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## RESEARCH AND OPTIMIZATION OF THE MULTISERVICE CORPORATE NETWORK

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*Multiservice corporate networks are an essential component of modern enterprise communication infrastructures, enabling the delivery of voice, video, data, and other services over a single network infrastructure.*

*In this article, the challenges and opportunities associated with optimizing multiservice corporate networks are explored. The authors review the latest research and optimization techniques for multiservice networks and discuss the benefits of adopting an optimized multiservice network for modern enterprises. In addition, common pitfalls and challenges are examined, associated with multiservice network optimization and recommendations for overcoming these challenges are provided.*

*Key topics covered include an overview of multiservice corporate networks, the challenges of designing and optimizing these networks, approaches to optimizing multi-service networks, best practices for network design and management, and the benefits of an optimized multiservice network.*

**Keywords:** *multi-service corporate networks, optimization, design, virtualization, protection.*

**Introduction.** In today's interconnected world, multiservice corporate networks have become an integral part of the enterprise. With an increasing demand for bandwidth capabilities such as video conferencing, cloud services [1], and data analytics, the need for effective network optimization [2] has become even greater. A well-optimized network provides faster data transfer, lower latency, and improved application performance, resulting in better performance and better customer satisfaction [3].

The article is aimed at researching and optimizing multiservice corporate networks for enterprises. Let's start by defining multiservice corporate networks. The network consists of what components and services the multi-service network provides to the business [4].

Also, looking at the challenges businesses face in optimizing their multi-service enterprise networks and the impact these challenges have on network performance [5].

Next, look at what optimization processes are available in multiservice corporate networks, which include the processes and methods used in network optimization. Let

one describe such methods of network optimization as QoS and network virtualization function [6]. Let's check the software capabilities of OVS and OVS-DPDK [7]. How they can improve the bandwidth of information packets? Advantages of the Data Plane library when installed on OVS to optimize corporate networks [8]. And also how it can differ, and how the size of the information packet affects the bandwidth and factory resistance in multiservice corporate networks [9].

**Formulation of the problem.** The Problem of Optimization of Multiservice Corporate Networks. While multiservice corporate networks provide numerous benefits to enterprises, their optimization can be challenging due to the complexity of the network architecture and the variety of services they offer. The following are some of the key challenges and problems associated with the optimization of multiservice corporate networks:

**Congestion:** As the number of devices and services on a multiservice network increases, the network's bandwidth can become congested, leading to decreased performance, slow data transfer speeds, and dropped connections. This can result in lost productivity and frustration among employees, customers, and partners.

**Security:** Multiservice networks are vulnerable to various security threats, including malware, viruses, and unauthorized access. Enterprises must take measures to secure their networks and protect sensitive data from cyberattacks, which can be time-consuming and costly.

**Scalability:** As the enterprise grows and expands, the multiservice network must be able to scale accordingly. Adding new devices, services, and locations to the network can be challenging and may require significant investment in new infrastructure.

**Integration:** Multiservice networks often comprise various components and services from different vendors, making integration and management complex. Ensuring that all components work together seamlessly and efficiently can be difficult, leading to performance issues and increased maintenance costs.

**Monitoring and management:** Monitoring the performance of a multiservice network can be challenging due to the variety of services and components. Enterprises must have the proper tools and techniques to monitor and analyze network performance to identify issues and optimize resource allocation.

These challenges can impact the success of the enterprise and may require significant investment in time, resources, and expertise to overcome. However, by addressing these challenges, enterprises can optimize their multiservice networks and gain the numerous benefits associated with them, including increased collaboration, improved productivity, and enhanced customer satisfaction.

**Analysis of the relevance of the work.** Multi-service corporate networks are complex systems that provide various communication services to enterprises. These networks allow companies to share data, voice and video in different places and allow employees to access critical applications and resources from anywhere in the world.

