مجلة كلية التربية الاساسية
كلية التربية الاساسية – الجامعة المستنصرية
Journal of the College of Basic Education Vol.30 (NO. 128) 2024, pp. 89-103

Performance Evaluation of Virtual Local Area Network (VLANs)

Amjad wahab taleb [(1)]
Directorate of Education Al-Muthanna, Ministry of Education, Iraq
ah.saadk92@gmial.com

Fatemeh Saf Ara [(2)]
Azad University, Department of Software, Mashhad, Iran
fsafara@yahoo.com

Abstract:

The medical, financial, and academic spheres can't function without cutting-edge technological advancements. When it comes to quality of service (QoS) metrics like latency, throughput, bandwidth, and security, today's technology relies on high-performance networks. The use of optimized network engineering tools has allowed for the simulation of both the wired and wireless environments on campus, including and excluding virtual local area networks (VLANs). Packets are only sent to ports that are part of the same virtual local area network (VLAN) when hosts are linked together in a VLAN. By using the distinctive VLAN network, we can enhance the performance of wireless networks while conserving bandwidth. Further, VLANs significantly improve security of wireless network by limiting the hosts amount receiving duplicate frames broadcasted by switches; This enables hosts to keep sensitive data on a separate VLAN. The study examines wireless networks and compares them to VLANs via wireless networks. With the use of online surfing apps and transfer of files in environments with high-traffic, the suggested network is tested for latency and average throughput. By using VLAN technique to partition the region of network's broadcasting, the traffic has been substantially reduced, hence alleviating the network's workload. The use of VLAN significantly enhanced WLAN performance by mitigating wireless delay, according to the findings of the simulation run using the OPNET 14.5 modeler. With time, we looked at how protocols of adhoc routing like DSR,AODV, OLSR, GPR, and TORA may boost the wireless VLANs efficiency.

Keywords: Networks, Wireless, Virtual, Service, Access Points.
Note: The research is based on an M.A thesis or a PhD dissertation (No).

1. Introduction:

Wireless Local Area Networks (WLANs) provide users the freedom to move their devices from one place to another while still being able to access and exchange data, apps, and other network resources via radio transmission [1][2]. Wireless fidelity, or Wi-Fi, is the de facto standard for data transmission in WLANs. The requirement for high-speed data rates prompted the development of several standards, one of the most popular of which being the IEEE 802.11 standard, which is used for data transport in many modern wireless networks [3][4]. Table 1 displays the current most popular protocol [5].

Table 1. Various WLAN Standards summary

Standards	Max. Data Rate	RF Band	Range
IEEE 802.11a	54Mbps	5GHz	50 – 100m
IEEE 802.11b	11Mbps	2.4GHz	50 – 100m
IEEE 802.11g	54Mbps	2.4GHz	50 – 100m
IEEE 802.11	2Mbs	2.4GHz	50 – 100m

The WLAN infrastructure consists of Access Points (APs) and wireless stations, as shown in Figure 1. The capacity of each AP to accommodate wireless stations is specified by its specifications. A UTP cable may span a distance of up to 100 meters, connecting the network of wireless to the network of Ethernet between the access point and the switch or hub [6]. The Service Set identification (SSID) is a distinct identification assigned by a programmer to a wireless network. It enables mobile devices to move freely and establish automated connections with an access point device [1].

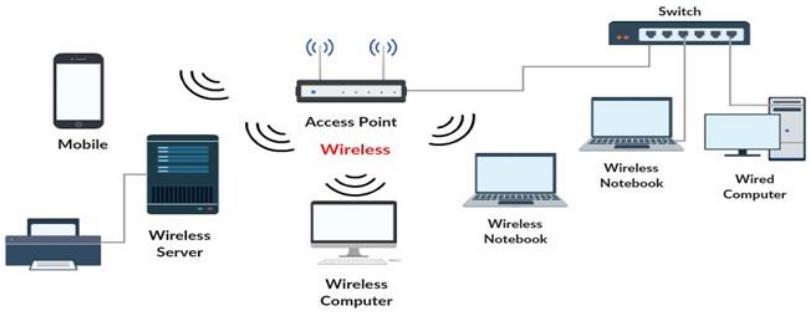

Figure (1). Wireless infrastructure diagram

In a standard Local Area Network (LAN), all nodes are physically situated inside the same LAN and do not need a router. This arrangement is referred to as a broadcast domain. The user's text is [7]. A virtual local area network (LAN) may be defined as a devices group that are linked to different physical segments of LAN but can communicate with each other as if they were on the same LAN. VLANs enable switches to split the network into broadcast with separate domains without delay [8]. When utilizing a VLAN trunk to connect switches that enable multi-Networks of VLANs to traverse the same connections of Ethernet, each frame transmitted between switches is tagged to indicate the VLAN it belongs to. As shown in Figure (2). The VLAN protocol is derived from the IEEE 802.1Q standard, which determine the structure for labelling frames [7].

