Virtual Learning Environment for Secondary Education on the Cloud

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Abstract

In this article there is viewed the strategy of how Virtual Learning Environment (VLE) for general secondary education in Latvia can be gradually transformed from digital resources located in schools to overall Cloud Computing application. There is identified structure of VLE functional and technological blocks on Unified computing facility (Cloud) as main digital unit in research e-infrastructure. The structure of research e-infrastructure for European Research Area is compared with composition of VLE on the Cloud.

Keywords: Terms—Virtual Learning Environment, Digital E-Learning, Secondary Education, Unified Computing Facility, Cloud Computing, E-Infrastructure, Academic IT service

1. Introduction

Latvia has a typical Primary & Secondary Education: pre-school education (corresponds to International Standard Classification of Education - ISCED level 0) for 5-7 year old children; basic education (ISCED level 1 and 2) and secondary education (ISCED level 3). There are two types of secondary education programmes: general secondary, vocational secondary education and training programmes.

In this paper there is discussed the usage of Information and Communication Technologies (ICT) in general secondary education.

The compulsory curriculum of 3-year general secondary schools is determined by the National Standard in the following profiles: (1) general comprehensive, (2) humanitarian / social, (3) mathematics / natural science / technical, (4) vocational / professional (arts, music, business, sports). All educational programmes must contain 8 compulsory and 3-6 selected subjects according to the profile. Schools can offer some optional subjects that take no more than 10-15% of the total study time or major in any of the compulsory subjects instead.

Education system is administered at three levels – national (Ministry of Education and Science), municipal (118 municipalities, inter alia 109 regions and 9 city municipalities) and institutional (833 primary and secondary schools, 221 000 pupils, 28 000 teachers). Year to year the number of pupils, teachers and schools decreases. There are approximately 30% small schools (up to 100 pupils), 46.4% medium schools (100 – 600 pupils) and 13.5% large ones (more than 600 pupils).

2. Virtual learning environment (VLE) for education

By VLE we understand a broad range of Information and Communication Technology (ICT) systems used to deliver and support learning in the school’s classroom and anywhere else at any time.

In Latvia VLE is being used for full spectrum educational necessities. There is available internet in schools, they are provided with informatics teacher and computer-room, as well as with modern interactive whiteboards. Also, high-speed internet in the country facilitates VLE development and moving schools to the Cloud.

According to Internet Household Download Index (http://www.netindex.com/) Latvia ranks in 12th place in the World for download speed (Latvia - the current Latvia Index is 27.53Mbps - European Union (EU) average Index is 16.02Mbps) and in 6th place for upload speed (Latvia- 18.03Mbps, EU-4.29Mbps).

In accordance with this year’s inquiry (Iespējamā misija, 2012, http://www.iespejamamisija.lv/lv/) 5th to 12th formers use VLE during the lessons to search for information on-line (66% of them do it
couple of times a week or more frequently), to listen to teachers’ presentations (64%), to use mobile phones for calculations, moviemaking or other purposes (64%).

Fairly diverse is the access to technologies at home and school. 98% of respondents have a computer with internet connection at their home, from them 95% admit that they can use the home computer for studying. However, it is different with the technological provision at schools – 40% of pupils admit that access to computers during the lessons is limited; for 40% the wireless internet is available only in specific places within school; and for 20% it is unavailable.

In Latvia there is a standard for informatics as subject for primary and general secondary education. However analysing the way informatics is being taught in secondary school we can see that in about a half of licensed education programmes it is meant to teach informatics at least for 70 lessons and in a half at least for 140 lessons, inter alia in 2/5 for 210 lessons.

In general secondary education ICT usage skills and abilities are being mastered according to ECDL (European Computer Driving Licence) all 7 modules’ (Information Technology general conceptions; Computer usage and file management; Text processing; Spreadsheets; Data bases; Presentation; Information and communication) requirements in full scale.

Optionally, “Basics of programming” is being taught in some schools.