In this article, the main object of research is the OVS virtual network switch (Open vSwitch), with the addition of the DPDK (Data Plane Development Kit) library. With the help of the DPDK library, adding it to OVS can increase the bandwidth by 4 or

more times to transmit packets of information over corporate networks and maintain the received network bandwidth. Also, depending on the number of processor cores, the throughput of information packets may vary. This article checks throughput on 2 core processors.

Multiservice corporate networks can be composed of several components, including routers, switches, servers, firewalls, and other networking equipment which is shown in Fig. 1. These components work together to facilitate communication and data transfer between different devices, enabling seamless collaboration between employees, customers, and partners.

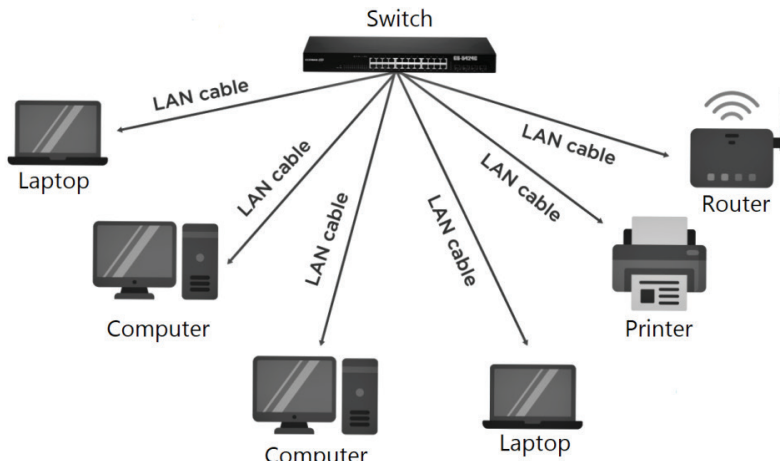


Fig. 1. Corporate network

The range of services provided by multiservice corporate networks can fluctuate based on the specific requirements of the enterprise. Some common services include:

Voice over IP (VoIP) – enables voice communication over the internet instead of traditional phone lines, providing cost savings and increased flexibility for businesses.

Video conferencing – allows for face-to-face communication between individuals or groups from different locations, improving collaboration and reducing travel costs.

Virtual private network (VPN) – provides secure remote access to enterprise resources, allowing employees to work from home or other remote locations.

Cloud services – allow businesses to store and access data and applications remotely, reducing the need for on-premises infrastructure and increasing scalability.

However, as multiservice corporate networks become more complex, they also become more challenging to manage and optimize. Poor network performance can lead to lost productivity, increased costs, and decreased customer satisfaction, which can ultimately impact the success of the enterprise.

To effectively manage and optimize a multiservice corporate network, it is crucial to have a deep understanding of its components, services, and performance metrics. This understanding allows businesses to identify issues and make informed decisions regarding network optimization and resource allocation.

Additionally, it is essential to have the proper tools and techniques for monitoring and analyzing network performance. Network analyzers, performance monitoring software, and other tools can provide valuable insights into network behaviour and help identify bottlenecks, security threats, and other issues that may affect network performance.

In conclusion, understanding multiservice corporate networks is a critical component of effective network management and optimization. By comprehending the components, services, and performance metrics of these networks, enterprises can make informed decisions regarding network optimization, resource allocation, and investment in new technologies.

**Optimization of multiservice corporate networks.** Optimization of multiservice corporate networks is a complex and ongoing process that requires careful planning, monitoring, and adjustment. As businesses increasingly rely on their networks to support a wide range of applications and services, it is essential to optimize the network to ensure that it can meet the needs of the organization, support growth and innovation, and deliver value to customers and stakeholders.

#### *A. Process of optimizing*

The process of optimizing multiservice corporate networks is shown in Fig. 2, and provide involves several key steps. These include:

**Assessment:** The first step in optimizing a multiservice corporate network is to assess the current state of the network. This assessment should include an analysis of network performance, capacity, and reliability. This may involve collecting data on network traffic, utilization, and performance metrics, as well as a review of network architecture and configuration.

