REVIEW

of the thesis for awarding the educational and scientific degree:

"**Doctor of Philosophy**",

under the Scientific Field: **5. Technical Sciences**,

the Professional Area: **5.3. Communication and Computer Techniques**,

the Scientific PhD Specialty: **"Computer Systems, Complexes and Networks"**

PhD Thesis Title: **Study of the Dependability Characteristics of a Fault-Tolerant Distributed Real-Time System with Adjustable Reliability**

PhD Thesis author: **Dipl. Eng. Edita Ananieva Djambazova**

Reviewer: **Acad. Vassil Stoyanov Sgurev, DSc**

I have been appointed as a member of the Scientific Jury regarding the procedure for the acquisition of the educational and scientific degree "Doctor of Philosophy" (PhD) of the aforementioned PhD Thesis by order №191 from 20.07.2023 of the Director of the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences, and based on the Development of the Academic Staff Act in the Republic of Bulgaria and based on §30 (2) of the Act's Institutional Regulation. At its meeting on 21.07.2023, the Scientific Jury selected me to be a reviewer of the PhD Thesis.

As a member of the Scientific Jury, I received on paper and electronically the PhD Thesis, the PhD Thesis abstract, the publications of the PhD student for the PhD thesis, and the accompanying administrative documentation.

The survey of the above documents demonstrates that they completely conform to the requirements of the Development of the Academic Staff Act in the Republic of Bulgaria, the Regulation for its enforcement, the Regulation for the conditions and the rules of acquisition of scientific degrees and holding academic positions in the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences.

All requirements of §3 of the Regulation for the specific conditions for the acquisition of scientific degrees and holding academic positions in the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences are fulfilled concerning the minimal credits in the Professional Area 5.3 Communications and Computer Engineering for awarding the educational and scientific degree "Doctor of Philosophy". In the group of indicators A, the PhD student has the required number of 50 points and in the group of indicators G, the required points are 30 while the PhD student has 100 points.

The subject of the PhD thesis presented for review is very important and topical not only for computer systems but also for a broader area of controlled technical systems operating in real time. The research in this field began a half-century ago and continues its intensive development. The class of real-time systems has bigger requirements than the conventional computer systems and they are related to their reliability characteristics.

The task of developing fault-tolerant distributed real-time systems is extremely difficult since the increase of the system's dependability can be implemented in the hardware, software, or both, applying hardware and software methods and means to achieve as little expenses as possible. In the PhD thesis, to solve this task mostly hardware means are used. With this respect, the PhD student uses the term "adjustable reliability". Fundamental concepts are shown to solve the issues.

The fault-tolerant distributed system with adjustable reliability proposed by the PhD student is accompanied by several tools for modeling dependable distributed systems. Their reliability characteristics are derived.

The PhD student has proposed model of the fault-tolerant distributed system with adjustable reliability. The methods to model this class of systems are selected. A description of the research tasks and the results of their fulfillment is given, by simulation modeling.

Based on the simulation results of the fault-tolerant distributed system with adjustable reliability important recommendations are given for its design and exploitation. The obtained results allow for the extension of the scope of that class of systems.

To describe the probabilistic nature of the operation of the proposed fault-tolerant distributed system with adjustable reliability an exponential distribution and Markov chains are used. Only one-step solutions are used.

In Chapter 3, the results of the study of the fault-tolerant distributed system with adjustable reliability are described and analyzed. For that purpose, a software product developed by the PhD student is used.

The obtained scientific, scientific and implementation, and implementation results are closely interrelated and it is not appropriate to strictly distinguish them. The amount and the thoroughness of these results completely cover the requirements for the acquisition of the educational and scientific degree "Doctor of Philosophy".

All presented publications are related to the PhD thesis theme.

The following remarks and recommendations about the PhD thesis can be made:

1. It would be appropriate to consider a case where if one of the many peripheral devices fails, the software self-adapts to operate without that device, i.e., the system operates with degraded functionality without stopping and disturbing the controlled objects.

2. It is not clear why for the simulation of the fault tolerance discrete network and network-flow structures are not used, as well as controlled multi-step Markov processes. They are very relevant for that purpose since they allow for a multi-step control of the fault-tolerance.

3. It would be desirable in the resolution of the fault-tolerance tasks to use additional characteristics to denote and use the risk and the probability of unfavorable events.

4. Many times the term "approach" is used incorrectly instead of the term "method".

The above remarks are recommendations for future work. They do not question at all the obtained research results of the PhD student.

During the preliminary discussions, I had the opportunity to make other remarks and recommendations as well and they were considered by the PhD student in the final version of the PhD thesis.

CONCLUSION

Bearing in mind the declared contributions in the reviewed PhD thesis, as well as the fact that all requirements of the relevant regulatory documents for the educational and scientific degree "Doctor of Philosophy" are observed, I firmly recommend to the Scientific Jury to award **Dipl. Eng. Edita Ananieva Djambazova** the educational and scientific degree "Doctor of Philosophy" (PhD) in the Scientific Field **5. Technical Sciences**, the Professional Area **5.3. Communication and Computer Techniques**, the Scientific PhD Specialty **"Computer Systems, Complexes and Networks"**.

На основание
ЗЗЛД

30.08.2023 Reviewer:

Sofia /Acad. Vassil Sgurev/