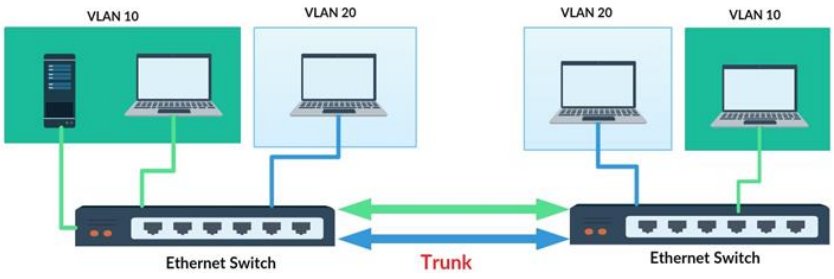

Figure (2). Network with two VLANs

Virtual local area networks (VLANs) provide many benefits, including decreased broadcasting, streamlined management, and the capacity to implement security measures [8][9]. The following are the primary advantages of VLAN :

Implementing virtual local area networks (VLANs) may enhance the performance of a network. These networks partition a vast broadcasting zone into smaller ones, therefore decreasing the volume of superfluous traffic. By

restricting packet transmission to just the ports inside the same VLAN, it is possible to decrease latency and overhead, as well as save bandwidth .
From an organisational perspective, VLANs are very effective for the purpose of logically grouping hosts based on departments or responsibilities. This makes them far more manageable compared to a larger broadcast domain .

-Safety measures: Unauthorised individuals inside the same network may be able to access sensitive information. However, by establishing virtual local area networks (VLANs), the number of devices that get copies of data packets broadcasted by switches may be greatly decreased. This allows for sensitive data to be stored on a different VLAN, ensuring better security .

-Cost savings: VLANs provide a more economical alternative to pricey routers for creating separate broadcast domains .
Infrastructure mode and adhoc mode are two operational modes specified by the 802.11 communications standard [10]. Wireless devices may establish connections with one another via access points in infrastructure mode, as seen in Figure 3. Typically, this mode is set as the default [6]. Figure 4 illustrates that wireless hosts have the capability to directly communicate with one other in ad hoc mode, without the need for an access point (AP). In this kind of network, each host functions as a client, and an point of access. An adhoc network is a temporary connection of network that enables hosts to interact with one other without using an point of access [12].

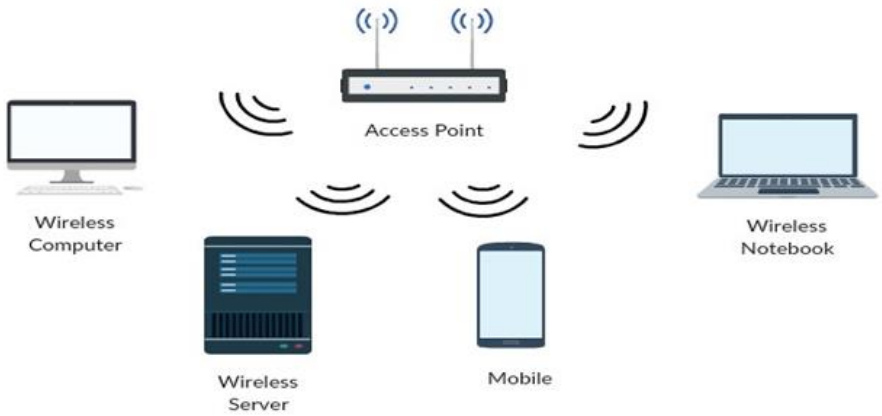

Figure (3). The infrastructure of 802.11 network has many modes of operating

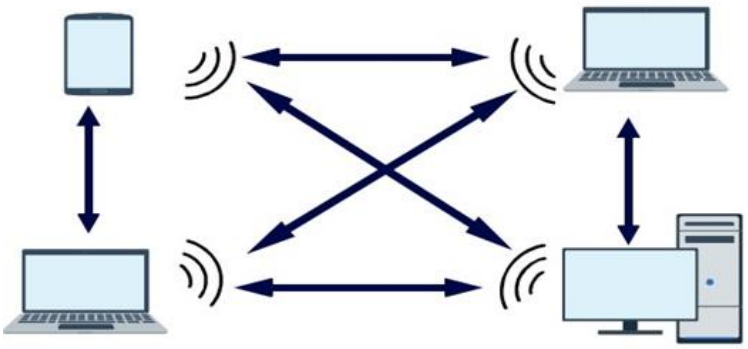

Figure (4). The operational modes of the 802.11 network are adhoc

The potential for enhancing the efficiency of wireless networks shown in this study is substantial. This section offers a succinct summary of wireless and VLAN networks, whereas the rest of the article is organized as follows: Section 2 of the document covers adhoc routing protocols, specifically focusing on the three primary categories of flat routing protocols: proactive, hybrid, and reactive. Section 3 presents a succinct summary of pertinent research in networks of wireless and networks of VLAN, In addition to the most important previous studies about the adhoc routing efficiency. Section 4 provides a comprehensive description of the simulation model, including the specifications of the tool, metrics, setup, and scenarios used to simulate three distinct network types: wireless networks, wireless VLAN networks, and wireless networks with VLAN, using protocols of adhoc routing. The outcomes of a comprehensive analysis of all the simulations carried out to provide the evaluated performance indicators are shown in Section 5. The conclusions are provided in section 6 depending on the completed task and performance evaluated.

