ABSTRACTS

of the scientific works for participation in the contest for the academic position of "Associate Professor" by field of higher education *4. Natural sciences, mathematics and informatics*, professional direction *4.6. Informatics and Computer Science (Information Security)*, announced in the State Gazette no. 96 of 17.11.2023 (Annotations of the materials under Art. 65 (1) of PRASPU for participation in the contest, including self-assessment of contributions) of Chief Assistant Magdalena Asenova Veselinova, PhD Department of Computer Technologies FMI of PU "Paisii Hilendarski"

Thirteen (13) publications, one (1) monograph and one (1) textbook have been selected for participation in this competition (see List of Research Papers).

I. Scientific Publications

1. Petrov, A., Petrov, A., **Veselinova, M.**, AUGMENTED REALITY. CREATING A VIRTUAL WORLD FOR EDUCATIONAL PURPOSES, International Conference "Automatics and Informatics'2017 Proceedings", 2017, 315-318, ISSN 1313-1850.

   The paper presents different approaches of creating augmented reality for educational purposes and the benefits they provide. A software architecture prototype is created with the main goal of providing a way to learn traffic rules. The prototype combines software agents and graphical interfaces to simulate a real environment suitable for children.

2. Kiskinov H., Petkova M., Zahariev A., **Veselinova M.**, Some results about conformable derivatives in Banach spaces and an application to the partial differential equations, *AIP Conference Proceedings* **2333**, 120002, (2021), https://doi.org/10.1063/5.0041758, ISSN 1551-7616, ISSN 0094-243X, ISSN 0000-1984, ISSN 0000-2005, ISSN 0000-1983, (WoS), (SCOPUS, SJR 2021 = 0.189).

In the paper we discuss conformable derivative behavior in arbitrary Banach spaces and clear the connection between two conformable derivatives of different order. As a consequence we obtain the important result that an abstract function has a conformable derivative at a point (which does not coincide with the lower terminal of the conformable derivative) if and only if it has a first order derivative at the same point. As an application of the obtained results we prove that the existence of a weak solution of a mixed (initial/boundary) problem for a parabolic partial differential equation with conformable derivative on time is equivalent to the existence of a weak solution of the same mixed problem for an appropriate considered parabolic equation with integer order derivative.

3. Hristev, R. and **Veselinova, M.**, ICT for Cyber Security in Business, 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1099 012035, doi:10.1088/1757-899X/1099/1/012035, ISSN 1757-899X, ISSN 1757-8981.

   The paper investigates and proposes an approach that can be used to recover information datasets. Private clouds that comply with the ISO 27001 - Information Security Management Systems standard are examined. Data access methods are analyzed and techniques by which private clouds deal with some cyber attacks are discussed. An approach by which user data can be recovered after being encrypted by a ransomware is described. Additionally, a method for integrating a private cloud into an existing IT infrastructure is presented, highlighting the important components that need to be considered for secure and effective data storage and processing in a cloud environment.

4. Kiskinov, H.; **Veselinova, M.**; Madamlieva, E.; Zahariev, A. A comparison of a priori estimates of the solutions of a linear fractional system with distributed delays and application to the stability analysis. *Axioms,* Vol. 10 (2021), No. 2, 75, ISSN 2075-1680, https://doi.org/10.3390/axioms10020075, **(Web of Science, IF 2021 = 1.824 – Q2),** (SCOPUS, SJR 2021 = 0.441).

   In this article, we consider a retarded linear fractional differential system with distributed delays and Caputo type derivatives of incommensurate orders. For this system, several a priori estimates for the solutions, applying the two traditional approaches by the use of the Gronwall's inequality and by the use of integral representations of the solutions are obtained. As application of the obtained estimates, different sufficient conditions which guaranty finite-time stability of the solutions are established. A comparison of the obtained different conditions in respect to the used estimates and norms is made.

5. Hristev, R. and **Veselinova, M**, Expand the Capabilities for Backups a Paas-Type Virtualization System, International Journal of Advanced Trends in Computer Science and Engineering, Volume 10, No.2, March - April 2021, doi: http://www.warse.org/IJATCSE/static/pdf/file/ijatcse781022021.pdf, ISSN 2278-3091.

The paper investigates and proposes an approach that can extend the process of creating backup copies by adding monthly archives to Proxmox VE. The research discusses the optimization of the backup creation process to reduce network traffic between nodes and storage, as well as optimizing the stored data. The built-in methods for creating backups in Proxmox VE are discussed, as well as three options for compressing the saved backup copies. A method for creating monthly archives in the Proxmox VE virtualization environment has been developed. In this environment, an efficient method for archiving virtual servers in a given IT infrastructure has been devised. Compression algorithms for backup copies are analyzed, with a comparison made between them. As a result, an approach for applying the discussed method for archiving virtual servers is proposed. The recovery of a virtual server from an archive is also discussed.

