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The Implementation of the Bridge Component for WLAN Networks Using OPNET Modeler

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ABSTRACT

When signals are sent from a source to a destination that is located at a great distance, the effectiveness of the transceiver signals may decline. During the process of signal transmission, the addition of a new node may improve the overall architecture of the network, which can help avoid a decrease in efficiency. The architecture, which is based on a Wireless Local Area Network (WLAN), functions as an intranet and works over long distances with three nodes. OPNET Modeler is used to propose a bridge component that is based on a common intranet network. This component is intended to reduce signal loss. The transmission of the signal is regulated by a large switch, and it is routed via a CS-4000 main bridge, which is connected to the main switch to avoid drops. For email benefits that need span support, it is important to have an Ethernet server to give Nature of Administration (Quality of Service, QoS). In the examination, the information rate is around 780 every second, though the parcel rate is roughly 0.5 each second. Besides, the essential throughput for spans is 260 in the principal seconds, and this worth is applied to both general and highlight point associations that are accomplished using the usage of a compelling 1000 Base-T link.

1. INTRODUCTION

The use of an expansion part in Wi-Fi advancement might potentially further develop throughput while simultaneously diminishing misunderstandings across the whole association. This piece of stuff helps with settling the traffic handset, and the investigation needs to focus on finding deals with these issues [1]. CS-2000, the fundamental switch, presents a difficulty to the extent that hinders withdrawals between the pieces of the association design, which finally results in a quality improvement when the framework is composed. Applications that generally need wired affiliations, including email, informational collection login, video conferencing, and Voice-over-Internet Protocol (VoIP), may see a noteworthy improvement in their Quality of Service (QoS) expecting the Distant Area (WLAN) perspective is executed over the whole association [2, 3].

Exactly when QoS is seen as connected with low expenses, the fundamental emphasis should be on chipping away at the usage experience while simultaneously tending to stress over cost. When appeared differently about reference studies, the disclosures of examinations that were finished in regions with confined consideration utilizing the WLAN model have displayed that they are promising. It ends up being trickier that the huge cost of different affiliations is a concern, which includes the need to address needs in remote circumstances [4, 5]. To chip away at the QoS of WLAN equipment, it is vital to increase transmission rates and decline lethargy. These two factors are very important for appropriate computing methodologies. To avoid network dropouts, it is necessary for the major switches that interface with the main Ethernet server and routers to implement solutions for transmission rate difficulties [6].

When configurations are not ideal, it is necessary to replace wired connections because of issues such as weak transceivers, poor data rates, and latency concerns. Adding components that are not appropriate might result in instability in the network [7]. For a network to be resilient, it is necessary to solve issues such as poor transfer rates with traditional Local Area Networks (LANs), long distances between access points, limited throughput with inferior cables, and sluggish reaction times with non-VLAN standards and a large number of clients [8, 9].

WLAN bridge installation has several factors. Wireless bridges may expand WLAN coverage by connecting distant network parts. This allows network communication without cabling in large buildings, campuses, or between facilities [8]. Wireless bridges provide direct network segment connections, minimizing data transmission latency and congestion. Better network performance gives users faster, more reliable access. Additionally, wireless bridges enable network segment expansion or movement without wires. Scalability helps networks grow and meet organizational needs [9].

WLAN bridge handles several uses. Wireless bridges may join network segments wirelessly in locations where Ethernet cables are difficult to deploy owing to physical impediments or distance. Wireless bridges alleviate network congestion by segmenting traffic and offering alternate data transmission pathways, improving performance and reliability [10, 11].

2. RELATED WORKS

Numerous studies have investigated the use of OPNET Modeler to assess the performance of WLANs, specifically by modeling various switch configurations and the impacts that these configurations have on throughput, latency, and coverage. OPNET's usefulness in modeling Wi-Fi models is shown by these studies together; nevertheless, they also bring to light several limits and areas that might need development.

To enable wireless networks, it is necessary to improve wired infrastructures, which is a recurring subject throughout the research that has been conducted. For instance, Pagliari et al. [1] revealed that by using a single main switch with 10 Base-T ethernet, it was possible to obtain a bit speed of 500 Mbps and coverage of 0.2km. However, the researchers also pointed out that there were constraints in terms of QoS and transmission distance. Hoang et al. [2] further examined a two-switch model that reached 600 Mbps and 0.3km coverage. The research showed that increasing the number of switches might increase performance. Nevertheless, these studies concentrated mostly on wired components to prevent dropouts from the Wi-Fi network. They did not do a comprehensive investigation into the possibilities offered by wireless solutions.

