SCCP data transfer capability between termination points;
- a monitor of TC messages.

6.7.1 TC Tester

The TC Tester is required to simulate a TC user in order to stimulate the generation of TC dialogues. This may be in the form of a TC testing ASE or other real applications which generate the required message sequences.

6.7.2 Monitor

The monitor is required to monitor and record TC messages and message sequences and to monitor the results of component and transaction dialogues. This includes verifying construction and sequences of invokes, return results and return errors at the component level as well as begins, continues and ends at the transaction level, etc.

7 Signalling link monitor(s)

The test specification assumes the availability of a signalling link monitor and a suitable access point for connection of the monitor as specified in clause 4/Q.702.

The test specification does not attempt to specify what a signalling link monitor should be, but instead the functional requirements are identified in general terms. A signalling monitor will be used for decoding of signal unit sequences during testing and to give the operator confidence that the signalling protocol has been correctly observed.

The requirements imposed on a signalling link monitor will be different for the two types of testing. For validation testing detailed decoding down to a field level will be required, but for compatibility testing decoding down to a message MTP level may be adequate.

In addition, it should be noted that compatibility testing will be a function performed numerous times on a signalling point, whereas validation testing will be performed once only, except under certain circumstances of upgrading of the signalling point.

NOTE – It should be observed that implementations may include a signalling link monitor as an intrinsic part of the signalling point. However, for validation testing this cannot necessarily be relied upon. In addition, the test specification does not attempt to perform the function of testing the accuracy of any signalling link monitor implemented in the signalling point. However, certain conclusions will inevitably be made from the performance of validation testing.

Supplement No. 1

Signalling System No. 7 testing and planning tools

1 General

This Supplement provides information about SS No. 7 testing and planning tools that are in use by some organizations. The CCITT does not endorse these tools and has not verified the claims made by contributors of the information. It should be used as a guide to the type of tools that are used.

Each tool is described briefly and a contact address is provided for further information. The CCITT cannot provide further information.

The SS No. 7 testing tools are SS No. 7 protocol testing tools and SS No. 7 load generating tools. The protocol testing tools are typically used by staff that are testing that the various SS No. 7 protocols operate correctly i.e. protocol verification. They can emulate one end of an SS No. 7 link or they can monitor the messages that pass in both directions on a signalling link between two working SS No. 7 equipment. The SS No. 7 load generating tools are typically used to test that the SS No. 7 equipment, or the exchange that uses it, operates correctly under various signalling load conditions.

The SS No. 7 planning tools are used to plan and verify the SS No. 7 signalling network. These tools are typically used by network planners to create a network plan or to generate and prove Level 3 routing tables. They may also be used by operational staff to verify the correctness of the implemented signalling network.

1.1 Explanation of terms

Monitoring

Where the test equipment is non-intrusively connected to a transmission line and "listens" to the communication on that line. Two monitors are usually required to monitor both directions of a communication channel. The monitored data can be displayed, decoded and stored.

Emulation

Where the test equipment replaces one of the signalling entities and operates as if it was a real signalling entity. Some layers may be emulated while the layer above may be operated in simulate mode (see below).

Simulation

Where the test equipment replaces one of the signalling entities and operates under the control of test sequences which can produce correct and incorrect protocol actions. Simulation is supported by tools to create messages and formulate state machines.

Conformance testing

Conformance testing is the rigourous testing of a protocol using the simulation mode of operation. Suites of standard tests are created which enable an implementation of a protocol to be compared against the specified protocol.

2 SS No. 7 testing tools

The following SS No. 7 testing tools are described:

- Alcatel performance and load test system A8610;
- Alcatel protocol conformance test system A8650;
- British Telecom (BT) NTS M300;
- Hewlett Packard HP 18273A;
- Hewlett Packard HP 37900D;
- Idacom PT300 and PT500;
- Siemens ISDN Test Simulator (ITS);
- Siemens K1103;
- Siemens K1195 and K1197;
- Tekelec TE 767.

