
G. S. RAKOVSKI NATIONAL DEFENSE COLLEGE

REVIEW

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on dissertation by YOANA ATANASOVA IVANOVA

**STUDY OF THE IMPACT OF CYBERATTACKS ON THE
TRANSPORT MANAGEMENT SYSTEMS**

for the Doctor's educational and research degree
in Higher Education Domain 5. Engineering Studies,
Professional Area 5.3 „Communication and Computer Engineering“
under the Doctor's program:
„Automated Systems for Information Processing and Control“

1. Topicality and significance of the scientific problem developed.

The dissertation work, developed by Assistant Ioana Atanasova Ivanova, is dedicated to a topical problem, both scientific and applied. This is determined by the fact that transport management systems, as an important component of any transportation system, are often the potential target of various cyber threats. All of this leads to the need to develop measures to strengthen and maintain a secure, functioning and sustainable transportation system by implementing effective means of protection, assessing the risk of cyber-threats and preventing possible adverse consequences.

A comprehensive methodology for assessing the vulnerability of the transport system to cyber attacks has not yet been developed.. Successful completion of such a task is only possible by creating an appropriate cyber defense system architecture, a model of cyber vulnerabilities, as well as simulation models, algorithms and technologies to enhance the sustainability of the transport management system.

The dissertation work of assistant Yoana Ivanova is devoted to this problem.

2. Background and structure of the dissertation.'

The dissertation consists of an introduction, three chapters, a conclusion and literature in a total volume of 274 pages - 217 pages of the main text and 58 pages in 8 Appendices. The dissertation contains 55 figures and 41 tables.

The dissertation presented by the author has no similar developments.

The Ph.D. student is very familiar with the state of the problem. The introduction of the dissertation justifies the relevance and defines the purpose and main tasks that are to be solved.

Chapter One analyzes the vulnerabilities and impact of cyber threats on the transportation management system, and in particular on the Traffic Control

Center (TCC). Based on the analysis of the main types of transport and transport systems, the choice of road transport is justified as the most appropriate for conducting experimental studies.

Chapter Two explores the possibilities of modeling the impact of cyber threats on the transportation management system. For this purpose, the Riverbed Modeler simulation software was chosen, through which a model of the Traffic Control Center and the traffic signaling system of the urban road transport system was developed. An experiment was conducted on the impact of a Denial of Service (DoS) attack on the Traffic Control Center. On the basis of the obtained results of the simulations, suitable remedies for cyber attacks were proposed.

In the Third Chapter is developed methodology for assessing the vulnerability of a system for managing transport to cyber attacks by modeling of complex systems on the basis of empirical research done and comparative analyzes. Measures are proposed to increase the resilience of the transport management system in the form of an eight-step structured sequence. In support of the methodology, a risk assessment was performed applying two different methods by using simulation results.

3. Characteristics of the scientific and applied scientific contributions in the dissertation. Authenticity of material.

The declared scientific results in the dissertation of the Ph.D. student are credible and are derived from the content of the main part and the applications of the development. I take these results as scientific and applied contributions. I accept the contributions suggested by the author in the author's summary of dissertation as follows.

1. Scientifically-applied contributions of the dissertation:

1. A model of adaptive architecture of a cyber defense system is proposed, on the basis of which simulated network configurations are created, as well as a model about link between the basic conceptual model of the Cyber Threat Triangle and the simulation and visualization tools through which vulnerabilities can be detected and reduced.

2. A model of a Traffic Control Center was developed in the simulated environment Riverbed Modeler Academic Edition 17.5, on the basis of which an assessment and analysis of the impact of DoS - attack on urban road transport system were made. The model is optimized and tested by conducting additional experiments.

3. A methodology for vulnerability assessment and planning of measures to increase the sustainability of the transport management system has been developed, using simulation modeling results to minimize financial costs and avoid real damage to the system in the implementation of cyberattack on it.

4. An assessment and analysis of the environmental effects of cyberattack on urban road transport systems has been carried out.

Applied contributions of the dissertation:

1. The logical functioning of a transport management system, and in particular of the Traffic Control Center, as its main subsystem, is justified.

2. The NetLogo simulation model of cyberattack against management structure based on reporting data from the Global Risk Map is analyzed and applied to create similar data models.

3. The possibilities of three different simulation agent-based modeling environments NetLogo, Aimsun and Riverbed have been analyzed, as two of them - NetLogo and Riverbed – have been selected for the experiments.

