IMPLEMENTATION OF HYBRID VLAN NETWORK CONFIGURATION

Michael Jordan [1], Joseph Dedy Irawan [2], Yohanes Yudha Saputra Bangko [3], Maqila Sulaiman Abu Zakaria [4]
[1] Computer Science and Information Engineering, National Dong Hwa University
[2,3,4] Informatics Engineering, Malang National Institute of Technology, East Java, Indonesia
611221301@gms.ndhu.edu.tw

ABSTRACT

The need for internet access has become a necessity provided by all agencies, where in the research conducted on campus 2 of the National Institute of Technology Malang, where the VLANs distributed are approximately 25, so that in distributing internet access requires good network management, where by implementing Hybrid VLAN the IP distribution process is easier and increases the efficiency of network management, by using Hybrid VLAN, the trunking process and IP access are carried out on the router side, From the results of the Implementation of Hybrid VLAN Network Configuration on the ITN Malang Infrastructure, it can be concluded as follows: The implementation of Hybrid VLAN has succeeded in increasing network efficiency by separating network traffic based on function and department, thereby reducing traffic density and improving overall performance, By separating the network into several VLANs, the level of isolation between various network segments has increased, which has an impact on increasing security and reducing the risk of unauthorized access, by implementing a Hybrid VLAN Network, network administrators can manage bandwidth according to the needs of the VLAN segment easily and quickly.

Keyword : *IP Configuration, Hybrid VLAN, Network Security, Trunking*

1. INTRODUCTION

In a case study on the IP distribution process in a network using vlans spread across each building and having a total of approximately 25 vlans, it is felt that better handling is needed, therefore, we implement Hybrid VLAN which aims to simplify the IP distribution process and increase the efficiency of network management. By using Hybrid VLAN, the trunking and IP access processes are carried out on the router side, so that the IP allocation process can be carried out more efficiently, facilitating network management on campus, ease of network configuration and maintenance, and the workload on the router can be reduced, so that overall network performance increases.

2. LITERATURE REVIEW

2.1. Computer Networks

A computer network (network) is a telecommunications network that allows computers to communicate with each other by exchanging data. The purpose of a computer network is to achieve its goals, each part of the computer network can request and provide services. The party requesting/receiving services is called a client and the party providing/sending services is called a server. This design is called a client-server system, and is used in almost all computer network applications. Two computers, each of which has a network card, are then connected via cable or wireless as a data transmission medium, and there is network operating system software to form a simple computer network. If you want to create a computer network that has a wider reach, additional equipment such as Hub, Bridge, Switch, Router, Gateway is needed as interconnection equipment [1].

2.2. Router

A router is a device that connects two or more packet-switched networks or subnetworks. It has two primary functions: managing traffic between these networks by forwarding data packets to their intended IP addresses, and allowing multiple devices to use the same Internet connection.

Think of a router as an air traffic controller and data packets as planes headed to different airports (or networks). Just as each plane has a unique destination and follows a unique route, each packet needs to be guided to its destination as efficiently as possible. In the same way that an air traffic controller makes sure that a plane reaches its destination without getting lost or experiencing major disruptions along the way, a router helps direct data packets to their destination IP addresses.

To route packets effectively, a router uses an internal routing table, which is a list of paths to various network destinations. The router reads the packet header to determine where it is headed, then consults the routing table to determine the most efficient path to that destination. It then forwards the packet to the next network in the path [2].

2.3. Switch

In general, a switch is a network component that functions to connect several computer devices in a network. This process allows users to exchange data and information to the intended device. The exchange of information is carried out in a directed manner so that data can be received directly without any interference such as collisions.

In addition, another opinion says that a switch is a type of component that connects a number of HUBs to form a wider network. Therefore, in the process the switch requires quite a large bandwidth.

Similar but not the same, switches and HUBs are two different things. The most striking difference lies in the way they work, where switches work more directed both in processing, sending, and receiving data. Switch performance is claimed to be much better than HUB, so don't be surprised if this one component has a slightly more expensive price. In general, the switch acts as a concentrator that functions to send and receive data from and to other devices [3].

2.4. Bridge

A network bridge is a network component used to extend a network or create a network segment. Bridges operate in the data-link layer of the OSI model. Bridges can also be used to combine two different network media, such as between Unshielded Twisted-Pair (UTP) and fiber optic cables or two different network architectures, such as between Token Ring and Ethernet. Bridges will create signals transmitted by the sender but do not convert protocols, so that the two network segments connected to the bridge must have the same network protocol (such as TCP/IP). Network bridges also sometimes support the Simple Network Management Protocol (SNMP), and some have other diagnostic features [4].

2.5. VLAN

VLAN stands for Virtual Local Area Network. VLAN is a logical network created within a physical network. In a VLAN network, a group of devices or computers are grouped into one logical network unit or segment, even though the devices are connected to the same physical network. This network is usually used to separate network traffic from various departments or areas within an organization.

With this technology, devices in one VLAN network can communicate with each other easily, while devices in different VLAN networks cannot communicate with each other. VLAN also allows network administrators to better manage and optimize network traffic.

