RECOMMENDATION ITU-R F.1397

ERROR PERFORMANCE OBJECTIVES FOR REAL DIGITAL RADIO LINKS USED IN THE INTERNATIONAL PORTION OF A 27 500 km HYPOTHETICAL REFERENCE PATH AT OR ABOVE THE PRIMARY RATE

(Question ITU-R 210/9)

(1999)

The ITU Radiocommunication Assembly,

considering

a) that the ITU-T has specified in ITU-T Recommendation G.826 the error performance parameters and objectives for international constant bit rate digital paths at or above the primary rate;

b) that the ITU-T has specified in ITU-T Recommendation G.829 the error performance events and the block structures for synchronous digital hierarchy (SDH) multiplex and regenerator sections;

c) that the ITU-R has derived in Recommendation ITU-R F.1092 the error performance objectives for constant bit rate digital path at or above the primary rate carried by digital radio-relay systems which may form part of the international portion of a 27 500 km hypothetical reference path;

d) that any real path link for digital data transmission at or above the primary rate may be realized using a linear and/or a redundant topology, depending on the needs of network providers;

e) that there is a need to establish the performance objectives for real digital radio links in order to allow a proper engineering of the radio links,

recommends

1 that for the error performance objectives applicable to each direction of any real radio link of length L_{link} the values in Table 1 should apply,

The lower limit of L_{link}, used to scale the objectives to the real case, is L_{min}. Provisionally L_{min} is 50 km.

TABLE 1

Rate (Mbit/s)	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
Errored second ratio (ESR)	$0.04 \times (F_L + B_L) \times L_{link}/L_R$	$0.05 \times (F_L + B_L) \times L_{link}/L_R$	$0.075 \times (F_L + B_L) \times L_{link}/L_R$	$0.16 \times (F_L + B_L) \times L_{link}/L_R$	See Note 6
Severely errored second ratio (SESR)	$0.002 \times (F_L + B_L) \times L_{link}/L_R$				
Background block error ratio (BBLER)	$2 \times 10^{-4} \times (F_L + B_L) \times L_{link}/L_R$ (See Note 8)	$2 \times 10^{-4} \times (F_L + B_L) \times L_{link}/L_R$			

where:

distance allocation factor: $F_L = 0.01 \times L_R/500$

block allowance factor, B_L:

– for intermediate countries: $B_L = B_R \times 0.02 \times (L_R/L_{ref})$ for $L_{min} < L_R \leq L_{ref}$

$B_L = B_R \times 0.02$ for $L_R > L_{ref}$

– for terminating countries: $B_L = B_R \times 0.01 \times L_R/(L_{ref}/2)$ for $L_{min} < L_R \leq L_{ref}/2$

$B_L = B_R \times 0.01$ for $L_R > L_{ref}/2$

block allowance ratio, B_R: $(0 < B_R \leq 1)$

reference length, L_{ref}: L_{ref} = 1 000 km (provisionally).

L_R is the rounded value of L rounded up to the nearest multiple of 500 km;

2 that for the error performance objectives evaluation in *recommends* 1, the error performance parameters for any real link are defined as follows:

– SESR is the ratio of SES events to total seconds in the available time during a fixed measurement interval;

– BBLER is the ratio of BBLE events to total blocks in the available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs;

– ESR is the ratio of ES events to total seconds in the available time during a fixed measurement interval.

In Annex 1 some examples of application of the proposed method are shown.

In Annex 2 some examples of real path, link, hop are shown.

NOTE 1 – The SES, BBLE and ES events and the block structure for SDH multiplex and regenerator sections are defined in the ITU-T Recommendation G.829, the SES, BBLE and ES events and the block structure for paths are defined in the ITU-T Recommendation G.826.

NOTE 2 – A real link is defined as a portion of a path coming from partitioning and it is characterized by its real length L_{link}.

NOTE 3 – The effects of interference and all other sources of performance degradations are included in the values in Table 1.

NOTE 4 – The error performance objectives apply only when the system is considered to be available. The entry and exit criteria into and from the unavailable state are defined in the relevant Recommendation (see ITU-T Recommendation G.826).

NOTE 5 – According to ITU-T Recommendation G.826 the suggested evaluation period is one month for any parameter. In radio-relay links these objectives should be respected for any month (see Recommendation ITU-R P.581).

NOTE 6 – The ESR objective for higher bit rate paths is still under study.

NOTE 7 – The provisional value of the reference length L_{ref} was chosen to cover the country border to country border distances of the majority of countries. The value of reference length for the terminating countries being half that of the full reference length L_{ref} for intermediate countries, is based on the assumption that the distance from country border to international gateway is, on average for most countries, half of the distance from country border to country border.

NOTE 8 – For systems designed prior to 1996, the BBLER objective is 3×10^{-4}.

NOTE 9 – In the case of multihop links the objectives derived according to this Recommendation apply to the overall links; the allocation of the objectives to each hop is under the responsibility of the network operators.

NOTE 10 – The Annexes 1, 2 and 3 may be used for additional guidance in the application of this Recommendation.

