

## CLOUD COMPUTING AS THE BASIS OF ELECTRONIC UNIVERSITY CAMPUS

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The problems of creation of university electronic campus are the main items of the discussion. Cloud computing is the basis of datacenter of the electronic campus. Server virtualization and desktop virtualization are implemented at Vladivostok State University of Economics. We consider efficiency of server and desktop virtualization at the article. Cloud computing allows to develop new educational models, new methods to communicate between teachers and students.

The current situation in the education sector is characterized as a systemic crisis manifested in the fact that the activities of the educational system contradict socio-economic context, the status of the university as the institutional intellectual center creating new knowledge and cutting-edge designs is lost, and the content, models, and technology of education are irrelevant. The national economics does not generate a request for specialists, in the most of the students direct on the middle level and the nest alumni have not self-actualization in Russia and they leave the country. Experts discuss the different options for the development of higher education, which are largely dependent on future scenarios of socio-economic development of Russia and the policy of state regulation in the field of education. The expert's opinion is that we will have the conversion of higher education, universities have to adapt to the new conditions and polycentric system of higher education will be developed, where regional universities are the centers of excellence, research, and development.

Informatization process of University is designed not only to help in achieving these goals, but to do this effectively. It now depends on whether the universities are able to respond to changing external requirements quickly, whether they have a flexible business models, consider whether the information technology (IT) as the basis of efficient management and a means to achieve competitive advantage, as well as an integral part of corporate strategy.

Past 15 years, most of the universities were engaged construction of the network infrastructure, the development of systems, applications, and services designed to automate the activities of the university, as well as providing access to Intranet and Internet resources. As a result, by the end of the "zero" years most of the universities have a network infrastructure which connects computers on campus, a server farm with servers and storage, ensuring the functioning of the university services automation.

Currently, the Corporate Information Environment (CIE) is a mandatory component of the educational institution, supports process management, provides access to data and support decision making. The main objective of CIE is automation of key areas of the university: managing the learning process, the support of the educational process, research management, administration, financial management, and management accounting, managing information resources.

External challenges cause to change IT strategy and organization of IT-department work, to deploy new technologies to support IT-processes. Implementation of these tasks can be combined into a single concept of creating an Electronic Campus of University (EC), which is based on the approach and methodology used in products such as "smart" home, digital city, and electronic government. The construction of such ECU requires union set of technologies, equipment, and software into a single concept (Figure 1). The introduction of

such a concept in the university makes new demands of IT staff and the organization of IT processes.

