REVIEW

of a dissertation
for the acquisition of the educational and scientific degree "Doctor of Philosophy"

in the field of higher education – 5. „Technical sciences“,
professional direction – 5.3. „Communication and computer technology“,
Doctoral program - “Communication networks and systems”

Author: M.Sc. Eng. Seyhan Sadik Myumyunali
Topic: „Research and improvement of the quality of service in satellite communication channels”
Reviewer: Assoc. Prof. Dr. MSc. Eng Egnar Ibrahimova Ozdikililer – Department of Information Technologies, University of Telecommunications and Posts - Sofia

1. The topic and relevance of the dissertation

The relevance of the problems raised and the related research on the dissertation can be defined as significant and broad-spectrum in terms of the development of satellite communications and the implementation and expansion of the services in them.

The search and experimentation of new orbits and the improvement of channel coding, the use of new modulation schemes and the expansion of the frequency spectrum lead to significant results related to improving the efficiency and quality of the connection. Choosing a channel code with higher efficiency would allow to reduce the speed of the code used and increase the frequency of the modulation used, while maintaining the probability of error. This, in the turn side, leads to an increase in the bandwidth of the channel. In order to obtain maximum noise resistance, it is necessary to perform optimization of the parameters of the modulation constellation after optimization of the channel code. The optimization of the modulation constellations allows to achieve an optimal compromise between the noise resistance of the radio channel, energy efficiency and the resistance to non-linear distortions.

The chosen topic allows for combining various statistical, analytical and software methods for data analysis and processing, and the means of information and communication technologies are used to ensure the transmission of satellite data and measurement productions with monitoring of satellite channel parameters. The presented topic leads to the creation of methodologies of procedures related to correct approaches in monitoring and control in satellite digital broadcasting communication systems, by determining optimal ranges of amendment of specific technical parameters and criteria related to the effective operation and setting of satellite communication channels.

2. Literature review for citations part

The review includes a list of 159 sources applied, 137 of which are literary sources, and the rest are Internet addresses, which according to the contents of the note can be distributed in the following directions:

- Standards for satellite communication and digital television broadcasting (DVB – S/S2)
- Research of satellite communication channel and evaluation of the efficiency of coding and modulation in order to improve the quality of services;
- Development, synthesis and conduct of research on simulation models of satellite communication system for data transfer;
- Presentation of technical means and system solutions for monitoring satellite reception parameters of digital television signals;
- Technical approaches applied to improve the quality of service in satellite communication channels;
- Research of communication channel for connection with low-coordinate small satellites of the type "Cubesat".

The literature review from period between 1963 to 2012 include nearly 65% of the cited papers. The period considered to be modern (2012-2022), which affects the last 10 years, covers about 35% of the sources. An evaluation has been made from the studied issues, which allows to take into account of the achievements so far related to the reflection of significance and usefulness in ensuring the quality of service in satellite communication channels in planning, construction, operation and management of them.

3. Methodology of research

The object of research is both the transmission (wireless) environment and the behavior in it of the signal parameters characterizing the satellite communication channels.

The subject of research is the different processes related to transmission, reception and synchronization, as well as the dependencies related to modulation and modulation errors (MER), field strength, bit/error ratio – bit error factor (BER), lost packets of information (PER), signal/noise ratio, channel coding type, etc.

The research methods are mainly divided into separate chapters, such as analytical, simulation and practical, and cover the dependencies of the parameters characterizing the implementation and quality of the service.

The place of study is, for example, concerning practical studies in a certain part of a coverage area with satellite digital television broadcasting. The “Matlab/Simulink” environment was used for simulation studies and practical experiments were carried out in laboratory conditions with available measuring equipment.

4. Contributions of the dissertation

In view of the research work carried out, two categories of contributions are grouped, reflecting the qualities and new aspects in the preparation of the dissertation, the doctoral

student has complied with the remarks from the preliminary review and has cleared the contributions from common known facts and has reformulated, shortened and unified them:

❖ Scientific and applied contributions:

- Analytical models of the communication channel “artificial satellite – earth” are synthesized, through which a comparative analysis is carried out for a certain bandwidth of the connection channel in different theoretically applicable variants of signal modulation.
- Simulation models have been created in the Matlab/Simulink virtual environment. Research has been done to fully assess the degree of influence of individual configuration parameters and stages of signal processing on service quality by assessing the binary error factor (BER),The signal-to-noise ratio (SNR) in the transmission channel and the signal vector diagram in scenarios with different modulation formats and transmission power at DVB-S2 standard. An assessment has been made of the effectiveness of the VHF and LDPC signal encoding in the satellite DVB-S2 connection channel. The signal-to-noise threshold levels (SNR) have been established for different combinations of the configuration parameters of the coders and respectively the coding depth to ensure quasi-error-free reception of signals for QPSK and 8-PSK modulation formats.
- A simulation model of DVB-RCS satellite communication system for broadband data transfer with multi-frequency multiple-access split-time MF-TDMA and mesh-topology has been developed. An assessment of the mechanisms for continuous resource allocation, dynamic speed-based capacity and dynamic volume-based capacity has been carried out to efficiently use frequency and service quality maintenance. The research and a comparative analysis of the performance (according to network throughput criterion) of the DVB-RCS satellite communication system for broadband data transfer has been made under 3 different scenarios in terms of the services supplied: for delay-tolerant services; for delay-sensitive services; performance evaluation against the number of users.
- A comprehensive model for analyzing the effectiveness of the application of polarization modulation is developed and studied in order to make better use of available frequency resources and speed up the timing of synchronization in high frequency narrowband or high dynamic satellite communication. Conducted for quality-of-service studies by determining the SER factor and its limits in different PM and DBPSK modulation formats and comparative analysis with Monte Carlo simulation in the AWGN satellite channel.

