VIRTUAL DESKTOP INFRASTRUCTURE TECHNOLOGY BASED STUDY & RESEARCH

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Abstract

The application of the Virtual Desktop Infrastructure (VDI) for the study and research process has been presented in the paper. The VDI includes three main types of Microsoft virtualizations technologies and provides a range of the virtual services and applications both in university classes and at self-work time. The purpose of the paper is to present the application of Virtual Desktop Infrastructure (VDI) in study and research and obtain technical characteristics of remote access to virtual resources. First, in the paper virtualization technologies have been introduced and highlighted their advantages, then explained functions of the elements of the VDI. Results of research are presented in the last part of the paper.

Key words: education; virtualization; virtual desktop infrastructure; virtual machine

Introduction

The application of modern technologies in the study and research process for improving the quality of the process depends on the Information Technologies (IT) infrastructure being used.

The IT infrastructure consists of different hardware and software components. Hardware usually includes personal computers, data storage devices and network equipment. Software includes user databases that are used to provide data storage, identification and authorization services. Another software being used are applications that provide communication and collaboration services, ex. e-mail,

instant messaging, document sharing and etc. They also implement virtual learning environments and computer-aided maintenance testing. The applications can be executed remotely via the Internet or the intranet thus resulting in improved system reliability (backups, data protection), availability (remote access from the classroom or home) and scalability.

The development of the IT infrastructure is one of key factors in determining the attractiveness of the university. One of the implementation solutions is virtualization technology that has a significant influence on the study and research process. The use of virtual desktops, remote access to virtual applications makes the process more effective and self-sufficient.

The evolution of virtual infrastructure started more than 50 years ago in mainframe system environments. Nowadays virtual machines (VMs), virtual networks and applications are widely used for implementing testbeds in research and study environments (BouSaba, (2010); Malaric, (2008); Murugiah, (2011)). Novel scenario-based virtualization tools are being implemented that enable convenient development and management of different networking platforms (Galan, 2009). A Web-based computer networks laboratory NVLab allows designing a small-scale computer network, where every router or PC in the testbed network gets a dedicated VM (Wannous, 2010). Laboratory users draw testbed networks by using a *Designer* tool implemented as a Java Applet with GUI interface. According to network configuration multiple copies of prototype VMs are initiated and connected and users access them via a Virtual Network Computing (VNC) client. The possibilities of integrating labs into the study and research environment are analysed in (Jaanus, 2010). The effective usage of virtualization platforms for different applications is presented and validated in (Fuertes, 2009). The validation has been made by carrying out a survey for teachers and students that use different virtualization tools for university applications. The usage of desktop virtualization for the information system security is presented in (Lunsford, 2010). Desktop virtualization provides opportunity to introduce more advanced or risky topics in IT courses and research projects, while safeguarding the computers in laboratories.

Global open research platform PlanetLab supports the development of new network services and enables remote performing of learning assignments. It is a network testbed made by more than a thousand of nodes distributed throughout the world and contributed by research institutions (Carbone, 2011). PlanetLab machines run software that supports distributed virtualization enabling to allocate network-wide hardware resources on demand to academic applications offering realistic snapshot of the Internet, where they can deploy new protocols, run experiments and measure network performance. Commercial environments such as Microsoft IT Academy provide remote access to virtual resources for IT specialist training and certification (Pacholec, 2009).

One of the most important tasks in the study and research process is the ability to provide the basic IT knowledge and skills to a large number of students at a time. For this purpose the usage of the Virtual Desktop Infrastructure (VDI) is proposed and has been presented in the paper. The VDI includes three main types of Microsoft virtualization technologies (Chappell, 2008) and provides a range of virtual services and applications both in university classes and remotely from home during a self-work time.

The purpose of the paper is to present the application of VDI in study and research and obtain technical characteristics of remote access to virtual resources.

The application of virtualization technologies

Hardware virtualization is often associated with running multiple virtual machines on one physical machine (Figure 1).

