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A discernment of round-robin vs SD-WAN load-balancing performance for campus area network

Anazel P. Gamilla[1], Anjela C. Tolentino[1], Reina T. Payongayong[2]
[1]Department of Information Technology, College of Engineering, Central Luzon State University, Munoz, Philippines
[2]Department of Information Technology, Baliwag Polytechnic College, Baliwag, Philippines

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ABSTRACT

Efficient load balancing is crucial for optimizing network performance and ensuring seamless connectivity in modern campus area networks (CANs). With the proliferation of data-intensive applications and the increasing reliance on cloud-based services, organizations are seeking effective load-balancing solutions to distribute network traffic evenly across available resources. The continuous improvement of devices, tools, and techniques to cater a large amount of network traffic, started to be employed on different campuses. Understanding the best approach to maximize the utilization of the network resources is crucial in order to stabilize and maintain the network. The study aims to discern the round-robin and software defined-wide area network (SD-WAN) techniques based on defined metrics and conducted with a predefined payload for commonly used application conditions. The analysis shows that SD-WAN delivers a much superior performance than round-robin based on the criteria. The local area network (LAN) test shows difference between the two types of technology for the three given metrics. The WAN test shows that the round-robin has higher packet loss, latency, and jitter than the SD-WAN technology. While round-robin may suffice for small-scale deployments with relatively homogeneous traffic patterns, SD-WAN offers more sophisticated capabilities for larger CANs with diverse application workloads and distributed locations.

Corresponding Author:

Anazel P. Gamilla
Department of Information Technology, College of Engineering, Central Luzon State University
Munoz, Philippines
Email: apgamilla@clsu.edu.ph

1. INTRODUCTION

In today's interconnected world, campus area networks (CANs) play a crucial role in facilitating seamless communication and data exchange within educational institutions, large organizations, and business campuses [1]. As the number of users on campus increases, the available resources decrease, resulting in a latency issue between users and service providers [2], [3]. With the ever-increasing demand for network resources and the emergence of data-intensive applications, efficient load balancing becomes paramount to ensure optimal performance and user experience in CANs. To address these challenges, load balancing techniques are employed to distribute workloads across the network or servers to prevent system overload and ensure efficient and expeditious handling of all requests [4]-[7]. By uniformly distributing network traffic, this enables you to avoid resource failure brought on by resource overload [8]-[10]. However, there are several problems that can affect the performance of devices such as inefficient algorithms, lack of flexibility, scalability issues, and limited visibility [11].

This study aims to discern and compare the performance of the round-robin load-balancing algorithm and the implementation of software defined-wide area network (SD-WAN) in a campus-wide network setup. The evaluation is conducted through a comprehensive analysis of specified testing parameters, considering the effectiveness and efficiency of each load balancing-approach [12]-[14]. This research assists the remodeling and administration in changing their preferences toward the current network on the campus and examines if there is a significant difference between the two technologies.

2. METHOD

2.1. Current network setup

The research was conducted at the university's network operation center (NOC) as shown in Figure 1. The current network architecture applies traditional methods that employ a static network that consists of three: data planes, control, and data management. The environment sets up with two types of hardware: one will utilize the round-robin and the SD-WAN [15]-[17]. The CAN provides two (2) internet services, and the router and switch equipment manages the network through virtual local area network (VLAN) and load balancing to support various offices. The network applies the multi-layer network model which contains an edge router at the network's edge that manages new traffic into the network. The core router is responsible for packet forwarding, acting as a link between other core routers, and managing the network's VLANs. The core switch and distribution handle internal network connectivity.

