SUMMARY

OF THE SCIENTIFIC WORKS

Of Ph.D. Grigor Velev

Scientific works are presented in three categories:
I.   Monographic works
II.   Scientific articles and reports
III.   Research and development

I.   MONOGRAPHIC WORKS

II.1.1. Velev G., **Telecommunication networks** *(monograph)*

This monograph presents telecommunication technologies, standards and principles of digital communication systems.

The monograph is divided into five parts and is intended to provide answers to the following main questions:

• The theoretical and physical foundations of communication environments based on the OSI model and protocols from the TCP/IP protocol stack, as well as the importance of standards and the main standardization bodies in the field of telecommunications;

• The processing of signals, their transmission and the main limiting factors for the speed of information transmission through a transmission channel, the main techniques used in transmission systems through a digital telecommunication network;

• The main differences between circuit and packet switching techniques;

• Local networks and organization of LAN connections;

• Provision of broadband access to the Internet, protocols and their operation;

• The process of designing a corporate communication network..

II.1.2. Velev G., **Routing in Mobile Ad-hoc Networks**

The book based on a dissertation presents the essence and main features of mobile ad hoc networks (MANETs). MANET routing protocols have been analysed and their classification has been updated for the purpose of the study. Methods and techniques for modelling and formal description of processes and algorithms have been reviewed.

A formal model of MANETs is proposed. Route detection algorithm for AODV protocol is described. A modified AODV model is proposed, taking into account the status parameters of the intermediate devices that establish the route. A model of a hierarchical cluster routing for MANET is developed at tactical level using a logical division of sub-networks to manage the mobility of members of the organizational group.

A generalized network model, modelling the processes of the hierarchical cluster routing proposed in Chapter Two is developed. The effectiveness of the modified AODV protocol compared to AODV, is analysed based on simulation studies.

II.   SCIENTIFIC ARTICLES AND REPORTS

II.2.1. Velev G., **Approaches to building MPLS-based enterprise telecommunication networks.** (Scientific Conference with International Participation (MT&S-2011) Proceedings, pp. 198 – 204, ISBN 978-619-90024-1-4, Sofia, 2012).

The selection of the most appropriate approach for building telecommunication network is crucial to the success of any enterprise. The report presents various options for building telecommunication next generation networks using protocols IP, MPLS and ATM.

II.2.2. Velev G., **An analisys and classification of routing protocols for mobile ad hoc wireless networks**, (International Scientific Conference "Hemus 2012", Proceedings, II-37 - II-42, ISSN 1312-2916, Sofia, 2012).

This article provides a classification of MANET routing protocols. To compare and analyse mobile ad hoc network routing protocols, appropriate classification is essential. The design of the protocols are driven by specific goals and requirements based on respective assumptions about the network properties or application area.

II.2.3. Velev G., **Development and improvement of the stationary communication system of Bulgarian Armed Forces**, (CIO Magazine, issue from 2012 – July, pp. 55-56, ISSN 1312-5605).

The rapid development of telecommunication technologies in recent years has a strong impact on all areas of public life, including the security and defence sphere. The role of built communication capabilities is particularly important in the context of "intelligent defence" of the principle of "uniting and sharing". The improvement of the communication system, as the main element of the command and control, communications, computers and intelligence (C4I) system, is one of the main priorities of the Ministry of Defence.

II.2.4. Velev G., **Mobile Distributed Networks - Defence Application**, (CIO Magazine, issue from 2013 – July, pp. 50-51, ISSN 1312-5605).

Rapid deployment of mobile users is required to create effective and dynamic communications for military (battlefield), emergency and disaster relief purposes. In these important network scenarios, organized or centralized connectivity cannot be relied upon, but the use of so-called mobile distributed networks (Mobile Ad Hoc NETworks – MANETs) is required. In Latin, the term "ad hoc" means "for this purpose only" and is an accurate description of the specifics of this type of wireless networks. MANETs are expected to play an important role in the future Digital Battle Fields, providing the necessary tactical networks.

