EMPIRICAL EVALUATION OF THE TRANSFER OF INFORMATION RESOURCES IN ACTIVE LEARNING

Radi Romansky *

Technical College – Sofia, Technical University of Sofia
Bulgaria

* Corresponding Author, e-mail: rrom@tu-sofia.bg

Abstract: Active learning is an alternative to traditional learning, using the capabilities of the global network to access remote information resources. The purpose of the article is to analyse the sources and factors of delay in the implementation of network services and the possibilities of access to distributed information objects depending on their size and remoteness. The research was conducted by collecting empirical data (monitoring) on the transfer of resources between client and server. A research organization model was developed and an implementation application was created. Experiments were carried out, and the obtained results were summarized and presented through statistical evaluations and graphical interpretation.

Key words: transfer evaluation, active learning, information resources, remote access, empirical assessments.

1. INTRODUCTION

Active learning is related to interaction between the participants in the learning process (student, teacher, expert), in which the learner himself controls the learning process. It is an alternative to traditional learning that increases the engagement of participants in the educational processes and improves the assimilation of knowledge through access to information resources [1, 2]. A statistical study presented in [1] confirms the effectiveness of active learning through a higher level of knowledge acquisition with reduced dispersion of statistical estimates. The perception of active learning is defined in [2] as a better alternative based on defined four areas of research: (1) Evidence from cognitive science on the effectiveness of active learning; (2) Better scores on assessments of teamwork, problem solving, and leadership skills; (3) Creating an inclusive learning environment; (4) Higher achievements of students established by research. In [3] it is stated that various strategies for active learning are described in the literature and an updated approach based on an interactive style of presentations, group online

discussions with feedback, individual experiments and projects for the analysis of information resources, etc. is proposed. In addition, in [4], along with the significant increase in the use of digital services and access to distributed information resources by learners, including people with visual impairments, existing obstacles for the latter group of learning participants are analysed. It is proposed to change the policy of educational institutions towards these people and improve library services in accessing information resources. A number of publications suggest different approaches to collaborative and active activity in organizing a learning environment, with [5] stating that this promotes problem solving through active information processing and aids critical thinking.

The summary is that the adopted approach in active and distributed learning requires continuous access to information sources, multimedia online e-books, distributed databases, knowledge bases and libraries, consultations with experts, etc. This requires an adequate approach of university management in organization of education, as a possible solution to increase the monitoring of education quality management using the tools for intelligent analysis of data in information systems is proposed in [6]. The article presents Learning Analytics (LA) models and a corresponding software tool designed for the needs of governing bodies, which will allow effective monitoring of the learning process and making timely decisions about the required information resources.

Regardless of the applied solutions, it should be borne in mind that e-learning (in the various variants active-, distributed-, mobile-, micro-, etc.) is intended for independent and individual study of the offered material, which is usually published in the web space. Very often in the contemporary digital world this leads to the optimization and integration of educational information resources, as discussed in [7]. An integrated model for teaching and designing learning resources, including in the cloud, is proposed, and a hierarchical mechanism for sharing educational resources with defining rights and regulating access in each organizational unit is proposed. A technological solution for reliable management of access to information resources in a combined learning environment (combining traditional, network and cloud resources) is discussed in [8]. All possible challenges of the digital ages for the user's personal data and privacy must be analysed when implementing systems using heterogeneous resources distributed in the network space and providing multiple user’s access to them [9].

The purpose of the article is to present an investigation of access to remote information resources needed for active distributed learning. An approach was applied to collect empirical data on the transfer of resources between a client and a server located in different nodes of the global network. For this purpose, a model for the organization of the research was developed and an application was created for the realization of which the products HTML, PHP, Java Script, and My SQL were used. The goal is to analyse the sources and factors of delay in the implementation of network services and the possibilities of access to the distributed information objects depending on the size and their remoteness. Experiments were

carried out, and the obtained results were summarized and presented through statistical evaluations and graphical interpretation.

2. INITIAL STATEMENT OF THE PROBLEM

Digital society offers various technologies to solve real world problems such as Internet of Things (IoT), Cloud Computing, Industry 4.0, Wireless Sensor Networks (WSN), Cyber Physical Systems (CPS). The contemporary digital age, as stated in [10], focuses on the automated conversion of data into applied knowledge, and the article offers an overview of the main theoretical framework in this direction, related to the theory of innovation. The information service of digital technologies requires the development of a unique system design, and for this purpose an automated system with increased productivity, better functional parameters and service time is proposed in [11]. Facilitated user access to information resources with ensured authentication and security in handling the data is indicated as an advantage. The main task of information service systems is traffic optimization, especially when it is heterogeneous, as in [12] a toolkit for choosing structural variants and parameters of a distributed environment with multiple access to resources is proposed. On the basis of the research carried out, all types of customers have been united in united subsystems of integral traffic, allowing as a final effect the formation of a common information flow.