The institute, represented by the authors, is engaged in VLE since 1985, described in also. The historical transformation of information and communications technology in education can be seen in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Historical transformation of ICT in education</th>
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<td><strong>Period</strong></td>
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<tr>
<td>Initial</td>
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<td>From the mid-eighties to the mid-nineties</td>
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<td>From the mid-nineties to ~2005</td>
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<td>From ~2005 up to now</td>
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3. Functional blocks of virtual learning environment for education

Several functional blocks of virtual learning environment (VLE) for education are identified and analyzed below.

3.1. Digital e-Learning content

There are very many digital e-Learning sources in the world: Content Repositories, Portals & Gateways, Institutional repositories, Stand-alone digital media resources, Community developed content. Subject portals/collections are General, Science, Social Sciences, Humanities.

Primary e-Learning systems content can be locked into fixed delivery packages intended for a single context and suitable for a single instructional usage strategy.

Next generation content systems are used being customized to meet the needs of specific users and consist of granular learning objects and that can be recombined and restructured to address multiple contexts and multiple learning modalities. A key characteristic of next generation content is separated into distinct layers that include content, structure, presentation, context, and pedagogy. Application of content to a particular user group, technology constraints, time constraints, previous knowledge, social context, and experience needed to make effective use of the content.

In Europe for digital e-Learning content delivering there is developed European Schoolnet (http://www.eun.org/), where the key stakeholders are the ministries of education, schools, teachers and researchers. European Schoolnet has developed the Learning Resource Exchange (LRE) service that currently enables schools to find over 240,000 or resources from more than 50 content providers.
3.2. Learning management system

Learning Management Systems improve access, security, provisioning, and digital content management. In education there are used many Learning Management Systems for classroom learning and 1:1 learning, on school premise maintained systems or Client Server systems (Software as a Service in the Cloud). Learning Management Systems are available in two broad categories-commercial system (Blackboard, Joomla, SharePoint) or open source system (Moodle, SAKAI).

3.3. Social networking

As a new educational instrument social networks are being used. Pupils actively use social networks and internet as a communication tool to discuss class activities, discuss exams, seek help or do group practice. The system will target to parents, public, teachers and pupils. Some of the social networking features are: Forums, E-mail services, blogs, announcements, uploads, language support, School WIKI. On the basis of social networking analysis software is being used, for example to gain learning analytics.

3.4. Pupils’ competition – subject Olympiads

Pupils’ competitions go on in many subjects, inter alia in informatics. In our context, the most interesting is The International Olympiad in Informatics (IOI), which is an annual competitive programming competition for secondary school students.

Pupils are solving problems of an algorithmic nature and execute computer program (in C, C++ or Pascal).

The institute, represented by the authors, is an organizer of national and international Olympiads in Latvia since 1986.

3.5. Management and administration of secondary education

There is a special software for schools’ finance management, work organization and administration, schools’ life administration (subjects’ hobby groups, additional education), learning analytics, centralized exams, etc. Usually, the administrative system is hierarchical – school, local government, the ministry.

4. Actual technology transformation

4.1. TV (interactive & broadband TV) Learning

TV for teaching has been used for a very long time, for example in the institute, represented by the authors, this method was applied from 1986 to 1989; however, nowadays there are modern interactive TVs and IPTVs.

4.2. Going Mobile

Mobile internet-enabled devices can join in solving e-Learning problems. eReader devices, smart phones and tablets, including the Apple iPad and iPhone, Amazon Kindle™, SONY® eBook Reader, The Droid and Mobipocket readers and other mobile devices help delivering mobile content, when and where pupils want it. Mobile devices is a modern technology to meet new learning standards in classroom, described for example in [7].

4.3. Going to Cloud

Education will be significantly different in next 20 years. Google, Intel, Red Hat, Novell, EMC, Microsoft (Live@edu, office365, etc.), Cisco, IBM, Intel, Adobe and other global companies offer their digital e-Learning solutions and technologies to go to the Cloud. Hewlett Packard – HP offers a
host of different cloud computing infrastructures. The HP BladeSystem Matrix offers a converged solution that contains shared and private cloud services. Oracle offers Platform as a Cloud Service and iCloud - Free Cloud Computing. Dell is on the forefront of offering cloud hosting strategies for Learning Management Systems applications such as Moodlerooms, Blackboard, and others.