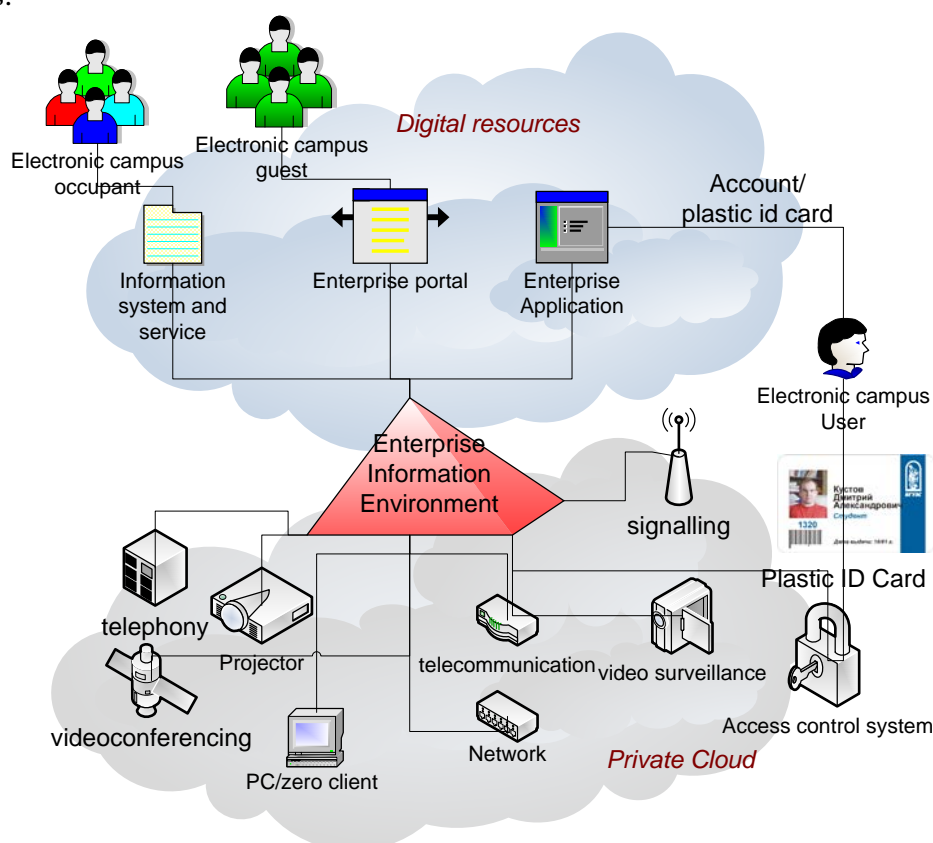


Figure 1 – Electronic campus

University relies on IT, its activities bases on IT-infrastructure, IT-services, and software systems. But there are some problems such as

- servers and network equipment are unreliable and inefficient;
- missing the centralized storage of backups and archives (poor data preservation);
- electrical power consumption of the server room is too much costly;
- conditioning system cannot cope;
- IT-support works inefficient, IT-department cannon be expanded science not enough money.

University raises demands to its IT infrastructure which are associated with the effectiveness of providing modern educational models, the maintenance of the IT infrastructure and its further development (Figure 2).

IT-infrastructure should be adaptable, reliable, productive, and effective. The demands can be provided with

- Server and desktop virtualization, and clustering provides adaptability;
- Server virtualization and clustering provides reliability;
- Clustering, server and desktop virtualization provides performance;
- Rapid deployment of new desktop (desktop virtualization) and reduction of IT-infrastructure maintenances provides efficiency.

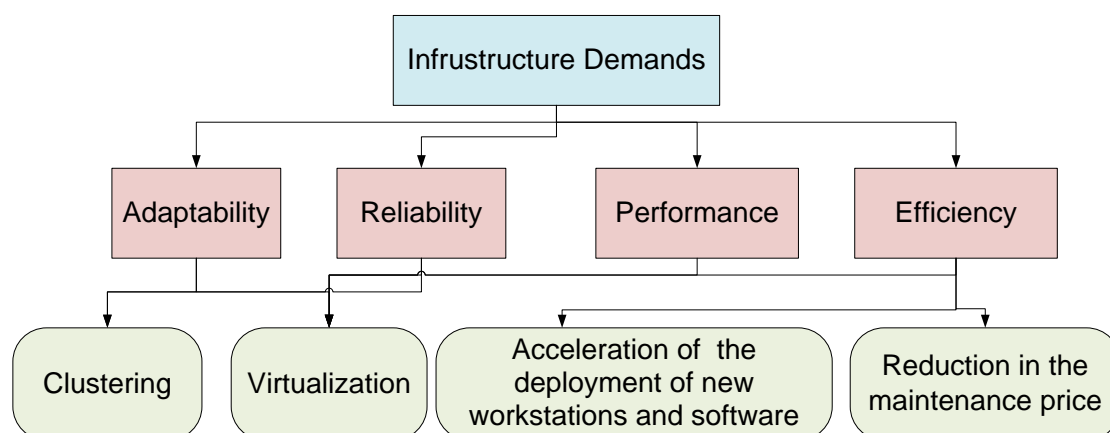


Figure 2 – Demands to IT-infrastructure of University

In recent years the virtualization technologies are being deployed at Vladivostok State University of Economics (VSUE). It leads to the need to upgrade computer and network infrastructure to meet the new requirements: relapse operating costs for the use of server hardware and client computers, reduction the time required for the deployment of new workstations and software applications (software), simplification license management, increasing the capacity of inter-server communication in a data center, and between the data center and distribution layer switches, improved manageability, and security of computer networks.

