Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University

Faculty of Computer Information System and Software Engineering
(full name of faculty)
Department of Computer Science
(full name of department)

QUALIFYING PAPER

For the degree of

Bachelor
(degree name)

topic: Development of the computer network for the delivery agency Routes of the world

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		Sulaimon Ademola Babatunde
	(signature)	(surname and initials)
Supervisor		Zolotyi R. Z.
	(signature)	(surname and initials)
Standards verified by		Matsiuk O.V.
	(signature)	(surname and initials)
Head of Department		Bodnarchuk I.O.
	(signature)	(surname and initials)
Reviewer		
	(signature)	(surname and initials)

Ternopil
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(full name of department)

APPROVED BY
Head of Department

_____ Bodnarchuk I.O.
(signature) (surname and initials)

« » 20___

ASSIGNMENT

for QUALIFYING PAPER

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1. Paper topic Development of the computer network for the delivery agency Routes of the world

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2. Student's paper submission deadline 10.07.2023

3. Initial data for the paper Literature sources about architecture, principles of operation and development of Web-resource.

4. Paper contents (list of issues to be developed)

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Chapter	Advisor's surname, initials and position	Signature, date	
		assignment was given by	assignment was received by
Life safety, basics of labor protection			

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LN	Paper stages	Paper stages deadlines	Notes
1	Analysis of the task for qualifying work. Selection		*Completed*
	and work with literary sources.		
2	Writing chapter 1		*Completed*
3	Writing chapter 2		*Completed*
4	Writing chapter 3		*Completed*
5	Writing chapter 4		*Completed*
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7	Plagiarism check		*Completed*
8	Preliminary defense of qualifying paper		*Completed*
9	Defense of qualifying paper		

Student _____ Sulaimon Ademola Babatunde
(signature) (surname and initials)

Paper supervisor _____ Zolotyi R.Z.
(signature) (surname and initials)

ANNOTATION

Development of the computer network for the delivery agency Routes of the world // Diploma thesis Bachelor degree // Sulaimon Ademola Babatunde // Ternopil' Ivan Puluj National Technical University, Faculty of Computer Information System and Software Engineering, Department of Computer Science // Ternopil', 2023 // P. __, Fig. – __, Tables – __, Annexes – __, References – __.

Keywords: analyzer, application, corporate computer network, degenerated core.

A functional diagram of a local computer network was developed. Distribution was created for IP addresses for all network components.

The network complies with accepted international standards (ANSI/TIA/EIA-568-A and ISO/IEC11801).

A tree-like physical connections topology based on a 5e twisted pair category centered in the switching cabinet implemented has been. The project provides the necessary drawings and calculations, the specification of materials and equipment necessary for the construction of a local computing network.

A network in work does not contain two levels. Its core is a Mikrotik RB2011UIAS-2Hnd-IN router with the RouterOS Level5 operating system, which provided the specified requirements for reliability, routing, protection, and the creation of encrypted tunnels between remote units. The routers configuration has been developed.

A structural network diagram the and a plan for the location of its elements in the building have been developed in accordance with the requirements for the expansion of the network and the possibilities of its further improvement

LIST OF SYMBOLS, UNITS, ABBREVIATIONS AND TERMS

SKS - Structured cable system

SCRAP - Local computing network

LAN - Local area network

VLAN - Virtual Local Area Network

VPN - Virtual Private Network

NO - Network Element

RTT - Round trip time

SLA - Service Level Agreement

SNMP - Simple network management protocol

MIB - Management Information Base

RMONMIB - The Remote Network MONitoring (RMON) MIB

TDR - Time Domain Reflectometry

RFC - Request for Comments

NVP - Nominal Velocity of Propagation

CONTENTS

INTRODUCTION

Computers are an indispensable attribute of the office of any modern company. If there are several computers, they are almost always connected to a network local. What additional capabilities of the network local can be used to optimize the work process? An undoubted advantage is the economical component configuration and installation of the network local, which makes it possible to equipment share and devices peripheral. A network local in an enterprise allows employees to easily share files, which reduces the working cost time and, therefore, increases productivity staff.

When using software that requires the work of several users (1C, specialized accounting, legal and other programs), creating and configuring a network local is mandatory. This will allow several employees to use a server centralized for joint work at the time same. The possibility of access from home to located files on the work computer - corporate mail, work files, etc. This possibility will in the event only appear that the configuration and creation of a network local was carried out, allowing to access provide to the Internet for all office computers.

Communicative benefits. For larger offices (especially those located on several floors), the configuration and installation of a network local is vital. Chat and video chat (web cameras will need to be purchased for this) allow employees who are physically far away to effectively interact.

The hierarchical three-level structure of the network corporate ensures maximum performance, structure scalability and availability. Networks of many small businesses expand slightly over time. It is a two-level hierarchical structure, in which the distribution and core levels are into one combined.

Level is often the practical most. The core, as known, of network is called "degenerate" if distribution levels and kernel functions are implemented by a device

single. The main implementation incentive for project with a core degenerate is to cost reduce of network while preserving the advantages of hierarchical three-level model.

The aim of the diploma project is to develop a project of the enterprise's corporate network computer on the kernel degenerate model based. To fulfill the goal, we need to solve the following tasks:

- choose technologies for network building;

- to develop a network computer project based on the degenerate model nuclei;

- select network active equipment, workstations and servers and software relevant;

- to develop deployment plan and programmatically realize scenariosconfiguration of the router main core and switches access;

- design a laying cable scheme;

- perform calculations of the economic effect of the creation and network operation.

1 ANALYSIS OF THE DESIGN TASK

1.1 Basics of building corporate networks

A network computer can be considered a connection some amount computers using a telephone line or cable and a modem, which enables data exchange between them. Located computers in the same room or building and connected one to other are called a computer local network (LAN). Computers number connected to such a network, as rule, is limited by the capabilities, usually of the cable system and used network equipment. Several local networks computer, when combined, usually form a network campus (CAN), as example, networks local of buildings neighboring or same enterprise buildings or educational institution. MAN (Metropolitan Area Network) is already a city-scale network, with several campus or networks local of enterprises and organizations can be connected. Wide Network Area is a large network scale covering, several cities, regions or regions [13].

GAN (Global Network Area) - a global network computer - combination of several scale large networks computer, on country scale. And, finally, Internet are the all networks network, which includes the World Wide Web, e-mail system, and other storage information and transmission systems.

And finally, if you need to create a local computer network in your entrance, house or office, then we will need cards network, a cable of the necessary length, and also needed hubs, repeaters and switches, on length depending and branching of your network. A LAN is a system for communication that high-speed data exchange provided between several computers in limited area. In contrast, a global network can extend over hundreds and thousands of kilometers. computer networks of both types have many common in software, but differ in the used telecommunication channels and communication equipment.

1.2 Local networks building principles

Network building, it is to take a number of different factors, such as, connected computers number in network, the from each other distance, ensuring the confidentiality transmit of data over network. In order to choose the most structure suitable for network in each specific case, we will basic concepts consider used in the description of networks computer. Such concepts have [8]:

- components for network;
- network organization methods that determine the computer access possibility to transmitted data over network and stored on other computers in network;
- computers roles in network;
- network computer topology;
- network computer technology;
- cable type of system used to computers connect;
- routing and connection in network.

Components main of a network local are nodes, that connected to another by a cable connectings, which is as usually called a segment.

Nodes in network most often are contained computers, however mayother equipment should also be located, for example:

- network printer;
- hub;
- switchboard;
- bridge;
- router.

Let's consider ways of organizing a network computer. Depending on the role of each specific network connected computer, networks are three types divided [15]:

- combined;
- with dedicated server;
- peers.

Network peer-to-peer, have equal rights all computers, and each user makes their computer's resources available or unavailable for public use: files, printers, etc. In this network computer find each other by name or by a unique address, and this turns out to be enough for the normal network operation.

In a network with a dedicated server, the access rights of an individual computer to network resources and addressing, i.e. the assignment of a unique address to each specific computer included in the network, is regulated by the dedicated server. The server, with the help of special software, ensures that the addresses in the network are not repeated, and that the information sent from one computer reaches the addressee and is unavailable to other network users. Management of access rights and distribution of network addresses is called administration and is performed by specialists - network administrators [13].

Connected computer to a network local can be called differently, on the main functions depending that it performs:

- server (Server);
- workstation (Workstation).

The workstation uses only the network local available resources.

The server performs certain actions at the request of workstations, providing them with its resources, for example, disk space, processing power of the processor, printer, modem and other equipment.

In fact, if you dig deeper, all interactions on the network happen at the application level. It looks something like this: the server program receives a request over the network from the client program from the workstation, processes it and sends a response.

Most often, the name of the server includes the name of its main function:

- file server;
- seal server;
- mail server;
- news server;
- Web-Server;
- database server;
- fax server, etc.

Servers can also be classified by a feature that indicates the nature of its use:

- dedicated server;
- non-dedicated server.

A dedicated server in a network local is intended exclusively for providing its resources for public use, and not for direct work on it, so it can fully function without a monitor and keyboard. Of course, it has reliability and power increased of the hardware, as well as the used software. The system operating of a server dedicated is most often used [14]:

- Linux, FreeBSD;
- Server Windows 2008, 2012 from Microsoft.

A non-dedicated server combines the workstation functions and server functions. In other words, it is a workstation that has some resources allocated to be across network shared. On a non-dedicated server (workstation), the system operating can OS be:

- Linux;
- Windows XP, Vista, 7, 8, 10 from Microsoft.

