INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

E.846

(03/93)

TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

ACCESSIBILITY FOR 64 kbit/s CIRCUIT SWITCHED INTERNATIONAL END-TO-END ISDN CONNECTION TYPES

ITU-T Recommendation E.846

(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 E.846 was revised by the ITU-T Study Group II (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.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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ACCESSIBILITY FOR 64 kbit/s CIRCUIT SWITCHED INTERNATIONAL END-TO-END ISDN CONNECTION TYPES

(Helsinki, 1993)

1 Introduction

Accessibility performance of networks varies very much in time. One reason is changing traffic load. A second reason is changing traffic handling capacity of networks, e.g. because of equipment faults, preventive maintenance, etc. The importance of the second factor is increasing as networks are becoming more complex.

As the quality of ISDN services depends on the end-to-end accessibility performance, an objective for accessibility performance should reflect the aspects which are important for users and should not depend on assumptions on network internal conditions. This objective has to cover fully operational as well as faulty network states.

Recommendation E.721 contains an objective for end-to-end blocking for circuit switched services in the evolving ISDN. This Recommendation is based on the assumption that the network and its components are fully operational and makes assumptions on the traffic load. It is therefore not sufficient for reliability engineering of networks nor is it sufficient to derive quality of service values.

Recommendation E.845 contains an end-to-end objective for accessibility performance of the international telephone service including effects of equipment faults and traffic congestion. However, this Recommendation defines "Connection Accessibility" as a long-term average access probability. This is not satisfactory, even when concentrating on busy hours only. For example, no access during 5% and full access during 95% of the busy hours will be perceived differently by users than a constant access probability of 95% during the same time period. But in both cases the long-term average access probability is the same.

When a connection attempt is blocked a user will retry if the connection is important for him. So, for users, both the probability to get through with the first attempt, and if this one is unsuccessful, the probability to get through with repeated attempts are important. For the first attempt the long term average success probability for connection attempts is an adequate measure. However, this quantity gives no indication about the probability to get through with repeated attempts in case the first one is unsuccessful. Therefore, the proportion of a short time interval which allows a successful connection is used in this Recommendation for specifying an acceptable network performance for repeated attempts.

2 Scope

This is a Recommendation on network performance. It covers the connection access phase for all network conditions from normal operation over degraded operation to unavailable states[1)]. It provides measures and objectives for accessibility performance of international circuit switched 64 kbit/s ISDN connection types (see Table 2/I.340: Al, A4, A7) between T-reference points. It covers effects of traffic load, failures, operational actions (planned and unplanned), etc. It does not cover blocking because of lack of channels at T-reference points nor catastrophic situations, e.g. earth quakes, floods, etc. It only covers connections which are all the way within ISDNs.

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1) Poor transmission quality of established connections is not considered, even at the beginning of the information transfer phase.

3 Purpose

This Recommendation sets end-to-end accessibility performance objectives for combined traffic and reliability design of ISDN networks and for defining operations strategies for such networks. Examples of application of this Recommendation are comparison of different network concepts including reliability aspects, dimensioning of networks for fault-free and faulty states, calculation of required availability of network components, evaluation of quality of service.

4 Definitions

In this Recommendation "**accessibility performance**" is defined as the ability of a network to provide a connection to the correct destination within specified delays when a correct request is received from the user side of the T-reference-point.

The term "accessibility" stands here for measures for accessibility performance (for "measure" see 3011 in Supplement No. 6 to Series-E Recommendations). The explicit definition of the measure is given in clause 5.

5 Short-Term-Accessibility

From a location in a network to a specific destination sometimes connection set-up is possible and sometimes not because somewhere in the network no resource is free (e.g. because of high traffic load, faults, etc.). If an interval of length T_a is taken, the proportion of the interval in which an additional connection is possible (within the specified delays) is a random variable (see Figure l). This random variable will be called "Short-Term-Accessibility" (STA). The distribution function of this random variable is the measure for accessibility performance defined here for repeated attempts. This measure reflects the proportion of time during which the STA is equal to or less than a given value.

