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CLOUD TECHNOLOGIES IN MANAGEMENT AND EDUCATIONAL PROCESS OF UKRAINIAN TECHNICAL UNIVERSITIES

This study analyzes opportunities for using cloud technologies in higher education in Ukraine. On the basis of principles of the system approach, it examines the main task of cloud technologies, strategic and tactical goals of cloud computing at the technical universities, as well as problems that arise in their implementation in the educational process. The paper discusses the main trends in the use of cloud technologies in higher technical education, analyzes cloud services used by leading technical universities in Ukraine in management and learning. The typical structure of a Technical University is considered with public, private, and hybrid clouds. The experience of Cherkasy State Technological University in the use of cloud technologies at management and learning is presented. Considerations are particularly given to distance support, mobile, and blending learning, virtualization mechanism to support the students learning at natural, mathematical sciences and engineering through the utilization of individual desktops.

Keywords: Cloud technologies, Higher technical education, e-learning.

1. Introduction

Every technical University in Ukraine aims at training specialists in different engineering programs, conducting research and utilizing efficiently the University scientific and human potential to satisfy state's socio-economic requirements.

However, there is a contradiction between contemporary technical education and the level of the modern technology development, especially information technologies. That happened because the traditional engineering education was established under the industrial society, although the whole world is already living in the information society.

This problem pertains not only technical education in Ukraine, but also in many countries of the world. Activity analysis of these and other international communities (CIDO initiative (http://www.cdio.org), International Network for Engineering Education and Research (iNEER) (http://www.ineer.org)), universities and research organizations shows that introduction and wide use of innovative pedagogical, information and communication technologies (ICT), for instance, cloud technologies, is a one of the ways of the higher engineering education evolution and the successful adaptation of technical universities to the modern requirements of the information society, market economy, and integration processes in higher education of different countries.

In this paper the following issues are considered: the analysis of Ukraine opportunities at using cloud technology in higher education (part 2); principles of system approach for using cloud technologies at the universities (part 3); the main directions of using cloud computing at higher technical education in Ukraine (part 4), specifically, e-learning, teachers, and students training at open courses of world leading universities, IT professional certification programs; cloud technology usage at studying mathematical, natural, and professionally-oriented disciplines (part 5), CSTU experience at cloud technologies implementation (part 6), University IT infrastructure based on the cloud technologies (part 7).

2. The analysis of Ukraine opportunities for using cloud technology in higher education

Use of ICT provides universities with the modern hardware and software computer equipment. Currently characteristics of the computer technology are changing and improving every day. However, Ukraine's universities cannot update their facilities to catch up with the rapidly

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changing modern computers. The same situation exists with the software and technological support. This is explained by the high costs of the technological provision of the education.

As the experience of developed foreign countries, for the effective solution of above challenges is the introduction in educational process of «cloud computing».

To solve this problem developed countries introduce 'cloud computing' at the universities. In Ukraine's universities cloud services originally appeared mainly as free hosting mailing services for students and faculty. Numerous other tools of cloud computing for education were not used due to the insufficient information about them and the lack of practical skills to use them for educational purposes. Only recently the student community and lecturers of Ukrainian universities began using innovative IT applications such as Google Groups, Microsoft Office Web Apps, Amazon EC2 and others.

New Internet technologies not only change the surrounding environment, but actively influence the form and content of education at all levels. Such technologies allow to motivate students, to intensify learning, contributing to the quality education. Successful use of these technologies requires an appropriate IT infrastructure. According to the statistics International Telecommunications Union (ITU3) – the number of Internet users in Ukraine increased from 0.72% in 2000 to 33.7% in 2012, the number of broadband Internet users in 2012 approached 3,643,460 people (http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx). Indicators of Internet user number and broadband Internet users in Ukraine exceed average indicators for developing countries, although still lag behind the developed countries. Another important factor that necessitates the development of clod technologies in the country is the development of data-centers on its territory. Currently there are 22 colocation data centers from 4 areas in Ukraine: Kiyv (15), Kharkiv (4), Mykolayv (1), Odesa (2) (http://www.datacentermap.com/quote.html?country=ukraine).

All factors considered, current national resources of IT-infrastructure in Ukraine are sufficient for the application of new web technologies in education.

3. System approach principles enabling to use cloud technologies at the universities

However, the existence of accessible and potentially powerful technologies does not guarantee their effective use in any domain. Increase the efficiency of the modern University, as a complex social system, designing and improvement of existing management systems in modern conditions should be implemented on scientific approaches, in particular system approach, and provide the formation of the main principles of the University management, the definition of control functions in accordance with the basic strategic goals and objectives of the University; building an effective organizational structure, creation and introduction of new information technologies at education management.

