RECOMMENDATION ITU-R F.697-2*

ERROR PERFORMANCE AND AVAILABILITY OBJECTIVES FOR THE LOCAL-GRADE PORTION AT EACH END OF AN INTEGRATED SERVICES DIGITAL NETWORK CONNECTION AT A BIT RATE BELOW THE PRIMARY RATE UTILIZING DIGITAL RADIO-RELAY SYSTEMS

(1990-1991-1997)

Scope

This Recommendation provides the error performance and availability objectives for the local-grade portion at each end of an integrated services digital network connection at a bit rate below the primary rate utilizing digital radio-relay systems. This Recommendation also provides consideration on local grade unavailability objectives in Annex 1.

It should be noted that this Recommendation could be used only for systems designed prior to the approval of Recommendation ITU-R F.1668 in 2004.

The ITU Radiocommunication Assembly,

considering

a) that the error performance and availability objectives for digital radio systems which form all of a local-grade portion of an integrated services digital network (ISDN) connection at a bit rate below the primary rate (connections between the T reference point according to Fig. B-3 of ITU-T Recommendation G.960 and the local exchange), as specified in Fig. 1 of ITU-T Recommendation G.821, should be defined (see Note 1);

b) that the error performance objectives for an international digital connection forming part of an ISDN have been specified in ITU-T Recommendation G.821 by the ITU-T and that this Recommendation includes the performance objectives for the local-grade portion of the network;

c) that Recommendation ITU-R F.1189, based on ITU-T Recommendation G.826, gives error performance objectives for constant bit rate digital paths at bit rates at or above the primary rate carried by digital radio-relay systems which may form part of the national portion of a 27 500 km hypothetical reference path;

d) that propagation and interference effects suggest that the performance and availability objectives should be stated statistically as a fraction of time;

e) that digital radio systems in the local-grade network may operate either below or above a frequency of about 10 GHz, and therefore several types of anomalous propagation phenomena may affect the error performance;

f) that a bit error ratio measurement requires a certain duration of time which depends upon the magnitude of the bit error ratio;

g) that the occurrence of periods of unavailability due to anomalous propagation conditions, interference, equipment failure, and other effects are sufficiently variable so that it is necessary to define the objectives averaged over a long period,

recommends

1 that error performance should be assessed in terms of the events errored seconds (ES) and severely errored seconds (SES) and the parameters errored second ratio (ESR) and severely errored second ratio (SESR) as defined in ITU-T Recommendation G.821 (see also Recommendation ITU-R F.594);

2 that the following error performance objectives apply to each direction and to each $N \times 64$ kbit/s channel ($1 \leq N < 24$ (or < 32, respectively)) (see Note 9) of a digital radio-relay system used to form all of the local-grade portion at each end of an ISDN connection (see Note 2) which take account of fading, short-term and long-term interference (see Note 3) and all other sources of performance degradation (see Note 4) during periods for which the system is considered to be available (see Notes 2 and 5);

2.1 that the SESR should not exceed 0.00015 in any month (see Note 6);

2.2 that the ESR should not exceed 0.012 in any month (see Notes 6 and 9);

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* Radiocommunication Study Group 5 made editorial amendments to this Recommendation in 2012 in accordance with Resolution ITU-R 1.

3 that the total bidirectional unavailability (see Note 2) lies between *A*% and *B*% due to all causes for the local-grade circuit. The values of the *A*% and *B*% and the measurement period are currently under study;

4 that Annex 1 should be used for guidance on local grade unavailability objectives.

NOTE 1 – No Hypothetical Reference Digital Path (HRDP) is proposed for local-grade applications. Administrations are advised to develop their own representative network model in accordance with Annex A of ITU-T Recommendation G.801 in order to validate prima facie compliance with international standards.

The local-grade circuit may be made up from one, or more than one transmission system and/or hop of radio equipment. No specific length has been defined, but current circuit lengths of 10 km or more are not uncommon.

NOTE 2 – The concept of unavailability of a digital radio-relay system is defined in *recommends* 3 of Recommendation ITU-R F.557.

Unavailability is determined by two main effects: equipment unreliability and adverse propagation (mainly rain attenuation). The division of unavailability objectives between equipment failure and propagation factors will depend upon the specific arrangements of the administration concerned, for example, the provision of protection equipment and the mean time to repair. The difference between these factors may be more than one order of magnitude.

For example, a number of values for unavailability have been proposed ranging from 0.01% averaged over one year to up to 1.0% averaged over one or more years for a bidirectional radio system.

Administrations are urgently requested to provide further information.

