RECOMMENDATION ITU-R M.1228

METHODOLOGY FOR DETERMINING PERFORMANCE OBJECTIVES FOR NARROW-BAND CHANNELS IN MOBILE SATELLITE SYSTEMS USING GEOSTATIONARY SATELLITES NOT FORMING PART OF THE ISDN

(Question ITU-R 112/8)

(1997)

Summary

This Recommendation describes the recommended methodology for determining performance objective for narrow-band channels in GSO MSS systems. In this methodology, elements of performance objective such as signal quality and availability, and steps for developing performance objective are indicated.

The ITU Radiocommunication Assembly,

considering

a) that performance objectives should be based on user requirements and levels of performance that can be achieved in practice;

b) that mobile satellite communications channels may experience severe signal propagation impairments such as multipath, which can establish an irreducible error rate in digital channels;

c) that permissible levels of interference to feeder links and service links of mobile satellite systems should be based on performance objectives for the mobile-satellite services (MSS),

recommends

1 that the methodology of Annex 1 be used for the development of end-to-end performance objectives (service and feeder links) for narrow-band channels in MSS systems using geostationary satellites with transparent transponders.

NOTE 1 – For the purposes of this Recommendation a “narrow-band channel” utilizes an emission bandwidth that is no more than three times the channel information rate (including all in-band signalling, headers, trailers, error control, synchronization and randomization information).

NOTE 2 – Further work is needed to establish a methodology for MSS systems using on-board processing, systems using satellites that interconnect service links, systems using spread spectrum modulation or systems using non-geostationary satellites.

ANNEX 1

Methodology for determining MSS performance objectives

1 Introduction

A performance objective is specified for a particular type of communications channel using the geostationary-satellite orbit (GSO). The methodology described below can be used for the development of end-to-end performance objectives (service and feeder links) for narrow-band channels in MSS systems using geostationary satellites with transparent

transponders. Further study is needed for systems using on-board processing and systems using satellites that interconnect service links, for which separate Recommendations may be developed. This methodology is not applicable for those channels forming part of the ISDN.

2 Form of performance objectives

In order to fully describe the overall performance three elements must be addressed:

– the threshold(s) of required baseband signal quality (e.g. bit error ratio (BER) for digital channels) for each downlink or an uplink containing a demodulator;

– the radio path temporal availability (as defined in Recommendation ITU-R M.828) associated with each signal quality threshold (i.e. a percentage of time for which each performance threshold is to be met);

– special design and operating conditions associated with each performance threshold and availability. These include: spatial availability which reflects the intended operating environment for which temporal availability applies, as specified by parameters such as minimum elevation angles and antenna polarization loss; multipath characteristics; operational needs (e.g. relatively high availability for dedicated signalling channels); and equipment parameters (e.g. mobile earth station antenna characteristics) that should be specially considered in a performance analysis.

3 Steps for determining end-to-end performance objectives

The process described below yields the end-to-end performance objectives for a particular mobile satellite communications channel in a particular direction of transmission. The process involves development of a performance objective based upon user requirements and the performance of comparable mobile services (Step 1), and testing it against achievable performance (Step 2). The developed performance objective is accepted if it is shown to be achievable in a practical manner.

S*tep 1*: Determine the signal quality and overall availability desired by the end users of the system. These are determined through coder/decoder (codec) and modulator/demodulator (modem) evaluations and analyses of user requirements.

The desired voice signal quality may be determined by subjective testing of a particular, selected voice codec or several types of candidate codec, any of which might be used in the subject channel. Ideally, this testing would be performed using bit error patterns that are expected to be encountered in the operating environment (i.e. consistent with the special conditions that may be part of the performance objective). For data channels (including those used for facsimile and other image transmissions), the desired signal quality may be established by modem capabilities and the requirements of users and users' peripheral devices or, in some cases, interconnected networks.

The above user performance needs as well as considerations of signalling and system control provide a basis for determining the desired levels of performance.

Step 2: Evaluate the performance of a representative system taking account of degradation caused by intra-system factors (e.g. intermod, frequency reuse factors, fading of the desired signal) and full loading on the system, and compare the results with the performance objectives hypothesized in Step 1. This is accomplished using a link power budget analysis in which practical transmission and operating characteristics are considered (see § 4 regarding feeder link and service link fading). The values used for statistical and stochastic parameters may be a self-consistent set of nominal values associated with the desired radio link availability (i.e. instantaneous values that yield equivalent error rates), the overall levels of which may be determined by simulation or statistical analyses of time-varying degradation.

Each set of specified signal quality and availability levels must be considered using separate link budgets. The special conditions associated with the hypothesized performance objective should be observed (or further developed) in this analysis. If the desired performance (Step 1) is achievable with a certain power margin allocated to the time and

spatial-based random losses respectively, and taking into account interference in both the uplink and downlink paths, it may be used as the performance objective. These margins are needed in order to show that at least the minimal expected levels of interference from other systems can be accommodated.

4 Determination of uplink and downlink performance objectives

Step 2 above requires link power budget analyses of the representative system with uplink and downlink parameters adjusted to meet the end-to-end performance objective (with power and availability margins for interference in the uplink and downlink).

Since the fades associated with link availability in the service link are of much shorter duration than the fades arising from rain attenuation and spatial-based random losses in the feeder and service links, the performance objectives need to be met assuming simultaneous fading of both time and spatial associated random losses (they are conditionally dependent). Because there generally are few land earth stations in a system, each of which may provide several feeder-link carriers, substantial power margins may be included to yield high feeder-link radio path availability at full loading. As a result, end-to-end combined radio path availability is generally limited by the service link. Given the equipment parameters and the service and feeder-link unavailability allowances, the uplink and downlink carrier-to-noise power levels can be determined using appropriate impairment models (e.g. signal propagation models) or simulations, and end-to-end combined radio path performance can be calculated for comparison with the specified signal quality level.