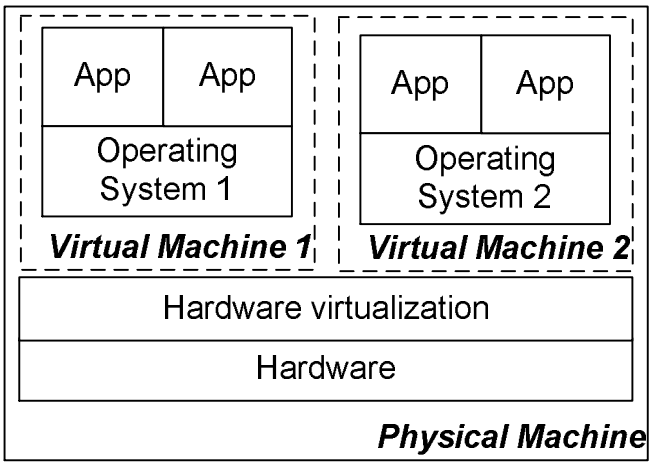

Figure 1. Hardware virtualization

As each virtual machine has its own operating system, applications, stored data and personal settings and operates in an isolated environment, the malfunction of a single virtual machine does not affect other instances of computing resources.

Hardware virtualization can be accomplished in three different ways: 1) server virtualization, 2) virtualization within a single desktop 3) virtual desktop infrastructure. Hardware virtualization is defined as desktop virtualization when used on the user host machines. Meanwhile it is known as server virtualization when used on a server.

The Virtual Desktop Infrastructure (VDI) technology is a mixed solution of both server and desktop virtualization techniques. By this approach, a server hosts a number of virtual desktops and each user can reach their virtual desktop from any location via a network access.

The server virtualization provides an optimal use of hardware thus improving dynamic allocation and reallocation of the resources and centralized management of server infrastructure. This results in faster server recovery as well as increased availability and scalability of application services.

The virtual desktop infrastructure allows significantly reducing desktop administrative and management tasks, i.e. instant application installation, removal or upgrade, easier data backup and restore ant etc. This gives an opportunity for students to start their virtual PCs on home computers without the risk of a virus infection or data loss due to possible malfunction of hardware and software. They are provided with the same working environment in computer classes, libraries and at home, anywhere where they are able to connect to the university network.

The mentioned hardware virtualization technologies also solve incompatibility issues of software and operating system it is being executed. Meanwhile ensuring smooth usage of multiple incompatible applications installed on the same operating system is a challenging task (Chappell, 2008). Commonly the applications share various system resources, such as registry entries, specific dynamic link libraries

(DLLs) and relational databases. However there are cases when specific versions DLLs are required for different applications to run at a time in a single operating system. Application virtualization solves this problem by creating application-specific copies of all shared resources at a runtime of a virtual application. The installation becomes much easier, as applications are no more competing for different DLL versions. The use of virtualization technology results in shortened maintenance time and reduced cost of applications.

Virtual Desktop Infrastructure

As various computing applications are being used in different study courses and research projects there is a need to provide an easy-to-access computing environment to students. The Virtual Desktop Infrastructure (VDI) with Web access has been implemented to be used in the study and research process. The structure of the VDI is presented in Figure 2. The **Hyper-V PCs** is an array of physical servers connected to a cluster. There are more than 100 virtual desktops hosted in the cluster. Students access all virtual applications via a Web browser from the page http://vdi.ktu.lt.

