

# REVIEW

by Prof. Dr. Radoslav Yoshinov

on a dissertation for obtaining an educational and scientific degree  
"Doctor" with author mag. Eng. Tihomir Dimitrov Tenev on the topic  
"DEVELOPMENT OF HIERARCHICAL TAXONOMY THAT  
INCORPORATES PATTERNS FOR IMPROVING SECURITY IN  
INFORMATION SYSTEMS BASED ON MICROSERVICE  
ARCHITECTURE"

under the scientific guidance of Assoc. Prof. Dr. Eng. Simeon  
Emilov Tsvetanov and Assoc. Prof. Dr. Dimitar Birov  
in a professional direction  
4.6 "Informatics and Computer Science"  
Doctoral Program in Computer Science

## 1. Introducing the PhD student

Mag. Eng. Tihomir Dimitrov Tenev holds a Bachelor's degree in Electrical Engineering and Electrical Equipment from the Technical University of Sofia and a Master's degree in Computer Science from the Technical University of Sofia. He currently works as a "Senior Application Support" in SAP Labs Bulgaria, and his professional experience is in the support of Java-based applications, JavaScript applications, QA environment management, the role of Scrum Master, dealing with problematic situations with customer software. He has worked as a "Platform Support Engineer" at HP-Bulgaria, as an expert in "Analysis and Energy Balance of Power" at CEZ Bulgaria EAD and as a "Design Engineer" at PM Electrical Ltd., Sofia (Bulgaria).

I believe that these positions in themselves speak of sufficient experience in software engineering and maintenance of information platforms.

## 2. Actuality of the PhD work

The design and construction of software products goes through a number of successive stages from setting and validating requirements, developing and coordinating design, creating the product using various software languages and technologies to comprehensive testing of the finished product (quality assurance). Because applications often have access to data containing critical sensitive

information, security is an important aspect of designing and building a software product. The risk of seizure of the developed product by an intruder in order to compromise it, to penetrate it, by seizing rights in order to replace information already stored on a medium must be taken into account. Most often, the security of an information product is examined in the three parts of the information product - the client part, the server part and the database it uses. This approach is widespread, but does not work effectively in the case where the final product becomes relatively large, and part of the requirements in the process of its design is to be easy to maintain with continuous working hours. Managing large software applications is sometimes a difficult task because a feature is usually closely related to a number of other features. This type of relations creates a prerequisite for a domino effect in case of an error in any of the relational functionalities. A modern solution to the problem of managing large software applications is the use of an architecture for software development called "Microservice Architecture". The dissertation researches and develops a hierarchical taxonomy of models for improving security in software systems based on microservice architecture.

The importance and relevance of the dissertation is immediately apparent, the aim of which is to study, categorize and granulate a new generation of software architecture, also called Microservice Architecture, to transform the rationale and solutions provided by different security models to the context of microservice architecture. to make a hierarchical model of all categories of microservice architecture, which will serve as a skeleton in the construction of a detailed hierarchical taxonomy applied in information systems to assess the risk of penetration and make recommendations for their improvement by creating a sustainable environment for microservice application by implementation of appropriate security models. A conceptual model of a microservice application located on a cloud platform is proposed. Service models are also specified that correspond to an application of this type.

### **3. Degree of knowledge of the state of the problem and general characteristics of the work**

The dissertation provides an in-depth overview of the achievements in the development of a hierarchical taxonomy of models for improving security in information systems, dedicated entirely to a new generation of software architecture - "Microservice Architecture". An analysis of the threats for each of the areas defined for architecture of this type has been made, which allows for a more precise positioning of the selected security models.

In the description of the hierarchical taxonomy, an object-oriented modeling language is used, which uses a language for defining interfaces using "Managed object format". Modern tools for microservice management are considered, and

solutions for use are proposed to them, following the good practices of the selected security models from the hierarchical taxonomy of security models.

The bibliography of the dissertation cites 111 literary sources: books, scientific articles and Internet publications. The methods and means for risk assessment in a new generation software architecture - "Microservice Architecture" are analyzed in detail. An analysis of the threats for each of the areas defined for architecture of this type has been made, which allows for a more precise positioning of the selected security models. Based on the review analysis, the doctoral student formulates the purpose and tasks of the dissertation.