In active (distributed) learning, the main task is providing remote access to information resources and creating information flows [13]. Usually, the traffic is formed by statically or dynamically generated objects in the web space, containing text, graphics, multimedia, which defines it as heterogeneous. On the other hand, the most commonly used access technology is "client-server" [14]. It has time-recognized advantages, but along with that, the classic "client-server" model also has disadvantages: ✓ file servers are very busy; ✓ protocols for data exchange on the network are very "talkative", which causes its congestion; ✓ in the presence of a larger number of clients, the speed of exchange with the server drops significantly.

The main purpose of the classical scheme is within a local network and is practically inapplicable to heterogeneous networks due to multi-level incompatibility. In addition, the management of the traffic flows could be difficult. Investigation of the traffic in an IP-based corporate network by tracking the packets exchanged in the network by using monitoring tools and mathematical distributions is presented in [15].

The preliminary goal is to conduct an investigation to clarify the possibilities of information service in maintaining the processes of e-learning in different network situations. One of the widely used approaches is based on computer processes modelling, which can be done in a deterministic [16] or stochastic [17, 18] direction. In the case presented here, another also widely used approach, based on the program monitoring and processing of experimental data was chosen. To

organize the experiments, a software tool was created to monitor and collect information about the time parameters of access to resources, their delivery and visualization on the browser page. In order to check the functional capabilities, it is planned to carry out experiments on real information objects in the web space with additional analysis of the obtained results.

3. ORGANIZATION OF THE STUDY

The universal client-server model has advantages over the classic scheme, the main one being the ability of a client, regardless of its platform, to contact competitively with an arbitrary configuration of a database server by means of Web technology or an HTTP server. The structure of this model includes two parts (Figure 1), with the first covering the components between the client and the Web-server, and the second part referring to everything that lies behind the Web-server. The operation of an application in such an environment can be described by the operations: (1) establishing a client-server connection to access a page; (2) entering the necessary data in a Web browser; (3) control of the entered data through a script language; (4) sending the request to the server; (5) server query processing and SQL query generation; (6) executing the SQL query from the data server; (7) generation by the web-server of an HTML page with the received data with the possibility of interpretation by the client; (8) sending the result to the client and viewing it from a browser.

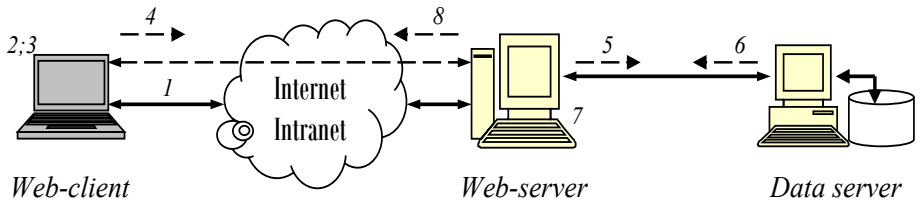


Figure 1. Universal "client-server" scheme

In the organization of the active distributed learning based on the presented technological model, the time parameters of the information service are important. For their research, a network software application was developed for registering and analysing information processes, using the concept of "client-server" communications in a distributed (network) environment according to the model of Figure 2. Two basic components of the information servicing are determined – client (front-end part) and server (back-end part), and the model predicts the following phases: (1) generation of user request (*resolve time*); (2) making the connection (*connection time*); (3) interval before start of transmission (*start time*); (4) transmission of data from the server (*server time*); (5) delivery of the information to the client (*load time*); (6) information service process for one web page (*total time*).

The products HTML, PHP, Java Script and My SQL were used in the implementation, and the goal was to provide a maximally simplified and easy-to-use user interface. The purpose is to analyse the information sources and factors of delay in the implementation of network services and the possibilities of access to the distributed information objects depending on the size and their remoteness.

