MINISTRY OF SCIENCE AND EDUCATION OF THE REPUBLIC OF KAZAKHSTAN

Non-Profit Joint Stock Company
ALMATY UNIVERSITY OF POWER ENGINEERING AND TELECOMMUNICATIONS

Department _____Telecommunication systems and networks_____

«Admitted»
Head of the Department _Baykenov A.S._
dts, professor _____
(Surname and initials, degree, rank)
_____ «_____» _____ **20__**
(sign)

DIPLOMA PROJECT

Theme: _Development of laboratory works with a terminal_
server on the Multiservice Subscriber Access Networks discipline

Specialty: _____5B071900 – Radio engineering electronics and telecommunications___

Implemented by: _Kim Y.N._ _ICTe-14-9_
(Student's surname and initials) group

Scientific Supervisor: _Semenyakin N.V., senior lecterer, PhD_
Ceeel (Surname and initials, degree, rank)
(sign) « 30 » 05 20 18

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of Economy section:
associate Professor, PhD, Tuzelbayev B.I.
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(sign)

Almaty 2018

MINISTRY OF SCIENCE AND EDUCATION OF THE REPUBLIC OF KAZAKHSTAN

Non-Profit Joint Stock Company
ALMATY UNIVERSITY OF POWER ENGINEERING AND TELECOMMUNICATIONS

Institute of Space Engineering and Telecommunications (ISET)
Specialty: <u>5B071900 – Radio engineering electronics and telecommunications</u>
Department: <u>Telecommunication systems and networks</u>

ASSIGNMENT
For diploma project implementation

Student: <u>Kim Yekaterina Nikolayevna</u>
<div align="center">(name, patronymic and surname)</div>

Theme: <u>Development of laboratory works with a terminal server</u>
<u>on the Multiservice Subscriber Access Networks discipline.</u>

Approved by Rector Order № <u>155</u> of « <u>23</u> » <u>october</u> 20 <u>17</u>
Deadline of completed project: « <u>25</u> » <u>may</u> 20 <u>18</u>

Initial data for project, required parameters of designing result, object initial data:
<u>VM VirtualBox software should be installed on a personal Computer.</u>
<u>The concept of virtualization and technology of terminal</u>
<u>servicing should be considered. The number of workstations -</u>
<u>not less than 6. The main reference literature - Claudio Rodriguez.</u>
<u>Terminal Services: from A to Z. - CEO WTSLabs Inc Microsoft MVP, 2009.</u>

List of questions for development in diploma project or brief content:
<u>The creation of virtual machine and organization of</u>
<u>terminal server on the basis of server operational system</u>
<u>Windows Server 2008 are considered in the diploma project.</u>
<u>The calculations of the server load are carried out. The</u>
<u>life activity safety includes the calculations of natural</u>
<u>lightening and air exchange. The technical and economic</u>
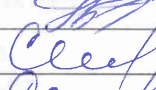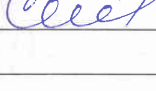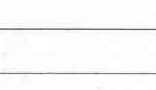<u>basis of the project is given.</u>

List of illustrations (with exact specifying of mandatory drawing):

Terminal Service architecture; TS physical structure; Terminal Server Licensing; Terminal Services Session Directory; Remote Desktop; Remote Desktop Protocol; Virtual server model; Oracle VM virtualBox Manager; VBox start page; Creation of VM; RAM settings; Connection of hard disk; Hard Disk File Type; Created Virtual Machine; Choosing the .iso file; Settings export; Settings import; Running VM MS-Win_2008; logging to the system; Setting a password. Result; MS Office 2010 installation; Installed MS Office; Start settings; Add Share window; Additional Driver Installation; New CD image; Components to install; Shared Folder appeared; Result; Creation of new account; Computer Management Window; Addition of a user; Server manager Window; Add Roles Wizard window; Addition of users; Terminal Server Configuration; RDP Connection; laboratory class; Structure of capital costs; Structure diagram of operating costs;

Recommended main references:

IBM Global Education. Virtualization in Education.- White Paper, 2007. Грейси Линтнер. Полное руководство по терминальным службам Windows Server 2008. Charlie Russel, Craig Zacker with the Windows Server Team at Microsoft. Introducing Windows Server 2008 R2. - N.: Microsoft Press, 2010. Christina Anderson, Kristin Griffin. Windows Server 2008 Terminal Services Resource Kit. - N.: Microsoft Press, 2008. Claudio Rodrigues. Terminal Services: from A to Z, - CEO, WTSLabs Inc. Microsoft MVP, 2009. Oracle VM VirtualBox User Manual, version 5.1.22. - N.: Oracle Corporation, 2017. Windows Server 2016. Книга рецептов. Глава 7. Службы удаленных рабочих мест.

Project adviser with corresponding sections specifying:

Section	Advisor	Dates	Sign
Life activity safety	Begimbetova A.S.	2.03.18 – 25.05.18	
Economy	Tuzelbayev B.I.	5.04.18 – 25.05.18	
Main section	Semenyakin N.V.	10.02.18 – 30.05.18	
Computer Science	Semenyakin N.V.	10.02.18 – 30.05.18	

S C H E D U L E
of diploma project implementation

№	Sections, list of developing questions	Dates of bringing to Scientific Supervisor	Notes
1	Theoretical part. Collection of information	13.01.18 – 25.01.18	Done
2.	Installation of software on personal computer, preparation to the laboratory works performance	26.01.18 – 30.01.18	Done
3	Laboratory work n1	31.01.18 – 5.02.18	Done
4	Laboratory work n2	6.02.18 – 10.02.18	Done
5	Laboratory work n3	11.02.18 – 15.02.18	Done
6	Laboratory work n4	16.02.18 – 25.02.18	Done
7	Creation of laboratory works set	26.02.18 – 10.03.18	Done
8.	Calculation part	11.03.18 – 20.03.18	Done
9	Analysis of working conditions of the students while working in the laboratory room with a PC	21.03.18 – 29.03.18	Done
10	Calculation of the air exchange	30.03.18 – 5.04.18	Done
11	Spot load of the students when working with a PC	6.04.18 – 10.04.18	Done
12	Calculation of natural lightening	11.04.18 – 20.04.18	Done
13	Section Conclusion	21.04.18 – 22.04.18	
14.	Technical and economic justification for the realization of complex of labs	23.04.18 – 25.04.18	Done
15.	Calculation of economic efficiency: – investment costs – annual operating costs – income	26.04.18 – 1.05.18	Done
16	Conclusion. Paperwork	2.05.18 – 25.05.18	Done

Assignment issue date   « _10_ »   _January_   20 _18_

Head of Department: _____   _Baykenov A.S._
                     (sign)   (Surname and initials)

Scientific Supervisor: _____   _Semenyakin N.V._
                     (sign)   (Surname and initials)

Assignment submitted for implementation:
_____   _Kim K.N._
                     (sign)   (Surname and initials)

Аңдатпа

Осы дипломдық жобада абоненттік қолжетімділік Мультисервисті желілері пәні бойынша Windows 2008 Server операциялық жүйесінің негізінде терминалды сервер құру ұсынылатын виртуалды зертханалық жұмыстар жиынтығы берілген. Тіршілік қауіпсіздігі бөлімінде студенттердің қалыпты жұмыс істеуі үшін қажет жағдайлар – табиғи жарық және кондициялау есептері жүргізілді. Экономикалық бөлімінде зертханалық жұмыстардың енгізудің экономикалық тиімділігі есептелді.

Аннотация

В данном дипломном проекте представлен комплекс виртуальных лабораторных работ по предмету Мультисервисные сети абонентского доступа, где на базе операционной системы Windows 2008 Server предлагается создание терминального сервера. В главе «Безопасность жизнедеятельности» производится расчет естественного освещения и кондиционирования – условий, которые требуются для нормальной работы студентов. В экономической части рассчитывается экономическая эффективность внедрения лабораторных работ.

Abstract

The diploma project represents a complex of virtual laboratory works on Multiservice Subscriber Access Networks discipline, where the organization of terminal server on the basis of Windows Server 2008 is offered. In the Life activity safety section the calculation of natural lightening and air exchange system is calculated, which are the conditions for normal students' work. The economy section includes the economic efficiency of laboratory works' introduction.

Contents

Introduction

Optimization of expenses for modernization of equipment, increasing the speed of the system, reliable protection of information are priority tasks that must be addressed to the head of a successfully developing business enterprise. A lot of companies pick the group of IT infrastructure by using terminal access as a solution to these problems.

The system of terminal access involves building a computer network in such a way that all the information that employees work with is actually concentrated in a single place - the terminal server, the primary computer of big computing power.

Information processing (modification, addition, deletion and other operations) is performed only on the main server. At the employee's workplace, only a broadcast of his actions is graphically displayed on the monitor, so instead of the usual system unit, a special compact device (thin client) is installed, the function of which is to organize access to the server using a special program. Advantages of the terminal access system are economy, safety, simple operation.

The use of terminal access as an effective IT solution is suitable, first of all, for dynamically growing organizations, where the constantly increasing number of jobs requires more rational use of the resources available in the company.

In order to deploy such a service on personal computer it is necessary to have a special operating system. For this project we will use OS Windows Server 2008 installed on virtual computer, so it will be something like a real server [1].

The relevance of this diploma project is to reduce economic costs. The refusal of the overall physical equipment allowing students to acquire skills in handling network equipment having at their disposal only a computer.

The purpose of the project is the development of a complex of virtual laboratory works on the subject of MSAN with a terminal server.

To achieve the purpose the following tasks are set:

1. Consider the technology of virtualization and terminal access;

2. Study the operation of the terminal server;

3. Familiarize with the functionality of the VM VirtualBox software and learn how to create virtual machines on its basis, perform all the necessary settings for the connection of a real computer with a virtual;

4. Deploy a terminal server based on Windows Server 2008.

Also, the diploma project includes the calculations of server load.

Some of the main requirements under which the regulatory working conditions are provided - correct lighting of the student's place, fresh air, the observed temperature, corresponding to the standards. All the points are considered in this diploma project.

The calculation of costs for the introduction of the laboratory works, as well as the period of its payback is performed .

1 Theoretical part

1.2 Virtualization

A virtual computer is a rational representation of a computer in software. By decoupling the actual physical hardware coming from the operating system, virtualization offers much more operational flexibility and also raises the utilization speed of the basic actual physical hardware. Even though virtualization is implemented largely in software, many contemporary microprocessors right now incorporate hardware options explicitly created to enhance the effectiveness of the virtualization activity.

In a traditional physical computer, one example of the operating system supports one or even more program programs. In a virtualization atmosphere, a single actual physical PC runs program which abstracts the actual physical computer's materials to ensure that they could be discussed between a number of "virtual computers." Each virtual computer might be operating a unique operating system from all the various other virtual devices on the physical device. A crash or any other application error on any of the virtual models leaves all of the various other virtual devices unaffected.

Types of virtualization:
- Desktop virtualization;
- Server virtualization;
- Application virtualization;
- Network virtualization;
- OS – level virtualization;
- Storage virtualization.

In this work we will consider the concept of Server Virtualization. Server virtualization enables an actual server to be divided to run two separate safe virtual servers. This generates a chance to consolidate the actual physical servers, therefore helping to bring down the computer acquisition as well as control expenses by eliminating "infrastructure sprawl" at the server amount.

If the source needs of one of the server based items, running in a virtual server expands, due to increased use for. This improved resilience leads to more effective use of present bodily server resources, reduced power usage and greater general reliability [2].

1.1 Terminal Services concept

A terminal server is a powerful computer and a server operating system that allows you to perform tasks for multiple users. Terminal clients are low-power computers that can perform only one function - to connect to the terminal server using the RDP protocol. All applications run on the server, and the user only sees the transmitted image with the help of the terminal client.

The server operating system, in addition to the terminal server role, on the same hardware allows the implementation of other services: a file server with a fault-tolerant disk array, a print server, a backup server, etc.

The terminal access server has hardware and software that can significantly improve data security and management flexibility, which is difficult and expensive to achieve when working on conventional computers.

Authorization of users for access and protection with firewall from attacks over the Internet can protect data consolidated on one server, easier and cheaper, providing a high level of information security. In the network of ordinary office computers, this can not be achieved.

The effect of the appearance of the terminal server in the organization can be compared with the appearance of a local network: computers that were integrated once into the network allowed users to exchange files without the help of floppy disks, use e-mail and access the Internet, print documents from the same place to the common printer. Terminal server provides a new level of work with information technology: not just store files on the hard drive, but manage information flows on an organization's scale as easily as files on a separate computer.

So, let us list the tasks that terminal access solves:

- improving the performance of client-server applications (for example, 1C) by running them in the data center. For this purpose there is a special term - "proximity to data", the better the connection between the client part of the program and the server, the faster the tasks are executed.

- transfer users from PC to thin clients. Instead of a computer with data user is installed a miniature device that allows you to connect to the terminal session. The thin client does not require maintenance, does not make noise, does not get warm, consumes little electricity. Allows you to minimize technical support in the workplace.

- saving traffic in WAN networks, and as a result, reducing the width and cost of the channel. In the case of terminal access, traffic that used to pass between client stations and servers is replaced with traffic of the remote screen image.

- centralized management of licenses and software, allows you to bring all categories of jobs to a unified form. One administrator can manage thousands of jobs. The terminal server farm allows you to quickly deliver the necessary enterprise applications, centrally install updates, manage employee data.

- for the user: the speed of work with corporate programs is increased, stability is improved, and cases of contacting technical support are reduced.

- for the administrator: the transition to the terminal access system allows you to automate many routine tasks of the system administrator associated with the deployment, updating and maintenance of user workstations. But to get all of the above pluses, it is critical not to make mistakes during the selection, configuration and operation of the terminal farm. Often there are cases when incorrect administration of even the most simple terminal server turns the work of the administrator and users into a nightmare [3].

Terminal Services consists of four components: the Windows Server 2008 multi user kernel, the Remote Desktop client, the Terminal Services Licensing service, and Session Directory Services.

Multi-user kernel. The multi user kernel extension, created for Windows NT 4.0 Server, Terminal Server Edition, have been extended and completely incorporated as a regular part of the Windows Server 2008 family kernel. These are resident on the server at all of times, no matter if Terminal Services is enabled or not.

Remote Desktop client. The client software is the application which installs and supports connection between the client and the server computer on which services of terminals are started.

Terminal Services Licensing service. This method allows terminal servers to receive also terminal server client access license (TS CAL) for the equipment and the users who are connected to the server of terminals.

Session Directory Services. The session directory (SD) will contain the report of sessions, indexed on a user name and also allows the user to be connected repeatedly to the terminal server on which there is disconnected user's session and also to resume a session.
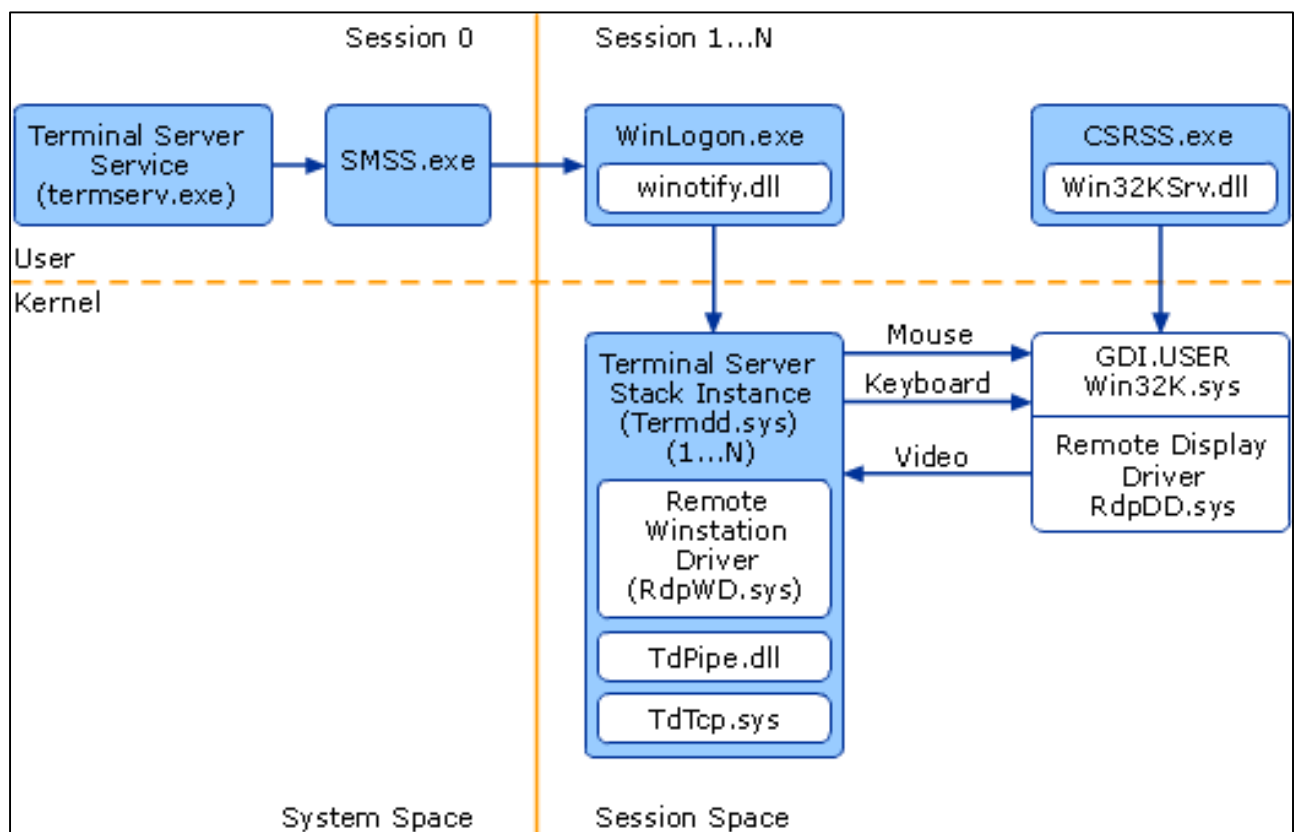

Figure 1.1 - Terminal Services Architecture

The following table describes the Terminal Services architecture components.

Table 1.1 - Terminal Services Components

Component	Description
CSRSS.exe	The Client-Server Runtime Subsystem is the process and thread manager for all logon sessions.
RdpDD.sys	Captures the Windows user interface, transforms it into a form that is converted by RDPWD into the RDP protocol.
RdpWD.sys	Unwraps the multi-channel data, transfers it to the appropriate session.
SMSS.exe	Session Manager creates and manages all sessions.
Termsrv.exe	Manages client connects, initiates creation and shutdown of connection contexts.
Termdd.sys	The RDP protocol, which listens for RDP client connections on a TCP port.
Tdtcp.sys	Packages the RDP protocol onto the underlying network protocol, TCP/IP.
Wlnotify.dll	Runs in the session's WinLogon process to create processes in the user session.
Win32k.sys	Manages the Windows GUI environment taking the mouse and keyboard inputs and sending them to the appropriate application.
WinLogon.exe	Handles user logons and logoffs and processes the special Windows key combination Ctrl-Alt-Delete.

As the Windows Server 2008 Terminal Server loads the core operating system, the Terminal Server service (termsrv.exe) is started and begins waiting for session connections. Each connection has a unique session identifier or "SessionID" to represent an individual session to the Terminal Server, and each process created within a session is "tagged" with the associated SessionID to separate its name space from other session name spaces.

The console session (Terminal Server keyboard, mouse and video) is always loaded first, treated as a client connection for special case, and is assigned SessionID 0. The console session starts off as a normal Windows Server 2008 session with configured Windows display, mouse and keyboard drivers loaded.

Then, after creating the console session the Terminal Server service calls the Windows Session Manager (SMSS.EXE) to create two idle client sessions which then wait client connections. To create the idle sessions, the Session Manager starts the Client-Server Run-time Subsystem (CSRSS.EXE) and a new SessionID is assigned to that process. The CSRSS process also invokes the WinLogon process (WINLOGON.EXE) and the Windows Manager and GDI kernel module (Win32k.sys) under the newly connected Session ID (Appendix A).

The Windows image loader recognizes this Win32k.sys as a Session Space loadable image by a previously defined bit set in the image header. It then relocates the code portion of the image into physical memory with pointers from the virtual kernel address space for that session if Win32k.sys has not already been loaded. By design, it always attaches to a previously loaded image's code (Win32k.sys) if one already exists in memory (that is, from any active application or session). The data (or non-shared) section of this image is then allocated to the new session from a newly created SessionSpace page able kernel memory section.

Unlike the console session, Terminal Server client sessions are configured to load separate drivers for the display, keyboard, and mouse. The display driver is the Remote Desktop Protocol (RDP) display device driver (rdpdd.dll), and the mouse and keyboard drivers are replaced with the RDP driver Rdpwd.sys. These drivers allow the RDP client session to be both available and interactive, remotely. Finally, Terminal Server also invokes a connection listener thread for the RDP protocol (Termdd.sys), which listens for RDP client connections on a TCP port.

At this point, the CSRSS process exists under its own SessionID namespace, with its data instantiated per process as necessary. Any processes created from within this SessionID will execute within the SessionSpace of the CSRSS process automatically. This prevents processes with different SessionIDs from accessing another sessions data [4].