Local networks peer-to-peer, in workgroups computers are united, where they function as workstations or dedicated servers, providing part resources of their for use

in workgroup. Networks peer-to-peer are administer easier, but do not provide information protection in high degree.

Networks local with a server dedicated, on the contrary, have increased security and reliability of information on the server stored.

The network type affects for access switches requirements and routers core in a network model two-tier.

If the topology of a network computer describes the geometric configuration of cable connections between computers, then technology network should be understood as a set of describing standards for process of transmission information, or in hardware features network implementation adapters and the information principles for transmission in them embedded. Network adapters are electronic designed devices to data transfer from one computer to another using computer network.

Two or more connect computers into a single network computer, systems of cable (SCS) based on copper shielded electrical wires (Cupper cable) are most often used. There are also fiber-optic cable systems, which, compared to electrical cables, have a higher throughput and low losses, but are more expensive. Therefore, optic fiber connections cable are used where it is necessary to transmit a large flow of information over a distance long at speed high, for example, between city districts or when creating a long-distance or international network. An alternative to a cable simple connection can be communication radio and based communication on infrared radiation. However, these types of communication did not become widespread.

Electrical cable systems use cables two types. Sshielded coaxial cable are first type with a wave resistance of 50 Ω, a twisted pair is a other [12].

A pair twisted is insulated two copper wires together twisted, but this type of connection in its form pure is not suitable for between two computers communication and is used only for special switching cabinets connections.

For communication between computers, cables containing several twisted pairs (3, 4, 1000 or more) are used in a common insulating sheath. Depending on the effective range of operating frequencies, twisted pairs are divided into several categories, according to table 1.1.

Table 1.1 – Categories of twisted pairs

Category	Class	Frequency range, MHz
1	AND	to 0.1
2	IN	to 1
3	WITH	until 16
4		to 20
5	D	up to 100
6	IS	up to 200
7	F	up to 600

Pair twisted can be unshielded and shielded. Pair twisted shielded has many varieties on the type of screen used depending. Pairs twisted shielded, to unshielded compared ones, have greater immunity, but are also more expensive. Most often, an cable unshielded of the fifth category with twisted pairs 4 is for the system cable ethernet used.

Network wireless technologies include a wide range of solutions, from global voice ranging and networks data that allow the user to establish wireless connections over significant distances, and ending with infrared and radio communication technologies used at short distances. Wireless networking technologies are used in portable and desktop computers, pocket computers, personal digital assistants (PDAs), cellular phones, pen computers, and pagers. Technologies wireless can be used for various purposes. Mobile users can use their cell phones to access e-mail. Travelers with computers laptop can Internet connect through stations base installed in airports,

at train stations and other public places. At home, you can connect devices to a desktop computer for data synchronization and file transfer [12].

Wireless technologies allow a variety of access to devices data world around, and reduce or completely eliminate the cost of laying expensive fiber optic or cable data channels, while providing all the capabilities of networks wired.

Network wireless adapters, which are internal and external, allow computers connect to you without the help of any other physical connections or cables. The data transmitted into small packets is divided and between the computer and the receiving transmitters broadcast are in the form of radio signals in a specially allocated frequency range.

1.3 Three-level network architecture and setting work tasks

When creating the modern integrated architecture of corporate networks, it is desirable to use the following general set of architectural and engineering principles:

- modularity;
- fault tolerance;
- hierarchy.

Hierarchical network design divides the network into smaller and more manageable networks. Each level of the hierarchy is focused on certain roles. This design approach offers network architects a high level of flexibility to optimize and select the right network hardware, software, and functions to fulfill specific roles for different network layers.¶

One of the most popular network architectures is the architecture developed by Cisco. The most popular Cisco architecture for a corporate network is the three-level architecture shown in Figure 1.1.¶

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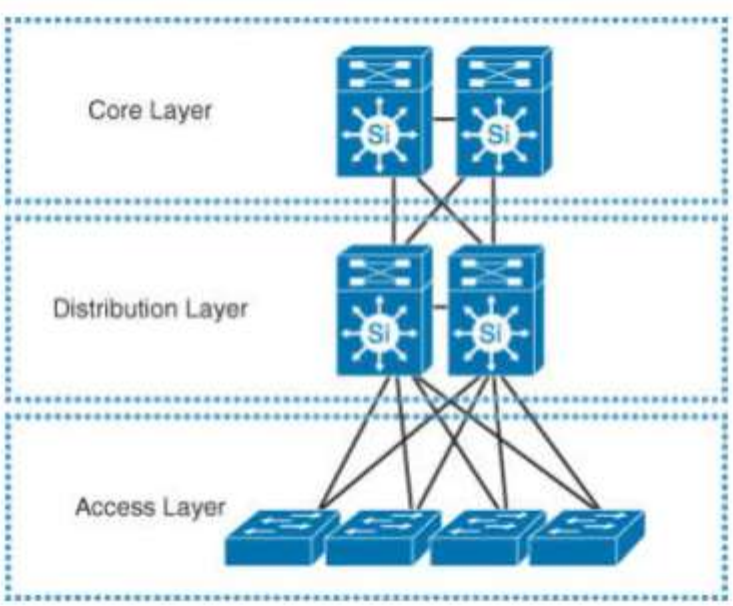

Figure 1.1 - Architecture Cisco for a corporate type networks

This scheme network fully meets the requirements of fault tolerance, hierarchy and modularity.

Layer access is tier first or boundary of the campus (town) type network. This is where, as we see, end devices (PCs, printers, cameras, etc.) wired part connected of the network campus. This is also the place where, sa rule, extend the network devices that to one level - wireless access points and IP phones. The layer access provides an intelligent separation between the infrastructure network and the devices computing that use this infrastructure. It security provides, QoS and policy trust boundary. It is the layer first of in network protection security architecture and point first of negotiation between end devices and infrastructure network. When campus overall looking at design, the switch access provides most of the layer access listed services and is a element key in many services campus providing.

The layer distribution acts as a boundary control and service between kernel and access. Several goals combines. It is point aggregation for al switches access and connectivity provides and services policy for flows traffic in the access distribution block. An element in network core that participates in the basic routing scheme. Aggregation providing, control policy, and points isolation between the unit distribution and network rest.

The core is a devices network complex (switches and routers) that provide redundancy channel and transmission data high-speed between segments different of the level distribution. Provides transport traffic between routing high-performance and sites. Because importance critical of this level, design core principles need provide an level appropriate of tolerance fault that enables smooth and fast network recovery after failure occurs.

This network scheme is mainly intended for large organizations and communication operators where uninterrupted service provision is the basis of the company's work.

The three-level hierarchical structure provides maximum performance, availability network and scale ability the structure network. However, the networks of many small businesses expand slightly over time. Therefore, a hierarchical two-level structure, in which distribution levels and core are combined one level into, is often the practical most. Core is called "degenerate" if the core functions and levels distribution are by the same device implemented. The incentive main for using a core degenerate design is cost network reduce while benefits retaining of model three-tier hierarchical. The model two-level is presented in Figure 1.2.

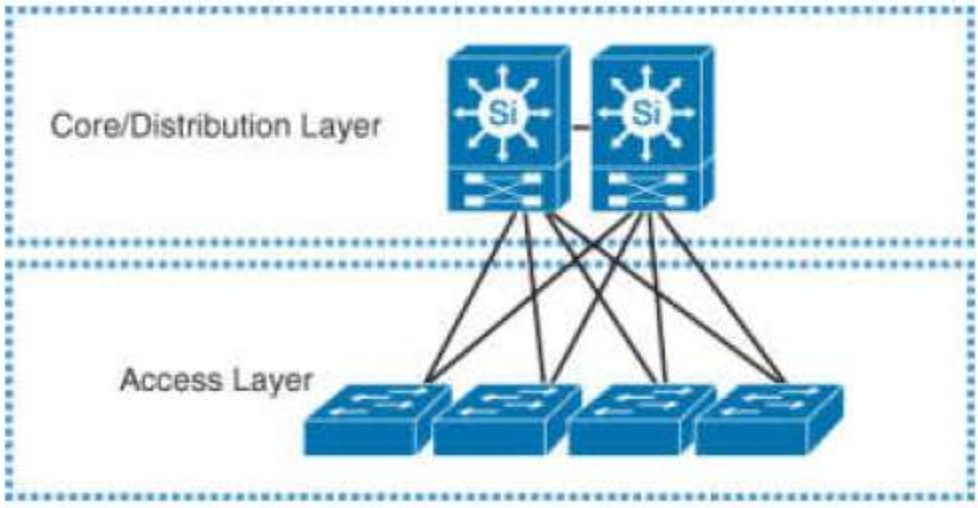

Figure 1.2 – Two-level network model

One of the factors main influencing the choice of tier three and tier two network architecture is network type (headquarters regional, office remote, , main or secondary campus), which determine helps network nature and future growth potential (from a perspective for network).

Size sometimes of increases network due to aggregation / distribution level and the interconnections number between them significantly increases (as a rule, it leads to complications arising on the control plane and data plane), as can be seen in Figure 1.3.

So not every project needs a separate kernel. The advantages of a network with a degenerate core include:

- lower cost of hardware devices due to the rejection of one level of architecture;
- hierarchical model providing;
- ease of setup;
- fewer connections.

