УДК 004.7

Adaptive Network Reconfiguration in Multipath Environments

Karam Mahfod (ITMO University).
Scientific supervisor – associate professor (qualification category "ordinary associate professor"), Vladimir Bogatyrev

Introduction. The necessity for dynamic reconfiguration in multipath networks is becoming increasingly critical in the modern landscape of digital communications, where network traffic exhibits unpredictability and constant evolution. This project is devoted to the development of a sophisticated algorithm capable of adaptively managing network resources in response to these changes. By integrating artificial intelligence (AI) methodologies, we aim to significantly enhance the network's capability to self-adjust in real time. This integration not only allows the network to respond promptly to immediate traffic demands but also to predict and mitigate future network conditions, effectively preventing congestion and potential failures [1]. The innovative aspect of our project lies in the application of machine learning techniques for analyzing network data, which empowers the algorithm to make decisions in real time, thereby optimizing network performance and ensuring reliability.

Main Part. Our project's methodology is composed of several critical components. These components are integral to achieving our vision of a dynamically reconfigurable multipath network system:

1. Reconfiguration Algorithm Design: We are in the process of developing an algorithm that leverages real-time network data to dynamically adjust traffic distribution across multiple paths. This design aims to ensure efficient data transmission while significantly reducing the risks of network congestion and potential failures. Utilizing advanced AI techniques, the algorithm will be capable of assessing network conditions and making immediate, intelligent adjustments. This represents a major advancement over traditional static routing methods, offering a more flexible and efficient approach to network traffic management.

2. Incorporation of Machine Learning for Predictive Analysis: A central feature of our algorithm is the integration of machine learning to predict network trends and identify potential problem areas. By analyzing a combination of historical and current network performance data, the algorithm is capable of forecasting future network states. This proactive adjustment is essential for pre-empting network issues, ensuring a consistent and reliable network service, and reducing downtime caused by unpredictable network behavior [2].

3. Comprehensive Testing Through Simulations and Real-World Trials: To validate the practicality and effectiveness of our algorithm, extensive simulations, followed by rigorous real-world tests, will be conducted. These tests are crucial in evaluating the algorithm's performance across different network environments and scenarios, ensuring its adaptability and robustness in actual network applications. This testing phase is vital for refining the algorithm, confirming its effectiveness, and preparing it for deployment in real-world network settings [3].

In conclusion. This project endeavors to revolutionize the way multipath networks are managed by introducing a dynamic, intelligent reconfiguration mechanism. The anticipated outcome is a significant enhancement in network adaptability, efficiency, and reliability. By employing an algorithm that is both reactive to current network states and anticipatory of future network conditions, we expect to see a transformative improvement in network management. This project not only aims to overcome the existing challenges in network technology but also sets a new standard for future network innovations [4].

List of sources used:

[1] S. Kandula, D. Katabi, B. Davie, A. Charny, "Walking the Tightrope: Responsive Yet Stable Traffic Engineering," ACM SIGCOMM Computer Communication Review, 2005.
[2] Z. Cao, Z. Wang, E. Zegura, "Performance of Hashing-Based Schemes for Internet Load Balancing," IEEE Infocom, 2000.
[3] A. Elwalid, C. Jin, S. Low, I. Widjaja, "MATE: MPLS Adaptive Traffic Engineering," IEEE Infocom, 2001.
[4] M. Khattar Awad, M. Hassan Hafez Ahmed, A. F. Almutairi, I. Ahmad, "Machine Learning-Based Multipath Routing for Software Defined Networks," Journal of Network and Systems Management, vol. 29, article no. 18, Jan. 20, 2021.