II.2.5. Velev G., **A model of modified AODV routing protocol for mobile ad hoc networks,** (Scientific Conference with International Participation (MT & S-2013) Proceedings, pp. II-41-51, ISSN 2367-5942, Sofia, 2014).

In recent years, mobile and wireless networks have a tremendous rise in technological advancement. Due to dynamic changing topology of MANET, it is desirable to design effective routing

algorithms that can adapt its behavior to frequent changes in the network. The report proposes a model of modified Ad hoc On-Demand Distance Vector Routing algorithm for mobile ad-hoc networks as it includes metrics for evaluating the state of the nodes in process of route discovery.

II.2.6. Velev G., **Security issues in mobile ad hoc networks**, (Scientific Conference of the University of Shumen "Bishop Konstantin Preslavski", Proceedings, 296 – 300, ISBN 978-954-9681-65-9, Shumen, 2015).

Mobile ad hoc network (MANET) is a system of wireless mobile nodes that dynamically self-organize in arbitrary and temporary network topologies. The provision of security services in the MANET is related to a set of challenges specific to this new technology. In this report security issues, vulnerable nature of the mobile ad hoc network and the main attack types that exist in it are discussed.

II.2.7. Velev G., **Architecture of a mobile self-organizing network for the tactical level**, (CIO Magazine, issue from 2016 – July, pp. 62 – 63, ISSN 1312-5605).

Mobile self-organizing networks emerged as a concept for military dynamic wireless networks as early as the 1970s. The current development of portable devices, which are constantly increasing their computing power, becoming smaller, cheaper, more convenient and capable of performing more and more applications and network services, as well as the improvement of wireless communication technologies, sparked the interest of researchers and industry in these networks again, at the beginning of our century. Their specific properties make them applicable in many areas– for military and special operations tactical networks, in disaster situations, virtual classrooms, home and office networks, and more.

II.2.8. N. Stoianov, M. Bozhilova, G. Velev, **Towards security requirements of the SPIDER project** (Proceedings Scientific Conference with International Participation on Cyber security in the Information Society, pp. 25-31, ISBN 978-954-9681-82-6, Shumen, Bulgaria, 2017г.)

The need for using sensor systems and networks for intrabuilding situational awareness in urban military operations demands strict requirements for theirs security and reliability. The report defines concepts related to security in accordance with purpose and functions of the sensor system.

II.2.9. Enev, E., Grigor Velev, Nikolai Stoianov, and Maya Bozhilova, **Requirements to the Sensor Platform and Network for Indoor Deployment and Exterior Based Radiofrequency Awareness** (International Research Conference "105 Years Research and Knowledge for the Security and Defence, Bulgarian Military Academy "G. S. Rakovski", pp. 299 – 303, ISBN 978-619-7478-00-6, Sofia, 2017)

This report presents results from the study of problems related to using sensor platform and network for indoor deployment and exterior based radiofrequency awareness in urban operations. There are selected main tactical requirements and space and time parameters in which must work technical means for acquisition of information and data. The report provides also additional information about future trends of experimentations within this project.

II.2.10. Velev G., Iliev R., **Generalized net's model of route in MANETSs using a hierarchical cluster algorlthm,** (Ninth International Scientific Conference "Hemus 2018", Proceedings, Plovdiv, II-97 - 109, ISSN 1312-2916, Sofia, 2018).

In the report is presented a Generalized Net's Model of the route in the Mobile Ad hoc NETworks (MANETs) using a hierarchical cluster algorithm m-AODV (modified AODV) to improve route searching by analysing the status parameters of the intermediate network devices.

II.2.11. Stoianov N., M. Bozhilova, G. Velev, **Next-generation technologies support operations in the city,** (CIO Magazine, issue from 2018 – July, pp. 68-69, https://cio.bg/digitalizacia/2018/07/24/3432763_tehnologii_ot_novo_pokolenie_podpomagat_operaci ite_v/, ISSN 1312-5605).