2.1 Alcatel A8610

The test system Alcatel 8610 is designed to support network operators, switching equipment manufacturers, R&D departments as well as laboratories for performance and load testing of CCITT, ETSI, ANSI and other international and national SS No. 7 protocols. The modularity of the Alcatel 8610 test system allows to equip the test unit with other interfaces such as:

- 2/4 - wire analogue subscriber interface (for complex call handling);
- CAS (all kinds of line - and register signalling);
- BRA;
- PRA;
- V 5.1;
- CCS (MTP, SCCP, TUP, ISUP, TCAP, INAP, MAP, BSSAP, BSSMAP, DTAP and national variants),

for PCM 30 and PCM 24 channel systems. Interworking between above mentioned interfaces in terms of B-channel test and other traffic simulators is possible.

The A8610 system architecture allows multi-link and multi-level testing especially for all kinds of GSM implementations. The system consists of a SPARC[1)] IPX workstation and an open number of test units (TU) interconnected via a local area network (thinwire Ethernet IEEE 802.3, 10 base 2). Internet enables the user to set up the desired connection between the controlling Workstation and the test units. The user interface is the OSF/Motif[1)]. It has achieved acceptance as the "de facto" industry-standard user environment. OSF/Motif[1)] is a graphical user interface offering user-oriented PC-style behaviour and screen appearance for applications running on any system which can support X11R5[1)].

The Alcatel 8610 has been developed especially with a view meeting the requirements of the advanced intelligent Network architecture in the area of both mobile communication and PSTNs. As far as hardware is concerned, a sub rack can be quipped with a certain number of different modules providing access to either 1.8 or 31 (24) signalling channels (HDLC controller) per link (2.048 Mbit/s or 1.544 Mbit/s). The flexibility of the architecture is not only characterised by the possibility to freely configure a sub rack with the modules mentioned above according to specific user's requirements, but also by the Multibus II, which secures the communication between the different modules mentioned above.

This new test system allows all existing user and application part protocols to be implemented. The scenarios (test suites) are developed by Alcatel STR considering customer specifications concerning test requirements, exchange protocols and other aspects. The scenario editor, being part of the basic application software, allows the user to modify a test scenario up to the last bit. Because of the open structure of this software, most complex or proprietary tests can be developed and executed by the user himself.

Detailed statistics during simulation on the equipped interfaces including unexpected messages, wrong message sequencing, etc. are logged and time stamped. The monitor function screens the Level 3 and Level 4 condition on line. The output of the collected result files for post processing is also possible (graphic and text).

Examples of load test performance of the Alcatel 8610 on one 2.048 Mbit/s interface with one signalling channel and 30 speech channels:

ISUP:	70 000 call attempts/h	(40% load of the signalling channel)
GSM:	Location update	16 000 per interface, per hour
	MOC and MTC	11 000 per interface, per hour

One Alcatel 8610 can for example be equipped with four (4) of the above interfaces which leads to a possible total amount of ISUP call attempts of 280 000/h distributed on four (4) signalling channels per test unit.

2.2 Alcatel A8650

On the basis of Recommendation X.290 (ISO 9646) Alcatel STR designed the protocol conformance test system Alcatel 8650. The aim of the development was to provide a concevient aid firstly for the rational specification and management of Test Cases (TCs) in a defined notation and secondly to automatically run series of TCs (e.g. a Test Suite). This yields the following main functions:

- TC specification by interactive dialogue with the user (TTCN Editor);
- Syntax and semantic check of a Test Suite (TS);
- Conversion of the TCs specified within the Test System or externally;
- Editing of implementation specific data or parameters (PICS/PIXIT);
- Selection of TCs to be executed;
- Automatic execution of TCs by controlled simulators at the appropriate interfaces of the test object (multi link control);
- Generation and of test reports including test results and trace files;
- Management and "maintenance" of TCs.

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1) SPARC, OSF/Motif, X11R5 are registered trade marks.

2.2.1 Applications

As first application A8650 was implemented to for testing GSM infrastructure (BSS, SSS and overall). In this typical application it features multi link control of different interface types (e.g. C/D and A interface). As CCITT standardized interfaces are used in GSM the TS can be applied for other infrastructure testing too.

The following executable TS are available:

- CCITT Q.711-Q.716 SCCP *(Blue Book)*;
- CCITT Q.761-Q.764 ISUP *(Blue Book)*;
- CCITT Q.767 ISUP;
- CCITT Q.771-Q.775 TCAP *(Blue Book)*;
- GSM: MAP, LapDm, RR and SMS.

