MEASURING OF BLOCK ERROR RATES IN HIGH-SPEED DIGITAL NETWORKS

P. Ivaniga[a)], L. Mikuš[b)]

[a)] *Department of Information Network, Faculty of management science and Informatics, University of Zilina*
[b)] *Department of Information Network, Faculty of management science and Informatics, University of Zilina*
e-mail:Petr.Ivaniga@frkis.fri.utc.sk

Summary Error characteristics is a decisive factor for the digital networks transmission quality definition. The ITU – T G.826 and G.828 recommendations identify error parameters for high – speed digital networks in relation to G.821 recommendation. The paper describes the relations between individual error parameters and the error rate assuming that these are invariant in terms of time.

1. INTRODUCTION

The recommendation ITU G.826 [1] defines qualitative parameters and final values for high – speed error transmission evaluation. In this recommendation are eliminated following problems that were not solved in G.821 recommendation.

- The error performance requirements in G.821 are based exclusively on 64 kb/s connections.
- Application for the high-speed network going out of the multiplex factor was little deep [2].
- The qualitative parameters definition was aimed at the defective bits measuring, and therefore the measuring during the operation was very difficult.

These absences conduced, to the statement of following requirements:

- Usability of the given recommendation for higher transmission speed
- The possibility of qualitative parameters measuring during the operation
- Transmission of measured medium independence
- Applied transmission system of measured independence (plesiochronous, synchronous or cellular).

2. ERROR UNITS AND ERROR PARAMETERS DEFINITION

ITU G.826 recommendation follows four basic parameters for the block error rate valuation:

- **Errored Block (EB)** – block, which contains one , or more error bits
- **Errored Second (ES)** – limited period of one second , which contains one , or more error blocks.
- **Severely Errored Second (SES)** – length interval of one second, which contains at least 30 % of error blocks, or severely errored limited period.
- **Background Block Error (BBE)** – block, does not belong to severely errored second.

Severely errored limited periods for measuring during the operation are defined differently for PDH (Plesiochronne Digitale Hierarchie) and SDH (Synchrone Digitale Hierarchie) systems. In this category are defined alarms as loss of framing synchronization, alarm broadcasting AIS (Alarm Indication Signal) signal reception. Severely error limited occurs, when the error rate is bigger then 10^{-2}. DM (Degraded Minute) parameter – reduced quality minute, which as defined in G.821 recommendation, did not approve in experience and is not applied in G.826 recommendation.

We acquire absolute values of these quantities by error unit measured as stated above. It is naturally more effectual to use relative values. G.826 recommendation defines three relative error parameters:

- **Errored Second Ratio (ESR) –** error seconds –to-total sum of seconds in followed measuring interval ratio.
- **Severely Errored Second Ratio (SESR) –** severely errored second - to – total sum of seconds in followed measuring interval ratio.
- **Background Block Error Ratio (BBER) –** error blocks – to – total sum of blocks in measuring time interval ratio.

These error parameters are valid, assuming that the system is serviceable. According to ITU G.826 recommendation, in case at least 10 second with error rate bigger than 10^{-3} follow one after another, the transmission system is not serviceable. The system becomes serviceable, when at least 10 seconds, that are not severely error.

3. BIT ERROR RATIO AND PROBABILITY OF BASIC EVENTS AS FUNCTIONS OF TIME

In real ratio – relay links Bit Error Ratio (BER) depends on propagation conditions and can be represented by a stochastic process. A precise relationship between time t and BER is derive the distribution t(BER) from distribution t(V) from distribution t(V) of fade margin V that could be known or proposed for given path [3],[4]:

$$t(V) = k_p.10^{-\frac{|V|}{\lambda}} , \qquad (1)$$

t - relative worst month time when input fade margin V exceeds the given value,

k_p - coefficient adjusted to considered path,

λ - coefficient which depends on frequency range and diversity mode

Let also assume that the relationship between BER and fade margin V[dB] could be approximated by equation

$$\text{Log (BER)}= \varphi - \beta|V| \tag{2}$$

$\varphi -$ is a constant adjusted to the link

$\beta -$ is a coefficient reflects the rate of change of the function BER(V)