The article presents the project to develop an innovative system to support military operations in urban environments, by improving situational awareness of the interior of buildings. The main task of the project is to provide a real-time map of the interior of a building of interest, detecting and locating the presence of people in that building, using data from internal and external sensors, providing otherwise unattainable information to those involved in the operation .

II.2.12. Velev G., Bozhilova M., **A cluster routing algorithm model for mobile ad hoc networks for defence and security,** (Tenth International Scientific Conference "HEMUS 2020" Plovdiv, Proceedings, II-179 - II-186, ISSN 1312-2916, Sofia, 2020.

A Mobile Ad hoc NETwork (MANET) is a system of mobile wireless devices that dynamically self-organize into a temporary network topology without a preexisting infrastructure. Due to the mobile nature of the network, creating reliable clusters that can sustain for a long period of time is a challenging problem. The report proposes approach for clustering MANET, taking into account the receiving signal level from the cluster-head and limiting the number of members of the cluster. The cluster-head node is selected based on the current energy of the device and its degree of communications connectivity. The proposed approach makes it possible to increase stability of the cluster structure, and therefore the efficiency of the MANET routing.

II.2.13. N.T. Stoianov, M.G. Bozhilova, G.R. Velev, **Honeypot types as a possible data source for the CYRADARS project** (Математичне та Імітаційне Моделювання Систем, МОДС 2020, П'ятнадцята Міжнародна Науково-Практична Конференція, p.p.144 - 146, УДК 004.94(063), ISBN 978-617-7571-93-2, Україна, м. Чернігів, 2020)

The report presents a review of types of honeypots from CyRADARS points of view. A honeypot could be used for collecting current malware attack patterns, studying hacker behaviour, looking for internal attacks from insiders, etc. Having threat intelligence without impact on production systems and networks is a promising tool for a collection of research data. The study reviews open source honeypots. The aim is to select the most applicable honeypot types and the ways they should be deployed so the CYRADARS tools will be fed with relevant data.

II.2.14. Yanakiev, Y., Stoianov N., Kirkov D., & Velev G., **Defence Strategy and New Disruptive Technologies Nexus: Implications for the Military Organisations** (Journal of Defence & Security Technologies. 3(1), 2020, pp. 7-41.https://www.jdst.eu/publications/defence-strategy-and-new-disruptive-technologies-nexus-implications-military, ISSN 2534-9805 (print), ISSN 2534-9813 (electronic), NACID: 1763).

This article aims to explore the role of strategy in the field of defence, with a particular focus on how technological innovation can influence the development of strategy. The key question is how and in what ways technological advances can affect the development of defense strategy. It begins with an evolution of the concept of defense strategy in recent years, as well as its possible future transformation along the trends of new and emerging defense technologies. Various conceptual models of defense strategy are then analyzed based on case studies of national defense strategy documents presented in the EU Predictive Methodology for Technology Intelligence Analysis (PYTHIA) consortium, as well as EU and NATO documents . Finally, the article summarizes some conclusions about the dynamic nature of the relationship between the development of defense strategies and technological innovation. In addition, some ideas are presented on how defense research can respond to operational needs by supporting with new knowledge the production and delivery of the most needed weapon systems.

II.2.15. Laso, P.M., L. Salmon, M. Bozhilova, I. Ivanov, N. Stoianov, G. Velev, C. Claramunt, Y. Yanakiev, **ISOLA: An Innovative Approach to Cyber Threat Detection in Cruise Shipping.** (Developments and Advances in Defense and Security. Smart Innovation, Systems and Technologies, vol 255, pp.71-81, https://doi.org/10.1007/978-981-16-4884-7_7, Springer, Singapore, 2022)

Today's cruise ships can carry more than 5,500 passengers and 2,200 crew members with an average voyage time of seven days. The cruise industry represents a large part of the travel market and demand is growing. Despite the large number of people on board, crime reporting on cruise ships has so far been relatively low. While the ship itself faces security threats, activities on board and ashore provide many opportunities to exploit security targets and issues. With the proliferation of onboard data activities and sensors, there is an urgent need to develop data fusion algorithms to provide a global view of the information environment. The research presented in this paper develops an analysis of current cyber risks at sea, with a specific focus on cruise ships, which are currently under development under the H2020 ISOLA project. The paper describes and discusses several algorithms for data synthesis and finally discusses further needs for more secure cyber environments.

