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Virtual Local Area Network for Optimizing Network Performance using Simplified Form of Action Research

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ABSTRACT

Virtual Local Area Network (VLAN) is an effective solution for improving network performance and efficiency in educational environments, particularly in computer laboratories. This study aims to implement and evaluate VLAN at the Computer Laboratory of Universitas Mulia using a simplified action research approach involving a single intervention cycle. The initial diagnosis revealed that the conventional flat network topology resulted in a broad broadcast domain and reduced performance under high traffic conditions. Through VLAN segmentation, the laboratory was logically divided into five segments based on functionality. Evaluation was conducted using throughput measurement and Quality of Service (QoS) indicators, including packet loss, delay, and jitter, based on TIPHON standards. The results indicated consistent improvements in data flow and stability, with reduced packet loss under 0,3% and average delay and jitter remaining below 20 ms across all segments. In addition to technical improvements, interviews with the network administrator highlighted significant benefits in bandwidth management and traffic control during examinations. This study demonstrates that a simplified approach can be replicated in similar educational institutions with limited resources and provides a foundation for more structured and controlled network development.

I. INTRODUCTION

The undeniable advancement of information and communication technology (ICT) has had a significant impact on the need for computer network infrastructure across various sectors, including higher education [1]. According [2], a reliable computer network serves as the backbone for supporting academic activities such as learning, research, and administration. At Universitas Mulia, computer networks play an essential role in supporting various activities in the computer laboratory, which serves as the center for IT practices and experiments.

As the number of devices and users increases, the conventional network topology currently used has begun to show its limitations [3], [4]. High data traffic creates potential for collisions and increases the broadcast domain, which negatively affects network performance [5], [6]. This condition calls for technical solutions so that the network can be managed efficiently without compromising speed and security.

Virtual Local Area Network (VLAN) is one of the solutions widely adopted in modern network management [7]. VLAN allows logical separation of broadcast domains without being limited by the physical location of devices, thereby enhancing network efficiency, security, and scalability [8]. The use of VLAN on Mikrotik devices and manageable switches has proven to help reduce collision domains and optimize network traffic flow [9], [10].

Several studies have highlighted the success of VLAN implementation in improving network performance. Some studies state that VLAN can divide a network into several segments to facilitate management and improve performance [11], [12]. According [13] further noted that VLAN also provides flexibility in network structuring, particularly in educational institutions with dynamic needs. However, the characteristics and specific requirements of each institution require contextual studies before VLAN can be implemented comprehensively.

Recent studies have explored the benefits of VLAN in improving network segmentation, security, and traffic efficiency, particularly in environments with limited resources. According [14] emphasized that although VLAN configurations may slightly reduce throughput due to segmentation overhead, they allow better control over traffic flow and improved logical organization. Whereas according to other studies [15] further demonstrated that VLAN implementation can strengthen security enforcement and improve traffic isolation, making it suitable for institutional networks without requiring complex or costly infrastructure upgrades. Considering these practical advantages, VLAN was selected in this study as an appropriate and scalable solution for optimizing the performance of the computer laboratory network at Universitas Mulia.

At Universitas Mulia, particularly in the Computer Laboratory, this study was designed to examine the effectiveness of VLAN in improving network performance. Using a simplified form of action research [16], his study implemented VLAN and analyzed its impact through throughput measurements and broadcast packet analysis. This simplified form focused on a single intervention cycle without iterative refinements, appropriate for addressing the practical network issues identified.

The main objective of this research is to evaluate the extent to which VLAN implementation can increase throughput, reduce collision domains, and simplify network management in the Computer Laboratory environment at Universitas Mulia. The results of this study are expected to serve as a reference for network infrastructure development at Universitas Mulia and similar institutions.

The literature review shows that VLAN technology is not only relevant in the technical context but also supports managerial aspects in network management. This is reinforced by Sunaryo [17] who stated that VLAN configuration on Mikrotik devices facilitates the administration of medium- to large-scale networks..

This study also considers recommendations from previous studies to strengthen topology design and VLAN implementation strategies. Therefore, VLAN deployment in the Computer Laboratory of Universitas Mulia is designed to be adaptive to local needs and technological developments.