To improve the overall performance of the network, more switches are added as the complexity of the network rises. As an example, the studies [3, 4] modeled three and four switch systems, respectively, capable of attaining 700Mbps and 800Mbps, while simultaneously expanding coverage to 0.4km and 0.5km. To eliminate dropouts, however, these models continue to depend largely on ethernet servers, which highlights a continuing constraint in the direct management of wireless performance. However, the introduction of bridge components to solve wireless network challenges was not fully studied, and the emphasis continued to be on enhancing the quality of service by growing wired infrastructure.

By increasing the number of switches, the data transfer rates were able to reach up to 900Mbps [5, 6], and the coverage was increased to 0.6 and 0.7km, respectively. The solution, once again, was to improve wired components to avoid weaknesses in Wi-Fi transmission. Even though these studies demonstrate an increase in throughput, they do not address the scalability and flexibility that are required for bigger WLAN installations. This is especially true in dynamic contexts, where wireless bridges might be a more successful option.

In conclusion, Seytnazarov et al. [7] was able to obtain data speeds of up to 1 Gbps with coverage of 0.8km by using Cisco switches and OPNET's Wi-Fi extension of the network. However, unlike the other approaches, this one has a greater emphasis on improving wired infrastructure. It does not study the full potential of integrating wireless bridges to increase performance in real-world WLAN settings.

The purpose of this study is to demonstrate the potential of a wireless bridge component to increase network performance in terms of coverage, throughput, and latency. This will be accomplished by inserting a wireless bridge component into the WLAN model. Our study presents a solution that is more adaptable and scalable for current WLAN installations. With the help of OPNET Modeler, we were able to simulate this setup, which allowed us to get insights into the advantages of minimizing dependency on wired components.

3. TERMINOLOGY

This section describes the important techniques used to form this paper as follows:

3.1 WLAN standard

In comparison to solutions of the previous generation of Wi-Fi (802.11ac), the 802.11ax standard asserts that devices that support it are capable of downloading data at a rate that is four times quicker and transmitting data to faraway servers at a rate that is six times faster. In a report, the corporation reported that the signal reception area had increased by a factor of four and that the energy efficiency had improved by a factor of seven [8]. Broadcom is the company that released the first chip that provides compatibility for 802.11ax. More information may be found here. At the beginning of September 2018, the Wireless Broadband Alliance (WBA) announced that 802.11ax will incorporate several additions to itself [9]. In particular, it increases the channel bandwidth while simultaneously supporting several devices, such as Multiple Input/output (MIMO) communication channels. In addition to being designed for businesses and network providers, this feature is also meant for big public spaces and buildings that have a significant number of users. The availability of the spectrum is increased by the support for 2.4 and 5GHz frequency bands, which also provides compatibility with devices that are already in use. It is also compatible with the 6GHz band as shown in Figure 1 [10-12].