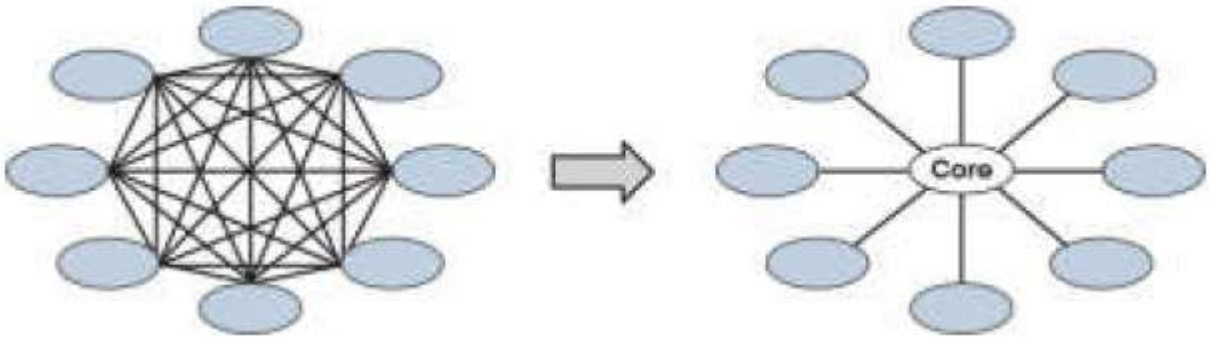

Figure 1.3 – Network core using

Disadvantages include reduced tolerance fault and redundancy. Actual result developments network always should answerbusiness plans and goals; it also can be derived from percentage growth annual projected of the business.

For example, if the business priority is to expand without the additional cost of purchasing additional network hardware platforms (capex reduction), then cost savings will be the design constraint and business priority, and the network designer in this type of scenario must find an alternative design solution such as collapsed architecture (two-tier model), although technically it may not be the optimal solution.

The architecture tier two of the degenerate places core demands heavy on the router central. This is device only that provide should:

- uninterrupted Internet access;
- NAT local network translation address,
- the network basic organization of protection against firewall attacks,
- routing between physical subnets or VLAN subnets,
- connecting employees to corporate resources via the Internet.

Concentrating a number large of inside functions one device is possible only when ensuring fault tolerance and high speed.

The aim of the bachelor's thesis is to develop a project of the enterprise's computer corporate network based on the degenerate kernel model. To achieve the goal, the following tasks must be solved:

- choose technologies for network building;
- to develop a computer network project based on the degenerate model nuclei;
- select active network equipment, servers and workstations and relevant software;
- develop a deployment plan and programmatically implement configuration scenarios for the core router main and switches access;
- cable design laying scheme;
- perform calculations of the economic effect of the operation and creation of network.

It is necessary to develop a rational, flexible structural scheme of the company's network, to for modes provide of rapid recovery of server information operational, and also to issue work out the of ensuring the necessary protection data level.

In the first chapter, theoretical aspects of LAN construction, technologies construction network, necessary equipment for construction their, principles basic of network area local construction, network computer methods organization, network technologies, connecting types of cables used in networks area local, as well as connection issues of routing and networks.

2 DESIGNING A NETWORK WITH A DEGENERATE CORE

2.1 Information flows and enterprise structure

Let's consider the organizational and staffing structure of the unit. The director of the enterprise is at the head of the organization. The division includes 4 departments, one of which is a specialized department directly subordinate to the chief. Each department has a different number of departments under its control. In each department, in turn, employees serve according to the staffing and accounting schedule.

Figure 2.1 illustrates all of the above.

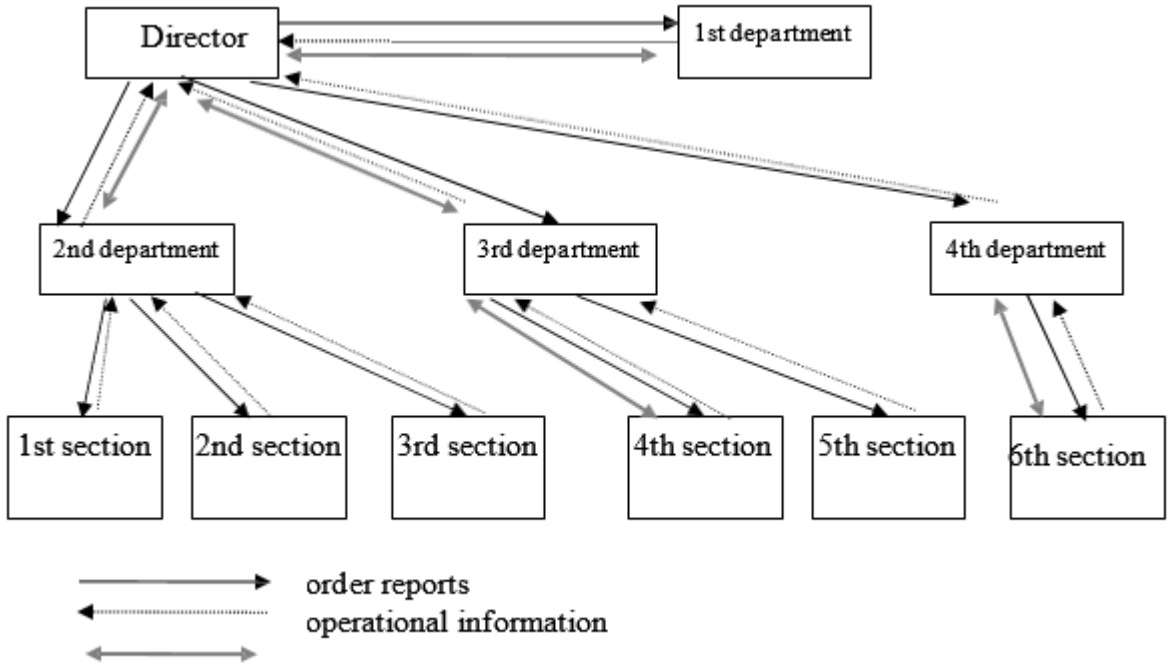

Figure 2.1 – Organizational of organization structure

A total of 23 people are involved in the unit, each of whom is expected to allocate a personal computer for use.

A network computer is several computers within a limited area (computers located in the same room, in one or several nearby houses) and connected to single lines connection Today, most networks computer are local computer networks, which are located inside one building office and are based on the server / client model computer. A connection network consists of two computers participating in communication and a path between them. It is possible to network create using technologies wireless, but it is not widespread yet [9].

In the client/server model, communication network is divided into two areas: the client side and the server side. By definition, a client requests information or services server from. The server, in turn, serves the client's requests. Often, each party in the client/server model can functions perform of both server and client. When creating a network computer, it is necessary to choose various components that determine which software and equipment you will be to use able when forming your corporate network. A network computer is an integral part of modern business infrastructure, and a corporate network is only one of its applications and, accordingly, should not be the only factor determining the choice of components network. The required components for the Intranet should become an addition to the existing network.

Each company formulates its own requirements for network configuration, determined by the nature of the tasks to be solved. First of all, it is determine necessary how many people will work in the network. In fact, all subsequent stages of network creation will depend on this solution.

The number of workstations directly depends on the expected number of employees. Another factor is the company's hierarchy. For a company with a horizontal structure, where all employees must have each access to other's data, the optimal solution is a simple peer-to-peer network [8].

A company built on the principle of a vertical structure, in which it is known exactly which employee and to which information he should have access, should focus

on a more expensive network option - with a dedicated server. Only in such a network there is a possibility of administration of access rights (Fig. 2.2).

In our case, there are 23 workstations at the enterprise, which need to be connected to a local network. Moreover, they are united in the following groups:

- director of the enterprise - 1 workstation;
- direct subordinate department - 2 workstations;
- secretary – 1 workstation;
- departments 1, 2 and 3 of the 2nd department with 3, 2 and 4 workstations, respectively;
- departments 4 and 5 of the 3rd department each have 3 and 4 workstations;
- department 6 of the 4th department - 3 workstations