6. Hristev, R., **Veselinova**, **M**, Using private cloud for information arrays recovery from ransomware attacks, AIP Conference Proceedings 2505, 060006 (2022); https://doi.org/10.1063/5.0100654, ISSN 1551-7616, **(Web of Science),** (SJR 2022 = 0.189).

   The paper presents a method for installing and configuring the NextCloud private cloud version 21.0.1 on Debian 10.9.0, using an approach to protect against data loss after infection with ransomware. The aim of the research is to present a method for data recovery after ransomware infection, hence the approach for accessing stored data through a synchronization client is explored. In the conducted research, user data is stored in a private cloud and synchronized with a controlled workstation infected with the CERBER ransomware. The paper presents results obtained from a real applied experiment of the proposed method, which can be used for successful data recovery after a ransomware attack.

7. Golev, A., Hristev, R., **Veselinova, M.**, Kolev, K., CRYPTO-RANSOMWARE ATTACKS ON LINUX SERVERS: A DATA RECOVERY METHOD, International Journal of Differential Equations and Applications, Volume 21, No. 2 (2022), pages: 19-29, ISSN1311-2872; ISSN 1314-6084, (SJR 2022 = 0.137).

   The paper analyses the advantages and disadvantages of using two of the main cloud infrastructure models - public and private clouds. The used classification of cloud models is according to the ownership and users that use the infrastructure. For the purpose of the research, a server running WordPress site and MySQL database in a controlled Linux Debian environment is used. The server is infected with the GonnaCry cryptovirus and its mode of operation is investigated. After infection, two approaches are presented to recover the data in the server environment, one is through the private cloud web interface and the other is through a created bash script. The developed bash script demonstrates the applicability of the approach in high load infrastructures, highlighting the wide applicability of the presented approaches.

8. Hristev, R., **Veselinova**, **M.**, Kolev, K., Ransomware Target: Linux. Recover Linux Data Arrays after Ransomware Attack., IConTech 2022: International Conference on Technology, The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 2022, Volume 19, Pages 78-86, ISSN: 2602-3199, (SCOPUS).

The paper analyzes the evolution of cryptoviruses for Linux and proposes an approach for using a private cloud to recover data sets after ransomware infection in a Linux environment. For the purpose of the research, a virtual machine with Linux operating system, Debian distribution, version 11 was used, and then user files were infected with a cryptovirus. The user's data is stored in a private cloud and synchronized with the controlled workstation that is infected with GonnaCry. The experiment performed demonstrates the capability of the proposed method for effective data recovery after ransomware attack.

9. Hristev, R., **Veselinova**, **M.**, Kolev, K., Ransomware Attacks on Windows Server: Infection and Recovery, International Journal of Differential Equations and Applications, Volume 22, No. 1 (2023), pages: 57-66, ISSN (Print): 1311-2872; ISSN (Online): 1314-6084, https://www.ijpam.eu/en/index.php/ijdea/article/view/6028/306, (SCOPUS, SJR 2022 = 0.137).

   The paper summarizes the main trends in ransomware attacks in 2022 and focuses on the results of a real experiment. Additionally, it systematizes the key stages in the development of ransomware, with focus on the RaaS (Ransomware-as-a-Service) model. In the conducted experiment, a virtual server with Windows Server 2019 operating system infected with the Sodinokibi ransomware was used. The used ransomware is provided in RaaS format. The virtual machine has a .NET Framework web application installed, which uses a Microsoft SQL Server database. The database and executable files of the application are synchronized with an external server hosting a private cloud. The article presents an approach through which the executable files of the application and the database can be successfully restored after their infection in the server environment. Detailed results are described, with special attention to the technical aspects of recovery after a ransomware attack.

10. Hristev, R., **Veselinova**, **M.**, Kolev, K., AUTOMATED CONFIGURATION OF DISK ARRAYS FOR CLUSTER NODES IN LINUX, Proceedings of the International Scientific Conference “INFORMATICS, MATHEMATICS, EDUCATION AND THEIR APPLICATIONS” IMEA’2022, 23-25 November 2022, Pamporovo, Bulgaria, pages: 147-156. ISBN: 978-619-7663-33-4.