For Virtual Learning Environment are used Public, Private, Hybrid Clouds. A hybrid cloud within secondary education typically comes in two flavours: a cloud run by an education-focused provider for use only by a group of schools; or an arrangement in which the underlying infrastructure or all or part of the application is hosted offsite by a public cloud provider, but more sensitive components, and sometimes the application itself, are maintained within a private cloud by the school. Several solutions are analysed in [2], [3], [4], [5], [6].

5. Unified computing facility leverage school education

The Institute of Mathematics and Computer Science University of Latvia (IMCS UL) has longstanding traditions in developing and maintaining progressive e-infrastructure and providing public services in related areas. Different layers of e-infrastructure are available today to support scientific research: GÉANT network, GRID technologies and scientific field-specific e-infrastructures.

Today for researchers in Latvia IMCS UL provides:

- networking and international connectivity to GÉANT (IMCS is partner of GN3 - http://www.geant.net and have responsibility in Latvia for National Research and Education Network (NREN)), CERT.LV, domain names .LV;

During the last years, IMCS UL and other research institutions have developed their own e-infrastructure platforms. This year IMCS UL has started project on upgrading Cloud Computing facilities with 1.3 Petabyte data storage and High Performance Computing (HPC) (~ 40 Teraflops).

![Unified computing facility represented as three Rubik’s cubes](image)
We show Cloud platform’s design with Rubik’s cube Lego process in Figure 1. Unified computing facility [1] is incorporated in European Research and Education Network GÉANT as national node - National Research and Education Network (NREN).

6. Leveraging strategy of moving secondary schools to the cloud in Latvia

The financial benefits of Cloud computing provides cost-efficient centralization of schools’ IT infrastructure. As a result of such strategy computer maintenance and server costs are reduced, schools need technical ICT staff with lower qualification which allows to decrease the personnel costs. The strategy has been developed to achieve secondary education VLE technical coverage’s gradual transition to Unified computing facility’s resource usage. An extra gain from this transition is e-Learning process’ modernization and digitalization, [8] and [9].

6.1. Modes of strategy governance

The proposed strategy of virtual learning platforms is considered foremost as a process (objectives, strategies, partners, stages, etc.) and not as an essentially technological intervention. There are two major models as strategy in force: a centralised platform model, funded and implemented by government, and an “institutional” model, funded and developed for itself by the educational institution concerned. These two models coexist in Latvia. The authors represent the “institutional” model, as the most effective present solution of moving secondary schools to the Cloud maintained by the institute.

6.2. Networking

There is a high-speed internet in Latvia, although not in every school. We provide schools with data transmission speed of 10 mbps and backbone intercity connection of 1Gbps.

6.3. Infrastructure as a Service in the Cloud

The strategy schedules to initiate the transition to Cloud should be analysed. In the strategy it is drawn that moving to the Cloud will be started by Infrastructure as a Service, by usage of Unified computing facility [1] for the following classes of tasks:

- Software for Olympiads in informatics. Olympiads’ tasks are solved overseen by special programme on one virtual machine in Cloud. Informatics’ Olympiads are organized based on algorithm development and testing in real computer environment. IMCS UL already provides Latvia’s and Baltic’s Olympiads with them for several years. Latvia, since the first participation in international Olympiad in 1992, has earned 5 gold, 13 silver and 33 bronze medals (http://www.eduardische.com/ioi/data/IOI_Country.pdf), which, taking in consideration the state’s size, is an outstanding achievement that has also gained positive noticing internationally (http://www.scholze-simmel.at/it_star/wp-content/uploads/nl_2_12.pdf).