1.2 Terminal services physical structure (components)

The service of terminals provides remote access to Windows desktop through the software of "the thin client", allowing the client computer to serve as the terminal emulator. He provides an effective and reliable way of distribution of programs on the basis of Windows, providing a uniform point of installation with several users having access to a desktop of the Windows Server 2008 operating system where they can start programs save files and use network resources as though they were sitting on this computer. For computers under control of the Windows Server 2008 operating systems the client program of services of terminals (connection to a remote desktop) is already installed. The Windows Server 2008 operating systems also include the software of the client of services of terminals for computers with 16-and 32-bit operating systems. A Terminal Services client can exist in the most different forms. Hardware devices of the thin client which start the built-in Windows OS can start the client software of terminals services for on which services of terminals are started. Windows, Macintosh or UNIX computers can start the client software of services of terminals for connection to the server of services

of terminals for display of applications on the basis of Windows. This combination of clients of services of terminals provides access to applications on the basis of Windows practically from any operating system.
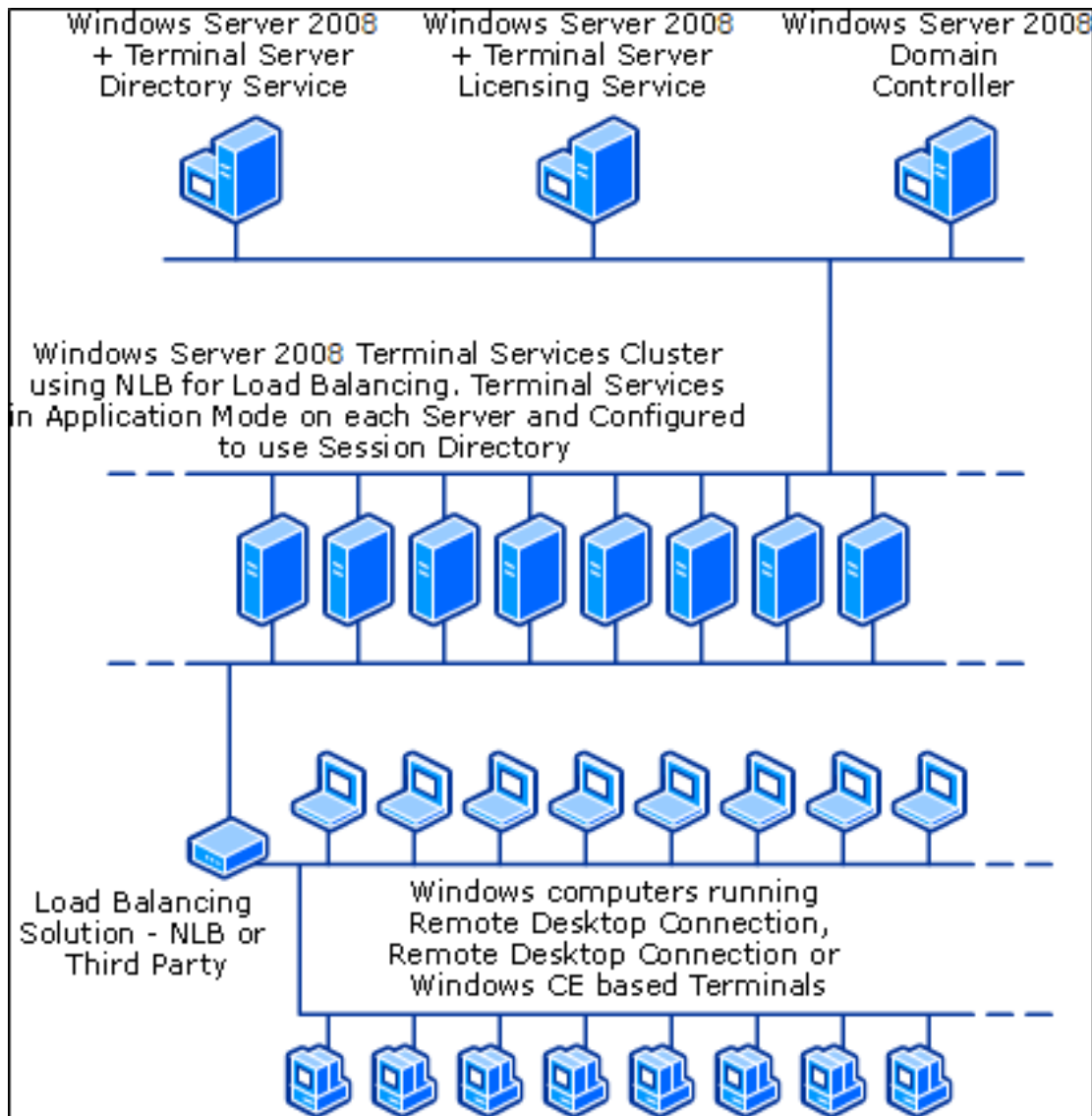

Figure 1.2 – TS physical structure

Terminal Server Licensing. The server of licenses is a computer on which licensing of the server of terminals is established. The server of licenses stores all tokens of licenses of the licenses TS CAL which have been established for group of servers of terminals, and traces the given license markers. One server of licenses can serve many servers of terminals at the same time. The terminal server has to have an opportunity to be connected to the activated server of licenses that on client devices constant tokens licenses were granted. The server of licenses which was installed, but isn't activated, will give only temporary tokens of the license.

The family of the Windows Server 2008 operating systems provides the control system of licenses of clients known as licensing of the server of terminals. This system allows servers of terminals to receive and operate tokens of the license

of client access of the client terminal (TS CAL) for the devices and users who are connected to the server of terminals. Licensing of the server of terminals is a component service Windows Server 2008, Standard Edition; Windows Server 2008, Enterprise Edition; and Windows Server 2008, Datacenter Edition. He can operate the licenses of clients and licenses of clients and also supports the servers of terminals working under control of Windows Server 2008 and also the Windows 2000 Server operating system. It considerably simplifies a task of management of licenses for the system administrator, minimizing insufficient or excessive purchase of licenses for the organization. Licensing of the server of terminals is used only with the server of terminals, but not with a remote desktop for administration.
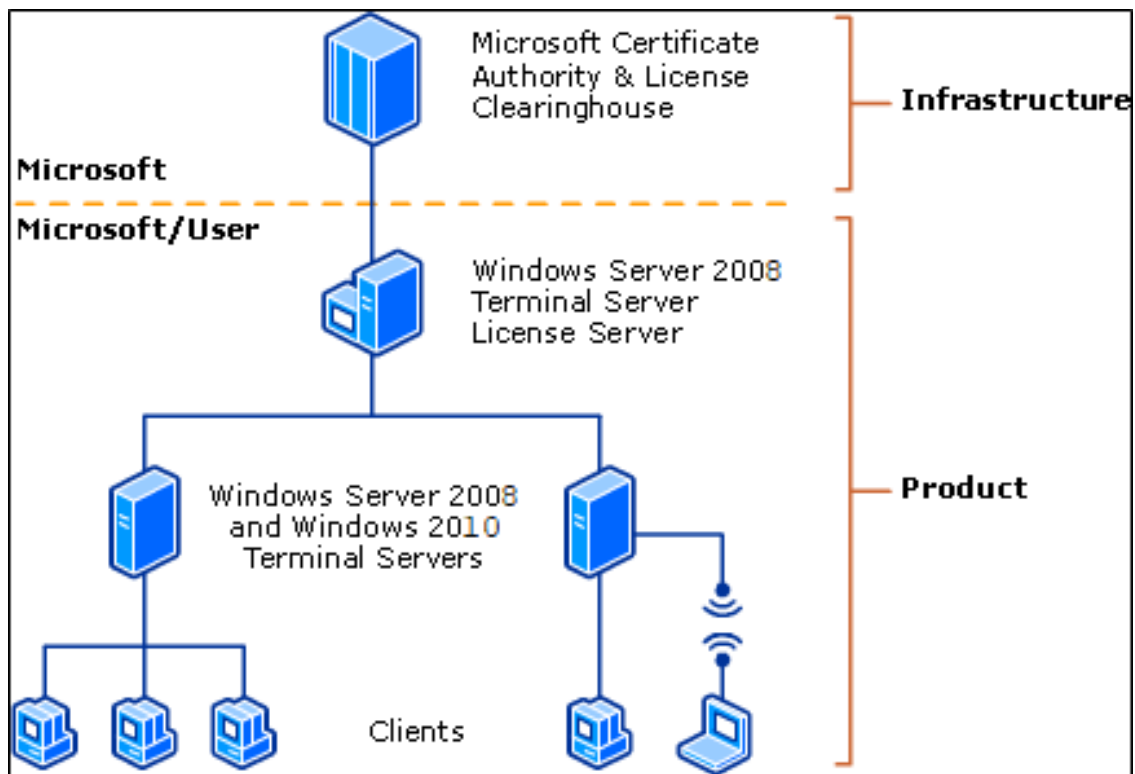

Figure 1.3 - Terminal Server Licensing

The server of terminals for Windows Server 2008 (known as the application server mode in Windows 2000 Server) provides expansion and management of applications for users on different devices through the application server mode. Each device or the user who initiates a session on the final server under control of Windows Server 2008, has to have the license for one of the following actions:
1. Windows Server 2008 Terminal Server Device Client Access License;
2. Windows Server 2008 Terminal Server User Client Access License;
3. Windows Server 2008 Terminal Server External Connector.
Note that additional licenses, such as licenses of Microsoft or other applications, operating system and client access can be required. Licenses in the previous list are required even if other superstructures are used over Windows Server 2008.

The service of licensing of services of terminals is connected only with licensing for the client of the server of terminals. He isn't used for licensing of any other applications or services and doesn't replace or doesn't interact with the license for any other component or doesn't change your rights and obligations for End User License Agreement (EULA). The service of licensing of the server of terminals isn't replacement for purchase of the client license TS.

The signs TS CAL represent electronic submissions of real licenses, but they aren't the actual licenses. Therefore if the token of the license is lost, it doesn't mean that you have lost the actual license. If you have a documentation confirming that you have bought the actual license the token of the license can be republished. To the contrary, only because you have a license token, it doesn't mean that it is surely compared with the actual legal license.

Licensing of services of terminals is intended for management of these tokens of the license to allow the administrator to estimate more precisely requirements to licensing of the organization. However there are several situations when the token of the license isn't compared with the actual license. The administrator has to define whether really it so, and if necessary to acquire additional licenses (but not to establish the corresponding tokens of the license) for accounting of this discrepancy [5].

All communication during process of licensing happens between the client and the terminal server and also between the terminal server and the server of licenses. The client of the server of terminals never contacts directly the server of licenses.

When the client device tries to be connected to the terminal server in the On the Device mode, the server of terminals defines whether the client has a license marker. Clients of the server of terminals store license tokens in the following section of the register:

HKEY_LOCAL_MACHINE\Software\Microsoft\MSLicensing

If the client has no license token, the server of terminals tries to contact the server of licenses from the list of the found servers of licenses. If the contact isn't made, the server of terminals restarts detection process. If the server of licenses doesn't answer, the device can't be connected to the server of terminals if it doesn't work during the grace period of the server of terminals (Appendix B).

When the server of licenses responds, the server of terminals requests a temporary token for the device as it is the first time when the device was connected to the server of terminals. Then the server of terminals places this temporary token in the device. After the user has provided the valid registration data that has led to successful login, the server of terminals specifies to the server of licenses to note the given temporary token as checked.

Next time, when the user will try to be connected to the terminal server in the On the Device mode from this device, the server of terminals requests CAL token for Windows Server 2008 TS for this device. If on the server of licenses tokens of CAL TS Device are available, the server of licenses deletes one token from an

available pool, marks it as given out to the device, registers a device name, a user name of the device and date of issue, and then pushes this token of the CAL device on the device.

If on the server of licenses there are no tokens of the TS CAL device, it will look for at first any other server of licenses in the domain, the working group or the website. Servers of licenses support information on where there are other available servers of licenses and if they have license markers. If other server of licenses which has stock is available, the first server of licenses requests a license token from the second server of licenses and brings him to the server of terminals which then transfers a token to the client device. If there are no available tokens of the CAL TS device, the device will continue to be connected to a temporary token.

Temporary tokens allow to connect devices within 90 days, and then to expire. The client licenses TS Device Device providing termless licenses expire in 52-89 days from the date of their delivery. The terminal server always tries to update these tokens in 7 days prior to the expiration of their action. The purpose of this system is restoration of tokens of TS CAL which are lost because of such events as equipment failure or reinstallation of an operating system.

Client License Distribution Per User. When the server of terminals is adjusted in the User mode, the server of terminals has to have an opportunity to find the server of licenses after the expiration of a grace period. In spite of the fact that on the server of licenses it is possible to establish CAL tokens on the user for each user, there is now no way to appoint CAL token for each user to a certain account of the user.

Client License Distribution for External Connector. There is currently no support in Terminal Server Licensing or the Microsoft Clearinghouse for the External Connector. In order to use an External Connector license, you will need to configure your terminal server in Per User mode.

Session Directory. In the computing environment on the terminal server all implementation of applications and data processing happen on the server. In the balanced loading servers of terminals are grouped in farms, and each farm is represented on client computers as one name of the computer with one IP address. The device which is carrying out balancing of loading redirects the entering session connections on each car of a farm according to her algorithm of balancing of loading. Use of the solution of balancing of loading with the server of terminals distributes sessions on farm servers for increase in productivity. The Session Directory of services of terminals available in Windows Server 2003, Enterprise Edition, works with your solution of balancing of loading.

The Session Directory is a function of balancing of loading which allows users to be connected easily to the disconnected session on a farm of servers on which services of terminals are started. The Session Directory is a database which traces the user's sessions which work on balancing with loading servers of terminals. He provides information when the user is repeatedly connected (after shutdown intentionally or because of failure of network) to provide repeated

connection of the user besides to a session, but not to begin a new session. The Session Directory which can support several thousands of sessions also supports a cluster. Management of sessions of services of terminals of services works with service of balancing of loading for ensuring transparent connection of users to the initial server on which their disconnected session of the server of terminals is placed.

The components of Terminal Services Session Directory are:

- A network load-balancing solution;

- Two or more Terminal Servers logically grouped into a Terminal Server cluster;
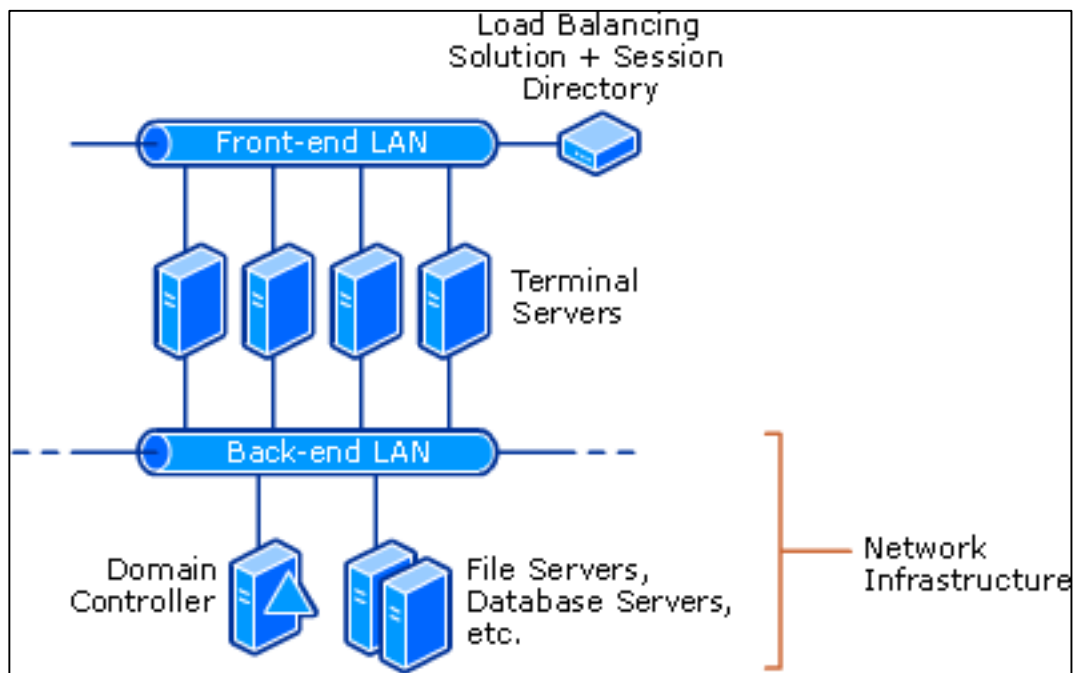
- A Session Directory server.

Figure 1.4 - Terminal Services Session Directory

Balancing of network loading, the technology of a clustering included in Windows Server 2008, Enterprise Edition and Windows Server 2008, Data Center Edition allows servers to provide high efficiency and protection against failures. Balancing of network loading distributes IP traffic on several copies (or copies) services TCP/IP, such as Terminal Server or IIS, each of which works at a separate host in a cluster. Clients get access to a cluster with use of one or several virtual IP addresses; from there NLB cluster evenly breaks client inquiries between hosts. From the point of view of clients the cluster is represented the only server. In process of increase in traffic of the enterprise network administrators can just add the additional server and include it in a cluster.

In the environment with balancing of loading each cluster of services of terminals is represented to client computers as one name of the computer with one IP address. The device or the service which is carrying out balancing of loading

redirects connections to separate servers (knots) in a cluster according to his algorithm of balancing of loading.

Balancing of loading unites resources of processing of several servers with use of the network TCP/IP protocol whereas Session Directory traces the disconnected sessions in a cluster and provides repeated connection of users to the same sessions.

Members of a Session Directory can consist only of servers of Enterprise and Datacenter terminals. The computers working under control of Windows Server 2008, Standard Edition cannot join the Session Directory as they lack the required technology of a clustering; however the computer under control of Windows Server 2008 Standard Edition can work as the server of catalogs of sessions.

1. The entering connection with a cluster balances load of one knot which provides the invitation for login.

2. When the user enters a cluster of the server of terminals, the server of terminals receiving initial request for login sends a user name to the server of the catalog of sessions.

3. The server of the Session Directory checks a user name for the database and sends result to the requesting server. The database of the Session Directory is the jet database containing the list of sessions, indexed on a user name.

4. If the user has no disconnected sessions, process of registration continues on the server on which initial connection is placed.

5. If at the user the session on other server is disconnected, the initial server of a hosting sends the client information necessary for the client for continuation of authentication on the server on which the disconnected session is placed. Transition from one server to another is transparent for the user.

6. When the user enters the disconnected session, the Session Directory is updated. The database of the Session Directory of the server of terminals is updated and requested by servers of terminals at each login, leaving the system or disconnection from a session.

Advantages of use of Session Directory:
- It allows users to be connected to the disconnected sessions repeatedly;
- Allows to apply single-user user politicians;
- Shortcomings of use of Session Directory;
- The Windows 2008 Enterprise-version is required at least;
- The external balancer of loading is required.

The Session Directory is the simple service Windows and the small database working on the server of terminals in your environment. When the server of terminals is adjusted for participation in the catalog of a session, record is created in this central database at each start of a session. These records are requested or updated by servers of terminals in a cluster at each login, leaving the system or shutdown of their session. Users can quickly be connected to already existing disconnected sessions even if the client doesn't know to what server they have been connected. The service of the catalog of a session (the database) is easy (from the

point of view of the required resources), and one server of the session server can process several clusters of Terminal Server [6].

Remote desktop for administration. You can use Remote Desktop for administration for remote management of network, using the configuration similar to the configuration shown in the following drawing.

The remote desktop for administration provides remote access to a server desktop by means of the protocol of remote access of services of terminals (RDP) on port 3389. RDP transfers the user interface to the client's session and also transfers clicks and clicks of a mouse from the client to the server. You can create up to two simultaneous remote connections. Each session which you enter doesn't depend on other sessions of the client and also a server console session. In effect, you can use Remote Desktop for Administration for an entrance on the server far off as though you have been registered locally [7].

If you need to be connected to a server console session far off (for example, for access to applications which direct only the user interface to the console), either use the Remote Desktops equipment, or use "Connection to a remote desktop" from a command line. When you try to be connected to a console session, far off or locally, you will be notified if one more user is already connected to a session of the console. The message of the notice will be displayed after confirmation of your registration data of an entrance and will contain information on the user who has logged in on a console session, including a user name, location of an entrance (local or remote) and a condition of a session (in use, blocking or idle time).
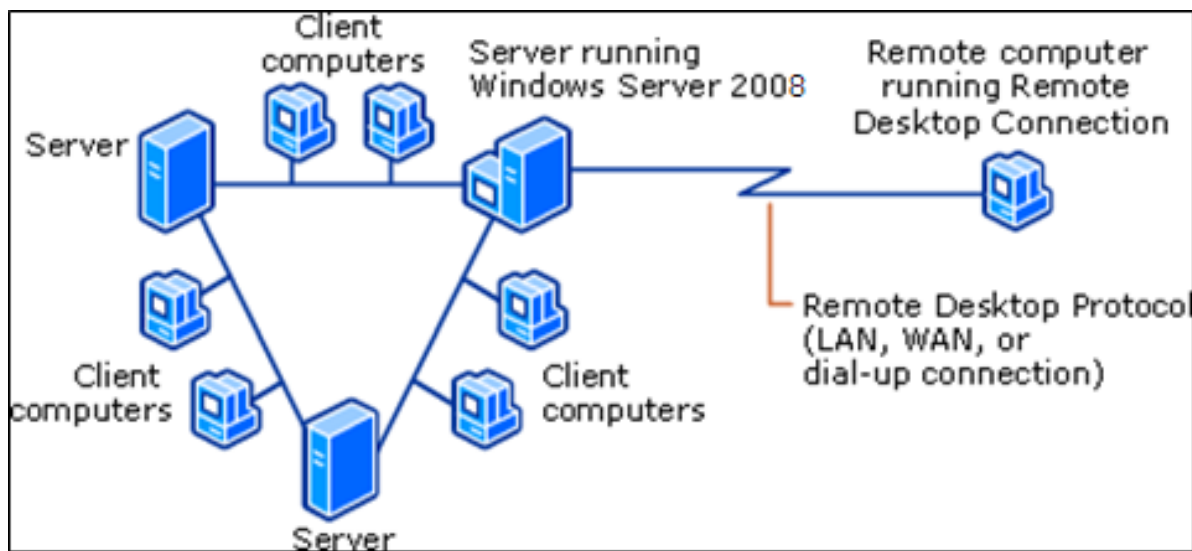

Figure 1.5 - Remote Desktop

Connection to a remote desktop for administration uses TCP/IP either on the existing network connection, or through remote access. The server of remote access on which one of Windows Server 2008 of family of operating systems works provides two different types of connection to remote access:
- Network and remote connections;
- Virtual private networks.

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Protocol of a remote desktop (RDP). The protocol of a remote desktop (RDP) is the protocol of the protected network communication intended for remote management and also for remote access to virtual desktops, applications and the terminal RDP server. RDP allows network administrators to diagnose and fix remotely problems which certain subscribers face. RDP is available to the majority of versions of the Windows operating system. RDP for Mac OS Apple is also an option. The version with an open source code is also available.

Remarkable RDP properties include enciphering, authentication of smart cards, reduction of bandwidth, sharing of resources, a possibility of use of several displays and a possibility of temporary shutdown without leaving the system. RDP also allows to redirect such functions as audio and the press.

RDP can support up to 64 000 independent channels for data transmission. Data can be ciphered with use of 128-bit keys, and function of reduction of bandwidth optimizes data transmission speed in low-speed connections.

The RDP protocol is intended for ensuring remote access through port 3389. The application or packages of support of RDP transfer data which have to be transferred, and the communication service of Microsoft sends data to RDP channel. From there the operating system ciphers data of RDP and adds them to a frame that he could be given.

The Redirector driver for the server of terminals operates all operations of the RDP protocol. This driver consists of subcomponents, such as RDP (Wdtshare.sys) driver which processes the user interfaces, transfers, enciphering, compression and framing. The transport driver (Tdtcp.sys) is responsible for packing of the protocol so that he could be sent through TCP/IP network.

Newer versions of RDP are much safer. Later Windows operating systems contain the mechanism of definition of to what users access to system through RDP session is allowed. There is also an opportunity to forbid any remote access to system if they don't use authentication at the network level.

It is usually recommended that administrators and end users used only RDP when it is absolutely necessary and that they start it with the minimum level of privileges [8].

1.4 Modern usage

"The terminal server" is used in many ways, but from the main sense if the user has a consecutive device, and they need to move data on local network, it is that product which they need.

