Deterministic Model Investigation of Processes in a Heterogeneous E-Learning Environment

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ABSTRACT

The investigation of characteristics of access and use of resources in different distributed environments in the network space is aimed at determining optimal levels for the basic parameters of the supported processes. On the other hand, with the development of the possibilities of the digital space and the significant change in the level of informatization of the society, it is necessary to take the necessary measures to ensure secure access to information resources and in particular to the profiles of personal data. In this respect, the purpose of the article is to propose an organization of heterogeneous environment with resources stored in different places (own memories and cloud data centres). A general architecture and functionality of the main sub-systems are presented. Deterministic model investigation by using petri net apparatus based on preliminary formalization is provided to analyse the effectiveness of the processes for regulated and secure access to resources.

KEYWORDS

Access Regulation, Data Protection, Discrete Formalization, Functionality of E-Learning Environment, Heterogeneous Resources, Model Investigation

INTRODUCTION

The contemporary digital age is characterized by total informatization of society and expansion of the field of applicability of electronic services, which is discussed in a number of publications. As stated in (Chatterjee, 2021) "*there has been an immense advancement of internet technology*", analyzing the contribution of the Internet of Things (IoT) and its impact on human capital and people's daily lives. In addition, the article (Khouja et al, 2018) should be noted, where it is declared that information technology (IT) "*is a very important aspect for higher education institutions in both teaching, research and administration*" and the managers of these institutions realize their strategic importance. This determines the growing role of IT professionals in developing the right approach to managing IT and their successful implementation in educational institutions in accordance with their business strategies. In this regard, the article provides a systematic review of the literature using various scientific and unconventional data. In addition to the positive conclusions of the study, it should made point out some features that may adversely affect business objectives, such as the need for additional costs for equipment and licensing of products, creation of new structural units, training of employees, etc.

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The positive impact of modern information and communication technologies on management in higher education is also confirmed by the study in (Egoeze *et al*, 2018), which in conclusion confirms the need for the ever-expanding scope of their application in administrative services. The conclusions made in the article are based on questionnaires and the collected data are analyzed with the help of ANOVA.

Cloud computing (CC), a constantly evolving technology for providing services in the global network, also provides good opportunities for the realization and improvement of university education. A study of the factors influencing human capital and cloud perception is presented in (Hiran, 2021), and the results show that the importance of organizational factors is greater than that of technological, environmental and sociocultural factors. This should reflect on the approaches for the implementation of cloud computing in higher education institutions.

In the digital world, the use of new IT in all areas of public life, including university communications, requires proper organization of processes and ensuring secure access to distributed information resources and their legal use (Glet & Kaczynski, 2020) based on the requirements for strict information security (Monev, 2020). The need for reliable regulation of these processes is growing by setting specific requirements for the protection of resources in access and use (Romansky & Noniska, 2020a) and ensuring adequate cybersecurity in the network space. The result is the document of the European Commission "General Data Protect Regulation" in force since May 2018. The introduction of specific requirements such as "privacy by default" and "privacy by design" in organizing data processing environments, as well as the paradigm "right to be forgotten / to be erased " (replaced the previous one "right to be left alone") correspond to the inalienable rights of people for "right to privacy" and "right to data protection" (Romansky & Noniska, 2020b).

As mentioned above, when developing a technological system, it is recommended to conduct a model study, through which certain quantitative estimates for basic functional attributes can be obtained (Digalovski & Rafajlovski, 2020). On the basis of adequate initial formalization of the studied object and subsequent application of an appropriate modelling approach, useful conclusions can be made about the behaviour of the system and the development of the processes in it (Cheryshov *et al.*, 2020). The success of this study depends on a properly defined experimental design based on predetermined sets of primary and secondary factors.

The aim of the article is to propose a new approach for common organization of a heterogeneous environment of information and training resources located in different places in the global network and using cloud computing and possibly social media. This poses serious challenges for IT professionals to provide platforms for the protection of information and personal data of human capital. Specifically, a general architectural concept of an e-learning system called Heterogeneous e-Learning Environment (HeLE) is proposed as a new concept. The study proposed here can be taken as a continuation of the problems discussed in (Romansky & Noninska, 2016) and (Romansky & Noninska, 2019). The contribution of the article can be determined by defining the functionality of the main subsystems, expressed in a set of procedures for regulating access to different resources (internal and external), the defined formalization of processes and proposed conceptual model, as well as in the organization of deterministic model investigation using the apparatus of a Petri net with discussion of the obtained analytical results. The goal of the article is to determine specific collection of procedures for counteracting the possible risk of illegitimate access and violation of the principles set by the "CIA triad" (confidentiality, integrity, availability) (Romansky & Noniska, 2020a). The efficiency of the construction of the proposed environment is confirmed by an analysis of the behavior of the determined analytical model.

The article is organized as follows. The next section discusses some related work in the field. Section 3 presents the proposed generalized architectural model and functional sub-systems. The next two sections 4 and 5 are devoted to the presentation of the formalization and the conducted model investigation with analysis of the obtained results. Finally, conclusion and brief discussion is made in last section.

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