VLAN aims to separate network traffic from various departments or areas within an organization. By separating network traffic, network administrators can optimize network performance by organizing network traffic to run more efficiently. The way VLAN works is by dividing the physical network into several logical networks or VLANs. Each VLAN has a unique identity called a VLAN ID. Devices connected to the VLAN network will be given an IP address that matches its VLAN ID. In this way, devices in one VLAN can communicate easily, while devices in different VLANs cannot communicate.

The use of VLAN is to optimize network performance by separating network traffic from various departments or areas within an organization. By separating network traffic, network administrators can organize network traffic to run more efficiently. In addition, VLAN also allows network administrators to better control access to the network and strengthen network security.

VLAN is a computer network technology that can help separate network traffic from various departments or areas within an organization. By separating network traffic, network administrators can optimize network performance by managing network traffic. The goal is for the system to run more efficiently and can strengthen network security by better controlling access to the network. However, implementing VLAN also requires careful preparation and more careful management [5].

3. RESEARCH METHODS

3.1. Design

Design is the initial process in the Implementation of Hybrid VLAN Configuration at ITN Malang. Design aims to facilitate every process that will be passed during the Implementation of Hybrid VLAN.

3.2. Needs analysis

Identify network requirements, such as the number of VLANs required, the types of devices to be connected, and network traffic patterns. Identify network segments that require special isolation or prioritization.

3.3. Distribution Router Network Topology

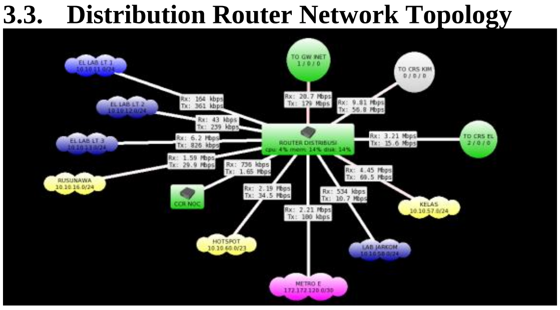


Figure 1. Distribution Topology

In the distribution router network topology, the main distribution router becomes the center of Hybrid VLAN management. This router connects various VLANs spread across laboratories, offices, and public areas at ITN Malang. For example, several laboratories such as EL LAB LT 1, EL LAB LT 2, and EL LAB LT 3 are connected through this distribution router, ensuring that each VLAN can communicate well without interfering with other VLANs. This distribution router also manages VLAN allocation for various connected subnets, such as 10.10.11.0/24 for EL LAB LT 1 and 10.10.12.0/24 for EL LAB LT 2, thus facilitating network management and segmentation.

3.4. Right Node Network Topology (Electrical Engineering & FTI Lecture Building)

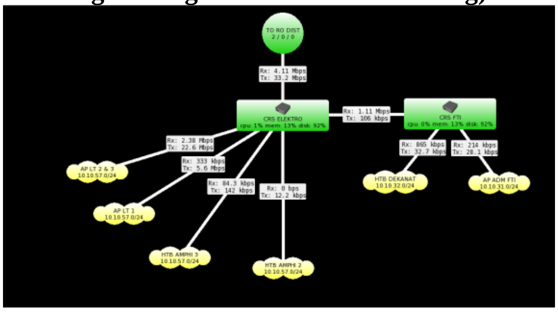


Figure 2. Right Node Topology

For the network topology in the electrical and industrial technology (FTI) lecture building, CRS ELEKTRO and CRS FTI act as the main switches connected to the distribution router. These switches implement Hybrid VLAN by grouping different devices in the appropriate VLAN. Each floor of the building has an access point connected to the main switch, and each access point is configured in the appropriate VLAN to support network segmentation and security. For example, access points on floors 2 and 3 (AP LT 2 & 3) are grouped in the same VLAN, while access points on floor 1 (AP LT 1) have different VLANs, according to their needs.

3.5. Left Node Topology (Chemical & Machine Building)

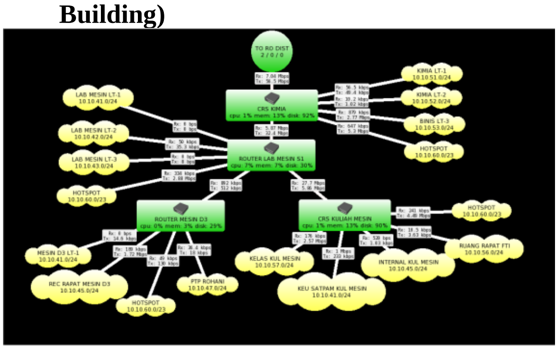


Figure 3. Left Node Topology

In the chemistry and mechanical engineering building, the network design involves the CHEMISTRY CRS, S1 MECHANICAL LAB ROUTER, and MECHANICAL COURSE CRS as the central point connecting various laboratories and hotspots through Hybrid VLANs. Each network device in this building is configured to be in a VLAN that matches their function and location. For example, the chemistry lab and the mechanical lab are grouped into different VLANs to separate their network traffic, but still allow communication between VLANs through a distribution router that manages routing between VLANs. Overall, this design is done with the aim of optimizing network performance, ensuring effective segmentation, and providing stable and efficient connectivity across campus. The implementation of Hybrid VLANs centralized in the distribution router allows for more flexible and structured network management, ensuring that each part of the network can be accessed safely and efficiently according to its specific needs. This mature design will be a strong foundation for the implementation of Hybrid VLANs at ITN Malang, ensuring that every implementation process can run smoothly and in accordance with the planned network needs.