The most common scientific approach to education management is system approach in the contemporary concepts of pedagogical management. The system approach is the examination of the object as an integral multiple elements together with the relationships and links between them. It means that the research object is considered as a system. Considering the system approach we discuss the action organization method, covering any activity type, identifying patterns and correlations to use them effectively.

Complex application of scientific approach basic principles (integrity, hierarchy structure, structuring, plurality, consistency) at a modern university with a wide use of ICT including cloud technologies should provide its holistic and perspective development as an educational system.

The main task of cloud technologies use at a University is creation the favorable conditions for students to study, making the young people ready for entering the University, improving the teachers and students qualification, retraining the faculty using up-to-date information, communication, psychological, and pedagogical technologies.

The strategic aim of the cloud technologies adoption at a University is the implementation of modern techniques to education to help to provide the information society with highly qualified specialists as well as to expand the information and educational space of a university and to implement the continuous education principles for all kinds of people.

Tactical goal of cloud technologies adoption at a University is the wide use of modern informational, communication, and pedagogical technologies in education and research. It contributes to the intensification of study, activation of students educational and cognitive activity, stimulating their creative potential, increase of the independent, individual, and collective role of work.

The given goals and tasks provide the mechanism for development the realization program of cloud technologies use and development at a university which will ensure their wide introduction in education in various forms and levels.

We will examine the nature of cloud technologies development and main directions of their implementation taking into account the goals and principles of the system approach and its' use in education at a university.

4. The main trends in cloud computing application in Ukraine's technical universities

In the document «The NIST Definition of Cloud Computing» the National Institute of Standards and Technologies (NIST) is pointed out that Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics (On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured service), three service models (SaaS - Software as a Service, PaaS - Platform as a Service), IaaS - Infrastructure as a Service) (Fig. 1), and four deployment models (Private cloud, Public cloud, Hybrid cloud, Community cloud) [1].
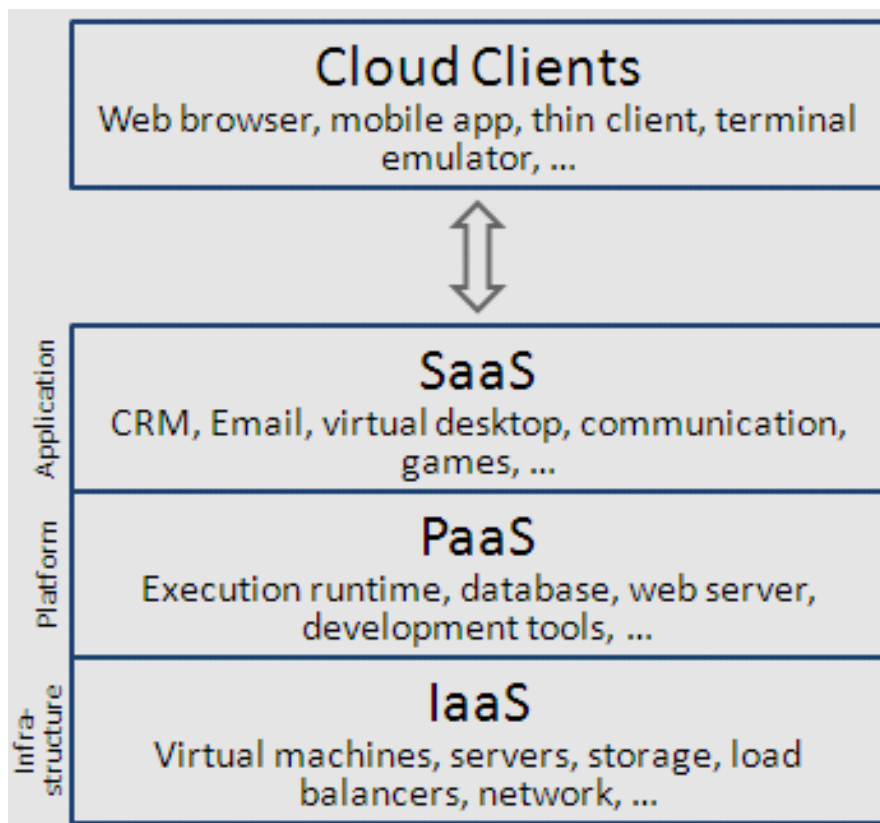

