(The article is published in the head journal of communication ministry of Russia "Electrosvjaz", No.10, October, 2006)

Multithreshold algorithms for satellite networks with optimum characteristics

Zubarev U.B., Zolotarev V.V., Ovechkin G.V., Dmitrieva T.A.

SRI RAS ,MNITI , Moscow, RGRU Ryazan

(

The summary. Last results on hardware realization of multithreshold decoding algorithms (MTD) are considered. The opportunity of practically extremely high processing rate achievement is emphasized. Concrete realizations and immediate prospects are discussed. The examples of exchange between key parameters of algorithms for different conditions of application are submitted.

The major aspect of computer science development and telecommunications now became actually general transition of communication systems and data processing to digital methods of creation, storage and data transmission. Full real transition to digital processing will be completed, probably, only in 15-20 years. Practically all countries of the world have already generated national and international programs of transition to universal digital processing and data transmission. At the moment the world is approximately in one third of long and very uneasy way to full society "digitation".

The leading part in scientific and technical maintenance of this complex social and technological process is played with modern methods of maintenance of high reliability of a digital exchange. It is important to specify, that their realization at refusal of analog messages and transition to the discrete data becomes extremely important problem which should be solved in view of prospects of development of digital communication networks including satellite. The leading part at the decision of this most complicated technological problem is allocated{removed} to powerful modern methods of noiseproof coding which only and will allow to solve a problem really an effective utilization of expensive digital communication channels.

If there are no any codes in some system of digital communication it corresponds to very inefficient using of the channel throughput, usually not exceeding several percents from its theoretically designed capacity. And, if requirements to quality and reliability of digital transmission raise, efficiency of use of the channel falls even more, as thus it is necessary, for example, or to increase channel capacity of transfer, or to lower speed of data exchange. Moreover, the inevitable and very useful tendency of coding, preliminary "packing" of information flows, the audio and visual is especial, all will develop in a direction of increasing compression factors of the initial information. And it already has now led to that "fragility" of strongly compressed images which are restored with the big distortions even if only insignificant part of bits this packed image is accepted from the channel incorrectly has considerably increased. Thus requirements to reliability of transmitted such "packed" data even faster raise.

All these reasons, i.e. deep understanding of importance of coding in digital systems, have resulted in 70th years of the last century in the first big technological revolution in communication systems, when the decoders working at Viterbi algorithm (VA) for satellite channels began to be created. The graph for bit error rate (BER) as functions bit energy to noise ratio E_b/N_0 at code rate R=1/2 for VA with a standard code of length K=7 and Gaussian noise which takes place in satellite and space channels, is submitted at fig. 1.

Clearly, that application VA, the main achievement for 1970s, could not satisfy completely experts on communication systems. Therefore all world continued to work on creation of decoding algorithms with higher code gain (CG) that would allow to raise in further efficiency of use of digital networks resources.

The further development of coding techniques – concatenation of codes with decoding at VA and Read – Solomon (RS) codes. Characteristics of this concatenated code decoding are submitted on fig.1 as VA-RS which shows substantial increase of a noise stability in satellite channels in comparison with standard VA.

For last decade a turbo codes have really proved, that work near channel capacity already became technologically accessible purpose. But in the same degree all turbo have shown convincingly that the fundamental problem of the coding theory: decoding complexity was not solved with turbo decoders.

