Koncept računarstva u oblaku u obrazovnim sistemima

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Apstrakt: Kloud tehnologija predstavlja sistem koji omogućava efikasnije, jednostavnije i jeftinije korišćenje IT resursa. Ekonomičnost primene ove tehnologije ogleda se u optimizaciji operativnih troškova, optimizaciji kapitalnih investicija, kao i smanjenju troškova. Elektronsko obrazovanje kao sistem počinje da "živi" krajem 20. veka u obliku IT aplikacija. Danas se ove aplikacije nalaze u novom okruženju – računarstvu u oblaku.

Količina podataka koju treba obraditi raste i ima tendenciju ubrzanja. Neophodno ju je memorisati, transferisati i procesuirati u jedinici vremena, što iziskuje razvoj određenih sistema. Dati sistemi koji omogućavaju menadžment resursima su big data sistemi, internet stvari, kloud platforme, virtualizacija, veštačka inteligencija, 5g, itd. Platformska struktura koja nosi navedene sisteme jeste računarstvo u oblaku.

Primenom računarstva u oblaku kao nove tehnologije za realizaciju elektronskog obrazovanja unapređuju se obrazovni i naučno-istraživački sistemi, u pogledu skladišnih i protočnih kapaciteta, brzine obrade podataka i dostupnosti informacija sa ciljem kvalitetnijeg obrazovnog okruženja koje poseduje veću mogućnost kontrole, ekonomičnije je, efikasnije i bezbednije u odnosu na tradicionalan koncept. U radu je predstavljen prikaz uticaja IKT odnosno računarstva u oblaku na obrazovne sisteme koji bi trebalo da budu deo novih kretanja iz razloga prednosti koje ova tehnologija nosi sa sobom.

Ključne reči: računarstvo u oblaku, obrazovni sistem, informaciono komunikacione tehnologije, elektronsko obrazovanje

Cloud computing concept in education systems

Abstract: Cloud technology is a system that enables the use of IT resources more efficiently, simply and cheaply. The cost-effectiveness of applying this technology is reflected in the optimization of operating costs, the optimization of capital investments, as well as the reduction of costs. Electronic education as a system began to "live" in the late 20th century in the form of IT applications. Nowadays, these applications are in a new environment - Cloud Computing.

The amount of data that needs to be processed grows and has a tendency to accelerate. This huge amount of data is necessary to store, transfer and process in a unit of time this requires the development of certain systems. The given systems that enable the management of the given resources are big data systems, internet of things, cloud platforms, virtualization, artificial intelligence, 5g, etc. The platform structure that carries these systems is cloud computing.

The use of cloud computing as a new technology for the realization of e-learning enhances educational and research systems, in terms of storage and flow capacity, data processing speed and availability of information with the aim of a better educational environment with greater controllability, is more economical, efficient and safer in relation to the traditional concept. The paper presents the impact of ICT and cloud computing on educational systems, which should be part of new trends due to the advantages that given technology brings.

Key words: Cloud Computing, education system, ICT, e-education

1. Introduction

Cloud computing is an infrastructure that enables the use of computing resources, namely servers, databases, data warehouses, network subsystems, software applications and special artificial intelligence (AI) systems. The resources provided are available online. Cloud computing makes it faster to access and pay for only the resources which are used. In this paper there is an attempt to represent influence of given concepts on educational systems in order to comprehensively improve governance processes on a long-term basis. Economics affects all aspects of the education system, ie. there is a need to reduce operating costs. It is only logical that the funds are less in the budget, and therefore the IT sector, which is required to do more with less money.

There are 2.5 quintillion bytes of data created every day at a certain speed, but speed is increasing with the advent and development of the Internet of Things (IoT), which has been recognized as an opportunity to change how educational institutions operates and enhance student learning experience, as well as experiences for teachers and other stakeholders (Srivastava, et al. 2020). We now do more than half of web searches from a mobile phone. More than 3.7 billion people use the Internet (up 7.5 percent from 2018). Google processes more than 40,000 searches every second (3.5 billion searches a day) on average (Forbes, 2019)

These changes affect the education system as well as the wider socio-economic system. Due to the improvement of conventional business processes, certain development methods are used as an important part of the development process, as well as new ICT technologies, which enable business automation. The modern ICT technologies on the market are big data systems; iot, virtualization, 5g, cloud systems, artificial intelligence, robotization. The given technologies are part of the business solution, and converge into a well-organized information system that optimizes information management and business system.