**Identification of Areas of Improvement:** Once the current state of the network has been assessed, the next step is to identify areas of improvement. This could entail pinpointing bottlenecks or other performance issues, along with identifying opportunities to enhance network capacity, reliability, or security.

#### PROCESS OF OPTIMIZING

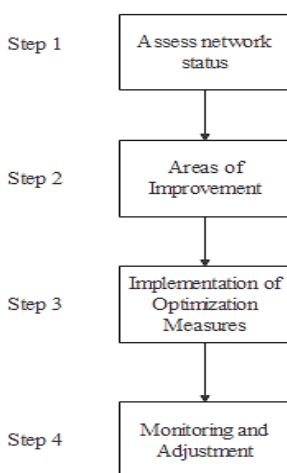


Fig. 2. Process of optimizing network

**Implementation of Optimization Measures:** Once areas of improvement have been identified, the next step is to implement optimization measures. This may involve changes to network configuration, the deployment of additional hardware or software, or the implementation of new policies or procedures. It is important to carefully monitor the impact of these changes on network performance and to adjust as needed.

**Monitoring and Adjustment:** The final step in optimizing a multiservice corporate network is to continuously monitor network performance and adjust optimization measures as needed. This may involve the collection of data on network traffic, utilization, and performance metrics, as well as ongoing reviews of network architecture and configuration.

#### *B. Optimization methods used in network*

Several optimization methods can be used to improve the performance of multi-service enterprise networks. These include load balancing, packet filtering, protocol optimization, network segmentation, and others. But in the article, we will pay attention to QoS and NFV.

QoS manages network resources by setting multiple data transmission needs and prioritizing the transmission of specific data types.

In particular, QoS is necessary to ensure the high performance of critical and non-elastic applications, such applications are VoIP and video conferencing. They have maximum bandwidth requirements and minimum delay limits and are very sensitive to tremors and packet loss.

Quality of Service (QoS) is a network-based mechanism that helps one to control and prioritize traffic, transmit more critical traffic, and send it to the network. This feature helps ensure performance for critical network traffic.

QoS can be measured in quantitative terms with parameters such as packet loss, data transfer rate, transmission delay, trembling, throughput, availability, etc.

Without QoS, network data can become disorganized, filling networks, where performance is reduced, or in some cases, the network is completely shut down. This is indicated in Fig. 3.

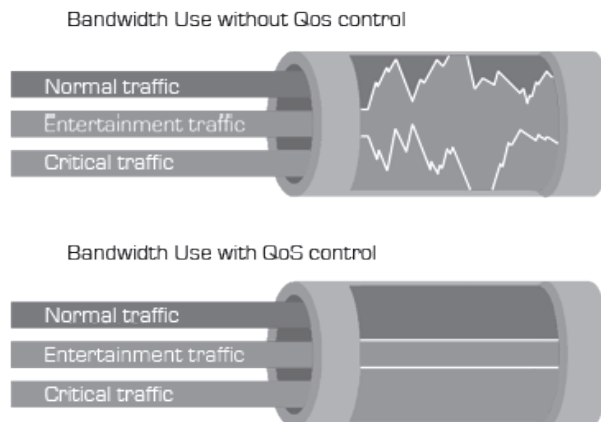


Fig. 3. Control without QoS or with QoS

Quality of service is important, as enterprises should provide stable services for employees and clients. Quality of service determines the quality of experience (QoE). If the services provided by the organization are unreliable, the relationship between customers and employees may be in danger.

Network virtualization is also an equally important factor in network optimization, along with QoS, it can optimize the network, for example, when transferring a large number of files.

Network virtualization is a technique illustrated in Fig. 4, enabling the creation of multiple virtual networks on a single physical network infrastructure. This can be very useful in optimizing the multiservice corporate network of an enterprise as it allows the network to be partitioned into different segments, each with its own set of policies and characteristics.