1. Connection with Raw TCP socket: the raw connection of sockets of TCP which can be initiated from the server of terminals or from a remote host / server. It can be a point-to-point or the general where consecutive devices (for example, readers of cards, scanners, readers of bar codes, scales, etc.). Can be shared by several devices. Sessions of TCP can be initiated from application of the TCP server or from the server of terminals.
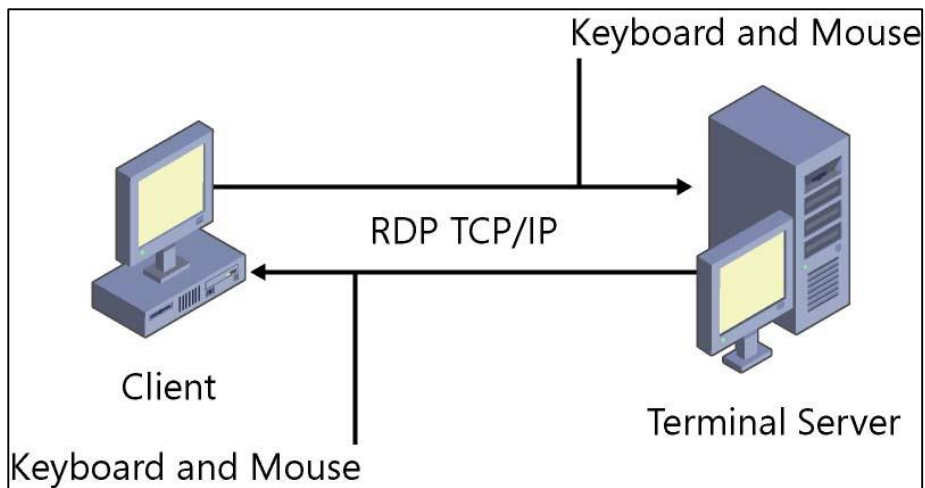
Figure 1.6 – Remote Desktop Protocol

2. Raw UDP connection of sockets: for use with applications on the basis of UDP servers of terminals can transform data of the consecutive equipment for transport through UDP software packages to the principle "point-to-point" or share on several devices.

3. Control of the console - the return Telnet, the return SSH: in terminology of control of the console users can use the return Telnet or SSH for connection to the consecutive device. They start Telnet or SSH on the client (personal computer) and are connected to the server of terminals, and then connected to the consecutive device. In this application servers of terminals are also called console servers as they are used for connection to console ports which can be found on such products as routers, UATS, switchboards and servers (Linux or Sun). The idea consists in getting access to these devices through their console port.

4. Connect consecutive applications with the driver of COM/TTY port: for contact with devices which are directly connected to consecutive COM ports of the server, many software applications have been written (robotic assembly cars, scanners, readers of cards, sensors, blood analyzers, etc.). The companies can want to connect these applications because devices which have been directly connected to COM ports of the server have to be moved to location at some distance from the application server. As the initial application is intended for direct communication with concrete COM port, for ensuring communication through IP network the decision, seamless both for the application, and for the device has to be realized.

5. Consecutive tunneling between two consecutive devices: consecutive tunneling allows users to establish connection through Ethernet with a serial port on other server of terminals.

6. Backup: this application is intended for a solution with connection. For example, the user needs to replace a wire of RS-232, RS-422 or RS-485 and to execute their data through Ethernet without any changes on the server or the final consecutive device, the user wants to replace the parallel rented line of the modem with their parallel network Ethernet, or someone has a car for the choice and placement which places IC on boards, and they want to move the server to the back

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room where the equipment will be in safety from damages. This application is ideal where there is a device with the application written for collection of information from this device (the general with sensors). This application allows them to eliminate conducting.

7. Virtual modem: the virtual modem is one more example of use of the return application. He can be used for replacement of modems, but at the same time a set of the AT teams is used. The IP address is entered into a set of the AT teams instead of a phone number of the consecutive device [9].

2 Laboratory works

2.1 Laboratory work #1

Purpose: study the concept of server virtualization, creation of virtual machine on the basis of Oracle Virtual Box software.

2.1.1 Preliminary preparation

A virtual computer is a logical representation of a computer in software. By decoupling the physical hardware from the operating system, virtualization provides more operational flexibility and increases the utilization rate of the underlying physical hardware.

In a traditional physical computer, one instance of the operating system supports one or more application programs. In a virtualization environment, a single physical computer runs software that abstracts the physical computer's resources so that they may be shared between multiple "virtual computers." Each virtual computer may be running a different operating system from all of the other virtual machines on the physical machine. A crash or other program error on any of the virtual machines leaves all of the other virtual machines unaffected.

Server virtualization allows a physical server to be partitioned to run multiple secure virtual servers (Figure 2.1). This creates an opportunity to consolidate physical servers, thus helping to reduce hardware acquisition and management costs by eliminating "infrastructure sprawl" at the server level. If the resource requirements of one of the server-based products running in a virtual server grows, because of increased usage for example, moving that virtual server to a different physical server with more available resources is as simple as copying a file.

This ease of replication of virtual servers also means that it's simple to maintain snapshots of virtual servers as file back-ups and quickly restore complex systems to operation in the event of physical server hardware failures. This increased resilience results in more efficient use of existing physical server resources, lower operating costs, reduced power consumption and greater overall reliability [2].
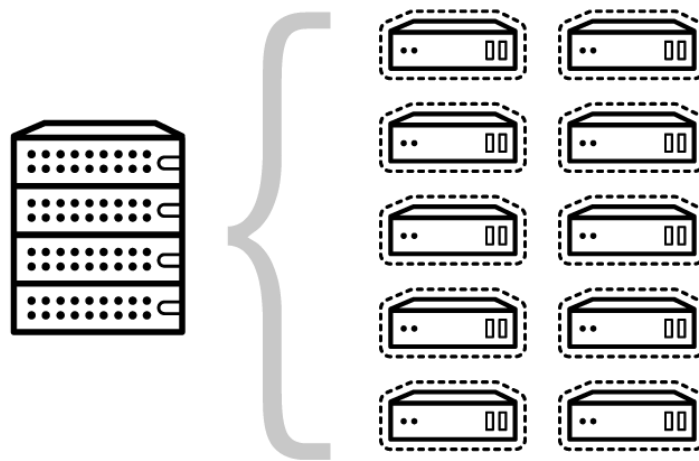
Figure 2.1 – Virtual server model

Oracle VM VirtualBox is a free, open source, cross-platform application for creating, managing and running virtual machines (Figure 2.2). Virtual machines are computers the hardware components of which are imitated by the host computer. Oracle VirtualBox allows you to set up one or more virtual machines on a single physical computer and use them simultaneously. Each virtual machine can perform its own operating system, including versions of Microsoft Windows, Linux, BSD, and MS-DOS. You can install and run as many virtual machines as you like – the only practical limits are disk space and memory [10].

2.1.2 Work assignment

2.1.2.1 To become acquainted with Oracle VM VirtualBox Software functions

2.1.2.2 Create a client virtual machine

2.1.2.3 Make necessary settings for connection of real computer and client machine

2.1.2.4 Settings export and import

2.1.2.5 Review questions

2.1.3 Methodological instructions for the execution of the work

Open the Oracle VM VirtualBox Manager. The interface of the program when you turn on VB is on Figure 2.3. VirtualBox has a fairly clear, easy-to-use interface
and functional.

2.1.3.1 Addition and setting of virtual client machine.

There are several steps to create the virtual machine. Add the client machine, as shown in Figure 2.4.

Name it, select the required operating system and its version – Windows 2008 (64-bit), for example.
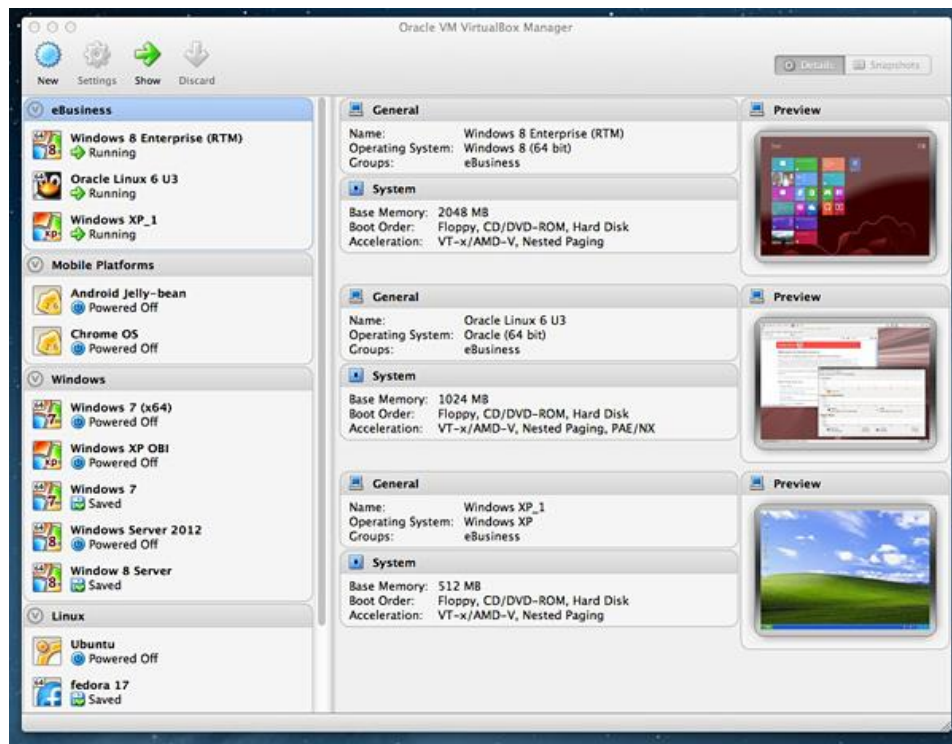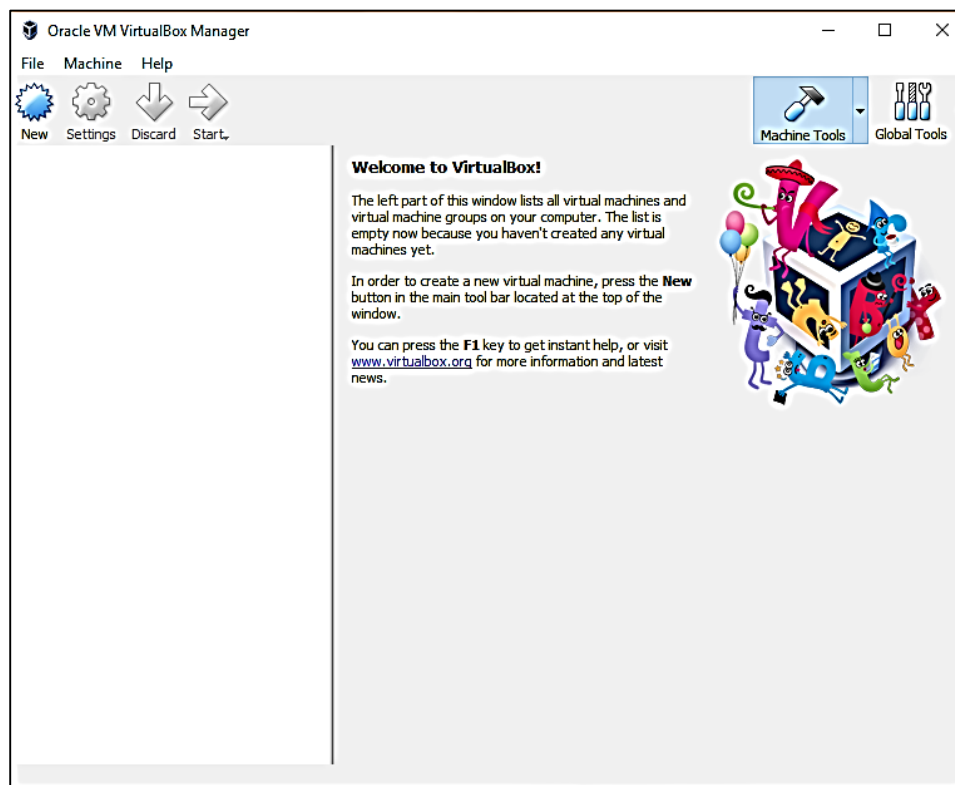
Figure 2.2 – Oracle VM VirtualBox Manager
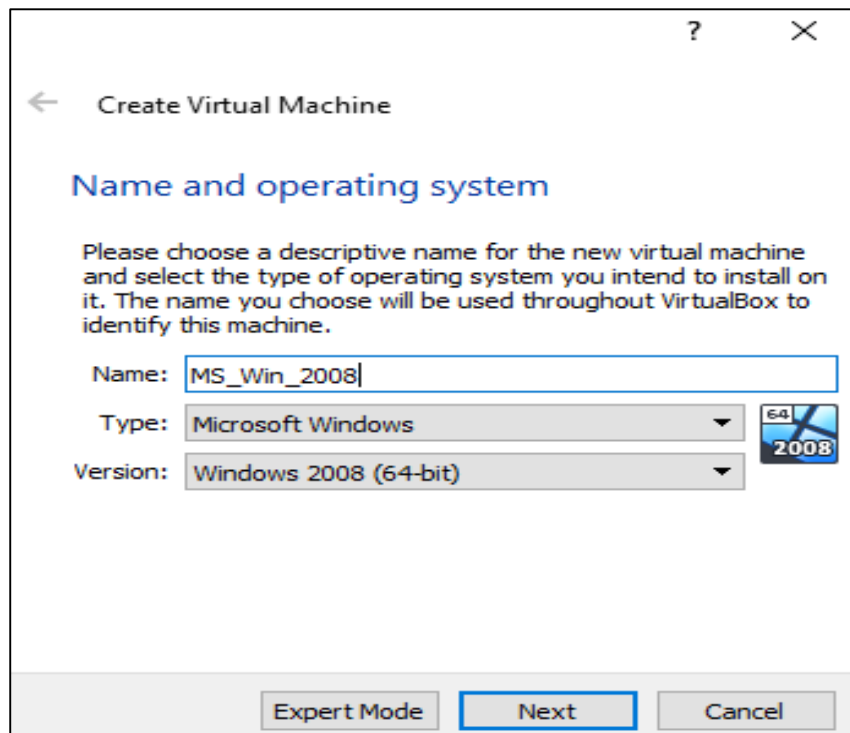

Figure 2.3 - Virtual Box start page

Figure 2.4 – Creation of VM

The VirtualBox program recommends the minimum amount of RAM for a given virtual machine (Figure 2.5). You can select the required amount of memory by yourself. Here it is necessary to adhere to this recommendation: you can not exceed the size of the allocated memory, which is marked on the scale in green, so as a result, do not have problems with the work of the virtual machine being created.
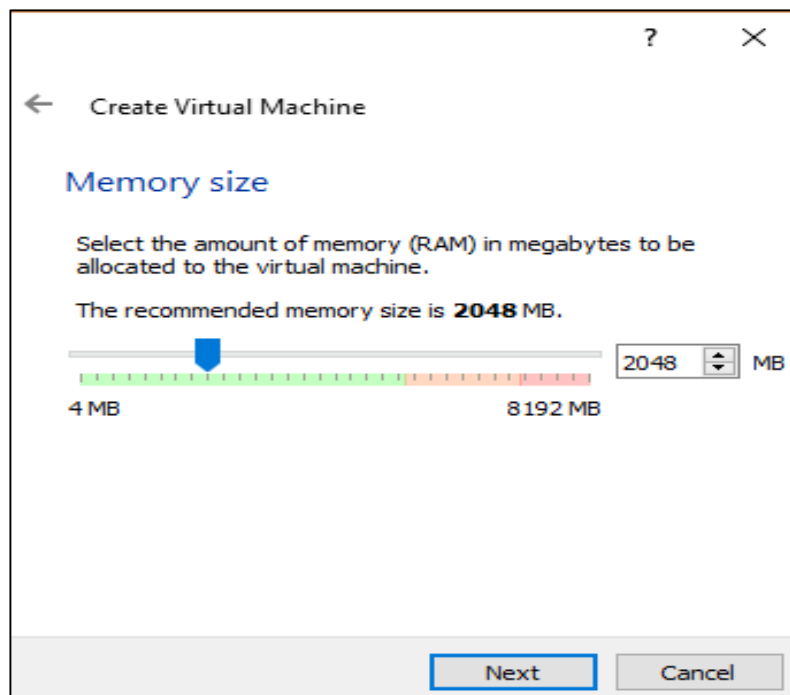

Figure 2.5 – RAM settings

Virtual memory is part of the physical memory of your computer that will be used in a virtual machine. Virtual memory is allocated from the instruction of the main (host) operating system for the operation of the guest operating system on the virtual machine. The allocated RAM will be used only when this virtual machine is running.

You can select your RAM size by moving the cursor on the scale, or enter the memory size in the digital value in MB. In the future, if necessary, you can change the amount of allocated RAM in the settings of this virtual machine.

The next step is to create a virtual hard disk, because the virtual machine can not work without such a hard disk (Figure 2.6). A virtual hard disk is a file of a special type that is stored in the file system of the operating system of your computer.

In this window (Figure 2.6), you can choose from three options:

- Do not connect a virtual hard disk - you can connect a virtual hard disk after creating a virtual machine;

- Create a new hard disk - a new virtual hard disk will be created;

- Use an existing virtual hard disk - the virtual machine will be connected to the previously created virtual hard disk.

To create a new virtual disk, click the "Create" button. The program VirtualBox itself recommends the amount of hard disk for a particular operating system.

In the next window you will need to select the type of virtual hard disk (Figure 2.7). You can select the following disk formats (virtual containers):

- VDI (VirtualBox Disk Image) - VirtualBox drive format;

- VMDK (Virtual Machine Disk) - VMware disk format;

- VHD (Virtual Hard Disk) - Microsoft disk format.

If you are going to use only VirtualBox to create and run virtual machines, then you can leave the default selection: VDI format. Disks of this format will be opened in the program Virtual Box.

Next you will need to choose the storage format: dynamic or fixed.

The dynamic hard disk file will take up a small space on the physical hard drive of your computer. As the data is filled, it will increase in size to the limit.

The file of the fixed hard disk will immediately take up the whole volume of the virtual hard disk.

After making all the settings a virtual machine is created. A client virtual machine with the name specified during the configuration should appear in the left window of the program as it is shown in Figure 2.8.

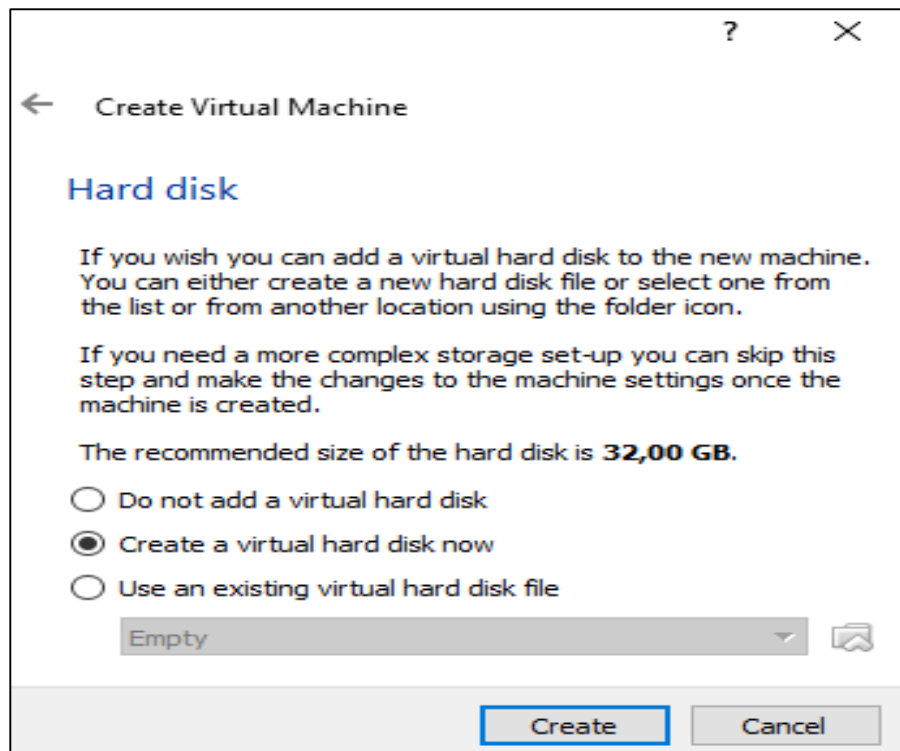In the right part of the window you can see some parameters of the virtual machine.
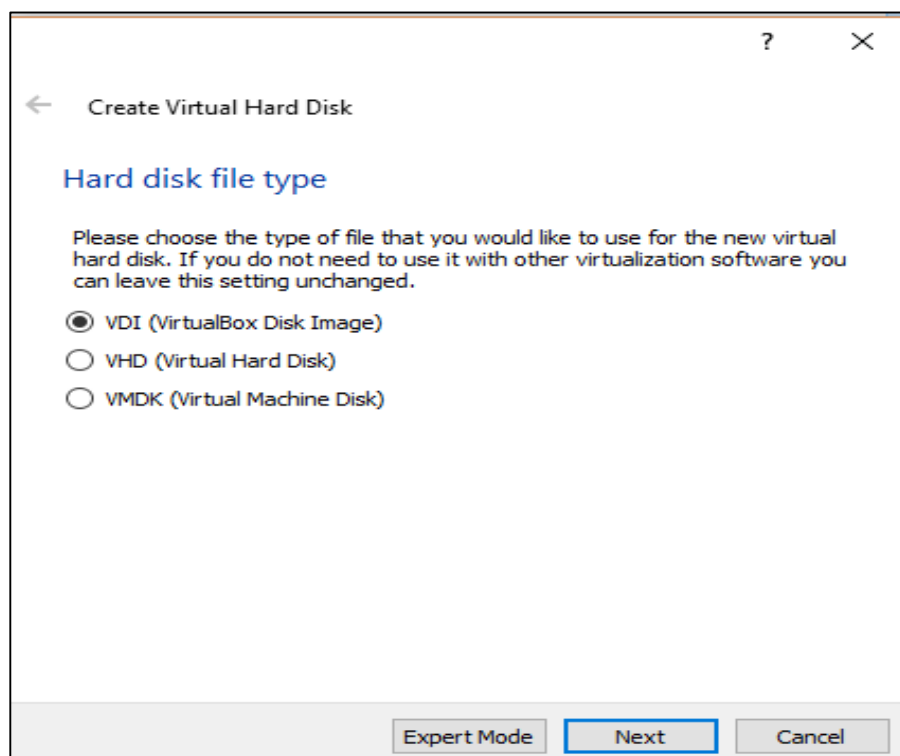
Figure 2.6 – Connection of hard disk
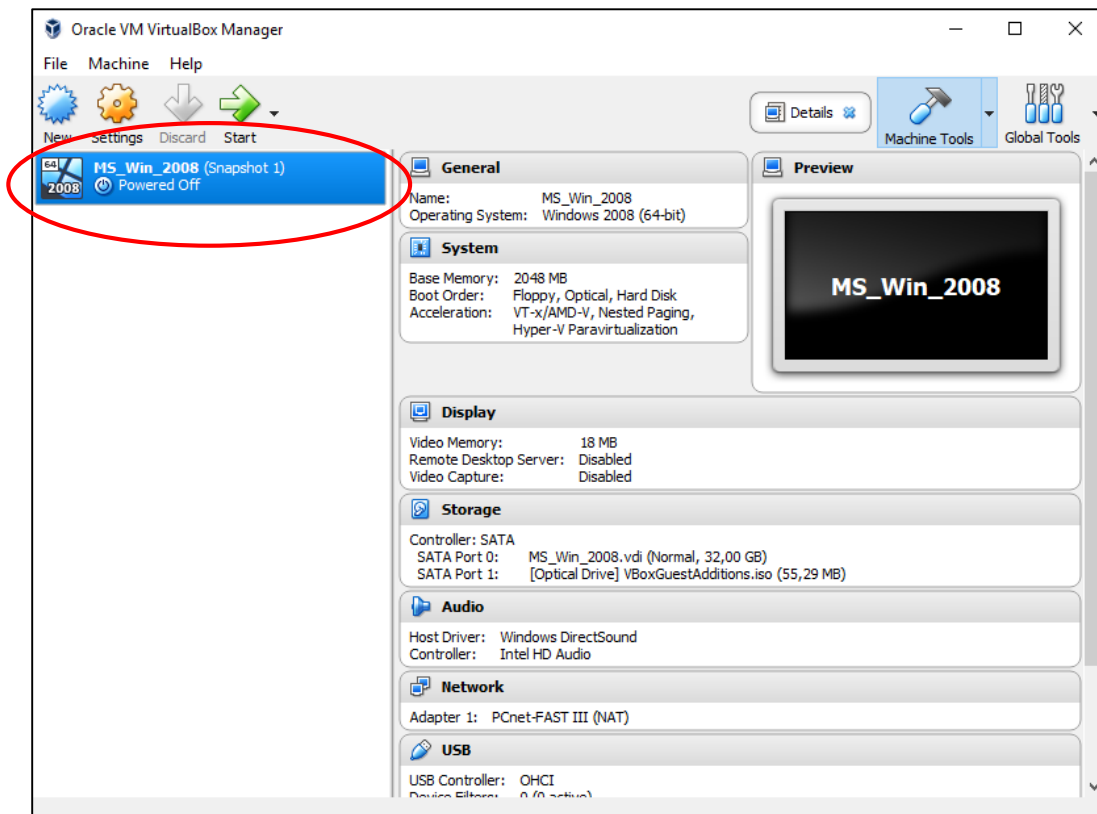