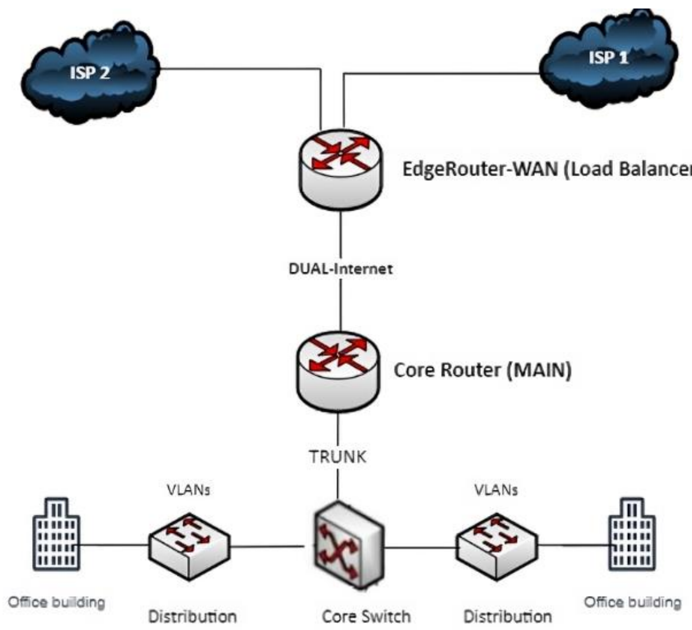

Figure 1. Campus area network setup

2.2. Experimental setup

The edge router in the network is tested using two separate routers that handle round-robin and SD-WAN load balancers as shown in Figure 2. Client requests are distributed to application servers in rotation using round-robin mechanisms [18]-[20]. The test runs locally and online during the busiest time of day on campus. It provides a more accurate view of the two types of technology interacting while transferring data for both internal and external transactions [21]. The testing was executed directly to the edgerouter to avoid distractions and constraints, and the subsequent is done at the WAN setup with specific settings for each condition. Given that there are two internet service providers (ISPs) on the network, each method dynamically implements the quality of service (QoS) approach. Each algorithm uses different approaches, like round robin ensure fairness in resource allocation among different network connections or paths, while the SD-WAN dynamically optimizes resource allocation based on real-time network conditions, application requirements, and predefined policies.

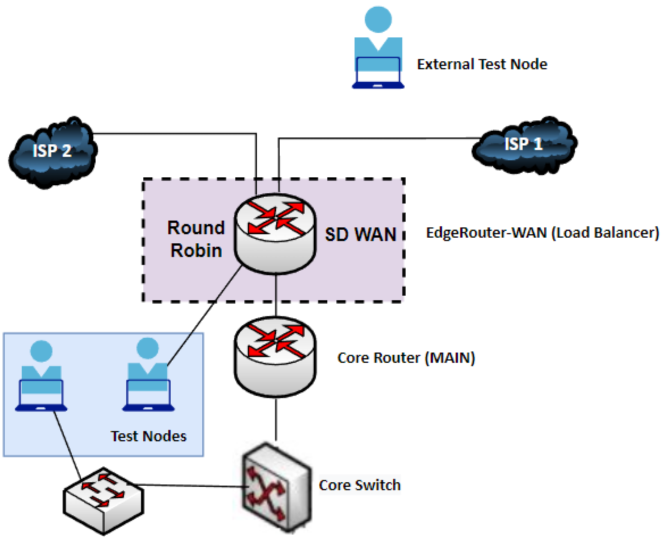

Figure 2. CAN test setup

2.3. Network performance evaluation

The test scenario is conducted based on the ability to handle are among the measures used to evaluate the two scenarios. The packet loss (also known as "packet drop") is used to determine the percentage of packets that are unable to be delivered. Latency, often known as ping or delay, is the amount of time it takes for a message to travel from your computer to a server and back. Lastly, the Jitter test is used to determine how variable your latency is. In a nutshell, it shows how consistent your delay is. The measurements used are based on the industry standard for assessing network performance [22]-[25]. These tests play a crucial role in load-balancing scenarios as they help assess the efficiency of load distribution mechanisms and identify potential areas for improvement to achieve optimal network performance. Collectively, packet loss, jitter, and latency tests provide valuable insights into the performance characteristics of a network. The test scenario is conducted with a predefined payload for selected application conditions that are regularly used such as Zoom, 1080p gaming stream, and 720p H264 Webrtc stream transmitted to the server to obtain the required output for data measurements that will be used to evaluate the network's performance. The test settings include the following condition: packet size, frequency, duration, and acceptable delay. A percentage difference is used to show the variance between the two technologies that are expressed as a percentage.

3. RESULTS AND DISCUSSION

3.1. Test results

This section covers the comprehensive network test results, including packet loss, latency, jitter, and local area network (LAN) test. By examining the results within the broader framework of network management and optimization, this provides the foundation for informed decision making and continuous improvement of network performance and reliability.

3.1.1. Packet loss test results

The test was set by transmitting packets which define the packet size of 5.56 MB of data, a frequency of 250 pings per second that gives a total of 2500 pings for a duration of 10 seconds, and an acceptable delay of 250 milliseconds, with 10 test runs for each type of application. Figure 3 and Table 1 Zoom testbed show that the packet loss occurs more in the round-robin type of load balancing which has an average of 81.70% packet loss for round-robin and 57.05% in SD-WAN. The condition set for a 1080p game stream was tested with the same predefined condition of 6.67 MB of data with a frequency of 300 pings per second with a total of 3000 pings for the 10 seconds duration and an acceptable delay of 50 milliseconds for 10 tests runs for the three defined preset approximation. This exhibits that the packet loss is more extreme in the round-robin with an average of 85.14% compared to 62.53% in the SD-WAN technology. With the identical conditions and defined prerequisites of 6.32 MB of data, a frequency of 284 pings per second, a total of 2840 pings for a length of 10 seconds, and an acceptable delay of 100 milliseconds, another ten test runs revealed 80.11% packet loss in round-robin and just 59.79% in the 720p H264 Webrtc stream.

