INTERNATIONAL TELECOMMUNICATION UNION

CCITT E.434

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

SUBSCRIBER-TO-SUBSCRIBER MEASUREMENT OF PUBLIC SWITCHED TELEPHONE NETWORK

Recommendation E.434

Geneva, 1992

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT 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 Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation E.434 was prepared by Study Group II and was approved under the Resolution No. 2 procedure on the 16th of June 1992.

CCITT NOTES

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

2) A list of abbreviations used in this Recommendation can be found in Annex A.

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SUBSCRIBER-TO-SUBSCRIBER MEASUREMENT OF THE PUBLIC SWITCHED TELEPHONE NETWORK

1 Introduction

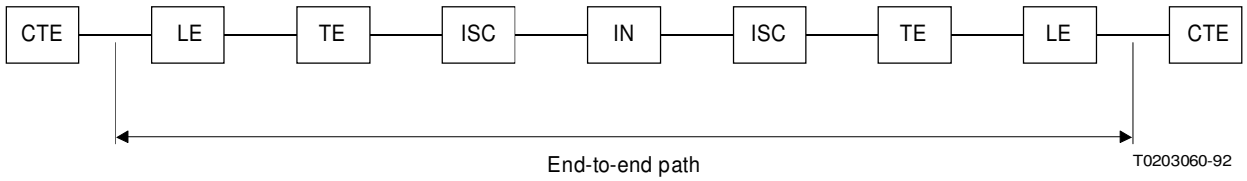
Subscriber-to-subscriber [1] service quality measurements are taken end-to-end as defined in Figure 1/E.434. These measurements are taken:

- to relate network quality to customer' expectations which are based upon previous experience with the network;
- to ensure that objective measures are made of the network;
- to ensure that acceptable thresholds of quality are being met;
- to ensure that regulatory requirements are met;
- to ensure that the distant correspondent's level of quality meets other network providers' needs.

To assess the network service quality requires the collection of the following:

- end-to-end network measurements results;
- customer perception of network quality.

Related publications in this area are Recommendations E.424, E.431, E.433, E.435 and M.1235 and the *Hand Book on Quality of Service and network performance: Annex E, E-series Reommendations which include numerical objectives to be published in 1992).*



LE Local exchange
TE Transit exchange
CTE Customer's terminating equipment
ISC International switching centre
IN International network

FIGURE 1/E.434

Reference diagram for end-to-end measurements

2 Scope

The aim of this Recommendation is to define end-to-end measurements of the public switched telephone network (PSTN), detailing:

- the methods and processes for testing;
- the measurements required;

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[1] Subscriber-to-subscriber type test calls are defined in Recommendation E.424.

– elements of an end-to-end system;

– the operation of an end-to-end system,

with recommendations to define interfaces and protocols.

3 Methodology

3.1 *End-to-end network measurements/results*

To obtain a duplication of the subscriber-to-subscriber connection, the measurement must replicate the total end-to-end connection. Test calls are required to be generated for the assessment of the network between subscriber terminals.

The results will be used to assess four areas of performance monitoring:

– connection setup/release;

– connection retainability;

– transmission quality after connection is established;

– billing integrity.

3.2 *Customer perception of network quality*

There are various methods to evaluate the customers perception of the network quality; market surveys (interviews), operator keyed trouble reports (OKTR), service observations and customer complaints.

This subjective data can be correlated with the subscriber-to-subscriber measurements. In this manner the objective measures can either support the customers' perception or require further investigation by the network provider when the customers' perception does not agree with the objective data.

4 A typical end-to-end test call system

An end-to-end test call system would typically consist of three elements:

– test call controler,

– test call transponder,

– test call responder.

This is shown in diagrammatic form in Figure 2/E.434.

