

REVIEW

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

field of higher education – 5 Technical Sciences

professional field – 5.3 Communication and Computer Engineering

doctoral program – “Communication Networks and Systems”

Author: Eng. Emmanouil Themistoklis Kypraios

Topic: Methods and Algorithms for Research on Multiplexed Signals in Passive Optical Communication Networks

Reviewer: Prof. Krasen Kirov Angelov, PhD, Technical University – Gabrovo

1. Topic and relevance of the dissertation work

The passive optical network with the application of spectral multiplexing of signals (WDM-PON) is considered as a promising architecture for future high-speed networks, especially where very high bandwidth or isolated channels are required (for example, corporate services, elements of communication in 5G mobile cellular networks, special applications, etc.).

The issues of WDM-PON communication networks are an active topic in the research community, including hybrid WDM/TDM approaches, spectrum optimization, protection, reliability and integration with new network architectures. Technologies around spectral multiplexing (DWDM, CWDM) continues to develop, and standards such as ITU-T G.9802 for WDM-PON are in the process of development and expansion. This defines passive optical networks with spectral multiplexing of signals as an actively researched technology, and the relevance of the dissertation work – as indisputable.

The topic of the dissertation is fully presented, being developed into four main chapters, which sequentially examine the current state and the main problems in modern passive optical communication networks with spectral multiplexing, the process of creating models of a multi-channel optical communication network and their research and analysis, the implementation of an experimental system for studying multiplexed optical signals in a passive optical network.

2. Overview of the cited literature

A total of 79 literary sources are included in the reference list, of which 5 are in Bulgarian, 72 in English and 2 are on the Internet. The majority of the literary sources have been published in the last 7 years.

The analyzed literary sources are relevant to the problem under consideration and sufficiently and completely reflect the scientific and applied achievements reached at the world level in this field. As a result of the analysis, the doctoral student has appropriately defined the object, subject, objectives and tasks of the dissertation work.

I believe that the doctoral student has demonstrated a very high level and depth of knowledge of the researched scientific problem and the ability to analyze, draw theoretical conclusions and recommendations with practical value regarding technologies in the field of

optical communication networks and the challenges associated with their planning, design, construction and optimization.

3. Research methodology

The dissertation is prepared in a total volume of 126 pages and includes 128 figures, 12 tables and 9 formulas. A clear and correct formulation of the subject area, the object of research, the goal and tasks of the dissertation is made. The structure of the dissertation includes a sequence of introduction and four chapters with formulated conclusions for each of them. General conclusions are made on the dissertation and summarized scientific and applied contributions are derived.

The dissertation uses the methods of analysis of information in the literature and theoretical sources and the conduct of applied research related to the issues of modern passive optical networks with spectral multiplexing of signals: comparative analysis, induction and deduction, modeling, experiment and verification.

For the purposes of the study, in Chapters 2 and 3, simulation modeling of a multi-channel optical communication network was applied, and in Chapter 4 - experimental research and verification through a specially created stand with multiplexing of optical signals in a passive optical network. I believe that the research methodology in the dissertation work has been correctly selected and implemented through the application of appropriate approaches and research tools.

4. Contributions of the dissertation work

The dissertation work of Eng. Emmanouil Kypraios is a comprehensive, logically consistent and well-structured scientific product. It clearly highlights the analysis and evaluation of the developed methods and algorithms for the study of multiplexed signals in passive optical communication networks. In this regard, I believe that the dissertation work contains the claimed contributions related to the enrichment of existing knowledge, and I accept their classification as scientific-applied and applied, as follows:

A) Contributions of a scientific and applied nature:

1. A methodology and algorithm for optimal planning, sizing, modeling and research of passive optical networks with spectral multiplexing of signals are proposed.
2. Simulation models are synthesized for research, analysis, performance assessment and solving optimization problems in high-speed multi-channel optical networks using different formats for optical signal modulation and various complex configuration parameters.
3. The degree of influence of the high optical density in the fiber core on the occurrence of nonlinear effects (FWM, SPM and XPM) in different formats of optical signal modulation (RZ and NRZ) is studied.
4. Dependencies are derived for determining the boundary conditions and the maximum value of the Q-factor for different input parameters and network range, with criteria for evaluating the value of propagation losses, eye diagrams of channel optical signals and the optimal value of the input optical power.