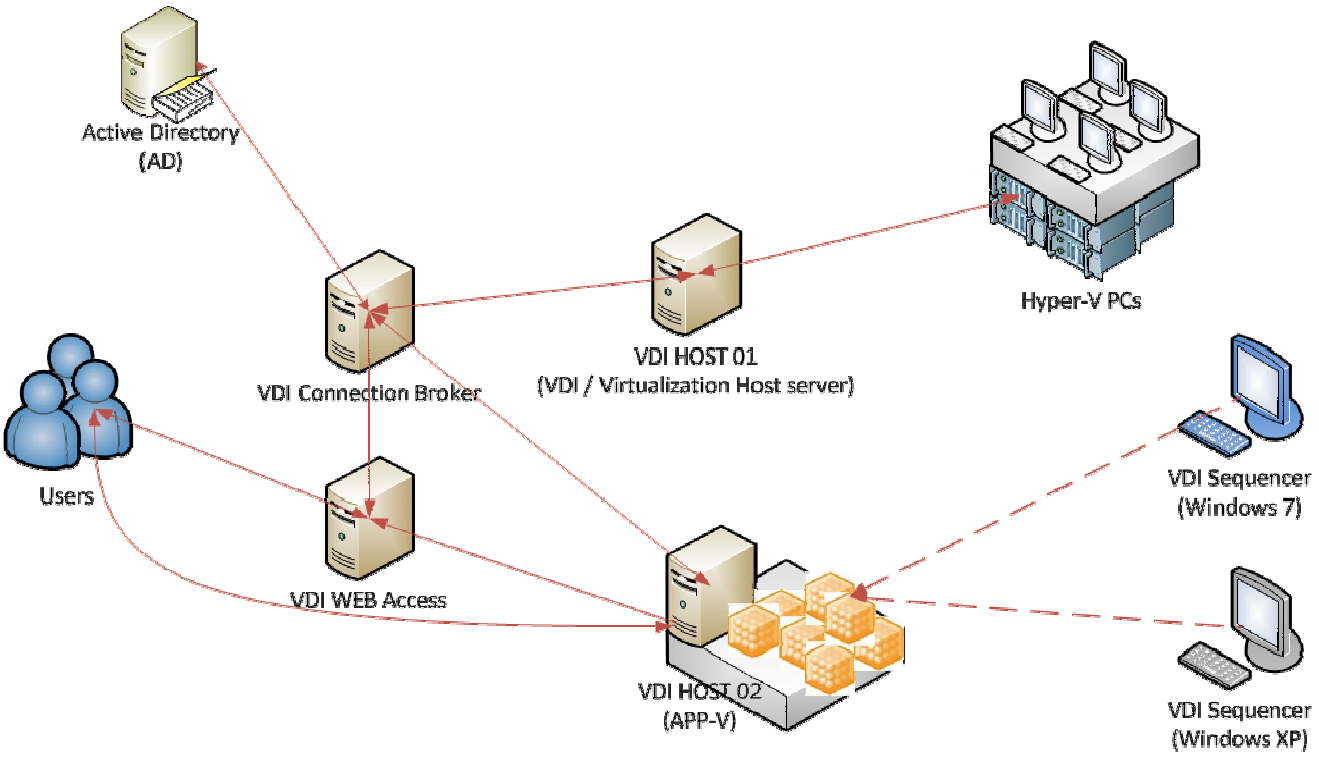

Figure 2. Virtual Desktop Infrastructure

The virtual server **VDI Web Access** is responsible for the publication of virtual PC and virtual application resources to network users. The **Active Directory (AD)** contains information about both hardware resources (computers, workstations, printers) and users (students, teachers, administrators). The virtual server **VDI Connection Broker** distributes multiple users' connections to virtual machines. The

virtual server **VDI Host 01** protects the virtual server and host names and IP addresses and distributes user traffic when connecting to a virtual work environment. The virtual server **VDI Host 02** manages virtual programs for accessing them from the VDI Web Access and from the university network PCs. The server consists of the App-V server and Terminal server (TS). The App-V server provides the user access to virtual applications from university network PCs running together with local PC applications. Terminal services provide the user interface of an application to the client. The virtual servers **VDI Sequencer (Windows 7)** and **VDI Sequencer (Windows XP)** convert applications to virtualized packages for execution on Windows 7 or Windows XP platforms.