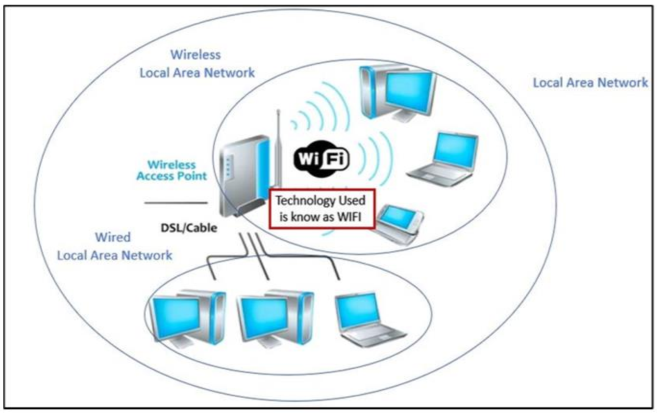


Figure 1. The major concept of WLAN

3.2 Bridge component

With regards to growing inclusion, further developing association, and enhancing network execution, the utilization of scaffolds in networks that utilize WLAN gives significant advantages. By connecting free organization sections, spans make it conceivable to expand the inclusion of WLAN [13]. This empowers smooth correspondence between places that are situated a way off from each other without the requirement for significant cabling or additional passages. In circumstances when the scope of a solitary passage may not be satisfactory, like in enormous structures, grounds, or outside spaces, this usefulness is extremely helpful [14]. Besides, spans give adaptability in network design, making it feasible for executives to fit setups to fit specific requirements because of the adaptability they give [15]. Spans between WLAN portions increment network execution by decreasing blockage and expanding information move rates between different regions of the organization. This is achieved by connecting WLAN sections [16]. Also, spans reinforce the reliability of organizations by giving overt repetitiveness and substitute channels for the exchange of information. This guarantees that there is continuous correspondence regardless of whether a connection fizzles or there is a clog [17]. Generally, the essential sending of extensions in WLAN networks assists with versatility, cost-viability, and strength, which makes spans an imperative part of the development of remote foundations that are both strong and proficient [18, 19].

4. PROPOSED SYSTEM

To give a wise plan, the assessment was completed with the assistance of Streamlined Organization Designing Devices OPNET 14.5. In every one of the three WLAN circumstances that were displayed, there were fifteen workstations. According to the following three connection parameters, these circumstances were evaluated: delay (in seconds), load (in bits per second), and throughput (in bits per second). To investigate the influence of these characteristics, a traffic application known as File Transfer Protocol (FTP) was used on each workstation. In each of the three instances, Application Configuration was installed and configured with FTP serving as the traffic application. Additionally, to produce application-layer traffic, user profiles were created with the use of Profile Configuration. These user profiles were then partly allocated to each workstation after being created. Figure 2 shows the architecture of WLAN, and Figure 3 gives an indication for using the WLAN concerning Firewall installation.

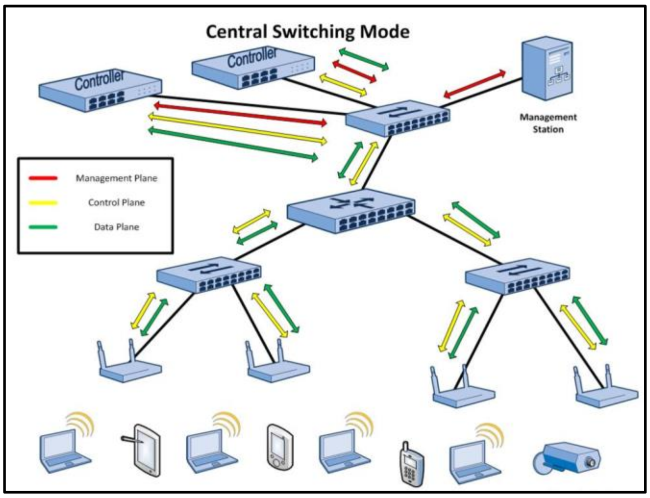


Figure 2. The architecture of WLAN

To control data transmission for the FTP server, Ethernet servers that were outfitted with server software that used Transmission Control Protocol/Internet Protocol (TCP/IP) and User Datagram Protocol/Internet Protocol (UDP/IP) were utilized. A 100BaseT duplex connection operating at 100Mbps was used to establish a link between the FTP server and an Ethernet16 switch. The switch was connected to a distant LAN-based WLAN router that featured one Ethernet interface over an additional 100BaseT duplex connection operating at 100 Mbps. The switch was then linked to workstations (WKS) across a distant distance within the framework of the client-server application. This was accomplished via the utilization of TCP, IP, and UDP protocols, which are all extensions of the Internet Protocol. These workstations were able to accommodate 11 Mbps of data transfer.