Figure 2.7 – Hard Disk File Type

Figure 2.8 – Created Virtual Machine

2.1.3.2 VM Settings
Let us choose the optical virtual disk (.iso file) – Figure 2.8
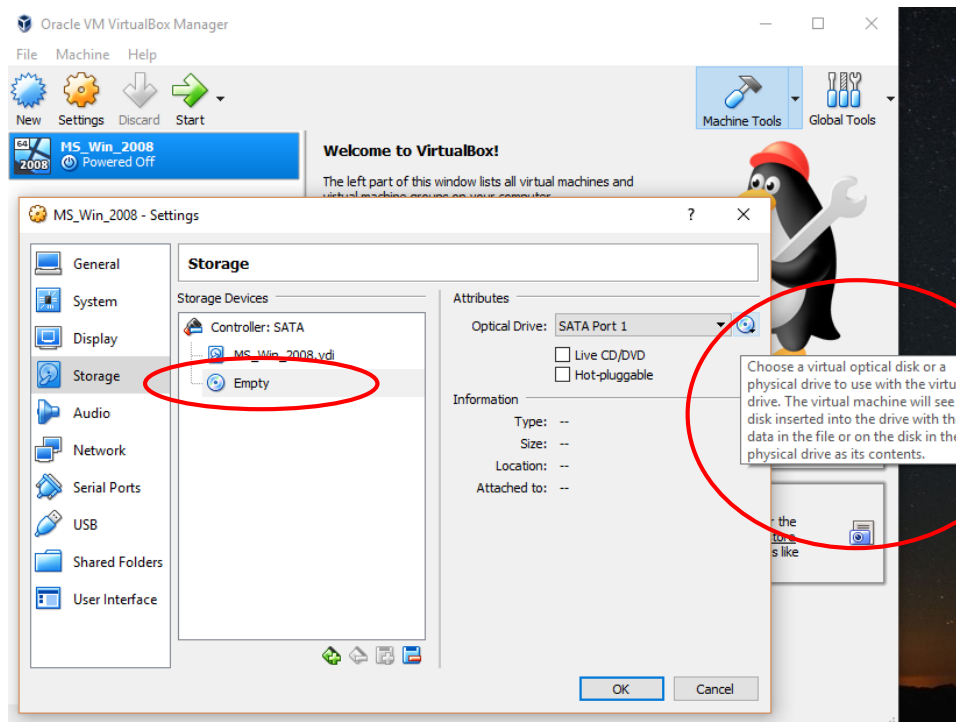

Figure 2.8 – Choosing the .iso file

In the "Storage" section you will need to select a virtual disk. The virtual disk file is already displayed here, but it's almost empty, since the operating system has not yet been installed. Therefore, to install the system, you will need to select the .iso image file with the operating system.

Click on "Empty", in the right part of the window opposite the item "Optical drive" click on the button with the image of the disk, and then in the context menu select the item "Select the image of the optical disk ...". Using File Explorer locate the desired operating system image on your computer.

2.1.3.3 Export and import appliance

The configuration of the existing VB virtual machine is exported to the .ova file (Figure 2.9). The file ".ova" (Open Virtual Appliance) is a universal virtual machine data storage file that can be used in various programs for virtualization of operating systems. The virtual machine that is exported to this file can then be imported (Figure 2.10) as a VirtualBox program, or as a VMware Workstation or Microsoft Hyper-V within the supported guest systems.
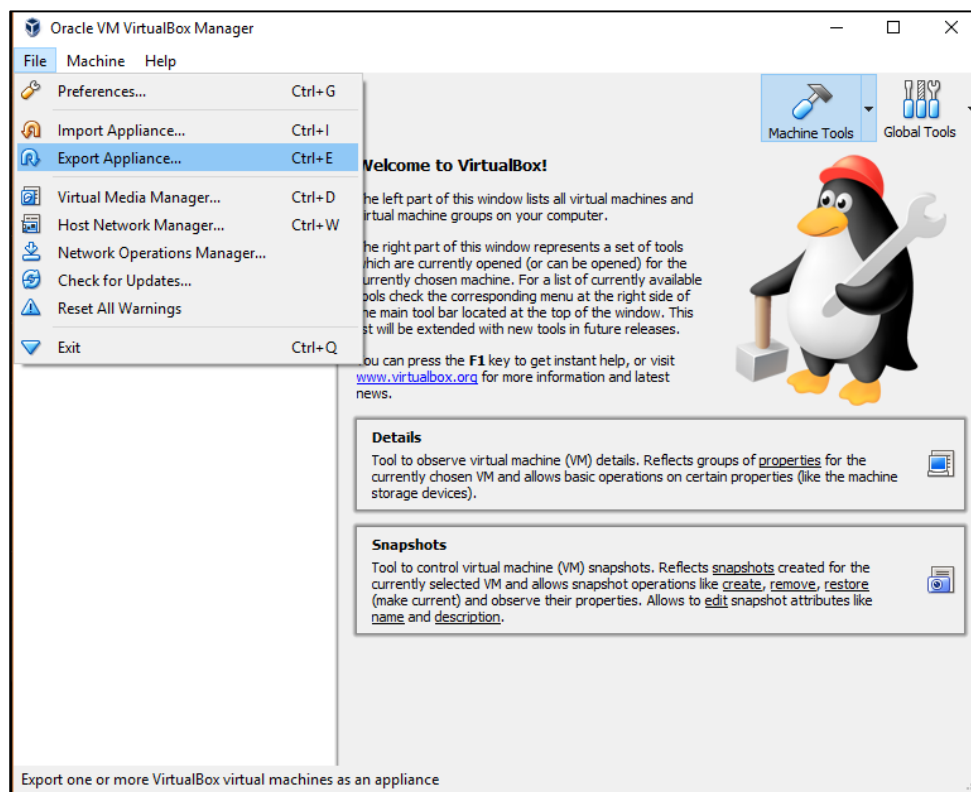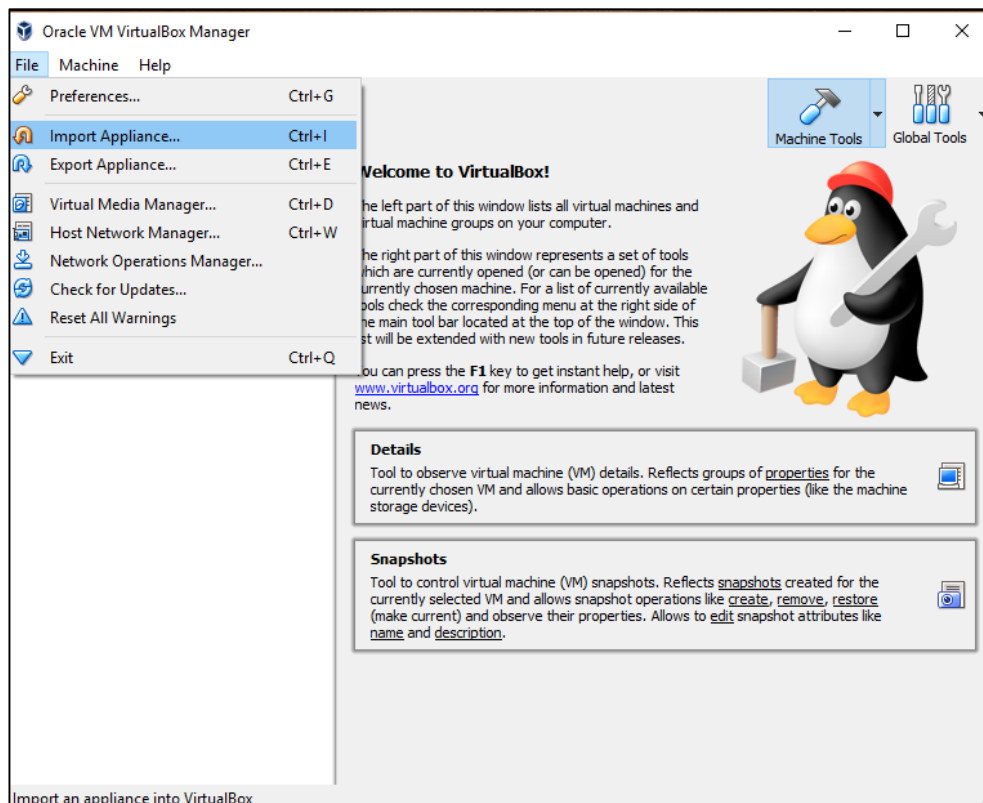

Figure 2.9 - Settings export

Figure 2.10 - Settings import

2.1.4 Review questions

2.1.4.1 What is virtualization?

2.1.4.2 What are the advantages of a virtual machine before a real equipment?

2.1.4.3 What settings it is necessary to make to configure the connection between the real computer and the virtual machine?

2.1.4.4 What is export and import of settings?

2.2 Laboratory work #2

Purpose: OS Windows Server 2008 and MS Office installation

2.2.1 Preliminary preparation

Microsoft Windows Server - a set of server operating systems from Microsoft Corporation. Server software - a software component of the computer system that performs service functions at the request of the client, giving it access to certain resources or services. Windows Server 2008 opens new opportunities for organizations, providing all users, regardless of their location, access to a full set of network services. In addition, Windows Server 2008 provides tools for analyzing the status and diagnostics of the operating system. Windows Server 2008 introduces a number of new and improved security technologies that enhance the security of the operating system and provide a solid foundation for the organization of the enterprise. The limited mode of operation of Windows services allows to prevent disruption of the operation of critical server services by abnormal activity in the file system, registry or network, and contributes to the security of systems.

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Technologies such as Network Access Protection (NAP), RODC, public key infrastructure (PKI) improvements, limited mode of Windows services, a new bidirectional Windows firewall, and support for next-generation cryptography also increase the security of the operating system Windows Server 2008. The Windows Server 2008 operating system is designed so that administrators can easily modify the infrastructure to adapt to the changing needs of the organization while maintaining the flexibility of the infrastructures . The mobile user experience has also been enhanced with technologies such as RemoteApp and the Terminal Services Gateway, which allows you to run programs from any remote location [11].

2.2.2 Work assignment

2.2.2.1 Installation of the operating system from .iso image file

2.2.2.2 Microsoft Office installation

2.2.2.3 Settings export

2.2.3 Methodological instructions for the execution of the work

2.2.3.1 Operating System Installation

Run the virtual machine created in laboratory work #1 (Figure 2.11), select the operating system.
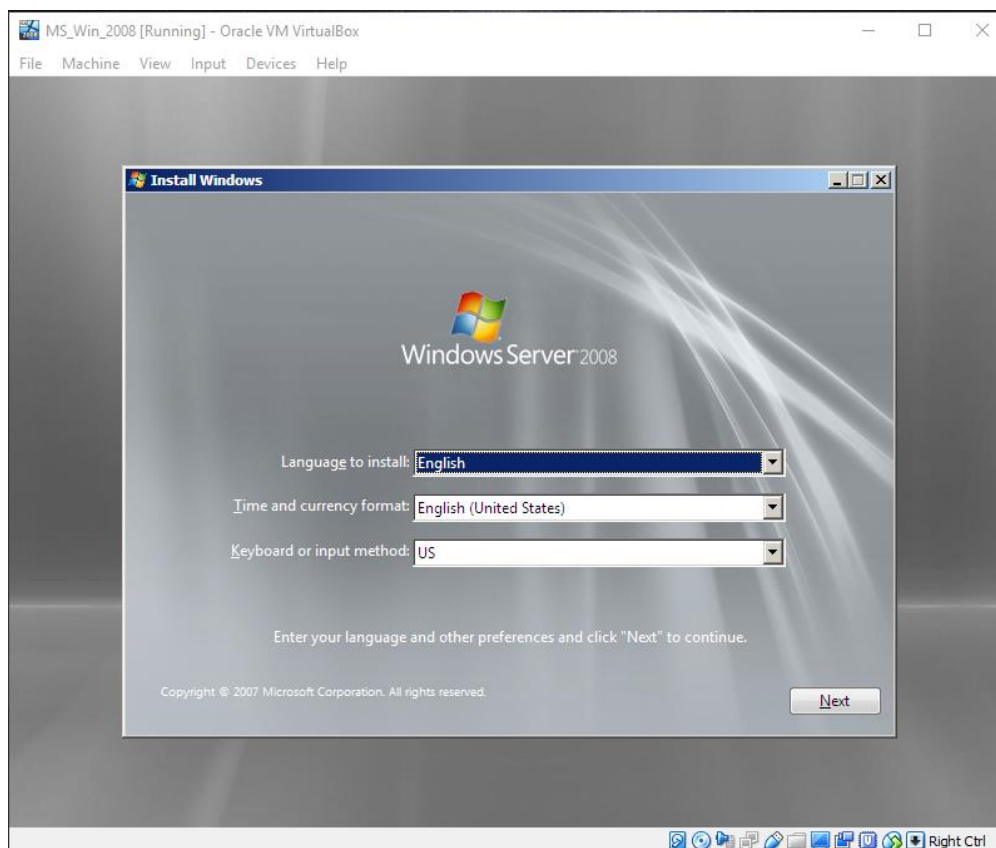

Figure 2.11 – Running VM MS_Win_2008

The installation process will reboot your computer. At the end of the installation, you will see the login screen, press CTRL + ALT + DEL to enter (Figure 2.12).

Note. The operating system on the virtual machine actually has no complete control over a mouse and the keyboard. It will be possible only if you start the virtual machine in the full-screen mode. Otherwise the virtual machine will need to use in common devices with other applications / other virtual machines. VirtualBox has a special key to return the ownership of a mouse and the keyboard back to the host operating system. This host key is the right Ctrl key on the keyboard. Users can change this parameter in VirtualBox Global Settings.

Enter the user name. For the English-language OS version, enter "Administrator". By default, the Username field is empty, so the first time you need to enter it.

The default password is blank, click OK. The system prompts you to change the password (Figure 2.13).

Note. When setting a password, it is necessary to use 6 characters in different registers, numbers and special symbols. It is necessary to invent a password more complicated, because this is the password of the most important user in the system.
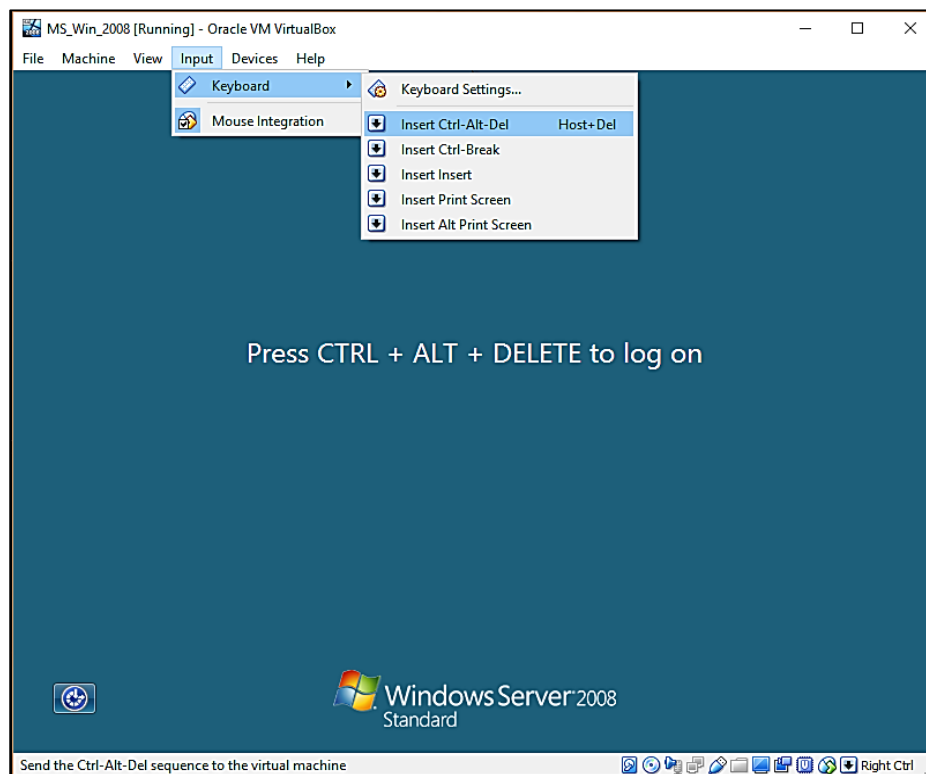
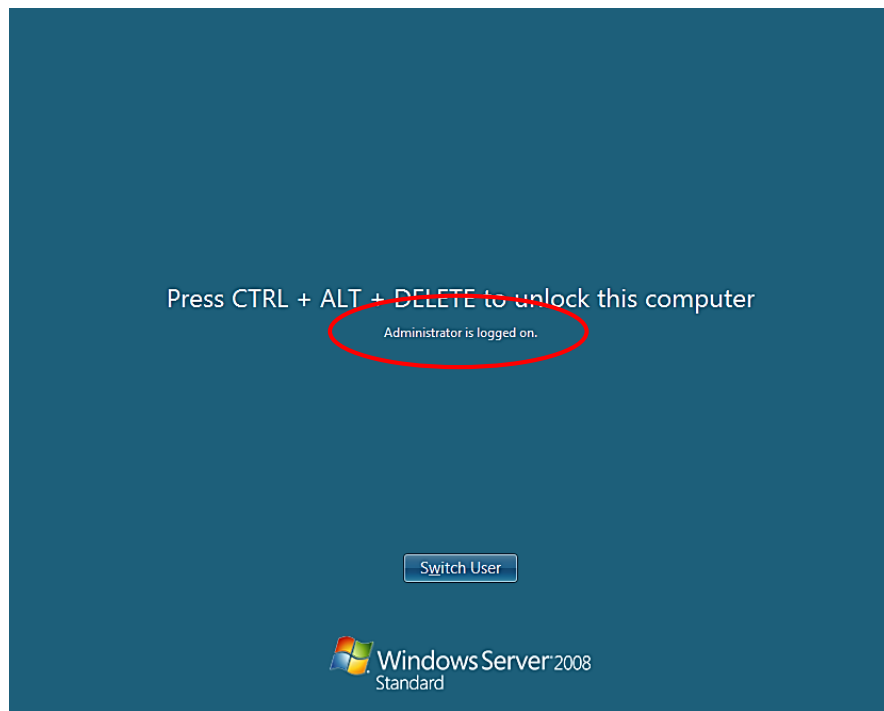

Figure 2.12 – Logging to the system

Figure 2.13 – Setting a password. Result

2.2.3.2 Microsoft Office Installation

Run the installator. The installation window appears. If you do not want to choose the features of the installation and agree with the default installation options, click the Install button in this window. If you want to set the disk space for the installation of Microsoft Office 2010 and the list of applications for the package that you want to install, click the Settings button. The installation of the required files on your computer will begin (Figure 2.14).
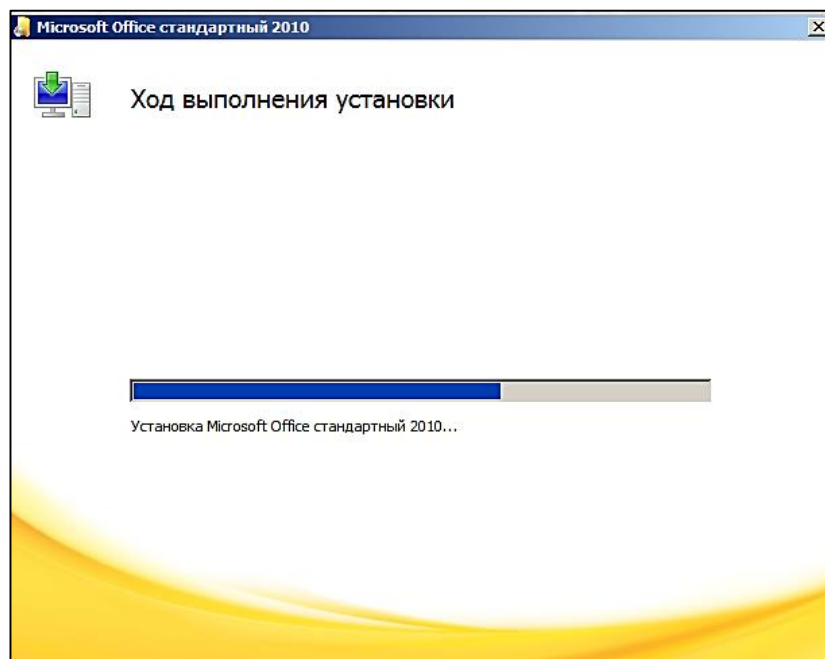

Figure 2.14 – MS Office 2010 installation

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In order to be able to navigate, which part of the work has already been done, an indicator appears in the appeared window - a color bar. When it is full, it means that the installation is complete. Click on the Close button in this window. This completes the process of installing the Microsoft Office 2010 software package (Figure 2.15).