In addition to previously discussed literature [18], [19] other studies have also explored VLAN implementation within educational environments. One study conducted in a university setting demonstrated that VLAN segmentation effectively optimized bandwidth usage by reducing latency and limiting broadcast domains. The configuration of VLANs on Mikrotik-based networks proved beneficial in creating reliable and manageable sub-networks. Another implementation in an informatics laboratory context highlighted improvements in security, flexibility, and access control through logical network segmentation. These examples reinforce the feasibility of VLAN as a replicable and cost-effective solution for enhancing network performance and management, particularly in institutions with limited infrastructure and resources.

With this background, this article is expected to contribute scientifically to practitioners and academics who wish to optimize computer networks in educational environments using VLAN technology.

II. METHOD

This research employed a simplified form of action research [20], allowing the researcher to directly intervene in the network system while systematically evaluating the outcomes. The simplified approach was adopted due to the specific focus on a single-cycle intervention targeting practical improvements rather than multiple iterative cycles. This approach was chosen based on a review of previous literature and was considered appropriate for the research objective, which focuses on the direct implementation of Virtual Local Area Network (VLAN) technology and the analysis of its impact in the Computer Laboratory of Universitas Mulia.

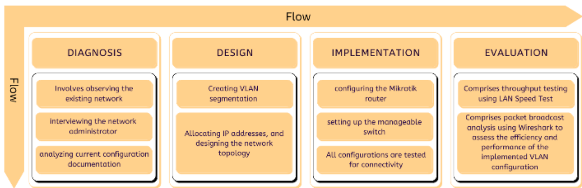


Figure 1. Research Flow

The research flow shown in Figure 1 represents a systematic sequence designed to ensure that problem-solving efforts are conducted in a scientific manner. The main outline of each stage is as follows:

A. Diagnosis

The initial stage of the research involved identifying problems in the conventional network at the Computer Laboratory of Universitas Mulia. This identification was carried out through direct observation, interviews with the network administrator, and analysis of existing configuration documentation. The main issues identified were high broadcast traffic, a wide collision domain, and a decline in network performance during simultaneous.

B. Design

Based on the diagnosis results, the researcher designed a new network topology with VLAN implementation. The design included determining VLAN segmentation for each laboratory, allocating appropriate IP addresses, and configuring hardware devices such as manageable switches and routers. This design aimed to separate broadcast domains and improve network efficiency.

C. Implementation

The implementation was carried out by configuring network devices using a Mikrotik RB941-2nD router and a D-

Link DGS-1210-20 switch. VLAN configuration was performed using the Winbox application for the router and the web GUI for the switch. In addition, IP address settings, DHCP server, and DNS configurations were established. Each configuration was tested using command prompt tools to ensure connectivity between VLANs.

D. Evaluation

The initial stage of the research involved identifying problems in the conventional network at the Computer Laboratory of Universitas Mulia. This identification was carried out through direct observation, interviews with the network administrator, and analysis of existing configuration documentation. The main issues identified were high broadcast traffic, a wide collision domain, and a decline in network performance during simultaneous. In addition to throughput, this study also measured Quality of Service (QoS) indicators: packet loss, delay, and jitter, which are critical in evaluating network reliability and responsiveness.

To provide a standardized evaluation framework, this research adopted the TIPHON standard. According to Hizkiana, dkk [21], TIPHON offers a reliable benchmark for interpreting network performance metrics, especially in educational and institutional environments. By referring to this standard, the analysis of QoS parameters becomes more comparable and justifiable across similar network studies.

All measurements were conducted under normal operating conditions during peak usage hours to reflect realistic network load. The results are presented in the subsequent section along with analysis and visual comparisons.

III. RESULTS AND DISCUSSION

A. Diagnosis Stage

At the diagnosis stage, the researcher conducted a series of activities to identify network issues in the Computer Laboratory of Universitas Mulia. The observation results showed that the conventional network in use still applied a simple subnetting method with a single router accommodating the entire laboratory. This condition resulted in high broadcast traffic and a wide collision domain, which negatively affected network performance during simultaneous usage. The results of the observation of the old topology are shown in Figure 2.