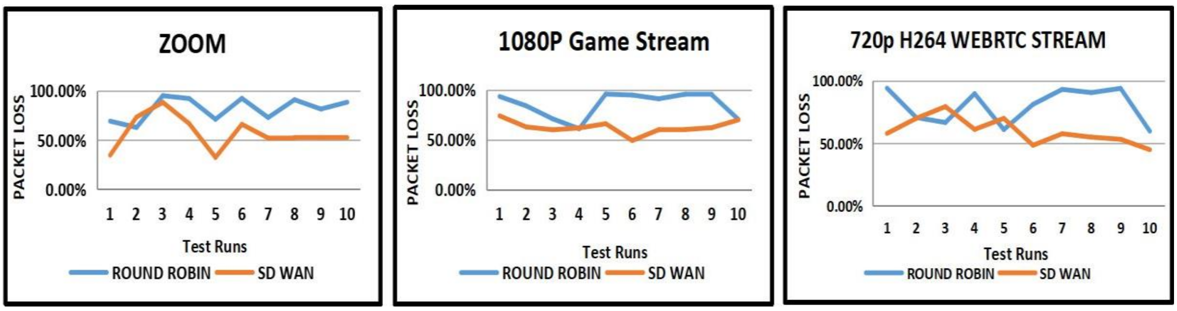

Figure 3. Packet loss test results

Table 1. Packet loss average test results

Test condition	Round-robin (%)	SD-WAN (%)
Zoom	81.70	57.05
1080p game stream	85.14	62.53
720p H264 Webrtc stream	80.11	59.79

3.1.2. Latency test results

The latency was tested with the same predefined condition with 10 test runs for the three defined preset approximations. Figure 4 and Table 2 show that the standard round-robin has an average latency of 4882.72 ms, which is slightly higher than the SD-WAN, which has a latency of 3967.96 ms. The SD-WAN detected an average of 5040.51 ms in the 1080p game stream, but only 4173.24 ms in the SD-WAN. The same thing happened with the 720p H264 Webrtc stream, with 4899.52 ms being detected on one side and just 3970.07 ms on the other one.720p H264 Webrtc stream.

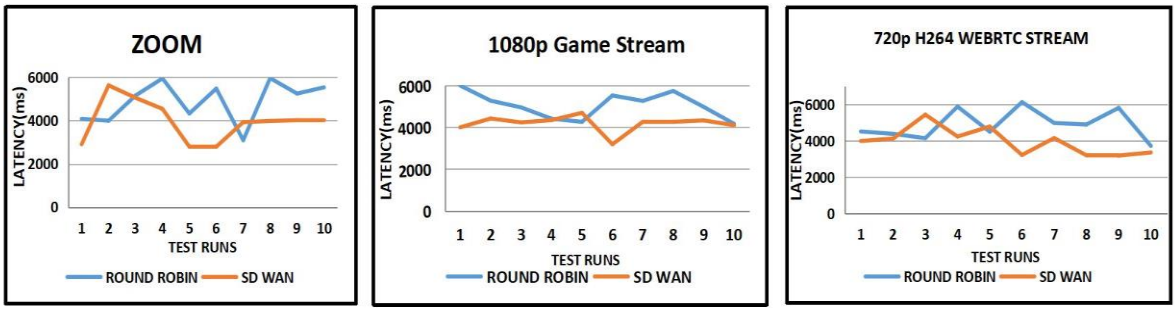

Figure 4. Latency test results

Table 2. Latency average test results

Test condition	Round-robin milliseconds (ms)	SD-WAN milliseconds (ms)
Zoom	4882.72	3967.96
1080p game stream	5040.51	4172.24
720p H264 Webrtc stream	4899.51	3970.07

3.1.3. Jitter test results

In analyzing the jitter test results, it shows the complex dynamics of network performance, highlighting different performance metrics in different streaming scenarios. The jitter test shows averages of 1855.184 ms for round-robin and 1523.264 ms for Zoom, with 2026.273 ms for the 1080p game stream and 1978.981 ms for the 720p H264 Webrtc stream, as shown in Figure 5 and Table 3. Furthermore, the 1080p game stream shows 1372.137 ms while the 720p H264 Webrtc stream shows 1320.86 ms.

