

REVIEW
from
Prof. Eng. Raycho Todorov Ilarionov, DSc

of a dissertation
for the acquisition of the educational and scientific degree "PhD" in the
field of higher education – 5. "Technical Sciences"
professional field – 5.3. "Communication and Computer Engineering"
PhD program – "Communication Networks and Systems"

Author of the dissertation: *Mag. Eng. Boris Blagoi Arsov*

Dissertation topic: *"Efficiency and Quality of Service Management in Mobile
Broadband Networks"*

1. Topic and topicality of the dissertation

The actuality of the issues raised and the research related to the dissertation work are defined as topical and broad-spectrum in terms of the development of mobile broadband communications and improvement of the quality of their services.

The research and issues addressed in my dissertation submitted for review include the processes related to modeling approaches, architecture selection and implementation, the necessary equipment and proper configuration through monitoring and evaluation of signal parameters in broadband mobile networks to improve communication performance and the quality of services in them. As criteria for determining the quality of service, various evaluation parameters and quality indicators related to signal characteristics and the signal/noise ratio have been used, with set criteria for the maximum permissible values of the parameters bandwidth, data rate, etc.

The chosen subject gives opportunity for combining heterogeneous statistical analytical and software methods for data analysis and processing, and the means of information and communication technologies are used to improve the efficiency and quality of services in broadband mobile networks, where the main emphasis is on the evaluation of the parameters of the channel as well as the dependencies between them, determining the quality of the signals and the efficiency of the network.

2. The structure of the dissertation and an overview of the cited literature

The dissertation includes an introduction, five chapters, a conclusion, a list of abbreviations used, a list of publications on the dissertation, a list of references, the dissertation, with a volume of 171 pages. It was developed based on an analytical review of 142 literature sources and 42 Internet-based sources. The exposition in the first chapter of the dissertation will allow the dissertation student to evaluate correctly the current state of the problem and formulate the purpose and tasks of research in the dissertation work.

The cited literature covers the period of the last 20 years, with nearly 60% of the total amount analyzed in the interval of the last 10 years. It can be said that an assessment of the problem has been made, which makes it possible to take into account the achievements to date related to the reflection of importance and usefulness in the planning, construction, operation and management of broadband mobile networks.

From the reference made for the fulfillment of the minimum national requirements and the requirements for acquiring the educational and scientific degree "PhD", it can be seen that the scientometric data of the candidate M.Sc. Eng. Boris Blagoi Arsov cover and exceed in terms of points the minimum national requirements and the requirements of TU-Gabrovo.

A group of metrics	Indicator	Number of points	
		Requirements	Eng. Arsov
		1	2
A	1. Dissertation work for the award of the educational and scientific degree "doctor": "Efficiency and Quality of Service Management in Mobile Broadband Networks", Professional direction: 5.3. Communication and computer technology, Speciality: Communication networks and systems,	50	A = 50
G	7. Scientific publication in publications that are referenced and indexed in world-renowned databases of scientific information		G.7 = 13.33
	8. Scientific publication in non-refereed peer-reviewed journals or in edited collective volumes: 2 independent and 2 co-authored	30	G.8 = 50 Total: G = 63.33

Separately, the doctoral student has also presented 11 co-authored works directly related to the topic of his dissertation work and his work as a control body and expert in the Agency Electronic Communications (AEC) in the Republic of S. Macedonia, which is a good certificate of his competence in this field.

3. Methodology, purpose and tasks of research in the dissertation work

The subject of the dissertation work is management of efficiency and quality of services in broadband mobile networks, where the main emphasis is on the evaluation of the channel parameters as well as the dependencies between them, determining the quality of the signals and the efficiency of the network.

The subject of research are the various processes at the physical level related to the communication channel, as well as the dependencies concerning the parameters determining the efficiency of information transmission in specific conditions.

The research methods are mainly identified in the separate chapters, such as analytical, simulation and practical, and cover the dependences of the parameters characterizing the implementation of the individual models. The study site is an example of practical studies of the communication channel in a certain part of a coverage area in

a wireless network. The software environments Matlab/Simulink, TEMS Investigation, Ariesso, GIS on the ESRI platform were used for the simulation studies. Exemplary models of radio coverage in a broadband mobile network using wireless channels are presented through simulation models demonstrating the mutual correlation and dependence of the parameters in them.

