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PROTECTIVE CORPORATIVE NETWORK

Abstract
for a Master's Degree
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INTRODUCTION

The purpose of the diploma project is to design a corporate communication network of Yang logistics centre. The topicality of the topic is due to the rapid growth of international trade and the increased burden on the logistics centre of the Federal Republic of Nigeria.

Currently, the growth of international trade entails the rapid development of such industries as logistics. Its main functions in the trading system are the timely provision of products to the consumer at minimal production costs, physical distribution of material resources, territorial distribution of raw materials, components and finished products to reduce the cost of moving from production to the place of consumption.

To build a network of such a plan in the graduate project, it is necessary to solve the issues of building a high-speed, well-protected and meeting modern standards for the information cable systems of the network.

The internal networks of logistics centres need periodic modernization, associated with the installation of powerful high-capacity server equipment, and virtual private access to logistics network elements.

–	Chapter 1 reviewed the main characteristics of corporate networks. The analysis of the protocols used for communication networks such as VPN, MGCP SIP, as well as recommendations of h.323 recommendations was carried out. Particular attention is paid to the consideration of the organization of IP-telephony in corporate networks

–	Chapter 2 presents the main types of network equipment, their specifications, software components and protocols.

–	The structure of communication and the telecommunications systems in the Federal Republic of Nigeria as well as regulations guiding the telecommunications sector are presented in Chapter 3.

–	Chapter 4 presents the development of project requirements and the selection of network equipment and server components, as well as software and hardware information protection tools.

–	In the 5th chapter, we study the various data encryption technologies and try to select which technology will be most suitable for the kind of network that we are building.

–	We calculate the main characteristics of the designed data transmission network in Chapter 6.

The diploma project calculated network bandwidth, peak bandwidth of channels Ethernet, maximum allowable cable fading, transient fading.

Choosing the right equipment for a corporate network must meet the criteria for unification (supporting the necessary technologies, protocols and services), ease of administration and reliability.

Data transmission channels should be closed on the transport part of the network, and users' access to the network's resources is authorized.

The main trends in the organization of networks of this kind are associated with the use of powerful switching equipment, which implements support for modern technologies. The equipment meets the requirements for reliability and convenience in operation, and thanks to a flexible system of capacity and bandwidth, system unification and the ability to provide a variety of services, including administration, allows this manufacturer to come to the forefront of industry competitors.

The projected communications network is designed for a single electronic secure document, storage of documents, transmission of information of special applications, sharing access to printing devices, servers with databases, centralized access to the Internet, providing access to global data networks, financial trading and information systems, exchange between users of text, graphic information, as well as the work and use of certain multimedia applications, sufficient privacy and security.

GENERAL DESCRIPTION OF WORK

The goal of the research is to modernize the telecommunications network. This is since outdated technologies and equipment are still widely used, we must keep up with development, and productivity is at a low level of development.

Relevance of the subject

The work corresponds to paragraph 1 «Digital information and communication and interdisciplinary technologies, production based on them» of the State Program of innovative development of the Republic of Belarus for 2021–2025.

The work was carried out in the educational institution Belarusian State University of Informatics and Radioelectronics within the framework of research work 21-2033 "Processing, coding and transmission of information in network-centric systems".

The aims and tasks of the work

The aim of the work is to develop a corporative network for Yang Logistics company. The enterprise is located the western part of the Federal Republic of Nigeria.

To achieve the goal, it is necessary to solve the following tasks
1. Comparative analysis of existing technologies for building telecommunications transport networks**;**
2. Justification of the expected operational and technical requirements of the network**;**
3. Compare various transmission protocols and choose the most suitable;
4. Selections of equipment and main functional blocks for the organization of the corporate network**;**
5. Calculate the main technical parameters of the designed corporate network

In the search below we have its main branch Company in Lagos and its branches in the following states: Ogun, Oyo and Ondo.

This project aims to achieve easy and high security national communication. We use in the design of this project Next Generation Multiservice Networks, which known that it is an ideal solution for all geographically distributed companies and organizations with multiple branches. On the other hand, using IP telephony, customers only pay for traffic which is very affordably priced.

Personal contribution of the author

The content of the dissertation reflects the personal contribution of the author. It consists in the scientific substantiation of networking algorithms (methods, software tools, etc.), setting and conducting experiments to study characteristics, assessing the efficiency of the developed algorithms, processing and analyzing the obtained results, formulation of conclusions.