    In this paper, the differences between software and hardware RAID controllers, different types of RAID arrays, and the local disk space of a Proxmox VE high availability virtualization cluster are analyzed. The ways in which Proxmox VE stores its data locally are described in detail. A script is created to automate the creation and configuration of a software RAID 1, which is used for subsequent node settings. The script optimizes the human resources responsible for cluster scalability.

11. Hristev, R., **Veselinova**, **M.**, Kolev, K., SYSTEM ARCHITECTURE FOR AUTOMATED BACKUP AND RECOVERY OF DISK VOLUMES IN CONTAINERS, International Journal of Differential Equations and Applications, Volume 22, No. 1 (2023), pages: 165-174, ISSN (Print): 1311-2872; ISSN (Online): 1314-6084, https://www.ijpam.eu/en/index.php/ijdea/article/view/6028/306, (SCOPUS, SJR 2022 = 0.137).

This paper investigates the available backup and recovery methods for containerization and proposes a system architecture to automate the backup process in containerized environments. The proposed architecture can provide a comprehensive and highly efficient solution to automate the backup and restore processes of containerized environments, offering multiple benefits that increase the reliability, efficiency, and manageability of backup and restore operations. The main components of the system are a backup agent, a management server and a storage server. Some of the advantages that are observed due to their development are comprehensive data protection, system availability, scalability, secure data recovery in case of a system failure.

12. Hristev, R., **Veselinova**, **M.**, Ismail, E., DATA RECOVERY OF DATA STORED IN A PRIVATE CLOUD INFRASTRUCTURE WITH OWNCLOUD INFINITE SCALE, International Journal of Differential Equations and Applications, Volume 22, No. 1 (2023), pages: 155-163, ISSN (Print): 1311-2872; ISSN (Online): 1314-6084, https://www.ijpam.eu/en/index.php/ijdea/article/view/6028/306, (SCOPUS, SJR 2022 = 0.137).

    This paper analyzes the key aspects in the data recovery process in the context of a private cloud infrastructure, utilizing the capabilities of ownCloud Infinite Scale. A real experiment is performed where user data is stored in a private cloud environment and synchronized with a controlled workstation running a Windows-based operating system, which is subsequently infected with the Thanos encryption virus. An approach is proposed by which corrupted data can be successfully recovered. Based on previous research conducted by the same authors, it can be summarized that the proposed approach to recover corrupted data after a cryptovirus attack is successfully applicable to the more general case, regardless of the cryptovirus family used and the operating system of the infected machine.

13. H. Kiskinov, E. Madamlieva, **M. Veselinova**, A. Zahariev; On variation of constant formulae for linear fractional delayed system with Lebesgue integrable initial conditions. AIP Conf. Proc. 11 December 2023; 2939 (1): 040001. https://doi.org/10.1063/5.0178529, **(Web of Science)**, (SCOPUS, SJR 2022 = 0.164).

    In the present work is considered the Cauchy (initial) problem (IP) for a linear delayed system with derivatives in Caputo's sense of incommensurate order, distributed delays and locally Lebesgue integrable initial functions. For this IP is studied the important problem of existence a formula of variation of constants. The obtained results extend the corresponding ones in the particular cases of fractional systems with constant and variable delays. The proposed conditions are almost the same as the conditions which guarantee the same result in the case of linear differential equations with distributed delays with integer order of differentiation.

II. MONOGRAPHS

14. **Veselinova, M.**, Hristev, R., Implementation of cloud services for improving digital data security, Plovdiv University Press, 2024, 233 pp., ISBN: 978-619-7663-97-6 (in Bulgarian).

The monograph presents an in-depth study dedicated to the methods of data storage, stored and processed in contemporary IT infrastructures, and their effective recovery, utilizing the capabilities of cloud environments. The value of the data stored and processed in IT infrastructure far exceeds the value of the corresponding technologies for their storage and management. The technical means used for data storage serve as tools for access and processing, but the true value derives from the information that can be extracted from them. Therefore, conscious understanding and effective management of data emerge as key elements for the successful functioning and development of modern organizations. The flexibility and security imposed by the modern working environment require a reconsideration of the implemented methods of data storage, necessitating the exploration of alternative methods for data storage. Cloud environments offer such an alternative method.

This monograph is intended for researchers, graduate students, and undergraduates working in the area of information assurance for data security.

The content of the monograph, presented over 233 pages, consists of an introduction, six chapters, a conclusion, and a bibliography with 87 titles.

The first chapter discusses the basic concepts related to cloud computing, including what cloud computing is and how it differs from traditional methods of data storage and processing. The service models in cloud computing - Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) are discussed, providing a clear overview of their functionalities and benefits. Additionally, the types of clouds - public, private, community and hybrid - are discussed. An overview is given of the differences between them and how one can choose the right one for their specific needs.