3.6. IP Address

The following is a table of IP address distribution to provide an overview of IP Address allocation in the Implementation of Hybrid VLAN Configuration at ITN Malang. Each specified VLAN ID is connected to a specific IP Address subnet to organize more efficient network traffic segmentation and management.

Table 1. Distribution Router IP Address

RO – Distribusi	
VLAN ID	**IP ADDRESS**
16	10.10.16.0/24
21	10.10.21.0/24
31	10.10.31.0/24
32	10.10.32.0/24
41	10.10.41.0/24
42	10.10.42.0/24
43	10.10.43.0/24
44	10.10.44.0/24
45	10.10.45.0/24
46	10.10.46.0/24
47	10.10.47.0/24
51	10.10.51.0/24
52	10.10.52.0/24
53	10.10.53.0/24
54	10.10.54.0/24
56	10.10.56.0/24
57	10.10.57.0/24
550	10.10.60.0/23

The main distribution router manages the various VLANs spread across the campus. For example, VLAN 16 (10.10.16.0/24), VLAN 21 (10.10.21.0/24), and VLAN 57 (10.10.57.0/24) each manage traffic for different areas, ensuring that each network segment is properly managed. VLAN 550 (10.10.60.0/23) is used for various hotspots across the campus.

Table 2. IP Address of Electrical Laboratory Building

Electrical Laboratory Building		
Room Name	**VLAN ID**	**IP ADDRESS**

Recording & Jurusan	21	10.10.21.0/24
HOTSPOT	550	10.10.60.0/23

In the Electrical Lab Building, VLAN ID 21 (10.10.21.0/24) is used for the recording room and departments, while VLAN ID 550 (10.10.60.0/23) is used for hotspots, ensuring that each area has adequate connectivity.

Table 3. IP Address of Lecture Building 3

Lecture Hall 3		
Room Name	**VLAN ID**	**IP ADDRESS**
Pengajaran & Perpustakaan	21	10.10.21.0/24
HOTSPOT KELAS	57	10.10.57.0/24
HOTSPOT	550	10.10.60.0/23

The VLAN settings in Lecture Building 3 include VLAN ID 21 (10.10.21.0/24) for teaching and library, VLAN ID 57 (10.10.57.0/24) for class hotspot, and VLAN ID 550 (10.10.60.0/23) for public hotspot, providing clear and efficient segmentation.

Table 4. IP Address of Lecture Building 2 (FTI)

Lecture Building 2 (FTI)		
Room Name	**VLAN ID**	**IP ADDRESS**
Dekanat	32	10.10.32.0/24
Admin FTI	31	10.10.31.0/24
Pengajaran	45	10.10.45.0/24
Ruang Rapat FTI	56	10.10.56.0/24
HOTSPOT KELAS	57	10.10.57.0/24
HOTSPOT	550	10.10.60.0/23

In Lecture Building 2, VLAN ID 32 (10.10.32.0/24) is used for the dean's office, and VLAN ID 31 (10.10.31.0/24) for the FTI administration, ensuring that each department has proper and secure network segmentation.

Table 5. IP Address of Lecture Building 1

Lecture Hall 1		
Room Name	**VLAN ID**	**IP ADDRESS**
Recording & Jurusan	21	10.10.21.0/24
HOTSPOT	550	10.10.60.0/23

Lecture Building 1 allocates VLAN ID 21 (10.10.21.0/24) for the recording room and departments, and VLAN ID 550 (10.10.60.0/23) for the hotspot, maintaining network efficiency and security in this area.

Table 6. IP Address of the Machine Laboratory Building

Machine Laboratory Building		
Room Name	**VLAN ID**	**IP ADDRESS**
Floor 1	41	10.10.41.0/24
Floor 2	42	10.10.42.0/24
Floor 3	43	10.10.43.0/24
HOTSPOT	550	10.10.60.0/23

The Engineering Lab building has a VLAN for each floor: VLAN ID 41 (10.10.41.0/24) for floor 1, VLAN ID 42 (10.10.42.0/24) for floor 2, and VLAN ID 43 (10.10.43.0/24) for floor 3. VLAN ID 550 (10.10.60.0/23) is used for hotspots throughout the building, supporting good segmentation and traffic management.

Table 7. IP Address of D3 Machine Laboratory Building

D3 Machine Laboratory Building		
Room Name	**VLAN ID**	**IP ADDRESS**
Recording & Jurusan	45	10.10.45.0/24
PTP Rohani	47	10.10.47.0/24
HOTSPOT	550	10.10.60.0/23

In the D3 Machine Lab Building, VLAN ID 45 (10.10.45.0/24) is used for the recording room and departments, VLAN ID 47 (10.10.47.0/24) for PTP Rohani, and VLAN ID 550 (10.10.60.0/23) for hotspots, ensuring efficient network management.

