

# **OPINION**

**of a dissertation  
for awarding an educational and scientific degree of "Doctor" in**

**in the field of higher education – 5. Technical Sciences  
the professional field – 5.3 “Communication and Computer Engineering”  
doctoral program – "Communication Networks and Systems"**

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**Topic of the dissertation: “Research and Improvement of the Quality of Service in  
Satellite Communication Channels”**

**Member of the scientific jury: Prof. Teodor Bozhidarov Iliev, PhD**

## **1. General description of the dissertation work and the presented materials.**

The dissertation is in the volume of 129 pages, and is structured in five chapters: Chapter I – Status, problems and perspectives in the construction and operation of satellite communication channels and services, Chapter II – Synthesizing models for simulation research of a digital system according to the DVB-S2 standard, Chapter III – Experimental research of signal parameters and characteristics in satellite digital television systems, Chapter IV – Investigation of “satellite-earth” link communication channel parameters and Chapter V – Investigation of the performance of a satellite communication system for data transmission under efficient modulation methods. It contains 72 figures (11 figures in the first chapter, 21 figures in the second chapter, 10 figures in the third chapter, 15 figures in the fourth chapter, 15 figures in the fifth chapter), 23 tables and 44 mathematical expressions.

## **2. Topic and relevance of the dissertation work**

The topic of the dissertation work is in the field of satellite communication channels, in particular in satellite television systems according to the DVB-S/S2 standard and in communications with satellite systems operating in low Earth orbit. The unwanted superimposition of various interferences and noises in the satellite communication channels is an important task related to the quality of service of the users. This is necessary in connection with the processing, transmission and reception of satellite communication signals in satellite transmitters and receivers – modulation, channel coding, multiplexing, polarization characteristics of the signal, synchronization, configuration, adjustment and coordination of the transceiver equipment. For this purpose, it is necessary to use appropriate evaluation parameters and quality indicators such as the equivalent isotropic radiated power (EIRP), the field strength, the spectral and vector characteristics of the signal and the signal-to-noise ratio under the criteria of the maximum permissible values of the modulation error rate (MER), bit (BER) and packet (PER) error rates etc.

## **3. Overview of the cited literature**

The PhD student demonstrates in-depth knowledge of the state of the issues on the topic of the dissertation work, expressed through the scope and depth of the interpretations of the used literary sources in the literature review carried out. The list of used literature includes 159

sources, of which 13 are in Cyrillic, 124 are in Latin, and 22 Internet sites, most of which are from the last 10 years.

Cited publications from articles in scientific journals and proceedings of scientific papers reflect in sufficient completeness the reached world level in the field of digital television systems.

#### **4. Research methodology**

The PhD student has formulated the following general goal: creation of methodologies of procedures related to correct approaches in configuration, monitoring and control of satellite communication systems for digital television and data transmission, by determining optimal ranges of variation of specific technical parameters and criteria, related to the effective operation and setup of satellite communication channels.

Appropriate instrumentation was used in the simulation studies. The chosen methodology for analytical and simulation studies is adequate. The methods used for computer modeling and analysis in the MATLAB/Simulink environment, as well as the Free Space Propagation Simulator, have allowed the PhD student to implement practical and simulation studies in a certain part of a satellite digital television broadcasting coverage area. The results of the research are presented in graphic and tabular form, with the relevant analysis and conclusions.

#### **5. Contributions of the dissertation work**

In my opinion, the contributions of the dissertation work have a scientific-applied and applied nature with significance and usefulness in the monitoring and control of communication systems for satellite digital broadcasting. The contributions can be summarized as follows:

##### ***Scientific-applied contributions:***

1. Analytical models of the communication channel for the “satellite-earth” transmission channel are synthesized, through which a comparative analysis is performed to determine the throughput of the channel under different theoretically applicable variants of signal modulation.
2. Simulation models were created in a MATLAB/Simulink virtual environment, based on which studies were conducted to comprehensively evaluate the degree of influence of individual configuration parameters and signal processing stages on the quality of service by evaluating the digital error rate (BER), the signal-to-noise ratio (SNR) in the transmission channel and the vector diagram of the signal at different modulation formats and transmission power according to DVB-S2 standard. The effectiveness of BCH and LDPC signal coding in a satellite DVB-S2 link channel has been evaluated. The signal-to-noise ratio (SNR) threshold levels for various combinations of channel code configuration parameters and coding depth, respectively, have been established to ensure quasi-error-free reception of signals for QPSK and 8-PSK modulation formats.
3. A simulation model of a DVB-RCS satellite communication system for broadband data transmission with MFTDMA time division multiple access and mesh topology is developed. Mechanisms for continuous resource allocation, rate-based dynamic capacity, and volume-based dynamic capacity have been evaluated for efficient frequency utilization and service quality maintenance. Research and comparative analysis of the performance (according to the network throughput criterion) of the DVB-RCS satellite communication system for broadband data transmission has been made in 3 different scenarios regarding the delivered services: for delay-tolerant services; for delay-sensitive services; performance evaluation against the number of users.

4. A comprehensive model has been developed and studied for the analysis of the effectiveness of the application of polarization modulation in order to more optimally use the available frequency resources and accelerate the synchronization time in high-frequency narrowband or high-dynamic satellite communication. Conducted for quality of service evaluation studies by determining the SER ratio and its bounds under different PM and DBPSK modulation formats and benchmarking with Monte Carlo simulation in a satellite channel with AWGN noise.

***Applied contributions:***

1. Practical studies have been carried out and an approach has been proposed for the optimal selection of frequency parameters and construction equipment for a satellite communication system and ensuring quality broadcasting of satellite television programs.
2. An experimental set-up of a communication channel for connection to an artificial satellite of the “CubeSat” type with hardware transceiver modules and a module-simulator of a satellite communication channel was developed and studied in laboratory conditions. A study was made to evaluate the packet error in a communications channel for connection with an artificial satellite of the “CubeSat” type, and graphical dependences were presented, providing information for the search for optimal solutions in the selection of the operating frequency range, altitude and parameters of the orbit, the transmission power, parameters of the receiving-transmitting antenna, as well as to evaluate the influence of the complex combination of these parameters.

The contributions have a scientific-applied and applied character with the significance of novelty in the considered issue and are an extension of existing knowledge.

**6. Publications and citations of publications on the dissertation work**

The main results obtained during the development of the dissertation work have been published in 6 scientific works, of which three publications were presented at the international scientific conference Unitech and the other three – at the TechCo conference. The publications were made during the period 2020-2022 and reflect a significant part of the research conducted by M.Eng Seyhan Myumyunalı and I believe that they gave the scientific community in Bulgaria an opportunity to get acquainted with his dissertation work.

I accept as equal the participation of the PhD student in all publications in which he is a co-author.

There are no data on citations of the publications presented on the dissertation work.

**7. Authorship of the obtained results**

The one independent publication of the PhD student M.Eng Seyhan Myumyunalı, as well as the two publications in which he is in first place, are proof of his participation in conducting scientific research on his dissertation work. The presented scientific ideas and approaches presented and defended in various scientific forums are an assessment of the PhD student's personal contribution.

It follows from this that the materials presented in the dissertation work are the independent development of the PhD student.

**8. Author's summary and author reference**

The author's summary is in a volume of 39 pages, as the numbering of the mathematical expressions and figures corresponds to that in the dissertation work. In my opinion, the