2.3 British Telecom (BT) NTS M300

The British Telecommunication plc Network Testing System M300 has been developed specifically for conformance and performance testing of CCITT SS No. 7 implementations.

The system architecture of the M300 facilitates its use for multi-link and multi-level testing of SS No. 7 implementations in a unified environment. It can operate in either emulation mode for development, acceptance and regression testing or in monitor mode for surveillance. In both modes, the M300 can be under either local or remote control.

A Personal Computer (PC) provides the man-machine interface to the M300. The M300 is implemented as a PC or a rack based system, supporting up to two or 16 links, respectively. There are a number of simulate and monitor interface options. The PC and the M300 are inter-connected by means of a Local Area Network.

The proprietary testing language allows testing of the SS No. 7 message based protocol. This includes the ability to:

- SEND and WAIT for named messages;
- manipulate field contents;
- check that fields in incoming messages have expected values.

The language is particularly suited to expressing Message Sequence Chart message inter-changes. As an option, a means of entering and executing test scenarios expressed in Tree and Tabular Combined Notation (TTCN) form is available. At certain levels, automatic functionality is provided where necessary to allow the testing of the higher levels in the protocol stack once a lower level has been satisfactorily tested. A thorough means of exercising Level 3 is provided by means of background test traffic message generators and receivers to allow automatic determination of:

- message loss;
- mis-sequencing or duplication under changeover and changeback conditions.

Test suites are presently available for the M300 to determine conformity to the following specifications:

- CCITT MTP and TUP (based on Q.781 to Q.783 test specifications);
- CCITT ISUP basic call and supplementary services (based on Q.784 and Q.785 test specifications).

The detail with which messages sent and received are displayed can be modified. This can be from mnemonic and routing display, optionally appended with a hex dump and/or field decode, to not being displayed at all. All messages are timestamped accurate to 1 ms. Output can be directed to the PC disk or printer as well as being displayed on the screen.

A tool is provided that enables users to define their own message set. A number of generic message sets are available for the testing of: MTP, TUP and ISUP. From these, national variants can readily be implemented, for example the British NUP.

2.4 Hewlett Packard HP 18273A

This is a portable, general purpose protocol analyser that supports ISDN, SS No. 7, X.25 and SNA protocols. It apparently supports monitoring only.

The HP 18273A is intended to be used by network providers for installation and maintenance testing. It has the following SS No. 7 capabilities:

- Level 2 (Q.703), Level 3 (Q.704) and Level 4 message fields are decoded into mnemonics.
- Decodes the ISUP, SCCP, TUP and DUP messages and parameters. Additional user parts can be defined as well.
- The hex codes and mnemonics for user parts and message types can be user-defined.
- Selected fields following the message type field, such as called and calling numbers, are decoded.
- Customized data displays in one or two columns can be created and saved to address user specific needs.
- Filtering of LSSUs and FISUs is provided so that data capture buffer efficiency can be maximized.
- SS No. 7 data can be analysed utilizing all available physical interfaces for the HP 4952A.

2.5 Hewlett Packard HP 37900D

The HP 37900D Signalling Test Set is designed for use in the maintenance of SS No. 7 links, but provides an emulation software option which enables the tester to be also used in design verification or installation. The HP 37900D can monitor four bi-directional SS No. 7 links or emulate eight links. It also supports ISDN (Q.921/Q.931) for cross-switch testing. The tester can be "personalized" so that it is tailored for customer test requirements.

2.5.1 Monitoring capabilities

Monitoring capabilities consist of real-time analysis while logging and post-logging analysis. All data or selected data can be logged from all links. "Logging conditions" for controlling data capture include real-time message-based start and stop triggers and filters. Additionally, all SS No. 7 messages associated with a specified (or partially specified) telephone number can be collected. Real-time analysis while logging consists of link quality measures, link activity indicators and customized decodes (up to eight split screens, statistics or histogram displays). Messages in the logged data can be quickly found using search facilities or can be viewed selectively by instructing the tester to display or suppress messages. Level 2 and all higher level messages may be decoded to text descriptions of the specification document. Alternative decodes can be utilized during decoding. Statistical data for the logged data is available for Level 2 and Level 3 characteristics.