For illustration, Appendix I shows examples of simulated STA distribution functions.

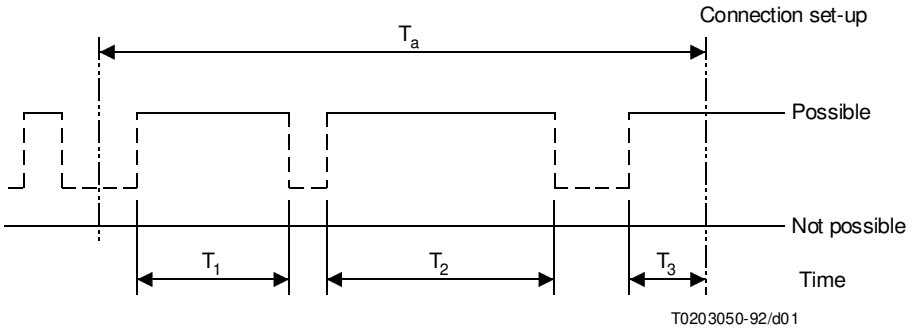

FIGURE 1/E.846

Example for illustrating the definition of the random variable STA

6 Objective for accessibility performance

To reflect successive trials of users when encountering blocked connection attempts, the following value for T_a is specified:

$$T_a = 5 \text{ minutes}$$

The criteria for defining successful connection attempts are given in Annex A.

The objective for accessibility performance is specified by means of a Long term average probability of successful connection attempts and a mask for the distribution function of the Short-Term-Accessibility as shown in Figure 2.

In order to comply with this Recommendation, two conditions have to be met for all time consistent one-hour intervals (one-hour period starting at the same time each day):

1) The average access probability has to be greater than or equal to

$$P_a = 0.94$$

NOTE – To allow, in addition to blocking in normal busy hours, some contribution from exceptionally high load and degraded network states, this value is 1% lower than the corresponding value in Recommendation E.721.

2) Any actual distribution function of the Short Term Accessibility has to be below the mask given in Figure 2.