NOTE 3 – Short-term interference is the interference due to the existence of anomalous propagation conditions, and typically consists of very high levels of interference which only occur rarely, and exist for short periods of time. Long-term interference is interference which arises from sources within line-of-sight of the victim receiver, and is typically low in level and constant in value.

NOTE 4 – In the design of systems, the degradation of performance due to the sharing of the spectrum with satellite systems and other services needs to be taken into account, where appropriate.

NOTE 5 – In considering specific values for the error performance objectives, administrations may wish to take account of Note 5 of Table 2 of ITU-T Recommendation G.821 (Allocation of a block allowance of 30% for the local- and medium-grade portion at each end of the hypothetical reference connection (HRX)).

NOTE 6 – The term “any month” as used in this Recommendation, is defined in Recommendation ITU-R P.581. Where measurements are used to ensure compliance with this Recommendation, then propagation conditions also need to be assessed and related to propagation data representative of “any month” conditions.

NOTE 7 – Prior to the approval of Recommendation ITU-R F.1189, real digital radio-relay links forming part of the local grade portion within an ISDN were designed by applying the error performance objectives of the earlier version of this Recommendation (i.e. Recommendation ITU-R F.697-1, published in 1994) directly at the system bit rate. As a consequence, translation rules were suggested to normalize error performance measurement results obtained at the system bit rate to the 64 kbit/s level (see Annex 2 of Recommendation ITU-R F.634).

NOTE 8 – The ES allowance includes all performance degradations other than unavailability.

NOTE 9 – *N* is less than 24 in the 1.544 Mbit/s based hierarchy and less than 32 in the 2.048 Mbit/s based hierarchy.

ANNEX 1

Local grade unavailability objectives

1 Introduction

As indicated in ITU-T Recommendation G.821, local grade refers to the portion of the HRX between the subscriber and the local exchange. A variety of different digital radio system configurations and capacities are now available for local network use, including both point-to-point and point-to-multipoint (P-MP) systems operating in many different frequency bands, both above and below 10 GHz.

Several of these systems are designed specifically for use in city environments, where a wide range of traffic requirements exist, and where in general, communications involve relatively short distances. Radio systems are also available for use in rural local network applications mainly for telephony purposes.

The natural advantages of radio in local network applications are versatility, and speed of provision of service, but this can be offset by high costs in comparison to other media, particularly where the radio equipment is serving only one or a few subscribers. For this reason, fairly simple and cost-effective radio system designs are normally used, often without protection switching. For P-MP systems, hot stand-by protection switching is often used at the central node.

2 Local-grade unavailability objectives

The concept of unavailability of a digital radio-relay system is defined in *recommends* 3 of Recommendation ITU-R F.557. So far no standards have been developed by the ITU-T or the ITU-R for local-grade unavailability.

For local-grade radio systems, unavailability is determined by two main effects: equipment unreliability and adverse propagation (mainly rain attenuation).

The unavailability due to rain attenuation will normally comprise a number of events which occur every year so that it is possible to derive an annual unavailability figure for this effect, which may be useful as a parameter when designing and implementing links. Unavailability due to equipment failure occurs less frequently (e.g. about every three years on average for typical mean time between failures (MTBFs)), but results in longer interruptions, as it depends upon the maintenance organization for restoration of service. However when considering geographical areas where rainfall predictions result in very small probabilities, annual variations should be considered. Therefore, it may be desirable to adopt a similar three-year minimum estimation period.

As far as the unavailability due to equipment is concerned, it has to be taken into account that radio equipment for local network applications is usually simple all solid-state of low to medium power. A MTBF of 50 000 h or better can be expected for a single transceiver.

Typical applications consist of one bidirectional hop, utilizing two transceivers, which gives a link MTBF of at least 25 000 h. For economic reasons, protection switching is normally not used in point-to-point local-grade radio systems.

Unavailability due to equipment unreliability is given by the expression:

$$\text{Unavailability}\,\% = \left(1 - \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \times 100\%\right)$$

where:

MTBF: equipment mean time between failures (h)

MTTR: mean time to restore (service) (h).

The resulting unavailability is shown in Fig. 1 as a function of MTTR.

Due to differing operational environments, the MTTR will vary over a wide range. Values from 6 to 48 h have been suggested corresponding to unavailabilities of between 0.01% and 0.200%. The portability of the type of equipment used in the local-grade network, however, may allow rapid and easy replacement of faulty units, so that the MTTR may not be excessive in an urban environment. The MTTR can vary considerably in rural applications.