Make settings export and import like in Laboratory work #1.
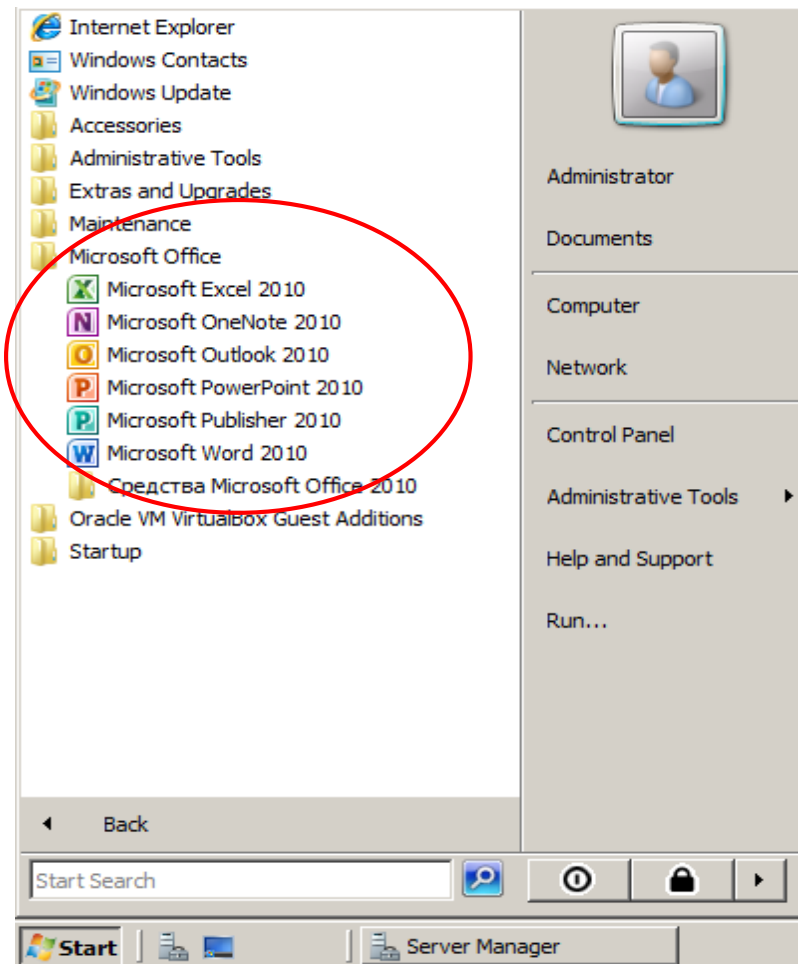

Figure 2.15 – Installed MS Office

2.2.4 Review questions

2.2.4.1 What can you tell about the OS Windows Server 2008?

2.2.4.2 Which technologies help us to run the programs on the computer from remote location?

2.2.4.3 Describe the authorization process in Windows Server 2008.

2.2.4.4. Which key in VirtualBox is host by default?

2.3 Laboratory work #3

Purpose: creation of shared folder and network subscribers

2.3.1 Preliminary preparation

Working simultaneously in the main operating system and virtual, created with the help of the program VirtualBox, there is a need to transfer various files from one OS to another. For these purposes, the developers of VirtualBox have added the ability to create a Shared folder, which will be available for file sharing between both operating systems.

A workgroup is a group of computers connected to a network that share resources. When you configure the network, the Windows operating system automatically creates a workgroup and assigns it a default name. In Windows Server 2008 for computers that are members of a workgroup, you can create accounts that will have free access to the server over RDP.

Remote Desktop Protocol (RDP) is an application layer protocol that is used to access remote computers without direct contact with them. The speed of the Internet directly determines the speed at which you will work with RDP. This protocol is used to manage the computer at a distance, that is, running applications on it and performing various tasks.

10 versions of this protocol are developed, the latest of which 8.1 was released in 2013 and is available as an update package for Windows 7 SP1 and Windows Server 2008 R2. The protocol is used in two modes: for administration and for access to the application server.

Features of the remote desktop created with RDP:
- Full-color transmission of colors;
- You can use the current tools to encrypt information;
- Playback audio from a remote machine on a local PC;
- You can connect local resources to a remote computer;
- The ability to use a local and network printer;
- Use of the clipboard for data transfer;
- Provides access to the ports of the local computer (serial and parallel) [12].

2.3.2 Work assignment

2.3.2.1 Organize a network resource (folder) and establish a connection, so that it could be accessed from both real and virtual computer

2.3.2.2 Create a network subscriber and add it to the Remote Desktop group

2.3.2.3 Review questions

2.3.3 Methodological instructions for the execution of the work

2.3.3.1 Shared Network Folder

First, create a new folder on your real computer, which will be used for work between real computer and virtual one and open the Virtual Machine Settings window (Figure 2.16).
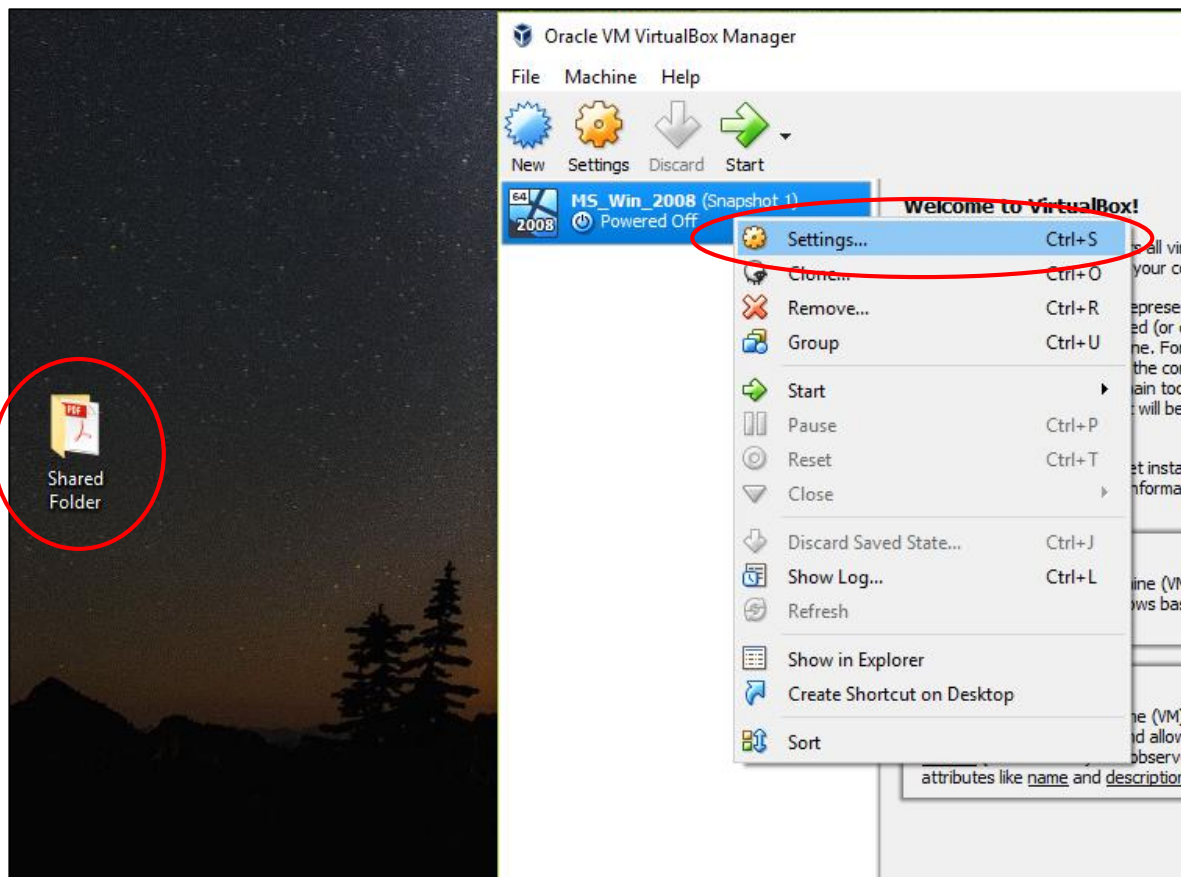
Figure 2.16 – Start settings

Note. To add a shared folder, virtual machine in the VirtualBox program for which these folders are connected must be **powered off**, not stopped or saved.

The Virtual Machine Settings window opens. Select the "Shared Folders" section on the left. On the right, click the button in the form of a folder with a plus sign - this is a browse button to select the folder that is intended to be shared with the main and guest OS. In file explorer we select a new created folder on a real computer. In the Add Folder window, check the "Auto-connection" option and click "OK" (Figure 2.17).

Now start the virtual machine for which the shared folder with the main OS is configured. In the menu of the VirtualBox window, choose the "Devices" section from the top, and in it - the command "Insert Guest Additions CD Image" (Figure 2.18).
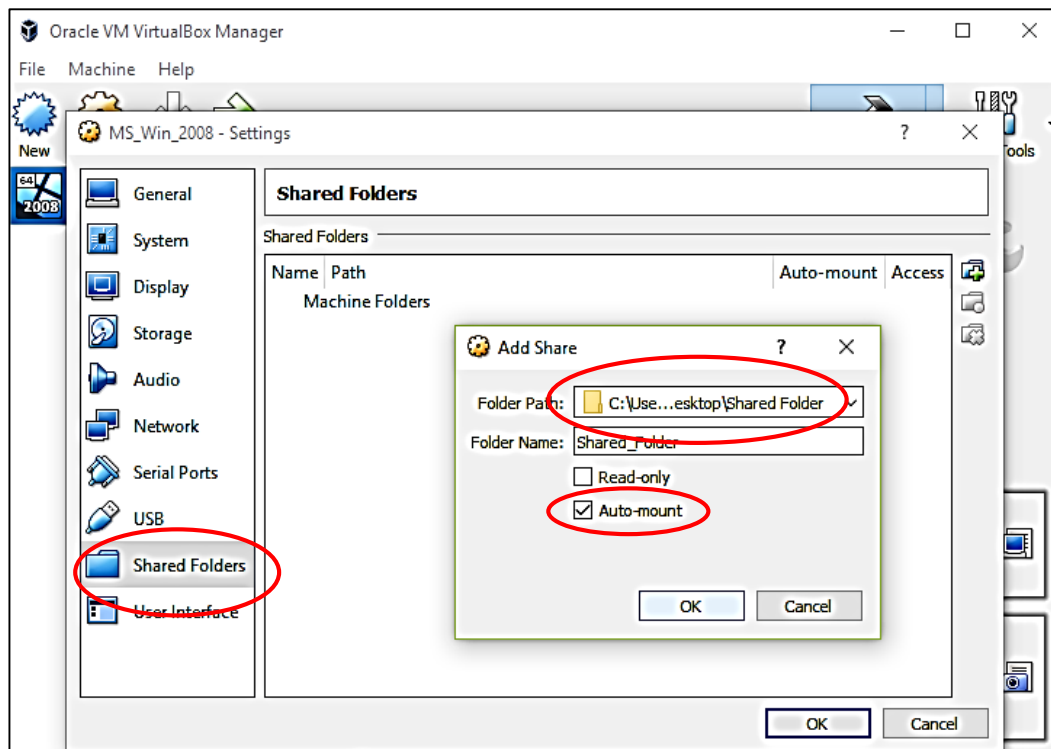
Figure 2.17 – Add Share window

Next, on the virtual machine, open the tab Computer. There we will see the connected image of the CD with the VirtualBox logo (Figure 2.19). We click it. In the VirtualBox additions window select the file to download (choose the one with the name **"VBoxWindowsAdditions"**). Make sure that you chose the right one, then start the installation.
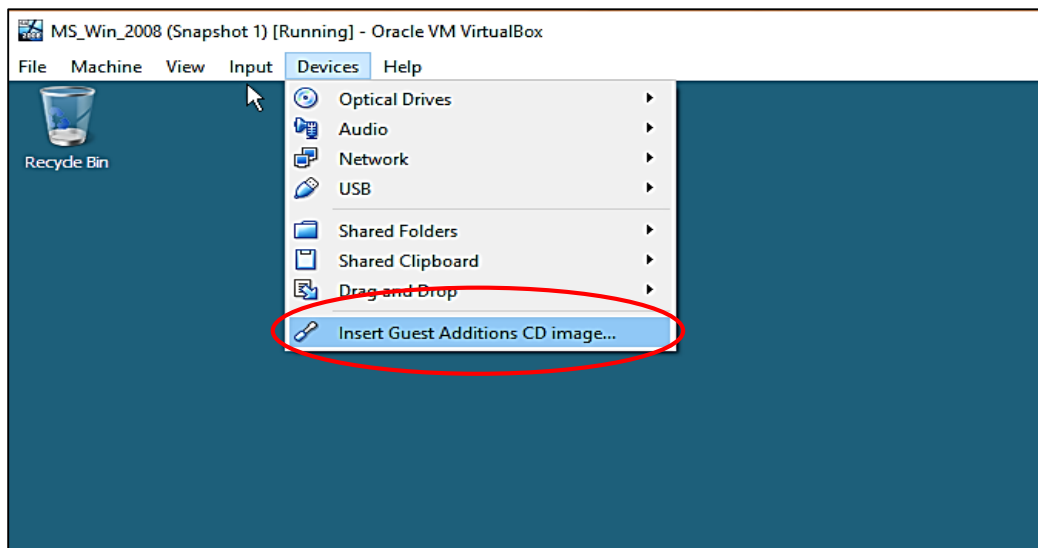
Figure 2.18 – Additional Driver Installation
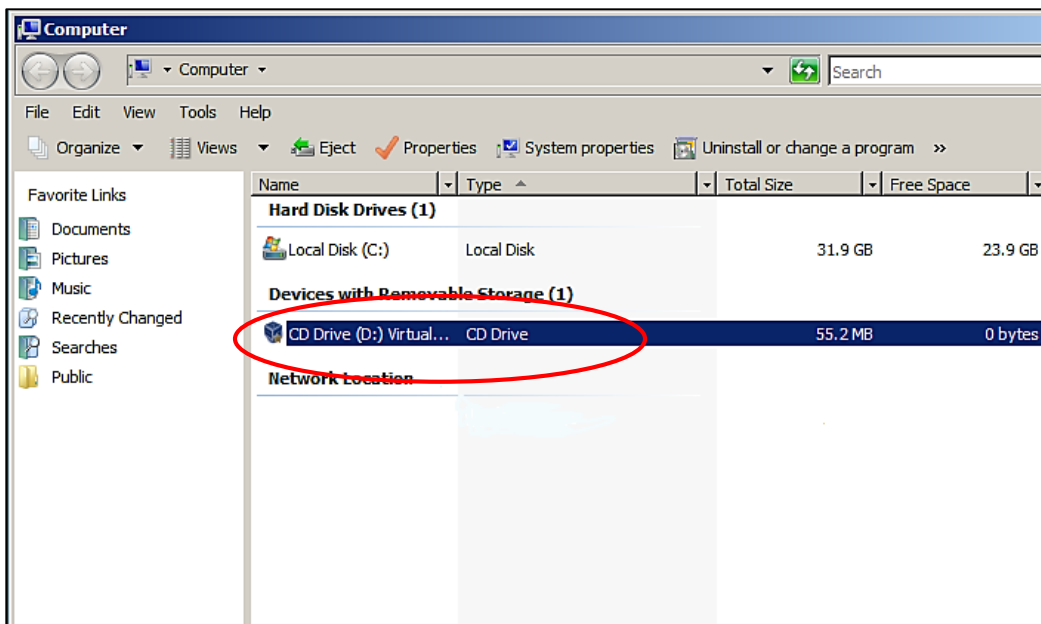
Figure 2.19 – New CD image

In the third install window choose the following components (Figure 2.20):
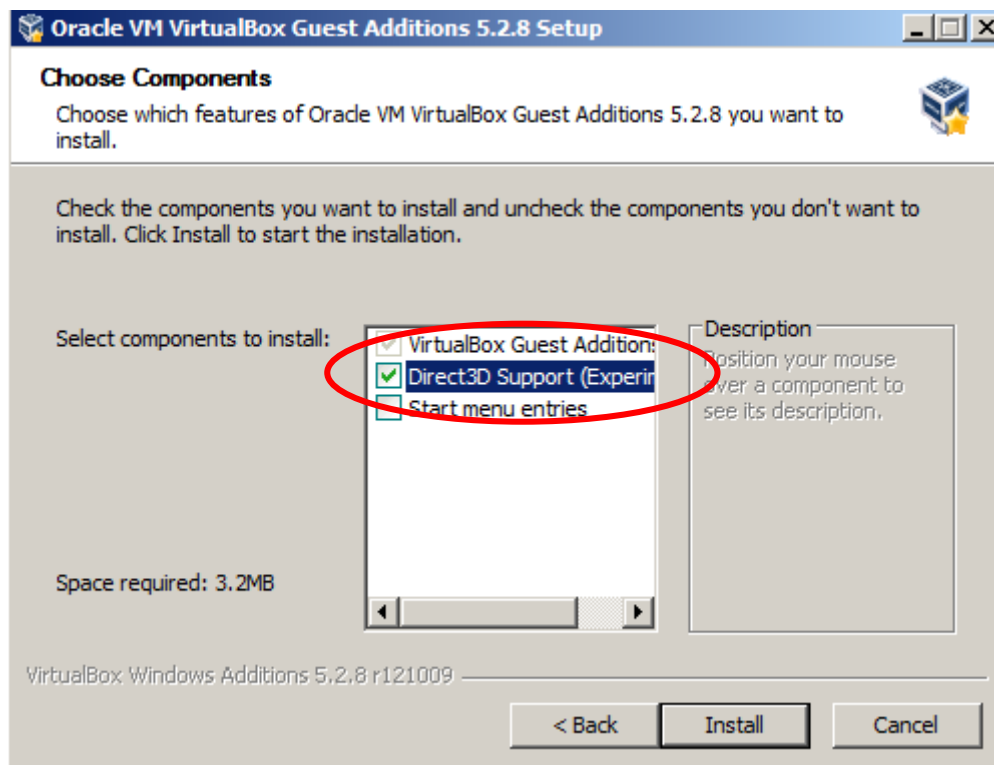
Figure 2.20 – Components to install

The last window for installing additions VirtualBox will notify you to reboot the virtual machine. Agree and click "Finish".

When the virtual machine reboots, the shared folder can be immediately displayed in Computer under the "Network Location" section (Figure 2.21).
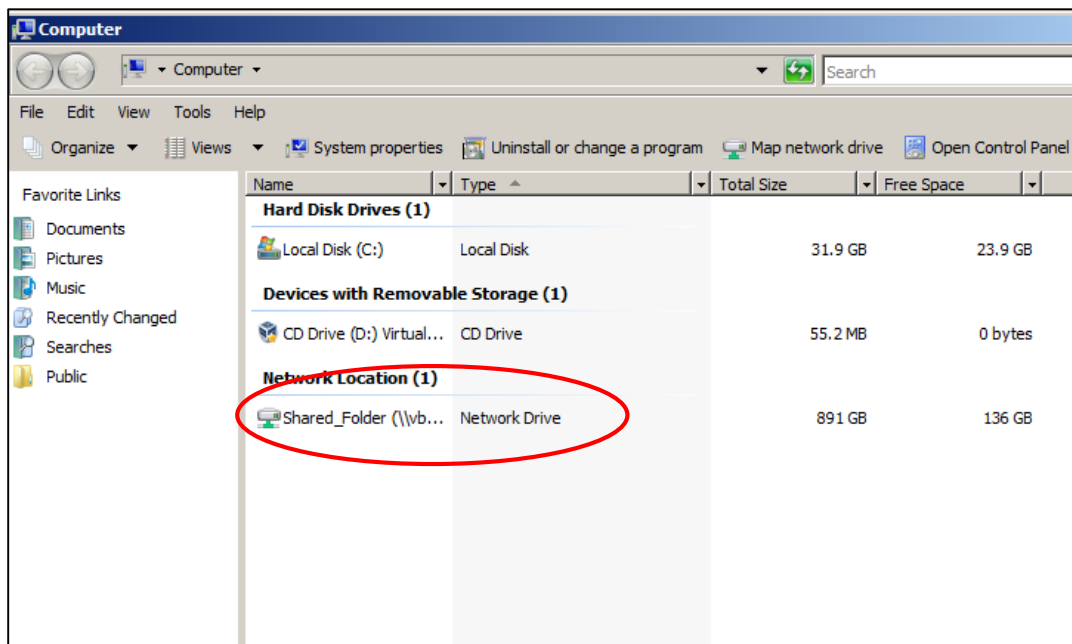
Figure 2.21 – Shared Folder appeared

So, the shared folder of the host and guest OS is created. We can test it. Just will put some file in a shared folder on a real computer and open it from the shared folder in the virtual machine (Figure 2.22).
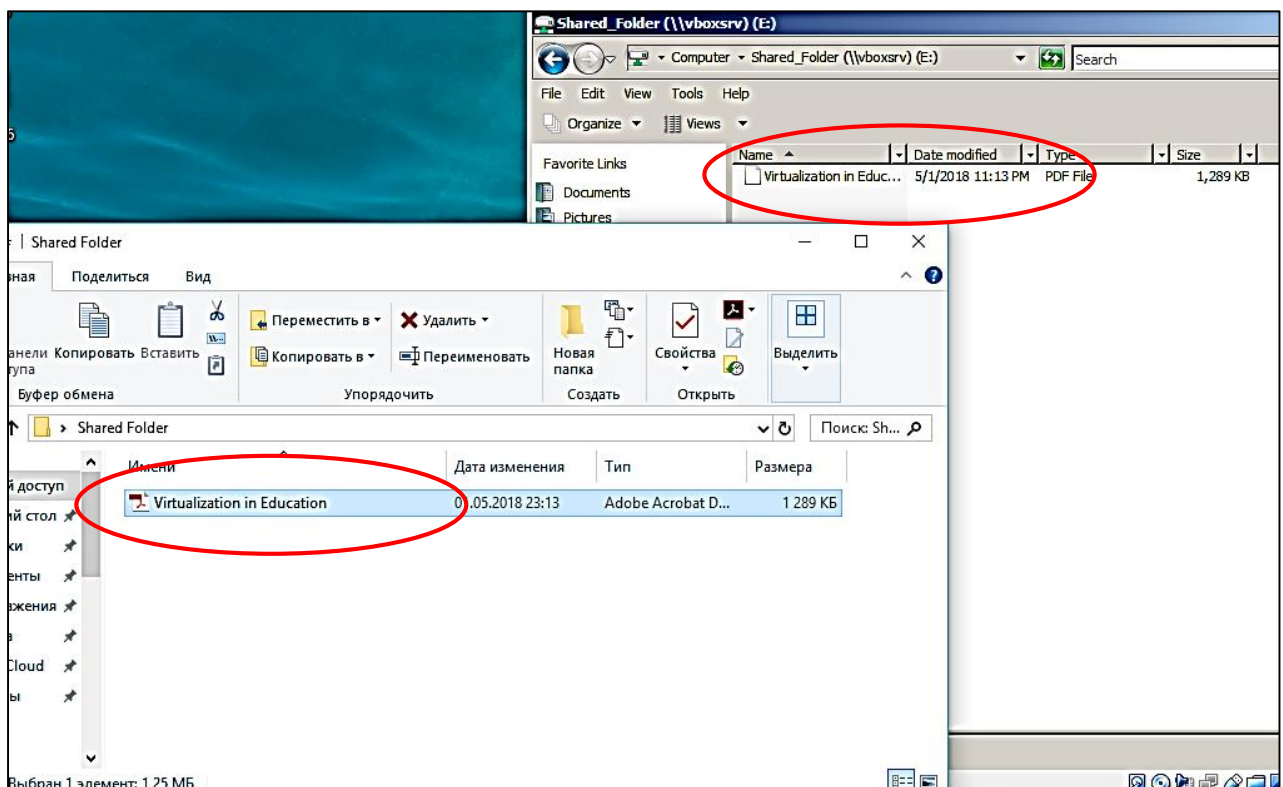
Figure 2.22 - Result

2.3.3.2 Adding new network subscriber to a group

So, we need to add a user with regular access (limited rights) in Windows Server 2008 to work through RDP.

Click on the administrator icon from the Start menu, for quick access to user accounts. In user accounts, create a new user by clicking on the link "Manage another account". In the appeared window enter the account name (let us use the name "student 1" and choose an account type – **standard user** (Figure 2.23). Click the new icon "Student 1" and set a password. A new account is created.