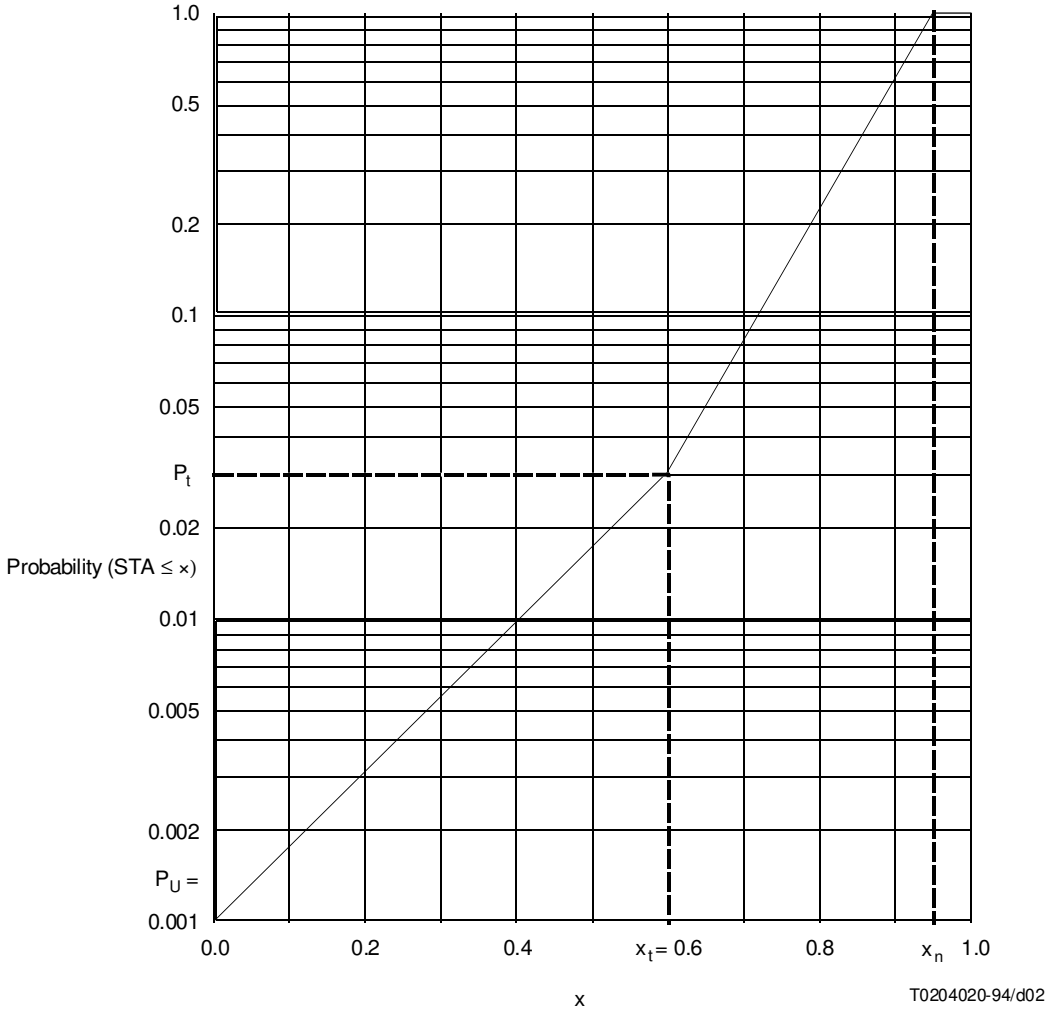

FIGURE 2/E.846

Mask for the distribution function of the Short-Term-Accessibility (STA)

Blocking at the T-reference point because of lack of B-channels is not included in the objective.

The practical meaning of the mask is as follows. Assume that a large sample of non-overlapping intervals of duration T_a is taken. The proportion of those intervals having an average probability for successful connection attempts smaller than the value given on the x-axis, has to be less than the corresponding value on the mask.

The mask in Figure 2 is defined by the following parameter values:

$$P_u = 0.001 \qquad P_t = 0.03$$

$$X_n = 0.95 \qquad X_t = 0.6$$

The mask reflects the idea that network states with lower STA have to be less probable than states with higher STA. P_u can be interpreted as the maximum acceptable unavailability of the traffic relation.

The objective in this Recommendation is a minimum requirement. It is up to the concerned network operators to provide a better network performance.

Annex A

Success criterium for connection attempts

(This annex forms an integral part of this Recommendation)

The following table sets the maximum delays between reference events for the characterization of a successful connection attempt.

TABLE A.1/E.846

Characterization of successful connection attempts

Call phase	Parameter	Reference Events Codes [a] Start	Stop	Success citerium
Before dialling	Activation time of layer 1 (for basic access)	not yet defined		Activation time of layer 1 < x [b]
	Establishment delay	Q5	Q9a	Delay between SABME and UA < y [b]
After dialling	Connection setup delay (according to the definition of Rec. I.352)	$P1_a$ (*en-bloc*) P3 (*overlap*)	$P6_b$ $P6_b$	Connection setup delay a) Without Intelligent Network data base inquiry: < 10 seconds b) With Intelligent Network data base inquiry: < 12 seconds

[a] The reference events codes are defined in Recommendation I.353.

[b] The values of x and y are for further study.

NOTES

1 This table does not take into account all the possible situations where the success criterium is not satisfied. For instance, neither misrouting nor double connections are covered.

2 The measurement is supposed to be performed at a single measurement point MPT1.

Appendix I

Examples of STA distribution functions

(This appendix does not form an integral part of this Recommendation)

To illustrate the Short-Term-Accessibility (STA) concept, this appendix contains simulated STA distribution functions for a fully operational international traffic relation.

Distribution functions of the STA of three trunk groups in series have been generated by simulation for T_a = 5 minutes for different trunk group size. These trunk groups represent an international and two national trunk groups of an international relation.