Table 1 shows virtual desktop implementations with the installed software in the VDI. The implemented VDI not only allows significantly reducing the administrative and management tasks, but also results in reduction of software license expenses. As only a small number of university students use virtual applications at the same time, the amount of software licenses needed is significantly smaller comparing when applications would be installed locally in PCs.

Table 1. Virtual Desktops and software

Virtual machines	**Applications**
150 virtual desktops (VDs) with Windows 7 OS and differential discs	MS Office 2010; MathCad 2001; Adobe Reader, Windows Live Essentials; 7-Zip; MS Visual Studio 2010; MS Light Switch; Putty; App-V Client
Terminal servers	Dynamics CRM; Stekas Plius; Simulator Designer

The technical characteristics of remote access to VDI

The access to virtual resources during the study and research process is provided via the Internet. The precise regulation of access time is important to the process. This results in generation of high intensity data streams among clients and VDI infrastructure at some moments. The monthly variation of maximum values of data streams generated between teaching class with 76 PCs and VDI is presented in Figure 3.

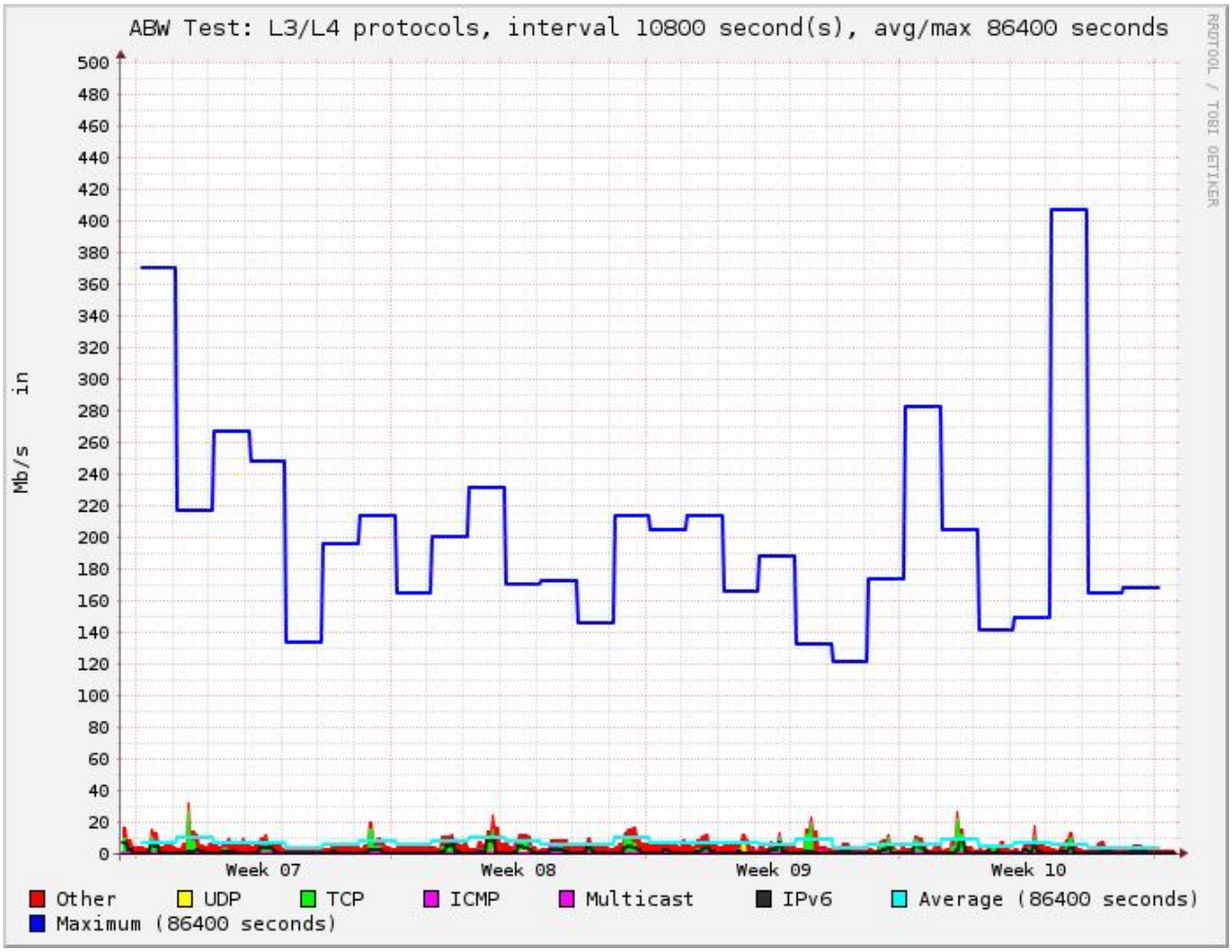

Figure 3. Monthly variation of maximum values

The convex line represents the maximum values of the instantaneous data streams (B_{max}=410 Mb/s). The network load is recurrent during the week. The observed increase of data streams at the beginning of the month is related with student registration into the VDI system. The similar increase at the end of the month is related to the examination period.

The TCP and UDP protocol data represent a relatively small part of the overall data streams. They are completely indistinguishable at night time and grow up to 5-10% during the working hours. The monthly data stream variation is presented in Figure 4. The time and intensity of data traffic bursts is associated with the learning and research schedule and the nature of tasks being performed.

The detailed variation of data streams generated at the beginning of working hours is presented in Figure 5. By the beginning of the working hours data stream intensity is rather low, averaging at 1 Mb/s. Students start connecting to the VDI and opening remote files at the beginning of classroom session thus increasing data traffic up to average 5 Mb/s. (Maximum value is 28 Mb/s).

The successive student activities involve random access to virtual desktops for data exchange and editing, therefore the average data traffic intensity is less than 2 Mb/s. The remote saving of data is performed at the end of the classroom session as well as disconnecting from the VDI, so data traffic is increased again.