Task setting and discussion of the results were carried out together with the supervisor, Associate Professor, PhD, Khatkevich O.A.

Testing and implementation of results

The main provisions and results of the dissertation work were reported and discussed at: 58th scientific conference of postgraduates, undergraduates and students (Minsk, April 18-22, 2022) and International scientific and technical seminar "Technologies of Information transmission and processing" (Minsk, March – April 2023).

Author's publications

According to the results of the research presented in the dissertation, 2 author's works was published, including: 2 articles and abstracts in conference proceedings.

Structure and size of the work

The dissertation work consists of introduction, general description of the work, six chapters with conclusions for each chapter, conclusion, bibliography, eight appendixes.

The total amount of the thesis is 107 pages, of which 99 pages of text, figures on 20 pages, tables on 5 pages, a list of used bibliographic sources (25 titles on 2 pages), a list of the author's publications on the subject of the thesis (2 titles on 1 page), graphic material on 4 pages.

Plagiarism

An examination of the dissertation «*Protective Corporative Networks*» by Uzor-Ejikeme Chimbudike Anthony was carried out for the correctness of the use of borrowed materials using the network resource «Antiplagiat» (access address: https://antiplagiat.ru) in the on-line mode 15.05.2023. As a result of the verification, the correctness of the use of borrowed materials was established (the originality of the thesis is 80%)

SUMMARY OF WORK

In the first chapter of the master's work, a review and detailed analysis of the general principles of building multiservice corporate network in a logistics centre is carried out. The technical requirements that must be taken into account when designing and creating corporate network for a logistics centre are considered. A set of problems and the main tasks of optimizing modern communication networks are also described in detail. The main categories of the complex of optimization problems are: optimization of the structure, functioning, plans for the creation and modernization of networks. To solve the problems of optimizing the structure of communication networks, one of the simplest and most effective ways is the network segmentation method. There are several ways to segment networks:
   – with the help of servers;
   – with the help of firewalls;
   – using VLAN (Virtual Local Area Network – virtual local area network).

The application and main content of the hierarchical model of representation of multiservice networks are considered. The hierarchical model gives a clear idea and understanding of the structure of modern communication networks, which greatly facilitates the task of designing telecommunication systems. A brief review and analysis of the protocols used in modern multiservice communication networks is carried out. In conclusion, we can say that the processes of designing, building and commissioning data transmission networks are very complex and time-consuming. A balanced and systematic approach is required to create, optimize and modernize multi-service communication networks.

The second chapter provides an overview of protocols, technologies and equipment used in building corporative networks. The most promising and widely

used options for organizing access networks are considered in detail. Currently, a popular and effective solution is to use a group of OAN (Optical Access Networks) technologies to build access networks. Optical access technologies have a number of advantages:

    – ensuring a high level of reliability;
    – ensuring a high level of flexibility;
    – ensuring high transmission speed;
    – the ability to build up network nodes;
    – low operating costs.

From the OAN group of technologies, it is worth paying attention to FTTB (Fiber to the Building) technology. In terms of technical and economic parameters, this is a profitable solution. The costs of designing and building access networks of this type are much lower compared to FTTH (Fiber to the Home) and PON (Passive Optical Network) technologies. This technology is easy to implement in existing networks with copper cable infrastructure. The use of this technology will ensure high network performance. FTTB access networks are easily scalable and provide great opportunities for further network upgrades.

The third chapter discusses the structure of communication in the Federal Republic of Nigeria. The logistics company is located in the Western part of Nigeria. We also study the Nigerian Communication Commission and the role it plays in regulating the communication sector.

The organizational structure is considered and the characteristics of the enterprise Yang Logistics centre are given.

Yang logistics company povides the following services: plan, implement, and control the movement and storage of goods, services, or information within a supply chain and between the points of origin and consumption.

The company employs 500 people. The company headquarter is located in Lagos state with three other branches in Oyo State, Ogun State and Ondo state. The company has plans to expand in the future therefore, the network is built with scalability in mind.

The existing corporate communication network of the enterprise is organized using ADSL technology and includes: 200 workstations, copper cable infrastructure, 10 switches, 1 router, 4 servers (databases, e-mail, FTP, IP-telephony, VPN).