The technological basis of ECU is data center ensuring proper functioning and performance of the required systems and services EIS.

By the end of 2012 at VSUE modernizes the data communication network. New core switch (Cisco 6509) was evolved and optical communication lines were updated. After upgrading the data center all the physical servers are integrated directly into the core of the network. It provides non-blocking switching at a speed of 10 Gbit/s in 2013. Two clusters were built: cluster of server virtualization and virtual desktop cluster (Figure 3).

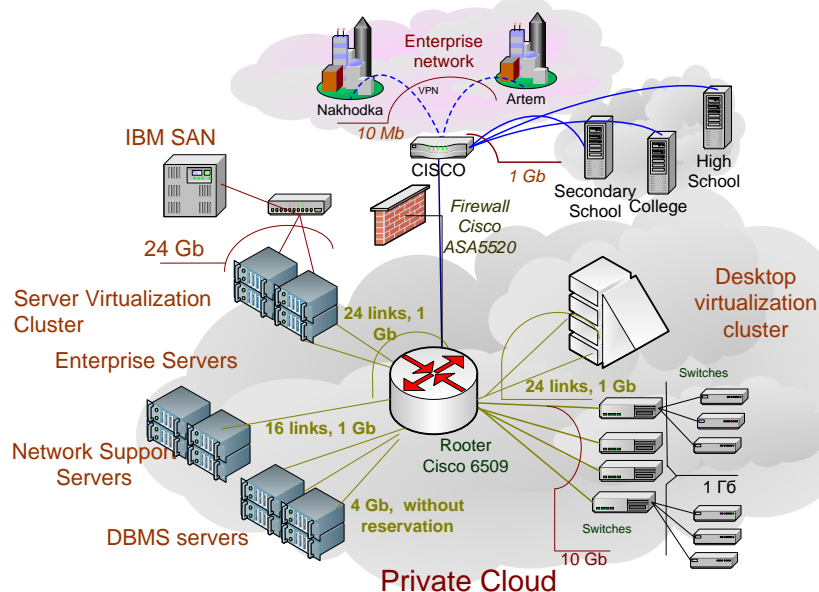


Figure 3 - VSUE's data center architecture

The private cloud has been created in computing infrastructure using server virtualization technologies VMWare. The effects obtained from the deployment: improving operational reliability and performance of all services and ECU's systems, efficiency of resource consumption and savings due to the rational allocation of computing power on the tasks according to their needs, reducing downtime, minimizing deployment time and cost of their maintenance.

Some features of server virtualization cluster are reduced in table 1.

Table 1. Features of Electronic Campus

Features	2010	2013
The numbers of servers	100	32
Virtual servers	30	160
Network storage area	2 SAN IBM	2SAN IBM DS3524 (96x900GB + 192x600 GB)
Energy costs	3 million rubles	1,8 million rubles
Required power conditioners	7,26 kWt/h	4 kWt/h
Hypervisors	VMWare ESXi, Citrix	VMWare (vSphere 5.5)  4 hypervisors, RAM 1,5 TB  64 cores (Intel)

Server virtualization had solved some problems of IT-infrastructure and ensured some demands. But there are some problems with desktop maintenance at VSUE. The problems in 2010:

- High cost of desktops maintenance, high noise levels and energy consumption;
- Permanent rapid growth of system requirements;
- Poor efficiency of computing power of employee's desktops and computer classes(10%);
- Requirements to deploy new desktop rapidly
- Risks associated with the actions of users
- More time for maintenance of existing IT- infrastructure rather than developing it;
- Preservation of data
- Difficulties to support mobility of users, their work from home and from business trips.

We should had selected technology to desktop deployment in future. We had considered three technologies (Table 2).