2. Overview of adhoc routing protocols:

The strategies of routing that especially built for adhoc networks have a substantial influence on data transfer and network performance. Each routing protocol employs a distinct methodology to ascertain the most efficient route between nodes, since each node in the network serves as a router and aids in discovering and preserving routes to other nodes. Ad hoc networks often use one of three specific types of routing protocols: proactive, reactive, or hybrid [12, 16].

Proactive routing, also known as table-driven routing approaches, guarantees that each node in a network always has a route to every destination listed in its routing table. The user's text is [12]. Reactive routing techniques, often

called as at-request protocols of routing, include the node of source that creating routes just when data is prepared for transmission. If a path is not discovered, the protocol will start a route discovery process to find a method to the target [16]. The concept behind hybrid routing approaches is that nodes have the ability to be both proactive and reactive, based on their proximity to other nodes and the surrounding region [13]. The user's text is "[12]."
In this section, provides the routing operations performed brief overview by the well-recognized OLSR, AODV, GRP, TORA, and DSR protocols. Figure 5 depicts the methods of routing that were adopt it in this study.

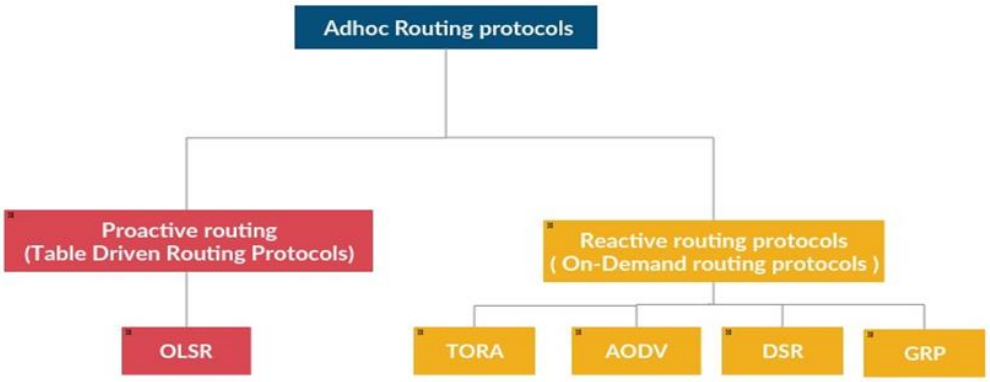

Figure (5). The protocols of adhoc routing

Optimized link state routing (OLSR) [17] is a proactive technique that employs a link state algorithm. Efficiently adjusting network parameters while minimizing the generation of superfluous control messages is crucial to the protocol's concept. Consequently, the responsibility for managing the transmission of control messages and the production of link status information in the network is assigned to a specific group of nodes referred to as Multi Point Relays (MPR). The decision of sharing status information with specific nodes is left to the discretion of individual MPRs [15].
Nodes that are not included in a selected route do not need to retain information of routing or participate in exchanges of routing table, resulting in less broadcast activity when using Adhoc On-Demand Distance Vector Routing (AODV) [13]. When a source node has to send data to a destination node but lacks knowledge of the route, it initiates the process of path discovery [14]. The user's text is "[18]."
Dynamic Source Routing (DSR) consists of two processes: discovery of route and management of route [13]. The DSR routing method is very efficient and simple. Upon receiving a request, the source node immediately initiates route

discovery to identify a path and adds the path information to the header of packet. Intermediate nodes only need to updated of maintain routing information if they are participating in discovery of route or maintenance [14][17]. The main objective of the temporally ordered routing Algorithm (TORA) is to minimise the quantity of control messages sent in a mobile dynamic environment [15]. For data to be sent to its intended destination, each node must make a query. In essence, the primary purpose of TORA is to build a route from the starting point to the destination, continuously maintain the accuracy of this route, and eliminate it if it becomes incorrect.

An example of a proactive routing strategy is the Geographic Routing technique (GRP). The GRP source node utilizes GPS with little user intervention to collect network data [16].

3. Previous Studies:

By implementing virtual local area networks (VLANs), you may reduce the amount of broadcast traffic, enhance network security, and organize hosts into logical groups within the same domain. It excels in performance, security, and bandwidth efficiency. The field of wireless and VLAN networks has garnered significant attention from several authors.

