INTERNATIONAL TELECOMMUNICATION UNION

CCITT

E.850

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

(10/92)

TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

CONNECTION RETAINABILITY OBJECTIVE FOR THE INTERNATIONAL TELEPHONE SERVICE

Recommendation E.850

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.850 was revised by Study Group II and was approved under the Resolution No. 2 procedure on the 30th of October 1992.

____

CCITT NOTE

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

Recommendation E.850[1)]

CONNECTION RETAINABILITY OBJECTIVE FOR THE INTERNATIONAL TELEPHONE SERVICE[2)]

(revised 1992)

Introduction

This Recommendation is one of a set of Recommendations, comprising Recommendations E.810, E.830, E.845, E.850 and E.855 concerned with the accessibility, retainability and integrity of telephone services.

The CCITT,

considering

(a) that "premature release" is defined in Recommendation E.800 as the event that an established connection will be released for a reason other than intentionally by any of the parties involved in the call;

(b) that premature release is a measure of connection retainability;

(c) that a prematurely released connection is considered high in annoyance as perceived by telephone users;

(d) that the probability of a premature release is a function of network component failure intensity and call holding time;

(e) that the objective should take account of the expectations and tolerances of users to the premature release impairment as well as the capabilities of current technology;

(f) that the objective might not be met at the present time but should be viewed as a long-term goal;

(g) that the objective should take into account the concerns of network planners and system designers, provide useful guidance to each, and it can be used by Administrations in a consistent way to measure connection retainability performance;

(h) that connection retainability is defined in Recommendation E.800,

recommends

1 Definitions

A **prematurely released telephone connection** is known as a cutoff call when the connection is completely broken, or

1) when a single interruption occurs lasting for longer than ten seconds which causes the transmission quality of the connection to be unsuitable for voice communications;

2) when a succession of interruptions occur lasting less than ten seconds where the product of the average duration of each interruption and the frequency of occurrence (i.e. average number of interruptions/seconds) exceeds 0.005.

---

1) Formerly G.181, in *Red Book*, Fascicle III.1.

2) Some of the terms in this Recommendation, for example, the noun "measure", are used in the sense of their definition given in Recommendation E.800.

2 A measure to quantify telephone connection retainability performance

The measure to be used shall be the complement of connection retainability, namely the probability of a prematurely released telephone connection when normalized to a call holding time of one minute (P_r). The estimator of the **premature release probability is the premature release call ratio (P_{re})** which is defined as:

$$P_{re} = \frac{1 - \frac{R_N}{N}}{T}$$

where N is the number of telephone calls successfully established in some period of time, T is the mean call holding time in minutes and R_N is the number of telephone calls successfully completed out of such N calls (see Annex A and Annex B).

3 Overall objective for premature release probability

The provisional objective for the normalized premature release probability (P_r) shall be such that the performance is better than the values given below:

for typical international connections:

$$2 \times 10^{-4} \leq P_r \leq 4 \times 10^{-4}$$

for 90th percentile international connections:

$$4 \times 10^{-4} \leq P_r' \leq 8 \times 10^{-4}$$

for worst case international connections:

$$8 \times 10^{-4} \leq P_r'' \leq 1.6 \times 10^{-3}$$

Note 1 – It is intended to establish a single value for P_r, P_r' or P_r'' in the future.

Note 2 – The typical 90th percentile and worst case connections mentioned above shall be assumed to be those hypothetical reference connections (HRXs) given in Recommendation E.830.

Note 3 – See Annex B.