Fig. 1. Three service cloud models

In work [2] are considered a taxonomy to classify a variety of XaaS (Anything as a Service) offerings, which extends the traditional SaaS, IaaS, and PaaS areas (Fig. 2).
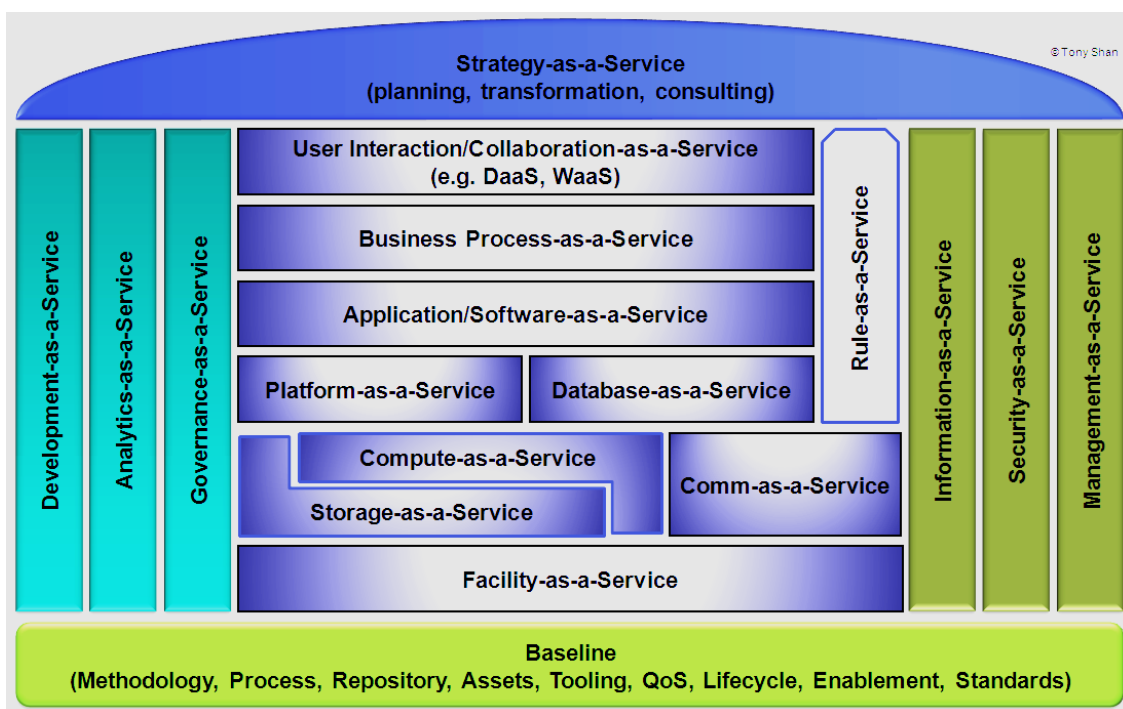
Fig. 2. Cloud Taxonomy and Ontology [2]

The cloud computing distinguishes from the previous models (distributed computing, grid computing) first of all with the principle of computing power, rent of necessary software, hardware or the provision of the entire infrastructure as a service on Internet. The table 1 provides an overview of cloud providers whose services the Ukraine's universities use the most [3].

Table 1.

Cloud Providers (Vendors) Overview

#	Provider (vendor)	Cloud service Model	#	Provider (vendor)	Cloud service Model
1	Google Apps Engine	SaaS	6	Oracle	PaaS/SaaS
2	Microsoft Azure Services Platform	IaaS / PaaS	7	IBM	IaaS / SaaS
3	Amazon Web Services	IaaS / PaaS	8	Cisco	IaaS
4	VMware	IaaS	9	GoGrid	IaaS
5	Rackspace	IaaS / PaaS	10	Salesforce	IaaS/PaaS/SaaS

Application of cloud computing in university education gives the opportunity for higher education organizations to use computing resources and software applications on Internet as a service, allows intensifying and improving the learning.

Today there is no alternative for collaborating on text documents, electronic worksheets, presentations, data stores, files and synchronization. Table 2 provides a list of vendors of cloud offices and services, which are to some extent used by universities of Ukraine.

Table 2.