In 2012, Kadyamatimba A., Mbougni M. [17], Helberg Z. P. N. A., & Dube E., They evaluated routing protocols in mobile ad hoc networks using HTTP traffic simulations. The research provided performance insights, including the efficiency and reliability of different routing protocols.

In 2014, Meen P.K. [11], He used OPNET to simulate WLAN performance across various applications, assessing metrics like throughput and latency. The study identified performance variations and optimization needs for different application types.

In 2018, AL-Khaffaf D. A. J. [8], He analyzed LAN performance using IEEE 802.1Q VLAN switching techniques. The method involved simulations to enhance network efficiency, yielding improved throughput and reduced latency.

In 2021, Makeri, Y.A. et al. [9], they evaluated VLAN implementation to enhance network performance and security in enterprises. They used performance metrics and security assessments, finding VLANs improve both efficiency and protection.

In 2023, Nourildean, S.W. et al. [19], they tested ad hoc routing protocols in wireless networks to enhance VLAN performance. They used simulations to

find improved network efficiency and reduced latency with specific protocols.

4. Methodology: simulation model used:

4.1 Simulation Tool:

The simulations were conducted using the OPNET 14.5 simulator, which offers a realistic setting for creating, implementing, and assessing network situations using diverse metrics. This article explores the VLAN evaluation utilization on networks of wireless and checks the effect of five protocols of adhoc routing —DSR, GRP, AODV, TORA, and OLSR —on improving the performance of wireless VLANs in terms of throughput.

4.2 Simulation performance metrics:

This study considers two essential performance measures to evaluate the network:

• Latency: The time it takes for a packet to get from its source node to its destination. Performance is shown by a reduction in the duration of delay, which is quantified in seconds.

The network throughput refers to the mean rate at which data packets are sent and received successfully by all nodes. This measure is sometimes referred to as the packet delivery ratio. The measurement is expressed in units of bits per second. Throughput is a metric that quantifies the efficiency of a wireless network.

4.3 Simulation setup:

This is the setup for the simulation. Conducts a study to evaluate the efficacy of integrating VLAN into the wireless network, starting by analyzing the model of WLAN without and with VLAN. The setup is based on the concept of using two servers and two switches to provide a connection between two separate components. The simulations use models that include a square area of 1000 m × 1000 m. These models consist of twenty nodes, with each node being wirelessly connected to an access point using a distinct Basic Service Set (BSS). The IEEE 802.11b MAC standard, which allows for wireless data transmission speeds of up to 11 Mbps, was previously used [18]. Figure 6 depicts the wireless connection from PC1 to PC5 and access point 1, PC11 to PC15 and access point 4, PC6 to PC10 and access point 2, and PC16 to PC20 and access point 3.

Except for access points 2 and 4, which are connected to switch 2, all the other access points are linked to switch 1 using 100Base-T. ethernet server 1

is connected to switch 1 using a 100Base-T connection, while ethernet server 2 is connected to switch 2 using another 100Base-T link.

When each node of the network was assigned the responsibility of administering one of the two Ethernet servers, there was an increase in the flow of network application traffic. FTP and HTTP applications were responsible for generating the application traffic. In addition, it is necessary to establish a connection between the workstations and the profiles after identifying the applications by adding a node to each application.

4.4 Scenarios of simulation:

Considering a square area of 1000 meters square, we have formulated three different scenarios for our simulation research:

The first scenario is a wireless network that does not use VLANs. Figure 6 illustrates the scenario in which a wireless network is considered. An access point (AP) was established in each section to ease the transmission of wireless communications. The network has a single broadcast domain, enabling all workstations to interact with the two servers, hence enhancing the wireless network's performance. Two Ethernet servers host applications used by workstations, and all access points are interconnected by two Ethernet switches. In order to monitor performance, we analyze the latency and throughput of wireless LANs.