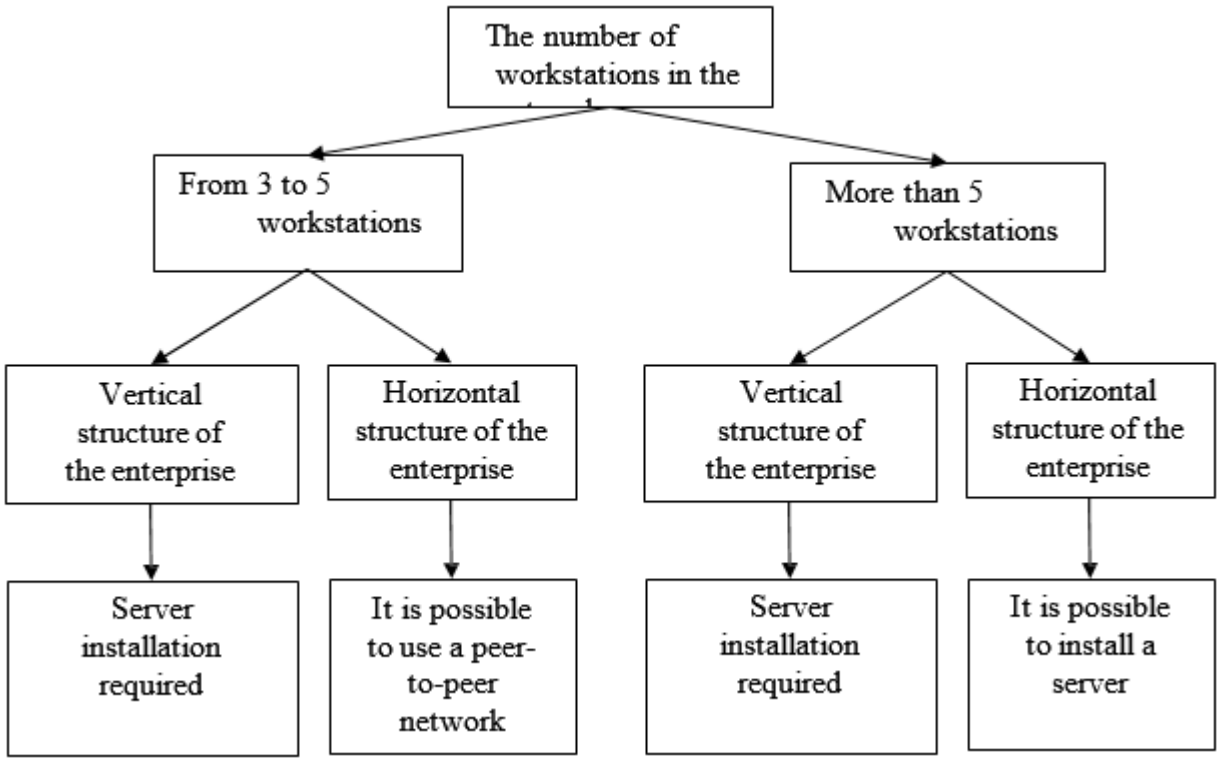

Figure 2.2 – Selection of type network

Based on the type network selection scheme, that in this case it can be decided the server is required installation , because we have a vertical structure enterprise, that is, delimited access to information.

2.2 Enterprise topology network design

The main one stages of planning is the creation of a preliminary scheme. At the same time, type network depending, the question of length limiting of the segment cable arises. This may not be essential for office small dimensions, but if network covers many floors in building, the problem appears in a completely different light. In this case, it is necessary additional repeaters install or switches.

Thi situation with our organization, the network entire was located on the same floor, and the network segments distance is not so great that the use of repeaters is necessary.

The layout of the room affects the choice of topology network much more strongly than it might seem at first glance (Figure 2.3).

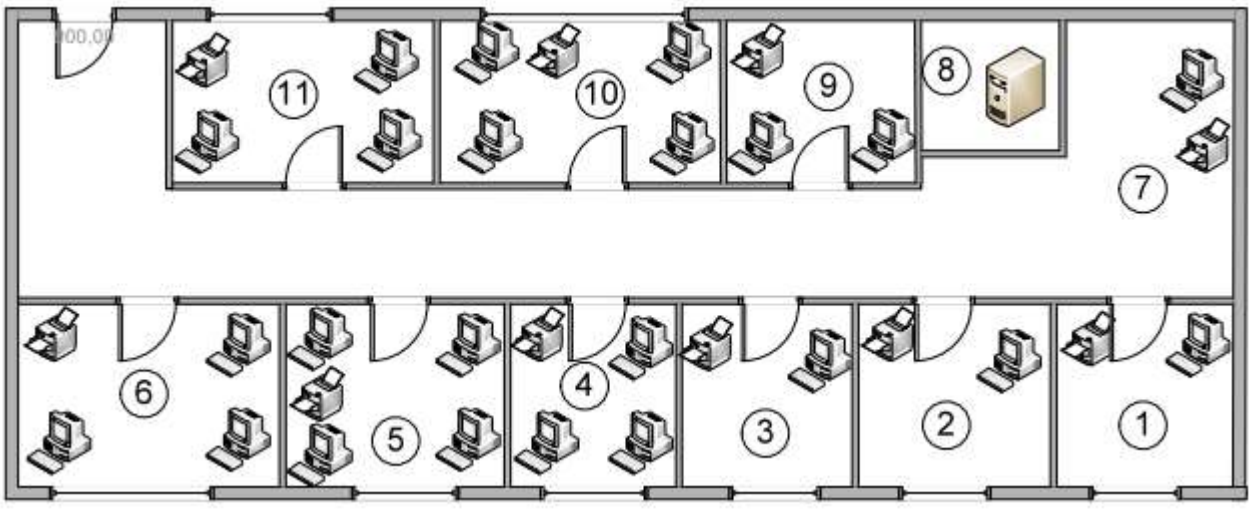

Figure 2.3 – Floor plan

The following are marked in the figure: 1 – office of the director of the enterprise, 2,3 – department of direct reporting, 4 – department 6 of the 4th department, 5,6 departments 4 and 5 of the 3rd department, 7 – secretaries, 8 – room of the system administrator, 9 ,10,11 - departments 1,2 and 3 of the 2nd department. After location determining of installation server, you can immediately determine how much cable will be needed.

In contrast to the installation of a peer-to-peer network, when LAN building with server, another question arises - where best place is to server install. Several influence factors the choice of location:

- due to the high level noise, it is advisable to install the server separately from other workstations;
- it is necessary constant access provide to the server for maintenance;
- for reasons of information access, security server should be restricted.

Thus, the only possible place for server installing was chosen, which does not reconstruction require of internal premises. It was decided to server install in room 8, because only this room meets the requirements, that is, the level noise in the cash register room is minimal, room 8 is isolated from others, therefore, server access will be limited (Figure 2.3). It is more convenient to maintain the server, because when installing the server in the office of the director or deputy. the director of service will be hindered in connection with their performance of their official duties, and in the office of the personnel department, server access to third parties is not greatly hindered. Placing the server in other offices does not meet any conditions.

Architecture network is a combination of topology, access method, standards necessary to create a workable network.

The topology choice is determined, in particular, by the layout of the premises in which the deployed network was. In addition, the cost of purchasing and installing

equipment network is of great importance, which is an important issue for the company, and the price range here is also quite large.

The "star" topology type is a more productive structure, each computer, server including, is connected by a separate segment cable to a central switch or hub.

The main advantage of such a network is its resistance to failures caused by problems on individual PCs or by damage to the network cable.

Figure 2.4 shows network organization's topology.

The using technology of cable twisted pair (100Base-TX) is the most popular. Such a cable does not cause difficulties when laying.

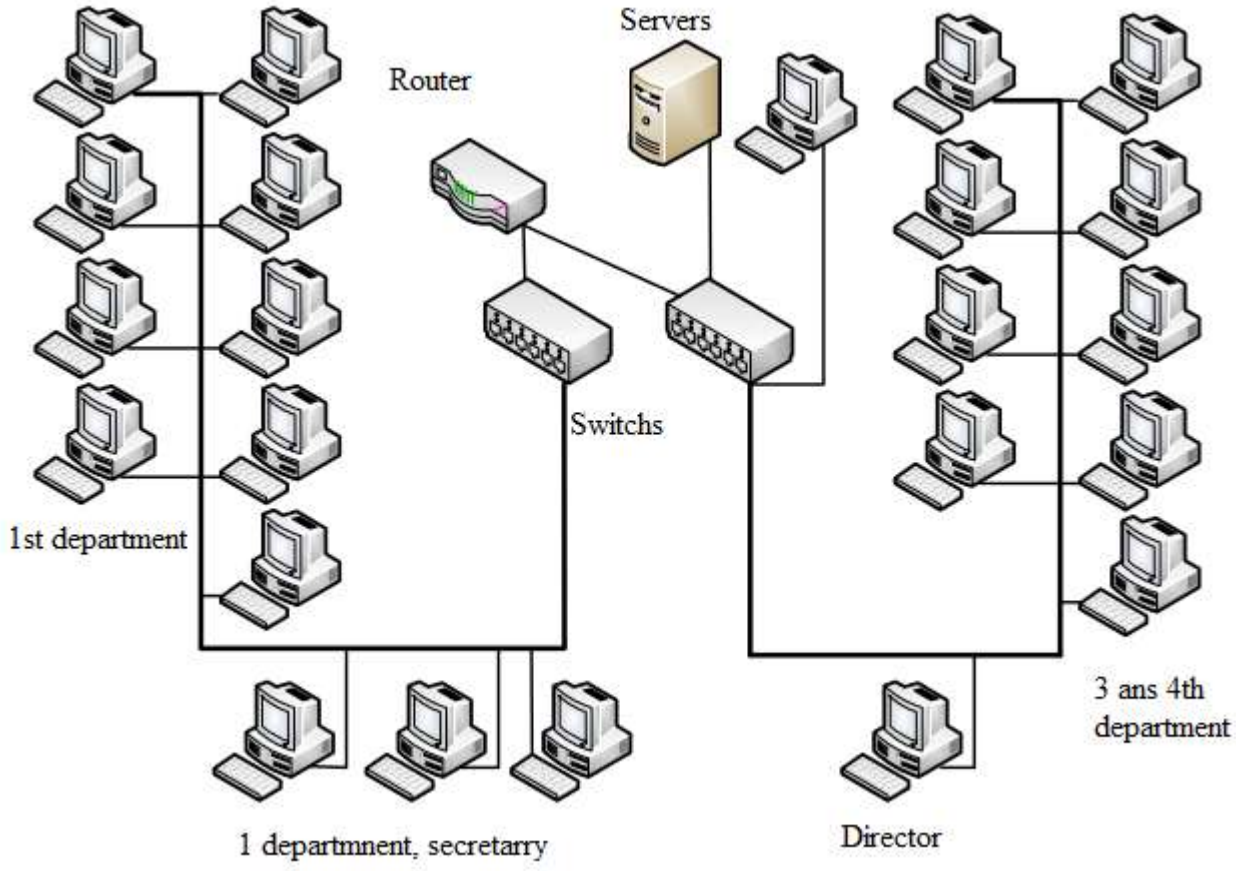

Figure 2.4 – Topology of the organization's network

The next important aspect of network planning is the sharing of resources network (printers, faxes, modems).