Vendors of cloud offices and services

Vendor	IBM Docs	Google Docs	Office Online (previously Office Web Apps)	Zoho Docs
Sait	greenhouse.lotus.com	docs.google.com	office.microsoft.com/ru-ru/web-apps onedrive.live.com	www.zoho.com/docs

Examples of the most popular modern services in Ukraine based on cloud computing for education are the Live@edu, Microsoft's (https://login.live.com) and Google Apps Education Edition (http://www.google.com/enterprise/apps/education).

A list of cloud services Windows Live from Microsoft includes: *Windows Live Mail, Windows Live SkyDrive, Windows Live Messenger, Windows Live for Mobile, Windows Live Alerts, Office Online (previously Office Web Apps)*.

Office Online is an online office suite offered by Microsoft which allows users to create and edit files using lightweight, web browser based versions of Microsoft Office applications: Word, Excel, PowerPoint, and OneNote. The offering also includes Outlook.com, People, Calendar and OneDrive, all of which are accessible from a unified app switcher.

Google develops and provides a range of applications and services which are accessible from any page in a browser (Mozilla Firefox, Google Chrome, Opera, Internet Explorer etc.) when connected to the Internet. In our opinion, the most frequently used Google Apps for Ukrainian academia are the following: *Google Calendar, Google Docs, Gmail, Google Knol, Google Maps, Google Sites, Google Translate, YouTube*.

In the above mentioned list of services Google Apps plays a special role. It is a service provided by Google to use its domain name to work with Google services. Domain name registration is possible through a registrator authorized by Google. Google Apps has free basic and professional packages. Google Apps Education Edition is developed for educational purposes and is a free package for educational organizations including all the opportunities of professional package (http://www.google.com/intx/uk/enterprise/apps/education/products.html).

This gives a university the opportunity to use cloud services described below:
– cost saving for student mail server managing and keeping; as there is no need for keeping high disk space server, protecting against spam and viruses, thereby reducing the expenditures for support staff;
– increasing data and information resources accessibility; creating of mailing group for notifying on the conferences, changes in the schedule, graduates mixes, administrative events;
– competitive advantage offering maximum of the possible services to students; educational organizations create a competitive advantage over others that limit the student by basic services;
– supporting community graduates and establishing relations with them with minimal efforts and money.

The usage of cloud solutions enable universities to deploy mobile resources such as e-learning systems, digital libraries, and expand resources for research, web portals, information systems, OLE system, provide hosting services.

Applications that a university uses are integrated into the infrastructure of the cloud provider. The University must pay attention to the standardization and automation of deployment and service updating in provider infrastructure; take account of billing procedures.

Public cloud allows universities to deploy infrastructure on the cloud of a cloud provider, use common applications that reside on provider servers and storage systems. Compared with the private cloud the public cloud institutions can be much larger though it is possible to increase or decrease the cloud size on demand. In addition, this deployment model allows to transfer risks from universities to cloud services providers which servers provide corporate infrastructure.

Cloud providers as Amazon, Google, Microsoft, IBM etc. provide cloud resources for its customers that are located on sites consisting of data centers. Usually the same infrastructure is shared by multiple clients but each has its own secure cloud.

If necessary, universities can deploy on a *private cloud*. This model is used by universities that need more control over its resources and ensuring the safe data usage. Such clouds are created only for one organization in such a way that control over data security and quality of provided services is ensured. University's firewall protects the cloud. Access to cloud services and resources are available only to employees and students of the University.

Universities can use *hybrid cloud model*. This model combines the public and private clouds. Having chosen this model university corporate network system administrator should determine the way of application distribution for public and private clouds. It is recommended to use a hybrid cloud when small amount of data is used without application statefulness.

Thus, for the cloud technologies deployment and usage in universities it is necessary to consider the peculiarities of the cloud architecture and specific categories of users, and also rebuild management infrastructure and university procedures of operational management according to cloud technologies.

Flexibility and dynamism of the cloud infrastructure enables universities to combine reasonably the usage of peaks and slumps of workplace load and minimize operating costs.

Let's consider some examples of cloud technologies possible use at Ukrainian technical universities.

4.1. E-learning

The modern projects of e-learning are using the virtualization process and such concepts as «Elastic infrastructure», «Partitioning of Shared Resources», and «Pooling Compute Resources».

Currently there are a number of specialized solutions for e-learning, for example, *Moodle, Blackboard, Google OpenClass, Canvas, Piazza, eFront, ILIAS, Claroline, Sakai, OpenSIS* and other. Some of them are services that are as an information management system (like solution with open-codes OpenSIS), other are system of education management (Moodle, Canvas, ILIAS, Claroline, Piazza), and others integrate components of both systems (OpenClass). In Ukraine, the most common is the LMS Moodle (moodle.org).