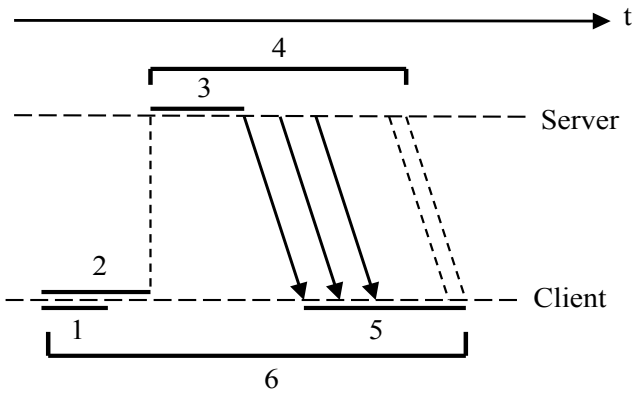


Figure 2. Research organization model

The main form of the application includes a field for entering the address of the analysed page and a button to start the process. When the button is activated, monitoring of the size (bytes), speed ("speed") and time to load the requested page from the allocated space ("total time") begins. In the process of work, the times "resolve time", "connection time" and 'start time" are also registered. The experimental results are stored in a database implemented by means of two tables – for PHP-session results and for JavaScript-session results.

4. EXPERIMENTS AND ASSESSMENTS

A separate module has been created for visualization of the accumulated experimental (monitored) data. It records times associated with receiving the information objects in the browser. When conducting an experiment, the requested page is visualized in the browser, and the investigated components are presented in the bottom part. If no address is entered or the requested page does not exist, the application displays the corresponding message. Possibilities are provided for tabular visualization of the accumulated data and for their graphical interpretation after each traffic measurement, and two modes are provided – for visualization of the measurements in table form and for building a graph based on these data. For the latter, it is necessary to define parameters for the field of the graph, as well as to set the scale, colours and other attributes of the graphical representation.

Empirical estimates of the transfer of educational information resources and their use T [%] are summarized in Figure 3, classified by the size of the transferred pages according to Table 1.

Table 1. Classification of the information resources

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
< 0,01 Kb	0,01-1 Kb	1-10 Kb	11-100 Kb	101-10^3 Kb	>10^3 Kb

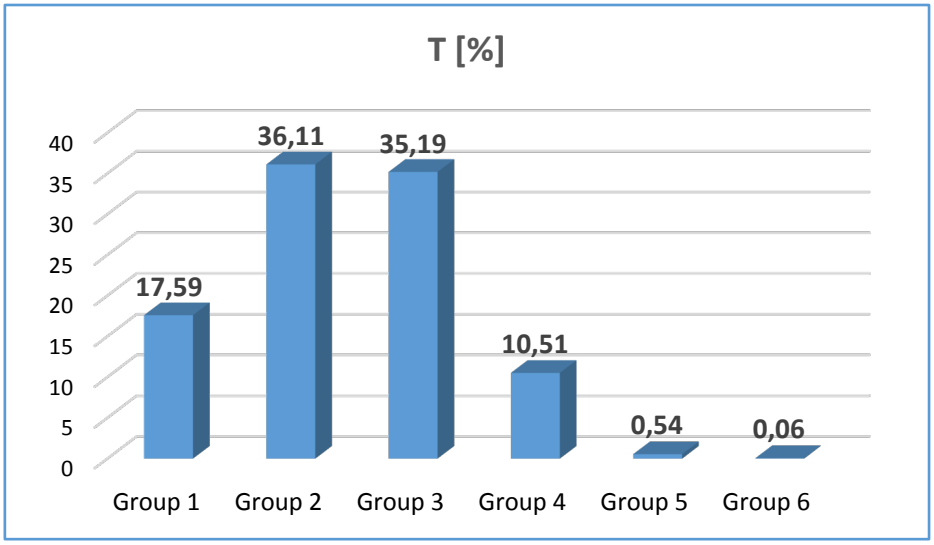


Figure 3. Usability of information objects

The highest assessments of usability are for the first four groups, which allowed to determine the type of main objects for conducting the experiments with the developed monitor, systematized in Table 2.