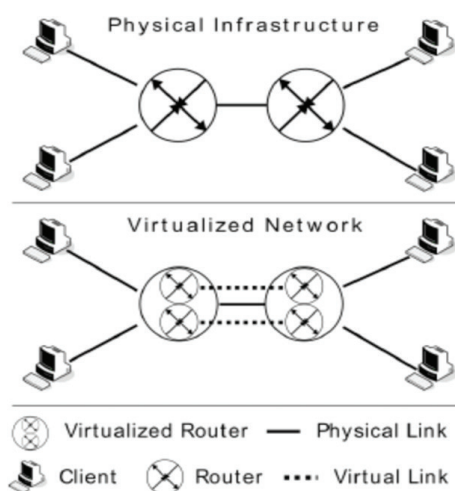


Fig. 4. Network Virtualization or Physical Infrastructure

By implementing network virtualization, an enterprise can create separate virtual networks for different services such as voice, video, and data, and can allocate resources accordingly. This enables the enterprise to prioritize critical services and ensure that they receive the necessary bandwidth and quality of service (QoS) to operate efficiently.

In terms of optimization, network virtualization can help reduce costs by allowing multiple virtual networks to share the same physical infrastructure. This can reduce the need for additional hardware and can also simplify network management.

Overall, network virtualization is a powerful tool for optimizing the multiservice corporate network of an enterprise. By creating separate virtual networks, an enterprise can prioritize critical services, improve network security, and reduce costs.

NFV stands for Network Function Virtualization. It is a technology that enables the implementation of network functions in software, instead of hardware. This means that network functions, such as firewalls, routers, load balancers, and other network services, can be virtualized and run on standard servers or in the cloud, instead of using dedicated hardware appliances.

In a network architecture that is implemented according to traditional criteria, individual hardware devices: gateways, routers, load balancers, firewalls, switches, and intrusion detection systems are configured to perform various network tasks.

When using a virtualized network, individual hardware is replaced by virtual software applications running on virtual machines.

The NFV architecture consists of three parts components of which are displayed in Fig. 5.

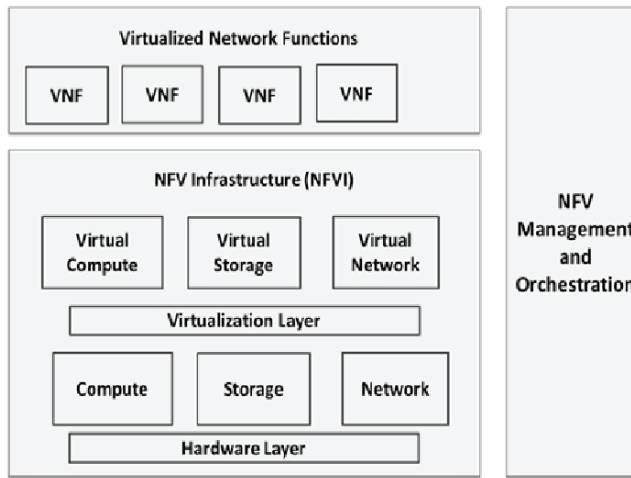


Fig. 5. NFV architecture

Centralized virtual network infrastructure: The NFV infrastructure can rely on either a container management platform or a hypervisor, both of which abstract computing, storage, and of network resources.

Software applications: The software replaces the hardware components of the traditional network architecture to provide different types of network functions (virtualized).

Framework: A framework (MANO - management, automation, and network orchestration) is required to manage infrastructure and provide network functions.