ANNEX 1

Examples of SESs and SESR calculation

This annex shows some examples of the application of this Recommendation to real links, in order to derive the objectives.

The calculations are given for SES only; the objectives for ES and BBLER can be derived by following the same approach.

The procedure can be divided into 2 steps:

Step 1: deriving Recommendation ITU-R F.1092 objectives;

Step 2: scaling the results to the real link length.

Step 1: from Recommendation ITU-R F.1092 we have:

Rec. ITU-R F.1092 Obj $= 0.01 \times (L_R/500 + B_R \times 0.02 \times L_R/L_{ref}) \times 0.002$ for $L_{min} < L_R \leq L_{ref}$

Rec. ITU-R F.1092 Obj $= 0.01 \times (L_R/500 + B_R \times 0.02) \times 0.002$ for $L_R > L_{ref}$

Step 2: from this Recommendation we have:

$$\text{link obj} = \text{Rec. ITU-R F.1092 Obj} \times L_{link}/L_R$$

Where the number of SES events/month is required, it can be computed as follows:

$$Ev = \text{Link obj} \times \text{Time}$$

where (intermediate country is assumed)

L_R (L rounded): assumed to be the length of the real link rounded up to the first 500 km multiple

B_R: assumed to be equal to 1 (as defined in Recommendation ITU-R F.1092)

L_{ref}: assumed to be equal to 1 000 km (as defined in Recommendation ITU-R F.1092)

L_{link}: the length of the real link

link obj: maximum number of events per month for the real link

Time = 2 592 000 s (30 days have been assumed)

Ev: number of SES events/month.

Three examples of calculation are given on 50, 105 and 1 100 km links.

Example 1: A real link 50 km long:

$$L_{link} = 50 \text{ km}$$

In this case (since the length of the real link is equal to 50 km) L_R is equal to 500 km (50 km rounded up to the first multiple of 500).

Recommendation ITU-R F.1092 Obj = $(0.01 \times 500/500 + 0.02 \times 500/1\,000) \times 0.002 = 0.02 \times 0.002 = 4 \times 10^{-5}$ that corresponds to 104 SES/month.

The objective for the given link is given by:

link obj = $104 \times 50/500 = 10$ SES/month.

Example 2: A real link 105 km long:

$$L_{link} = 105 \text{ km}$$

In this case (since the length of the real link is equal to 105 km) $L_R = 500$ km (105 km rounded up to the first multiple of 500).

Recommendation ITU-R F.1092 Obj = $(0.01 \times 500/500 + 0.02 \times 500/1\,000) \times 0.002 = 0.02 \times 0.002 = 4 \times 10^{-5}$ that corresponds to 104 SES/month.

The objective for the given link is given by:

link obj = 104 × 105/*500* = 22 SES/month

Example 3: A real link 1 100 km long:

$$L_{link} = 1\,100 \text{ km}$$

In this case (since the length of the real link is equal to 1 100 km) L_R is equal to 1 500 km (1 100 km rounded up to the first multiple of 500 km).

Recommendation ITU-R F.1092 Obj = (0.01 × *1 500*/500 + 0.02 × 1) × 0.002 = 0.05 × 0.002 = 10^{-4} (see Note 1) that corresponds to 259 SES/month.

The objective for the given link is given by:

link obj = 259 × 1100/*1500* = 190 SES/month.

NOTE 1 – This is an example for $L_R > L_{ref}$.

NOTE 2 – Rounding to the nearest integer has been used for fractional results.

ANNEX 2

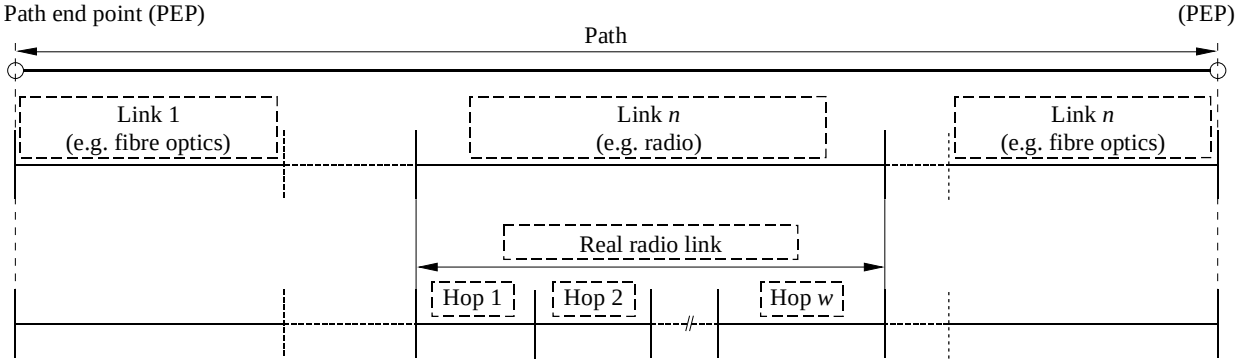
Example of a path, link, hop

This annex clarifies the meaning of some terms related to the connection, used in the body of the Recommendation.