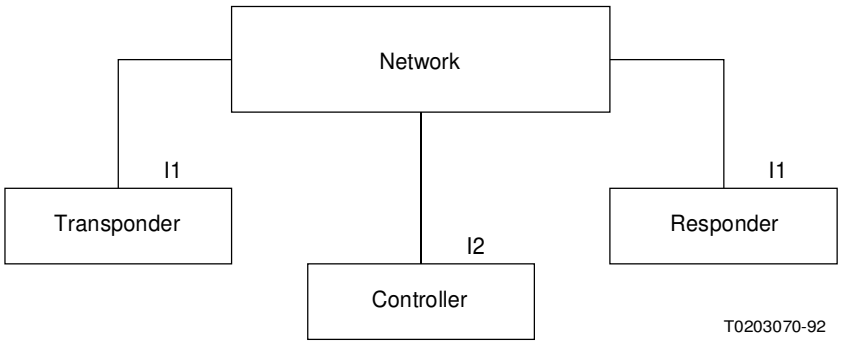

FIGURE 2/E.434

Typical test call system configuration

4.1 *Interfaces*

The sytem is composed of two interfaces, I1 and I2, see Figure 2/E.434. The I1 interface can be broken down into 3 parts:

- 2-wire connection to the network;
- end-to-end protocol for communication between transponder/responder;
- transmission measurement technique.

It is envisaged that the connection point for I1 can be at the test access point at the 2-wire main distribution frame (MDF) in an exchange/remote concentrator unit building or via a portable responder/transponder to a network terminating equipment (NTE) socket.

The 12 interface is the communication between the controller and transponder/responder. It is a 2-wire interface or a private wire link to the network.

4.2 *Test call controller*

A controller is assigned to a number of transponders/responders. The controller schedules the test calls, controls the transponders/responders, receives and stores test results.

Analysis of test results can be done at the controller or at a high order processor via a standard interface. The controller-to-responder ratio is dependent on the capacity of the controller.

4.3 *Test call transponder and responder*

The test call transponder initiates test calls to responders operating under instructions received from the system controller. Both transponders/responders make measurements and record the results of the test calls. These results are transferred to the transponder to be uploaded to the controller via the I2 interface. An option could exist to upload test call results from the responder directly to the controller. Transponder/responder functionality could be combined in a single type of equipment.

5 Planning and scheduling

5.1 *Goals*

When planning subscriber-to-subscriber test, it is necessary to decide the goals of the testing. These goals help determine the content and frequency of the test.

5.2 *Test plan*

A test plan is required to ensure that the test results provide valid information consistent with the goals of the testing. Statistical methods (estimations of distributions, sample size, confidence intervals, etc.) should be used to develop this test plan and to make inferences from the test results.

Other consideration for the test plan include traffic patterns which reflect customer usage, time of day and day of week calling.

5.3 *Duration of test period*

Test should be carried out within a period of time which is consistent with the goals of testing. In general, this will be to ensure network conditions are static during the period that the tests are being conducted.

5.4 *Number of test sites*

When determining the specific locations and numbers of test sites to be used in a given country, factor such as geographic diversity of subscriber and location of high usage centres should be considered.

It would be ideal to have the transponders/responders at each switching node. Test facilities are essential at the local switching unit to enable to test close to the subscriber. A measurement unit at each switching node would benefit any maintenance requirement and would provide the ability to test to any part of the network. However, this is dependent on unit costs and Administrations' requirements. Portable responders could be used to provide flexibility to measure all parts of the network.

For international testing, the number and location of tests sites should ensure that test calls will be routed via gateways to provide measurements of service quality on the international routes typically encountered by subscribers in the originating country.

5.5 *Scheduling of test programme*

This section addresses the test call programming and various aspects of scheduling tests. Two types of testing should be considered: routine testing and on-demand testing described below.

The recommendations in this section are primarily applicable to routine testing which has easily definable requirements because of its periodic nature. While many of the considerations described below apply to both routine and on-demand testing, it is difficult to provide guidelines for on-demand testing because the requirements vary depending on the circumstances motivating the tests.