General characteristics of the dissertation include - introduction, eight chapters (each of which ends with description of conclusions), conclusion, contributions, references, list of publications on the dissertation, declaration of originality, appendices.

Chapter One INCREASING THE SECURITY OF SOFTWARE SYSTEMS BASED ON MICROSERVICE ARCHITECTURE discusses microservice architecture accompanied by a conceptual application. A justification is made for the need to increase security and the advantages of using security models are considered.

Chapter Two PROPOSALS FOR MITIGATION REDUCTION IN THE ACCOUNT AND IDENTITY PART examines the threats in the area of Account and Identity, offers a list of security models and gives recommendations for each of the models.

Chapter Three PROPOSALS FOR MITIGATION IN PART COMMUNICATION discusses the threats in the field of Communication, offers a list of security models and gives recommendations for each of the models.

Chapter Four PROPOSALS MITIGATION PROPOSALS IN THE DATA STORAGE PART examines the threats in the field of Data Storage, offers a list of security models and provides recommendations for each of the models.

Chapter Five PROPOSALS FOR MITIGATION OF THREATS IN THE WORLD SERVICE ENVIRONMENT discusses the threats in the field of Microservice Environment, offers a list of security models and gives recommendations for each of the models.

Chapter Six PROPOSAL MITIGATION PROPOSALS IN PART MIRCO SERVICES DISTRIBUTED ON PLATFORMS OF DIFFERENT SUPPLIERS discusses the threats in the field of Microservices are offered by each of the models distributed on the platforms of different suppliers.

Chapter Seven DEVELOPMENT HIERARCHICAL TAXONOMY MODELS TO IMPROVE SECURITY SOFTWARE APPLICATIONS BASED ON MIKROSARVISNA architecture is dedicated to building a hierarchical taxonomy of security models for systems based on microservice architecture, make the choice of methodology for description of hierarchical taxonomy define the relations

between the separate areas are created, a graphical interface is created and an analysis of the achieved results is made.

Chapter Eight APPLICATION OF SECURITY MODELS THROUGH THE USE OF MODERN TECHNOLOGIES FOR MANAGEMENT OF MICROSERVICES describes the implementation of the models of security configurations. Solutions are proposed according to the requirements set in each of the models.

CONCLUSION; CONTRIBUTIONS; REFERENCES; LIST OF PUBLICATIONS ON THE DISSERTATION; DECLARATION OF ORIGINALITY; APPENDICES.

Total number of pages - 151; total number of table figures and UML diagrams - 39; number of applications - 1; number of publications of the author on the topic of the dissertation - 5, number of literary sources - 111.

The above proves that the doctoral student has in-depth knowledge of the subject of the research.

#### **4. Correspondence of the proposed research methodology and the set goals and objectives of the dissertation**

The subject of the dissertation is the development of methods and models for improving security in software systems.

The object of the study are software systems based on microservice architecture ..

The aim of the dissertation is to develop a hierarchical taxonomy of models for improving security in software systems based on microservice architecture. The doctoral student has formulated nine tasks, through the solution of which to achieve the set goal, namely:

To categorize and granulate a new generation software architecture, also called Microservice architecture, in order to present it in different forms; To make a threat analysis for each of the presented categories of microservice architecture; To find appropriate security models that fall into the scope of the different categories, relying on the analysis of threats; To transform the justifications and solutions provided by the different security models to the context of a wet service architecture; To make a hierarchical model of all categories of microservice architecture, which will serve as a skeleton in the construction of a detailed hierarchical taxonomy; To find and use an appropriate object-oriented modeling language in order to make the selected security models readable, respecting the hierarchy of the individual categories; Transform the modeling language so that it can be represented graphically; To find modern products with the help of which a sustainable environment for microservice application can be created; To study which of the presented security models can be applied through the selected

modern products for management of microservice applications, as well as to give an example solution.

The development has interesting summaries and guidelines for future development.

The chosen methods correspond to the main goal and tasks set for solving by the doctoral student.

## **5. Characteristics of the nature and assessment of the authenticity of the material on which the contributions of the dissertation are based**

The models that are created and used correspond to the target task. For some, empirical numerical results have been obtained, while for others, concepts for solutions have been presented and guidelines for future research have been given. I have not noticed any errors in either the concrete or the conceptual models. I also find that the proposed strategies are well-founded.