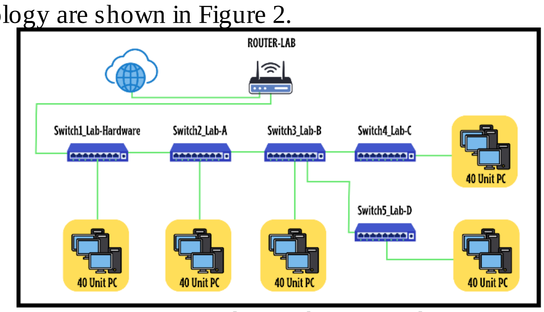


Figure 2. Existing topology with One Broadcast Domain

In the topology shown in Figure 2, the main router (Router-Lab) manages a single network address for all laboratories using a basic subnetting method. Several key findings from the diagnosis results are presented in Table 1.

TABEL I
INITIAL IDENTIFICATION OF EXISTING NETWORK TOPOLOGY

Aspect	Finding
Network Address	The router provides a single network address (192.168.99.0/24) shared by all laboratories.
Number of Hosts	Approximately 200 hosts (40 PCs in each of Lab Hardware, Lab A, Lab B, Lab C, and Lab D) in one subnet.
Subnet Mask	/24 (255.255.255.0) supporting up to 254 hosts in one network.
Broadcast Domain	All devices are part of one broadcast domain; broadcast packets are distributed across all labs.
Collision Domain	The collision domain is very wide due to the absence of network segmentation between labs.

From Table 1, it can be concluded that the existing network structure in the Computer Laboratory of Universitas Mulia was not optimal in supporting network performance. All devices were within a single subnet and broadcast domain, which resulted in a high potential for collisions and unrestricted broadcast traffic across all laboratories. This condition negatively impacted the quality of network services, especially when the number of active users increased simultaneously.

The observed network structure prior to VLAN implementation can be classified as a flat network, where all 200 devices across five laboratories (Lab Hardware, Lab A, Lab B, Lab C, and Lab D) were connected within a single subnet (192.168.99.0/24) and shared the same broadcast domain. This flat network topology meant that any broadcast communication initiated by a single device would be propagated to all other connected devices, as shown in Figure 4. Such behavior not only increases unnecessary traffic but also leads to network congestion, especially during simultaneous usage by multiple labs. The lack of logical or physical segmentation made the network susceptible to performance degradation and reduced manageability.

As part of the documentation in the diagnosis stage, the following displays the old network configuration obtained from the Mikrotik device using the *print* command.

```
[admin@Router-Lab] > /ip address print
Flags: X - disabled, I - invalid, D - dynamic
 #   ADDRESS            NETWORK         INTERFACE
 0   192.168.99.1/24    192.168.99.0    ether1

[admin@Router-Lab] > /ip dhcp-server print
Flags: X - disabled, I - invalid
 #   NAME       INTERFACE  RELAY            ADDRESS-POOL     LEASE-TIME  ADD-ARP
 0   dhcp1      ether1                      dhcp_pool        10m         yes
```

Figure 3. Existing Router Configuration Documentation

The documentation in Figure 3 provides a real depiction of the basic network configuration before the implementation of Virtual Local Area Network (VLAN) technology. At the diagnosis stage, an observation was also carried out on the network condition prior to VLAN implementation. One of the methods used was monitoring network traffic using the Wireshark application.

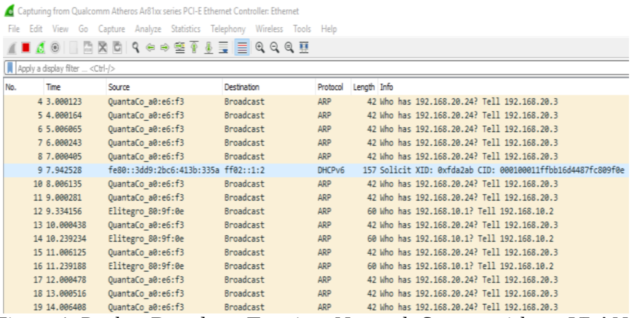


Figure 4. Packet Broadcast Test in a Network System without VLANs

Figure 4 shows a Wireshark capture that illustrates a large number of ARP broadcast packets distributed across the entire network. These packets originate from specific source addresses and are broadcast to all devices on the network. This condition demonstrates that, prior to VLAN implementation, all devices were within a single broadcast domain without segmentation. Broadcast packets from one device were propagated throughout the entire network, potentially burdening network traffic and degrading performance during periods of high traffic.