2. Information technologies and cloud computing

Due to better understanding the IT environment, and, if one looks at IT from the inception of computers to the present day, it may be possible to divide the interval into intervals in which IT possessed certain characteristics on the basis of which the relevant trends were defined. The 1950s were characterized by large mainframe computers, followed by mini computers in the 1960s, with the 1980s being characterized by personal computers and client server architecture. The end of the 20th century saw the emergence of the Internet, and the beginning of the 21st century was characterized by virtualization of server platforms, which formed the basis for the development of cloud services (cloud computing).

Technologically speaking, cloud computing can be defined as a service that offers unlimited amounts of disk space, processing power, working memory, bandwidth, etc. in the moment as needed and as needed in a way that independently controls the allocation of given resources, either through its own application/ specific portal.

Economically speaking, it is a service where the company is no longer the owner of the infrastructure or is in charge of its maintenance (administration), but pays the time rent of the amount of resources that it needs at a given moment. This means that the company no longer needs capital investments related to the IT sector. Given includes the procurement of a large amount of IT equipment that needs to be maintained without the need for it. The company also has no need to rush to acquire new hardware when current needs go beyond the capabilities of a given infrastructure.

Cloud computing can be divided into certain categories with sufficient accuracy depending on the economic and technological aspects. According to first category, from economic aspect, it can be separated into public, private and hybrid (public-private). The public cloud is owned by the provider - the service provider (Amazon, Google, Microsoft, etc) and the user pays for the service (service). There are many examples: Amazon EC2, Google Apps Engine, Windows Azure, etc. The private cloud is owned by the company and some departments, teams, etc. use the services when they need and how much they need. One of the given definitions of cloud computing is not satisfied, and it is an economic definition that is not fully satisfied, because a given resource for a company is a capital cost or an investment. In other words, all resources belong to a given company.

However, since this technology reduces costs, and the depletion of resources itself is large as a result of the application of new technologies (deployment of virtualization processes, the top components that make up infrastructure, etc), the private cloud is a cloud. A hybrid model where part of the services is in the cloud (resources are outside the company, ie with the provider of the service provided) and part is with the owner/ user. Based on the second category, where the technological aspect dominates, the following division is distinguished: IaaS (Infrastructure as a Service) - infrastructure as a service, PaaS (Platform as a Services) - platform as a service and SaaS (Software as a Services) - software as a service.

The following development trends are currently available: Green Cloud Computing, Edge Computing, Cloud Cryptographs, Load Balancing, Cloud Analytics, Mobile Cloud Computing Big Data, Cloud Deployment Model. For example, Green Cloud Computing saves energy, while in Edge Computing, data is processed at the edge of the network instead of in the data warehouse. Edge Computing is a new field that also optimizes resource utilization and improves system security. Cryptography can convey content with sufficient security. Cloud analytics is a combination of data analytics and cloud computing technologies. Cloud analytics is useful for both small and large organizations. Analysis has a broad scope, because there are many areas that require research. Cloud analytics consists of business intelligence tools, analytics management, and risk management.

Many organizations define the combination of public and private cloud as the best business solution. In a survey of nearly 800 companies in 2019, 94% used some form of cloud. Many businesses are still in the early stages of implementing cloud, deploying around 20% of their applications on a given platform. Gartner predicts that more than half of cloud-based companies today will move all their resources to the cloud by 2021. The worldwide public cloud service market will reach 228 billion in 2019, growing 15.8% over 2018 in US dollars. Software as a service will remain the largest segment, reaching over 170 billion dollars in 2023. Further, due to revenue, IBM and Oracle are corporations that have a significant role in the cloud computing world, compare to, for example, Google and Alibaba (Pažun, 2018). Comparing to 2017 when the estimated revenue of the world's largest cloud-based companies, according to Gartner, Microsoft Commercial cloud (Azure, Office365, Microsoft365), when was 21,2, in 2019 was 44.5 (in billions of dollars), as well as Google Cloud Platform, G Suite from 4,0 in 2017 has increased in 2019 with 8.9. Estimated revenue of Amazon AWS has been increased as well, from 20.4 in 2017, to 35 billion of dollars in 2019. (Gartner, 2019)