Table – 2. Variants of desktop deployment

	PC under centralized control (MS System Center)	Terminals (MS RDS, NComputing)	Desktop virtualization (VMWare View, Citrix XenDesktop)
Centralized control	Yes	Yes	Yes
Noise level	High	Medium	Low
Power consumption	High	Medium	Low
Rapid deployment	Low	Medium	High
Performance	High	Medium	High/Medium/Low
Cost of ownership	High	Medium	Low
Risks from user	Low	High	Low

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All teachers and staff of VSUE used PC at their work in 2010. We could use PC as a terminal or as a desktop further. We decided not to use PC any more. Desktop virtualization is the best solution to desktop deployment at our University. We selected type of clients: thin or zero. The features of the types are shown in table 3.

Table 3. Selection of clients

Features	Thin client	Zero client
Performance	5-8 Mpx (software decoding)	50 Mpx (hardware decoding)
Embedded operating system	Yes	No
Acceptable lifetime	5 years	10 years
replacement parts	Yes	No
Speed of deployment of new desktop	Medium	High
Protocols	Any	PCoIP
Power using the switch	No	Yes
consumption of electricity	94 kWt/h	35 kWt/h
Noise level	Medium	Low (without noise)
Cost, rubles	25000	19500

We had selected zero client because the technology is the most effective and productive. We selected desktop virtualization technology from VMWare or Microsoft (Table 4).

Table 4. Desktop virtualization technologies

Features	VMWare	Microsoft
Hypervisor	VMWare ESX	Microsoft Hyper-V
Support for zero clients	Yes	No
Operating system for hypervisor	Microsoft Windows, Red Hat, SUSE Linux , FreeBSD, NetWare, Solaris 10	Microsoft Windows, SUSE Enterprise Linux
Protocols to connect client to server	RDP, PCoIP, HTML Access	RDP
RAM for hypervisor	2 GB	10 GB
Operating system for client	Microsoft Windows, Ubuntu	Microsoft Windows

We had selected VMWare as the only technology supporting zero clients. Moreover VMWare support HTML Access protocol allowing work into enterprise network from home or business trip by Internet.

Datacenter of VSUE is shown on figure 4.

