

# OPINION

**From Associate Professor Violeta Todorova Bozhikova, Ph.D., Eng.  
Technical University-Varna,  
Professional direction 5.3. "Communication and Computer Engineering"**

**Subject:** dissertation work for the acquisition of the educational and scientific degree "**DOCTOR**" in professional direction 5.3. "Communication and Computer Engineering".

**Author:** Teodora Ivanova Pasarelska, doctoral student of self-study in doctoral program "Telecommunications" - NBU.

**Topic of the dissertation:** "Research on methods for planning and distribution of the radio frequency spectrum in the Republic of Bulgaria".

**Scientific supervisor:** Prof. Dr. Plamen Marinov Tsvetkov.

**Grounds for presenting the review: member of the Scientific Jury, according to Order No. Z-RK-27/17.10.2024 of the Rector of the NBU.**

The review was prepared in accordance with the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for the Implementation of this Law and the Ordinance on the Development of the Academic Staff at the NBU.

## **1. Significance of the researched problem in scientific and scientific-applied terms**

The subject of the dissertation submitted to me for opinion is "Research on methods for planning and distribution of the radio frequency spectrum in the Republic of Bulgaria". The investigated problem is significant for the development of the telecommunications sector and has an impact on the economy in our country. That is why the relevance of the problem developed in the dissertation work in scientific and scientific-applied terms is indisputable.

The dissertation work has a total volume of 214 pages including text, tables and illustrations. Its content is structured in 5 chapters, including a conclusion. The dissertation concludes with lists of sources of information used and abbreviations and definitions used.

The large volume of used literary sources (212 in number) is evidence of a comprehensive overview and is in accordance with the subject of the dissertation covering the basic principles of the management and distribution of the radio frequency spectrum.

The layout of the doctoral work, the researches, analyzes and findings made show the competence of the doctoral student regarding the researched problem.

The dissertation work has its scientific and scientific-applied contributions, based on extensive studies and analyses, as well as on the proposed methodology for conducting a simulation study to determine the mutual influence between radio-electronic equipment of users of a radio-frequency resource for mixed use.

## **2. Justification of the objectives and tasks in the dissertation work**

The dissertation was developed and aims to serve as a scientific-methodical guide in solving real problems related to the distribution, planning and management of the radio frequency spectrum in our country.

The formulated main objectives in the dissertation work are:

- 1) Study of the methods of distribution, planning and management of the radio frequency spectrum to ensure the implementation of modern wireless broadband electronic communication services and achieve efficient, shared, dynamic and loyal use of this resource;
- 2) Allocation of sufficient and appropriate radio frequency spectrum for the provision of telecommunication services;
- 3) Provision of conditions for coordinated and harmonized use of the radio frequency spectrum.

In order to achieve the defined goals, the following main tasks are defined in the dissertation:

Task 1: Analysis of the current state of the methods, approaches and strategies for planning and management of the radio frequency spectrum in the Republic of Bulgaria and their harmonization with European and world trends.

Task 2: Research and analysis of the basic principles and current trends in the management and allocation of the radio frequency spectrum.

Task 3: Exploring the possibilities and planning the necessary technical, regulatory and organizational procedures to ensure the implementation of modern wireless broadband electronic communication services.

Task 4: Development of approaches and methodology for radio frequency spectrum management. Development of computer models, conducting simulation and real field studies of objects.

In conclusion, the dissertation has clearly defined and scientifically based goals and objectives.

## **3. Correspondence between the chosen methodology and research methodology and the set goals and tasks of the dissertation**

The chosen methods and research methodology in the doctoral work are in accordance with the stated goals and objectives.

The dissertation follows a research methodology with a methodical action plan related to several main guidelines as follows:

- An analytical review of the current state of the radio frequency spectrum in the Republic of Bulgaria and harmonization with European and world trends is made.
- Terrestrial networks and radio frequency bands 900 MHz and 1800 MHz are analyzed. 2 GHz, 2.3 GHz, 2.6 GHz and 3.6 GHz radio frequency bands, 700 MHz and 800 MHz bands are considered.
- The radio frequency spectrum for the fourth generation (LTE), for terrestrial digital radio broadcasting - DVB-T, the frequency ranges suitable for "point-to-point" and "point-to-multipoint" networks, as well as satellite telecommunication networks for provision of mobile services, radio frequency spectrum for devices with a short range of action, frequency ranges intended for "Machine-to-Machine" (M2M) communication and others.
- A study of the methods of allocation, planning and management of the radio frequency spectrum is carried out, emphasizing a method of using spectrum that is not individually assigned, a method with an individually assigned limited resource, a method of licensed



joint access to radio frequency spectrum and a method of determining the right to use radio frequency spectrum.