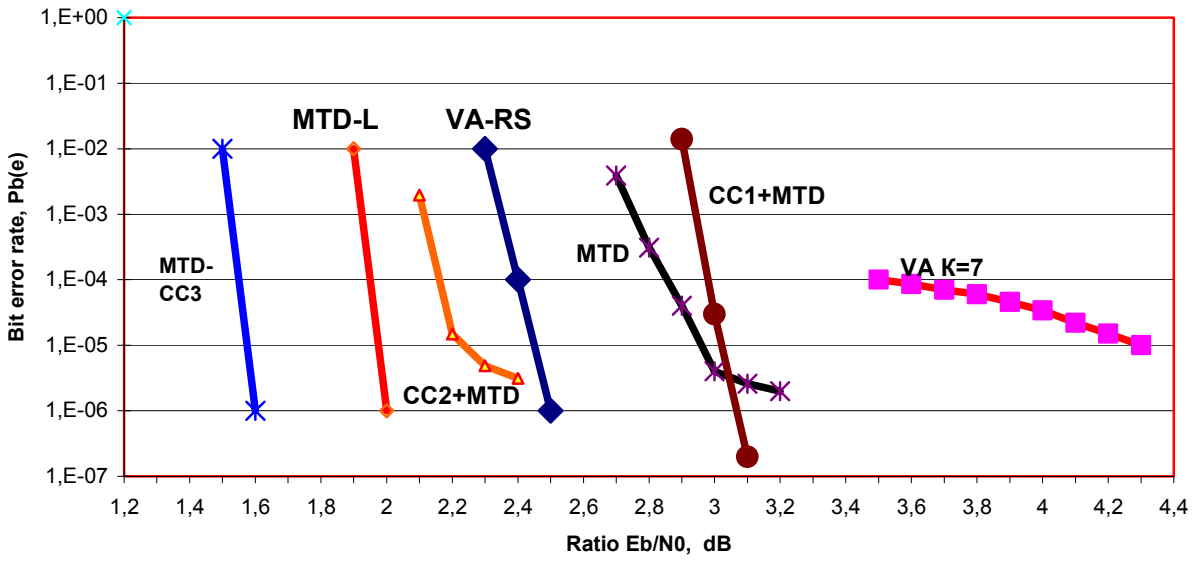
In [5] and a number of publications of authors and other Russian experts in the field of the theory and techniques of coding it has been shown, that at comparable efficiency of coding and the subsequent decoding there are methods, in particular, multithreshold decoders (MTD) [1-3] which ones for some typical parameters are actually at 2 decimal order better on number of operations, than turbo decoders. They allow to provide high reliability of data transmission in channels at rather high noise level and practically unlimited speed [5,6]. Their very high efficiency at hardware realization is defined by an opportunity of absolutely parallel operations of decoding. In many cases MTD algorithms developed from 1972 reach optimum i. e. the most plausible decision at significant noise level and only with linear from code length decoding complexity.

MTD is characterized with a very small number of operations, soft versions of these decoders can correct in channels with big enough noise level streams of the data on speeds till 2-15 Mbit/s [5], even for various digital television systems. In this direction new development also are conducted.

New results for MTD are submitted at fig.1 also.

(Full text of this article is submitted in Russian part of our veb-site.)

MTD decoder parameters on PLIS Xilinx , VA and AV+RS concatenation



The literature

1. U.B.Zubarev, V.V.Zolotarev.- Multithreshold decoders: prospects of hardware realization. // In: « 7-th the International conference and an exhibition «Digital signals processing and its application », March, 16-18, 2005, Issue VII-1, M., pp. 68-69.
2. U.B.Zubarev, V.V.Zolotarev, G.V.Ovechkin, V.V.Strokov. Multithreshold decoders for high-speed satellite liaison channels: new perspectives. // Telecommunication, 2005, №2, with 10-12.
3. V.V.Zolotarev, G.V.Ovechkin. Noiseproof coding. Methods and algorithms. The directory under edition of the member - correspondent of the Russian Academy of Science J.B.Zubareva, M., « the Hot line a Telecom », 2004, 128 with.
4. Berrou C., Glavieux A., Thitimajshima P. Near Shannon Limit Error-Correcting Coding and Decoding: Turbo-Codes. Proceeding of ICC ' 93, Geneva, Switzerland, pp. 1064-1070, May 1993.
5. Web-site SRI the Russian Academy of Science: **www.mtdbest.iki.rssi.ru**.
6. V.V. Zolotarev. The Multithreshold Decoder Performance in Gaussian Channels // In Proc. 7-th Int. Symp. on Comm. Theory and applications, ISCTA ' 03, July, 2003, Ambleside, UK, pp. 18-22.
7. T.A.Dmitrieva, V.V.Zolotarev. Development of decoding algorithm on the basis of the multithreshold decoder.-DSPA-06