OPINION

by **Prof. Maria Petkova Hristova,** PhD
on the Thesis for awarding educational and scientific degree "Doctor"
Scientific Field: 4. Natural Sciences, Mathematics and Informatics;
Professional Area: 4.6. Informatics and computer sciences;
Doctoral program: Informatics

Author of the PhD Thesis: **Tasho Dimitrov Tashev**

Thesis Title: **Algorithms for conflict-free scheduling of a packet crossbar switch node**

This opinion was prepared according to order № 65/27.02.2023 г of the Director of BAS Institute of Information and Communication Technologies (IICT), by which I was selected as a member of the scientific jury on the procedure for doctoral thesis defense of doctoral student Tasho Dimitrov Tashev, on the subject Algorithms for conflict-free scheduling of a packet crossbar switch node for the acquisition of educational and scientific degree PhD in professional area: 4.6. Informatics and Computer Science.

General description of the presented materials

As a member of the scientific jury, I received:
• PhD Thesis;
• Abstract in Bulgarian and English;
• Attestation for exams taken and credits received;
• a list of printed scientific publications on the dissertation subject;
• copies of printed scientific publications on the dissertation subject;
• reference on the fulfillment of ICT minimum requirements.

The presented set of materials is in accordance with Art.8 of the Regulations on the specific conditions for acquiring scientific degrees and for occupying academic positions at IIKT-BAS.

Actuality, aim and tasks of the dissertation work

The thesis is thematically situated at the interface between computer science, in particular algorithmization and modeling of information processes, and technical sciences, in particular telecommunication systems, where commutation plays an essential role. Switching summarizes the processes of constructing a transmission path for the telecommunications signal from a given input to a given output among groups of inputs and outputs of the switching system. The most important function of switching is to ensure the collective use of the resources of the telecommunications system that carries the signals and manages the data exchange. The channel switching inherent in classical systems has been replaced in digital systems by packet switching and is usually implemented in exchanges, switching nodes, concentrators and routers. They are components of a computer network, including the Internet, and run specialised telecommunications software.

Tasho Tashev's dissertation is dedicated to a packet switch with a matrix switch. The main subject of study are conflict-free scheduling algorithms, modeled with the means of the formal apparatus of Generalized Networks (NG). The goal of this dissertation is formulated as: gaining methodological experience in the use of the Generalized Networks apparatus in the modeling of conflict-free scheduling algorithms for a matrix switch packet switch with input buffering of the "virtual output queues" type and developing a new, more efficient algorithm called MiMa (Minimum of Maxima) and its formal OM model. The task is also to approbate a

methodology for computer simulations of its throughput, providing an unambiguous comparison of different algorithms. The goal thus set has the potential of a PhD thesis. To achieve the goal, four tasks are defined.

Knowledge on the area researched

The clearly defined goal, well motivated and specifically formulated tasks, good and logically coherent structuring and content-rich presentation of the dissertation text, as well as the 130 cited sources (all correctly cited in the text), give me reason to assume that the PhD student has a good knowledge of the theoretical and applied aspect of the problem area, subject of the research.

Research methodology

The research methodology and scientific instruments used to acchieve the aim of the dissertation are appropriately chosen and contribute to the fulfillment of the dissertation tasks, which is proved by the presented results.

General characteristics of the dissertation work and its contributions

The dissertation consists of 138 pages, 42 figures and 4 tables. The work is structured by an introduction, a statement in five chapters and a conclusion, directions for future research, a list of author's publications on the dissertation work topic, a declaration of originality of the obtained results, a bibliography and meets the requirements of Art. 27(2) of the Regulations for Implementation of Development of the Academic Staff in Republic of Bulgaria Law.