The exemple of online learning systems new generation is the joint product of companies Pearson and Google called OpenClass (http://www.joinopenclass.com). OpenClass combines elements of LMS and social networks. The users can run this product from Google Apps. The beta version of OpenClass is implemented. Many universities test this beta version, including the universities of Ukraine, for example Crimean Engineering and Pedagogical University [3].

On the one hand, e-learning system is an effective educational technology which allows to replace some traditional learning programs, reduce learning costs, and intensify the learning. On the other hand, online learning creates a lot of its own problems.

So, there is a new problem of higher education: *the most successful universities will be able to attract millions of students from all over the world; weak universities will lose students and they can't withstand the online projects of strongest universities*.

4.2. Teachers and students training at open courses of world leading universities

The most popular and successful online learning projects using the advantages of cloud computing is massive open courses (*Massive online-Open Course* - MOOC) offered by projects *Coursera* (https://www.coursera.org), *MIT OpenCourseWare* (http://ocw.mit.edu/index.html), *Stanford Online* (http://online.stanford.edu/course), *Udacity* (http://www.udacity.com), and *edX* (https://www.edx.org).

Project Udacity was created for education democratization and improving the training on computer science. Courses are offered as video lectures based on integrated tests, homework; there are also video conferences, forums in the format of «student-teacher», «student-student». As a pedagogical concept the model «learning by doing» is used. The assignments for each lecture are intended to help students to understand the concept and ideas presented at the lessons.

Coursera Project offers free online courses of leading American universities. Courses include lecture notes, homework assignments, tests, and exam questions. Unlike the project Udacity, Coursera project offers courses not only at computer science but other courses including «economics, finance and business», «mathematics and statistics», «society, network and information», «public and social science, health, medicine, and biology».

EdX offers interactive online classes and MOOCs from the world's best universities. Online courses from MITx, HarvardX, BerkeleyX, UTx and many other universities. Topics include biology, business, chemistry, computer science, economics, finance, electronics, engineering, food and nutrition, history, humanities, law, literature, math, medicine, music, philosophy, physics,

science, statistics and more. EdX is a non-profit online initiative created by founding partners Harvard and MIT.

MIT OpenCourseWare is a web-based publication of virtually all MIT course content. OCW is open and available to the world and is a permanent MIT activity. For higher engineering education courses in electrical engineering, systems engineering, computer science, engineering and economy (total 2150 courses) would be useful.

Stanford Online offers a variety of professional education opportunities in conjunction with many of the University's schools and departments. Stanford Online also offers an array of free online courses (including some engineering disciplines and computer science) taught by Stanford faculty to lifelong learners worldwide.

The main goals for teachers of Ukrainian universities during training on MOOC are: to use methods of MOOC for improvement of traditional and distance learning, qualification improvement, improvement of existing and development of new educational courses on the basis of the obtained knowledge and experience.

4.3 IT professional certification programs

Gap between knowledge that a student gets in a higher school and the actual need of economy in highly qualified professionals is one of the main problems of higher education in Ukraine. Certification programs are popular now at helping contemporary specialists (graduates, students) to improve their skills and knowledge required in the work practice. Certification enables IT specialists and students to acquire up-to-date and needed skills at the job market that are of value for employers, as well as to improve the level of their professional capabilities.

To provide services on a competitive level modern specialist must know the latest technologies. They must be well trained to achieve this. Modern information technologies are developing so fast that it is quite difficult for professionals to remain competent and qualified enough specialist without specialized training.

Professional certification enables IT professionals to complete training and receive formal confirmation of their knowledge and skills of the latest ICT. The most admitted certification system now is a so-called international IT certification which allows to obtain a certificate from a vendor/manufacturer of a product. For many years the leaders at this field are hardware, software, networking and telecommunications equipment, etc. manufacturing companies (Microsoft, Google, HP, Cisco, Oracle, IBM and others).

Cloud technologies have opened entirely new opportunities for self-education and knowledge and skills improvement for students and graduates of IT specialties. Certification programs provide unlimited technical possibilities for the instructors of ICT disciplines to improve students and professionals skills.

In that context certification programs are one of the actual ways to obtain the necessary knowledge and skills in the field of cloud technologies, which are currently being offered by leading cloud providers including Microsoft, IBM, HP, Google, Cisco, VMware, and others.