Next, for the user to work on RDP, you need to enter the user in the group "Remote Desktop Users". For this we run "Computer Management" in the Start menu, go to "System Tools" – "Local Users and Groups" – "Groups" – "Remote Desktop Users" (Figure 2.24).
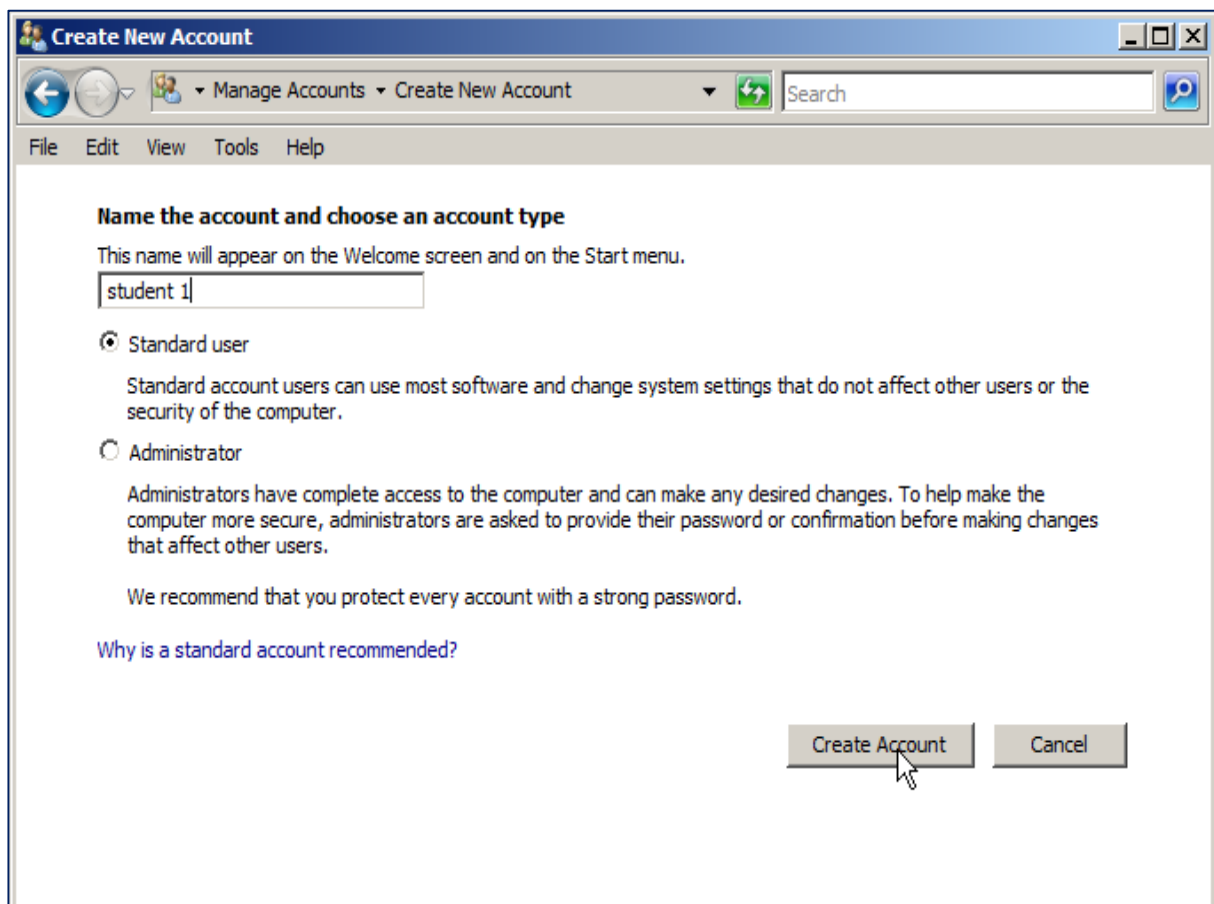
Figure 2.23 – Creation of new account
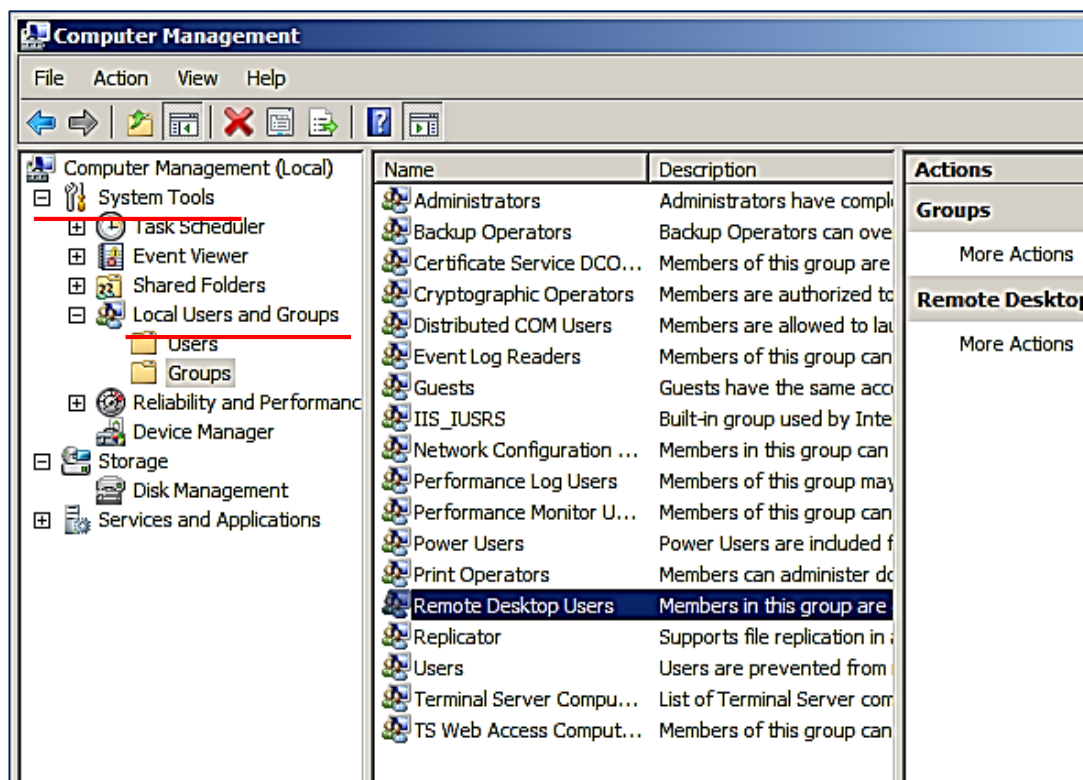
Figure 2.24 – Computer Management Window

In Remote Desktop Users Properties click the Add, enter user "Student 1" and click "OK" (Figure 2.25).
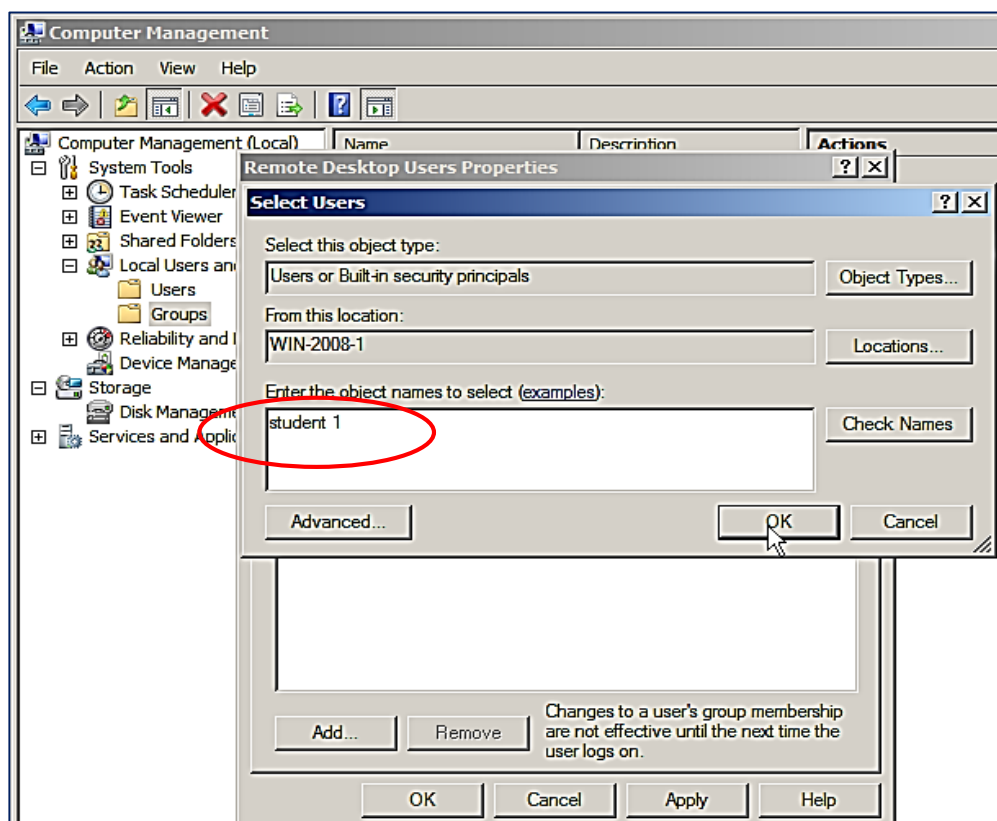
Figure 2.25 – Addition of a user

The user is added. After that, it can connect and work on RDP. You can created and add more users at will.

2.3.4 Review questions

2.3.4.1 What is Shared Folder? Describe the algorithm of its creation.

2.3.4.2. Where the Remote Desktop Protocol is used?

2.3.4.3. Name the features of remote desktop.

2.3.4.4 What does the RDP session depends on?

2.4 Laboratory work # 4

Purpose: configuration of terminal server

2.4.1 Preliminary preparation

The method of terminal access has been known for more than 20 years, and its essence is the following: on the terminal server, applications for several users are simultaneously executed.

From the client (terminal) only scan-codes of pressed keys or coordinates of the mouse cursor are accepted and the information intended for display is transmitted. At the same time, there are no special requirements for the client device.

Differences between virtualization and terminal access. When terminal access is created, separate user accounts are created that allow many employees to work simultaneously in a single operating system so that they do not interfere with each other. Client computers are installed special applications that allow users to work with individual sessions on the terminal server. It should be remembered that in the terminal mode, not every application can be started.

In addition, with terminal access, the isolation occurs at the session level, and if the application of one of the users causes a failure at the operating system level, then the rest of the users working on the same server will restart together with the user who caused the failure.

The technology of virtualization is much wider than terminal access and provides great opportunities. However, it is quite natural that virtualization requires large server capacities in comparison with terminal access. From the point of view of remote access, virtualization practically does not differ from terminal access. On the server, virtual machines with client operating systems are raised; on the client machine, a client program is installed, through which the user connects to the entire infrastructure.

Terminal server is easier and cheaper to deploy, however, it does not provide a high level of user isolation.

Virtualization will be useful if the user needs administrator rights to work, or an application that the user is unstable or uses undocumented features of the client operating system [13].

2.4.2 Work assignment

2.4.2.1 Installing Terminal Services

2.4.2.2 Check up the connection to a remote desktop

2.4.2.3 Review questions

2.4.3 Methodological instructions for the execution of the work

2.4.3.1 Installing Terminal Services

Start the server manager in the Start menu. Expand the "Roles" tab and click "Add roles" (Figure 2.26).
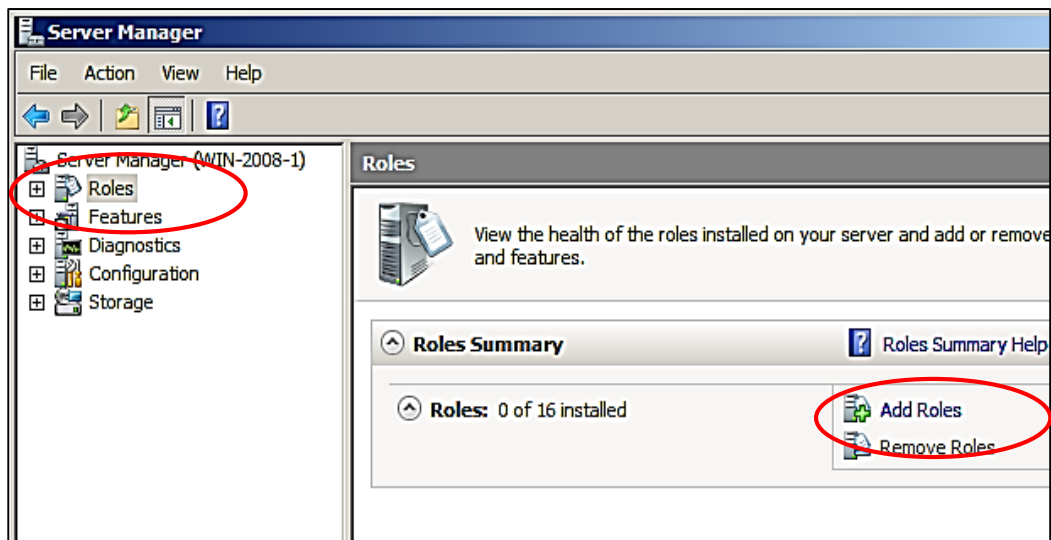

Figure 2.26 – Server manager window

The "Add Roles Wizard" will start. Click "Next", then select the role of "Terminal Services" in the list and click Next twice again (Figure 2.27).
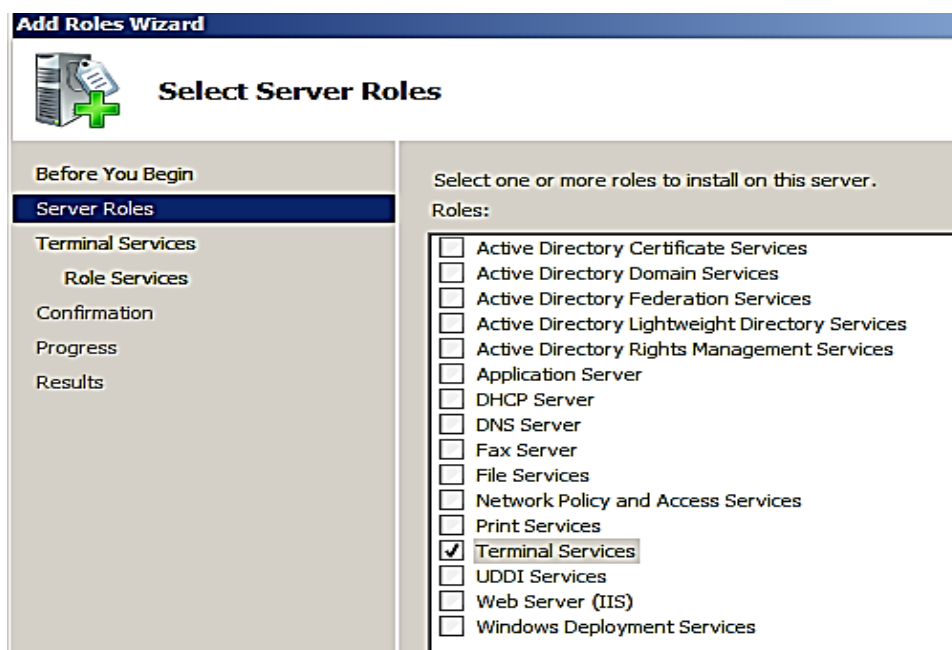
Figure 2.27 – Add Roles Wizard window

You can see the window for selecting role services. In it, select the "Terminal Server" and "TS Licensing" and again 2 times "Next".

The authentication method is set to "Do not require Network Level Authentication", so that you can connect from old clients. Then click "Next".

The next step is to select the Licensing Mode: "Per Device" or "Per User". To understand how these modes differ, consider a simple example.

Suppose you have 5 licenses. In the "Per Device" mode, you can create an unlimited number of users on the server that can connect through the remote desktop from only 5 computers on which these licenses are installed.

If you select the "Per user" mode, only 5 selected users will be able to log into the server, regardless of which device they are connected to.

Most of people do not have Terminal Access Licenses, so you can leave your option at **Configure Later**. This will give you unlimited access to the Remote Desktop Server for 4 Months (120 Days). These are acceptable conditions for us, so choose the mode configure later you best and click "Next".

At this point, you need to add users or a group of users who will have access to the terminal service. To do this, click "Add", "More", in the "Search" window that opens, select the user (you may add the user created in Laboratory work #3 – Student 2) and click "OK". In order for all users without exception to be able to connect to our terminal server, add the group "Everyone" (Figure 2.28). Then click "OK" and "Next".
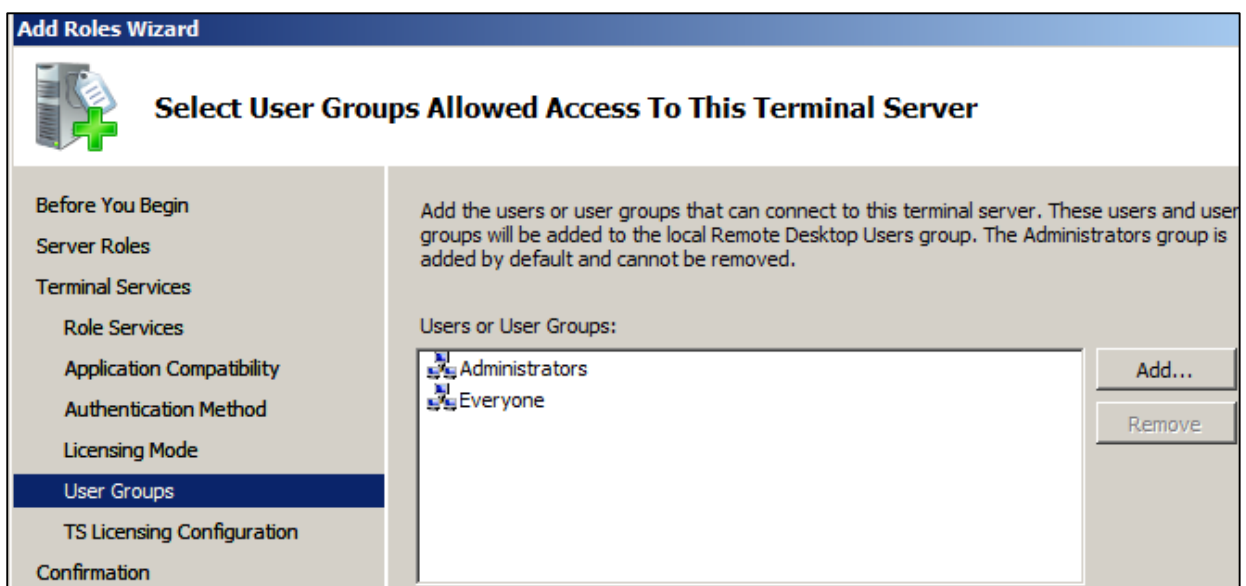
Figure 2.28 – Addition of users

Now you need to configure the discovery scope for Terminal Licensing. Select "This workgroup" and click "Next". Check all the settings and click "Install". After installation, a reboot is required.

If everything is done correctly, after rebooting, we will see a window with the message that the installation was successful, but with a warning that you need to configure the license settings on the Terminal server. Let us specify the license server manually. To do this, start the "Terminal Services Configuration" snap-in

("Start" - "Administration" - "Terminal Services"). There we see that the terminal license server is specified as automatic (Figure .2.29).
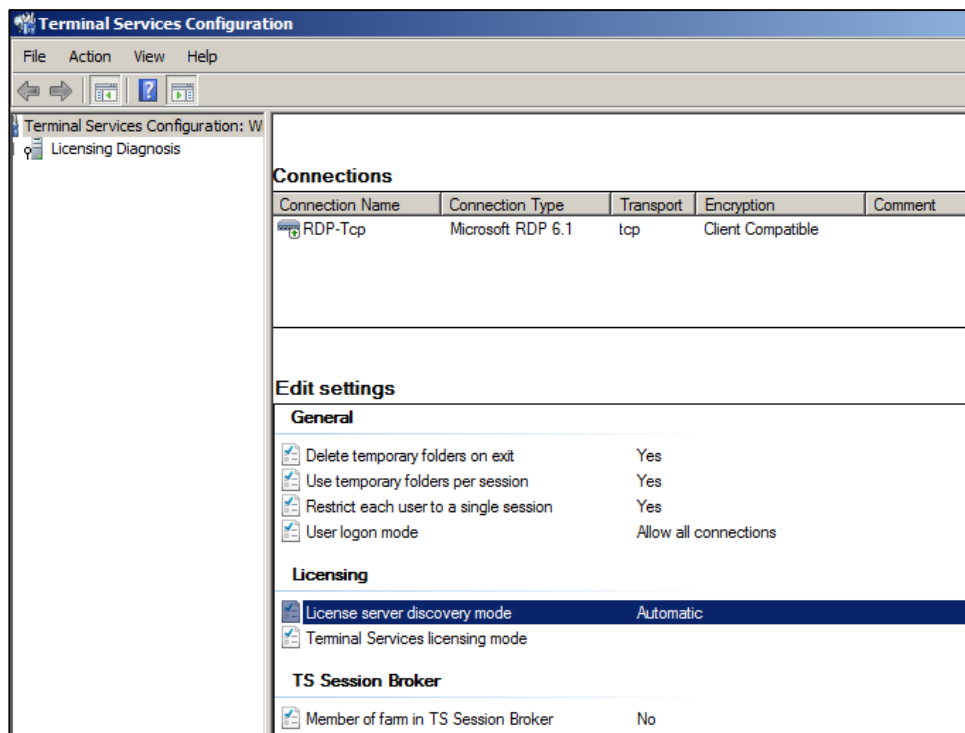
Figure 2.29 – Terminal Server Configuration

The terminal server installation is finished. You can connect to the server using the Windows client "Remote Desktop Connection".

2.4.3.2 Connecting to a remote desktop using the built-in Windows RDP client

To activate the client side of the connection, i.e. on the remote machine, go to Start, All Programs, Accessories and Remote Desktop Connection (Figure 2.30). Fill in the gap with IP-address of a computer you want to connect to.

Figure 2.30 – RDP Connection

2.4.4 Review questions

2.4.4.1 What is terminal access?

2.4.4.2 List the differences between virtualization and terminal access.

2.5 Server load intensity calculation

In order to calculate the server load intensity we need the following data (Table 2.1), obtained by statistical analysis for the month:

Table 2.1 – Average server access number at working hours

Call time	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Connection per hour	6	11	13	21	8	20	23	19	8	4

So, the total Asterisk server load is 133 calls/day.

To calculate load intensity we use formula (1):

$$A = \lambda \cdot T \tag{1}$$

T – random value, average service time duration of 1 call, measured in units.

λ – average frequency of arriving calls measured by the number of calls, call/h. It is the general characteristic of random call flow.

Load characteristics - average frequency of arriving calls λ, traffic A is usually appraise at peak hour - a time interval in the period of the greatest load of the communication system.

From Table 1, we calculate the average number of connections per hour – formula (2):

$$\lambda = \frac{N}{t_w} \tag{2}$$

where N – number of incoming connections at working hours,
t_w – call time.

$$\lambda = \frac{133}{10} = 13, \text{call/h}$$

The average duration of one call (T) is calculated by the formula (3):

$$T = t_{sr} + t_{est} + t_s + t_{off} \tag{3}$$

where t_{sr} = 0,1 s – the reaction time of the switching system, defined as the time interval from the moment the user sent the "busy" signal to the server until the "server response" signal was received;
- t_{est} = 2 s – average connection time;
- t_{off} = 3s – average time for user to disconnect;
- t_s – average connection time.