Table 8. IP Address of Chemistry Laboratory Building

Chemistry Laboratory Building		
Room Name	**VLAN ID**	**IP ADDRESS**
Floor 1	51	10.10.51.0/24
Floor 2	52	10.10.52.0/24
Floor 3	53	10.10.53.0/24
HOTSPOT	550	10.10.60.0/23

The Chemistry Lab Building uses VLAN ID 51 (10.10.51.0/24) for the 1st floor, VLAN ID 52 (10.10.52.0/24) for the 2nd floor, VLAN ID 53 (10.10.53.0/24) for the 3rd floor, and VLAN ID 550 (10.10.60.0/23) for hotspots, maintaining optimal network availability and segmentation on each floor. With structured IP Address and VLAN settings, ITN Malang can ensure that every part of the campus network can be properly organized and optimized, supporting the network segmentation required for security and operational efficiency. This Hybrid VLAN implementation allows for more flexible and centralized management on the distribution router, so that it can accommodate diverse network needs in various buildings and rooms.

4. RESULTS AND DISCUSSION

4.1. Implementation and Results

In the implementation of the Hybrid VLAN Network Configuration on the ITN Malang Infrastructure, there are several Mikrotik Configurations, namely IP Address Configuration, VLAN Configuration, Bridge Configuration.

4.2. IP Address Configuration

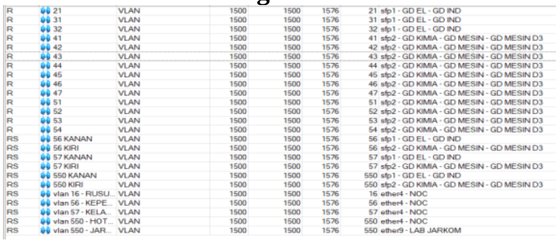
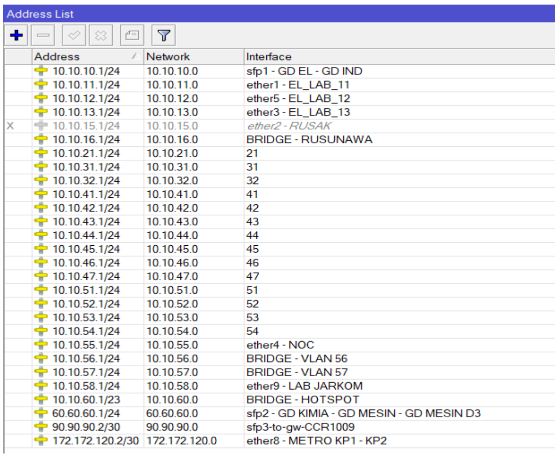


Figure 4. VLAN Interface View

The image above shows the interface display on the Distribution Router which is connected to each node on Campus 2.



Address List

Address	Network	Interface
10.10.10.1/24	10.10.10.0	sfp1 - GD EL - GD IND
10.10.11.1/24	10.10.11.0	ether1 - EL_LAB_11
10.10.12.1/24	10.10.12.0	ether5 - EL_LAB_12
10.10.13.1/24	10.10.13.0	ether3 - EL_LAB_13
X 10.10.15.1/24	10.10.15.0	ether2 - RUSAK
10.10.16.1/24	10.10.16.0	BRIDGE - RUSUNAWA
10.10.21.1/24	10.10.21.0	21
10.10.31.1/24	10.10.31.0	31
10.10.32.1/24	10.10.32.0	32
10.10.41.1/24	10.10.41.0	41
10.10.42.1/24	10.10.42.0	42
10.10.43.1/24	10.10.43.0	43
10.10.44.1/24	10.10.44.0	44
10.10.45.1/24	10.10.45.0	45
10.10.46.1/24	10.10.46.0	46
10.10.47.1/24	10.10.47.0	47
10.10.51.1/24	10.10.51.0	51
10.10.52.1/24	10.10.52.0	52
10.10.53.1/24	10.10.53.0	53
10.10.54.1/24	10.10.54.0	54
10.10.55.1/24	10.10.55.0	ether4 - NOC
10.10.56.1/24	10.10.56.0	BRIDGE - VLAN 56
10.10.57.1/24	10.10.57.0	BRIDGE - VLAN 57
10.10.58.1/24	10.10.58.0	ether9 - LAB JARKOM
10.10.60.1/23	10.10.60.0	BRIDGE - HOTSPOT
60.60.60.1/24	60.60.60.0	sfp2 - GD KIMIA - GD MESIN - GD MESIN D3
90.90.90.2/30	90.90.90.0	sfp3-to-gw-CCR1009
172.172.120.2/30	172.172.120.0	ether8 - METRO KP1 - KP2

Figure 5. IP Address List View

The image above shows the IP List display used on each interface according to its respective VLAN ID.