Advantages of NFV:

Unlike network platforms, which are built on special hardware, NFV supports a software infrastructure that does not depend on hardware. Commercial off-the-shelf x86 server hardware (COTS) acts as a common computing platform for virtual machines (VMs) that provide network functions. Server computing, memory, and storage resources can be dynamically utilized by multiple virtual machines concurrently, allowing for adaptable performance and scalability tailored to each service while optimizing costs. In contrast to specialized hardware platforms that cater to a single service and are amortized over time, NFV facilitates scalability and responsiveness to service demands, hosting multiple services on a single physical server to achieve cost-effectiveness.

Following the ETSI NFV reference architecture, hardware resources such as computation, storage, and network undergo abstraction through a virtualization layer referred to as a hypervisor. This hypervisor is responsible for creating and managing



virtual machines that share underlying hardware resources. The implementation of Virtual Network Functions (VNFs) is carried out using one or more of these virtual machines. The management and orchestration of NFV, known as MANO, are overseen by top-level applications dedicated to NFV Infrastructure Lifecycle Automation (NFVI) and VNF services. Combining virtual machines and services into a network corresponds to a software-defined network controller (SDN) that automates subnet membership and policy enforcement [7, 9].

### *C. Importance of continuous optimization*

Continuous optimization of multiservice corporate networks is critical for ensuring network performance and enterprise success. As network traffic patterns change, new applications are deployed, and business needs evolve, it is essential to continuously optimize the network to ensure that it can meet the needs of the organization. Here are some reasons why continuous optimization is important:

**Improved Network Performance:** Continuous optimization can help to improve network performance by identifying and addressing issues before they become significant problems. By monitoring network traffic, utilization, and performance metrics, network administrators can identify bottlenecks or other performance issues and take steps to address them proactively.

### ***Software and practical application***

#### *A. Virtualization tools*

Open vSwitch (OVS) is a multi-layer virtual switch that is shown in Fig. 6 designed to enable network automation, flexibility, and scalability in virtualized environments. It was initially developed by Nicira Networks and is now maintained by the open-source community.

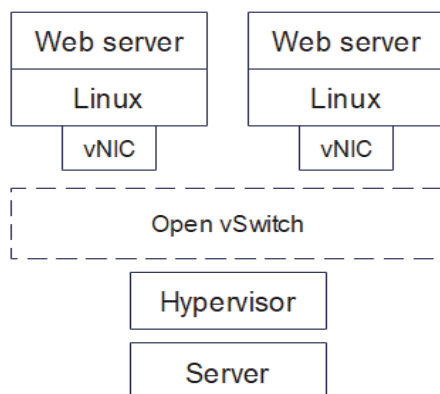


Fig. 6. Deploying Open vSwitch as a server-to-server virtual network switch

OVS is built as a software-based switch that can run on top of existing hypervisors, such as KVM and Xen, as well as on physical switches. It offers features such as VLAN tagging, virtual port mirroring, access control lists, and network overlays. OVS can also integrate with OpenFlow controllers to enable software-defined networking (SDN) in virtualized environments.



OVS is designed to provide a flexible and extensible platform for network virtualization, allowing network administrators to create and manage virtual networks in a way that is similar to traditional physical networks. It is also highly scalable, allowing administrators to add or remove virtual switches as needed, without disrupting network traffic.

OVS-DPDK (Open vSwitch with Data Plane Development Kit) is a version of Open vSwitch which is shown in Fig. 7 and uses the Data Plane Development Kit (DPDK) to accelerate packet processing on commodity hardware. DPDK is a set of libraries and drivers that allows network applications to run in user space, bypassing the kernel networking stack and achieving high packet processing rates with low latency.

OVS-DPDK is designed to handle large amounts of traffic at a line rate while maintaining low latency and high throughput. It achieves this by using DPDK to offload packet processing to multiple CPU cores while maintaining the control plane of Open vSwitch in the kernel. This enables OVS-DPDK to handle a large number of virtual machines (VMs) and network functions, such as load balancing, firewalls, and intrusion detection systems.