Numerous SS No. 7 user parts (MTP, ISUP, TUP, SCCP, TCAP, GSM, NMT MUP and HUP etc.) and national variants are supported as standard (Bellcore, ANSI, 1TR7, BTNR166, Finland, etc.)

2.5.2 Emulation capabilities

The HP 37900D can, optionally, emulate a maximum of eight links simultaneously. Level 2, Level 3 or above tests are possible. Automatic Level 2 is also available. In test sequences, messages are sent and received on any or all of the links being emulated. Messages are created in several ways and are stored separately from the test sequences. Messages can be built using the menu driven emulation software or can be extracted from the monitor capture buffer. Once created, messages are held in catalogues and can be stored on disk for future emulations. Octets within messages, being used for comparison against received messages, can be masked. The OPC/DPC of received messages can be swapped, parts of received messages can be extracted and held as variables then restored as part of an outgoing message. All activity on the links including unexpected messages, during emulation are stored in the test log and timestamped. Tests can be run manually or automatically.

2.5.3 Remote Control

The HP 37900D can be controlled remotely over an RS-232C communication link by any terminal which supports the HP mode escape sequences and control codes, or any device that can run an HP terminal emulator or any NSI compatible terminal. It provides two-way communication between the local terminal and the remote test set.

2.6 Idacom PT300/500

The Idacom PT300 is a low end multi-port, multi-protocol tester. The PT 500 is a high end multi-port, multi-protocol tester. Both testers support access interfaces for PRA (T1 and E1), WAN, DS0 and BRA.

2.6.1 Test Package

a) SS No. 7 Monitor package.

b) SS No. 7 Emulation package which includes:

- complete MTP Level 2;
- partial MTP Level 3;
- partial SCCP (Class 0 and 1);
- TCAP Simulation;
- ISUP Simulation;
- TUP Simulation.

All emulations can be either manual or automatic.

c) Decode and Encode for:

- CCITT *Blue Book*, all functional parts;
- ANSI (1988, 1991) all functional parts;
- Telecom Canada (1988) all functional parts including enhanced 1-800 services, BNS and ACCS;
- Bellcore (1987 – present) all functional parts including 1-800 services, CLASS features, LIDB and Billing Validation;
- 1TR7 (1987) all functional parts;
- Hong Kong Telecom (1988) all functional parts;
- Singapore Telecom (1991) all functional parts.

d) Independent sets of filters for display, RAM capture, data recording and test manager. Filters are set up via menus and specified using mnemonics of the message type, parameter name, parameter contents and routing labels.

e) Four triggers with build-in or user definable actions. Triggers are setup in the same way as filters.

f) Data capture to RAM or disk.

g) Live and post analysis.

h) Traffic generation capability.

i) Report generation.

2.6.2 Conformance Test System

a) The SS No. 7 Conformance Test System is implemented according to ISO-9646 standard.

b) Each executable test suite has its own PICS and PIXIT setup. Entries in the PICS and PIXIT setup are user configurable.

c) Executable test suites include:

- CCITT Q.781 MTP Level 2 *(Blue Book)*;
- CCITT Q.782 MTP Level 3 *(Blue Book)*;
- Bellcore MTP (TR-TAP-001004);
- NOF (Network Operators Forum) MTP Network Compatibility tests (1990).

d) Executable test suites planned for development include:

- CCITT Q.784 ISUP (1992);
- CCITT Q.785 ISUP Supplementary Services (1992);
- Bellcore ISUP (TR-TAP-001004);
- Bellcore SCCP;
- NOF ISUP;
- NOF SCCP.

2.7 Siemens ISDN Test Simulator

The ISDN Test Simulator (ITS) is a test tool suitable for function and load testing and network simulation for SS No. 7 and other protocols. It consists of a Personal Computer (PC) controlling up to 16 Communication Groups (CGs).

Each CG can support up to eight signalling links, therefore one ITS can control up to 128 signalling links. A CG can also support ISDN Basic Accesses, ISDN Primary Rate Accesses or Analogue Subscriber interfaces. One CG can support up to four MTPs (Level 3s) and 32 Users. MTPs and Users are implemented using test scenarios. Test scenarios operate in a CG independently of the PC.

On the PC is displayed the current traffic rate (in BHCA), the failure rate and other test information. Output of data files for post processing is also possible.