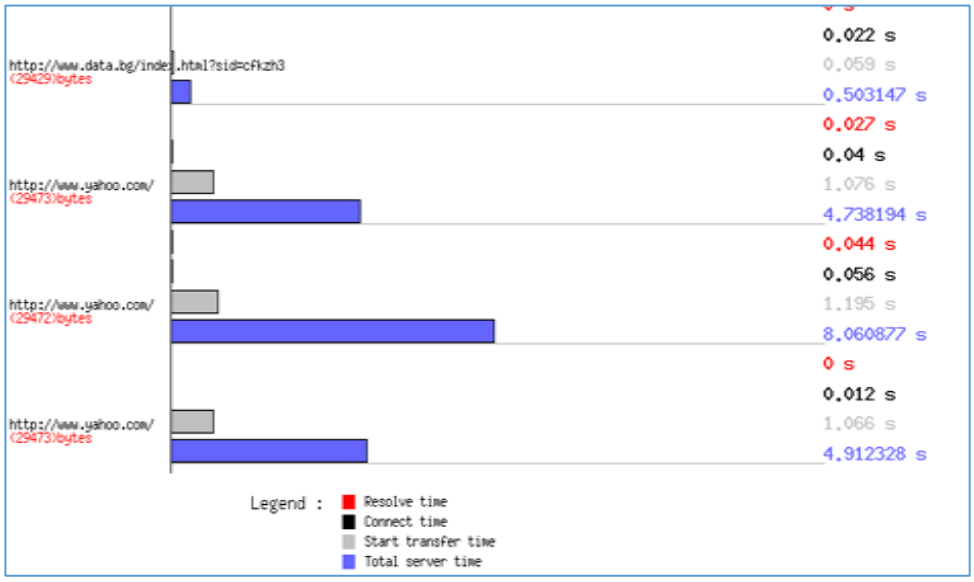
Table 2. Types of objects for conducting the monitoring experiments

Static pages (HTML objects)		Dynamic pages (web objects)		www objects with size 25-30 Kb	
Text	Text & images	53 Kb	200 Kb	*28 Kb*	*29 Kb*
Test1	Test2	dir.bg	start.bg	data.bg	yahoo.com

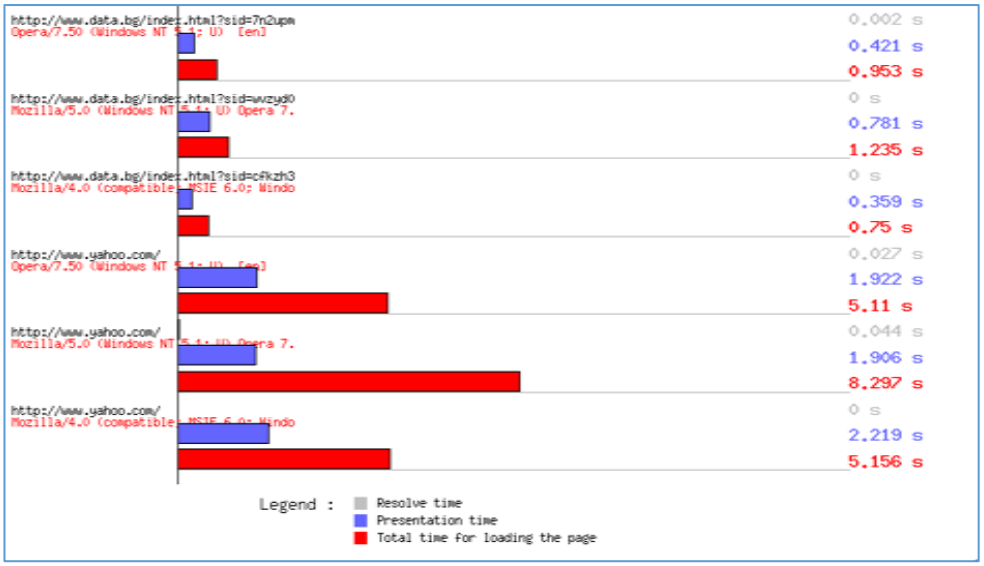
In the analysis, it should be taken into account that the limitations of the client's computer can affect the speed of information delivery. On the other hand, the unlimited time to use information resources can conflict with network processes when transferring information between server and client. These limitations are reflected in the initial phase ("resolve time') and in the final phase ("presentation time") of the transfer connection.

Regarding the server, two components can also be defined, imposing certain restrictions – the size of the information object (determines the latency of the connection) and the value of the information exchange (limits the transfer rate).

Part of the experimental results are presented in Figure 4.



Server time



Client time

Figure 4. Experimental results

The experimental data for request servicing by the server show that "Start transfer time" is a relatively small part compared to "Total server time", and for static objects the restrictions for the client are relatively minimal (the client does not have a significant impact on the total service time). With dynamically generated pages, there is a certain increase in "Presentation time" and "Total time for loading the page", but the impact on the client is also not significant. A summary of sample data from the experiments is presented in Figure 5.

