

ERROR RATE MODELLING

Vladislav Skorpil

Department of Telecommunications, Brno University of Technology, Purkynova 118, 612 00
Brno, CZECH REPUBLIC, skorpil@feec.vutbr.cz, <http://www.vutbr.cz/>

The main cause of degradation which infringes services providing by telecommunication network as a voice distortion for voice services, damage or change of information in case of data services is digital networks error rate. Standards for measuring and testing algorithms in telecommunication networks are defined in recommendations of the organization ITU-T, series G. Their studying is the aim of this paper. The second aim further is to create models of data transmission whose error rate was to be evaluated in agreement with recommendations ITU-T G.821, G.826, G.828, G.829 a G.8201. Programme MATLAB is used for modelling.

Keywords: BER, SES, BBE, ESR, SESR, simulation

1. INTRODUCTION

This paper comes from reference [6] first of all. The recommendation ITU-T G.821 [1] specifies the error rate parameters, matters and requirements for every direction $N \times 64$ kbit/s of digital connection ($1 \leq N \leq 31$ or ≤ 24) with switching-over rings. The recommendation ITU-T G.826 [2] specifies error rate parameters for international line working on level of primary order (2,048 Mb/s or 1,544 Mb/s) and higher or for $N \times 64$ kbit/s digital line ($1 \leq N \leq 31$ or ≤ 24). The fields of application of the ITU-T G.828 recommendation are paths based on Plesiochronous digital hierarchy (PDH) or Synchronous digital hierarchy (SDH). There is not included influence of ATM multiplex in the event of cellular based network ATM. That it defined in I.356. This recommendation (G.826) specifies error-rates matters, parameters and requirements primarily for international digital lines with constant transmission bit rate, based on Synchronous digital hierarchy (SDH). The error rate specifications observance of this recommendation guarantee in the majority of cases the observance of conditions in the G.821 ($N \times 64$ kbit/s) and G.826. The G.821 is therefore often the only specification, that is required on design of synchronous digital lines. The ITU-T G.829 recommendation is applicable on multiplex sections and regenerators of the SDH technology. Defined matters are independent on physical transmission medium. The recommendation ITU-T G.8201 [5] specifies fault matters, parameters and aims for optical data units (ODUk) of optical transmission network, that the G.709/Y.1331 recommendation defines more closely.

2. DESCRIPTION OF THE PROBLEM

In our research are inside of programme environment Matlab version 7.2.0.232 simulated and evaluated error rates in agreement with ITU-T G.821, G.826, G.828, G.829 a G.8201 recommendations. Source files are divided to m-functions, so they

can be possible to use them uniformly in more recommendations, for every direction of transmission and so they can be effectively modified.

2.1 Model of bit based G.821

It is created common model of two-ways data transmission, that is loaded with error rate for the recommendation G.821.

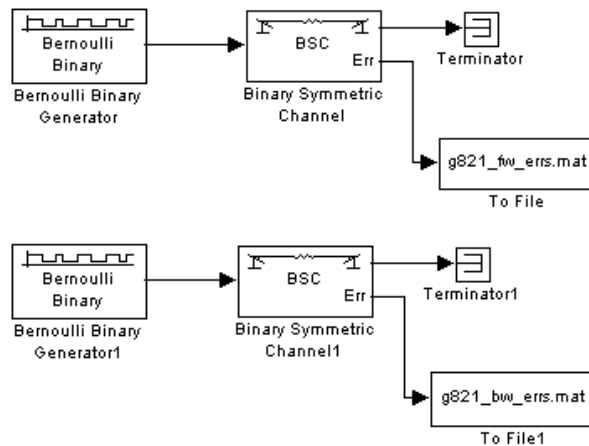


Fig.1 Model of data transmission, used in G.821

Fault bites are generated with explicit probability in Binary Symmetric Channel block and errors are generated always in the same way for the same input parameters of simulation. The necessity to evaluate the results of error rates also statistically that way falls off. The input parameters are the number of transmission seconds, transmission rate and the parameter, that indicates the probability of error bites generation for every transmission direction. Further it is possible to choose graph displaying and limiting values of error rate, which are however in the recommendation G.821 fast given.

2.2 The model of block based G.826, G.828, G.829 a G.8201 recommendations

For the rest of block based recommendations was not used Simulink for transmission line modelling but error blocks were generated in script directly. The blocks are evaluated immediately after their generation, which is in harmony with direction of recommendations to in-service monitoring. The result is very essential acceleration of the simulation and limitation of requirements to computing PC storage, for which were without this modification some simulations with higher bit rate basically non-productive. The new optional parameter is the possibility to display the monitoring blocks.

For models of recommendations G.829 and G.8201 finishing time is estimated during the simulation, because for this high transmission bit rates simulations are time exacting. They are I order tens minutes in agreement with simulated capacity of transmitted data and PC efficiency. The optional table with error parameters of single blocks can be part of listing.