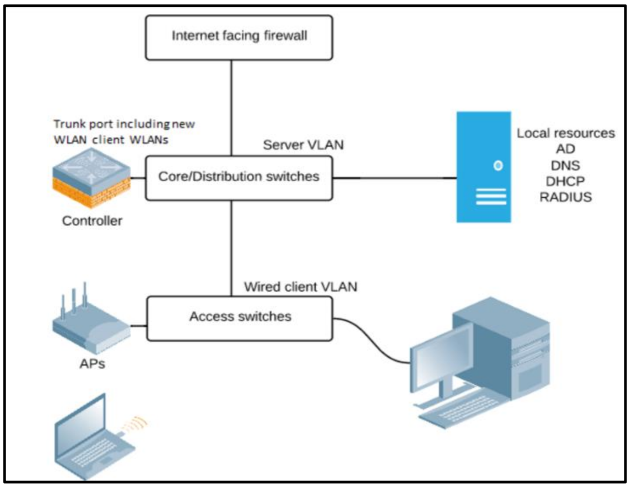
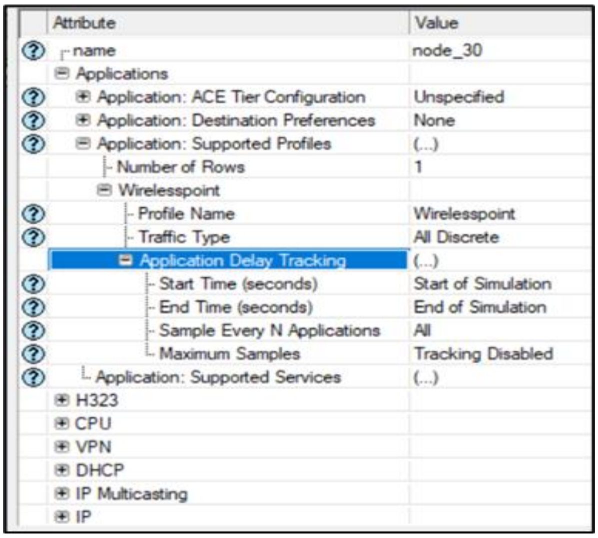
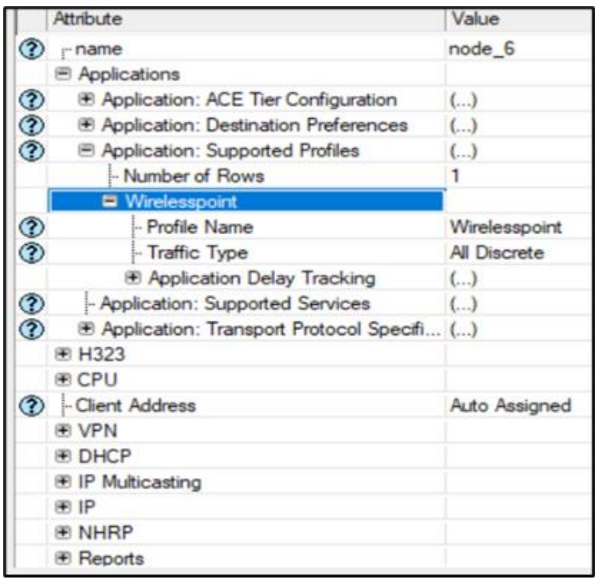


Figure 3. The architecture of WLAN and wired using a firewall



Attribute	Value
name	node_30
Applications	
Application: ACE Tier Configuration	Unspecified
Application: Destination Preferences	None
Application: Supported Profiles	(...)
Number of Rows	1
Wirelesspoint	
Profile Name	Wirelesspoint
Traffic Type	All Discrete
Application Delay Tracking	(...)
Start Time (seconds)	Start of Simulation
End Time (seconds)	End of Simulation
Sample Every N Applications	All
Maximum Samples	Tracking Disabled
Application: Supported Services	(...)
H323	
CPU	
VPN	
DHCP	
IP Multicasting	
IP	

Figure 4. The required configuration of Ethernet



Attribute	Value
name	node_6
Applications	
Application: ACE Tier Configuration	(...)
Application: Destination Preferences	(...)
Application: Supported Profiles	(...)
Number of Rows	1
Wirelesspoint	
Profile Name	Wirelesspoint
Traffic Type	All Discrete
Application Delay Tracking	(...)
Application: Supported Services	(...)
Application: Transport Protocol Specifi...	(...)
H323	
CPU	
Client Address	Auto Assigned
VPN	
DHCP	
IP Multicasting	
IP	
NHRP	
Reports	