B) Contributions of an applied nature:

5. Simulation models of multi-channel high-speed optical communication networks have been developed and studied to solve optimization problems according to the criteria of achieving a minimum BER value (Min. BER) or maximum Q-factor and ensuring maximum network performance and efficiency for different input signal parameters.
6. An experimental setup of a passive optical network with spectral multiplexing of signals for the delivery of interactive services has been developed and studied, designed to perform three main tasks: to allow a wide variety of practical studies (traffic processing, introduction of new services and modules for management and communication, etc.); to be a platform for conducting general research in the field of passive optical networks; to provide convenient and easy training for personnel.
7. A practically oriented approach to experimental research has been proposed and experimental results have been presented for the complex determination and evaluation of the energy balance and parameters of the model for the study of multiplexed optical signals in a passive optical network, using specialized measuring equipment.

5. Publications and citations of publications on the dissertation work

The validation of the results obtained in the dissertation work is ensured by the presented 6 scientific publications from participation in national and international scientific conferences. All publications present the different aspects of the research on the dissertation work.

The analysis of the presented publications and the attached reference with scientometric data shows that 64.98 points were obtained for a group of indicators G, which doubles the minimum of 30 points according to the minimum national requirements. In addition, of the presented 6 publications, 2 are single-authored, which also exceeds quantitatively and covers the additional minimum requirements (5 publications, of which 1 independent) of TU – Gabrovo.

From the above facts it follows that the candidate meets the minimum national requirements for acquiring the educational and scientific degree “doctor” under Art. 2b, para. 2, 3 and 5 of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB) and the minimum quantitative requirements of TU - Gabrovo.

There is no data presented on known citations of publications on the dissertation.

6. Authorship of the obtained results

A sufficient volume of scientific research has been carried out on the problems of the dissertation work. Active work continues in this area, which is evident from the information sources used.

In compliance with the national regulatory requirements and the internal rules of TU-Gabrovo, a comprehensive review of the submitted publications on the dissertation work and the dissertation manuscript itself was carried out, and the authorship of the texts was validated after a due check and the absence of plagiarism was established. The above facts give reason

to consider that the results obtained within the framework of the research are largely the merit of the doctoral student Eng. Emmanouil Kypraios and his personal authorial contribution.

7. Author's abstract and author's reference

The author's abstract is in a volume of 48 pages and fully corresponds in structural and content terms to the dissertation reviewed by me. The requirements for layout have been met and all necessary attributes have been included in accordance with the Regulations for the acquiring of scientific degrees and holding academic positions at TU-Gabrovo. The abstract gives an unambiguous, clear and complete idea of the key aspects of the research, analyses and contributions of the dissertation work.

The author's reference presents summaries of the publications on the dissertation work, the subject of which covers the individual scientific research tasks defined in the dissertation work.

8. Comments, recommendations and remarks on the dissertation work

I believe that the dissertation of Eng. Emmanouil Kypraios and the scientific research on it have been fully and completely presented and published. The doctoral student has demonstrated the necessary high level of in-depth technical knowledge, research skills, analytical, critical and creative thinking and focus on results in the development of the dissertation.

Regarding the content of the scientific materials submitted for review on the dissertation, I could not point out more significant critical remarks. I would like to note the need for better precision and correctness in the terminology used, imported from foreign languages, ensuring a wider range of analyzed literary sources and increasing attention to detail in terms of the layout of scientific works.

I recommend that in the future developments and research of the doctoral student on this topic, the scope be expanded in terms of the relationship with the mechanisms for effective traffic processing, new methods for coding and encrypting data in optical communication channels, as well as in terms of technological innovations in the field of optical communication equipment. It will be of great interest for the obtained results to be directed for presentation and publication in international scientific forums and publications, indexed and referenced in global databases.

The above remarks and recommendations do not belittle the obtained results and scientific value of the presented dissertation work and are intended to serve as useful guidelines in the future scientific and research development of the doctoral student and his aspiration to increase his visibility in the scientific world.

9. Conclusion

I consider that the presented dissertation meets the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria and the regulations for the acquiring of scientific degrees and holding academic positions at the Technical University - Gabrovo.

The achieved results give me reason to propose that the educational and scientific degree "Doctor" be acquired by Eng. Emmanouil Themistoklis Kypraios in the field of higher

education – 5. Technical Sciences, professional field – 5.3. Communication and Computer Engineering, doctoral program – “Communication Networks and Systems”.

13.02.2026

Reviewer: /signature/
/Prof. Krasen Angelov, PhD/