INTERNATIONAL TELECOMMUNICATION UNION

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TRANSMISSION MEDIA CHARACTERISTICS

RELIABILITY AND AVAILABILITY OF ANALOGUE CABLE TRANSMISSION SYSTEMS AND ASSOCIATED EQUIPMENTS

ITU-T Recommendation G.602

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.602 was published in Fascicle III.3 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation G.602

RELIABILITY AND AVAILABILITY OF ANALOGUE CABLE TRANSMISSION SYSTEMS AND ASSOCIATED EQUIPMENTS

(Malaga-Torremolinos, 1984)

1 General section

Transmission system: all that is necessary in order to provide an adequately operational transmission path (e.g. 4 kHz channel) between the terminating interfaces. It includes translating equipment, line terminal equipment, line intermediate equipment, cable, power feeding, primary power and standby power supplies and might also include the changeover equipment when automatic protection switching is provided.

2 Definitions

a) **reliability in analogue cable transmission systems**

The reliability of a single unit of an analogue transmission equipment or of a complete transmission system is defined as the probability that this item can perform its required function for a given time interval. One parameter to quantify this reliability is the mean time between failures (MTBF). A failure of the system is considered to occur when there is:

1) complete loss of signal;

2) one in which the pilot level drops by 10 dB below nominal value;

3) when the total unweighted noise power, measured or calculated with an integrating time of 5 ms exceeds 1 million pW (10^6 pW) on the 2500 km hypothetical reference circuit (see Recommendation G.222).

In all instances, this condition must last at least 10[1)] seconds.

b) **availability in analogue cable transmission systems**

The availability of an analogue transmission system is defined as the ability of the system to be in a state to perform adequately (operating) at a given instant of time or at any instant of time within a given time interval. In this Recommendation, the availability of an analogue transmission system is quantified by the ratio of the time during which the system is operating to a specified total time.

Four factors influencing availability are:

- reliability of the equipment;
- automatic protection switching;
- maintenance procedures;
- cable routing and protection.

In considering the importance to be attached to the individual factors, economic aspects should play an important role.

Note - Experience has shown that in many cases the cable faults are dominating (in the order of 95% of the unavailability time) over the equipment faults and that the length of the line section and the kind of route (running along roads with heavy traffic, etc.) have a decisive influence on the achievable availability values.

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1) This value should be considered as being provisional.

3 Objectives

a) *Reliability*

As indicated in the definition of availability, reliability is but one of the factors involved in obtaining an availability objective. Therefore, no specific objective for reliability is recommended.

b) *Availability*

1) *Hypothetical reference circuit (2500 km)*

The objective for the availability of a 2500 km hypothetical reference circuit in one direction should be greater than 99.6% for a one year duration. This takes into account outages for both translating and line equipment and the cable and associated powering equipments. To achieve this objective, appropriate protection switching may be required.

2) *Translating equipm*ent

The design objective for the availability of translating equipment in the Annex and in Figure A-1/G.602, for a 2500 km hypothetical reference circuit as recommended for the different transmission systems, should be greater than 99.9% measured for a period of one year for one direction of transmission.

3) *Line section*

The design objective for the availability of a 280 km homogeneous section for one direction shall be derived from the overall requirement for the hypothetical reference circuit. The exact value is dependent on the network design.

ANNEX A

(to Recommendation G.602)

Calculation example

Example of Reliability and Availability calculations for a line section in one direction based on the following assumptions:

1) Line repeater MTBF = 2 x 10^5 hours (one way);

2) 100 line repeaters in section;

3) Each failure lasts 4 hours;

4) 12 tube cable with 1 : 5 protection switching.

a) *Reliability* (MTBF)

- 100 repeaters will have failure in $\left(\frac{2 \times 10^5}{100} \right)$ = 2000 hours

b) *Availability* (A)

- This is approximately 4½ failures per year × 4 hours = 18 hours outage per year (0.2%)
- Without protection switching A_1 = 99.8%

  Non-available $X_0 = 2 \times 10^{-3}$

- With automatic protection switching:: $A_2 = \left[1 - \frac{(N + M)!}{(M + 1)!N!} X_0^{M + 1} \right] \times 100\%$

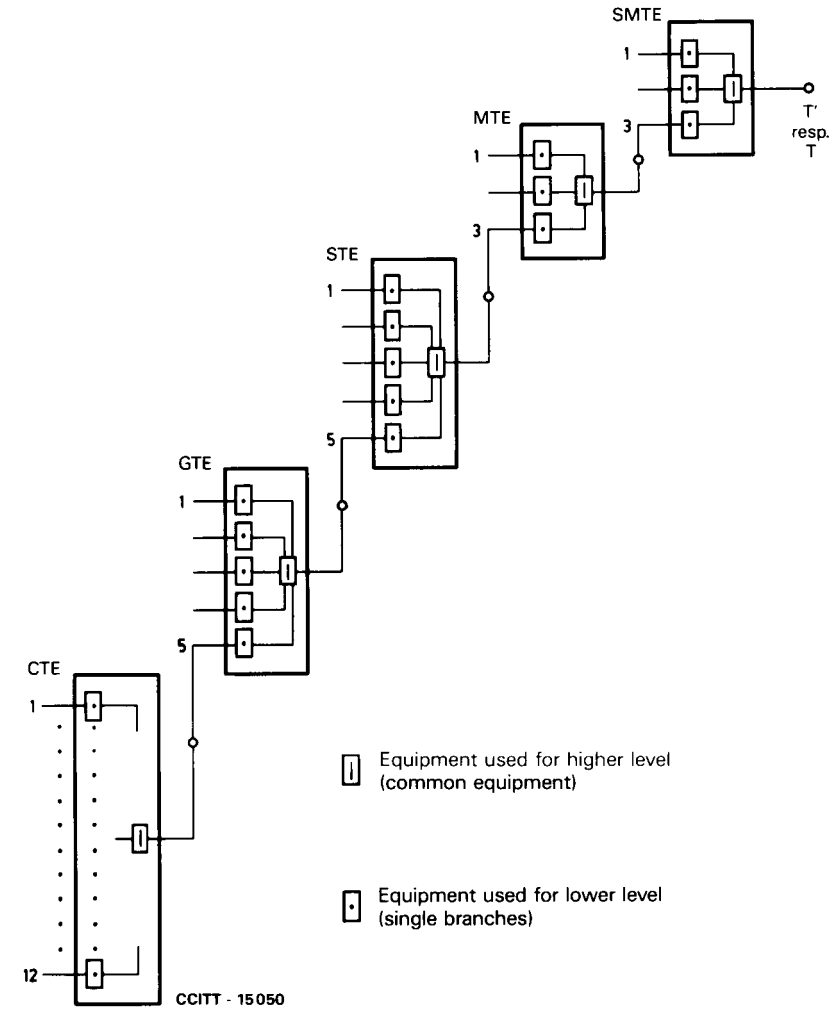
where

N = 5 (number of systems in service)

M = 1 (number of protection systems)

$$A_2 = \left[1 - \frac{6!}{2!\,5!} (2 \times 10^{-3})^2 \right] \times 100\% = \left[1 = (12 \times 10^{-6}) \right] \times 100\% = 99.999\%$$

Note - Calculations are for electronics only and do not take into account cable cuts.



CTE = Channel translating equipment
GTE = Group translating equipment
STE = Supergroup translating equipment
MTE = Mastergroup translating equipment
SMTE = Supermastergroup translating equipment

FIGURE A-1/G.602

Plan of modulator stages showing common equipment and single branches
(Plan one of Recommendation G.211 has been shown as an example)