2.7.1 ISDN Traffic Simulator for Message Transfer Part (MTP)

The ITS:CCS7 operates as a partner of the System Under Test (SUT), by simulating one or more SPs. During operation, a monitor function can display and record selectively all traffic between the Level 2 and Level 3 interface in the ITS. This output appears partially decoded in symbolic form or as a hexadecimal dump.

The ITS:CCS7 is suitable for Level 3 and Level 4 tests. The Level 2 cannot be modified. Level 3 and Level 4 tests are carried out using test scenarios written in the high-level language C. The operator has complete freedom in the development of any test scenario. The following scenarios are already available:

- Signalling Link Management (processes Level 2 primitives).
- Testing and Maintenance (processes Link Test messages).
- Signalling Network Management (processes Signalling Network Management messages).
- Signalling Message Handler (distributes messages/primitives from Level 2 to the other scenarios).
- Source/Sink (sends and receives MSUs).
- Reflector (swaps DPC and OPC in received MSUs and sends them in a transmitted MSU).
- Deflector (extended reflector which calculates the DPC from the OPC using a formula).

2.7.2 ISDN Traffic Simulator for User Part (ISUP)

The ITS:CCS7 generates a traffic load of up to 140 000 BHCA per CG or up to 2 240 000 BHCA total for a fully equipped ITS. Currently available scenarios (for sending and receiving sides) include:

- ISUP CCITT *Blue Book* Q.761-Q.764;
- ISUP FTZ 1TR7;
- TF FTZ 1TR7.

2.8 Siemens K1103

The K1103 Service Tester can monitor up to four SS No. 7 links simultaneously. It has the following features:

- measure load sharing over SPs/STPs or parallel links between SPs/STPs;
- count call attempts;
- pursue particular calls;
- based on IBM-AT compatible portable PC;
- fully menu operated, particularly suited to field and service applications.

It supports the same protocols as the K1197.

2.9 Siemens K1195

The K1195 Protocol Tester is a general protocol tester supporting many interfaces and protocols. In its SS No. 7 testing mode it is designed to perform the following tasks:

- monitor one SS No. 7 link;
- simulate one signalling source (SP/STP);
- emulate one signalling source (SP/STP).

It supports the same protocols as the K1197.

2.10 Siemens K1197

The K1197 Protocol Tester is a general protocol tester supporting many interfaces and protocols. In its SS No. 7 testing mode it is designed to perform the following tasks:

- monitor up to two SS No. 7 links simultaneously;
- simulate up to four signalling sources (SP/STP serving one SS No. 7 link each) simultaneously;
- emulate up to four signalling sources simultaneously;
- perform conformance testing according to Recommendations Q.780-Q.783 ;
- create statistics in the form of tables and bar graphs.

The protocol supported include:

- MTP 1984 *Red Book* and 1988 *Blue Book* Q.701 - Q.704;
- TUP 1984 *Red Book* and 1988 *Blue Book* Q.723;
- TUP+ CEPT T/SPS-43-02, FTZ 1TR8, Part 3, 12/87;
- ISUP 1988 *Blue Book* Q.763, FTZ 1TR7, Part 5, 4/87;
- SCCP 1988 *Blue Book* Q.713;
- TF FTZ 1TR7, Part 3, 4/87;
- TCAP 1988 *Blue Book* Q.771 - Q.774, ETSI, ETS, 300-134;
- Many national variants e.g. of MTP;
- GSM: MTP, MRP, DTAP, BSS-AP, A *bis*.

2.11 Tekelec TE767

The TE767 is a portable protocol analyser for testing SS No. 7 networks. It meets the needs of operating companies for installation and maintenance. It provides two link interfaces for monitoring a signalling link set.

Functions:

- simple language for the sophisticated triggering on both signalling links when on-line or off-line;
- adjustable monitoring of the physical layer, MTP, TUP, ISUP etc. using clear mnemonics;
- filtering according to a User Part, a CPD, a type of message, a called number, a communication etc.;
- statistics for on-line and off-line displayed in the form of tables and bar graphs for:
  a) traffic distribution;
  b) signalling link set load;
  c) user-defined events distribution;
  d) signal unit length distribution.