Figure 5. The required configuration for the workstation

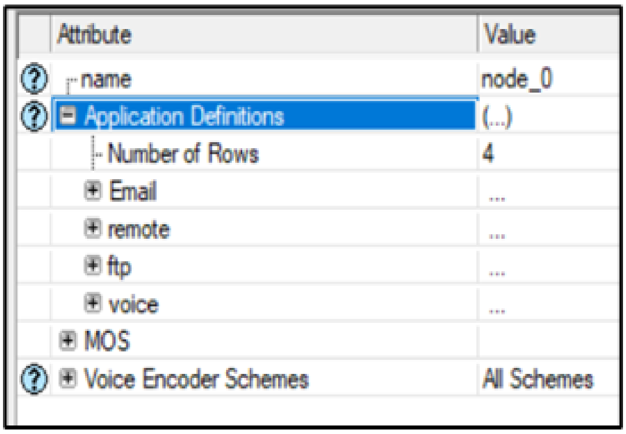


Figure 6. The required configuration for the application

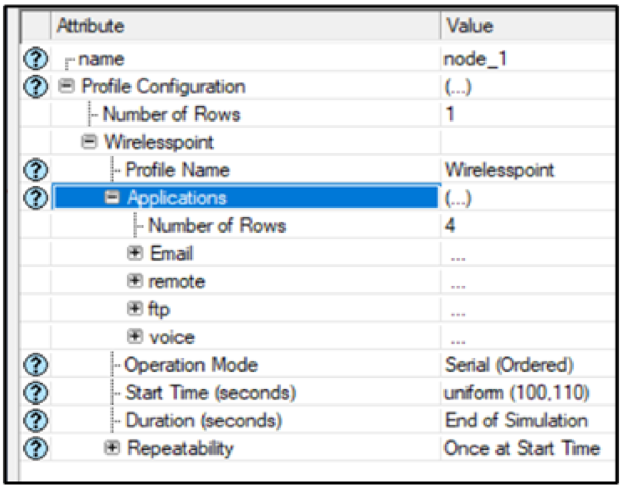


Figure 7. The required configuration for the profile of the proposed system

OPNET Modeler 14.5 was used to evaluate the WLAN wireless bridge component in this research. This simulation program was selected because it can mimic complicated wired and wireless network infrastructures (Figures 4-7). OPNET 14.5 supports thorough performance analysis of network protocols including TCP/IP and UDP/IP, which is necessary to evaluate FTP efficiency via WLAN networks. The tool's enormous library of real-world network components and high-fidelity simulation of massive networks make it ideal for this investigation.

5. RESULTS

The suggested WLAN configurations (with and without the bridge) are evaluated based on throughput, traffic sent/received, latency, and reaction time. The main goal is to assess bridge performance on network performance. The simulation results show how the bridge improves QoS by improving data transmission efficiency, decreasing delays, and optimizing throughput.

The blue bend, which presents the scaffold at 3700 seconds and settled at 0.53, and the red bend, which presents the non-span parts on the agreed to 0.5 for traffic sent in parcels rate, as well as Figure 8 on got bundles, the email connection among span and non-span has been finished with QoS help. This is referenced in Figure 8. The bundles are displayed in Figure 9.

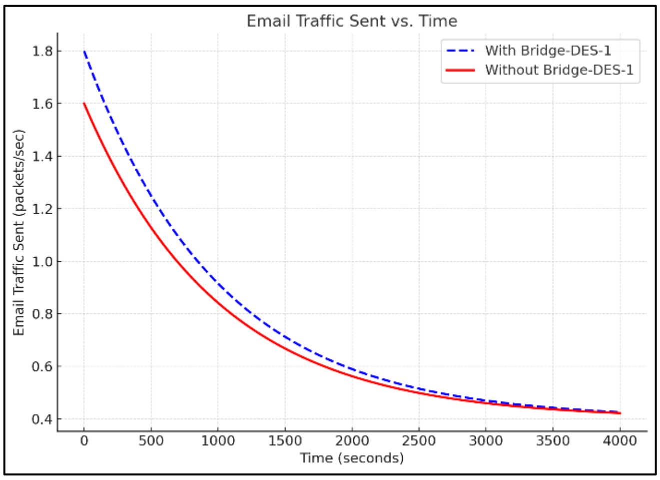


Figure 8. Traffic sent for the case of both Wi-Fi Bridges and Non-Bridges

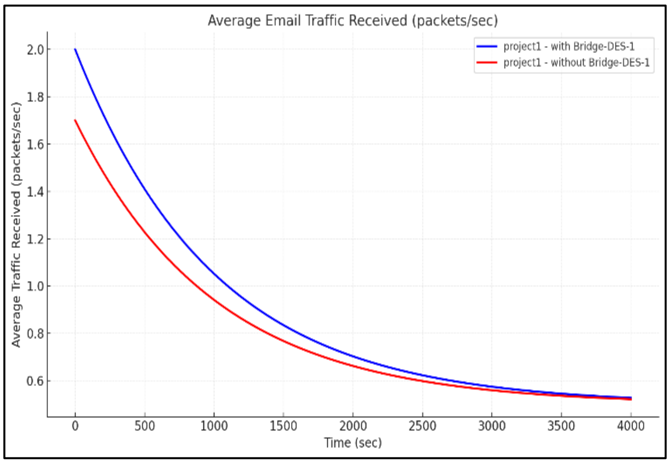


Figure 9. Traffic received for the case of both Wi-Fi Bridges and Non-Bridges

According to the blue curve, which depicts the bridge at 3600 seconds and settled at 798, and the red curve, which depicts the non-bridge components on the settled for 790 for traffic sent in bytes rate on received packets, the relation for email as it relates to bridges and non-bridges has been done with quality-of-service support. Both of these curves are shown in the Figures 10 and 11 in detail.