The listed resources can be used both in networks peer-to-peer and in networks with a dedicated server. However, in the case of a network peer-to-peer, its comings short are apparent immediately. To work with components listed, they must be workstation installed or devices peripheral must be connected to it. When station is disabled, all components and services related become unavailable for collective use.

In server networks, such a computer exists by definition. A server network never shuts down, except for short maintenance shutdowns. Thus, round-the-clock access is ensured workstations to the network periphery.

The enterprise has ten printers: each in a separate room. The administration went to great lengths to create the most comfortable working conditions for the team.

Now the issue of connecting network printer. There are several ways to do this.

1. The connected printer is to workstation that is closest to it, as a result this workstation becomes a print server. The such a connection disadvantage is that when performing printing tasks, the productivity of the workstation decreases for some time, which will negatively affect the operation of application programs during intensive use of the printer. Also, if the machine is shut down, the seal server will become unavailable to other nodes.

2. Direct server connection. In this case, it is permanently available to all workstations. The disadvantage of this solution is due to the limitation in printer cable length.

3. Connecting through network a special network interface. The printer is equipped with a interface network and is network connected as a workstation through a switch (hub).

4. Dedicated connecting to a print server. An alternative to the third option is the use of specialized print servers. Such a server is a network interface, arranged in a separate case, with one or connectors more (ports) for connecting printers. However, using a print server is impractical in this case.

In our case, due to the unprofitability of installing a special network printer, the most way suitable to connect a printer network is the 1st connection to a workstation. This decision was also influenced by the fact that the printers are located near those workstations that need most printer.

Let's consider the connecting networks principles and routing. To understand exactly how data is exchanged between networks, consider the example of two networks local A and B each other connected at one point a connection node called (Figure 2.5). A node network may have a computer or device special a with two cards that performs one of the following functions [14]:

- a router, sometimes also called a gateway;
- switch (switch).

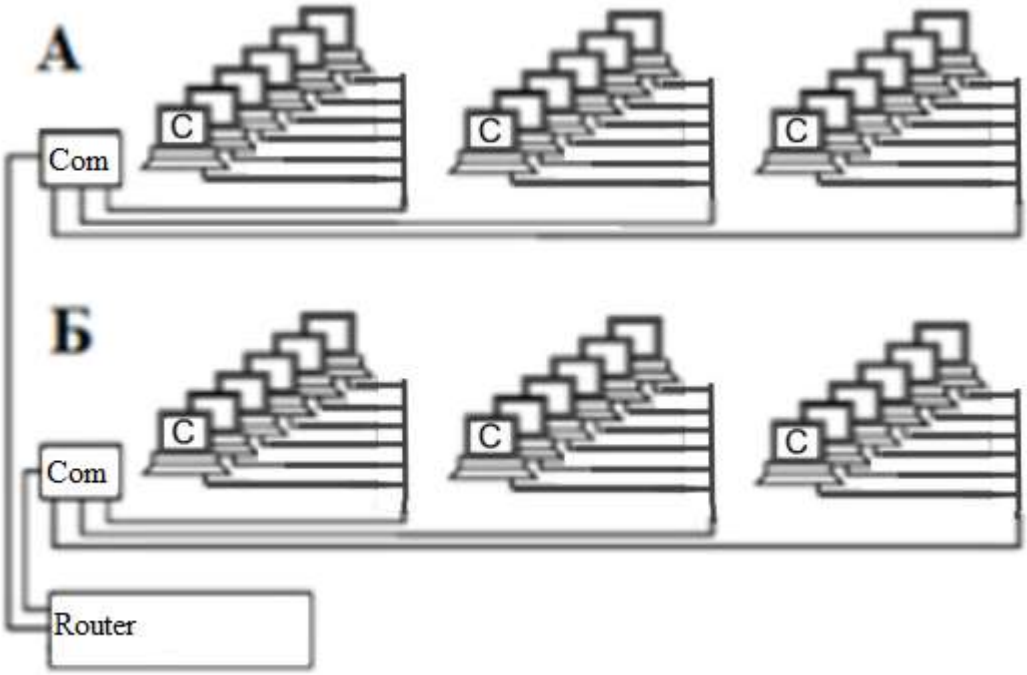

Figure 2.6 – Joining of two subnets

The choice of one or another device located at the node depends on the degree of network integration.

A router (internet gateway) performs similar functions to a bridge, but, unlike it, has its own address network in each subnet and can networks connect with different

technologies using, for example, Token Ring and Ethernet. The connects router not the segments cable of one network local, but already different networks, which may even differ in technologies terms used, for example, based on cable coaxial and pair twisted. The number of local networks interconnected by routers can be very large. The Internet is just such an association.

A two network cards computer, each connected to its own cable segment, can be as a router used. This approach is by enterprises used to get intelligent traffic filtering functions without buying expensive D-Link or Miktoik routers.

Direct delivery of data packets within the same network occurs regardless of its topology: bus common, star or ring. The technology network used does not play a role either.

And what will happen if computer 1 from network A wants to send a data packet addressed to computer #5, which is in network B? Computer #1 in the process of sending will determine that the address of the recipient of the packet is not included in the network range address A, and forward it to the intermediate delivery point - gateway A, which is a router component functional. The received the data packet router will look at its table routing and determine that the packet should be sent through gateway B. When the packet data through gateway B enters the network appropriate, it will be safely by the computer received.

2.3 Development of a network logical model

The Packet Tracer Cisco program is great for networks modeling of varying complexity. It is a multifunctional program network simulation that allows you to with network experiment behavior and evaluate possible scenarios. As an part integral of the network academy's comprehensive learning environment, Tracer Packet provides

authoring, visualization, simulation, attestation, and functions collaboration, and teaching facilitates and principles of complex technology learning.

The network being developed must contain a degenerate core layer represented by a router. It, in turn, combines access level switches, as well as a WEB server and a DNS server.

Level switches access already unite end users into workgroups, access providing to shared printers, resources. The general simulated network is shown in Figure 2.7.

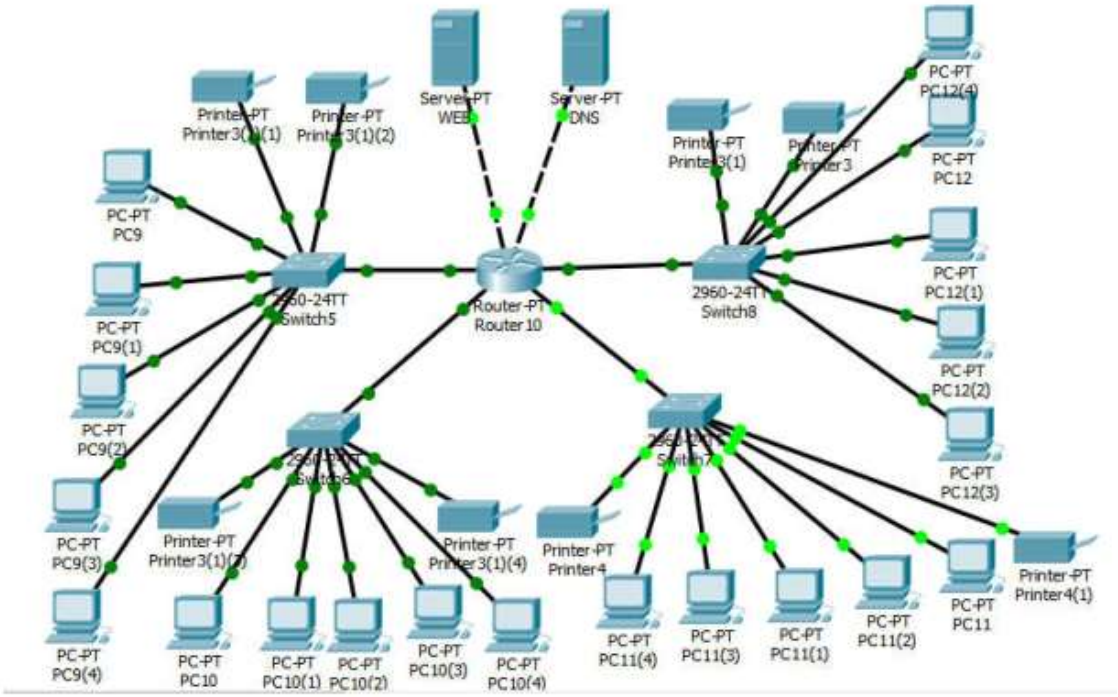

Figure 2.7 – A simulated network with a degenerate core

Cisco Packet Tracer has also the ability to simulate the passage of a message between nodes, while viewing how its content changes, what transmission used protocols are. The stages of a message passing through the network are shown in Figure 2.8.

The functionality of the program makes it possible to configure network devices using the graphical interface (Figure 2.9) or the line command.

It is with the help of the line command that it is to fully realize possible

capabilities of the program for configuring network equipment, and how it happens in reality. VLAN, DNS, DHCP settings are included, sites are raised. It is also possible to download the settings and upload them to the appropriate Cisco equipment.