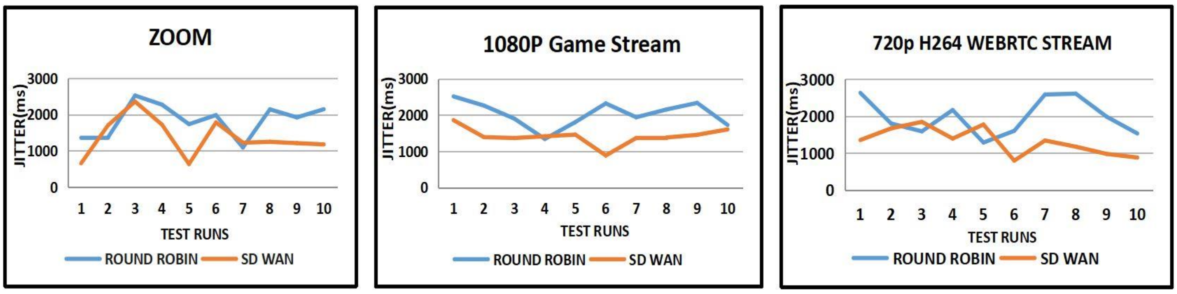

Figure 5. Jitter test results

Table 3. Jitter average test results

Test condition	Round-robin milliseconds (ms)	SD-WAN milliseconds (ms)
Zoom	1855.184	1523.264
1080p game stream	2026.273	1415.293
720p H264 Webrtc stream	1978.981	1320.860

3.1.4. LAN test results

Table 4 shows the local lan test which shows that there is a little difference between the two types of technology such as the recorded value for round-robin and SD-WAN was considered as good latency as well as for jitter and packet loss. The final WAN test average data for the 10 test run exhibit that the round-robin in the three types of condition has 35.5315%, 30.6223%, and 29.0493% difference or higher packet loss than the SD-WAN technology. The same with the latency, the round-robin is significantly higher with 20.671%, 18.8493%, and 20.9579% differences. Finally, a difference of 19.6493%, 35.5059%, and 39.888% was also detected in the jitter test. Exploring different directions for further study, we can continue to expand the understanding and develop more efficient, scalable and reliable load balancing solutions that meet the evolving needs of networks. Future research could explore the development of dynamic load balancing mechanisms that support machine learning or predictive algorithms to optimize load balancing and resource allocation.

Table 4. Local LAN test

Test condition	Round-robin	SD-WAN
Latency	24 ms	23 ms
Jitter	0.146 ms	0.118 ms
Packet loss	0%	0%

4. CONCLUSION

The evaluation of load balancing performance in the context of a CAN has demonstrated the advantages of SD-WAN over the round-robin approach. Through a comprehensive analysis of specified testing parameters, it becomes evident that SD-WAN offers numerous benefits that make it a more advantageous load-balancing solution in CAN environments. The discernment between SD-WAN and round-robin load balancing performance in CANs highlights the superiority of SD-WAN in terms of dynamic adaptability, scalability, fault tolerance, simplified management, and improved user experience. SD-WAN's ability to intelligently distribute traffic based on real-time network conditions ensures optimal performance, reduced latency, and efficient resource utilization. By leveraging SD-WAN, organizations can achieve enhanced network performance, improved user satisfaction, and seamless connectivity in their CAN environments.

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BIOGRAPHIES OF AUTHORS

Anazel P. Gamilla holds a Master's degree in Information Technology (MIT) from Tarlac State University (TSU), Philippines. An Instructor of the Department of Information Technology, College of Engineering, former Chief of Management Information Systems Office at Central Luzon State University (CLSU) and a Department of Information Technology and Communications Technology (DICT-ILCDB) trainer. Her current research interests include computer networks, SDN, and cyber security. She can be contacted at email: apgamilla@clsu.edu.ph.

Anjela C. Tolentino is a faculty member of the Department of Information Technology, College of Engineering in Central Luzon State University (CLSU), Philippines. A former Chief of the Department of Information Technology. She earned her BS degree in Information Technology major in Network Administration from Central Luzon State University and MS degree in Information Technology major in Network Administration from Nueva Ecija University of Science and Technology (NEUST), Philippines. Her research interests include networking, software development and application and data science. She can be contacted at email: anjelatolentino@clsu.edu.ph.

Reina T. Payongayong received a Bachelor of Science in Business Administration, majoring in Computer Management, from Baliuag University, Philippines, and a Master of Information Technology from St. Linus University, Philippines. An instructor in the Institute of Information Technology and Innovation Department at Baliwag Polytechnic College, Philippines. Her research interests include computer science and information technology, business and management, and education. She can be contacted at email: rpayongayong@btech.ph.education and reinapayongayong@gmail.com.