5. Using cloud technology at teaching mathematical, natural, and professional courses

Examination of the experience of ICT using in engineering students higher math teaching in the US has provided an opportunity for scientists of the Kryvyi Rig National University [4] to affirm that now development stage of the higher engineering school leading medium at engineering students higher mathematics learning are online ICT and cloud services of general purpose (learning management system, allocation of open learning materials system, communication and collaboration facilities) and special purpose tools (computer mathematics web-system: *webMathematica, WolframAlpha, MapleNet, SAGE, vxMaxima*, mathematical editors, trainers, training web-expert systems) which are an integral part of the mobile mathematical environment [5]. Different models of ICT and cloud technologies usage at engineering students higher mathematics studying are being implemented at the Ukrainian technical universities, particularly at CSTU.

For teaching IT students at CSTU and other Ukraine's universities free cloud environment are used for program development in different programming languages (*C, C++, Html, Java,*

Javascript, Pascal, Perl, PHP, Python, Ruby, SQL, Visual basic, Scheme). They include the following browser programming system: Scratch.mit.edu, PascalABC.NET, IDEOne.com, CodePad.org, CollabEdit.com, editor.condex.net/pythonv3, TouchDevelop.com.

The virtualization technology provides big opportunities for training students in computer majors, work with operating systems and computer networks in real time. This advantage is used in the teaching of such courses as «Operating systems», «System programming», «Parallel and distributed computing», «Computer networks», «Information Security». There are a specific virtual environment and the necessary software for various disciplines. Use of cloud technology at higher mathematics and other mathematical, natural and professional courses teaching for engineering students majors allows to reach the high mobility level of students and teachers. The textbooks content together with other electronic educational resources, support facilities of mathematical and professional activities are carried in the web environment which substantially expands the range of ICT tools that can be used for training.

There is a new form of training – mass open distance learning courses. The leading forms of the training organization are cloud oriented lectures, practical and laboratory classes.

6. CSTU experience according to the implementation of cloud technologies

CSTU where the authors work is a typical regional technical university which teaches IT, mechanical engineering, chemistry, construction engineering students. So it has all the issues stated above. Here are some practical steps for the university to solve cloud technologies implementation issues.

1. The e-learning system based on system Moodle 2.5 is designed and implemented for realization of the blended model of learning, improvement of traditional teaching, conducting various types of teaching control, as well as for testing the creating distance courses in CSTU. About 100 teachers are trained for to use the distance learning technologies. They created more than 250 distant courses. The university operates an electronic library.

2. The University received free license program of the IT Academy Microsoft (software package DreamSpark) for the software from Microsoft. Note that every year approximately 20% of the Information Technologies and Systems Chair of CSTU graduates are trained in Microsoft Virtual Academy, HP Accredited Technical Associate, other educational programs and get certificates.

3. The University makes extensive use of open source system and problem-oriented software, cloud technology at education at IT field. At CSTU Information Technologies and Systems Faculty cloud-oriented IT infrastructure with use of Google and Microsoft Office 365 services is being implemented.

4. In January 2013 the Memorandum about the establishment of Research and Teaching Center of HP was signed between the HP Company and CSTU. The Test Center on the basis of Certiport company was created in cooperation with HP in CSTU. This center has trained 30 teachers on the program HP ATA (Accredited Technical Associate). It provides training and certification of IT professionals in 4 areas: Networks; Server & Storage; Connected Devices; Cloud. Besides, CSTU professors who teach computer courses study at courses provided with Coursera, Udacity, EdX projects.

5. During last years Ukrainian universities including CSTU actively do research at using cloud technologies in education, including engineering education. In 2012 a joint research laboratory on the use of cloud technologies in education in Kryvyi Rig National University and Institute of Information Technologies and Training Means of NAPSU (http://cc.ktu.edu.ua) was established. Video is available on http://www.ustream.tv/channel/cc-seminar. The results of this work are discussed at scholarly conferences and seminars held at different levels including The International Workshop «Cloud Technologies in Education'2013» (CTE2013) (website of the seminar: http://tmn.ccjournals.eu/index.php/cte/2013). Presentation of reports on the seminar is available on the website http://cc.ktu.edu.ua/?p=163. Co-organizers of these seminars are: Institute of Information Technologies and Learning Tools of the NAPS of Ukraine, Kryvyi Rih National University, Cherkasy State Technological University, National Technical University "Kharkiv

Polytechnic Institute", Taras Shevchenko National University of Luhansk, Kherson State University, Eastern Washington University. The best reports will be published in the electronic journal «Information technologies and teaching facilities» – scientific reviewed electronic edition, providing information to readers and is available at: http://journal.iitta.gov.ua.