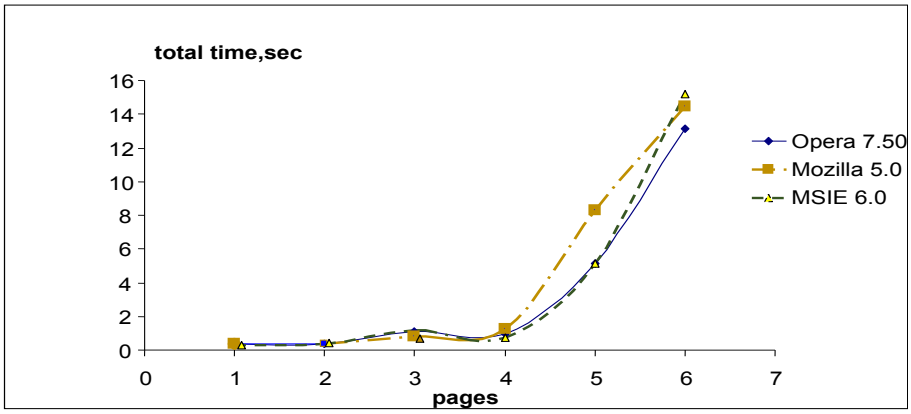


Figure 5. Total time for dynamic resources.

The analysis of the obtained results when studying the limitations of both sides (client and server) show that for dynamically generated resources the most important factor is the limitation on the server side. The server execution time and the page visualisation time at the client from the moment the first data packets arrive are almost the same, from which it can be concluded that the network has almost no influence in this case. It has a significant impact only when entering external pages, such as yahoo.com (Figure 6).

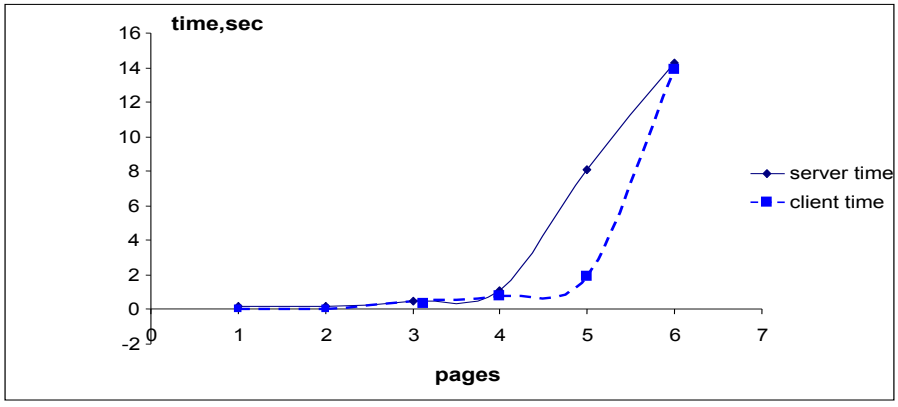


Figure 6. Influence of transfer parameters at different type of resources

5. CONCLUSION

Based on the conducted measurement experiments, it can be concluded that the client part does not have a significant impact on the parameters of delivery and service of information resources, while the server has a significant impact on loading the page (especially on dynamic pages). The latter is determined by the fact that in such cases the server does not search in its tree, but in a database. The current state of the network also has an influence, i.e. the loading speed of the page at a given moment, as well as its load. The transfer also depends on the type of information resource (static or dynamic), as well as on server-side restrictions. Based on the analysis, it was found that there is a significant difference between data transfers that are received from a database and those where data is read from a file. The second group of data has a better performance than the first, where a strong restriction is observed.

REFERENCES

[1] Flugelman, M.Y., R.M. Glueck, R.M., Aronson, D., Shiran, A. The two envelopes method for active learning. *GMS Journal for Medical Education*, vol. 39, no. 3, 2022, pp. 1-11.