5.5.1 *Routine testing*

Routine testing is conducted on a national and international basis at regularly defined intervals for the purpose of evaluating current service quality levels and identifying the trends in service quality as they evolve over time.

Network providers need to know the quantity of test traffic being generated, and coordination and agreement is required on quantity, accounting and stopping test traffic for special reasons, i.e. high demand. For international testing, the quantity of test traffic being generated needs to be controlled and coordinated bilaterally.

It is noted that reporting the quantity of failures, even if reoccuring, is essential for continuing the measurement in order to statistically represent the Quantity of Service of the network under test.

5.5.2 *On-demand testing*

On-demand testing may be conducted in response to special circumstances, changes to network conditions, or as a follow-up to previously completed routine testing. On-demand, testing may include testing to isolate or sectorize service quality problems, evaluation of the service quality levels on specific routes (for example, restoration facilities or a new international route), and testing from locations other than those that are usually used in routine testing.

5.5.3 *Number of test calls*

The number of test calls depend on the parameters to be measured and the desired accuracy for those parameters. The number of test calls should be large enough to provide statistically valid results within the desired accuracy for each parameter measured, and small enough to allow the data to be collected over a fairly short period of time.

Consideration should be given to trunk size and traffic volumes on the route when test call quantities are being determined.

5.6 *Availability of responders*

Another consideration in keeping the test period relatively short is to ensure the availability of the test devices. These responders must be dedicated for use during a particular test period to avoid scheduling conflicts for the use of the responders. Such conflicts may result in inaccurate and misleading test results: for example, test calls may have failed to complete because the terminating responder was in use for a different study rather than a genuine network failure. The availability of responders will be achieved through careful coordination and scheduling.

6 Control centre

It is recommended that each Administration have a nominated control centre responsible for managing the subscriber-to-subscriber test program. The responsibilities of this centre should include:

- planning and scheduling tests;
- coordinating tests between Administrations;
- maintaining test equipment;
- collecting and analysing test data;
- reporting of test results;
- referring follow-up actions as required by test results.

6.1 *Central timing of testing system*

National networks administrating the system should impose a centralised timing. This will ensure there is no clash between testing sub-systems.

6.2 *Coordination of all test calls*

All routine and on-demand testing involving another Administration needs to be coordinated. A single point of contact is required in each Administration. This contact will coordinate and agree testing programmes.

The control of testing will be tiered. One point of contact will have overall responsibility centrally and will assign responsibility to other individuals within pre defined catchment areas.

7 Results

Results should report all the key performance indicators and associated measurement methods. This includes the thresholds set, statistical spread and other factors affecting the results: for example, sample size, time of day and testing locations. All reports have to be completed on timely basis.

Test results/analysed data should be made available to managers' network investigation centre and maintenance. Previous results/analysed data may be stored on an off-line mass storage medium for later retrieval if required.

Results should be available in a standard ASCII format.

8 Service quality agreement

It is recommended that there be a formal service quality agreement (SQA), agreed and supported at senior management levels, to ensure that a commitment is made at the working level. Such agreements are produced and agreed between Administrations. This will ensure that:

a) results are exchanged regularly, including:
   - summary of all results (key performance indicators) for the duration of the testing period,
   - a detailed breakdown of the used for the summary;

b) measurement methods are compatible;

c) targets and thresholds are set for transmission performance;

d) commitment is made by the Administration to target service improvements:

- recommendation of the opportunities for improvement, and
- location(s) of faults

The placement of units within the domain of other Administrations is dependent on the cooperation of the offering Administration. If equipment is exchanged, an agreement would address installation, maintenance and the portability of units within the network.

Another agreement may be required for the accounting of test calls. In lieu of the benefits of the quality improvements, the cost could be shared by the Administrations.

It is recommended that a quarterly review on performance between Administrations be a suitable period to support the SQA.

It is recommended that similar service agreements be made between the relevant national and international network providers.