B. *Design Stage*

After diagnosing the existing network, the next stage was designing a new network topology by implementing Virtual Local Area Network (VLAN) technology, which functions to separate broadcast domains and reduce collision domains. The purpose of this design is to improve the efficiency and performance of the network in the Computer Laboratory of Universitas Mulia.

As a result of the design stage, VLAN segmentation was created to separate the broadcast domains of each laboratory. The following table presents the VLAN segmentation design and IP address allocation planned for the Computer Laboratory of Universitas Mulia. Each laboratory was assigned a specific VLAN ID and IP address range to ensure that data traffic is more controlled and efficient.

TABEL II
INITIAL VLAN SEGMENTATION DESIGN AND IP ADDRESS ALLOCATION

VLAN ID	Laboratory	IP Address Range	Subnet Mask
10	Lab Hardware	192.168.99.0 – 192.168.99.63	255.255.255.192 (/26)
20	Lab A	192.168.99.64 – 192.168.99.127	255.255.255.192 (/26)
30	Lab B	192.168.99.128 – 192.168.99.191	255.255.255.192 (/26)
40	Lab C	192.168.99.192 – 192.168.99.255	255.255.255.192 (/26)
50	Lab D	192.168.100.0 – 192.168.100.63	255.255.255.192 (/26)

The segmentation of VLANs was designed based on the functional roles of each laboratory, such as hardware practice, programming, and networking. For logical clarity and ease of configuration, each VLAN was labeled as Lab Hardware, Lab A, Lab B, Lab C, and Lab D. In total, five VLANs were defined, with each lab assigned a unique VLAN ID and corresponding IP address range to ensure effective broadcast domain separation.

The design shown in Table 2 is expected to minimize collision domains and optimize data traffic flow, as each laboratory has its own logically separated network segment through VLANs. With this segmentation, broadcast packets will be distributed only within each VLAN's scope without affecting other segments.

As a continuation of the VLAN segmentation design and IP address allocation, a new network topology was designed to physically and logically implement this separation.

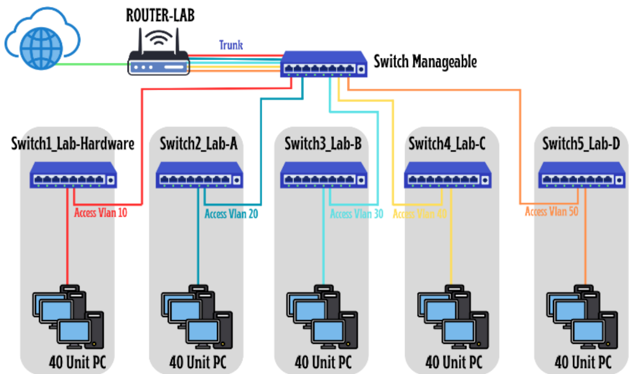


Figure 5. Design of New Topology

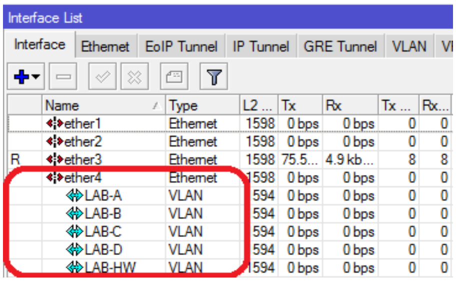
The new topology, as shown in Figure 5, illustrates a structured implementation where the Router-Lab acts as a VLAN gateway and the manageable switch handles VLAN tagging and forwarding. Each laboratory switch is connected to specific tagged ports corresponding to its VLAN ID. Access ports on each lab switch are assigned to their respective VLANs to ensure logical segmentation of the broadcast domains. This setup enhances data traffic control, reduces collision domains, and supports better scalability and manageability of the network infrastructure at the Computer Laboratory of Universitas Mulia.