The general scheme of the multiservice communication network of the enterprise is presented in Figure 1.
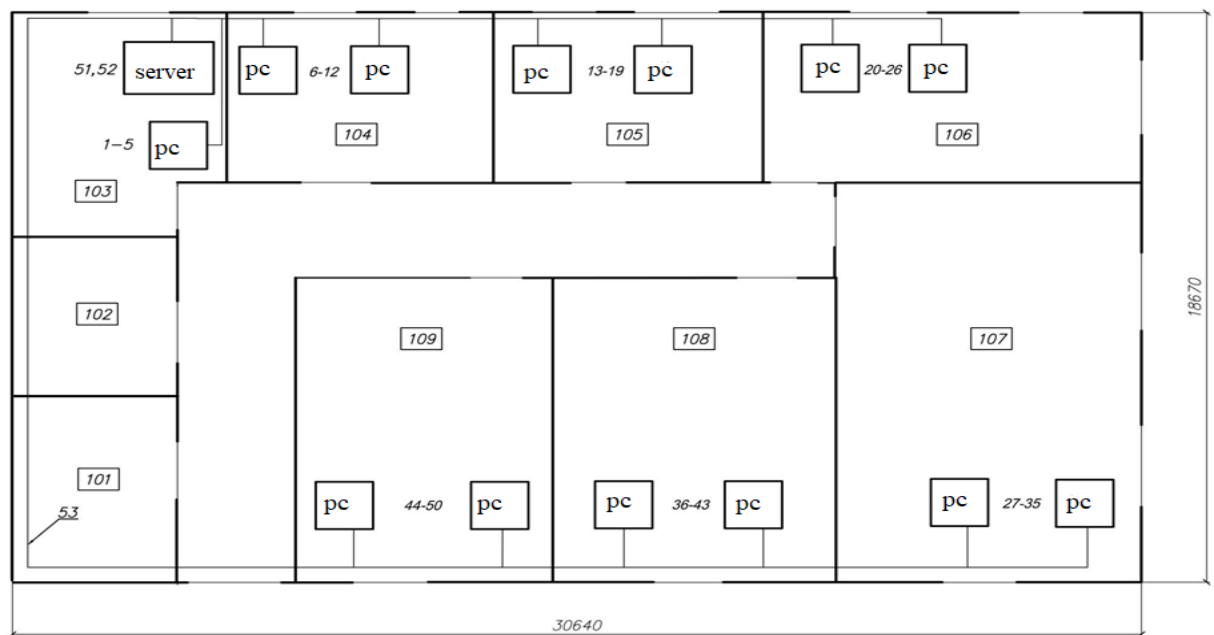
Figure 1 - General diagram of the communication network of the main office of Yang Logistics centre

A basic diagram showing the locations of the enterprise in the Republic of Nigeria can be seen in the figure 2 below.

Figure 2 – Map of Western Nigeria showing the different locations of the enterprise

A pre-project analysis of the corporate multi-platform communication network of the organization was carried out, during which it was revealed that the existing network could not cope with the volume of tasks assigned to it. The telecommunications and server equipment used at the enterprise is obsolete and does not adequately cope with the load in the network. Due to overloads, the failures of this equipment have become more frequent. Users complain about the low data transfer rate and, as a result, slow and incorrect operation of e-mail applications and databases, as well as IP telephony.

Based on the type of services implemented by the enterprise, as well as the results obtained during the pre-project survey, the following technical requirements are formulated for the projected corporate multi-service communication network:

– ensuring fault tolerance of both individual nodes and the communication network as a whole;

– ensuring the reliability of the communication network;

– ensuring high performance of the communication network;

– ensuring flexibility and scalability of the communication network;

– ensuring a high level of information security of the communication network;

– a significant increase in throughput;

– renewal of cable infrastructure;

–updating telecommunications and server equipment, as well as their software.

The fourth chapter provides an analysis of the telecommunications equipment market and a brief overview of manufacturing companies. The most high-quality solutions and offers of companies for small, medium and large businesses have been studied. To ensure reliable and efficient operation, the required quality of services provided, scalability and flexibility of the designed communication network, as well as a high level of information security, it is advisable to use switches with the ability to form a stack and a firewall from Cisco. Server equipment selected by Dell. Also, uninterruptible power supplies were selected to provide protection against voltage surges, normal operation of the equipment. All the technical characteristics and main features of the selected products are also described.