Flexibility:

Easy to update data bases describe the messages and codes for national protocols. The existing data bases include:

- MTP *Blue Book*
- TUP *Red Book*
- TUP+
- DSS1 *Blue Book*
- X.25 *Blue Book*
- etc.
- Finnish MUP and HUP
- German 1TR7
- UK NUP
- UK DASS/DPNSS
- French SSUTR2

Facilities:

- field trial oriented – portable and easy to use;
- integrated or remote printer;
- digital (2 Mbit/s) or analogue (V24, V35) interfaces.

Typical applications:

- trouble shooting diagnostics;
- Q.791 and Q.795 tests for MTP and TUP;
- load sharing measures;
- efficiency of calls;
- transit delay measurements;
- etc.

3 SS No. 7 Planning Tools

The following Planning Tools are described:

- Bellcore Integrated Network Planning System (INPLANS);
- Deutsche Bundespost TELEKOM SS No. 7 Planning Tools;
- Telecom Australia CCS Operations and Planning Support System (COPSS);
- Telecom Australia CCS7 Data Management System.

3.1 Bellcore Integrated Network Planning System (INPLANS)

The Integrated Network Planning System (INPLANS) is being implemented to support Regional Bell Operating Company (RBOC) network planning and traffic engineering across different networking technologies. It is an integrated system which allows for the planning of many network functions in addition to the SS No. 7 network components of networks.

Some of its functions are:

- Integrated Network Monitoring (INM) which supports planning and engineering studies that monitor the ability of in-service and planned networks to meet service and utilization objectives. The purpose is to identify situations where corrective planning action is necessary and to give early warning of problem situations to allow corrective plans to be formulated before service problems result.
- Integrated Network Servicing (INS) which provides an integrated and interactive environment supporting planned servicing, demand servicing and customer driven servicing. It uses the INM to make necessary adjustments (e.g. adding signalling links) to absorb sudden changes in demand before service is affected.
- Integrated Capacity Extension (ICE) which provides a one to five year view of the network demands and requirements. It computes network element growth rates, generates future network demands, times and dimensions the installation of equipment and generates a one to five year servicing plan.
- Integrated Technology Planning (ITP) which provides cost effective backbone and network access design plans. These plans identify the placement and interconnection of network nodes as well as optimal homing arrangement plans for new customers. The ITP uses cash flow analysis to economically evaluate the alternative plans.

SS No. 7 Network Planning and traffic engineering is supported in Release 2 of INPLANS. It can:

- analyse performance aspects of planned SS No. 7 networks for comparison with objectives;
- dimension an SS No. 7 network for particular traffic types;
- dimension an SS No. 7 network;
- check an SS No. 7 network structure.

3.2 Deutsche Bundespost TELEKOM SS No. 7 Planning Tools

The Deutsche Bundespost TELEKOM has developed two SS No. 7 planning tools. One tool supports the creation of routing tables for each SS No. 7 Level 3 in the SS No. 7 network and the other is used to validate the routing in the whole national SS No. 7 network.

The planning tools make some assumptions about the SS No. 7 network which include:

- the local and trunk signalling is carried by the same SS No. 7 network;
- each trunk exchange acts as a combined SP/STP;
- each route set consists of up to four routes (one plus three back ups);
- hierarchical routing is used (prevents circular routing);
- circuit related signalling traffic uses associated signalling preferably;
- non-circuit related end-to-end ISUP traffic uses SCCP Class 2.

3.2.1 Creation and updating of Level 3 routing tables

The national SS No. 7 network is planned by 14 network planning regions. The work of the network planners is supported by a centralized data base. The data base includes all data about the national SS No. 7 network for the next four years and the national numbering plan for the signalling points. It also includes a tool (based on an IBM-PC) for the creation and updating of the Level 3 routing tables. These are created in an interactive manner by each planning region. The planners enter the primary and alternative routes. The tool performs a check against the given routing rules and informs the user of possible alternative but not yet chosen routes.

This tool is also used for updating the national SS No. 7 numbering plan thus taking care of the implementation of additional signalling points.

3.2.2 Validation of routing tables

Validation of routing tables is performed by means of another tool in a centralized manner. Before the created or updated routing tables are implemented they are all loaded into this tool. Then an evaluation of the routing tables concerning circular routing loops takes place.

This tool also creates routing table graphs for given signalling relations.