For prediction of error performance parameters it is necessary to drive distribution t(BER) from (1) and (2). To solve this problem let's suppose that there is given a reference point (t_0, V_0, B_0) on the distribution curves (1) and (2). Indeed substituting the pair of coordinates (t_0, V_0) into equation (1) we can write for unknown coefficient k

$$k = t_0 10^{\frac{|V_0|}{\lambda}} \tag{3}$$

With this expression represent distribution (1) in the form

$$t(V) = t_0 \cdot 10^{\frac{|V_0|-|V|}{}} \tag{4}$$

Using the pair $(V_{0,} B_0)$ after similar manipulation equation (2) can be written as

$$\log(BER) - \log(B_0) = -\beta(|V_0| - |V|) \tag{5}$$

Comparing equation (4) and (5) we can see that both of term $(|V_0| - |V|)$. It is explicit expression can be easily found from equation (5). Substituting it into (4) and talking inverse function we can write resulting distribution BER(t) as

$$BER(t) = B_0 \left({}^{t_0}\!/_{t} \right)^m \tag{6}$$

Where the index $m = \beta\lambda$ is supposed to be a known positive number greater than one.

4. PROBABILITY OF BASIC EVENTS AS FUNCTIONS OF TIME

If relation BER (t) is known, the probability of block events can be represented as functions of time percentage t.

Probability incidence Errored Block

$$P_{EB}(t) = 1 - e^{-N_B \cdot \frac{B_0}{\alpha} \cdot \left(\frac{t_0}{t}\right)^m}, \tag{7}$$

Probability incidence Errored Second

$$P_{ES}(t) = 1 - e^{-n \cdot N_B \cdot \frac{B_0}{\alpha} \cdot \left(\frac{t_0}{t}\right)^m}, \tag{8}$$

Probability incidence Severely Errored Second

$$P_{SES}(t) = 1 - F[u_1(t)] \tag{9}$$

Where

$$u_1(t) = \frac{0.3n - n \cdot P_{EB}(t)}{\sqrt{n \cdot P_{EB}(t) \cdot (1 - P_{EB}(t))}} \tag{10}$$

In Fig.1 the curves $P_{EB}(t), P_{ES}(t)$ and $P_{SES}(t)$ are shown for VC-4 path with

$B_é = 10^{-3}, t_0 = 0{,}0001, \alpha = 1$ and m=10.

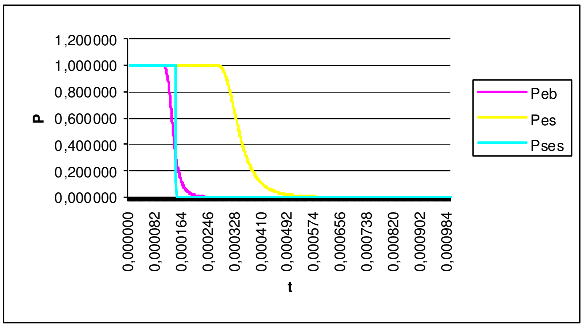

Fig. 1. Simulation with parameters Nb=18792,B0=0.001,alfa=1,t=0.0001, m=10 n=8514

5. CONCLUSION

As seen in the diagram in the Figure 1, the P_{SES} jump coefficient changes its value in a small interval from 0 to 1. For the evaluation according to the G.826 recommendation is operative fact, that the current number of error bits in the error block is not important, if the severely error extend does not follow.

Acknowledgement

This work is assisted by the FRI FGU 7/2006 institutional grant.

REFERENCES

[1] Ivaniga, P.: Error rate model for high-speed digital network. *Elektrorevue 35/2005 ISSN 1213-1539, s.1-9.*

[2] Minkin, V., Voschinin, A.: Asymptotic metod for predicting Error performance parameters and objectives for constant bit rate digital paths. *Journal of Radio Electronics n.2, Russian Academy of Sciences. ISSN 1684-1718.*

[3] Čerňanská, M.: Syntéza reči a tvorba prozódie. *Konferencia eLearn 2006 Žilinská univerzita v Žiline ISBN 80-8070-505-4.*

[4] Ivaniga, P.: Měření blokové chybovosti ve vysokorychlostních digitálních sítích. *Telekomunikace ISSN 0040- 2591, 1/2006 s.15-18.*