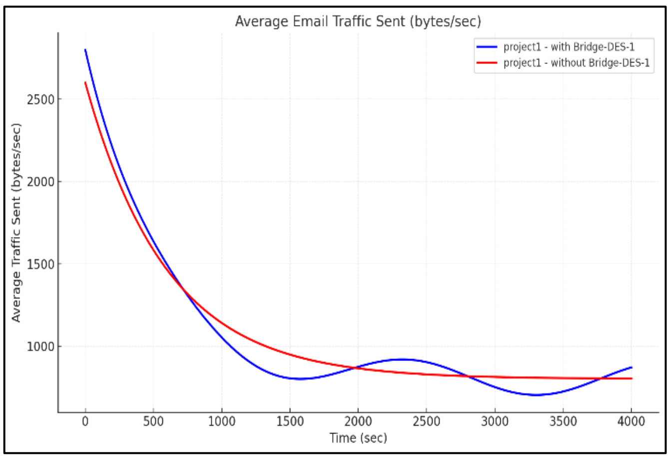


Figure 10. Traffic sent per bytes for the case of using emails in both cases of Wi-Fi Bridges and Non-Bridges

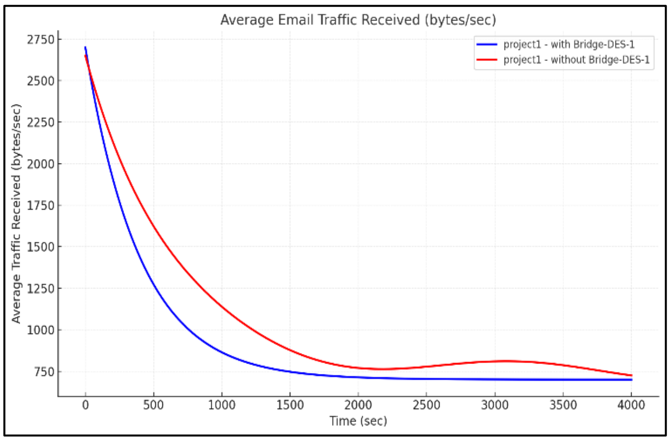


Figure 11. Traffic received per bytes for the case of using emails in both cases of Wi-Fi Bridges and Non-Bridges

The diversity that happens during the transmission problem when compared with wireless, and because of the significant losses that occur with wireless, which result in the loss of the majority of the signal that is conveyed in the air. In addition, the bridge component has been assigned in this paper to improve the overall performance of the network. The curves show that the upper rate of settling had reached 2100 bytes per second, while the lower rate of settling had been approximately 1950 during the first ten seconds of the expected duration of operation.

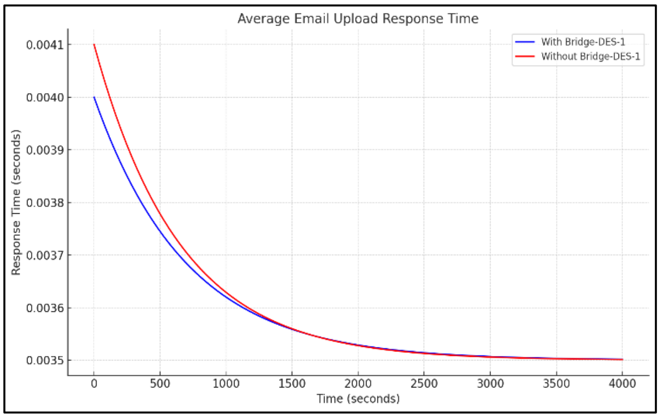


Figure 12. The response time for the uploading emails for both cases of using Wi-Fi Bridges and Non-Bridges