4.3. VLAN Configuration

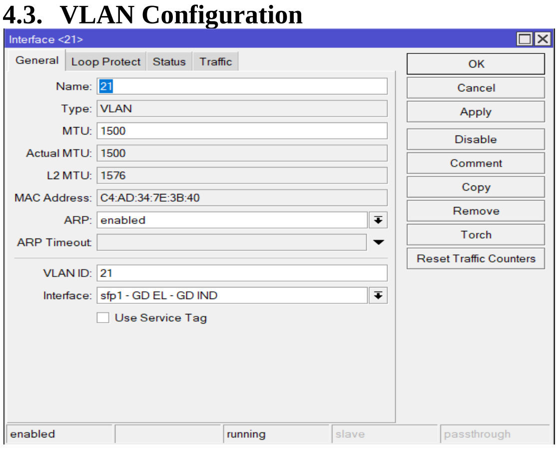


Figure 6. Display Creating a VLAN Interface

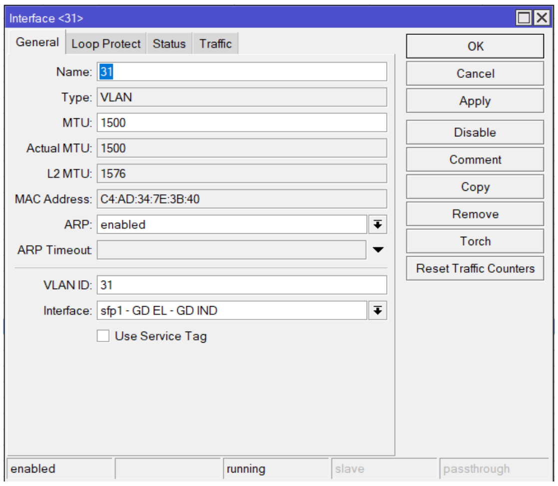


Figure 7. Display Creating VLAN Interface

The display above is the display when creating a new VLAN interface and giving it a VLAN ID and interface name.

4.4. Bridge Configuration

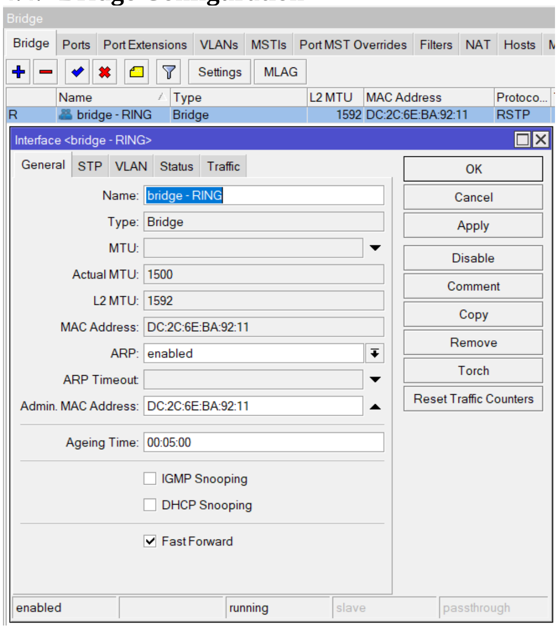


Figure 8. Making a Bridge

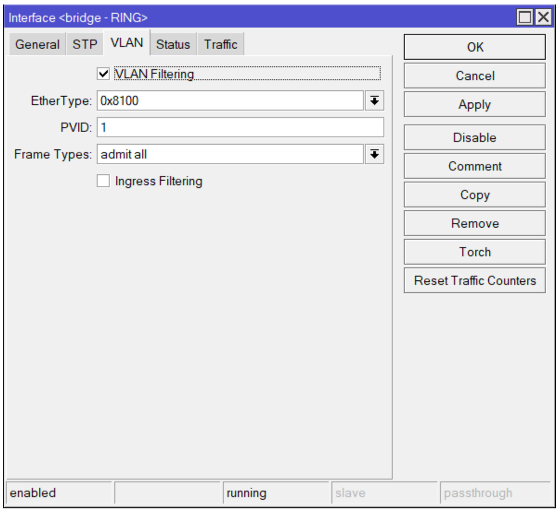


Figure 9. VLAN Filtering view

In the display above, it is applied to the VLAN Receiving Router or to the lower Node of the Distribution Router and activates VLAN Filtering so that the router can receive several VLANs on the Interface.

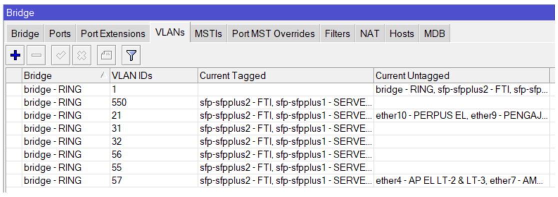


Figure 10. Adding VLAN ID to Bridge

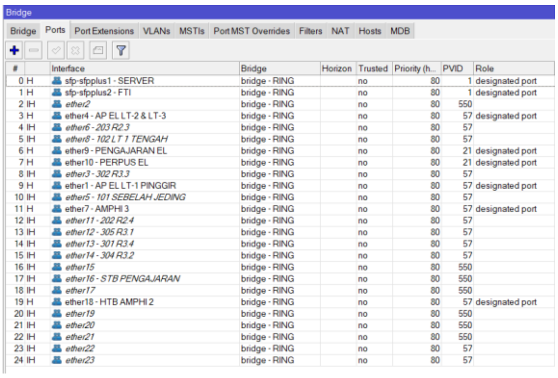


Figure 11. Tagging VLAN ID on Client Port

On the Client Node, add VLANs ID to the Bridge to forward the VLAN ID to the Client, and provide Tagging on each Port with the VLAN ID according to Segment Requirements.

4.5. Testing

The analysis was conducted from the test results on the output results of the Hybrid VLAN Network Configuration Implementation on the ITN Malang Infrastructure. The results of this analysis determine the accuracy of the Configuration in providing a more Efficient Network Infrastructure.

The following is an analysis of the test results that have been carried out.