II.2.16. Velev G., **Machine learning and 5G networks,** (Eleventh International Scientific Conference "Hemus 2022" Plovdiv, Proceedings, II-153-159, ISSN 1312-2916, Sofia, 2023.

In recent years, there is needs for a higher level of intelligence in the mobile networks, in order to deeply and accurately learn the operating environment and users behaviors to build a pro-actively and efficiently (self-)updatable networks. This report describes the role of machine learning in 5G networks to build adaptable performing next generation mobile network.

II.2.17. Velev G., **Cloud technologies and services in communications**, (Eleventh International Scientific Conference "Hemus 2022" Plovdiv, Proceedings, II-153-159, ISSN 1312-2916, Sofia, 2023).

The report examines cloud technologies in the field of communications and services provided for electronic exchange of information in collaboration, training, business processes, etc. An approach for using different software solutions for organizing communication exchange between work teams related to security and defence is proposed.

III. RESEARCH AND DEVELOPMENT

This section includes educational and methodological works related to the author's participation in the development of technical-economic reports, tactical-technical tasks, projects for the building and development of communication and information systems, as well as programs and methods for testing and accepting communication systems, automated information systems and subsystems, as well as other source documents necessary for the acquisition of communication and information products for the needs of the Ministry of Defence, the Bulgarian Army and their subordinate structures.

In 2000, a Tactical and Technical Assignment. was prepared for the construction of a fragment of the stationary digital integrated communication system of Bulgarian Armed Forces (SCISS-BA) – "STRANDJA-2" (H. Petkov – leader, G. Velev – developer) based on innovative communication technologies to modernise the stationary communication system of Bulgarian Armed Forces.

In 2001, working projects were developed for the construction of the stationary communication and information system of Bulgarian Armed Forces, in which the various subsystems were designed. The author has independently developed the subsystem "Radio relay transmission systems" and Appendices - Part II including a map with all OSS and KIV of SCISS, calculation of radio relay intervals and optical cable lines. The entire SCISS topology is reflected in the appendix. As a co-author in the design, he participated in the development of system-wide issues for the system, functional requirements and the set of supplies for the construction of the fragment of the SCISS of Bulgarian Armed Forces.

In 2006, the author participated in the development of programs and methods for conducting tests for putting into operation the subsystems of the fragment of SCISS-BA "Strandja-2" and the system as a whole. The fragment of SCISS-BA "Strandja-2" was put into operation in 2007.

In 2008, a team (A. Temelkov, head) prepared a Tactical and Technical Assignment for the expansion and development of the SCS of the BA, by upgrading with MPLS/IP functionality and optimizing the management of the SCS of the BA, in which the author participated.

In 2013, a technical and economic report on the development of the corporate information system for defence was developed (387 pages), including a thorough study of existing systems, technologies, solutions and global trends in the construction of such systems and their modernization on cloud infrastructure. The document was developed by: G. Velev (leader), R. Iliev, A. Genchev, N. Stoyanov, M. Angelov, I. Ivanov, I. Hristozov, Y. Yordanov, G. Grncharov.

In 2014, a Tactical and Technical Assignment (121 pages) was prepared for building the system (by G. Velev, A. Genchev and R. Iliev), based on the application of modern cloud technologies and information environments for joint work (adopted by Armaments Council).

In 2017, a Tactical and Technical Assignment (145 pages) was prepared for the construction of a "Communication and information system of a battalion combat group. System, architectural and technical requirements for building the system are included in the Assignment.

In 2017, a Tactical and Technical Assignment (38 pages) was prepared for the modernization of the "Communication transmission subsystem (network) ensuring the operation of the "Coastal system for control of shipping and protection of the maritime border – Ekran -M". System and technical requirements for the modernization of the communication network providing subscriber systems from the Ekran system are included in the Assignment.