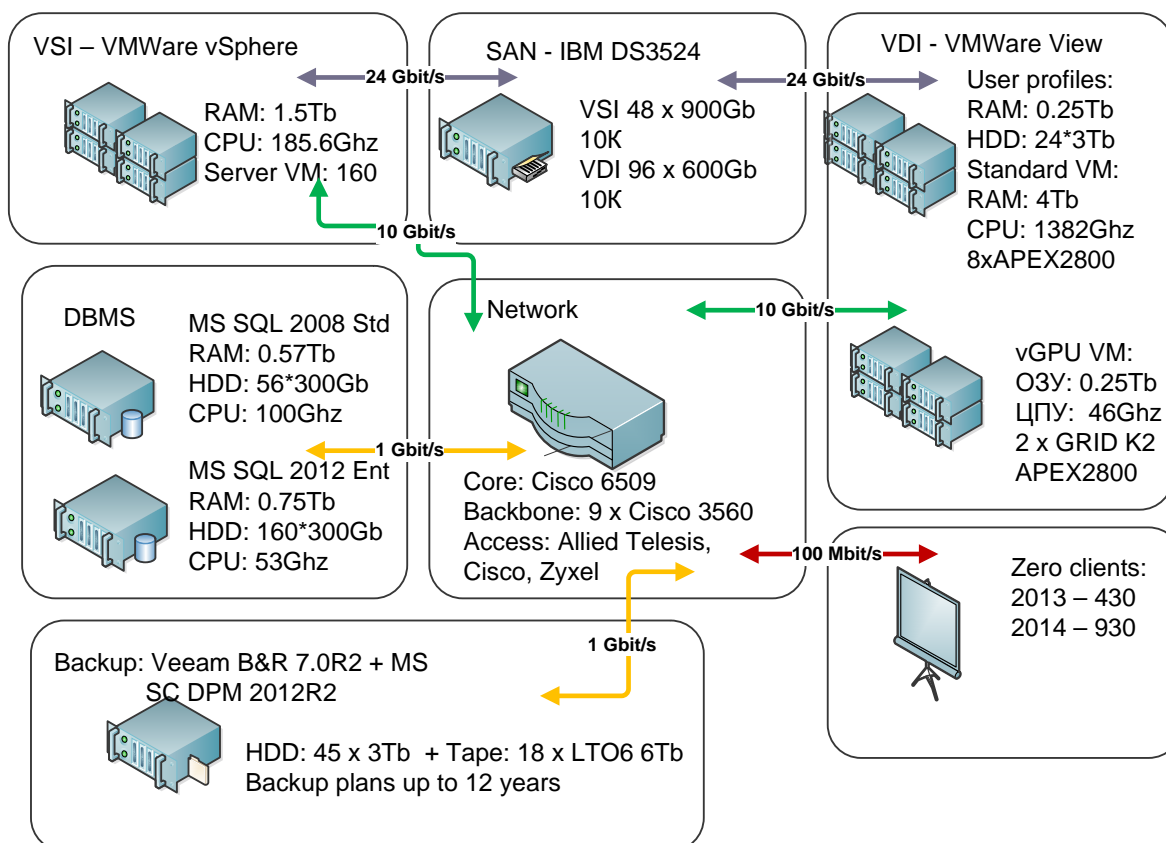


Figure 4 – Structure of VSUE datacenter

We have two clusters: server virtualization and desktop virtualization. Server virtualization cluster has 4 servers. Desktop virtualization cluster has 8 servers intended to 900 zero clients and GRID K2 server intended to 3D graphics on 50 zero clients. The datacenter has 2 SAN. Solution Veeam is used to make backups of all data from server and desktop virtualization cluster and SAN.

At present to automate ECU's infrastructure management Microsoft System Center 2012 is deployed. It allows monitoring data center, archival copy, and fulfilling configuration management. Data protection manager is used to make backups of databases. The network management system (Cisco Prime Infrastructure) and Service Desk-based System Center Service Manager have been deployed also. The systems will ensure quality control of the network, as well as IT-support.

Server and desktop virtualization clusters are connected to two storages (IBM DS325 SAN) through two SAS switches (Figure 5). Two switches and two SAN provide reliability of IT-infrastructure for servers and desktops.

The first computer classes with zero clients (90 personal places) are deployed in 2012 to teach student. Other computer classes with zero clients (200 personal places) are deployed in 2013. 60 zero clients are deployed at the library in 2013. 50 zero clients for staff are deployed at the University in 2013 also. 30 zero clients for 3D graphics are deployed in 2014.