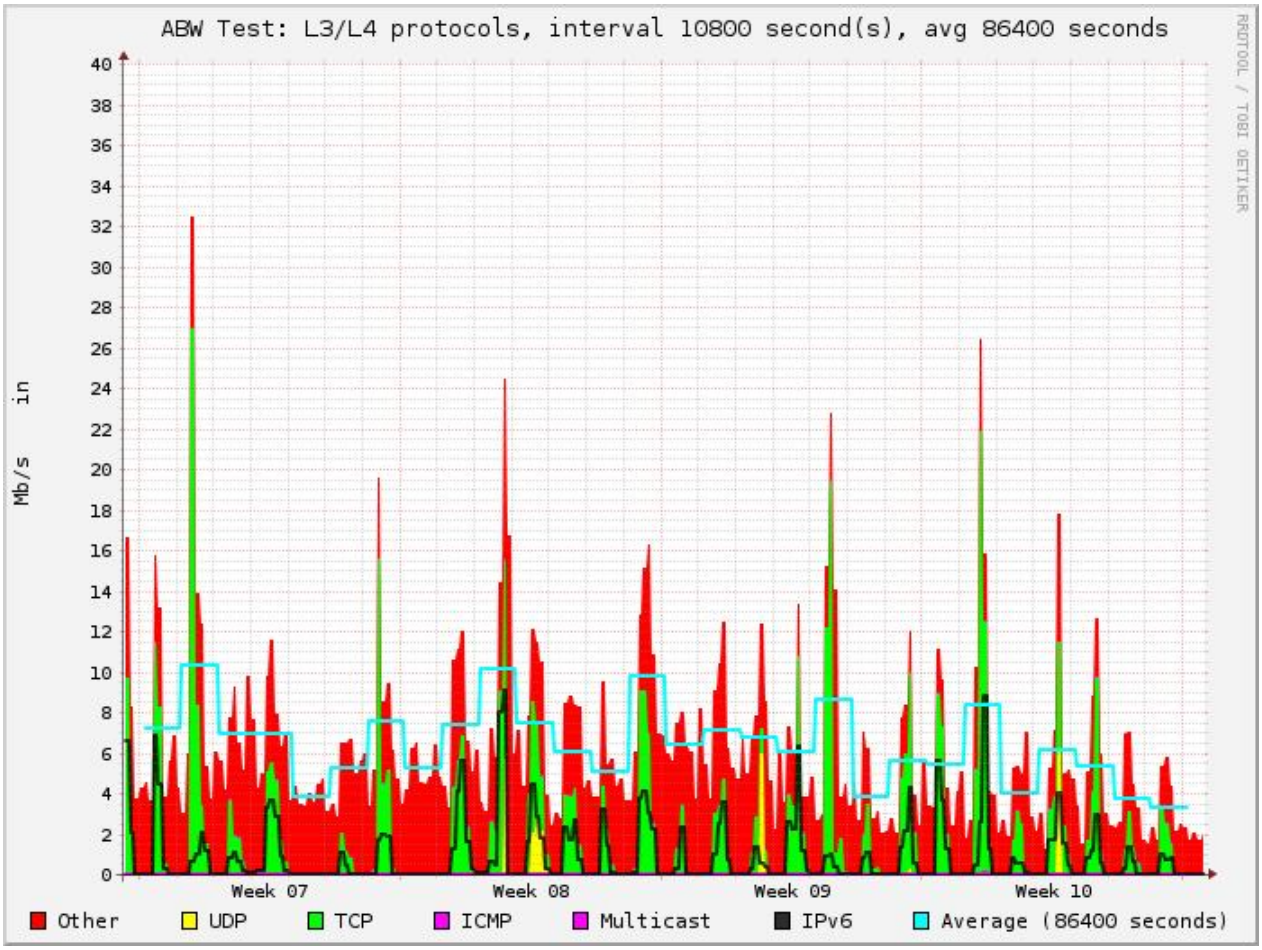

Figure 4. The actual monthly data stream variation

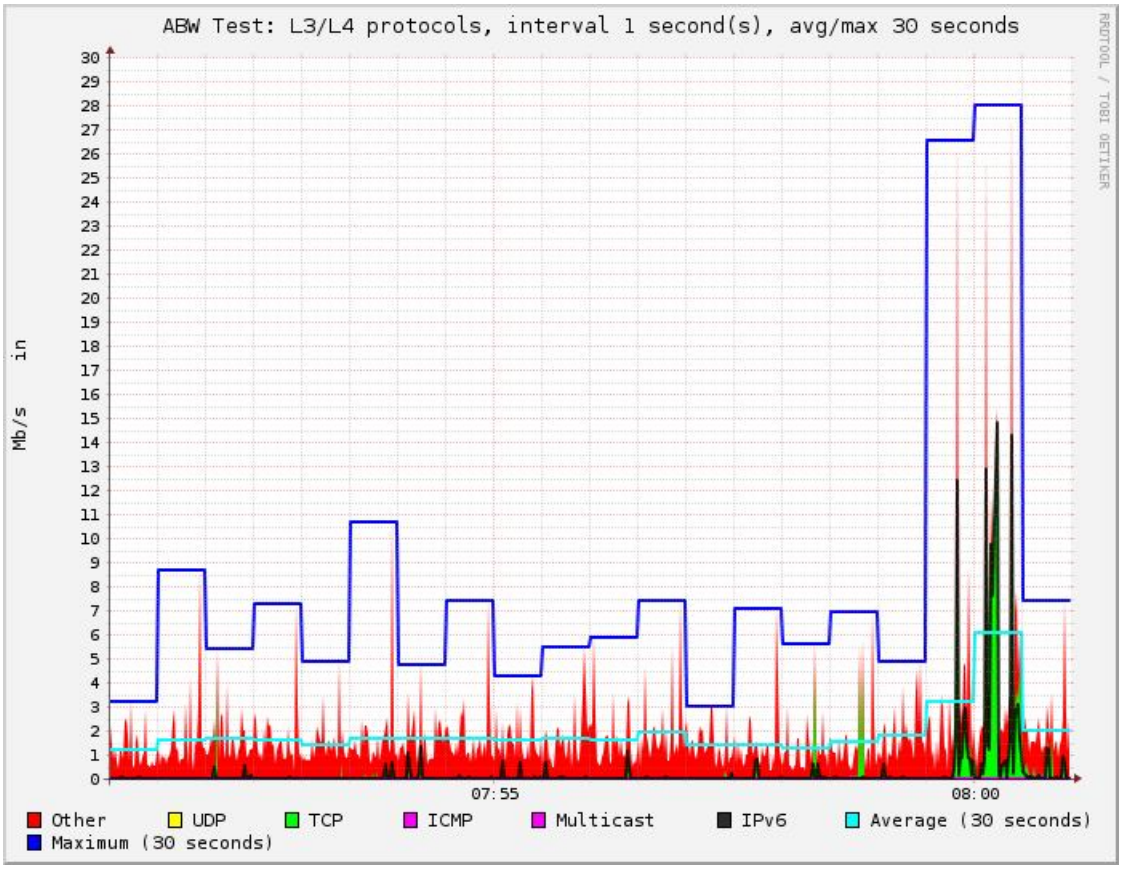

Figure 5. Data streams at the beginning of the working day

The measured data traffic intensity of remote opening (download) and saving (upload) operations on a single file is presented in Table 2.

Table 2. Remote document Download/Upload times

VDI KTU desktop files		
Download/Upload	**File 1**	**File 2**
File (PDF) size, MB	0.39	3.61
Download file size, MB	0.63	3.84
Download Time, s	2.70	7.00
Download Rate, Mb/s	1.87	4.39
Upload file size, MB	0.50	4.34
Upload Time, s	2.20	15.00
Upload Rate, Mb/s	1.82	2.31

The data has been obtained by using the network packet analyser Wireshark. The data transfer rate up to 1.8-4.4 Mb/s has been determined. The opening and saving times are directly proportional to document sizes.

The measured document printing time, when using MS Word remote application running on the VDI, does not depend on the number of symbols, if the access rate to the VDI is sufficient (Table 3).

Table 3. Remote document printing times

VDI desktop files		
Printing (Word format)	**File 1**	**File 2**
Print page size, characters	5	4000
Print file size, kB	12.30	12.90
Print time, s	56.00	82
Download file size, MB	0.62	1.3

In order to evaluate the efficiency of the VDI, the measured parameter values have been compared with values obtained using commercial Clouds (Table 4).

Table 4. File download in commercial Clouds

EyeOS Cloud	**File 1**	**File 2**
File size, MB	2.5	5
Download Time, s	23	35
B,Mb/s	0.87	1.14
iCloud	**File 1**	**File 2**
File size, MB	2.5	5
Download Time, s	12	22
B,Mb/s	1.67	1.82

It has been determined, that the difference in response time visible to the users of commercial Clouds and users of VDI does not exceed 2 times, if the Internet access rate is not less than 2-5 Mb/s. These experiments confirm the expediency of using VDI for remote application access.

Conclusions

The Virtual Desktop Infrastructure (VDI) presented in the paper is implemented in Kaunas University of Technology and is being used in study and research process. University students have remote access to the same working environment from campus computers or from home by connecting to the VDI via virtual private networks.

The obtained technical characteristics of remote access to virtual resources confirm the expediency of using VDI in study and research process.

The implemented VDI infrastructure not only allows significantly reduce administrative and management tasks, but also saves university's expenses for the software licenses.

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