

NOTE 4 – Spatial availability is defined as the cumulative probability of link availability arising from the joint distribution of location and orientation dependent random losses in the link.

NOTE 5 – For maritime and aeronautical earth stations at low elevation angles operating through the digital mobile-satellite channel, the BER performance objectives given in *recommends* 1 might be achieved for a lower percentage of the time.

NOTE 6 – In the case of backup using a previous generation satellite the BER performance objectives given in *recommends* 1 might be achieved for a lower percentage of the time.

NOTE 7 – The effects of aggregate interference from other systems and services should be taken into account in ensuring that the overall performance objectives of the digital MSS channel are met.

NOTE 8 – A BER objective better than 1×10^{-6} for more than 99% of the available time (reflecting propagation conditions) is apportioned between the MSS link and the other components forming part of the end-to-end ISDN link. With reference to the hypothetical reference connection (HRX) given in Fig. 1 of ITU-T Recommendation G.821, 90% of the performance objectives (errored seconds (ES), severely errored seconds (SES)) are apportioned to the MSS radio link since it is the most significant contributor to BER degradation. Therefore, the BER performance apportioned to the MSS radio link is 9×10^{-7} , during the available time.

NOTE 9 – Further study is required for the necessity of short-term performance criteria to define the associated BER thresholds and percentages of time.

ANNEX 1

Methodology for calculating unavailability of the MSS radio link based on the unavailability defined for the ISDN in ITU-T Recommendation G.821

1 Introduction

For fixed services (FS) and fixed-satellite services (FSS), quality objectives for the ISDN are defined by ITU-T Recommendation G.821. For MSS, on the other hand, availability is the main quality objective so far and it is assessed by the statistics of C/N versus a threshold C/N which corresponds to a specified BER in probability. In the mobile ISDN era where mobile-satellite communication systems will be incorporated in the global ISDN system, however, circuit quality of MSS should be defined so as to keep consistencies with the FS and FSS.

This Annex discusses various propagation impairments for mobile-satellite systems (such as maritime mobile-satellite service (MMSS), aeronautical mobile-satellite service (AMSS) and land mobile-satellite service (LMSS)) from a viewpoint of the available and unavailable time defined by ITU-T Recommendation G.821, and stresses the importance of the concept that unavailability and degradation during available time are two different measures for evaluation of mobile-satellite communication in the mobile ISDN era.

2 Definition of parameters used in ITU-T Recommendation G.821

To clarify the discussion in this Annex, parameters used in ITU-T Recommendation G.821 are listed below.

– Available time and unavailable time

A period of unavailable time begins when the BER in each second is worse than 1×10^{-3} for a period of ten consecutive seconds. These ten seconds are considered as the unavailable time. A new period of available time begins with the first second of a period of ten consecutive seconds each of which has a BER better than 1×10^{-3} .

– SES

One-second period which has a BER worse than 1×10^{-3} .

– ES

One-second period in which one or more bits are in error.

In ITU-T Recommendation G.821 for ISDN performance objectives, availability is not discussed and only percentages of SES and ES are defined.

3 Relation between availability defined by traditional analysis and ITU-T Recommendation G.821

Table 1 summarizes the characteristics of fading phenomena for various MSS. From this Table, it can be recognized that:

- LMSS propagation environments are most complex due to the variety of fading phenomena, and
- a consideration of availability for MMSS is needed because the fading period of MMSS is comparable with 10 s which is a criteria for available and unavailable time in the ITU-T definition.

TABLE 1

Characteristics of propagation impairments in several MSS communication environments

Service Characteristics	MMSS	AMSS	LMSS-V (vehicular)	LMSS-P (handheld terminal)
Communication environment	Line-of-sight	Line-of-sight	Line-of-sight Out-of-sight	Line-of-sight (out-of-sight communication is difficult)
Primary factor of fading	Sea reflection fading	Sea reflection fading Ground reflection fading	Shadowing by terrain, buildings and trees Multipath fading	Same as LMSS Shadowing by human body
Typical fade depth ⁽¹⁾	Within 10 dB	Within 8 dB	Varies with environment (more than 20 dB when maximum)	Within 10 dB
C/M ⁽²⁾	More than 6 dB	More than 7 dB	0-20 dB (various)	More than 6 dB
Dominant frequency component of variation	0.5 to several hundred Hz	20 to several hundred Hz	10 to several tens of Hz (multipath fading) Below 1 Hz (shadowing by terrain)	Several Hz or below

⁽¹⁾ Fade depth: 50-99 percentile fade level.

⁽²⁾ C/M ratio of direct wave power, C , to average multipath power, M .

Figure 1 shows an example of flat fading in which the C/N value changes with time. Since noise level N can be regarded as constant in the ordinary case, the variation of C/N is equivalent to that of the received level. Also, C/N and BER correspond to each other, the variation of C/N in Fig. 1 can be regarded as a variation of BER, (here, BER is defined as a probability, not the BER in one second mentioned above. We will therefore write the former BER_{prob} and the latter BER_{sec} to distinguish them). We denote the median (nominal) value of C/N as C/N_{med} , and the threshold C/N value at which BER_{prob} becomes the threshold BER as C/N_{thres} , for example 1×10^{-3} .