4.6. Node Traffic Bandwidth Testing

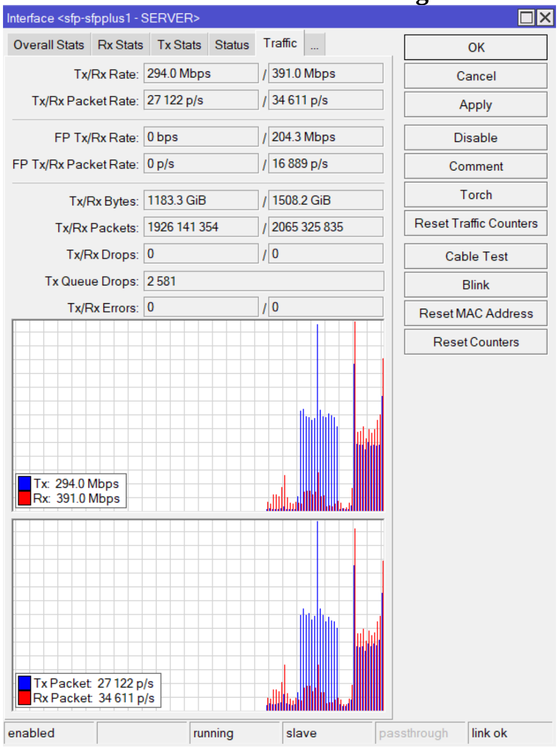


Figure 12. Lecture Building Node 3

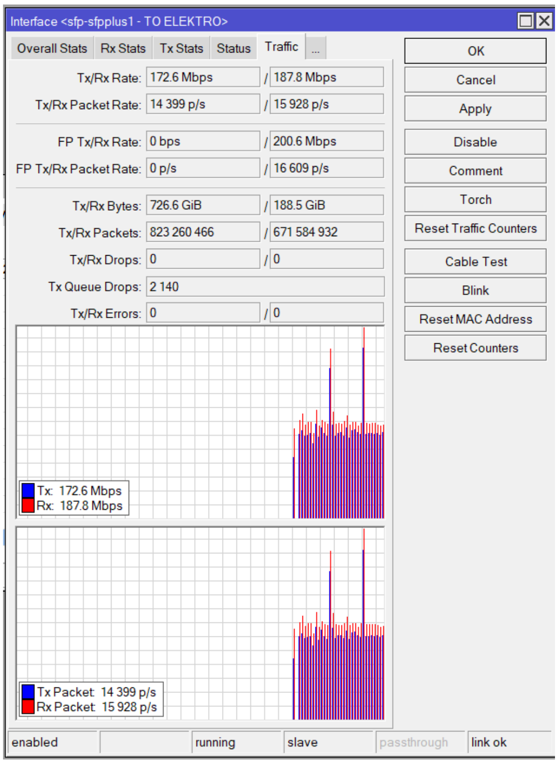


Figure 13. Lecture Building Node 2 (FTI)