4. Algorithms have been developed to build models in the simulation environments used, which can be applied to other similar studies.

5. Comparative characteristics of the methods for assessing the vulnerability of the system to cyber attacks have been performed - simulation modeling and “penetration tests”.

6. A risk assessment was performed using the simulation modeling results obtained to prove the work hypothesis regarding the negative impact of cyberattacks on the transport management system.

4. Evaluation of the scientific results and contributions of the dissertation.

The main contributions of the dissertation can be defined as the adaptation, improvement and further development of existing knowledge, methods and technologies for solving specific problems and applying the results obtained in practice.

The results of the research carried out in this work represent the personal work of the Ph.D. student and outline the importance of the contributions made to the theory and practice related to cybersecurity in the transport management system.

I accept the results of the experiments and believe that they would be used by other authors.

I accept the main scientific and applied results, considering them to be the personal work of the author.

5. Evaluation of publications related to the dissertation and authorship

Number of publications related to the dissertation is 3 individual. One of them was reported at a scientific conference at the G.S.Rakovski Defense and Staff College in 2018. Two have been published in international refereed journals in English, in 2018 and 2019, respectively. Scientific publications are

relevant to the topic of the dissertation.

They tested the main scientific and applied contributions of the Ph.D. student. I do not know that the Ph.D. student was quoted.

6. Opinion on the presence or absence of plagiarism.

The contributions to the dissertation are the personal work of the Ph.D. student. It should also be noted the good methodological and scientific guidance of the Research Advisor Col. Assoc. Prof. Ph.D. Ivan Hristozov, which led to the successful completion of the assigned tasks and the achievement of the goal of the dissertation.

I do not know that an anonymous and motivated written signal has been received to establish plagiarism in the dissertation and / or in its publications

7. Literary awareness and competence of the Ph.D. student.

The literary awareness of the PhD student is much better. The list of references contains 108 titles, 35 of which are in Bulgarian and Russian and 73 in English. Literature sources are cited and used correctly.

8. Evaluation of the author's summary of dissertation.

Author's summary of dissertation has been developed according to the requirements in terms of volume, structure and content and correctly reflects the main scientific and applied contributions received in the dissertation.

9. Critical remarks.

I got acquainted with the dissertation in connection with the preliminary defense and as an internal reviewer I submitted my notes to the Ph.D. student. Many of them were taken as appropriate in the final design of the work. Despite the proven contributions, the dissertation would benefit if the following recommendations are taken into account:

- The results achieved should be summarized.

- For greater clarity in the developments of this type is recommended presenting the methodology of the study, in which it is carried out with a display scheme;

These notes and recommendations do not significantly affect the importance of the contributions to the dissertation. The dissertation is a thorough and well-formed scientific work from the study of a current problem and has made significant scientific and applied contributions, proving the ability of the Ph.D. student to independently develop important questions about theory and practice.

10. Personal impressions and other issues on which the reviewer believes he should take a stand.

I have known the Ph.D. student since 2012 as a student in the Master program "Communication and Information Systems and Technologies in Security and Defense" at the G.S. Rakovski National Defense College. I consider that she is a highly trained researcher with an affinity for novelty and research. I believe that the Ph.D. student Ivanova has acquired the necessary knowledge and experience and is able to formulate and develop scientific and applied scientific problems independently.

11. Conclusion.

In the dissertation, the scientific and applied results necessary in quantity and quality are achieved.

The dissertation fully complying with the requirements of the Act on the Academic Staff Development in Republic of Bulgaria and the Regulations governing the application of the Act, implementation and Rules for the development of the academic staff at G. S. Rakovski National Defense College. for the acquisition for the Doctor's educational and research degree.

I recommend that the Ph.D. student continue his work in this field in the future.

12. Evaluation of dissertation.

Considering the volume and quality of the dissertation, the indicated scientific and applied results and the possibilities of the candidate for further scientific work, **I give a positive evaluation** and I propose to the Honorable Scientific Jury to award to the Assistant Professor Yoana Atanasova Ivanova the Doctor's educational and research degree in Higher Education Domain 5. Engineering Studies, Professional Area 5.3. Communication and Computer Engineering, Doctor's program „Automated Systems for Information Processing and Control“ for her dissertation: „Study of the Impact of Cyberattacks on the Transport Management Systems“.

26 February 2020

Reviewer :

(Assoc. Prof. Eng. Veselina Aleksandrova Gagamova, PhD)