C. *Implementation*

The implementation stage was carried out after the VLAN topology design had been carefully prepared. The purpose of this implementation was to apply VLAN configuration on network devices so that network segmentation could function as designed. The implementation was conducted on hardware including a Mikrotik RB941-2nD router and a D-Link DGS-1210-20 manageable switch, with the assistance of Winbox software, the switch's web GUI, and command-line tools for connectivity testing. Each VLAN was created on the trunk interface connected to the manageable switch, namely ether4.

The implementation results are shown in several parts. The first part presents the list of VLAN interfaces that have been configured on the Mikrotik router. Each VLAN has a specific

VLAN ID and is associated with the trunk interface, ether4, which connects to the manageable switch.



(a)

```
[admin@Router-Lab] > /ip dhcp-server print
Flags: X - disabled, I - invalid
 #   NAME         INTERFACE   ADDRESS-POOL    LEASE-TIME
 0   dhcp_vlan10  vlan10      pool_vlan10     10m
 1   dhcp_vlan20  vlan20      pool_vlan20     10m
 2   dhcp_vlan30  vlan30      pool_vlan30     10m
 3   dhcp_vlan40  vlan40      pool_vlan40     10m
 4   dhcp_vlan50  vlan50      pool_vlan50     10m
```

(b)

```
[admin@Router-Lab] > /ip dhcp-server print
Flags: X - disabled, I - invalid
 #   NAME         INTERFACE   ADDRESS-POOL    LEASE-TIME
 0   dhcp_vlan10  vlan10      pool_vlan10     10m
 1   dhcp_vlan20  vlan20      pool_vlan20     10m
 2   dhcp_vlan30  vlan30      pool_vlan30     10m
 3   dhcp_vlan40  vlan40      pool_vlan40     10m
 4   dhcp_vlan50  vlan50      pool_vlan50     10m
```

(c)

Figure 6. (a) Interface Vlan, (b) DHCP Server, (c) IP Pool

From the configuration shown in Figure 6*(a)*, it is evident that each laboratory has been mapped to its own VLAN, enabling logical network segmentation to optimize traffic flow. The second part documents the DHCP servers activated on each VLAN interface. The DHCP server is responsible for automatically distributing IP addresses to clients connected within each VLAN. The configuration shown in Figure 6 *(b)* ensures that each device within a VLAN obtains an IP address according to its segment without requiring manual configuration on the client side.

TABEL III
INITIAL VLAN SEGMENTATION DESIGN AND IP ADDRESS ALLOCATION

VLAN ID	Laboratory	Member Ports (Tagged)	Member Ports (Tagged)
10	LAB-HW	1, 2	15
20	LAB-A	3, 4	15
30	LAB-B	5, 6	15
40	LAB-C	7, 8	15
50	LAB-D	9, 10	15

The next part displays the output indicating the range of IP addresses (IP pools) allocated for the DHCP server in each VLAN. These IP pools ensure that the IP address distribution does not overlap between VLANs. In Figure 6*(c)*, the configuration ensures that each device within a VLAN obtains an IP address according to its segment without requiring manual configuration on the client side. Finally, the implementation of VLANs through the manageable switch was carried out by configuring each VLAN for each laboratory via the web GUI interface of the D-Link DGS-1210-20 switch.

Each VLAN is associated with specific ports that have been adjusted to meet the needs of the network topology. After all VLANs were configured, the switch displayed a VLAN configuration summary through the 802.1Q VLAN Settings menu. This summary shows the list of all VLANs created, the ports included as members (untagged/tagged), and the trunk port that has been configured. The following figure presents the summary of VLAN configuration on the switch.