- Exams. Similarly to the Olympiads’ tasks, national centralized exam in informatics is being secured by the institute. To carry out this task there is a virtual machine being operated in the Cloud. In the future it is foreseen to use Cloud resources for other subject exams as well.

- Schools servers’ placement in Cloud. Schools servers’ transfer to Cloud resources, initially dividing each school’s virtual machine, is a solution that can be achieved fast, both technically and managerially.

6.4. Platform as a service in the Cloud

1) On the basis of Drupal 7.0 there has been made a controlled social network – platform with the functionality as follows: homepage for every school, blog, wiki, forum and collaborative software. The social network’s users (parents, teachers and pupils) are requested to authorize.

- School level.
  Environment of the social network is used by parents, teachers and pupils.
- National level.

Social network is being used for teachers’ qualification guaranteeing.

Two social networks (blog, forum, direct e-mail to the moderator) - one for pupils, one for teachers, which ensures methodological online consultation work about digital resources (int.al. video) distributed on Unified computing facility’s resources, as well as on the global digital e-Learning resources.

2) Moodle in Latvia there is an accumulated experience in Moodle usage in higher educational establishments. Those schools which want to make use of this experience can initially try Moodle functionality on one virtual server.

6.5. Software as a Service in the Cloud

Used for e-mail services.

7. Structural composition of virtual learning environment

Nowadays in Europe the e-infrastructure’s IT services for academic environment are being structured in a number of layers and in every layer there are available different services. E-infrastructure services as layers are demonstrated in Figure 2. Also historically the layers have developed from the basis – Network layer – initially, from a simple Internet access in the academic environment to special GEANT network in Europe.

Formerly the school informatization developed alongside with Research and Education Network. Currently school education network’s connection with Research and Education Network has vanished, and schools are provided with Internet by ISP. If we examine Research and Education Network’s structural set-up and VLE, then we can see a resemblance in upper levels: for every specific research direction an ESRI infrastructure is formed and there is a need for every study subject to create their VLE blocks, which comprise of methodology for teaching, and virtual classrooms of physics, chemistry, manual training etc. The virtual classroom is specific need for secondary education.

VLE’s functional blocks are placed in research e-infrastructure’s environment; shown in the Figure3.
8. Virtual learning environment services as despaired services

In the article is introduced the academic IT services’ classification (Despaired, “At the same time” and Unwanted academic services), described the purposes of those services’ application, their link to knowledge transfer, innovation, core business and outsourcing.

Service is an action consumed by the users (institutions, individuals or businesses) and often does not require any further processing. Information technology (IT) is an important service that supports many other business services. Service description usually consists of:

- the service description’s explanation – what is the particular service;
- description of possible help – how do I get the help;
- service’s cost and pricing – what and how much does it cost;
- service’s support description – what service support I can receive from its provider;
- delivery of the service – how do I get this service.

As often as not to provide some service one has to get permission, e.g., a licence.

To ensure the necessary service there are a couple of maintenance financing models:

- pay per service usage;
- project funded services;
- institution based funding of services.

Frequently the acquisition of permission is linked with setting up of a project or action of some institution. Typically, the firsts of the financing models is related to services.

Usually in society there are certain notion of what provides specific services and where they can be received, e.g., public transportation services in city are provided by one or a number of specially formed companies, operations with money are carried out by banks, etc. We can draw up a rather static structure of service providers’ network to get the idea of service receipt possibilities, this also refers to IT.

We will divide the academic IT services in the following types:

- despaired services;
- “at the same time” type services;
- unwanted academic services.
8.1. Despaired services for the Internet development in Eastern Europe

With despaired services we understand such services which are being provided typically to the established notions of society about the way it receives them.

In Eastern Europe we can find a lot of anomalies – despaired services which do not comply with international and European practice, e.g., a substantial part of Latvian Post’s business is the post’s payment system (practically it carries out a limited bank function), post offices sell goods, it has created a data transmission network and provides Datacom services, there are Internet access points in post offices and it carries out Internet service provider functions.