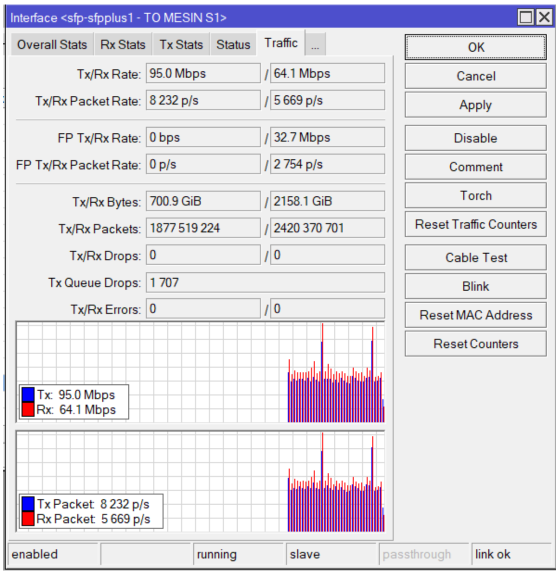


Figure 14. Lecture Building Node 1

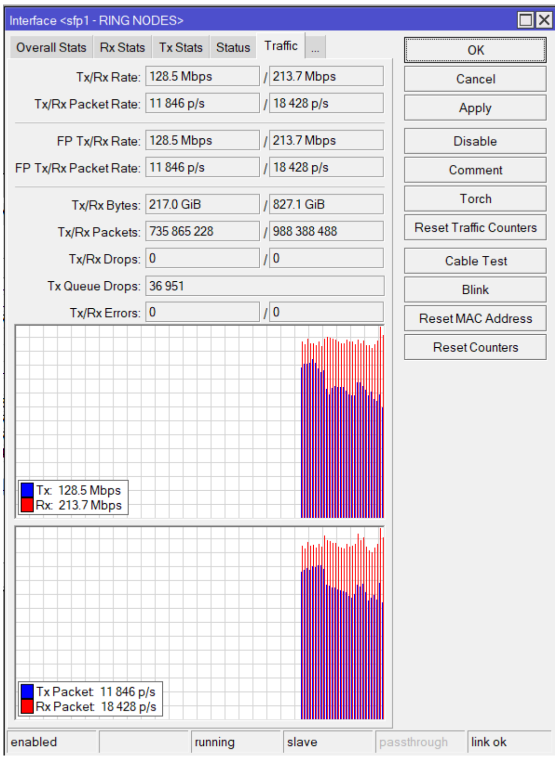


Figure 15. S1 Machine Laboratory Building Node

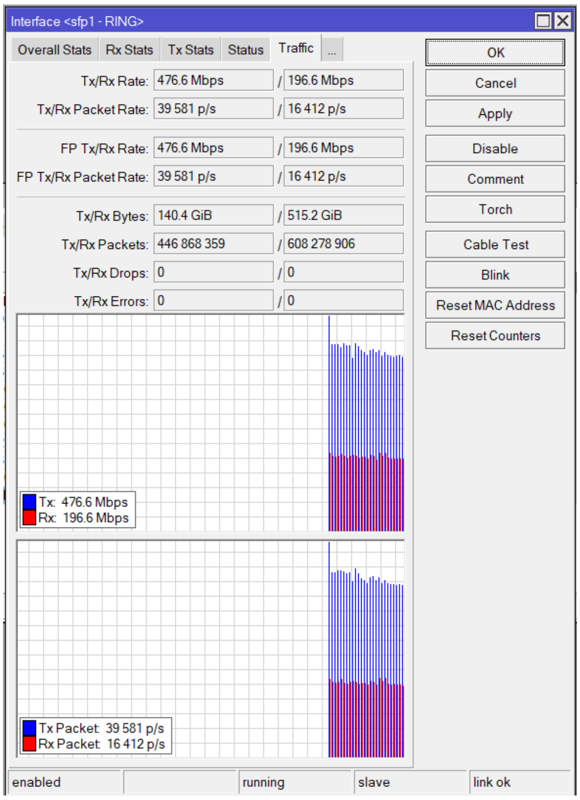


Figure 16. D3 Machine Laboratory Building Node

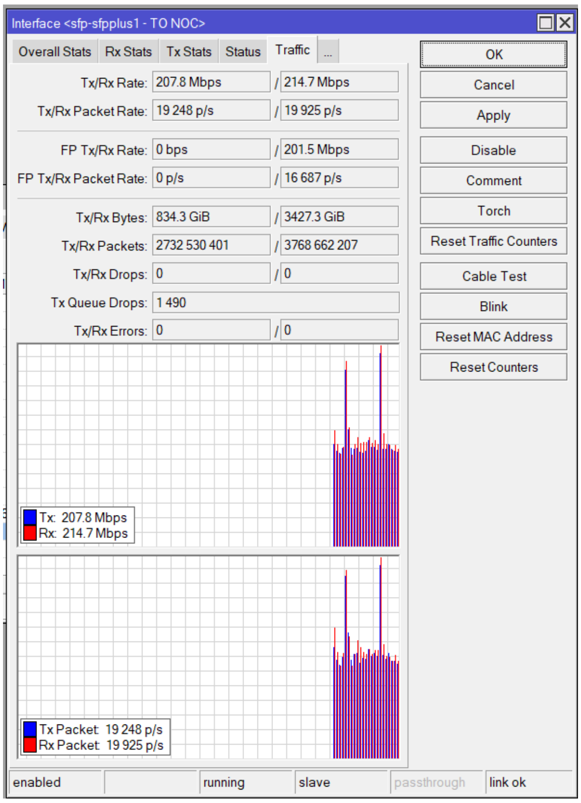


Figure 17. Chemistry Laboratory Building Node

Each existing node can provide bandwidth smoothly and in accordance with the distributed bandwidth.