According to statistics, the average duration of the user's work is 3 hours. We get:

$$T = 0.1 + 2 + 8 + 214 = 233.6$$

We convert seconds into hours: 233.6 s = 0.065 hours. Now substitute the data into formula (1)

$$A = 13 \cdot 0.065 = 0.845 \text{ Erl}$$

The speed of information transfer depends largely on the speed of its creation, the methods of encoding and decoding. The highest possible transmission rate in a given channel is its bandwidth. The bandwidth of the channel, by definition, is the transmission rate of information when using the "best" source for the channel, the encoder and the decoder, so it characterizes only the channel.

Since the medium for transmitting remote work on the server is the Internet, or any other IP network, we need to calculate the channel speed necessary for high-quality data transmission. For calculation, we need to know: the characteristics of the connection used and the average number of calls to the server per hour. Let's calculate the required data transfer rate on the channel according to the formula (4):

(4)

$$C = \lambda \cdot R$$

where, R – speed of data transfer using RDP, kbps.

According to the regulations, the coding of useful information using the G.729 codec is 8 kbps, in fact, in addition to useful information, the service information is encoded, the codec's transmission speed is about 16-20 kbps [14].

$$C = 13 \cdot 19 = 247 \text{ kbps}$$

When carrying out the calculations, it was found out that a communication channel with a speed of 247 kbps is required to transmit the average number of access to the server per hour via the communication channel. This speed will be cut from the overall speed provided by the provider for the company. The allocated speed for the server channel will be 256 kbps [14].

The next step is to calculate the packet transport quality indicators - namely, the delay caused by the standing of the packet in the queue and the time spent on the transfer. Since different queues are used to service IP-telephony packages and other services, the calculation will be carried out separately, based on the typical packet size for each type of service. It is a detailed calculation of quality indicators below.

For data transmission, the actual packet size is determined by the calculated path - 1904 bits. The bandwidth of the channel is 1 Mb / s. Therefore, the time required to transmit 1 packet is determined as follows (formula 5):

(5)

$$T_s = \frac{b_{real}}{B_{chan}}$$

$$T_s = \frac{1904}{1} = 1.9 \text{ ms}$$

Since the calculated load of the subscriber group is A = 0.845 Erlang, and the packet transmission interval for each subscriber (sample time) t_s = 20 ms, the transmission rate of packets from the whole group will be calculated by the formula (6):

(6)

$$\lambda = \frac{A}{t_s}$$

$$\lambda = \frac{0.845}{20 \cdot 10^{-3}} = 42 \text{ packet/s}$$

Here we determine the utilization rate ρ - the traffic indicator of the communication channel, which affects the time of standing in the queue (Formula 7):

(7)

$$\rho = \lambda \cdot T_s$$

$$\rho = 42 \cdot 1.9 \cdot 10^{-3} = 0.08$$

After this according to considering the fact that all telephony packages have the same size, the following quality indicators are determined. The total number of packets r in the system (Formula 8):

(8)

$$r = \frac{\rho^2}{2 \cdot (1-\rho)} + \rho$$

$$r = \frac{0.08^2}{2 \cdot (1-0.08)} + 0.08 = 0.083$$

Packages in the service queue are (formula 9):

(9)

$$\omega = \frac{\rho^2}{2 \cdot (1-\rho)}$$

$$\omega = \frac{0.08^2}{2 \cdot (1-0.08)} = 0.0035$$

This figure can be useful when configuring queues on equipment - in hardware, you can specify the maximum size of the queue of packets. In this case, there is less than 1 packet in the system for maintenance, the value is rather

conditional; it indicates that the system is working with a large margin of performance. But with further optimization, this figure will be much more real.

Time of staying of packets in the queue T_w (formula 10):

$$T_w = \frac{\rho \cdot T_s}{2 \cdot (1-\rho)} \tag{10}$$

$$T_w = \frac{0.08 \cdot 1.9}{2 \cdot (1-0.08)} = 0.82 \text{ ms}$$

The total time that the packet was found in the T_r system, including the time of service and the time spent in the queue – formula (11):

$$\tag{11}$$

$$T_r = \frac{T_s \cdot (2-\rho)}{2 \cdot (1-\rho)}$$

$$T_r = \frac{1.9 \cdot (2-0.08)}{2 \cdot (1-0.08)} = 1.98 \text{ ms}$$

As we can see, this time is much less than the required quality score of 300 ms for RPD connections. Hence, it is possible to reduce the bandwidth of the communication channel, and thereby save costs.

The results of the calculation are given in Table 2.2.

Table 2.2 - Calculation of quality indicators

Type of indicator	RDP session
Average bandwidth for the service	64-256 kbps
Total group load	0,845 Erl
The average packet transmission rate	42,25 pack/s
Packet service time	1,9 ms
Utilization coefficient	0,08
Number of packets in a system	0,083
umber of packets in a queue	0,0035
Time of a package in the system	3,52 ms
Staying time in queue	0,28 ms

3 Life activity safety

3.1 Analysis of the working conditions of the students when working in the laboratory room with a PC.

The purpose of the diploma project is to develop virtual laboratory in the VirtualBox environment. The main task of laboratory works is the replacement of physical network equipment with virtual one. Virtual model will be extremely close to the real equipment. The laboratory class on Figure 3.1. will be considered in the

chapter "Life Safety". The cabinet parameters: room length L = 4 m, room width B = 3 m, room height H = 3 m.

Working conditions are conditioned by the technology of production, its organization and labor process, as well as the surrounding sanitary and hygienic situation. In particular, the technology of production organization includes the mechanization of technological processes, the introduction of semi-automatic and automatic methods of production, remote control of equipment, technological processes, etc.

According to GOST 12.1.005-88 OSSS (Occupational safety standards system), the data characterizing the category of work is given in Table 3.1. The work of people in this room belongs to the second category (Ib).

One of the main conditions under which the regulatory working conditions, is the correct lighting of the student's place. Places are illuminated so that you can work without straining your eyes, to be aware of the whole learning process. Creation of sharp shadows and areas of light in a room where laboratory works will be performing is unacceptable due to the presence of the effect of blinding. The audience for the labs is placed at the university, where classes are kept in the daytime, proceeding from this, the natural lighting. Natural lighting is formed by solar disk, as well as diffusion light of sky radiation.

Table 3.1- Characteristics of the categories of work

Categories of work	Energy costs, kcal/hour	Characteristics of work
Physical	138-172	Performed sitting, standing or tied to walking and accompanied by a physical stress
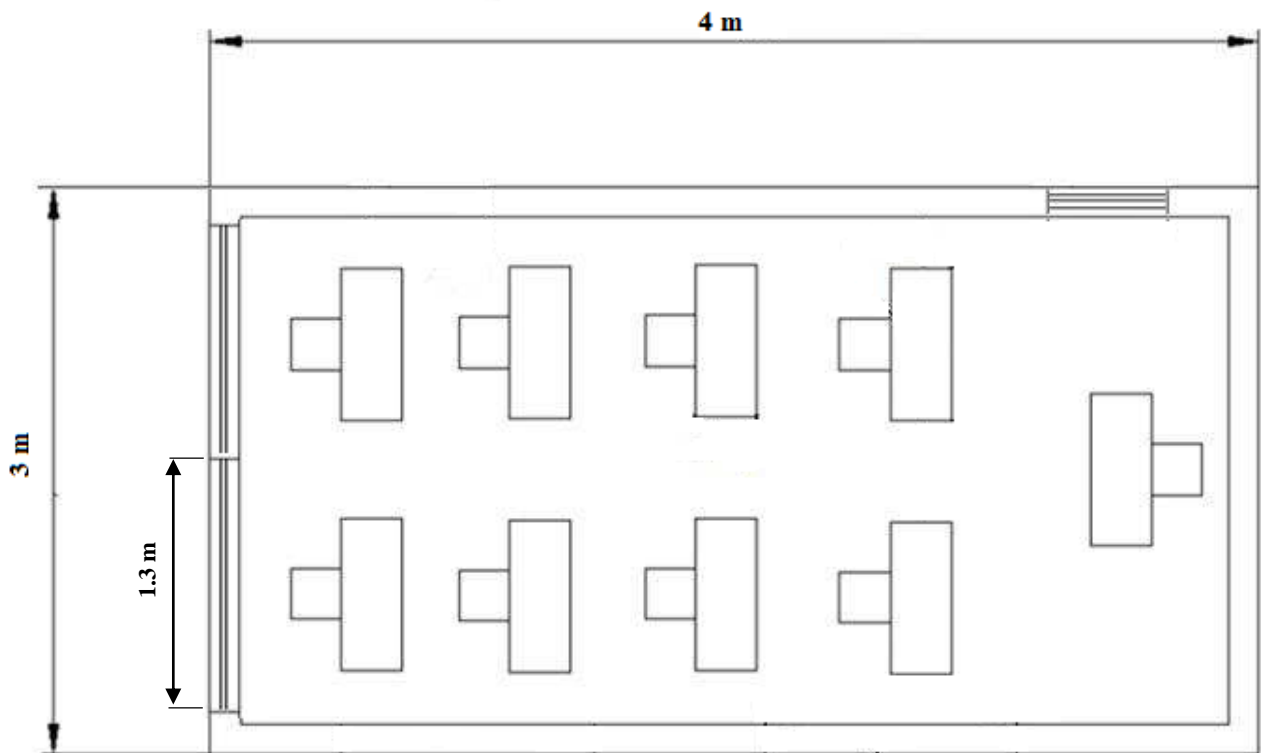
Figure 3.1 – Laboratory class

For correct operation fresh air is needed. For a person there are certain standards of the amount of cubic meters of air for normal working conditions. The temperature is kept due to the air conditioner. The heat loads in audience that comes from equipment, glass, heated solar rays and from people, exhaling air in the room are calculated.

3.2 Calculation of the ventilation and air exchange system [15]

Ventilation is the most important means of ensuring normal sanitary and hygienic conditions in production premises.

Ventilation systems should be made in accordance with the chapter of BR11-33-75 (Building Regulations) "Heating, ventilation and air conditioning".

Outside air is supplied to the production premises:

a) when the cubic capacity of the room is up to 20 m^2 per worker - not less than 30 m^3 per person;

b) at a room cubicle of 20 - 40 m^2 per worker working at least 20 m^3 per person.

By its purpose, ventilation is divided into general and local, and by the method of supplying fresh air into the room, it is natural and mechanical.

General exchange ventilation is arranged in those cases when harmful emissions are formed in the entire volume of the room. At the same time, the air exchange in the room is more or less evenly distributed. General exchange

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ventilation is characterized by the rate of air exchange (1/h), which shows how many times in an hour the whole air in the room will be renewed. Local ventilation provides ventilation directly to the workplace. It can be performed as a draft, in the form of local pumps, as well as in the supply air, in the form of air palls. The advantage of local ventilation (exhaust ventilation) is that the suction of minimum air volumes with a high content of harmful substances in it prevents air pollution of the entire room.

With natural ventilation, air movement occurs by the influence of natural factors (temperature or wind pressure).

Mechanical ventilation, carried out by the device of the air ducts and mechanical fans, ensures the maintenance of a constant air exchange regardless of external meteorological conditions. At the same time, the air coming in during winter time is heated, and in the summer it is cooled.

In addition, the incoming air can be moistened and drained, if necessary. Mechanical ventilation can be supply or exhaust, as well as supply and exhaust. For example, in the premises of charging battery stations, exhaust ventilation is required to remove air, saturated with vapors of acids, and also explosive mixture of hydrogen and oxygen. In industrial workshops and in areas with a high emission of harmful gases, vapors, dust and in hot shops where reliable air exchange is necessary, supply and exhaust ventilation is used.

However, in a number of cases it is permissible to use less accurate formulas with generalized coefficients that take into account several factors or only the most significant of them. The application of this method is justified by the fact that the actual performance of any calculated, designed and installed ventilation is checked both before its start-up and during operation. If deviations from the required indicators are detected, they are removed by changing the performance of the ventilator. The amount of air necessary to provide the required parameters of the air environment is determined by calculation. This takes into account the type of premises and production hazards, the rooms with heat dissipation-excess heat, rooms with heat and moisture release- heat and moisture; rooms with gas and dust emissions - the number of harmful gases (fumes), dust.

In the presence of heat, the amount of air that must be removed from the room is determined by the formula (3.1):

$$L_a = \frac{Q_u}{C_a \cdot t \cdot j_y} \qquad (3.1)$$

where C_a - heat capacity of dry air, kcal / kg, 0.24;
$t = t_{out} - t_{in}$;
t_{out} - the temperature of the air leaving the room, C °;
t_{in} - the temperature of the air entering the room, C °;
j_y - outgoing air volume, determined as a function of temperature, kg / m^3;
Q_u - heat in the room, kcal / h.

Firstly, we determine the heat released by the switching equipment of the station using the formula 3.3 :

$$Q_{eq} = 860 \cdot P_{eq} \cdot n, \qquad (3.3)$$

where P_{eq} power consumed by the equipment, 12 kW/h;
n - coefficient of heat transfer to the room, 0,95.
860 kW/h - thermal equivalent.

$$Q_{eq} = 860 \cdot 12 \cdot 0.95 = 9804 \text{ kcal/h}$$

Now we will determine the heat emitted by the lighting installations:

$$Q_l = 860 \cdot P_l \cdot a \cdot b \cdot \cos y \qquad (3.4)$$

where P_l - power of lighting installations, 1.28 kW / h;
a - the conversion factor of electrical energy into thermal energy, for equipment $a = 0.1 \div 0.2$;
b - coefficient of simultaneous operation of equipment in the room, if all equipment is operating, $b = 1$;
$\cos y = 0.7 \div 0.8$.

$$Q_l = 860 \cdot 1.28 \cdot 0.2 \cdot 1 \cdot 0.8 = 176.128 \text{ kcal/h}$$

Define the heat released by people:

$$Q_p = N \cdot (q\text{-}q_{per}), \qquad (3.5)$$

where N – number of workers;
$(q\text{-}q_{per})$ – obvious heat, kcal/h.
Q - heat release of one person in this category of work, kcal / h.

$$Q_p = 10 \cdot (125\text{-}50) = 750 \text{ kcal/h}$$

Let us determine the heat introduced by solar radiation:

$$Q_s = m \cdot F \cdot q_{gl} \cdot K, \qquad (3.6)$$

where m - the number of windows in the room;
F - the area of one window, m^2;
q_{gl} - solar radiation through a glazed surface, that is, the amount of heat introduced per hour through a glazed surface of 1 m2, kcal / h;
K - correction factor, for windows with double glazing $K = 0,6$.

$$Q_s = 4 \cdot 2.4 \cdot 0.6 \cdot 65 = 374.4 \text{ kcal/h}$$

Heat output in the natural way, for the warm period of the year in the calculations can be taken equal to zero, $Q_{ht} = 0$.

Then we get the total amount of excess heat:

$$Q_{ht} = Q_{eq} + Q_l + Q_p + Q_s, \qquad (3.7)$$

$$Q_{ht} = 9804 + 176.128 + 750 + 374.4 = 11\ 104.528 \text{ kcal/h}$$

$$Q_h = \frac{Q_u}{V_r}, \qquad (3.8)$$

where V_r – room volume, 36 m^3.

$$Q_h = \frac{11\ 104.528}{36} = 308.459 \text{ kcal/h}$$

Hence, the amount of air that must be removed from the room (the value of t in the calculations is chosen depending on the heat of the air: if the heat of air is Q_h <20 kcal / h, then we take t = 6 C^0):

$$L_a = \frac{11\ 104.528}{0.24 \cdot 6 \cdot 1.206} = 2394.7 \text{ m}^3/\text{h}$$

The typical value for ventilation system performance is 1000 – 10 000 m^3/h.

3.3 Spot load of the students when working with a PC in laboratory room

Since many of us use computers at work, computer eye strain became the main complaint related to work. Studies show that eye strain and other intrusive visual symptoms occur in 50-90% of computer workers. These problems can range from physical fatigue, reduction productivity and increasing the number of operational errors, up to insignificant irritants, such as eye twitches and red eyes.

In the process of working with a PC, the main load is in the eyesight, the reason for the loss of strength and concentration of the eyes during the work with the monitor, unlike other types of work. The monitor blinks due to the frequency horizontal deployment in conventional monitors, which does not exceed 60 Hz.

Reflection from walls and other surfaces, as well as from a computer screen can cause computer eye strain. You must install a monitor with anti-glare coating and, if possible, make walls with a matte finish finishing. Students who wear glasses should purchase lenses with anti-reflective coating (AR). AR coating reduces glare, minimizing the amount of light reflected from the front and back surfaces of glasses lenses. Natural light passes through the light barriers, which are directed to the north and north-east - indicator of natural light. The illumination is usually higher than 1.2%, in places with snow cover no less than 1.5%.

Elimination of external light, by closing curtains or blinds is a way out of the situation. You can also reduce the number of bulbs or fluorescent lamps, or you can use lamps and tubes of lower intensity. Location of the monitor or screen The

computer should be such that the windows are on the side, not the front. The level of illumination is provided taking into account the required contrast between the display and the environment around, as well as the properties of the work performed and user needs. Illuminance is calculated by the formula (3.9

$$E = \frac{F}{S},$$

(3.9)

where E - the surface flux density of light;
F - with a uniform distribution of the light flux, which is perpendicular to the illuminated area;
S - the illumination.
One of the important elements used in lighting the audience - natural light [16].

3.4 Calculation of natural lighting

Lighting is extremely important for human health. With the help of vision, a person receives the overwhelming majority of information (about 90%) coming from the outside world.

In terms of work safety, visual ability and visual comfort are extremely important. A lot of accidents occur, among other things, because of poor lighting or because of mistakes made to the worker, due to the difficulty of recognizing a particular object or understanding the degree of risk associated with servicing machine tools, vehicles, containers, etc. Light creates normal conditions for work.

When designing new premises, when reconstructing old ones, when designing the natural lighting of other objects, it is necessary to determine the area of the light apertures that provide the standardized value of NLC in accordance with the requirements of BR RK 2.04-05-2002 "Natural and artificial lighting. Norms of designing».

The height of the working surface above the floor level is $h_r = 0.7$ m. Light sources are gas-discharge lamps. The rated power is 40 W; the nominal luminous flux is 3120 lm.

The classroom has two windows, window parameters: width 1.3 m and height 1 m each. The windows are located on one side of the room, the depth is $l = B - 1 = 2$. Nearby is a nine-story building, located at a distance $P = 15$ m. Windows are plastic with retractable, external adjustable shutters.

The total area of the windows is determined by the formula (3.10) for lateral illumination:

(3.10)

$$S_0 = \frac{S_n \cdot e_n \cdot \eta_0 \cdot S_0 \cdot K \cdot K_B}{100 \cdot \tau_0 \cdot r_1},$$

where S_n – floor area, м²:

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$$S_n = B \cdot L = 3 \cdot 4 = 12 \text{ m}^2.$$

$_n$ − normalized value of NLC:

$$e_N = e_{NLC} \cdot m, \tag{3.11}$$

where e_{NLC} − value of NLC, for class of visual work IV, $e_{NLC} = 1.2$;
m − coefficient of light climate, for the orientation of light holes SE m=0,65

$$e_N = 1.2 * 0.65 = 0.78.$$

K_b − safety factor; $K_b = 1,3$;
τ_0 - common light transmittance - formula (3.12);
τ_1 - coefficient of light transmittance of the material; for double glass $\tau_1 = 0.8$;
τ_2 - coefficient that takes into account the loss of light in the light-coverings; $\tau_2 = 0.75$;
τ_3 - the coefficient that takes into account the loss of light in the bearing structures, with side illumination is 1;
τ_4 - coefficient that takes into account the loss of light in sunscreens, $\tau_4 = 1$;

$$\tag{3.12}$$
$$\tau_0 = \tau_1 \cdot \tau_2 \cdot \tau_3 \cdot \tau_4$$

$$\tau_0 = 0.8 * 0.75 * 1 * 1 = 0.6.$$

η_0 − light characteristics of windows.

To determine the coefficient η_0, it is necessary to know the ratio of length to depth (to the most remote point from the window). Since the windows are located only on one side, this ratio is equal to

$$\frac{L}{l} = \frac{4}{2} = 2.$$

It is necessary to know the ratio $\frac{B}{h_1}$, where h_1 − height from the level of the conventional working surface to the top of the window.

$$h_1 = h_w + h_{n.w} - h_r = 3 + 0.8 - 0.7 = 3.1 \text{ m},$$

where h_1 − height from the level of the conventional working surface to the top of the window.

For the relations found, we determine that the coefficient η_0 is equal to $\eta_0 = 9.5$.

To define coefficient r_1 it is necessary to find $\frac{l}{B}$, where l − distance of the calculated point from the outer wall at the side lighting. For this case, for the most distant point from the window, we can take $l = 3$, in which case this ratio is equal to

$$\frac{l}{B} = \frac{3}{5} = 0.6.$$

Taking factor $\rho_{av} = 0.5$, the ratio r_1 is equal to $r_1 = 2$.

r_1 – coefficient that takes into account the increase in NLC with side lighting due to light reflected from the surfaces of the room and the underlying layer adjacent to the building.

K_b – coefficient that takes into account the shading of windows by opposing buildings. To find it, conditionally take into account the interfloor overlapping is 30 m, and the attic is 2 m. Thus the height of the building is

$$H = 30 + 2 = 32m.$$

Determine the height of the location of the curtain of the opposing building above the windowsill of the window in question, if the working area is on the fourth floor. Then

$$H_c = 32 - 4 = 28m.$$

Coefficient K_B can be found from ratio $\frac{P}{H_c}$ which is equal to

$$\frac{P}{H_c} = \frac{15}{28} = 0.53.$$

From there, K_B is determined as $K_B = 1.7$.

We substitute all the values in the calculation formula:

$$S_0 = \frac{12 \cdot 0.78 \cdot 9.5 \cdot 1.2 \cdot 1.7}{100 \cdot 0.6 \cdot 2} = 1.51 \text{ m}^2.$$

Since there was one-way side lighting, the area of the light apertures on one side should be 1.51 m². The area of 1 window is 1.3 m² and there are two such windows. This means that the windows' size meet the standards [16].

3.5 Section Conclusion

In this section, negative factors which influence on the person at work for the personal computer and the question of illumination of workplace were considered. When calculating lighting, room parameters, throughput of window openings were taken into account. In the classroom windows correspond to the standards of BR, thus, when students work, there will be no difficulties. For correct lighting, the windows must be kept in the purity. The operability of a student is influenced by the classroom temperature that is why the calculations of conditioning were carried out. The required amount of air exchange L = 2394.5 m³ / h.

4 Economical part

4.1 Technical and economic justification for the realization of complex of laboratory works

The main purpose of the diploma project is creating of virtual laboratory works on the basis of software VM Oracle VirtualBox with terminal server. The great advantage is that this software is available free in the Internet.

Server virtualization allows you to reduce energy costs and maintenance of IT infrastructure, reduce capital costs, increase the resiliency of your servers and save space. The principle of server virtualization is that one hypervisor is installed on one physical server - a special hardware or software solution that allows you to install a group of virtual servers in a virtual environment, thus instead of several physical servers (each of which is loaded by 3-5% its capabilities), you use a single physical server on which several virtual servers are installed - savings per person.

