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ENHANCING NETWORK INFRASTRUCTURE BY IMPLEMENTING SDN AND NFV SOLUTION

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Abstract

The rapid growth of the internet has led to a proliferation of network devices, creating significant challenges for system administrators in configuring and maintaining complex heterogeneous networks. This technical paper presents strategies for enhancing network infrastructure by leveraging effective network device configurations to boost connectivity and performance across core internet protocols. The paper discusses the limitations of current network management approaches, introduces novel frameworks and technologies for unified configuration and management, and outlines best practices for improving network reliability and efficiency.

Keywords: Network infrastructure, network device configuration, connectivity, performance, Internet protocols, network management

I. INTRODUCTION

The internet's meteoric rise as an indispensable global communications backbone has unlocked a trove of innovative applications and services that drive modern economic and societal progress. However, this remarkable expansion, coupled with the escalating complexity of the internet's underlying infrastructure, has posed substantial challenges for network administrators tasked with managing and sustaining this vital system. As the proliferation of diverse network devices across intricate, heterogeneous networks has accelerated, these professionals now confront a daunting challenge in properly configuring and overseeing this increasingly diverse ecosystem of interconnected hardware and software components sourced from a multitude of vendors [1].

The cumbersome, error-prone nature of traditional network management approaches has further exacerbated these challenges, leading to a troubling "ossification" of the network and impeding the ability to adapt to evolving requirements and emerging technologies. Given the internet's indispensable role in today's world, the critical importance of addressing the complexity and constraints inherent in network device configuration and management cannot be overstated [2].

II. HIGH-LEVEL ARCHITECTURE FOR EFFECTIVE NETWORK CONFIGURATION AND MANAGEMENT

Existing network management approaches often rely on manual, error-prone processes that struggle to keep pace with the dynamic nature of modern networks. The emergence of novel network architectures, such as software-defined networking and network function virtualization, has the potential to address these challenges by enabling more automated and intelligent configuration and control of network devices and resources. Protocols like NETCONF, which provide a standardized framework for managing network device configurations, can streamline the deployment and updating of network components across complex, heterogeneous environments. Moreover, advancements in network monitoring and analytics tools have empowered network administrators to gain deeper insights into the performance and behavior of their infrastructure, allowing them to proactively identify and address issues, optimize resource utilization, and enhance the overall reliability and efficiency of their networks [3]. These novel technologies and frameworks offer a promising path forward, as they can help network operators overcome the limitations of traditional manual network management approaches and keep pace with the rapidly evolving demands of modern internet-based applications and services.

III. IMPROVING NETWORK DEVICE CONFIGURATION AND MANAGEMENT

One of the key challenges in managing complex, heterogeneous network environments is the lack of a unified, standardized approach to configuring and controlling network devices. Historically, network administrators have been forced to grapple with a proliferation of vendor-specific management interfaces and protocols, each with its own unique syntax and semantics, making the task of deploying and maintaining network infrastructure a daunting an error-prone endeavor. To address this issue, the Internet Engineering Task Force has developed the NETCONF protocol, which provides a standardized framework for managing the configuration of network devices. NETCONF leverages a structured data model, based on the YANG modeling language, to define the configuration and state information for network elements, enabling a more streamlined and consistent approach to network management.

Moreover, emerging research has explored the development of domain-level data models that can map the aggregate properties and requirements of a network domain to the specific configuration parameters of individual devices. This approach allows network administrators to manage their infrastructure in terms of high-level policies and service-level objectives, rather than being constrained by the low-level, device-centric configuration details.

IV. LIMITATIONS OF CURRENT NETWORK MANAGEMENT APPROACHES

The configuration and management of network devices have traditionally been arduous, manual processes that rely on a limited set of tools, often resulting in error-prone and inefficient outcomes. The internet's extraordinary scale and deeply interconnected nature, with its intricate web of underlying protocols and physical infrastructure, have created an exceptionally complex system where any updates or modifications to the core elements present formidable technical and logistical challenges that network operators struggle to address [1].