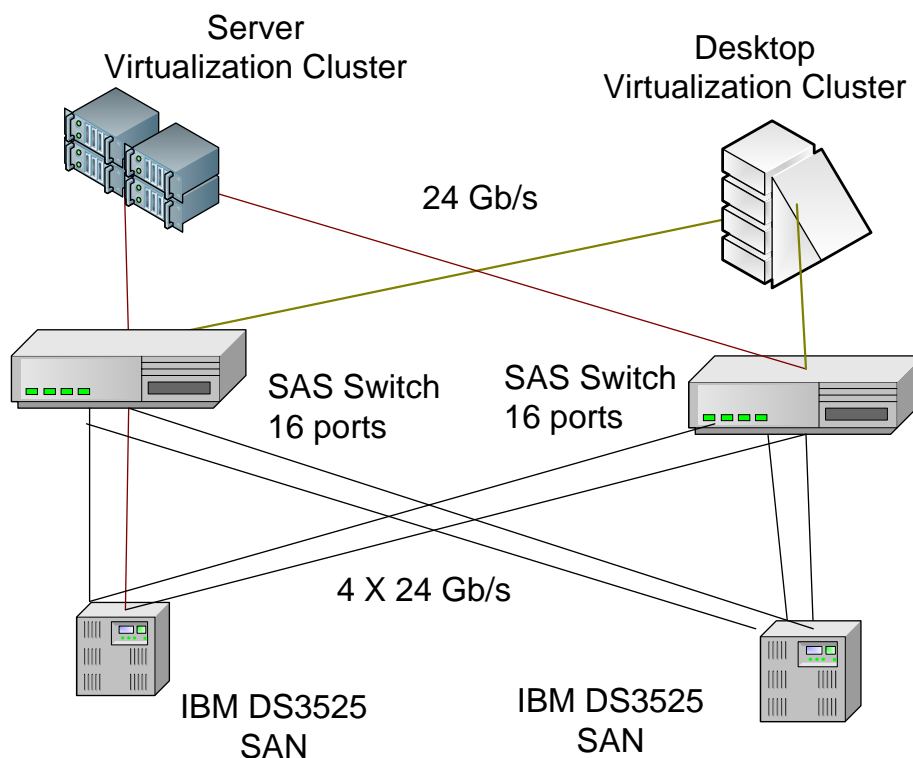


Figure 5 – Connections between virtualization clusters and SAN

Desktop virtualization involves replacing the client computers to zero clients connected to the data center. This solution is claimed there that require a large number of similar jobs with frequently changing application software and an increased risk of loss of efficiency due to the inept actions of application users. Changing-over to the zero clients can significantly improve IT processes to support user workstations (as well as reduce energy consumption, improve ergonomics) (Table 5).

Table 5 - Costs of desktop maintenance for 5 years

	PC (rubles)	Zero Client (rubles)
Client device	19000	19500
Windows + SA / VDA	3 500+3 000	4 500
VMWare View 5.5	0	5600
Data center resources	0	4000
Salary	25000	5000
Power	8400	1200
UPS	1200	200
Total	60100	40500

We develop and deploy information systems and services for ECU. The information systems and services are the main tools to teach, learn, and work for students, teachers, and all staff. The systems and services should be developed so that its cost of maintenance would be small. We have to change the systems and services simply as possible without recoding or with minimum recoding.

We use meta-data repository to provide simple changes (Figure 6).

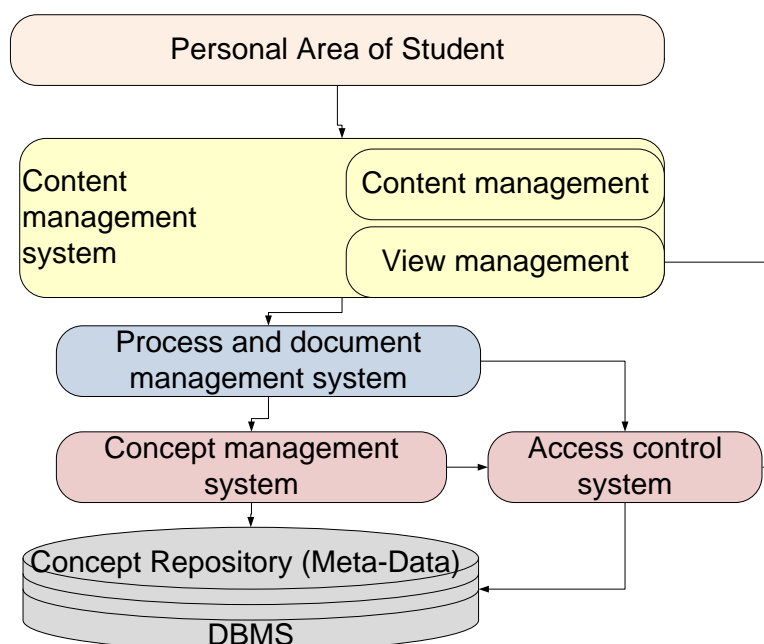


Figure 6 – Software architecture of ECU

To improve the quality of education the service "Personal area of student" has been developed in 2012. The service provides virtual private workplace for each university's student. It includes access to all the necessary teaching and learning materials, schedule, progress, testing, financial information and advanced communications capabilities for interaction between administrative services of the University, faculty, and other students.

The service is developed through content management system. The system is developed as superstructure on process and document management system. Process and document management system is developed as superstructure on concept management system which connects with meta-data repository. All of the systems are developed at VSUE and allow to change information systems and services very fast.

Table 6 – Some features of Electronic campus

	2010	2013
Number of information systems at the University	57	66
Number of assigned access rights	6 millions	17 millions
Number of changed access rights per day	30000	100 000
Deployment of information system (rating system to evaluate teachers and departments)	3 months at VSUE	1,5 months at Far East Federal University