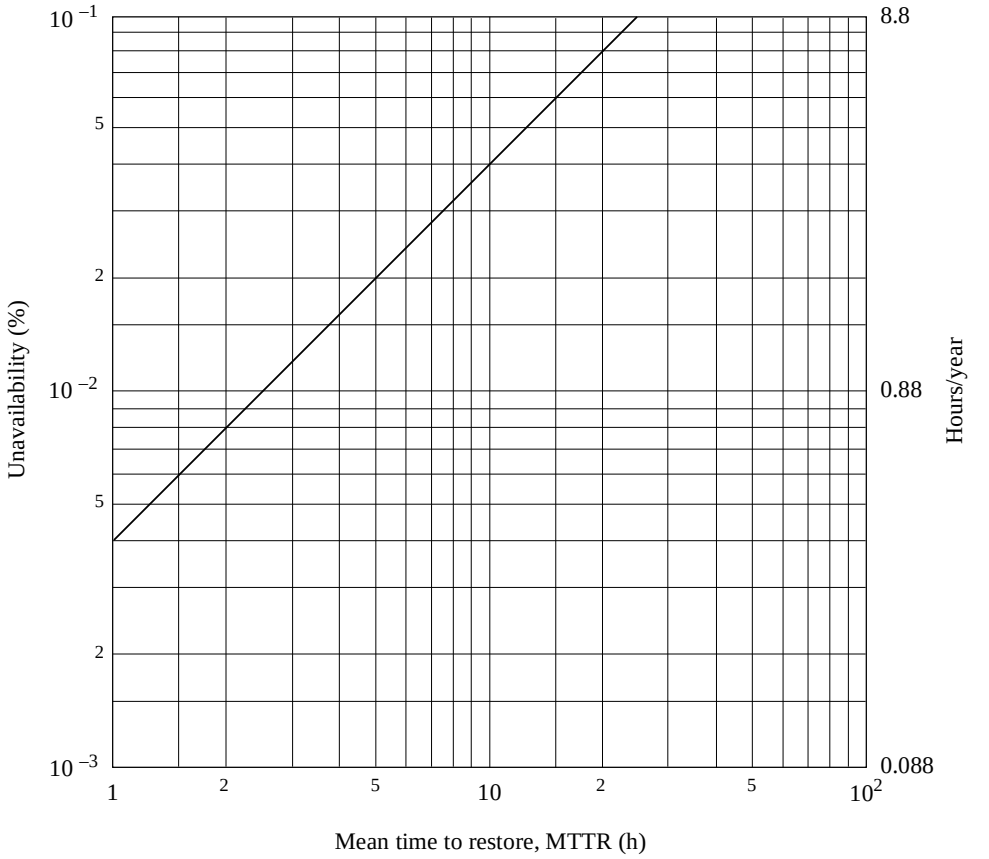
Unavailability due to primary power supply failure may be controlled by the conditions existing at the users' premises. In some cases, in order to realize a highly reliable link, the unavailability due to power failure can be reduced to a negligible amount by adopting battery back-up systems at the users' premises. Otherwise, the unavailability depends basically on the reliability of the commercial primary power supply.

3 Radio system considerations

The frequency bands above about 17 GHz are suited to local-grade radio applications since the hop lengths required are normally fairly short, although bands below about 17 GHz are also frequently used for such applications. These applications often cover rapid provision and special services, with radio equipment sometimes installed on non-network premises. These situations compound the difficulties experienced in considering the variable factors involved in MTBF, MTTR and equipment protection arrangements discussed in § 2. Hence it is too early to make firm recommendations for unavailability, but the contribution caused by adverse propagation can be assessed, and this is largely attributed to rainfall attenuation at frequencies above about 17 GHz.

FIGURE 1

Equipment reliability
(bidirectional link comprising two 50 000 h mean time between failures (MTBF) transceivers)



Unavailability due to rainfall attenuation is dependent upon frequency band, climatic conditions, and the system fade margin available for a given hop length. Appropriate standards can be respected by proper choice of these parameters, in relation to the availability required.

In Japan, the frequency bands around 21 and 26 GHz are being used with a rainfall unavailability objective from 0.004% to 0.0004% per year as a block allowance. When low unavailability of 0.0004% is required, the hop length is limited to 3.5 km for the point-to-point systems and to 2 km for P-MP systems.

In the United Kingdom, the 18 GHz band has been used extensively within the local area network. The achieved unavailabilities vary from better than 0.001% for low capacity point-to-point systems, to 0.01% for low capacity for P-MP systems and 0.005% for high capacity systems.

Use has also been made of systems operating at 28.5 GHz. A study of these systems demonstrates the effect of the value chosen for unavailability on the required system fade margins, although this depends on the rainfall conditions, which may be more favourable in the United Kingdom than in many other countries.