[2] Kovarik, M.L., Robinson, J.K., Wenzel, T.J. Why use active learning. *Active Learning in the Analytical Chemistry Curriculum*, Chapter 1, Jan. 2022, pp 1-12, *CS Symposium Series,* vol. 1409. DOI: 10.1021/bk-2022-1409.ch001

[3] Lugosi, E., Uribe, G. Active learning strategies with positive effects on students' achievements in undergraduate mathematics education. *International Journal of Mathematical Education in Science and Technology*, vol. 53, no. 2, 2022, pp. 403-424. DOI: 10.1080/0020739X.2020.1773555

[4] Akbar, A., Jabbar, V., Saleem, Q.A., Ashiq, M. Access and use of digital information resources by students with vision impairment: Challenges, prospects and expected role of libraries, *International Journal of Disability, Development and Education*, Jul 2022. DOI: 10.1080/1034912X.2022.2095356

[5] Hunter, R.A. , Pompano, R.R., Tuchler, M.F. Alternative assessment of active Learning. Chapter 15 in "*Active Learning in the Analytical Chemistry Curriculum*" (*ACS Symposium Series*, vol. 1409), 2022, pp. 269-295. DOI: 10.1021/bk-2022-1409.ch015

[6] Doneva, D., Gaftandzhieva, S., Bliznakov, M., Bandeva, S. Learning analytics software tool supporting decision making in higher education. *International Journal on Information Technologies and Security*, vol. 12, no. 2, 2020, pp. 37-46.

[7] Hua, X. An optimization method for integrating educational information resources based on edge computing, *Journal of Sensors*, vol. 2022, art. ID 9891117, 2022, 12 p. https://doi.org/10.1155/2022/9891117

[8] Romansky, R., Noninska, I. Technological organization of the access management to information resources in a combined e-learning environment. *International Journal on Information Technologies and Security*, vol. 11, no. 4, 2019, pp. 51-62.

[9] Romansky, R., Noninska, I. Challenges of digital age for privacy and personal data protection. *Mathematical Biosciences and Engineering,* vol. 17, no. 5, August 2020, pp.5288-5303. DOI: 10.3934/mbe.2020286

[10] Hilbert, M. Digital technology and social change: the digital transformation of society from a historical perspective, *Dialogues in Clinical Neuroscience*, vol. 22, no. 2, 2020, pp.189-194. DOI: 10.31887/DCNS.2020.22.2/mhilbert

[11] Kravets, O.Ja., Atlasov, I.V., Aksenov, I.A., Molchan, A.S., Frantsisko, O.Yu., Rahman, P.A. Increasing efficiency of routing in transient modes of computer network operation, *International Journal on Information Technologies and Security*, vol. 13, no. 2, 2021, pp. 3-14.

[12] Spitsyn, A., Mutin, D.I., Bikkulov, I.M., Frantsisko, O.Yu., Atlasov, I.V. Multi-objective selection of structure variants for a corporate heterogeneous integrated system of information management. *International Journal on Information Technologies and Securit*y, vol. 13, no. 1, 2021, pp. 27-38.

[13] Caffrey, M., Commins, S. Examination of distributed learning on recent and remote memory using in-person and online experimental paradigms. *PsyArXiv*. 5 Jan 2022. DOI: 10.31234/osf.io/xk9rw.

[14] Barabanova, I.A., Kravets, O.Ja., Tkalich, S.A., Mutin, D.I. Analysis of the intermediate layer work in the three-tier architecture "client-server" of automation engineering problems. *IOP Conference Series: Materials Science and Engineering*, vol. 537, no. 3, 2019, art.032011. DOI: 10.1088/1757-899X/537/3/032011

[15] Nedyalkov, I., Stefanov, Al., Georgiev, G. Studying and characterization of the data flows in an IP-based network. *International Journal on Information Technologies and Security*, vol. 11, no. 1, 2019, pp. 3-12.

[16] Romansky, R., Noninska, I. Deterministic model investigation of processes in a heterogeneous e-learning environment. *International Journal of Human Capital and Information Technology Professionals (IJHCITP)*, vol. 13, no 1, 2022, article 28, pp. 1-16. DOI: 10.4018/IJHCITP.293228

[17] Romansky, R. Stochastic approach to investigate protected access to information resources in combined e-learning environment. *Mathematics*, vol. 10, no. 1, art. 2909, August 2022; DOI: 10.3390/math10162909

[18] Romansky, R. Mathematical modelling and study of stochastic parameters of computer data processing. *Mathematics*, vol. 9, no. 18, art. 2240, September 2021, DOI: 10.3390/math9182240

Information about the author:

Radi Romansky is a full professor at Technical University of Sofia, Doctor (Dr) in Computer Engineering and Doctor of Science (D.Sc.) in Informatics and Computer Science; Full member of European Network of Excellence on High Performance and Embedded Architectures and Compilation (HiPEAC). He has over 220 scientific publications and over 25 books. Areas of scientific interests: ICT, informatics, computer architectures, computer modelling, privacy and data protection, etc.

Manuscript received on 25 November 2022