In the second chapter, conventional data storage methods are examined in detail. Conventional methods such as Direct Attached Storage (DAS), Network Attached Storage (NAS), Storage Area Network (SAN), and shared directories are thoroughly discussed. A comparative analysis is conducted, outlining the key characteristics of these methods, including the type of storage and the protocols used for data access. Additionally, descriptions of popular public cloud providers such as Google Drive, OneDrive, Dropbox, pCloud, and JustCloud are provided. The ways to access data stored in public clouds are explored, along with descriptions of their functionalities and capabilities. Characteristics of data storage in private clouds are also described, with a focus on three types of private clouds - ownCloud, Nextcloud, and ownCloud Infinite Scale. A detailed comparison between public and private clouds is made, considering parameters such as connectivity, scalability, costs, and others. Finally, a comparative analysis is presented between the use of conventional storage methods and cloud storage. This provides a clear overview and a basis for making informed decisions when choosing a storage method that meets the specific requirements and needs of the business or project.

The third chapter introduces the threats that exist for the stored data in IT infrastructure. Categories of malicious software, methods of distribution, and their impact are presented. Special attention is given to ransomware, as this category of viruses is the most dangerous from a data perspective.

The fourth chapter details the installation of the three investigated types of private clouds - ownCloud, NextCloud, and ownCloud Infinite Scale. The creation of a virtual environment capable of running private clouds is described, along with the configuration of the operating system on which they can be installed. A comprehensive description of enhancing the security of the installed private clouds is also provided, along with specific instructions for this purpose.

In the fifth chapter, three typical scenarios for configuring a private cloud are examined, depending on the size of the organization that will use it and the volume of stored data. The file structure of data stored in a private cloud is described, along with the methods of accessing them. An original method for implementing a private cloud in an existing IT infrastructure is presented.

Chapter six is devoted to data recovery methods. Methods for recovering data stored in conventional environments are described, with attention to scenarios in which they are suitable to be used, as these methods do not always yield successful results. An approach for recovering deleted and overwritten data stored in private clouds, both on user workstations and in server environments, is presented. A script for automated recovery of large arrays of deleted data in a private cloud has been developed.

The monograph is written based on results obtained in seven authored scientific publications.

III. TEXTBOOKS

15. Cholakov, G., Veselinova, M., Textbook on Databases, 2019, https://drive.uni-plovdiv.net/index.php/s/URjP0lycM3zDZaV, ISBN 978-619-202-540-3, (in Bulgarian).

The contents of the textbook, set out in 97 pages, consist of an introduction, 8 chapters, 2 appendices and a bibliography of 20 titles. The textbook introduces working with relational databases using the SQL relational language standard. The main objective is to teach the learner the basic concepts of relational databases, the use of the concrete implementation of the SQL language to create objects, manipulate and retrieve data from them. Not all aspects of the language are discussed in detail. Operators from the SQL standard are used, and some differences between implementations in leading relational databases such as Oracle, Microsoft SQL Server, and MySQL are noted.

The fundamental aspects of the SQL language are explored in detail. The basic SQL operators, along with their functions and purposes, are thoroughly described, providing an understanding of how the operators work and how they can be used for effective database management. A brief demonstration of the database design and normalization process is presented. An Entity-Relationship data model is created, serving as the foundation for illustrating subsequent examples. A database is created where primary and foreign keys are defined for tables, ensuring the integrity and efficient linkage of data. The process includes inserting the tables with real data to demonstrate how they can be managed and modified. The relational operators provided by the SQL standard are extensively discussed, emphasizing their crucial role in data processing and retrieval from the database.Views in databases are examined, covering their creation and significance. Focus is placed on transactions – what they represent, when it is appropriate to use them, and how they are managed. The guide presents methods for initiating transactions, confirming or rolling back changes, and scenarios where transactions are essential for data integrity. Creation and execution of stored procedures and functions are explained, along with the creation and usage of cursors and triggers. Concrete examples illustrate how cursors can be used to modify data in the database. The textbook includes two appendices containing solutions to exercises and resources for creating and inserting data tables.

The textbook has been developed in accordance with the requirements and curriculum of the following specialties at the Faculty of Mathematics and Informatics at Paisii Hilendarski Plovdiv University: Software Engineering, Software Technologies and Design, Informatics, Business Information Technologies.

Signature:

CHIEF ASSISTANT MAGDALENA VESELINOVA, PHD

07.02.2024
Plovdiv