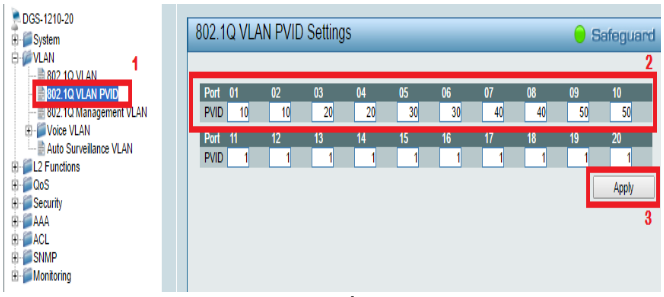


Figure 7. PVID Configuration Result

With the VLAN configuration on the switch as shown in Figure 7, network segmentation has been established according to the design. Each laboratory now has a separate broadcast domain, resulting in more controlled, efficient, and secure data traffic. This implementation serves as an essential foundation in supporting the network performance of the Computer Laboratory at Universitas Mulia.

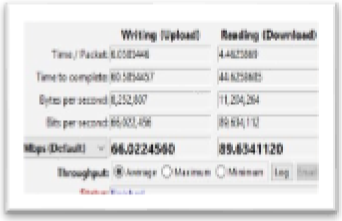
D. Evaluation

The evaluation stage was conducted to compare network performance before and after the implementation of the Virtual Local Area Network (VLAN). This evaluation included throughput testing and broadcast packet analysis to assess the effectiveness of network segmentation in improving performance and traffic efficiency.

The following presents part of the documentation from the network throughput testing using the LAN Speed Test application. These figures show the details of write (upload) and read (download) speeds obtained on the network after VLAN implementation for various file sizes. These results served as the basis for compiling the throughput summary table.

(a)

(b)



(c)

Figure 8. Throughput testing with (a)10 MB, (b)20 MB, (c)50 MB

From the documentation shown in Figures 8 *(a)*, *(b)*, and *(c)* it is evident that network performance improved after the VLAN implementation, both in terms of write and read speeds. These results were then summarized in table form to facilitate easier analysis and comparison. The overall throughput testing results are as follows.

TABEL IV
INITIAL VLAN SEGMENTATION DESIGN AND IP ADDRESS ALLOCATION

File Size	Without VLAN Write (KBps)	Without VLAN Read (KBps)	With VLAN Write (KBps)	With VLAN Read (KBps)	Write Increase (%)	Read Increase (%)
10 MB	58,760	61,597	66,012	90,152	12.34%	45.36%
20 MB	59,297	73,242	67,825	89,516	14.38%	22.22%
50 MB	57,270	76,463	66,022	89,634	15.28%	17.23%
Rata-Rata	58,44233333	70,434	66,61966667	89,76733333	14,00%	28,27%

From Table 4, it can be concluded that the VLAN implementation in the network of the Computer Laboratory at Universitas Mulia had a significant positive impact on network performance. There was an increase in both write and read speeds for each file size tested. This improvement resulted from the reduction of the collision domain and the separation of broadcast domains between laboratories, making network traffic more efficient and controlled.

Throughput evaluation shows a significant improvement in network performance after VLAN implementation. On average, write speeds increased by 14.00%, while read speeds increased by 28.27%, with a very significant increase of 45.36% for reading 10 MB files. These results reflect how logical network reorganization can streamline data flow and reduce unnecessary traffic.

The significant increase in read speed can be attributed to how VLAN reduces broadcast noise, allowing requested data to reach its destination faster without being disrupted by irrelevant traffic. Similarly, while the increase in write speed is more moderate, it still indicates that the network becomes more stable and responsive after segmentation.

The graph in Figure 9 illustrates a comparison of network throughput before and after the implementation of the Virtual Local Area Network (VLAN) at the Computer Laboratory of Universitas Mulia. Throughput is measured in kilobytes per second (KBps) for both write and read speeds on files of 10 MB, 20 MB, and 50 MB in size.

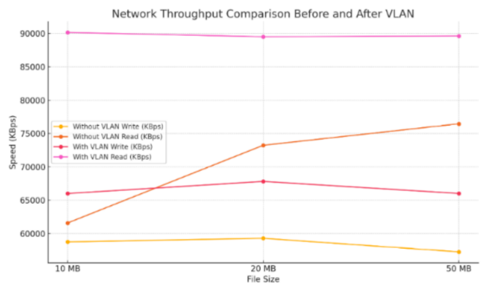


Figure 9. Network Throughput Comparison Before and After VLAN

In addition to throughput measurements, a QoS (Quality of Service) assessment was conducted to further validate the impact of VLAN implementation. The metrics evaluated include packet loss, delay, and jitter, as recommended by the ITU-T Y.1541 standard.