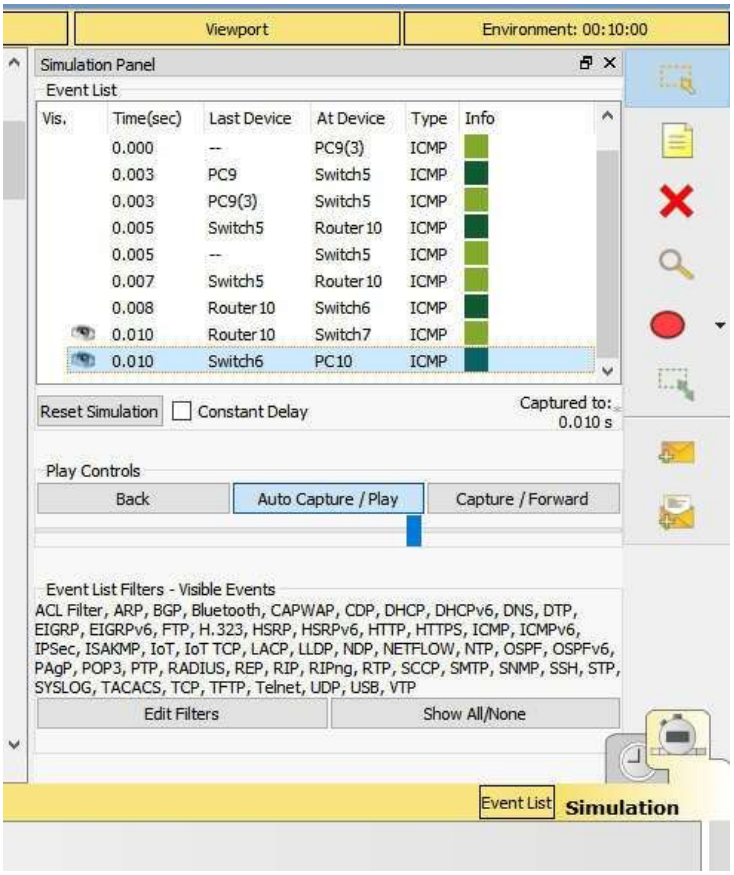

Figure 2.8 – Passage of packets

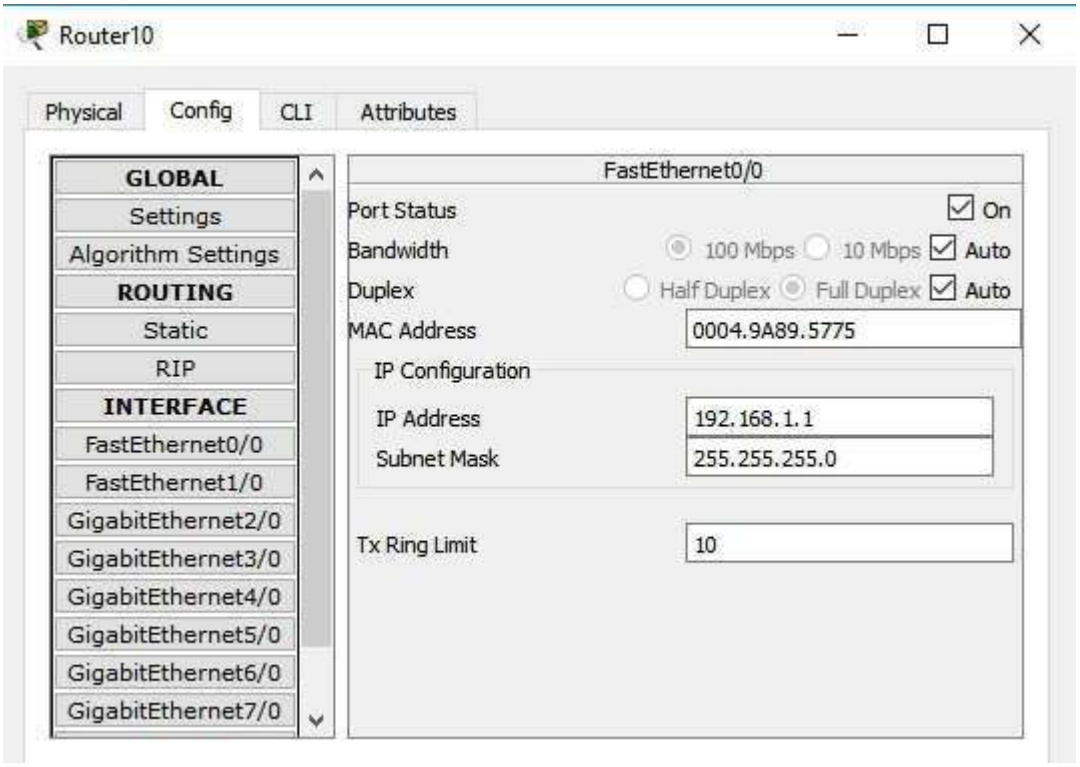

Figure 2.9 - Graphical interface of the router

Therefore, the modeled network corporate with a degenerate core meets the set tasks for functioning, satisfies modern methods of networks building, and can be put into practice.

3 COMPUTER NETWORK DEVELOPMENT

3.1 Calculations of the cable amount of and cable channel

When calculating the length of a horizontal cable, the following obvious provisions are taken into account. Each telecommunication socket is connected to the equipment switching in the cross floor by cable one. In accordance with the ISO/IEC 11801 standard, the cables length of the subsystem horizontal should not exceed 90 m. Cables are laid in cable ducts. The descents, ascents and turns of these channels are taken into account also.

There are two methods of calculating the amount of cable for the horizontal subsystem:

– method summarization;

– empirical method.

The summation method consists in calculating the length of the route of each horizontal cable and then adding these lengths. A technological margin of up to 10% is added to the obtained result, as well as a margin for processing in sockets and on cross panels. The considered advantage method is high accuracy. However, in the absence of automation design and tools of a SCS with a number larger of ports, this approach turns out to be excessively time-consuming, which practically excludes, in particular, the calculation of several options for the cable system organization. It can be recommended for use only if the developer has specialized automatic design programs (for example, the Caddy package), when performing routine accounting operations of all descents, turns, etc., as well as the calculation of the total length of each slip is transferred to the means of computer technology. Calculations of the number of cables using the summation method are given in Table 3.1.

In the work, it was decided to also use the empirical method, because it implements in practice the provisions of the well-known central limit theorem of probability theory and, as development experience shows, it gives good results for cable systems with more than 30 workstations. Its essence is to apply a generalized empirical formula to calculate the total length of the horizontal cable spent on the implementation of a specific cable system.

Table 3.1 - Cable length calculations using the summation method

room no	Number of computers	computer number	Cable length (m)
1	1	1	30
2	1	2	35
3	1	3	40
4	3	4	50
		5	45
		6	45
5	4	7	60
		8	60
		9	55
		10	55
6	3	11	70
		12	65
		13	65
7	1	23	10
9	2	21	10
		22	15
10	4	17	20
		18	20
		19	25
		20	25
11	3	14	30
		15	30
		16	35
	23		895
With 10% reserve			985

Based on the assumptions made, the average length Lav of the cable routes is assumed to be equal to:

$$L_{av} = \frac{(L_{\max} + L_{\min})}{2} * K_S + X \,. \tag{3.1}$$

The parameters Lmin and Lmax are the cable route length from the point of entry of the cable channels into the crossover to the telecommunication outlet of the nearest and farthest workplace, respectively.

The parameters Lmin and Lmax are calculated features taking into account the of the laying cable, all descents, ascents, turns, inter-floor through openings (if they exist), etc.

The coefficient of technological reserve Ks is equal to 1.1 (10%).

Stock for cable processing X = X1 + X2. From the side of the workplace (X1), it is taken as equal to 30 cm. From the cross-country side - X2 - it depends on its dimensions and is numerically equal to the distance from the point of entry of the horizontal cables into the cross-country room to the farthest switching element, again taking into account all descents, ascents and turns Next, the total number of Ncr cable runs, which is enough for one cable coil, is calculated:

$$N_{cr} = \frac{L_{cb}}{L_{av}}, \tag{3.2}$$

where Lcb is the cable length reel.

Cable reel length standard values are 305, 500 and 1000 m, with the result rounded down to the nearest whole number. In the last step, we obtain the total amount of cable Lc required to create a cable system:

$$L_c = L_{cb} * \frac{N_{t0}}{N_{cr}},$$

(3.3)

where Nt0 is the number of telecommunications outlets.

Based on the empirical calculation method, we will get the following results: the length of the cable segment maximum is 70 meters, the minimum is 10 meters, the cables number is 23.

Using the aforementioned calculation formulas, we will get an exemplary required cable length 1012 meters.

Looking at this figure, we conclude that 3 bays of UTP twisted pair (305 meters each) will be needed to implement the project. The cable is taken into account with a small margin, which will be required when laying the cable and during operation.

Calculations of the cable channel were carried out along the perimeter of each room, then everything is summed up. Approximately 190.0 meters of cable channel will be required.

Angles will be taken as a percentage - 20% of the total length of the cable channel.

From the above calculations, it is possible to draw a conclusion about the exemplary equality of the obtained results, taking into account the permissible error.

3.2 The structure of a local computer network

Let's describe the cable system. The organization is located on the 2nd floor of the building. The occupied area is 150 square meters. m. The floor is divided into 10 rooms with a central corridor. The entire cable network (Figure 3.1) is laid in the void between the raised floor and floor slabs.