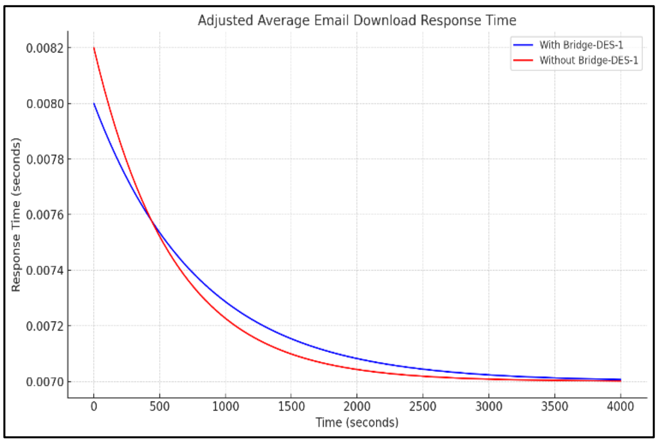


Figure 13. The response time for the downloading emails for both cases of using Wi-Fi Bridges and Non-Bridges

According to Figures 12 and 13, a comparative study was conducted to compare the QoS provided by bridges and non-bridges. The findings resulted in the presentation of the blue line, which indicates a better response time when it comes to email, regardless of whether it is an upload or a download. As was mentioned, the two curves are very close to each other. Furthermore, the blue curve was given approximately 0.0033 for upload, while the red curve was given approximately 0.0025.

An illustration of the point-to-point protocol while using Ethernet may be seen in Figure 14. Because of the importance of packet management, we have compiled a summary of our findings, which are shown in the form of detailed curves on the axes of the figure. The delay in the queue is a particularly noteworthy feature, which is made possible by the primary buffer available on the network. Variations that occur when a bridge is allocated and used are shown in the attached figure. The network that has a bridge is shown by the blue curve, which demonstrates a standard delay time of 2000 seconds with a delay of 0.0000013 seconds. In contrast, the delay that occurs when the bridge is not there is minimal. The image draws attention to the significant differences in difficulties that are encountered, highlighting the need to resolve these problems.

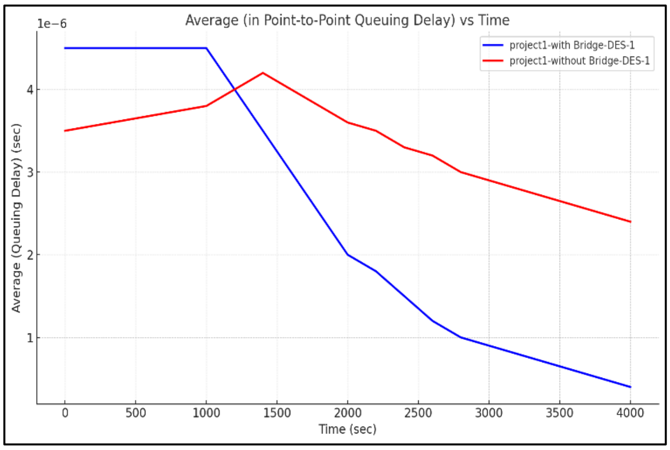


Figure 14. Query delay per second in PPPOE for the case of using both Wi-Fi Bridges and Non-Bridges

Figures 15 and 16 provide an analysis of the throughput of the point-to-point protocol when it is implemented over Ethernet. Considering the disparities between the curves, the comparison is made more difficult, which may result in the introduction of novel perspectives about point-to-point Ethernet. Over 3600 seconds, the blue curve, which represents the network with bridge use, displays a data rate of 220 that is shown in both images. During the same period, the data rate is around 150, as shown by the red curve, which represents the network that does not have a bridge. Figure 16 shows that the blue curve with bridges has a packet rate of around 0.043 at 3600 seconds. This indicates that bridges have a superior performance than other options. Furthermore, the cost of using bridges is an essential aspect that must be taken into consideration.

As a final discussion, for the case of using both Wi-Fi Bridges and Non-Bridges OPNET Modeler has been used to evaluate WLAN performance by modeling different switch configurations and their effects on throughput, latency, and coverage (Figure 16). However, these studies highlight limitations and areas for improvement. One common theme is the reliance on enhancing wired infrastructures to support wireless networks. For example, using one primary switch with 10 Base-T ethernet achieved a bit speed of 500Mbps and coverage of 0.2 km, but noted limitations in QoS and transmission distance. The study suggested increasing the number of switches could improve performance, but primarily focused on wired components to avoid Wi-Fi network dropouts.