3. Cloud computing role in education system development

Nowadays, the importance of cloud is obvious. Some advantage is related to educational sustainability because given concept provides the required infrastructure, software, and storage, as well as cost reduction and improvement of education quality (Vaquero, 2011). Universities use cloud technology in higher education in many shapes. Virtual classroom is a concept which is used due to reducing the need for expensive textbooks by providing e-books and video materials to students online. Applications and storage systems are in the cloud, or students can use services such as Google Drive and Dropbox to store files, and the need to invest in storage devices is minimized. Also, software purchases are reduced when they are able to process text and spreadsheets online through Google Docs.

Virtual Labs, other form in which students can perform hands-on instructor-led exercises in online labs that are safe, convenient, and accessible anytime, anywhere, and on any device. These solutions reduce the cost of both students and educated institutions. For example, the Google Company, as the most valuable brand, has announced its cloud platform (GCP) as a project with free accessibility. Users can download 15 Google cloud services, including 30 GB of compute engine/ month, five GB of storage cloud storage/ month, Pub/ Sub with a capacity 10 GB/ month, and cloud function with a capacity of two million callings/ month, and meet their needs through these services by GCP. (Asadi, et al. 2019)

One of the studies conducted in the mid-2000s regarding the use of cloud computing in higher education showed that universities could still find themselves in the "early adoption" phase alongside other sectors, such as commercial and government. The factors that influenced the decision to use cloud computing in higher education were different from other sectors. In other words, according to company COMING - Computer Engineering, 70% of IT leaders in the field of higher education (out of 302 respondents) considered that improving IT services was the most important factor, while only 38% gave the primacy of cost reductions. Comparison of the given data with the most recent ones, however, results in increased investment in the IT sector.

Research shows that IT investments are very important in the field of higher education. In 2012, a survey by the Gartner Group found that 49% of educational institutions were already involved in some form of cloud computing. More recent research shows that schools and universities will increase their investment in cloud applications and infrastructure by 22.3% by 2023, due to the latest five-year forecast (Marr, 2018). According to Metaari (formerly Ambient Insight), an ethics-based quantitative market research firm that identifies revenue opportunities for advanced learning technology suppliers in 126 countries, funding for higher education technology companies increased to 740.58 million US dollars in 2019, twice as much as funding in 2018. What was surprising, according to research conducted by Metaari, is reduced funding for companies that support learning in lower education (below 12 years old pupils, aka PreK-12). Funding for academic education represented 8.6% of global investment in 2019, a decline of 11.2% in 2018 and significantly less than 21.4% in 2017. And as well, it should be mentioned that USA has returned to the first place as the leading learning technology investment hub, where it alternates with China (Adkins, 2020).

On the other hand, some disadvantages of cloud usage should be mentioned. Data security is a statistically significant challenge when it comes to cloud systems implementation in higher education (Juma, Tjahyanto, 2019). Cloud security providers have developed systems security protocols; however, the question is whether the systems in question are secure enough. A possible solution for providing the security of sensitive data in the cloud comes in the form of a combination of firewall and data encryption process (Mircea, Andreescu, 2010). Lack of control is an important issue, because if an organization places all its resources on the public cloud, allowing decentralization of information management to a certain limit, the question of control or dependence of the service provider arises. The organization integrates into an intricate network of services, which can be interrupted or whose costs could dramatically increase.

The pattern of cloud computing implementation, from development to the deployment of its resources in universities, is given in the following figure:

Source: Mircea, Andreescu, 2010

Presented technology enables the creation of reports and analyzes that should lead to rational curriculum decisions by study levels based on identified needs.

The phases of the strategies and/ or development of the transition to the cloud computing, according to the experience of the universities are (Rainer, Turban, 2009; Mircea, Andreescu, 2010): development of knowledge database on Cloud Computing; defining the university's needs for IT resources, solution testing, choice of solution, management of a given solution.

Solutions to the application of cloud computing in higher education are given in Figure 2:

Figure 2. Opportunities for deploying cloud computing in higher education

Source: Asniar; Budiawan, 2016

Figure 2 shows that SaaS (Software as a Service) and IaaS (Infrastructure as a Service) services may be suggested for students, lecturers/ researchers and administrative staff. Meanwhile, PaaS (Platform as a Service) and IaaS (Infrastructure as a Service) are services that can be offered to IT staff.