The purpose of the research is related to the creation of methodologies from procedures related to correct approaches in modeling, selection and implementation of architecture, the necessary equipment and the correct configuration, by monitoring and evaluating the parameters of signals in broadband mobile networks, related to improving the efficiency of communication and the quality of services in them.

For the realization of the formulated goal, the tasks set by the dissertation are related to:

- ❖ Creation and description of analytical methodology in designing and calculating the parameters of a broadband mobile network.
- ❖ Development and synthesis of simulation model in Matlab's Simulink graphical environment for WCDMA (End-to-End Physical Layer) study and performance study of broadband mobile network model.
- ❖ Carrying out a study of the parameters of a broadband mobile network and opportunities to improve the quality of services in a densely populated urban area and statistical processing of the results.
- ❖ Carrying out practical measurements of the coverage and broadcasting of the mobile operators in the Republic of S. Macedonia related to the quality of services and diagnostics during the operation and setup of cellular networks in urban and suburban areas, and through the results to make an independent assessment of the quality of the provided radio coverage and to propose methods and measures for its improvement.

4. Dissertation publications and contributions

Regarding the coverage of the results of the dissertation work, five publications at international conferences and scientific publications are presented, fully covering the minimum requirements regarding the considered criterion. Two of the works were presented at the International Scientific Conference "Unitech" and two at a national conference and "TechCo". Two of them are independent. The publications were issued in peer-reviewed collections from the international scientific conference "Unitech" and the national conference "TechCo" in the study period 2022-2023, actually representing nearly 2/3 of the content of the dissertation work. One of the publications was presented at an international scientific conference and was published in the American AIP refereed publication, which has a Scopus rank. The publications present a large part of the conducted research and present the main conclusions of the dissertation work.

In view of the scientific and research work carried out, the following **scientifically applied** and **applied** contributions can be presented, reflecting the qualities and new aspects in the preparation of the dissertation work:

Scientifically applied contributions

- ❖ An analytical methodology for designing and calculating the parameters of a broadband mobile network is presented.
- ❖ 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;
- ❖ A simulation model of the WCDMA End-to-End Physical Layer was synthesized, based on 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;

Applied contributions

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

In the dissertation, a significant amount of scientific research and experimental activity was carried out by the doctoral student under the guidance of his supervisor. I believe that a huge share of the conducted research and compiled analyzes in connection with summarizing the results are entirely personal contributions of the doctoral student. The orientation of the obtained results greatly enhances the currently existing research on signal processing processes - generation, coding, modulation, transmission and reception of signals - by synthesizing analytical and simulation models and conducting practical experimental results in broadband mobile networks.

6. Abstract and author reference

The abstract is in a volume of 42 pages, and the numbering of the mathematical expressions and figures corresponds to that in the dissertation work. I believe that the abstract is structured well and in accordance with the requirements, reflects sufficiently fully and correctly the relevance of the work, its purpose and tasks, applicability of the results and approbation.

From the author reference made, I did not find any plagiarism by the author in the presented dissertation and the published works related to it. I believe that the content and layout of the dissertation and the author's abstract meet the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for the Acquisition of Scientific Degrees and the Occupancy of Academic Positions at TU-Gabrovo.

7. Opinions, recommendations and remarks on the dissertation work

I believe that in-depth methodical, and with different orientation, sets of researches in software and real experimental environment have been done regarding the issues raised in the dissertation work. In connection with the described research, analyzed results, synthesized models and implemented practical experiments, the following remarks and recommendations can be defined:

- In separate places in the report of the presentation, stylistic and grammatical errors regarding the speech when presenting the information are noticeable, which could easily have been prevented;
- Structurally, I suggest making corrections to language differences and dropping some commonly known facts;
- To check for the same type of presentation of the same variables in the different analytical dependencies in the separate chapters of the dissertation.
- Regarding the formulated contributions to the dissertation work, it is good to make a clearer categorization and specification of the scientific-applied contributions.

8. Conclusion

The topic of the dissertation is current and well developed. The issues raised and related research, as well as their justification, are up-to-date and comprehensively described in the development.

I believe that the submitted dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason **to propose** that the educational and scientific degree "Doctor" **be acquired** from the M.Sc. Eng. Boris Blagoi Arsov in the field of higher education - 5. "Technical sciences", professional field - 5.3. "Communication and computer engineering", doctoral program - "Communication networks and systems".

March.8th.2024

Reviewer: **/signature/**
(Prof. Eng. Raycho Todorov Ilarionov, DSc)