❖ Applied contributions:

- Practical experiments have been conducted and an approach has been proposed for optimal selection of frequency parameters and equipment for the construction of a satellite communication system and provision of quality translation of satellite television programs.

- Developed and researched is the experimental setup of a communication channel for communication with an artificial satellite type "Cubesat" with hardware reception-transmission modules and a module-imitator of a satellite communication channel in laboratory conditions. A package error assessment study has been conducted in a communication channel for communication with an artificial satellite type "Cubesat" and graphical dependencies are presented, providing information for the search for optimal solutions in the selection of operating frequency range, height and parameters of the orbit, transmission power, reception antenna parameters, etc.as well as to assess the impact of the complex combination of these parameters.

5. Publications and citations on publications on the dissertation

In terms of reflecting the results of the dissertation, six publications were presented at international conferences and scientific publications, fully meeting the minimum requirements for the criterion under consideration. Three of the works were presented at the International Scientific Conference “Unitech” and three at the National Conference and “TechCo”, one of which is independent, and the other five were prepared in co-authorship with the scientific director and author’s team. The publications are published in collections with scientific peer review by the International Scientific Conference “Unitech” and the National Conference “TechCo” in the period of training 2020-2022, and actually present nearly 2/3 of the content of the dissertation.

In this regard of research, I can recommend that the PhD student continue to publish his results in both similar with impact factor and Scopus rank publications. The applied results have scientific value in the indicated direction, allowing them to be used in implementation activities and participation in national and international projects under various operational programs.

6. Authorship of the obtained results

In the exposition of the dissertation was realized a significant volume of research and experimental activity by the doctoral student under the guidance of his scientific supervisor. I think that a huge share of the conducted research and analysis in connection with the generalization of the results is entirely personal contribution of eng. Seyhan Myumyunali. The orientation of the results obtained greatly builds on the current research on the processes of signal processing – generation, encoding, modulation, transmission and reception of DVB-S/S2 signals – by synthesizing simulation models and conducting practical experimental results.

7. Authorship and author's report

The content of the author corresponds to the content of the dissertation. The meanings of the figures and formulas in the author coincide with those of the dissertation. My assessment of the author is that; he meets the generally accepted requirements and faithfully reflects the content and contributions of the dissertation. The author gives a clear idea of the

essence of the problem, the purpose and the tasks of the dissertation, as well as the way in which they are solved. The results of analysis, modeling and experiments, conclusions and contributions are briefly and clearly outlined. It is formed in 39 printed pages and has the same structure of the dissertation, ending with a short summary in English.

8. Opinions, recommendations and remarks on the dissertation

In my opinion, dissertation is made with methodological, in-depth and different focus sets of studies in a software and real experimental environment regarding the problems raised in the dissertation. In connection with the described studies, analyzed results, synthesized models and implemented practical experiments, I defined remarks and recommendations in the preliminary review, which are taken into account and I find that they have been removed. However, in some places in the dissertation there are stylistic, spelling and grammatical errors in terms of the presentation of the information.

In my opinion, the dissertation achieves the stated goal, with the defined tasks being performed at a high scientific level and the dissertation has a finished character I recommend that in the future the PhD student should continue his research working together with colleagues from TU Gabrovo, and the results obtained should be presented and published in international conferences and in refereed journals with “impact factor” (WoS) or Scopus rank.

9. Conclusion

I don’t know the author in person. Dissertation review is based on the pre-submitted material.

The topic of the dissertation is up-to-date and well developed. The problems identified and the related research, as well as their justification, are satisfactorily significant and comprehensively described in the paper.

In my opinion the presented dissertation **meets the requirements** of the **Law on the Development of Academic Staff** in **The Republic of Bulgaria.** The obtained results give me reason **to propose** to the Honorable Jury that the educational and scientific degree of "Doctor of Philosophy" should be awarded to M.Sc. engineer Seyhan Sadik Myumyunali in the field of higher education – 5. „Technical sciences“,
professional direction – 5.3. „Communication and computer equipment (engineering)“,
Doctoral program - “Communication networks and systems”

15th of January 2023

Reviewer: **/signature/**
/Assoc. Prof. Dr. MSc. Eng. Egnar Ibrahimova Ozdikililer/