Thus, to assess the technical and economic efficiency of the project, it is necessary: to calculate the capital costs; calculate the number of employees, the cost of services; income; effective capital investments and investments[17].

4.2 Calculation of investment costs [18]

Capital costs are calculated by the formula (4.1)

$$C = P + C_p + C_s + C_d, \tag{4.1}$$

where P – price of the equipment;
C_p – cost of workplaces for 1 year;
C_s – cost for installation of equipment (5% of the cost of equipment);
C_d – cost of the development period.

In the diploma project laboratory work is virtual, that is why the physical network equipment will not be used – the work will be performed in a virtual machine. This virtual machine replaces the required switches and client machines.

Table 4.1 – Name and value of physical equipment

Name of equipment	Quantity	Price, tenge	Cost, tenge
D-Link Switch DGS-3650	4	350 000	1 400 000
SFP module D-Link DEM-315GT	8	73 600	588 800
Total			1 988 800

The cost of equipment is provided by Ruba Technology, taking into account the exchange rate as of April 13, 2018 - 329 tenge per dollar. Based on the data in Table 4.1, it can be noted that higher costs are expected, which is the reason for the urgency of training on the virtual simulator, which fully pays for these costs. [19]

Costs of equipment would be 1 988 800 tenge, but creating virtual laboratory works we reduce costs to zero.

Table 4.2 – Calculation of costs for the organization of the workplace [20], [21]

Name of equipment	Quantity	Price, tenge	Cost, tenge
Laptop Acer Aspire A315-21 (NX.GNVER.001)	6	189 990	1 139 940
Computer desk	6	6 645	39 870
Chair	12	4 910	58 920
Total			1 238 730

Total costs for the organization of workplace are 1 238 730 tenge.

The cost of the development of laboratory work is calculated by the formula (4.2)

$$C_d = S_{dev} + D_{PC} + P_r + C_{el} + E_n,$$ (4.2)

where S_{dev} – payment to the developer;
D_{PC} – computer depreciation;
P_r – monthly rent price;
C_{el} – the amount for electricity during the project;
E_n –cost of missing equipment and additional materials.
Electricity costs are calculated by the following formula (4.3)

$$C_{el} = W \cdot T \cdot S,$$ (4.3)

where W – consumable power $W = 0.3$ kW;
T – working hours;
S – cost of 1 kW per hour of electricity $S = 22$ tenge/kW-h.
On average, in one month 22 six-hour working days, $T = 132$ h.

Calculation of electricity costs

$$C_{el} = 0.3 \cdot 132 \cdot 22 = 871 \text{ tenge.}$$

The power consumed for necessary needs is calculated as 5% of the power used by the main equipment. Cost of electricity for necessary needs

$$C_{el.n} = C_{el} \cdot 0.05 = 43 \text{ tenge.}$$

Total energy costs

$$C_{el.total} = C_{el} + C_{el.n} = 871 + 43 = 914 \text{ tenge.}$$

The cost of additional materials is 5% of the cost of the system

$$E_n = 189\ 990 \cdot 0.05 = 9499 \text{ tenge.}$$

Computer depreciation will be 40% of the price

$$D_{PC} = 189\ 990 \cdot 0.4 = 75\ 996 \text{ tenge.}$$

Calculate the cost of developing laboratory works according to formula (4.2)

$$C_d = 240\ 500+75\ 996+27\ 000+721+9499 = 353\ 716 \text{ tenge.}$$

Table 4.3 – Calculation of costs for the development

Name of expenses	Cost, tenge
Monthly salary for the developer	240 500
Computer depreciation at development time	75 996
Monthly rent of a premise in development	27 000
Energy costs during the development	871
Costs for additional materials and missing equipment at the time of development	9499
Total	353 716

Calculate the capital costs by the formula (4.1)

$$C = 0+1\ 238\ 730+61\ 936+375\ 230 = 1\ 675\ 896 \text{ tenge.}$$

Table 4.3 – Capital costs for the organization of the workplace

Name of expenses	Cost, tenge	Specific weight, %
Cost of equipment	0	0
Cost of workplaces	1 238 730	74
Installation of equipment	61 936	4
Development costs	375 230	22
Total	1 675 896	100

Figure 4.1 builds the structure of capital expenditures. You can clearly see that most of the costs covers the organization of workplaces.

4.3 Calculation of annual operating costs [18]

Operational costs are determined by the formula (4.4)

$$C_{op} = PF+T_s+D+C_{el}+M+C_{adm}, \tag{4.4}$$

where PF – payroll fund (basic and additional wages);
T_s – social tax;
D – depreciation deductions;
C_{el} – electric power from the production side;
M – costs for materials and spare parts;
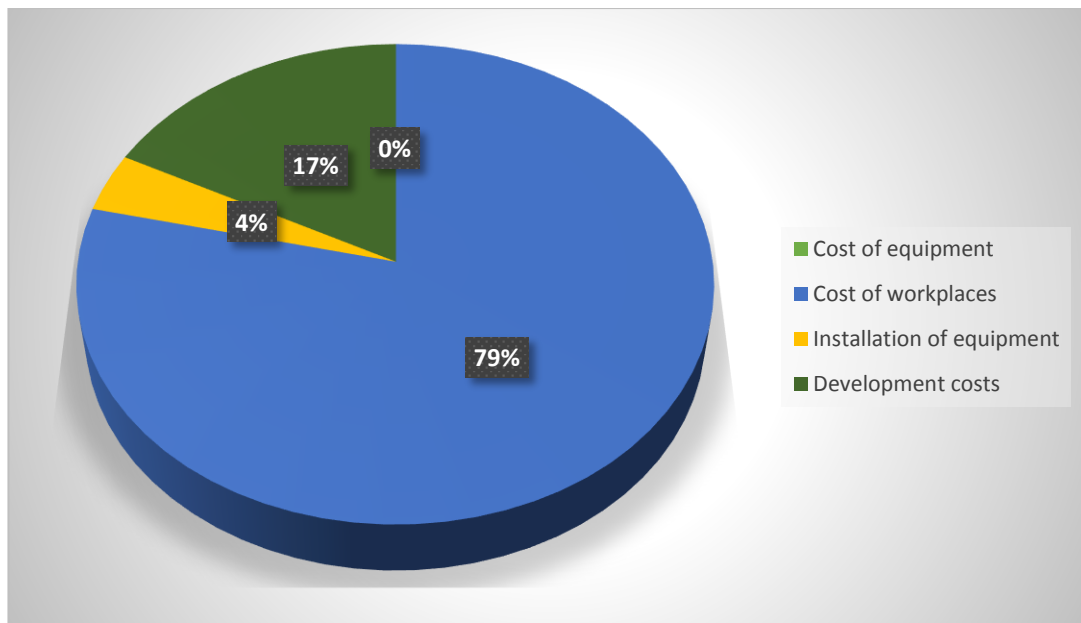C_{adm} – other administrative and operational expenses.

Figure 4.1 – Structure of capital costs

Table 4.4 - Average salary of staff per month

List of staff	Quantity	Monthly salary, tenge	Salary per year, tenge
Engineer	1	90 000	810 000
Scientific Supervisor	1	160 000	1 440 000
Total			2 250 000

Average salary of the working staff per month is given in Table 4.4 to determine the wage.

The wage fund also takes into account additional wages (payment for work on holidays, overtime, etc.) in the amount of 30% of the basic salary.

Laboratory works are designed for 1 month. The operator will maintain the equipment for 9 months, so the additional wage is calculated by the formula (4.5)

$$W_a = W_p \cdot 0.3, \qquad (4.5)$$

where W_p – annual basic salary fund.

Substituting these values into formula (4.5), we calculate the total sum of additional wages:

$$W_a = 2\ 250\ 000 \cdot 0.3 = 675\ 000 \text{ tenge.}$$

Payroll fund is equal to the amount of basic and additional wages:

$$PF = W_p + W_a, \qquad (4.6)$$

We calculate the wage fund according to the formula (4.6)

$$PF = 2\ 250\ 000 + 675\ 000 = 2\ 925\ 000 \text{ tenge.}$$

Deductions for social tax are from 9.5 %:

$$T_s = 0.095 \cdot (PF - 0.1 \cdot PF) = 250\ 087 \text{ tenge.}$$

The amount of depreciation is accounted according to the established norms, which are calculated as a percentage of the value of fixed assets (4.7)

$$D_0 = \frac{F \cdot N_D}{100\%}, \qquad (4.7)$$

where F – carrying value of fixed assets, tenge;
N_D – depreciation rate.
Calculate the depreciation of equipment and office furniture using the formula (4.7).
Depreciation of computer equipment is 40% of the price:

$$D_1 = 1\ 139\ 940 \cdot 0.4 = 455\ 976 \text{ tenge.}$$

Depreciation of office furniture is 15% of the price:

$$D_2 = 98\ 790 \cdot 0.15 = 14\ 818 \text{ tenge.}$$

$$D = D_1 + D_2 = 455\ 976 + 14\ 818 = 470\ 794 \text{ tenge.}$$

Cost of electric power is calculated by the formula (4.8)

$$C_{el} = W \cdot T \cdot S, \qquad (4.8)$$

where W – consumable power $W = 1.6$ kW;
T – hours of work for 1 year, $T = 2200$ hours per year;
S – cost of 1 kW per hour of electricity $S = 22$ tenge/kW-h.
Define the cost of electricity:

$$C_{el} = 1.6 \cdot 2200 \cdot 22 = 77\ 440 \text{ tenge.}$$

The power consumed for necessary needs, for example light, or occasionally the inclusion of an air conditioner is calculated as 5% of the power used by the main equipment. The cost of electricity for the necessary needs:

$$C_{el.n} = C_{el} \cdot 0.05 = 3\ 872 \text{ tenge.}$$

Total energy costs:

$$C_{el.total} = C_{el} + C_{el.n} = 77\ 440 + 3\ 872 = 81\ 312 \text{ tenge.}$$

The cost of additional materials and missing equipment is calculated as 5% of the cost of the system:

$$M = 1\ 238\ 730 \cdot 0.05 = 61\ 936 \text{ tenge.}$$

Expenses of additional costs is 10% of the operational costs:

$$C_{adm} = 3\ 752\ 307 \cdot 0.1 = 375\ 230 \text{ tenge.}$$

Consequently, the operating costs based on the formula (4.4) will be:

$$C_{op} = 2\ 925\ 000 + 250\ 087 + 470\ 794 + 77\ 440 + 61\ 936 + 375\ 230 = 4\ 160\ 487 \text{ tenge.}$$

The most part of the operating costs is occupied by the payroll fund. Important in these costs are depreciation charges. The smallest part of the operating costs is allocated to electricity because of the selection of energy-saving equipment.

Enter the data on operating costs in Table 4.5 and calculate the specific weight of each cost.

Table 4.5 – Operating costs

Operating cost Items	Cost, tenge	Specific weight, %
Payroll fund	2 925 000	69
Social tax	250 087	7
Depreciation deductions	470 794	12
Costs for materials and spare parts	77 440	2
Electricity costs	61 936	1
Other expenses	375 230	9
Total	4 160 487	100

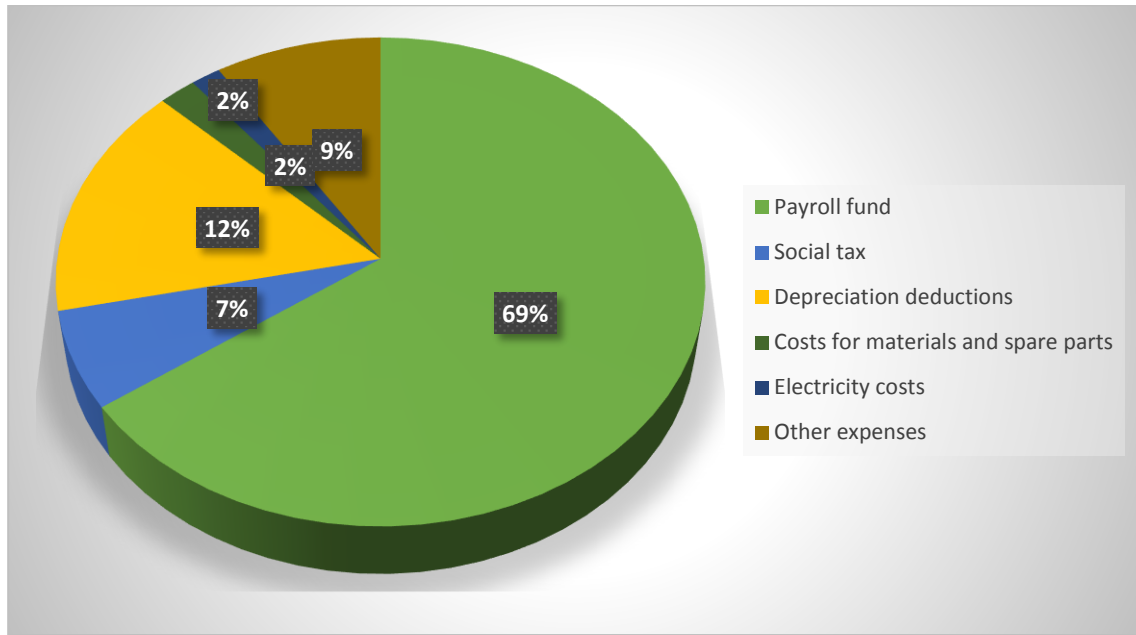Figure 4.2 represents the structure of operating costs.

Figure 4.2 – Structure diagram of operating costs

4.4 Calculation of income

It is calculated that the courses will be 2 groups of 8 people, given that in the academic year is 9 months, the cost of tuition is expected to be set at 30 000 tenge per person.

$$I = 30\ 000 \cdot 4 \cdot 8 \cdot 9 = 8\ 640\ 000 \text{ tenge.}$$

4.5 Calculation of economic efficiency

The profit from the introduction of these rates is the income from the core business, net of operating expenses. Net profit is determined by deducting income tax of 30% (for the Republic of Kazakhstan)

We calculate the profit of the enterprise before taxation.

Profit from the introduction of training courses is calculated by formula (4.9)

$$P = I - C_{op}, \tag{4.9}$$

where I – annual income;
C_{op} – operating costs.

$$P = 8\ 640\ 000 - 4\ 160\ 487 = 4\ 479\ 513 \text{ tenge.}$$

The net income remaining available is profit taking into account income tax.

The calculation of corporate tax will be 20% of the profit under the formula (4.10)

$$CT = P \cdot 20\%, \tag{4.10}$$

$$CT = 4\ 479\ 513 \cdot 0.2 = 895\ 903 \text{ tenge.}$$

The amount of net profit taking into account income tax according to the formula (4.11) will be

$$NP = P - CT, \tag{4.11}$$

$$NP = 4\ 479\ 513 - 895\ 903 = 3\ 583\ 610 \text{ tenge.}$$

Absolute economic efficiency will be calculated using formula (4.12)

$$\tag{4.12}$$
$$E = NP/C_{\Sigma},$$

$$E = 3\ 583\ 610\ /\ 1\ 675\ 896 = 2.14$$

The payback period is the reciprocal of the absolute economic efficiency and is given by formula (4.13)

$$\tag{4.13}$$
$$T = 1/E,$$

$$T = 1/2.48 = 0.47 \text{ year.}$$

Based on the received data, we get that the costs for this project will pay off in approximately 6 months.

All the economic indicators for the project are shown in Table 4.6

Table 4.6 – Indicators of economic efficiency of the project

Indicator	Value
Capital costs, tenge	1 675 896
Operating costs, tenge	4 160 487
Profit before taxation, tenge	4 479 513
Profit after taxation, tenge	3 583 610
Economic efficiency	2.48
Payback period, months	6 months

Taking into account all the data obtained, in the development of complex of laboratory works on data networking virtualization technologies at an educational institution with capital expenditures in the amount of 1 675 896 tenge, net annual income will amount to 3 583 610 tenge. This project pays off for 6 months. Consequently, it can be concluded that the introduction of such laboratory works is cost-effective.

Conclusion

In the diploma project, a complex consisting of four laboratory works was developed.

In laboratory works, the technologies of virtualization and terminal access were considered. Also, the operation of Remote Desktop Protocol was studied. The first laboratory work was about creation and configuration the virtual machine. It was organized in the basis of Oracle VM VirtualBox software. The second included the installation of OS Windows Server 2008 and MS Office on virtual machine. The third work was about creation of shared network folder, adding new network subscribers to a remote desktop. The fourth laboratory work was about configuration of a terminal server and connection of a user to a remote computer. Also, the server intense load has been calculated. The results are included in table 3.2. All the tasks were carried out and the purpose achieved.

The Life activity safety section includes the calculation of such a parameters, like natural lightening and air conditioning.

The economy section includes the calculations about economy efficiency of introduction of laboratory works. The payback period is about 6 months, it is a cost – effective project.

Abbreviated terms

1. OS – Operating System
2. MSAN – Multiservice Subscriber Access Networks
3. VM – Virtual machine
4. RDP – Remote Desktop Protocol
5. WAN – Wide Area Network
6. TS CAL – Terminal Server
7. CAL – Client Access Line
8. SD – Session Directory
9. TCP – Transmission Control Protocol
10. UDP – User Datagram Protocol
11. COM port – Communication port
12. RAM – Random Access Memory
13. VDI – VirtualBox Disk Image
14. VMDK – Virtual Machine Disk
15. VHD – Virtual Hard Disk
16. NAP – Network Access Protection
17. PKI – Public Key Infrastructure
18. OSSS – Occupational safety standards system
19. BR – Building Regulations
20. AR coating – Anti-Reflective coating

List of references

1 Тодд Мазерс. Часть III. Реализация служб терминалов и пакета Citrix Metaframe // Администрирование Windows Server 2003/2000 на терминальном сервере = Windows Server 2003/2000 Thin Client Solutions. — 3-е изд. — М.: «Вильямс», 2007. — С. 1072. — ISBN 1-57870-276-3.

2 IBM Global Education. Virtualization in Education. - White Paper, 2007. – 3 p.

3 Грейсон Митчем. Полное руководство по терминальным службам Windows Server 2008. – 23 p.

4 Charlie Russel, Craig Zacker with the Windows Server Team at Microsoft. Introducing Windows Server 2008 R2. – N.: Microsoft Press, 2010. – 95 p.

5 Christina Anderson, Kristin Griffin. Windows Server 2008 Terminal Services Resource Kit. – N.: Microsoft Press, 2008. – 15 p.

6 Microsoft TechNet library. // Technical article. // How terminal services works. URL: https://technet.microsoft.com/pt-pt/library/cc755399(v=ws.10).aspx Application date: 2.04.18

7 Running a Remote Desktop Connection session within another Remote Desktop Connection session is supported with Remote Desktop Protocol 8.0 for specific scenarios". Support.microsoft.com. 2012-11-02. Retrieved 2014-02-13.

8 Windows Server 2016. Книга рецептов. Глава 7. Службы удалённых рабочих мест. – 56 p.

9 Claudio Rodrigues. Terminal Services: from A to Z. – CEO, WTSLabs Inc. Microsoft MVP, 2009. – 48 p.

10 Oracle VM VirtualBox User Manual, version 5.1.22. – N.: Oracle Corporation, 2017. – 11 p.

11 Технический обзор Windows Server 2008. // Technical article. // URL : http://www.windowsfaq.ru/content/view/641/94/ . Application date: 15.04.18

12 Алла Рудь. Что такое ftp, ssh, sftp и для чего используется RDP. // Technical article. // URL: https://hyperhost.ua/info/chto-takoe-ftp-ssh-sftp-i-dlya-chego-ispolzuetsya-rdp/ . Application date: 20.04.18

13 Karma Group. Что выбрать: виртуализацию или терминальный сервер? // Technical article. // URL: https://www.karma-group.ru/article_virtualization_or_terminal_server/ . Application date: 20.04.18

14 Гольдштейн Б.С IP-телефония. – N.: БХВ-Петербург, 2006. – 87 p.

15 Баклашов Н.И., Китаева Н.Ж., Терехов Б.Д. Охрана труда на предприятиях связи и охрана окружающей среды: Учебник. – М.: Радио и связь, 2008. – 385 с

16 Хакимжанов Т.Е. Сборник задач по охране труда и безопасности жизнедеятельности: Учеб. пособие для вузов, Алматы: Эверо, 2007г. -88с

17 Т.М.Попова, Т.В.Ходанова. Дипломное проектирование. Методические указания к выполнению экономической части.- Алматы: АИЭС. 2000.-27 с.

18 Базылов К.Б., Алибаева С.А., Бабич А.А. Методические указания по

выполнению экономического раздела выпускной работы бакалавров. – Алматы: АИЭС, 2009. - 44 с

19 Организация оплаты труда работников предприятия в условиях либерализации цен и приватизации. – М.: НИИ труда. 1994. – 208 с.

20 Интернет – магазин техники. // technodom.kz: Сайт выбора ноутбука. 2017. URL: https://www.technodom.kz/catalog/notebooks/p/51280/ (дата обращения: 22.04.2018)

21 Интернет – магазин мебели. // zeta.kz: Сайт выбора стула. 2017. URL: http://zeta.kz/ru/product/1178-izo-n/ (дата обращения: 22.04.2017).

22 С.В. Коньшин, А.П. Кондратович. СТ НАО 56023-1910-04-2014. Общие требования к построению, изложению, оформлению и содержанию учебно-методических и учебных работ. Алматы: АУЭС, 2014

Appendix A

Terminal Services Command Reference (Windows Server 2008)

Command	Description
Change	Changes terminal server settings for logons, COM port mappings, and install mode.
Change logon	Enables or disables logons from client sessions on a terminal server, or displays current logon status.
Change port	Lists or changes the COM port mappings to be compatible with MS-DOS applications.
Change user	Changes the install mode for the terminal server.
Chglogon	Enables or disables logons from client sessions on a terminal server, or displays current logon status.
Chgport	Lists or changes the COM port mappings to be compatible with MS-DOS applications.
Chguser	Changes the install mode for the terminal server.
Flattemp	Enables or disables flat temporary folders.
Logoff	Logs off a user from a session on a terminal server and deletes the session from the server.
Msg	Sends a message to a user on a terminal server.
Mstsc	Creates connections to terminal servers or other remote computers.
Qappsrv	Displays a list of all terminal servers on the network.
Qprocess	Displays information about processes that are running on a terminal server.
Query	Displays information about processes, sessions, and terminal servers.

Appendix B

Terminal Services Command Reference (Windows Server 2008 R2)

Command	Description
Query	Displays information about processes, sessions, and terminal servers.
Query process	Displays information about processes that are running on a terminal server.
Query session	Displays information about sessions on a terminal server.
Query termserver	Displays a list of all terminal servers on the network.
Query user	Displays information about user sessions on a terminal server.
Quser	Displays information about user sessions on a terminal server.
Qwinsta	Displays information about sessions on a terminal server.
Rdpsign	Enables you to digitally sign a Remote Desktop Protocol (.rdp) file.
Reset session	Enables you to reset (delete) a session on a terminal server.
Rwinsta	Enables you to reset (delete) a session on a terminal server.
Shadow	Enables you to remotely control an active session of another user on a terminal server.
Tscon	Connects to another session on a terminal server.
Tsdiscon	Disconnects a session from a terminal server.