

## RECOMMENDATION ITU-R M.1741\*

**Methodology for deriving performance objectives and its optimization  
for IP packet applications in the mobile-satellite service**

(Questions ITU-R 85/8, ITU-R 87/8, ITU-R 112/8 and ITU-R 233/8)

(2006)

**Scope**

This Recommendation stipulates the methodology for deriving performance objectives and its optimization for IP packet applications in the mobile-satellite service. The guidelines for the performance parameters and objectives for physical and MAC layers, the methodology for derivation of the performance objectives, and the guidelines for the optimization of TCP performance in IP packet data applications in the mobile-satellite service are provided in Annexes 1, 2 and 3 to this Recommendation, respectively.

The ITU Radiocommunication Assembly,

*considering*

- a) that Internet Protocol (IP) packet transmission has become one of the major applications in modern communication networks including mobile-satellite systems;
- b) that hypothetical reference circuits, technical characteristics, performance objectives and availability requirements have been stipulated for conventional mobile-satellite services (MSSs) in a number of existing Recommendations;
- c) that technical characteristics and performance should be defined on the basis of IP packet layers, in addition to basic digital transmission performance of the MSS bearer link;
- d) that Recommendation ITU-R M.1636 stipulates definitions for reference models and performance parameters as a technical basis for the development of IP packet applications in the MSS;
- e) that the guideline for the performance objectives of the physical and link layers of MSS systems serving IP packets, together with the methodology to derive performance objectives for IP packet transmission for the system are required to facilitate effective use of spectrum resources by the system;
- f) that the transmission control protocol (TCP) is one of the most widely spread transport layer protocols over IP, where special attention is required for optimization of the operational parameters if it is applied to a system with large transmission delay such as MSS links,

*recommends*

- 1 that the guidelines for performance objectives in Annex 1 should be used for IP packet transmission in the MSS;
- 2 that the methodology in Annex 2 should be applied for derivation of the performance objective for IP packet applications in the MSS;
- 3 that the guidelines in Annex 3 should be taken into account when the operational parameters of TCP over IP packet transmission in the MSS are determined.

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\* This Recommendation should be brought to the attention of Radiocommunication Study Group 4 and Telecommunication Standardization Study Group 13.

## Annex 1

### Guidelines for performance objectives for IP packet transfer in the MSS

#### 1 Introduction

Terminals in the MSS have a number of performance requirements regarding employed protocols to ensure that the characteristics of the satellite link (such as large delay, variable error rate, a periodic disruption) are tolerated and adequately handled. The protocols to be considered, which operate under IP packet transmission over the satellite link, include the physical (PHY) and the media access control (MAC) layers. This section identifies the characteristics and performance of PHY and MAC layers that can contribute to the performance of IP packet transmission over the MSS link.

#### 2 Physical layer (Layer 1)

##### 2.1 Packet-based multiple access channel

Radio channels and their resources are generally accessed by a number of mobile-satellite terminals to connect to satellite access gateways through an MSS link for IP packet transmission. The sharing mechanisms of the radio channels and their resources for the packet-based multiple access involve a combination of techniques. One of the possible resource management approaches for the mobile-satellite terminals to access the radio channels is to utilize the channels in the forward direction on a time-division-multiplex (TDM) basis, and in the return direction on a time-division-multiple-access (TDMA) basis. In this case, each satellite access gateway manages a set of forward (to-mobile) and return (from-mobile) channels. In addition, mobile-satellite terminals may support one or more transmit/receiver pairs.

The TDMA for the physical layer requires certain transmission scheduling protocols, which are described in detail in § 4.4.

##### 2.2 Physical layer roles

The PHY layer is responsible for the transfer of an information bit stream over the satellite link, and includes the following functions:

*At a transmitter:*

- encoding, scrambling and interleaving;
- modulation of the encoded bit stream;
- transmission of the modulated signal on a multiplexed channel.

*At a receiver:*

- reception of a modulated signal;
- demodulation of the signal into an encoded bit stream;
- decoding, descrambling and de-interleaving.

The PHY layer transfers an entire frame together with the measured information concerning parameters of the satellite signal such as timing and power level.

### 3 MAC layer (Layer 2)

The MAC layer is responsible for controlling access to the PHY layer (channel resources) by each connection and for the establishment and provision of the connection for the delivery of IP packets over the MSS link. The MAC layer generally performs the following functions:

- addressing of physical devices or logical connections, and scheduling of resources for transfer of information between these entities in both the forward and return directions on a packet-based multiplexed channel;
- packing and unpacking of IP packets into MAC frames, including segmentation and reassembly, as required;
- buffering and flow control of information from the upper layer (i.e. IP layer);
- automatic repeat request (ARQ) (if required for the particular, error sensitive connection).

### 4 Guideline for designing IP packet data transmission system in the MSS which may influence performance of the network layer (Layer 3) and higher

This subsection describes the performance parameters and guidelines for system design of PHY and MAC layers for IP packet transmission in MSS, which can affect the performance of IP packet transmission over the MSS link.

#### 4.1 Bit error ratio

The bit error ratio (BER) for the MSS link can be derived from the design of the MSS link that depends on the physical layer characteristics of the link such as the modulation and the error coding scheme, transmitting power and link margin, receiver sensitivity and so forth. An example of BER performance for a 64 kbit/s bearer channel is shown in Table 1.

TABLE 1  
Example of BER performance

| Channel   | MSS terminal demodulator BER | MSS gateway demodulator BER | Measurement period |
|-----------|------------------------------|-----------------------------|--------------------|
| 64 kbit/s | $\leq 10^{-6}$               | $\leq 10^{-6}$              | 1 500 s            |

The values of the example in Table 1 are measured after synchronization of the signal has been established. All possible causes of the BER degradation, such as phase noise, loss of synchronization lock, clock and cycle slips during the measurement are included but any degradation caused by burst error due to multipath fading, blockage, shadowing or adjacent channel interference is excluded.

#### 4.2 Buffering and flow control

The IP packets arriving from the upper layer (i.e. IP networking layer) will be buffered at the MAC connection sub-layer before being transmitted by the packet-based multiple access channel of the PHY layer. The control mechanism and the size of the buffer will affect the performance of the IP packet transmission. For example, if the buffer size is sufficiently large, loss of packets due to the buffer overflow can be decreased, while the buffering delay can increase significantly if the buffer size is too large. Therefore, the mechanism of the buffer control, including the size of the buffer, needs to be determined carefully taking account of the trade-off between the loss and the delay of IP packet transmission.