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Table 1 below shows a comparative overview of Software-Defined Networking (SDN) versus traditional network devices in terms of performance and reliability, with source references:

Metric	SDN	Traditional Networks	Source
Performance	Higher throughput due to optimized and dynamic routing capabilities	Throughput depends on static routing, often suboptimal under varying network loads	[7]
Latency	Lower latency as centralized control enables quicker path recalculations	Higher latency due to distributed control and slower adaptation to network changes	[7][9]
Scalability	Improved scalability, especially for data centers and large networks where routing complexity increases	Limited scalability as distributed control can lead to bottlenecks in large, complex networks	[9]
Reliability	High reliability with faster fault detection and recovery; centralized control enables immediate action	Limited fault detection and slower recovery, as troubleshooting may be manual or involve multiple protocols	[4][7]
Configurability	Highly configurable, enabling automated adjustments and on-demand changes in network configuration	Configuration changes are manual and require significant effort, increasing the risk of errors	[8]
Security	Centralized control provides enhanced security but is vulnerable to central point failures	Decentralized, which can distribute risk, but limited in enforcing uniform security policies across the network	[5] [7]
Deployment Cost	Higher initial deployment cost due to SDN controllers and new hardware	Lower initial cost but potentially higher long-term operational costs due to manual management	[6][8]

Table 1: comparative overview of Software-Defined Networking (SDN) versus traditional network devices

V. IMPROVING NETWORK INFRASTRUCTURE WITH EFFECTIVE DEVICE CONFIGURATIONS

Network device configurations play a crucial role in enhancing the overall performance and reliability of network infrastructure [5]

One approach involves the use of model-driven network management frameworks, such as NETCONF, which provide a standardized mechanism for managing network device configurations [6]. NETCONF leverages XML-based data modeling to enable more efficient and error-free configuration of network elements, reducing the likelihood of human-induced errors [7]

Furthermore, the emergence of Software-Defined Networking has introduced new possibilities for automating network device configurations [8][9]. SDN separates the control and data planes,

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allowing for centralized management and programmable control of network resources. By integrating SDN with network device configuration practices, network administrators can dynamically adjust device settings to optimize performance and adapt to changing network conditions [10].

In addition to these advancements in network management protocols and data modeling, the proliferation of software-defined networking and network function virtualization technologies has the potential to further enhance the configuration and control of network devices. By decoupling the control and data planes of network components, these architectures enable a more programmatic and agile approach to network management, where the configuration and behavior of network elements can be dynamically adjusted in response to evolving requirements and conditions.

The separation of control and data planes in SDN architectures allows for centralized, software-based control of the network, facilitating real-time adjustments to device configurations and policies [11]. Similarly, NFV enables the virtualization of network functions, such as routing and firewalling, which can be dynamically deployed and scaled as needed, further enhancing the flexibility and responsiveness of network infrastructure [12].

These emerging technologies, when combined with standardized configuration management protocols like NETCONF and data modeling languages like YANG, provide network operators with a powerful toolset to streamline the deployment, monitoring, and optimization of their network environments [12]. By embracing this holistic approach to network configuration and management, organizations can unlock new levels of agility, efficiency, and reliability in their critical internet-based infrastructure.

Figure 1 below depicts a high level architecture for implementing SDN and NFV based solution.