To gain a more comprehensive understanding of the network performance after VLAN implementation, this study also conducted a quality of service (QoS) evaluation using three primary indicators: packet loss, delay, and jitter. These parameters are essential for assessing the stability and reliability of a network, especially in environments with high user density such as educational laboratories.

The data collected from each VLAN segment includes multiple test sessions using packet capture (PCAP) files, which were analyzed to measure the number of packets sent and received, the delay during transmission, and the variation in delay (jitter). The results are summarized in the following table.

TABEL V
QUALITY OF SERVICE (QOS) METRICS FOR EACH VLAN SEGMENT BASED ON PCAP ANALYSIS

Variable	Desc	TESTING LAB					
		LAB – A PCAP 1	LAB – A PCAP 2	LAB – B PCAP 1	LAB – B PCAP 2	LAB – C PCAP 1	LAB – C PCAP 2
Packet Loss	**Packet Sent**	5250	5868	5594	5181	5179	5518
	Packet Received	5250	5868	5594	5180	5179	5518
	%	0,00%	0,00%	0,00%	0,02%	0,00%	0,00%
Delay	**Total Delay**	59,87574	57,759106	62,989384	58,077414	81,909187	90,697714
	Delay Average (s)	0,011404903	0,009843065	0,011260169	0,011209692	0,015815638	0,016436701
Jitter	**Total Jitter**	60,273809	57,96681	63,049126	58,076827	81,90106	90,66057
	Jitter Average (s)	0,011480726	0,009878461	0,011270848	0,011209579	0,015814068	0,016429969

Variable	Desc	TESTING LAB			
		LAB – D PCAP 1	LAB – D PCAP 2	LAB – HW PCAP 1	LAB – HW PCAP 2
Packet Loss	**Packet Sent**	5368	5124	5341	5192
	Packet Received	5365	5109	5341	5192
	%	0,06%	0,29%	0,00%	0,00%
Delay	**Total Delay**	76,405431	57,163249	61,521479	53,042901
	Delay Average (s)	0,014233501	0,011155981	0,011518719	0,010216275
Jitter	**Total Jitter**	76,668627	57,208014	61,455337	53,190123
	Jitter Average (s)	0,014282531	0,011164718	0,011506335	0,010244631

The results in the table show that packet loss rates across all VLANs remain consistently low, with values ranging from 0.00% to 0.29%, indicating a highly reliable network connection. Notably, VLAN D recorded a slightly higher packet loss of 0.29%, which is still within an acceptable range for general data traffic.

Regarding delay, the average delay observed ranges between 0.0098 to 0.0164 seconds (or 9.8 ms to 16.4 ms), which implies minimal latency during data transmission. This performance is indicative of an efficient network with low propagation and queuing delays.

In terms of jitter, or variation in packet delay, the observed values range from 0.0098 to 0.0164 seconds (approximately 9.8 ms to 16.4 ms). These results suggest that the network maintains a consistent and stable delay pattern, which is crucial for real-time applications such as video conferencing or online examinations.

To provide a meaningful interpretation of the measured values, the results are compared against the TIPHON (Telecommunication and Internet Protocol Harmonization Over Networks) standards, which offer benchmarks for QoS metrics. Packet Loss; According to TIPHON, a packet loss rate between 0% and 2% is categorized as "Very Good". Since all VLANs fall within this range, the network performance in terms of reliability is considered excellent. Delay; TIPHON defines a delay of less than 150 milliseconds (ms) as "Very Good". The observed average delay in all VLANs is well below this threshold, confirming excellent responsiveness in data transmission. Jitter: TIPHON states that jitter values below 75 milliseconds are classified as "Good" to "Very Good". The jitter results obtained in this study (9.8–16.4 ms) fall into the "Very Good" category, indicating strong stability in network performance.