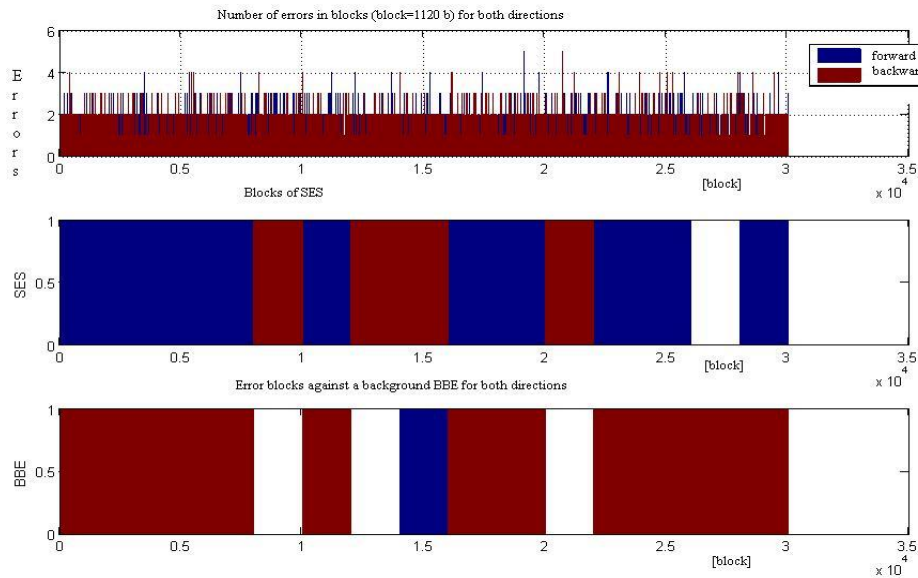


Fig.2 Sample of graphic output, error characteristic of seconds and blocks

2.3 Results of simulations

Simulation model generates bit errors relatively equally, it does not happen to more expressive generation of errors accumulation. The bit-based recommendation G.821 as the block-based recommendation G.826 can be used for evaluation of error rate digital connection $N \times 64$ kbit/s ($1 \leq N \leq 31$, respectively ≤ 24). The error rates by them are effected primarily by time error distribution on the ground of different definitions of these two recommendations. It is determinate for the G.826, that it is not important the number of error blocks until severely error second (SES) does not take up. G.826 is so tolerant towards accumulated errors, because great number of error bits in one's second interval means eminently smaller number of error blocks than the same number of error bits divided more equalize along one second. I

2.4 Error rate characteristics

Bit error rate (BER) that will be speculated further, is given as a ratio of the number of failure bits to the number of all transmitted bits and it is independency of bit rate. It is used at following of behaviour and of dependence on fault parameters. It is possible to change BER by the help of input simulation parameter $fw.ErrP$, that determines the probability of occurrence of failure bit and that matches with a small deviations in principle to parameter BER. It is used a model of the recommendation G.828 at the next text. The bit rate of the connection matches SDH VC-12, so 2.24 Mbit/s and the transmission time is 30 seconds. The number of transmitted bits is 67.2 Mb for one direction, block size is for this type of connection fast defined as 1120 bits, i.e. 2000block/s.

The genesis of errors is followed from beginning, so of $BER=0$ toward low values, input parameter of probability of error genesis ($fwErrP$) is changed and genesis of error seconds ES and their ratio ESR is traced. The model returns next values:

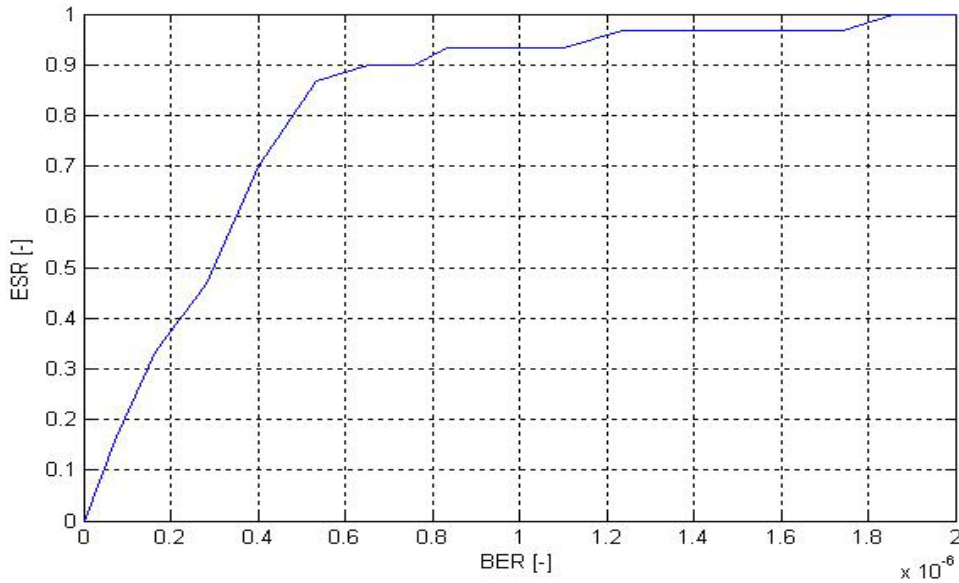


Fig.3 Dependence ESR on small values of BER

It can be seen, that input simulation parameter in principle corresponds to detected bit error rate BER. Error seconds ES and their ratio ESR growth rapidly to the value one, the model then begins generate equally errors, for every second at least one. The parameter ESR oneself so up majority of other simulations stabilizes very quickly in to the value of one.

Similarly is traced behaviour of the magnitude BBE, which is the number of error blocks which are out of court of SES. A parameter BBER – ratio of BBE to general of the number of tracked blocks, which be out of court SES, corresponds with it. This parameter BBER thus corresponds to error blocks EB, until the number of EB do not get over into indication of SES. Till then BBER with BER accordance with the model grow constantly.

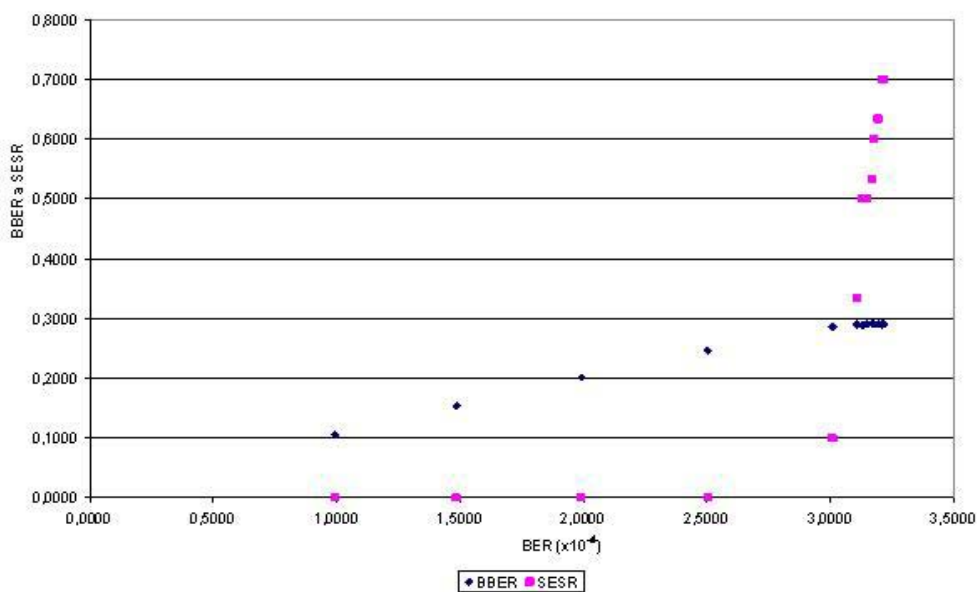


Fig.4 Dependence BBER and SESR on BER

It can be seen from the graph, how with growing bit error rate BER error blocks BBE and then also EB increase. As parameter BBER approximates to the value of 30% of all blocks that do not belong below SES, these seconds begin re-evaluate like SES and SESR then grow up rapidly. It is connected directly with definition of SES at G.828. How the number of SES grow up, also matters SEP begin find out and their intensity parameter SEPI grow up. SEP occurs, if subsequently follows 3 as far as 9 SES. SEPI is the number of SEP regions to the general of the number of seconds in accessible system state.

With further growing error rate the connection gives to the inaccessible state. At all the earlier mentioned fault parameters are speculated over only they, that occurred during the accessible system state. The number of evaluated error events then begins after this state come down. The inaccessibility occurs, if subsequently follows 10 and more SES. The system becomes accessible, if subsequently succeed at least 10 seconds, which are not high disturbed (SES).

3. CONCLUSION

Main specifications of the recommendations ITU-T G.821, G.826, G.828, G.829 and G.8201 are described at this paper, which deal with error rate in telecommunication network. Single recommendations upon themselves in a certain measure go together and they differentiate primarily at the area of availability and at defined characteristics. At proposal of the G.826 was given stress to measuring possibility in the working which admits use resources of error monitoring like are CRC and BIP, that contain current transmission systems.

Basic model of data transmission, which are loaded by certain error rate, was formed in a programming tool MATLAB and in a simulation environment Simulink. Single recommendations are applied upon these models. Input parameters are optional after possibility of single recommendations and simulation outputs that way are error rate parameters and qualitative characteristics about which was written at this paper. Results and context, that simulations and study of recommendations brought are at the paper also discussed.

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