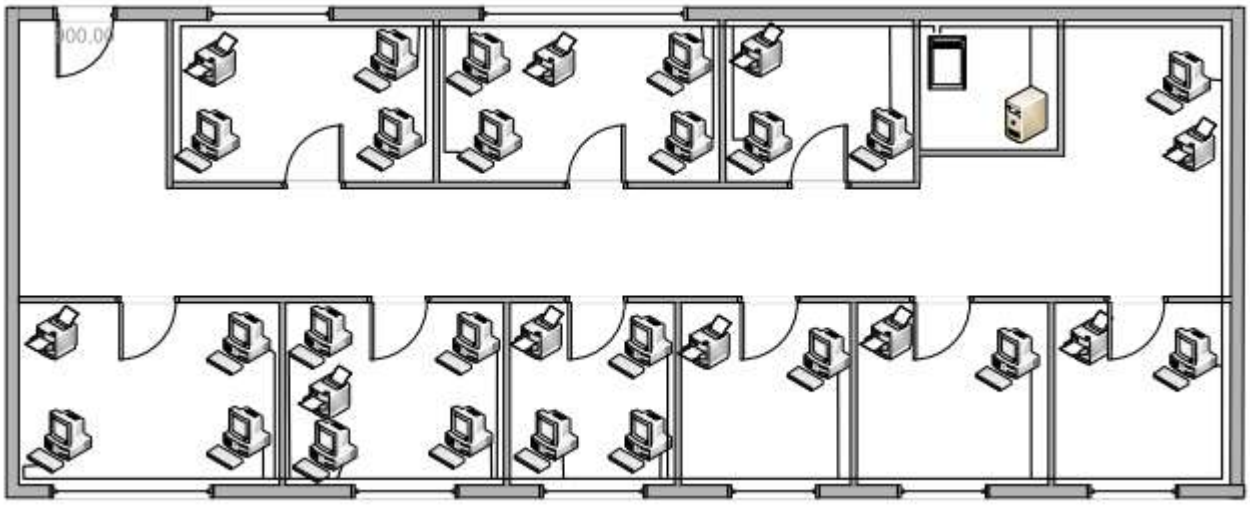

Figure 3.1 – Organization of cable system

The SCS will be mounted using Siemon cable, standard UTP (Twisted pairs Unshielded) – (twisted pairs unscreened) categories 5, international standard of systems cable.

The technology of installation and deployment of SCS can be considered on the example of one workplace, since all workplaces are organized identically. Each cable two pairs are used for data transport (one pair for receiving and one for transmitting data), one pair for a digital telephone and one pair for an analog telephone (if a fax machine or modem connection is required).

Installation of the SCS (after drawing up the project) begins with laying the cable between the server and client parts.

Integration with telephony

The presence of free pairs in the cable suggests their use for the telephone network; the agency uses digital intra-office telephony, controlled by the Coral 1 digital telephone exchange, manufactured by Tadiran, ECI Telecommunications, Israel. Two wires are used to transmit voice and digital data, just like conventional analog telephony.

The SCS is built according to the "star" topology, although, to be more precise, the organization's SCS is a tree: all network clients are branches of the central "trunk" channel. But topologically, the entire network is a "star", with the center in the form of a cascade of server room network switches. A D-Link DGS-1016D/F1 switch is as network switch used, which supports an exchange speed of 10/100/1000 Mbit per second. The capacity of the switch is 16 network ports (Figure 3.2).

The user's workplace (SCS termination) consists of two SCS sockets: standard RJ 45 (eight-pin connector for network connecting a computer) and standard RJ 11 (six-pin connector for any type telephone connecting). The outlet block is contained in the so-called "floor box" - literally "box in the floor" - in a special mounting compartment made in the false floor slab, where power cables and SCS elements are mounted for connecting the end user. Connection of user terminals is carried out by using standard patch cords (RJ 45 and RJ 11 standards, respectively).

Figure 3.2 - Switch DGS-1016D

3.3 The main units administrative network

Grouping into workgroups computers provides two important benefits to users and administrators network. The important most servers of the domain constitute (form) a administrative single unit that uses jointly the security service and the user's information of the cards account. Each workgroup has a database single user containing and credentials group, as well as settings security policy. All servers domain function

either as a domain primary controller or as a domain backup controller containing a database copy. This means that only need administrators to manage account one card for user each, and user each only needs to password use (and remember) the for one card account. Expanding the unit administrative from a computer single to an entire domain.

The second advantage of domains is for convenience user: when users network browse for resources available, they see the grouped network into domains, rather than printers and servers scattered throughout the network.

A network operating system runs on a network server. On the other hand, client computers can run different operating systems. In order for the client's system operating to be able to network use, special drivers must be installed to network card interface allow the of the computer client to network communicate. These drivers work like drivers printer, allowing programs application information send to printer. Network driver software enables applications to send and receive information over the network. Each network computer contains more or one network cards interface that connect the to the network computer.

It is obvious that the network performance depends not least on the computer used as a server. When using Windows 2008 Server, it is necessary to focus on the most high-speed computer. In this case, as always, there is a choice between ready-made servers offered by manufacturers and suppliers of computer equipment, and self-assembly servers. If you have some experience, a self-assembled server can be an alternative to the finished product. The great variety of components makes it impossible to name specific species "iron" for procurement and assembly. Therefore, attention should be paid to the following points [15].

From the very beginning, Windows 2008 Server makes high demands on the amount of RAM. And they grow even more in the using case a server network (here the amount of RAM must be at least 2 GB).

A small body for such a computer is contraindicated, because it can lead to overheating, especially when using a productive processor and several hard drives. The ideal case would be a Big Tower type case, among other things, which provides the possibility of further expansion of the system. Even more convenient dedicated server cases, supplied with powerful power supplies, additional fans, removable plugs and a protective front panel.

If the server will be equipped with two or more hard drives, it is necessary to think about its additional cooling. For this, special fans are installed, which can be additionally installed in the system unit.

After a successful installation of Windows 2008 Server, user configuration is performed.

The main element of centralized administration in Windows 2008 Server is the domain. This are is a group of running servers with Windows 2008 Server system that functions as a system single. All servers Windows 2008 in a domain use user credentials the same set, so you need only to fill credentials user on server one in the domain to be all servers recognized in that domain.

Relationships trust are relationships between domains allow authentication end-to-end, where a single credential user in a domain is granted entire network access t. If the trust relationships and domains are well planned, all computers Windows 2008 will recognize each account card user's, and the user will need only to login enter use password once to any server access in network.

Into domains grouping computers provides important two benefits to users and administrators network. The important most thing is that the servers domain constitute (form) a administrative unit single that jointly uses the service security and the account information user's cards. Domain each has a database single group and user credentials containing and settings security policy. Servers domain either function as a primary controller domain or as domain a backup controller containing a database copy. This

means that administrators need only to one account manage card for user each, and user each needs only to use (and remember) the one card account password. Expanding the unit from administrative a computer single to an domain entire.

The second advantage of domains is made for the convenience of users: when users browse the network for available resources, they see the network grouped into domains rather than servers and printers scattered throughout the network.

Let's consider the issue of information protection.

Research and analysis of numerous cases of impacts on information and unauthorized access to it show that they can be divided into accidental and intentional [14]. To create means of information protection, it is necessary to determine the nature of threats, the forms and ways of their possible manifestation and implementation in an automated system. To solve the problem, all the variety of threats and ways of their influence is reduced to the simplest types and forms that would be adequate for their multitude in an automated system.

Studies of the experience of designing, manufacturing, testing and operating automated systems indicate that information in the process of input, storage, processing and transmission is subject to various random influences.

The reasons for such effects may be:

- equipment failures and failures;
- interference on the communication line from the effects of the external environment;
- human errors as links of the system;
- system and system technical errors of developers;
- structural, algorithmic and software errors;
- emergency situations;
- other influences.

Intentional threats are related to human actions, the reasons for which may be a certain dissatisfaction with one's life situation, material interest, or just entertainment from self-affirmation of one's abilities, like hackers, etc.

There is no doubt that there will be accidental or deliberate attempts to break into the network from the outside. In connection with this circumstance, it is necessary to carefully foresee protective measures.

The following regular information access channels are typical for computer systems:

- user terminals, the most accessible of which are workstations in computer classes;
- system administrator terminal;
- functional control operator terminal;
- information display means;
- means of downloading software;
- means of documenting information;
- information carriers;
- external communication channels.

Windows 2008 Server has security features built into the system operating. Windows 2008 Server provides many tools for network monitoring activity and usage network. The OS allows server view and see uses resources; see connected currently users to the server and see what open files are on them; data check in the log security; event log entries; and specify which errors the administrator should be alerted to if they occur.

3.4 Configuring hardware in a network with a degenerate core

According to the hierarchical concept networks, the process of interaction between computers is several functional levels divided that perform a certain range of tasks. The levels of the model hierarchical correspond should as closely as possible to the goals set for them. In cases most, the network model hierarchical implies the definition of levels three: the access level, the distribution level, and the core, which perform their tasks functional own.

The core network is high-speed responsible for transmission of traffic network. The purpose primary of the included network device is to packets switch.

Summarization takes place at the layer distribution traffic and routes aggregation.

The layer access is responsible for the formation of traffic network, performs of entry network points control and provides services other of devices border.

The purpose of introducing a core into the network hierarchy is to increase the speed of packet switching. The in speed switching increase is achieved using two strategies.