7. University IT infrastructure based on the cloud technologies

The rapid development of cloud computing requires the universities to integrate cloud services in education, to review its IT infrastructure and to implement the innovative technologies in educational process.

Currently there are three basic location apps models at the Ukrainian universities: *local* (on premises); *the company-hosting* (hosting); and *in the cloud* (cloud).

The most traditional model apps deployment is local on the user side. The apps deployment on-the premises needs substantial investment in IT infrastructure: hardware resources, software, network communications and the IT staff. The advantage of this model is the full control of the University IT -infrastructure, hardware and software.

However the support and development of its own IT environment is complicated by the need to meet a number of technical requirements: the high equipment cost, its maintenance/repair, the lack of computing resources, low data security, telecommunication costs and others because of the university budget limits.

The model with apps deployment on the hosting. Hosting is a service that provides the hardware platform, software, infrastructures and staff to maintain it. The university model of IT infrastructure on the hosting basis has less control over it infrastructure, hardware and software and it is not a free service.

Placement model of IT infrastructure in the cloud requires the university to cover the expenses for rented hardware and software resources, which leads to a considerable reduction of the initially planned expenditures. Usually cloud services payment is calculated on the amount of used computing resources. The cost is the biggest advantage of the cloud model compared with the traditional IT-infrastructure.

Today cloud computing and policies of the largest companies in relation to educational institutions allow universities to save money on technological advances of management activities and learning

The modern approach to the organization of IT-infrastructure at the University gives an opportunity to organize computer laboratories using cloud computing technology (Fig. 3).

Cloud technologies that use IT infrastructure in a public or a hybrid cloud fully or partially, can provide an effective solution to these problems. The servers in this scheme could be located in two ways: rental and collocation. You can rent a server from the large IT-company or service provider that provides this service. It is cheaper than the service provided for a short period of time. If the University has its own server, it is easier to use server collocation. The provider places the equipment in your data center and ensures their maintenance. The service collocation is cheaper and you can use it for a long period of time.

This type of computer laboratory organization has both advantages and disadvantages. The advantages in comparison with the common virtualization include:
- efficiency, that is reduced expenses on IT infrastructure and used software;
- flexibility that allows to study and perform the tasks not only in the building of the educational establishment, but anywhere because the Internet connection is enough to get quick and easy access to information;
- computing resource scalability that makes any required computational performance and amount available for users due to the basic idea of cloud computing, only the consumed resources should be covered;
- data storage reliability that means that all data on the servers of major cloud providers are copied repeatedly and if one of them breaks down, the user data will be available from a different server;

- cloud computing increases the service life of existing infrastructure since the life cycle of computers is extended due to server side that performs computational processes;
- educational process flexibility is the possibility to use both Windows and Linux, and any other software, including different versions of the same product;
- technical requirements of IT infrastructure engineering is provided by the provider.

The main challenge in cloud technologies usage is the need for high-speed Internet connection. Some Ukrainian universities can't afford it yet. Another challenge is the limited functionality of some software products on the Internet.
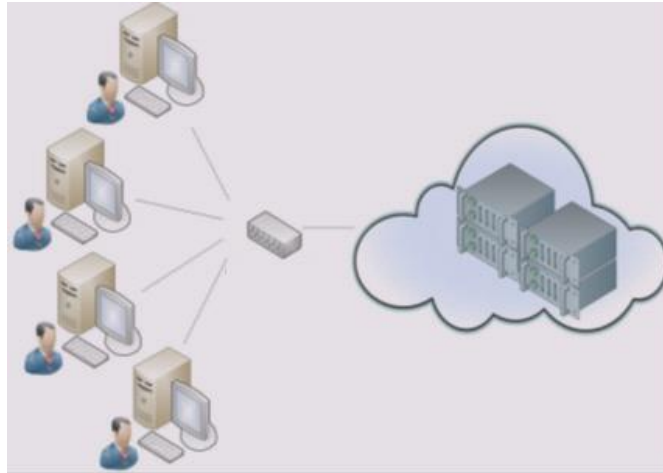

Fig. 3. Organization of computer laboratories at the University using cloud computing.