4.7. VLAN Traffic Testing

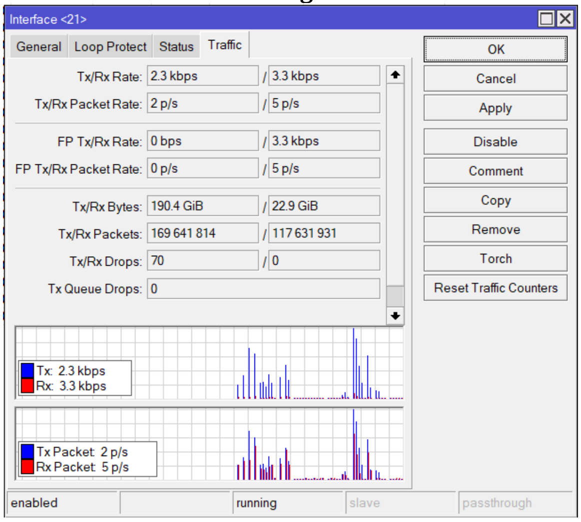


Figure 18. VLAN 21 interface

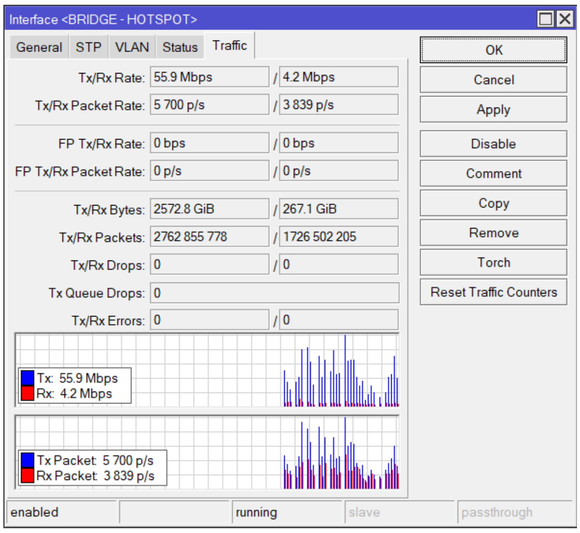


Figure 19. Bridge VLAN Hotspot

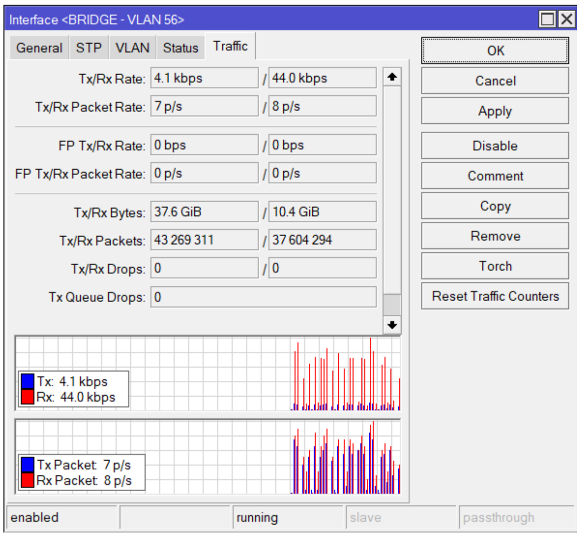


Figure 20. Bridge VLAN 56

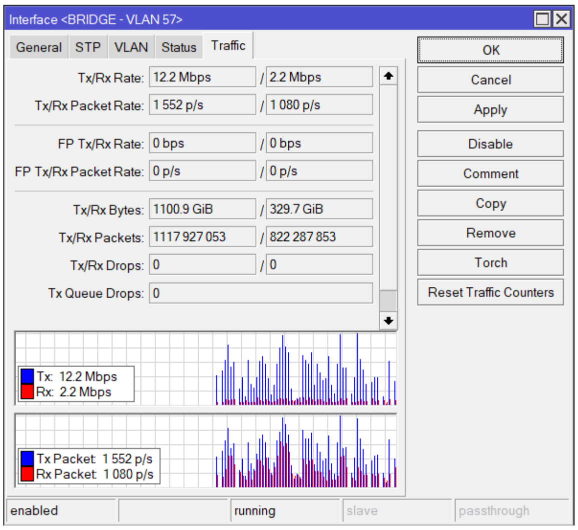


Figure 21. Bridge VLAN 57

The test above shows the traffic results on each VLAN that have been differentiated based on the needs and access rights of each segment.

4.8. Router Load Test Results

The router load can be seen from the CPU Load on the mikrotik, the higher the percentage of CPU Load on the mikrotik, the greater the router load. In the implementation of hybrid VLAN, it can be seen that the router load only increases by about 1-2% compared to routers without using hybrid VLAN which can increase by about 2-4%. The following is a picture and comparison table.

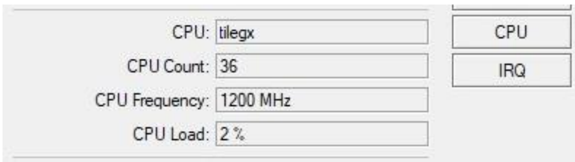


Figure 22. CPU Load after Hybrid VLAN implementation

Figure 23. CPU Load before Hybrid VLAN implementation

Table 9. CPU Load Measurement

Measurement Time	**CPU Load Before Hybrid VLAN Implementation**	**CPU Load After Hybrid VLAN Implementation**
Morning (08.00 -10.00)	3%	1%
Afternoon (11.00 – 14.00)	3%	2%
Afternoon (15.00 -18.00)	2%	0%
Evening	3%	1%

Measurement Time	CPU Load Before Hybrid VLAN Implementation	CPU Load After Hybrid VLAN Implementation
(19.00 – 23.00)		

In the morning, CPU load dropped significantly from 3% to 1% after using Hybrid VLAN. This shows that Hybrid VLAN helps distribute network traffic more efficiently, reducing the load on the CPU. In the afternoon, CPU load with Hybrid VLAN was only 2%, reflecting increased efficiency during peak periods. In the afternoon, CPU load dropped drastically to 0%, and in the evening it dropped to 1%. This confirms that Hybrid VLAN is very effective in reducing CPU load through more even traffic distribution and more efficient IP management..

5. CONCLUSION

From the results of the Implementation of Hybrid VLAN Network Configuration on the ITN Malang Infrastructure, it can be concluded as follows: The implementation of Hybrid VLAN has succeeded in increasing network efficiency by separating network traffic based on functions and departments, thereby reducing traffic congestion and improving overall performance. By separating the network into several VLANs, the level of isolation between various network segments has increased, which has an impact on increasing security and reducing the risk of unauthorized access. Networks that have been configured with Hybrid VLAN are better prepared to handle future growth and change, both in terms of adding new devices and changing network topology. By implementing a Hybrid VLAN Network, network administrators can divide network segments as needed by using only one path connecting between nodes. By implementing a Hybrid VLAN Network, network administrators can manage bandwidth according to the needs of the VLAN segment easily and quickly. Administrators can also apply Quality of Services to clients according to the VLAN segment and existing needs easily and quickly

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