A relatively large number of different methods exist for software architecture development (Pazun, Langovic, 2019). Following figure shows that cloud computing development process can be organized in several stages.

Figure 3. Cloud computing development process

Source: Vaishali, 2014

The preparation phase includes understanding the technology of the cloud and user requirements, then it comes to understanding the feasibility of the project, and in order to get a more realistic picture, swot analysis is used. The analysis phase includes the analysis of user requirements. Phase 3 is reflected in the process of moving to the selected cloud platform. This is followed by the integration of new systems with the existing/ legacy system. Phase 4 represents the final transition to the cloud, ie the migration of data and applications to the cloud, ie the observed platform. It is necessary to provide adequate training for all users for successful migration. In final phase, the information system is active/ operative, as well as the process of evaluation is ongoing.

Considering on-going so-called industry's fourth revolution driven by the use of artificial intelligence and changing the work area from task-centered to human-based, future predictions for the technology include the connections to higher education as a dialectical, intricate, and intriguing opportunity, due to change society for the better. (Qasem, et al. 2019)

4. Edtech implementation due to Covid 19 reality

The explosion of the use of online tools to support learning during the pandemic, and in which we still find ourselves, was the only possible variant of continuing or maintaining some continuity in the teaching process. Precisely the situation emphasizes how necessary it is for the complete educational system (the process of lifelong learning, improvement, etc, as well) to have the possibility of blended learning, that is, how much is important the cloud computing platform existence, that given process

potentiates. Number examples can be captured along countries and their struggle with current situation. Some schools have organized a virtual teachers' room and virtual classrooms on various platforms (Loomen, Microsoft Teams, Yammer) where teachers have communicated daily with their students, given them instructions, checked their activity and completion of tasks, somewhere with central support, including a learning management platform/ system. Programs such as Office 365, Skype, Blackboard are used. Access and cloud services are being created. In Serbia, like in many countries, the most popular edtech tools during COVID-19 pandemic for audio-video classes have been Zoom and Microsoft Teams (WorldBank, 2020). Following table emphasizes two the most used edtech meeting tools during spring 2020.

Table 1. Online meetings Teams vs. Zoom comparison

Features	Microsoft Teams	Zoom
Compatibility		
Desktop App	Windows, Mac	Windows, Mac, Linux
Mobile App	iOS, Android	iOS, Android
Capacity		
Maximum Meeting Attendees	250	300 (optional upgrade up to 1000)
Audio and Video		
HD Video Capable	Yes	Yes
Join Meeting with Audio Only	Yes	Yes
Streaming Quality		Better overall
Chat		
Chat Within and Outside Meetings	Yes	Yes
Content Sharing		
Screen Sharing	Yes	Yes
Application Sharing	Yes	Yes
Annotate Shared Content	No	Yes
Work collectively on a document	No	Yes (share documents via LU Box, Office 365 or Google Drive and share screen)
Whiteboard	Yes	Yes
Remote control of screen	No	Yes
Meeting Capabilities		
Break-out rooms ² for discussions and subdivision	No	Yes
See whether participants in the room are focusing or not ³	No	Yes
Polling (voting)	Yes, via 3rd party plugins	Yes
Moderated Q&A	No	Yes (via webinar function)
Cloud Recording	Yes	Yes
Local Recording	No	Yes
Join Before Host	Yes	Yes
Security		
Approved for Confidential Data	Yes	Yes
Approved for Restricted Use Data	Yes	Yes
Encrypted Meetings	Yes	Yes

Source: Authors, according to official app sites

² This is a way of subdividing the group with each group having the possibility of participating in discussions and presentations

³ In Zoom, monitoring if the participants are focusing on the meeting or if they are working on something else on their computers

5. Conclusion

When it comes to education systems, perhaps the best solution is a hybrid form of cloud that allows part of the resources to remain within the system and the part to be moved to the public cloud of the service provider. Nowadays, it would be useful for resources to develop or grow into a single data center of local character with a shared cloud “around” a given data center, which would be shared by educational institutions. Everything is strategically viewed optimizing the business through reducing business costs and increasing productivity and efficiency.

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