4 Allocation of the overall objective

It is desirable, for planning purposes, to allocate the overall objective for a typical connection to the national systems and the international chain of the HRX. The overall objective is given by:

$$P_r = P_{r_{n1}} + P_{r_{n2}} + P_{r_i}$$

where $P_{r_{n1}}$ and $P_{r_{n2}}$ are the premature release probabilities for originating and terminating national systems respectively and P_{r_i} is the premature release probability of the international chain. The allocation of the overall objective to national systems and international chain shall be as follows:

$$P_{r_{n1}} = P_{r_{n2}} = \alpha \; P_{r_i}$$

Note 1 – α is provisionally recommended as being equal to 2. Thus, for example, if:

$$P_r = 3 \times 10^{-4}$$

then

$$P_{r_{n1}} = P_{r_{n2}} = 1.2 \times 10^{-4}$$

and

$$P_{r_i} = 0.6 \times 10^{-4}$$

Note 2 – Further allocation of the overall objective to the circuits and exchanges used in a connection might also be desirable.

Note 3 – Objectives for the permissible probability of premature release of an established telephone connection in Integrated Digital Networks (IDNs) and mixed (analogue/digital) networks, due to transit digital or local and combined local/transit exchange malfunctions, are specified in the Recommendations Q.504 or Q.514.

ANNEX A

(to Recommendation E.850)

Relationship between the premature release probability and its estimator

The following relationship exists between the premature release probability normalized to a 1-minute holding time (P_r) and its estimator P_{re}:

$$\lim_{N \to \infty} P_{re} = \lim_{N \to \infty} \left(\frac{1 - \frac{R_N}{N}}{T} \right) = P_r, \text{ if such limit exists}$$

On the other hand, for the purpose of network design, the probability of a premature release with a mean call holding time of T minutes, $P(Z, T)$, can be expressed using the formula

$$P(Z, T) = \frac{Z}{Z + T^{-1}}$$

where

$$Z = \sum_{i=1}^{L} Z_i$$

and Z_i is the average number of failures per minute of an i component in the hypothetical connection between two users as shown in Figure A-1/E.850. The connection holding time and the time between failures for the individual components are assumed to be exponentially distributed.

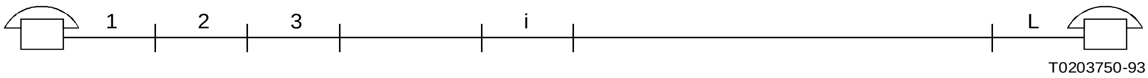

FIGURE A-1/E.850

Hypothetical connection to estimate the retainability of an established telephone connection

In practice, $Z << T^{-1}$ and therefore P_r can be approximated as follows:

$$P_r = P(Z, T)_{T=1} = \frac{Z}{Z + 1} \approx \frac{P(Z, T)}{T}$$

Also, the following relationship exists:

$$\lim_{N \to \infty} \left(1 - \frac{R_N}{N}\right) = P(Z, T)$$

ANNEX B

(to Recommendation E.850)

A method to estimate the premature release probability for an international telephone connection

In this annex, a method is described which can be used to estimate the premature release probability for an international telephone connection.

The method is based on placing end-to-end test calls, whose mean holding time is T in minutes, and observing those which are prematurely released due either to transmission or switching failures, or transmission interruptions lasting longer than ten seconds.

From the results of Annex A, it follows that the simple estimator of P_r is:

$$P_{re} = \frac{1 - \frac{R_N}{N}}{T}$$

If it can be reasonably assumed that the occurrence or non-occurrence of a premature release for each of the test calls constitutes independent events, then the binomial sampling theory can be used to derive confidence intervals for P_r, and to determine minimum sample sizes (N).

In particular, it would be required that N be chosen such that:

$$P_r \{ |(R_N/N) - P_r T| \leq e P_r T/100 \} \geq a/100$$

where e is the estimation error in percent, and a is the confidence level in percent. Writing $P = P_r \times T$, it follows from the central limit theorem that, for large N,

$$\frac{(eNP)}{100}) \ / \ [NP(1 - P)]^{½} \geq Z_a \qquad \text{(B-1)}$$

where Z_a is the root of the equation:

$$(2/\pi)^{½} \int_0^{Z_a} \exp\,(-1/2\, y^2)\, dy = a/100$$

Neglecting terms of order P^2, the inequality (B-1) becomes:

$$N \geq (100\, Z_a/e)^2 / P \qquad \text{(B-2)}$$

In this last formula, P is generally not known. As an example, however, if we have to verify that P is in conformity with the overall objectives of typical connections (see § 3), such that P is in the order of 3×10^{-4}, then a choice of a = 90% and e = 40% would lead to $N \geq 56\,720$.