In addition to the technical evaluation, qualitative insights were gathered through informal interviews with the network administrator, who provided valuable feedback regarding the impact of VLAN implementation on day-to-day network operations. According to the administrator, the segmentation of the network into distinct VLANs has significantly simplified bandwidth management. For instance, during examination sessions, traffic within specific VLANs can be prioritized or restricted to ensure optimal performance and avoid congestion.

The administrator also noted that the ability to isolate traffic per laboratory allowed for more effective troubleshooting and faster resolution of network issues, as any disturbances could be traced back to a specific VLAN segment. Moreover, implementing VLANs made it easier to apply differentiated policies per lab, such as firewall rules, access control, and DHCP configurations, without affecting other segments.

Overall, the VLAN configuration has not only improved technical performance but also enhanced administrative control over the network. It has provided a more organized, secure, and flexible environment for managing lab activities, especially in scenarios with high concurrent usage.

However, this study did not involve broader stakeholders such as students, lecturers, or technical support staff, which limits the scope of qualitative evaluation. Future research is encouraged to incorporate multi-stakeholder perspectives to obtain a holistic view of the network's usability, performance, and impact on academic activities

E. Discussion

Although this study applied a simplified form of action research with a single intervention cycle, the results provided valuable insights into the impact of VLAN on network performance. The implementation of the Virtual Local Area Network (VLAN) at the Computer Laboratory of Universitas Mulia had a tangible and measurable impact on improving both network performance and efficiency. This improvement is particularly significant in environments where high data traffic and dense device connectivity demand a more sophisticated approach to network management [22], [23]. VLAN segmentation successfully separated the broadcast domains of each laboratory, thereby significantly reducing the broadcast traffic load that previously spread indiscriminately across the entire network, which aligns with findings from previous studies on the benefits of VLAN in minimizing unnecessary broadcast propagation [24][25].

The throughput testing results showed a clear and consistent increase in both write and read speeds following VLAN implementation, with significant average gains recorded across various file sizes. These improvements illustrate the effectiveness of VLAN segmentation not only in optimizing data traffic flow but also in minimizing the collision domain, which is critical for maintaining network stability and performance under high load conditions [26].

Although documentation of post-VLAN broadcast analysis was not available in this study, the applied network configuration and designed topology strongly support the widely accepted theory that VLAN implementation limits broadcast packet distribution strictly within its respective segment. This structural segmentation inherently reduces the potential for broadcast storms and improves overall network reliability. Furthermore, this implementation facilitates comprehensive network management and control, enabling administrators to apply targeted policies, enforce security measures, and allocate network resources more effectively.

Furthermore, although this study utilized a simplified form of action research with only a single intervention cycle, the approach proved to be both practical and applicable in small-scale educational institutions with limited resources. The simplicity of the Diagnosis, Design, Implementation, Evaluation sequence offers a replicable model for similar contexts, particularly in developing infrastructures where network optimization is essential, but budget constraints exist. Future implementations are encouraged to incorporate broader stakeholder involvement including technical staff and users to provide more holistic feedback on network improvements.

IV. CONCLUSION

Based on the implementation and evaluation results, this study concludes that the application of a Virtual Local Area Network (VLAN) at the Computer Laboratory of Universitas Mulia significantly improved network performance and efficiency. The logical segmentation of VLANs successfully separated broadcast domains among laboratories, thereby reducing the collision domain, minimizing broadcast packet distribution, and optimizing data traffic flow. Throughput tests showed notable improvements in both write and read speeds across multiple file sizes, supported by Quality of Service (QoS) indicators such as packet loss, delay, and jitter all of which met the TIPHON standard. In addition to technical gains, qualitative feedback from the network administrator indicated improved manageability, especially during traffic-intensive scenarios like examinations. The use of a simplified action research approach despite being limited to a single intervention cycle proved to be practical and effective. This model can be replicated in similar educational institutions with constrained resources. Future research is encouraged to incorporate multi-stakeholder evaluations and extend the assessment to other QoS parameters to enrich the understanding of VLAN's impact on network optimization.

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