Chapter one of the study provides an overview of approaches, methods and tools for research on information interaction models. It motivates the use of the apparatus of Generalized Networks as a formal tool to describe parallel processes. Chapter two describes Generalized-Network models of algorithms with input Buffering and Virtual Output Queues. The OM-models developed for two algorithms (and three modifications thereof) with sequential computation are described and conclusions are drawn on the appropriateness of using generalized nets. In Chapter 3 generalized network models of conflict-free scheduling algorithms and results of computer simulation of throughput are presented. In Chapter 4, the problem of synthesizing a new conflict-free scheduling algorithm in a packet switch with a matrix switch is solved by proposing an OM-model MiMa. The developed new numerical procedure for exact upper bound of the algorithms throughput in a given range of switching field dimensionality is presented in Chapter Five. Suggestions on "improving" the MiMa algorithm are made are made. In the conclusion, the main results obtained in the thesis are reported and directions for future research are given.

I accept the main four *scientific-applied and applied contributions* summarized by the doctoral student at the end of the dissertation and in the abstract, which were achieved by solving the tasks set in the thesis. I consider that original and significant results have been obtained, which correspond to the aim set in the dissertation. The contributions can be defined as the enrichment of an existing scientific field with new knowledge and applied aspects.

Fulfillment of the minimum requirements of IICT for doctor degree in Professional Area 4.6. and assessment of dissertation publications

The author's publications on PhD Thesis topic (one independent) are 7 in total. Five of them are scientific publications referenced and indexed in world-famous databases with scientific information such as: Numerical Analysis and Its Applications, Springer (*Scopus/ Web of Science*, JCR-IF); AIP Conference Proceedings (Scopus, with SJR); Proceedings of the 8th IEEE International Conference on Intelligent Systems (*Scopus/ WoS*), Proceedings of the 6th

IEEE International Conference on Intelligent Systems (*Scopus*). According to the reference submitted by the doctoral student for the fulfillment of the minimum requirements of IICT with the required 30 points for group "D" (Scientific publications referenced and indexed in world-famous databases with scientific information (Web of Science, Scopus, Zantralblatt, MathSciNet, ACM Digital Library, IEEE Xplore and AIS eLibrary) the PhD student collects *88 points* from five submitted publications, thus exceeding the requirement. According to the NACID registration reference, Tashev's points for this group are 132.

I think that dissertation results are very well presented to the scientific community and that dissertation work and the original results obtained are personally made by the doctoral student. No evidence of plagiarism was found in the work.

A total of 6 citations of 3 publications of the PhD student were noted.

Abstract of PhD Thesis

The author's abstract corresponds in volume and content to the requirements of ZRASRB and the Regulations for specific conditions for acquiring scientific degrees and for holding academic positions in IICT.

Critical notes, questions and recommendations

In an applied aspect, I think it would be useful to clarify to a greater extent how modelling by means of Generalized Networks contributes to the improvement of existing packet switches with matrix switches and what are the challenges of searching for a new algorithm based on the so-called "hard" conflict criterion.

Q: What advantages does the proposed MiMa algorithm have over the previously known software and hardware solutions to the problem of switch node conflicts.

As a remark, it should be noted the presence of inaccuracies in the numbering of figures and tables in the dissertation, which leads to the difference in the number of pages, figures and tables mentioned by the doctoral student in the dissertation and in the abstract (in Bulgarian and English).

My recommendation to Tasho Tashev is to continue his research in the field, as the topic has a high degree of applicability and broad prospects for development.

CONCLUSION

My assessment of the dissertation work, the abstract and scientific publications on the dissertation of Tasho Dimitrov Tashev is *entirely positive*. The PhD student demonstrates a thorough theoretical knowledge in the specialty of the doctoral program "Informatics" at the frontier with the technical sciences, where a high level of proficiency in the terminology of the thesis topic and a proven ability for independent research are applied.

Considering the original scientific and applied contributions obtained, I think that the dissertation fully meets the requirements of the Law on the Development of Academic Staff in Republic of Bulgaria, the Regulations for its implementation, as well as the Regulations for the specific conditions for acquisition of scientific degrees and for holding academic positions in IICT. All this gives me confidence to recommend to the respected members of the scientific jury **to award Tasho Dimitrov Tashev the educational and scientific degree "Doctor" in the professional field 4.6. Informatics and Computer Science, Doctoral program Informatics.**

25.04.2023   Prep

На основание

ЗЗЛД