

REVIEW

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

field of higher education – 5 Technical sciences

professional direction – 5.3 Communication and computer technology

doctoral program – Communication networks and systems

Author: Eng. Boris Blagoy Arsov, MSc

Topic: Performance management and quality of service in mobile broadband networks

Reviewer: Prof. Dr. Eng. Grigor Mihaylov

1. Topic and topicality of the dissertation

The problems of increasing the efficiency and quality of services in modern broadband information transmission technologies and the access of users to the networks for the transmission of such information have always been the attention of specialists working in the field of telecommunication services and their applications.

The topic of the dissertation considered in this aspect directly corresponds to the efforts to increase the efficiency of the connection between individual users and provide an environment for access to the information sources of a larger number of users at a higher speed of data exchange. Like comes out from such position at the assessment on the dissertation the reviewer quite definitely accepts that the subject on research and related topics are current and immediate related to needs on the contemporary informative community.

In this sense, it can be unconditionally assumed that the dissertation deals with current problems related to the development and application of the fundamental theory and practice of communication systems.

I accept the justification of relevance made by the doctoral student and consider that the stated considerations are correct and well-founded.

2. Overview of the cited literature

The dissertation has a volume of 174 pages and includes 5 chapters, conclusion, list of publications on the dissertation, list of used abbreviations, used literature. The analysis of the problems of ensuring the information potential, efficiency and quality of services in broadband communication systems and the trends in solving them by applying appropriate techniques shows that the doctoral student knows the issues in depth, based on many literary sources (184), the majority of which are quite modern, published in specialized scientific journals and renowned international forums.

3. Research methodology

The purpose of the dissertation is formulated on the basis of an in-depth and reasoned analysis of the current state of problems in ensuring the effectiveness and quality of services of radio channels in broadband communication systems and specifically in mobile networks.

For the conducted analyzes and research in the actual part of the dissertation, modern mathematical tools are applied, i.e. appropriate methods for analysis and synthesis and modeling of processes in communication networks. These methods can be applied to the theory and practice of information transmission systems, digital signal processing, computer modeling, etc. The simulation studies, which have a high evidentiary value and are implemented in a suitable programming environment, confirm the correctness of the methods, algorithms and mathematical proofs developed in the dissertation work. The results are

presented in tabular and graphic form, with a thorough analysis of the same. Each chapter is accompanied by a summary and conclusions from the main results obtained. In general, in my opinion, a significant amount of research work has been done.

The tasks set in the dissertation are adequate to the problem and are solved in the necessary volume and at a high scientific level.

4. Contributions of the dissertation work

As a result of the research within the framework of the dissertation work, the following contributions, defined as scientific and applied, were obtained:

1. An analytical methodology for designing and calculating the parameters of a broadband mobile network is presented. In it, mathematical dependencies related to network load factors in the forward and reverse direction, with determination of radio coverage, radio propagation losses, and antenna gain are derived. All this is supported by examples of application of this methodology in radio coverage planning in dense, medium and sparsely built-up urban environments;

2. On the basis of the obtained analytical results, it was found that when the mobile station moves and approaches the limits of cell coverage, it is necessary to broadcast with greater power in order to ensure the required quality. The power control algorithm has limits, and when the power regulation reserve resource is used up, it switches to channel switching (handover). Broadcasting with a very high power leads to a decrease in the sensitivity of the system, therefore the parameter BPC is introduced to regulate the power, the value of which is 0.7 at a speed of movement of the subscriber of 3km/h and 0 at a speed of movement of the subscriber of 50km/h h;

A simulation model of WCDMA End-to-End physical layer is synthesized Physical Layer , on the basis of which research was done and graphical results were displayed for three different cases of the environment and the user's movement in it. Based on this, the effective BER values can be determined depending on the SNR, related to ensuring the quality of services under the different conditions;

4. Experimental results of the parameters of a broadband mobile network in urban conditions are presented, by using specialized software applications installed on a mobile station. The signals from 2 operators in an urban environment in 2/3/4 and 5G modes of operation along certain routes were investigated by changing the speed of movement of the mobile measuring station. From the statistics and the analysis of the obtained results, 12 specific conclusions have been established, related to improving the efficiency of management and ensuring a better quality of services in an urban environment;

5. The proposed experimental set-up and practical studies were carried out by the regulatory body for the Republic of S. Macedonia - the Electronic Communications Agency (AEC). Statistics, processing and analysis of the practical results for voice services and data transfer of the most important operators for the country have been carried out. Macedonia. A process has been developed that includes network monitoring, measurements of key performance parameters and cell optimization to improve efficiency and quality of service;

6. Real measurements were made related to the emission of non-ionizing radiation from the base stations of the mobile operators related to the commissioning of the new 5G technology. Diagnostics and evaluation of the operating characteristics related to ensuring the quality of service in urban areas have been carried out, problem areas have been localized and basic technical and technological solutions for its improvement have been defined.

5. Publications and citations of publications on the dissertation work

From the presented publications, I can conclude that the obtained results have been approved widely enough at authoritative forums and are available to the scientific community in the field of communication systems.

I believe that the PhD student's dissertation publications contain the main contributions he claims. This corresponds to the requirements of the Law on the Development of the Academic Staff and the Rules for its Implementation for the publication of the most essential parts of the dissertation work.

6. Authorship of the obtained results

Judging by the publications, it is clear that the doctoral student has been working on this topic for many years. The fact that two of the publications are independent, and in the other two the doctoral student is the lead author in the team, speaks for the authorship of the contributions of the dissertation work. This, as well as the author's specific presentation style, give me reason to have no doubt about the leading role of Boris Arsov in the preparation of the publications.

7. Abstract and author reference

The abstract is prepared accurately and presents the main points of the scientific research conducted by the doctoral student and accurately reflects the content of the dissertation work and the results obtained.

8. Opinions, recommendations and remarks on the dissertation work

As for certain weaknesses and critical remarks, such can be pointed out. But before that, the reviewer shares the following: Even when the first edition of the author's dissertation was presented, a number of inaccuracies and remarks of a terminological and semantic nature, etc., were pointed out. The reviewer confidently confirmed that the majority of these weaknesses have been removed in the latest edition.

Nevertheless, the following recommendations and observations can be made:

- In certain places in the exhibition, more detailed explanations and comments related to generally accepted and known facts are allowed ;
- I recommend the candidate to make fuller use of his professional qualifications and publish articles in specialized international journals with an impact factor, which will expand his contacts with the international scientific community.

These notes do not detract from the value of the dissertation.

9. Conclusion

In terms of volume, completeness and thoroughness, the dissertation **meets** the requirements of the Law on Higher Education, the Law on the Development of the Academic Staff and the Rules for its Implementation for the Awarding of the Educational and Scientific Degree "Doctor" in the Republic of Bulgaria.

The achieved results give me reason **to propose** that the educational and scientific degree "Doctor" be acquired from the Eng. Boris Blagoy Arsov, MSc in the field of higher education - 5 Technical sciences, professional direction - 5.3 Communication and computer technology, doctoral program - Communication networks and systems.

18.03.2024

Signature: /signature/
/Prof. Dr. Eng. Gr. Mihaylov/