Similar calculations based on varying assumptions are reproduced in Figure B-1/E.850.

Based on these results, it is proposed that for an average holding time of T = 1 min, N = 60 000. For other values of T (in minutes), N = 60 000/T.

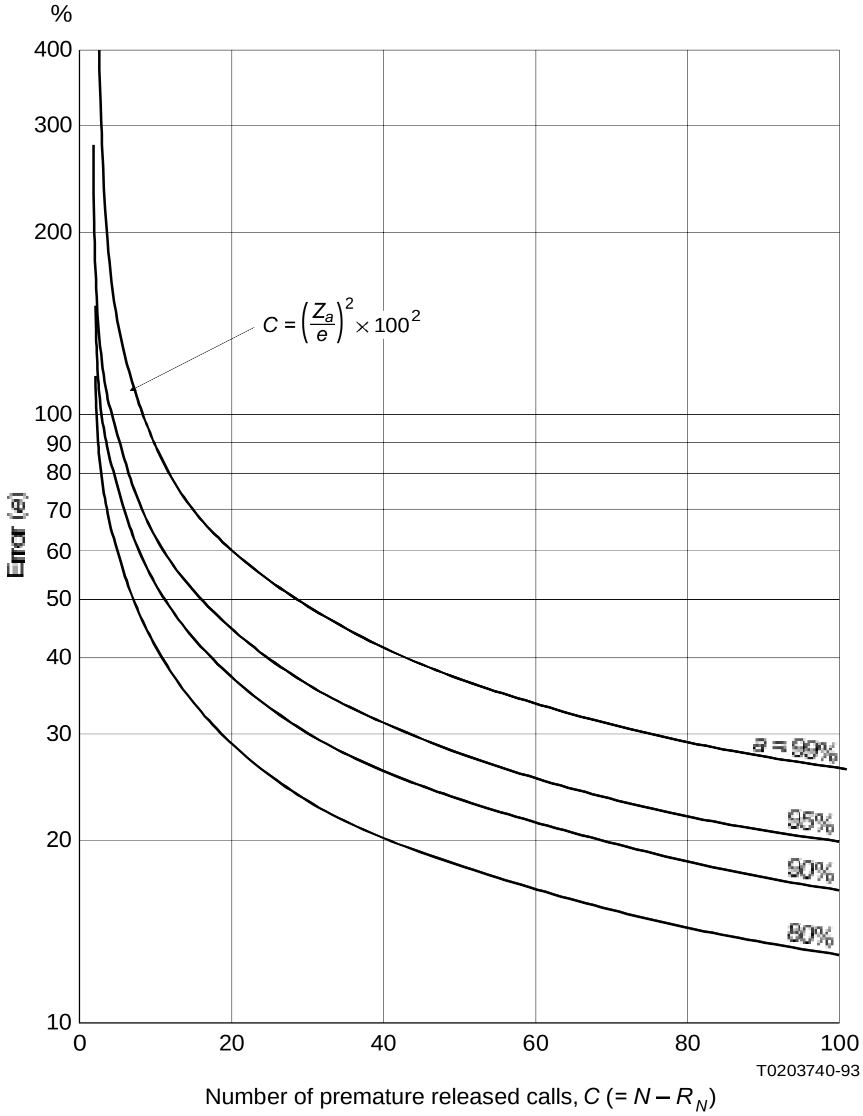

FIGURE B-1/E.850

Relative precision in estimating P_r from large samples when C/N = 0.1

Bibliography

TORTORELLA (M.): Cutoff calls and telephone equipment reliability, *The Bell System Technical Journal*, Vol 60, No. 8, pp. 1861-1890, 1981.