1. Full reach. It is by implementing carried out a ban on the use of standard routes to reach internal destinations and reducing partially optimized routing.

2. Prohibition on the network implementation rules. It is by implementing carried out a ban on access network control, a ban on the network implementation rules, as reducing well load on the memory and processor.

In most networks small, the degenerate (collapsed) type core is used. A degenerate core consists of one router that acts as the core of the network and is connected to all routers other of the layer distribution.

The introducing purpose of level distribution into the hierarchy network is to network section localize that is affected by the change topology; size table routing management, as well as traffic network aggregation.

To achieve these goals, two main strategies are used, implemented which are at the level distribution.

1. Summary of routes. It is carried out by implementing the localization of the section network that is affected by the change topology, hiding detailed information about the routes from the core network devices and layer devices access.

2. Minimization of the channels number of layer distribution connecting with the core network. It is by reducing carried out the complexity of making a decision about packet switching and creating prerequisites for route summarization and traffic aggregation.

The purpose of introducing an access level into the hierarchy network is to shape traffic network, as well as access control to the network. Level access connects devices channels high-speed of networks local with channels of the network global that traffic carry to the level distribution. The forming task of traffic network is mainly solved at the stage of bandwidth determining the of the transmission information channel. It is location related to the of the "server - service" pair. Network control access is based on filtering packet. Traffic not intended for a node outside the LAN should not be forwarded by the access layer device.

We use static addressing. The of IP distribution addresses presented is in table 3.2.

We summarize the functions requirements that must be router programmed in table 3.3.

Based on the tasks and requirements, a network designed degenerate with a core was. Shows a diagram of a computer network at the third network level of the OSI

model. The network consists of one IP subnet 192.168.1.0 with a 24-bit mask. The diagram shows the IP addresses of router interfaces and control interfaces of switches.

Drawings Shows the diagram of a computer network at the channel level.

Based on the requirements and tasks, a network with a degenerate core was designed. Drawing shows a diagram of a computer network at the third network level of the OSI model. The network consists of one IP subnet 192.168.1.0 with a 24-bit mask. The diagram shows the IP addresses of router interfaces and control interfaces of switches.

Table 3.2 - Distribution of IP addresses

No	Computer name	IP address	Network mask	switch number
1	2	3	4	5
1.	Director	192.168.1.10	255.255.255.128	1
2.	Department direct subordination	192.168.1.11	255.255.255.128	1
3.		192.168.1.12	255.255.255.128	1
4.	6 departments	192.168.1.13	255.255.255.128	1
5.		192.168.1.14	255.255.255.128	1
6.		192.168.1.15	255.255.255.128	1
7.	5 departments	192.168.1.16	255.255.255.128	1
8.		192.168.1.17	255.255.255.128	1
9.		192.168.1.18	255.255.255.128	1
10.		192.168.1.19	255.255.255.128	1
11.	4 departments	192.168.1.20	255.255.255.128	1
12.		192.168.1.21	255.255.255.128	1
13.		192.168.1.22	255.255.255.128	1
14.	1 department	192.168.1.23	255.255.255.128	2
15.		192.168.1.24	255.255.255.128	2
16.		192.168.1.25	255.255.255.128	2
	2 departments	192.168.1.26	255.255.255.128	2
17.		192.168.1.27	255.255.255.128	2
18.		192.168.1.28	255.255.255.128	2
19.		192.168.1.29	255.255.255.128	2

Continuation of table 3.2

1	2	3	4	5
20.	3 departments	192.168.1.30	255.255.255.128	2
21.		192.168.1.31	255.255.255.128	2
22.	Secretary	192.168.1.32	255.255.255.128	2
23.	Server 1	192.168.1.40	255.0.0.0	
24.	Server 2	192.168.1.41		
25.	Router	192.168.1.1	255.255.255.128	2
26.		80.255.1.2	255.0.0.0	
27.	Reserve add	192.168.1.129 -192.168.1.255	255.255.255.128	(3)
28.	ress pool			

Table 3.3 - Degenerate Core Router Requirements

Function	Mechanism	Selected equipment
Broadcasting of addresses	Masquerade	Mikrotik RB2011
Access to corporate servers via the Internet	DST-NAT	Mikrotik RB2011
Grouping of physical ports to offload the processor	Switch hardware offload	Mikrotik RB2011

4 LIFE SAFETY, BASICS OF LABOR PROTECTION

4.1 First aid for shock

Let's consider the procedure that determines the mechanism of providing pre-medical care in case of suspected shock by non-medical workers.

Shock is a state between life and death; a general severe disorder of the body's vital functions, caused by a violation of the nervous regulation of vital processes; characterized by disorders of hemodynamics, breathing, and metabolism.

Signs of shock in the victim:

- pale, cold and moist skin;
- weakness;
- restlessness;
- dry mouth, feeling thirsty;
- frequent breathing (more than 20 breaths per minute);
- disturbance of consciousness; faint.
- Causes of shock can be:
- external bleeding;
- internal bleeding;
- injuries of various genesis;
- burns;
- heart attack, etc.

The sequence of actions in the provision of pre-medical assistance to victims of suspected shock by non-medical workers:

1) make sure there is no danger;

2) conduct an examination of the victim, determine the presence of consciousness, breathing;

3) call an emergency (ambulance) medical team;

4) if the victim is not breathing, start cardiopulmonary resuscitation;

5) eliminate the cause of shock: stop bleeding, immobilize the fracture, etc.;

6) provide the victim with an anti-shock position:

a) transfer the victim to a horizontal position;

b) put a box, a roll of clothes, etc. under the feet of the victim in such a way that the feet are at the level of his chin;

c) put clothes/pillow under the victim's head;

d) cover the victim with a thermal cover/blanket;

7) ensure constant supervision of the victim until the arrival of the emergency (ambulance) medical assistance team;

8) if the victim's condition worsens, call the emergency medical dispatcher again before the emergency (ambulance) medical team arrives.

4.2 Development, design of a room for psychological relief of employees

The tense rhythm of the life of school workers, the intensification of their work against the background of low motor activity create a well-known dissonance between the demands placed on the intellect, the emotional sphere, and the relatively small physical load. The work of the nervous system in this mode often leads to increased tension, the inability to relax, get out of a tense state, and find mental balance. In most cases, people prone to "diseases of the century" - neuroses, hypertension and ischemic heart disease - can record increased muscle tension, loss of the ability to voluntarily relax muscles. In addition, intensive study of some subjects causes the need to relieve mental tension. All this puts before the psychological service of the school the urgent task of creating a psychological relief office (CPR).

The office of psychological relief at the school works in five modes:

- Psychological relaxation of employees and schoolchildren after hard work at the end of the working (school) day or at a specially designated time.

- The psychological mood (mobilization) of those employees and schoolchildren who find it difficult to get into the busy rhythm of work at the beginning of the working day, learning the skills of mobilization under stress (control, exam, etc.).

- Removing the psychological burden of teachers and schoolchildren according to the course prescribed by the psychotherapist.

- Psychoprophylactic work with practically healthy teachers and schoolchildren (teaching relaxation methods, meditation, autogenic training, conflict-free communication skills, communication training, etc.).

- Ensuring the process of intensive training, including the methods of suggestopedia, relaxopedia, hypnopedia, as well as the use of the psychological unloading room as an experimental base for the development of new training methods.

The question of the possibility and necessity of attending sessions of psychological relief is decided by employees of the psychological service on the basis of psychodiagnostic data, depending on the nature of the impact. For individual work, 5 to 30 minutes are allotted for one person, 60 minutes for a group. If there are 12-15 places in the CPR, its capacity is 60-80 people per shift, and up to 200 people can receive course treatment at the same time, since classes are held two or three times a week. When conducting intensive training classes, the passing possibility of CPR decreases, however, persons who undergo an intensive course simultaneously experience a psycho-prophylactic effect.

There are certain technical requirements for the arrangement of the CPR. The office should consist of two interconnected rooms. The first room is simultaneously the office of the psychological service. All the equipment used for psychotherapy sessions and intensive training classes is brought here. In addition, from the operator's room

through a special mirror glass on one side, it is possible to observe the behavior of visitors in the psychotherapy room. Such a hall is equipped with 10-15 soft chairs with high headrests and built-in connectors for connecting individual headphones. The area of the hall should be at least 40

CONCLUSION

The following conclusions were obtained as a result of the bachelor thesis.

1. Theoretical aspects of building networks, technology of building networks, topologies of local networks, types of connecting cables, as well as issues of connecting networks and routing are considered.

2. A functional diagram of a local computer network was developed, a structural diagram of the network was planned, namely, a method of managing the exchange, network architecture and network resources, with the help of a room plan, cable and cable channel calculations were made. Distribution of IP addresses for all network components.

3. The network complies with accepted international standards (ANSI/TIA/EIA-568-A and ISO/IEC11801).

2. A tree-like topology of physical connections based on a category 5e twisted pair centered in the switching cabinet has been implemented. The project provides the necessary calculations and drawings, the specification of equipment and materials necessary for the construction of a local computing network.

3. A computer network does not contain two levels. Its core is a Mikrotik RB2011UIAS-2Hnd-IN router with the RouterOS Level5 operating system, which provided the specified requirements for reliability, routing, protection, and the creation of encrypted tunnels between remote units. The configuration of routers has been developed.

4. A structural diagram of the network and a plan for the location of its elements in the building have been developed in accordance with the requirements for the expansion of the network and the possibilities of its further improvement.

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