In this article we will analyse the role of such anomalies in Eastern Europe’s development, in a narrow activity field – e-infrastructure’s development for science and education as well as the connected services.

Of course, the notions of society about the typical service provider network change and in the long run anomalies vanish. Moreover, those processes go side by side with new innovative businesses’ development and outsourcing.

Since the historical development of the Internet took place in universities, the Research and Education Network (REN) is also sustained by universities.

Historically, REN development was furthered by universities with their resources and research funds. The Internet in the academic environment was not perceived as IT service with an appropriate service payment system.

In Eastern Europe during the time of great political changes it was impossible to get the public funding for large Internet services development projects and maintenance. Short-term Internet development projects and donations appeared. For more information on Latvia science’s funding policy see [1]. International commercialization of the Internet started in the mid-90s when an innovative purpose of the Internet was seen by universities. There was no other choice of how to find the funding; therefore its development was typically a pay per service usage IT service, where payments were made between academic institutions.

Hence research infrastructure was developed according to actual revenues and needs of practical research without any state support, public financing for science infrastructure in Latvia, for a long time, was negligible and episodic, and only from 2006 state aid was received for funding international connectivity to GEANT.

Such approach in the academic environment and in this manner developed IT services we will call despaired services, which in some way, from the point of international practice, are anomalies.

Thus the academic community step by step furnished e-infrastructure’s base level development and maintenance.

8.2. Data centres’ development as despaired services

Nowadays the actions of computing layers above and including the Network Layer are commonly concentrated in data centres. Data centres are also seen as an important e-infrastructure’s component in the academic environment, because they provide cloud services, HPC services, collocation services and other computing services.

Even though the initial period of the Internet introduction and modern data centres’ development projects in the academic society has a gap of almost two decades, Eastern European research institutions still struggle to obtain the public funding for data centres’ maintenance. European Union’s structural funds ensure only the primary investments for data centres’ foundation or modernization. IMCS UL’s estimation points out that 30% of funding have to be obtained by the institutions themselves from IT pay per service usage services. Thereby we will also classify those services as despaired services.

8.3. Moving secondary schools to the cloud as despaired services

The third group of despaired services in the academic environment is related to Virtual Learning Environment, using the same computing resources that are within the framework of academic e-infrastructure.
Virtual Learning Environment used for full spectrum of educational necessities. There are available internet access points in schools, they are provided with informatics teacher and computer-room, as well as with modern interactive whiteboards; also high-speed internet in the state’s facilities, all-round education’s digitalization and moving schools to the cloud.

8.4. "At the same time" type services

"At the same time" type services, according to our classification, is one type of academic IT services, whose provision is closely related to some despaired IT service. Explicitly this group contains Networking Layer based services:
- maintenance of academic users’ registry, identity, authorization/authentication;
- the Information Technologies Security Incident Response Institution’s services for academic users and state;
- register and domain name on-line management system maintenance.

Computing Layer’s despaired services are interlinked with the specific (defined by the European Strategy Forum on Research Infrastructures – ESFRI) research e-infrastructure’s services.

8.5. Unwanted academic services

In some places there are services being rendered, whose provision from academic institutions’ side is unnecessary, unreasonable and undesirable, e.g.:
- rental of research and education institutions’ disposable premises;
- polygraphy’s, printing facility’s and scientific article data base’s maintenance;
- conferences’ organization as a business;
- software development (part which, according to Frascati Manual, is defined as non-research);
- teleconferences, internet service provider business and telco services.

9. Conclusions

Moving secondary schools to power of Cloud we comprehend as a process of convergence, where the existing ICT e-Learning technologies are transformed into Cloud Computing services. We offer our Cloud to global companies which want to introduce their technologies in the schools of Latvia. Using introduction strategy’s institutional model, there is no initial need to solve scalability and granularity problems, although, soon (by increasing the number of involved schools, load on Cloud and interest about digital e-Learning) the functional blocks should be made granularly, forming Cloud federation and structuring functionality blocks in administrative way (by municipalities), as well as by subjects.

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10. References