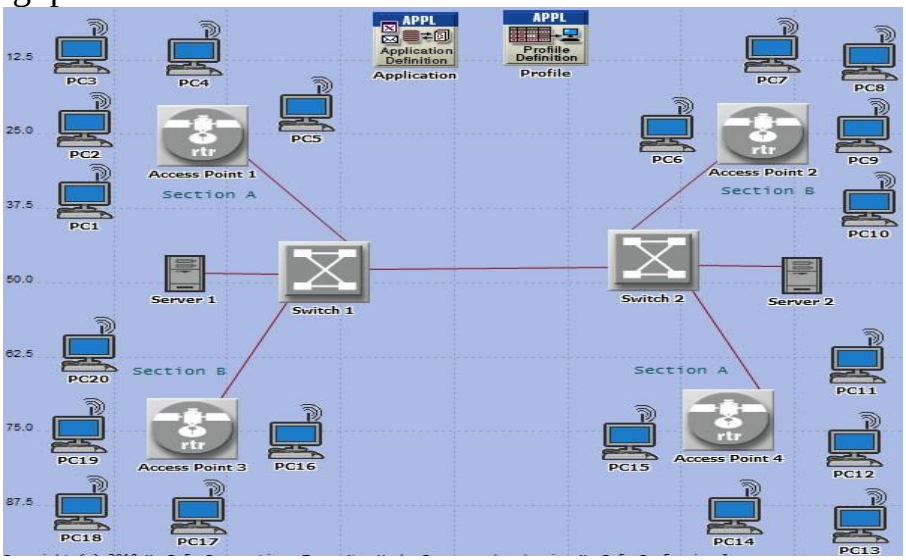

Figure (6). The network of wireless LAN being proposed consists of 20 workstations

Figure 7 depicts the second scenario, whereby a wireless network is implemented using virtual local area networks (VLANs). In this scenario, VLANs are implemented on the wireless network, thereby segregating it into two distinct VLANs, namely VLAN10 and VLAN20. VLAN 10 consists of ten workstations (PC1-PC5) that are connected wirelessly to Access Point 1. VLAN 20 consists of ten workstations (PC6-PC10) that are wirelessly linked to access Point 2, as well as ten workstations (PC16-PC20) that are wirelessly linked to access Point 3. Additionally, Ethernet Server 2 is connected to VLAN 20. VLAN trunks are used when there are interconnected switches since they enable several VLANs to extend over 100base-T Ethernet lines concurrently. In order to monitor performance, we analyze the latency and throughput of wireless LANs.

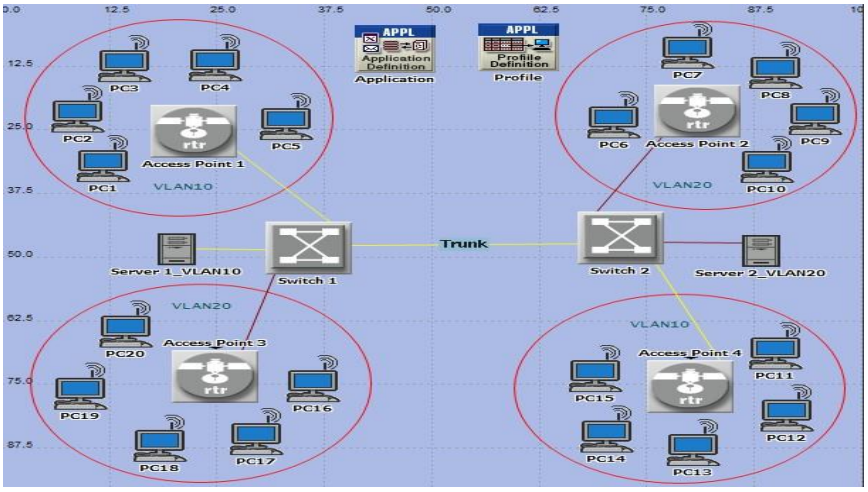

Figure (7). network of The wireless LAN is proposed to have two VLANs

The third potential result is improving the efficiency of a wireless VLAN network by using routing techniques. This case study examines the impact of five distinct adhoc routing protocols (AODV, OLSR, DSR, TORA, and GRP) on the improvement of the network's wireless VLAN throughput performance. The effect of increasing the quantity of workstations on the performance of the network of VLAN wireless is shown in three distinct network scenarios: low density, medium density, and high-density networks. In the low-density configuration, there are ten workstations per virtual local area network (VLAN). In the medium-density configuration, there are twenty workstations per VLAN. In the high-density configuration, there are thirty workstations per VLAN. During the performance monitoring phase, we examined the latency and throughput of wireless LANs.

5. Simulation results and discussions:

A wireless network, both with and without VLAN configurations, was used to manage the network. The performance of the two situations is evaluated using the simulation parameters of throughput and average latency. The OPNET 14.5 modeller is used to get the simulation results.

Figure 8 illustrates the performance levels of a wireless network with and without VLAN in relation to wireless latency. After completing the initial configuration, the both networks performance remains consistently stable throughout the period of whole simulation. By using VLAN technique to partition the region of network's broadcasting, the traffic has been substantially reduced, hence alleviating the network's workload. The use of VLAN significantly enhanced WLAN performance by mitigating wireless delay.