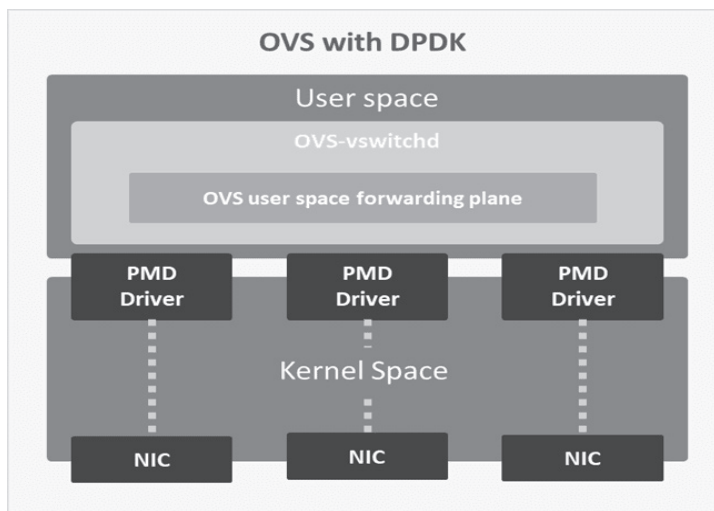


Fig. 7. OVS with DPDK

OVS-DPDK also supports features such as network overlays, virtual port mirroring, access control lists, and Quality of Service (QoS) policies. It can integrate with OpenStack and other cloud orchestration platforms to provide network automation and virtual network management.

*B. Practical application ovs and ovs-dpdk*

In comparison, we use OVS and OVS-DPDK and check how OVS-DPDK is effective compared to OVS. And what impact does a set of data plane libraries and network card drivers have on fast packet processing?

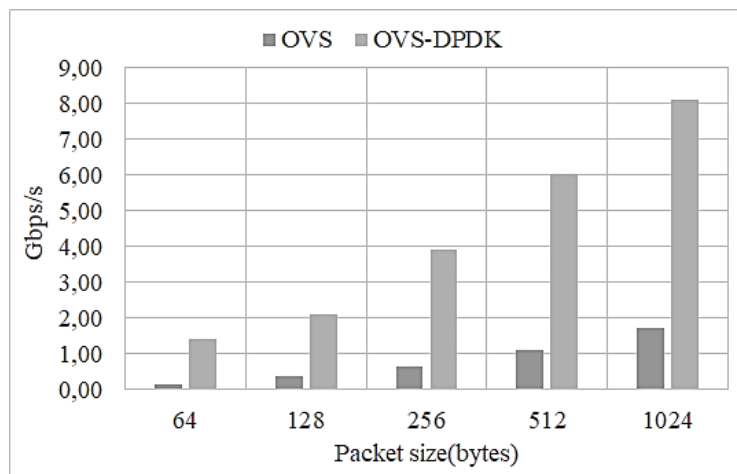


Fig. 8. Open vSwitch or Open vSwitch Data Plane Development Kit and advantage at times

OVS bandwidth, bandwidth is (0.15 Gbps), (1.10 Gbps) and (1.72 Gbps), when the packet sizes are 64, 512 and 1024, respectively. As for OVS-DPDK, it is (1.4 Gbps), (6.0 Gbps) and (8.1 Gbps) when the packet sizes are 64, 512 and 1024, respectively. As one can see from Fig. 8 and Table 1, the advantage of the Data Plane Development Kit is tangible and promising at packet processing speed.

The difference in the benefits of OVS-DPDK ranges from 4.7 to 9.3 times compared to OVS.

Table 1

#### Open vSwitch or Open vSwitch Data Plane Development Kit and advantage at times

2 core	OVS	OVS-DPDK	Advantage
64	0,15	1,40	9,30
128	0,38	2,10	5,52
256	0,64	3,90	6,10
512	1,10	6,00	5,45
1024	1,72	8,10	4,70

**Conclusions.** Research and optimization of networks of multiservice enterprises are crucial for modern enterprises to increase their productivity, efficiency and competitiveness.