In the fifth chapter, the mathematical model of a data tranmission network is built, a detailed analysis of the transmitted traffic in the corporate communication network and its characteristics is carried out. We also studied the methodology for optimizing data flows on which the following restrictions are imposed:

– absence of errors in the transmission of data blocks (frames, packets, messages) over the LAN;

– no delay in signal propagation when transmitting data blocks via LAN;

– all switching nodes (MC) and LS are absolutely reliable;

– negligible latency in the transmission of data blocks inside the switching unit;

– full reception of the relay data block;

– infinite storage capacity on each MC;

– the time intervals between the appearances of external adjacent data blocks at the input of the MC are distributed exponentially;

– the current bandwidth of the drug can take any non-negative values

Based on the results of the analysis, the required bandwidth is calculated, and the quality of the applications is assessed. The results of simulation of the virtual model of a multiservice communication network according to two scenarios are considered and analyzed. In the first scenario, a multiservice communication network is modeled without making any changes. In the second scenario, a variant of a moderated communication network is modeled. In the second case, a replacement was made on the cable infrastructure, broadband access technology, communication and server equipment, and the method of segmentation of the communication network using VLAN was applied. A comparative analysis of the model before and after modernization is carried out according to the following parameters:

– loading of communication channels between buildings;

– loading a WAN connection (Wide Area Network);

– response time of the e-mail server;

– the response time of the web page;

– response time of the database application is the response time of the FTP server.

We also dicussed how the architecture of a secure network can be synthesised. In the table 1 below we can see how the security services in the enterprise are distributed.

Table 1 – Distribution of security services in Yang logistics centre by layers of the OSI model

Level	Security Services	Protocols
Applied	All types of security services are used	VPN
Views	Confidentiality of connections	-
Session	Not applicable	-
Transport	Authentication, connection confidentiality, access control, integrity	SSL, TLS
Network	Authentication, confidentiality of connections and traffic, access control	IPSec
Channel	Confidentiality of connections	PPP, L2TP
Physical	Confidentiality of connections, traffic	-

Replacement of server equipment, redistribution of network information resources by optimizing the structure by segmentation using VLAN technology, as well as the use of a firewall for access control made it possible to reduce the average response time of a web page from 12 seconds to 1.7 seconds and ensure a

high level of information security and reliability of the company's data transmission network.

In the sixth chapter, we analyzed and discussed the various available data encryption technologies including VPN, IPSec and investigated how we can incorporate these technologies into our corporate network.

According to the comparative analysis, we can say that the model of the modernized multiservice communication network meets all the parameters formulated in the terms of reference. This configuration of the data network provides a high level of performance, flexibility, and also makes it possible to expand it in the future.

CONCLUSION

In the thesis project, the principle of building protective corporate computer network was considered, the architecture of the local computer network between the branches of the logistics company with the choice of active network equipment and a structured cable system was developed.

The main characteristics of the designed data transmission network was calculated. We investigated how to build a mathematical model of the data transmission network as well as synthesise the architecture of a corporate network. We also carried out assessment of the end-to-end quality of the corporate network for data transfer applications.

1 The corporate network of the logistics company is a complex multi-profile structure with a hierarchical management system. Therefore, when developing a project for system integration, it is important to properly design a network, from the reliable and correct operation of which will depend subsequently the steady operation of the entire network.

2 The projected network should ensure the exchange of data between the headquarters of Yang Logistics Centre and its branches, the use of electronic mail. Connection to the Internet at workplaces of all users, the possibility of using an internal information portal.

3 The specifics of the work of the network presupposes close cooperation of all structural divisions and services located in different branches of the company, which means a sufficiently large amount of transmitted information and the need for stable and efficient operation of the projected network.

4 Protection of service information from unauthorized access is a prerequisite for network design.

5 Using VPN MPLS is an important condition in protecting the transmitted information.

6 The protocol proposed by the IETF MEGACO working group is best suited for managing key components of the VoIP network (management server and

voice gateways), which greatly simplifies the administration and scalability of the network. But for signal exchange between IP phones and the management server, the protocol SIP version 2 is better suited. It is simpler to configure and use than H.323, but at the same time more flexible and no less functional.

LIST OF AUTHOR'S PUBLICATIONS

Conference abstracts

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2–A Uzor-Ejikeme C. A, M. A. Noise and interference in the transmission of speech signals in the corporate networks: тезисы докладов 59-я научная конференция аспирантов, магистрантов и студентов БГУИР, 18 Апреля 2023 г. / Белорусский государственный университет информатики и радиоэлектроники; руководитель: О.А. Хацкевич – Минск, 2023 – p 173 –175