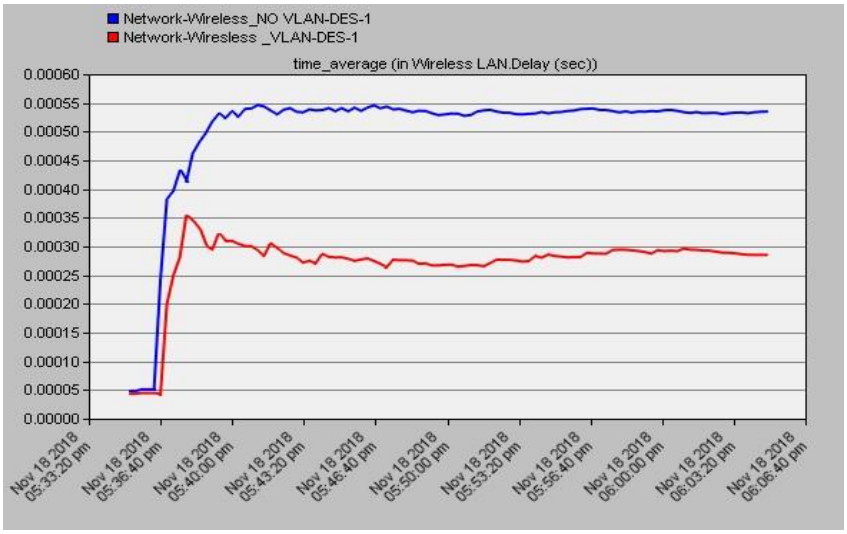

Figure (8). The latency of the wireless local area network (LAN) in both scenario 1 and scenario 2

Figure 9 illustrates that the wireless throughput of the VLAN is inferior to that of the WLAN scenario, the reason for this is a network of wireless without a VLAN setup, there is only one broadcast domain, resulting in more traffic compared to a network of wireless with VLAN. After the process of network convergence, the both networks performance remains consistently stable over the whole duration of the simulation. A direct relationship exists between the throughput and the amount of traffic received and sent. Virtual Local Area Networks (VLANs) do not directly increase network performance, but they may enhance bandwidth utilization by separating a large network area into several smaller domains, resulting in less traffic.

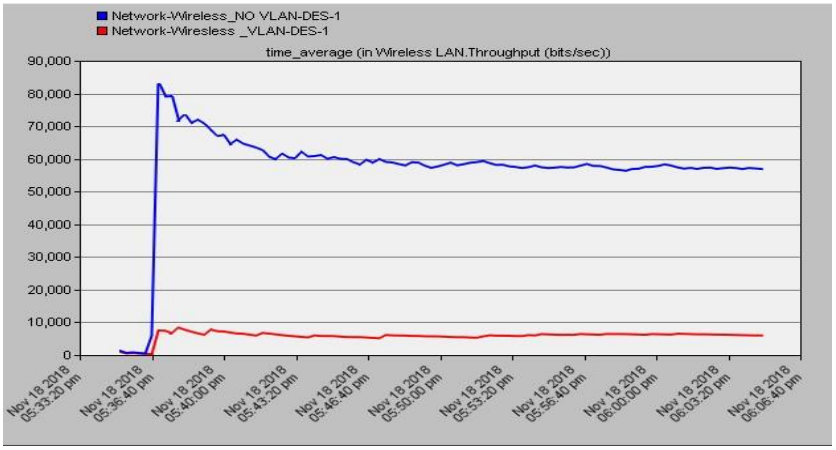

Figure 9. The wireless LAN throughput in scenario 1 and scenario 2

Figure 8 and Figure 9 illustrate the outcomes of a wireless network's VLAN selection, revealing that VLAN implementation effectively decreased latency but simultaneously decreased throughput. The primary drawback of VLAN is that it does not meet the requirements of low latency and fast throughput, which are both desired in networks of wireless. Therefore, we suggested to enhance the VLAN functionality by including several protocols of adhoc routing such as TORA, OLSR, GRP, AODV, and DSR. Our intention was to investigate the impact of these protocols on the throughput the wireless VLAN network performance. Considering the results obtained from the use of ad hoc routing protocols, as shown in figures (10, 11).