The definition of path is given in ITU-T Recommendation G.826; an example of a radio link forming a portion of a path is given in Fig. 1.

FIGURE 1

Example of a portion of path



ANNEX 3

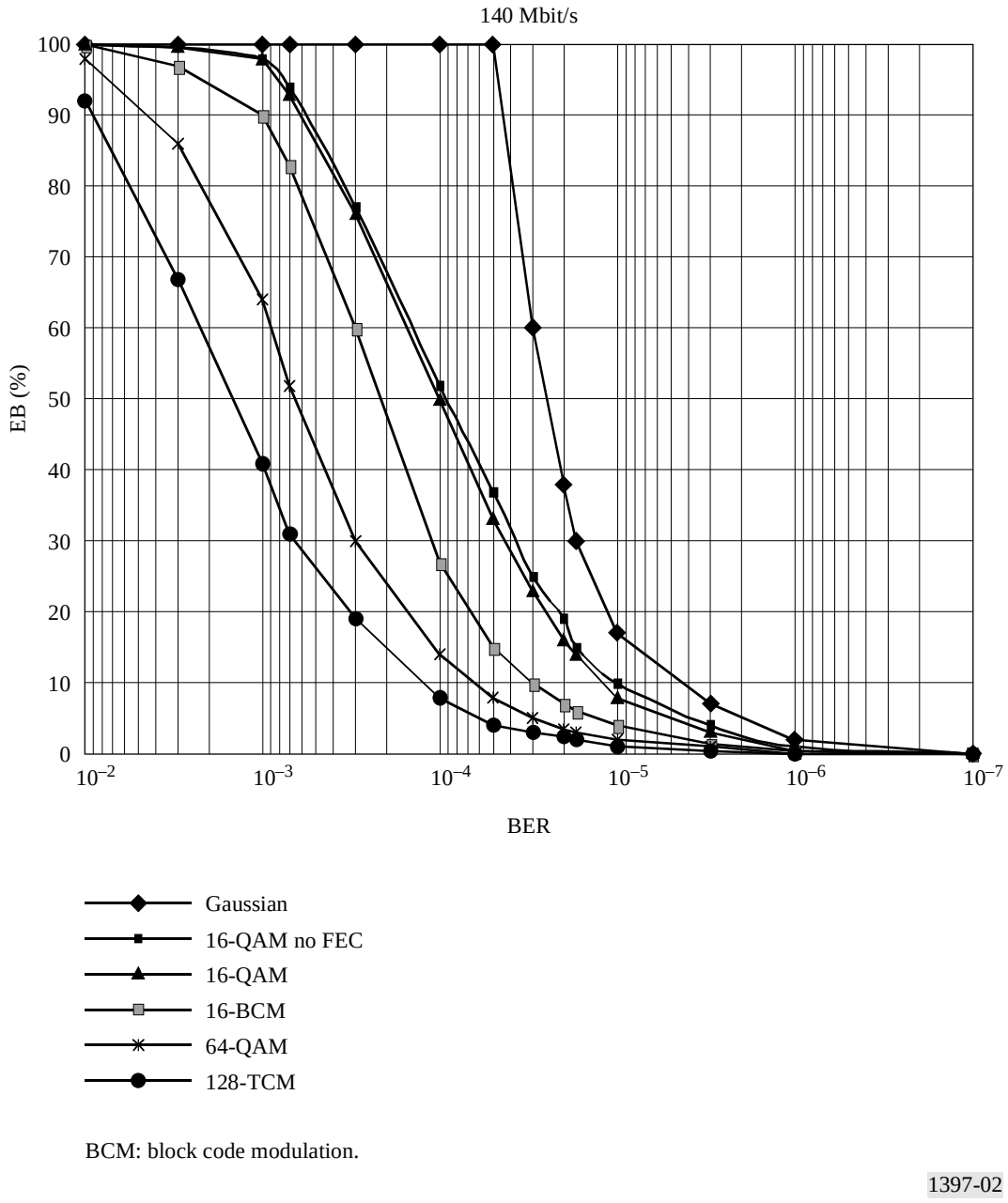
Relationship between BER and errored blocks (EB)

In order to find the relationship between BER (ITU-T Recommendation G.821) and the percentage of EB (ITU-T Recommendation G.826), some measurements have been carried out on several digital radio-relay systems, with different modulation codes.

The results, obtained in the laboratory by setting the BER value by means of a variable attenuator on a simulated hop are reported in Fig. 2, showing on the horizontal axis the BER and on the vertical axis the percentage of EB.

FIGURE 2

Relationship between BER and EB



BCM: block code modulation.

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The Fig. 2 gives the percentage of EB related to each BER value for each system, in particular it is possible to read which value of BER corresponds to the ITU-T Recommendation G.826 SES threshold (30% EB).

As far as the SES parameter is concerned, the design of radio links according to this Recommendation (and according ITU-T Recommendation G.826) could be made by following the usual methods adopted up to now, provided that the value of BER corresponding to 30% EB is used instead of the 10^{-3} BER value that was used for design of links according to ITU-T Recommendation G.821.