- The implementation of modern wireless broadband electronic communication services is being investigated. Emphasis is placed on innovations such as 5G technology and IoT integration.
- Spectrum management and the regulatory framework are analyzed, noting spectrum licensing and allocation, public-private partnerships, organizational strategies and infrastructure development, and operational management.
- A methodology is being developed for conducting a simulation study to determine the mutual influence between radio electronic equipment of the users of a radio frequency resource for mixed use. Scenarios and an exposition of a simulation research method are presented. Data is collected and analyzed.
- Mathematical analysis and interference models are prepared for emerging systems and techniques such as 5G base stations. Mathematical concepts and approaches to the study of base station interference are defined, surveying signal propagation, interference modeling, and interference mitigation techniques.
- Tests and studies are carried out, ending with concrete results and evaluation of the validation of the mutual influence between the radio-electronic equipment of the users of the radio-frequency resource for mixed use.

In summary, it can be emphasized that the research methodology and methodology used correspond to the goals and tasks set in the dissertation work.

#### **4. Scientific and applied scientific contributions of the dissertation work**

I believe that the number of contributions formulated by the doctoral student is too large (a total of 37), which are mostly scientific-applied.

I am convinced that the contributions presented by Teodora Pasarelska in the dissertation work are her own work, but they could be presented in summary, for example, in the following 5 groups concerning «Research», «Analysis», «Research and Analysis», «Systematization», «Development of new approaches, models and methodologies» (this could include contributions numbered 22, 24, 32 and 36).

In conclusion, regardless of the notes made, there is a large volume of work, proving the doctoral student's competence on the topic of the dissertation, a consistent and analytical approach in conducting the studies and an ability to synthesize the resulting conclusions, conclusions and contributions. The proposed contributions can relate to obtaining new knowledge and enriching the researched area with new knowledge, as well as to the application of scientific knowledge in practice. They have the potential to enrich the accumulated theory and practice in the field of communication technologies.

#### **5. Publications on the dissertation work**

The publication activity of the doctoral student corresponds to the field of the dissertation work. 6 publications are presented, all published in 2022 and 2023. Four of the publications are scientific articles in peer-reviewed and refereed scientific journals and collections from the NACID reference list.

Of the presented publications for the dissertation work, there are none that are referenced in world-renowned databases, there are no publications abroad, and no citation data. Nevertheless, the doctoral student's publication activity is sufficient to meet the requirements related to the presentation and defense of a dissertation.

#### **6. Citation by other authors**

At the time of drafting the opinion, there are no citations of the doctoral student's publications in world-renowned databases.

One of the deposited scientific publications (with number 4 - doi: <https://doi.org/10.33919/YTelecomm.22.9.7>) is cited in Google Scholar.

### 7. Opinions, recommendations and notes

I believe that the dissertation work has its scientific value and meets the mandatory legal requirements of the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for its implementation, as well as the regulations of the New Bulgarian University.

The dissertation makes an impression both with the volume of studies, analyzes and results, as well as with the volume of the abstract and formulated contributions. My opinion is that the abstract should be presented more compactly, in a reduced volume, and the contributions should be summarized, which would not reduce the value of the work done by the doctoral student. I will also note that "thorough" and "detailed" in the formulation of the contributions are not appropriate definitions for the qualitative evaluation and quantitative measurement of the results of the dissertation work.

I will make several recommendations regarding the candidate's dissertation work and future activities:

- I recommend that the candidate's future scientific activity be oriented mainly towards scientific publications in world-renowned specialized journals and referenced and peer-reviewed databases such as Scopus, Web of science and others.
- I recommend expanding the doctoral student's participation in international scientific forums, in a different format, such as conferences, symposia, congresses, etc., including abroad. This will lead to the worldwide presentation of the candidate's scientific publications, to the establishment of useful scientific contacts and to future collaborations in the wider scientific community.

### CONCLUSION

The dissertation work submitted to me for opinion with author Teodora Ivanova Pasarelska represents an extensive study, having its scientific and scientific applied value.

The doctoral thesis fully complies with the mandatory legal requirements of the Law on the Development of the Academic Staff of the Republic of Bulgaria and the Rules for its implementation, as well as with the Normative Regulations of the New Bulgarian University.

Based on all of the above, I give my **positive assessment** regarding the dissertation work on the topic "Research of the methods for planning and distribution of the radio frequency spectrum in the Republic of Bulgaria" and **I support** the awarding of Teodora Ivanova Pasarelska with the educational and scientific degree "**Doctor**" in the scientific specialty "Telecommunications", in a professional direction 5.3. Communication and computer technology.

Date: 26.10.24

Signature:.....

/Assoc. Prof. Eng. Violeta Todorova Bozhikova/