Fig. 4 presents a modern typical organization of IT infrastructure of an average Ukrainian university described in operation [3]. In this example, software is deployed on a single physical machine for ESX virtualization proposed by VMware [6]. It is installed directly on a physical server and allows to divide it into multiple virtual machines that can run simultaneously, allocating the physical resources of the primary server for certain tasks (in our case - deploying a virtual server).
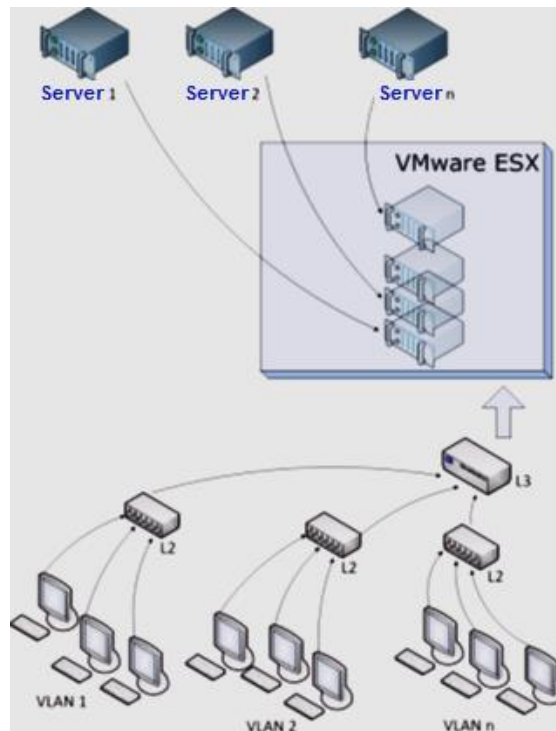

Fig. 4. Modern organization of IT infrastructure of an average university

8. Conclusion

The rapid spread of cloud computing sets the task of integrating cloud services in the management system of educational institutions, changing their IT infrastructure, and implementation of innovative technologies in education.

Modern Internet technologies do not only change the world around us, but also actively allow the introduction of innovation in education. This does not only change the form, but also contents and methods of education. As a result of these Internet innovations we can intensify the motivation of students for new knowledge, enhance the process of teaching and learning, as well as influence and improve the overall quality of education.

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ХМАРНІ ТЕХНОЛОГІЇ В УПРАВЛІННІ І НАВЧАЛЬНОМУ ПРОЦЕСІ УКРАЇНСЬКИХ ТЕХНІЧНИХ УНІВЕРСИТЕТІВ

Це дослідження аналізує можливості використання хмарних технологій у сфері вищої освіти в Україні. На основі принципів системного підходу, перевіряється головне завдання хмарних технологій, стратегічних і тактичних цілей хмарних обчислень в технічних університетах, а також проблем, що виникають у процесі їх реалізації в навчальному процесі. У статті обговорюються основні тенденції використання хмарних технологій у вищій технічній освіті, аналізуються хмарні сервіси, використовувані провідними технічними вузами України для управління та навчання. Типова структура технічного університету складається з державних, приватних, і гібридних хмар. Представлено досвід Черкаського державного технологічного університету в галузі використання хмарних технологій в управлінні та навчання. Детально розглянуто дистанційну підтримку, мобільне, і змішане навчання, механізми віртуалізації для підтримки навчання студентів природних, математичних і технічних наук за рахунок використання індивідуальних робочих місць.

Ключові слова: Хмарні технології, вища технічна освіта, електронне навчання.

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ОБЛАЧНЫЕ ТЕХНОЛОГИИ В УПРАВЛЕНИИ И УЧЕБНОМ ПРОЦЕССЕ УКРАИНСКИХ ТЕХНИЧЕСКИХ УНИВЕРСИТЕТОВ

Это исследование анализирует возможности использования облачных технологий в сфере высшего образования в Украине. На основе принципов системного подхода, проверяется главнач задача облачных технологий, стратегических и тактических целей облачных вычислений в технических университетах, а также проблем, возникающих в процессе их реализации в учебном процессе. В статье обсуждаются основные тенденции использования облачных технологий в высшем техническом образовании, анализируются облачные сервисы, используемые ведущими техническими вузами Украины для управления и обучения. Типичная структура технического университета состоит из государственных, частных, и гибридных облаков. Представлено опыт Черкасского государственного технологического университета в области использования облачных технологий в управлении и обучения. Детально рассмотрено дистанционную поддержку, мобильное, и смешанное обучение, механизм виртуализации для поддержки обучения студентов естественным, математическим и техническим наукам за счет использования индивидуальных рабочих столов.

Ключевые слова: Облачные технологии, высшее техническое образование, электронное обучение.