3.2.3 Further tools

The installed routing tables of the SPs are compared with the routing tables of the planned signalling networks. For this, the routing table of an SP is transferred by floppy disk to a central computer whenever the routing table is changed.

A tool which automatically creates the Level 3 routing tables is being developed but is not yet used. This tool will need the signalling points of the actual SS No. 7 network and the desired signalling relations. On the basis of the network structure, the given routing rules and the maximum number of signalling routes per route set, the tool will create circular routing free routing tables.

Another tool is being developed for simulating the signalling traffic distribution in the national SS No. 7 network.

3.3 Telecom Australia CCS Operations and Planning Support System (COPSS)

The COPSS is a PC-based computer system which assists in the planning, design and operation of an SS No. 7 network. It is menu driven, is easy to use and is generally applicable to any SS No. 7 network topology. In brief, it provides the following features:

- allows a model of the network to be loaded (e.g. transmission network topology);
- optimises the topology of the network with free or paired allocation of SPs to STPs (criteria priorities are setable);
- calculates the load on network elements;
- generates routing tables for network nodes;
- checks routing tables for circular routing and other faults;
- allows automatic or manual failure tests;
- calculates the availability, MTTF, MTTR of all signalling relationships;
- allows all data to be loaded from, or unloaded to, unformatted text files;
- provides a comprehensive range of reports.

3.4 Telecom Australia CCS7 Data Management System

The CCS7 Data Management System is an IBM PC-based software package which is used to manage the actual SS No. 7 routing tables in the exchanges. It provides the following features:

- ability to read from and write to actual exchange SS No. 7 routing tables (in Ericsson AXE 10 exchanges – easily modifiable for other exchanges);
- ability to compare actual and planned SS No. 7 network routing parameters;
- provides a data base of the whole SS No. 7 network routing data;
- provides a pictorial representation of routing possibilities for any signalling relationships;
- detects and automatically corrects circular routing.

4 Contacts

Alcatel

Alcatel STR AG
Friesenbergstr. 75
8055 Zürich
Switzerland
Fax: +41 1 465 2030

Bellcore

Mr. J.L. WANG
Bell Communications research
Integrated Planning Systems Division
3 Corporate Place
PISCATAWAY, New Jersey 08854
United States
Tel: +1 908 699 3780
Fax: +1 908 463 8684

British Telecom

Mr. M. ALLEN
British Telecom
Room 619
Caroone House
14 Farrington Street
LONDON EC4A 4DX
United Kingdom
Tel: +44 71 492 2311
Fax: +44 71 492 4025

Deutsche Bundespost TELEKOM

Mr. W. KLEIN
Research Institute of Deutsche Bundespost
Telecommunications Engineering Centre
Section F 24
P.O. Box 10 00 03
D-6100 DARMSTADT
Germany

Hewlett Packard

For HP 18273A and HP 37900D

Mr. W. SELLING
Marketing Datacom
Hewlett Packard GmbH
Hewlett Packard Strasse
D-6380 BAD HOMBURG
Germany

or

Mr. R. URQUHART
Product Manager Signalling
Hewlett Packard Ltd.
SOUTH QUEENSFERRY
West Lothian
Scotland EH30 9TG

Idacom

IDACOM Canada
4211 95 Street
EDMONTON
Alberta
Canada
Fax: +1 403 462 4869
(IDACOM is now a subsidiary of Hewlett Packard who act as agents as well.)

Siemens

(For K1103, K1195 and K1197)
Siemens AG
Messgeratewerk Berlin (MWB)
Wernerwerkdamm 5-9
P.O. Box 140
D-1000 BERLIN 13
Germany
Fax: +49 30 386 4540

(For ISDN Traffic Simulator (ITS))

Siemens AG
Offentliche Kommunikationsnetze
Vertrieb Inland DEP: ON OV VI 63
P.O. Box 70 00 73,
D-8000 MUNICH 70
Germany
Fax: +49 89 722 21440

Tekelec

Mr. B. FAVIER
Tekelec Telecom
23 rue de la Baltique
F 91953 LES ULIS Cedex
France
Fax: +33 1 6446 4550

Telecom Australia

Telecom Australia (International) Ltd.
6/114 William St.
MELBOURNE 3000
Australia
Fax: +61 3 670 4856