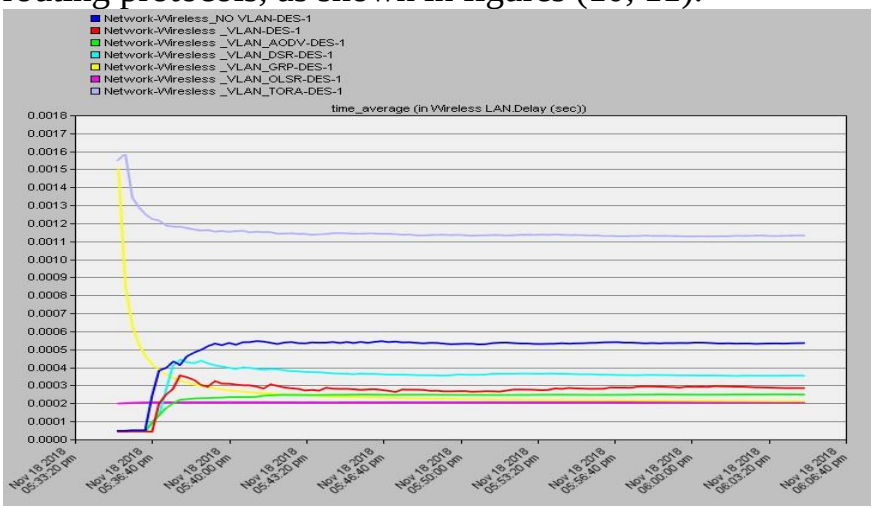

Figure 10. The average latency in a wireless network analysis with 20 nodes

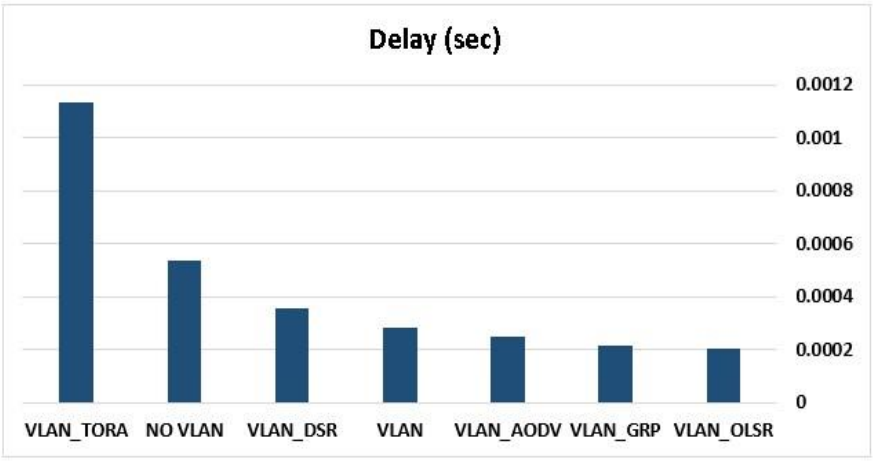

Figure 11. The latency of the wireless local area network (LAN) for a network consisting of 20 nodes

Conclusion:

Through this study, the following conclusions were reached:

- The traffic is substantially reduced By using VLAN technique to partition the region of network's broadcasting, hence alleviating the network's workload.
- The use of VLAN significantly enhanced WLAN performance by mitigating wireless delay.
- The VLAN functionality is enhance by including several protocols of adhoc routing such as TORA, OLSR, GRP, AODV, and DSR

References:

1. Tambe, S.S.: 'Wireless technology in networks', *International Journal of Scientific and Research Publications*, 2015, 5, (7), pp. 1-3

2.Mittal, I., and Anand, A.: 'Wlan architecture', *International Journal of Computer Trends and Technology*, 2014, 8, (3), pp. 148-151

3.Alimi, I.A., and Mufutau, A.O.: 'Enhancement of network performance of an enterprises network with VLAN', *American Journal of Mobile Systems, Applications and Services*, 2015, 1, (2), pp. 82-93

4.Elechi Onyekachi, O.: 'Design and Simulation of Wireless Local Area Network for Administrative Office using OPNET Network Simulator: A Practical Approach', in Editor (Ed.)^(Eds.): 'Book Design and Simulation of Wireless Local Area Network for Administrative Office using OPNET Network Simulator: A Practical Approach' (2014, edn.), pp. 27-34

5.Krupanek, B., and Bogacz, R.: 'OPNET Modeler simulations of performance for multi nodes wireless systems', *International Journal of Metrology and Quality Engineering*, 2016, 7, (1), pp. 105

6.Mewara, H., and Saini, M.K.: 'Performance Analysis of Access Point for IEEE802. 11g Wireless LAN Using Opnet Simulator', *International Journal of Advanced Engineering Research and Science (IJAERS)*, 2014, 1, (1), pp. 14-18
7.Abdullah, S.A.: 'Simulation of virtual LANs (VLANs) using OPNET', *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)*, 2016, 11, (6), pp. 67-80
8.AL-Khaffaf, D.A.J.: 'Improving LAN performance based on IEEE802. 1Q VLAN switching techniques', *Journal of University of Babylon for Engineering Sciences*, 2018, 26, (1), pp. 286-297
9.Makeri, Y.A., Cirella, G.T., Galas, F.J., Jadah, H.M., and Adeniran, A.O.: 'Network Performance Through Virtual Local Area Network (VLAN) Implementation & Enforcement On Network Security For Enterprise', *International Journal of Advanced Networking and Applications*, 2021, 12, (6), pp. 4750-4762
10.Ali, A.H., Abbas, A.N., and Hassan, M.H.: 'Performance Evaluation ofIEEE802. 11g WLANsUsing OPNET Modeler', *American Journal of Engineering Research*, 2013, 2, (12), pp. 9-15
11.Meen, P.K.: 'Performance Metrics of WLAN for Different Applications using OPNET', *International Journal of P2P Network Trends and Technology (IJPTT)*, 2014, 4, (5)
12.Jayakumar, G., and Ganapathy, G.: 'Performance comparison of mobile ad-hoc network routing protocol', *International Journal of Computer Science and Network Security (IJCSNS)*, 2007, 7, (11), pp. 77-84
13.Manickam, P., Baskar, T.G., Girija, M., and Manimegalai, D.D.: 'Performance comparisons of routing protocols in mobile ad hoc networks', arXiv preprint arXiv:1103.0658, 2011
14.Shrivastava, L., Bhadauria, S.S., and Tomar, G.: 'Performance Evaluation of Routing Protocols in MANET with different traffic loads', in Editor (Ed.)^(Eds.): 'Book Performance Evaluation of Routing Protocols in MANET with different traffic loads' (IEEE, 2011, edn.), pp. 13-16
15.Maheswara, P.V., and Naik, K.B.: 'Routing protocol performance issues and evaluation considerations in MANET', *International Journal of Engineering Research and Applications (IJERA)* ISSN, 2013, 2248
16.Elsadig, M.A., and Fadlalla, Y.A.: 'Mobile ad hoc network routing protocols: performance evaluation and assessment', *International Journal of Computing and Digital Systems*, 2018, 7, (01), pp. 59-66
17.Kadyamatimba, A., Mbougni, M., Helberg, Z., and Dube, E.: 'Performance Evaluation of Routing Protocols in Mobile Ad Hoc Networks Using Http Traffic', DOI, 2012, 10, pp. 69-74