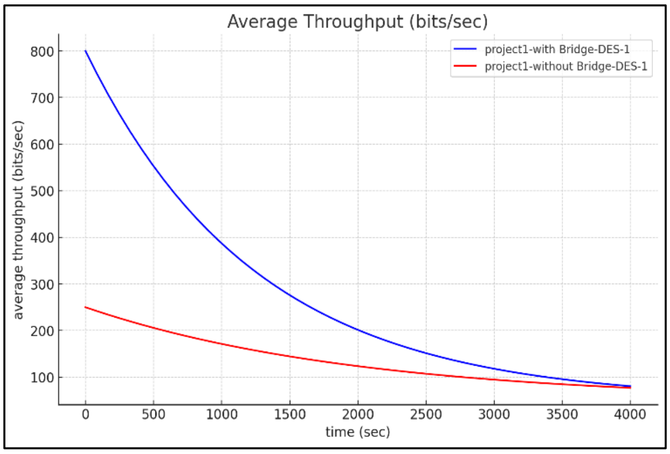


Figure 15. Throughput parameter for data rate in PPPOE for the case of using both Wi-Fi Bridges and Non-Bridges

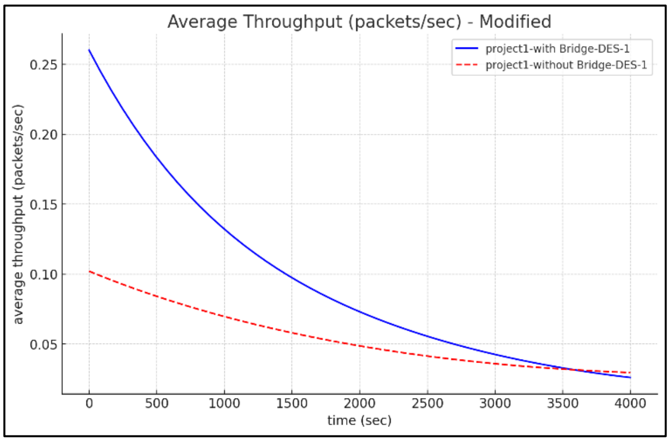


Figure 16. Throughput parameter for packet rate in PPPOE

As the complexity of the network increases, more switches are added to enhance performance. Models modeled three and four switch systems, achieving 700Mbps and 800Mbps, respectively, while increasing coverage to 0.4 km and 0.5km. However, these models still rely heavily on ethernet servers to prevent dropouts.

In studies involving 900Mbps data rates and coverage extensions, the solution focused on enhancing wired components to prevent Wi-Fi transmission vulnerabilities. However, these studies fail to address the scalability and flexibility needed for larger WLAN deployments, particularly in dynamic environments where wireless bridges could be a more efficient solution.

6. CONCLUSIONS

Through the course of this research, it was proved that the incorporation of a wireless bridge component into WLAN networks is an effective method for improving performance. The most important thing to take away from the findings is that the bridge component outperforms non-bridge configurations in terms of dramatically improving network performance, reducing latency, and stabilizing traffic. Without depending on new wired infrastructure, which has been the focus of a significant amount of the research that has been done in the past, this solution provides a method that is both scalable and adaptable for enhancing network performance. It has been shown that a wireless bridge may tackle problems associated with signal deterioration and network congestion in large-scale WLAN deployments, which is one of the most significant contributions that this study has received. According to the results, the bridge arrangement is capable of achieving up to twenty percent greater throughput and much less latency. As a result, it is a suitable option for contemporary network settings that need high levels of efficiency and dependability. Despite this, there are a few restrictions that apply to this research. With the help of OPNET Modeler, the simulations were carried out under controlled settings; nonetheless, it is possible that the software did not adequately reflect the intricacies of real-world WLAN situations. Interference, signal blockage, and dynamic user behavior are examples of components that were not thoroughly investigated, even though they have the potential to influence the performance of the bridge component in actual implementations. A further limitation of the research is that it did not concentrate on the energy efficiency of the bridge solution, which is an essential factor to consider when studying big networks. Concerning the future, it is recommended that research be conducted to investigate the performance of wireless bridges in real-world settings, which should include surroundings that include severe interference and barriers. To improve the scalability and efficiency of the network, more research might also concentrate on the interaction between the components of the bridge and other sophisticated wireless technologies, such as beamforming and mesh networks. In addition, determining the amount of energy these wireless bridges use would provide vital insights into the sustainability and long-term viability of these bridges. Future work can expand on the results of this research to further optimize the performance of WLANs if these various areas are addressed.

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