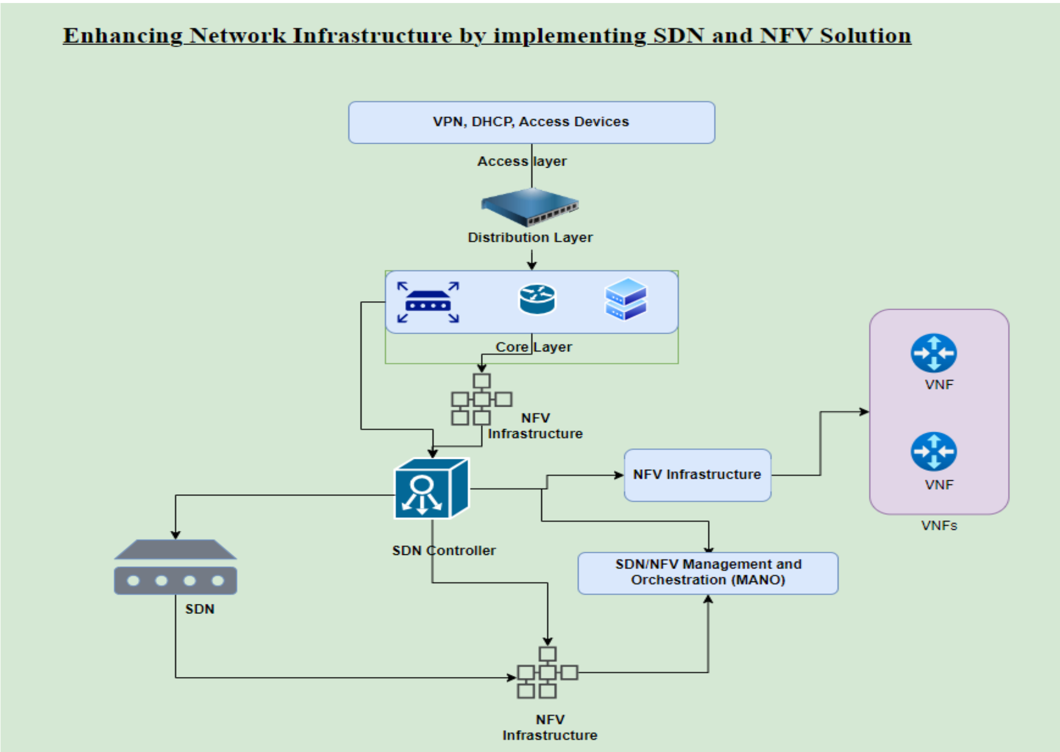

Figure 1 implementing SDN and NFV based solution

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VI. CONCLUSION

As the internet continues to evolve and support an ever-growing array of critical applications and services, the need for effective network infrastructure management has become increasingly vital. Network administrators must contend with the escalating complexity of modern networks, characterized by a proliferation of diverse network devices and the intricate interplay of numerous network protocols.

To address these challenges, a multifaceted approach is required, drawing on the latest advancements in network management frameworks, software-defined networking, and virtualization technologies. By embracing unified configuration and control mechanisms, leveraging the programmatic capabilities of SDN, and adopting standardized best practices, network operators can enhance the reliability, flexibility, and performance of their infrastructures, ensuring the internet remains a robust and resilient backbone for a wide range of essential digital services [1].

REFERENCES

1. Kalmanek, C., Misra, S., & Yang, Y. (2010, January 1). Guide to Reliable Internet Services and Applications. https://doi.org/10.1007/978-1-84882-828-5
2. Nishimura, T. (2015, December 11). A Flexible Router with Tangible Network Interfaces for Sharing a Last Mile. , 54, 303-308. https://doi.org/10.1145/2837126.2837166
3. Rayes, A. (2003, April 7). Operation management of IP broadband access networks. Elsevier BV, 26(7), 679-690. https://doi.org/10.1016/s0140-3664(02)00200-1
4. Medhi, D., & Ramasamy, K. (2017, September 6). Network Routing: Algorithms, Protocols, and Architectures. O'Reilly Media. https://shop.elsevier.com/books/network-routing/medhi/978-0-12-800737-2
5. Enns, R., Bjorklund, M., Schoenwaelder, J., & Bierman, A. (2011, June 1). Network Configuration Protocol (NETCONF). Internet Engineering Task Force (IETF) , undefined(undefined). https://datatracker.ietf.org/doc/html/rfc6241
6. Haleplidis, E., Pentikousis, K., Koufopavlou, O., Hadi, S J., & Meyer, D. (2015, January 1). Software-Defined Networking (SDN): Layers and Architecture Terminology. Internet Research Task Force (IRTF). https://datatracker.ietf.org/doc/html/rfc7426
7. Kreutz, D., Ramos, F M V., Veríssimo, P E., Rothenberg, C E., Azodolmolky, S., & Uhlig, S. (2014, December 19). Software-Defined Networking: A Comprehensive Survey. Institute of Electrical and Electronics Engineers, 103(1), 14-76. https://doi.org/10.1109/jproc.2014.2371999
8. McKeown, N., Anderson, T., Balakrishnan, H., Parulkar, G., Peterson, L., Rexford, J., Shenker, S., & Turner, J. (2008, March 31). OpenFlow. Association for Computing Machinery, 38(2), 69-74. https://doi.org/10.1145/1355734.1355746
9. Nunes, B A A., Mendonca, M S., Nguyen, X., Obraczka, K., & Turletti, T. (2014, January 1). A Survey of Software-Defined Networking: Past, Present, and Future of Programmable Networks. Institute of Electrical and Electronics Engineers, 16(3), 1617-1634. https://doi.org/10.1109/surv.2014.012214.00180
10. Schönwälder, J., Björklund, M., & Shafer, P. (2010, September 1). Network configuration management using NETCONF and YANG. Institute of Electrical and Electronics Engineers, 48(9), 166-173. https://doi.org/10.1109/mcom.2010.5560601

11. Keith, A W., Wang, W., Kurt, M P., Daniel, P G., & Dimarogonas, J. (2010, October 1). A domain-level data model for automating network configuration. , 1337-1342. https://doi.org/10.1109/milcom.2010.5680134
12. Nataf, E., & Festor, O. (2010, January 1). End-to-end YANG-based configuration management. , 674-684. https://doi.org/10.1109/noms.2010.5488381