18.Quwaider, M., Rao, J., and Biswas, S.: 'Neighborhood route diffusion for packet salvaging in networks with high mobility', in Editor (Ed.)^(Eds.): 'Book Neighborhood route diffusion for packet salvaging in networks with high mobility' (IEEE, 2008, edn.), pp. 168-175
19. Nourildean, S.W., Mohammed, Y.A., and Attallah, H.A.: 'Virtual local area network performance improvement using ad hoc routing protocols in a wireless network', Computers, 2023, 12, (2), pp. 28

تقييم أداء الشبكات المحلية الافتراضية

امجد وهاب طالب[1]
مديرية تربية المثنى ، وزارة التربية العراقية، العراق
ah.saadk92@gmial.com

فاطمة ساف آرا[2]
جامعة آزاد، قسم البرمجيات، مشهد، إيران
fsafara@yahoo.com

المستخلص:
لا يمكن للمجالات الطبية والمالية والأكاديمية أن تعمل بدون التطورات التكنولوجية المتطورة. عندما يتعلق الأمر بمقاييس جودة الخدمة (QoS) مثل زمن الوصول والإنتاجية وعرض النطاق الترددي والأمان، تعتمد تكنولوجيا اليوم على شبكات عالية الأداء. سمح استخدام أدوات هندسة الشبكات المحسّنة بمحاكاة كل من البيئات السلكية واللاسلكية في الحرم الجامعي، بما في ذلك واستبعاد شبكات المنطقة المحلية الافتراضية (VLANs). يتم إرسال الحزم فقط إلى المنافذ التي تعد جزءًا من نفس شبكة المنطقة المحلية الافتراضية (VLAN) عندما يتم ربط المضيفين معًا في شبكة VLAN. باستخدام شبكة VLAN المميزة، يمكننا تحسين أداء الشبكات اللاسلكية مع الحفاظ على عرض النطاق الترددي. علاوة على ذلك، تعمل شبكات VLAN على تحسين أمان الشبكة اللاسلكية بشكل كبير من خلال الحد من عدد المضيفين الذين يتلقون إطارات مكررة تبثها المفاتيح؛ وهذا يمكّن المضيفين من الاحتفاظ بالبيانات الحساسة على شبكة VLAN منفصلة. تدرس الدراسة الشبكات اللاسلكية وتقارنها بشبكات VLAN عبر الشبكات اللاسلكية. باستخدام تطبيقات تصفح الإنترنت ونقل الملفات في بيئات ذات حركة مرور عالية، يتم اختبار الشبكة المقترحة من حيث زمن الوصول والإنتاجية المتوسطة. باستخدام تقنية VLAN لتقسيم منطقة البث في الشبكة، تم تقليل حركة المرور بشكل كبير، وبالتالي تخفيف عبء عمل الشبكة. أدى استخدام VLAN إلى تحسين أداء WLAN بشكل كبير من خلال التخفيف من التأخير اللاسلكي، وفقًا لنتائج تشغيل المحاكاة باستخدام نموذج OPNET 14.5. مع مرور الوقت، نظرنا في كيفية تعزيز بروتوكولات التوجيه التفضيلي مثل DSR وAODV وOLSR وGPR وTORA لكفاءة شبكات VLAN اللاسلكية.

الكلمات المفتاحية :الشبكات، اللاسلكية، الافتراضية، الخدمة، نقاط الوصول.

ملاحظة : هل البحث مستل من رسالة ماجستير او اطروحة دكتوراه ؟ كلا :