The article discusses the parts of optimizing multiservice corporate networks. Among the optimization methods, Quality of Service is considered, which allows one to select critical or priority tasks when transferring data in the corporate network. That allows one to optimize resources and not lose bandwidth. Network virtualization is also considered, which allows balancing the load on the corporate network and improving network

bandwidth, their methods and software implementations in network virtualization. The efficacy results of OVS-DPDK compared to OVS are analysed. So that when adding a DPDK library, the bandwidth of this data increases and varies from 4.7 to 9.3 times when checking packets from 64 to 1024 bytes.

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## ДОСЛІДЖЕННЯ ТА ОПТИМІЗАЦІЯ МУЛЬТИСЕРВІСУ КОРПОРАТИВНИХ МЕРЕЖ

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*Мультисервісні корпоративні мережі є важливим компонентом сучасних корпоративних комунікаційних інфраструктур, що забезпечує передачу голосу, відео, даних та інших послуг через єдину мережеву інфраструктуру.*

Дослідження та оптимізація мереж мультисервісних підприємств мають вирішальне значення для сучасних підприємств для підвищення їх продуктивності, ефективності та конкурентоспроможності. Хоча мультисервісні корпоративні мережі надають підприємствам численні переваги, їхня оптимізація може бути складною через складність мережевої архітектури та різноманітність послуг, які вони пропонують. Основні виклики і проблеми, пов'язані з оптимізацією мультисервісних корпоративних мереж можна звести до наступних складових: перевантаження, яке може призвести до втрати продуктивності; безпека, несанкціонований доступ, втрата даних, інфікування; масштабованість, можливість додавання нових пристроїв, служб і місць у мережу; інтеграція, можливість підключення різних компонент та служб від різних постачальників; моніторинг і керування, для швидкого виявити проблем та оптимізації розподілу ресурсів.

Ці виклики можуть вплинути на успіх підприємства та вимагати значних інвестицій у часі, ресурсах і досвіді для подолання. Однак, вирішуючи ці проблеми, підприємства можуть оптимізувати свої мультисервісні мережі та отримати численні переваги, пов'язані з ними, включаючи розширення співпраці, підвищення продуктивності та підвищення рівня задоволеності клієнтів.

У цій статті ми досліджуємо проблеми та можливості, пов'язані з оптимізацією мультисервісних корпоративних мереж. Ми розглядаємо останні дослідження та методи оптимізації мультисервісних мереж і обговорюємо переваги впровадження оптимізованої мультисервісної мережі для сучасних підприємств. Ми також досліджуємо типові підводні камені та проблеми, пов'язані з оптимізацією мультисервісної мережі, і надаємо рекомендації щодо подолання цих проблем.

Основні теми, що розглядаються у статті, включають огляд мультисервісних корпоративних мереж, проблеми проектування та оптимізації цих мереж, підходи до оптимізації мультисервісних мереж, найкращі практики проектування та управління мережею, а також переваги оптимізованої мультисервісної мережі.

У статті розглядаються складові оптимізації мультисервісних корпоративних мереж. Серед методів оптимізації було розглянуто *Quality of Service*, що дозволяє виділити критичні або пріоритетні завдання при передачі даних у корпоративній мережі. Це дозволяє оптимізувати ресурси і не втрачати пропускну здатність. Також була розглянута віртуалізація мережі, яка дозволяє збалансувати навантаження на корпоративну мережу та покращити пропускну здатність мережі. Їх методи та програмні реалізації у мережевій віртуалізації. Проаналізовано результати ефективності *OVS-DPDK* порівняно з *OVS*. Що при додаванні бібліотеки *DPDK* пропускну здатність цих даних збільшується і варіюється від 4,7 до 9,3 разів при перевірці пакетів від 64 до 1024 байт.

**Ключові слова:** мультисервісні корпоративні мережі, оптимізація, проектування, віртуалізація, захист.

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