## **6. PhD Contributions**

In the dissertation the doctoral student claims for the following six contributions: (the reviewer categorizes them as scientific-applied and applied)

1. Research and analysis of architectures based on microservices has been performed in order to increase security.

2. A conceptual model is proposed, applying microservice architecture, with the help of which they are Graphical.

3. An analysis of the threats on the defined vulnerable areas has been performed, for each of which appropriate security models and the justification of the decisions have been proposed.

4. A hierarchical model is developed and a hierarchical taxonomy of security models is presented with the help of object-oriented modeling.

5. A graphical interface has been developed that illustrates the connections between vulnerable areas in the microservice architecture and the selected security models.

6. The architecture of a platform implementing the proposed models through the use of modern technologies for microservice management is presented.

The reviewer does not accept contributions (1 and 3) so verbalized. I believe that in the dissertation not only research and analysis on contributions 1 and 3 has been performed, which is only part of the way to contribution, but the corresponding systematization has been made, which already allows to be accepted (1 and 3) as contributions.

The reviewer accepts the scientific and applied contributions (2, 4) of the doctoral student.

The reviewer accepts all applied contributions (5, 6) of the doctoral student.

The reviewer accepts the contributions described in this way, recommending that the doctoral student learn to present his / her achievements more clearly.

### **7. Degree of the dissertation's personal participation in the contributions**

The personal participation of the doctoral student is judged by the publication activity of the doctoral student reflected in the materials published on the dissertation. The doctoral student convincingly presents the achieved results, with very good and thorough argumentation, as well as uses professional graphic design of the materials.

The nature of the research presupposes a very good and wide preparation in the field of risk assessment, new generation software architectures - "Microservice architecture" necessary for the more precise positioning of the selected security models. I believe that the doctoral student has succeeded, and I do not question his personal participation in the development of the dissertation material.

### **8. Conformity of the abstract with the requirements for its preparation and adequacy of reflection of the main positions and contributions of the dissertation**

The presented project for the abstract is in accordance with the rules for preparation of the abstracts for the dissertations, indicated on the website of Sofia University. Reflects the results achieved as well as the contributions of the author. It is graphically very well designed and includes the necessary information describing in summary the dissertation.

### **9. Opinions, recommendations and notes**

In the dissertation a very complex, dynamically developing and perspective area is developed. This implies sufficient in-depth knowledge, the ability to interpret and formulate strategies for effective development of the field. The content and graphics of the material are very well developed. This material is of interest to a specialized circle of readers and if it is published after processing it will have a multi-applicative effect.

I recommend the doctoral student to publish in scientific journals with impact factor. I recommend more accurate verbalization by the doctoral student of his achievements - to learn more clearly and accurately to present their contributions. I have made some non-essential remarks on the copy provided to me.

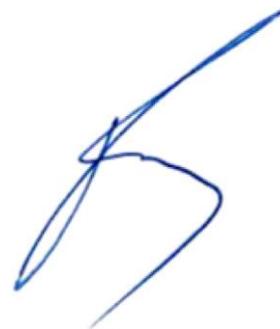
## 10. CONCLUSION

The content and contributions of the dissertation of Mag. Eng. Tihomir Dimitrov Tenev fully covers the requirements of the Law for development of the academic staff of the Republic of Bulgaria, of the Regulations for its application and of the Regulations for the conditions and the order for acquiring scientific degrees at Sofia University. Significant research work has been carried out in terms of volume and content. There are a sufficient number of scientific and applied contributions. A sufficient number of publications on the dissertation published at prestigious scientific forums are presented. The educational doctoral minimum set in the individual plan is covered. The personal participation of the doctoral student in the development and the received contributions is indisputable. This gives me reason to strongly recommend to the Honorable Scientific Jury to award a mag. Eng. Tihomir Dimitrov Tenev the educational and scientific degree "Doctor" in the Professional Department "Informatics and Computer Science" in the Doctoral Program "Computer Science"

**REVIEWER:**

/Prof. R, Yoshinov PhD/

Sofia, 12.06. 2020

A handwritten signature in blue ink, consisting of several overlapping loops and a long horizontal stroke extending to the right.