The traffic offered to the trunk groups was poissonian with negative exponential holding time with a mean value of 3 minutes. The traffic streams on the three trunk groups were independent of each other. All blocked connection attempts were repeated with a probability of 0.75 and a mean delay of 66 seconds (a constant delay of 13 seconds plus a negative exponentially distributed interval). The offered traffic load was chosen for a blocking probability of 1.66 % on each trunk group without repeated attempts.

The STA was evaluated in consecutive 5 minute intervals. The simulated time was 360 hours in each case (see Figure I.1).

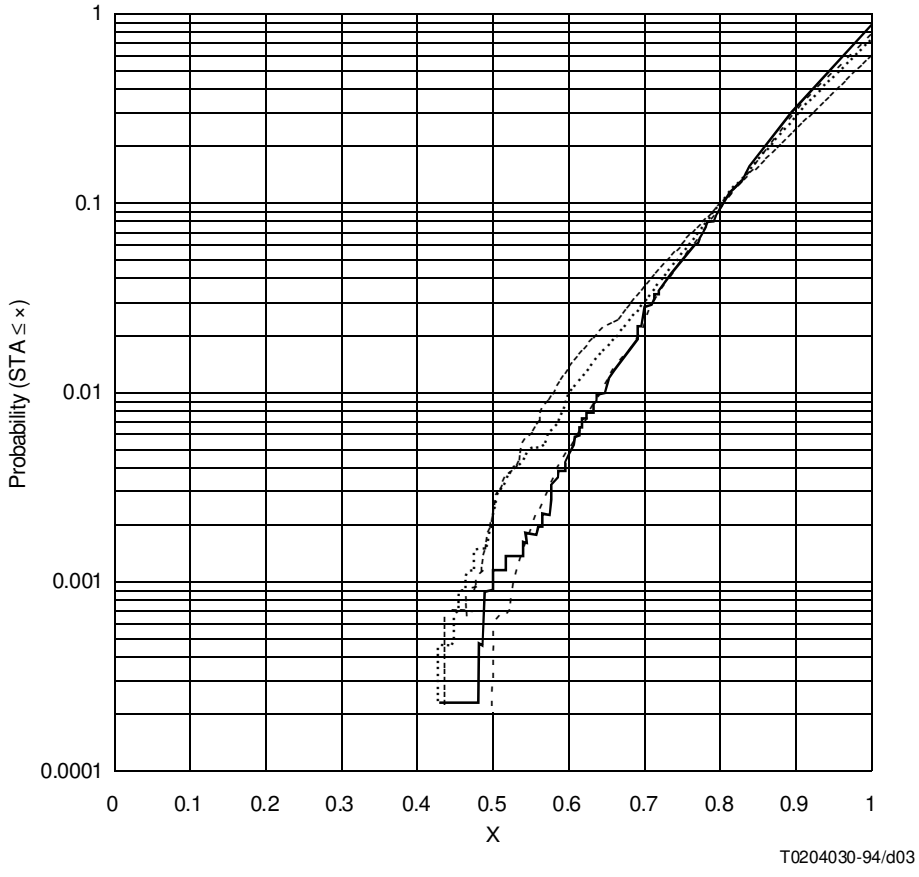

FIGURE I.1/E.846

Examples of simulated Short-Term-Accessibility (STA) distribution functions

Appendix II

Evaluation of the STA distribution function

(This appendix does not form an integral part of this Recommendation)

NOTE – This appendix will be replaced later on by a Recommendation for compliance tests. The subject is for further study.

By counting successful and total connection attempts over successive intervals T_a and dividing the first by the second, estimates of samples of the random variable STA are obtained[2)]. They can be used to evaluate an empirical distribution function. This can be done by observing real traffic or additional test traffic. A sufficient number of connection sufficient attempts within the intervals T_a are necessary to achieve precision of the results.

The problem with this direct kind of measurement is the long observation time necessary to get enough data for covering rare situations. It is the same problem as with measuring availability. To reduce the observation time, many traffic relations in the network which use the same configuration and type of equipment can be measured simultaneously.

An alternative is to calculate the distribution function of the STA from operational data such as availability of equipment and traffic measurement results.

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2) Unsuccessful attempts due to lack of channels at T-reference points have to be counted as successful.