9 Setting failure/objective thresholds

Threshold values are objective levels of performance and can be set to categorise failure conditions. They could be defined as part of the test plan, of used as a means of analysing the data. These thresholds must be reviewed periodically to ensure that they are consistent with customers perception of network quality.

All threshold values to be used in the analysis and compilation of test results should normally be set in the controller. Optionally, threshold values could be set in the transponder/responder or in the post processing facility. In the central analysis and compilation of test results from all generators, threshold values are very useful to sort out traffic relations with poor quality.

10 Data storage of system

The transponder/responder must have the capability to store sufficient data of a test sequence. The controller should have the capacity to store multiple test sequences and test results from many transponder/responders. The controller should also have the capability to transfer data to a mass storage medium.

11 Action to improve Quality of Service

11.1 *Statistical analysis*

Statistical analysis is required to resolve higher issues. An analysis of key performance indicators will be required. The analysis will provide the basis to identify areas to improve the Quality of Service.

11.2 *Timetable for the level of network improvement*

Following the statistical analysis, any area identified for improvement should be dealt with immediately and, where appropriate, follow-on testing should be used to ensure problems are being resolved. This schedule of events is dependent on the Administration and network under test (national or international).

11.3 *Segmented testing*

Following the analysis which identifies areas of poor performance, additional testing that allows segmentation of the network may be appropriate to isolate the source of the network problems.

12 Security of system

It is desirable to maintain an appropriate level of security for the end-to-end test call system in order to:

– control access to, and operation of, the controller and testing network;

– prevent misuse of transponders/responders;

– prevent subscriber numbers being called.

The security measures may include password access, screening of numbers, encryption of data, etc.

13. Transponder/responder communication

There is an urgent need for an agreed end-to-end communications protocol between transponder/responders to allow compatibility of test systems from different manufacturers and different Administrations. This requires further study/definition.

The protocol should be capable of conveying the following types of information:

– capabilities/identification;

– types of measurements and sequence;

– measurement method;

– exchange of results;

– release/clearing sequence;

– maintenance functions (eg. self test);

– synchronisation.

14 End-to-end quality measurements

The recommended parameters essential to objectively measure the Quality of Service as perceived by customers, are categorized into two areas:

– call connectivity,

– transmission quality.

It should be noted that the parameters measured should be consistent will the goals of the test plan and that it may not be appropriate to measure all of the parameters described in this section for every test.

14.1 *Call connectivity*

The essential parameters required to assess the connectivity quality are:

– start dial signal delay (SDSD);

– call disposition;

– post dialling delay (PDD);

– call completion rate.

Call failure will be categorized as due to technical network faults, equipment failure and network congestion.

14.2 *Transmission quality*

The essential parameters to assess the transmission (call clarity) quality are:

– loss;
– attenuation distorsion;
– total distortion;
– group delay distorsion;
– idle channel noise;
– impulsive noise;
– round-trip delay;
– echo;
– clipping.

For compatibility between manufacturers' and Administrations' systems, it is essential to have a common measurement methodology. This requires further study/definition. This will ensure measured results are comparable between Administrations exchanging results and for comparing networks.

It should be noted that, unless there is detailed agreement on measurement methodologies, comparison of numeric data can be misleading.

15 Billing integrity

Checking the billing integrity could be seen as a supplementary feature to the normal test call function. Quality of Service test call systems may be suitable for introducing test calls of known duration, charge band rate and origination time. This data can then be correlated with charge band rates and the customers bill to assess billing integrity. Questions related to billing integrity are contained in Recommendation E.433.

ANNEX A

(to Recommendation E.434)

Alphabetical list of abbreviations used in this Recommendation

CTE Customer's terminating equipment

IN International network

ISC International switching centre

LE Local exchange

MDF Main distribution frame

NTE Network terminating equipment

OKTR Operator keyed trouble report

PDD Post dialling delay

PSTN Public switched telephone network

SDSD Start dial signal delay

SQA Service quality agreement

TE Transit exchange